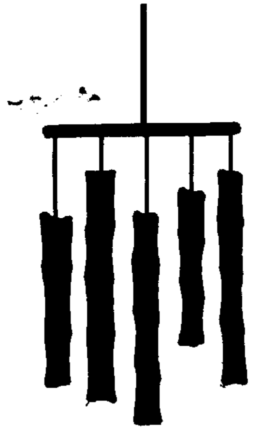


ELECTRONIC Wind Chimes

THE TINKLING SOUND OF A SUMMER BREEZE THROUGH YOUR AMPLIFIER SYSTEM

BY JOHN S. SIMONTON, JR.

WITHOUT stretching a point too much, you could call wind chimes the original background music with no power other than the wind.

Now, you can build a set of electronic wind chimes that doesn't rely on the wind for power so you can use it indoors or out, windy days or still.

How It Works. The operation of the wind chimes as a system can easily be understood by referring to Fig. 1, which shows one of the three identical channels that make up the complete unit. The principal operational divisions are a random voltage generator, a comparator, and a ringing oscillator. The output of the random voltage generator is compared to the voltage developed across *C* as it charges through *R* and a pulse is generated at the comparator output whenever the random voltage is within about a half volt of the capacitor voltage. Each pulse from the comparator triggers the associated ringing oscillator and simultaneously discharges *C* slightly so that the voltage across this capacitor never reaches the supply level.

The complete schematic is shown in Fig. 2. The three random voltage generators are made up from transistors *Q1* through Q6 which are wired to form 3 separate astable multivibrators. The time constants of these astables have been selected so that their combined periods and duty factors produce a long-duration, pseudo-random pattern. The outputs of these astables are summed by resistive networks (*R13, R14* and *R15; R16, R17* and *R18; R19, R20* and *R21*) to produce three different randomly varying voltages. Each of these voltages is smoothed by a capacitor (*C10, C11* and *C12*) and applied to the base-2 terminal of a unijunction transistor. The emitter of each UJT connects to a capacitor (*C13, C14* and *C15*) which is charged through a resistor from the supply (*R22, R24* and *R26*).

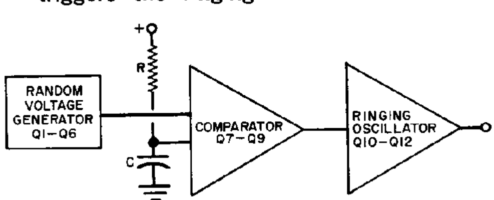
At some random time the voltage at the emitter gets close enough to the base-2 voltage to allow the UJT to fire. This causes the capacitor to discharge through the emitter/base-1 junction and a pulse to develop across the base-1 resistor (*R37, R38* and *R39*).

The ringing oscillators are parallel-T types consisting of a transistor gain stage (*Q10, Q11* and *Q12*) with a parallel-T notch filter in the feedback loop. A trimmer potentiometer (*R46, R47* and *R48*) in each T adjusts the loss of the network so that the circuit can be set just below the point of oscillation. Each pulse from the UJT kicks the circuit into the rapidly decaying oscillation characteristic of a chime. The outputs of the three individual oscillators are mixed in a resistor matrix (*R49, R50* and *R51*) and capacitively coupled to the output.

Zener diode *D1* is used to eliminate voltage variations resulting from battery aging which would otherwise change the gain (and consequently sustain) characteristics of the ringing oscillators.

Resistors *R54, R55* and *R56* couple some

Fig. 1. When random voltage exceeds charge on C, the comparator output triggers the ringing oscillator circuit.



