Number 18 on your Feedback card

FYI: FQY

Another look at the Fractal Quad Yagi.

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While moving several times during the last few years, I had to leave behind my previous antennas and masts. Thus, when we finally arrived at a QTH that was more or less permanent, it was time to start over from scratch. Scratch is a good term to describe my ham budget, too. I began looking for an antenna design that fit the following criteria:

1. Use of available materials at reasonable cost (free is good).

2. Small enough to fit on an easily erected mast and rotate with a TV rotator.

3. Better gain than the existing vertical antennas I already have.

4. Good directivity to limit QRM.

5. Low radiation angle to work DX.

Since 10 meters is now opening up, I decided to stick to a single band antenna for simplicity's and cost's sake.

While surfing the Internet for antenna ideas, I stumbled across Chip Cohen N1IR's Web site, [www. fractenna.com]. I was intrigued with his Fractal Quad Yagi (patent pending) because of its small size and ease of construction. I decided to put one together just to find out whether such a design had merit.

Design

As described on Chip's Web site, the 10 meter FQY is similar to a cubical quad in shape, but is in a smaller form. In fact, the elements are a little over 4 feet per side. He claims impedance to be close to 50 ohms, so it can be fed directly with 50 ohm coax. It has 3 dBd gain, front-to-back ratio in excess of 25 dB, and a bandwidth of 500 kHz for less than 2:1 VSWR.

He also describes construction of a 10m FQY built by Phil N1ZKT, using #9 aluminum ground wire (available from Radio Shack), and plastic water pipe for spreaders. I followed his construction method as much as possible. Along the way I did some work of my own, such as coming up with equations for scaling the driven element for different frequencies (like designing for the CW band). Although Chip's design was simplified to allow duplicate driven and reflector framework, I tried to enlarge the reflector and do away with a stub, although as seen in the photo, a small stub had to be added later to tune the reflector.

For purposes of folding the wires, each length between bends is broken up into segments, the total of which equals the length of each element. **Fig. 1** shows the length for each segment of 1/4 of the element, the same pattern repeating for the other three sides. Unlike the figures published on the Fractenna Web site, the figures in **Fig. 1** go from the attachment point of the feedline to where the element again comes closest to the boom, this being the logical starting point for the end of the wire. You should also note that these figures will hold for #9 wire only. Adjustment will have to be made if you are using a different wire diameter. As far as spacing between elements goes, I had available a 10-ft. piece of aluminum pipe and I figured I could experiment with different spacings. The results shown here are for 6.5-ft. spacing, wider than Chip's 4.5 feet.

Construction

The first part of building the FQY consists of fabricating a framework to hold the elements. As I had experience constructing quads, this part was fairly simple. Although spiders could be constructed of nonconductive material to keep metal away from the near field of the elements, I used aluminum, as

