March 14, 1967 S. CUTLER ETAL 3,309,454

ELECTRICAL MUSICAL INSTRUMENT AUTOMATICALLY PRODUCING SELECTED RHYTHMS

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Fig. 1

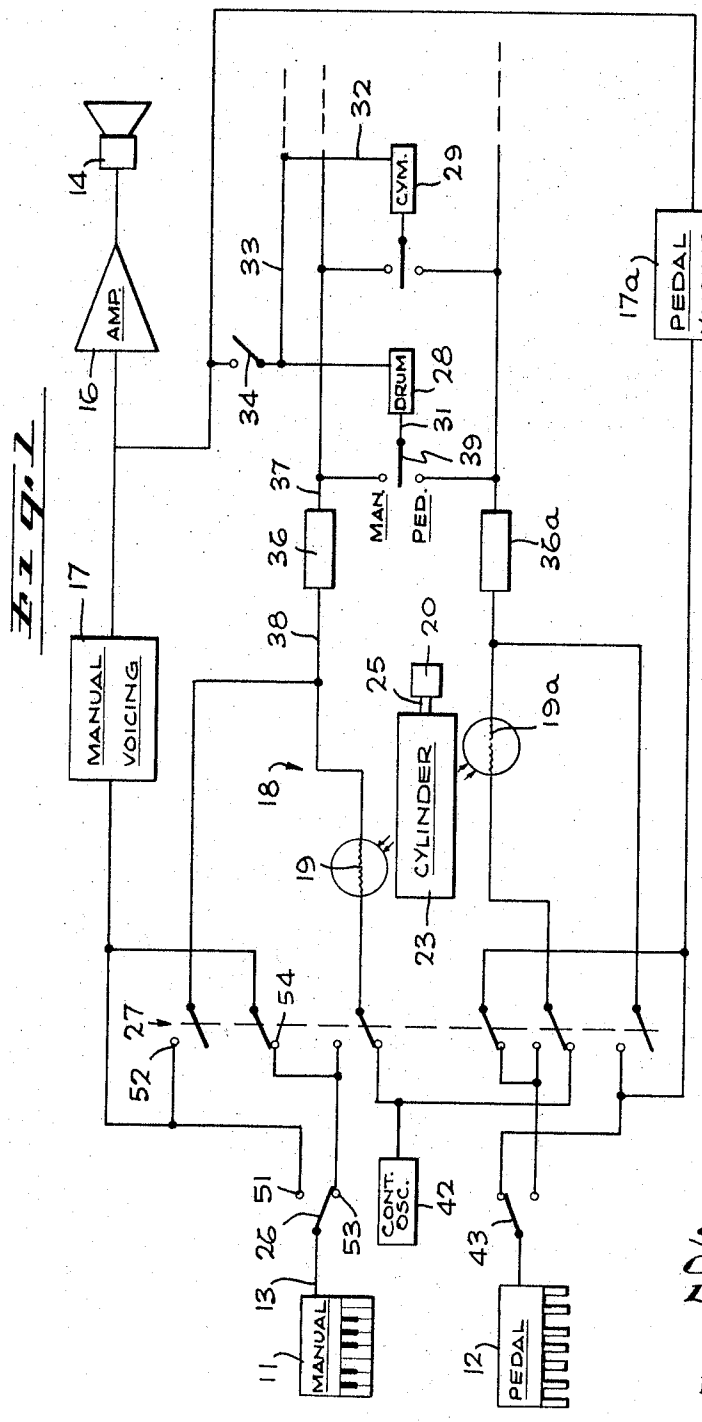


Fig. 2

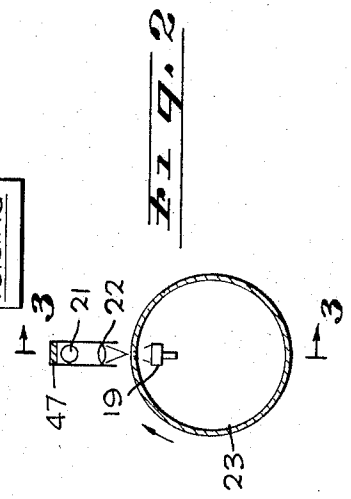
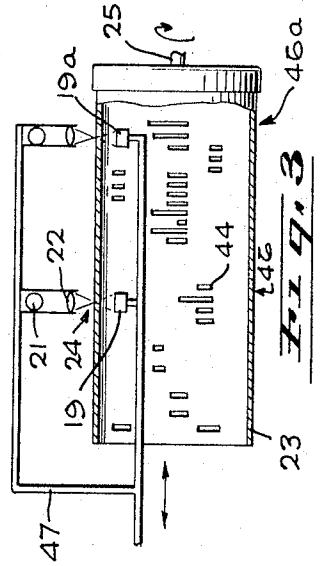