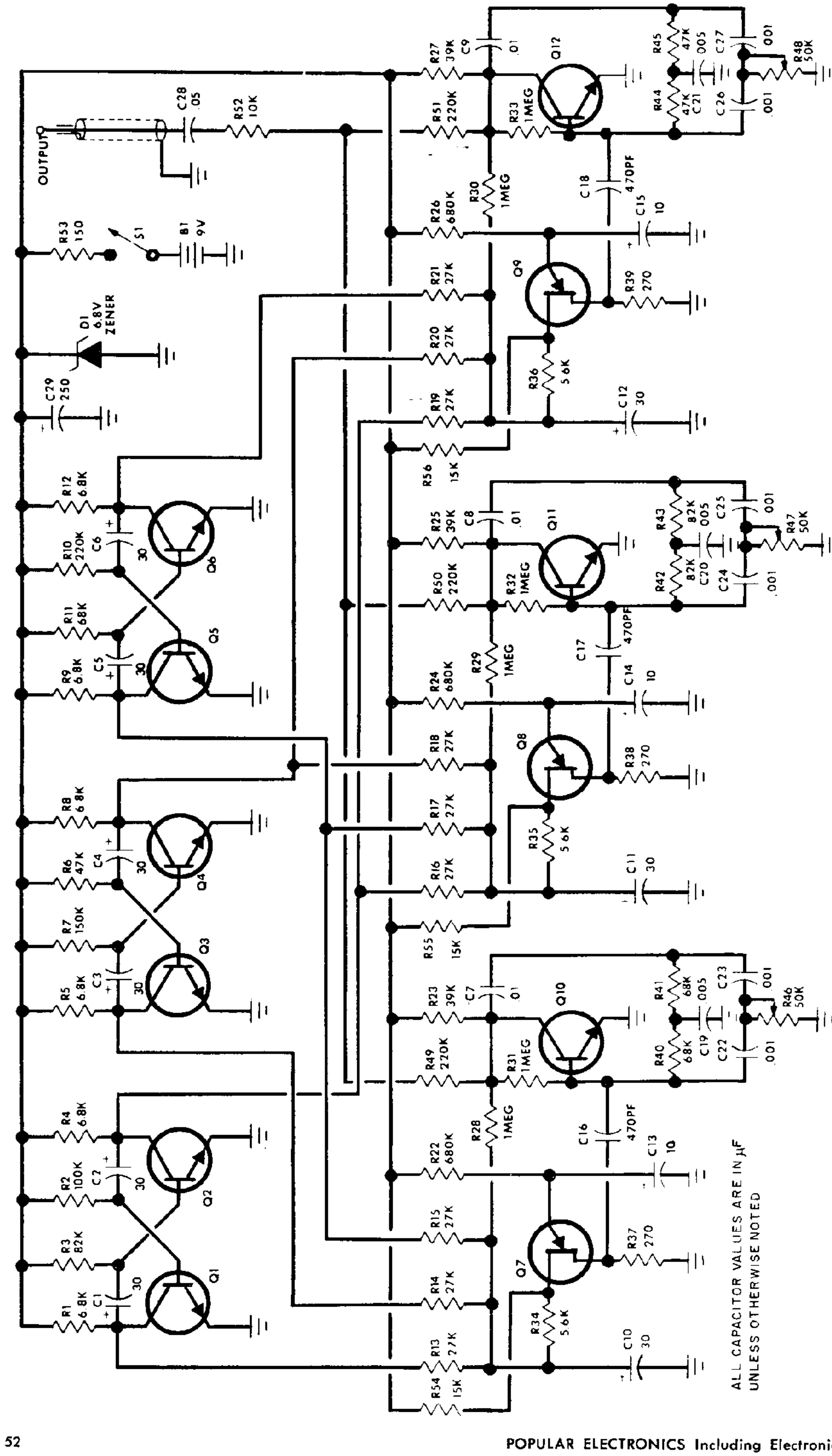


Fig. 2. The voltages from the three random-voltage generating multivibrators (Q1-Q6) are compared in the UJT circuits (Q7-Q9). When the UJT fires, it triggers its tone generator. Outputs of three tone generators are mixed in resistors.

of the random voltage generator output directly to the ringing oscillators in such a way that, when the random voltage is high, the gain and sustain duration of the oscillators is increased. This squelching action allows the sustain on some of the strikes to be considerably longer than would otherwise be possible because of the danger of the circuit breaking into continuous oscillation.

Assembly. Any assembly technique from point-to-point wiring to perf-board may be used for the wind chimes but etched circuit boards will produce the most trouble-free and professional looking unit with the least hassle. Circuit boards may be etched using the full size layouts shown in Fig. 3 or purchased from the source listed. Note that two PC boards are used to keep the project small. One board mounts the three multivibrators, while the other board contains the remainder of the circuit. Spacers are used between the boards.

