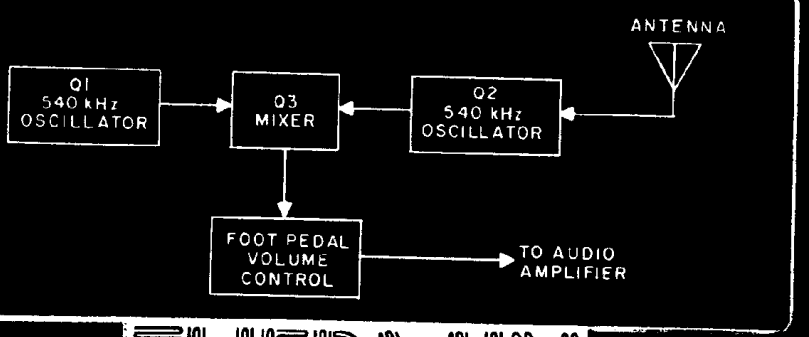
ULTRA SIMPLE THERMIN



Here's a real Now Sound from the past!

by Steve Daniels

WHENEVER THE MAD SCIENTIST IN THE movies bends over a console that looks like something from ELEMENTARY ELECTRONICS, you can bet that any weird background music heard is played in part by an electronic curiousity called a Theremin. The Theremin is an old device whose circuits have been around for years but were often too unstable or too complex for an experimenter. We now present the Ultra Simple *Thermin*—a stable, solid-state musical instrument with a live and most extraordinary sound. We'll also show you how to make a swell-to-great expression pedal for controlling the volume with your foot.

Leon Theremin, a Russian, invented the first Theremin and planned to display it at the 1939 New York World's Fair. A ballerina was to dance between two columns, her body capacitance to generate music. Unfortunately, when the dance was graceful, the music wasn't and contrarywise. Thus, the ultimate Theremin never appeared but the smaller versions have ever since. Our *Thermin*, so simple and so small, took an abbreviated form of Leon's surname, Theremin.

With practice it's possible to play any kind of tune on the UST, making it a natural for Rock Combos. Another plus in this application is its ability to work through a standard Hi-Fi amplifier or musical instrument amplifier. Adding effects to home recordings or school plays or just jamming with friends are some of the ways UST can prove its worth. Cost is all of ten bills if you'll settle for a cigar box or similar case.

Some Thumbnail Thermin Theory. Everybody knows that a superhetrodyne receiver works by mixing too high frequency signals and amplifying one of the resulting (sum or difference) frequencies. That is exactly what happens in the UST. As two signals are mixed, the resultant difference frequency falls within the audio spectrum. Look at the schematic and you'll see two oscillator circuits similar to those found in wireless mikes. Each oscillator generates a signal at approximately 540 kHz depending on the setting of the loopstick slugs. Each RF signal is then coupled through C5 or C6 to the gate of Q3 where mixing occures. Initially, the oscillators are adjusted to generate signals of the same frequency; therefore, no audio note is heard. But if someone were to approach an antenna connected to the tuned circuit of one of the oscillators, his or her natural capacitance would *load* the circuit and lower the frequency of oscillation. A beat note, whose frequency is in proportion to the amount of body loading, i. e., distance from the antenna, would be heard.

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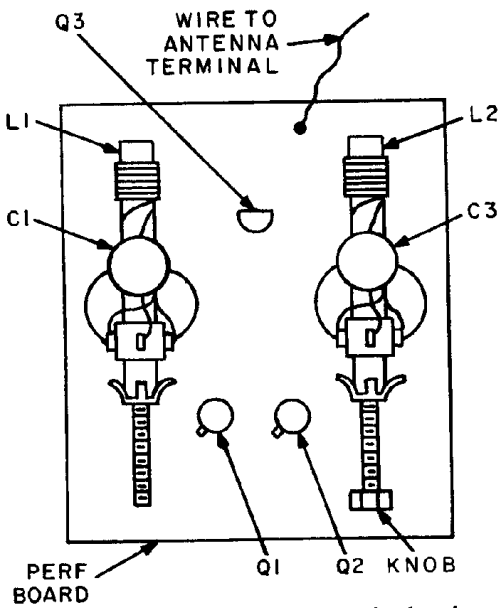
What makes this circuit stable is the use of a FET as the mixer. It provides a very high-Z load to the oscillators to prevent the external amplifier and cable from affecting frequency.

