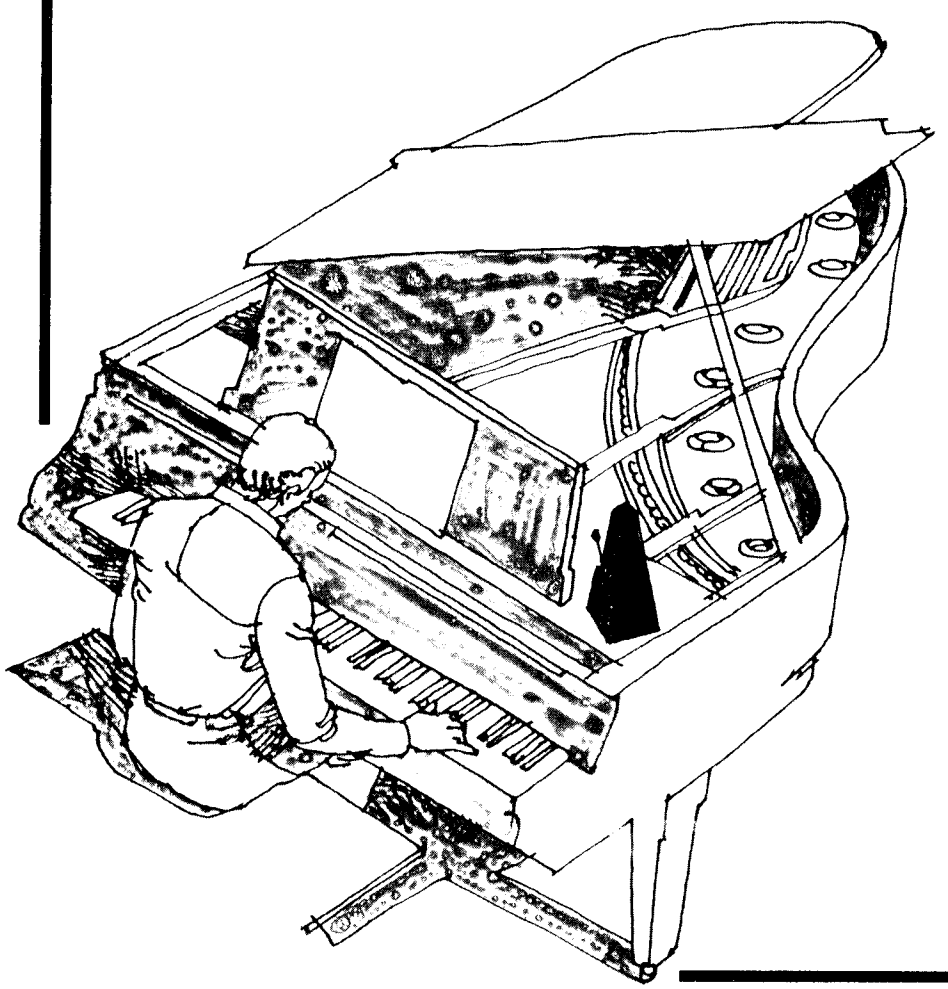
BY MILTON L. CHESTNUT

BUILD THE

ULTIMATE METRONOME

Provides accented beats to make tuning and syncopation easier.



A METRONOME, whether mechanical or electrical in operation, provides some sort of audible signal on a fairly stable time basis. The drawback of such devices is that there is no provision for accenting certain beats in a measure. The Ultimate Metronome described here overcomes this disadvantage by providing accented beats. A switch is used to select accents on the basis of 1 in 1 up to 1 in 7. (1 in 15 is possible with a slight alteration.) Beats are indicated visually (LED) and audibly. The metronome can be built for about $8.

How It Works. As shown in Fig. 1, the main timing signal is generated by *IC1* connected as an astable multivibrator. The length of time that pin 3 is low (near zero volts) is determined by *R3* and *C4*, while *R3*, *R4*, *R5*, and *C4* determine how long pin 3 is high (near +5 volts). By adjusting *R5*, the output frequency can be varied from 30 to 1000 pulses per minute. Capacitor *C5* is used to bypass the external modulation input, while *R1* is a pull-up for the input to *IC2*. The latter is a monostable multivibrator that delivers a pulse whose width is determined by *R2* and *C3*. The pulse width is independent of the input trigger and, with the values shown, is about 250 microseconds. This insures that both the speaker pulse and the *IC3* counter input pulse will always have the same duration regardless of the trigger rate.

