March 3, 1970 D. A. BUNGER 3,499,092

ACCOMPANIMENT CHORD RHYTHM SYSTEM

Filed Aug. 12, 1968 3 Sheets-Sheet 1

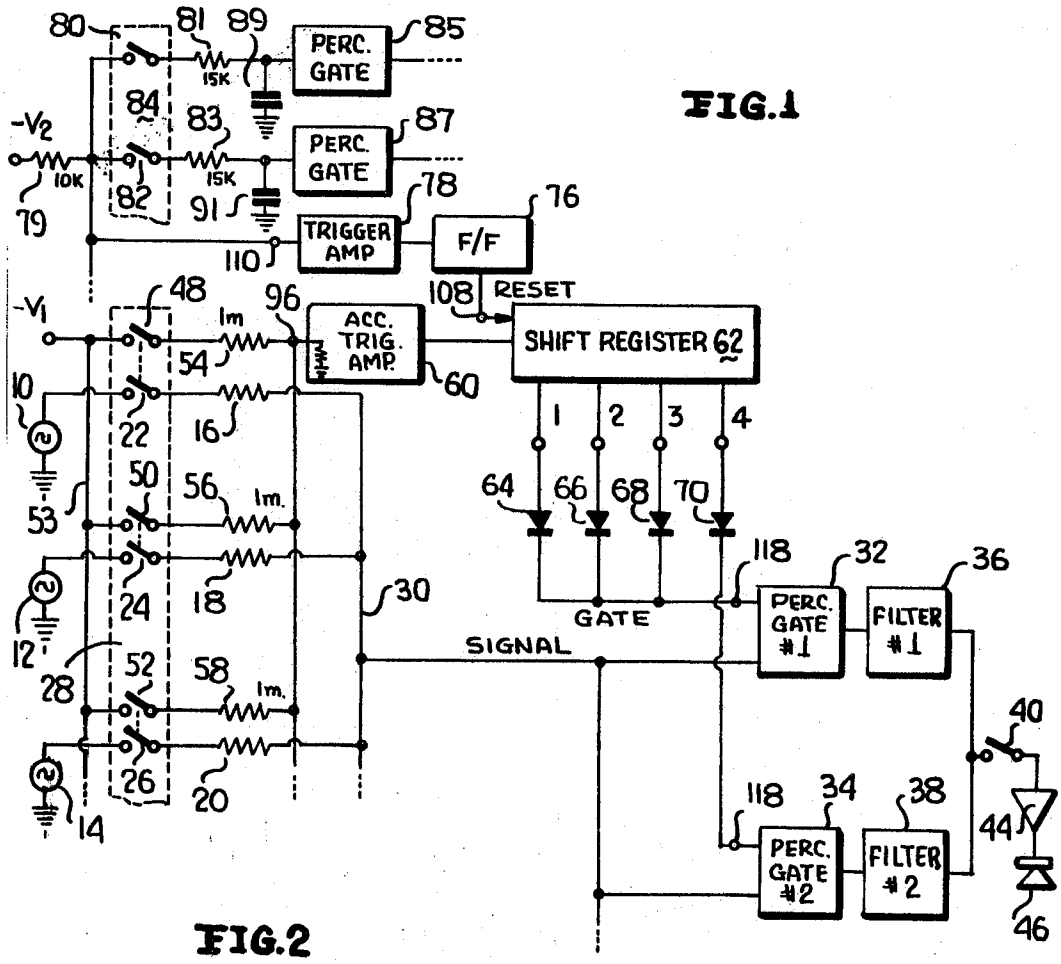
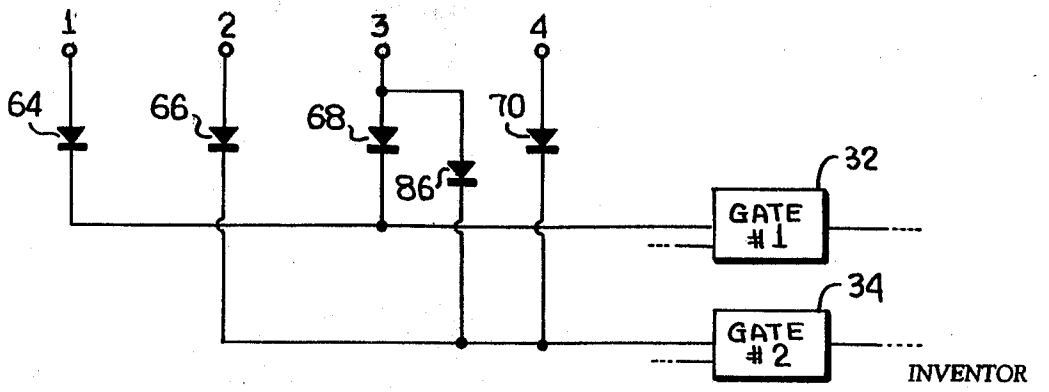


