United States Patent [19]

Bunger

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[54] **AUTOMATIC CHORD AND RHYTHM SYSTEM FOR ELECTRONIC ORGAN**

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[73] Assignee: **D. H. Baldwin Company**, Cincinnati, Ohio

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[21] Appl. No.: **657,359**

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **3,918,341**
Issued: **Nov. 11, 1975**
Appl. No.: **454,426**
Filed: **Mar. 25, 1974**

[52] **U.S. Cl.** **84/1.01;** 84/1.03; 84/1.17; 84/DIG. 12; 84/DIG. 22

[51] **Int. Cl.**[2] **G10H 1/00;** G10H 5/00

[58] **Field of Search** .... 84/1.01, 1.03, 1.17, 84/1.24, DIG. 12, DIG. 22

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Primary Examiner—Stanley J. Witkowski
Attorney, Agent, or Firm—Kirkland & Ellis

[57] **ABSTRACT**

The present system provides an automatic chord accompaniment and/or an automatic rhythm system, actuation of only one left hand operated key producing proper distribution of root, third, fifth and seventh parts of a chord and root and fifth parts of a bass line. The bass and/or chord notes may be automatically rhythmically pulsed or selectively converted to a continuous mode, while the chord notes may be rhythmically pulsed to simultaneously sound different accompaniment instruments, such as guitar, piano, banjo, etc., at different rhythmic intervals, a touch bar being provided to select a minor chord when desired. A set of musical key selector buttons is provided which automatically provides seventh chords in correct positions for a given key selection. One or more accompaniment instruments may play different rhythmic sequences when seventh chords are sounded, while actuation of two or more keys, simultaneously, defeats the chord and bass accompaniment.

22 Claims, 15 Drawing Figures

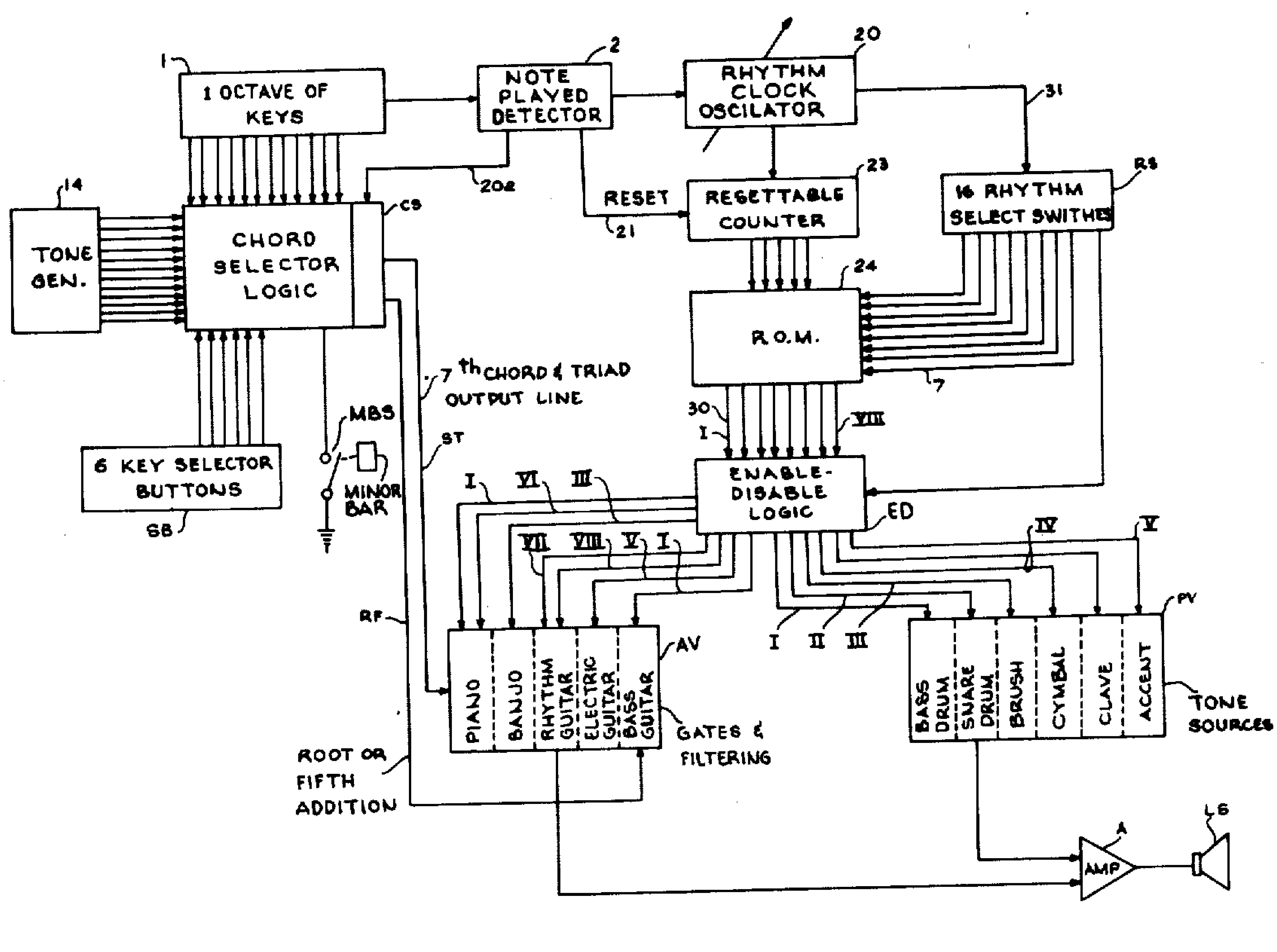
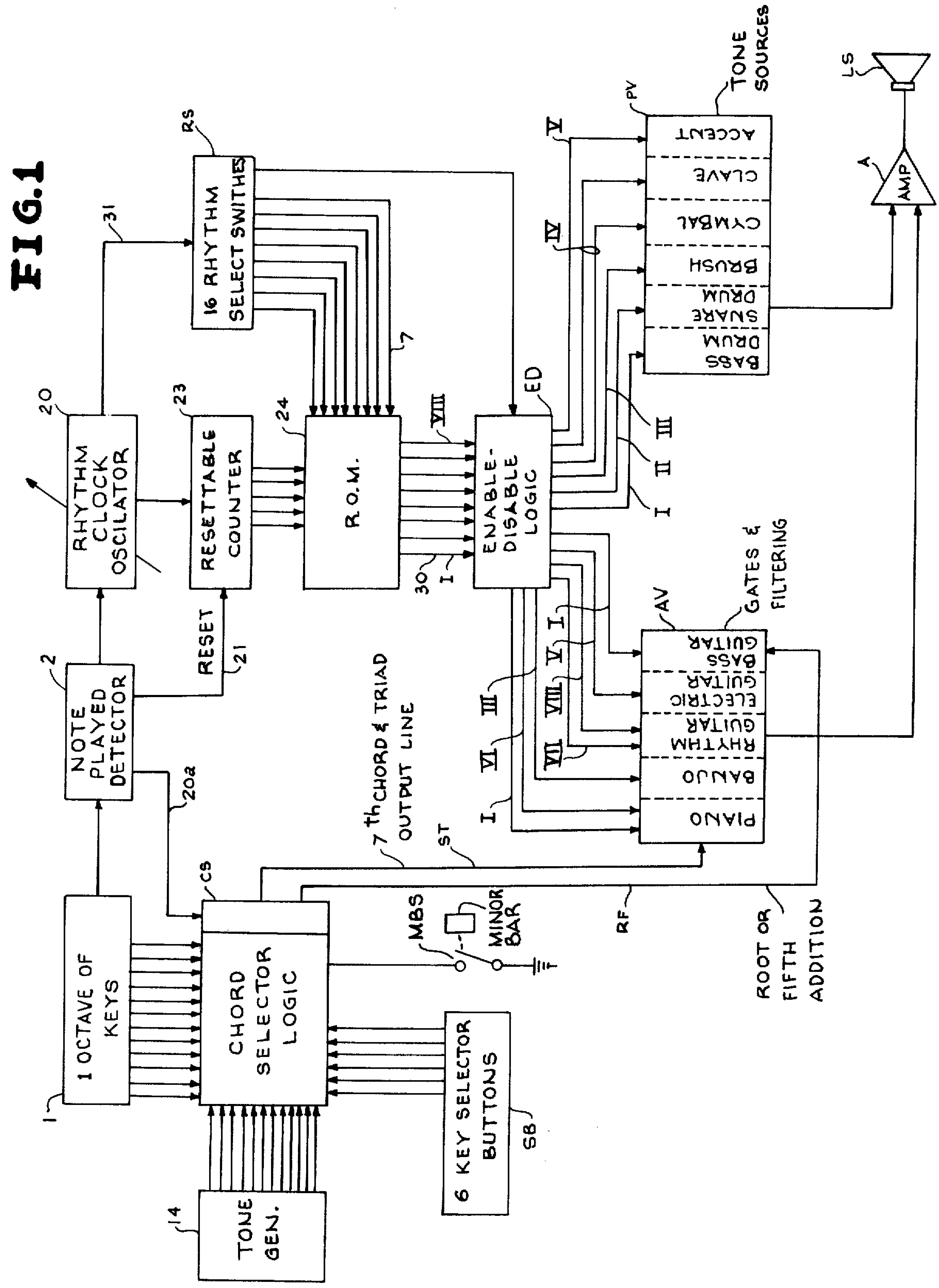


FIG.1


1 OCTAVE OF KEYS
NOTE PLAYED DETECTOR
RHYTHM CLOCK OSCILATOR
16 RHYTHM SELECT SWITHES
RESETTABLE COUNTER
RESET
R.O.M.
ENABLE-DISABLE LOGIC
CHORD SELECTOR LOGIC
TONE GEN.
6 KEY SELECTOR BUTTONS
MINOR BAR
MBS
7th CHORD & TRIAD OUTPUT LINE
ROOT OR FIFTH ADDITION
TONE SOURCES
ACCENT
CLAVE
CYMBAL
BRUSH
SNARE DRUM
BASS DRUM
GATES & FILTERING
BASS GUITAR
ELECTRIC GUITAR
RHYTHM GUITAR
BANJO
PIANO
AMP
LS
A
PV
AV
ED
RS
CS
SB
ST
RF
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2
7
14
20
20a
21
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24
30
31
I
II
III
IV
V
VI
VII
VIII

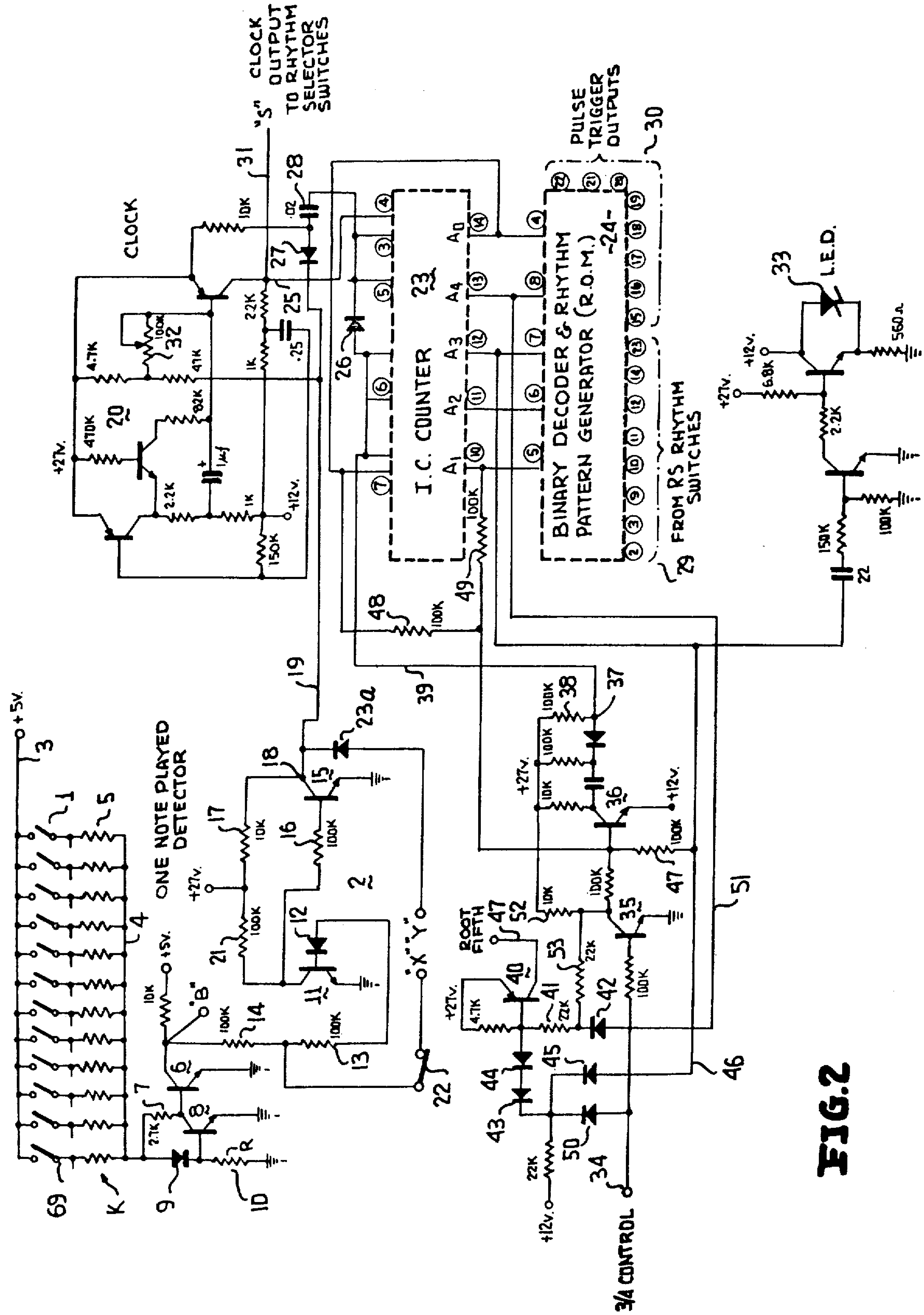
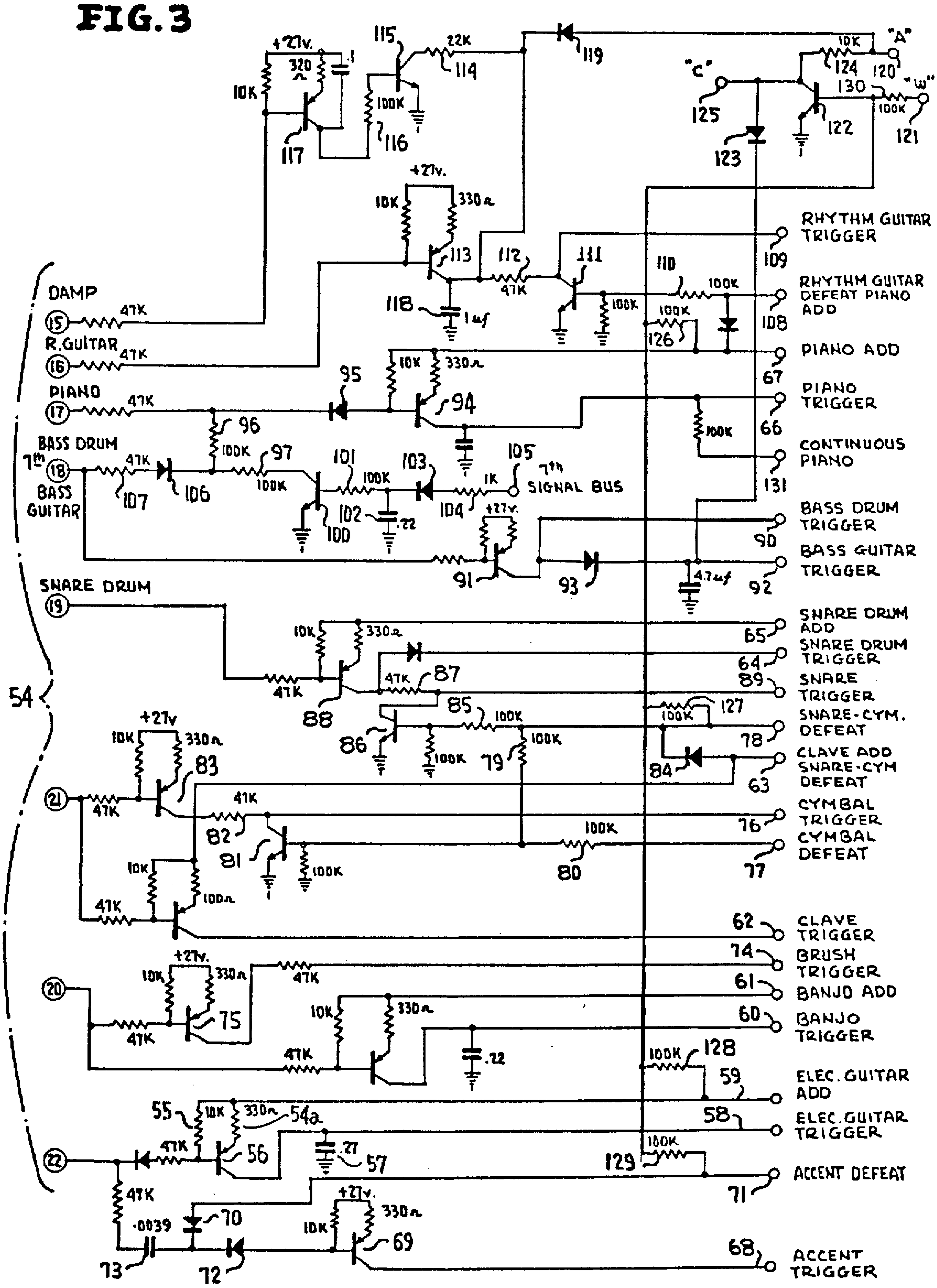

