Construction of Coplanar Search Coils

by Dave Emery

I have been surprised to read many articles and forum posts which claim that coplanar coils are very difficult to make. Quite to the contrary, the coplanar is, without any doubt, the easiest coil for the amateur to produce aside from a mono coil.

A coplanar search coil consists of a Transmit or “TX coil”, a smaller Receive or “RX” coil and a feedback coil which is known as a “Bucking coil”.

The bucking coil is wired in series with the transmit coil but with its phase reversed. For a VLF detector a tuning capacitor connects across both the TX and the bucking coil. With a PI detector, a damping resistor connects across these two coils.

A null is achieved when the fields from both the transmit coil and the bucking coil provide a signal of equal amplitude and opposite phase to the receive coil.

The bucking coil is wound without any spacing around the RX coil. The bucking coil therefore uses the RX coil as its former.

Coil Winding and Number of Turns

The number of turns for each coil depends firstly on whether the coil is for use in a VLF or a PI detector. For a VLF the number of turns of wire and the wire diameter used to wind the TX coil will be dependent on the resonant frequency of the coil and the value of the tuning capacitor required to achieve resonance.

For a PI detector, one needs to design to a specific inductance value. For most non critical PI's with a search head between 7 and 10 inches in diameter, a good starting point is 25 turns of #31 wire wrap wire for the transmit coil. The receive coil will be half the diameter of the transmit coil. I use twice the number of turns on the receive coil on either a VLF or a PI to provide a step up transformer action.

Note: For a PI, a small current limiting resistor, typically about 22 Ohms will be required to be placed in series with the transmit coil.

The bucking or feedback coil is where most people get lost when trying to make a coplanar coil. In reality, the bucking coil is very simple to calculate. The turns ratio between the TX coil and the Bucking coil is simply the ratio between the area enclosed by the transmit coil and the area enclosed by the receive coil.

OK, so for a transmit coil which is twice the diameter of the receive coil, the turns ratio is simply 4:1. This of course is due to the fact that doubling the size of a circle gives you four times the area. So for a 25 turn transmit coil the bucking coil is 6 ¼ turns.

Now, it's fair to ask the question “How do I wind to ¼ turn”. SIMPLE!!! Wind six turns of wire right on top of the receiver coil and leave a movable loop made of about a half turn of wire. Move the loop around to get a good null, and then glue it down.

Fig 1: Plywood base with L-hooks screwed in

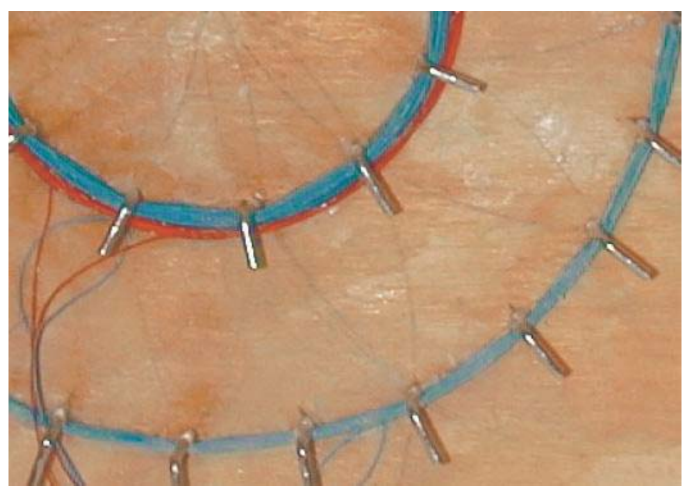

Fig 2: Close-up of windings

Construction Method

A plywood base has the TX and RX coils marked out in pencil. It is then drilled and 90 degree bend hooks are screwed in to provide the formers for the coils. See Fig. 1.

After liquid soap is applied to the plywood base and the hooks, the coils are now wound around the formers. The soap insures the release of the coils after they are glued.

