United States Patent [19]

Harris

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[54] **RHYTHM ACCOMPANIMENT SYSTEM**

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[51] **Int. Cl.** **G10h 5/00**
[58] **Field of Search** 84/1.01, 1.03, 1.17, 1.24

[56] **References Cited**

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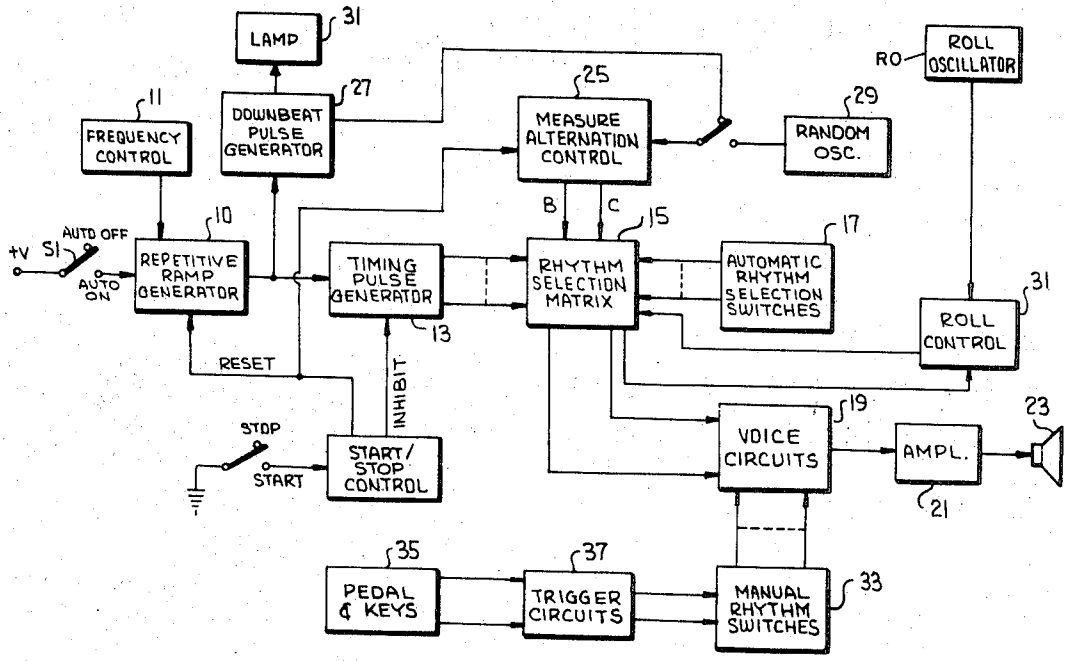
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Assistant Examiner—Stanley J. Witkowski
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[57] **ABSTRACT**

A system is disclosed for developing rhythmic accompaniment sounds from a free running repetitive ramp waveform having a controllable repetitive rate, there being a series of master timing pulses developed by triggering appropriate circuits at different ramp voltage levels during each ramp cycle. Certain of the master timing pulses are selected to form each required rhythmic pattern, the selected pulses being employed to trigger voice circuits to produce desired tones. In one embodiment a pattern selection circuit is employed to permit selective generation of any one of four pattern modes, namely: a first continuously repeated pattern; a second continuously repeated pattern; a pattern in which the first and second patterns are alternated; and a pattern in which the first and second patterns are randomly selected. In the preferred embodiment, 13 master timing pulses are provided during each measure and are separated by one, two, or three timing units in a 24 timing unit measure, an arrangement which permits of obtaining authentic accompaniment rhythms. A novel cowbell voicing circuit and a novel drum roll control circuit permit rhythmic generation of realistic cowbell and drum roll sounds in response to selected master timing pulses.

11 Claims, 11 Drawing Figures



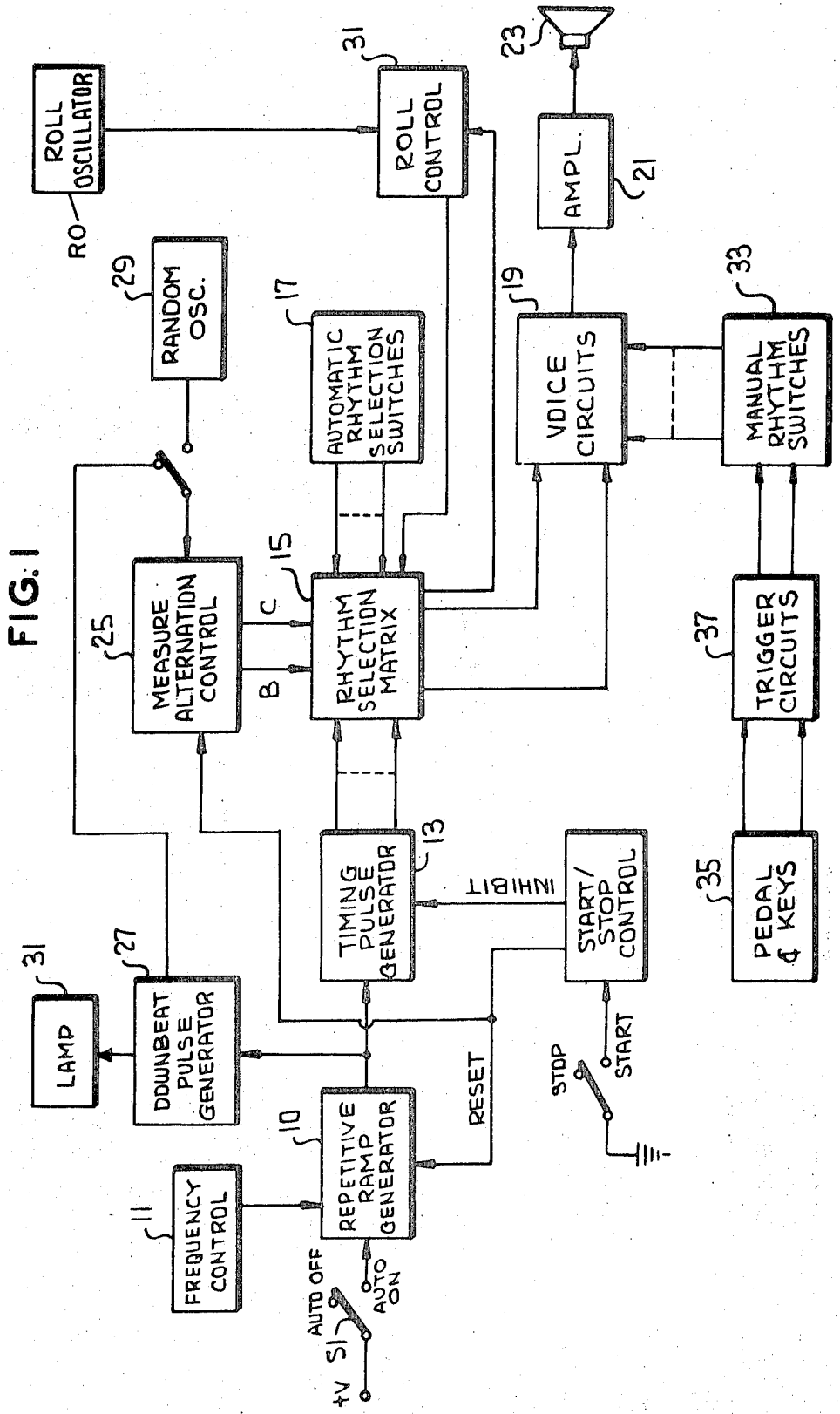
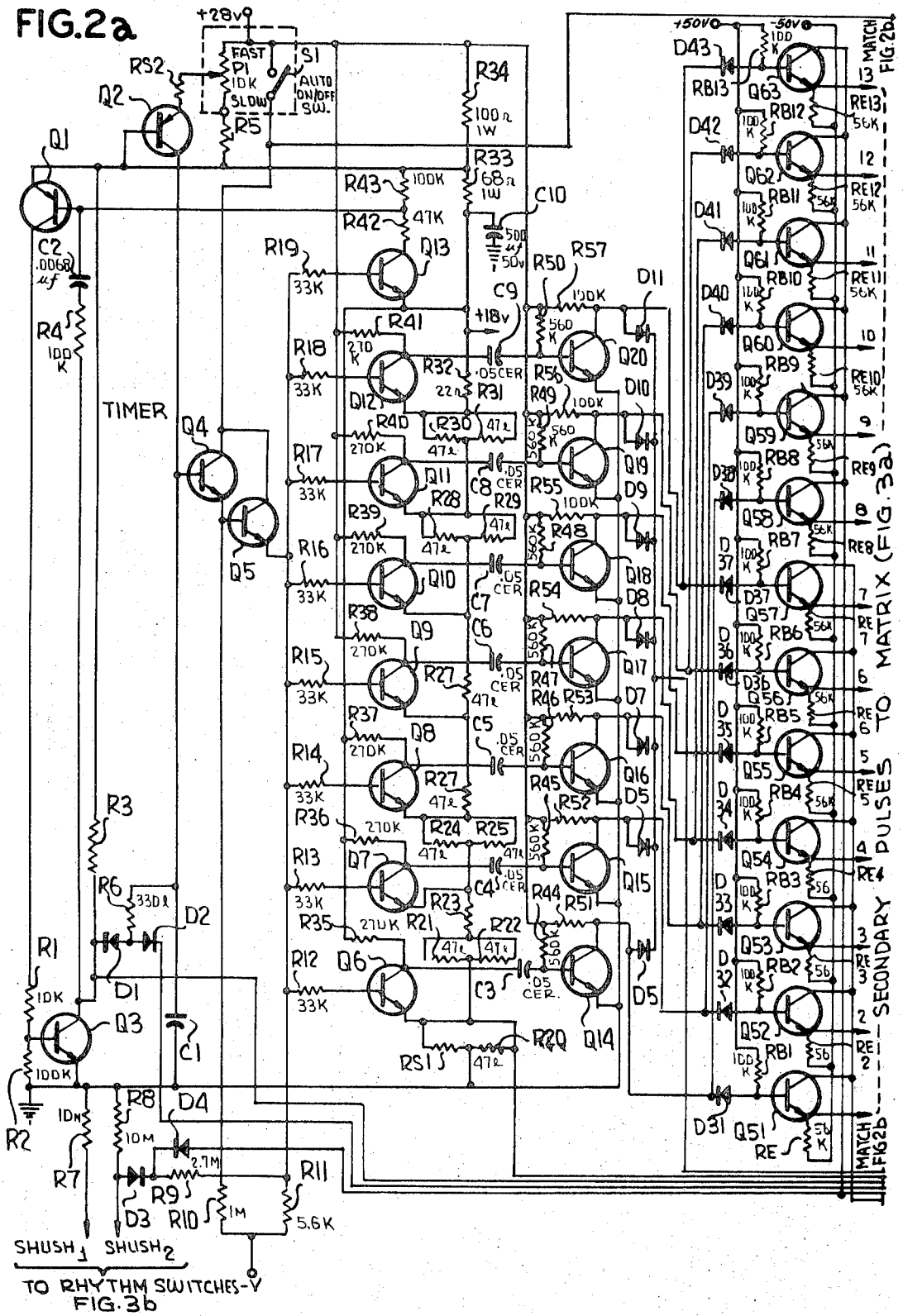

ROLL OSCILLATOR
RO
ROLL CONTROL
31
23
AMPL.
21
RANDOM OSC.
29
AUTOMATIC RHYTHM SELECTION SWITCHES
17
VOICE CIRCUITS
19
MANUAL RHYTHM SWITCHES
33
MEASURE ALTERNATION CONTROL
25
C
B
15
RHYTHM SELECTION MATRIX
TRIGGER CIRCUITS
37
TIMING PULSE GENERATOR
13
INHIBIT
START/ STOP CONTROL
PEDAL & KEYS
35
LAMP
31
DOWNBEAT PULSE GENERATOR
27
REPETITIVE RAMP GENERATOR
10
RESET
STOP
START
FREQUENCY CONTROL
11
AUTO OFF
AUTO ON
51
+V

FIG. 1

FIG.2a


+28v
FAST
P1
10K
SLOW
S1
AUTO ON/OFF SW.
R52
Q2
R5
Q1
R34
100Ω 1W
R33
68Ω 1W
C10
500 µf 50v
R43 100K
R42 47K
Q13
R19
33K
C9
+18v
R50
R57
100K
D11
C2 .0068 µf
R4 100K
R41 270K
R18 33K
Q12
R32 22Ω
.05CER
R31
R56
R49
100K
D10
TIMER
Q4
Q5
R40 270K
R30 47Ω
47Ω
R17 33K
Q11
C8 .05 CER
R28
R29
47Ω
R55
D9
R39 270K
47Ω
R16 33K
Q10
C7 .05 CER
R48
Q18
D8
R38 270K
Q9
C6 .05 CER
R54
R15 33K
R27 47Ω
R47
R46
R53
Q17
D7
R37 270K
Q8
C5 .05 CER
R14 33K
R27 47Ω
R45
R52
Q16
D5
R36 270K
R24
R25
47Ω
47Ω
R13 33K
Q7
C4 .05 CER
R23
R44
R51
Q15
D5
R35 270K
R21
R22
47Ω
47Ω
R12 33K
Q6
C3 .05 CER.
R20
Q14
RS1 47Ω
R3
R6 330Ω
D2
R1 10K
D1
Q3
C1
100K
R2
R8 10M
D4
10M
R7
2.7M
R9
D3
R10 1M
R11 5.6K
SHUSH1
SHUSH2
TO RHYTHM SWITCHES-Y FIG. 3b
+150V
-50V
D43
RB13
Q63
RE13 56K
D42
RB12
Q62
RE12 56K
D41
RB11
Q61
RE11 56K
D40
RB10
Q60
RE10 56K
D39
RB9
Q59
RE9
D38
RB8
Q58
RE8
D37
RB7
Q57
RE7
D36
RB6
Q56
RE6
D35
RB5
Q55
RE5
D34
RB4
Q54
RE4
D33
RB3
Q53
RE3
D32
RB2
Q52
RE2
RB1
D31
Q51
RE
MATCH FIG.2b
MATCH FIG.2b
SECONDARY PULSES TO MATRIX (FIG. 3a)

