2200m Transmit Antenna at N6LF

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For the past several years I've used the 630m transmit antenna described in earlier reports. All was well until the end of February 2019 when mother nature decided to remind me of the vulnerability of wire antennas. My antenna had about 2800' of wire with spans varying from 120 ' to 170'. An ice storm followed immediately by a 2'+ of very wet snow completely knocked down the antenna providing the incentive to replace it. This time around I wanted to operate on both 630m and 2200m. I was anxious to get on 2200m where I have never operated so I built the 2200m tuner first. The tuner for 630m will be built later using the same feed and tuning scheme which has worked well.

Fortunately in the old antenna the wires broke before the support poles were damaged. That was an important lesson, when rebuilding the antenna I did not use stronger wire! The weakness in the wire saved the supports! Wire is easy to replace, supports are not! In fact I used weaker wire in latest incarnation. The original antenna used #14 aluminum electric fence wire which is lighter and stronger than the #14 copper wire used for the rebuilding. Electric fence wire is much less expensive than copper but, because it's made from a stronger, harder alloy than typical Al conductors, the resistance is significantly higher. At 630m, where the antenna was reasonably efficient this additional loss was not serious. However, at 137 kHz the radiation resistance (Rr) will be much smaller than the 475 kHz value and the loading inductor loss much higher. Even reducing the radiating power from 5W on 630 to 1W on 2200m the current in the antenna is higher making it much more difficult to get reasonable efficiency. At 2200m efficiency is a challenge even with an antenna as large as this one.

I set a efficiency goal of 1% so ≈100W from the transmitter would allow me to radiate the allowed maximum power.

Antenna description

There are five support poles arranged in a square with one pole in each corner and one in the center as shown in figure 1. The center pole is ≈93' and the perimeter poles 75-80'. The four corner supports lie on a 240' in diameter circle.