Assembly of each board is relatively straightforward. Observe the polarity of all electrolytic capacitors and the zener diode, use care in installing the transistors to make sure that they are properly oriented. As with most printed circuit construction, use a small soldering iron rated at no more than 35 watts and just to be on the safe side heat-sink the leads of the transistor and diode while soldering them in place. Some of the pads on the PC board are close together so be particularly careful of solder bridges.

Mount the components on the circuit boards following the parts placement diagrams. Epoxy can be used to fasten a battery clip to the larger board so that it holds the battery in the position indicated. Roughen both mating surfaces with sand paper before gluing and note that the clip must be positioned so that the battery can be inserted from the side. Save the mounting of resistors *R49*, *R50* and *R51* for last and when you get to these parts note that one of the leads of each resistor passes completely through the PC board they mount on and mates with the connecting points marked "X" on the lower board.

For convenience we will at this point designate the smaller of the two boards the tone board and the larger of the two the RVG (random voltage generator) board. Solder lengths of #22 insulated wire to points "A", "B", "C", "D", "E" and "G" on the tone board. Make sure that these wires are long enough to reach to the corresponding points on the RVG board when the two are placed one above the other. Fasten the two circuit boards together (tone board above the RVC board) using 1" stand-offs and 4-40 × 1¼" machine screws. Orient the two boards so that the long leads from resistors *R49-R51* pass through the "X" holes on the RVG board. Trim the leads from the tone board to proper length and solder them to the corresponding points ("A" through "G") on the RVG board.

Finish assembly by hooking up the battery connector and switch to the "+" and "–" points on the RVG board and using a

PARTS LIST

B1—9-volt transistor battery
C1-C6,C10-C12—30-µF, 10-volt electrolytic capacitor
C7-C9—0.01-µF disc capacitor
C13-C15—10-µF, 10-volt electrolytic capacitor
C16-C18—470-pF disc capacitor
C19-C21—0.005-µF disc capacitor
C22-C27—0.001-µF disc capacitor
C28—0.05-µF disc capacitor
C29—250-µF, 10-volt electrolytic capacitor
D1—6.8-volt zener diode
Q1-Q6—2N5129 transistor
Q7-Q9—2N4871 UJT
Q10-Q12—2N2712 transistor
R1,R4,R5,R8,R9,R12—6800-ohm, ½W, 10% resistor
R2—100,000-ohm, ½W, 10% resistor
R3,R42,R43—82,000-ohm, ½W, 10% resistor
R6,R44,R45—47,000-ohm, ½W, 10% resistor
R7—150,000-ohm, ½W, 10% resistor
R10,R49,R50,R51—220,000-ohm, ½W, 10% resistor
R11,R40,R41—68,000-ohm, ½W, 10% resistor
R13-R21—27,000-ohm, ½W, 10% resistor
R22,R24,R26—680,000-ohm, ½W, 10% resistor
R23,R25,R27—39,000-ohm, ½W, 10% resistor
R28-R33—1-megohm, ½W, 10% resistor
R34-R36—5600-ohm, ½W, 10% resistor
R37-R39—270-ohm, ½W, 10% resistor
R46-R48—50,000-ohm PC trimmer potentiometer
R52—10,000-ohm, ½W, 10% resistor
R53—150-ohm, ½W, 10% resistor
R54,R55,R56—15,000-ohm, ½W, 10% resistor
S1—Spst switch
Misc.—Circuit boards, wire, solder, 1" and ¼" standoffs, battery connector and clip, 4-40 hardware, case, phono plug, etc.
Note—The following are available from PAIA Electronics, Inc., Box 14359, Oklahoma City, OK 73114: set of etched and drilled circuit boards (3721pc) at $5.50 postpaid; complete kit of parts including PC boards but less case (3721K) at $16.95 postpaid; case as shown (3711c) at $2.50 plus postage for 1 lb.

