March 3, 1970 D. A. BUNGER 3,499,091

STEPPING RHYTHMIC INTERPOLATER

Filed Feb. 10, 1967 3 Sheets-Sheet 1

FIG.1

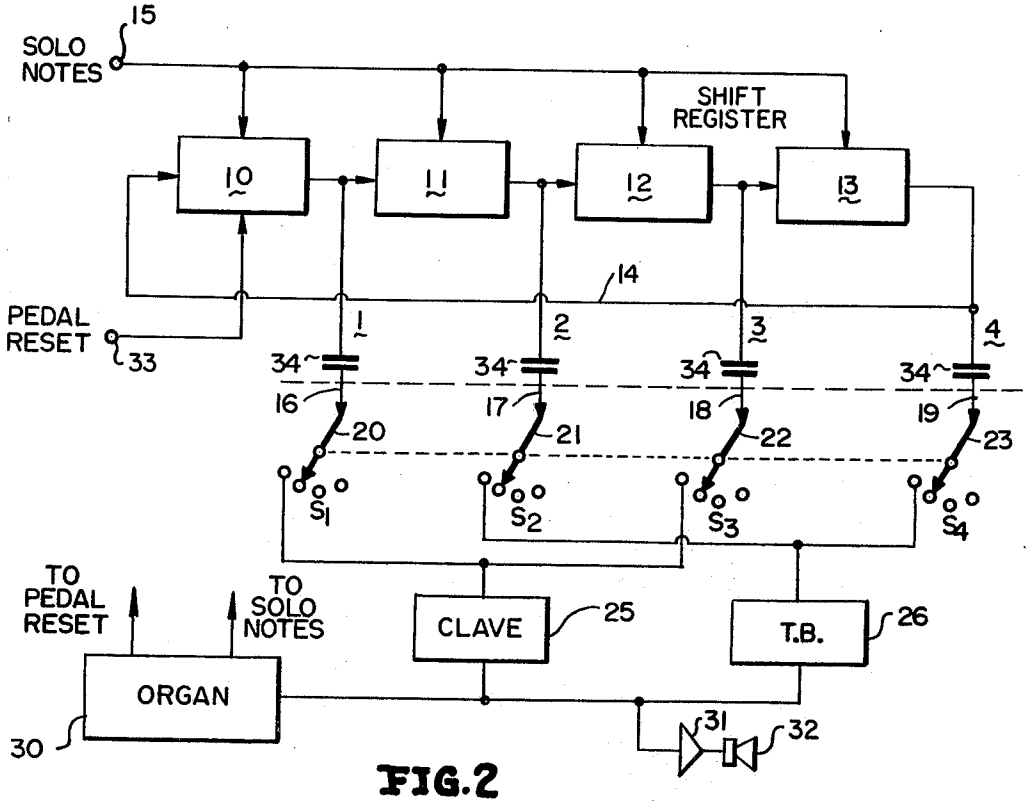
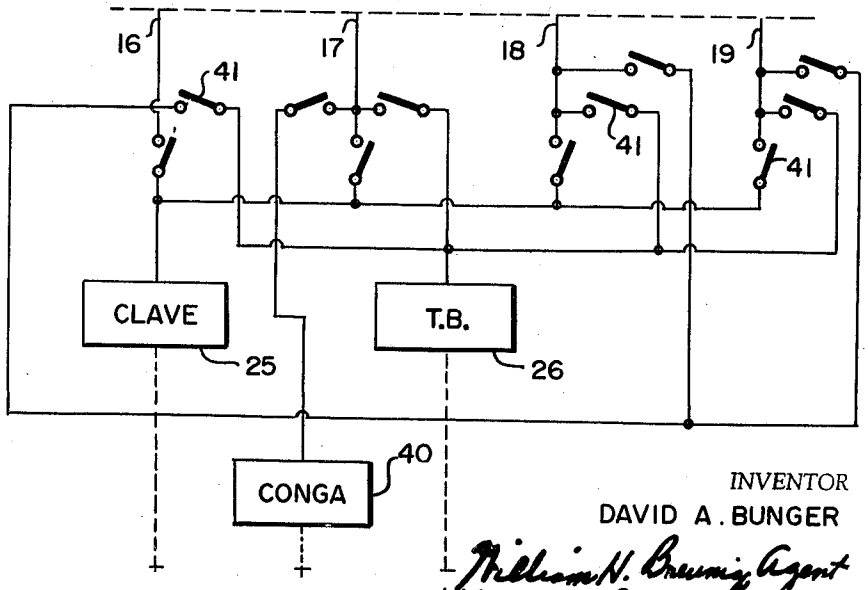


