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The “Litz Blitz”

by Dan Petersen, W7OIL

In this world there are crystal sets - and then there are CRYSTAL SETS. In my quest for the “perfect” crystal set I have found out one thing - There is no such animal! There are times however that one makes a quantum leap into a new level of performance. The set I am about to describe is just such a leap. I have made an effort to optimize performance by investigating some different technologies than I have not used before. The result is the “Litz Blitz”. Litz for the type of wire used and Blitz because that is German for “lightning” - and it rhymes with “Litz”.

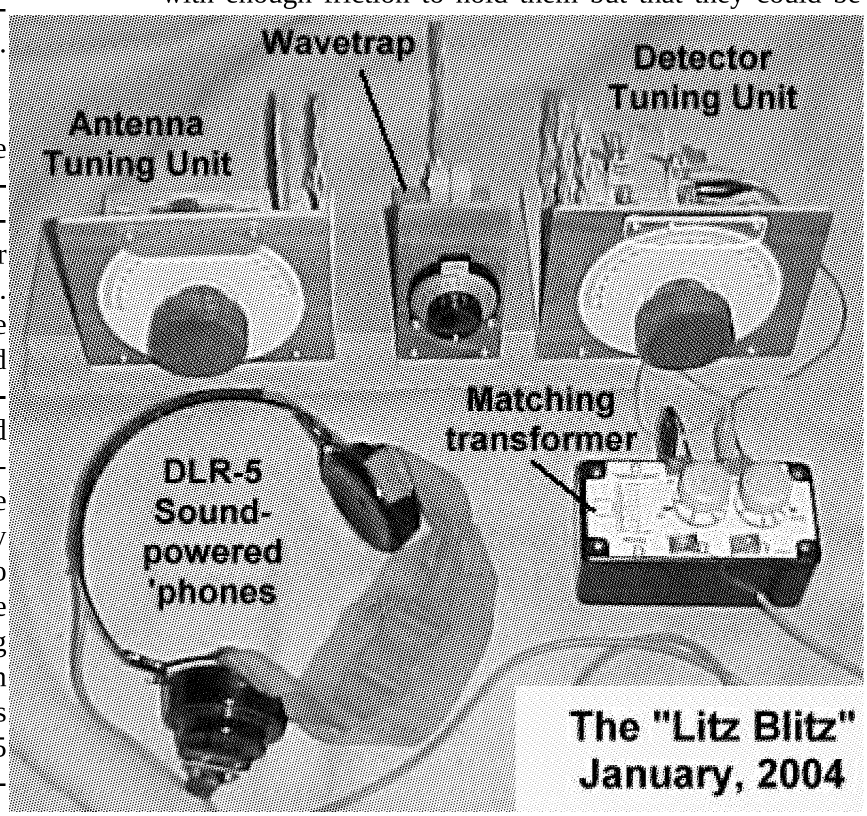
In the Beginning:

Recently I came into possession a couple of items that enabled me to make a new radio that out-performs any crystal set I have ever made before. The first item was a roll of “litz” wire.

The term litz wire is the shortened form of the German word litzendraht (pronounced LITS-en-drawt) meaning woven wire. It is wire constructed of individual film insulated wires bunched or braided together in a uniform pattern of twists. The multistrand configuration minimizes the power losses otherwise encountered in a solid conductor due to the “skin effect”, or the tendency of radio frequency current to be concentrated at the surface of the conductor. In order to counteract this effect, it is necessary to increase the amount of surface area without appreciably increasing the size of the conductor. It is also essential to position each individual strand in the litz construction in a uniform pattern moving from the center to the outside and back in a given length. The wire I used in the “Litz Blitz” is called 165/46 which means it consists of 165 strands of #46 wire. Litz wire comes in many different varieties, depending on the application and operating frequency Polyurethane is the film most often used for insulating individual strands. Litz wires are generally further insulated with a single or double wrap of (usually) nylon. The resulting wire looks not unlike cotton or especially silk covered wire from the old days. It is interesting stuff to deal with. It’s quite flexible, unlike single-strand wire. This makes it attractive for use in another experiment in technology I wanted to try, the use of spider-web coils.

Spider, spider ...

Spider-web coils have a special attraction to me. They are supposed to be quite efficient as the contact between the adjacent wires and the wires to the form is minimal. Also, to me, the spider-web coil has an esthetic appeal as it gives the set an “old-fashioned” appearance reminding me of the days of spark-gaps and ozone in the air. I decided to further reduce the contact with the form by removing the form entirely. This I accomplished by cutting out a round core and drilling 11 evenly spaced holes into the rim. I then fashioned eleven “spokes” that could be inserted into the holes with enough friction to hold them but that they could be



The "Litz Blitz" January, 2004

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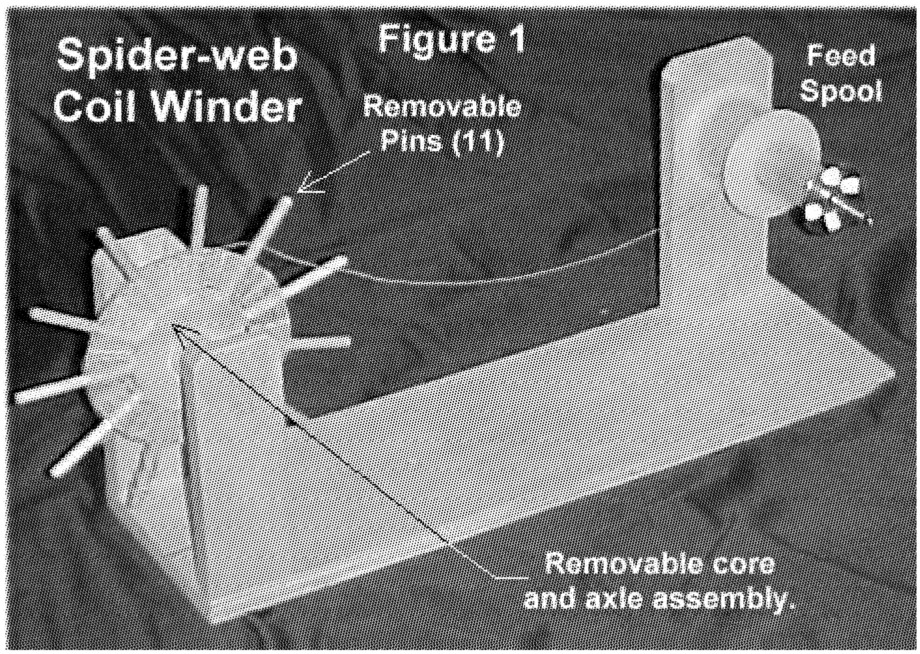
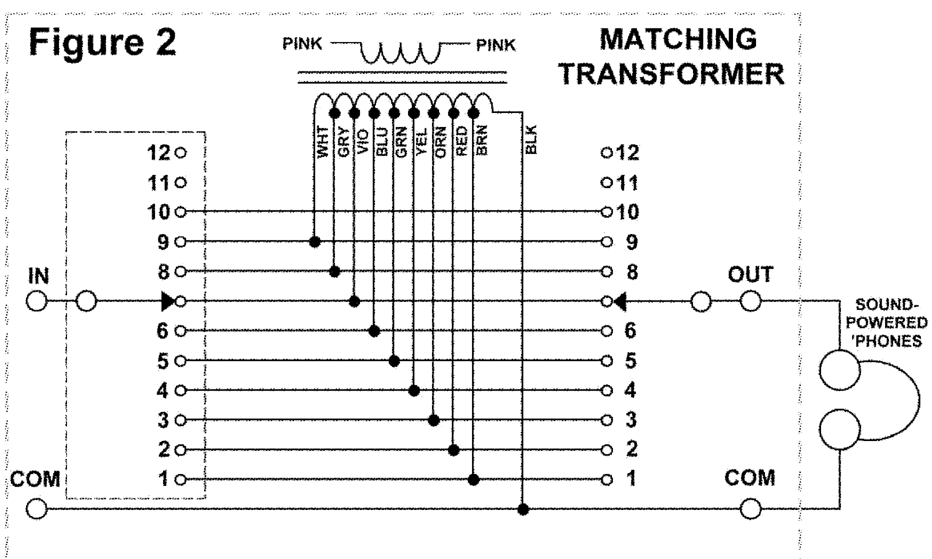