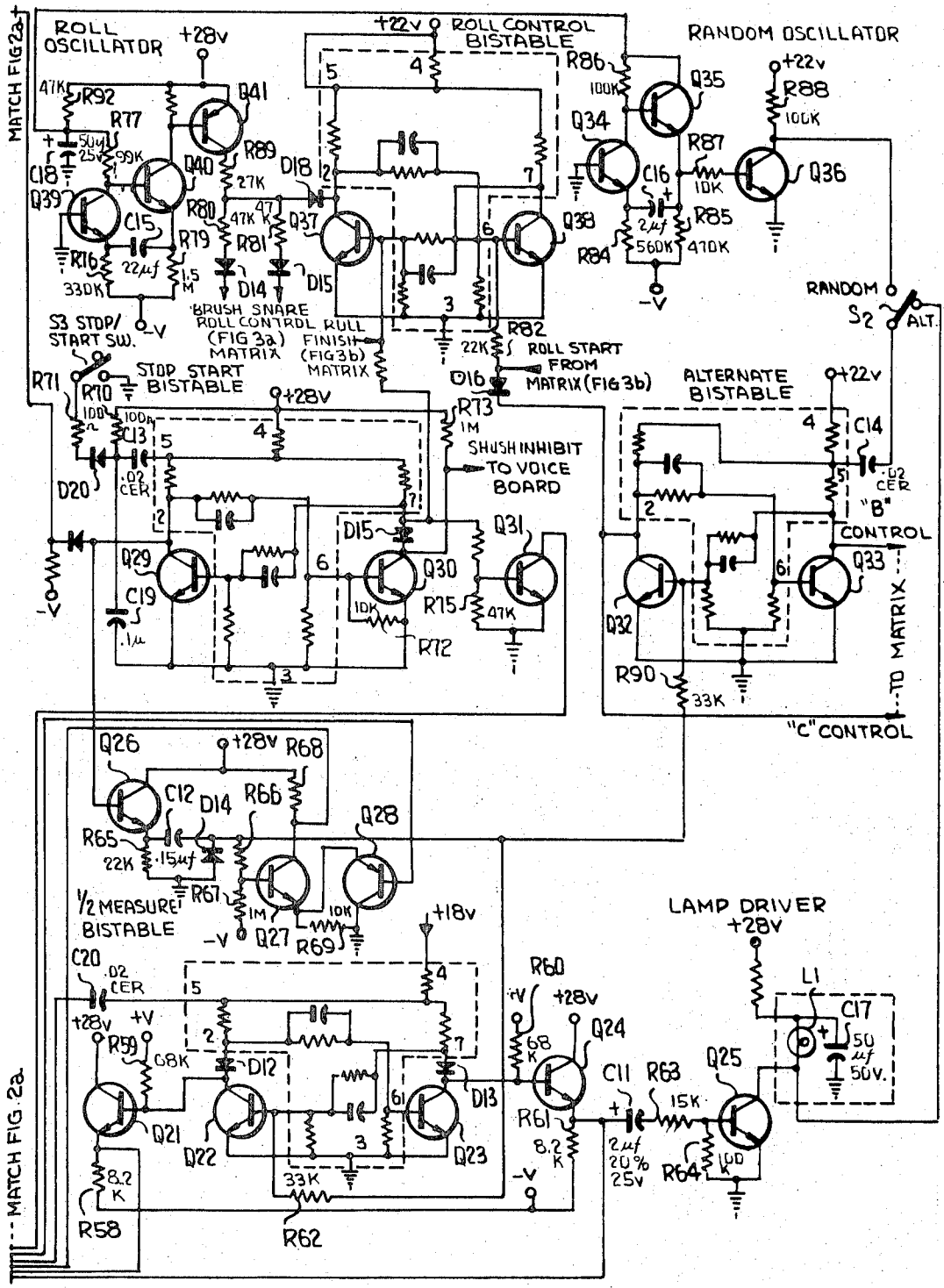

ROLL OSCILLATOR
+28v
+22v ROLL CONTROL BISTABLE
RANDOM OSCILLATOR
MATCH FIG 2a
R92
R77
Q41
Q40
Q39
C18
C15
R16
R79
R80
R81
D14
D15
D18
Q37
Q38
R86
Q35
Q34
R88
R87
Q36
C16
R85
R84
-V
RANDOM
S2
ALT.
S3 STOP/ START SW.
BRUSH SNARE ROLL CONTRDL (FIG 3a) MATRIX
ROLL FINISH (FIG 3b) MATRIX
R82
ROLL START FROM MATRIX (FIG 3b)
D16
STOP START BISTABLE
ALTERNATE BISTABLE
R71
R70
R73
SHUSH INHIBIT TO VOICE BOARD
C13
C14
D20
Q29
Q30
Q31
R75
R72
Q32
Q33
"B" CONTROL
R90
TO MATRIX
"C" CONTROL
Q26
R68
C12
D14
R66
Q28
R65
R67
Q27
R69
½ MEASURE BISTABLE
+18v
LAMP DRIVER
L1
C17
C20
R59
D12
D13
Q21
Q22
Q23
R60
Q24
R61
C11
R63
Q25
R64
R58
R62
MATCH FIG. 2a

FIG. 2b

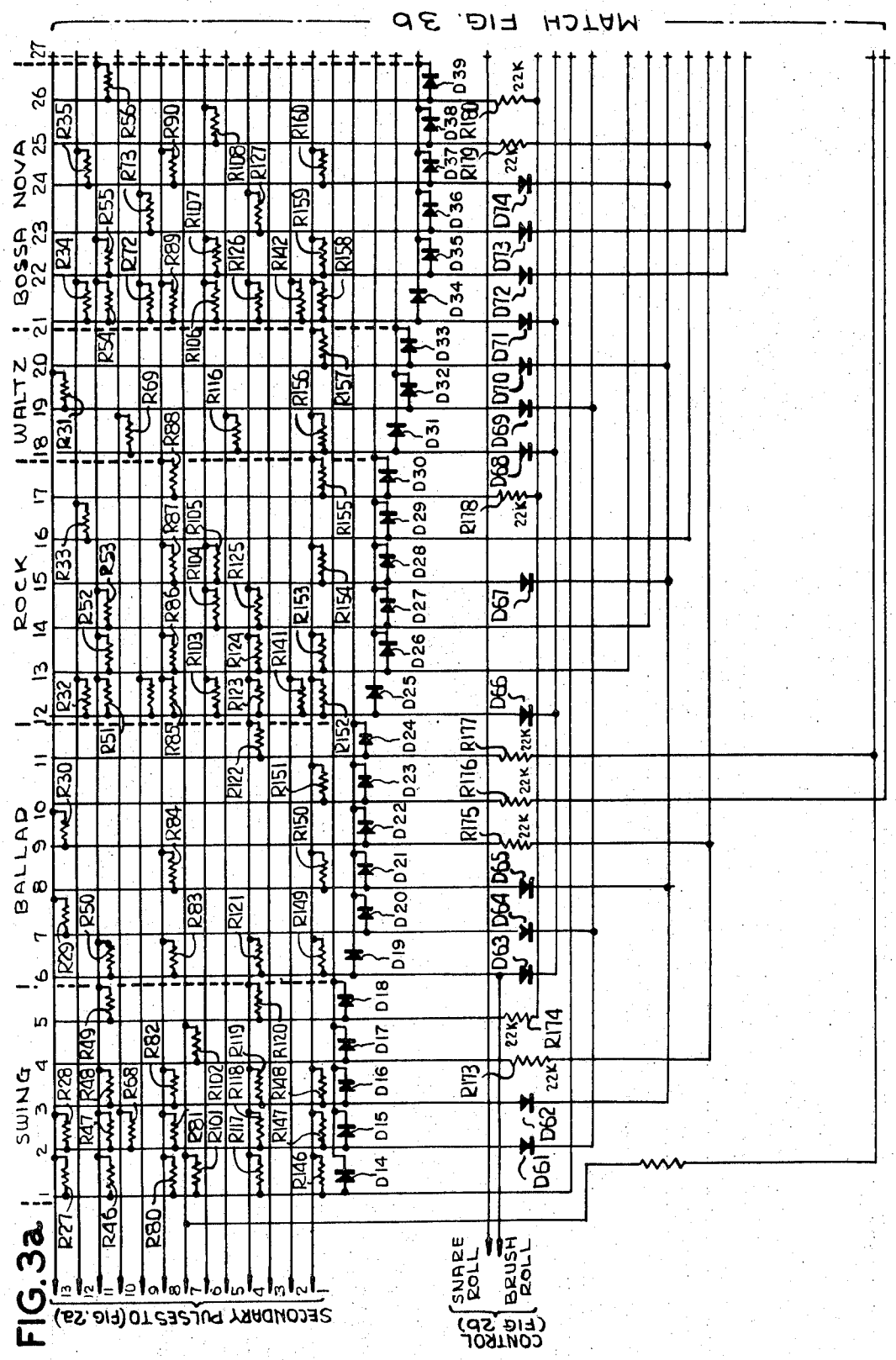

MATCH FIG. 3b
SWING
BALLAD
ROCK
WALTZ
BOSSA NOVA
SECONDARY PULSES TO (FIG. 2a)
CONTROL (FIG. 2b)
SNARE ROLL
BRUSH ROLL
22K

FIG. 3a

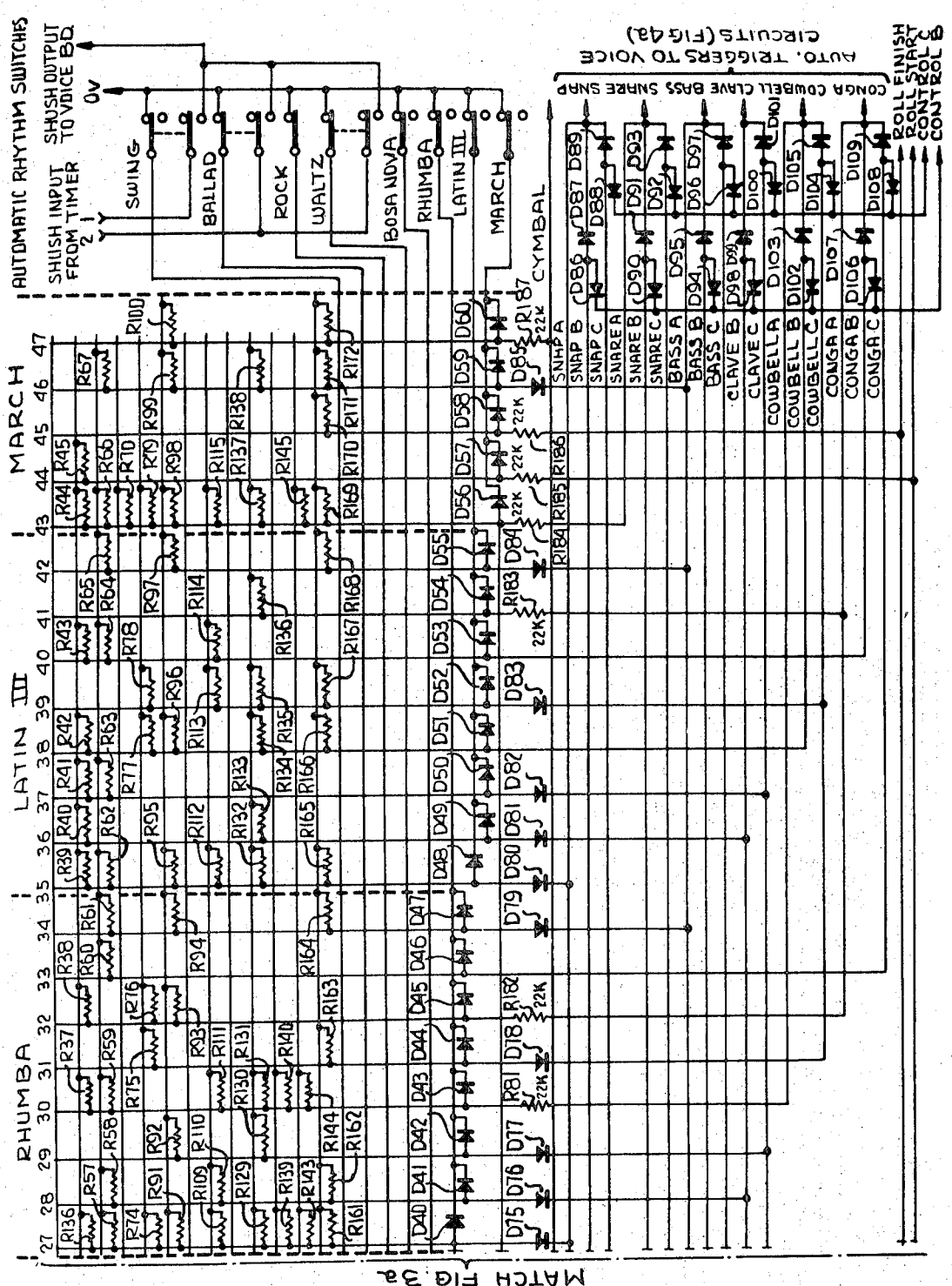

AUTOMATIC RHYTHM SWITCHES
SHUSH INPUT FROM TIMER
SHUSH OUTPUT TO VOICE BD
0V
SWING
BALLAD
ROCK
WALTZ
BOSA NOVA
RHUMBA
LATIN III
MARCH
CYMBAL
AUTO. TRIGGERS TO VOICE CIRCUITS (FIG 4a)
CONGA COWBELL CLAVE BASS SNARE SNAP
ROLL FINISH CONTROL
ROLL START CONTROL
RHUMBA
LATIN III
MARCH
MATCH FIG 3a

