Huge antenna systems such as this one boggle the minds of most of us. Some of us will be emerald green with envy, and a few will be angry at the apparent (to them) opulence. Most of us, however, will rejoice in the fact that making dreams come true is still quite possible and certainly worth doing.

A Super Antenna System
28 Elements on 75 Meters

BY MIKE LAMB*, N7ML

In my early Novice days in 1958, I remember listening to a fellow amateur, "Johnny," who lived on a 1400 foot hill outside my town of Longview, Washington. Johnny had a massive Sterba Curtain array for 15 meters and would ragchew with Europeans on 15 meters AM, giving them 59 reports. I had a Hallicrafters S-38D receiver and a 75 foot "long-wire" antenna. I remember putting my ear right on top of the receiver speaker and turning the volume control wide open. I could not even hear a whisper of the stations with whom Johnny was ragchewing.

Even though over 40 years have passed, I can remember thinking to myself that someday I really wanted to have a station and antenna "like Johnny." I had all but forgotten about that "commitment" until about four years ago, when I erected my two 190 foot rotating towers with six stacked triband Yagis and three stacked 40 meter 3-element monobanders. One day when I was working a big pile-up of Europeans on 20 meters, I was thinking about just how much fun I was having and had this flashback to the days of listening to Johnny doing this many years ago. It was then I realized that I had set a sub-conscious goal for myself that had long since been forgotten but finally was being met!

After playing with the higher frequency bands and enjoying the pile-ups the six-triband stacked array (see October 1995 *QST*) created, I decided to try the 75 meter band, where DXing is dominated by a relatively few Big Guns out here in the western states. My first attempt was a four-element Lazy-Vee array which is electrically similar to a four-square vertical array. That antenna did very well for me, but I was still not competitive with the top tier out on the West Coast.

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Enter The Computer

In the spring of 1997 I purchased Brian Beezley's AO antenna modeling program. I spent a couple months trying every configuration of wire antenna I could think of that fit on my existing towers and property. I tried inverted-Vee Yagis, more vertical dipoles, vee beams, bi-squares, etc. One of the problems with computer modeling programs is that you never seem to settle on the perfect design for your real-world restrictions.

Finally, during the summer of 1997 a 5-element quad array (two 3-element quads with a common reflector) was erected from a catenary rope strung between the 180 foot points of my two 190 foot towers. I literally spent most of my spare time over a two month period trying to tune the quads for maximum front-to-back rejection. That antenna did a very good job, but the noise level was very high and I was still not competitive with the fellows having the new well-tuned, inductively loaded 3-element Yagis on the West Coast.

Introducing WA2WVL

After putting up my quad array, I started working the VK's and ZL's in the 75 meter DX window with good results. Although I was getting respectable reports, several of them told me of Floyd, WA2WVL's superior signal out in New York State with his monster nine-element array described in the *ARRL Antenna Compendium #4*. His signal was even stronger than the Big Gun signals on the West Coast! Floyd used a single catanary like I already had installed between my two towers with diamond loops for reflectors and switchable driven elements.

Impedance curve for European 14-element array displayed by the AEA CIA-HF Complex Impedance Analyzer and Amidon 1.5 to 1 unun transformer for matching directly to 75 ohm hardline.

Back To The Computer

Having more experience with the computer modeling program, I decided to go back and try it again. This time I used the shift and rotate commands, which allowed me to more accurately model sloping wires. After several weeks of trying everything I could think of, I finally settled on using the same catenary I used for the quad array, but for supporting two 7- element wire Yagis that were placed side by side and sloping away from the catanary (see fig. 1).

N7UA and K6UA each use a six-element Yagi composed of two side-by-side 3-element Yagis, horizontal over ground. Both Dale and Bob are at the top of the pecking order on 75 meters with their arrays. If I had four towers, I could have had both Yagis parallel to ground and that would have added about 2 or 3 dB of additional gain. However, sloping wires was the best I could do.

After spending an additional week optimizing the double Yagi design, I wound up with about 15 dBi gain over ground at an angle of 20 degrees and a front-to-back ratio in excess of 30 dB according to the computer. This is about 3 dB better than the quad array according to the computer. However, I don't think that the quad array was properly tuned, and therefore I suspect I may have over 5 dB of actual gain over the old quad array. Because of a high power-line noise problem, I chose to optimize the front-to-back performance at the expense of about 0.5 dB less than maximum gain.

The new 14-element Yagi array design calls for feeding the two driven elements from the ends where they come together at the center catenary. The drive impedance is very high—about 12,500 ohms. Thanks to suggestions from K6UA and N7UA, I decided to feed the driven elements with open-wire feedline that I made using 14-gauge copper wire and Delrin 1/4 inch rod stock. Utilizing a new prototype product from AEA called the CIA-HF complex Impedance Analyzer, I tuned a 3/4 wavelength piece of open wire feeder for 3.795 MHz. By placing a short at the opposite end of the feedline from the antenna feedpoint, I reflected a high (close to infinite impedance) back to the antenna.