CLOCK
"S" CLOCK OUTPUT TO RHYTHM SELECTOR SWITCHES
I.C. COUNTER
BINARY DECODER & RHYTHM PATTERN GENERATOR (R.O.M.)
PULSE TRIGGER OUTPUTS
FROM RS RHYTHM SWITCHES
L.E.D.
ONE NOTE PLAYED DETECTOR
ROOT FIFTH
3/4 CONTROL

FIG. 2

FIG. 3


DAMP
R. GUITAR
PIANO
BASS DRUM
BASS GUITAR
SNARE DRUM
7th SIGNAL BUS
RHYTHM GUITAR TRIGGER
RHYTHM GUITAR DEFEAT PIANO ADD
PIANO ADD
PIANO TRIGGER
CONTINUOUS PIANO
BASS DRUM TRIGGER
BASS GUITAR TRIGGER
SNARE DRUM ADD
SNARE DRUM TRIGGER
SNARE TRIGGER
SNARE-CYM. DEFEAT
CLAVE ADD SNARE-CYM DEFEAT
CYMBAL TRIGGER
CYMBAL DEFEAT
CLAVE TRIGGER
BRUSH TRIGGER
BANJO ADD
BANJO TRIGGER
ELEC. GUITAR ADD
ELEC. GUITAR TRIGGER
ACCENT DEFEAT
ACCENT TRIGGER
"A"
"C"
"W"

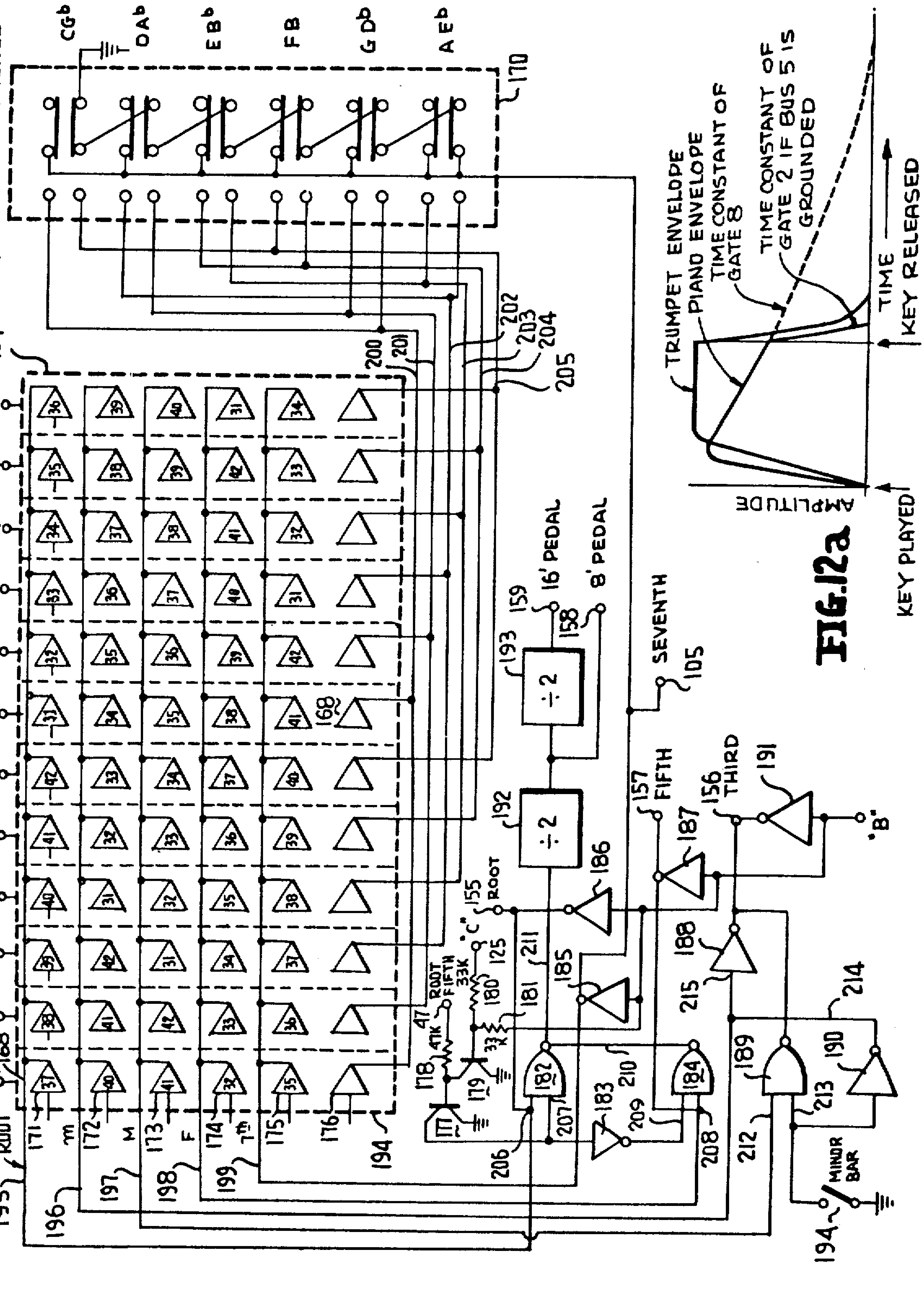

KEY SELECTOR SWITCHES
CG♭
DA♭
EB♭
FB
GD♭
AE♭
170
194
C
C#
D
D#
E
F
F#
G
G#
A
A#
B
ROOT
m
M
F
7th
16' PEDAL
8' PEDAL
SEVENTH
FIFTH
THIRD
ROOT
'C'
'B'
ROOT FIFTH
47K
33K
33K
÷2
MINOR BAR
TRUMPET ENVELOPE
PIANO ENVELOPE
TIME CONSTANT OF GATE 8
TIME CONSTANT OF GATE 2 IF BUS 5 IS GROUNDED
AMPLITUDE
TIME
KEY PLAYED
KEY RELEASED

FIG. 4

FIG. 12a

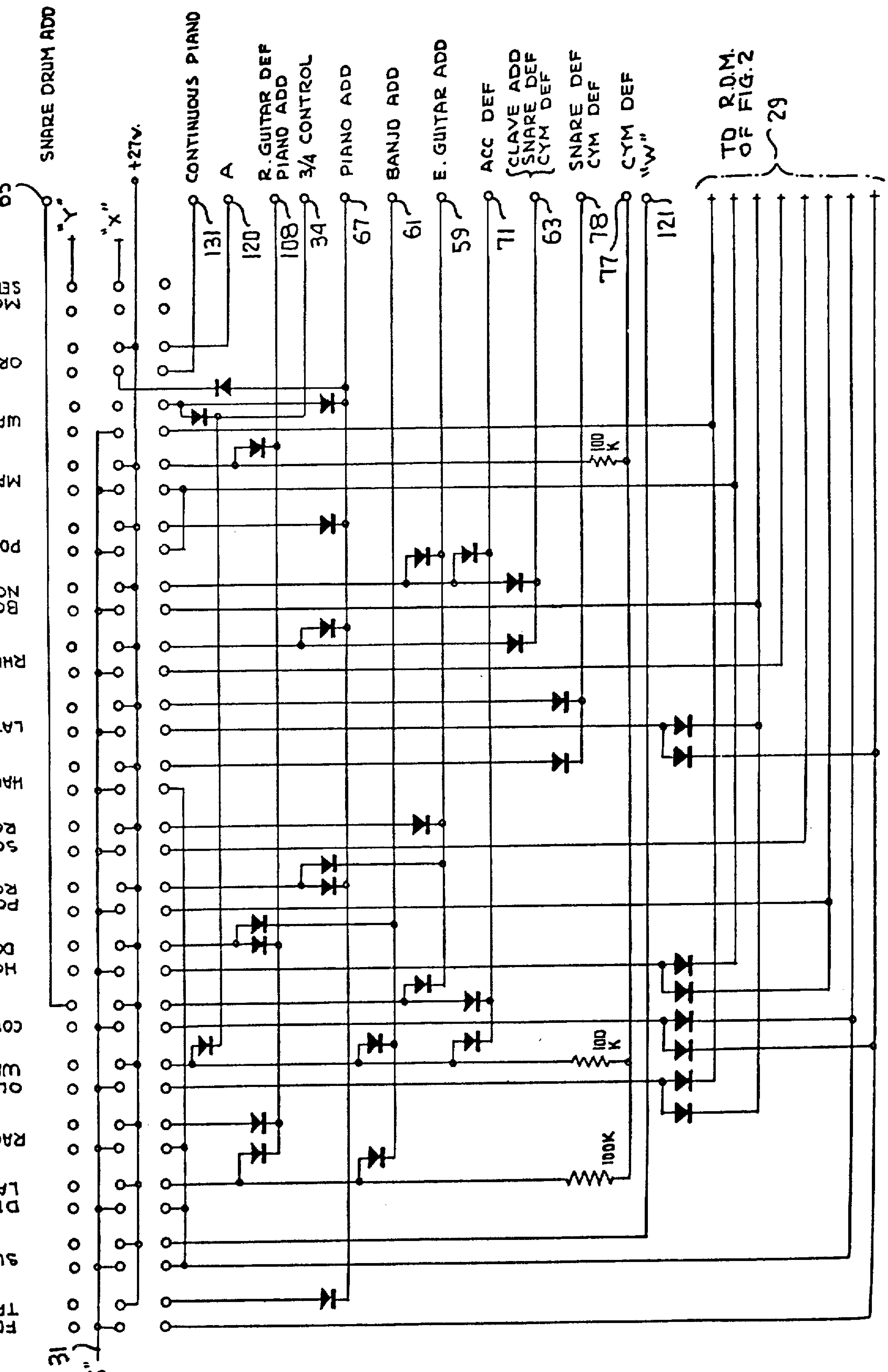

65
SNARE DRUM ADD
"Y"
"X"
+27V.
CONTINUOUS PIANO
131
A
120
R. GUITAR DEF
PIANO ADD
108
3/4 CONTROL
34
PIANO ADD
67
BANJO ADD
61
E. GUITAR ADD
59
ACC DEF
71
CLAVE ADD
SNARE DEF
CYM DEF
63
SNARE DEF
CYM DEF
78
77
CYM DEF
"W"
121
TO R.D.M.
OF FIG.2
29
MODE SELECTOR
ORGAN
WALTZ
MARCH
POLKA
BOSA NOVA
RHUMBA
LATIN III
HAWAIIAN
SOUL ROCK
POP ROCK
HOE DOWN
COUNTRY
OLD TIME WALTZ
RAGTIME
DIXIE LAND
SWING
FOX TROT
100K
31
"S"