FIG. 3b

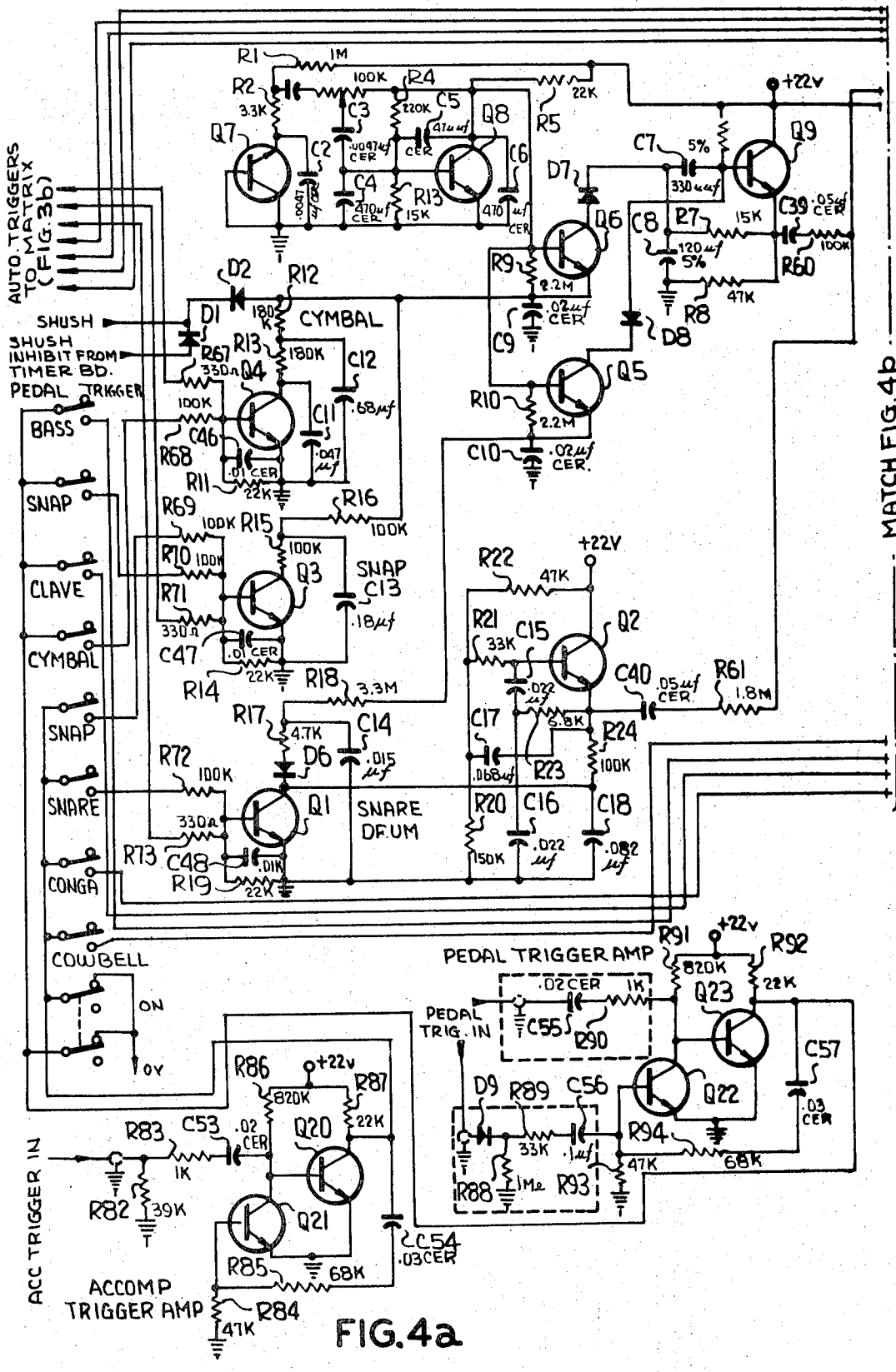
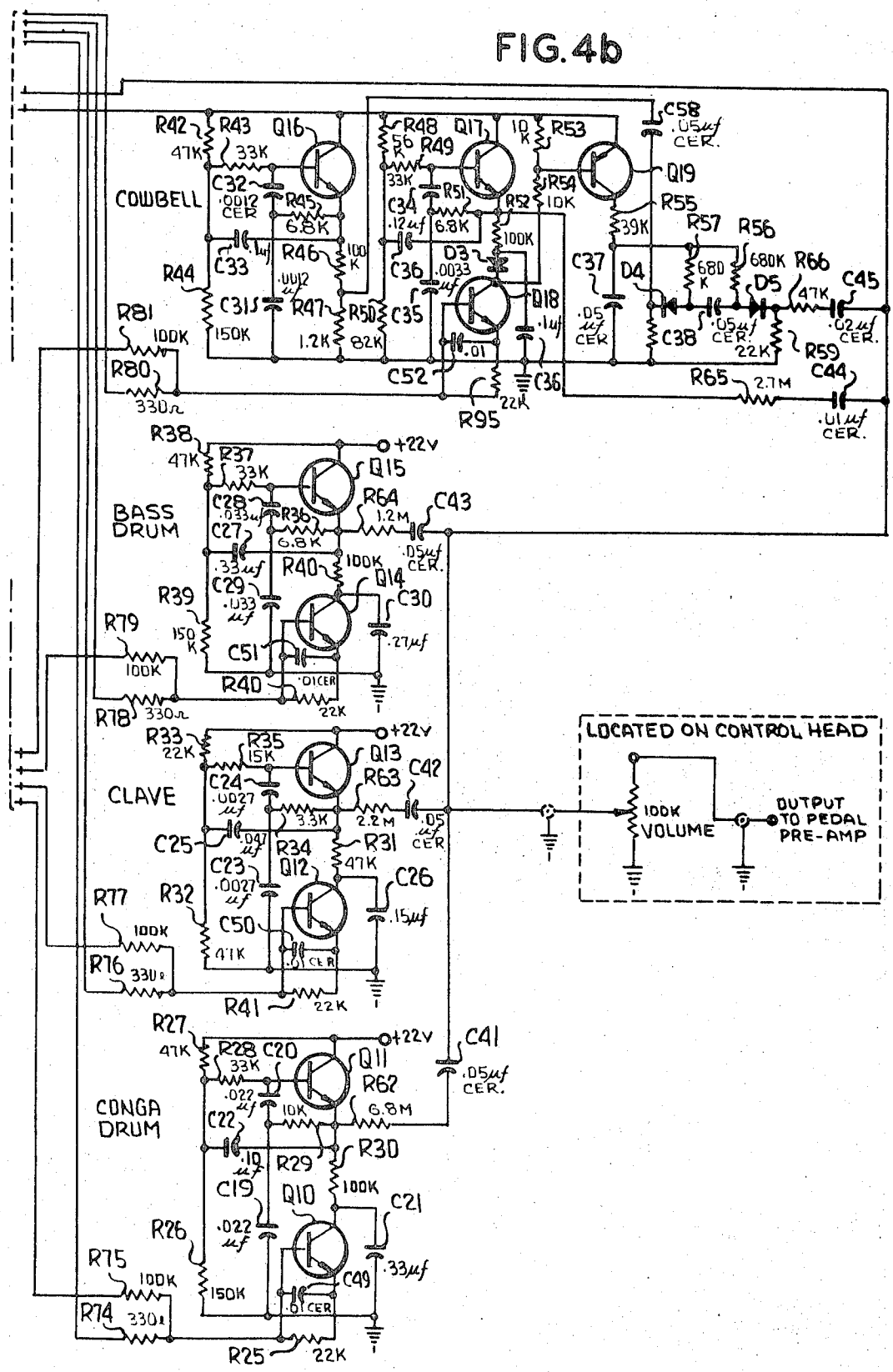

AUTO. TRIGGERS TO MATRIX (FIG. 3b)
SHUSH
SHUSH INHIBIT FROM TIMER BD.
PEDAL TRIGGER
BASS
SNAP
CLAVE
CYMBAL
SNAP
SNARE
CONGA
COWBELL
ON
0V
CYMBAL
SNAP DRUM
SNARE DRUM
+22V
PEDAL TRIGGER AMP
PEDAL TRIG. IN
ACC TRIGGER IN
ACCOMP TRIGGER AMP
MATCH FIG. 4b

FIG. 4a

FIG. 4b


COWBELL
BASS DRUM
CLAVE
CONGA DRUM
LOCATED ON CONTROL HEAD
100K VOLUME
OUTPUT TO PEDAL PRE-AMP
+22v
R42 47K
R43 33K
Q16
C32 .0012 CER
R45 6.8K
C33 .1µf
R46 100K
R44 150K
C31 .0012 µf
R47 1.2K
R50 82K
R81 100K
R80 330Ω
R48 56K
R49 33K
Q17
C34 .12µf
R51 6.8K
C36 .0033 µf
D3
R52 100K
Q18 .1µf
C35 .01
C52
R95 22K
C36
R53 10K
C58 .05µf CER.
Q19
R54 10K
R55 39K
R57 680K
R56 680K
C37 .05µf CER
D4
D5
R66 47K
C45 .02µf CER.
C38 .05µf CER
22K
R59
R65 2.7M
C44 .01µf CER.
R38 47K
R37 33K
Q15
C28 .033µf
R36 6.8K
C27 .33µf
R64 1.2M
C43 .05µf CER.
R40 100K
Q14
C29 .033 µf
C30 .27µf
R39 150K
R79 100K
C51 .01CER
R40 22K
R78 330Ω
R33 22K
R35 15K
Q13
C24 .0027 µf
R63 2.2M
C42 .05 µf CER
3.3K
C25 .047 µf
R34
R31 47K
Q12
C23 .0027 µf
C26 .15µf
R32 47K
C50 .01 CER
R77 100K
R76 330Ω
R41 22K
R27 47K
R28 33K
C20 .022 µf
Q11
R62 6.8M
C41 .05µf CER.
C22 .10 µf
10K
R30
R29 100K
C19 .022 µf
Q10
C21 .33µf
R26 150K
C49 .01 CER
R75 100K
R74 330Ω
R25 22K

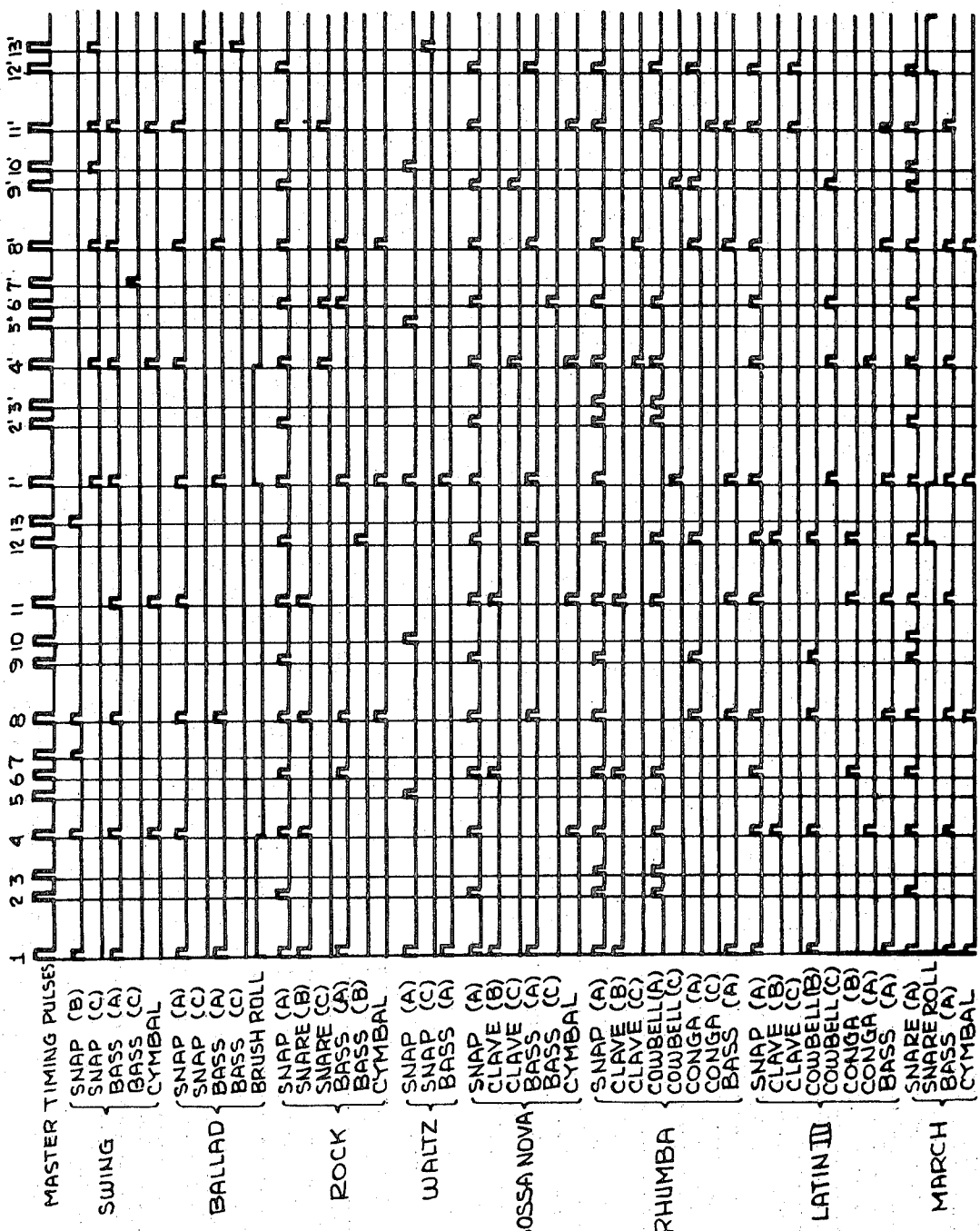
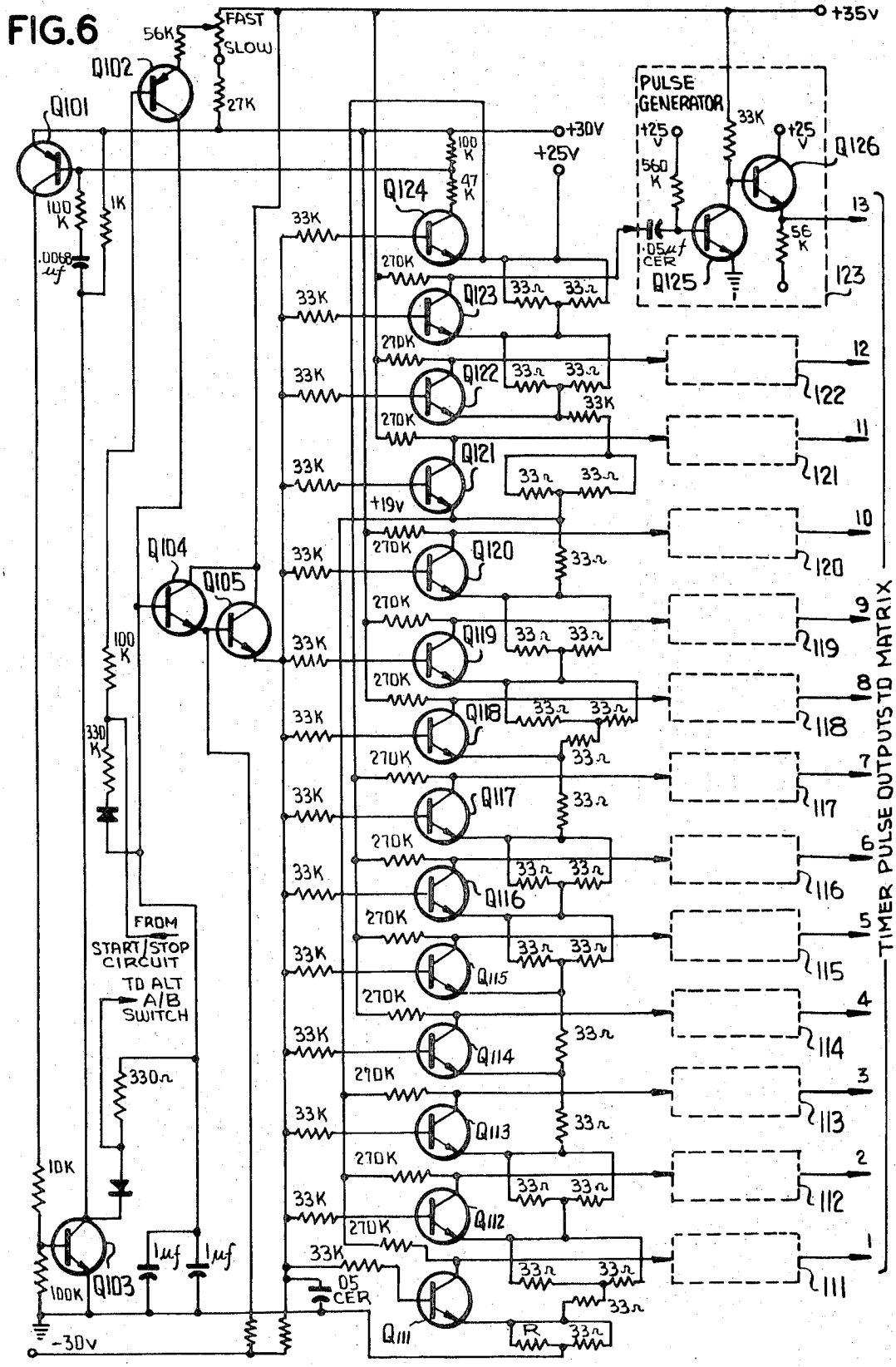

