Remotely tuned 1m Dia HF loop antenna for 7 to 29MHz

© Martin Ehrenfried - G8JNJ

The following is a description of a prototype loop antenna I've been constructing.

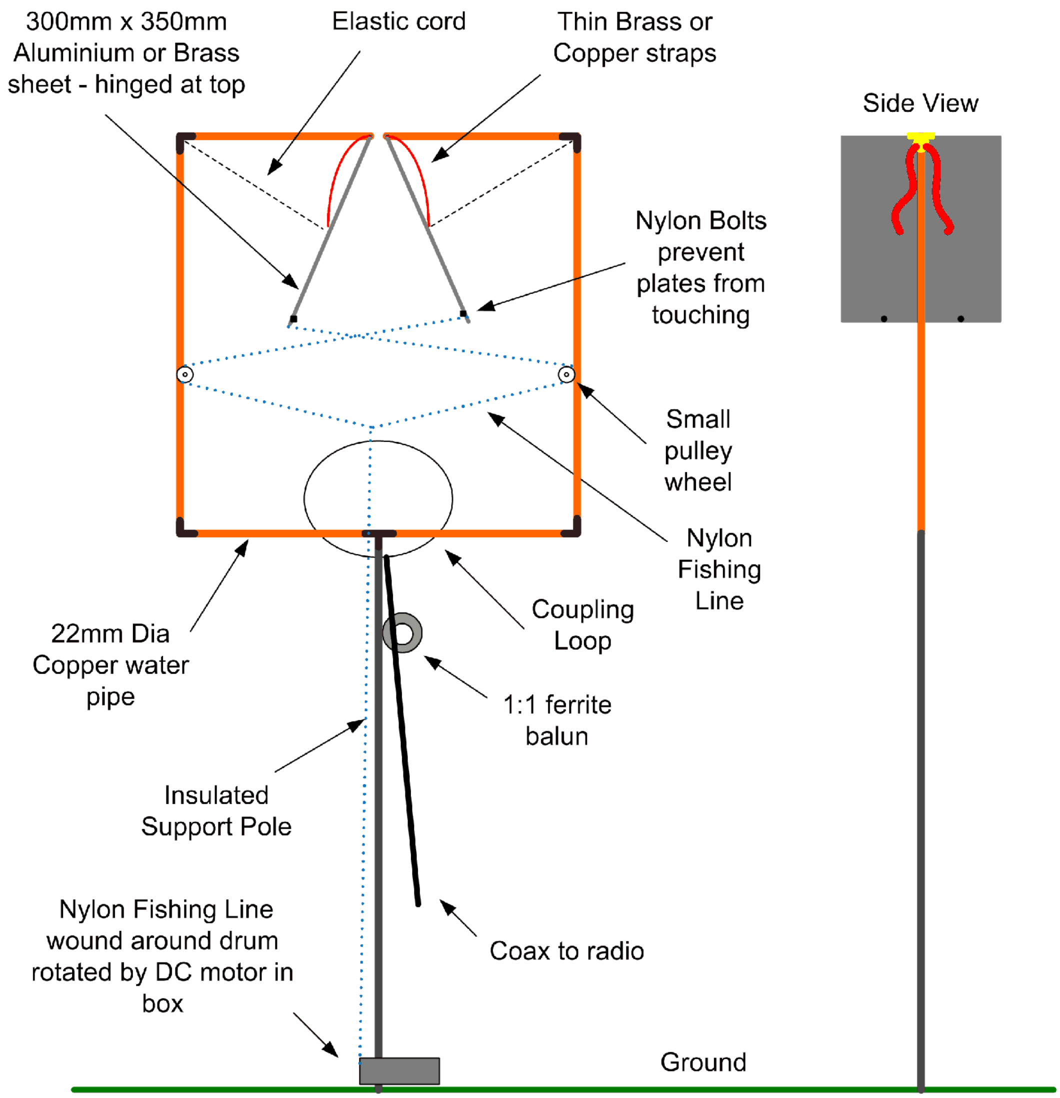
The big challenge with all small loop designs is to minimise resistive losses. Many loops are only operated at low power levels (typically 10watts or less). At these power levels losses are not particularly noticeable (although they do reduce the loops efficiency). I wanted to be able to operate with 100 watts, which meant that the main design problem was the method used to construct the tuning capacitor so that it was capable of withstanding an operating voltage of greater than 8,000 Volts and currents in excess of 40 amps. It also had to have sufficient range of capacitance to permit tuning of the loop over a broad frequency range. Commercial loop antennas use vacuum variable capacitors in order to meet this set of design parameters. However such devices cost several hundred pounds, even on the surplus market.