At the ground level I have a 550 foot length of 70 ohm hard-line going back to the operating shack from a remote antenna switch. Various lengths of RG-11 coax from the antenna switch feed each of my 75 meter antennas. In order to match the 70 ohm coax to the open-wire feeder, I again used the CIA-HF to find the 70 ohm point on the open-wire feedline by tapping up from the short toward the antenna. In order to utilize the 50 ohm CIA-HF, I used a new Amidon 1.5:1 unun which converts 70 ohms to 50 ohms and placed it directly between the open-wire feeder and the

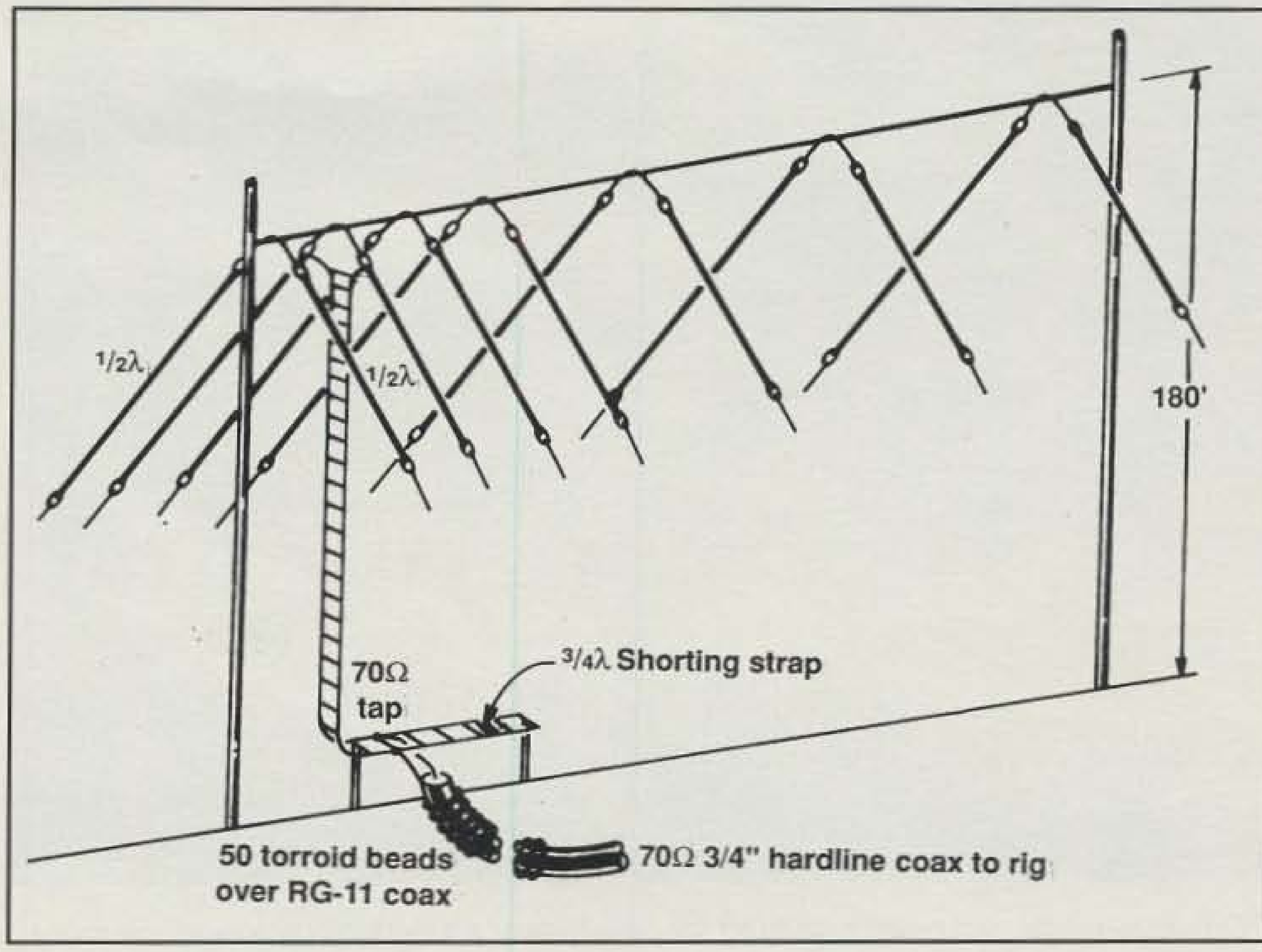


Fig. 1– The 14-element wire Yagi array for 75 meters (composed of two 7-element Yagis, side by side).