FIG.2



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STEPPING RHYTHMIC INTERPOLATER

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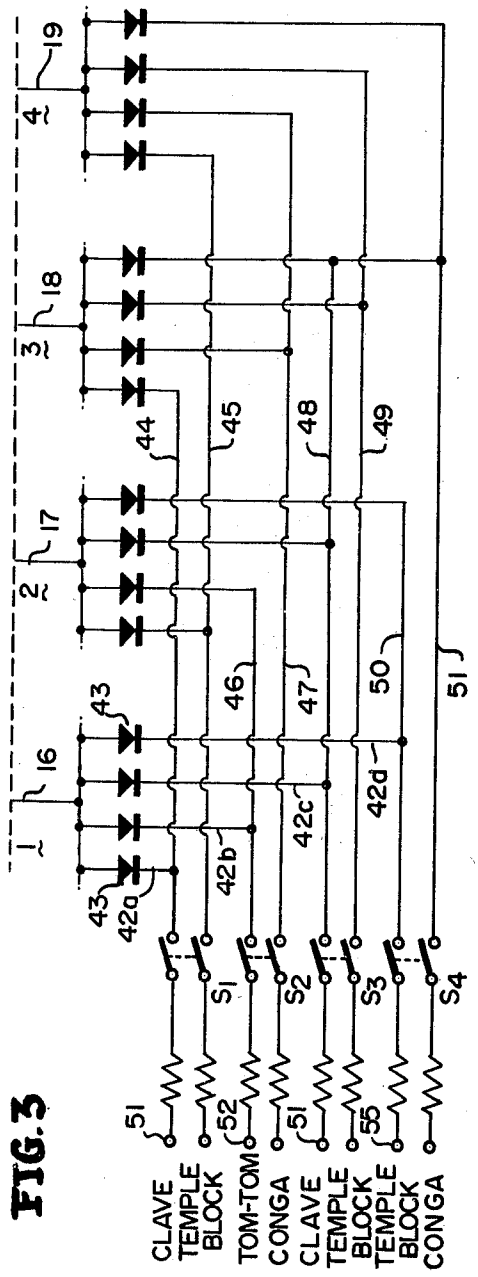

