DRUMMER BOY
INSTRUCTIONS

Essentially, the Drummer Boy is a variable speed digital counter that has 11 different beats—ranging from a slow waltz to a fast cha-cha—played either by a bass drum, wood block, clave, conga, snare drum, or a combination. Self-powered and having both variable tempo and volume control, the Drummer Boy is easily connected to an instrument power amplifier.

Ring Counter. The circuit of the Drummer Boy can be divided into three sections: an eight-stage ring counter, a switching and decoding system, and an electronic tone generator.

In the ring counter (see Fig. 1), the basic timing is provided by *Q18*, a conventional UJT relaxation oscillator whose frequency is determined by capacitor *C18* and by the setting of the tempo control, *R63*. Each time the UJT fires, a positive pulse is generated across *R60*. The pulse turns on *Q17*, which momentarily causes the shift buss to be shorted to ground.

With the exception of a modification in the start circuit of stage 1 (*Q1,Q2*), the eight ring counter stages are identical. With switch *S1* off, *Q1* is biased on by the combination of *R2* and *R3*; and *Q2* is off. When *S1* is turned to start, the momentary surge of charging current on *C19* causes a voltage spike across *R62*. This positive-going spike is passed through *D1* to the emitters of *Q1* and *Q2* causing them to change their states. As long as *Q2* is on, the current flow through the common emitter resistors, *R7* and *R5*, keeps *Q1* off.

When a pulse from *Q17* occurs on the shift buss, the collector of *Q2* is effectively grounded and the emitter of *Q1* is lowered to the point where it turns on. Simultaneously, while *Q2* was on, *C2* accumulated a charge so that, when *Q2* turns off, *C2* discharges through *R5* and *R7* and the biasing resistor on *Q3*. This causes *Q3* to turn off. When the shift buss returns to normal (*Q17* not triggered), *Q2* will not turn on because *Q1* is saturated. At the same time, *Q3* is off and *Q4* is on.

Each time a pulse occurs on the shift buss, this same procedure is repeated down the string of eight counters. Thus, a pulse appears to walk down the outputs numbered 2 through 8 on Fig. 1. When the last stage is reached, the output goes through switch *S1* back to the first stage and the counting continues. The process continues until *S1* is turned off, which also shorts out *C19* to insure that it will be completely discharged for the next sequence.

An RC differentiating network is connected to the output of each pair (for example, *C3* and *R13* for *Q3* and *Q4*) to convert the square-wave output to spikes. These are used in the diode matrix to decode the selected rhythm patterns and trigger the various tone oscillators.

Since the ring counter normally counts in eight beats, a waltz tempo using six beats is obtained by bypassing stages three and four with the closing of switch *S2*, *S3* or *S4*.

Decoding and Switching. The output from stage one of the ring counter (terminal E) is the downbeat signal and is processed in a special way which will be described later. The other seven outputs (2 through 8) are coupled to the diode matrix shown in Fig. 2. The diodes are arranged to pick up the correct beats for the selected rhythm. (The use of diode coupling permits more than one ring counter output to be tied to a single tone generator without intercoupling.) Rocker switches *S2* through *S12* are used to select the desired rhythm, while switches *S14* through *S18* and their associated coupling diodes select the tones. Switch *S13* permits emphasis on the downbeat when desired and couples the first ring stage to the bass tone generator.

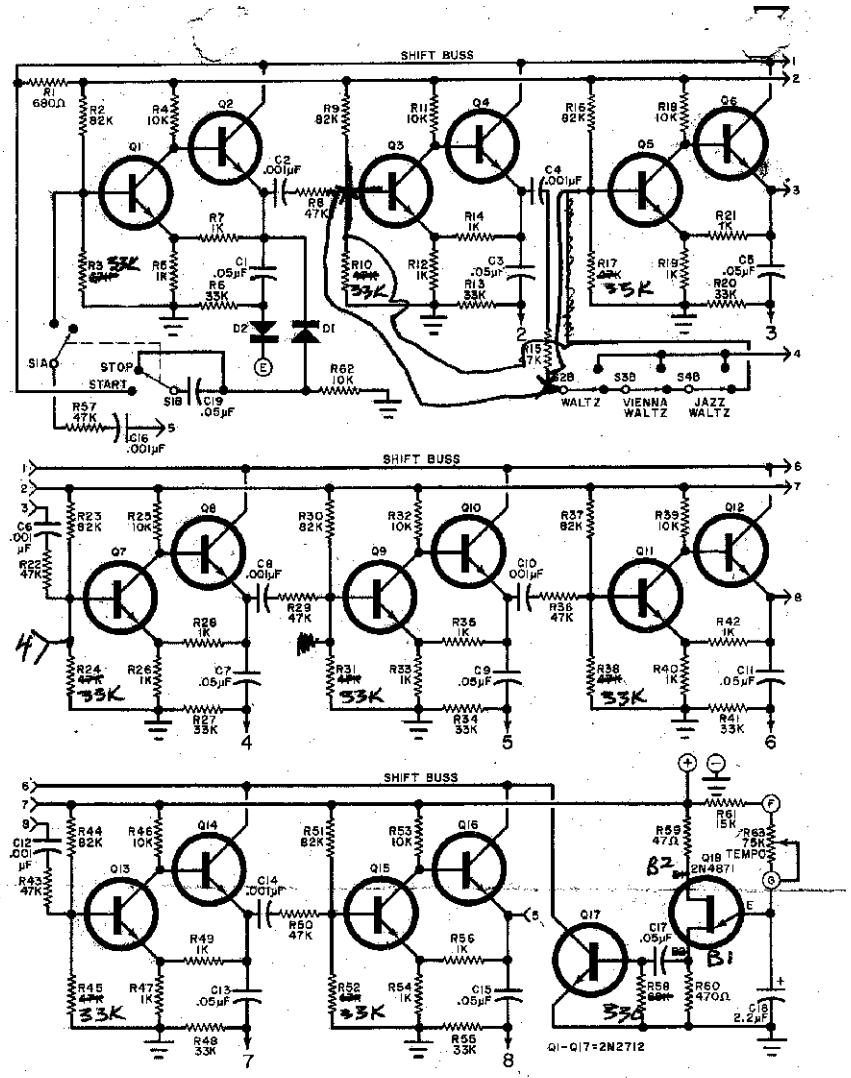


Fig. 1. Generated by Q18, the shift pulses are passed down the counter.