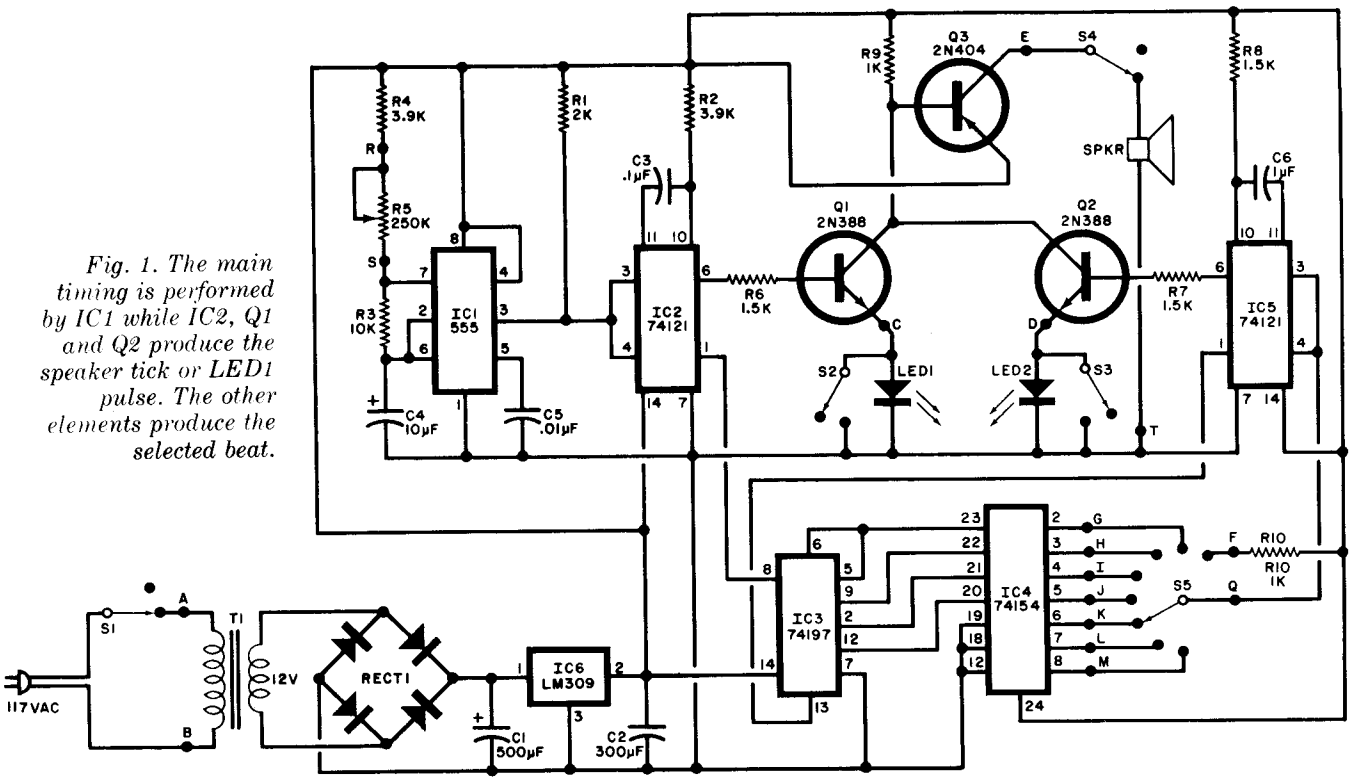


Fig. 1. The main timing is performed by IC1 while IC2, Q1 and Q2 produce the speaker tick or LED1 pulse. The other elements produce the selected beat.

PARTS LIST

C1—500-μF, 16-V electrolytic capacitor
C2—300-μF, 10-V electrolytic capacitor
C3—0.1-μF, 50-V ceramic disc capacitor
C4—10-μF, 6-V low-leakage electrolytic capacitor
C5—0.01-μF, 50-V ceramic disc capacitor
C6—1-μF ceramic capacitor
IC1—555 timer
IC2,IC5—74121
IC3—74197
IC4—74154
IC6—LM309, 5-V, 1-A regulator
LED1,LED2—Red light emitting diode
Q1,Q2—General-purpose transistor npn (2N388 or similar)
Q3—General-purpose transistor pnp (2N404 or similar)
R1—2000-ohm ½-W, 10% resistor
R2,R4—3900-ohm, ½-W, 10% resistor
R3—10,000-ohm, ½-W, 10% resistor
R5—250,000-ohm, linear-taper potentiometer
R6,R7,R8—1500-ohm, ½-W, 10% resistor
R9,R10—1000-ohm, ½-W, 10% resistor
S1 to S4—Spst switch
S5—Single-pole, 8-position, nonshorting rotary switch
SPKR—8-ohm, 2" speaker
T1—12-volt, 300-mA transformer (Radio Shack 273-1385 or similar)
Misc.—Suitable enclosure, line cord, grommet, switch knob, mounting hardware, etc.