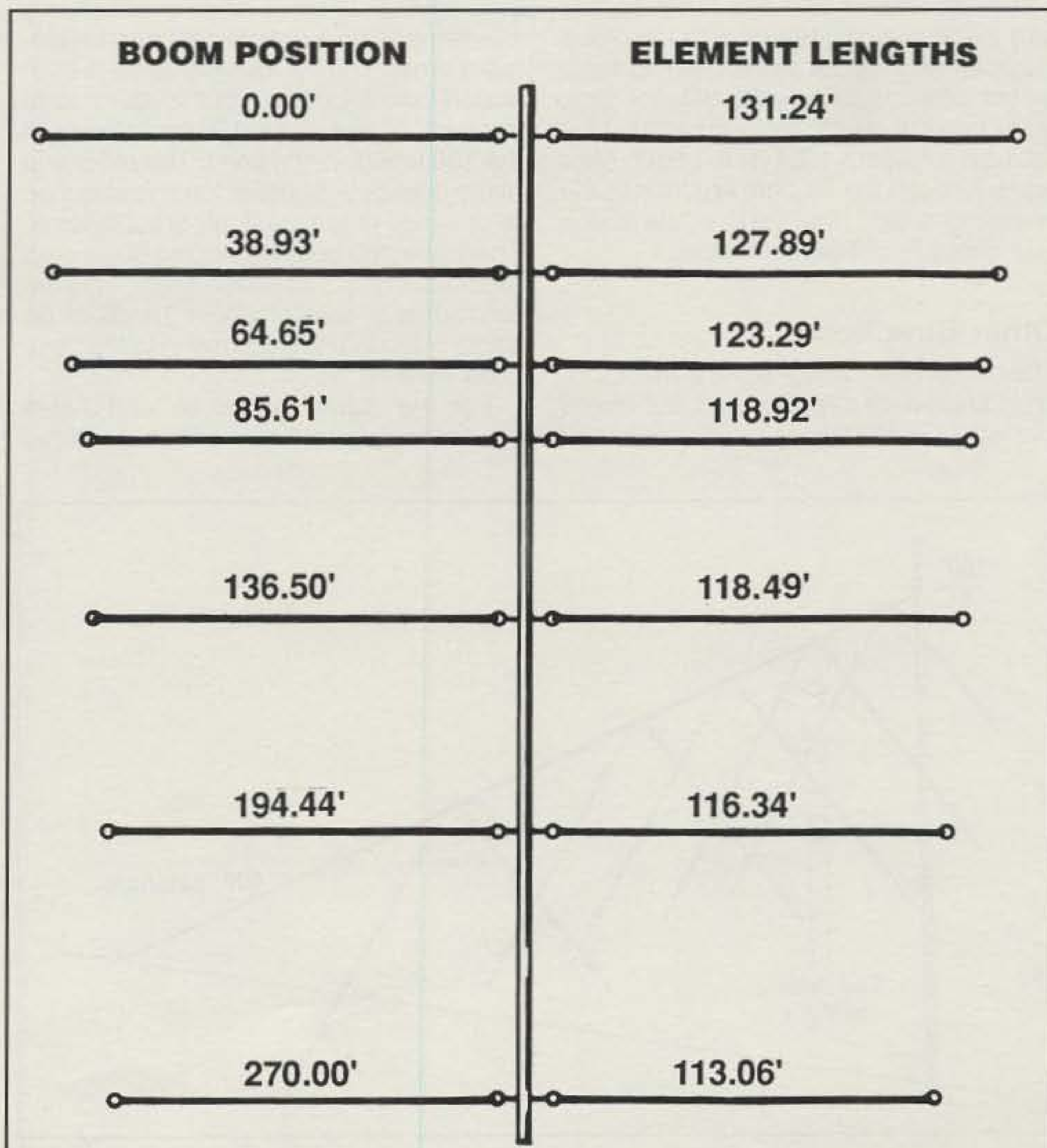
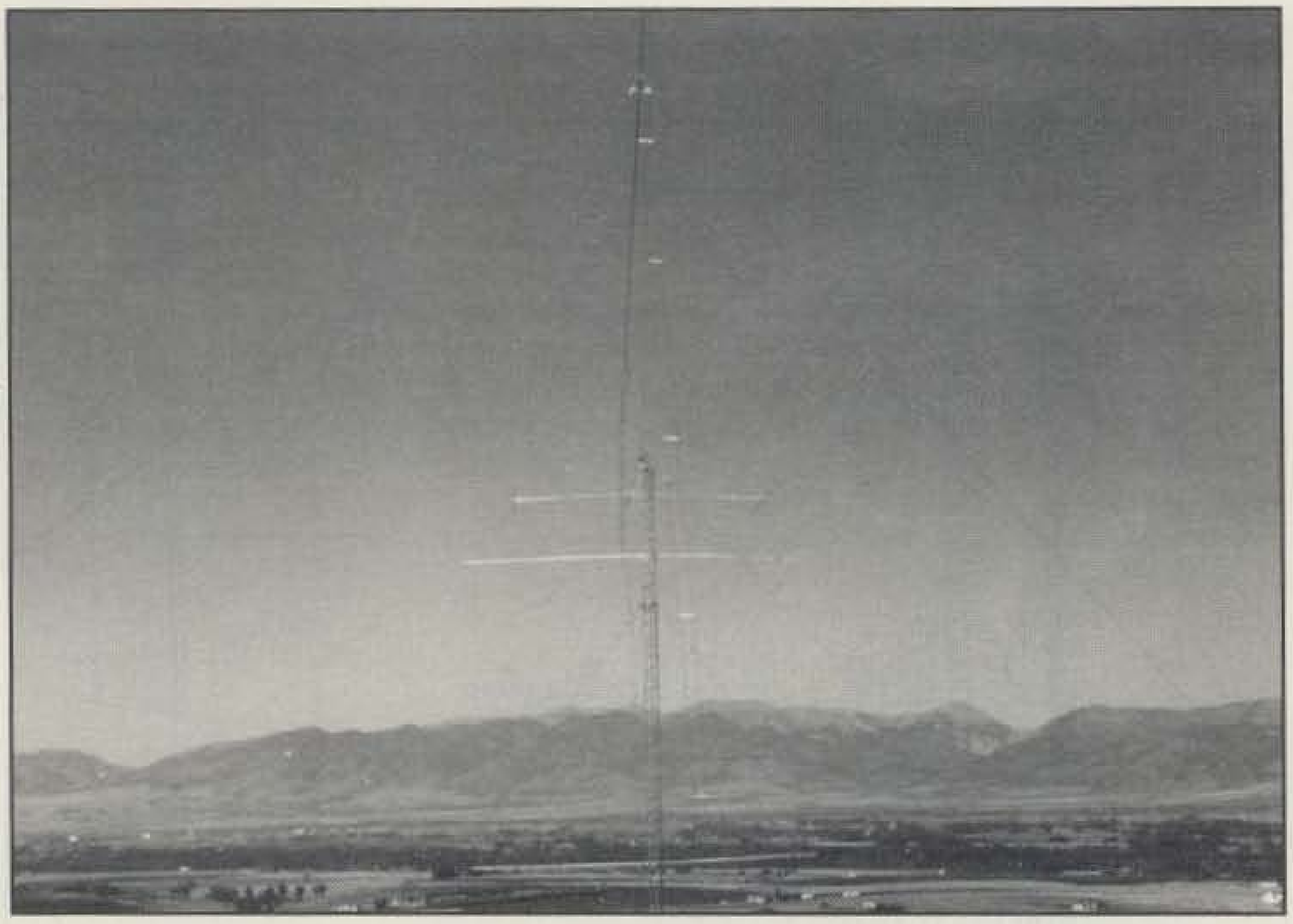