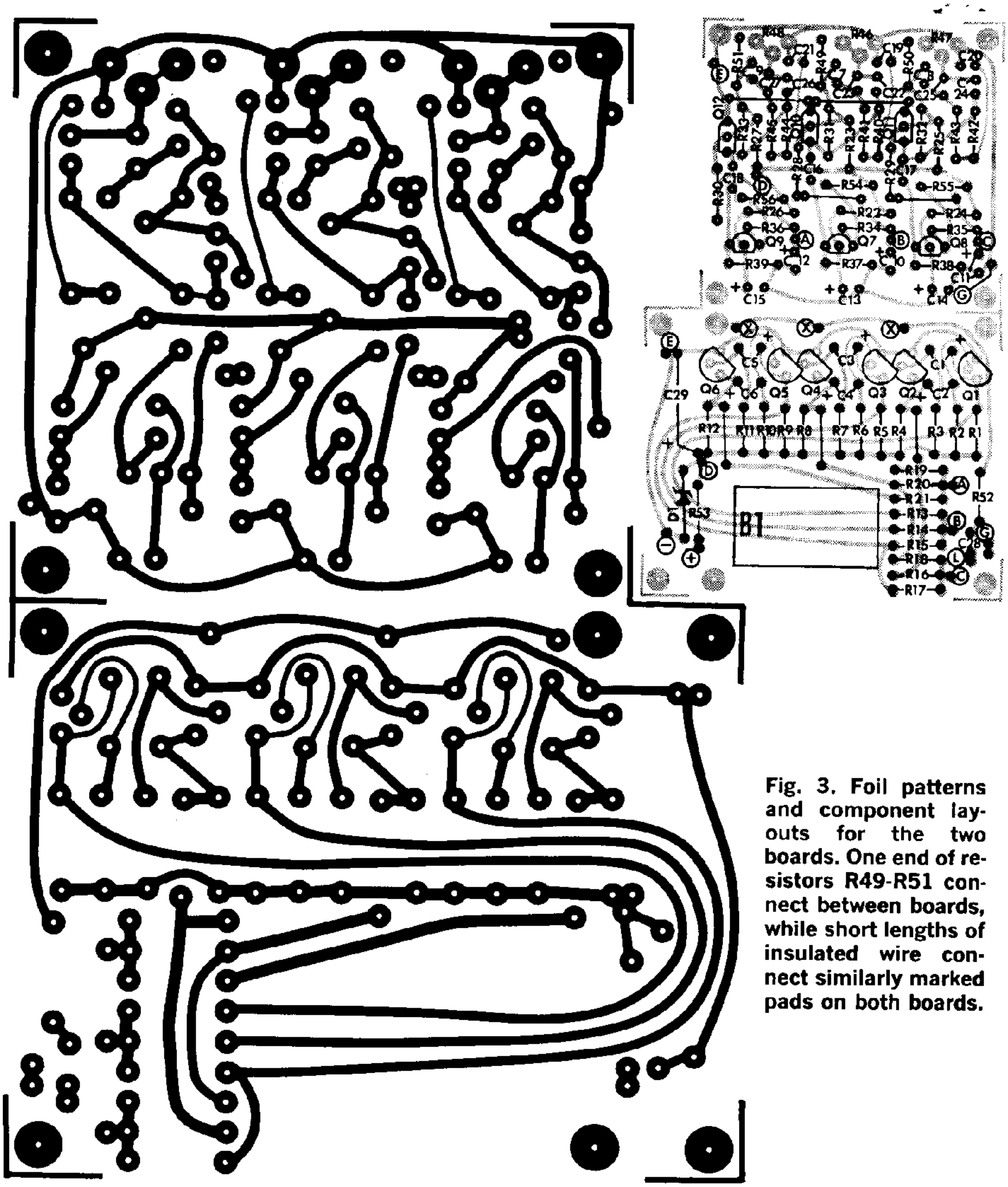


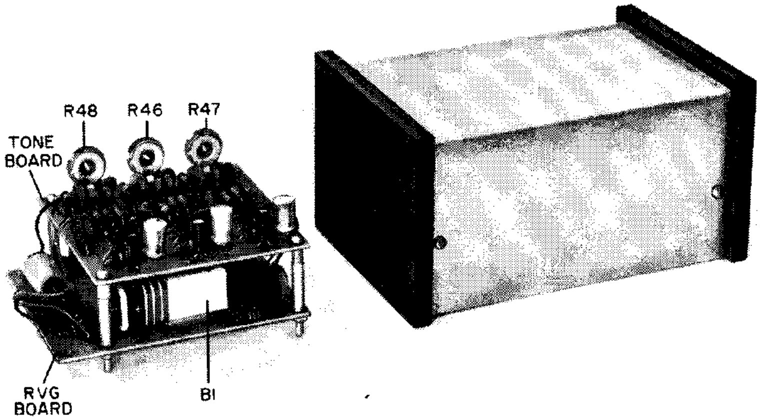
Fig. 3. Foil patterns and component layouts for the two boards. One end of resistors R49-R51 connect between boards, while short lengths of insulated wire connect similarly marked pads on both boards.

length of RG-174/U or similar thin coax or audio cable to make the connection between RVG board points "G" (coax shield) and "L" and whatever type of plug matches the amplifier you will be using.

Testing and Operation. The unit is now ready to test. Check over all connections and component parts and snap a fresh 9-volt battery into the battery connector and clip the battery into the battery holder.

Plug the output into one of the auxiliary inputs of a hi-fi or musical instrument amplifier and turn on the amplifier and wind chimes. Rotate the adjusting discs of trimmer controls *R46*, *R47* and *R48* fully clockwise as viewed from the closest edge of the circuit board.

These potentiometers act as sustain controls for the three chimes and regulate the tone between a dull "thunk" and a ringing chime-like tone. One at a time, turn the trimmers from the extreme counterclockwise limits of their rotation. For some part of each trimmer's rotation, a constant tone should be heard from the amplifier and this



Note how the smaller tone board is mounted over the random voltage generator board. Prototype was mounted in case as shown at the right.

tone should increase in pitch as the control is rotated counterclockwise. At some point before the extreme counterclockwise limit is reached, the tone should cease. After the effect of each trimmer is tested, return it to it's clockwise limit. Do not pay any attention to the dull strike tones that you hear at this point.

Once satisfied that all oscillators are operating properly, you can proceed to preliminary adjustments. Beginning with *R46*, advance the trimmer counterclockwise until the point is reached at which the oscillator begins to produce a steady tone and then back off until the tone just stops. At this point you will be listening for two things: a random pattern and the sustain of the oscillator. You will hear a number of dull sounding strikes generated by the other two oscillators which at this stage are detuned but you should also hear a single ringing tone being generated by the oscillator associated with *R46*. Listen to this tone for a few minutes to make sure that the strikes are random. If sustained oscillation occurs while you are listening, back off on the trimmer very slightly.