1 2 3 4 5 6 7 8 9 10 11 12 13 1' 2' 3' 4' 5' 6' 7' 8' 9' 10' 11' 12' 13'
MASTER TIMING PULSES
SWING
SNAP (B)
SNAP (C)
BASS (A)
BASS (C)
CYMBAL
BALLAD
SNAP (A)
SNAP (C)
BASS (A)
BASS (C)
BRUSH ROLL
ROCK
SNAP (A)
SNARE (B)
SNARE (C)
BASS (A)
BASS (B)
CYMBAL
WALTZ
SNAP (A)
SNAP (C)
BASS (A)
BOSSA NOVA
SNAP (A)
CLAVE (B)
CLAVE (C)
BASS (A)
BASS (C)
CYMBAL
RHUMBA
SNAP (A)
CLAVE (B)
CLAVE (C)
COWBELL (A)
COWBELL (C)
CONGA (A)
CONGA (C)
BASS (A)
LATIN III
SNAP (A)
CLAVE (B)
CLAVE (C)
COWBELL (B)
COWBELL (C)
CONGA (B)
CONGA (A)
BASS (A)
MARCH
SNARE (A)
SNARE ROLL
BASS (A)
CYMBAL

FIG. 5

FIG.6


+35v
FAST
SLOW
56K
27K
Q102
Q101
100 K
1K
.0068 uf
+30V
+25V
100 K
47 K
Q124
PULSE GENERATOR
+25 V
33K
+25 V
560 K
Q126
.05uf CER
Q125
56 K
13
123
33K
270K
Q123
33Ω
33Ω
12
122
Q122
33K
11
121
Q121
+19v
Q104
Q105
Q120
10
120
100 K
330 K
Q119
9
119
Q118
8
118
Q117
7
117
FROM START/STOP CIRCUIT
TO ALT A/B SWITCH
330Ω
Q116
6
116
Q115
5
115
Q114
4
114
Q113
3
113
10K
1uf
1uf
100K
Q103
Q112
2
112
.05 CER
Q111
R
1
111
-30v
TIMER PULSE OUTPUTS TO MATRIX

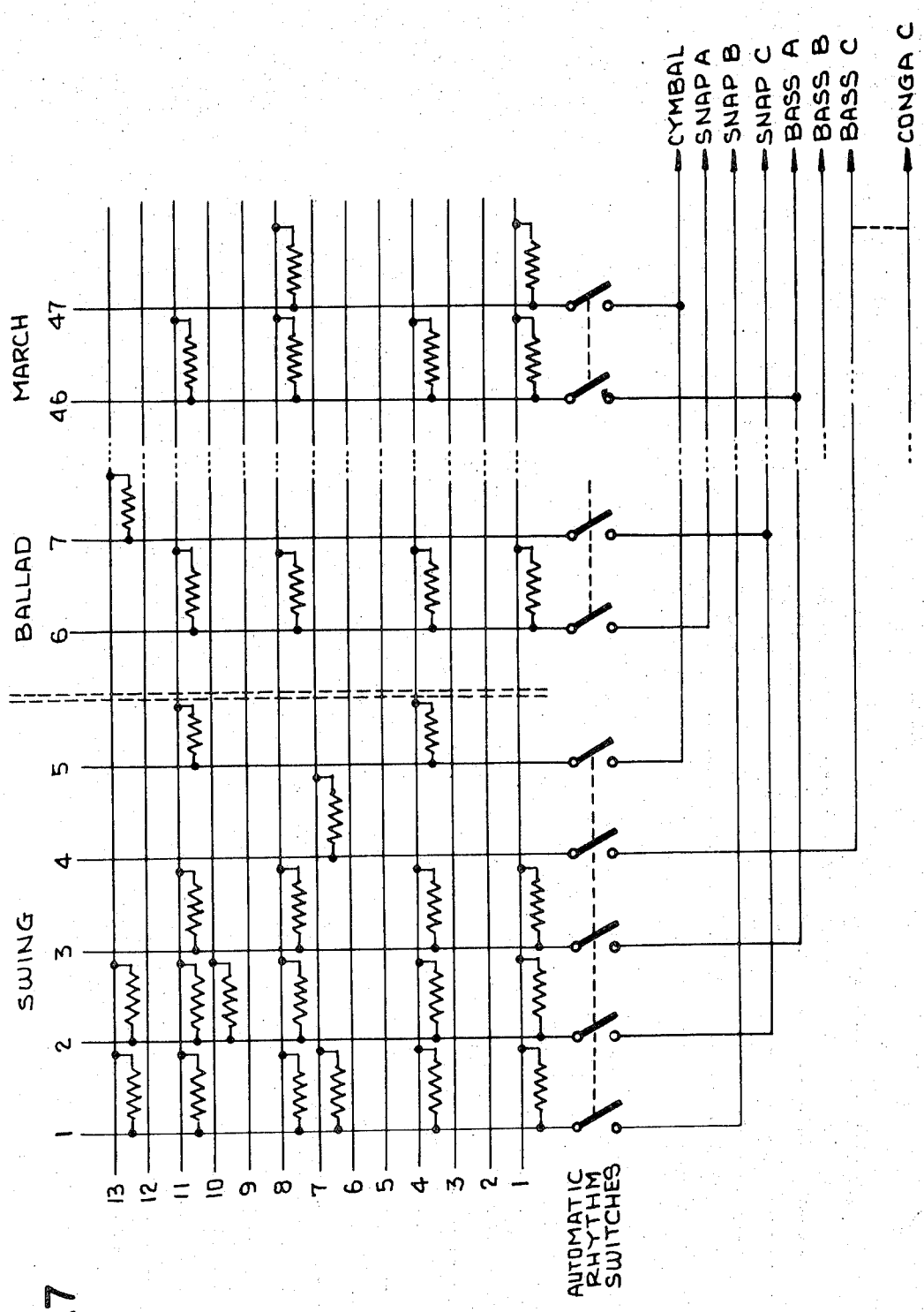

SWING
BALLAD
MARCH
1
2
3
4
5
6
7
46
47
13
12
11
10
9
8
7
6
5
4
3
2
1
AUTOMATIC RHYTHM SWITCHES
CYMBAL
SNAP A
SNAP B
SNAP C
BASS A
BASS B
BASS C
CONGA C

FIG.7

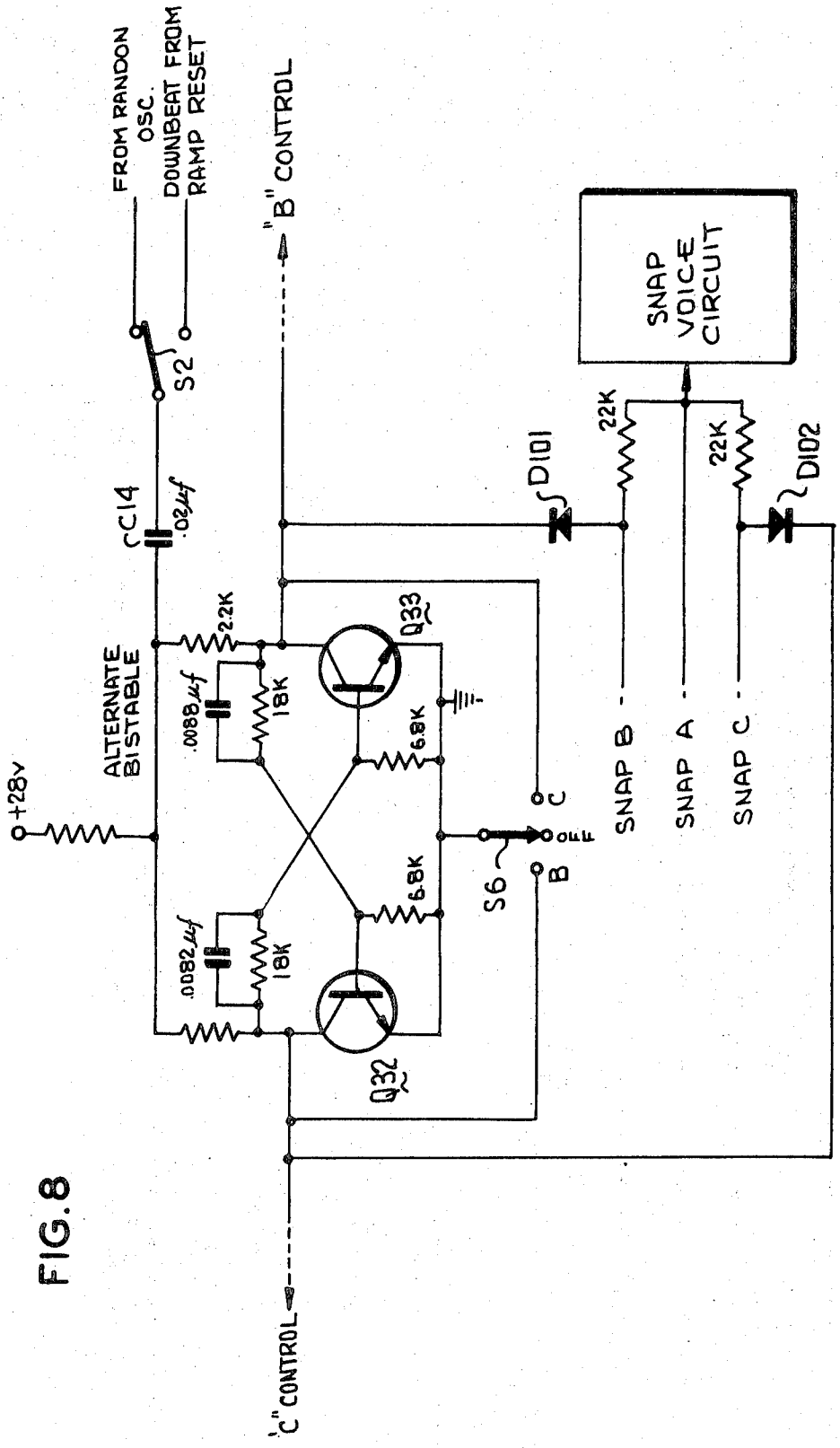

FROM RANDON OSC.
DOWNBEAT FROM RAMP RESET
S2
"B" CONTROL
SNAP VOICE CIRCUIT
22K
22K
D101
D102
C14
.02μf
2.2K
Q33
ALTERNATE BISTABLE
.0088μf
18K
6.8K
+28v
C
OUT
B
S6
SNAP B
SNAP A
SNAP C
6.8K
.0082μf
18K
Q32
"C" CONTROL

FIG.8

RHYTHM ACCOMPANIMENT SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to rhythmic accompaniment systems and more particularly to a selectively actuable rhythmic accompaniment system of the free running type.