Construction. First, locate and drill holes for the output and antenna jacks. A hole larger than the diameter of the cable for the pedal goes in the back, and a grommet is inserted to prevent damage to the insulation. A hole on the front panel for the slide switch is made with a nibbling tool, while a clamp for the battery can be just a strip of sheet metal bent to shape and screwed to the side wall. Mount and tighten all components.

The author used a 3½-in. x 4½-in. punched phenolic terminal board and push-in terminals to construct the circuit. You'll probably find it convenient to wire an oscillator on either side of the board with the mixer in the middle. Don't wire in C5 until the rest of the oscillator section is complete; this way you can decide where Q5 will go and make the gate connections with no trouble. Start by bending the coil mounting brackets at right angles. Mount one on either side of the circuit board. Snap the coils in place and put a knob on the coil which will be connected to the antenna. Finish the tuned circuits by soldering 3-in. leads to each coil terminal and by soldering the 270pf capacitors across opposite lugs (1 and 3). Wire one oscillator at a time; orient Q1 and Q2 so both emitters point toward the front of the case.



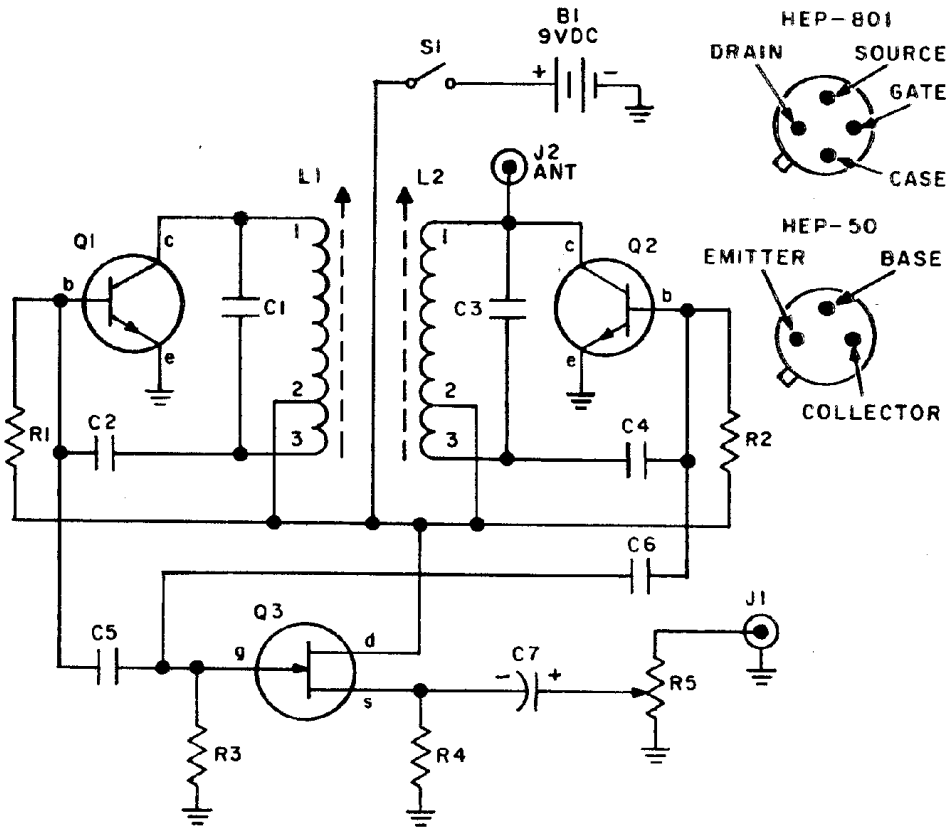
Basic parts layout involves angle brackets for mounting loopsticks. Suggested transistor orientation aids assembly; position Q1 and Q2 emitter leads toward front of board.

