N4PC comes through with another interesting antenna design based on some fascinating history. As the song says, everything old is new again.

A Two-Band (12 and 17 Meter) Half-Square Antenna With Coaxial Feed

BY PAUL CARR*, N4PC

"What is a half-square antenna?" you may ask. That's an honest reaction, so let me introduce you to the antenna. A half-square antenna consists of two quarter-wave vertical elements spaced one-half length with a horizontal wire connecting the tops of the quarter-wave elements. That sounds like two-thirds of a bobtail curtain, doesn't it? Yes, you are right. It is a simple, economical DX antenna that works great, and its history is almost as interesting as the performance of the antenna. Read on.

A Brief History of The Half-Square Antenna

Chapter 1. The half-square antenna was designed, modified, an article published, and then discovered. That sounds unlikely, but it's true. The antenna was designed by Woody Smith, W6BCH, shortly after WW II. Woody had experimented with an inverted ground plane prior to the war, and his thought was of extending the concept to two or more elements. The antenna consisted of a full-wave wire bent at a quarter wave from each end in an "upside down U" configuration. (We know this as a half-square antenna configuration.)

A problem arose. Before Woody could build the antenna, he had to move. He tried to interest some of his friends in building and testing the antenna. The reaction was universal: Nothing that simple could be any good. If it were any good, someone else would be using it!

Facing rejection, Woody tried a more elegant version—three vertical radiators instead of two. This was the birth of the bobtail curtain. Reports began coming back—great DX performance on 40 meter DX, especially beyond 2500 miles.

The original article "Bet My Money on a Bobtail Beam" appeared in the April 1948 issue of *CQ*. Reader response was great. Some readers reported great results although they had only enough room for two vertical elements. I'm sure Woody smiled.

Chapter II. Ben Vester, K3BC, had built an 80 meter version of the bobtail curtain in the early seventies. He found it to be an excellent DX antenna, but Mother Nature played a trick on him. During a storm the horizontal phasing line was broken near the center vertical radiator. Ben, without knowing, had Woody's original antenna design—two vertical radiators connected by a horizontal phasing line. Ben concluded the antenna's great performance was primarily due to the low angle of radiation instead of the additional gain of the third element. He named his discovery "The Half-Square Antenna" and reported his results in March 1974 *QST*.

Chapter III. Enter Jim Stevens, KK7C. While Jim was living in an apartment in Europe, he began to search for an antenna to use on the path from Europe to the United States. Ben Vester's article caught his eye. The design had good points and bad points. On the plus side, it was a low-angle radiator, small size (only one-half wavelength horizontally), easy to install, and economical. The bad point: How to feed the antenna and make it ground independent. Jim concluded that one-quarter wavelength from the end of the radiator there was a low-voltage, high-current point. The impedance at this point should have been about 50–75 ohms, and furthermore, this was a convenient point to attach a coaxial feeder. He tried the arrangement, and it exceeded his expectations. Jim had a winner.

Chapter IV. How do I fit into this history? Well, I built a 40 meter half-square antenna to use as a companion antenna during the test of "The N4PC Loop Antenna." I fed the antenna at the junction of the vertical element and the horizontal phasing line as Jim had done, but I used a balanced feeder instead of coax. I matched the system at my station using a transmatch. The antenna proved to be an excellent performer, but after the tests were concluded, the half-square was removed to make room for other experiments.

The half-square would not stay down. Gus Hansen, KBØYH, and I began to experiment with a 17 meter version of the antenna. We had both built versions and compared notes during our many QSOs. I built two antennas—one fed with coax and a second fed with balanced line. These antennas were placed perpendicular to each other, so by switching antennas in the shack, the patterns could be verified. The antenna fed with balanced line could be matched on other bands to determine the feasibility of a multiband half-square. This gave rise to another question: Could this antenna be made to work effectively on 12 and 17 meters with a single coaxial feed? I ran patterns and impedance tests on the 17 meter antenna using an antenna analysis program. The results were used as an input to a computerized Smith chart. The Smith chart showed that if I placed a half-wave stub of 300 ohm balanced line at the feed point, at the transmitter end of the stub there would be a close match to 50 ohms—on both bands. Guess what? It works.

Predicted Results

A glance at the predicted patterns might be in order.