Rhythmic accompaniment systems are known in the prior art. Certain of these are free running, that is, they are neither synchronized with nor slaved to the playing of a musical instrument, but rather produce rhythmic accompaniment tones to which the player may conform his tempo. The free running type accompaniment system is contrasted to what has become known as the automatic and semi-automatic accompaniment systems which automatically conform their tempo and/or measure duration to the tempo initiated by the player. The present system is of the free running type and is disclosed in a preferred embodiment along with alternative circuitry for providing certain features. The system may be built into a musical instrument, such as an electronic organ, or may be separate and apart from any musical instrument or instruments with which it might be utilized for rhythmic accompaniment.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention a rhythmic accompaniment system is actuable to function as a free running rhythm system producing selected rhythm patterns in selected tempos and tone voices and is de-actuable to permit the operator to completely control the tempo and rhythm pattern. When operating in the free running mode, the system is capable of producing any one or combination of a plurality of rhythms, each rhythm comprising a two measure pattern consisting of two single measure patterns which alternate continuously. Alternatively, the two patterns may be evoked randomly if so elected by the operator. A downbeat lamp flashes on the first beat of each measure, and means are provided to permit tempo selection over a wide range of measures per unit time. Both manual and automatic operation may be employed either separately or together to achieve desired rhythmic effects.

The system utilizes 13 master timing pulses per measure, the pulses being spaced by integral numbers of fixed time units to provide an overall thirteen pulse measure of 24 timing units duration. In one embodiment the thirteen master timing pulses are derived at corresponding levels of a repetitive ramp waveform, each ramp corresponding to one measure. Alternatively, two ramps are provided during each measure, each ramp producing seven primary pulses of which only six are employed during alternate half-measures to produce the total of 13 pulses per measure. Depending upon the selected rhythm, various ones of these timing pulses are chosen during each measure and applied to selected voice circuits to produce the desired rhythmic sounds.

Some frequently encountered rhythmic patterns extend over two measures. In such patterns the musical part completed by one rhythmic pattern may be the same for all measures, while another voice in the same pattern may be two measures long. For example, in one type of rhumba pattern the part played by the bass drum is the same for each measure whereas the part played by the conga drum is periodic over two measures. In accordance with the present invention, provision is made for automatically alternating two rhythmic measures, and alternatively for randomly evoking two different rhythmic measures. In an alternative embodiment, four pattern modes are actuable by the operator wherein a first or second rhythmic measure may be continuously repeated, the first and second rhythmic measures may be continuously alternated, and the first and second rhythmic measures may be randomly evoked.

A further provision of the present invention permits adjustment of the slope of the timing ramp to permit the operator to control the measure time and hence the tempo of the automatic rhythmic accompaniment.

A further feature of the present invention permits resetting of the timing ramp whenever the system is started to assure that the system always starts on the downbeat or first beat of each measure.

In still another feature of the present invention a novel cowbell voice circuit is provided which gates on a 1 KHz oscillator and a linear gate for 2 KHz continuous oscillator, the two signals being combined to provide a realistic cowbell tone.

In still another feature of the present invention certain pulses gated from a rhythm selection matrix are employed to initiate and eventually terminate trigger signals applied to drum-simulating voice circuits to produce drum roll effects over a desired number of beats in each measure.

It is accordingly a broad object of the present invention to provide a novel rhythmic accompaniment instrument.

It is another object of the present invention to provide a rhythmic accompaniment instrument which is capable of providing rhythmic patterns and voices which are more realistic than those produced by prior art instruments of this type.

Still another object of the present invention is to provide a rhythmic accompaniment instrument capable of operation in four different rhythmic measure modes, including continuous alternation of two different rhythmic measures, and the random selection of said two rhythmic measures.

Still another object of the present invention relates to the generation of thirteen uniquely spaced master timing pulses from which substantially any desired rhythm pattern can be generated.

Still further objects of the present invention include the generation of cowbell and drum roll rhythm sounds by means of novel circuitry.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of specific embodiments thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a block diagram of a preferred embodiment of the present invention;

FIGS. 2*a* and 2*b* taken together comprise a schematic circuit diagram of the timing circuits of the embodiment illustrated in FIG. 1;

FIGS. 3*a* and 3*b* taken together comprise a schematic diagram of the rhythm selection matrix employed in the embodiment illustrated in FIG. 1;

FIGS. 4*a* and 4*b* taken together comprise a schematic circuit diagram of voice generator circuits utilized in conjunction with the system illustrated in FIG. 1;

FIG. 5 is a timing diagram illustrating various master timing pulses and rhythmic patterns produced in the system of FIG. 1;

FIG. 6 is a schematic diagram of an alternative circuit for producing the master timing pulses required for the system of FIG. 1;

FIG. 7 is a schematic diagram of a portion of an alternative matrix circuit for use in place of the circuit illustrated in FIGS. 3*a* and *b*; and

FIG. 8 is a schematic diagram of an alternative circuit to be provided in the system of FIG. 1 to permit four different modes of a rhythmic pattern operation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now more particularly to FIG. 1 of the accompanying drawings there is illustrated a block diagram of a rhythmic accompaniment system wherein closure of switch S1 actuates a repetitive ramp generator **10**, the frequency of which is selectively adjustable by means of frequency control element **11**. The ramp signal is applied to a timing pulse generator **13** which provides a plurality of master timing pulses of individual signal lines, at each pulse provided at a time corresponding to a respective level of the ramp signal provided by generator **10**. The master timing pulses occur in a repetitive pattern which comprises a musical measure. The master timing pulses are spaced in time in accordance with the criteria described in detail hereinbelow and are applied to respective lines in a rhythm selection matrix **15**. Matrix **15** also receives one or more signals from automatic rhythm selection switches **17**, matrix **15** being arranged so that predetermined ones of the timing pulses are provided as output pulses in accordance with which of the automatic rhythm selection switches are actuated. The output pulses from matrix **15** are applied to voice circuits **19** wherein appropriate accompaniment tones are generated in response to each output pulse from the matrix. The generated tones are combined and applied to an amplifier **21** and in turn to loud speaker **23**.

Rhythm selection matrix **15** also receives two gating signals from measure alternation control unit **25** which is essentially a bi-stable device. When unit **25** is in a first state it provides a "B" signal which causes a rhythm selected by switches **17** to be produced in a first rhythmic pattern of output pulses from matrix **15** during each measure. Likewise, when unit **25** is in a second state it provides a "C" signal which causes the selected rhythm to be produced in a second pattern during each measure. The state of the measure alternation control unit **25** is illustrated as being controlled either by downbeat pulse generator **27** or random oscillator **29**. Downbeat pulse generator **27** receives the ramp signal from repetitive ramp generator **10** and provides a pulse corresponding to the downbeat or first pulse in each measure. This downbeat pulse lights lamp **31** at the console of the unit and also changes the state of measure alternation control unit **25**. Consequently, when downbeat pulse generator **27** is in control of unit **25**, the two rhythmic pattern measures produced by signals B and C will alternate. Random oscillator **29**, when effective, changes the state of unit **25** at a frequency which is random with respect to the frequency of repetitive ramp generator **10** so that the measure produced by signals B and C at matrix **15** change randomly, that is, not in regular measure alternation.

The Roll oscillator RO output is fed to the Roll control unit **32** which responds to appropriate output pulses applied thereto from matrix **15** to apply a return Roll signal to the matrix. This signal gates one or more input signals to the voice circuits **19** for a predetermined period of time between two master timing pulses supplied by generator **13**. During this predetermined period of time the appropriate voice circuit simulates a drum roll as opposed to the relatively short percussive sound produced by the usual output pulse for matrix **15**.

Voice circuits **19** may be actuated manually, either in conjunction with or independently of automatic voice circuit actuation, by appropriately actuating various ones of manual rhythm switches **33**. If for example, the clave manual switch is closed, each pedal actuation at console unit **35** initiates a trigger pulse, via trigger circuit **37**, which passes through the pedal clave switch at unit **33** to trigger the clave voice circuit. Actuation of a key at unit **35** likewise initiates a trigger at circuit **37** which passes through the appropriate accompaniment rhythm switch to trigger an appropriate voice circuit at unit **19**.

The system of FIG. 1 is illustrated in greater detail in FIGS. 2*a*, 2*b*, 3*a*, 3*b*, and 4*a* and 4*b*. With particular reference to FIG. 2*a*, repetitive ramp generator **10** of FIG. 1 comprises a variable resistor P1 connected in series with fixed resistor R5 between +28 volts DC and +22 v. DC setup at the emitter electrode of PNP transistor Q1. The collector of Q1 is connected via resistor R1 to the base of NPN transistor Q3 which, along with Q1, comprises a mono-stable multivibrator. The emitter of Q3 is connected directly to ground and its base is connected to ground via resistor R2. The center arm of variable resistor P1 is connected via resistor RS2 to the emitter of PNP transistor Q2, the base of which is connected to +22 v. and the collector of which is returned to ground via timing capacitor C1. The collector of Q2 is also connected to the base of NPN transistor Q4, the emitter of which is connected to the base of further NPN transistor Q5. The emitters of Q4 and Q5 are returned to −50 volts DC through respective resistors R10 and R11. Transistors Q4 and Q5 and resistors R10 and R11 comprise a compound emitter follower circuit which serves to buffer the linear ramp applied to the base of Q4 from the threshhold switching circuits connected to the emitter of Q5. Also connected to the collector of Q2 is a resistor R6 which is also connected to the collector of Q3 via diode D1 and to a one-half measure bi-stable circuit, to be described in detail below, via diode D2.

The collector of Q3 and the base of Q1 are connected via a series connected resistor R4 and capacitor C2. The collector of Q3 and the emitter of Q1 are connected via resistor R3 at +22 v.

Transistor Q2, in conjunction with resistors RS2, P1, and R5, comprises a constant current generator, the current from which flows from the collector of Q2 at a level depending upon the setting of P1. The constant current charges timing capacitor C1 to produce the required linear ramp of voltage at the base of transistor Q4; that is, if C1 is initially uncharged, the voltage thereacross increases linearly.

The linear ramp voltage, which also appears at the emitter of Q5, is applied in parallel to each of resistors R12 through R19, inclusive. Each of R12 through R19 feeds the base of a respective NPN transistor Q6 through Q13 which are connected to progressively increasing (in a positive sense) emitter potentials. More particularly, resistors RS1 and R20 through R33 inclusive comprise a complex voltage divider network connected between R5 and ground from which various taps are connected to the emitter of Q6 through Q13. The potentials connected to the various emitters vary in accordance with a desired pulse timing sequence such that normally non-conducting transistors Q6 through Q13 are gating on at times corresponding to predetermined voltage levels of the ramp appearing at the emitter of Q5. Non-conduction of Q6 through Q13, in the absence of the ramp voltage at the emitter of Q5, is assured by virtue of the slightly negative voltage appearing at the emitter of Q5 via resistor R11.

The collectors of Q6 through Q12 are AC coupled via capacitors C3 through C9 inclusive to the bases electrode of respective NPN transistor switches Q14 through Q20, inclusive. Transistors Q14 through Q20 have their emitters returned to ground and are biased to normally conduct from +28 volts DC through their collector-emitter circuits through respective collector resistors R51 through R57. This biased-on condition is accomplished by means of +28 volts DC applied to the bases of Q14 through Q20 via respective base-bias resistors R44 through R50. The collectors of each of transistors Q14 through Q20 are connected to the anode of respective diodes D5 through D11, the cathodes of which are tied together and connected to the collector of NPN transistor Q31. The operation of Q31 is described in greater detail subsequently; however, for present purposes it is to be understood that when Q31 conducts, diodes D5 through D11 shunt the collectors of Q14 through Q20 to ground and render them unable to provide positive-going output pulses.

As the ramp voltage at the emitter of Q5 increases, Q6 through Q12 are sequentially turned on. The transition from off to on of each of these transistors transmits a corresponding negative-going pulse via coupling capacitors C3 through C9 to the base of the appropriate transistor Q14 through Q20, rendering the latter momentarily non-conductive. The non-conductive intervals for Q14 through Q20 produce positive-going primary pulses (No. 1 through No. 7) at the collectors of these transistors, assuming of course that transistor Q31 is not conducting and therefore diodes D5 through D11 do not shunt the collectors to ground. Sometime after Q12 is turned on by the ramp signal, Q13 is also turned on, causing Q1 to conduct. This effectively fires the mono-stable circuit comprising Q1, Q3, R1, through R4, and C2. Q3 conducts for approximately 2 milliseconds and thereby discharges timing capacitor C1 via R6 and D1. Discharge of C1 removes the positive voltage from the emitter of Q5, and each of transistors Q6 through Q13 are thereby rendered non-conductive. At the conclusion of the interval during which Q3 is conductive, linear charging of C1 begins again by means of the constant collector current from Q2. Sequentially switching of Q6 through Q12 is repeated to provide a sequential primary pulse No. 1 through No. 7 at the collectors of respective transistors Q14 through Q20.

Pulse No. 1 – No. 7 are applied to the base of respective NPN transistors Q51 through Q63 inclusive. The emitters of these transistors are connected via respective emitter resistors RE1 through RE13, inclusive, to −50 volts DC, the bases being connected via respective base resistors RB1 through RB13, inclusive, to +50 volts DC. In addition the bases of Q51 through Q63 are connected to the anodes of respective diodes D31 through D43, inclusive, the cathodes of which are connected to the collectors of different ones of transistors Q14 through Q20. More particularly, the collector of Q14, which provides primary pulse No. 1, is connected to the cathodes of D31 and D38. Likewise, primary pulse No. 2 is applied to the cathodes of D32 and D39, primary pulse No. 3 is applied to the cathodes of D33 and D40, primary pulse No. 4 is applied to the cathodes of D34 and D41, primary pulse No. 5 is applied only to the cathode of D35, primary pulse No. 6 is applied to the cathodes of D36 and D42, and primary pulse No. 7 is applied to the cathodes of D37 and D43. The collectors of Q51 through Q57, inclusive, are connected to secondary pulse control line (1), and the collectors of Q58 through Q63, inclusive, are connected to secondary pulse control line (2). These control lines emanate from a circuit to be described in detail subsequently; however for present purposes it is to be understood that one or the other of these control lines, but not both, is at +28 volts DC while the other is at substantially ground potential.

