By Sam Kennedy, KT4QW

A 10/17 Meter Hanging Loop Antenna

Loops work! Build a hanging loop for 10 and 17 meters that will give almost 3 dBd of gain. It's compact, horizontally polarized, has a broad azimuth pattern, requires no matching network and can be easily rotated.

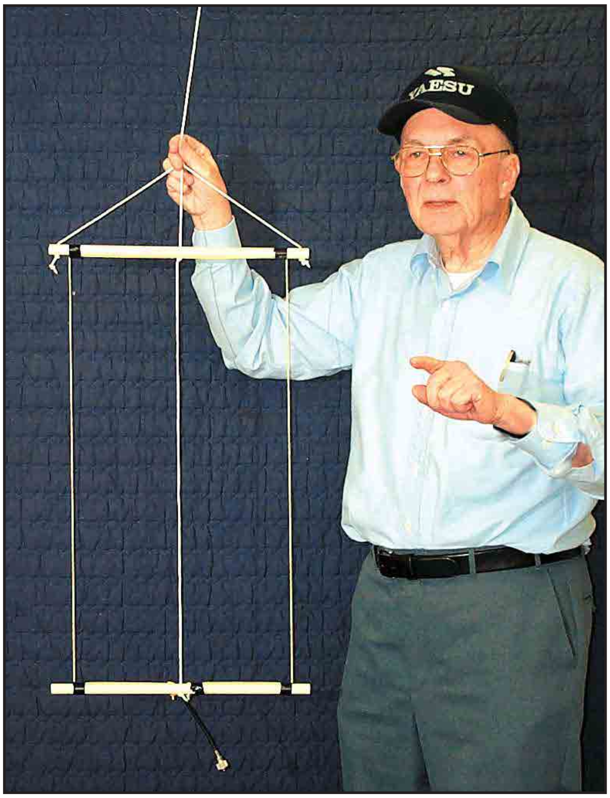

Figure 1—At a radio club meeting, the author explains the hanging rectangular loop using a scale model of the antenna. The antenna shown is a workable 2 meter loop. Although the antenna has relatively low gain at VHF, the smaller model serves well to illustrate the design.

I have experimented with several "hanging" antenna designs because the numerous tall trees in my yard furnish good support for hanging antennas. As most of my hanging antennas up to this point have been vertically polarized, I decided to try my luck with a horizontally polarized loop. A square loop proved to be too unwieldy for a hanging design and could not be easily matched on a multi-band basis using a single coax. As a result, I researched the available material and noticed the single rectangular 10 meter loop design in *The ARRL Handbook*.[1] Basic loop antenna design dates from the 1930s, but loops work just as well today as they did then!

Design

One big advantage of this antenna is that it has a feed-point impedance of 50 Ω. This same design can, of course, be scaled to any frequency, and more than one loop can be hung within the same frame. In this case I combined the 10 and 17 meter bands. I also tried to include a 15 meter element. It resonated okay, but it interacted with the 17 meter element, so I could not achieve a flat SWR on either band. Using *The ARRL Handbook* design as a launch point, I used *NEC4WIN95* modeling software and rescaled it to 17 meters.[2]

After careful examination, and a series of optimizing sequences, my new design, which theorized results that were very pleasing, emerged. I used 18.140 MHz as the 17 meter center frequency to ensure a low SWR across the entire phone band. Covering all of 17 meters was no problem, as it is a narrow band. Later, I included the 10 meter element and embedded it in the hang-up harness. I centered the 10 meter loop at 28.500 MHz and, of course, it could not cover the entire band without supplemental tuning. It does, however, cover the popular low-phone portion with a favorable SWR.

Figure 1 shows a scaled 2 meter model of the antenna, sized for demonstration purposes only, as the relative gain at VHF is low. The radiation pattern is essentially that of a dipole. The gain of this antenna is realized by compression of its vertical lobes into the main lobe and the take-off angle is low. The antenna has very good performance characteristics and it suits the needs of 10 and 17 meter communications for both distant and local coverage. Figure 2 shows the antenna's basic layout.