former. This provides an impedance transformation between the detector and the headphones. The phones I use were originally from Great Britain and are military sound-powered units. Sound-powered units work as a dynamic system the same as "regular" headphones but are optimized in their construction to be extraordinarily sensitive. They were originally meant to be used as communication units that could be connected together with a pair of wires - no battery power or amplifiers needed. The same sound-powered element can be used as both an earphone and a microphone. Sound-powered phones, when used with crystal sets, do work best when they are paired with an impedance-matching transformer. I have connected the headphones directly to the output of the "Litz Blitz" and while they work "OK" they work immensely better with an impedance matching transformer. One thing is for sure however, I am a convert to the sound-powered headphone! Word of caution though - sound-powered headphones can be spendy. I have seen some sell on E-bay for big bucks!

easily removed when the coil was finished. I eventually went as far as to run a 3/4" diameter axle through the core and placing it and the wire-spool onto a base to make a coil-winding machine (See Figure 1). The axle/core/spoke assembly drops into a pair of slots. To use you wrap the start of the wire a couple of times around the axle, then start turning the form. While doing this you feed the wire to the outside of one spoke and to the inside of the next. This alternating in and out of the spokes is what gives the spider-web coil its distinctive appearance. For the "Litz Blitz" I used 48 turns of 165/44 litz wire on a 2" inside diameter, 11 spoke form. The spokes are 3/16" in diameter. The same size coil is used for both the Antenna and the Detector tuning units as well as the Wavetrap. Once the coil is wound apply a thin line of glue to the area where the wires cross and allow to dry. Once the glue is dry the spokes can be removed and the core removed from the finished coil.

While on the subject of impedance matching, Figure 2 is the schematic of the matching transformer unit. I used a pair of Radio Shack twelve-position rotary switches so I could hook up the transformer in any tap combination. You may note that the secondary is not used. I am using the Bogen as an "autotransformer" which uses only one winding to operate. I can switch the input and the output to any combination of taps or run the unit "straight through". The two pink wires are for a low-impedance speaker connection and are not used in this application.

I had noticed that in several of the high-performance crystal set designs I have seen that the various parts of the set were movable in relation to each other. Some sets were even built as a collection of "modules" that were arrayed around the operating position. Mike Peeble's design is one where the modules are arrayed all over the bench. I did not want to be that casual so I opted for a base with a center guide plate. The Detector Tuning Unit is mounted to the right side of the base whereas the Antenna Tuning Unit and the Wavetrap are able to slide along the base. Attached to the set in its own "module" is a Bogen T-725 line trans-



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The Modular Approach

The set itself consists of three modules, the Antenna Tuning Unit, The Wavetrap, and the Detector Tuning Unit. Figure 3 shows the schematic of the Litz Blitz set. The schematic indicates that as far as components are concerned, it is a very simple unit. The Antenna Tuning Unit consists of two components, L1 which is the 48 turns of 165/44 litz wire on a 2" inside diameter, 11 spoke form. The other component is the tuning capacitor, which is the dual-gang 365pF variable available through the Xtal Set Society. As the ATU was on the left side of the base-rail I placed the coil on the right side of the ATU (as seen from the front). The electrical connections of the ATU form a series-parallel tuned circuit. I used cotton-covered wire because (a) I had some and (b) I wanted to keep a vintage look to the set. You will note in the picture that the detector coil and detector circuit sits on a "sled" of its own so the coupling between the tuning coil and the detector coil can be varied. Fahnestock clips are used for connections throughout so changes can be made easily. Porcelain standoffs are also used to reduce any losses through the wooden components.

Performance:

Performance? Wow! My grading on the 1 to 10 "Guglielmo" is about 9.547821. The scale runs from ten (Who needs another set when you have this one) to one (I need another set-you can have this one). Once I connected the set to the "RMS Titanic" antenna, the ground and the transformer and headphone combo I was amazed at the selectivity of this set. It tunes VERY sharply - I can separate two loud stations 20 KHz apart with no interference from the neighboring station. I can separate DX stations 10KHz apart as in the case of CFFR-Calgary on 660, KBOI-Boise

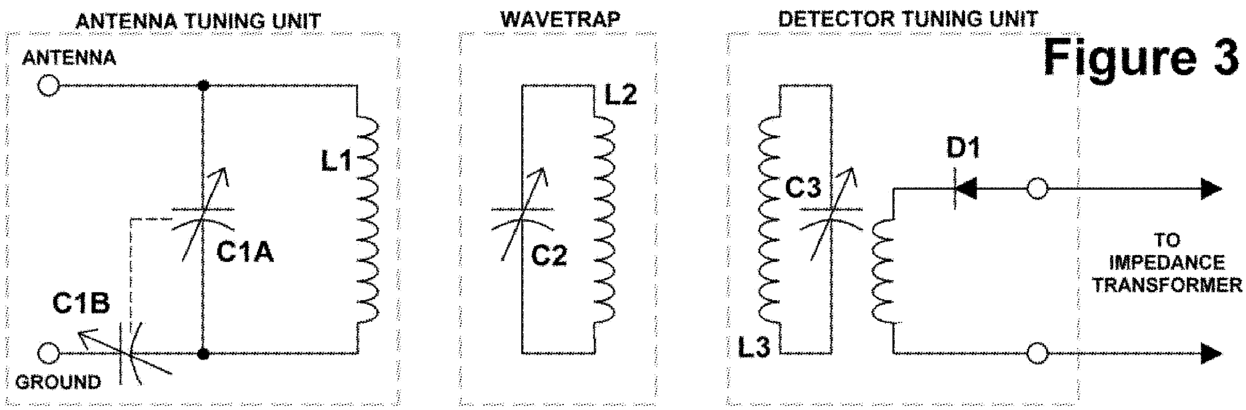

Figure 3

The Wavetrap module is no more than a parallel tuned circuit consisting of the same type of coil as L1. It is placed between the ATU and the Detector Tuning Unit to help suppress unwanted interference. I mean, how many times do YOU want to listen to Disney Radio's "Hamster Dance"? The coil of the wavetrap unit can be varied front-to-back as well as the entire module sliding along the base-rail. This gives me a great deal of latitude in adjusting the wavetrap as they can be touchy little buggers. To help alleviate the touchy problem I used a vernier on the tuning capacitor. The variable capacitor is one of the XSS's single-gang variable capacitors. The vernier I feel is necessary because the tuning on the wavetrap is VERY sharp. You can go right by the desired null point and not even know it. In retrospect I would probably put verniers on all three modules.

Last but not least is the Detector Tuning Unit or DTU. Figure 4 shows the details of the DTU. The tuning coil is the same as L1 and L2 while the tuning capacitor is another one of Rebecca's little single-gang gems. The detector coil is wound on the same form as the tuning coils but consists of 20 turns of #24 cotton-covered wire.