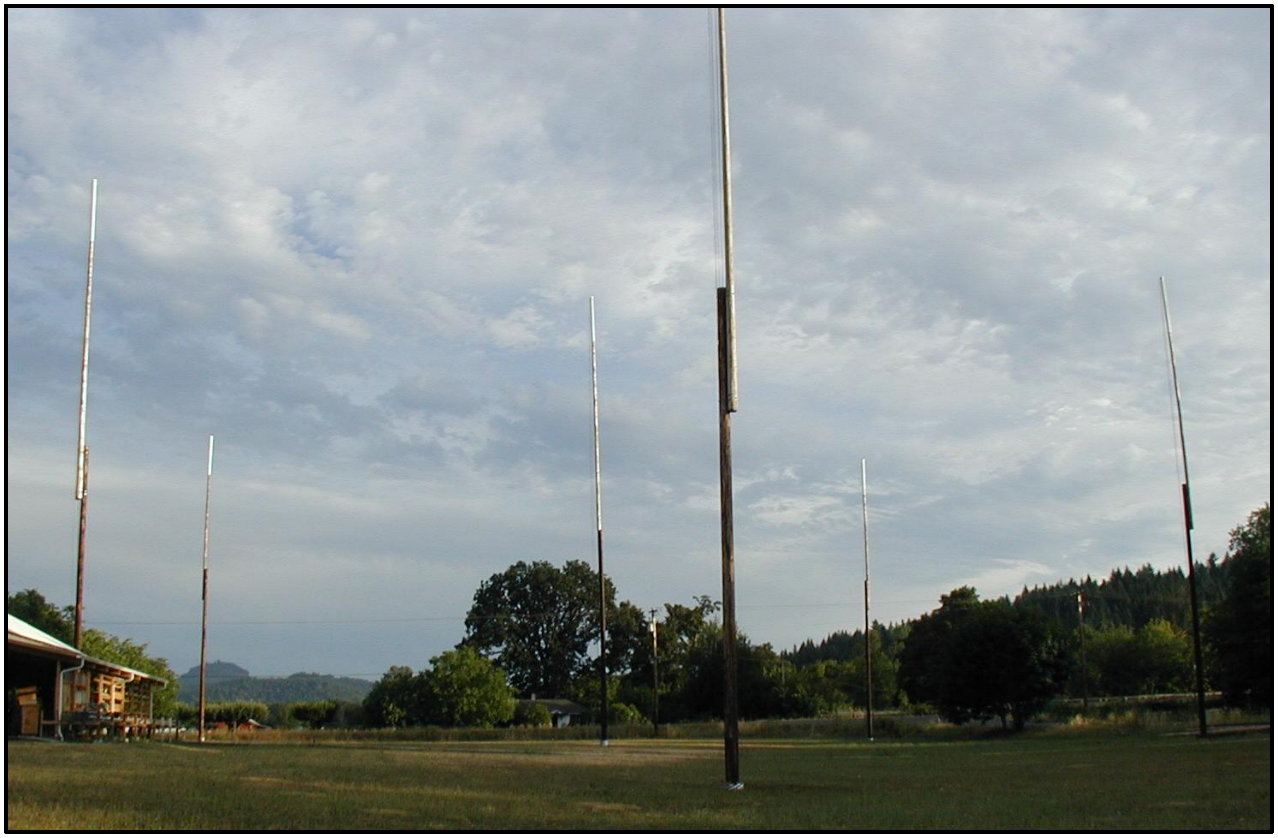

Figure 1 - Photograph of antenna support poles.

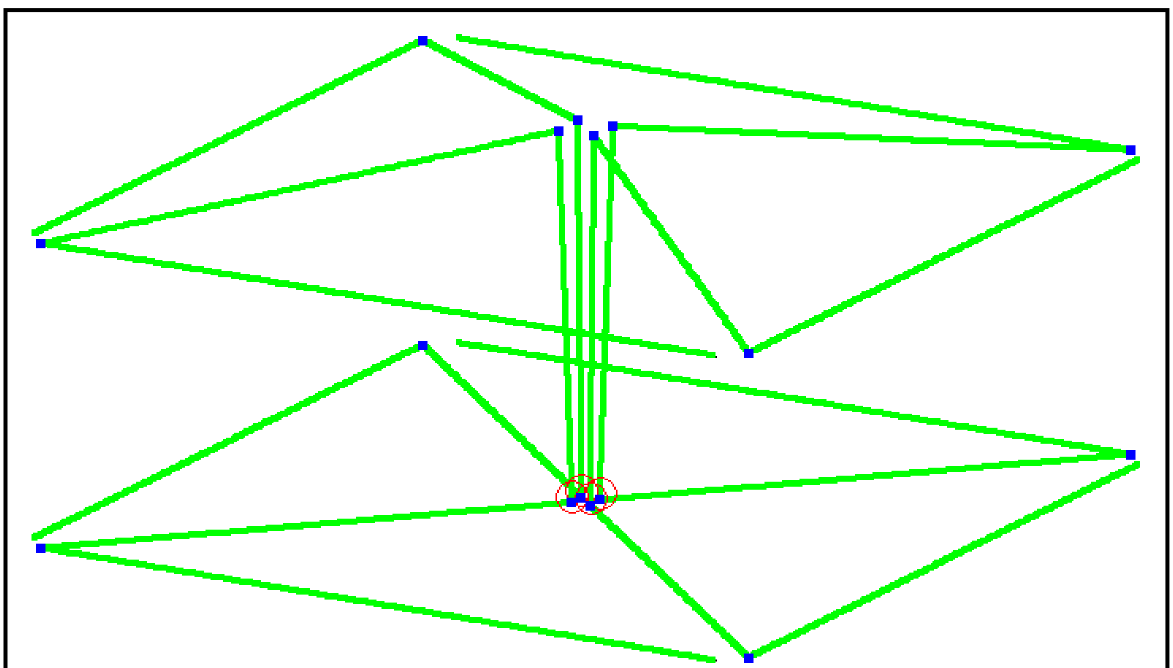

Figure 2 - EZNEC model for the antenna.