A "rotator" string has been included, attached to one bottom corner of the loop. This allows you to stabilize the direction of the loop or to rotate it, if desired. You'll need only to rotate it about 45° to get stations out of its deep side nulls or to null an undesired signal. A rotation angle of 90° is the maximum that would ever be necessary. I did try the loop both with and without a balun and found no measurable difference in SWR or in radiation characteristics. I chose to use the simplest approach and eliminated the balun. While not a critical consideration, if the antenna wires make contact with foliage, the loop may become detuned.

The ARRL Handbook has a good description of the slingshot method of launching lines into trees.[3] I've found that I can usually launch a line over the desired limb with a few tries. That tree in the backyard isn't a tower, but it's the next best thing to it.

Figures 3 and 4 show the elevation and azimuth radiation patterns. Note that the blue outside trace is the loop and the red trace represents a half wave horizontal reference dipole at the same frequency and height. Referring to the current distribution plot, Figure 5, you'll note that the bottom half of the loop forms a virtual half-wave dipole joined to and feeding the top half, which is also a virtual half-wave dipole. The two dipoles thus

[1]Notes appear on page 45.

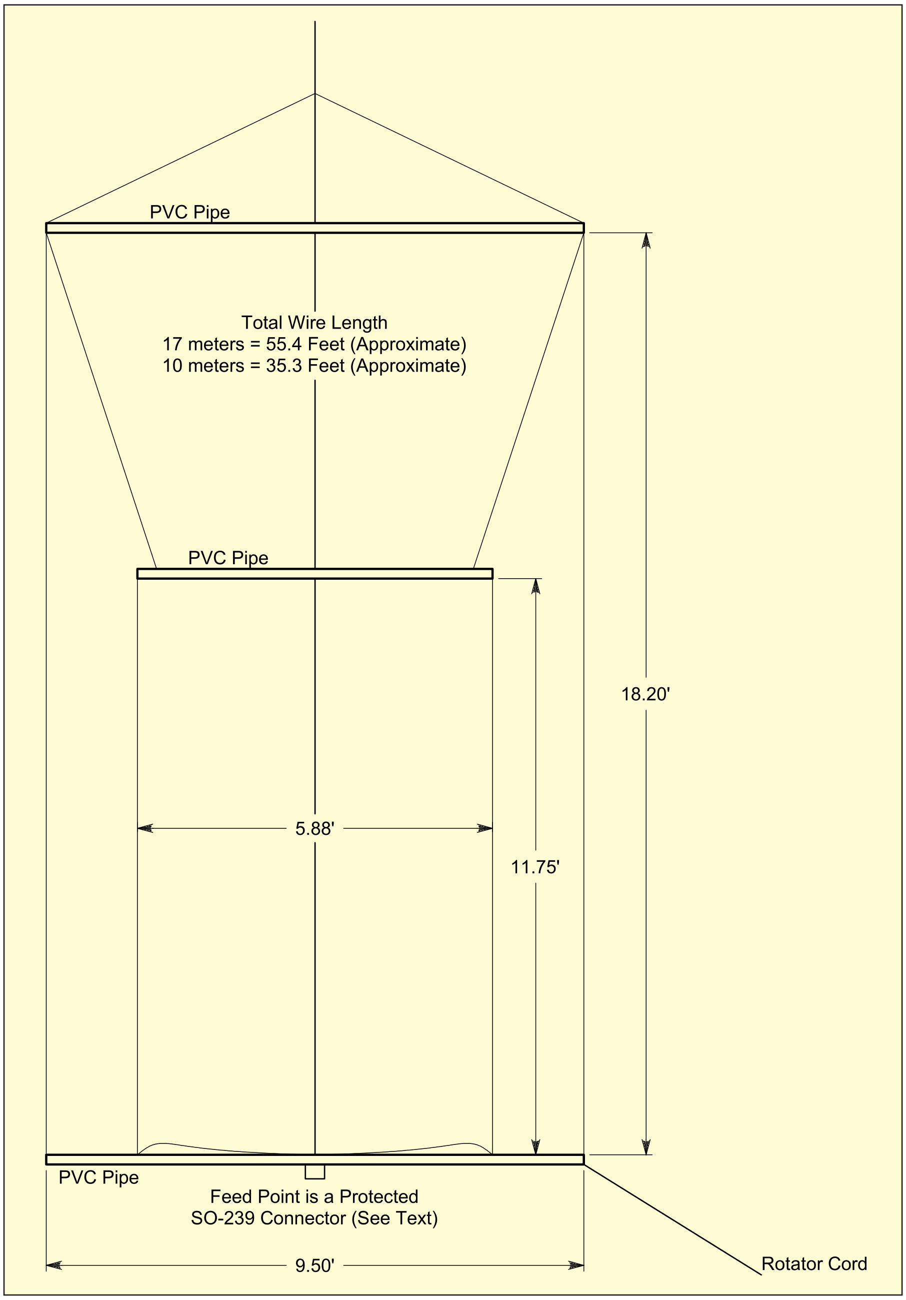

Figure 2—The rectangular loop for 17 and 10 meters.

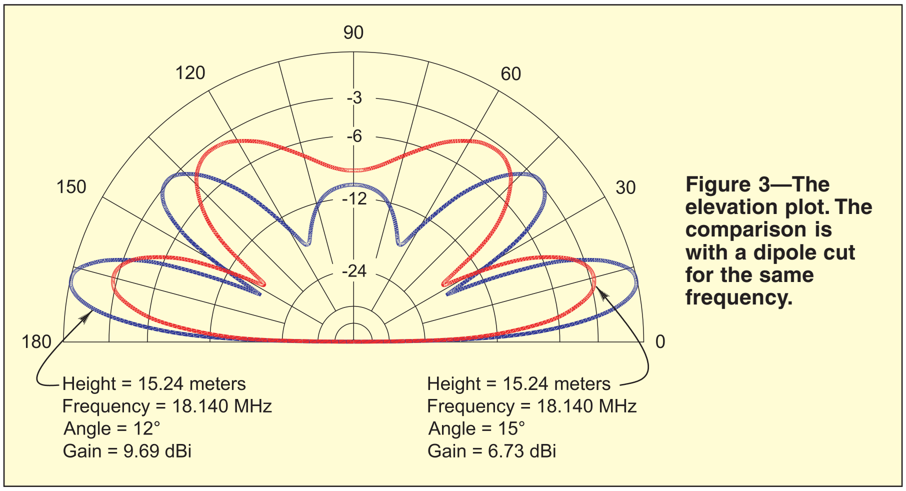

Figure 3—The elevation plot. The comparison is with a dipole cut for the same frequency.