FIG. 3

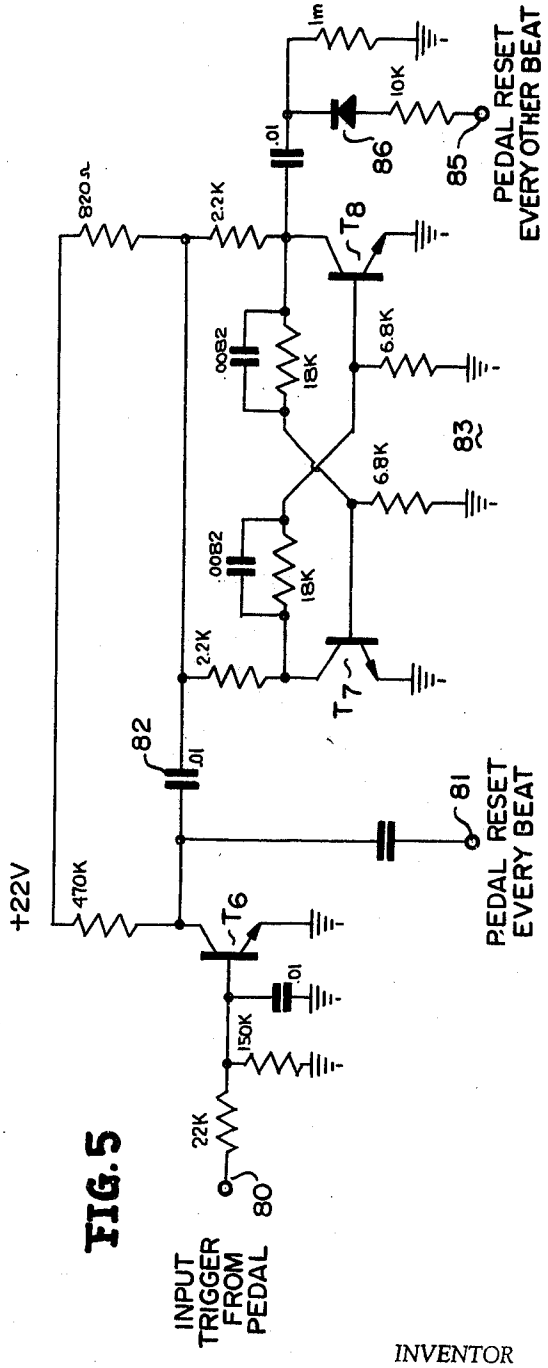

FIG. 5

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STEPPING RHYTHMIC INTERPOLATER

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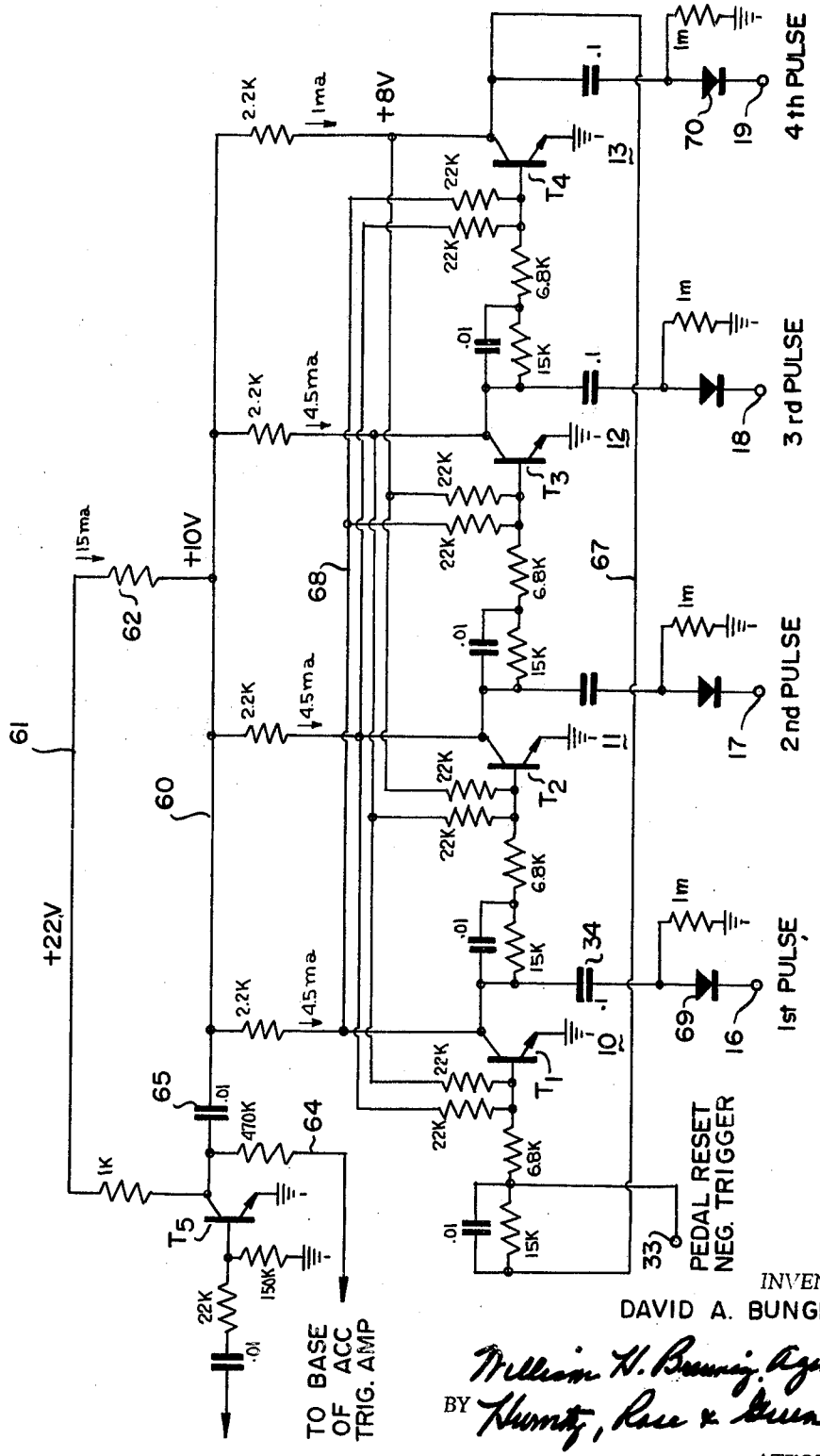
FIG. 4