Fig. 3



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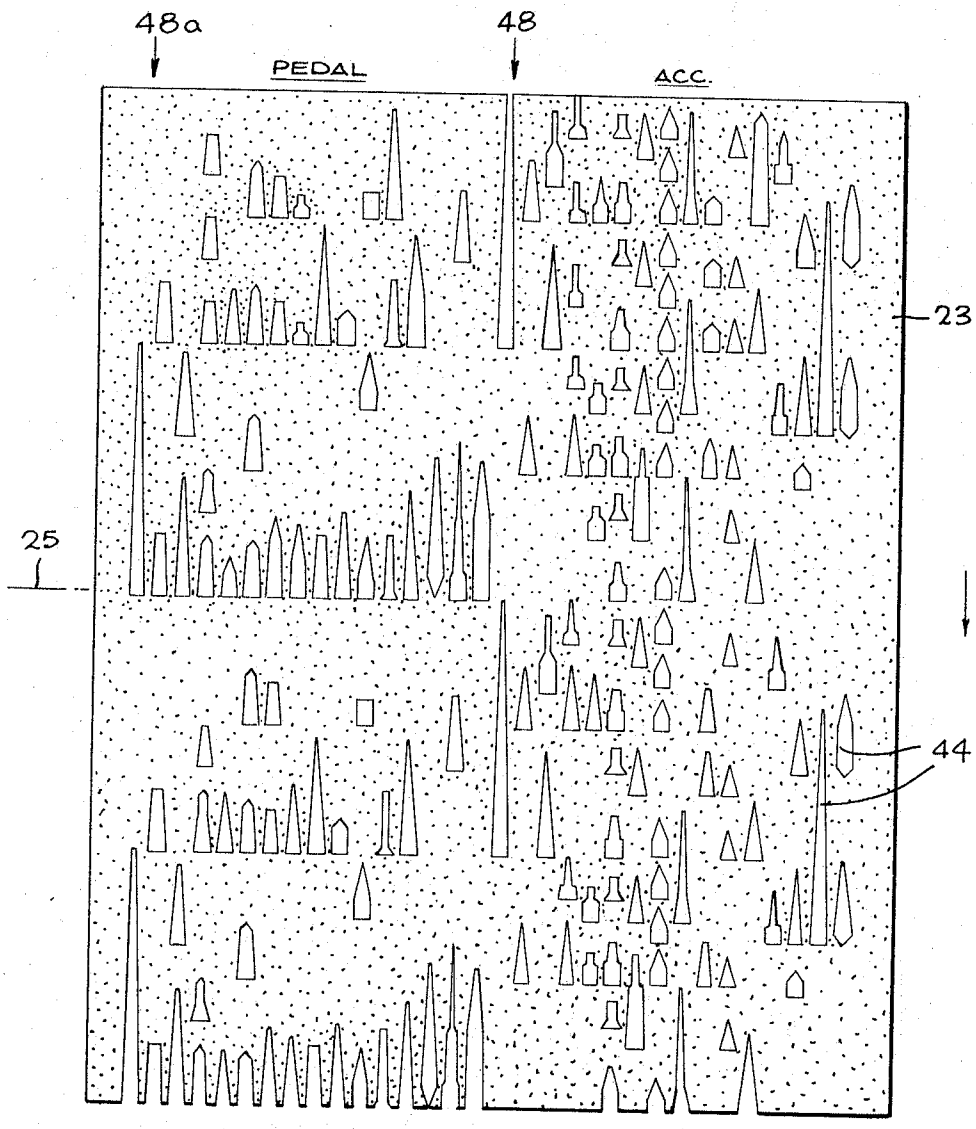
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Fig. 4



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ELECTRICAL MUSICAL INSTRUMENT AUTOMATICALLY PRODUCING SELECTED RHYTHMS

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18 Claims. (Cl. 84—1.18)

This invention relates to electrical musical instruments, and more particularly to an instrument which will automatically produce selected rhythms at tonal pitches determined by the keys depressed by the musician.