form a one-over-one horizontal array. This compresses the higher vertical lobes into the main lobe. As a result, small (but worthwhile) gain is realized compared to a single dipole, close to 3 dB. As with any antenna, the higher you hang it, the lower the radiation angle. This usually improves the performance of the antenna, depending on distances and propagation conditions. This antenna gives a better impedance match to 50 Ω cable at the feed point than a simple dipole at the same height (72 Ω).[4] You can actually "tune" the feed point impedance by slightly changing the aspect ratio of the rectangle. The wider the horizontal dimension is, the higher the impedance.

Construction

Table 1 gives the materials needed for building the antenna and a step-by-step guide for constructing the antenna follows below.

1) Prepare the two 10 foot schedule 40 PVC spreaders and place them at the proper points in the ground. Drive four small stakes in the ground corresponding to the dimensions of the loop. See Figure 6.

2) Unspool the 14 gauge stranded copper wire and apply it around the ground stakes. This forms the rectangular loop and allows the PVC spreader pipes to be correctly positioned at the top and bottom. Start and end the wire at the center of the bottom of the loop, leaving enough extra to connection to the feed point. *Be sure to allow enough extra length for pruning, as necessary.* The total length of the wire used is calculated by the following formula: Length in feet = 1005/MHz. Always cut a little longer than calculated; then adjust.