17 Meters (see fig. 1). The horizontal pattern is very similar to that of a half-wave dipole. The pattern is comprised of both

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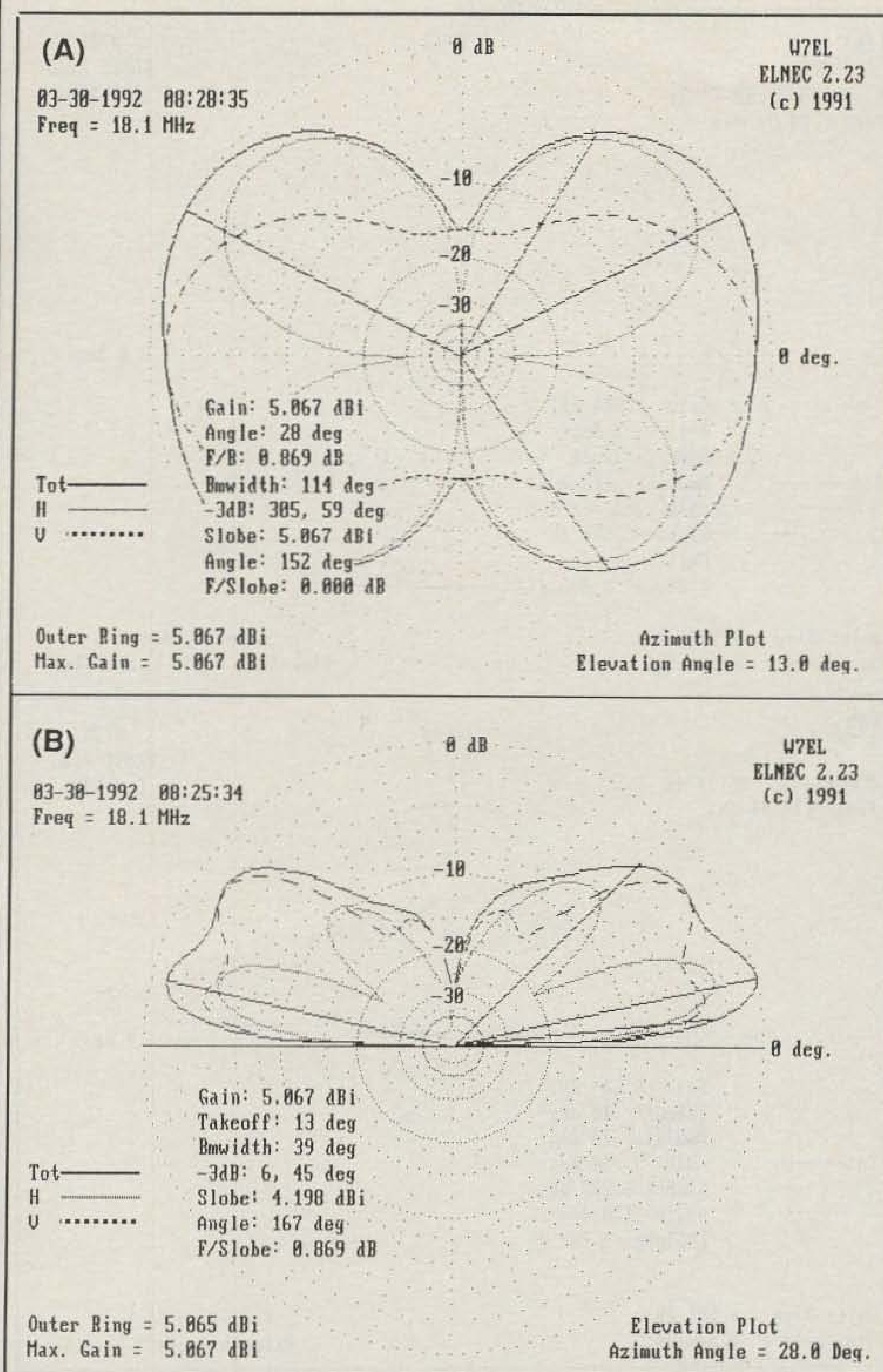

Fig. 1– (A) Azimuth plot for 17 meters. (B) Elevation plot for 17 meters.

vertical and horizontal components, and it is slightly skewed due to the feed point being at the junction of a vertical element and the horizontal phasing line. It also has a broad horizontal beamwidth. The vertical pattern also shows the vertical and horizontal components.