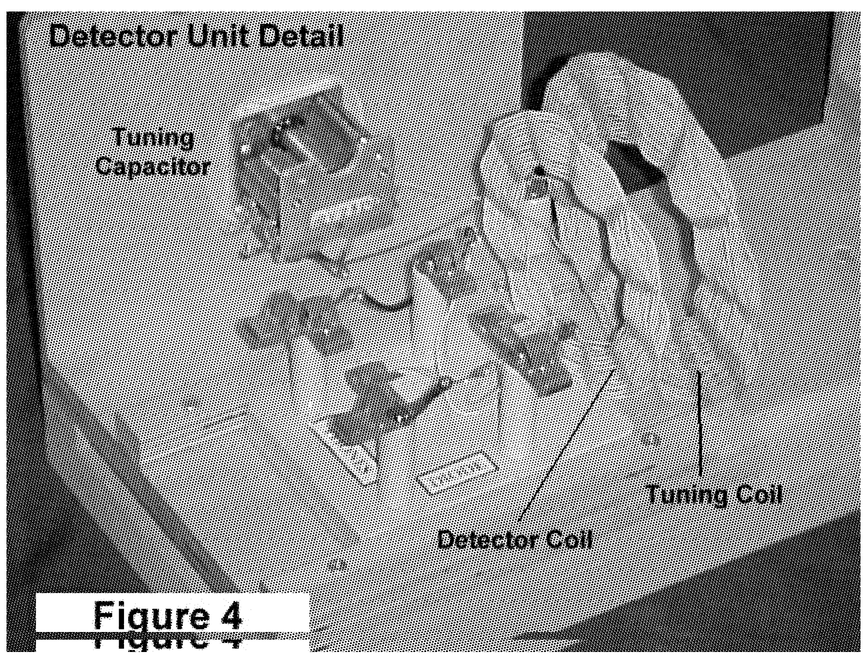

Figure 4

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on 670 and KNBR-San Francisco 0n 680. These I pick up most nights of the winter from here in SW Washington State. In a week's time I had netted 59 stations in six western states, two Canadian provinces and Baja California, Mexico. As I am not in the near-field of any local blowtorches I rarely use the wavetrap. It was handy however for digging out XEPRS on 1090 KHz as I do have a loud local at 1080 KHz (KOTK). I could make 1080 disappear completely with careful adjustment of the wavetrap.

This one's a winner in every respect. I do caution that it is a design that should be tackled by at least an intermediate builder. I am already making plans for changes and improvements in the basic design. This set has opened a whole new area of exploration for me.

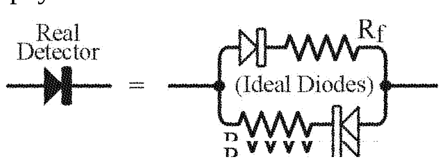
Optimizing Passive AM Detectors

Part 2: The Strategy
by John Davidson

Detector Semi-Equivalent Circuit
To work on detection optimization strategies, we'll need some mental scaffolding: a model. An accurate detector model requires calculus because detector resistance changes continuously with signal strength. We can make a very useful but only roughly accurate model of the detector from the approximate average operating values of R_f and R_r discussed in Part 1. This will be good enough to reveal the strategy for detector optimization.

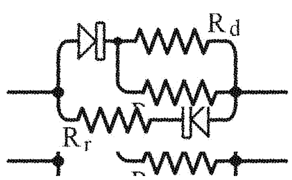
The basis of the model is fixed values of *effective* forward and reverse resistors kept separated by ideal diodes. This circuit is shown in Figure 8 where a black diode denotes a real diode and a white diode denotes an ideal diode. "Ideal diodes" are imaginary and have zero forward resistance and open in reverse. Bear in mind that the values for these resistances will apply to only one value of RF signal strength, the price we pay to avoid calculus.

Figure 8. (Limited) Diode Equivalent Circuit.



Since the reverse resistance R_r is always higher than the forward resistance R_f, it is obvious that the detector conducts current both directions at least as much as the reverse leakage current. Thinking about this, we should be able to change the parts in this circuit to make an equivalent one with just one diode with a leakage resistor around it. Indeed we can by first dividing the forward resistor, R_f, into an equivalent pair of resistors, one equal to R_r and whatever is left over, call it R_d as shown in Figure 9. It turns out that $R_d = R_f\, R_r / (R_r - R_f)$.

Figure 9: Diode Model Simplification



These resistor values can be fixed resistors equal to average effective values over the waveform but they must be variable if we vary the amplitude of the waveform. We can get by with fixed values now. It will not change any behavior if we connect the middle resistor to the left node through its own ideal diode as shown in Figure 10. Here the two lower R_r resistors with ideal diodes in opposite directions (in the dashed circle of Figure 10) can be combined into one R_r resistor if we eliminate the lower two diodes. This results in a simpler detector circuit of Figure 11 that behaves like a

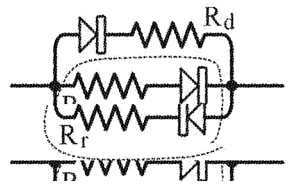
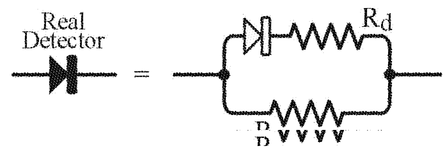


Figure 10: More Simplification of Diode Model

Figure 11: (Limited) Equivalent Circuit Used.



the real diode for one signal level. Now we can replace the real diode in our crystal radio circuit with this signal specific detector equivalent circuit showing parts that reveal its true behavior.

Loss of RF To That Evil Reverse Leakage
Consider the audio side of the radio with the detector model inserted, as shown in Figure 12. Since the headphone bypass capacitance, C_b, is near zero impedance at RF, R_r is effectively grounded for RF on the right, so looking from the viewpoint of the tuner, RF wise, the whole circuit appears shunted (or paralleled) by R_r. The circuit will behave about the same (for RF) in this situation if we move right end of R_r from the top of C_b to the bottom (ground) rail, as shown in Figure 13.

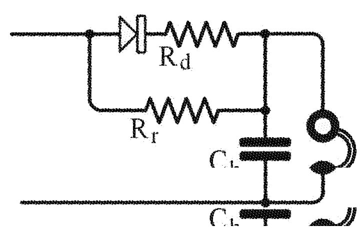
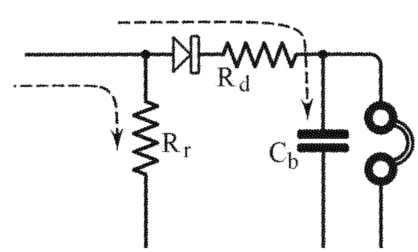


Figure 12: Diode Equivalent Circuit in Radio.

Figure 13:Paths for RF



In Figure 13 the dashed lines represent RF current paths. The upper dashed line represents the RF flow through the diode where it is "changed" to 'DC' on C_b and provides audio for the phones. The lower dashed line is the loss of RF dissipated in R_r. This RF leakage through R_r is both a loss of power and a load on the tuner, materially reducing loaded Q and consequently selectivity. This is not all R_r takes from us.

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Loss of 'DC' To That Evil Reverse Leakage

Consider what happens to the 'DC' placed on the bypass capacitor, C_b, for the phones. After the ideal diode places the 'DC' charge on the bypass capacitor, we can view C_b locally as a sort of source for this 'DC' for the phones, since all charge that flows to the phones must appear across C_b first. Current leaves the bypass capacitor, C_b via three paths. These are illustrated as dashed lines in Figure 14. The far right path through the phones is where we want all the 'DC'to flow to make sound. The ideal diode prevents any flow back through R_d. The lower left path through R_r and the coil is the problem. The coil is very low resistance for 'DC,' effectively a short circuit (no resistance). For DC analysis (only), the circuit will behave about the same if we just move the left side of R_r from the top of the coil to the ground rail, as illustrated in Figure 15. This illustrates how charge flow that was placed on C_b by the ideal diode during the positive RF half-cycle is continually drained off in two directions: to the phones and R_r. In this way, R_r competes with the phones for 'DC' placed on the bypass capacitor, C_b, taking signal from us again.