3) Connect the antenna wires to the feedpoint connector temporarily. Do not solder until you have completed the tune-up procedure.

4) Carefully measure the wire and temporarily tape it in place on the spreader PVC pipes. Tape it in enough places to ensure that it holds its shape. Note that the antenna wire is fastened to the surface of the PVC pipe. The wire does not go through the PVC; only the feedpoint assembly is positioned through the PVC pipe.

5) Build the hanging harness by paying attention to Figure 7. It is advisable to melt the rope instead of cutting it, to avoid end fraying. *Caution*—be very careful when melting synthetic rope!

6) Hoist the antenna up to your prepared test location so that the bottom of the antenna is at least a half wave above the ground, if possible. Using an antenna analyzer, minimize the SWR at the center operating frequency. To avoid being

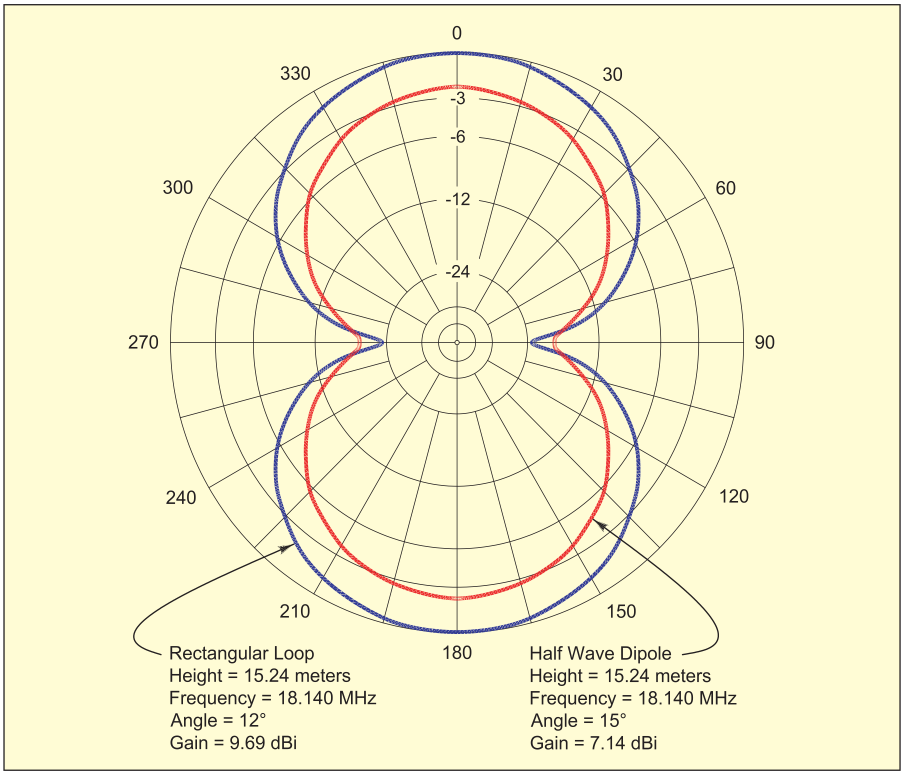

Figure 4—The azimuth plot. Again, a dipole cut for the same frequency is compared.

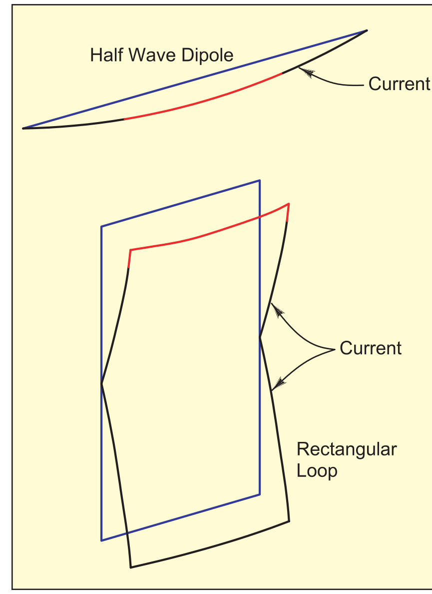

Figure 5—A current distribution plot. The antenna is compared with a dipole cut for the same frequency.