FIG.1

FIG.2



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ACCOMPANIMENT CHORD RHYTHM SYSTEM

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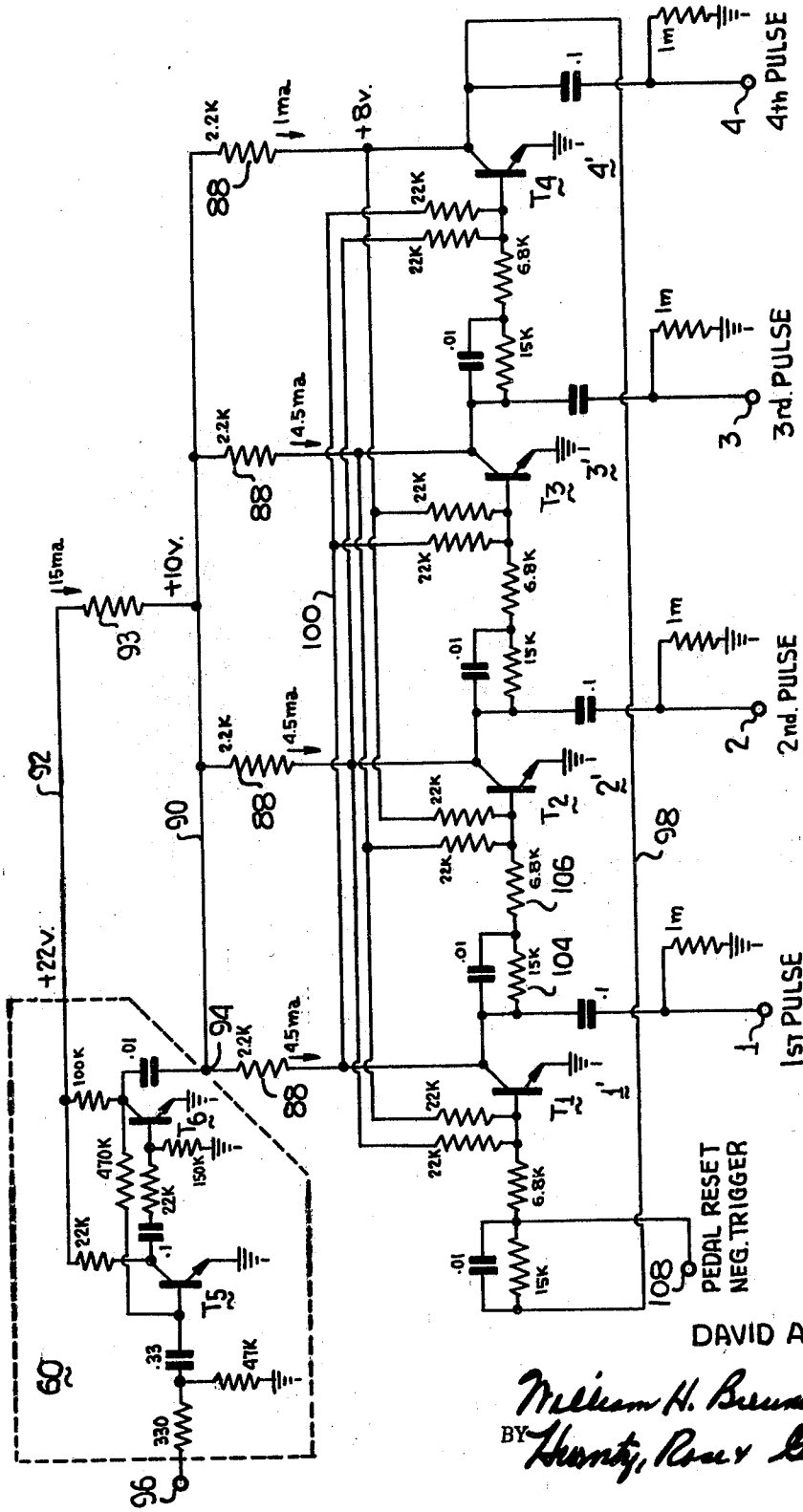