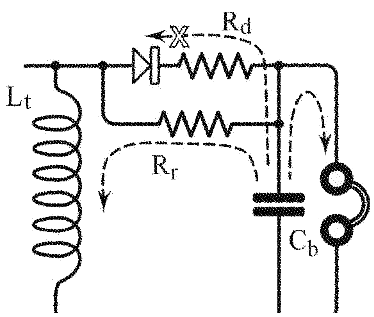

Figure 14: Paths for 'DC' Flow From C_b

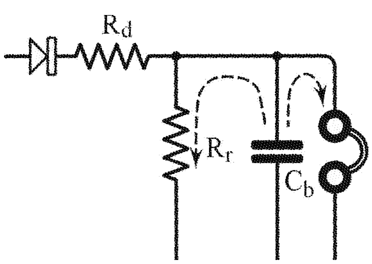

Figure 15: Paths for 'DC' Flow From C_b in Revised Circuit.

Detector Equivalent Circuit Combined Effect

Combining the resulting RF and DC equivalent circuits resulting above we can assemble a whole detector model of Figure 16. By including the radio's L_t and C_b with the diode model we can see opportunities to make further simplifications. Since C_b is essentially a short circuit for RF and L_t is essentially a short circuit for 'DC,' the ends of the two R_r resistors connected to them respectively can be moved directly to the bottom rail as shown in Figure 17.

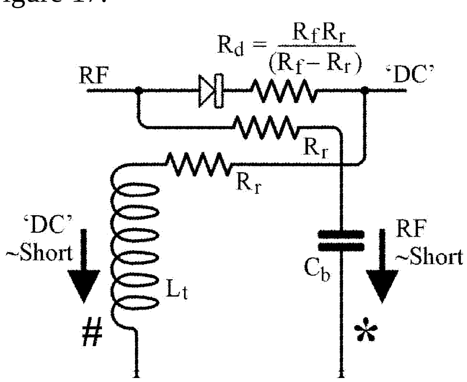

Figure 16: Whole Detector In Radio.

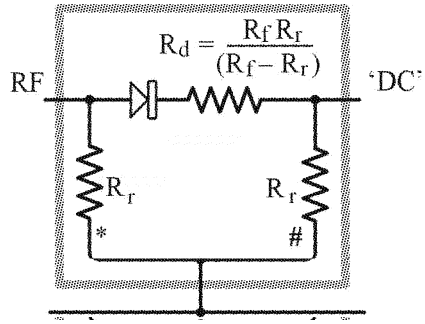

Figure 17. In Situ Equivalent Circuit.

Note:
* Connect via C_b

Connected via L_t

This gives us a restricted equivalent circuit for a diode valid only when it is in the radio. To be valid, it requires the phantom paths marked "*" and "#" to ground through radio components not shown. Now the detector equivalent circuit is beginning to look a lot like the resistive attenuator it mimics in our sets. We can now plug this back into the radio to produce Figure 18. Recall that these resistors change value as the signal strength changes. For strong signals, R_r goes higher and R_f goes lower. We could replace these fixed resistors with pots that we control with the signal level, as shown in Figure 19. If we could build a unity gain ideal detector simulator around this circuit, we could adjust the three-gang pot to the correct value for the given signal the circuit would produce the same signal level in the phones as the real diode.

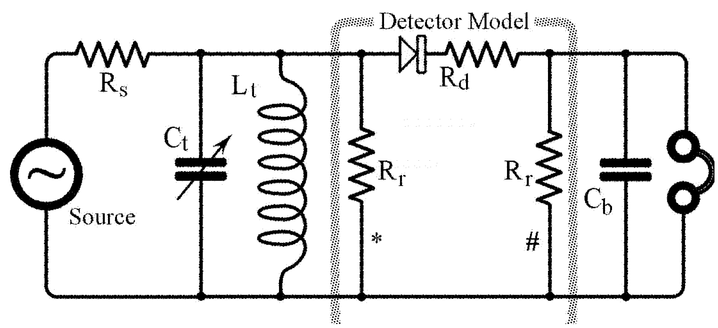

Figure 18. Detector Model In Whole Radio.

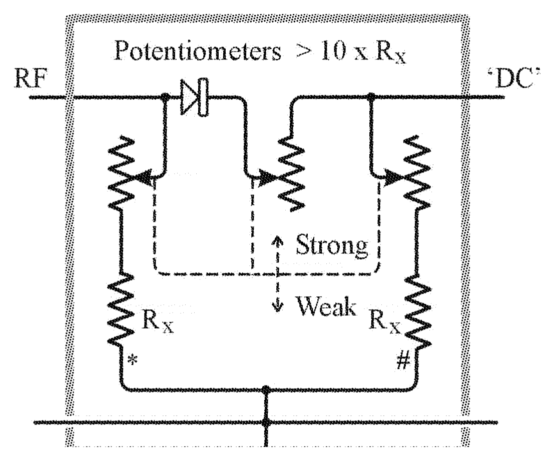

Figure 19. Model Showing Signal Strength Effect.

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Detecting The Strong Local Signals

For strong signals, the signal voltage pushes far to the extremes of the curve of Figure 5 in Part 1. There, relative to forward conduction, reverse leakage is insignificant since the diode is pushed well into cut-off. Lines drawn to points far out on the left of Figure 5 have low slopes (high resistance.) This tells us that the two R_r resistors get so large that the signals almost stop flowing through them and we can practically ignore them. They effectively 'blow up' and evaporate out of the picture, as implied in Figure 20.

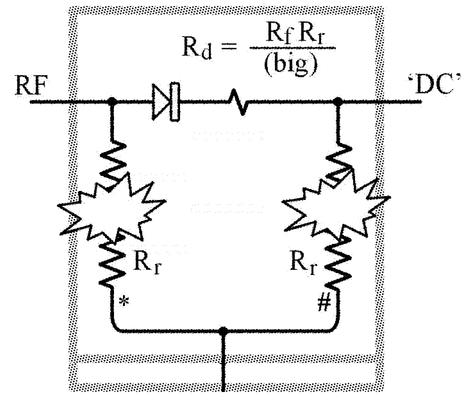

Figure 20: Strong Signal Behavior.

This eliminates the R_r losses. Also stronger signals take the forward voltage to points high and to the right of the curve of Figure 5. Lines drawn to these points have steep slopes meaning low resistance. Since, $R_d = R_f\ R_r\ /\ (R_r - R_f)$ increasing R_r and reducing R_f inflates the denominator of R_d making R_d approach a short circuit. This clears the way for the ideal diode in the detector model to dominate as a true one-way gate. So detection becomes very efficient for strong signals, exactly where we don't need efficiency. Consequently we do not focus on the strong signal behavior.

Detecting The Feeble Oscillations of Weak DX

As the signal weakens, detector performance deteriorates until it finally behaves like a plain resistor. Weak signals use a smaller part of the diode curve, the part of Figure 5 very close to the axis. In that case, there is very little difference between the slope of the diode I-V curve on the forward side and the reverse side. That means the values of R_f and R_r are almost equal for very small signals.

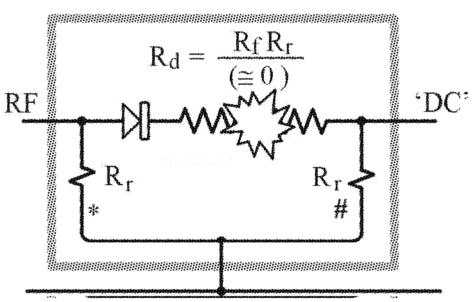

Figure 21: Response To Weak Signals.