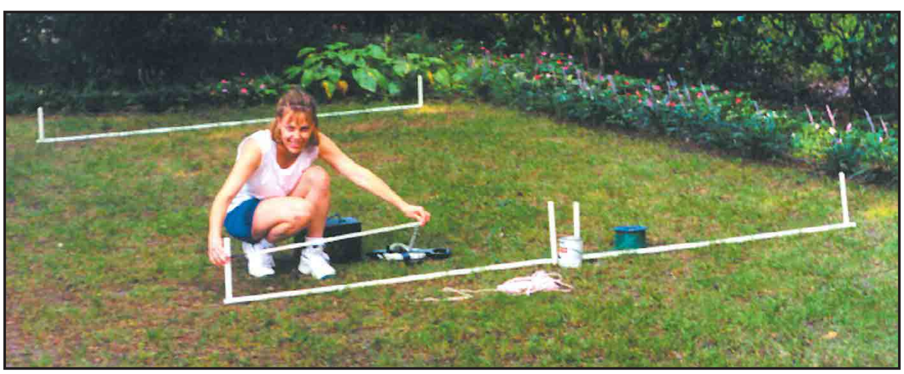

Figure 6—The layout technique used for quick wire measurement and assembly of the loop and its associated hang-up harness. Note the use of PVC pipe stakes, carefully positioned and squared, for forming the structure. Both the 17 and 10 meter elements can be put into place during this operation.

Table 1
Materials for the 10/17 Meter Loop

2 each	PVC pipe, 10 feet, 1/2" schedule 40 (use uncut—full length).
4 each	End cap, 1/2" PVC.
65'	Wire, #14 stranded copper, green vinyl insulated.
25	Tie wraps or equal, black UV resistant.
50'	Rope, nylon or dacron, 1/4" or smaller (for harness fabrication).
50'	Cord, construction-type, nylon (for rotator cord).
1	Silicone sealer, medium size tube.
1	Tape, electrical, vinyl black roll.
1	Container, durable plastic pillbox type design for quick disconnect.
1	Connector, SO-239 for coaxial cable disconnect.
1	Brazing rod, 1/8" brass.
1	Solder, 60/40, rosin core.
1	Paint, camouflage green, Plasti-Kote #17035.

misled by the analyzer's indications, use 50 Ω coaxial cable, cut to a multiple of a half-wave length at the center design frequency. Make sure to use the correct value of velocity factor (VF) in your calculations. The formula for a half-wave length of coax in feet is: Length= (491.8/MHz)×VF, where VF is the velocity factor of the coaxial cable used. The VF for RG-8X is 0.75 and for RG-8/U it is 0.66. For other types of cable see *The ARRL Handbook*. If you use, for example, RG-8X, one half wave would be 20.3 feet in length. Since you would need it a bit longer than that for testing, you would probably want to use two half wavelengths or 40.6 feet.

7) If you choose to minimize visual attention of the completed antenna, spray paint the entire unit, including the rope, with flat olive green paint. Protect the SO-239 connector from overspray by masking. A light "hazing" of spray paint is adequate and the painting will not affect the antenna's performance.

Note that PVC spreader pipes are specified in Table 1. To prevent bowing, use Schedule 40 PVC pipe for this application. Construction of this antenna is simple; however, a large flat space is needed for the layout. The harness arrangement shown in Figure 7 includes details about the knots used. It is difficult to achieve a good hanging shape with two or more elements, so it is important to have an easy means for shape adjustment. Using this construction technique the antenna may appear flimsy. It does, however, make for a very tough and survivable structure. My original unit has survived a hurricane and severe weather at my location for over three years.