FIG.3

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March 3, 1970 D. A. BUNGER 3,499,092

ACCOMPANIMENT CHORD RHYTHM SYSTEM

Filed Aug. 12, 1968 3 Sheets-Sheet 3

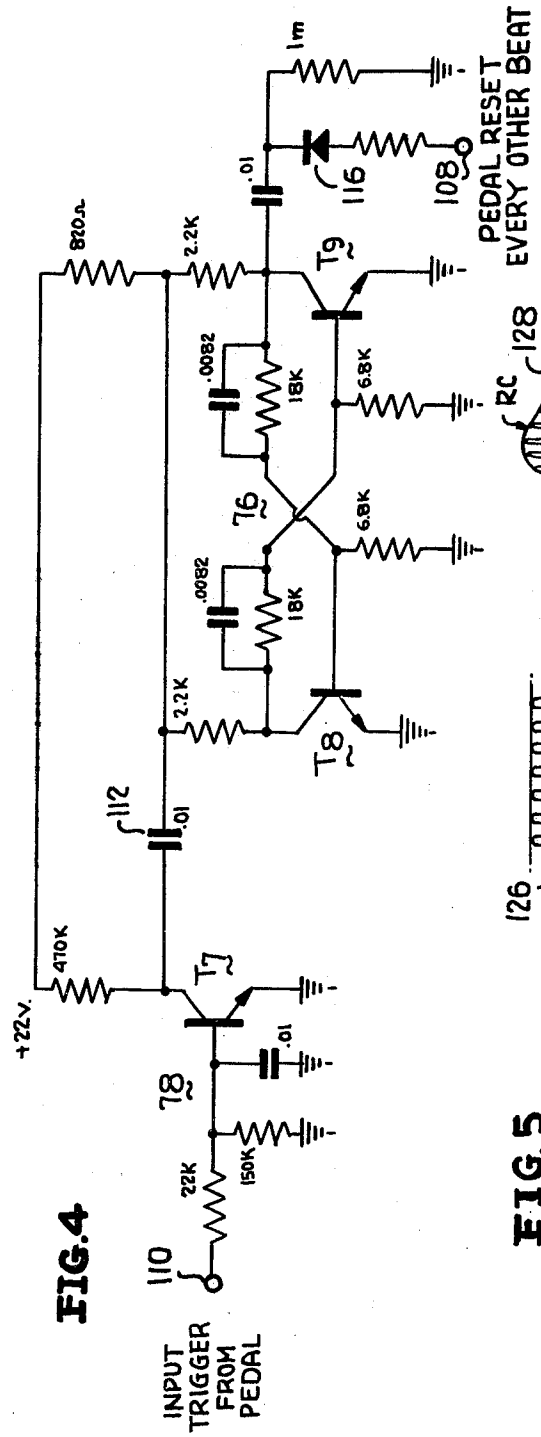


FIG. 4

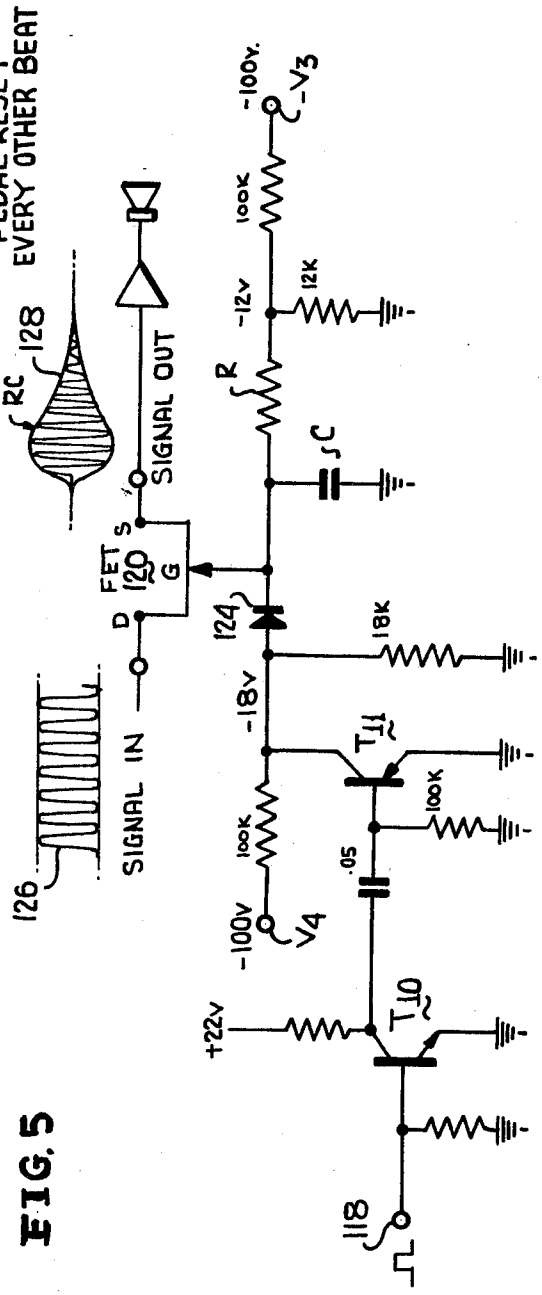


FIG. 5

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United States Patent Office 3,499,092 Patented Mar. 3, 1970

3,499,092

ACCOMPANIMENT CHORD RHYTHM SYSTEM

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Continuation-in-part of application Ser. No. 615,217, Feb. 10, 1967. This application Aug. 12, 1968, Ser. No. 751,871

Int. Cl. G10f *1/08*

U.S. Cl. 84—1.03 18 Claims

ABSTRACT OF THE DISCLOSURE

The playing of chords on an accompaniment manual keyboard of an electronic organ is facilitated by use of a shift register which can be stepped along by the mere repetition of one note of a chord and which can be reset by a flip-flop triggered by alternate keyings of a pedal keyboard. The shift register output may be programmed to actuate normally-off gates to pass signals through tone-color filters of diverse character to obtain desired rhythm patterns comprised of different voices. A resistive network is provided which advances the shift register for each actuation, whether or not keys are then already actuated.

This application is a continuation-in-part of my application Ser. No. 615,217, filed Feb. 10, 1967, entitled "Stepping Rhythm Interpolator," assigned to the same assignee as the present application.

BACKGROUND OF THE INVENTION