I tried making variable capacitors from sliding copper clad printed circuit board, and as a trombone arrangement using plastic sleeved copper water pipe (as shown on various loop construction websites). But I found that the PCB material tended to heat up and change capacitance value, and the sliding copper pipe and insulating sleeve collected water and tended to arc over.

Finally I arrived at the design shown on these pages. A very simple moving flap arrangement which is easy to fabricate with materials that can be obtained from almost any major DIY store.

Note that my square version uses 15mm Dia copper water pipe for ease of construction. However 28mm Dia pipe and octagonal shape (use 45 degree elbows) would give approx 2dB more gain at 7MHz but would cost about £15 more in materials (at current prices).

1m Dia Remote Tuned Loop Antenna



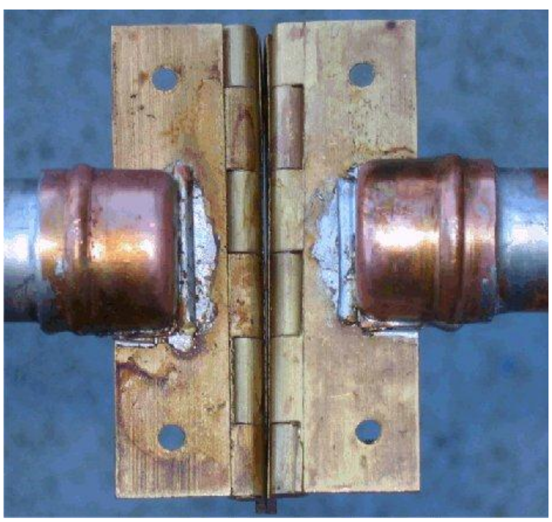
The antenna can be remotely tuned by powering the DC motor so that it either pulls or slackens the Nylon Fishing Line attached to the hinged capacitor plates. This causes the plates to move towards or away from each other. The spacing between plates must be greater than 2mm when closed to prevent high voltage flash-over. With the dimensions shown a capacitance range of 3 – 250pF should be achievable. The hinge has a strap of thin sheet brass across the moving parts in order to ensure a low impedance connection with no sliding contacts. The plates can be made larger and 'Tear' shaped in order to increase the Max to Min capacitance ratio and antenna tuning range. With the dimensions shown the loop should operate over the range 7-29MHz.

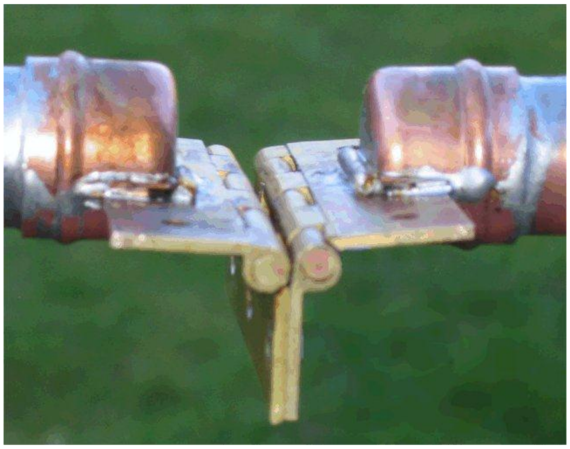
I soldered up the loop and hinge assembly and checked it with a temporary feed loop and no tuning capacitor.