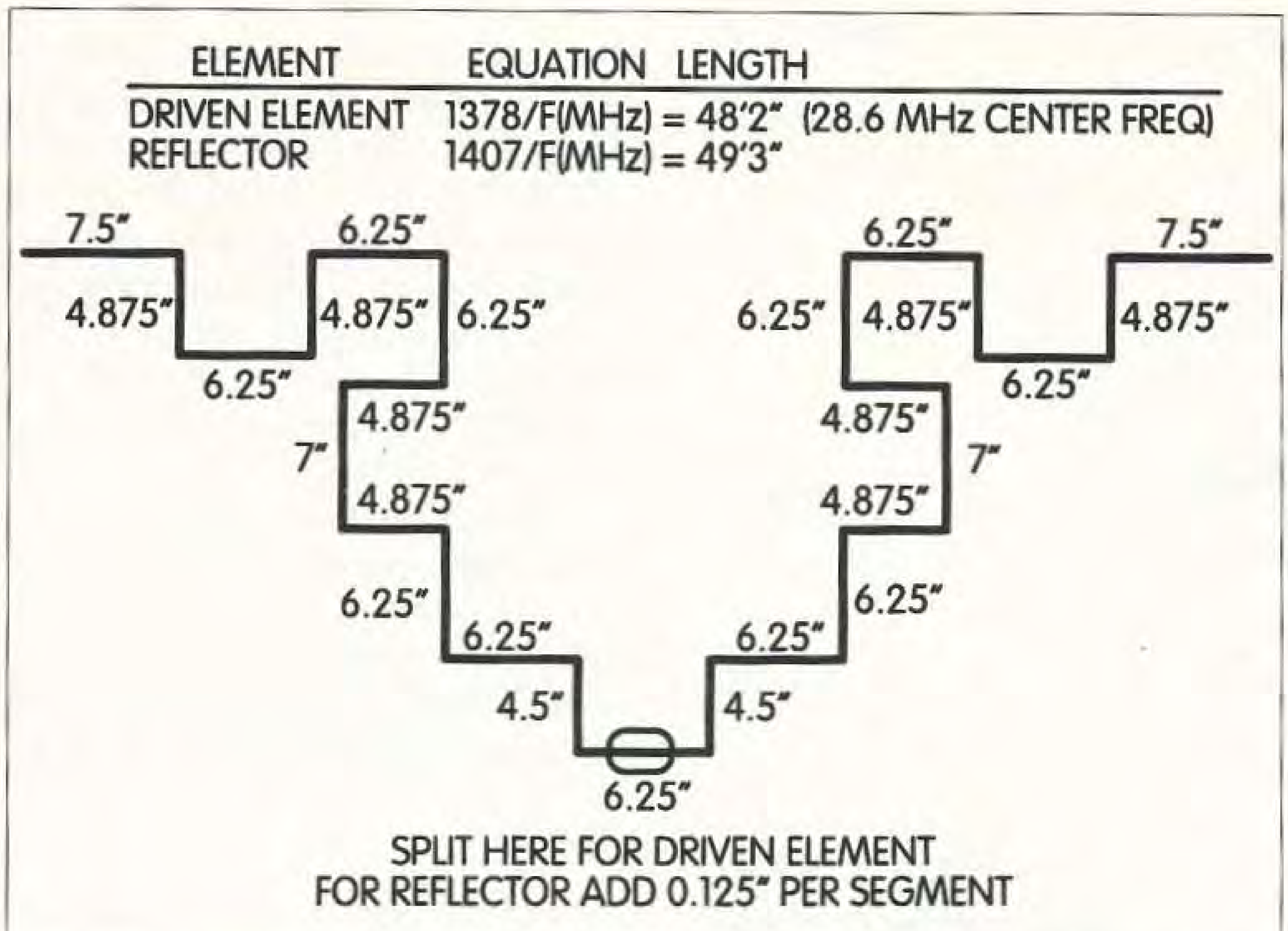

Fig. 1. Segment chart, one side (with feed).

that's what I had available. In fact, as the photo shows, some spiders are fabricated from surplus extruded aluminum from a discarded window. The spiders are drilled to accept muffler clamps the size to fit the boom, and spreaders are attached using hose clamps. You may have to cut notches as I did to allow the hose clamps to secure the spreaders tightly. Spreaders are constructed from 1/2" plastic water pipe. Cross pieces to hold the elements are then constructed from 1-1/4" plastic pipe cut to 5" length. A 7/8" hole is then drilled through the side to allow the spacer to slide down the spreader. A screw can be drilled into each spacer to hold it in position on the spreaders once the elements are mounted. A hole is then drilled in the end of each spreader large enough to pass a cable tie through to hold the outside corners of the element. An alternate spacer having a smaller silhouette could be fabricated from 1/2" plastic pipe by cutting a notch in the center and mounting to the spreader with a screw.

Once the framework is built, the elements can be bent and mounted. First, the total length of the element should be measured on the wire. If you use Radio Shack wire, it comes in 40-ft. lengths, so wire will have to be added to complete the element. Then a mark should be made at each 1/4 section of the wire. Next, a wooden block marked with the length of each bend is used to measure off the segment length and the wire is bent around the corner of the block to a 90 degree angle.

Care must be taken to bend the wire in the correct direction to form the pattern. I found that the best way to make accurate bends is to bring the center of the wire from the previous bend even

Materials List

Qty.	Item
3	40-ft. rolls #9 Radio Shack aluminum ground wire
1	bag of 100 8-in. cable ties
4	x 10 ft. schedule 40 1/2-in. plastic water pipe
1	x 10 ft. schedule 40 1-1/4-in. plastic water pipe
1	x 6 ft. aluminum angle or equiv.
1	x 6.5 ft. 1-1/2-in. aluminum pipe
4	2-in. muffler clamps

Table 1. Materials list.