In recent years there have been known two general types of rhythmic interpolators to provide rhythmic patterns of percussive voices in electronic organs. 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 continuous control of the player, as he plays, but the player must follow the tempo of the device, such as exemplified in U.S. patents to Park, Nos. 3,146,290 and 3,255,292.

In another form, a rhythmic pattern is pre-established for each measure of the music (or for each two measures), 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 may be heard. Tempo may be manually established or may be automatically computed from the time separation of the signals. This type of device is exemplified in U.S. patents to Campbell, Nos. 3,140,336 and 3,247,309.

In addition to the above, the present inventor discloses in a co-pending application, Ser. No. 615,217, filed Feb. 10, 1967, a stepping rhythm interpolator in which a shift register is employed to call forth percussive sounds in a predetermined sequence. No sound occurs until the player keys a particular key in a keyboard, say an accompaniment manual. The playing of a note steps along the register to the next stage, which may call forth a percussive sound different from the preceding one. The resetting of the register to restart a desired sequence may be accomplished by keying a pedal keyboard.

According to the present invention, the principal object of which is to produce a rhythmic sequence of chords in an electronic organ in diverse voices, a shift register is used to actuate gates in series with various tone-color filters so as to make the gates operative to pass the signals corresponding to the desired sequence of voices. Another object is to make it possible for a player to repeat a chord, played say with three fingers, by the mere lifting and redepressing of a single key corresponding to one note in the chord.