12 Meters (see fig. 2). The horizontal pattern has become less like that of a dipole and is approaching omnidirectional. If you double the predicted beamwidth (the pattern is symmetrical about the phasing line) there are 244 degrees between the 3 dB points. This occurs because the separation between the vertical elements is about 0.7 wavelength.

The vertical pattern shows more contribution from the horizontal component, which indicates there is more radiation from the phasing lines. The predicted angle of maximum radiation is one degree less than a dipole at the same height as the phasing line.

Construction and Tuning

Perhaps a short word picture of what we're about to build is in order (see fig. 3). Pic-

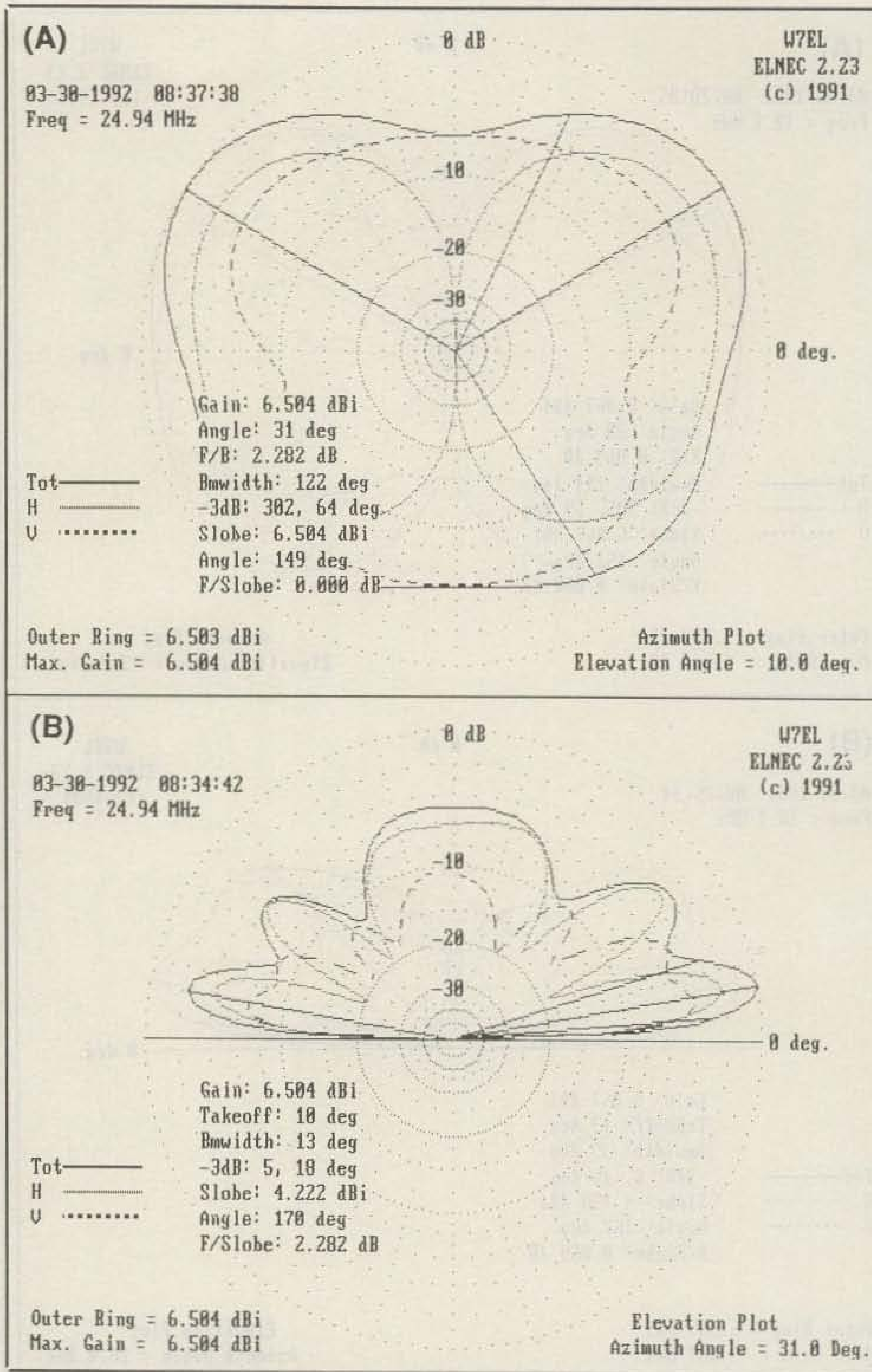

Fig. 2– (A) Azimuth plot for 12 meters. (B) Elevation plot for 12 meters.