FIG.5

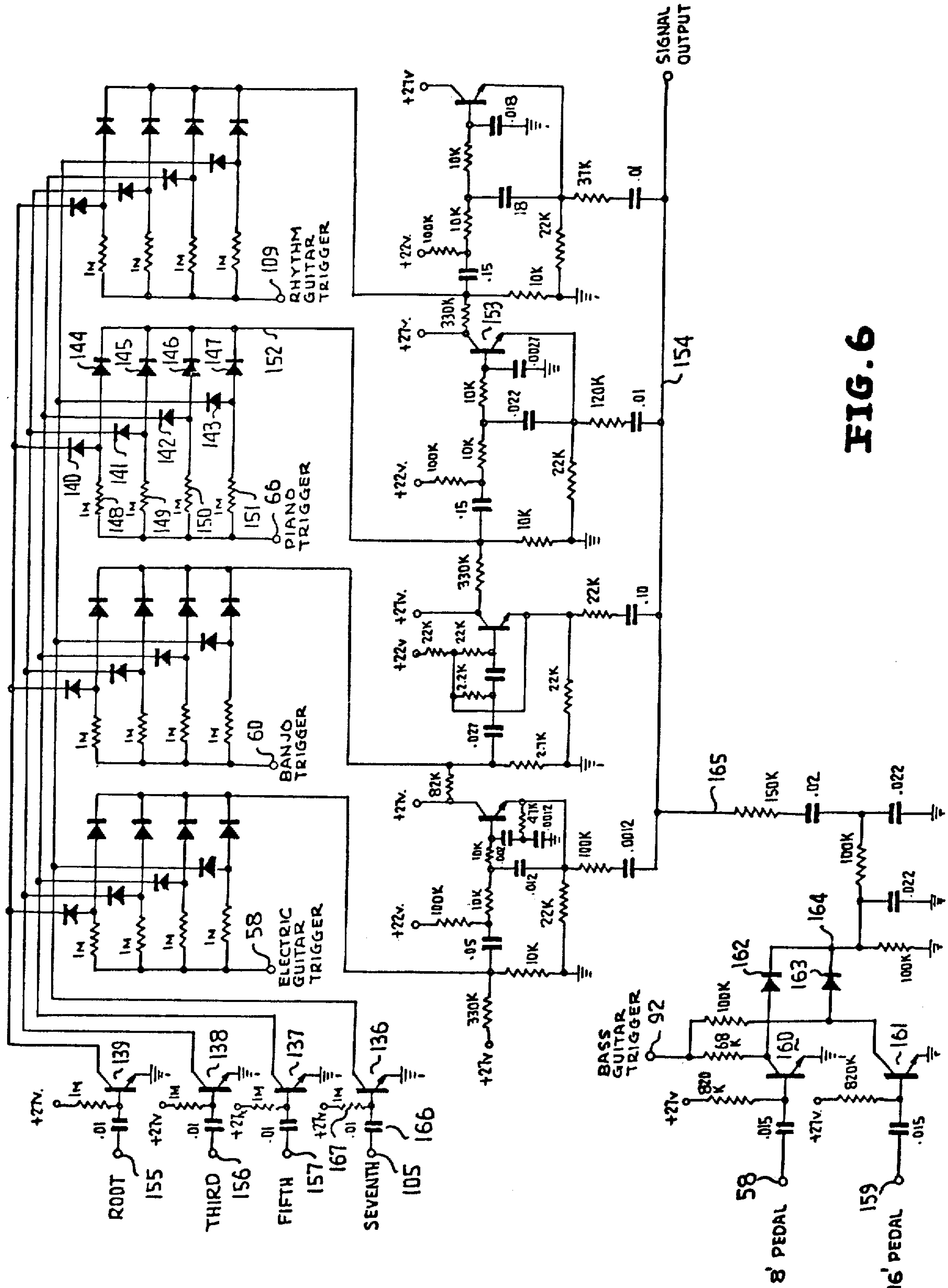

SIGNAL OUTPUT
RHYTHM GUITAR TRIGGER
PIANO TRIGGER
BANJO TRIGGER
ELECTRIC GUITAR TRIGGER
BASS GUITAR TRIGGER
ROOT
THIRD
FIFTH
SEVENTH
8' PEDAL
16' PEDAL

FIG. 6

FIG.7

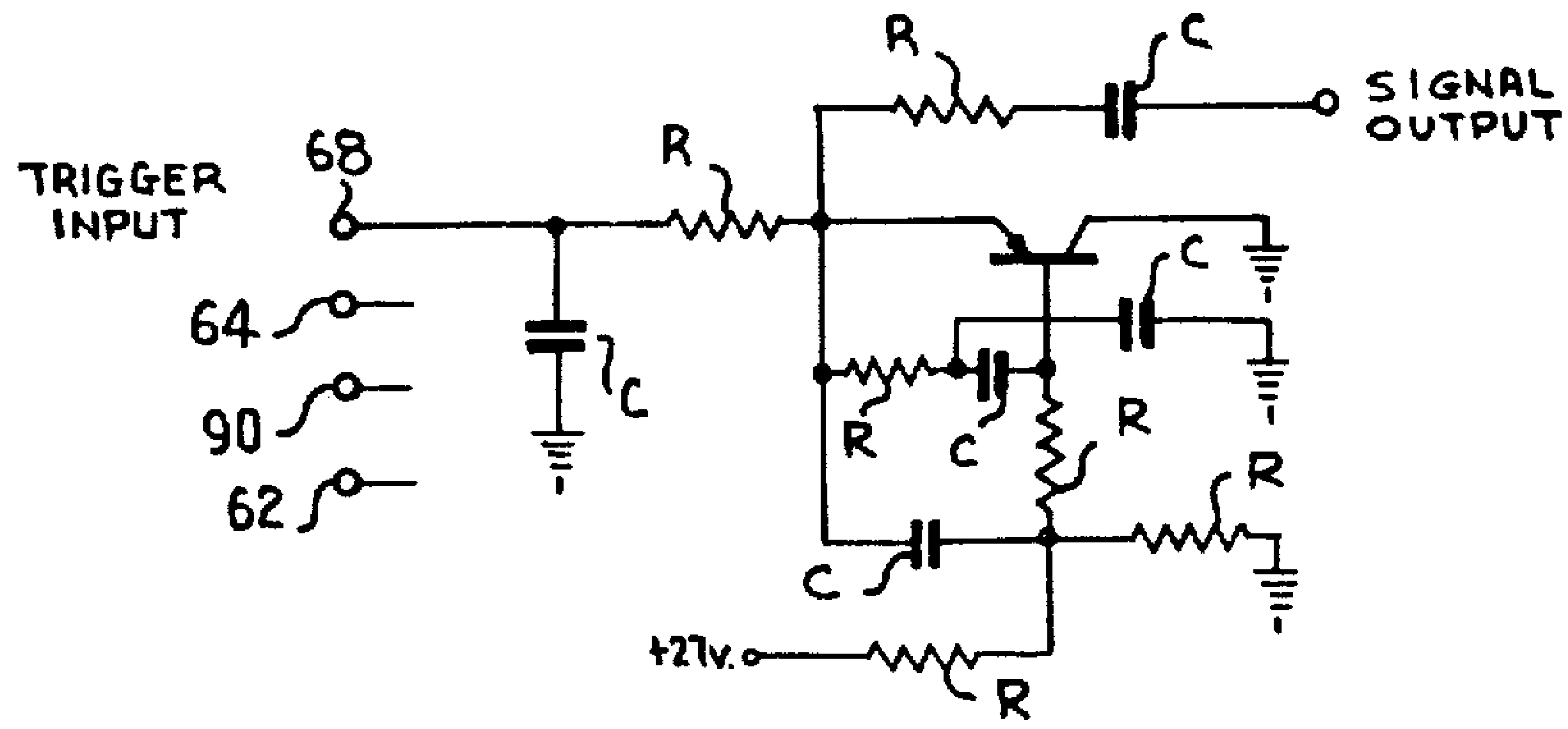


FIG.8

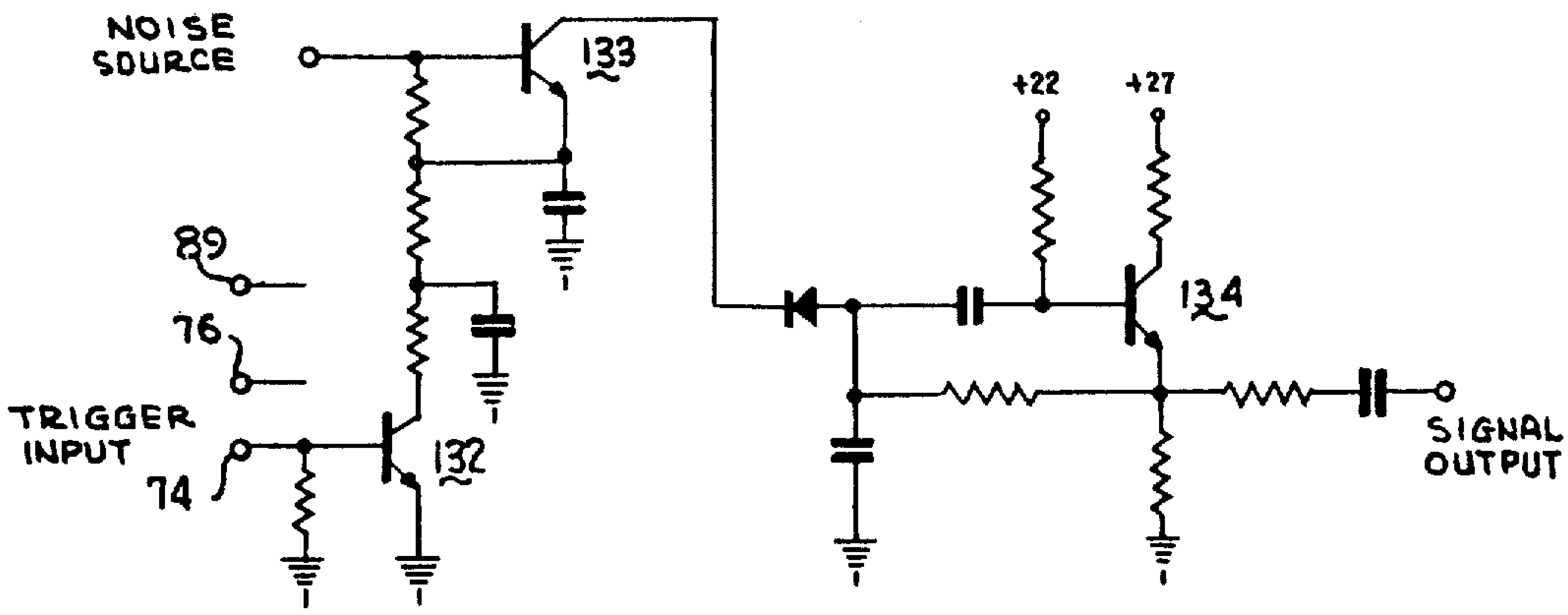
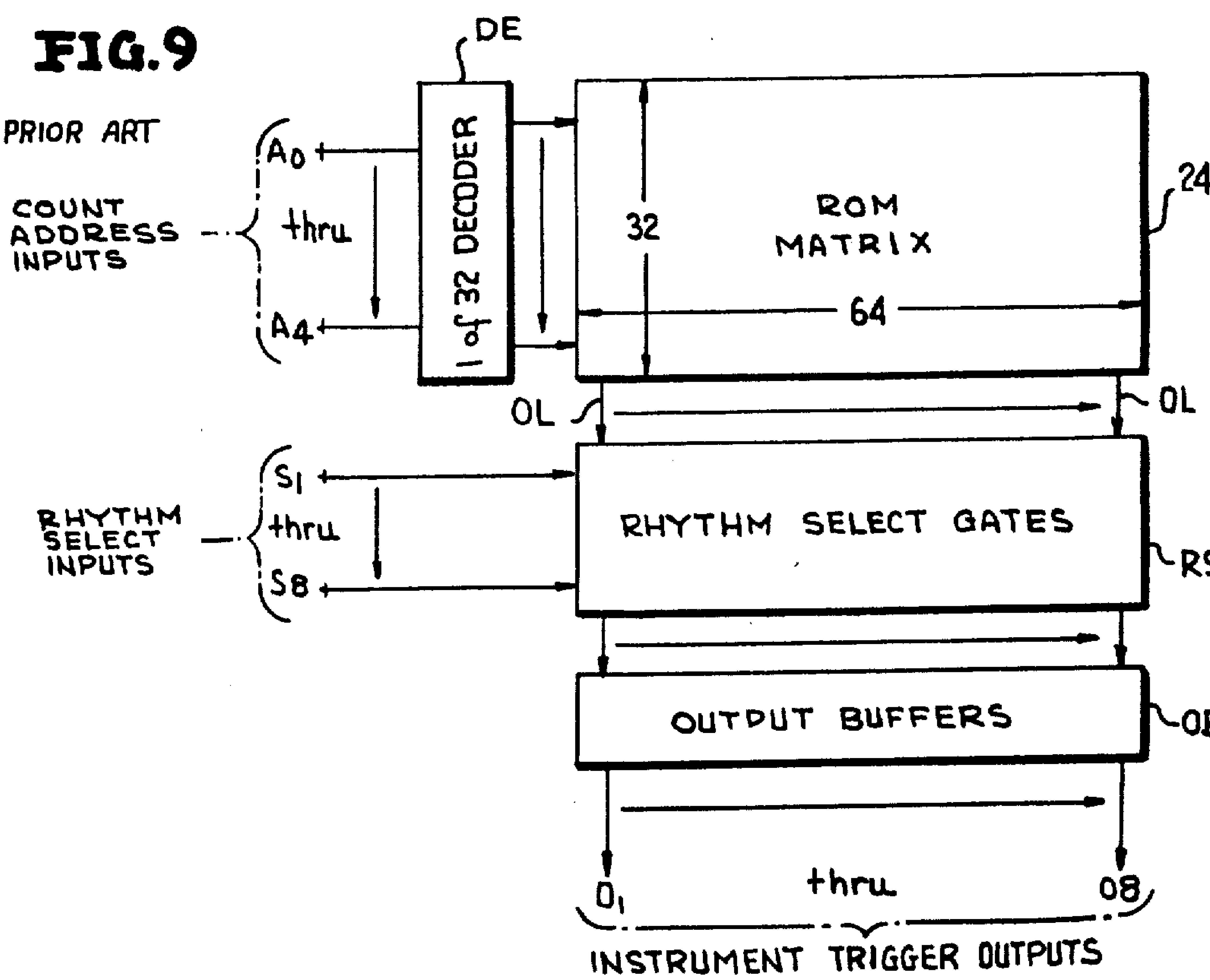