In the absence of a positive-going primary pulse applied to its base diode, each of transistors Q51 through Q63 is biased off by the fact that its base junction is shunted to ground by its base diode connected in series with one of the normally conducting transistors Q14 through Q20. A positive-going primary pulse applied to the cathode of any one of the diodes D31 through D43 biases that diode off and thereby increase the voltage at the base of the associated transistor Q51 through Q63. If that transistor has +28 volts DC applied to its collector by the appropriate secondary pulse control line, that transistor is rendered conductive and a positive pulse, corresponding to the positive pulse applied to its base diode, appears across the emitter resistor of that transistor. The various signal lines numbered 1 through 13 and connected to the emitter electrodes of corresponding transistors Q51 through Q63 carry secondary pulses, or master timing pulses, to respective horizontal lines 1 through 13 of the rhythm selection matrix to be described in detail below in relation to FIGS. 3*a* and 3*b*.

Referring now to FIG. 2*b* there is illustrated a half-measure bi-stable circuit. The half-measure bi-stable circuit comprises four NPN transistors Q21 through Q24, inclusive, interconnected by respective coupling resistors and capacitors to provide bi-stable operation. Output transistors Q21 and Q24 are always of opposite states in accordance with the existing state of the half-measure bi-stable circuit. Secondary pulse control line (1), which as described above is connected to the collector electrodes of Q51 through Q57, is derived from the emitter electrode of Q24. Secondary pulse control line (2), which as described above is connected to the collector electrodes of Q58 through Q63, is derived from the emitter electrode of Q21. Trigger pulses are applied to the half-measure bi-stable circuit via capacitor C20 from the collector of Q3 each time the master timing ramp waveform is reset. Thus, for alternate cy-

cles of the ramp waveform, the half-measure bi-stable circuit alternates states, and likewise secondary pulse control lines (1) and (2) alternate states. Thus, during one ramp cycle Q51 through Q57 are gated on by the master timing pulses, and during the next ramp cycle Q58 through Q68 are gated on by the primary timing pulses. In this manner, Q51 through Q63 are gated on sequentially over two ramp periods to provide 13 secondary or master timing pulses. The 13 master timing pulses constitute a musical measure, and consequently two timing ramp periods determine the duration of each measure.

The relative spacing between the master timing pulses is determined by resistors RS1 and R20 through R33 associated with the emitter circuits of Q6 through Q13. A particular set of values, indicated in the drawings, yield a preferred timing relationship between these pulses such as that illustrated in the top line of the timing diagram in FIG. 5. The 13 pulse measure is divided into 24 equal time units, with adjacent master timing pulses being separated by integral numbers of units. More particularly, each ramp period or half-measure (during which primary pulses No. 1 through No. 7 are generated) is divided into twelve equal timing units wherein primary pulses No. 1 and No. 2 are separated by three timing units, pulses No. 2 and No. 3 by one timing unit, pulses No. 3 and No. 4 by two timing units, pulses No. 4 and No. 5 by two timing units, pulses No. 5 and No. 6 and pulses No. 6 and No. 7 by one timing unit each, and pulses No. 7 and No. 1 by two timing units. Since primary pulse No. 5 actuates a transistor only in alternate ramp periods, only six secondary or master timing pulses are generated in alternate half-cycles. Thus, the spacing between master timing pulses 8 and 7 is the same as the spacing between primary pulses No. 7 and No. 1, the spacing between master timing pulses 9 and 8 is the same as the spacing between the primary pulses No. 1 and No. 2, etc. The only difference between the secondary portion of each measure and the first portion thereof is the three timing unit spacing between pulses 11 and 12, due to the omission of primary pulse No. 5 in the second half of the measure. Two complete measures of master timing pulses are illustrated in FIG. 5 for reasons to be described in detail below.

As described above, the constant current delivered to timing capacitor C1 to generate the master timing ramp is determined by the setting of the center arm of the variable resistor P1. The greater the current the shorter the period of time required for the ramp voltage to trigger each successive resistor Q6 through Q13 and recycle itself. Since the number of ramps generated per unit time can be controlled in this manner, the measure time, and hence the tempo of the accompaniment system, is controlled by means of P1. Resistor RS2, in series with the emitter of Q2 and the center arm of P1, is preferably selected to provide a tempo of two measures per second when the center arm of P1 is set to the minimum resistance or "fast" tempo position.

Because of the wide component tolerance spread effecting the time interval between the primary pulses No. 7 and No. 1, it is necessary to select resistor RS1 in the emitter circuit of Q6 such that the time between primary pulses No. 7 and No. 1 is as desired. As illustrated in the master timing pulse timing diagram, FIG. 5, RS1 is selected to provide a two timing unit spacing between pulses No. 7 and No. 1, which is the same spacing as between primary pulses No. 4 and No. 5.

Each time transistor Q24 in the half-measure of bi-stable circuit is rendered conductive, signifying the start of a measure, a pulse is applied via coupling capacitor C11 and resistor R63 and R64 to the base of a transistor Q25. The collector-emitter circuit of transistor Q25 is connected in series with an indicator lamp L1 and resistor R91 between +28 volts DC and ground. When pulsed, NPN transistor Q25 turns on, providing a current path by which lamp L1 may be lit. Capacitor C17 is connected across lamp L1 to ground to maintain the lamp lit for a period of about 100 milliseconds at each downbeat or first master timing pulse in each measure.

It is sometimes desirable to have a rhythm accompaniment of two measure duration; that is the rhythm pattern in alternate measures is somewhat different. The control circuitry for achieving this is illustrated in the FIG. 2*b* and includes an alternate bi-stable circuit comprising NPN transistors Q32 and Q33 interconnected by various resistors and capacitors to provide conventional bi-stable operation. A "B" control signal is provided from the collector of Q33 and a "C" control signal is provided from the collector of Q32. Depending upon the state of the alternate bistable circuit, one of the B and C control signals is at +16 volts DC while the other is at substantially ground. Trigger signals are applied to the alternate bi-stable circuit via coupling capacitor C14 from the arm of a toggle switch S2. When S2 is in its alternate position, each pulse through downbeat lamp L1 is conducted through S2 and C14 to trigger the alternate bi-stable circuit. In this mode the alternate bi-stable circuit is switched by the first timing pulse of each measure and has a switching frequency which is half that of the half-measure bi-stable circuit. Alternatively, with switch S2 in its random position, a trigger is applied to the alternate bistable circuit via capacitor C14 from a random oscillator circuit comprising NPN transistors Q34, Q35, and Q36. More particularly, transistors Q34 and Q35 are interconnected by appropriate resistors R84, R85, and R86 and capacitor C16 provides an oscillatory signal at the emitter of Q35 which signal has a low frequency on the order of 5 Hz. This signal is applied via resistor R87 to the base of Q36 which has its collector emitter circuit connected in series with the resistor R88 between +22 volts DC and ground. The collector of Q36 thus provides a train of positive-going pulses of approximately 50 millisecond pulse width and approximately 200 milliseconds period. These pulses, with S2 in the random position, trigger the alternate bi-stable circuit at the 5 Hz rate, which is random relative to the frequency of the ramp timing signal. For either position of S2, the B and C control signals alternate state and, in a manner to be described in relation to FIGS. 3*a* and 3*b* below, determine the rhythmic pattern to be produced during each measure.

Also illustrated in FIG. 2*b* is a stop/start bi-stable circuit comprising NPN transistors Q29 and Q30 interconnected by appropriate resistors and capacitors to operate in bi-stable fashion. It is the state of this bi-stable circuit which influences the condition of transistor Q31 such that in one state of the stop/start bi-stable circuit Q31 is conductive to shunt the collectors of Q14 through Q20 of FIG. 2*a* to ground via diodes D5 through D11, thereby inhibiting the primary timing

pulses. In the other state of the stop/start bi-stable circuit, transistor Q31 is non-conductive, conduction through diodes D5 through D11 is blocked, and the master timing pulses are sequentially generated. Stop/-start switch S3, a normally open grounding switch, when actuated changes the state of the stop/start bi-stable circuit via triggering capacitor C13 and a bounce suppression network including resistors R70 and R71, diode D20 and capacitor C19.

A one-shot multivibrator, including NPN transistors Q26 and Q27 and PNP transistor Q28 has the function of resetting the timing ramp to its start condition whenever the system is started, as by actuation of switch S3. The base of Q26 is connected to the collector of Q29 in the stop/start bi-stable circuit and its collector is connected to +28 volts DC. The emitter of Q26 is connected to ground via resistor R65 and is coupled to the base of Q27 via capacitor C12 and resistor R66. The junction between capacitor C12 and resistor R66 is connected to the cathode of clamping diode D14, the anode of which is connected to ground. The base of Q27 is connected to −50 volts DC via resistor R67. The collector of Q27 is connected to +28 volts DC via resistor R68 and to the junction between resistor R6 and diode D1 via diode D2, poled for conduction through the collector-emitter circuit of Q27. The emitter of Q27 is tied directly to the emitter of Q28 and, via resistor R69, to the collector of Q28. The base of Q28 is connected to the emitter of transistor Q6, in FIG. 2*a*, Q6 being the first to trigger during each ramp period.

The system is started when transistor Q29 turns off. At this time Q27 is turned on for nominally 6 milliseconds under the influence of capacitor C12 and resistor R66 via buffer Q26. The drop across C12 necessary to provide the correct transient time for Q27 is achieved by clamping diode D14 which quiescently (i.e. when Q27 is off) clamps one-side of C12 substantially to ground potential. When Q27 is conductive, timing capacitor C1 is discharged via R6, D2, and the collector emitter circuits of transistors Q27 and Q28. This effectively turns off Q6 and assures, for all practical purposes, that the ramp waveform and timing pulses produced therefrom are recycled when the system is started.

To assure that the system starts in the first half of each measure, the positive transient voltage appearing at the junction of C12 and R66 when Q29 turns off is employed via resistors R90 and R62 to trigger the alternate bistable and half-measure bistable circuits respectively. This assures that the B control signal, at the alternate bistable circuit, and secondary pulse control line (1), at the half-measure bistable circuit, are rendered positive when the system starts.

Stop/start switch S3 is described above as being effective to stop or start the automatic rhythm accompaniment tones of the present invention. S3 is preferably a foot switch which when employed to stop the accompaniment effectively shunts the timing pulses to ground via diode D5 through D11 as described. Note however that the timing circuit is still operative in the sense that the master timing ramp sequentially actuates Q6 through Q13. In order to completely disable the master timing circuit, switch S1, which is ganged to variable resistor P1, is opened to thereby apply −50 volts DC to the collectors of Q4 and Q5 via resistor R93. This effectively cuts off Q4 and Q5 and prevents application of the ramp voltage to Q6 through Q13. Since Q13 is prevented from triggering Q1 and Q3, timing capacitor C1 cannot discharge and the repetitive ramp pattern is terminated. Opening of S1 also drives the collector of transistor Q29 of the stop/start bistable circuit negative via diode D19 and resistor R93 so that Q29 is maintained off. If S1 is now closed, Q4 and Q5 are enabled and current flows into C1 to re-initiate the repetitive ramp waveform.

Resistor R72 connected between the base of the emitter of Q30 in the stop/start bistable circuit serves as a bias during turn on of the system power supply such that the system settles in a condition whereby Q31 is conductive to inhibit the primary timing pulses from Q14 through Q20.

There is also provided in FIG. 2*b* a roll oscillator comprising NPN transistors Q39 and Q40 interconnected by appropriate resistors and capacitors to provide an oscillatory output signal at a frequency of approximately 25 Hz. This signal, taken from the collector of Q40, is applied to the base of PNP transistor Q41, the emitter of which is connected to +28 volts DC and the collector of which is connected to a common junction from which the brush roll control signal (via resistor R80 and diode D14) and snare roll control signal (via resistor R81 and diode D15) are provided, these signals being positive pulses at the 25 Hz rate if Q41 is not inhibited. Said common junction is coupled via diode D18 to the collector of NPN transistor Q37 which, along with NPN transistor Q38 and appropriate resistive and capacitive interconnecting circuitry, comprises a roll control bistable circuit. In one state of the roll control bistable circuit Q37 is conductive to ground, effectively shorting out the brush and snare roll control signals. In the opposite state of the roll control bistable circuit Q38 is conductive and Q37 is not, thereby rendering the brush and snare roll control signal operative to effect the appropriate simulated drum rolls as described hereinbelow. The state of the roll control bistable circuit is determined by the roll start signal applied to the base of Q38 and the roll finish signal applied to the base of Q37, both of which signals are received from the rhythm selection matrix described in detail in reference to FIGS. 3*a* and 3*b*. The roll start signal triggers Q38 on and Q37 off to enable the brush and snare roll control signals; the roll finish signal triggers Q37 on to inhibit the brush and snare roll control signals.

Before describing the rhythm selection matrix, brief mention should be made of the shush (1) and shush (2) signals. Shush is a term which refers to the background noise appropriate to some rhythm accompaniments. Shush (1) is a consistent noise level realized by connecting R7 to a suitable voice circuit in the manner described hereinbelow with reference to FIGS. 4*a* and 4*b*. Shush (2) refers to a noise character which decreases through the beginning portion of the measure until reaching a consistent level at the middle of the measure, which level is retained until the measure is completed. This is realized by mixing a steady noise signal, set up by R8, and a noise signal having a triangular envelope during the first half of the measure, and employing only a steady level during the second half of the measure. More particularly, the triangular envelope is generated from the master timing ramp during a first ramp cycle via resistor R9 connected to the emitter of Q5. During the next ramp cycle secondary pulse con-

trol signal (2), provided by the emitter of Q21, is supplied by diode D4 to override the ramp signal and provide a steady level for the shush (2) signal.