PARTS LIST
RING COUNTER AND SWITCHING CIRCUITS

C1,C3,C5,C7,C9,C11,C13,C15,C17,C19—0.05-μF disc capacitor
C2,C4,C6,C8,C10,C12,C14,C16—0.001-μF disc capacitor
C18—2.2-μF, 15-volt electrolytic capacitor
D1-D41—1N918 diode (or similar)
Q1-Q17—2N2712 transistor
Q18—2N4871 transistor
R1—680-ohm, ½-watt resistor
R2,R9,R16,R23,R30,R37,R44,R51—82,000-ohm ½-watt resistor
R3,R8,R10,R15,R17,R22,R24,R29,R31,R36, R38, R43,R45,R50,R52,R57—47,000-ohm, ½-watt resistor
R4,R11,R18,R25,R32,R39,R46,R53,R62—10,000-ohm, ½-watt resistor

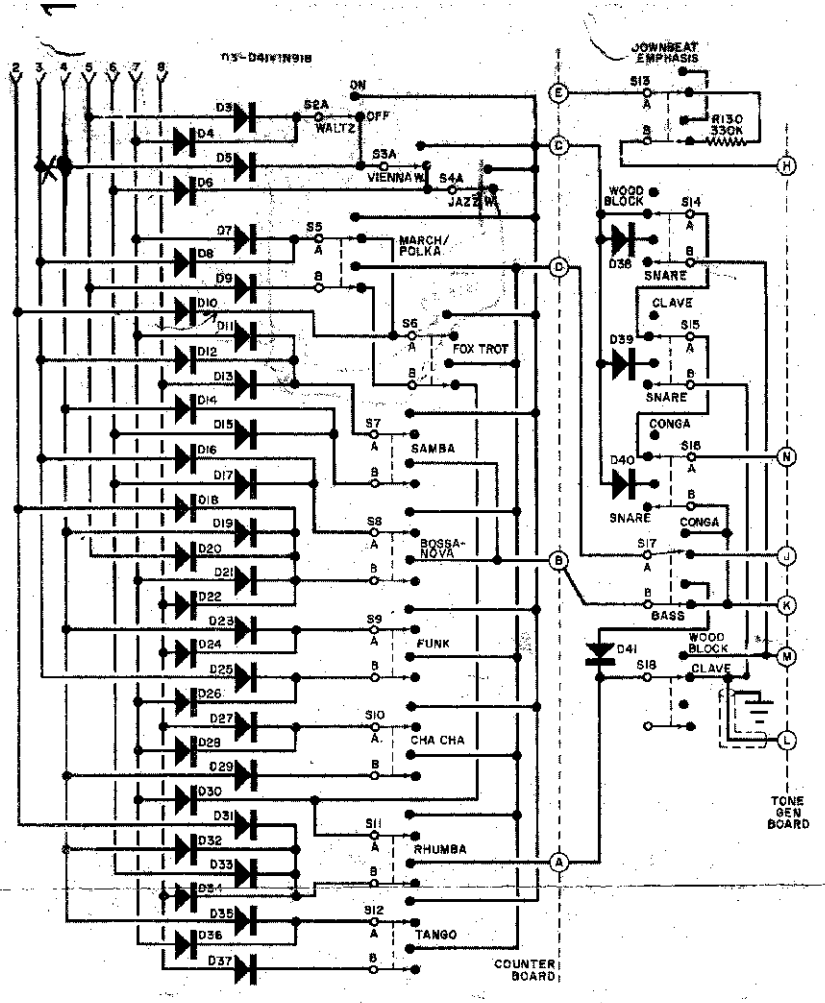


Fig. 2. The diode matrix determines the number and spacing of the pulses and after selection, the groups are passed to the tone generator.

R5,R7,R12,R14,R19,R21,R26,R28,R33,R35, R40,R42,R47,R49,R54,R56—1000-ohm, ½-watt resistor
R6,R13,R20,R27,R34,R41,R48,R55—33,000-ohm ½-watt resistor
R58—68,000-ohm, ½-watt resistor
R59—47-ohm, ½-watt resistor
R60—470-ohm, ½-watt resistor
R61—15,000-ohm, ½-watt resistor
R63—75,000-ohm, reverse audio taper potentiometer
R130—330,000-ohm, ½-watt resistor
S1-S18—Dpdt rocker switch
Misc.—Switch mounting brackets (2), mounting hardware, two-lug terminal strip, etc.

CONTROL IDENTIFICATIONS

S1	Start/Stop
S2	Waltz
S3	Vienna Waltz
S4	Jazz Waltz
S5	Polka (March)
S6	Fox Trot
S7	Samba
S8	Bossa Nova
S9	Funk (Watusi)
S10	Cha-Cha
S11	Rhumba
S12	Tango
S13	Downbeat Emphasis/Off
S14	Wood Block/Snare
S15	Clave/Snare
S16	Conga/Snare
S17	Conga/Bass
S18	Wood Block/Clave
R63	Tempo/Off
R129	Volume

Tone Generator. When a percussion instrument is struck, it generates a tone which is dependent on the instrument's size and the material out of which it is made. The tone then dies away. A similar effect can be obtained electronically by applying a sharp pulse to a parallel-T audio oscillator that is normally just below the point of oscillation. Once triggered, the circuit oscillates at its resonant frequency, with the oscillation decaying just as in a musical instrument. By selecting suitable time constants for the oscillator circuits, almost any tone can be simulated. Those used in the Drummer Boy are shown in Fig. 3.

As an example, note that in the conga drum circuit, the oscillator consists of a single high-gain transistor (Q19) stabilized by feedback through *R67*. A second feedback loop consisting of a parallel-T RC notch filter made up of *R70, R71, R72, C22, C23,* and *C24* is used. Normally, the circuit is quiescent. When a voltage spike appears at the input, it passes through *R64* and the *R65/C20* combination to put the circuit into oscillation. The spike is brief so that the circuit starts to oscillate quickly and dies away rapidly. The frequency of oscillation is determined by the component values in the parallel-T circuit. The "lossiness" of the circuit is preset by *R72*. Emitter follower *Q20* couples the output to the common audio line.

Circuits for the clave, wood block and bass drum are similar but the snare drum presents a special problem. In this case, we need the sound of the striking of the drumhead by the stick and also the sound of the snares striking the bottom drumhead. This problem is solved by using "white noise", which is similar to the interstation hiss heard on an FM receiver.