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United States Patent Office 3,499,091
Patented Mar. 3, 1970

3,499,091

STEPPING RHYTHMIC INTERPOLATER

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Int. Cl. G10f 1/08
U.S. Cl. 84—1.03 11 Claims

ABSTRACT OF THE DISCLOSURE

A register is stepped in response to each note sounded by a manual of an electronic organ. Each position of the register controls a percussive sound or sounds, the percussive sound or sounds being selected by switches from a group of available sounds, for each position of the register. One or more such sounds may be called forth at each register position.

To compensate for the possibility that a note may be inadvertently added or omitted by the player, the register may be reset in response to either each pedal note played or each second pedal note played.

Background of the invention

The stepping rhythmic interpolator of the present invention provides a rhythmic pattern each component of which is directly called for by the player.

There have been two types of rhythmic interpolator available heretofore. In one form, a rhythmic sequence of percussive sounds is generated, in a controllable tempo. The timing of the individual sounds forming the sequence is not under the continuous control of the player, as he plays, but the player must follow the tempo and the rhythm. This type of device is exemplified in the U.S. patents to Park, 3,255,292 and 3,146,290.

In another form, a rhythmic pattern is pre-established for each measure of the music or for each two measures of the music, but each complete pattern is initiated by a signal, i.e. the playing of a note or the closure of a switch. Each time the signal occurs, the same sequence of voices sounds. Tempo may be manually pre-established or may be automatically computed from the time separation of the signals. This type of device is exemplified in the U.S. patents to Campbell, 3,140,336 and 3,247,309.

In accordance with the present invention, a sequence of percussive voices or combinations of voices is set up by switches. The playing of successive notes on an accompanied electronic organ will then call forth the appropriate voices of the sequence, in a predetermined order, but no voice sounds unless and until a note is played. Thereby, the rhythmic interpolator is always under control of the musician, for each note that he plays on the organ. If he stops playing, the interpolator does not continue to sound. If he varies rhythm or the timing of notes in a measure, or tempo within a measure, the interpolator will nevertheless continue to provide precisely timed accompaniment. In the prior art devices these desiderata are not attainable.

