The evolution of the Zimbeams is off and running again. K4JZB carries his experiments on phased-beam antennas to a new high. They're easy to make, fun to use, and best of all, they work.

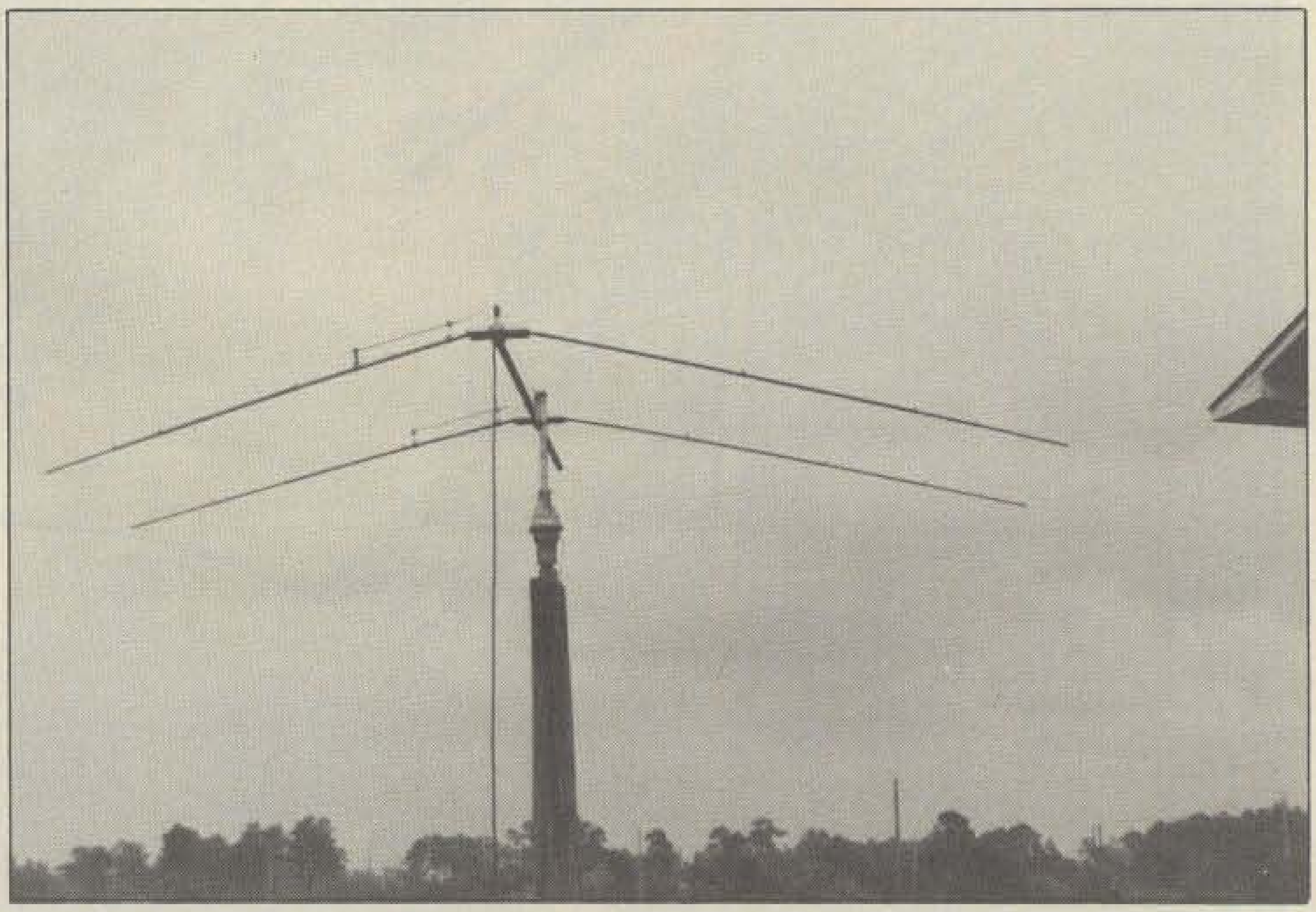
THE "ZIMBEAM" PHASED-BEAM ANTENNAS

BY ROBERT F. ZIMMER*, K4JZB

A project was set up to see if a practical and reproducible, all-driven phased-beam antenna could be designed and built. I felt that a beam was needed that would yield good gain and could be constructed by anyone with limited knowledge and/or ability. In all respects the results exceeded all of the above specifications.