ture this: an inverted "U" with two vertical elements one-quarter wavelength long and the horizontal phase (line at the top) at one-half wavelength. The antenna is supported by halyards attached to insulators in the corners. The system is fed in one corner where the vertical element meets the horizontal phase line. The feed line is routed along the halyard for about one-quarter wavelength. Specifically, this is how you build it.

Start by spreading two insulators to support the pattern. Next cut a piece of wire about 41 feet long. Measure 13 feet 6 inches from one end and fold the wire back on itself. Push the folded wire through one hole of the insulator far enough to allow the insulator to pass through the wire loop. Pull the slack out of the wire, forming a cinch knot on the insulator. Secure this cinch knot with a nylon cable tie. Trim off the surplus cable tie.

Now measure 27 feet 9 inches from the insulator. Allow enough wire to pass through one hole in the second insulator. If you are using insulated wire, remove enough insulation to allow for subsequent soldering to the feed line. Cut another wire 13 feet 9 inches and pass this wire (insulation removed if necessary) through the

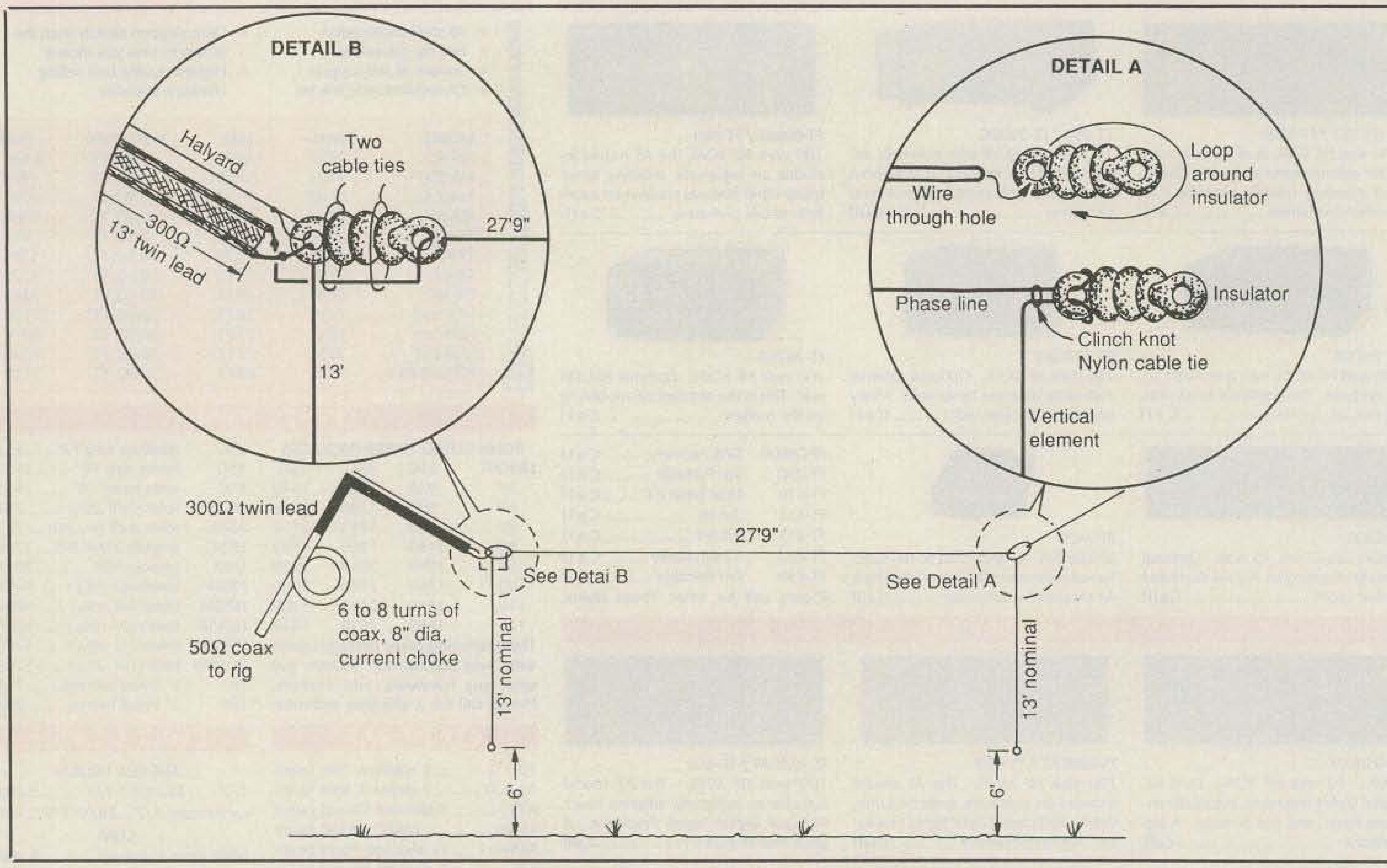

Fig. 3– Details for two-band half-square wire antenna.

second hole of the insulator. The halyard will also connect through this hole. Temporarily connect a 50 ohm coax to this junction with the center connector to the phase line and the braid to the certical wire. Attach halyards to the insulators and route the coax out its halyard about 13 feet. Make a loop in the halyard and attach the coax. This will keep the coax out of the antenna pattern. Hoist the antenna high enough into the air so the ends of the vertical elements will be about 6 feet off the ground. Route the coax to your rig and supply enough power to get an SWR reading. Trim the vertical elements by removing equal lengths from the vertical elements to get a resonant condition at 18.1 MHz. The SWR should be very close to 1:1. Lower the antenna and remove the coax.