Fig. 2– Element lengths and boom positions for the 14-element array.



Driven element and open-wire feed for 14-element array (looking toward Europe).

CIA-HF. Using the CIA-HF, I simply used a coax connector with two short copper wire leads and alligator clips to tap along the open-wire feeder and a shorting strap farther down the line with alligator clips until I had the lowest SWR possible. I set the taps for about 1.2:1 in the field. After going through the 70 ohm feedline to the operating shack, the SWR in the shack was about 1.05:1 at resonance.

Other Directions

The 14-element array covers the European short-path direction well, but I need two other antennas to cover the other parts of the compass. For the European long-path direction, I have assembled a 10-element array similar to the 14-element array. The 10-element array is supported from a catenary that is attached to the back of one of the 190 foot towers at the 180 foot guy-ring point. The other end of the catenary (600 feet long) is attached to a steel fence post at ground level. Therefore, the boom is sloping downward at about a 12 or 15 degree angle. This antenna has a gain of about 13 dB at an angle of 24 degrees according to the computer (see fig. 4).

For the South American and Asian directions, I use a 4-element Lazy H array with the upper elements at 195 feet supported from masts coming out of the tops of the two towers. The lower elements are supported at the 60 foot level. This antenna gives about 12 dB gain at 14 degrees elevation according to the computer. My towers are on a ridge that falls away about 200 feet at a distance of about four wavelengths. Plugging this into the computer gives a gain of about 13 dBi at a wave angle of 8 degrees. The Lazy H is bi-directional and therefore has a much higher noise level than the Yagi arrays, but it sure transmits well.

In order to cover all points of the compass, I am using 28 elements. If I phased them all together, do you suppose I could have a good omni-directional radiator?