There are six transistors (*Q27* through *Q32*) in the snare drum circuit. Transistor *Q31*, the white noise generator, is used as a reverse-biased pn junction operated above its breakdown potential. As the junction avalanches, the resulting shot noise closely approximates the Gaussian distribution of white noise. The noise is amplified by *Q32*, which is normally biased off. A voltage spike at input N excites a ring from the parallel-T oscillator *Q27* and *Q28* to generate the drum striking tone and also turns on *Q29* and *Q30*. Due to the action of capacitor *C46*, both *Q29* and *Q30* stay on long enough to accumulate a charge on *C47* and a resulting voltage envelope across *R115*. This envelope biases, *Q32* to turn it on and transmit the white noise to a voicing circuit consisting of *C50* and the primary of *T1*. The time constants of the triggering envelope and *T1* and *C50* are selected to achieve the desired sound of the snares.

Each tone generator is coupled to the common audio line through an isolating resistor and the outputs are amplified by *Q34*, with *Q33* acting as an emitter follower for coupling.

A power supply consisting of a bridge rectifier and suitable filters for the Drummer Boy is shown in Fig. 4.

Construction. The major portion of the Drummer Boy is assembled on two printed circuit boards. Be sure to align the semiconductors properly; get the proper polarities on the electrolytic capacitors; and use a low-power soldering iron and fine solder.

The accompanying photos show how the prototype was assembled; though any arrangement can be used. In the prototype, a bracket was constructed to hold the 11 rocker switches (*S2* through *S12*) that select rhythms and *S1* the start-stop switch. The physical arrangement of these switches is such that the edge connector pads for the ring counter board may be soldered directly to the pertinent switch contacts to form the support for the board. To make a good mechanical

PARTS LIST
TONE GENERATOR

C20,C22,C26,C31,C36,C39,C40,C41—0.05-μF disc capacitor
C21,C27,C32,C37,C42—0.1-μF disc capacitor
C23,C24,C33,C43,C48,C49—0.01-μF disc capacitor
C25,C28,C34,C35,C44,C45—0.005-μF disc capacitor
C38,C57—0.22-μF, Mylar capacitor
C46—0.1-μF, Mylar capacitor
C47,C51—2.2-μF, 6-volt electrolytic capacitor
C52,C53—30-μF, 10-volt electrolytic capacitor
C54,C55—30-μF, 15-volt electrolytic capacitor
C56—100-μF, 15-volt electrolytic capacitor
D42—1N918 diode (or similar)
J1—Open-circuit phone jack
Q19-Q29,Q31-Q34—2N2712 transistor
Q30—2N5139 transistor
R64—270,000-ohm, ½-watt resistor
R65,R74,R79,R80,R83,R93,R102,R122—68,000-ohm, ½-watt resistor
R66,R75,R84,R88,R89,R94,R98,R99,R103,R118—39,000-ohm, ½-watt resistor
R67,R73,R76,R85,R95,R104,R117—1-megohm, ½-watt resistor
R68,R77,R86,R96,R105—4700-ohm, ½-watt resistor
R69,R70,R71,R78,R87,R106,R107,R108—100,000-ohm, ½-watt resistor
R72,R81,R90,R100,R109,R115—50,000-ohm trimmer potentiometer, printed circuit type
R82,R92—470,000-ohm, ½-watt resistor
R91—150,000-ohm, ½-watt resistor
R97,R121—47,000-ohm, ½-watt resistor
R101,R116—330,000-ohm, ½-watt resistor
R110,R112,R113,R120—10,000-ohm, ½-watt
R111,R125—2200-ohm, ½-watt resistor
R114,R124—6800-ohm, ½-watt resistor
R119—680-ohm, ½-watt resistor
R123—15,000-ohm, ½-watt resistor
R126,R127—330-ohm, ½-watt resistor
R128—100-ohm, ½-watt resistor
R129—5000-ohm potentiometer with spst switch (S1)
T1—Miniature driver transformer 10K:2K; secondary not used

Note: The following are available from PAIA Electronics, Inc., PO Box 14359, Oklahoma City, OK 73114: etched and drilled tone generator board (#7701B) at $4.25 postpaid; complete kit of parts for tone generator at $17.75, plus postage for 1 lb; complete kit for Drummer Boy including circuit boards, hardware, and finished case (#7701K) at $55.00, plus postage for 10 lb. Oklahoma residents, add 2% sales tax.

