Powerful Crystal Set

A "something for nothing" radio.

by Pete Haas

This crystal set has several improvements on a classic design. The speaker volume, though not ear-shattering, is plenty loud. The cumulative effects of several "tweaks" will allow the set to drive a speaker. Here's a description of each improvement.

Ferrite Tuning Coils: I used a ferrite bar instead of larger air-core coils, because the bar has a much higher Q. The main tank circuit coil is wound on a flat ferrite bar. More iron surface area is exposed compared to a round slug and fewer turns of wire are needed. In general, the fewer turns of wire needed in a tank circuit, the higher the quality will be. A junked AM pocket radio is a good source for a ferrite bar. The exact dimensions of the bar aren't critical. Just find one that's close to the one described here. The coil has multiple taps so you will have some leeway.

Antenna Matcher: The use of an antenna matcher is essential, since the characteristics of long wire antennas vary according to many factors. The big factor is antenna length, but height above the ground, gauge of wire, resistance in the actual antenna connections, moisture content of the air, and solid ground connection, all also figure into the picture. (Yes, a crystal set will work without an earth ground, but try it with and without. There's an increase in volume with the use of a good earth ground.) The matcher here is simply a loopstick and a variable capacitor in the 250–365pF range. It markedly increases the crystal set's efficiency and allows just about any length of wire to be used as an antenna. If you have an outdoor CB or scanner antenna with a long coax run of 50 feet or more, you can use the coax as a long wire antenna by attaching it with a clip lead to the crystal set. Just be sure to *temporarily* disconnect the shield from its earth ground.

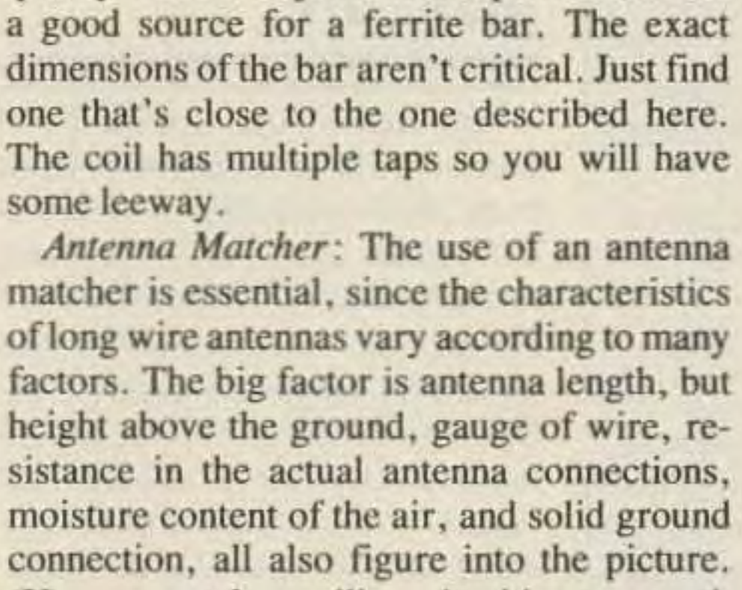

Figure 1. Hand-winding of the ferrite tuning coil.

". . . several 'tweaks' will allow the set to drive a speaker."

Voltage Doubler Detector: The voltage doubler produced slightly louder volume over a full-wave bridge rectifier. Technically, it's still a half-wave rectifier, but the circuit configuration uses both halves of the RF wave to charge two capacitors which fire off in series to produce twice the voltage—just like batteries do when placed in series. The voltage doubler increases volume before going through an audio step-down transformer.

Walkman Type Loudspeakers: These are passive but highly efficient loudspeakers that plug into the cassette player's headphone jack. The speakers have small powerful samarium cobalt magnets, and cones made of thin, very lightweight plastic such as Mylar. They don't rate well as hi-fi producers but they are capable of fairly loud volume with only a few milliwatts of drive.

Dual Tuning Circuit: Since two tank circuits are used, the received radio signal will have twice the current as compared to a conventional crystal set.

Selectivity Switch: This crystal set has a choice of wide or narrow selectivity. Adding a tap to L1 effectively reduces the number of turns, increasing the Q, and in turn the set's selectivity. If you want to tune in a weak radio signal that's right next to a powerful signal, the narrow position will help a lot. For maximum sensitivity and general bandscanning, use the wide position.

Construction

Dual 365 pF variables are hard to find, so I used two separate ones. There's a slight