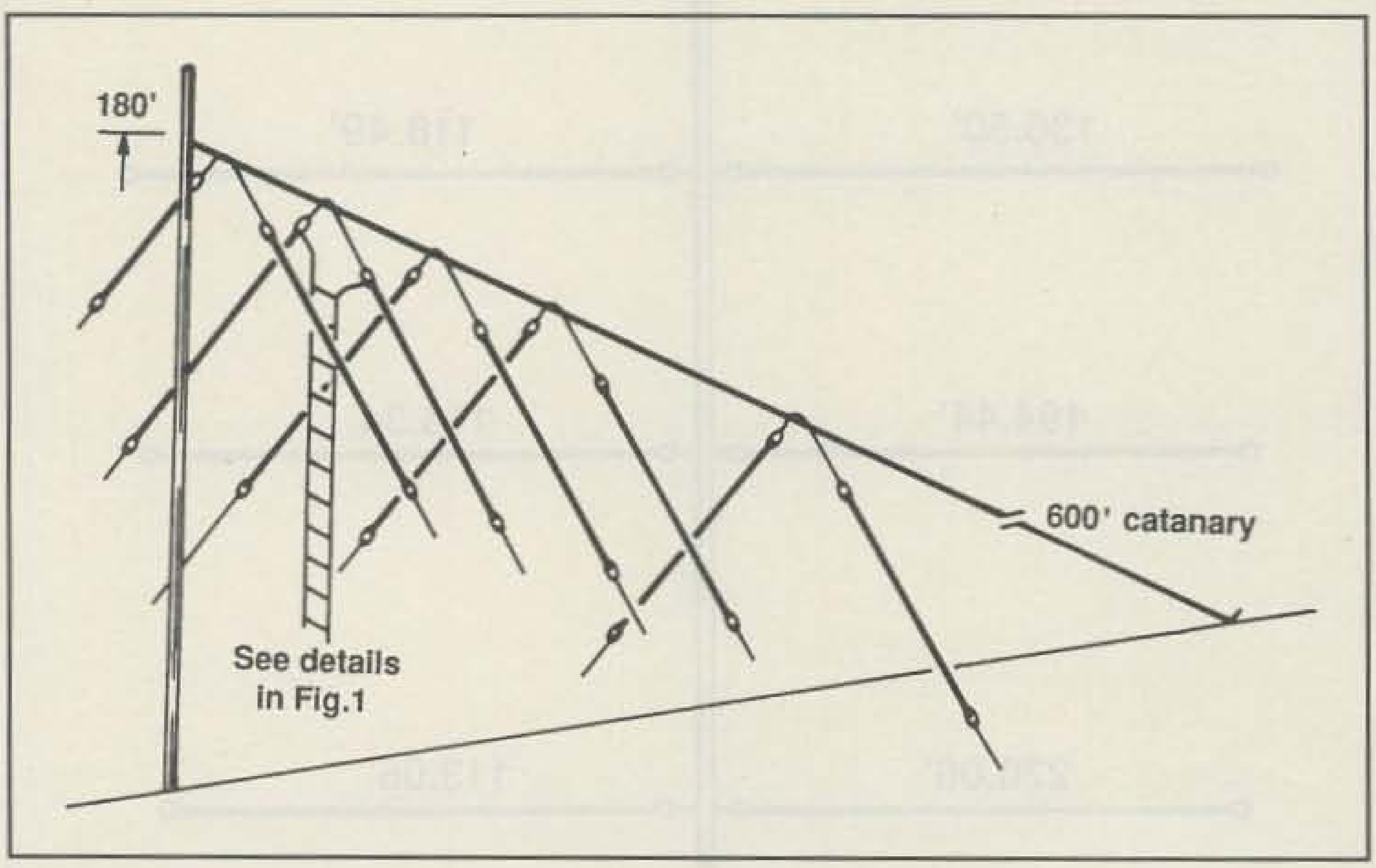


Fig. 3– Pictorial of the 10-element sloping wire Yagi (composed of two 5-element Yagis side by side).

CW Band

The two Yagi arrays are very narrow banded (about 45 kHz between 2:1 SWR points) because of their massive size. Because the activity level on 75 SSB is so much greater than 80 meter CW, I chose to design the antennas for 75. Checking with the computer, it was noted that if I tuned the 14-element array to the bottom of the 80 meter CW band, I had a bi-directional pattern with slightly more (about 0.6 dB) gain off the back. The forward gain is about 9.8 dBi over ground at about 24 degrees elevation angle. The advantage is that I can cover both long and short path to Europe with one antenna. The disadvantage is that the noise level on receive is much higher than when the antenna is tuned for the SSB band. To accommodate tuning the 14-element array to the CW band, I replaced the SSB short on the open-wire feeder with an SO-239 connector that will accept a shorted PL-259. Then I placed another short farther down the open-wire feeder away from the antenna. I tapped up from the short toward the antenna for a 70 ohm point.

To go from CW to phone, I simply go out into the antenna pasture and move the coax from the CW tap to the SSB tap and plug the shorting PL-259 into the SSB shorting position. I leave the shorting PL-259 tied with a short rope to the open-wire feeder so that it is never lost. The shorting strap for the CW position is soldered in place because it does not affect the SSB tuning beyond the SSB shorting plug.

Results

Upon putting the antenna on the air, I found that winter conditions on 75 had deteriorated significantly. However, when I found European signals they gave me excellent reports relative to other Midwest and West Coast stations. When comparing receive signals to a single vertical dipole, I could see about 18 dB of improvement with the 14-element array. The old 5-element quad array usually gave me