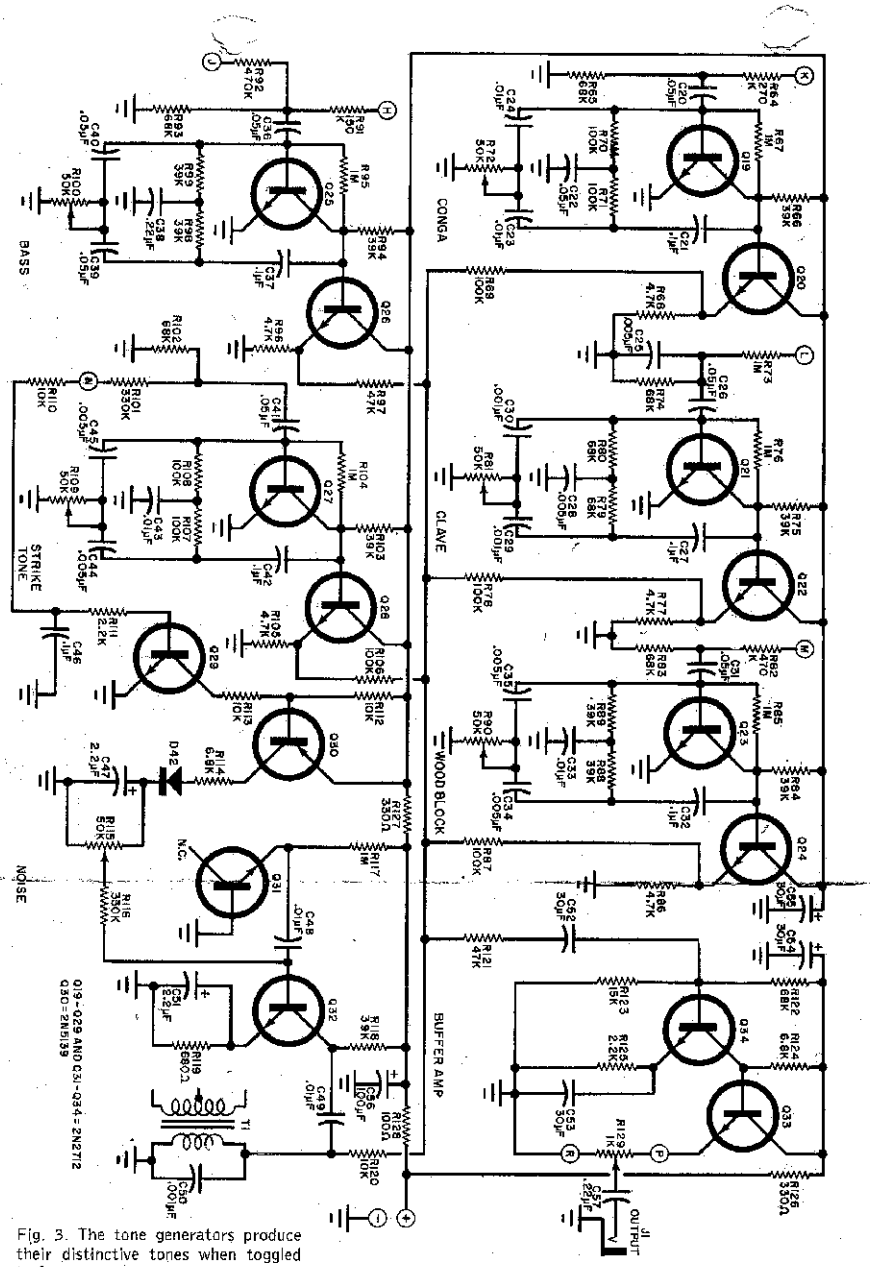


Fig. 3. The tone generators produce their distinctive tones when toggled by the switch-selected pulse groups.

connection, bend the center solder lugs on the switches 90 degrees. The various jumpers between the top row of switch contacts are made of insulated wire with connections to the appropriate tie points on the circuit board.

Another support bracket was made to hold the six instrument selection switches (S13 through S18) and the tempo and volume controls (R63 and R129). The switches are interconnected as shown in Fig. 2 with resistor R130 and diodes D38 through D41 soldered directly to the switch lugs. Secure a two-lug terminal strip (one grounded) to the bracket adjacent to R129. Use the ungrounded lug to mount one end of C57 and the grounded lug for the ground on the output coaxial cable to J1.

In the prototype, the tone generator board was mounted on four spacers on the bottom of the chassis and the power supply components were mounted beside it, with a nine-lug terminal strip for the small components.

Once the mechanical assembly is complete, interconnect the four major sub-

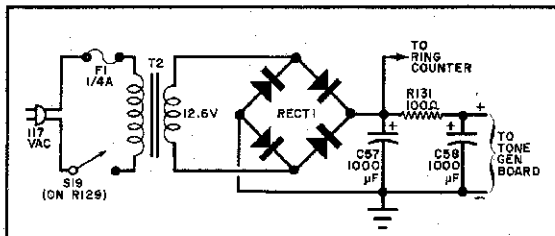


Fig. 4. The power supply, which is chassis mounted, provides a smoother dc to the tone generator than to the pulse counter.

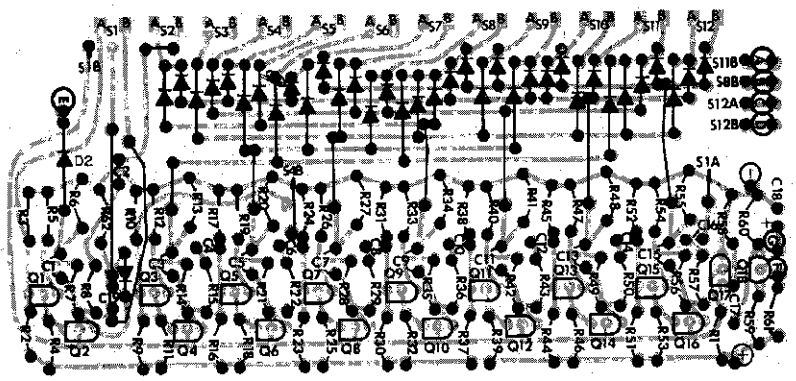
PARTS LIST
POWER SUPPLY

C57,C58—1000-μF, 25-volt electrolytic capacitor
F1—¼-ampere fuse and holder
R131—100-ohm, ½-watt resistor
RECT1—50-volt, 1.5-ampere bridge rectifier (Motorola MDA942A-1 or similar)
S19—Spst switch (on R129)
T2—Filament transformer; secondary, 12.6 volts, 300 mA

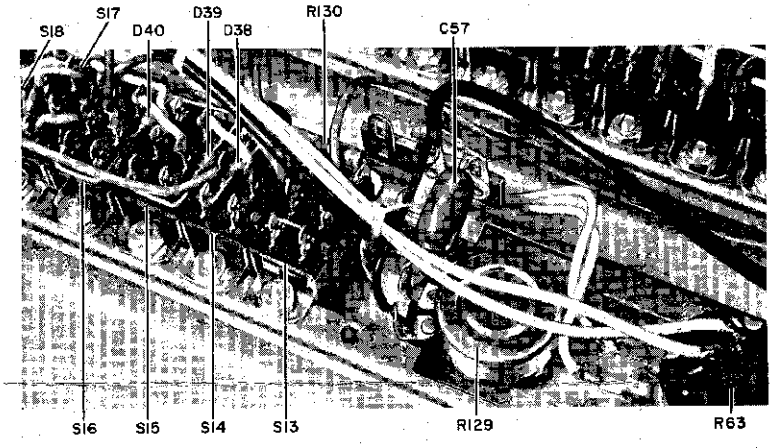
assemblies (counter, tone generator, switches, and power supply). Although the wiring from the six tone selector switches to the tone generator may be bundled and laced together to make a neat appearance, don't bundle the leads from the rhythm selector switches to the ring counter. There is always the possibility of mutual coupling between these leads and a trigger pulse intended for one tone generator can accidentally activate another. Note also that small diameter coaxial or other shielded audio cable is used to connect S18 to the clave oscillator. Because of its relatively high frequency and long sustain, this oscillator is particularly susceptible to erroneous triggering.

Shielded audio cable or small-diameter coaxial cable should be used to make the connection between output capacitor C57 and connector J1.