Summary of the invention

The circuitry of the present invention includes an electronic shift register, which advances one step for each input pulse. The input pulses derive from notes played on a musical instrument, such as an electronic organ, and more particularly from notes played on the accompaniment manual of the organ.

Assume a four position shift register. There are then four trigger outputs, which are respectively selectively and at will connected to various predeterminable combinations of percussive voice sources through a switching array. There can be a number of different switches each of which establishes a different combination of voices in response to the trigger outputs of the shift register. By actuating more than one switch the combinations available from single switches can be added, to provide more complex voices than are available to single switches.

Provision may be made for reset of the register with each pedal note played or each second pedal note played.

Description of the drawings

FIGURE 1 is a block diagram of a system according to the invention;

FIGURE 2 is a block diagram of a modification of the system of FIGURE 1;

FIGURE 3 is a block diagram of a further modification of the system of FIGURE 1;

FIGURE 4 is a schematic circuit diagram of the system of FIGURE 1; and

FIGURE 5 is a schematic circuit diagram of a reset circuit for the system of FIGURE 4.

Description of the preferred embodiments

In FIGURES 1, **10**, **11**, **12**, **13** are the successive stages of a shift register, SR, stage **13** feeding back to stage **10** via lead **14**. Terminal **15** is connected to a lead which sees a signal each time that a note is played on a predetermined manual of an electric organ, for example, the accompaniment manual. Thereby, for each note played the shift register SR advances one step. The several stages **10–13** of the shift register SR provide output signal on output leads **16**, **17**, **18**, **19**, respectively. These leads terminate in the ganged selector arms **20**, **21**, **22**, **23**, respectively, of step switches S1, S2, S3, S4. To the contacts of switches S1, S2, S3, S4 are connected tone sources. For example, a clave tone source **25** is connected to the first contacts of switches S1 and S3, and a temple block tone source **26** to the first contacts of switches S2 and S4. Accordingly, as shift register SR steps through its cycle one hears the sounds Clave, Temple Block, Clave, Temple Block. These sounds each occur concurrently with an organ tone, regardless of the tempo employed. The output of clave tone source **25**, temple block tone source **26**, and of the organ **30** itself are applied to the input on audio amplifier **31**, for application to a loudspeaker **32**.

The pedal notes of the organ, when played, may generate pulse signals which are applied to reset terminal **33** for application to all the stages of shift register SR, to reset the latter. Capacitors **34**, in series with leads **16–19**, inclusive, assure that control pulses will be applied from stops **10–13**, inclusive, only during shift, and the shift register SR is arranged to be reset so that the reset pulse effects transfer from stage **11**, **12** or **13** to stage **10**.

It is feasible to utilize the present system without pedal reset, for example for some types of Latin music. In such case, if the musician inadvertently interposes a note not called for by the music, or omits a note, the shift register SR will be out of step with the music, but the character of the music will mask the apparent defect. Or, the musician can readily re-synchronize by the manner of his playing.

In the system of FIGURE 2, three tone sources are shown, i.e. the clave **25** and the temple block **26** and additionally a Conga tone source **40**. Switches **41** are provided, which can connect each of leads **16–19** to any one or more of the tone sources **25**, **26**, **40**. Twelve switches can then provide very many diverse rhythmic tone patterns. The system can be extended to additional tone sources, additional register stages, or both, as desired.

The modification illustrated in FIGURE 3 of the accompanying drawings provides for four register stages,

four effective two contact switches, and four tone sources. Leads **16–19**, as in FIGURES 1 and 2, proceed to the register stages and four vertical leads **42***a*–**42***d* proceed via isolating diodes **43** to various horizontal leads **44–51**. These in turn are connected to tone sources, via switches S.