FIG.9

PRIOR ART



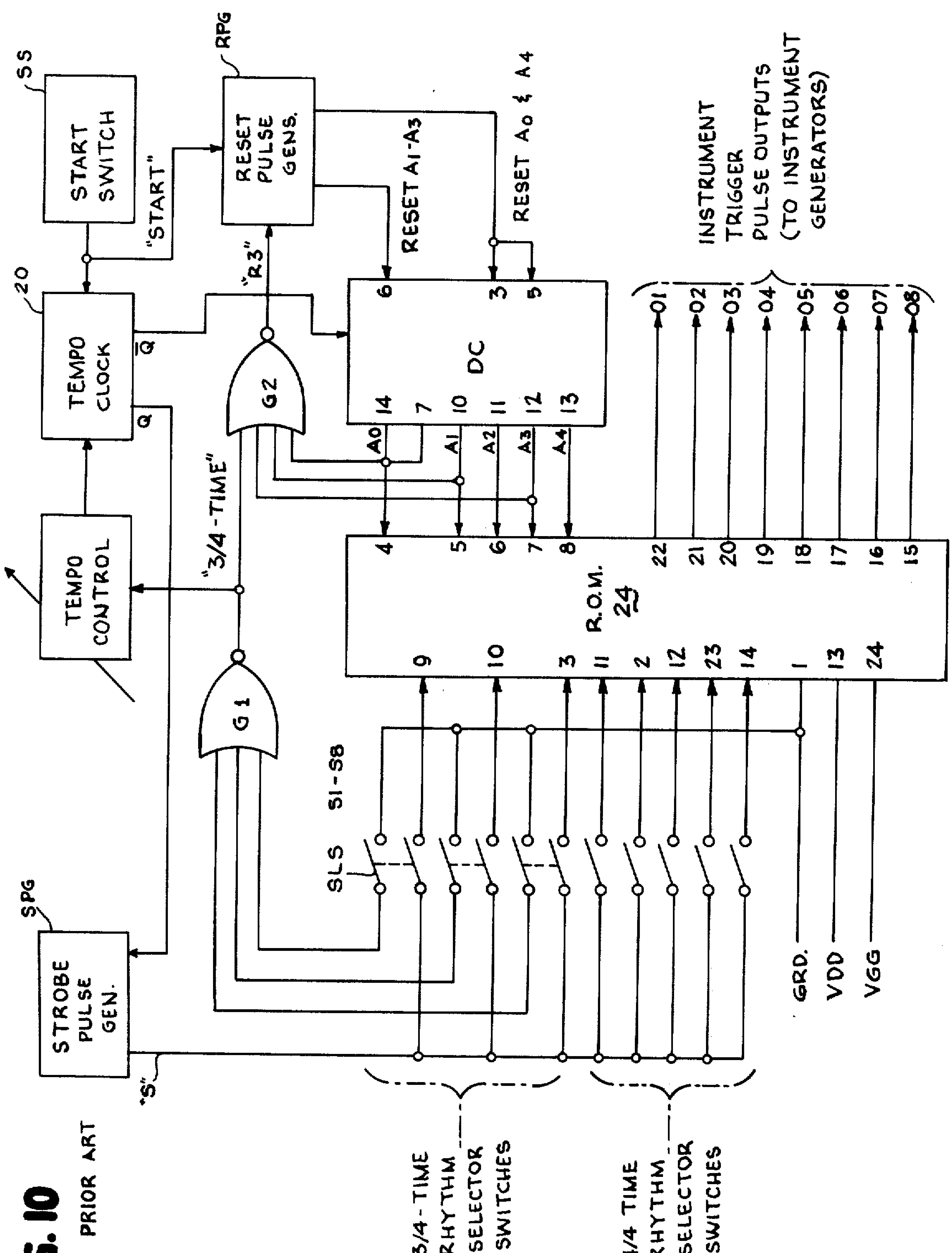


FIG. 10
PRIOR ART

FIG.11

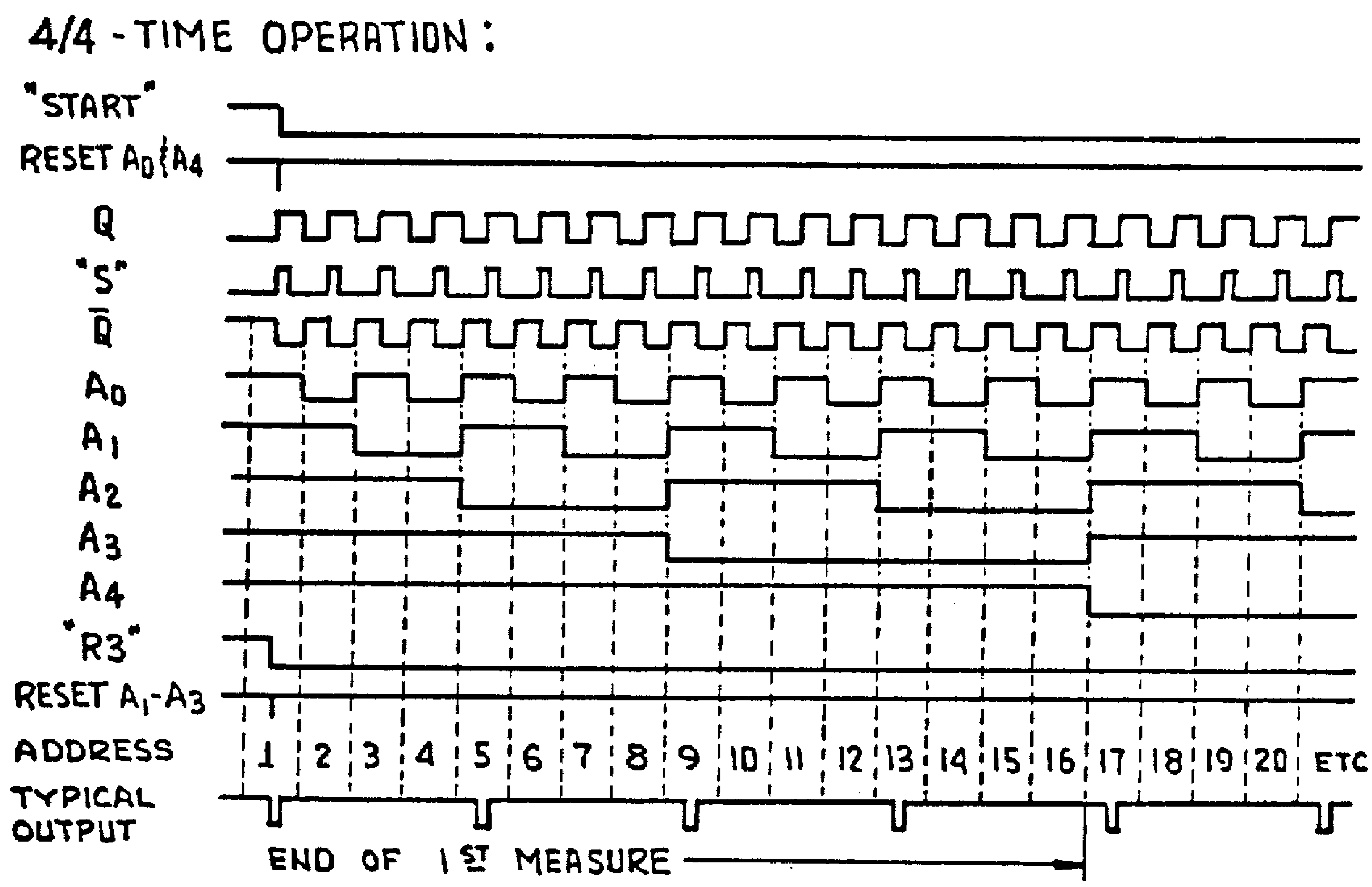

4/4 - TIME OPERATION:
"START"
RESET A0 & A4
Q
"S"
Q̄
A0
A1
A2
A3
A4
"R3"
RESET A1-A3
ADDRESS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 ETC.
TYPICAL OUTPUT
END OF 1ST MEASURE

FIG.12

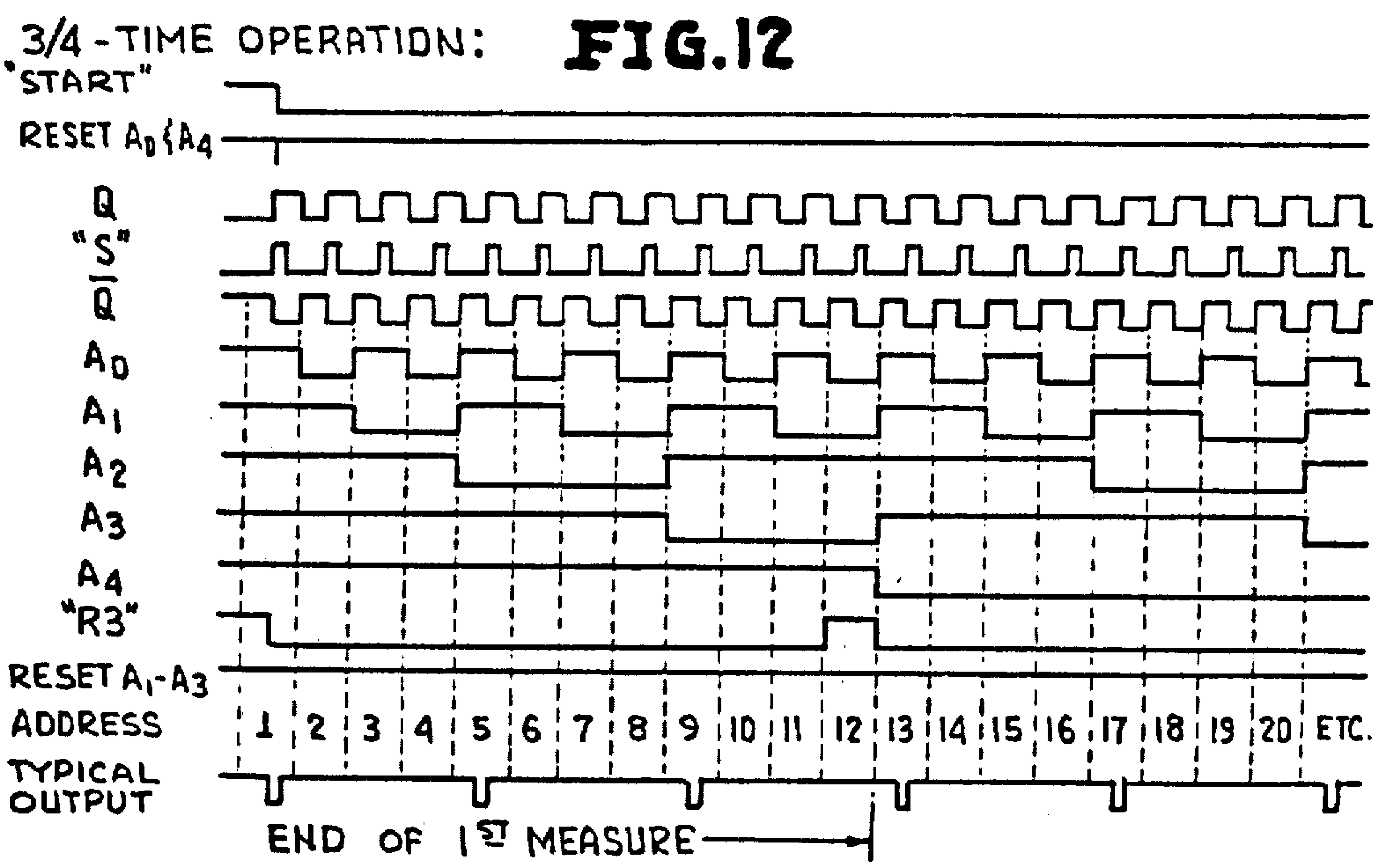

3/4 - TIME OPERATION:
"START"
RESET A0 & A4
Q
"S"
Q̄
A0
A1
A2
A3
A4
"R3"
RESET A1-A3
ADDRESS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 ETC.
TYPICAL OUTPUT
END OF 1ST MEASURE

FIG. 13a

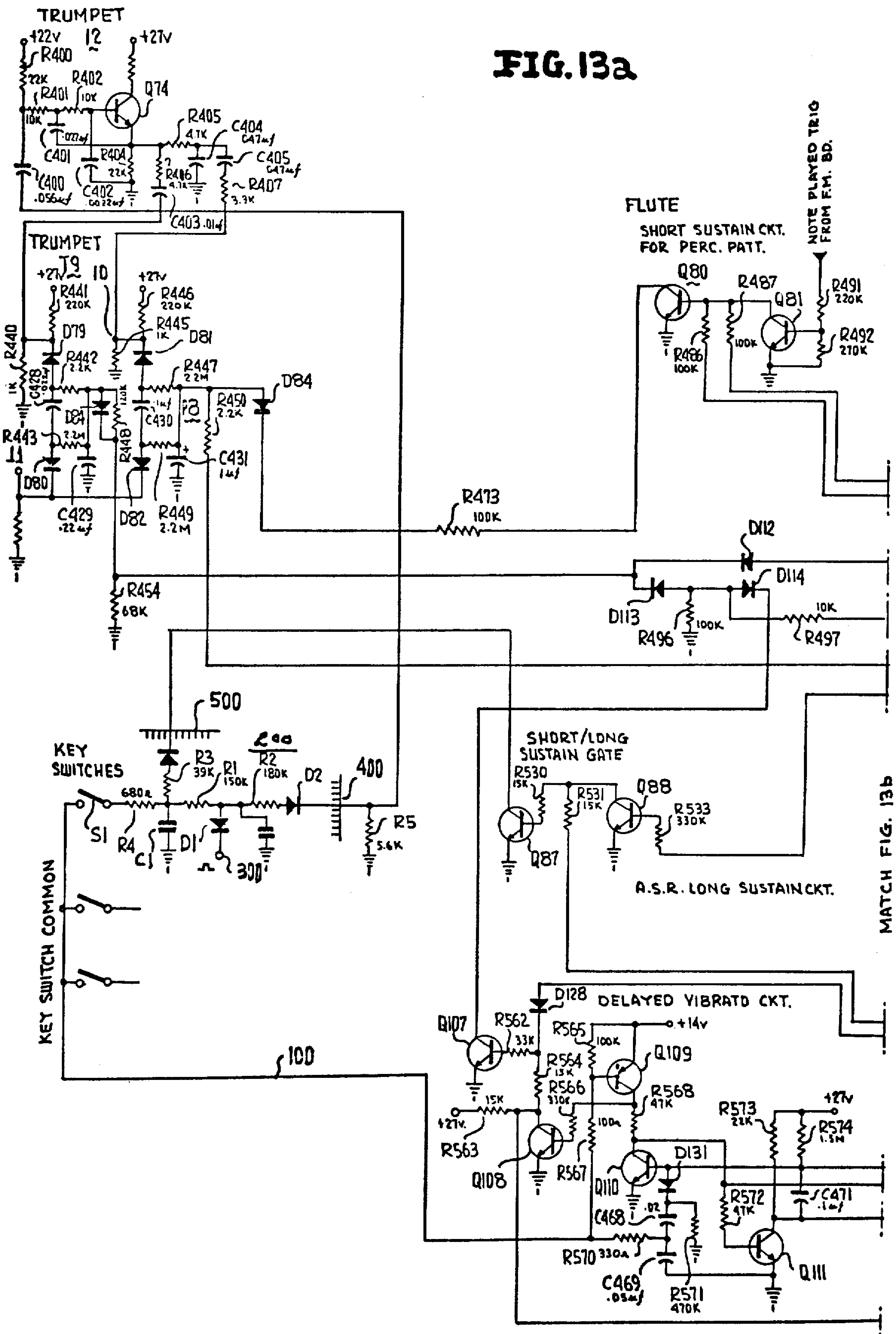
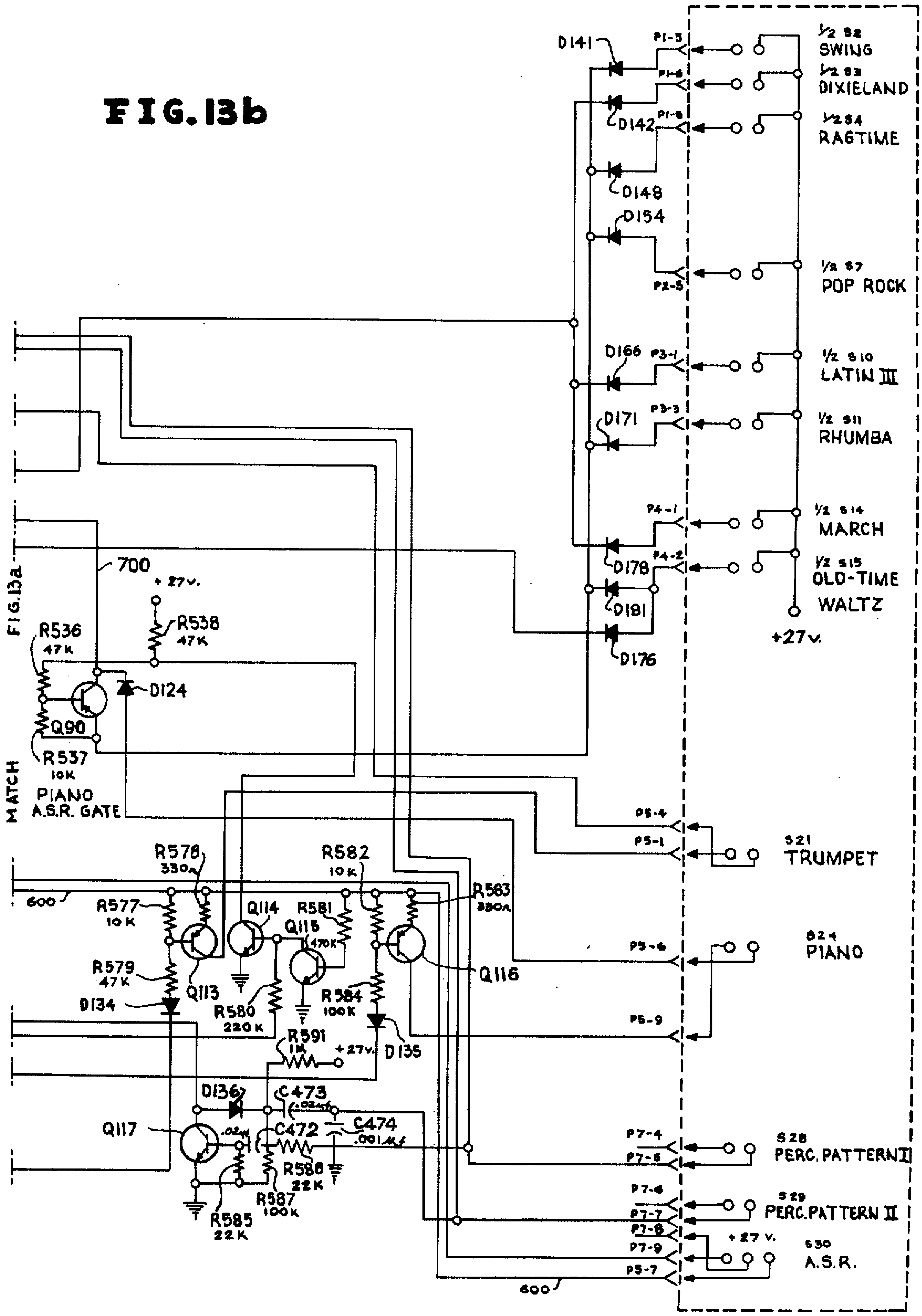