It is an object of this invention to provide an instrument as above wherein the means for injecting the desired rhythms may serve simultaneously a plurality of keyboards, as for example a manual keyboard and a pedal keyboard.

It is a further object of this invention to provide an instrument as above wherein the manual keyboard and the pedal keyboard may be separately connected to the output system of the instrument so that one can employ the automatic rhythm feature while the other is independent thereof.

It is a further object of this invention to provide a musical instrument capable of putting out automatically selected rhythms in which the attack and decay characteristics of the sounded tones are carefully and inherently built into the instrument, so as to be independent of the quality of the touch of the one who is playing the instrument.

It is a further object of this invention to provide a musical instrument having therein means for automatically sounding selected rhythms at tonal pitches determined by the musician who plays the instrument, and which also serve to stimulate or trigger special sound effects, particularly percussion effects, such as drums, cymbals and the like, produced naturally or artificially.

It is a further object of this invention to provide an instrument as discussed above having both a manual keyboard and a pedetal keyboard and wherein the rhythm-injecting mechanism is capable of synchronously injecting into the output of either or both keyboards a selected rhythm, as for example a particular dance pattern or rhythm.

It is a further object to provide an instrument in which selected rhythm patterns may be automatically injected into the output of the instrument and the tempo readily controlled at the will of the operator or musician.

In accordance with these and other objects which will become apparent hereinafter, a preferred form of the present invention is illustrated in the accompanying drawings wherein:

FIGURE 1 is a schematic diagram of the present invention.

FIGURE 2 is a cross-section of the rhythm introducing mechanism shown in FIGURE 1.

FIGURE 3 is a longitudinal section taken on line 3—3.

FIGURE 4 is a development showing the surface of the cylinder illustrated in FIGURES 2 and 3.

Referring to the drawings, there is illustrated in FIGURE 1 an electrical musical system consisting of a keyboard instrument having a plurality of keyboards. There

is shown by way of example in FIGURE 1 two keyboards, a manual keyboard **11** and a pedal keyboard **12**. Associated with the keyboards, and not shown because quite conventional, are suitable electric tone signal means. Tone signals are applied to the output **13** of the manual keyboard **11**, for example, whenever notes on the keyboard are depressed. Such tone signals are applied to an output system which includes an electro-acoustic transducer such as a loud speaker **14** and an amplifier **16**. Voicing networks are provided for each keyboard, numeral **17** representing the manual keyboard voicing.

In accordance with the present invention an envelope, or modulation producing gate means is provided at **18**. This gate means includes a light sensitive electric means **19**, which in the present example is shown as a light dependent impedance, and specifically a light-dependent resistor (LDR). The LDR has the characteristic of presenting a very high resistance to the passage of current except when light falls thereon, at which time the resistance drops very markedly. A light source **21** (FIGURES 2 and 3) is directed onto the LDR **19** through a suitable light path which includes a collimating and focusing optical system represented by the lens **22**. Interposed in the light path between the light **21** and the LDR **19** is the wall of a cylinder **23**, the LDR **19** being located inside the cylinder and the light **21** being located opposite thereto outside the cylinder. The cylinder **23** is rotated by a power means **20** connected by a shsaft **25** to the cylinder **23**.

The cylinder **23** constitutes a light intensity varying means and more specifically a masking means which serves the function of repetitively passing and blocking passage of light onto the LDR **19** as the cylinder **23** rotates, and in a time pattern conforming to a non-uniform rhythmic sound as for example a dance rhythm such as a fox-trot, waltz, beguine, etc. The wall of the cylinder is alternately translucent or light transmitting, and opaque or light non-transmitting, as one moves circumferentially around the cylinder at any given point along the cylinder axis. There is thus effected a series of transparent circumferential windows each series of windows lying on a given band or circumference of the cylinder. The cylinder is provided with a plurality of such series spaced axially along the cylinder **23**, as shown in FIGURE 3. As the cylinder rotates, a transparent portion or window moves into the light path **24**, to be followed by an opaque portion and then by another transparent portion. It is a characteristic of this invention that around any given circumferential band on the cylinder **23**, the light portions are arranged and patterned after the nature of an aperiodic musical rhythm, this aperiodicity being either in the repetition rate of the light passage or in the character of the opening of the light path at any given window, or both.