Research was done, reading antenna books and magazines back to the early 1930s. I found very little written on the subject of phased-beam antennas. The most information found was in the RSGB *Radio Communication Handbook* and the NAB *Engineering Handbook.*

It was decided to first try the two-element type with a driven antenna element and another element that would act as a director. Since it also would be driven, it could be fed at 180°, which would make the beam bi-directional or fed in the same phase as the driven antenna element. The latter was chosen, and it was also decided to tilt the elements forward 40°.



A two-element Zimbeam in phase with the elements forward 40°. The directivity and gain on this model were very good.

A boom was selected and two elements of equal length (267") were placed on it. Next, I put on a gamma-match consisting of ⅜" tubing 36" long, spaced 4" from the element. Next a 36" length of RG8U, with the outside covering and shield removed, was slid inside the ⅜" tubing, and this could easily be adjusted for low s.w.r. No. 12 electrical wire was used between the antenna gamma-match and the director gamma-match. Another gamma-match, as described, was put on the director, and believe it or not it worked right off the bat (where was Murphy?). This antenna is shown in fig. 1 and the photo.

The s.w.r. was adjusted down to 1.1 to 1 with very little effort. The antenna was installed 12' high, and it showed very good gain and directivity. The antenna was used on the 21 MHz band while plans were made for adding the out-of-phase element. It was decided to use a ¼ wavelength of RG8U to achieve 90° phasing between the antenna element and the reflector. The length of RG8U figured out to be 7'9".

The reflector element, also 267" long, was added, and another gamma rod and capacitor as described were put in place. As before, Murphy was not present, and the antenna worked right off with an s.w.r. less than 2 to 1. The front-to-back ratio left much to be desired, however, so further research was indicated.

The feedpoint was changed, and although the antenna worked better, I felt that the front-to-back ratio still needed improvement. I then tried 270° phasing, and here again improvement was noted; it did not completely satisfy me, however, so further research was indicated. After some time and study it was found that 225° phasing with 45° or ⅛-wavelength spacing might be what I was looking for. It was tried and the results were better, showing 18–20 dB front to back. The antenna shown in fig. 2 started to take shape. With only three elements on the boom at 12' high, it was showing signal strengths near to the four-element antenna that was 50' high.

It was at this point that I decided to consult the National Association of Broadcaster's *Engineering Handbook.* The a.m. broadcast stations use phased