I wanted to ensure that in it's basic form the loop was resonant above 29MHz, as I was concerned that the end capacitance with the hinge assembly fitted would be too great to allow operation on 10m.

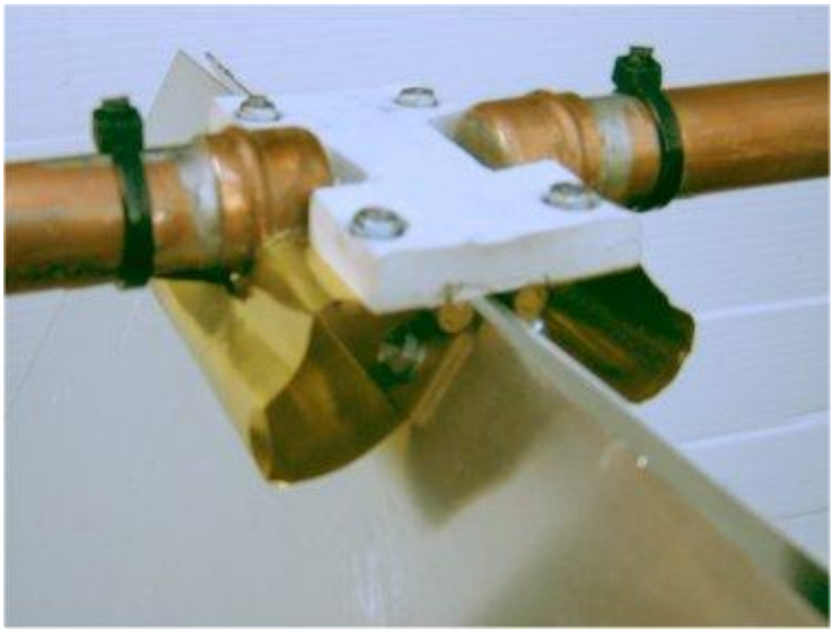
It looks like the design parameters I selected were OK as the resonance is at 31MHz.

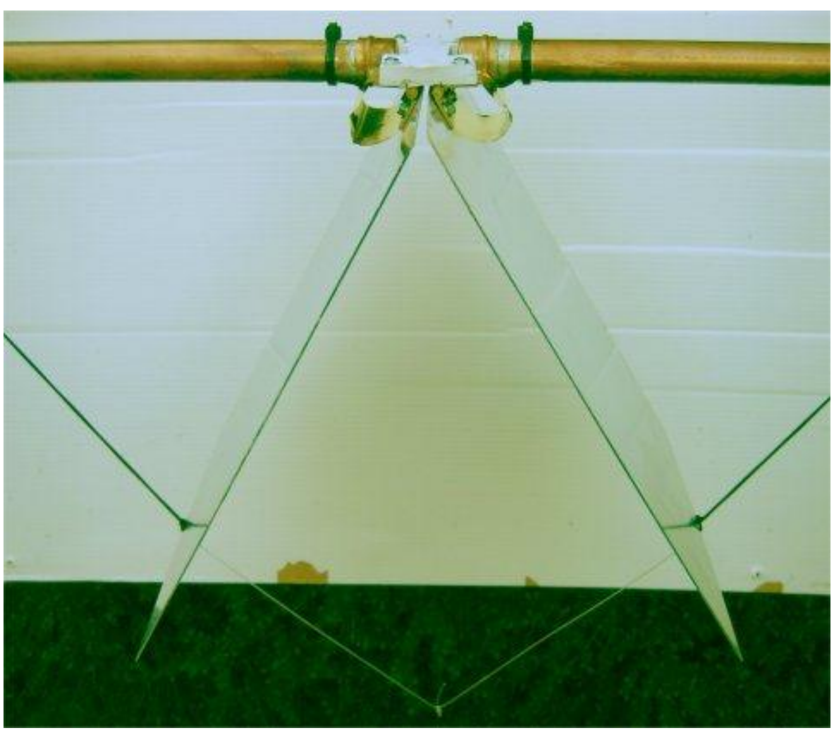
I decided to mount the brass hinges by cutting a slot in the end of the pipe and soldering them directly in.