For example, vertical bus **42***a* proceeds to lead **44**, vertical bus **42***b* to lead **46**, vertical lead **42***c* to lead **48**, and vertical lead **42***d* to lead **50**. Switch S1 connects lead **44** to Clave terminal **51**. Switch S2 connects lead **46** to Tom-Tom terminal **52**. Switch S3 connects lead **48** to Clave terminal **51** and switch S4 connects lead **50** to Temple Block terminal **55**. Thereby, according to which one or ones of switches S may be closed, the sounds of Clave, Tom-Tom, Temple Block sound on transfer of the shift register SR from stage **10** to stage **11**. The diodes **43** prevent sneak circuits, in conventional manner.

Assume that only switch S1 is closed. As the shift register moves through its stages, lead **16** is connected to lead **44**, lead **17** to lead **45**, lead **18** to lead **44** and lead **19** to lead **45**. The sequences of sounds is then Clave, Temple Block, Clave, Temple Block. On closure of switch S2 and switch S1, the Tom-Tom sound is added to the first two tones and the Conga sound to the last two, and in general by closing from one to four of switches S1–S4, in any desired combination, fifteen tone patterns are available.

In FIGURE 4 is provided a schematic circuit diagram which may be used in the system of FIGURES 1–3, inclusive, and particularly a shift register suitable for application in these systems is illustrated. Each of stages **10–13** includes a single transistor, these being identified as T1, T2, T3, T4. The emitters of the transistors T1–T4 are grounded and the collectors are connected to a +10 v. bus **60**, which derives its voltage from a 22 v. bus **61** via a voltage dropping resistance **62**. It is assumed that each of transistors T1–T3 is saturated, at 4.5 ma. but that transistor T4 is unsaturated.

Transfer pulses are applied at lead **64** to bus **60**, via trigger amplifier T5 and capacitor **65**. These pulses are derived from an accompaniment manual triggering amplifier. Similar pulses may be derived from the solo manual of an electronic organ. Accordingly, control of rhythmic accompaniment may derive from either manual of the organ.

The trigger amplifier T5 is normally off. A positive trigger pulse is applied to the input of T5 causing the transistor to saturate. This applies a negative trigger to bus **60** via capacitor **65**.

Transistors T1–T3 are saturated and the negative trigger pulse passing through their respective collector resistors has no effect on the state of the shift register.

The negative trigger pulse applied to T4 via its collector resistor is applied to the base of T1 via lead **67** driving T1 out of saturation. This raises the voltage at the collector of T1 and that rise is transferred to the base of T3 and T4 via lead **68** and to the base of T2 via the capacitor **100** and resistor **101** and **102**. Thus T2 and T3 remain in saturation, T4 becomes saturated and T1 is now unsaturated. Succeeding trigger pulses steps the shift register in like manner.

A negative going reset pulse is applied directly to the base of transistor T1, from terminal **33**, whenever a pedal note is played, provided pedal reset is utilized in the system.

It is feasible selectively to reset for each four notes or for each eight notes as desired. To provide selective reset, resort is had to the system of FIGURE 5 of the accompanying drawings.

In FIGURE 5, positive pulses produced by pedal actuation are applied to terminal **80**. Terminal **80** is coupled directly to the base of transistor T6, and reset pulses are derived from the collector of T6, which is resistance loaded, at output terminal **81**.

The collector of T6 is coupled, via capacitor **82**, to a flip-flop **83**, comprising cross-coupled transistors T7 and T8. The flip-flop **83** provides an output pulse from the collector of T8 only on each second pulse applied to the flip-flop. In effect, flip-flop **83** is a divide-by-two circuit. The output of T8 is a negatively going pulse, applied to pedal reset terminal **85** via diode **86**. Either terminal **81** or terminal **85** is connected to terminal **33**, at the will of the musician, so that reset may occur selectively on each pedal note, or on each second pedal note. Or, terminal **33** may be left unconnected, and reset dispensed with.

In general, any type of register may be employed in the practice of the invention, including a mechanical stepping switch. A wide variety of switching circuits may also be envisaged intermediate the register and only desired percussive tone sources.