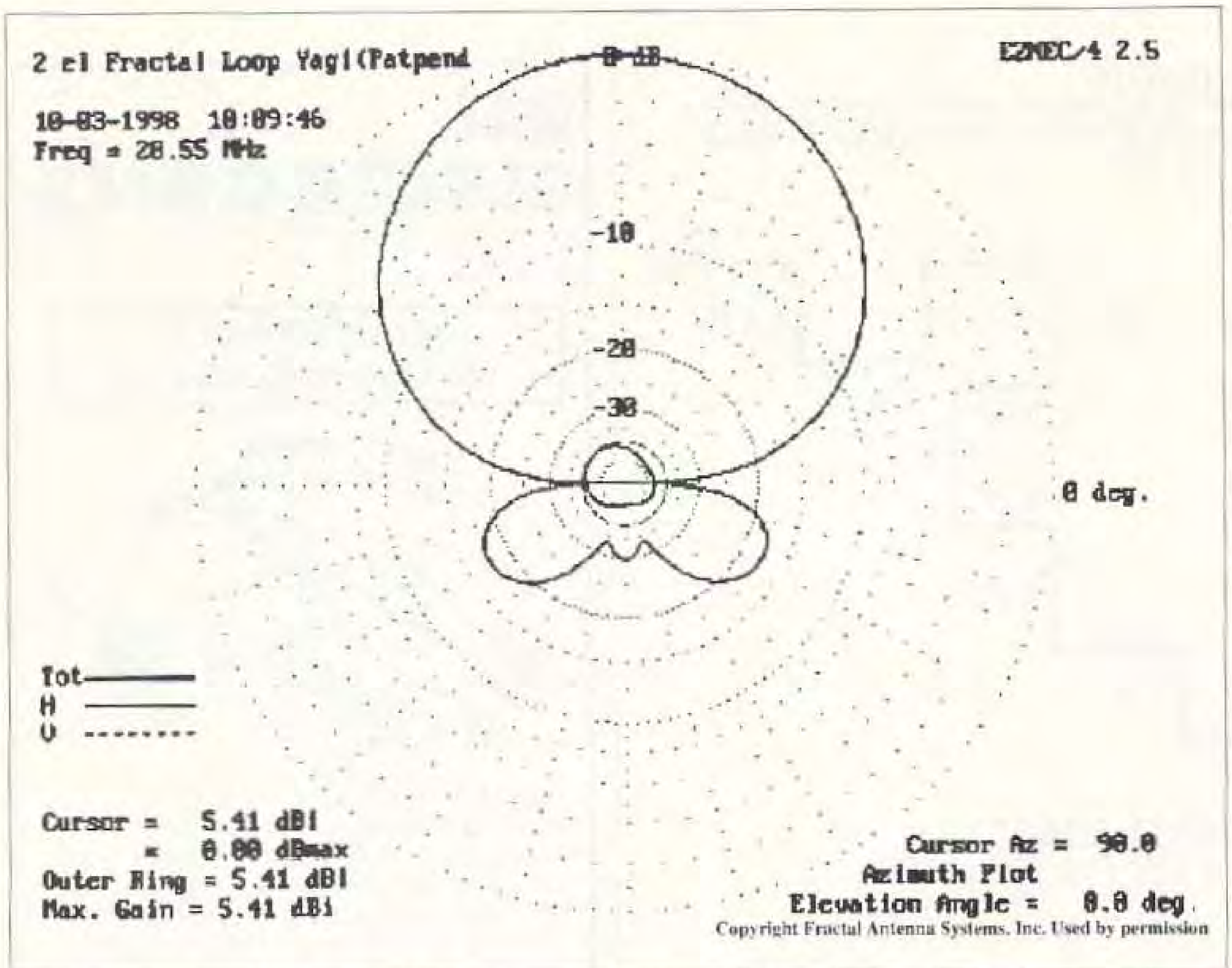

Fig. 2. Azimuth plot: Chip's free space azimuth plot. My version showed no lobes off the rear corners and a front-to-back of 12 dB.

with the mark, and then make the next bend. As the wire is bent, it will draw the previous bend forward to bring the outside edge of the wire even with the mark so that the outside edge of the previous bend to the inside edge of the next bend equals the segment length. As each quarter section of the element is finished, the mark made previously on the element can be used to judge if adjustments need to be made in bends. In this way, a full element should be able to be constructed with a minimum of rebending.

