Want A Dish?

Building your own is easier than you think.

by Ralph E. Herzler WA8WBP

A homemade dish does not need to be a mathematical nightmare. The literature is full of complicated formulae that supposedly tell you how to construct the dish of your dreams. You need not be a rocket scientist to cut through all of this mish-mash. Allow me to take you step-by-step through the process.

Calculations and Construction

The usual first decision in designing a dish is to establish the desired diameter. The larger the diameter, the greater the gain of a dish antenna system. Most of us are limited by physical or other constraints to a maximum diameter. In my case, the space available on the rotating bar of my satellite antenna system limited me to a four-foot dish. Since some of my QSOs involved hams using a dish of this size on the frequencies that I wanted (1269 and 2400 MHz), I was encouraged to proceed.

After you determine a suitable diameter, the next choice is the f/D ratio, where f is the focal length of the dish and D is the diameter already determined. The focal length is the distance from the deepest part of the dish to the closest end of the feed system. Feed systems may be of several kinds and are another subject. Suffice that the recommended f/D ratios for amateur work are between 0.4 and 0.6. I chose 0.5, which gave me a focal length of 24 inches.

Knowing the focal length and diameter makes it possible to determine the depth of the dish. The only formula necessary is: $d = D^2/16f$, where d is the dish depth, D is the dish diameter, and f is the focal length, all expressed in inches. Thus, my four-foot dish with a focal length of 24 inches would be $48^2/16 \times 24 = 6$ inches. that is all there is to the math!

With guidance from Bob Douglas W5GEL, I built a dish based on these dimensions and similar to the construction project by Keith Berglund WB5ZDP published in the May 1989 issue of *73 Amateur Radio Today* ("Inexpensive Mode-L Dish Antenna"). Instead of using a formula to establish the paraboloid, I simply laid out a scale on 1/2" plywood marking 1" points from zero to six in one direction and 4" points from zero to 24 (the dish radius) in the other direction. Draw lines from the zero-zero point to each of the six 1" points. By joining the intersection of these lines and the six 4" points on the other axis, the contour of half the dish was established. See Figure 1.

Sawing this contour from the marked plywood will produce an excellent bending fixture, as shown in Photo A. I chose to use aluminum channel for the ribs and found it, called "half-inch plywood channel," at a local distributor. When one end is clamped to the fixture, you can easily shape the channel to the fixture by using a rubber mallet. There is some springback to the formed piece, which I corrected by hand. If I were to do this again, I would deepen the curvature of the fixture enough to compensate for the springback. However, hand correction is accurate enough for this frequency range and below. Higher frequency operation might be a bit more fussy.

In my application, I felt it desirable to build a lighter unit than that described in Keith Berglund's article, while maintaining his excellent methods of attaching the ribs to a hub and providing means to attach the 1" and 3/4" sections of pipe for counterbalance and feed support, respectively. The counterbalance, in my case, is a 24" length of pipe coupled to the mounting flange with a pipe tee. The tee's purpose is to introduce coax and other wiring through a length of 3/4" PVC pipe and carry it to the feed device. The length of PVC pipe is such that the hot end of the feed device is at the focal point, in my case 24". Each end of the PVC pipe is threaded with an extra-long thread to provide for adjustment to the focal length. By using this method of supporting the dish feed, I was successful in avoiding additional feed supports. However, be prepared for your hardware man to doubt your sanity when you ask him to thread PVC pipe, since it is usually glued.

In a further effort to keep weight at a minimum, I cut pie-shaped sections of 1/4" mesh hardware cloth to fit the rib assembly so that the factory-finished edge forms the outer edge

Photo A. Plywood bending fixture.