SUMMARY OF THE INVENTION

Parallel-connected auxiliary key switches, operated concurrently with tone-signal key switches in an accompaniment keyboard, pass direct current to activate a trigger amplifier whose output triggers a shift register from one stage to the next, each stage being operative to actuate a tone-signal gate in series with a tone-color filter to provide a rhythm pattern of diverse voices. Signal keyed by pedal key switches activates a trigger amplifier to trigger a flip-flop connected to the shift register, so that alternate keyings of the pedal keyboard reset the shift register.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a part-schematic, part-block diagram of an embodiment of this invention;

FIGURE 2 is a similar type diagram of a variation of a portion of the diagram of FIGURE 1;

FIGURE 3 is a schematic diagram of a shift register and accompaniment trigger amplifier for use with the invention;

FIGURE 4 is a schematic diagram of a trigger amplifier and flip-flop for use with the invention; and

FIGURE 5 is a schematic diagram of a gate for use with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGURE 1, tone-signal sources **10, 12, 14** . . . represent three of a gamut of sources corresponding to notes of a musical scale and may, for example, each comprise a stage in a chain of continuously-running (during operation) frequency-dividing flip-flops as known in the art. Respectively connected in series with sources **10, 12, 14** . . . are decoupling resistors **16, 18, 20** . . . and key switches **22, 24, 26,** . . . operable by the respective keys (not shown) of, for example, an accompaniment keyboard **28**. The resistors **16, 18, 20** . . . have a common connection in a collector **30**, which, in turn, has connections to a pair of normally-off percussive-type gates **32** and **34**, to be described in detail with reference to FIGURE 5. Tone-color filters **36** and **38** are shown in series with gates **32** and **34**, respectively, and with a common connection to a stop-tab switch **40** in series with the usual amplifier **44** and loud speakers **46**.

Ganged respectively to the key switches **22, 24, 26,** . . . are auxiliary key switches **48, 50, 52** . . . , having a common connection **53** to a source of negative potential V_1. The switches **48, 50, 52** . . . , are in series with resistors **54, 56, 58** . . . which have a common connection to a trigger amplifier **60**, the output of which is connected to a shift register **62**, these latter two components being illustrated in detail in FIGURE 3. The shift register **62** has four outputs **1, 2, 3** and **4**, having connections respectively to four steering diodes **64, 66, 68** and **70**. An exemplary connection of the diodes is illustrated in FIGURE 1, with diodes **64, 66** and **68** coupled to gate **32** and with diode **70** coupled to gate **34**. The shift register **62** has also a reset input derived from a flip-flop **76**, which is in series with a trigger amplifier **78**, which is connected to negative source V_2 via a series resistor **79**. Also connected to resistor **79** are switches **80, 82** . . . , which are actuable by pedals (not shown) of a pedal keyboard **84**. In series with the switches **80, 82** . . . , are respective resistors **81, 82** . . . , and respective percussion or sustain gates **85, 87** . . . , with shunt capacitors **89, 81** . . . connected as shown.

In the operation of the system of FIGURE 1, assume that accompaniment key switches **22, 48,** and **26, 52** are closed together, as they might be in playing a chord having two notes a whole tone apart in the equally-tempered

scale. Also, assume that the shift register **62** is in such a state as to render output **1** effective. At the instant of switch closure, tone signals from sources **10** and **14** pass through key switches **22** and **26**, respectively, to collector **30**, from which they are transmitted to the signal input of both gates **32** and **34**. Since the gates are normally off, no signal will pass through. However, at the same instant, D.C. from source V_1, will pass through switches **48** and **52** to the trigger amplifier **60**. A pulse from the latter will enter the shift register **62** and cause a positive output at **1**. The diode **64** passes the pulse, thereby pulsing the gate **32** and turning it on. Then the signals from sources **10** and **14** will pass through the gate **32**, be modified in harmonic content by the filter **36**, be amplified by amplifier **44** (if the tab switch **40** is closed) and converted to sound in the speaker **46**. Since the gate is of the "percussive" type, the signal rises abruptly to a maximum and decays gradually depending upon the time constant of the gate circuit.