As shown in figure 2 the antenna has four identical wire antennas connected in parallel at the feedpoint, a vertical (≈83') with four top-loading wires and four counterpoise wires. The counterpoise and the bottom of the vertical are ≈8' above ground. Although the sketch shows four sources, in the actual antenna all of the vertical wires are connected together at the bottom and all of the CP wires are connected at the center to form the feedpoint. The loading inductor is placed in series with the counterpoise and the bottom of the vertical.

Tuning and feeding arrangements

Figure 3 is a simplified sketch of the tuning and feed arrangements.

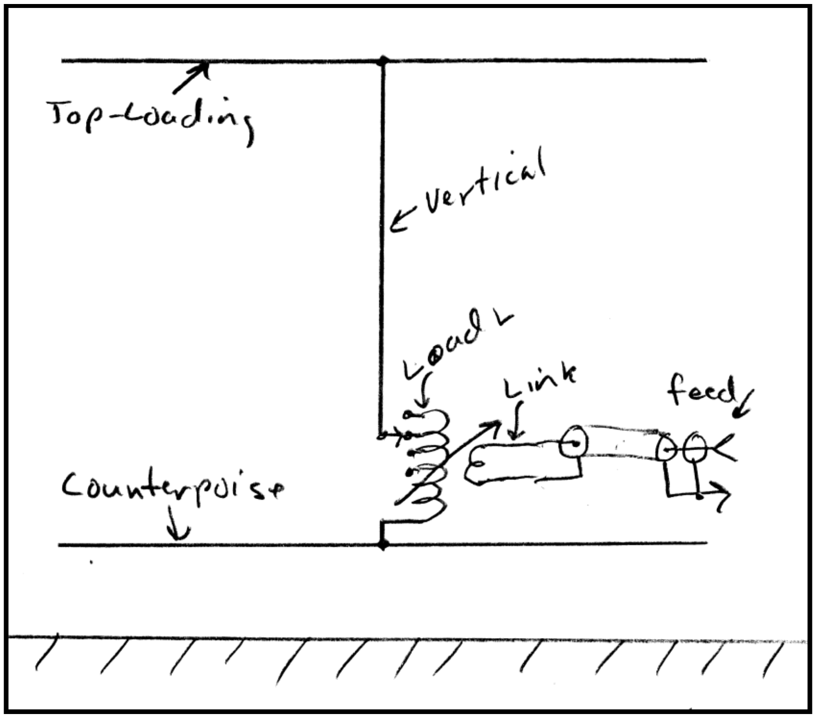

Figure 3 - Tuning and feeding arrangement.

From the earliest days of radio counterpoises have been recognized as efficient ground systems, especially at low frequencies where radial lengths of 0.1-0.4λ typical at BC and higher frequencies are not practical. However, counterpoises have a significant disadvantage: the feedpoint must be electrically isolated from ground and the potentials to ground are often very high, i.e. kV or even tens of kV. This is especially true when the antenna is electrically very small with high Q. Despite the large physical size, the new antenna is only ≈0.01λ at 137 kHz, very small electrically.

Besides isolation, it is necessary to have two variables, one to resonate and one for matching. For this antenna I chose to use taps on the loading inductor to adjust for resonance. For isolation and matching I chose inductive or "link" coupling to the feedline. Figure 4 is a very old but typical example.