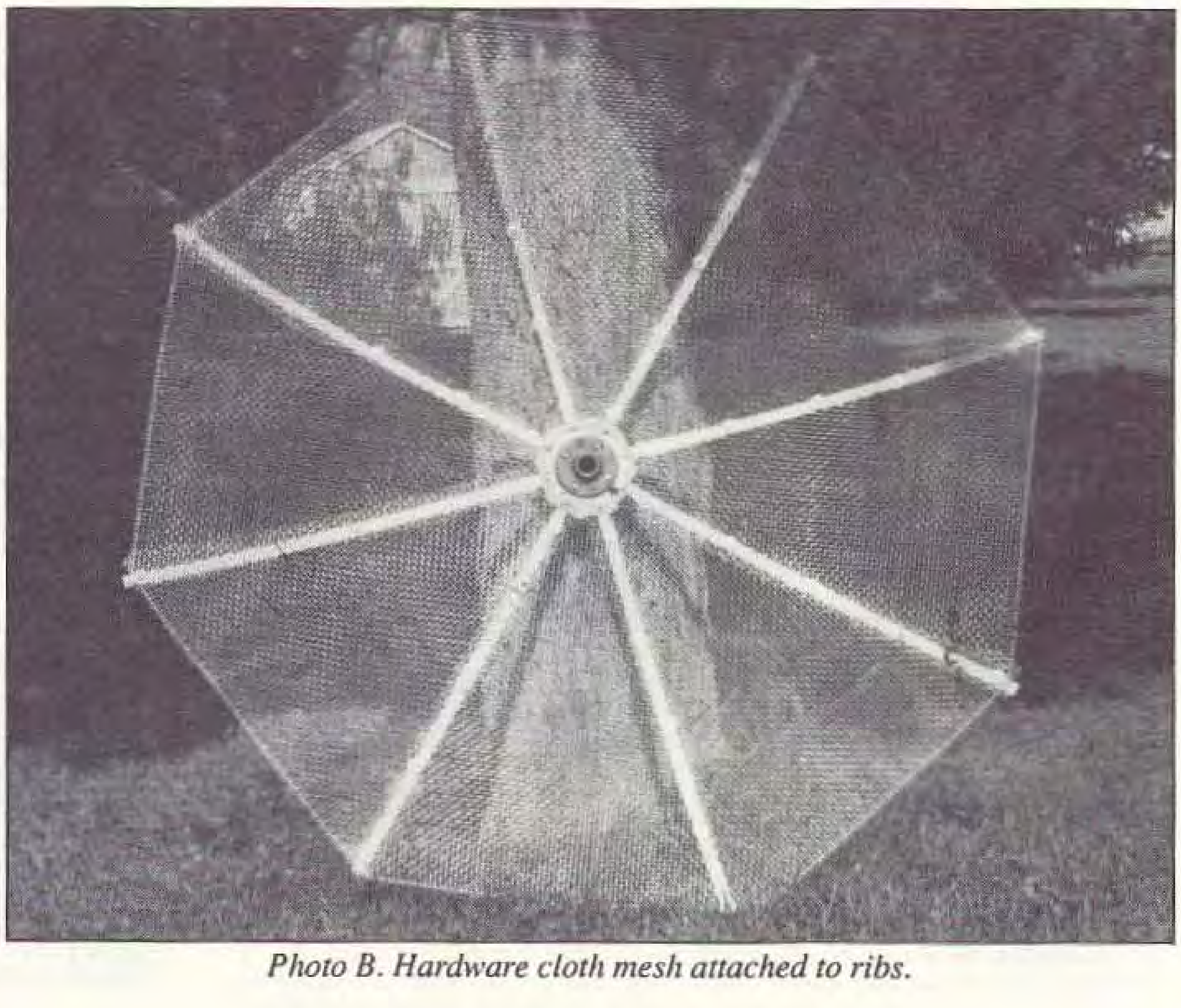

Photo B. Hardware cloth mesh attached to ribs.

of the dish. Note that these sections may be cut alternately up and down from 24" hardware cloth to minimize material usage. The sections were cut wide enough to overlap at the ribs and attached with #6 sheet metal screws and fender washers. No peripheral stiffening is necessary because the finished edge is sufficient support. This method of applying the mesh also avoids many cuts and scratches. Photo B shows the rib assembly with the mesh applied to the ribs.


Photo C. Completed dish in place on the rotating bar.

The Feed System

In choosing a feed system for this dish, I was confused by the complexity of the "feed horn" approach and could not visualize how both 2.4 GHz and 1269 MHz could function in the same enclosure. The adjustment looked tricky, and having the extra coax required for matching at 2.4 GHz bothered me. Having built several helix antennas, I thought that two concentric helices might be possible. It certainly would simplify aiming, compared to mounting two separate feeds off-center but on the same backplate. In fact, because Mode S aiming is so critical, skewing the receive antenna to compensate for off-center mounting would move the 70 cm antenna completely out of alignment. The concentric approach seemed the only way to go. Boy, did that raise some questions!

Would two helices mounted concentrically interact? With the 2.4 GHz helix being very close to a second harmonic of the 1269 helix, would it pick up enough RF to destroy the 2.4 GHz GaAsFET preamp when Mode L was being used? (I have nearly 50 watts in that Mode and it would be within 3/4" of the smaller helix.) Since I planned to run my coax and power wiring through the support pipe for the feed, would that interact with the feed system? These were questions that I could not find answers for. I could only try the system for real answers and, happily, all were favorable. No doubt I will be challenged from some corner, but the proof is that the system works.