TRUMPET
FLUTE
SHORT SUSTAIN CKT. FOR PERC. PATT.
NOTE PLAYED TRIG FROM F.M. BD.
KEY SWITCHES
KEY SWITCH COMMON
SHORT/LONG SUSTAIN GATE
A.S.R. LONG SUSTAIN CKT.
DELAYED VIBRATO CKT.
MATCH FIG. 13b
500
400
300
100

FIG. 13b


D141
P1-5
P1-6
D142
P1-8
D148
D154
P2-5
D166
P3-1
D171
P3-3
P4-1
D178
P4-2
D181
D176
½ S2 SWING
½ S3 DIXIELAND
½ S4 RAGTIME
½ S7 POP ROCK
½ S10 LATIN III
½ S11 RHUMBA
½ S14 MARCH
½ S15 OLD-TIME WALTZ
+27v.
700
+27v.
FIG.13a
R536 47K
R538 47K
D124
Q90
R537 10K
MATCH
PIANO A.S.R. GATE
P5-4
P5-1
S21 TRUMPET
R578 330Ω
R582 10K
R583 330Ω
600
R577 10K
Q114
R581
Q115
470K
R579 47K
Q113
Q116
P5-6
S24 PIANO
D134
R580 220K
R584 100K
D135
P5-9
R591 1M
+27v.
D136
C473 .02μf
Q117
.02μf
C472
C474 .001μf
R586 22K
R587 100K
R585 22K
P7-4
P7-5
S28 PERC. PATTERN I
P7-6
S29
P7-7
PERC. PATTERN II
P7-8
+27 V.
S30
P7-9
A.S.R.
P5-7
600

AUTOMATIC CHORD AND RHYTHM SYSTEM FOR ELECTRONIC ORGAN

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This is an application for reissue of Pat. No. 3,918,341 issued Nov. 11, 1975, on application Ser. No. 454,426, filed Mar. 25, 1974.

The present invention relates to an automatic chord and rhythm system in electronic organs.

Automatic chord and rhythm systems have in the past provided a complement of instruments, bass drum, snare drum, cymbal, etc., sounding as would a drummer, for a given rhythm. Little has been done for the rhythmic chord and bass accompaniment other than providing a rather simple bass-chord pattern. The present invention places emphasis on both aspects of an automatic chord-bass rhythm accompaniment device in that, for a given rhythm, a rhythm guitar, piano, electric guitar, bass guitar, bass drum, snare drum, cymbal and brush, etc., may each sound its own independent rhythmic pattern so that when combined they provide a very realistic and complete rhythm section, simulating the efforts of many musicians, and the various instruments sound as they would if musicians were playing them. This invention also provides a method by which one or more of the various accompaniment sounds (i.e., piano) plays a different rhythmic pattern than it otherwise would, when a preselected chord is sounded, greatly reducing the monotony of which prior art devices are guilty.

Most automatic chord devices provide a rather limited number of chords and do not allow one to play in all 12 musical keys. The present invention provides possible chords and allows one to play in any musical key from one octave of keys, through the use of six musical key selector buttons and a minor selection bar.

This invention is an improvement of a prior art system. In that system a clock pulse output is converted to thirty-two spatially distributed pulses which are applied to a matrix, the horizontal and vertical lines of which are selectively cross connected by FET's to provide a read only memory (ROM) for a variety of rhythms. The ROM has 64 output leads, which are connected to eight rows of rhythm select gates, the gate rows being selected by applying to them clock pulses, via one or more of eight rhythm selection switches.

SUMMARY OF THE INVENTION

An electronic organ including an automatic chord circuit providing control from an octave of keys, to provide chords in all twelve musical keys, selection of major triad or seventh chords appropriate to the selected musical key, conversion of the major triad or seventh chord to a minor chord responsive to actuation of a touch bar, in which rhythm is synchronized with and maintained by each key actuation, or in which rhythm is continuous once any key is actuated, in which one or more of the percussion voices sound in a modified rhythm when a seventh chord is sounded, in which plural chord instruments concurrently play different rhythms, in which a guitar voice is damped or undamped selectively, in which continuous chords in one voice can sound concurrently with rhythmic voices, and in which the chord logic system dissipates no power unless a key is actuated.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating the major sections and interconnections of the present invention;

FIG. **2** is a schematic wiring diagram of the pulse generator system and associated control circuitry of a preferred embodiment of the present invention;

FIG. **3** is a schematic wiring diagram of enable-disable trigger pulse logic, employed in the system of FIG. **1;**

FIG. **4** is a schematic wiring diagram of chord-bass logic circuitry, and of a musical key selector switch;

FIG. **5** is a circuit diagram of rhythm selector switches;

FIG. **6** is a schematic circuit diagram of chord and bass signal gates and associated filters;

FIG. **7** is a schematic circuit diagram of a representative rhythm voice;

FIG. **8** is a schematic circuit diagram of a representative rhythm voice derived from gating on noise;

FIG. **9** is a block diagram of a prior art system, the present invention representing an improvement of the system of FIG. **9;**

FIG. **10** is an expanded block diagram corresponding with the system of FIG. **9;**

FIGS. **11** and **12** are wave form diagrams pertaining to the system of FIGS. **9** and **10;**

FIG. **12a** is a timing diagram showing decay rates for certain [notes] *voices*; and

FIGS. **13a** and **13b** is a schematic circuit diagram of circuitry controlled by a manual solo keyboard, used with the system of FIG. **1.**

DETAILED DESCRIPTION OF PRIOR ART

First describing the prior art, in FIGS. **9–12,** inclusive, **24** consists of a 2048-bit read-only memory with addressing circuitry designed for musical rhythm pattern generation. The 32 × 65-bit memory array is arranged to provide a series of 32-eight-bit "words" for each of eight stored rhythm patterns. The eight bits of each word may correspond to eight percussive rhythm instruments. The 32 words are sequentially addressed by a 1-of-32 decoder which interfaces the count-address inputs to the ROM, and is included in the ROM.

The ROM **24** output is gated with a rhythm select pulse, which is switched externally to effect manual selection of one or more rhythms. This pulse strobes the output once for each count address and sets the width of the instrument trigger outputs. The select gates also perform an OR function necessary for intermixing rhythms. The output buffers are push-pull and provide low output impedance in both states.

Successive count address inputs are formed by a binary counter. When 4/4-time rhythms are desired the counter is allowed to run its full cycle. However, since 3/4-time rhythms are based on a shorter measure, four input addresses must be eliminated for each measure of these rhythms. When such rhythms are combined they both sound in 3/4-time and some events of the 4/4-time pattern are lost, but the over-all effect remains pleasant.

FIGS. **9** and **10** represent a system block diagram of a simplified form of the invention, according to the prior art. Note that several signal connections are desgnated. These designations correlate to those shown in he system timing diagram of FIGS. 11 and 12.

When the start switch SS is depressed V_{pp} is applied o the reset pulse generator RPG and the tempo clock !0. This results in resetting address signals A0 through \4 to the high level and in starting multivibrator oscilation of clock 20. The starting phase of the multivibraor is such that a strobe pulse (S) is immediately proluced by the strobe pulse generator SPG.

Strobe pulse S is applied to chosen rhythm select nputs of the ROM 24 via the selector switches SLS. Note that 3/4-time rhythms require DPST switches, vhereas 4/4-time rhythms require only SPST switches. The additional switch pole for 3/4-time is used to apply . dc input (ground) to NOR-gate G1.

Gate G1 serves two purposes: (1) in conjunction with he tempo control, it slows the tempo by a fixed amount vhen 3/4-time is desired; and (2) in conjunction with NOR-gate G2, it enables the elimination of undesired ount addresses.

The presence of the strobe pulse at any rhythm select nput (S1 through S8) results in the generation of a parallel 8-bit word at the instrument trigger outputs O1 hrough O8. The states (0's or 1's) of these outputs are letermined by the particular rhythm(s) selected, the ount address, and the ROM matrix coding. If a 1 exists n the coding of a given address, a negative-going pulse vill be produced. In the FIG. 10 example, the "typical output" is produced by coding a 1 at every major count 1/4 notes) in a hypothetical rhythm.

Inputs A0, A1 and A3 to NOR-gate G2 are low when ROM rows 12 and 28 are addressed by decoder DC. If a 3/4-time rhythm has been selected the output of G1 is also low, so that the output of G2 (R3) goes high for he duration of addresses 12 and 28. When the address s advanced to 13 or 29, R3 goes low and results in the generation of a reset pulse (reset A1-A3) that effects he elimination of addresses 13 through 16 and 29 hrough 32. Conversely, if no 3/4-time rhythm has been selected the output of G1 inhibits the decoding function of G2 and the decoder DC generates the full binary sequence.

FIGS. 11 and 12 show the generation of one measure each of 3/4- and 4/4-time rhythms. The tempo clock 20 frequency is shown identical for each rhythm, i.e., the empo has not been slowed by selection of a 3/4-time hythm (as described above). While this results in different measure times, the count-rate remains unchanged. Slowing the tempo by using the output of NOR-gate G1 results in equal measure times, but different count rates. The desirability of one alternative over the other is subjective, but is readily accommodated by including or not including G1's output as a factor in controlling tempo.

While FIG. 10 shows three 3/4-time and five 4/4-time hythms, as an example of the prior art, this selection is a matter of choice. Changes in this area affect only the number of DPST selector switches and NOR-gate (G1) nputs needed.

Gates G1 and G2 can be simple diode-logic types, followed by transistor inverters to provide the NOR function. The reset pulse generators RPG differentiate negative-going transitions provided by the start switch and G2 and apply the narrow reset pulses to the appropriate inputs of the decoder DC.

The strobe pulse gen SPG differentiates the positive-going transition of "Q" provided by the tempo clock 20. The differentiation network, which also sets the strobe pulsewidth, may be followed by a transistor amplifier to square the pulse and set the voltage levels, as is usual.

The present system uses the ROM (MCS/LSI memory) to store information about desired rhythm patterns in place of a diode matrix which was previously common. Operation begins with the actuation of a start-stop control which turns on the clock oscillator and resets the counter to the one (1) state (all outputs A_0 through A_1 equal to zero). One output of the clock is a short duration pulse (approximately 10 ms) which is selectively coupled to the rhythm select inputs of the memory device by the rhythm select switches. This signal is inverted and selectively gated by the memory, depending upon the information stored in the memory, and used to trigger the rhythm voices. It is therefore referred to as the "strobe" pulse. The second output of the clock is connected to the counter which counts clock pulses in a binary manner and provides a 5 bit binary word whose value corresponds to a particular time in the measure. Since the five binary bits have 32 different possible values, the measure can be divided into 32 discrete time intervals. This binary address activates a section of the memory which, depending upon the information stored in the memory, allows the strobe pulse applied to a rhythm select input to be inverted and coupled to any of eight outputs.

These outputs are connected to trigger amplifiers whose outputs are used to gate the rhythm voices. For some memory outputs the connection is made through a gate which allows the operator to cancel a voice from any automatic rhythm pattern. The bongo, accent, conga, bass, clave and cowbell voices consist of gated oscillators. The snare drum and cymbal voices are combinations of gated and filtered noise, and gated oscillations. The brush voice consists only of gated and filtered noise. Provision is made for triggering some voices from the accompaniment manual and the pedals of the organ. In addition to these triggers, a drum roll oscillator is provided whose output can be coupled through a switch to provide a repetitive trigger to the snare drum circuit, and a crash cymbal control is provided for random triggering of the cymbal circuit.