The effect of the transparent portions in the cylinder **23** is to repetitively render the LDR **19** conducting in accordance with a rhythmic pattern. By appropriately shaping the leading and lagging edges, when viewed circumferentially, of the transparent portions, as shown in FIGURE 4, the attack and the decay patterns of the tone signals passing through the LDR **19** may be controlled in any desired manner. The shape of the transparent portions thus is a function of the modulation envelope applied to the tone signal emanating from the keyboard **11**.

The LDR **19** may be selectively injected into the cir-

cuit of the instrument, between the keyboard **11** and the loudspeaker **14**, by means of suitable manually operable switches. One of these switches is a single pole, double throw channel switch **26**. The other switch is a multi pole, double throw mode switch **27**. The switch **27** has three arms or poles associated with the manual keyboard **11**, and a corresponding three arms or poles associated with the pedal keyboard **12**. By appropriate manipulation of the switches **26** and **27** various musical combinations and effects may be produced as will be described hereinafter.

Also in accordance with the present invention there are included a series of special sound signal generators, for the most part percussive sounds, typified for example by a drum signal generator **28** and a cymbal signal generator **29**. Such generators are known in the art. The drum generator **28**, for example, has the characteristic of delivering to its output an electric signal which, when applied to the loudspeaker **14**, simulates the sound of a drum beat. One beat is delivered whenever a trigger voltage is applied to its input **31**. In similar fashion the cymbal generator **29** applies to its output **32** an electric signal having the characteristics of a cymbal stroke. All of the special sound signal generators are connected to a common output bus **33** which is connected through a control switch **34** to the input of the amplifier **16**.

Triggering voltage is applied to the special sound generators by means of a trigger circuit **36** having the characteristic of delivering a single output voltage wave front to its output **37** at the onset of each burst of tone signal applied to its input **38**. In musical terms this means that each non-legato note signal applied to the input **38** produces at the onset of the note a trigger or stimulating voltage at the output **37**. Such of the special sound signal generators **28** and **29** as, at that time, are connected into the circuit through their input switches **39** will therefore deliver their predetermined sound signals to the amplifier **16**, simultaneously with the onset of the stimulating tone or note.

A continuous monofrequency signal is provided by an oscillator **42** connected selectively through the switch **27** to the input of the LDR **19** for a purpose to be described hereinafter.

The pedal keyboard **12** is connected into the circuit in the same way as is the manual keyboard **11** described above. Like the manual keyboard **11**, the pedal keyboard **12** has its own individual channel switch **43**, but its three switch poles of the mode switch **27** are ganged to the three switch poles which serve the manual keyboard **11**. The cylinder **23**, output circuit **14**, **16**, oscillator **42**, and special sound generators **28**, **29** are common to both keyboards.

The manual keyboard **11** and the pedal keyboard **12** each has its own separate set of masking patterns on the cylinder **23**. For example, the circumferential series of elongate transparencies or windows **44**, shown by the arrow **46**, represents a given rhythm pattern for the manual keyboard **11**. This pattern is brought into use by longitudinally moving the framework **47** which carries the LDR **19** and light **21** within the cylinder **23** until the light path **24** registers with the circumferential pattern **46**. Such registration simultaneously effects registration of the pattern **46***a* in the other half of the cylinder **23** with the LDR **19***a* and light **21***a*, which are associated with the pedal keyboard **12**. The patterns **46** and **46***a* represent the same rhythm, as for example a samba or fox trot. Therefore when the frame **47** is in that position, the manual and pedal will be modulated by the drum **23** with complementary rhythmic envelopes.

When a different rhythm is desired, it is only necessary to move the frame **47** longitudinally with respect to the cylinder **23** to bring a different pair of rhythm patterns **46** into registry with the respective LDR's **19** and **19***a*.

The wide variety of rhythm patterns available in the cylinder **23** is shown in FIGURE 4, which is a developed view of the surface of the cylinder **23**. The axis of the cylinder is represented schematically by the line **25**. The pattern **48**, for example, represents the manual keyboard envelope for a fox trot, while the corresponding pattern **48***a* represents the fox trot pattern for the pedal keyboard.

By arranging the cylinder surface **23** into two halves, one for the manual and the other for the pedal, it is possible to separate their respective LDR's **19** and **19***a* by the maximum distance, namely one half of the cylinder length, so as to minimize danger of light interference from one light path to the other. This arrangement also makes it possible to bring into play the full spectrum of available rhythms by moving the framework **47** only one-half of the length of the cylinder **23**. This structure is in contrast to the movement which would be required if the two complementary light paths, for manual and pedal respectively, were placed side by side in pairs along the length of the cylinder.