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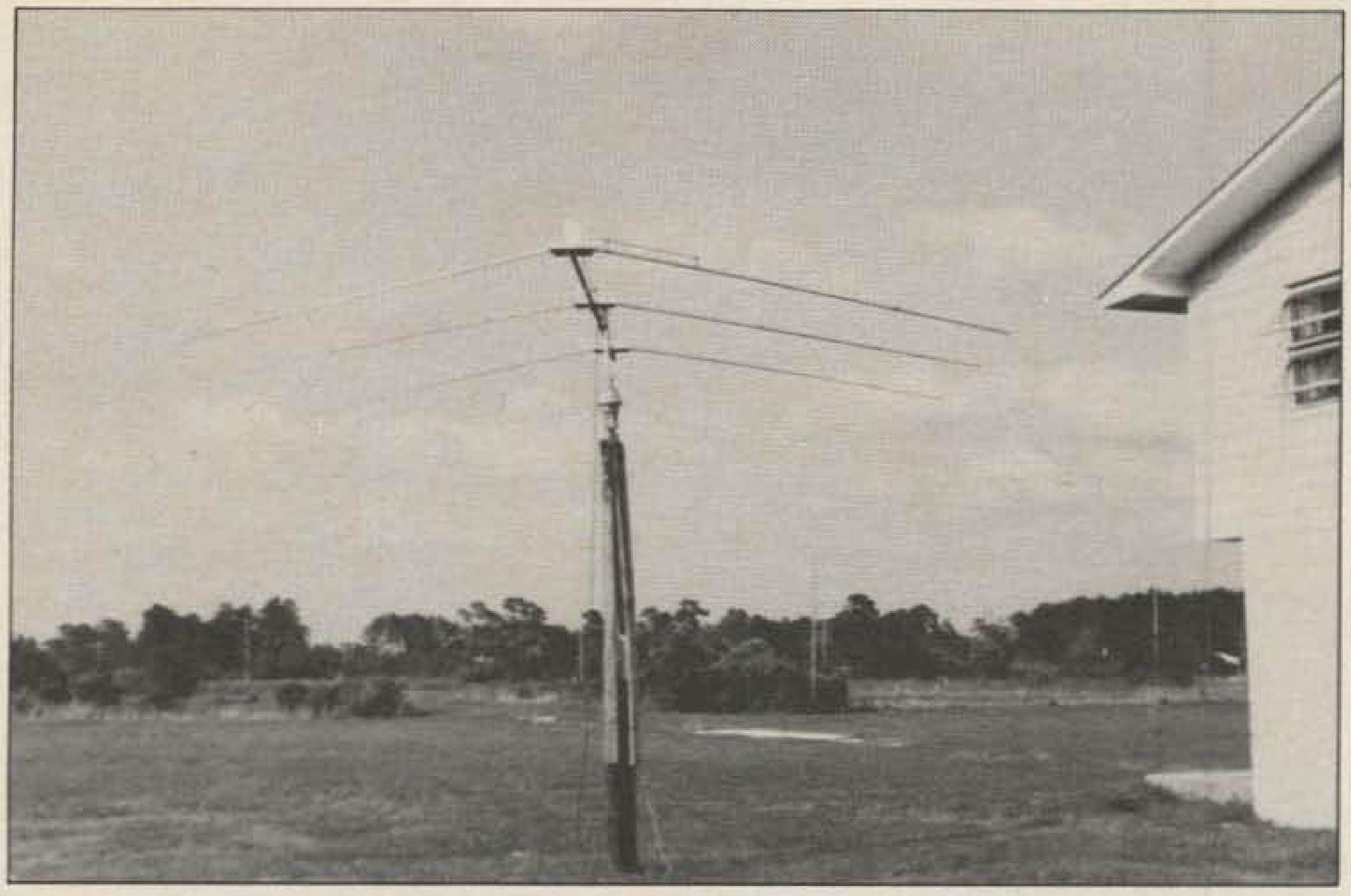


This version had the reflector at 180° and the director in phase. The elements are forward 40°. This one showed some promise, but more work was needed.

	DEGREES							
0	45	90	135	180	225	270	315	360
14MHz RG-8U	5¼'	10'7"	15'11"	21'1"	26'5"	31'8"	36'11"	
21MHz RG-8U	3'7"	7'7"	10'11"	14'6"	18'1"	21'10"	25'5"	
28MHz RG-8U	2.64'	5¼'	7.92'	10.56'	13.2'	15.84'	18.48'	

Table I– For poly RG8U with a velocity factor of 0.66. For more than 180° put the gamma-match on the other side of the element from the preceding element and add coax to make up the difference.

vertical antennas to protect other stations on the same frequency, but in other parts of the country. In their *Handbook* are pictured patterns for any degree of spacing and phasing. After much study what I was trying to do and how to do it became apparent. With 45° spacing (⅛ wavelength) the best phase angles were 90°, 105°, 120°, 135°, and 150°. With a phase angle of 180° the antenna was bidirectional. To get the maximum radiation in the opposite direction the phasing could be 210°, 225°, 240°, and 270°. From this one could deduce that the exact amount of phasing is not the least bit critical to getting excellent results.