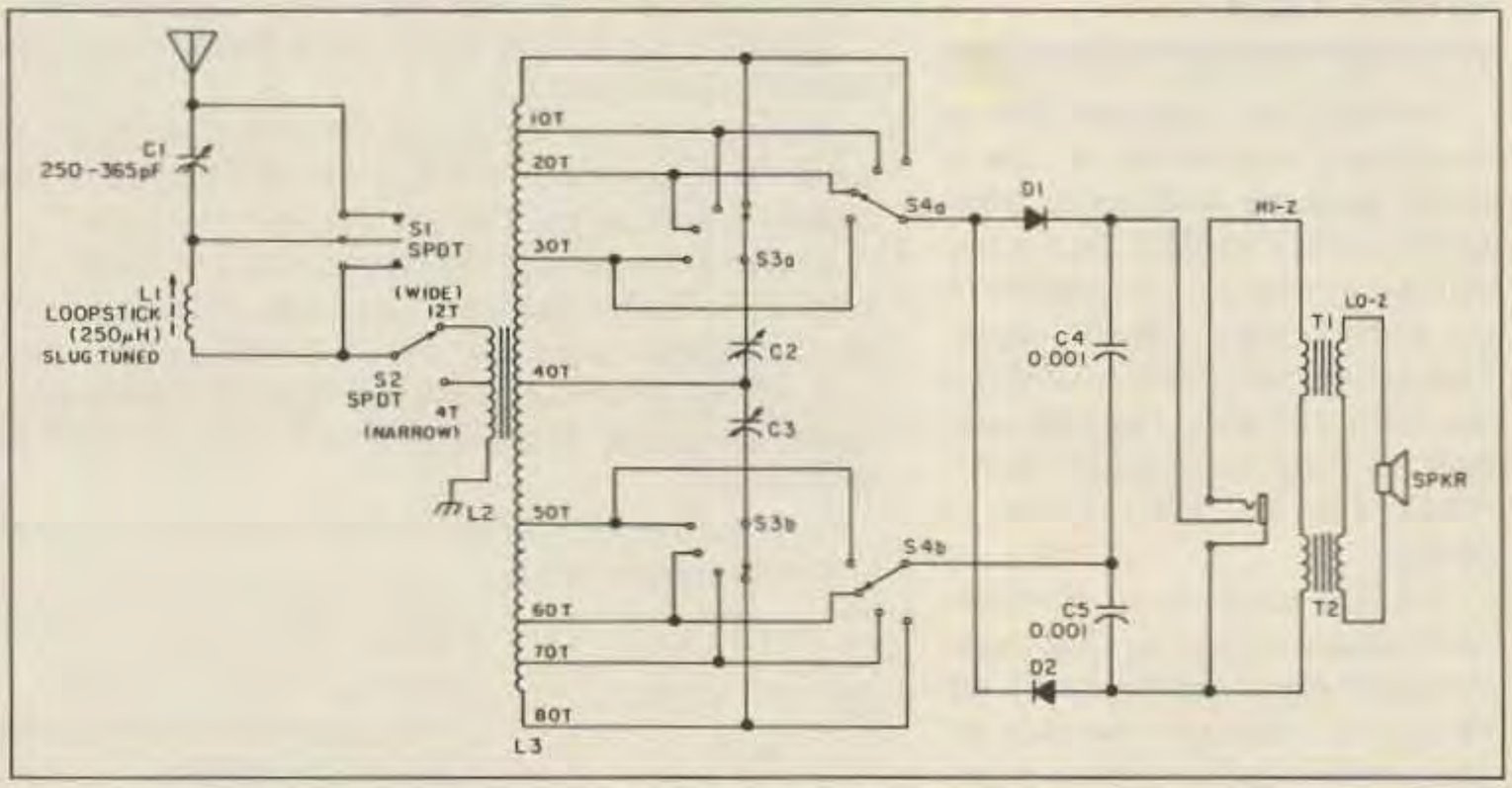

Figure 2. Schematic of the crystal set.

advantage to this. When you have a radio station tuned in for the loudest signal you may find that the mesh of the two capacitors isn't quite the same. That's because L3, which is wound by hand, does not have exactly the same inductance value on either side of the center tap. (L3 is wound on a flat ferrite bar salvaged from an old AM radio using 5/44 Litz wire. If you carefully unwind the original winding on a ferrite bar coil, you can reuse it to construct L2 and L3.)

The diodes can be any general purpose small signal germanium types. Use an ohmmeter to pick out ones with the lowest forward resistance. This will insure the loudest possible audio at the speakers.

The very high impedance transformers can be found at hamfests and in surplus parts catalogs like Meshna's. You can also use two or three transformers obtained from old tube-type radios or televisions. Connect the high impedance primaries and the low impedance secondaries in series. Though it requires more room in the project cabinet, this provides an excellent speaker driving system.

Parts List

C1, C2, C3	365 pF variables.
L1	Loopstick antenna coil (Miller 6300) or 11'2" of 5/44 Litz wire on a 5/16" OD slug tuned form (scramble wound). Coil is ¾" long. Litz wire is available from Midco, 660 North Dixie Hwy, Hollywood FL 33020.
L2	12 turns 5/44 Litz wire over center of L3, tapped at 8th turn.
L3	80 turns 5/44 Litz wire on ¼" x ¼" x 3" ferrite bar (length not critical) salvaged from an AM transistor radio. Tapped at 10, 20, 30, 40, 50, 60, & 70 turns. See Figures.
C4, C5	0.001 mF.
D1, D2	Germanium diodes.
S1, S2	SPDT switch.
S3, S4	2-pole, 4-position rotary switches.
T1, T2	Very high impedance transformer with ≈8Ω secondary. Try a 4800/3.2Ω or similiar, cat. #JT-19 (75¢) from John Meshna Jr., Inc., PO Box 62, E. Lynn MA 01904 ($20 minimum per order).

"Powering Up"

Once construction is complete, attach an antenna of at least fifty feet and hook up a good earth ground. A cold water pipe is an excellent choice. You may want to use crystal headphones to do the initial tuning. The earphone volume will be astounding. When you switch to the loudspeaker, some retuning will be necessary since the speaker/transformer combination presents more of a load and reduces the tuned circuit's Q. Using the least amount of inductance off L3 (the fewest turns of wire) will generate the loudest received audio.

There are a lot of tunable adjustments on this radio, so preserve every bit of RF energy by properly matching each component to the next. Spend some time using all the various combinations of coil taps and capacitor settings. Optimum settings will change from one end of the AM band to the other. Try the narrow selectivity and notice how radio signals tend to snap in and out as compared to a conventional crystal set where a strong station takes up half of the dial. Because of this set's exceptional sensitivity and wide tuning range, you may also hear some older cordless phone signals around 1700 kHz. The audio will have the characteristic buzz from the FM carrier, but there is also an AM component in the signal and you'll be able to make out what's being said on both sides of the conversation. Enjoy! 73