Miniature Magnetic Loops

By David Posthuma, WD8PUO

A General Overview

After several years of curiosity and several months of research, I recently built two magnetic loops. The fist loop is semi-portable and cost about $100 to construct. The second loop is designed for camping/back-packing, and is still in an experimental stage. The "back-pack" loop weighs only about 3 lbs, can be completely disassembled and cost only about $15 to construct. Both antennas cover at least three bands: 15, 17, 20 meters. Additional bands can be covered, based upon the inductance/capacitance ratio determined by the rough-tune coaxial capacitor. The loop design SWR ranges from 1.1:1 at the lowest frequency to 1.6:1 at the highest frequency. No traditional antenna tuner is required since the antenna contains its own tuning network. All part components (other than the optional motor) can be readily found in any ham shack and the local hardware store.

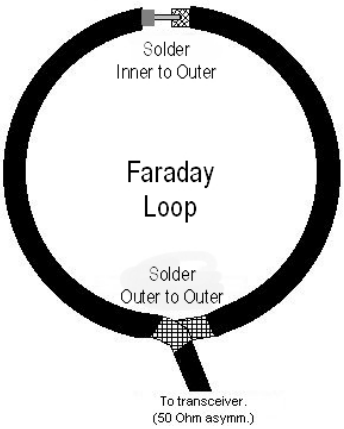
The magnetic loop antenna is a high-Q tuned antenna with a very narrow pass band…typical range is 10-25 KHz…and so must be retuned as the operator significantly changes frequency. Re-tuning is not a problem since the antenna is usually positioned only a few feet off the ground. The high-Q performance has an additional benefit of significantly reducing off-frequency noise, acting much like a pre-selector for receivers with a poor front-end. The performance of the magnetic-loop antenna is similar to a ½ wave dipole. When positioned vertically at only a couple feet off the ground, the antenna will exhibit bi-directional characteristics.

The magnetic loop antenna does not like being near metal of any kind. In fact, so sensitive is the loop to metal, that the best SWR is achieved by running the coax directly down to ground level and then away from the antenna, perpendicular to the antenna's face. If mast mounting is desired, the mast must not be made of metal. The loop is also sensitive to the presence of one's body, causing a slight de-tuning of the antenna. This is why some magnetic loop designers have experimented with low RPM DC or Step motor remote control. With practice, the user will be able to compensate for this de-tuning factor. Support structures for the loop should be comprised of unpainted wood, plastic or fiberglass.

A magnetic loop antenna is comprised of two loops

The larger of the two loops is usually constructed to be between 1/4 and 1/8 wavelength for the lowest frequency desired. Wire is not generally used for the larger of the two loops because the loop's diameter directly impacts its efficiency as a radiator. In my projects, I used 1" copper tubing for my first antenna; in the "back-pack" version, I used RG-213 coax (outer shield only).

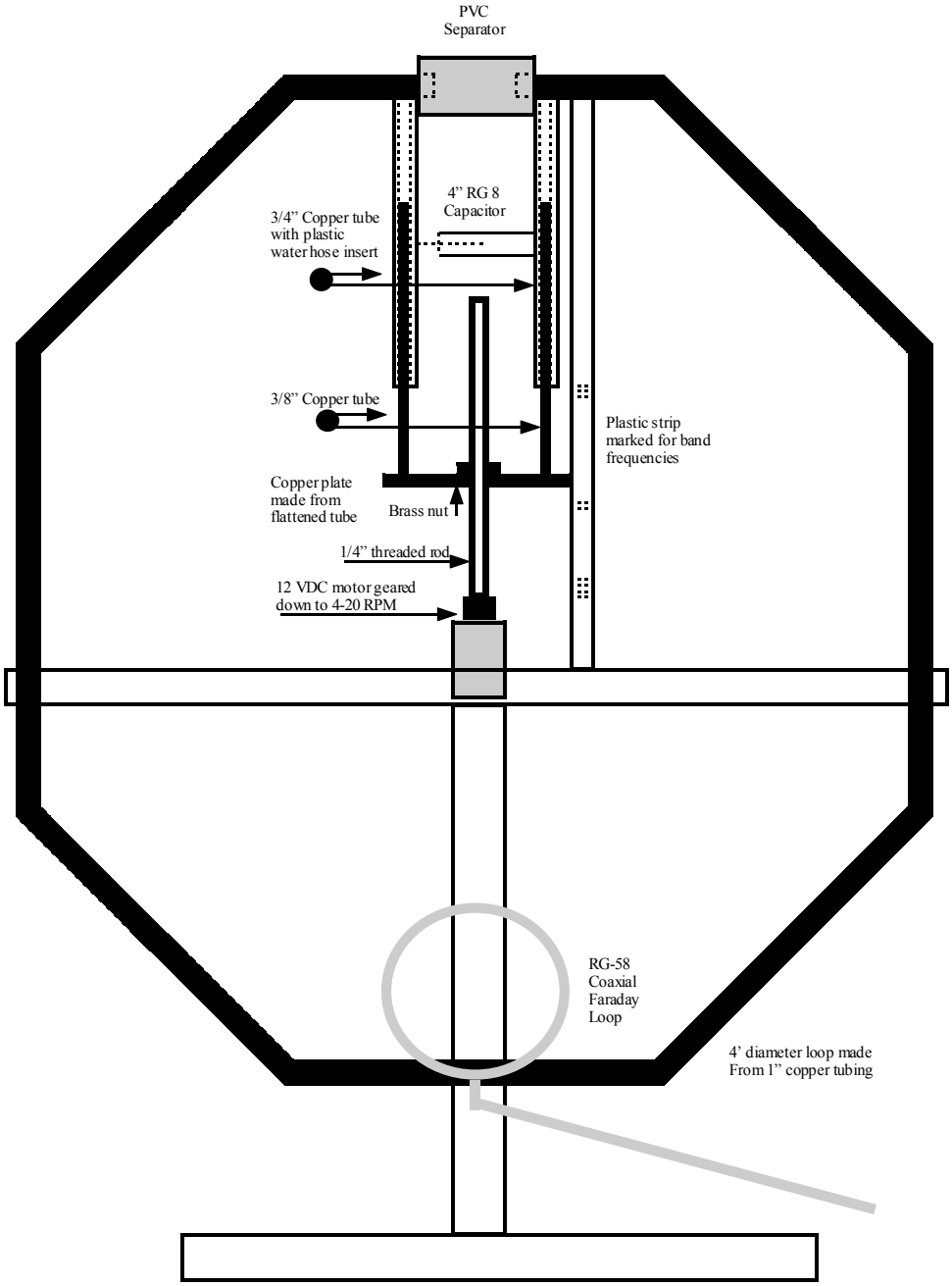
The smaller Faraday loop is "overlaid" next to the large loop but insulated from the loop…magnetic flux is your connection! I used RG-58 coax to construct this unique loop (please note construction details). The small loop diameter is always 20% of the large loop diameter. No balun is used. The coax is directly fed to the transceiver, using 50-ohm coax.