The lengths of RG8U used to achieve the degrees of phasing are shown in Table I for 28, 21, and 14 MHz. To get phasing of 180° it is necessary to put the gamma rod on the opposite side of the adjoining antenna element. To get more than 180°, as say 225°, use coaxial cable for 45° (3'7") and put gamma on the opposite side of the preceding element.

I decided to try 225° and 90°, although the patterns indicated that the best would be 225° and 135°. The decision was made because of something I read in the RSGB *Handbook* which stated that better results would occur with the least phasing one could use while still doing the job of directivity.

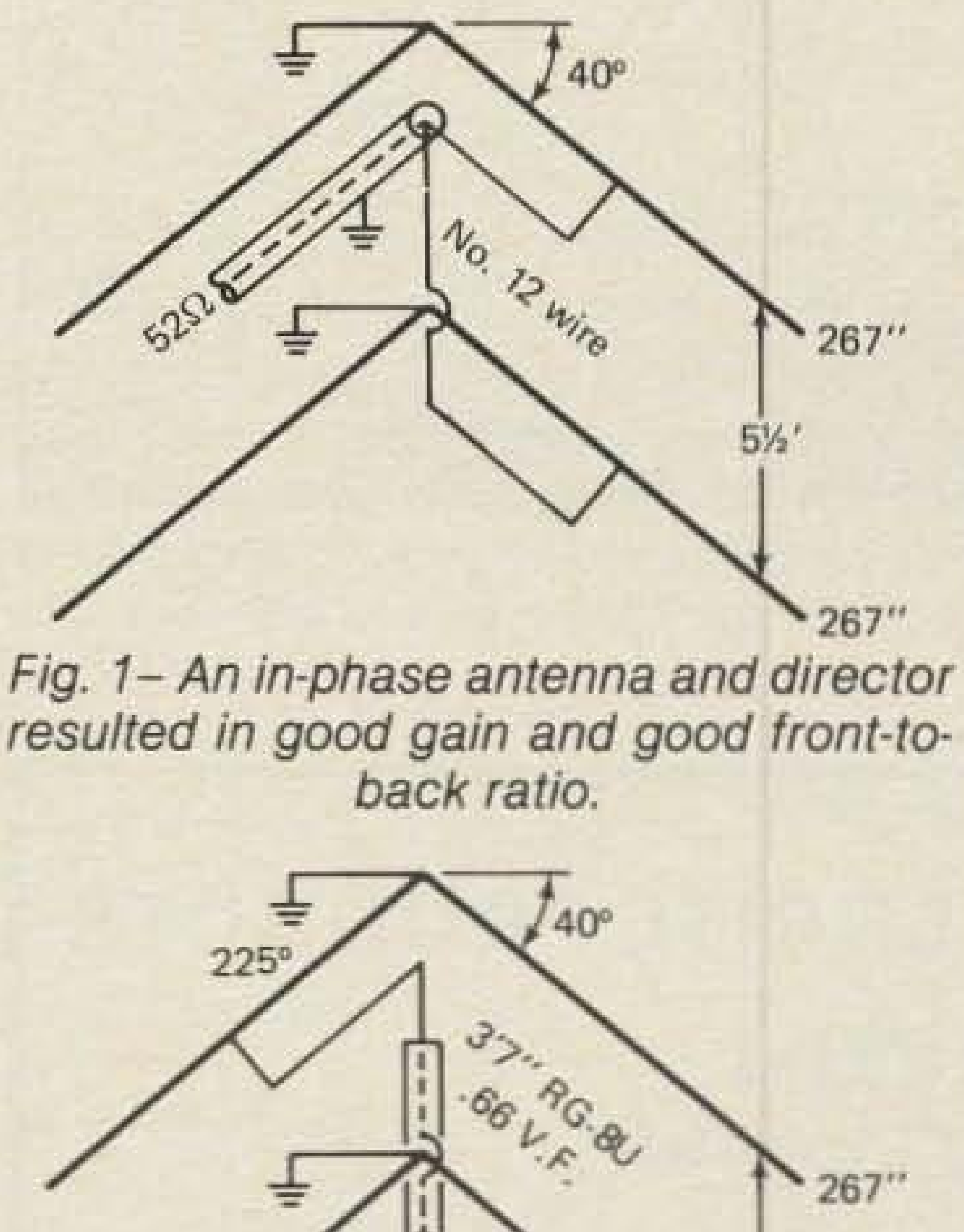


Fig. 1– An in-phase antenna and director resulted in good gain and good front-to-back ratio.