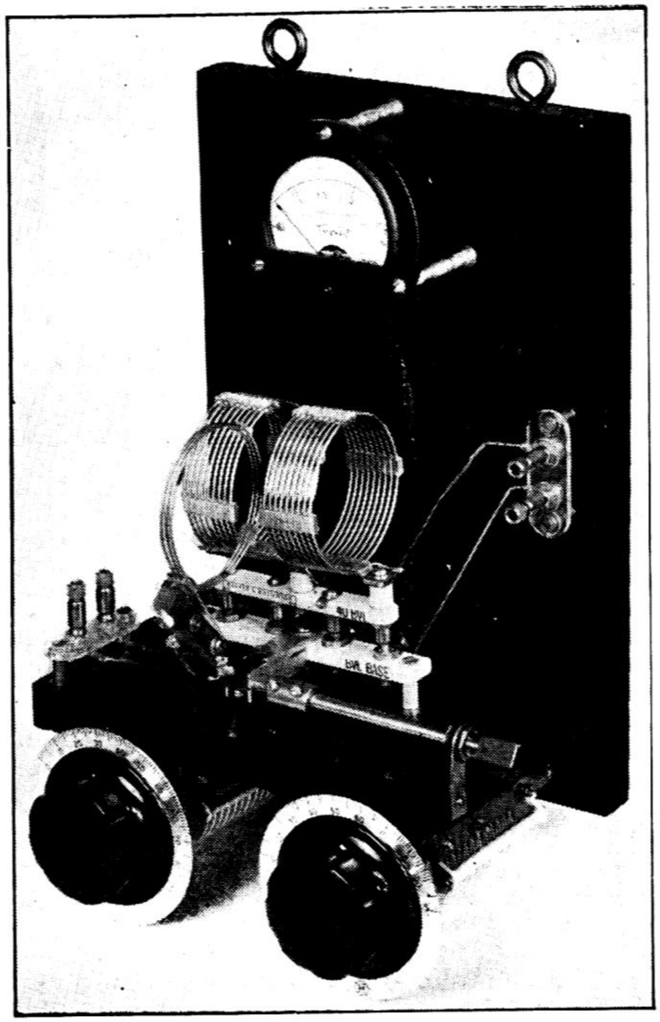

Figure 4 - Swinging link coupling example.

The last time I used link coupling was nearly 65 years ago as a young ham. The arrangement shown in figure 4 was state of the art then. The impedance seen on the link side of the circuit will depend on the turns ratio between the primary and secondary windings but also on the inductive coupling between the two coils. With the link you get isolation and, by varying the coupling, you can control matching. There is some interaction with the tuning but usually things converge quickly with a little fiddling.

One refinement which was also quite common was the use of a shielded loop like that shown in figure 5. The link is wound with coax. At the far end of the winding the braid is left O/C and the center conductor connected to the braid. This was done to reduce conduction of harmonics via the link-to-coil capacitance which is still a good idea.

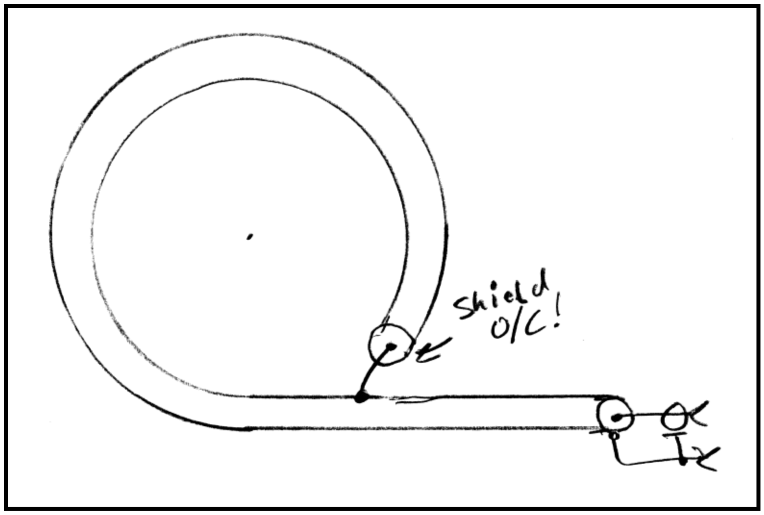

Figure 5 - Shielded link example.

Tuning inductor details

Figure 6 shows the "link". In my case there are four turns of RG8X wound on a plastic dog food bowl.

Figure 6 - Link assembly.

A large plastic box was used for the enclosure with the link attached to one end as shown in figures 7 and 8.