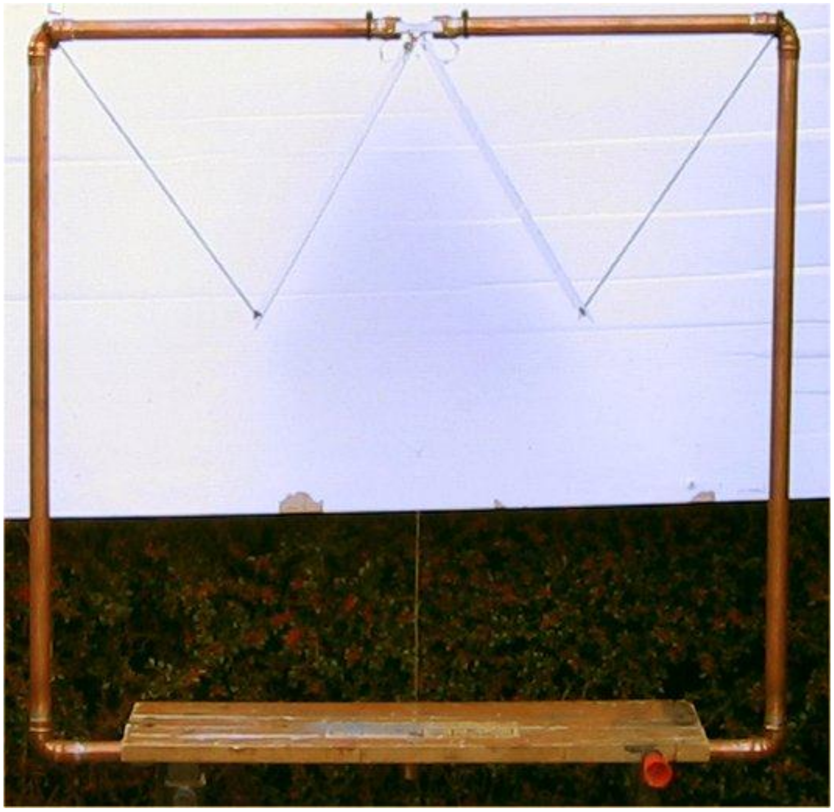


The next stage is to fit the tuning plates on to the hinges and make a Perspex plate to mount across the top faces of the hinges to hold them apart at the correct spacing. I may also have to use a spacer between the tops of the hinged plates to stop them shorting as they swing open. Some short straps made from thin brass sheet connect between the two halves of the hinges in order to ensure a good low impedance moving joint.