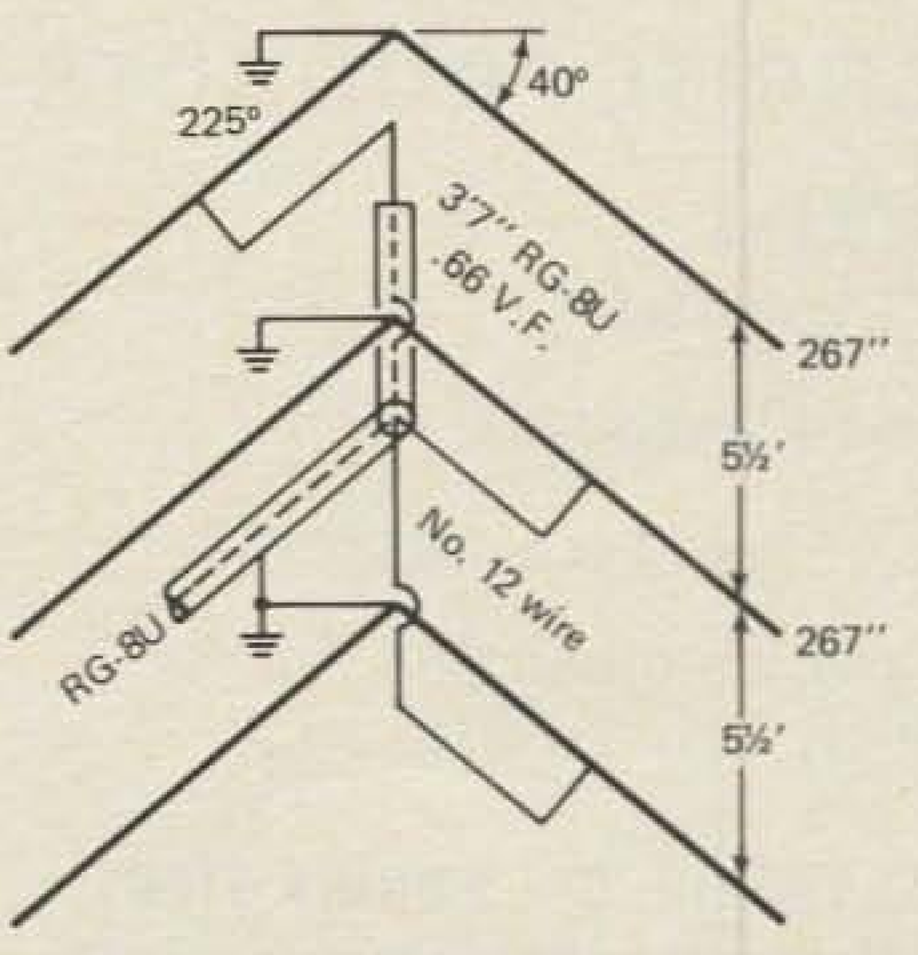