Assume now that the switches **22**, **48**, and **26**, **52** remain closed, as would be the case if the chord were held. Then if one finger were lifted for a short period, say one second, and then pressed back down on the key operating the switches **22**, **48**, signal from the source **10** would again be present at both gates **32** and **34** along with the signal from source **14**, the switches **26**, **52** for which having remained closed. At the same time, D.C. would pass through switch **48** causing another pulse at the input of the register **62**. This time the output **2** would be effective to pass a pulse through diode **66** to reactuate the gate **32** to pass another percussive sound at the pitches of both sources **10** and **14** and of a tone color determined by the filter **36**. In like manner, if the same finger were lifted again and then pressed back on the key operating switches **22**, **48**, percussive signals would again be heard corresponding to sources **10** and **14**, having been gated by a pulse through diode **68** from output **3** of the register **62**. However, another lifting and depression of the same key would cause a pulse to pass from output **4** through diode **70** and on to gate **34**, which would pass percussive signals at the same pitches (from sources **10** and **14**), but of a tone color determined by the filter **38**. Thus there would be a sequence of three successive percussive chords of one tone color followed by one chord of another tone color.

The utility of the system may readily be seen, because the outputs **1**, **2**, **3** and **4** may be connected in any one of a large number of combinations to one or both of the gates **32** and **34**, as well as to additional gates (not shown) connected to other tone-color filters (not shown). For example, in FIGURE 2, the outputs **1**, **2**, **3** and **4** are connected so that gate **32** is actuated first, then **34**, then **32** and **34** together (by means of an additional diode **86**), then gate **34** alone for a corresponding rhythmic sequence of the same chord, with varying tone colors.

Even if the same or another chord is played following the above described sequence, the shift register will revert to a condition wherein output **1** is effective. However, it is highly desirable to have the arrangement of the upper portion of FIGURE 1, whereby playing of a pedal key will act to reset the shift register **62** on the second closure thereof. This is accomplished by closure of a pedal key switch, such as **80**, which pulses the trigger amplifier **78** (by virtue of the passage of D.C. from V_2 to capacitor **89** via resistor **81** and gate **85**), thereby rendering the flip-flop **76** effective upon a second closure to reset the register **62**. This way, in 4/4 time, for instance, if a pedal were played on the third beat, it would not reset the register, thus allowing a full sequence of four rhythmic chords to be played. It will be obvious to one skilled in the art that not only can additional voices be made effective with additional gates and filters, but also larger shift registers with additional outputs may be employed, thus making available almost limitless rhythmic patterns, as desired.

In FIGURE 3 is provided a schematic diagram of a shift register and accompaniment trigger amplifier, which may be used in the system of FIGURE 1. Each of the stages **1'**, **2'**, **3'** and **4'** include 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 **90** (via respective load resistors **88**), which derives its voltage from a 22 v. bus **92** via a voltage dropping resistor **93**. It is assumed that each of the transistors at **T1**–**T3** is saturated, at 4.5 ma. but that transistor **T4** is unsaturated.

Transfer pulses for the shift register are present at point **94**, having been derived from the output of the accompaniment trigger amplifier **60** (comprising transistors **T5** and **T6** and associated components), at the input point **96** of which are applied D.C. pulses derived from the key switches **48**, **50**, **52** . . . . of FIGURE 1. A negative transfer pulse at **94** has no effect on the saturated transistors **T1**–**T3**, but the negative trigger applied to unsaturated transistor **T4** via its collector resistor is also applied via load **98** to the base of transistor **T1**, driving **T1** out of saturation. This raises the voltage at the collector of **T1**, and that rise is transferred to the base of transistors **T3** and **T4** via lead **100** and to the base of **T2** via the capacitor **102** and resistors **104** and **106**. Thus **T2** and **T3** remain in saturation. **T4** becomes saturated and **T1** is now unsaturated. Succeeding trigger pulses step the shift register along in like manner.

A negative-going reset pulse is applied directly to the base of transistor **T1**, from terminal **108** (see also FIGURE 1) on alternate pedal key depressions, provided pedal reset is utilized in the system. To provide pedal reset, resort is had to the system of FIGURE 4 of the accompanying drawings.

In FIGURE 4, positive pulses produced by pedal actuation are applied to the terminal **110** via trigger amplifier **78** (see also FIGURE 1), which is coupled directly to the base of transistor **T7**.