Here's another view of the loop with the tuning plates and elastic cords fitted



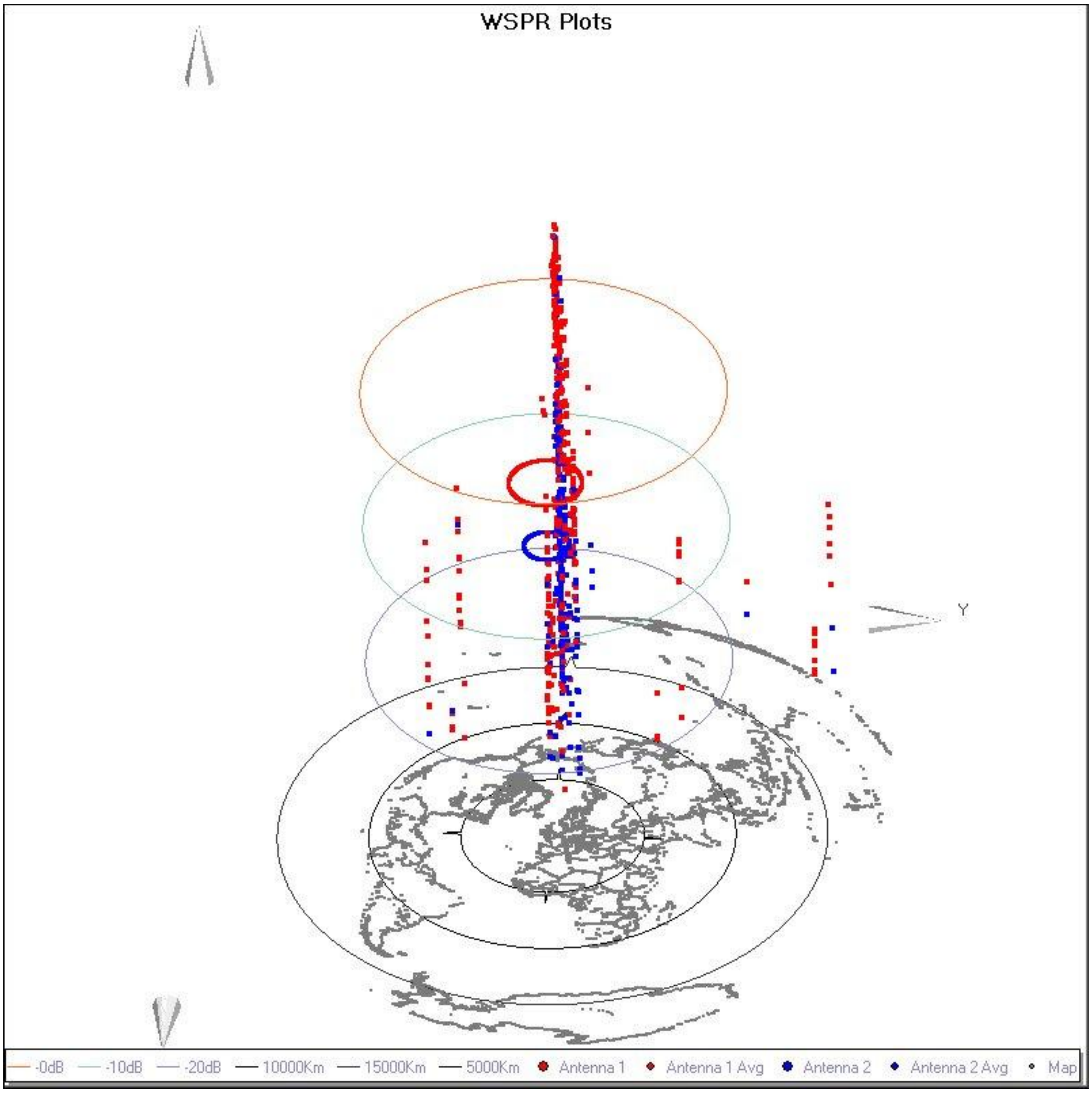
This is the loop under test on 10MHz; note the relative size of the coupling loop. The small size indicates that the loop has low losses resulting in a 'high 'Q' factor.

The tuning range of the loop with this size of plate was approximately 9MHz to 25MHz.

Unfortunately the tuning becomes very difficult at the low frequency end of the range, due to the very narrow 'capacitor' plate spacing. I think it may be preferable to use a fixed value capacitor in addition to the variable 'capacitor' plates in order to achieve smoother tuning. One possibility is to fit a coaxial connector across the tuning plates so that fixed lengths of coax (capacitive stubs) could be plugged in to permit easy band changes.

I also ran some comparison tests on 10MHz using my 30m long doublet at 10m AGL as a reference antenna. The loop was mounted as shown approx 2m AGL. I used WSPR in conjunction with automatic antenna switching to obtain signal reports over a 2 hour period. This produced a good selection of reports from all around the world, including a couple from Australia when I was using the loop.

My transmitted signal as reported by others was then imported into a 3D plotting application, which I used to produce this 2D screen grab.



The red trace is obtained using the 30m doublet and the blue traces using the 1m loop.

The large coloured rings are at intervals of 10dB the two small red and blue coloured rings indicate the average reported S/N and distance for each of the antennas.

As you can see the blue plots showing the loop performance are slightly lower and less frequent than the red plots for the doublet. However on average the loop performs only 4dB worse than the doublet. This is not bad considering the relative size and height differences between the two antennas.