Referring now to FIGS. 3*a* and 3*b* of the accompanying drawings, there is illustrated a resistive matrix in which the horizontal lines are thirteen in number, corresponding to the thirteen master timing pulses which are applied thereto and which are illustrated in the top line of each measure in FIG. 5. A total of 47 vertical matrix lines are illustrated, the vertical lines being divided into eight groups representing different rhythms. The number of rhythm groups illustrated is by way of example only and not to be considered limiting on the scope of the present invention. Vertical lines and horizontal lines are selectively interconnected at appropriate junctions by 100 K resistors so that a signal is provided on each vertical line in time coincidence with a pulse on a horizontal line to which that vertical line is resistively coupled. Thus, for example, vertical line 1 is seen to be resistively coupled to horizontal lines 1, 4, 7, 8, 11 and 13, indicating that during each measure the 1, 4, 7, 8, 11, and 13 master timing pulses appear on vertical line 1. Likewise vertical line 29 is resistively coupled to the 4 and 8 master timing pulse lines to thereby provide the 4 and 8 master timing pulses during each measure.

The groups into which the vertical lines are divided are as follows:

Line Numbers	Rhythm
1–5	SWING
6–11	BALLAD
12–17	ROCK
18–20	WALTZ
21–26	BOSSA NOVA
27–34	RHUMBA
35–42	LATIN III
43–47	MARCH

The LATIN III rhythm can represent the cha-cha, mambo, or samba according to the tempo selected by variable resistor P1. The other rhythms are self evident.

Each vertical line 1–47 is connected to the anode of a respective diode D14 through D60, respectively. The cathodes of D14 through D18, in the SWING rhythm group, are connected to one pole of a two-pole SWING switch which, when not actuated effectively grounds the cathodes of these diodes and thereby shunts positive pulses appearing on vertical lines 1–5 to ground. When actuated the SWING switch leaves the cathodes of D14 through D18 floating, thereby enabling vertical lines 1–5 to conduct their resistively coupled master timing pulses further along the circuit. Likewise, the diodes associated with the BALLAD lines 6 through 11 are shorted to ground by one pole of the BALLAD switch unless the latter is actuated. Similar selective shorting of the vertical lines in the ROCK, WALTZ, BOSSA NOVA, RHUMBA, LATIN II, and MARCH groups is accomplished by respective automatic rhythm switches. Thus by actuating the appropriate automatic rhythm switch a group of vertical lines corresponding to the selected rhythm are enabled.

The sequential pulses appearing on the vertical lines are connected to various appropriate voice circuits of FIGS. 4*a* and 4*b*, described in detail hereinbelow. The voice circuits respond to application of positive trigger pulses thereto to produce rhythmic sounds which simulate those produced by musical accompaniment instruments. Thus, and the inclusion of the following circuits is by no means limiting, there are provided the following voice circuits connected to respond to the triggers produced by the matrix of FIGS. 3*a* and 3*b*: Cymbal, Snap, Snare, Bass Drum, Clave, Cowbell, and Conga Drum. The Cymbal trigger line is resistively coupled to vertical lines 5, 17, 26, and 47 of the rhythm selection matrix. The snap trigger line is a combination of the Snap A, Snap B, Snap C signals. ("Snap", used herein interchangeably with "Brush", refers to the sound produced by striking a brush stick on a drum or the operation of a Hi-Hat.) The Snap A signal is connected directly to the Snap trigger line and receives pulses from vertical lines 6, 12, 18, 21, 27 and 35 of the matrix. The Snap B signal is selectively gated to the Snap trigger line by means of series diode 87 and shunt diode 86, the cathode of the latter being connected to the B control signal provided by the alternate bi-stable circuit in FIG. 2*b*. When the B control signal is positive, diode D86 is blocked and the Snap B signal is conducted through diode D87 to the Snap trigger line. When the B control signal is grounded diode D86 shunts pulses appearing on the Snap B line to ground and inhibits their application to the Snap trigger line. The Snap B signal is derived from vertical line number 1 of the matrix.

A Snap C signal is applied selectively to the snap trigger line via a diode gate comprising series diode D89 and shunt diode D88, the cathode of the latter being connected to the C control signal provided by the alternate bistable circuit of FIG. 2*b*. When the C control signal is positive D88 is blocked and the pulses appearing on the Snap C line are connected to the Snap trigger line. When the C control signal is grounded D88 acts to shunt all Snap C signals to ground and prevent their conduction to the Snap trigger line. Thus, depending upon the state of the alternate bistable circuit of FIG. 2*b*, either the pulses appearing on the Snap B line or those appearing on the Snap C line are conducted to the snap voice circuit via the Snap trigger line during any given measure. The Snap A pulses, however, are conducted to the Snap voice circuit during every measure, irrespective of the state of the alternate bistable circuit.

In like manner, these are provided, by means of various combinations of the vertical lines in the matrix, Snare A, Snare B, Snare C, Bass A, Bass B, Bass C, Clave B, Clave C, Cowbell A, Cowbell B, Cowbell C, Conga A, Conga B, and Conga C signal lines, which apply pulses to their respective voice circuits. All of the pulses appearing on a B trigger line are gated through to their respective voice circuits only when the B control signal from the alternate bistable circuit is positive. Likewise, all of the pulses appearing on a C trigger line are gated through to their respective voice circuits only during measures in which the C control signal provided by the alternate bistable circuit is positive The signals are applied to their respective voice circuits during every measure.

In addition, vertical lines 10 and 44 of the matrix are combined to provide the roll start signal, which is applied to the base of Q38 in the roll control bistable circuit of FIG. 2*b*. Likewise, vertical lines 11 and 45 are combined to provide the roll finish signal, applied to the base of Q37 in the roll control bistable circuit. The brush and snare roll control signals provided at the collector of Q41 are connected to the Snap A and Snare A lines respectively to provide a repetitive positive voltage to these signal lines, and thereby to their corre-

sponding voice circuits, whenever a roll is to be simulated.

Each of the SWING, BALLAD, and WALTZ automatic rhythm switches have an extra pole ganged thereto for purposes of providing shush effects. More particularly, the shush (1) signal is applied to the second pole of the SWING switch which, when actuated, applies the shush (1) signal to the Cymbal voice circuit, to be described below in reference to FIGS. 4*a* and 4*b*. The second pole of the BALLAD and WALTZ automatic rhythm switches selectively apply the shush (2) signal to the Cymbal voice circuit.

Operation of the matrix of FIGS. 3*a* and 3*b* may best be illustrated with reference to the timing diagram of FIG. 5. Using as an example the SWING rhythm, for which we assume that the SWING automatic rhythm switch has been actuated, the Bass A signal is pulsed by the first, fourth, eighth, and eleventh master timing pulse during each measure, these pulses being equally spaced (by six timing units) to provide the standard four beats to the measure required for the SWING rhythm. The Snap trigger line is pulsed by the Snap B signal during B measures at the first, fourth, seventh, eighth, eleventh, and thirteenth master timing pulses, and by the Snap C signal during C measures at the first, fourth, eighth, tenth, eleventh, and thirteenth master timing pulses. Thus, when the alternate bistable circuit of FIG. 2*b* operates in its alternate mode, during alternate measures, the Snap voice circuit is triggered by different pulse patterns in each measure. Also for the SWING rhythm it is seen that the Bass C signal pulses the base voice circuit during C measures at the seventh master timing pulse to provide an effective pre-beat (by the Bass Drum) before the third pulse of alternate measures. In addition, the Cymbal voice circuit is triggered by the fourth and eleventh master timing pulse of each measure.

To illustrate the effects of the roll control circuits, reference is made to the BALLAD rhythm mode wherein master timing pulse 1 appears on vertical line 10 of the matrix to provide a roll start pulse at the start of each measure. The roll start pulse turns off Q37 at the roll control bistable circuit of FIG. 2*b* to thereby enable the brush and snare roll control signals. The snare roll control has no effect at this time since it is connected to D56 and thereby shunted to ground via the MARCH automatic rhythm switch. However the brush roll control signal is applied to vertical line 6 to provide a Snap A signal. This signal keeps the Snap A line pulsed at 25 cps. for as long as the brush roll control signal is present. This condition obtains until the occurrence of pulse four, at which time the roll finish pulse is generated via vertical line 11 of the matrix to turn on transistor Q37 in the roll control bistable circuit. This inhibits the brush roll control signal which is thereby removed from the Snap A trigger line. The positive voltage appearing on the Snap trigger line during the interval between pulses 1 and 4 of each measure cause the Snap voice circuit to produce a characteristic brush roll sound over that interval during each measure.

The particular choice of 24 basic timing units in each measure permit accurate and realistic rhythmic patterns to be produced by the present system. More particularly, since 24 is readily divisible by two, three, four, six, eight and twelve, a larger variety of basic rhythms are readily reproducible. For example, four beats to a measure, as required by the BALLAD, SWING, etc., is readily provided by simiply utilizing pulses 1, 4, 8, and 11 in each measure, these pulses being separated by six timing units each. Three beats per measure, as required by the WALTZ, is readily achieved by means of pulses one, five, and 10, separated by eight timing units each, in each measure. A faster waltz, though not provided for expressly by the circuitry illustrated and described herein, can likewise be reproduced by utilizing pulses 1, 3, 5, 8, 10 and an additional master timing pulse between pulses 11 and 12, spaced two timing units from pulse 11. The variety of selectable rhythms is thus substantially unlimited by virtue of the particular timing arrangement selected.

The system as described heretofore is adapted to be built into a musical instrument such as an electronic organ, and as such must be adapted to permit manual keying of the various voice circuits when automatic rhythm accompaniment is either not desired, or of itself is not sufficient to produce the desired effects. To this extent, each of the voice circuits may be triggered via specially provided manual rhythm switches (FIG. 4*a*) such as the bass pedal, brush pedal, clave pedal, cymbal pedal, brush accompaniment, snare accompaniment, conga accompaniment, and cowbell accompaniment switches. The pedal switches receive a pedal trigger generated in a manner described hereinbelow and, when actuated, apply this trigger to the corresponding voice circuits of FIGS. 4*a* and 4*b*. The accompaniment switches are operative to apply accompaniment triggers, generated in the manner described hereinbelow, to corresponding voice circuits. These manual rhythm switches are operative in conjunction with an on/off button which, in the off position, shunts the accompaniment and pedal trigger signals to ground and which, in the on position, permits application of these trigger signals to the appropriate voice circuits.

Referring still to FIGS. 4*a* and 4*b* there is illustrated an accompaniment trigger amplifier comprising transistors Q20 and Q21 connected in monostable multivibrator configuration. Actuation of appropriate keys at the keyboard of the electronic organ provides a signal to the accompaniment input terminal which triggers the monostable circuit to provide an accompaniment trigger pulse to four of the manual rhythm switches. The accompaniment trigger pulse is approximately +22 volts in amplitude and has, nominally, a 5 millisecond duration. Likewise a pedal trigger amplifier is illustrated and is similar to the accompaniment trigger amplifier except that two mutually exclusive input circuits are provided. One of these is used in conjunction with the monophonic pedal latch system and the other with a polyphonic system. When triggered, the pedal trigger amplifier, comprising a one-shot multivibrator including transistors Q22 and Q23, provides an output pulse of the same general character as the accompaniment trigger. The pedal trigger is also applied to four of the manual rhythm switches as described above.

The cymbal, snap (brush), snare drum, bass drum, clave and conga drum voice circuits are conventional in nature, each responding to an input trigger applied thereto for providing a percussive tone simulating the sound signified by the name of the voice circuit. For example, the clave sound simulates two hard wooden rods struck together. A trigger received at the base of transistor Q12 of the clave circuit gates Q12 on for the duration of the trigger pulse. This renders Q13 conductive

and gates on the gated oscillator configuration including transistor Q13 to provide a sinusoidal signal of decaying amplitude and of such frequency to simulate the clave sound. The decay period is determined by resistor R34 and capacitor C23 connected in series between the emitter of Q13 and ground. Similar operation ensues in each of the cymbal, snap, snare drum, bass drum, and conga drum circuits, wherein gated oscillator of approximate frequency is triggered on by a transistor switch in response to each applied voice trigger pulse. The oscillator amplitude then decays upon removal of the trigger pulse. The triggers received by each of the conga drum, clave bass drum, cymbal and snare drum voice circuit are the appropriate automatic triggers supplied by the matrix of FIGS. 3*a* and 3*b*, or by the accompaniment or pedal triggers supplied by the manual rhythm switches in FIG. 4*a*. The Snap voice circuit receives three triggers, namely the brush accompaniment and the brush pedal trigger, as well as the automatic trigger provided by the matrix. The brush or snap voice circuit may thus be triggered manually by either pedal or key actuation.

A novel voice circuit included in FIG. 4*b* is the cowbell voice circuit which, when triggered, provides a combined 1 KHz and 2 KHz decaying tone, the frequency of the 2 KHz signal being prevented from shifting during the decay of the tone. The cowbell circuit includes a gated 1 KHz oscillator comprising NPN transistor Q17 and associated resistors and capacitors connected to produce the 1 KHz oscillatory signal at the emitter of Q17 whenever gating transistor Q18 is triggered on by an input trigger. To this extent, the 1 KHz signal is actuated as in the other voice circuits. Thus, when triggered, Q18 remains on for the duration of the trigger pulse, gating on the 1 KHz oscillator via resistor R52 and diode D3. Upon termination of the trigger pulse, Q18 turns off but the 1 KHz signal is sustained at a decaying amplitude over a sustain period determined by capacitor C36 and resistor R52. The gated decaying 1 KHz signal is applied to a common voice circuit output line via resistor R65 and capacitor C44.