If aluminum ground wire is used, a suitable connection will be needed at the wire ends. After several trials, I settled with the method of crimping a solderless eye terminal to each end of the wire. Then connection is made with a #6 screw through the eyes and tightened with a nut and tooth washer.

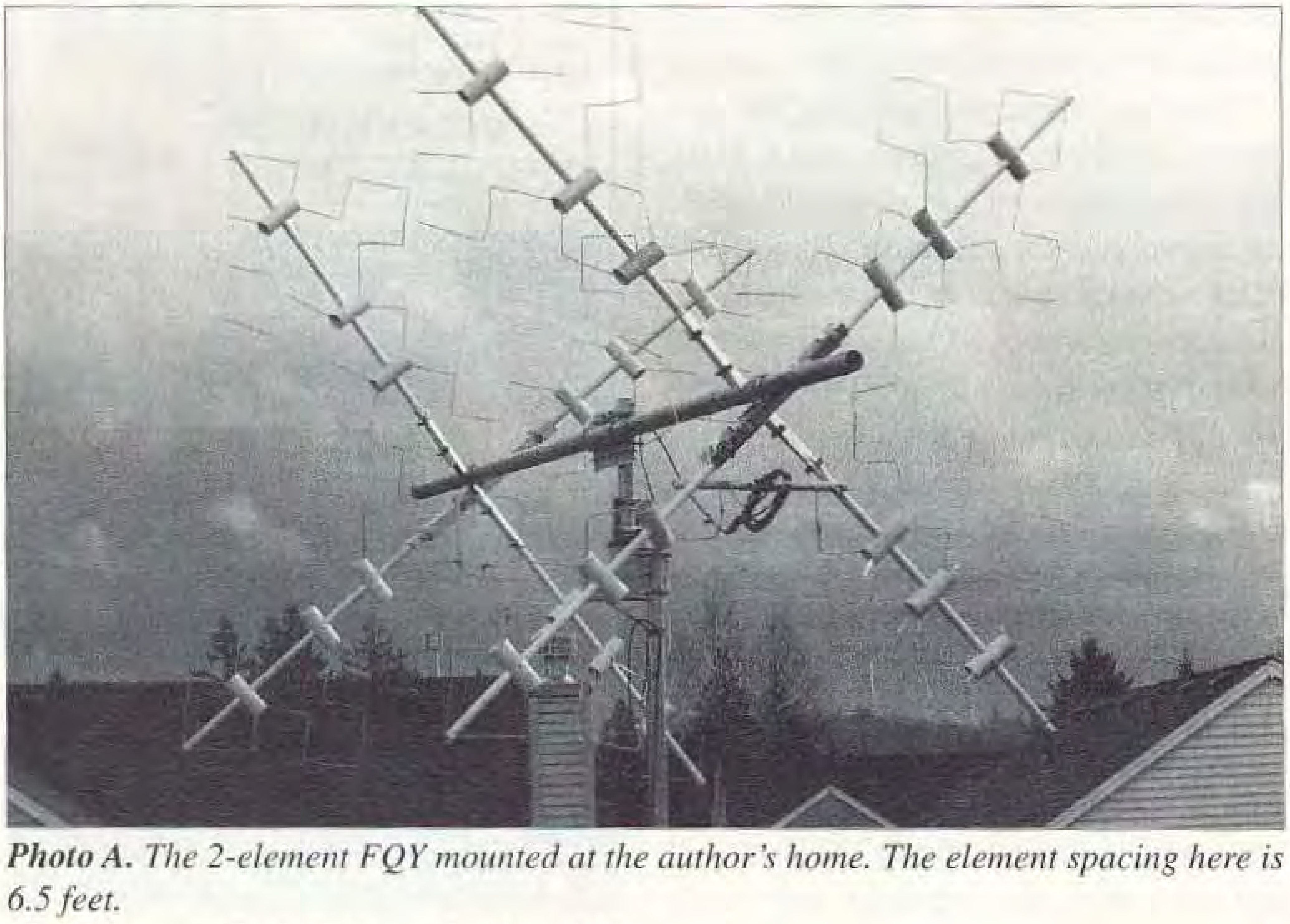

Photo A. The 2-element FQY mounted at the author's home. The element spacing here is 6.5 feet.

Once the elements are completed, they can be attached to the spreaders. This can easily be done by laying the element on a flat surface and overlaying the framework. Attach the element corners with cable ties first, and then attach the rest of the corners to the spreader spacers with cable ties. Once the element is attached, the cable ties can be trimmed and the spacers locked down with a screw.