When completed, check all wiring and check printed circuit boards for solder bridges and cold solder joints.

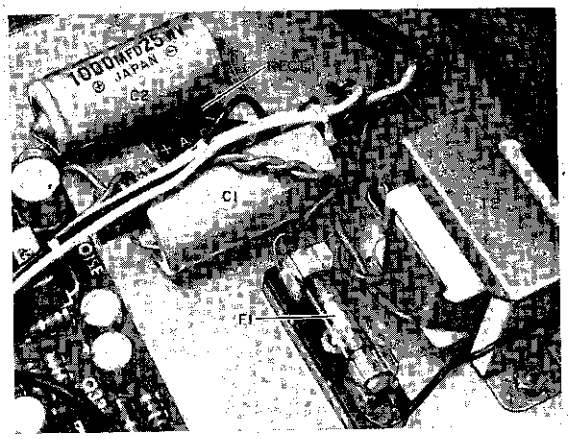


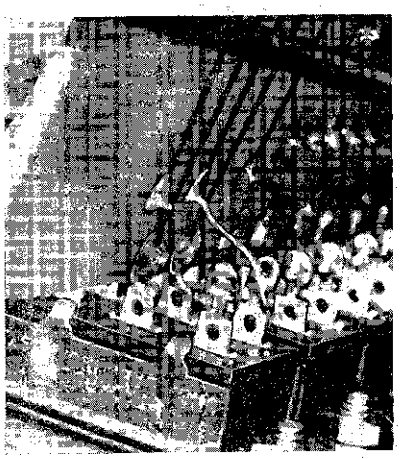
Component installation and external connections to the pulse generator.



The author's prototype used a pair of metal brackets to support the various switches and controls.

Fig. 6. pattern for the tone generator, and the component installation (above).





Lugs of the switches associated with the decoder-matrix board are bent 90 degrees so that they can be soldered directly to the pads on the boards.

Checkout and Tuning. Connect the Drummer Boy to a suitable audio amplifier and speaker. Place all tone generator controls in the full counterclockwise position (looking into the PC board). Turn on the power switch (through the Tempo control) and advance the volume until sounds are heard in the audio amplifier system. All rhythm selector switches should be off.

Using a small screwdriver, slowly advance each trimmer potentiometer (except R115 for noise) until a tone is heard. Then back the control off slightly until the tone just disappears. The bass drum may continue to come through at this point. The tempo control can be adjusted as desired

If a tone cannot be heard at all, look for trouble in the audio preamplifier

(Q33, Q34) the power supply. If one of the individual oscillators fails to operate, the problem is within that stage.

Once all the oscillators are operating, place *S14*, *S15*, and *S16* in the snare position, *S2* on waltz and *S1* on start. You should hear the familiar waltz rhythm, with the tempo adjustable through *R63*. You should also hear the bass drum on the downbeat and probably a distorted snare drum on the other two beats. Adjust both *R109* and *R115* to get a true snare drum sound. The level of the bass downbeat can be changed by switching *S13*.

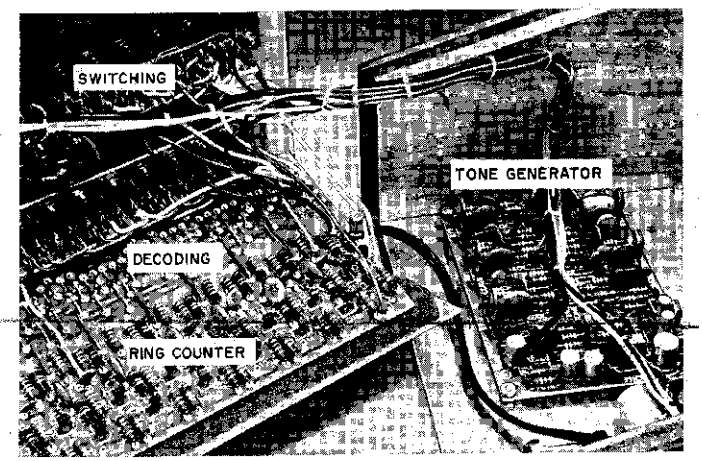
With the waltz rhythm still operating, set *S14* to the wood block position, and then adjust *R90* on the tone generator to get the best wood block sound. (Note also that taking either *S14*, *S15* or *S16* off the snare position removes the snare completely.) With *S14* back on snare, set *S15* to the clave position and adjust *R81* for the best clave sound. Put *S15* back to snare and set *S16* for conga. Adjust *R72* to get the best conga sound. All the tone generators have now been adjusted.

Turn off the waltz switch and turn on each rhythm switch one at a time. Note that the rhythms are properly generated. Turn off the main switch and see if the pattern in progress completes itself before stopping.

Operation. Obviously, the best thing to do is experiment. Bear in mind that more than one of the rhythm switches can be used at a time to produce unusual beats. Operating either of switches *S14*, *S15*, and *S16* removes the snare and substitutes the wood block, clave, or conga, respectively. However, neither of the switches takes precedence over the others.

The conga-bass switch (*S17*) allows the substitution of a conga for the bass on any beat except the downbeat, where the bass drum is permanent. At the same time that the conga-bass switch substitutes the conga for the bass in a pattern, it also substitutes for the conga either the clave or wood block as selected by *S18*.

The prototype was assembled within a sloping-front chassis with the layout shown here. The decoding and ring counter board is soldered directly to the lugs of the associated switches. The other end is cemented to a length of conventional rubber strip.



CONSTRUCTION NOTES

Before assembling parts on the circuit boards thoroughly scour the boards with steel wool. Use only rosin core solder, acid core solder is completely unacceptable and its use will seriously damage both the circuit board and components. Use a low wattage iron, 35 watts max., and heat sink all semi-conductor leads with needle nose pliers.

T1 is very susceptible to hum pickup if placed too close to power transformer T2. For this reason the drum board should be mounted so that T1 is on the opposite end of the board from the power supply.

Note that the RG-174/U is included to connect the clave oscillator to the interchange switches as shown in the pictorial diagrams. One end of the shield is grounded to the solder lug under one of the nuts on S18. The other end of this shield is left floating at the drum board.

Before soldering the ring counter board to the rocker switches S1 - S12 make sure that these switches are all perfectly in line and equally spaced. Check their alignment by holding their bracket in place in the case and checking to make sure that all switches have clearance. The alignment job will be easier if the nuts and bolts on each switch are tightened just enough to hold it in place but still loose enough to allow the switch to be moved up and down and side to side. When all switches are properly aligned the bolts may be tightened.