DETAILED DESCRIPTION

In FIG. 9, the outputs of a binary counter are represented by A_0–A_4. These are decoded in decoder DE to provide 32 spatially distributed output pulses. Since the counter is driven by a clock, the system has converted clock pulses to spatially distributed pulses. The latter pulses are applied to a matrix of the FET type, and the matrix content is read out on leads O1, there being 64 such output leads available, in the General Electric type GEM556M type ROM. These outputs are applied to rhythm select gates RS, which are selectively supplied with clock strobe pulses via selective switches S1–S8. If the S1 switch is closed, clock pulses are applied to the corresponding row of rhythm select gates, but these gates are selectively temporally conductive only according to the output pattern of the ROM. The outputs of the rhythm select gates are applied to output buffers, OB, and these supply trigger pulses to tone signal sources of a musical instrument.

Briefly describing the main features of the present invention, in FIG. 1, 16 automatic rhythms are provided and selected by a set of 16 push button rhythm select switches RS. Selecting any given rhythm automatically programs the correct rhythm, percussive and accompaniment voices for that rhythm. An MOS/LSI ROM **24** is used to store eight rhythm patterns. An adjustable rhythm clock oscillator **20** and resettable counter **23** are used in conjunction with the ROM **24** for the complete rhythm pulse generator. One output of the clock, on lead **31**, is a short duration pulse selectively coupled to the rhythm select input leads of the Rom **24** through the set of 16 rhythm select switches RS. Eight instrument trigger pulse outputs, on leads I-VIII (some are duplicated) are provided by the ROM **24**. Sixteen rhythms are generated from this eight rhythm capability by coupling the clock pulse on lead **31** to one or more of the rhythm select input leads, via RS, while enable-disable logic ED enables or disables certain of the eight instrument trigger pulse outputs on leads **30** to complements of percussive voices PV and accompaniment voices AV.

The rhythm percussion voices PV are generated by gated on oscillators or gated on noise from a noise generator, whenever a pulse is received from one of the trigger pulse outputs of the enable-disable logic ED. The accompaniment voices AV are developed by providing chord selector logic CS such that when one of the keys **1** is depressed, the note frequencies from generator **14** cause a **[** modified **]** chord signal to be applied to the inputs of signal gates AV. The signal gates AV are turned on whenever a trigger pulse is received from enable-disable logic ED.

ROM output line I is used to trigger the bass drum, II the snare drum, III brush, IV cymbal-clave and line V accent. Line I is also used to trigger a bass guitar voice and a piano voice whenever a seventh chord is sounded, as will be described in detail later. Line III also triggers a banjo voice. Line V also triggers an electric guitar voice. Line VI triggers a piano voice, line VII rhythm guitar and line VIII provides damping information for the rhythm guitar voice.

Included with the gates AV is filtering for each respective voice. The outputs of gates AV and tone sources PV are fed to amplifier A and loudspeaker LS.

A set of six key selector buttons Sb determines which keys **1** when depressed will provide a seventh chord on output line ST. Output line ST will represent either a major triad or a dominant 7th chord. If minor bar switch MBS is closed a minor triad or minor 7th chord will be applied to output line ST.

Through this arrangement 48 possible chords are provided and the musician is allowed to play in any of the 12 musical keys. Output line RF will provide either root or fifth bass frequencies to the bass guitar gate and filter contained in AV.

Note played detector **2** detects when any of keys **1** is depressed and starts rhythm clock **20**. Line **21** provides information to counter **23** to assure the rhythm will start on the downbeat. Line **20a** allows chord logic CS to provide an output on lines RF and ST when a key is played.

In this mode of operation everything is initiated and synchronized with the playing of a note. Another mode of operation allows the rhythm clock **20** to run continuously even if a key is not depressed, so that the rhythm percussive voices will sound independently of whether or not a key is played. The chord selector logic CS is still controlled by line **20a** which allows output signals on line RF and ST only when one key is depressed. If two notes are played the chord selector logic CS is defeated and no output will appear on lines RF or ST. Depending on the mode of operation the playing of two keys will stop the clock oscillator **20** or have no effect.

The enable-disable logic ED applies the eight output pulses from ROM **24** to gates AV and tone sources PV as a function of which rhythm selector switch RS is depressed, so that the appropriate complement of voices is sounded for the selected rhythm.

Objects of the present invention are as follows:

1. Provide an automatic chord attachment for electronic organs in which a maximum number of chords are available from one octave range of keys, with a minimum number of controls. Each key represents the root note of the chord sounded.

2. Provide all chords necessary to play in all twelve musical keys.

3. Provide a set of musical key selector buttons which automatically provides major triad and 7th chords which are appropriate to the selected musical key.

4. Provide a system in which a major triad or 7th chord is always sounded for each root note played and which provides a touch bar mechanism for converting to a minor triad or minor 7th chord.

5. Provide a system in which rhythm percussion and rhythm accompaniment are synchronized with the playing of a key to start on the downbeat and stop when the key is released, and which provides a mode button which will allow the rhythm percussion to run continuously once started by the playing of a key while the rhythm accompaniment remains a function of whether a key is depressed and means for stopping the rhythm percussion from a kick switch located on the expression pedal of the organ.

6. Provide a system in which one or more of the rhythm accompaniment voices sounds a modified rhythm whenever a 7th chord is sounded.

7. Produce sixteen rhythms from an eight input rhythm select device.

8. Provide a system in which different rhythm accompaniment sequences sound simultaneously.

9. Provide a system which has a pulse line for triggering a guitar voice and a pulse line for damping the guitar voice, allowing a realistic simulation of the sound of a guitar as actually played.

10. Provide a system which has an organ mode of operation in which the chord and pedal (root) will sound continuously when a key is depressed unless a rhythm button is depressed, in which case the pedal will play (root-fifth) rhythm of the given rhythm selected. Voicing of continuous chord will also be affected by what rhythm is selected. Continuous chord can sound simultaneously with other rhythm accompaniment voices sounding rhythmically.

11. Provide an integrated circuit chord logic design which dissipates no power unless a key is depressed.

Referring now more specifically to FIG. **2** of the accompanying drawings, there is illustrated, among other things, a tempo clock oscillator **20**, counter **23** and ROM **30** employed to provide an automatic rhythm generator forming a part of the apparatus of the invention. Also shown is an octave of keys **1** and note played detector circuitry **2**. One side of the keyswitches **1** **[** are **]** *is* tied to a common +5V bus **3**, the other side of the keyswitches **1** **[** are **]** *is* tied to a common bus **4** via resistors **5**. Thus whenever one or more keyswitches are closed a plus voltage appears on bus **4**. With one keyswitch closed base bias voltage is applied to transistor **6** via resistor **7** turning transistor **6** on and causing point "B" to be grounded. Base bias is also supplied to transistor **8** via diode **9**, but resistor **10** is selected such that the voltage developed at the base of transistor **8** is not enough to saturate it. Thus with one keyswitch **1** closed transistor **8** remains in an off condition. However, when two or more keyswitches **1** are closed enough bias voltage is developed across resistor **10** via diode **9** to cause transistor **8** to turn on, shunting the bias current to transistor **6** via resistor **7** to ground, turning transistor **6** off and allowing point B to rise to +**5V**. Thus the only time point B is grounded is when only one keyswitch is closed and this is the condition which is used to synchronize the entire operation of the present system. When point B is positive, base bias is supplied to transistor **11** via diode **12** and resistors **13** and **14** causing the collector of transistor **11** to be grounded. With transistor **11** saturated no base bias to transistor **15** via resistor **16** is available, thus transistor **15** is off, and +**27V** appears at its collector **18** via resistor **17**. The +**27V** at **18** is applied via lead **19** to clock oscillator **20** preventing the clock from running. When a keyswitch is closed, point B becomes grounded, transistor **11** turns off because no base bias is now available. When transistor **11** turns off, bias is supplied to transistor **15** via resistors **16** and **21** causing the collector **18** of transistor **15** to become grounded. When lead **19** becomes grounded the clock oscillator is turned on, and will continue to run as long as the collector **18** of transistor **15** remains at ground. This condition will exist as long as only one keyswitch **1** is closed. As soon as the keyswitch **1** is opened or two or more keyswitches are closed point B becomes +**5V**, the collector **18** of transistor **15** becomes +**27V** and the tempo clock **20** stops. This is defined as the synchronous mode of operation. Points X and Y are connected to a mode selector switch in FIG. **5**. With points X and Y open the synchronous mode is selected. If X and Y are tied together via the mode selector switch a continuous mode of operation is allowed. With X and Y tied together, once the clock oscillator is started by points B and **18** becoming grounded the junction of resistors **13** and **14** is connected via switch **22**, which is normally closed, via X - Y and diode **[23]** *23a* to the collector **18** of transistor **15**. When point B now becomes +**5V** upon release of the played key transistor **11** will not turn on because its base bias is now shunted to ground via switch **22**, X - Y, diode **[23]** *23a* and transistor **15** whose collector **18** is at ground potential. Thus transistor **11** wll remain off and transistor **15** will remain on, and the clock oscillator will continue to run. This condition will exist regardless of any keyswitch **1** operating. The clock oscillator will continue to run until such time that with no keyswitch closed either switch **22** or switch X - Y is momentarily opened. Opening of either of these switches and with point B at +**5V** (no note played) bias will again be supplied to transistor **11** which in turn causes the collector **18** of transistor **15** to become +**27V** and causes the clock oscillator to stop. Switch **22** may be located on the expression pedal of the instrument so that this operation can be readily performed.

Whenever line **19** becomes ground, which starts the clock oscillator, the I.C. counter **23** is reset to the downbeat condition. When line **19** is shunted to ground a negative pulse is applied via diode **27** and capacitor **28** to reset terminals **3** and **5** and via diode **26** to reset terminal **6**, causing the outputs on terminals **10, 11, 12, 13** and **14** of counter **23** to be set to +**27V**. Terminals **10, 11, 12, 13** and **14** of counter **23** are connected to address input terminals **5, 6, 7, 8** and **4**, respectively, of ROM **24**. This sets the ROM **24** to the condition which is necessary at the beginning of a measure. A pulse output from the clock **20** is applied to input terminal **4** of counter **23** via line **25**. Counter **23** then counts clock pulses in a binary manner and provides a five bit binary coded output on terminals **10, 11, 12, 13** and **14** of counter **23**, whose value corresponds to a particular time in the measure. The five binary outputs have 32 possible values. The system is arranged in a two measure manner so that each measure contains sixteen discrete time intervals.

The binary address of counter **23** activates a section of the memory of ROM **24** which allows a strobe pulse coupled to one of the input terminals **29** of ROM **24** to be coupled to the output terminals **30**. Depending on what information has been stored in the memory of ROM **24** a set of spatially distributed output pulses will appear on each output terminal **30**. The pulse distribution present on each output terminal is a function of which input terminal **29** is supplied with a strobe pulse from the clock oscillator **20** via the rhythm selector switches of FIG. **5**. Clock oscillator **20** provides a strobe pulse S to the rhythm selector switches via lead **31**. The ROM outputs **30** are gated with this strobe pulse when applied to one of inputs **29**. This pulse strobes the output once for each count address and sets the width of the instrument trigger outputs **30**.

The clock oscillator **20** is a gated on multivibrator, whose frequency (tempo rate) is controlled by adjustable resistor **32**, and provides a ten millisecond pulse at its output terminal **31**.

Output terminal 12 of counter **23** provides a positive going step every sixteeen counts. The positive voltage step is used to pulse a downbeat light emitting diode **33**.

When 4/4 time rhythms are desired the counter **23** is allowed to run its full cycle of **32** counts. However, since 3/4 time rhythms are based on a count system divisible by three, the counter must be converted to a **24** count system when 3/4 time rhythms are desired. This provides two measures of twelve counts each. This is done by eliminating the last four counts in each of the sixteen counts of 4/4 time. This arrangement facilitates the mixing of 3/4 and 4/4 time rhythms. When such rhythms are combined they both sound in 3/4 time.

In 4/4 time no voltage is applied to terminal **34**, thus transistor **35** is off and transistor **36** is on. Point **37** is held at +**27V** via resistor **38** and no information is fed via line **39** to reset pin **6** of the counter **23**. For this condition the complete thirty-two counts of the system **[** is **]** *are* obtained. Transistor **40** receives information from pin **12** of counter **23** via lead **46**, diode **45** and diodes **43** and **44**. Terminal **12** is +**27V** for the first eight counts and +**12V** for second eight counts of each measure.

In this respect the counter **23** is a conventional binary counter in which the stages have +**27V** on their output leads when off and +**12V** when on, and the binary output pulses are combined in binary decoder **24** to provide **32** counts, in conventional fashion.

Thus for the first half measure transistor **40** is off and then turns on for the last half of the measure supplying +**27V** to the root-fifth control line **47**. The root-fifth control line is connected to the chord-bass logic circuitry as shown in FIG. **4**, and will be explained later.

When 3/4 time is selected, +**27V** is applied to terminal **34** which turns transistor **35** on and the state of transistor **36** now becomes a function of the binary state of pins 10, 12 and 14 of counter 23 via resistors 49, 47a and 48, respectively. As long as any of these output pins are at +27V transistor 36 will be saturated. When all three outputs are at +12V transistor 36 will turn off. When one of these outputs returns to the +27V state, transistor 36 will again turn on causing a negative transient to appear on line 37, which is tied to reset pin 6 of the counter causing the counter to be reset to the downbeat condition. This will occur after the twelfth beat of each measure which in effect eliminates the 13, 14, 15, 16 counts of the first measure and the 29, 30, 31, 32 counts of the second measure, giving the twelve count per measure desired for 3/4 time. When +27V is applied to terminal 34 diode 50 prevents transistor 40 from being controlled from the counter via lead 46. Transistor 40 is now controlled from pin 13 of the counter via lead 51, diode 42 and resistor 41 such that transistor 40 is turned on only for the second measure in 3/4 time. The path from lead 51 is defeated in 4/4 time by appling +27V via resistors 52, and 53 to the junction of resistor 41 and diode 42.