When the board is ready, mount it in the box. Thread the 3-conductor pedal cable through the grommet in back and wire it to the circuit. One lead goes to the hot side of J1, one to the circuit board output terminal, and one to ground. Make the antenna by soldering a 1-foot length of busbar to the center contact of an RCA phono plug. Connect the antenna to the antenna jack and begin work on the swell-to-great pedal.

No Cake Baking Here. Make the pedal by screwing together a 6 x 3½-in. piece of thin sheetmetal and a piece of slightly smaller masonite. It must be hinged at the bottom with a butt hinge available from a hardware store. Fasten it to the masonite side of the pedal with short screws and nuts so that it won't restrict pedal movement. The base is a metal cake pan. Ours measured 9¼ x 5¾ x 2¾-in. Screw the pedal assembly to the inverted pan about a half-inch from the edge. Uncoil one turn of a small, firm spring and re-wrap it under the head of a 6-32 screw. Fasten the spring to the center of the pan in a position that raises the pedal about two inches above its base (include a solder lug under the nut for later use).

An angle bracket is used to mount the potentiometer shaft about 1½-in. from the bottom of the pan. Turn the shaft to its maximum counter-clockwise position, and file or sandpaper a small area on the top of the shaft to make it rough. Tin the area with solder using a very hot, clean iron. At this point, solder a 1½-in. length of No. 18 Busbar to the tinned area on the shaft. Bore a hole in the pan directly under the center of the pedal top and run a second piece of bus bar through this hole and solder to the upper end of the pedal. Use trial and error fitting to loop the two busbar ends together until the pedal moves freely up and down. When all is well, connect the 3-conductor cable from the UST. Ground the pedal with a wire from the solder lug to the cable ground.

Tuneup and Testing. Temporarily break the lead from the emitter of Q2 to ground; turn the UST on and place it near an AM



PARTS LIST FOR
ULTRA SIMPLE THERMIN

B1—2U6 or equal 9-volt battery
C1, C3—270pF disc capacitor
C2,C4—300pF disc capacitor
C5,C6—100pF disc capacitor
C7—10uF, 15 volt electroytic capacitor
L1,L2—Loopstick (Lafayette 32—41080)
Q1,Q2—HEP-50 or 2N706 transistor (Motorola)
Q3—HEP-801 N-channel junction field-effect transistor (Motorola)
R1,R2—100,000-ohm, ½-watt resistor
R3—3.9-Megohm, ½-watt resistor
R4—5,600-ohm, ½-watt resistor
R5—10-Megohm potentiometer modified as per text.
Misc.—4 x 6 x 3-in. box, perforated board, push-in clips, No. 18 bus wire, phone jack, RCA phono jack, hook-up wire, knob, solder lug, approx. 5½-feet of 3-conductor cable.

radio tuned to 540 kHz. Adjust the slug in L1 with a screwdriver for a strong carrier signal. Reconnect the Q2 emitter. With the antenna plugged-in, connect an amplifier to the output jack. Turn on the UST, depress the foot pedal and turn the L2 slug slowly until you hear a squeal. As you keep turning, the squeal should get lower and lower in pitch until it disappears. This will occur at two settings very close to each other. You will want the setting which allows you to change the pitch by moving your hand toward the antenna. If you have a problem with stability, lack of range, or sensitivity (your hand has to be too close to the antenna to get a tone), just play with the adjustment of L2 to get the best compromise. It's critical but should be stable once properly set.

Now start to practice by learning where various notes are located. Any special effects on your amplifier, particularly reverb, can be used to advantage for modifying the basic sound of the instrument. When people want to know how you get the squeals without touching anything, say there's a girl inside and when you bring your hand too close. . . . ■