Supplied with this kit is a pre-printed vinyl marking sheet. Note that for ease of application the adhesive on this sheet is not activated until the sheet is firmly pressed against the panel. Apply the sheet by following the instructions printed on its backing paper. The white line at the top of the sheet is meant to be aligned with the back most edge of the case top. When the sheet is firmly adhered wrap the loose edges under and adhere them to the back of the panel for a finished look. Prior to mounting the panel controls cut around their holes with a razor blade or sharp knife. If necessary additional sheets are available from PAIA Electronics, 6700 N. Classen Blvd., Okla. City, OK 73116, at a cost of $3.00 each postpaid.

Not listed in the parts list for the Tone Generator board are C29, C30 and C50. These are .001 mfd. disk capacitors.

RESISTOR COLOR CODING IS AS FOLLOWS:

R1, R119	680 ohm	blue-grey-brown
R2, R9, R16, R23, R30		
R37, R44, R51	82,000	grey-red-orange
R3, R8, R10, R15, R17		
R22, R24, R29, R31, R36		
R38, R43, R45, R50, R52		
R57, R97, R121	47,000	yellow-violet-orange
R4, R11, R18, R25, R32		
R39, R46, R53, R62, R110,		
R112, R113, R120	10,000	brown- black-orange
R5, R7, R12, R14, R19,		
R21, R26, R28, R33, R35,		
R40, R42, R47, R49, R54, R56	1,000	brown-black-red
R6, R13, R20, R27, R34, R41		
R48, R55	33,000	orange-orange-orange
R58, R65, R74, R79, R80,		
R83, R93, R102, R122	47	yellow-violet-black
R60	470	yellow-violet-brown
R61, R123	15,000	brown-green-orange
R64	270,000	red-violet-yellow
R66, R75, R84, R88, R89,		
R94, R98, R99, R103, R118	39,000	orange-white-orange
R67, R73, R76, R85, R95,		
R104, R117	1 meg.	brown-black-green
R68, R77, R86, R96, R105	4,700	yellow-violet-red
R69, R70, R71, R78, R87,		
R106, R107, R108	100,000	brown-black-yellow
R82, R92	470,000	yellow-violet-yellow
R91	150,000	brown-green-yellow
R101, R116, R130	330,000	orange-orange-yellow
R111, R125	2,200	red-red-red
R114, R124	6,800	blue-grey-red
R126, R127	330	orange-orange-brown
R128	100	brown-black-brown

All component values other than resistors are marked on the body of the component.

REPAIR NOTE

In the event that you experience difficulty a repair service is available. Before sending a unit back for repair please write to:

PAIA Electronics, Inc.
P. O. Box 14359
Oklahoma City, OK 73114
Attention: Repairs

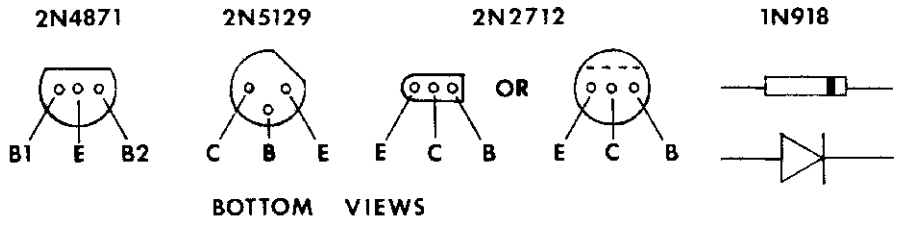
giving as full a description of the malfunction as possible. It is possible that some malfunctions can be diagnosed by mail but if no diagnosis can be made you will be supplied with a repair address and shipping instructions. Repairs are charged at the rate of $4.00 per hour plus parts and shipping. Repairs ordinarily take from 1 to 1 1/2 hours but repair times in specific cases cannot be estimated in advance.

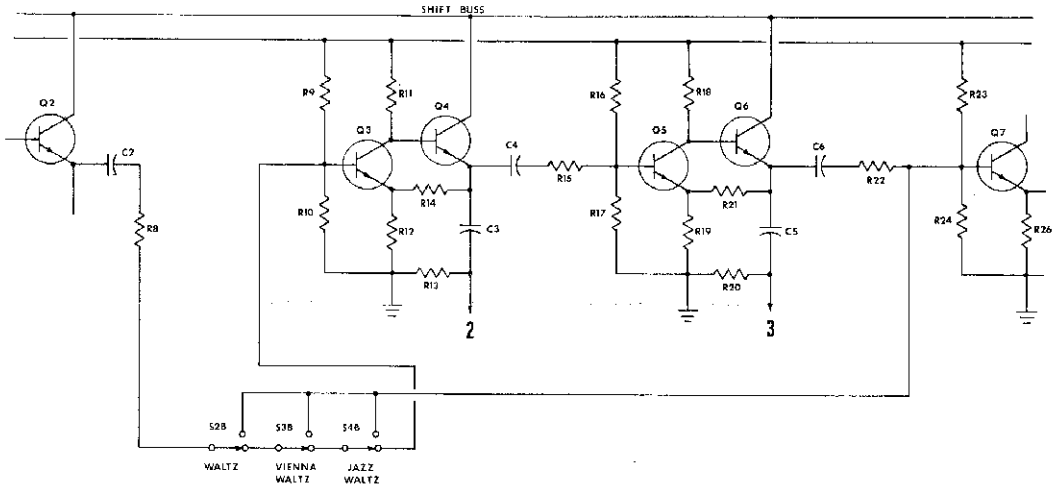
PLEASE NOTE: CORRECTION AND ADDITION TO RESISTOR COLOR CODING

R58, R65, R74, R79, R80
R83, R93, R102, R122 ..... was 47 ohm ..... yellow-violet-black
changed to 68,000 ohm ..... blue-grey-orange

Addition:
R59..... 47 ohm .....yellow-violet-black

TRANSISTOR AND DIODE BASING IS AS SHOWN BELOW:





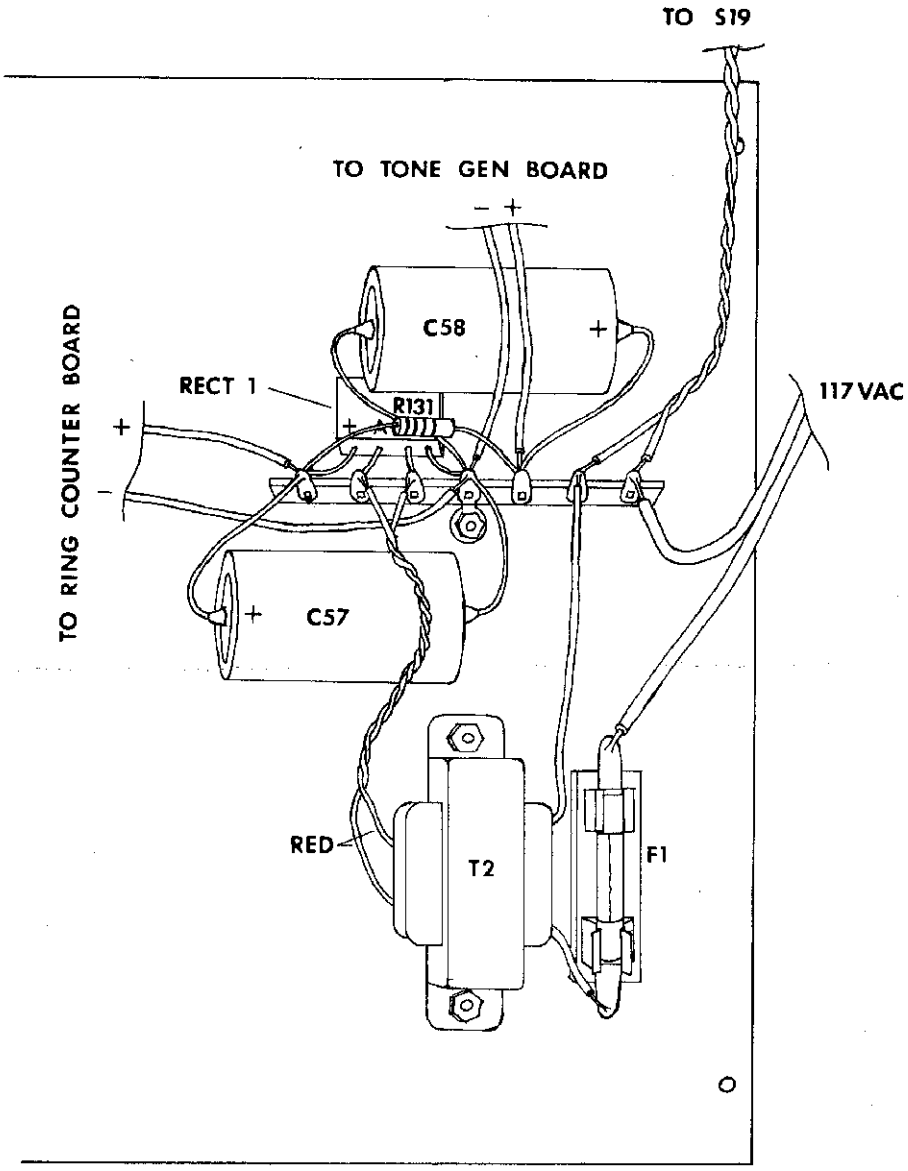
The schematic diagram of the ring counter assembly in the assembly instructions shows that stages 3 and 4 are bypassed during waltz rhythms. This is incorrect, stages 2 and 3 are the ones bypassed as shown in the supplimental drawing of the pertinent section above. This is an error only in the drawings - the circuit boards are correct.

In order for the ring counter assembly to fit in the case the switch lugs that mount the ring counter board must be bent to an angle of approximately 15°. This can most easily be accomplished after the circuit board has been soldered to the switch lugs. Don't be afraid of applying pressure to the circuit board, the G-10 fiberglass material is for all practical purposes indestructible. Hold the switch assembly in your left hand with the component side of the circuit board up and bend so that the foil side moves down. Apply the adhesive backed foam strip to the lower rear edge of the case top so that the foil side of the lower edge of the ring counter board rests against it when installed. This insulates the foil side of the circuit board from the grounded case.

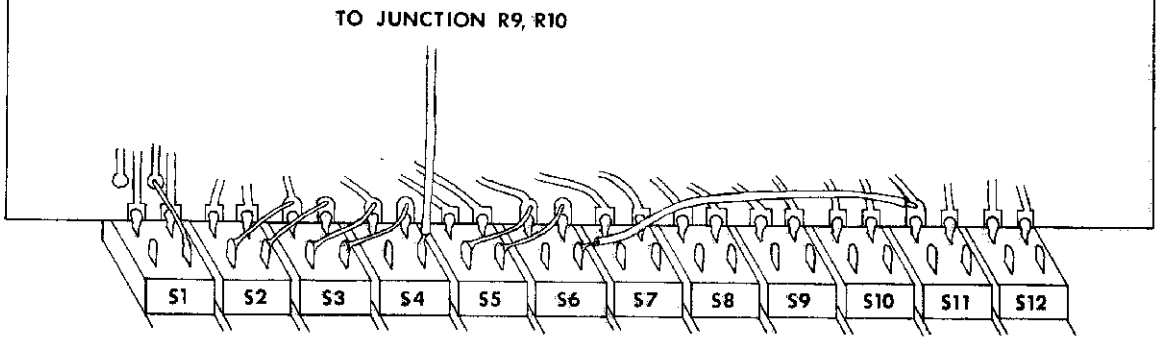
Note that the anode end of D5 goes to the output of ring counter stage 4 and not stage 3 as shown in figure 2. This is a schematic error only - the circuit board is correct.

Note that one of the 2N2712 transistors has its collector (center) lead cut short. This transistor has been pre-tested and selected for its noise characteristics and is intended for use as Q31.