As the signal level drops and both R_f and R_r converge on R_X from opposite directions, notice that the denominator of the expression $R_d = R_f\ R_r\ /\ (R_r - R_f)$ approaches zero which causes the value of R_d to go through the ceiling. This 'blowing up' of R_d has the effect of isolating the input and output sides of the diode model, as illustrated in Figure 21. For weak DX signals the diode behaves like a pair of shunt resistors of value $R_r \cong R_X$ that are connected by something approaching nearly an insulator, R_d. Very little 'DC' is produced by such a detector.

Basic Strategy: Detector Source—Load Matching

Because of this isolation between the input and output sides of the detector, the headphone circuit load on the 'DC' side has lost practically all influence on the RF tuner side and vice versa for feeble oscillations. The source—load impedance interaction between the tuner and the phones is all but completely disrupted by the isolation imposed by the diode. The phones see only the detector output resistance $R_r \cong R_X$ as a source impedance independent of the tuner impedance. The tuner sees only the detector input resistance $R_r \cong R_X$ as its load. Consequently, a key part of the strategy of transferring the most power to the phones is simply to source—load match both RF and audio sides of the diode to the diode's R_X. That produces the most audio across the phones.

Source—load matching amounts to making the voltage:current ratio (=resistance) of the source and load comparable. It is something like changing gears on a ten-speed bike to make the force:pedal-speed ratio compatible with the road condition.

On the audio side of the detector matching is often accomplished by using a headphone impedance matching transformer. Audio matching transformers normally have a DC resistance much lower than the audio matching impedance. This low DC resistance effectively shorts out the DC buildup on C_b. This causes audio distortion for strong signals (only) for reasons that warrant a whole 'nuther article. Suffice it to say that preventing the DC buildup on C_b for strong signals changes the detector's operating point enough that the audio varying 'DC' produced fails to accurately track the modulation envelope. To preserve this DC buildup, a resistor of the effective diode operating resistance is added in series with the diode and transformer. Since this value varies with signal strength an adjustable resistor is convenient so that it can be set to maximize audio fidelity. To prevent this resistor from wasting any audio power, an audio bypass capacitor is placed across this resistor.

On the RF side, matching is accomplished by viewing the tuner as a source and making its effective source resistance $R_S = R_X$. In practice, R_S is a composite of the transformed antenna-ground system impedance and tuner impedance. With coil tapping, transformers variable capacitor dividers or other impedance matching schemes, R_S can be transformed to match the diode R_X.

As a practical matter, since coil Q establishes coil loss resistance, it often drives matching and design for the whole radio. Coil loss resistance establishes what the antenna-ground must be transformed to match. That result establishes the R_X needed, driving the selection of the diode and audio transformer.

A difficulty arises for RF source-load matching. The anten-

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na system is the source, with a source resistance, call it A. For a matched condition, the combination of tuner resistance, T, and detector resistance, D, should equal A, so A = T & D. We can change diodes to make this true. However, from the detector's point of view, its source is the combination of the antenna and tuner, and matching requires A & T = D. We can adjust antenna loading to make this true, but it corrupts the diode match above. These adjustments can take several iterations to get close enough. Luckily, as with bike gears, it takes a big mismatch to make enough difference to notice.

Advanced Strategy: Impedance Escalation

Diode R_X is reasonably consistent within diode types but varies widely across different types. Luckily, R_X profoundly affects efficiency and offers an opportunity we shall exploit. In practice, we find that in well-matched radios, diodes with higher R_X outperform others. This is not exactly the result of any inherent efficiency of high R_X diodes. The reason is that diodes with higher R_X allow us to transform to higher voltage output to drive high R_X diodes to span more non-linearity (curvature). This impedance escalation is the essence of the advanced strategy, and the following is presented to exemplify why it works that way. Consider Figure 22, which illustrates the projection of a weak signal on an I-V curve for a typical low R_X germanium detector.

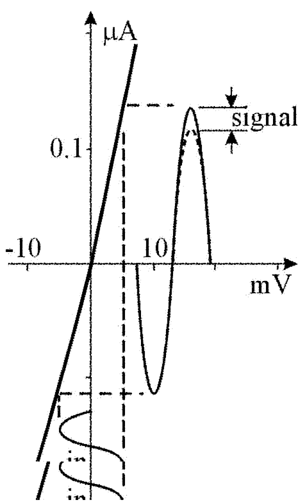

Figure 22: Germanium Diode Operation.

The graph scale selected is one useful for both germanium and Schottky diodes; on this scale the germanium curve has a relatively steep slope. (Scale is everything when comparing how these detectors function.) The RF signal voltage swing of almost $\pm$5 mV is shown as a sine wave about the lower vertical axis. The dashed lines project this signal up to intersect the I-V curve of the detector. Projection of this intersection to the right shows that this signal voltage produces an input current just over $\pm$ .1 mA representing a peak applied input power of about .005 mW (5 nW).

Relatively little of the forward & reverse current is converted to net 'DC' by this detector because it is conducting almost the same in both directions. To see this, we copy the lower negative half-cycle of the current waveform and invert it inside the positive half-cycle (shown as a dotted curve in the figure). It illustrates how much of the charge placed on C_b in the positive half-cycle is removed during the negative half-cycle. Only a small difference (net forward current of 0.021 uA, labeled "Signal") is left over to accumulate on C_b as 'DC' for the phones, but probably not enough to hear.

Next we apply this same signal power to a higher resistance detector, (a Schottky with R_X of 650KΩ is illustrated; like six Agilent 5082-2835 in parallel). We can see how it produces more net signal output. If we change nothing but the detector, the higher resistance detector will not conduct enough current to accept all the power. This can be verified by substituting a high resistance Schottky diode for a 1N34a in a radio that works well for the latter. The 1N34a will be more sensitive than the Schottky in that case because the Schottky will conduct almost nothing. To make it work we must change the transformation ratio of the tuner to provide the same power at a higher RF voltage and lower current compared to the tuner for the germanium example. (Remember that power is voltage multiplied by current.)

Viewed on the same scale, the slope of the I-V curve of the higher resistance Schottky detector is less steep than the germanium detector of Figure 23. A numerical example was graphed to ensure equal power input. Here almost a $\pm$ 20 mV RF signal applied across the diode producing a peak signal current of only about $\pm$ 0.03 mA (actually +.05, -.02) is still the same input RF peak power: .005 microwatts (5 nW).

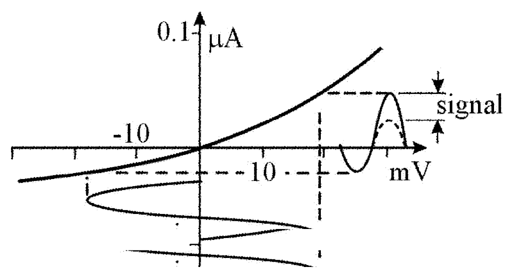

Figure 23. Schottky Diode Operation.

For the Schottky case the voltage is higher so the current (right side waveform) is much lower for the same power input. However, because of the wider voltage span across the Schottky I-V graph, the higher input voltage pushes farther up into forward conduction and farther back into reverse cutoff. This produces a greater *relative* difference between forward and reverse current, evident in comparing the dashed to solid curves in Figures 22 and 23. Although the total Schottky current is much smaller, the greater deviation can still produce about the same *net difference* between forward and reverse currents, 0.024 mA (labeled "Signal") as the germanium case. The effect of this net difference is RF current (charges) that ends up on C_b as net 'DC.'

So drawing much less current from the tuner, the higher resistance detector can still produce about the same net 'DC' current to charge C_b while doing so at a much higher voltage. Since power is the product of current and voltage, the higher resistance detector produces much more audio power when its source and load resistances are right, more likely resulting in a faintly audible signal.