The eight pulse trigger outputs 30 of the ROM are applied to terminals 54 and then to the enable-disable pulse trigger logic circuit as shown in FIG. 3. This circuitry allows the pulses appearing at 54 to be applied or defeated to the various voices as a function of what rhythm switch is operated in FIG. 5. Each rhythm switch when selected performs two functions. It applies the strobe pulse s to one of the rhythm select pins 29 of ROM 24 in FIG. 2. It also applies +27V via a diode and resistor matrix to the enable-disable logic circuitry in FIG. 3. Thus when a rhythm is selected and the clock oscillator is caused to run pulses will be applied to terminals 54. In each case the pulses are applied to the bases of PNP transistors. Each pulse goes negative from 30 27V to +12V and is ten milliseconds wide. For example, if the emitter resistor 54a and base bias resistor 55 [has] *have* +27V applied to them via lead 59, the PNP transistor 56 will turn on when a pulse is applied to its base charging the sustain capacitor 57 with a positive voltage for ten milliseconds. The voltage on capacitor 57 then decays away exponentially. For this example the voltage on capacitor 57 is applied via lead 58 to an electric guitar signal gate.

If no voltage is present on lead 59, no pulse signal will appear on lead 58. In this manner various voices are allowed to speak as a function of the rhythm selected. This arrangement, along with the ability to intermix rhythms, allows the present system to be expanded from eight rhythms to 16 rhythms, without a corresponding expansion of ROM capacity.

In a similar manner, where +27V is selectively applied to the emitters of the PNP transistors when a given voice is desired to be sounded, the following voices are controlled: electric guitar trigger 58 by lead 59, banjo trigger 60 by lead 61, clave trigger 62 by lead 63, snare drum trigger 64 by lead 65 and piano trigger 66 by lead 67.

The accent trigger on lead 68 is provided by transistor 69 whose emitter and base resistors are permanently tied to +27V. The accent trigger on lead 68 is thus present unless +27V is applied to accent defeat lead 71 and to the junction of diode 72 and capacitor 73 via diode 70. This prevents a negative pulse from the ROM at terminal 22 from being applied to the base of transistor 69, and thus no trigger pulses will appear on lead 68. The brush trigger lead 74 has pulses applied via transistor 75 whenever pulses appear on terminal 20 since there is no add or defeat type function associated with transistor 75.

Cymbal trigger lead 76 is supplied with pulses via resistor 82 and transistor 83. If transistor 81 is turned on, lead 76 will be grounded and no pulses will appear on trigger lead 76. Transistor 81 can be turned on by applying +27V to lead 77, or lead 78, or lead 63. Lead 77 saturates transistor 81 via resistor 80 and lead 63 saturates transistor [51] *81* via diode 84 and resistor 79.

In a similar manner pulses on snare trigger lead 89, supplied via resistor 87 and transistor 88 if +27V is applied to lead 65, can be defeated by transistor 86.

Transistor 86 will saturate whenever +27V is applied to terminals 63 or 78. The bass drum trigger lead 90 and bass guitar lead 92 via diode 93 will have pulses supplied to it via transistor 91 as long as pulses appear on ROM terminal 18.

Pulses on terminal 18 can also trigger transistor 94 which subsequently supplies a pulse to piano trigger lead 66. Transistor 94 can be triggered from terminal 18 via resistor 107, diode 106, resistor 96 and diode 95 if +27V is applied to piano add terminal 67 and transistor 100 is turned on. Thus, when a piano voice is selected by applying +27V to lead 67 the piano trigger line 66 is capable of having the spatially distributed sum of the pulses appearing on ROM terminals 17 and 18. This will be true when a seventh frequency signal is applied to terminal 105 which is detected by resistor 104, diode 103 and capacitor 102, which develops a d.c. bias for transistor 100 via resistor 101. If no signal is present on terminal 105, transistor 100 is off preventing transistor 94 from being pulsed from terminal 18. Transistor 94, however, still continues to be pulsed from terminal 17. Thus the piano trigger line 66 will have a set of pulses which are a function of whether a seventh frequency signal is available.

When the seventh signal is present line 66 will contain the spatial sum of pulses of terminals 17 and 18 and when seventh signal is not present line 66 will contain only the pulses present on terminal 17. By this method the rhythmic line sounded by the piano voice changes whenever a seventh chord is sounded. This effect adds realism to the overall rhythmic effect and greatly reduces the monotony which is characteristic of previous automatic accompaniment devices.

In a manner similar of that described earlier rhythm guitar trigger line 109 will have pulses present via resistor 112 and transistor 113 if pulses are present on ROM terminal 16, and no voltage is present on line 108, causing transistor 111 to be off and allowing the pulses to pass to line 109. Every time transistor 113 is pulsed sustain [capacity] *capacitor* 118 is charged for 10 [.] ms and then discharges exponentially. This causes the rhythm guitar voice to be sounded with a fixed length of sustain. An additional circuit is provided, consisting of transistors 117 and 115 and associated circuitry, such that whenever a pulse is present on ROM line 15 transistor 117 turns on which turns transistor 115 on via resistor 16. When transistor 115 is on sustain capacitor 118 has an additional discharge path through resistor 114. Thus the guitar voice can be sounded with two distinct lengths of sustain by the appropriate pulse distributions present on terminals 15 and 16. For example, a pulse may appear on terminal 16 on the downbeat of a measure causing the guitar voice to sound and sustain with a relatively long time constant appropriate for a guitar voice. One quarter note later another pulse may appear on terminal **16** causing the guitar voice to be triggered again. However, a sixteenth note after this second pulse a pulse may appear on terminal **15** causing the sustain capacitor **118** to be discharged at a substantially faster rate, through transistor **115** and resistor **114**, than normal. This simulates the effect of strumming a guitar and then damping the strings. This unique method of simulating a guitar voice adds greatly to realism.

When the organ switch in FIG. **5** is closed +27V is applied to terminal **120.** If no rhythm button is selected and a key is played the guitar voice will sound a continuous chord due to +27V present on terminal **109** via resistor **112** and diode **119.** In addition the bass guitar voice will sound a continuous root tone of the depressed key due to +27V being applied to terminal **92** via diode **123** and resistors **124.**

If in addition to the organ switch a rhythm switch is operated transistor **122** is turned on due to bias current via one of the following resistors **130, 126, 127, 128** or **129.**

With transistor **122** saturated no voltage appears at bass guitar terminal **92** because the junction of diode **123** and resistor **124** is shorted to ground via the collector of transistor **122.** This allows the bass guitar to return to the playing of a rhythmic pattern instead of a continuous sound.

Depending on which rhythm switch is operated the continuous guitar voice may or may not be defeated, and a continuous piano voice may sound depending on whether or not +27V has been applied to terminals **108, 131** or **67,** as previously described. Thus depending on what has been programmed by the matrix of FIG. **5** the guitar voice, or the piano voice, or both, may sound in a continuous fashion. In addition, depending on the rhythm selected the banjo and electric guitar may play a rhythmic sequence. The rhythm percussion voices, brush, bass drum, snare drum, etc. will still play the rhythm which has been selected. If in addition to the organ switch no rhythm switch is closed the rhythm percussion voices will not sound. By this arrangement, the use of one organ mode button can provide a wide variety of combinations in sound.

Terminal **125** supplies +27V to the chord logic circuitry of FIG. **4** so that when the bass guitar sounds continuously only the root tone is allowed, whereas when the bass guitar plays rhythmatically a root-fifth sequence is allowed.

Thus through the use of the diode resistor matrix in FIG. **5** and the enable-disable logic of FIG. **3** a wide variety of rhythms and effects **[** are **]** *is* obtained from a ROM limited to eight rhythms and eight voices.

By operating various of the switches in FIG. **5** in combination as even wider variety is obtainable.

FIG. **7** is a typical circuit arrangement for obtaining various rhythm percussion voices through the use of gated on oscillators. By proper selection of resistor and capacitor values, the circuit can be caused to oscillate at a given frequency and for a given length of time for simulating a given percussive tone.

FIG. **8** is a typical example of a circuit used for obtaining percussive sounds which are developed through the use of gated on noise such as brush, cymbal, etc. Transistors **132** and **133** form the gate and transistor **134** in conjunction with associated circuitry forms a conventional active filter for obtaining the desired sound.

The circuits of FIGS. **7** and **8** receive their respective pulses from the logic of FIG. **3** and have numbered terminals corresponding with those in FIG. **3.**

FIG. **6** shows the signal percussion gates and active filters associated with the generation of the electric guitar, banjo, piano, rhythm guitar and bass guitar voices.

Square wave frequencies of a given chord are applied to terminals **105, 155, 156** and **157.** The capacitor **166** and resistor **167** convert the square wave input to a pulse waveform at the collector of transistor **136** when the collector is supplied with voltage from one or more of the instrument trigger inputs, such as at **66.** Transistors **137, 138** and **139** operate in a similar manner. The square waves are converted to pulse waves because signals rich in all harmonics are desirable for application to the various active filters in simulating the various instrument sounds.

Frequency signals from FIG. **4** are present at the input terminals **105, 155, 156** and **157** only when one key is played.

Assume signals are present at these inputs and the piano trigger line is being pulsed rhythmatically with a percussive envelope which is generated in the circuit of FIG. **3.** The seventh signal present at the collector of transistor **136,** for example, is coupled to output bus **152** through the diode gating action of diodes **143** and **147** and bias resistor **151** with the percussive envelope of that which is present on lead **66.** In a similar manner the other chordal frequencies are gated to bus **152** through their respective diode gates. The signal present on bus **152** is applied to the active filter composed of transistor **153** and associated circuitry and then to the signal output bus **154.** The electric guitar, banjo, and rhythm guitar gates operate in an identical manner.

8′ and **16′** bass frequency square waves are applied to transistors **160** and **161,** respectively, and converted to pulse waves.

When terminal **92** is pulsed with a percussive envelope the bass signals appear on bus **164** via diodes **162** and **163.** This signal is then filtered and passed to the signal output via lead **165.**

Referring to FIG. **4,** when a key switch is closed, for example the C note key switch, +5V is applied to terminal **69** shown in both FIGS. **4** and **2.** Terminal **69** represents the supply voltage terminal of an integrated circuit pack **194** which contains six inverters (with open collector output) shown as **171** through **176.** There are twelve I.C. packages **168,** one for each key note designation C through B. All twelve I.C. packages are normally inoperative until a key switch is closed and +5V supplied to the associated I.C. package. Five of the six inverters of each package has an appropriate chordal frequency applied to its respective input. For example, circuit pack **168** associated with key switch C has a C frequency applied to the input of inverter **171,** D # applied to **172,** E applied to **173,** G applied to **174** and an A # applied to **175.** These frequencies represent the root, minor third, major third, fifth, and seventh chordal components for a C chord necessary for constructing major triads, minor triads, dominant sevenths and minor sevenths. The sixth inverter of each package such as **176** is used in conjunction with key selector switch **170** for automatically programming seventh chords.

All inverters which are associated with the root note of a given chord have their outputs wired to bus **195.**

Those inverters associated with minor third note have their outputs wired to bus **196**.

In a similar manner buses **197, 198** and **199** represent major third, fifth, and seventh, respectively. If no key switch is closed no signals will appear on buses **195** through **199** because no I.C. package has supply voltage provided. Because each inverter is of the open collector type their outputs can be "OR" wired to a given bus as described and will provide no signal to that bus until provided with supply voltage.

Assume key switch C is operated, +5V applied to terminal **69** buses **195** through **199** will contain appropriate signals for chord construction as previously described. Buses **195** through **199** are tied to additional logic circuitry. Bus **195** is tied to one input **206** of a two-input positive NAND gate **182** (with open collector) and also to root terminal **155.** Bus **198** is tied to one input **208** of NAND gate **184,** and fifth terminal **157.** The outputs of **182** and **184** are "OR" wired via lead **210** and applied to divider **192** via lead **211.** Lead **211** will have a root or fifth signal applied to it via NAND gates **182** or **184** depending upon whether (root-fifth) terminal **47** has voltage applied to it. With no voltage on terminal **47** transistor **177** is off, and input terminal **207** of NAND gate **182** is open, allowing the signal on input **206** to appear on lead **211** via **182.** The input to gate **183** is also open causing its output to be grounded, grounding input terminal **209** of NAND gate **184** and causing its output to be open. Since **209** is grounded the signal appearing on **208** is prevented from being gated to lead **211** via NAND gate **184.** Thus lead **211** will contain only the foot note frequency. When positive voltage is applied to terminal **47** transistor **177** will saturate if transistor **179** is off. This grounds the input **207** of NAND gate **182** and also the input to gate **183.** The signal on input **206** is now prevented from appearing on lead **211** via **182.** With the input of gate **183** grounded its output is open and input terminal **209** of NAND gate **184** is open allowing the signal on input **208** to appear on lead **211** via **184.** Thus lead **211** will contain only the fifth note frequency. Signal appearing on lead **211** is applied to divider **192** and then to divider **193** to provide bass frequencies on terminals **158** and **159.** The frequencies on **158** and **159** are then applied to bass guitar gating in FIG. **6** such that when a bass guitar trigger is received bass guitar root-tone or a fifth tone will be sounded. Thus the voltage on terminal **47** of FIG. **4** determines whether a root tone or a fifth tone will be sounded in the bass register. The voltage on terminal **47** is a function of the counter circuitry in FIG. **2** as previously described.

When the organ mode selector button is on voltage will be applied to terminal **125** saturating transistor **179** causing transistor **177** to be off regardless of the voltage condition on terminal **47.** This causes lead **211** to contain only the root note frequency.

Bus **197** is tied to input terminal **212** of NAND gate **189.** Minor bar switch **194** is normally open causing input **213** to be open, allowing the signal on input terminal **212** to appear on third terminal **156** via NAND gate **189.**

Bus **196** is tied to input **215** of gate **188,** however, with switch **194** open the output of **190** is grounded and thus the signal on bus **196** is grounded via lead **214** and is prevented from appearing at the output of **188.** Thus the major third frequency normally appears at terminal **156.**

If switch **194** is closed input terminal **213** of NAND gate **189** is grounded preventing signal at input **212** from being passed to terminal **156.** The input of **190** is also grounded causing the output of **190** to be open and allowing the signal on input terminal **215** to be passed to terminal **156** via gate **188** which represents the minor third frequency. Thus switch **194** controls whether the major or minor third frequency appears at terminal **156.**

Bus **199** is tied to the seventh terminal **105.** Whether a signal is present on terminal **105** is a function of the key selector buttons **170.**

If all switches of **170** are out as shown terminal **105** is preventing defeating the seventh signal. If one of the switches of **170** is closed seventh signal may or may not appear on terminal **105** depending upon the condition of lines **200** through **205.** If, for example, the CG switch of **170** is closed terminal **105** is connected to line **200** and **205.** The sixth inverter of each I.C. package is connected to one of the lines **200** through **205** as shown. The sixth inverter, such as **176,** has no connection to its input terminal. Thus if voltage is applied to terminal **[169]** *69* the output of **176** will be grounded, grounding line **200,** which subsequently grounds terminal **105** via the CG♭ switch of **170,** the seventh signal from sounding. With CG♭ switch closed terminal **105** will be grounded whenever a C,F #, F or B key switch is closed. When any other key switch is closed seventh signal will appear on terminal **105.** This allows seventh chords to sound for the appropriate chord when a given musical key switch of **170** is selected. If, for example, GD♭ switch of **170** was closed lines **201** and **200** would ground terminal **105** whenever a C, F #, C # or G key switch was closed, preventing the seventh signal from sounding.