Added resolution is given to the system by causing the focus of the light path **24** to concentrate light at the window opening, as shown by the arrow accompanying the numeral **24** in FIGURE 3.

Operation of the invention will now be described with special reference to FIGURE 1. When the instrument, which is essentially an electric organ, is turned on, the tone signal means are energized ready to put appropriate tone signals on the output **13** whenever selected keys of the manual **11** are depressed. The drum **23** is set in rotation by its drive means.

There will first be considered the operation when the channel switch **26** is in normal position **51** and the mode switch **27** is in keyboard position which is the upper position represented for example by the contact **52**. Under this condition tone signal from the keyboard **11** goes directly to the amplifier **16** through the manual voicing network **17**. Tone signals from the keyboard **11** are also applied to the input **38** of the trigger circuit **36**, bypassing the LDR **19**. Under these circumstances whenever the musician institutes the onset of tone signals, preceded by no tone at all, i.e., a non-legato note, a wave front voltage is applied at **37** which triggers whichever of the special percussion sounds **28**, **29**, etc. is connected into the circuit through its double throw switch.

If the musician plays in legato style, that is depressing one note before release of the preceding note or substantially simultaneously therewith, there will never be any output from the trigger circuit **36**, because this circuit requires a period of quiescence followed by onset of a tonal envelope. Under such legato playing therefore there will be completely normal operation of the manual keyboard without any stimulation of the special sounds **28** and **29**. Should the musician play the manual keyboard in non-legato style, however, then with the onset of each new tone there will be triggered the appropriate drum, cymbal or other special sound, which may be applied through the switch **34** to the amplifier **16**. This will sound along with the particular tones that are sounded from the manual keyboard **11**. It will be understood that the pedal keyboard **12** effects corresponding operation when its channel switch **43** is in the upper or normal position.

Operation will now be considered with the channel switch **26** in normal position **51** and the mode switch **27** in automatic position, illustrated by the contact **54**. Under this condition tone signals will pass, as before, directly from the keyboard manual **11** to the amplifier **16** through the voicing circuit **17**. Now however there will be brought into play the continuous oscillator **42**, which provides a steady signal to the LDR **19**. An envelope will be applied to this steady signal in accordance with whichever modulation pattern **46** on the cylinder **23** is in registry with the LDR **19**. This pattern will cause a corresponding output from the connected special sounds **28–29**, with the onset of each of the respective window openings **44** as it comes opposite the light path **24**. The net effect will

be a normal sounding of the keyboard tones **11** accompanied by the automatic percussion rhythm injected through the rotating cylinder **23**.

With the channel switch **26** in rhythm position **53** the mode switch **27** still in the automatic position **54**, operation is exactly the same as in the previously described condition when the channel switch **26** was in normal position **51**.

There will now be considered the operation when the channel switch **26** is in the rhythm position **53** and the mode switch **27** is in the keyboard position **52**. Under this condition tone signals from the keyboard **11** will be directed to the LDR **19** and hence will reach the amplifier **16** only after they have been modulated in accordance with one of the light patterns **46** on the cylinder **23**. Such output from the LDR **19** is then directed to the input of the manual voicing **17** and thence to the amplifier **16**. This automatically modulated tone signal is also applied to the trigger circuit **26** where it serves to actuate the special circuitry **28**, **29**, etc., at the same rhythm as is applied to the manual tones played on the keyboard **11**.

Summarizing, with the channel switch **26** in normal position **51** and the mode switch **27** in keyboard position **52**, the keyboard tones go directly to the speaker **14** unmodulated by the cylinder **23** and whatever keyboard envelope (non-legato) is produced by the fingers of the musician himself will simultaneously trigger the connected special circuitry **28**, **29**, etc. With the channel switch **26** still in normal position **51** and the mode switch **27** moved to automatic position **54**, the keyboard tones still go direct to the speaker **14** as before, but now the special circuitry **28**, **29** will be triggered by the modulation pattern selected on the cylinder **23**. Moving the channel switch **26** to ryhthm position **53** and leaving the mode switch **27** in automatic will not change this operation. Finally, with the channel switch **26** in rhythm position **53** and the mode switch **27** in its keyboard position **52**, the tone from the keyboard **11** will be modulated by the pattern on the cylinder **23** and the same pattern will serve to trigger the special circuits **28**, **29**.