The collector of transistor **T7** is coupled via capacitor **112** to a flip-flop **76**, comprising cross-coupled transistors **T8** and **T9** and their associated components. The flip-flop **76** provides an output pulse from the collector of **T9** only on each second pulse applied to the flip-flop, which acts as a divide-by-two circuit. The output of **T9** is a negative-going pulse, applied to pedal reset terminal **108** via diode **116**.

In general, any type of register may be employed in the practice of the invention, including a mechanical stepping switch.

An exemplary gate for use with the system of FIGURE 1 is illustrated in FIGURE 5, wherein transistors **T10** and **T11** and their associated components comprise a switch for the positive pulse applied at the terminal **118** from one of the outputs of the shift register **62** of FIGURE 1. The FET **120** serves as the gating element in the signal circuit, its drain terminal D having a connection with the collector **30** (of FIGURE 1), and its source terminal S being connected to one of the tone-color filters **36**, **38**. The FET **120** is normally biased into nonconduction by a negative potential at its gate terminal G by the voltage on the capacitor C, which has been charged through resistor R by the voltage divider connected to a source of potential $-V_3$. The transistor **T11** is normally off. The diode **124** is shown connected between the collector of **T11** and G of FET **120** and is normally reverse biased.

In operation, a positive pulse applied at terminal **118** drives **T10** and **T11** into saturation, forcing their collectors to ground potential. The negative charge on the capacitor C quickly passes via the diode **124** and transistor **T11** to ground thus carrying terminal G to ground and causing FET **120** to allow the signal **126** to pass through it quickly. However, upon cessation of the pulse at **118**, **T10** and **T11** turn off, diode **124** stops conducting and capacitor C charges up again from $-V_3$, driving FET **120**

into non-conduction at a rate determined by the time constant of R and C. Thus, a percussive-type envelope **128** (having quick rise time and gradual decay) is imparted to the signal input **126**.

What is claimed is:

1. In an electronic organ having a plurality of tone-signal sources corresponding to notes of a musical scale, a plurality of keying means respectively coupled to said sources, and at least two tone-color filters of diverse characteristics coupled to an output system, the combination comprising

at least two percussive gates coupled between said keying means and respective ones of said tone-color filters,

a shift register having plural stages,

means responsive to actuation of any one of said keying means for generating a control pulse,

means applying said control pulses to advance said shift register for providing a further control pulse on each advance, and

means coupling said plural stages selectively with said percussive gates for selective actuation of said percussive gates by said further control pulses to render said percussive gates selectively conductive.

2. The combination according to claim **1**, including pedal keying means, and

means coupled to said pedal keying means and responsive to operation thereof for resetting said shift register.

3. The combination according to claim **2**, wherein said last-mentioned means includes

a flip-flop coupled to said shift register in such mode that alternate actuations of said pedal keying means reset said shift register.

4. In an electronic organ having a plurality of tone-signal sources corresponding to notes of a musical scale, a plurality of key switches respectively coupled to said sources to call forth tone-signal and at least two tone-color filters of diverse characteristics coupled to an output system, the combination comprising:

at least two percussive gates coupled between said key switches and respective ones of said tone-color filters,

an electronic shift register having plural stages,

a direct current source,

a second plurality of key switches concurrently actuable one for one with said first plurality of key switches,

a trigger amplifier coupled to said shift register,

means including said second plurality of key switches connected in parallel between said direct current source and said trigger amplifier for initiating control pulses to advance said shift register for providing a further control pulse on each advance, and

means coupling said stages respectively with said gates for selective actuation thereof by said further control pulses.

5. The combination according to claim **4**, including pedal key switches, and

means coupled to said pedal key switches and responsive thereto for resetting said shift register.

6. The combination according to claim **5**, wherein said last-mentioned means includes

a flip-flop coupled to said shift register, whereby alternate actuations of said pedal key switches reset said shift register.

7. A rhythm system comprising in combination:

an electronic organ having a keyboard,

a plurality of tone-signal sources,

a shift register having plural stages,

means responsive to actuation of keys of at least a portion of said keyboard for generating a control pulse,

means applying said control pulses to advance said shift register for providing a further control pulse on each advance,

at least two tone-color filters of diverse character,

at least two percussive gates respectively coupling said sources with said filters,

means for selectively actuating said gates in response to said further control pulses, and

electroacoustic translating means coupled to said tone-color filters.