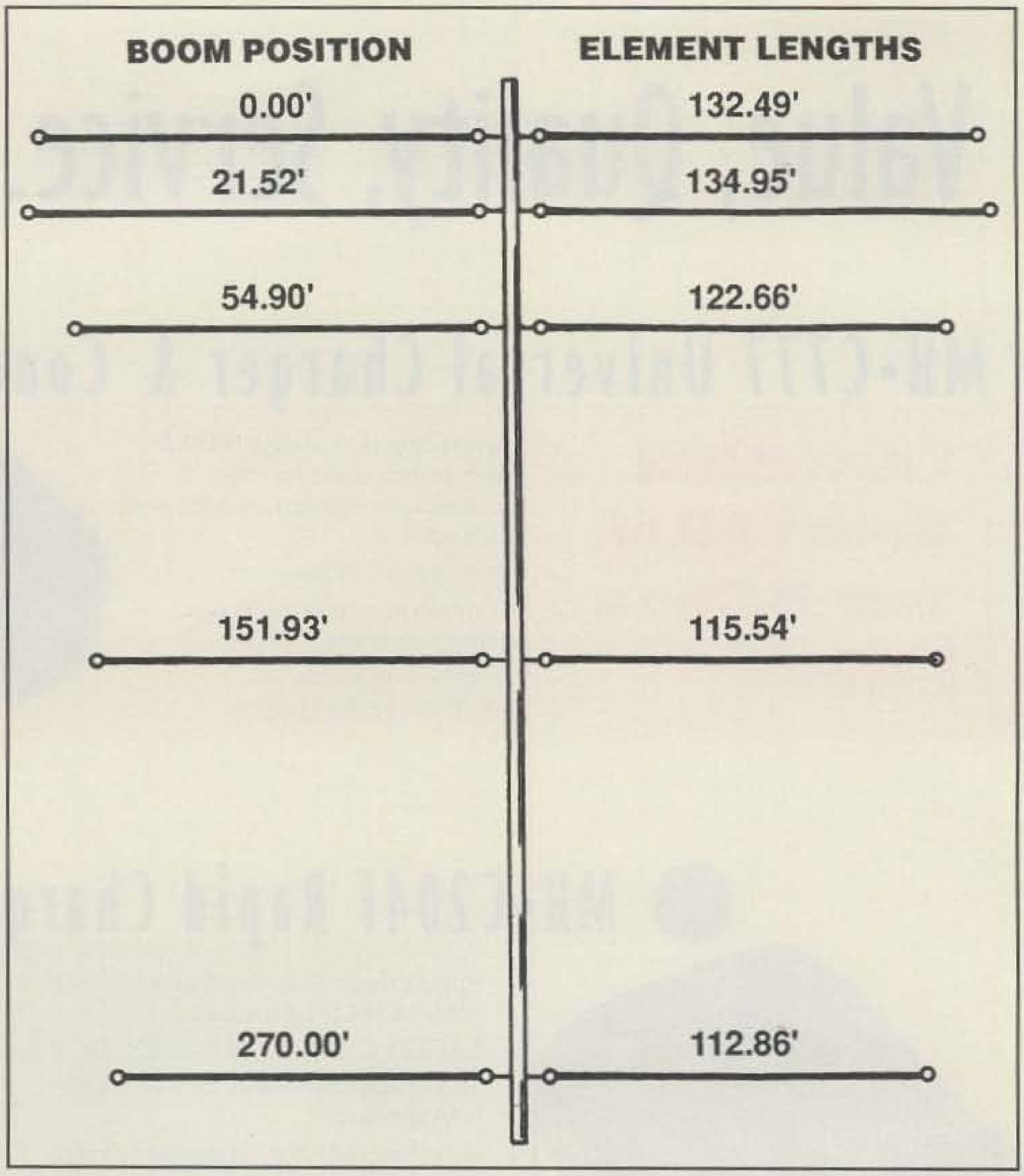
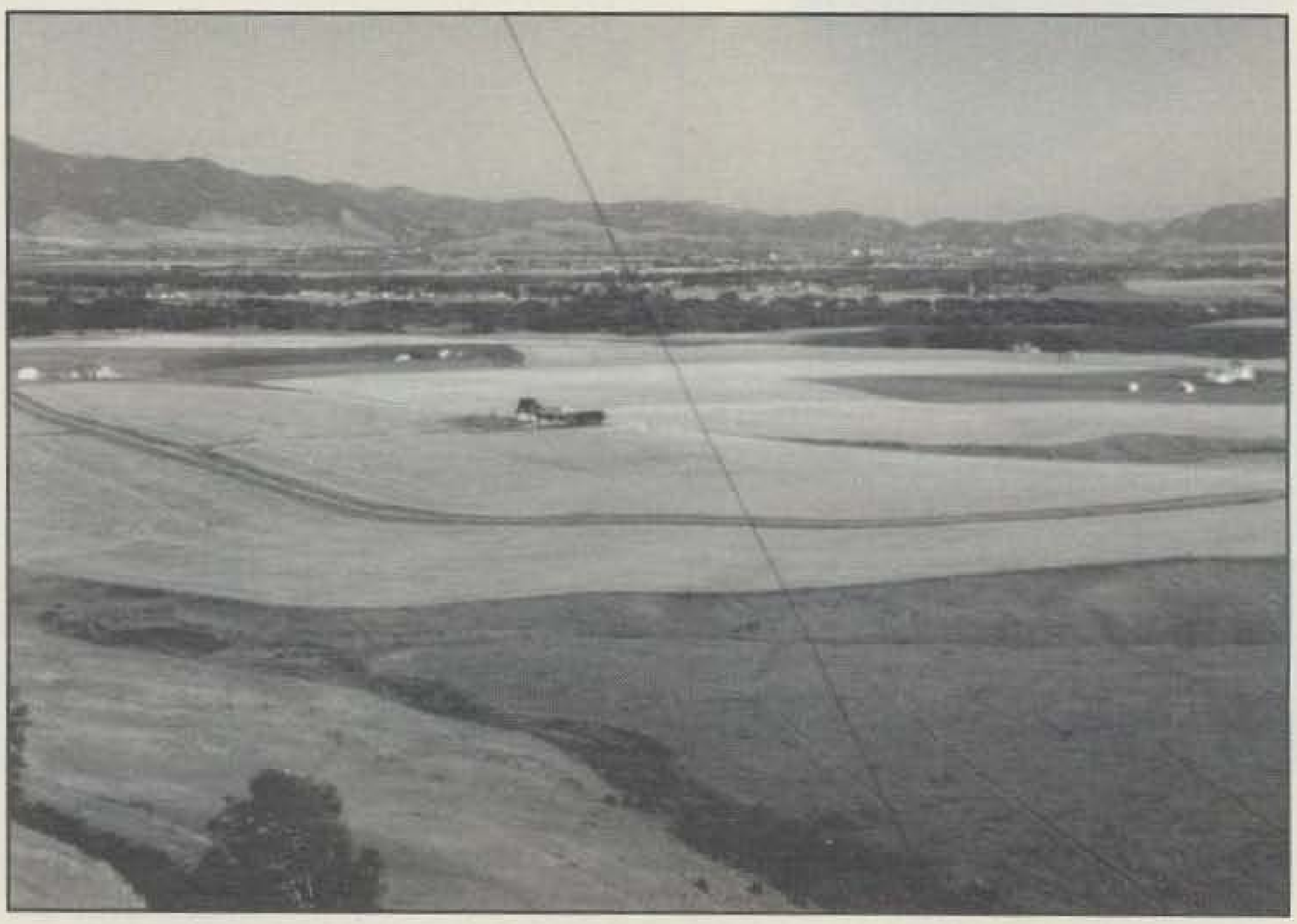


Fig. 4– Element lengths and boom positions for the 10-element wire array.