While there has been here illustrated specifically the creation of the modulation envelope by shaping transparent windows in the cylinder **23**, as shown in FIG. 4, it will be readily apparent that the attack and decay pattern may be also injected by means of density variation over a uniform area. It will also be readily apparent that while a cylindrical form of rotating member has been shown any other suitable repetitive means may be used for injecting the desired rhythm into the modulator.

By providing separate channel switches **26** and **43** for the manual and pedal, respectively, it is possible for a beginner to rapidly learn many otherwise difficult rhythms. This he may do by setting the pedal tones to be modulated automatically by the cylinder **23**, while setting the manul to bypass the cylinder **23**. By following the rhythm of the pedal, and manually providing keyboard rhythm, a beginner learns the proper rhythm to insert into the manual keyboard. He may reverse the pedal with the manual settings, and thus practice pedal rhythm to automatic manual rhythm.

What is claimed is:

1. In an electric music system having tone signal means, electro-acoustic transducing means, and circuit means connecting said signal means to said transducing means, the combination of:

light sensitive electric means interposed in said circuit means,

light means directed upon said light sensitive electric means,

modulation means comprising at least one group of aperiodic light intensity varying means interposed in the light path between said light sensitive electric means and said light means,

and means for cyclically and repetitively moving said modulation means with respect to said light path to iterate and reiterate aperiodic modulation of tone signals passing from said tone signal means to said transducing means.

2. The combination of claim **1** wherein said intensity varying means comprises a member having light transmitting and light non-transmitting areas, at least one of said areas having a light transmission characteristic which imparts a corresponding modulating envelope to said tone signals through the medium of said light sensitive electric means.

3. The combination of claim **2** wherein said light intensity varying means is constituted of a masking means, and wherein said one area is shaped as a function of said modulation envelope.

4. The combination of claim **2** wherein said member is rotatably mounted and has light transmitting and non-transmitting portions, one of said portions being formed as a circularly arranged pattern of discrete areas each shaped as said function, and

said moving means comprises means for rotating said rotatably mounted member.

5. The combination of claim **4** wherein said member comprises a cylinder and said pattern is circumferentially arranged thereon.

6. The combination of claim **5** wherein said member comprises a hollow cylinder,

said portions comprise a plurality of patterns each circumferentially arranged around said cylinder and comprised of alternate light blocking and light transmitting portions arranged to alternately open and block said light path as the cylinder rotates, and

means for adjusting the relative position between said cylinder and said light path to cause the latter to register selectively with a desired circumferential pattern.

7. The combination of claim **5** wherein said light sensitive electric means is located on one side of the cylindrical wall of said cylinder, said light means is on the other side of said cylindrical wall, and said light path passes through said cylindrical wall.

8. In an electric music instrument having tone signal generating means, electro-acoustic transducing means, and circuit means connecting said signal means to said transducing means, the combination of:

gating means interposed in said circuit means for repetitively passing and blocking tone signals,

trap-like sound signal generating means independent of said tone signal generating means for delivering the same discrete, unique sound signal in response to each triggering impulse applied thereto,

trigger means for delivering a triggering impulse to said sound generating means in response to the onset of tone signal applied thereto, and

circuit means for connecting output tone signal from said gating means to said trigger means.

9. A musical instrument comprising:

a source of manual keyboard tone signals,

an output system including electro-acoustic transducing means for sounding said signals,

gating means for aperiodically modulating tone signals passing from said tone signal means to said transducing means,

means for cyclically and repetitively actuating said gating means to iterate and reiterate the aperiodic modulation of tone signals to effect an aperiodic musical ryhthm,

circuit means including switch means for selectively applying tone signals from said manual tone source through said gating means and thence to said output system or alternatively directly to said output system,

a source of pedal keyboard tone signals, and

circuit means including switch means for selectively applying said pedal tone signals through said gating

means and thence to said output system or alternatively direct to said output system.

10. The combination of claim 9 including in addition:
a source of continuous signals,
trap-like sound signal generating means independent of said tone signal generating means for delivering the same discrete, unique sound signal in response to each triggering impulse applied thereto,
trigger means for delivering a triggering impulse to said sound signal generating means in response to the onset of tone signal applied thereto,
circuit means for connecting output tone signal from said gating means to said trigger means, and
switch means for selectively (1) applying tone signals to said gating means, or alternatively (2) applying continuous signals to said gating means while simultaneously applying tone signals directly to said output system, bypassing said gating means.