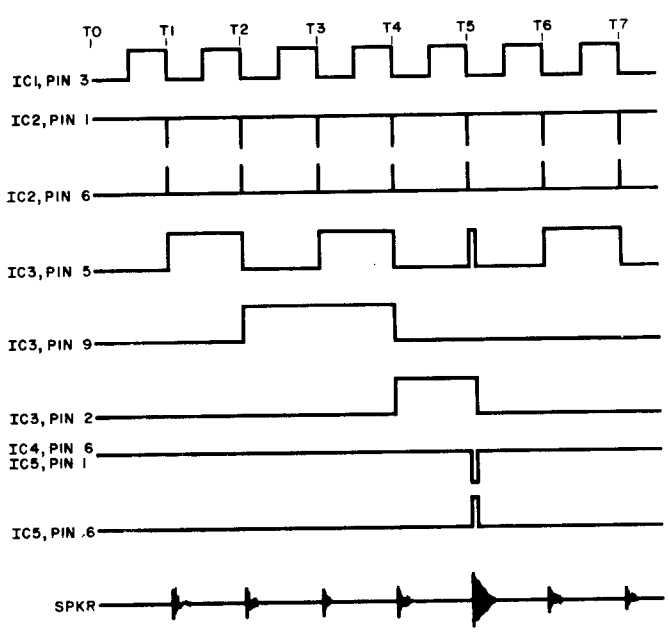


Fig. 2 Timing waveforms for the metronome.

The positive-going pulse from *IC2* (pin 6) drives *Q1* into conduction and, when *S2* is open, causes *LED1* to glow. When *Q1* conducts, it also forward-biases *Q3*, causing a current surge through the speaker (when *S4* is closed). This provides the main beat.

To generate the accented beat, the output from *IC2* (pin 1) is fed to the clock-1 (pin 8) input of *IC3*, a binary-counter/latch. As shown in the timing diagram in Fig. 2, the *IC3* output on pin 5 changes state with each input pulse. Pin 9 changes state every other input pulse, pin 2 every fourth input pulse, and pin 12 every eighth input pulse (not shown in Fig. 2). These four outputs thus make up a 4-bit binary count of the number of input pulses to *IC3*.

The four outputs are applied to *IC4*, a 4-to-16 decoder. The sixteen outputs of *IC4* provide binary combinations from 0000 to 1111 of decimal 0 to 15. With the circuit shown in Fig. 1, only

the first 7 of these outputs can be selected by *S5*. The timing in Fig. 2 assumes that *S5* is set to position 5 so that the accent pulse will occur every 5 beats.

The signal selected by *S5* is used to trigger *IC5*, a monostable multivibrator that operates like *IC2* except that the timing components (*R8, C6*) are selected to produce an output pulse of about 1 ms (instead of the 250 µs of *IC2*). When pin 6 of *IC5* goes high, *Q1* is driven into saturation, causing *LED2* to glow (*S3* open) for about 750 ms after *Q1* has stopped conducting due to the main beat. This action causes the speaker to produce a louder tone. When pin 6 of *IC5* goes high, pin 1 goes low, resetting *IC3* to a zero output. The next pulse from *IC2* then counts as the first beat of the next series of pulses. This same action takes place regardless of the beats per minute or the setting of *S5*.

When *S5* is in the F position, the trigger input of *IC5* (pins 3 and 4) is held high by *R10* to prevent any possibility of a stray accented beat. This also permits the use of the circuit as a conventional metronome. With *S5* in position G, every beat is accented to provide a volume increase. As mentioned before, other outputs of *IC4* and other positions of *S5* can be used to select accented beats up to a rate of 1 in 15.

Construction. Any type of construction can be used to build the metronome; and surplus or junkbox components will do. However, the LED's should be selected for similar light output. The size of the transformer given in the Parts List will fit on a pc board. Mount the finished board in a small enclosure with the switches, *R5* and LED's on the cover. Punch some holes in the cover for the speaker.

Calibration. Close *S1* and *S4* and set *R5* to midscale with *S5* in position F. Count the number of beats per minute (checking the operation of *LED1* at the same time). Calibrate the dial of *R5* accordingly. At higher speeds, use the accented beat to count. For example, with a 1-in-5 accent, count 27 accented beats in 60 seconds with *R5* set for 135 beats per minute.

LED1 is for the main beat, while *LED2* displays the accented beat. If you don't need these indicators, they and their associated switches can be omitted. ◈