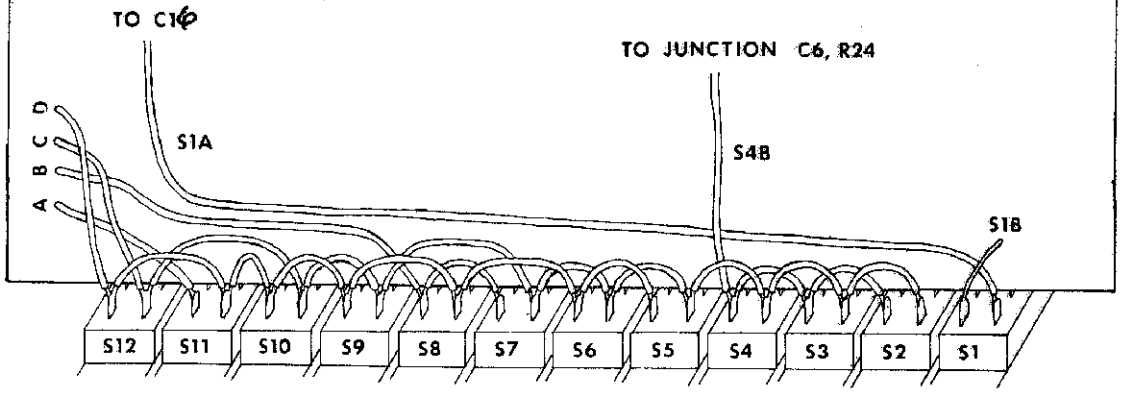
Note that S19 is located on R63 instead of R129 as shown in the power supply diagram.

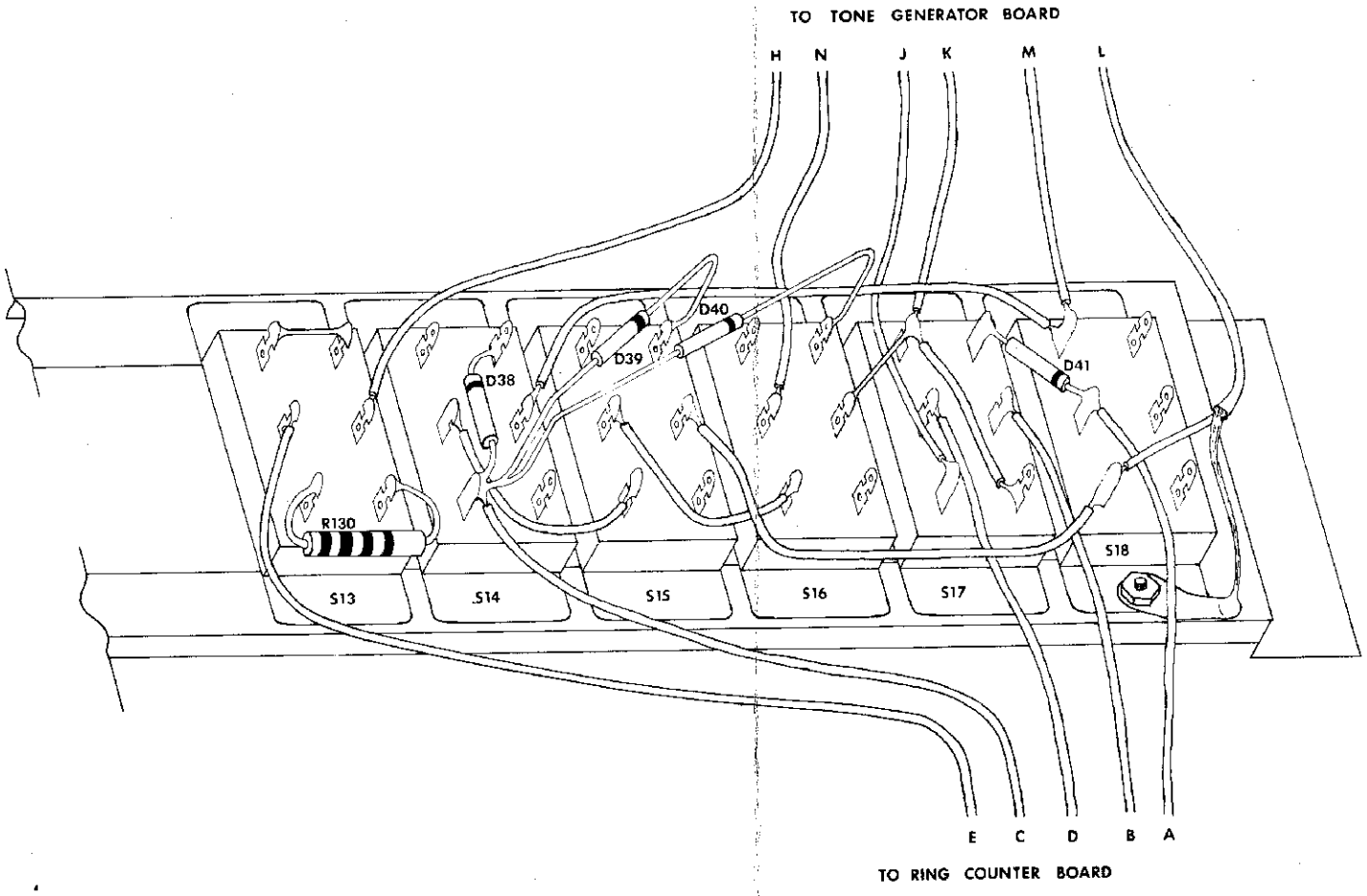

TO S19
TO TONE GEN BOARD
– +
C58
+
RECT 1
R131
+
+
–
TO RING COUNTER BOARD
117 VAC
+
C57
RED
T2
F1

CIRCUIT BOARD 7701A
FOIL SIDE



CIRCUIT BOARD 7701A
COMPONENT SIDE




TO TONE GENERATOR BOARD
H
N
J
K
M
L
D40
D39
D38
D41
R130
S13
S14
S15
S16
S17
S18
E
C
D
B
A
TO RING COUNTER BOARD

WALTZ	BASS	SK	IP		SNARE		SNARE	
VIENNA WALTZ	BASS	SK	IP	SNARE	SNARE		SNARE	
JAZZ WALTZ	BASS	SK	IP	SNARE	SNARE	SNARE	SNARE	
POLKA	BASS		SNARE		~~SNARE~~ BASS		SNARE	
FOX TROT	BASS	SNARE	SNARE		BASS		SNARE	
SAMBA	BASS		SNARE	CONGA		CONGA	SNARE	SNARE
BOSSA NOVA	BASS	CONGA	BASS	CONGA	CONGA	BASS	CONGA	CONGA
FUNK	BASS		BASS	SNARE			BASS	SNARE
CHA CHA	BASS			BASS			SNARE	SNARE
RHUMBA	BASS	CLAVE		CLAVE	BASS	CLAVE	BASS	CLAVE
TANGO	BASS			SNARE			SNARE	BASS
	1	2	3	4	5	6	7	8