11. Device for introducing rhythmic modulation into electric tone signals comprising:
a cylinder having at least one circumferentially arranged pattern comprising aperiodic alternate opaque and translucent portions,
light means,
a light dependent impedance,
light path means registering with said pattern and forming a path for passage of light from said light means to said light dependent impedance,
means for rotating said cylinder about its axis,
said light dependent impedance being adapted to be connected in a tone signal circuit to apply a rhythmic, aperiodic modulating envelope thereto as said cylinder rotates.

12. The combination of claim 11 wherein said portions are shaped with predetermined leading and lagging edges oriented circumferentially, thereby to endow the modulating envelope with predetermined attack and decay characteristics.

13. Device for introducing rhythmic modulations into electric tone signals from a pair of keyboards comprising:
a cylinder having a plurality of patterns, each arranged circumferentially around the cylinder and comprising a plurality of alternate opaque and translucent portions,
a pair of light means,
a pair of light dependent impedances corresponding respectively to said light means,
a pair of light path means registering respectively with a pair of said patterns spaced apart approximately one-half the axial distance between the patterns at each end of the cylinder and forming respective paths for passage of light from the light means to its respective light dependent impedance,
means for rotating said cylinder about its axis,
one of said light dependent impedances being adapted to be connected in the tone signal circuit of one of the keyboards, the other of said light dependent impedances being adapted to be connected in the tone signal circuit of the other said keyboard.

14. In an electric music instrument having tone signal generating means, electro acoustic transducing means, and circuit means connecting said signal means to said transducing means, said circuit means including key switches for selectively applying tone signals to said transducing means, the combination of:
trap-like sound signal generating means independent of said tone signal generating means for delivering the same discrete, unique sound signal in response to each triggering impulse applied thereto,
trigger means for sensing the onset of tone signal at the output of said key switch means and for delivering a triggering impulse to said sound signal generating means in response to the onset of tone signal sensed thereby, and
circuit means for connecting output tone signal from said generating means to said trigger means.

15. In an electric musical instrument having tone signal means, electro acoustic transducing means, and circuit means connecting said signal means to said transducing means, said circuit means including key switch means for selectively applying tone signals to said transducing means, the combination of:
gating means interposed in said circuit means for aperiodically modulating tone signals passing from said tone signal means to said transducing means,
means for cyclically and repetitively actuating said gating means to iterate and reiterate the aperiodic modulation of tone signals to effect an aperiodic musical rhythm,
trap-like sound signal generating means independent of said tone signal generating means for delivering the same discrete, unique sound signal in response to each triggering impulse applied thereto,
trigger means for delivering a triggering impulse to said sound signal generating means in response to the onset of tone signal applied thereto, and
circuit means for connecting output tone signal from said gating means to said trigger means.

16. In an electric music instrument having signal means, electro acoustic transducing means, and circuit means connecting said signal means to said transducing means, the combination of:
light sensitive electric means interposed in said circuit means,
light means directed upon said light sensitive electric means,
modulation means comprising at least one group of aperiodic light intensity varying means interposed in the light path between said light sensitive electric means and said light means,
means for cyclically and repetitively moving said modulation means with respect to said light path to iterate and reiterate aperiodic modulation of tone signals passing from said tone signal means to said transducing means,
trap-like sound signal generating means independent of said tone signal generating means for delivering the same discrete, unique sound signal in response to each triggering impulse applied thereto,
trigger means for delivering a triggering impulse to said sound generating means in response to the onset of tone signal applied thereto, and
circuit means for connecting output signal from said light sensitive electric means to said trigger means.

17. Device for introducing rhythm modulation into electric tone signals comprising:
a cylinder having at least one circumferentially arranged pattern comprising successive aperiodic portions having different light passage characteristics,
light means,
a light dependent impedance,
light path means registering with said pattern and forming a path for passage of light from said light means to said light dependent impedance,
means for rotating said cylinder about its axis,
said light dependent impedance being adapted to be connected in a tone signal circuit to apply a rhythmic, aperiodic modulating envelope thereto as said cylinder rotates.

18. In an electric music system having tone signal means, electro acoustic transducing means, and circuit means connecting said signal means to said transducing means, the combination of:
modulation means interposed in said circuit means for aperiodically modulating tone signals passing from said tone signal means to said transducing means, and
means for cyclically and repetitively actuating said modulating means to iterate and reiterate the aperi-

odic modulation of tone signals to effect an aperiodic musical rhythm.

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