Feed-point Connector

Figure 8 shows an effective way to feed the rectangular loop. I found this to be a practical way to build a strong, durable and weather resistant feed-point connection that provides plenty of support for coaxial cable. By incorporating a standard SO-239 connector, a "drip skirt" and a strong vertical support member, this method for making a quick disconnect feed-point connector for the hanging rectangular loop has worked well. While other techniques can be used, this one has proven to be satisfactory. No sealing compounds or tape are necessary to protect the connector from the weather, although protection can be applied, if you so chose. Note that it is helpful to heat the general area of the 90° bend on each section of brazing rod with a propane torch until it becomes somewhat discolored. This will anneal the brass and make it much easier to make the bend. To avoid "melt-down," the annealing process is accomplished before installing the rods into the connector, the cover and the PVC pipe.

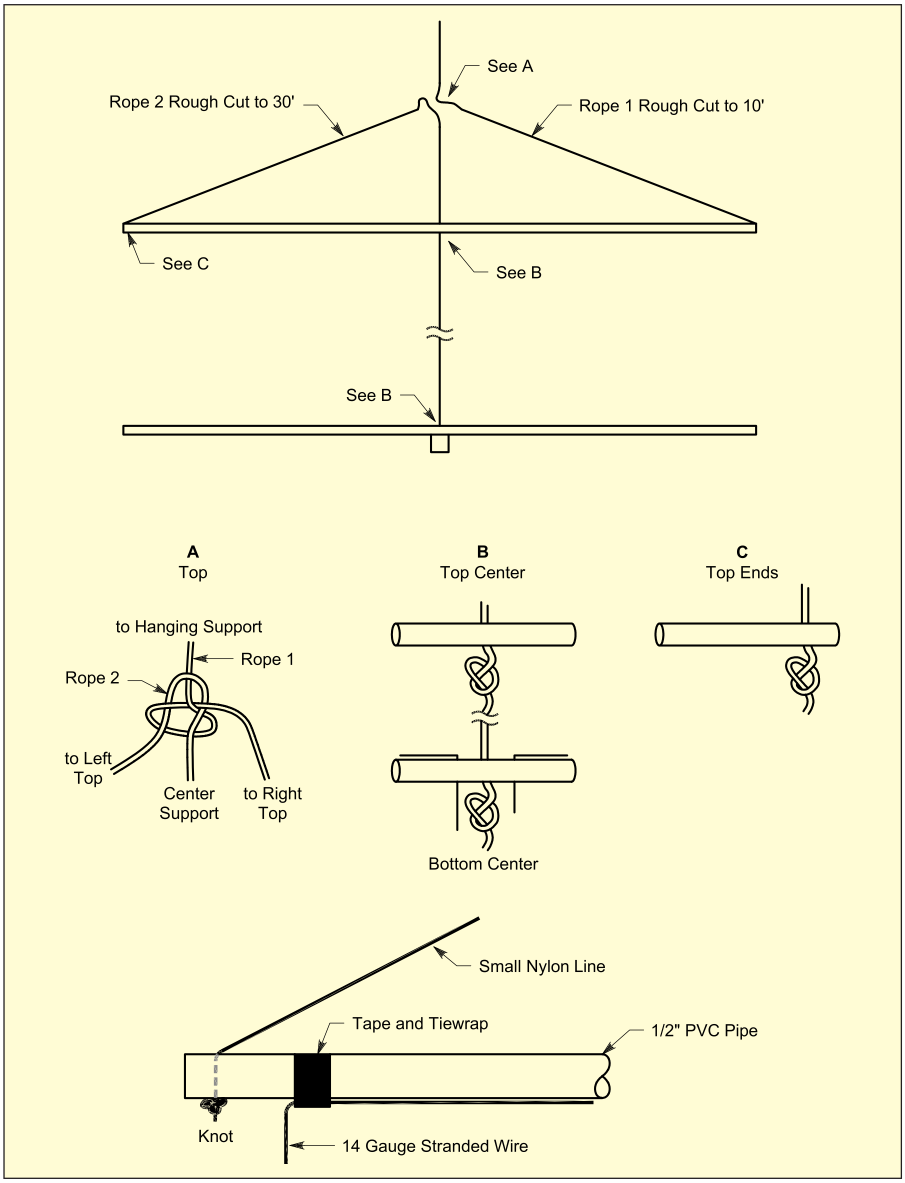

Figure 7—The rope harness is necessary for a stable hanging loop. For clarity, the knots are shown before tightening. The overhand knot is used because it holds firmly and is easy to adjust when necessary. Note that the antenna wires are fastened to the exterior of the PVC pipe.