When satisfied with the setting of *R46* proceed in a like manner to *R47* pausing to assure yourself that the strikes are random and that no sustained oscillation occurs. When satisfied with *R47* proceed to *R48*.

The wind chimes may be mounted in any convenient case. The case illustrated was made of sheet aluminum folded into a U measuring about 5″ × 2½″ × 3¼″. The ends of the U were sealed with walnut blocks having a rabbet cut around each edge. The ends are held in place by #4 wood screws. Holes in the back of the case allow the output coax to pass through and mount the slide switch. When completely assembled, the slide switch is positioned in the open space above *C29*. The circuit board fastens to the flat aluminum base plate with 4-40 hardware and ¼″ stand-offs and the bottom plate in turn attaches to the wood ends with #4 wood screws which also hold 4 rubber feet in place.

Modifications. Ringing chime-like tones are not the only possible sound. By turning the sustain trimmers clockwise, tones, resembling the percussive resonance of bamboo rods or solid wood blocks can be produced. Or for really strange sounds, the trimmers can be turned counterclockwise past the range in which continuous oscillation occurs.

After listening to the chimes for a while you may decide that you would like them better if the strikes were closer together or farther apart. This can be achieved without destroying the random pattern by varying the values of *R22*, *R24* and *R26*. The practical limits for these resistors are from 470,000 ohms to 2.2 megohms with strike being more closely spaced as the resistance decreases.

The pitch of the oscillators may be changed by varying the value of the resistors in the T filter; *R40* and *R41*, for example. Practical limits are from about 47,000 to 150,000 ohms with the pitch increasing as the resistance is lowered. The two resistors need not be identical. ◈