We now construct the matching stub. Cut 23 feet 6 inches of good-quality 300 ohm TV twin lead. I used TV lead with a velocity of 0.82 (Belder 8230). If the twin lead you use has a different velocity factor, compensate accordingly. Attach the twin lead at the point where the coax was attached and solder the connections. Secure the twin lead to the insulator with nylon cable ties. Route the twin out the halyard and attach it as you did with the coax. Make a current choke by placing about six to eight turns of coax into a loop about 8 inches in diameter. Try to keep the first and last turns of the coil separated. Use electrical tape to secure the coax to the twin lead by twisting the conductors together. Be sure that the center conductor of the coax attaches to the side of the twin lead that goes to the phase line.

Again, hoist the antenna into the air. Tune your rig to 24,930 MHz and check the SWR. Trim the twin lead for the best match on 12 and 17 meters. With careful tuning of the phase line and vertical elements, you should be able to obtain an SWR of 1.5:1 or better on both bands. After you have assured yourself that you have achieved the best SWR on both bands, solder the coax to the twin lead and waterproof the connection. I suspended 1 ounce fishing weights to the vertical elements with nylon twine to remove any curl in the wire. Hoist the antenna into the air and that's it.

On-The-Air Results

The results have been very gratifying. It seems strange for me to hear signals from New England and Europe at the same signal strength. I have had many long ragchew QSOs on both bands while running QRP. A standard comment seems to be "I can't believe you're running only 5 watts output to a pair of phased verticals." I smile.

Afterthoughts

The two computer programs used during the design phase were ELNEC by Roy Lewallen, W7EL, and MicroSmith by Wes Hayward, W7ZOI. I used ELNEC for the antenna analysis and MicroSmith to solve the matching stub problem. These are two excellent design tools for the modern ham shack.

Acknowledgements

I would like to thank Lew McCoy, W1ICP, my technical editor, who has always tried to keep me headed in the right direction. Gus Hansen, KB0YH, and Jim Stevens, KK7C, were quick to supply encouragement and in Jim's case, a field trial. I owe a special debt of gratitude to Hal Stahlhut for supplying historical data without which I could not have written about Woody Smith's early efforts. And thanks to Woody Smith, W6BCX, for a great antenna.

As with previous articles, I will try to answer all letters (SASE please).

The half-square is a great, simple antenna. Give it a try. You may be surprised.