Conclusions

Sensitivity and selectivity of crystal radios can be dramatically improved by escalating detector (and radio) impedances. High impedance detectors can operate more efficiently to improve sensitivity. They can produce audible signals without loading the tuner so much. This unloading

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of the tuner makes it tune sharper improving selectivity.

The higher the detector resistance, the higher the detection voltage, and that raises detection efficiency. For weak signals, detection efficiency for most radios is tiny fractions of a percent. In theory, we could approach 100%, and reap extensive sensitivity and selectivity benefits if we can continue to escalate the radio voltages (and consequently its impedances.) Very high resistance detectors are available like the Agilent 5082-2810 having Rx = 10 Megohms. However I have never seen an efficient audio transformer for several megohms impedance. In practice, insulation resistance and dielectric losses of the rest of the radio begin to overtake the gains at a tenth of this impedance level. As the radio impedance levels escalate, losses that are coupled in capacitively seem to become the main culprit. My strategy has centered on shielding schemes. At the time of this writing, I have been unable to make a radio benefit from impedance levels approaching a megohm. Hopefully, as we learn more about operating at escalated impedances, we can continue to tame the most inefficient part of the radio, the detector.

The Double "D" Radio or…
"Diode Dave does it, again!"

The "Peebles Choice"
by: Mike Peebles

Hi guys! The three-tuber/hybrid set is still in the R & D stages. Plan to have it up and running soon, and hope to get it in next time. I have it working, and it's just a matter of little adjustments…looks like it's going to be a real performer.

Sometimes we run into members that really impress us, thus we have Dan Petersen with us. This article is built and presented by Dave Schmarder. Dave resides at www.schmarder.com/radios and he builds some very impressive projects. Dan and I have both become acquainted with Dave, and we're impressed with his work, and let me tell you, a darn nice guy. Dave has a lot to offer in his web-site…his projects are outstanding and he has brought us a more versatile line of parts to aid in the construction of "state-of-the-art" crystal radios. Dave has a great sense of humor, very crafty, and he supplies us with Litz…He's in! Hah, no kidding, a real asset to the Xtal Set Society's community, and we heartily welcome him! I am proud to help him publish this real neat project and I hope you all enjoy it.

Introduction:

Hello, fellow readers, some of you may know me from my web site www.schmarder.com/radios. I have spent the last two years building crystal radios as a hobby and showing

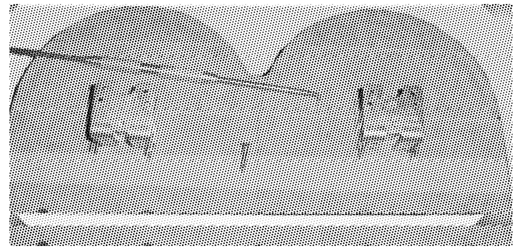

Photo:1 Laying out back of front panel

them off, on-line. This has provided me with a lot of fun. On my web site I only show the finished set, and some building procedures. I will attempt to correct this here, in my first article in the XSS newsletter. I want to thank Mike Peebles and Dan Peterson for their encouragement and suggestions for publishing here.

Procedures, Front Panel:

See Photo #1, 2 & 3: Cut a piece of 1/8 inch thick Garolite to 12 x 6 inches. Cover front of Garolite with masking tape. Mark a line 3/8 inches from the bottom. Mark for center and 2.5 inch increments for the 5 wood screws.

Measure 3 inches down from the top and 3 inches from each side with a line. The intersection of these lines will be the center holes for the capacitors and the compass point for the decorative curves. After drawing the circles, measure down 2 inches from the top center. This is called the capacitor's cleavage.

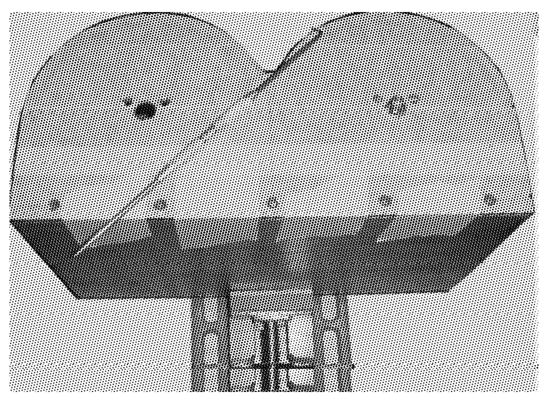

Photo:2: :Laying out front panel

Cut the rounded parts with a scroll saw, then use a small 1-inch belt sander and smooth the rounded edges. The cleavage area may be rounded and smoothed with a Roto-bit in a drill press. Carefully grind the edge, in the center until it looks even and pleasing.

Drill 1/16-inch pilot holes where the capacitors will be mounted plus, 5 along the bottom for the wood screws to

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fasten to the bottom board. Use a 9/64 drill for the 5 holes with a countersink if you will be using #6 flat head wood screws.

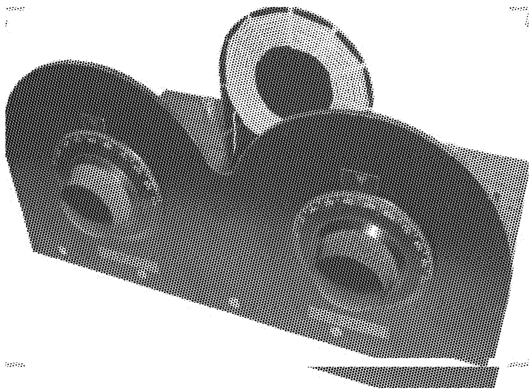

Photo:3: Finished unit, front view.

Using a ½ inch Forstner bit, drill the two holes for the capacitor shafts. Use a pocketknife, or other tool to bevel the edge of the ½ inch hole on the backside of the panel. This will insure that the capacitor will lie flat against the panel. Using the scribe, mark the position for the four-capacitor mounting holes. Drill and countersink the holes. Again, I like to drill a pilot hole using a 1/16 inch bit, it takes longer but the results are worth it.

Baseboard
:

See Photos #4, 7 & 8: The baseboard I used, is red oak, and is 12" x 7-1/4" x 3/4". There are 5 holes in the front edge that match with the front panel. I drilled 4 holes for the rubber feet. Four holes will be needed, two for the detector holder and two for the coil support bracket.

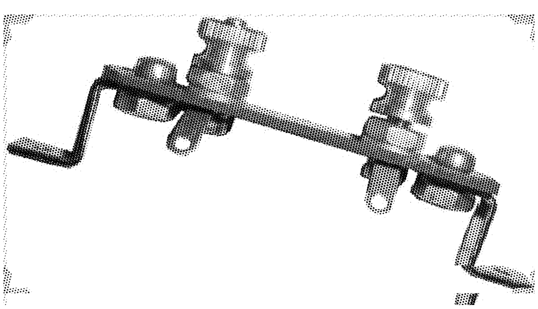

Photo:4: Detector holder

To make the terminals fit the baseboard, first drill four 1/16" pilot holes. The holes should be about 1 inch from each other. I drilled mine in pairs. On the underside, drill a half-inch hole, about a quarter inch deep using a Forstner bit. A drill press with a depth gauge helps. Use an 11/64" drill, to drill the four holes the rest of the way through. Put one of the 8-32 x 1" screws through the hole and see how it looks. If you need more depth, put the Forstner bit back in the drill press, and reset the depth gauge and have another run. Three additional 1/8" holes can be drilled through the baseboard just behind the capacitors to run the wires through. Having the wires run underneath makes a very nice top-side appearance.

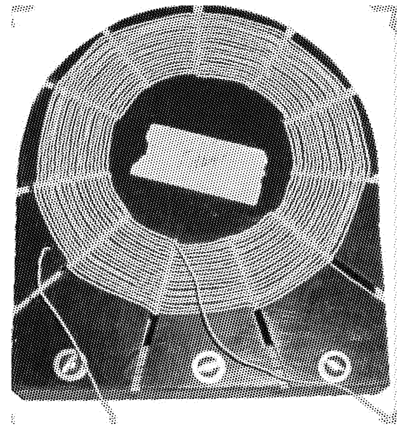

Photo:5: Coil detail, front.