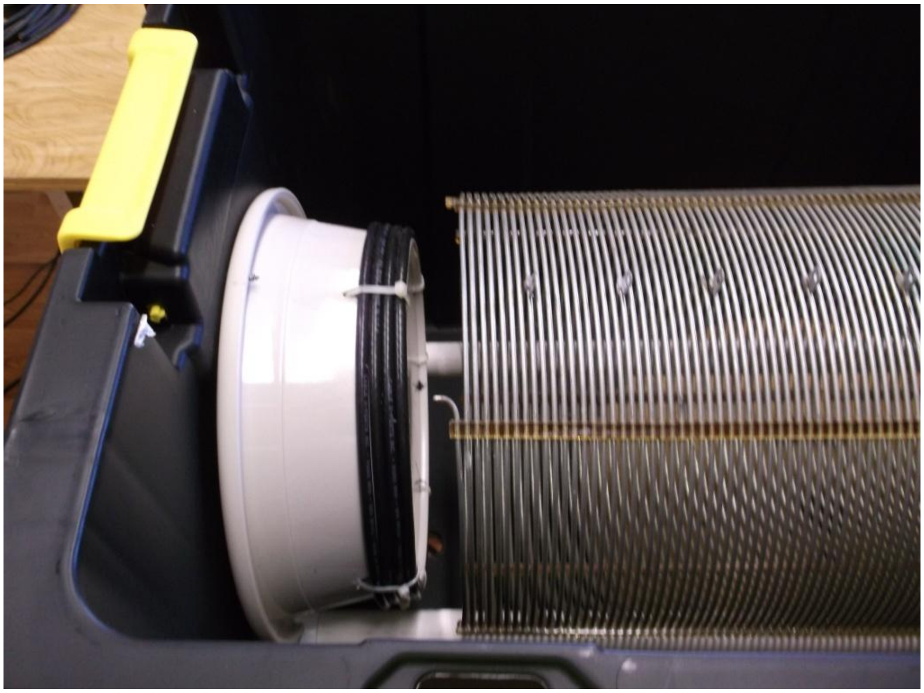

Figure 7 - Loose coupling example.

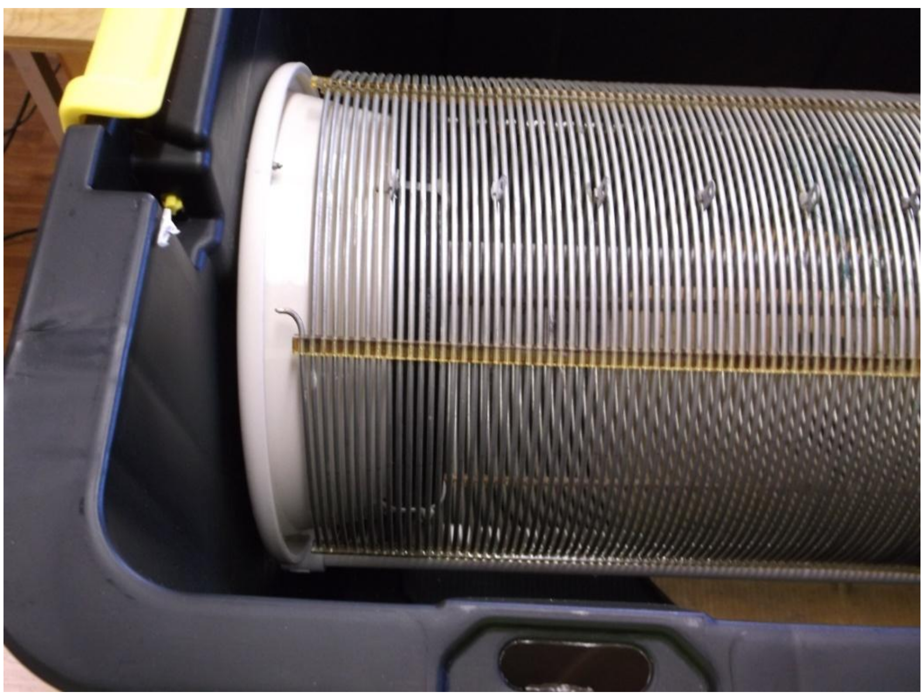

Figure 8 - Tight coupling example.