8. In an electronic organ having a plurality of tone sources corresponding to notes of a musical scale,

a plurality of switch means respectively connected in cascade with said sources,

means including a resistive network for generating a control pulse in response to each actuation of one of said keys regardless of whether or not others of said keys are concurrently in actuated condition,

a shift register having plural stages,

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

an output circuit for said organ,

at least one percussive gate interposed between said tone sources and said output circuit, and

means responsive to advances of said shift register for rendering said at least one percussive gate conductive.

9. The combination according to claim **8**, wherein said at least one percussive gate is a plurality of percussive gates connected in parallel, and

wherein said means responsive to said advances of said shift register is means for selectively rendering said percussive gates conductive as a function of the specific advances achieved by said shift register.

10. The combination according to claim **8**, wherein said means including a resistive network includes,

a D.C. voltage source,

a secondary switch operative with each switch of said switch means,

a relatively high resistance connected in cascade with each of said secondary switches,

a relatively low resistance summing resistance connected commonly in series with all said relatively high resistance switches, and

means connecting said secondary switches in said resistive network arranged to produce one of said control pulses across said relatively low resistance in response to each closure of at least one of said secondary switches.

11. In an electronic instrument for generating repetitive rhythm patterns,

a multi-stage shift register,

a plurality of keys,

means responsive to actuation of one or more of said keys regardless of whether or not one or more others of said keys are then in actuated condition for generating a control pulse,

means responsive to each of said control pulses for advancing said shift register from one stage to another, and

means responsive to each advance of said shift register from one stage to another for generating an audio tone.

12. The combination according to claim **11**, wherein said last means includes a means for determining the tonal character of said audio tone as a function of the totality of keys actuated at the time of said advance.

13. The combination according ot claim **12**, wherein is provided plural audio tone channels, and wherein is provided means for programming said plural audio tone channels to pass said audio tones according to the state of advance of said shift register.

14. The combination according to claim **13**, wherein said plural audio tone channels include at least two audio channels having respectively different tone-color filters capable of imparting respectively diverse tone colors to the output of said organ.

15. In an electronic organ,
a plurality of keys, each having an actuated and an unactuated condition,
a plurality of continuously operative tone-color sources,
a plurality of tone-color filters,
an audio output system connected in cascade with said plurality of tone-color filters,
means responsive to each actuation of one of said keys irrespective of the then condition of others of said keys for percussively transmitting tone from said tone sources to said audio output system selectively via at least one of said tone-color filters, and
means for programming operation of said the last named means in a sequence established by actuation of said keys.

16. In an electric organ,
a plurality of tone-signal sources arranged according to a musical scale,
a plurality of percussive gates connected in parallel to said tone-signal sources,
a separate tone-color filter in cascade with each of said percussive gates,
an audio output system connected in cascade with all said gates,
an array of keys actuable to call forth tone signals, and
means responsive to successive actuation of a key irrespective of whether others of said keys are then in actuated condition for rendering said percussive gates conductive in a predetermined sequence.

17. The combination according to claim 16, wherein is provided a further array of actuable keys, and
means responsive to actuations of any of said further array of actuable keys for initiating said predetermined sequence.

18. A percussive gate for an electrical signal representing a sound of a musical instrument, comprising:
a FET having a signal input electrode, a signal output electrode and a gate electrode,

a pulse forming network connected to said gate electrode,
a source of said electrical signal connected to said signal input electrode to apply said electrical signal thereto,
a load connected to said signal output electrode, said pulse forming electrode including a capacitor connected between said gate electrode and ground,
means including a source of negative bias voltage connected to said capacitor and normally maintaining said capacitor negatively charged to maintain said FET non-conductive,
a diode having its cathode connected to said gate electrode,
means including a source of diode blocking voltage connected to said diode for preventing current flow therethrough,
means for transiently grounding said diode, and
a relatively high resistance connected between said source of negative bias voltage and said gate electrode, the values of said capacitor and said relatively high resistance being arranged to provide an audibly long charge time of said capacitor following its transient discharge.

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84—1.08, 1.24