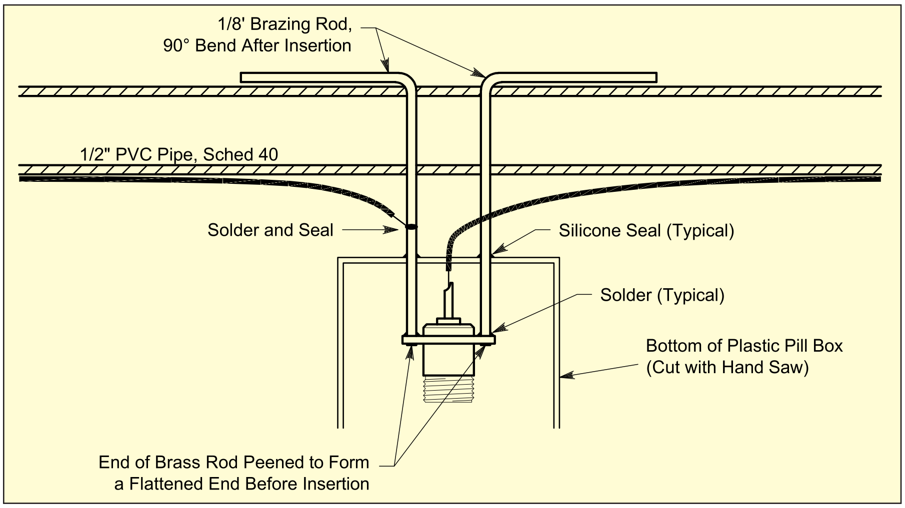

Figure 8—The feed-point connector assembly—it is a weather resistant connection that does not require taping and sealing.

Conclusion

Although I have no facilities for scientific measurement of the actual antenna gain, this antenna consistently gives more than 1 S unit higher received signal level than my inverted V or my 17 meter vertical. If you do decide to build one, you will be pleased with its performance. When I started using this antenna I was pleasantly surprised with results that truly lived up to, and frequently exceeded, its theorized prediction. It's the best simple wire antenna in my inventory.

Notes

[1]The rectangular loop design used here is based on a design in the 2004 as well as earlier editions of *The ARRL Handbook*, Newington: ARRL, 2004, "A Simple Gain Antenna for 28 MHz," p 20.43.

[2]My computer modeling used the *NEC4WIN95* modeling program by Orion Microsystems (**www.orionmicro.com**).

[3]A good description of this method of launching lines into trees is covered in the 2004 as well as earlier editions of *The ARRL Handbook*, "The Trusty Slingshot," p 20.7.

[4][*Editor's note*: The feed impedance will depend upon the antenna's height above ground and its frequency of operation. Many hams use full wave low frequency loops as multiband antennas on the loop's harmonic frequencies. The feed impedance will vary with frequency when a loop is used this way. In that situation, it is best to feed the loop with open wire or ladder line into an antenna tuner, one preferably designed for link coupling.]

Photos by the author.

Sam Kennedy, KT4QW, was first licensed in the 1950s as K4DEP, but has been interested in radio since the age of 7. Relicensed in 1996, Sam was assigned his current call, and earned the Amateur Extra ticket shortly thereafter. He attended both commercial and US Navy electronics schools and has worked with military radio, radar and navigation equipment. Sam enjoys the technical aspects of ham radio. You can contact him at 57 Huxley Pl, Newport News, VA 23606 or at **kt4qw@arrl.net**.