The usual practice was to physically fix the coil and move the link to vary coupling. However, I did just the opposite. The link is firmly attached to enclosure wall and the coil is moved. If you look closely at figure 7 you can see there are two parallel PVC pipes attached to opposite ends of the box. The coil is placed between these rails which act as a cradle. To adjust coupling the coil is simply slid coil left or right as needed. In figure 7 the coil has be moved to the right providing loose coupling. In figure 8 the coil has been placed all the way to the left for tight coupling. As shown in figure 9, the antenna is resonated using the taps at the near end of the coil. The match is done by varying the separation between the coil and link at the far end of the coil.

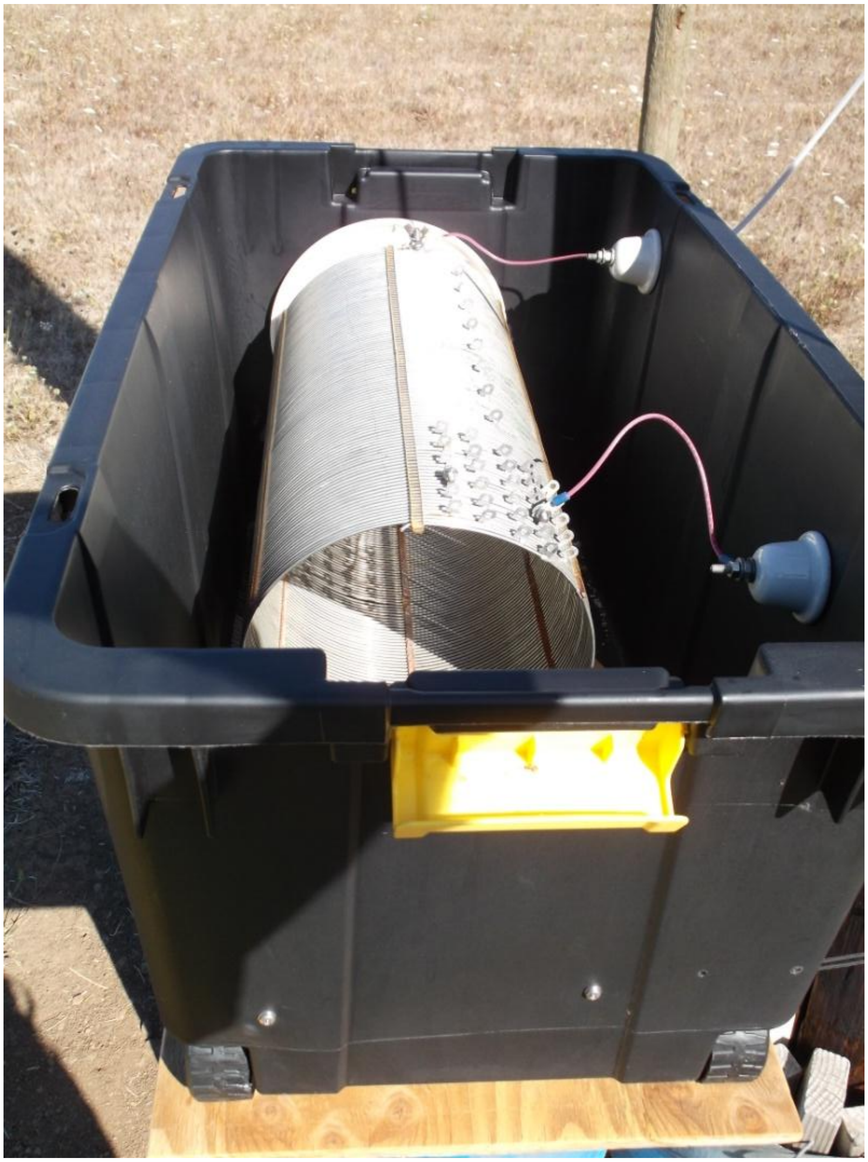

Figure 9- Assembled 2200m tuner.