Fig. 2 is a close up of the coils at this stage of the search coil

Fig 3: Hooks

manufacture. Fig. 3 shows the 90 degree bend hooks which I used. The hooks are available from most good hardware stores. The hooks are much easier to use than simple nails. Nails tend to trap the coils and make them difficult to remove.

After the coils are wound, cyano acrylate glue (crazy glue) is used to hold the windings together. The hooks are now rotated to allow the removal of the coils. Note the change in direction of the hooks in Fig. 4.

Install a small strip of copper tape with a piece of buss wire soldered to it onto the top search coil shell. This is to become the grounding for the sprayed on nickel which is used as a Faraday shield. Install small strips of copper tape over the top of the walls of the coil to allow an electrical connection to the bottom shell, see Fig. 5. Fig. 6is another view of the search coil shell at this point.

Tape the coil shells with paper tape to shield them from where the nickel spray is not supposed to be applied. See Figs. 7 & 8.

Fig 6: Copper strips from the side

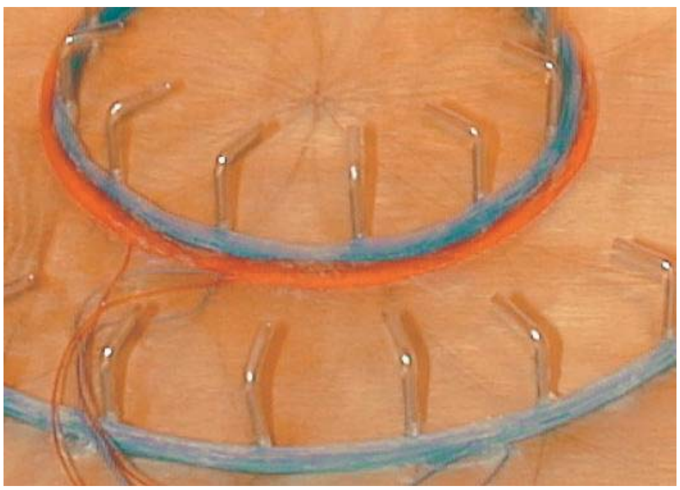

Fig 4: Hooks reversed for removal

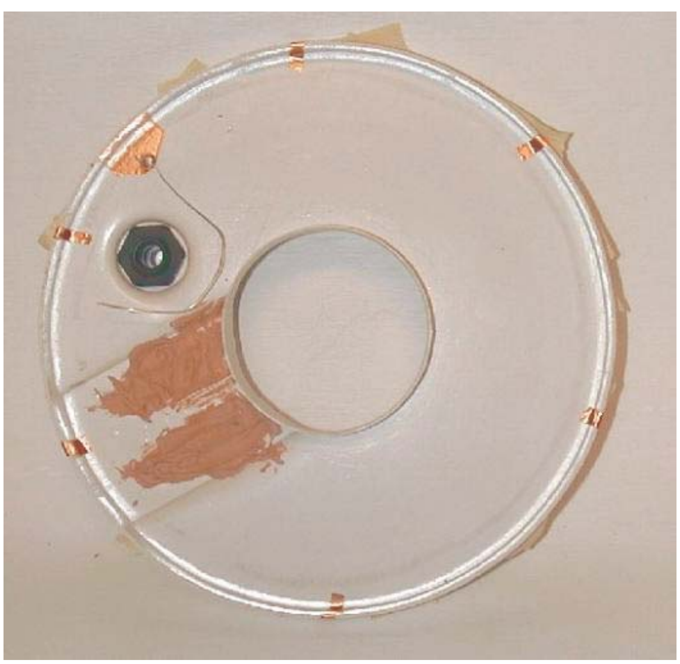

Fig 5: Copper strips for shielding

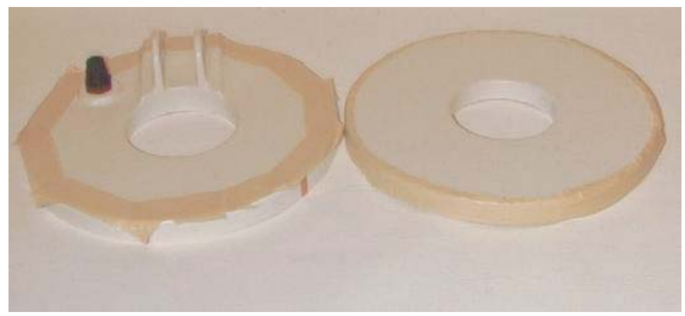

Fig 7: Shells masked for nickel spray

Fig 8: Super Shield nickel spray

Spray the insides of both coil shells with the nickel spray (Fig. 9). Do this outdoors. Be careful not to breathe any fumes. Do not smoke!!!! Do not spray near your car!!!

It was found later that a break in the Faraday shield was required to stop the sprayed bottom cover from upsetting the coil assembly's null balance. Note the break in the nickel coating. This break can be more easily made by adding some thin

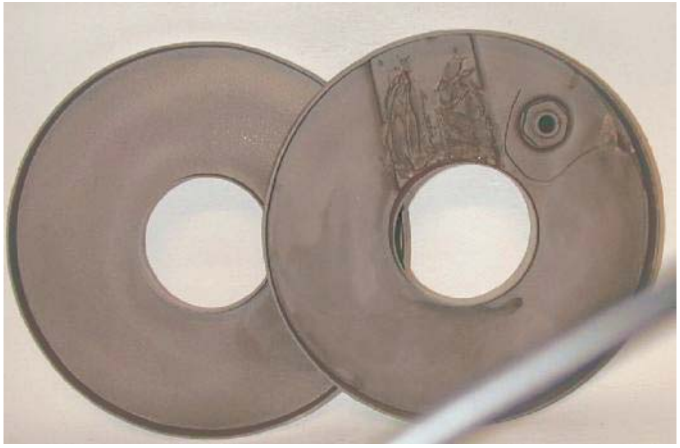

Fig 9: Nickel spray applied

tape prior to spraying and then removing the tape. The break shown in Fig. 10 was cut with a knife.

Glue the coils inside the top coil shell (Fig. 11). Bring the dual signal cable into the top search coil shell and connect the RX coil and the ground wire to the RX coax. Connect the TX and the bucking coil to the TX coax.