View toward Africa from the top of the Lazy H. The valley floor drops 400 feet from the base of the 190 foot towers.

only about 10 or 12 dB of improvement over the dipole. Perhaps the biggest improvement I have noticed so far is that the noise level on the 14-element array is about two to three S-units lower than with the old quad array. That has made a big difference in my ability to hear the weak signals out of Europe, but it has also made it much more difficult to be heard by the stronger stations when conditions are poor (I hear them with a much better signal to noise ratio, but I have only improved my transmit signal by less than half as much.).

Recent reports on the band during the very beginning of the season are netting me signal reports that are as big as any I received at the very peak of the season last year. This is a very good indication that things are indeed working as well as the computer would suggest.

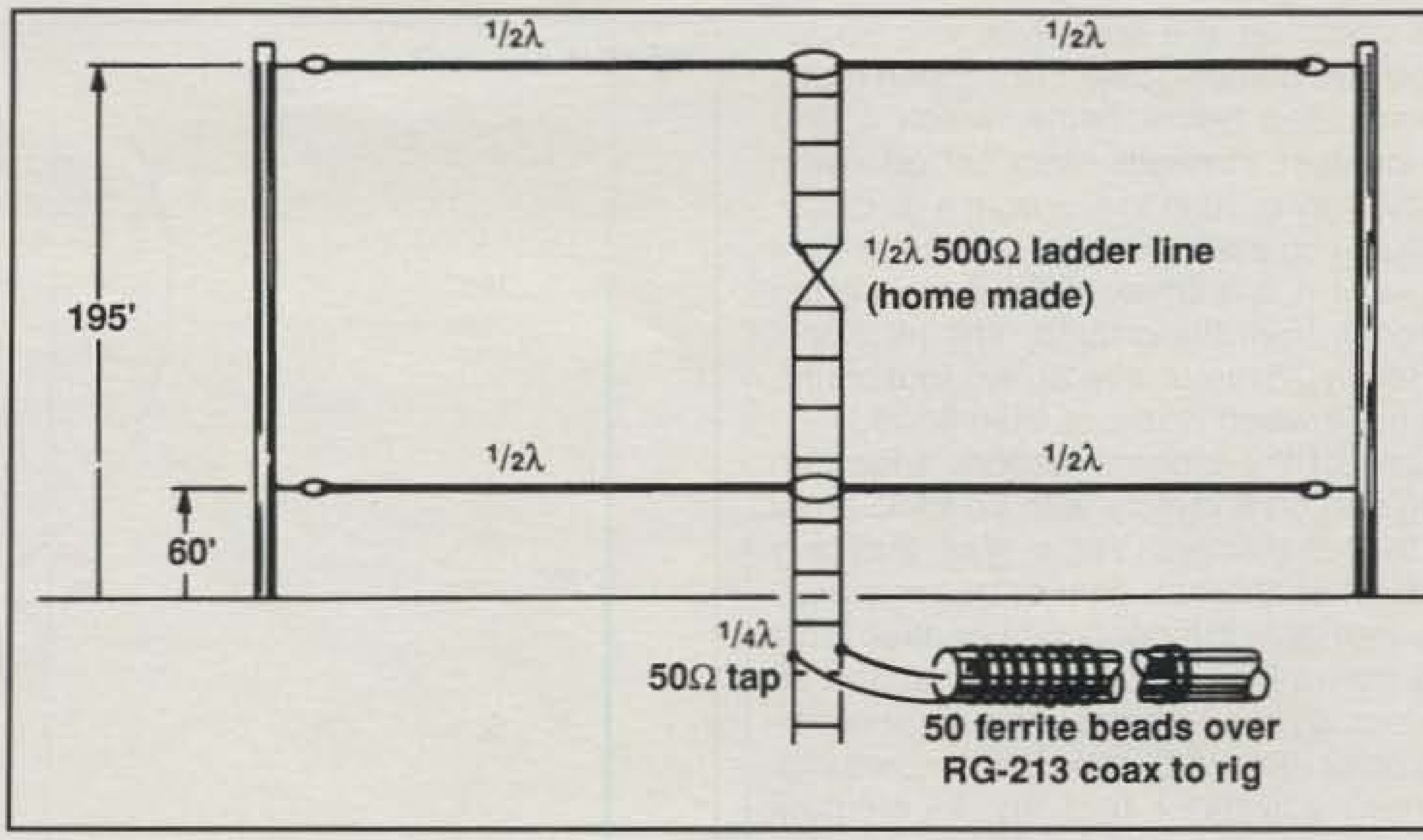


Fig. 5– The basic 4-element Lazy-H array.

Other Comments

I am very pleased that when I planned my original tower installations, I used Phillystran dielectric guy line. Otherwise, I doubt that my wire arrays would be very effective.

There are always trade-offs with whatever antenna installation one chooses. The switchable wire arrays on 75 meters afford me the opportunity to quickly switch between quadrants to find out which direction a weak station is coming from or to check front-to-back ratios. The disadvantage is that I have four nulls between the four lobes that are 10 to 12 dB down from the peak lobes. That means I have the equivalent of a high dipole or a four-square vertical array for the null directions. Fortunately, there is little DX in those directions, so I don't find it to be much of a problem.

I wanted to keep the large arrays as inconspicuous as possible for my wife and neighbors. To do that, I used #14 gauge electric fence copper wire I bought from the local Farm and Ranch Supply store. I pre-stretched the wire with my tractor about five percent (5%). For support ropes I purchased Seine Twine, which is 350 pound test strength black-tarred nylon that is very difficult to see from a distance. Unless you catch the sun at just the right angle, it is extremely difficult to see the antenna from the ground. The total cost for all my 75 meter wire arrays (not counting the towers) was less than $500.