What is claimed is:

1. A stepping rhythm device, comprising
a shift register having plural stages,
an electronic organ having a manual,
means responsive to playing of each note available to at least a portion of said manual for generating a control pulse,
means applying said control pulses to advance said shift register for providing a further control pulse on at least one percussive tone source, and
means for energizing said percussive tone source in response to said further control pulses.

2. A stepping rhythm device, comprising
a shift register having plural stages,
a source of control pulses,
means applying said control pulses to advance said shift register,
connections to separate stages of said shift register for providing further control pulses,
at least two percussive tone sources of diverse characters, and
means selectively energizing said tone sources in response to said further control pulses.

3. A stepping rhythm device, comprising
plural percussive tone sources of diverse characters, susceptible of emitting diverse tones when energized,
a plurality of leads,
means for at will connecting various of said plural percussive tone sources to said plurality of leads in a predetermined pattern,
means applying energizing sources in succession to said leads, whereby said tone sources sound in response to said pulses in an order determined by said predetermined pattern, wherein said last means is an electronic shift register having plural stages.

4. The combination according to claim **3**, wherein is provided means responsive to each of selected organ tones for advancing said shift register from stage to stage.

5. The combination according to claim **4** wherein said selected organ tones are the organ tones called forth by the accompaniment manual of an electronic organ.

6. The combination according to claim **5** wherein is further provided means for resetting said shift register in response to bass tones played on said electronic organ.

7. An electronic musical instrument for generating repetitive rhythmic patterns, comprising
an electric organ including first keyboard means for playing notes in sequence,
a pedal keyboard,
a shift register having multiple stages,
means responsive to actuations of said pedal keyboard for resetting said register,
means responsive to each operation of said first keyboard means to play a note for advancing said register from one stage to another,
means providing tone signals of diverse character,
means responsive to each advance of said shift register for calling forth a selected one of said tone signals of diverse character, and
an electroacoustic system for radiating audio tones corresponding with the called for tone signals.

8. An electronic musical instrument for generating rhythmic patterns, comprising

an electronic organ having a pedal keyboard,

a multi-stage electronic shift register,

means responsive to actuations of said pedal keyboard for resetting said multi-stage electronic shift register,

a source of pulses each generated at the will of a human operator,

means responsive to each of said pulses for advancing said shift register by one stage,

a plurality of percussive tone sources, and

means responsive to advances of said shift register for calling forth selected ones of said percussive tone sources as a function of the state of said shift register.

9. A stepping rhythm device for an electronic organ, said organ having plural playing keys, comprising

plural percussive tone sources of diverse tonal characters each capable of emitting a percussive tone when energized by an energizing pulse,

a plurality of leads,

manual switch means for interconnecting said percussive tone sources to diverse ones of said leads at will, and

means responsive to each of all actuations of said plural playing keys for applying energizing pulses to said plurality of leads in succession and thereby to one or more of said percussive tone sources to which the leads are connected.

10. The combination according to claim 9, wherein said last means is a shift register having plural stages having output connections to said leads, and means responsive to actuation of any of said playing keys for modifying the settings of the said stages, the setting of each of said states determining whether or not any one of said leads shall have one of said energizing pulses applied thereto by that stage.

11. A stepping rhythm device for control by player manipulation of a single organ multi-key manual, comprising

plural percussive tone sources of diverse characters, susceptible of emitting diverse tones when energized by voltage pulses,

a plurality of leads,

means for at will interconnecting various of said plural percussive tone sources to said plurality of leads in a predetermined spatial pattern, and

means responsive to said manipulation of said single organ manual for distributing said voltage pulses to said leads in a predetermined time pattern of application to said leads while generating each of said voltage pulses in response to one manipulation of any one of the keys of said manual.

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HERMAN KARL SAALBACH, Primary Examiner

U.S. Cl. X.R.

84—1.08, 1.24