The performance of this antenna system exceeded my most optimistic expectations. I am able to clearly hear Mode S signals that were down in the noise before, and my own signal on Mode L is much stronger than it was when I used a pair of 13-turn helix antennas. The finished dish, in place, is shown in Photo C. The construction of the feed is quite simple, as shown in the step-by step photos. Photo D is the 7" diameter backplate with the coax fittings in place. Two 9/16" holes, appropriately located on the periphery of the helix coils, were drilled to mount Type N connectors, and two other holes were drilled to secure the center tubing. The large hole was cut with a hole saw in a drill press; the others, simply drilled. The coax fittings were mounted with 4-40 bolts into tapped holes. The tubing support holes were tapped for 6-32 hardware.

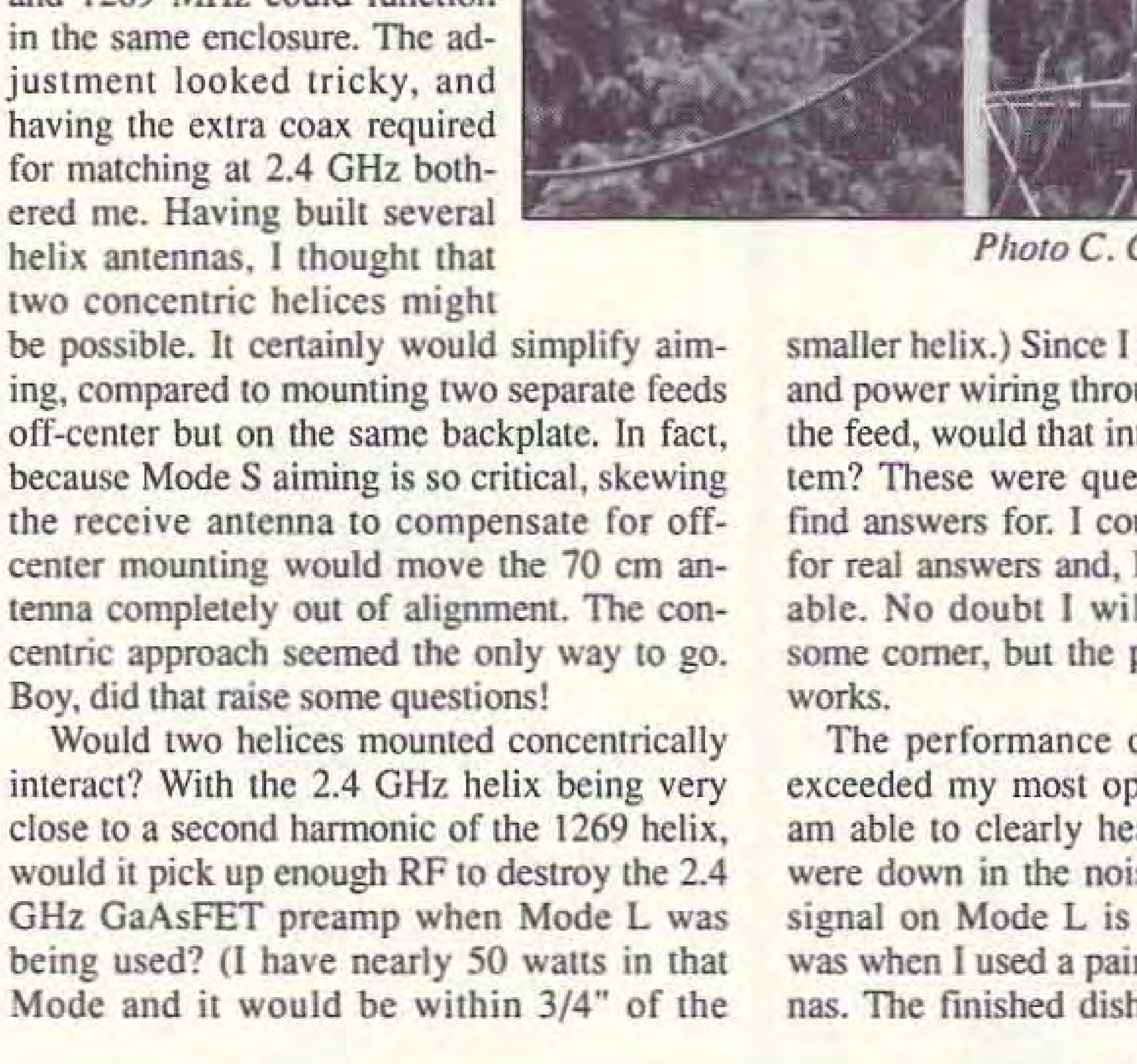
Photo D. Coax fittings in place.