Detector holder:

See Photos #4 & 7: The detector holder is made with a 2-1/2" x ¾" x 1/16" Styrene piece. There are four 11/16" holes drilled for two "Z" brackets and 2-screw/thumb-nut, diode connections. Three #8 solder lugs are used for the connections. One solder lug is connected to the "Z" bracket as a ground connection for the choke, and fixed capacitor. Styrene is very soft and melts easily, so solder the wires to the lugs before attaching them to the Styrene. I used the Styrene piece, due to low RF losses, and was afraid that if I mounted the diode connection in the wood, the moisture would reduce the tank's efficiency.

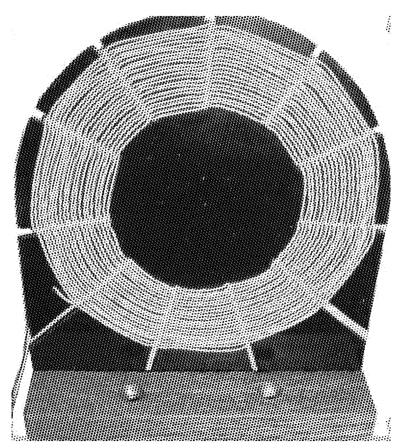

Photo 6: Coil detail, rear.

Coil Construction:

See Photos #5, 6 & 8: The coil is made with 165/46 litz wire wound on a 4-1/4" x 5" x 1/16" Styrene form, cut with 11 slots, and a 2" center hub. With 41 turns, of wire on the coil,

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you will have approximately 170 uh. Also, drill three 9/64” holes for the three #6 wood screws that will hold the coil to the wooden support block. The top edge is rounded so as to fit with the rest of the rounded edges for that appealing look.

The Double “D” Radio…or…”Diode Dave does it, again!”

Materials List:

Qty.	***Description***	***Use***	***Source***
1	Garolite, 6” x 12” x 1/8”	Front Panel	DS
1	Red Oak, 7-1/4” x 12” x 3/4”	Base Board	LH
1	Styrene, 4-1/4” x 5” x 1/16”	Coil Form	DS
1	Styrene, 3/4” x 2-1/2” x 1/16”	Detector Base	DS
1	Red Oak, 3/4” x 4-1/4” x 1/2”	Coil Support	LH
2	Large Knobs	Tuning	ANY
4	Rubber Feet	Bottom	ANY
2	Capacitor, Variable, “365”	Tuning	XSS
1	Germanium/Schottky Diode	Detector	XSS/PO
34’	Litz Wire, 154/46, 24ga Equiv.	Coil	DS
3’	Hook-up Wire	Circuit	ANY
1	RF Choke, 27mHy	Detector	DS
1	Trimmer Capacitor, 4 - 30pf	Detector	PO
1	Capacitor, Ceramic Disk, 100pf	Detector	PO
1	Resistor, 47K, 1/4 or 1/2W, Optional	Detector	ANY
2	Solder Lugs, #6	Var Caps	DS
7	Solder Lugs, #8	Terminals	DS
4	Screw, 6-32 x 1/4” - Flat-Head	Var Caps	DS
2	Screw, 6-32 x 1/8” - Binder-Head	Var Caps/Term’s	DS
4	Screw, 8-32 x 1” - Fillister-Head	Terminals	DS
2	Screw, 8-32 x 1/4” - Fillister-Head/Brass	Detector	DS
2	Screw, 8-32 x 5/8” - Fillister-Head/Brass	Detector	DS
7	Screw, #6 x 3/4” - FH Wood/Brass FR	Panel/Coil	DS
3	Screw, #6 x 1/2” - RH Wood/Brass	Coil	DS
2	Screw, #4 x 1/2” - RH Wood/Brass	“Z” Brackets	DS
6	Washer, #8 - Brass	Terminals	DS
3	Washer, #6 - Brass	Coil	DS
8	Hex-Nuts, 8-32 - Brass	Term’s, Det	DS
6	Knurled-Nuts, 8-32 - Brass	Term’s, Det	DS
2	Brackets, “Z” - Type	Detector	DS

Vendors:

DS	Dave Schmarder	http://www.schmarder.com/radios/xss/
PO	Peebles Originals	http://www.peeblesoriginals.com mike@peeblesoriginals.com
XSS	Xtal Set Society	http://www.midnightsxience.com xtalset@midnightscience.com
MSR	Mouser Electronics	http://www.mouser.com
LH	Local hardware	

Winding the coil is pretty simple, make certain to keep the windings fairly tight while winding. When my coil was finished, I drilled a small hole to poke the end of the wire through, to keep the coil from unraveling. Next you want to make the spacing between the wires as even as possible. This can be done with a scribe (General Tool #80) gently

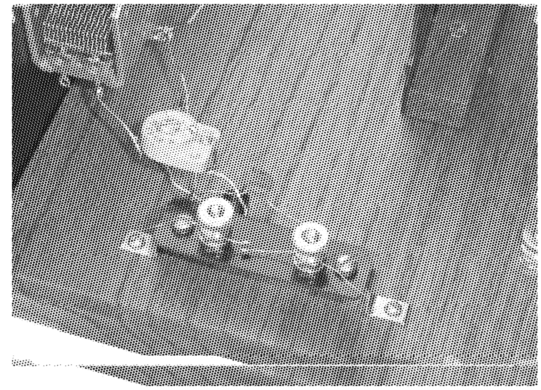

Photo:7: Wiring/Detector Detail.

pushing the wires towards the edge, the coil will then perform it’s best and will look great. Tin the ends of the wire with a hot soldering iron, it takes a little while to heat the wire and have the solder flowing on the strands. It is important to have the insulation melted on each strand.

Wiring the Set:

See Schematic #1 and Photos #7 & 8: I like to use tinned copper wire when I build my sets, it looks nice and is easy to use. Your set can be wired with what you have on hand. Use the circuit diagram for reference. The frame of the antenna capacitor should be connected to the antenna, minimizing hand-capacitance effects. This model, is intended to be used with an audio-matching transformer for “Sound-Powerd” phones, or other “dynamic-type”. If you wish to use a crystal earphone, or an external amplifier, connect a 47K resistor across the output terminals to provide the DC resistance path, that is required for the detector’s output load.

Operating the Set:

This radio requires an antenna and ground, but all of you know this. I like to tune the radio from the top of the band to the bottom. Start with the variable capacitors set to minimum value. Then start increasing the capacitance on each capacitor a little at a time, one at a time. I generally increase the detector capacitance a little faster than the antenna capacitance. This keeps the antenna from loading the tank circuit. Once I hear a station, I rock both capacitors back and forth a little until the best reception is obtained. It is recommended that you use large knobs if possible as you can get a vernier effect due to the larger diameter.

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Set's Performance:

I have been using this circuit in my radios for a while now and the performance is quite good. The large Litz/spider coil is where most of the performance resides. The spider coil is an improvement over a close wound cylindrical coil. The lower distributed capacitance gives a better tuning range and lower coil losses. The detector circuit provides a light load on the tank circuit, thus not damaging the "Q" of the circuit a great deal. By using a spider form, and an untapped coil, I found the short wave ghosting to be at a minimum. A double tuned set is more selective, but this radio is easier to tune. This radio will tune most of the band, depending on the exact coil inductance and your antenna system. If the bottom tunes well but the top doesn't, try taking a turn off the coil. Before cutting the wire, just let the wire lay away from the coil and test the reception.