One of the biggest lessons I learned long ago on 6 meters with an EME array of four 9-element Yagis was that any amount of antenna gain or power simply will not make up for poor propagation. This is a truism for all amateur bands, and 75 meters is no exception. When the northern polar route to Europe is corrupted with auroral activity, I find my 14-element super Yagi cannot compete with dipoles in southern California. However, when there is no polar absorption, I can really compete with any of the big guns west of the Mississippi. For someone who has always operated from the western USA, running a European pile-up on 75 meters is really a thrill.

Recommendations

For those readers who have an interest in 75 meters and who have a tall tower or two, I think you should consider putting up one or several wire arrays. The cost is considerably less than a dedicated 80 meter rotary Yagi on a tower large enough to handle it. I will warn you that without a portable impedance analyzer, the task may not be as enjoyable and may be down right frustrating, but the results should make it all worthwhile. Obviously, these same antenna ideas can be used on 160 or 40 meters with equally good results.

DXers are a great breed who are very competitive but are always willing to share their knowledge with others, knowing full well they may be planting the seeds for being knocked down a position in the pecking order. Several operators who have been on the band for several decades claim that 28 elements is the largest array they have heard of. It is my hope this article is an incentive for someone to build something much larger. I look forward to hearing about other stations' efforts in pressing this band to new limits. ■

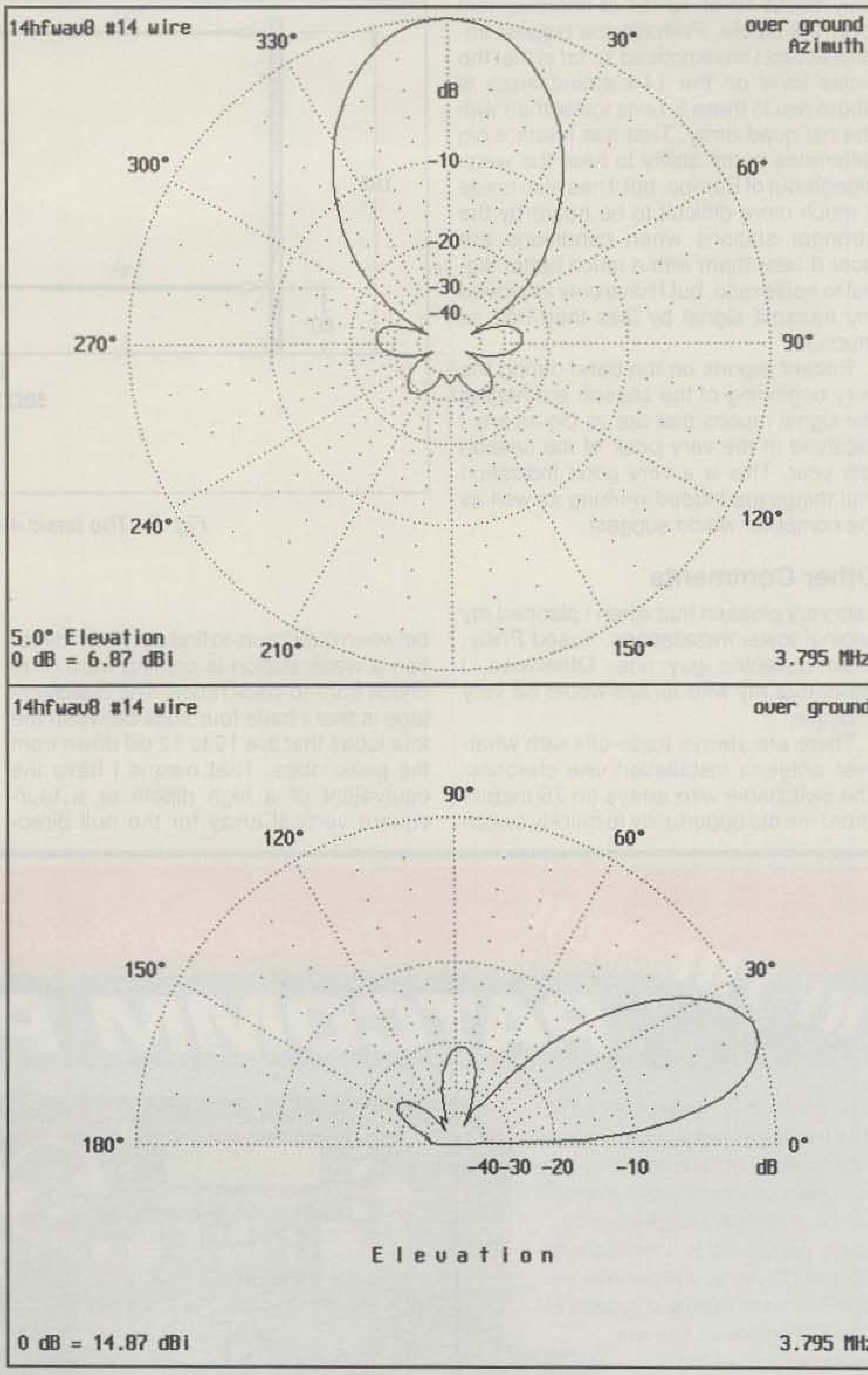


Fig. 6– Azimuth and elevation patterns for the 14-element array.