The center support tubing is a 6" long, 1-1/2" diameter PVC tailpiece standard plumbing fitting cut to 3-1/2" long, leaving the flange for securement. I coated the flanged end with PVC cement, inserted it in the 1-1/2" hole and secured it in place with two 6-32 bolts and washers.

The 2.4 GHz helix is three turns of #14 wire wound as a left-hand thread on the center support. I secured the lower end by carefully soldering it to the innermost type N fitting, wound it with 1" spacing between turns, and secured it at the outer end by bending it inward through a small hole drilled for that purpose. Photo E shows the helix mounted to the tubing. A small piece of brass shim stock is soldered to the coil near the backplate for impedance matching. A 3/4" PVC pipe thread to cement joint adapter is inserted in the support tubing. There is a stop in this fitting to keep the unthreaded pipe from entering the adapter too far. I removed this stop with a 1" drill and then cemented the adapter in the outer end of the 1-1/2" tubing, threaded end out. This is the support for the entire feed system. You now have a 2.4 GHz helix feed!

The 1269 MHz helix consists of two turns of 1/4" copper tubing. I wound this also as a left-hand thread, three inches inside diameter, spaced 2" between turns. One end was drilled to slip over the pin of the coax fitting and then the coil was carefully soldered in place. I used a piece of Lucite 1-1/2" i.d. and 3" o.d. to support the outer end of the 1269 helix. After drilling a small hole in the Lucite, I tied it with several turns of plastic fishing line.

Continued on page 35

Want A Dish?

Continued from page 32

The two helices should be tuned for minimum VSWR on their respective frequencies. This is done by bending the small brass strips closer to, or further from, the backplate, measuring as you go. The finished two frequency helix feed and the brass impedance matching strips are shown in Photo F. I am fortunate in having a Bird wattmeter and slug for the 1269 MHz frequency for this purpose. I had no equipment to adjust the 2.4 GHz helix. However, since this is a receive only frequency on OSCAR 13, it is not as critical as the 1269 adjustment.

I did not include any kind of isolation of the 2.4 GHz (SSB UEK 13) converter to protect it from the 1269 MHz RF. This was a gamble that I took after discussing it with Gerald Rodski, SSB's US representative. Jerry thought that this unit was tuned tightly enough to exclude the 1269 RF. While I was able to get by without protection for the Mode S converter, a more conservative approach would isolate it from the Mode L helix by a suitable RF relay.

I am grateful to Bob Douglas W5GEL for his encouragement and counsel on my project and to Keith Berglund WB5ZDP, whom I have never met, for his excellent mechanical design. Other data was gathered from the *RSGB VHF/UHF Manual*, the *ARRL Handbook*, and heaven knows how many other references. I hope that this concept may encourage others.

Note: A kit of formed, and drilled parts ready for assembly is available for both the dish and the feed from *Majara Corporation, 408 Liberty Rd., Sturgis MI 49091; (616) 651-6394.* 73