A mount at the feedpoint can be made with a piece of 1/2" plastic pipe cut to fit between spreaders and attached with screws. A balun or coaxial choke should be used at the feedpoint to prevent radiation from the feedline.

Results

With the FQY at 10 feet, measurements of VSWR were taken with the internal SWR meter on my ICOM 740. Resonant frequency was about 300 kHz lower than that shown, but bandwidth was about the same. Had I worked out the procedure above beforehand, I probably would not have had to adjust the driven element, but as this was the first attempt, trimming and rebending of wire ensued.

Tuning the reflector for front-to-back resulted in a best of 12 dB via ground wave. Chip informs me that increasing the boom length will decrease the modeled F/B and broaden the bandwidth to 800 kHz, more in keeping with my results.

A shortened boom length will increase the F/B as in Chip's version. The F/B stayed about the same with the antenna at 24 feet. It should also be noted that testing with sky wave signals resulted in a figure closer to 30 dB, actually better than the claimed 25 dB. I had no way to measure the forward gain empirically, so no figures are given here. However, recent testing by K1KW confirmed the results modeled by Chip as far as gain and F/B went, measuring against a reference antenna.

After verifying SWR and front-to-back, it was time to give the FQY the real test. How does it do on the air? With the antenna still at 10 feet, I started tuning across the band and heard VK2ARJ calling. I gave him a

Photo B. Bending the wire around a wooden block. The block is marked for the different length bends.

call and got a 5-5 signal report with 100 watts. This was encouraging. After finding and fixing a used TV rotator, a 10-ft. mast was installed on the roof and the antenna mounted. This got the boom height to 24 feet.

Many contacts were made over the next two weekends, including V63KU, H4OMS, BV5BG and A35RK. I also happened to catch a rare aurora opening to Europe at 2300 UTC, working OZ1GML, GM4WJA, OZ6MI, SMØFLY, and GØMJS. Two things began to become apparent. First, this antenna seems to radiate very well at low radiation angles. In doing comparison tests with a ground-plane vertical at 14 feet with stateside contacts, very little difference is noted between the FQY and the vertical, usually less than 2 S-units, depending on condition. However when the FQY and the vertical are compared on long haul contacts, say to Australia, the FQY performs much better than the vertical, on the order of 5 to 6 S-units. Most times, a signal that can be easily heard on the FQY is a struggle to copy on the vertical.

	Chip's Version	Measured
2/1 VSWR	500 kHz	1350 kHz
	28.3 to 28.8	28.150 to 29.5
F/B	>20 dB (measured)	12 dB (see text)
Gain	3 dBd (modeled)	---

Table 2. Results.

Second, the FQY seems to transmit better than it receives on long-haul DX. I consistently receive signal reports that are 1 to 2 S-units better than I am hearing. Stateside contacts usually are about the same on transmit and receive.

Front-to-back on sky wave paths is better than measured on ground wave also. Measurements made over time indicate the F/B is well over 20 dB, most times dropping an S9+20 signal to below S5. The same signal will drop to below S1 off the sides, indicating deep nulls.

The best test came during the *CQ* WWDX contest. At one point I started at the bottom of the phone band and called every DX signal I could hear up to where the signals quit. Although I didn't work every station on the first call, I did work every station. The toughest was CEØAA on Easter Island. He had a huge pileup, with US stations all across the country calling. It took quite some time, but I happened to catch an opening as his signal was coming up, and finally got through. Many contacts have been made since, with comparable results.

Conclusion

I could be satisfied with this antenna just the way it is at 24 feet. It fit neatly into all my criteria listed at the beginning.

This antenna has proven itself beyond my expectations. However, for all the answers I've gotten, a dozen more questions have been raised. What would this antenna do at 35 feet? Sixty feet? Could this antenna be scaled for other bands? I already have an idea for a fractal quad loop for 40 meters. Are the results I've seen reproducible? One thing is sure: Here is a field of discovery that is open for any ham with a modicum of mechanical skill and a healthy curiosity.

Acknowledgments

I would like to thank Chip Cohen for sharing his FQY design with us hams even though it is patent pending, and for his help and encouragement in writing this article. I would also like to thank Phil N1ZKT, who first constructed the 10m FQY. His ingenuity in designing the support structure inspired me to build my own. 73