The completed tuner with the enclosure covered was mounted on a PVC pipe cradle at the base of the antenna as shown in figure 10.

Figure 10 - 2200m tuner installed.

Note on antenna wire

This antenna needed almost 2800' of copper wire. Given the present cost of copper wire it was a significant expense. Shopping around I found, for a given wire size, the least expensive wire was insulated THHN house wire. Modeling of wire loss showed that #14 would be just fine. After shopping at Home Depot, Lowes, etc, the least expensive wire turned out to be 2 wire #14 with a #14 ground wire. A 1000' roll cost $156. A 1000' roll of this wire yielded 3000' of single strand solid #14. However, there is a downside to this wire, you have to strip the insulation from the 1000' and separate the three strands. That can be a real chore so I worked out a scheme to reduce the labor.

As shown in figure 11, I drilled a hole in a wood block just large enough that I could jam a box cutter knife into it. I then mounted the wire reel on an axel behind the blade as shown in figure 12. I then pulled the wire off the reel across the knife peeling off the insulation as shown in figure 13. This took some time to set up but greatly reduced the final labor.

Figure 11 - Installation of box cutter knife.

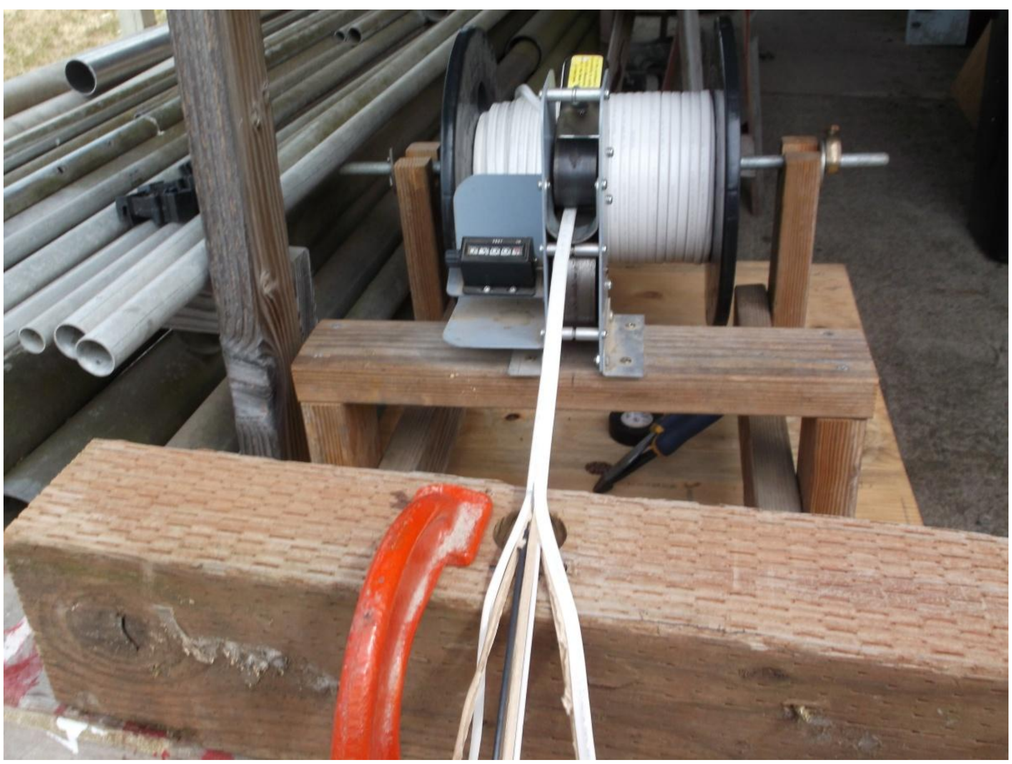

Figure 12 - Splitting the outside insulating cover.

Figure 13 -Stripped insulation.