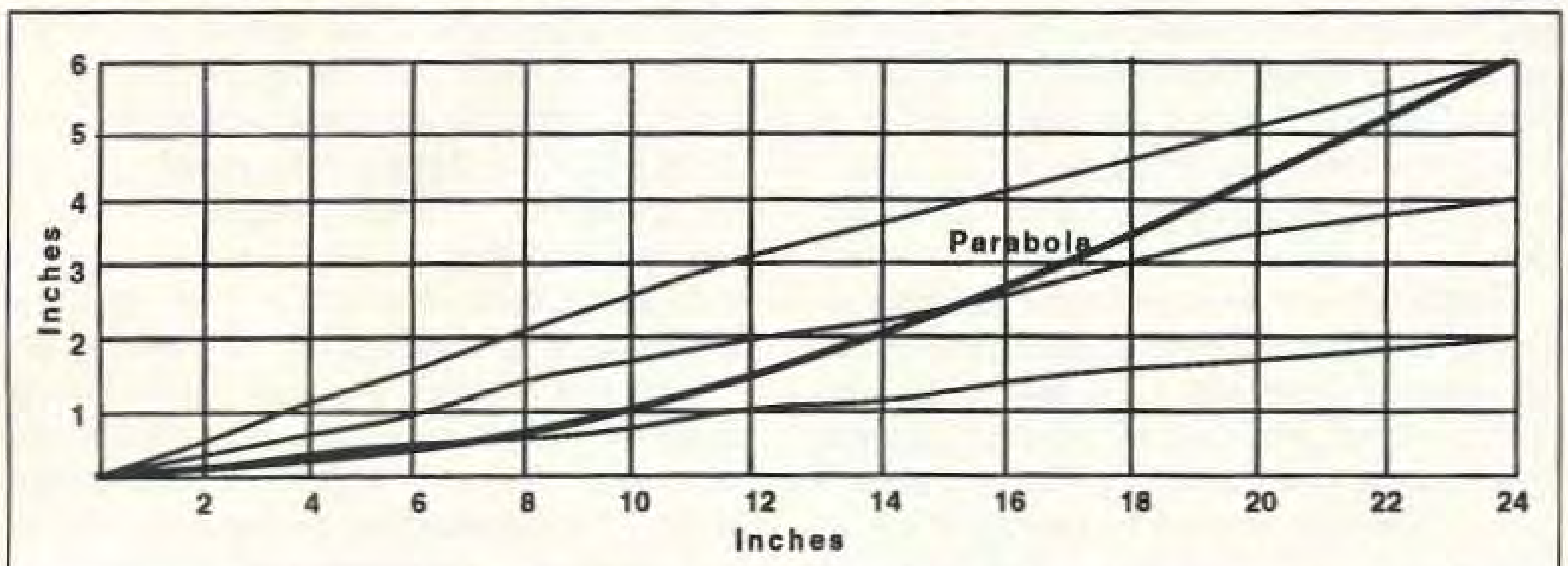

Figure 1. Parabola constructed graphically.

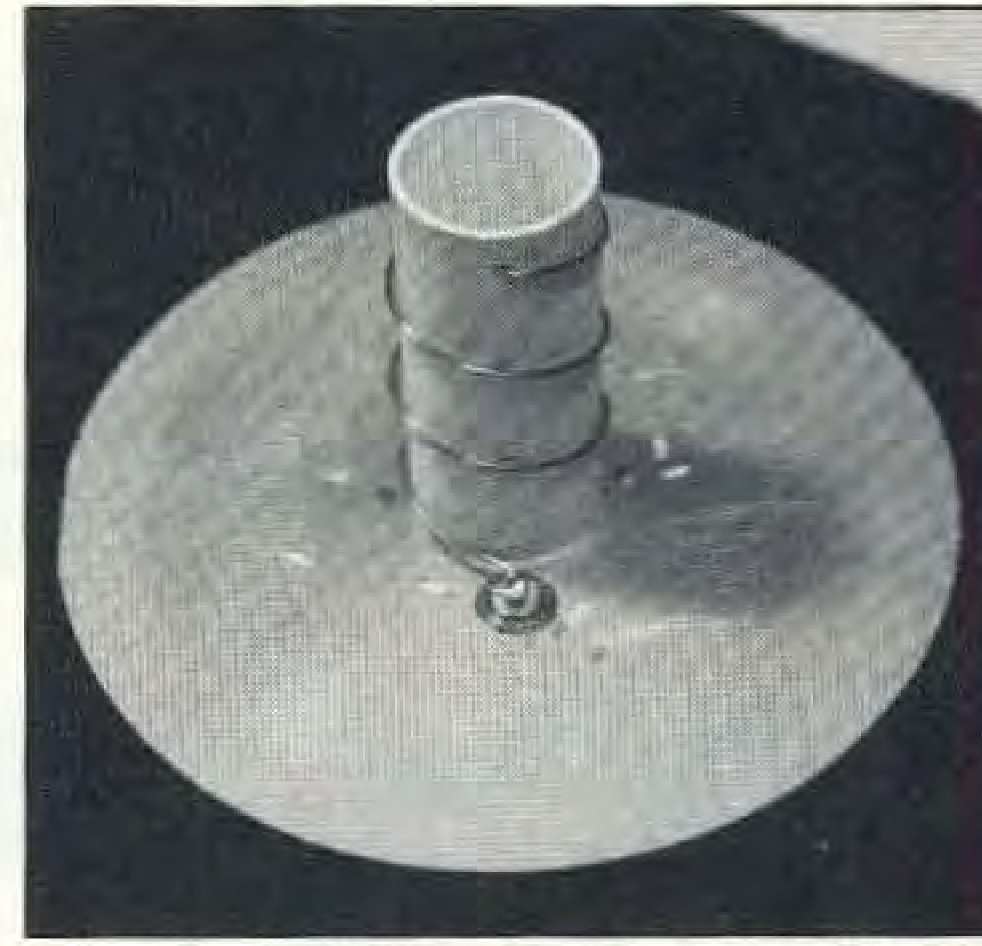

Photo E. Helix mounted to the tubing.

Photo F. Matching.