The 2 KHz oscillator in the cowbell voice circuit comprises NPN transistor Q16 and associated resistive and capacitive elements interconnected to provide a continuously running 2 Hz oscillator. The 2 KHz signal is applied via capacitor C58 to a linear gate which includes diodes D4 and D5, capacitor C38, and resistors R56 and R57. When conductive, the linear gate applies the continuous 2 KHz signal to the common voice circuit output line via resistor R66 and capacitor C45. When Q18 is gated on by an input trigger pulse, PNP transistor Q19 experiences a reduction in base voltage which renders it conductive. This supplies gating current via resistor R55 to the linear gate, turning the latter on and permitting passage therethrough of the 2 KHz signal. Conduction of current through Q19 also charges capacitors C37. When the input trigger applied to the base of Q18 terminates, the latter turns off and in turn renders Q19 non-conductive. The linear gate remains on due to the charge existing on capacitor C37, which now discharges through two resistive paths, one of which includes R57, D4 and R58, the other of which includes R56, D5 and R59. The amplitude of the 2 KHz signal applied through the linear gate to the common output line decreases as C37 discharges until eventually the linear gate is cut off and the 2 KHz tone terminates. Importantly, the linear gate (linear in the sense that no distortion of the 2 KHz signal is produced when passed therethrough) is required to prevent frequency shift of the 2 KHz signal, which shift would alter the character of the cowbell tone to produce something which is not realistic.

The output signals from all of the voice circuits are tied to a common output line which is connected to the center arm of the volume control, a variable resistor connected between the input terminal to the pedal preamplifier and ground.

Generation of the shush (1) and shush (2) signal proceeds when appropriate ones of the automatic rhythm switches are actuated as described in relation to FIG. 3*b*. More particularly, the shush output line from the automatic rhythm switches is connected to the cathode of diode D2, the anode of which is connected to transistor Q6 in the cymbal voice circuit. When an appropriate automatic rhythm switch is closed, the common shush line, in combination with the actuated switch and either of the shush (1) or shush (2) lines, provide a path for emitter current through diode D2 for transistor Q6. The latter conducts to feed suitable signal via the cymbal voice circuit (based on transistor Q9) to provide cymbal like noise at the system output unit for as long as the shush (1) or shush (2) signals are selected by the automatic rhythm switches. Note that the shush signals are not derived from rhythmic pulses gated through the rhythm selection matrix but rather are continuous sounds generated throughout each measure. A shush inhibit signal applied to diode D1 in FIG. 4*a* from the collector of transistor Q30 in stop/start bi-stable circuit of FIG. 2*b* prevents generation of a shush signal when the automatic rhythm system is off. More particularly, when the system is off, transistor Q30 in the stop/-start bi-stable circuit is non-conductive rendering the shush inhibit signal positive. This biases diode D1 on at the cymbal voice circuit and applies a positive voltage to the cathode of diode D2, which voltage is greater than the quiescent voltage at the base of transistor Q6. This prevents transistor Q6 from conducting as long as the shush inhibit is positive; therefore no shush signals can be generated at this time.

Referring now to FIG. 6 of the accompanying drawings there is illustrated an alternative approach to generating the master timing pulses in the system of the present invention. In the above-described embodiment there are two ramp signals generated for each measure, which results in the generation of seven primary pulses. These pulses are appropriately gated during alternate half-measures to produce thirteen master timing pulses per measure. In the circuit of FIG. 6 the approach is to generate one linear ramp per measure, which ramp triggers all thirteen master timing pulses directly, in the same manner as the seven primary pulses are triggered in the FIG. 2*a*. More particularly, the circuit of FIG. 6 includes a constant current source based on transistor Q102 which is directly analogous to the constant current source which includes transistor Q2 of FIG. 2*a*. Likewise, the reset mono-stable circuit for the ramp generator includes transistor Q101 and Q103, analogous to transistors Q1 and Q3 of FIG. 2*a*. Also provided is an emitter follower buffer circuit including transistors Q104 and Q105, analogous to transistors Q4 and Q5 of FIG. 2*a*. The values of the various resistors and capacitors associated with transistors Q101 through Q105 differ from the values of the com-

ponents employed with transistors Q1 through Q5 of FIG. 2*a*, primarily because of the nature of the ramp generated in FIG. 6, which ramp must have a duration of twice that of the ramp of FIG. 2*a*. The emitter of Q105 is coupled in parallel to the base of each of fourteen transistors Q111 through Q124. These latter transistors are normally non-conducting and are triggered into conduction at respective increasing voltage levels of the linear ramp signal appearing at the emitter of Q105. Transistor Q124, which is driven into conduction last of all transistors Q111 through Q124 during each ramp period resets the ramp signal by triggering the reset mono-stable circuit comprising Q101 and Q103. As each of Q111 through Q123 is driven into conduction a trigger pulse is AC coupled to a respective one of pulse generators 111 through 123, all of which are identical, only generator 123 being illustrated in detail. Each of the pulse generators includes a pair of NPN transistors Q125 and Q126 connected in cascade, with the input trigger being applied to the base of Q125 and the output signal taken from the emitter of Q126. Q125 is normally conducting and Q126 is normally non-conducting. When transistor Q123, for example, is driven into conduction by the input ramp, a negative going transition appears at the collector of Q123 which is coupled via an input coupling capacitor to the base of Q125 to turn the latter off. Voltage at the collector of Q125, and hence at the base of Q126, increases, rendering Q126 conductive to provide a positive-going pulse at the emitter electrode of Q126. This pulse is the master timing pulse provided by the pulse generator.

The 13 master timing pulses produced by pulse generators 111 through 123 are preferably spaced, as determined by the emitter biases for transistors Q111 through Q124, in the manner illustrated in the top line of the timing diagram of FIG. 5. As described, this particular spacing permits generation of authentic rhythm patterns not previously attainable in prior art rhythm systems. While other techniques for generating desired master timing pulse patterns may be employed in the scope of the present invention, those techniques described in relation to FIGS. 2*a* and 6 are believed the simplest and the most easily effected.

Referring now to FIG. 7 of the accompanying drawings there is illustrated an alternative approach to providing a rhythm selection matrix for performing the same function as the matrix illustrated in FIGS. 3*a* and 3*b*. More particularly, the thirteen input timing pulses are applied to horizontal lines of the matrix just as in FIGS. 3*a* and 3*b*, and the vertical lines of the matrix are selectively resistively coupled with the various horizontal lines and grouped in accordance with the particular selected tempos. Whereas selection of the tempo in FIGS. 3*a* and 3*b* is achieved by ungrounding respective groups of diodes D14 through D61 by means of the automatic rhythm switches, in FIG. 7 the shunt diodes are eliminated and replaced by respective series sections of each automatic rhythm switch. Thus actuation of the SWING automatic switch closes five switches in series with vertical lines 1 through 5 to enable the selected master timing pulses resistively coupled to these lines to be applied to the various voice circuit trigger lines.

It is to be stressed at this point that although the trigger patterns generated for each rhythm in FIGS. 3*a* and 3*b* are identical to the patterns selected in the circuit of FIG. 7, the particular patterns illustrated in FIG. 5 are not limiting as to the scope of the present invention. For example, it may be desirable to additionally generate a Snap A pattern for the SWING rhythm or eliminate the Snap C pattern in that rhythm. Numerous combinations are of course applicable to produce other desired rhythmic effects. The patterns illustrated in conjunction with the matrices in FIG. 3*b* and 3*a* and FIG. 7 and in the timing diagram of FIG. 5 are believed to be most authentic in so far as simulation of standard rhythm patterns are concerned. Likewise, additional rhythm patterns other than the eight illustrated in conjunction with FIGS. 5 and 3*a* and 3*b* may be provided by the techniques disclosed, their authenticity in simulating actual standard rhythm patterns being facilitated by the particular choice of master timing pulse spacing provided herein.

Referring now to FIG. 8 of the accompanying drawings there is illustrated a modified control circuit for providing greater flexibility in selecting measure patterns than is possible in the embodiment disclosed above. More particularly, there is illustrated in FIG. 8 the alternate bi-stable circuit, substantially identical to that illustrated in FIG. 2*b*, having a control switch S2 identical to that in FIG. 2*b* from which the state of the alternate bi-stable circuit may be controlled, either by the random oscillator or the downbeat signal as described in relation to FIG. 2*b*. In addition there is provided a switch S6 schematically illustrated as having three positions, namely an off position, a B position, and a C position. In the B position switch S6 grounds the collector of Q32 of the alternate bi-stable circuit and in the C position grounds the collector of Q33. If the collector of Q32 is grounded the collector of Q33 is at a positive voltage and the B pattern is continuously produced by the matrix as long as S6 is in this position. When S6 grounds the collector of Q33, in a similar manner, the C pattern is continuously produced. The addition of switch S6 therefore provides four different pattern modes, each capable of selection by the performer. These modes are:

1. with S6 in the B position, regardless of the position of S2, the B pattern is continuously produced during each measure;

2. with S6 in the C position, the C pattern is continuously produced, regardless of the position of S2, during each measure;

3. with S6 in the off position and S2 in the alternate position patterns B and C alternate during successive measures;

4. with S6 in the off position and S2 in the random position, patterns B and C are switched at a random rate relative to the repetition rate of the measures in accordance with the random triggering from the random oscillator, thereby producing a continuously varying rhythm pattern.

Thus two different single measure patterns may be produced or alternated or randomly selected in accordance with the settings at S2 and S6.

The B control and C control signals provided at respective collectors of transistors Q33 and Q32 may be employed as illustrated in FIGS. 3*b* to gate the various trigger lines at the output of the matrix. Alternatively these signals may be employed directly at the input circuits of each of the voice circuits of FIGS. 4*a* and 4*b*, as illustrated in FIG. 8. By way of example, the Snap voice circuit illustrated in FIG. 8 and the Snap B and

Snap C trigger lines are illustrated as being connected to the anode of respective diodes D101 and D102, the cathodes of which are connected to respective collectors of transistors Q33 and Q32. When the B control signal is high and the C control signal grounded, diode D101 is blocked and Snap B pulses are applied directly to the Snap voice circuit; diode D102 is grounded and thereby shunts the Snap C triggers to ground. Alternately, when the C control voltage is high, diode D102 is blocked permitting application of Snap C triggers to the Snap voice circuit; D101 shunts the Snap B triggers to ground.

While I have described and illustrated specific embodiments of my invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

What I claim is:

1. In a rhythmic accompaniment system, means for generating 13 timing pulses during each measure of music, said timing pulses being separated selectively in units of one, two or three fixed equal time units to total 24 of said time units per measure, and means responsive to said pulses for producing musical sounds.

2. In a rhythmic accompaniment system, a matrix having thirteen horizontal lines, means for applying 13 sequential timing pulses to said lines, 47 vertical matrix lines divided into eight groups of successive lines representing diverse rhythms, resistances selectively interconnecting junctions of said horizontal and vertical lines, a separate diode associated with each of said vertical lines, each of said diodes having its anode connected to one of said vertical lines, and means for selectively grounding the cathodes of said diodes or leaving said cathodes afloat in groups corresponding with said eight groups, and voice circuits connected to be operated by signals appearing on said vertical lines.

3. The combination according to claim 2, wherein is also provided a bistable flip-flop circuit responsive to be set in one state in response to a signal on one of said vertical lines and to be reset in response to a signal on another of said vertical lines, a source of drum roll signal, and means responsive to said bistable flip-flop circuit for sounding said drum roll signal while said bistable flip-flop is set.

4. In a rhythmic accompaniment system, means for generating 13 timing pulses during each measure of music, said means including a source of a linear repetitive ramp voltage waves, means for adjusting the tempo of said ramp voltage waves, means responsive to fixed levels along said ramp voltage wave for generating said timing pulses, said timing pulses being separated by units of one, two or three fixed equal time intervals of a total of 24 of said time intervals for each of said measures of music and means responsive selectively to said timing pulses for rhythmically generating musical sounds.

5. The combination according to claim 4, wherein each of said ramp voltage waves endures for one of said measures.

6. The combination according to claim 4, wherein each of said ramp voltage waves endures for one half of one of said measures, and wherein seven and six of said pulses are generated respectively during alternative ones of said ramp voltage waves.

7. In a rhythmic accompaniment system, a matrix having two orthogonally related sets of lines, means selectively interconnecting lines of one set to lines of the other set, a separate diode having its anode connected to each of the lines of said one set of lines, and means for selectively grounding the cathodes of said diodes and leaving said cathodes afloat, wherein is provided means for applying pulses to lines of said other of said set of lines in sequence, and voice circuitry connected to be operative in response to those of said pulses appearing on said one of said set of lines.

8. In a rhythmic accompaniment system, a matrix having two orthogonally related sets of lines, means selectively interconnecting lines of one set to lines of the other set, a separate diode having its anode connected to each of the lines of said one set of lines, and means for selectively grounding the cathodes of said diodes and leaving said cathodes afloat, wherein is provided means for applying pulses to lines of said other of said set of lines in sequence, and voice circuitry connected to be operative in response to those of said pulses appearing on said one of said set of lines, wherein is provided a bistable circuit responsive to be set in response to each of said pulses appearing on one line of said one set of lines and to be reset in response to each of said pulses appearing on another line of said one set of lines, and means responsive to said bistable circuit while said bistable circuit is set for generating a sound.

9. In a rhythmic accompaniment system, a matrix having two orthogonally related sets of lines, means selectively interconnecting lines of one set to lines of the other set, a separate diode having its anode connected to each of the lines of said one set of lines, and means for selectively grounding the cathodes of said diodes and leaving said cathodes afloat, wherein is provided means for applying pulses to lines of said other of said set of lines in sequence, and voice circuitry connected to be operative in response to those of said pulses appearing on said one of said set of lines, wherein is provided a bistable circuit responsive to be set in response to each of said pulses appearing on one line of said one set of lines and to be reset in response to each of said pulses appearing on another line of said one set of lines, and means responsive to said bistable circuit while said bistable circuit is set for generating a sound, wherein said sound is a roll signal.

10. In a music system, a source of musical signal, a bistable flip-flop, means responsive to said bistable flip-flop only in its set state for rendering said source of musical signal operative to sound a musical signal, a source of rhythmically occurring pulses occurring in repetitive sets of pulses, and means responsive to one selected pulse in each of said sets of pulses for setting said bistable flip-flop and responsive to another of said pulses in each of said sets of pulses for resetting said bistable flip-flop.

11. The combination according to claim 10, wherein said musical signal is a drum roll.

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