The coil cable is made with two parallel lengths of RG174U (miniature coax) inside a high flexibility heat shrink tubing (3M). Take care shrinking the tubing as the insulation of RG174U has a low melting point. Connect as above.

Fill the top coil shell with sand and cover with epoxy. The sand provides negative buoyancy for water hunting and makes the coil VERY strong. For land only hunting the sand can be omitted to conserve weight. Be sure however to make the coils rigid to each other as ANY movement between the windings will cause a false signal.

To close the two halves of the coil shell cut some spare plastic (provided with shells from Hays Electronics http://www.hayselectronics.com/parts.htm) into small pieces and place them inside a polythene squirter bottle. Add enough MEK (Methyl Ethyl Ketone) to cover the plastic pieces. Cover the top of the squirter bottle and leave overnight.

The liquid contents of the bottle now act like glue when applied between the two halves of the shell. AGAIN, BEWARE OF THE FUMES FROM MEK. **WORK OUTSIDE.**

You now have a very fine search coil. The depth capability is more than a Dual D but the search pattern below the coil is somewhat cone shaped. The lack of sensitivity at the sides of the coplanar coil however is not nearly as severe as one Australian manufacturer would have you believe. Don't take my word for this, try it yourself.

I would love to hear from all and any experimenters as to their results. Let us all share what we learn and discover so we can all benefit from each others knowledge. I must say now that I am not the inventor of anything here. I have only figured out what others have already done and made it as simple as I could for everyone to understand.

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Thanks to Mr. Bill Hays of Hays Electronics:
http://www.hayselectronics.com/index.htm

The coil I used is the I:7" Open coil housing, with liquid tight pigtail. Color White.

Fig 10: Small gap in the shield

Fig 11: Coils glued in