A magnetic loop requires a high-voltage variable capacitor

High voltage variable capacitors are expensive, often cumbersome and not readily available. I opted to use a combination of RG-213 coax for a rough-tune coaxial capacitor in parallel with a "piston-type" variable capacitor. The advantage of the piston-type capacitor is that it is easily and cheaply constructed from hardware-store components. The disadvantage is the narrowing of the overall band coverage (Originally I had hoped to cover 4 bands). The use of RG-213 or RG-8 coax for the rough-tune capacitor allows for voltages as high as 5000 volts. (Please note: the "back-pack" version is designed

exclusively for QRP levels of less than 25 watts). In my first antenna, I tuned the piston-type variable capacitor using a low RPM 12VDC motor (Jameco #155820, product #GH12-1830Y-P: Phone #1-800-831-4242) and a ¼" threaded rod. In the "back-pack" version, I make use of a slider, held in place by a rubber band. In my first antenna, I used two pairs of copper tubes separated by a plastic water hose inside the larger tube to comprise the piston-type capacitors. In the backpack version, RG-58 coax replaced the smaller diameter copper tube (inside conductor and insulation only, without the plastic hose insert), and the outside tube was reduced to 3/8" copper tubing.



The framework for both antennas is stock PVC from the local hardware store.

Note the coaxial "jumper" between the two-capacitor pistons…this is the rough-tune coaxial capacitor. The coaxial capacitor can be 4" to 12", depending upon the bands desired (longer lengths for 40 meter operation). Slightly heat the outer insulation and slide the inner braid and insulation in and out of the outer braid to accommodate your desired three bands.

I also used plexiglass and a red permanent marker to calibrate my capacitor location. An MFJ antenna analyzer and my K2 helped determine 100 KHz settings for each band. These markings simplify finding the resonate frequency of the antenna. If a faster motor is used, or if the antenna is adjusted by hand, the resonate frequency of the antenna will likely also be found by noticing the increase in volume from your receiver and then checking for the frequency with the lowest SWR.

I was easily receiving 5/9 reports on 20 meters SSB, with only 7 watts PEP, my K2 on internal battery and the antenna sitting on the driveway as pictured. I have a portable folded dipole for 20 meters, and found the performance to be quite similar. I was so impressed, that I began immediate work on the "back-pack" version.

The "Back-Pack" Version: *A Work In Progress*

The "back-pack" version maintains the same basic construction as the original magnetic loop. However, I am making some significant material and dimensional changes. To begin with…

- I reduced the loop from 4' to 3' in diameter.
- Instead of using copper tubing for the large loop, I used a scrap piece of RG-213 (outer shield only).
- I also substituted the inner wire and insulation from RG-58 coax for the copper tubing "pistons" in the variable capacitor. RG-58 coax is rated at about 1900 volts.
- While my current pictures display a high voltage capacitor in parallel with piston-type variable capacitor, the plan is to have several coaxial-type capacitors constructed of 3"to 9" RG-58…one for each major band segment…that will screw on to the top of the loop. This will allow for a reduced size for each of the piston-type capacitors.
- Also note from the picture that the 2 capacitor tubes are currently placed too close to each other, resulting in the antenna being unable to tune to 10 meters...a personal priority for this version. I will be attaching the tubes to either side of the PVC, resulting in significant reduction in tuner capacitance.
- A cross support was created using lightweight PVC tubing.
- The loops are attached to the cross support using Velcro. The entire antenna breaks down into a small package weighing about 3 lbs.

The "back-pack" version is not yet complete. I would encourage other antenna enthusiasts to expand and improve upon my efforts.