As stated previously, the system of the present invention is defeated when two or more key switches are closed simultaneously. Preventing signal from appearing on terminals **155, 156, 157, 158, 159** and **105** under these conditions is done by applying +5V to terminal B (FIG. **4**). This voltage is developed from FIG. **2** as previously explained. When +5 is applied to B inverters **191, 187, 185** and **186** are caused to have their outputs grounded which defeats signal from the above stated terminals, defeating the entire automatic programming of the chords.

Since under this condition the rhythm generator may be still running, which provides a control signal to root-fifth terminal **47,** B also saturates transistor **179** via resistor **181,** preventing any control voltage on terminal **47** from affecting transistor **177** and thus causing undesirable transient effects from triggering dividers **192** and **193.** When no keys are depressed no power is applied or dissipated by the twelve I.C. packages developing the chordal components.

The material hereinabove provided relates to the rhythm section of an electric organ. The following material relates the rhythm section to a melody section of the organ.

Referring to FIGS. **13a** and **13b,** when key switch **S1** is closed plus voltage via lead **100** and transistor **Q109** is supplied to an individual note gate **200.** This allows the generator signal on terminal **300** to be passed through the gate composed of diodes **D1** and **D2** and resistor **R2** and to appear on output signal bus **400.** Capacitor **C1** charges to the keying voltage and if bus **500** is not grounded will allow the signal through the gate to gradually decay in an experimental fashion after the switch S1 is opened. If bus **500** is grounded, the signal through the gate will quickly decay.

When a key switch is closed current through resistors **R565** and **R567** turn transistor **Q109** on and thereby supply voltage to transistors **Q110, Q111** and **Q108.** When a key switch is closed the voltage on bus **100** falls slightly causing a negative transient to be coupled via resistor **R570,** diode **D131** and capacitor **C468** to the base of transistor **Q110** causing **Q110** to turn off and allowing the voltage from the collector of **Q109** to appear at the base of **Q111** via resistors **R568** and **R572.** This saturates **Q111** and couples a negative transient to the base of **Q110** via capacitor **C471. Q110** will remain off until resistor **R574** charges capacitor **C471** to a value which will overcome the base emitter drop of **Q110** turning **Q110** on and **Q111** off. Thus when a key is played a positive **10** ms pulse appears at the collector of **Q110** and the collector of **Q111** remains at ground for the same length of time.

If the ASR switch is as shown +27V appears on bus **600** providing supply voltage to transistors **Q116, Q115, Q113, Q107** and **Q108. Q115** is saturated causing **Q114** to be off which in turn causes **Q90** to be off and thus prevents **Q90** from passing any voltage appearing at its emitter to be passed to the piano gate **P8** via lead **700.** In a similar manner **Q107** is saturated via **D128** grounding the cathode of **D114** preventing any voltage from being passed to the trumpet gate **T9** via resistor **R497.**

Since **Q116** as supply voltage via lead **600** transistor **Q116** will turn on for **10** ms every time a key is played due to its base being coupled to transistor **Q111** via resistor **R584,** and diode **D135.** Thus a positive voltage **10** ms pulse appears at the collector of **Q116** which is applied to the piano gate **P8** via lead **700,** diode **D124** and piano switch **S24,** if the piano switch is closed. **S24** is shown in the "off" or open position. This 10 ms pulse charges capacitor **C431** and provides bias to the linear gate composed of diodes **D81** and **D82** via resistors **R447** and **R449,** turning the gate on, and passing any signal which appears at its input to its output. After 10 ms, bias of gate **P8** decays exponentially due to the discharge of capacitor **C431,** causing the signal to decay in a slow exponential fashion. Signal input to the gate **P8** is received via filter **12** from signal bus **400.** If bus **500** is grounded and a key is released before gate **P8** has decayed the signal at the gate output will decay quickly, due to the short sustain time of note gate **200.**

Thus piano gate **P8** is pulsed with a 10 ms pulse every time a key switch is closed and gate **200** is turned on for as long as the key switch remains closed. The resulting signal envelope would appear as shown in FIG. **12a.** Also when a key switch is closed and transistor **Q109** turns on, **Q108** turns on due to bias current via resistor **R566. Q108** turns **Q113** on via diode **D134** and resistor **R579. Q113** thus supplies voltage to trumpet gate **T9** via trumpet switch **S21** and diode **D112,** for as long as the key switch is closed. When **Q113** turns on capacitor **C429** is charged with a time constant of **C429** and **R448** and is selected to simulate a trumpet attack. When the key switch is released and **Q113** turns off capacitor **C429** primary discharge path is through diode **D84** and resistor **R454** to ground. This is a much faster discharge than that of gate **200** with bus **500** grounded. Also shown in FIG. **12a** is the envelope of the trumpet for a key played and released. Thus the trumpet signal will appear on signal output terminal for as long as the key switch remains closed while the piano will gradually decay.

If the ASR switch is closed no supply voltage will appear on lead **600** and thus no trigger voltage will be available to the piano gate or the trumpet gate via the piano and trumpet switches even if they are closed.

Since there is no voltage on lead **600,** transistor **Q115** will be off, which allows transistor **Q114** to become saturated for 10 ms every time a key switch is played, due to bias current via resistor **R580** from the collector of transistor **Q110.** Transistor **Q114** will then pulse **Q90** if voltage is present at the emitter of **Q90** which in turn provides a trigger pulse to piano gate **8** via lead **700.** Whether voltage is present at the emitter of **Q90** depends upon which rhythm switch is operated. If the Rhumba switch were closed **+27V** would appear at the emitter via diode **D171** and the piano would be allowed to sound exactly in the same manner as previously described. If no voltage is present at the emitter the piano will not sound when a key switch is closed. As examples, it is shown that rhythm buttons Old Time Waltz, Rhumba, Pop Rock. Ragtime and Swing will supply voltage to **Q90** when selected via diodes **D181, D171, D154, D148** and **D141,** respectively. Thus the piano voice is automatically selected as a function of which rhythm is selected.

Since no voltage is present on lead **600** transistor **Q107** is not provided with bias current via **D128,** but is still held in saturation due to bias current via resistors **R562** and **R564.** However, whenever a key switch is closed and **Q109** turns on **Q108** turns on due to bias current via **R566. Q108** shunts the bias current of **Q107** causing **Q107** to turn off. This in turn removes ground from the cathode of diode **D114** which will then allow voltage to be applied to trumpet gate **T9** via diode **D113** and resistor **R497** via certain of the rhythm buttons. Voltage will be supplied to resistor **R497** via rhythm switches labelled Dixieland, Latin III and March and diodes **D142, D166** and **D178,** respectively. Thus, the trumpet voice will be allowed to sound for certain rhythms. Additional voices can be controlled in the manner described, the description being exemplary.

When Old Time Waltz is selected and the piano is allowed to sound voltage is also applied to transistor **Q88** via resistor **R533** and diode **[s]** **D176.** If ASR swich is closed voltage is also applied to resistor **R531** but is shunted to ground by **Q88.** This allows **Q87** to be "off", which removes sustain bus **[5]** *500* from ground. Now when a key is played and released the piano voice will have a long sustain because of the long sustain of gate **200.** This is not true for the other rhythm buttons which select the piano voice because **Q88** will be off and **Q87** will ground sustain bus **500.**

Perc Pattern I switch will cause the piano to be reiterated by applying the strobe pulse of the rhythm generator to the note played detector circuitry via transistor **Q117,** causing a 10 ms pulse to be applied to the piano gate at the strobe pulse rate.

Perc Pattern II switch will cause a piano to be sounded in a particular rhythm, which is a function of what rhythm button is selected, by applying the ROM output pulse which appears on pin **20** to the note played detector via diode **D136** and capacitor **C473.** Perc I and II buttons only affect the piano, and not the trumpet.

Since the strobe pulse and the ROM output pulse switch between **+27V** to **+12V,** transistor **Q80** will be supplied with bias current via resistors **R486** or **R487** depending upon whether Perc I or Perc II switch is operated. If transistor **Q80** is allowed to be saturated the piano gate **8** will have a shorter sustain than normal because of an additional discharge path of sustain capacitor **C431** via diode **D84** and resistor **R473** and transistor **80**, **Q80** will be saturated only if **Q81** is off. **Q81** is off only when a note from the left hand automatic chord section is being played. The note played trigger pulse is +5V when no left hand rhythm or chord is played and is at ground when one of these keys is played.

Thus when a left hand key is played and the piano is played by holding down a key switch in the right hand the piano will be pulsed but the length of sustain will be shorter than normal, allowing the effect to be more distinctive than would be the case if the piano were allowed to have its regular long sustain, as provided by gate **P8**.

What I claim is:

1. In an electric organ an array of *playing* keys, means responsive to actuation of selected ones of said array of *playing* keys for sounding a triad chord, means responsive to actuation of the unselected ones of said array of *playing* keys for sounding a seventh chord, *musical* key selector switches, and means responsive to *actuation of* said *musical* key selector swtiches for selecting which of said *playing* keys shall be selected *ones of said playing* keys.

2. The combination according to claim **1**, wherein is provided means for sounding said chords in one rhythm in response to actuation of one of said selected *playing* keys and in another rhythm in response to actuation of one of said unselected *playing* keys.

3. In an electronic organ, a keyboard, said keyboard including a set of solo keys and an octave of chord control keys, each of said chord control keys representing a root note, control means [, means] responsive to actuation of any one and only one of said chord control keys for calling forth a chord [, means responsive to said control means for selecting the chords called forth by said chord control keys] in all twelve musical keys, *said control means including manually operable musical key selector means for discriminately selecting seventh chords in response to actuation of predetermined ones of said chord control keys*, and means for disabling said control means in response to actuation of more than one of said chord control keys.

[**4.** The combination according to claim **3** wherein said control means are manually operable musical key selector means.]

5. The combination according to claim **3** wherein said chords are selectively major triad and dominant seventh chords and, wherein is included mechanical means for converting said major triad and dominant seventh chords to minor triad and minor seventh chords.

6. The combination according to claim **5**, wherein is included means for initiating rhythmical sounding of said chords to start on a downbeat in response to actuation of one of said octave of chord keys and to stop in response to release of said one of said octave of keys.

7. The combination according to claim **5**, wherein is provided means for automatically calling forth a first rhythm in response to calling forth a triad chord and a second diverse rhythm upon calling for a seventh chord.

8. An automatic chord device for an electronic organ having percussive and accompaniment voices, comprising an array of keys, a set of rhythm select switches, means responsive to actuation of only one key of said array of keys for sounding a musical chord, means responsive to actuation of one of said rhythm select switches for selecting a first rhythm pattern of a percussive voice and [another] *at least two other diverse* rhythm patterns *each* [of an] *for different* accompaniment [voice] *voices*, and means for concurrently sounding said chord [in said another rhythm] in said accompaniment [voice] *voices in said at least two other diverse rhythm patterns* and [for sounding said chord in] said percussive voice in said first rhythm *pattern*.

9. The combination according to claim **8**, wherein said percussive voices are bass drum, snare drum, brush, cymbal, clave and accent and wherein said accompaniment voices are piano, banjo, rhythm guitar, electric guitar and bass guitar.

10. The combination according to claim **8**, wherein said accompaniment voices are string instrument voices.

11. The combination according to claim **8**, wherein is further included a set of seventh selector switches, and means responsive to selective actuation of said seventh selector switches for controlling which keys of said array of keys shall call forth a seventh chord and which shall call forth only a triad chord.

12. The combination according to claim **11**, wherein is provided means responsive to actuation of any one of said array of said keys which calls forth a seventh chord for modifying the rhythmic [pattern] *sequence* of said *other diverse* rhythm patterns.

13. In an electronic organ system, an array of keys, means selectively responsive to actuation of any one of said keys for calling forth a musical chord of tones of selectively major and minor character and in a first rhythmic sequency, mechanically, operable means for converting said musical chord from a major chord to a minor chord and vice versa, and control means operative to convert said musical chord from a chord containing no seventh component to a chord containing a seventh component and for concurrently modifying said rhythmic sequence.

14. An electronic organ, comprising a clock for producing recurrent pulses, means responsive to said pulses for generating recurrent trains of spatially distributed pulses, a read only memory matrix having input terminals and output terminals, means applying said spatially distributed pulses to said input terminals, a plurality of keys, means for deriving a variety of patterns of output pulses from said output terminals in response only to selective actuation of a single one of said keys, and means for rhythmically sounding a musical [chords] *chord* in response to said patterns of output pulses such that plural [ones] *voices* of said musical [chords] *chord* sound in diverse rhythms concurrently.

15. The combination according to claim **14**, wherein is provided means for adding seventh chord components to said chords at will.

16. The combination according to claim **15**, wherein is provided means for varying said rhythmic patterns of said chords in response to operation of said last named means.

17. The combination according to claim **14**, wherein is included means for playing in twelve diverse musical keys.

18. The combination according to claim **14**, wherein said chords are all played in major keys and wherein is provided player operated means for converting major keys to minor keys.

19. The combination accordingly to claim **14**, wherein is provided a keyboard having a group of playing keys, means responsive to playing of any one key of said group of playing keys for calling forth a major triad chord corresponding with that one key, and touch bar means for converting said major triad chord to a minor triad chord.

20. The combination according to claim **19**, wherein is included a set of key selector switch actuators, means selectively responsive to said switches when actuated for determining which of said group of playing keys shall provide a seventh chord.

21. The combination according to claim **20**, wherein is provided an output line for said chords, wherein said memory provides normally either a major triad or a dominant seventh chord, and touch bar means for converting said major triad to a minor triad and said dominant seventh to a minor seventh.

22. In an electronic organ, an array of playing keys, means responsive to actuation of selected ones of said array of playing keys for sounding chords, means for selecting rhythmic patterns, means for sounding said chords in a selected rhythmic pattern in a first sequence of rhythm accompaniment voices in response to actuation of first predetermined selected ones of said array of playing keys, and for sounding said chords in said selected rhythmic pattern in a second sequence of rhythm accompaniment voices in response to actuation of second predetermined selected ones of said array of playing keys.

23. An electronic organ, comprising a clock for producing recurrent pulses, means responsive to said pulses for generating recurrent trains of spatially distributed pulses, a memory matrix having input terminals and output terminals, means applying said spatially distributed pulses to said input terminals, a plurality of keys, means for deriving a variety of patterns of output pulses from said output terminals in response only to selective actuation of a single one of said keys, and means for rhythmically sounding a musical chord in response to said patterns of output pulses such that plural voices of said musical chord sound in diverse rhythms concurrently.

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