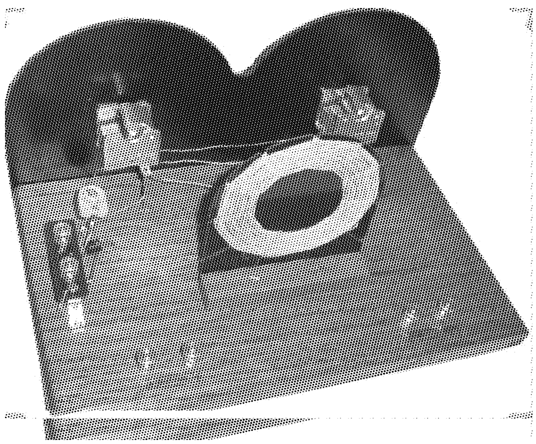

Photo:8: Finished unit, rear view.

If you use an audio matching transformer and sound powered headphones, your set's efficiency will improve. A Schottky diode will further improve the selectivity of the radio. I hope you enjoy building this set or one like it. Don't be afraid to experiment and substitute parts if you have them. Thank you for your support. *I'll leave the light on for you.*

MEMBERSHIP CORRESPONDENCE

Kevin Busse, Prior Lake, MN N0ZBO. "Living within eyesight of a radio station's massive antenna famr, and only being able to pick up that one station on every single crystal set I've built over the past 2-years, I've often wondered how others can make the claim, "I live right next to a radio staion, and I can still get 'X-number' additional stations on my receiver." I've tried building traps, and all they do is drop the volume of the powerhouse broadcaster, but still no other stations come through."

"After reading a few reviews and comments on the Internet, I came to the conclusion that the famous Heathkit CR-1 might be the solution to my single station problem. But do I spend the money (have you seen the prices a CR-1 goes for on E-bay? Yikes!), or try to tackle the construction on my own? Fran Golden has an exellent website on doing up your own CR-1 at http://ohmslaw.com that go me pointed in the right direction, including the plans and front panel label, downloadable as a .PDF file. I robbed the tuning capacitors, knobs and a diode from a couple of beginner Technokits that I stocked up on. The Technokits are similar to the old style Radio Shack crystal radio kits, and a mail-order company called All Electronics has them at a few bucks each. I bought several for the crystals and the simple transistor radio type tuners. A trip to Radio Shack netted the 6 x 3 x 2 project box and the binding posts for the phones, antenna and ground connections.'

"I built the CR-1 to Fran's specifications, but was disappointed in the extremely weak volume. It wasn't that I couldn't hear any other stations, but even the powerhouse broadcaster was at a whisper. After double and triple checking, the problem seemed to be the coil, so what could be done to improve it? Time to open the junk box... I had some extra 1 -inch diameter PVC pipe left over from a previous coil project, along with plenty of 30ga magnet wire. Time to tinker.'

"The solution I came up with is very similar to the original Heathkit CR-1 plans, and Fran Golden's adaption. The change I made is with the coil. The coils are wound on 1" outside diameter PVC pipe, 4 3/4" long. Spacing between coils is 1/8" using 30ga wire. The first coil is 150 turns, and the second is 75 turns, with a tap at 75 turns. Using the new coil, the receiver came to life. Of course the powerhouse was still blasting into the earphones, but for the first time I'm getting not one, not two, but three additional stations! All clear, interference free, and at great volume. Finally I have some "variety" in my listening! Wind the coil as you would any ordinary coil, don't worry about Fran's overlapping windings or ferrite cores, they're not needed with this coil arrangement. You're making a whole new coil to use with this set, just don't forget the 1/8" spacing between the two coils, and the tap after the first 75 windings for the diode.'

"The one thing currently missing with my version of the CR-1 is the two 350pf capacitors shown in the drawing. As Radio Shack continues to move away from stocking parts for the homebrewers and kit builders, various capacitors, resistors, and even suitable detector diodes are impossible to get through them. When I can get my hands on the 350pf caps, I will add them to the CR-1, which I know will improve reception even better.'

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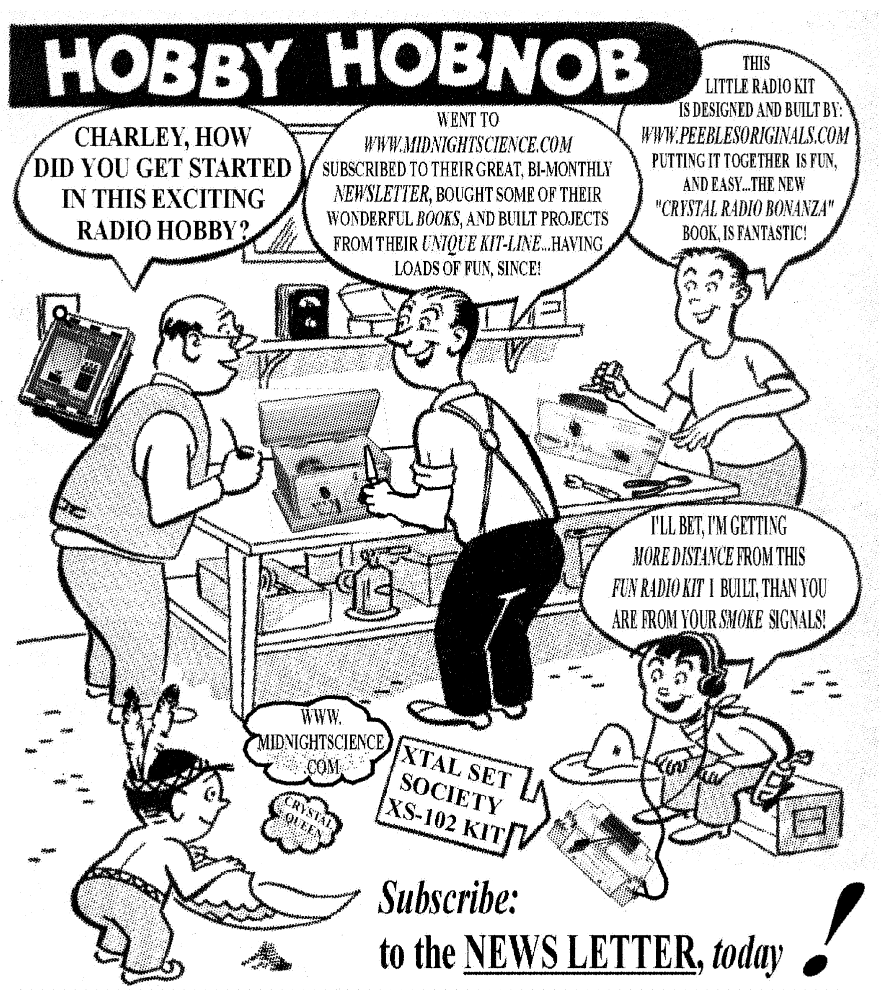
"So if your experience with trying to receive more than one station on a crystal set has been like mine, I recommend building this version of the Healthkit CR-1. I'm delighted in the performance of this set, as I'm sure the original kit-builders were when they put together their original Healthkit CR-1's all those years ago.'

Rob Noury, Jamestown, NC. "On your last Jan. 04 newsletter about coil forms. yes the toilet tissue tube is too flexible but I still find it's the best for coil efficiency, or at least close to it. When I use the toilet tissue. Roll I cut a piece of construction paper to coil form size, and with ordinary glue stick coat the construction paper on one side with glue then wrap a round tube good and firm and give it a good clear coat and it will dry good and firm. Just ordinary family dollar construction paper 2 big packs for a dollar. Family dollar $2.00 a can clear coat will do. You don't even have to wait for the glue to dry to clear coat. The color variety of the construction paper may add interest also. I hope this will be helpful info. Good Dx-ing!"



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