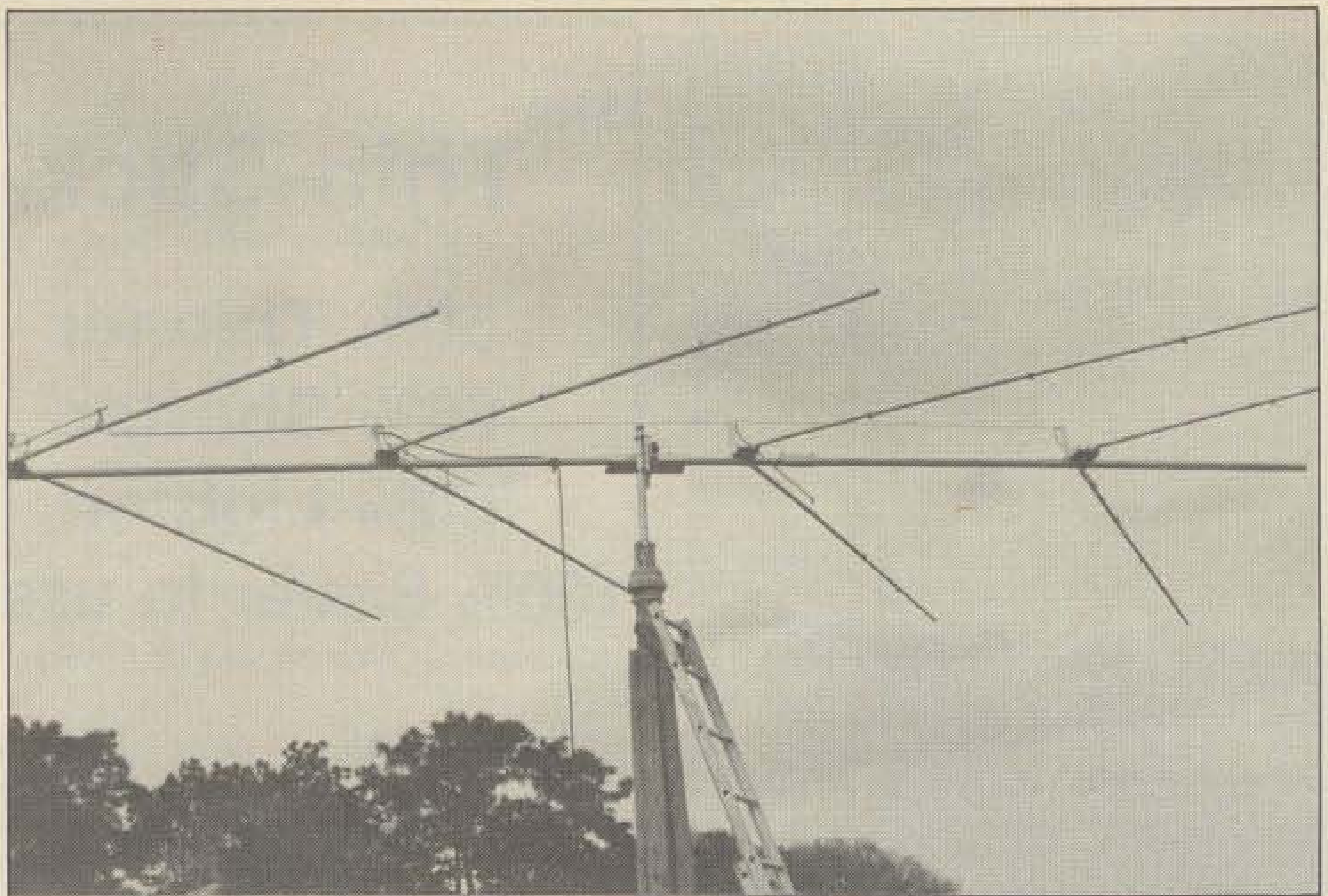
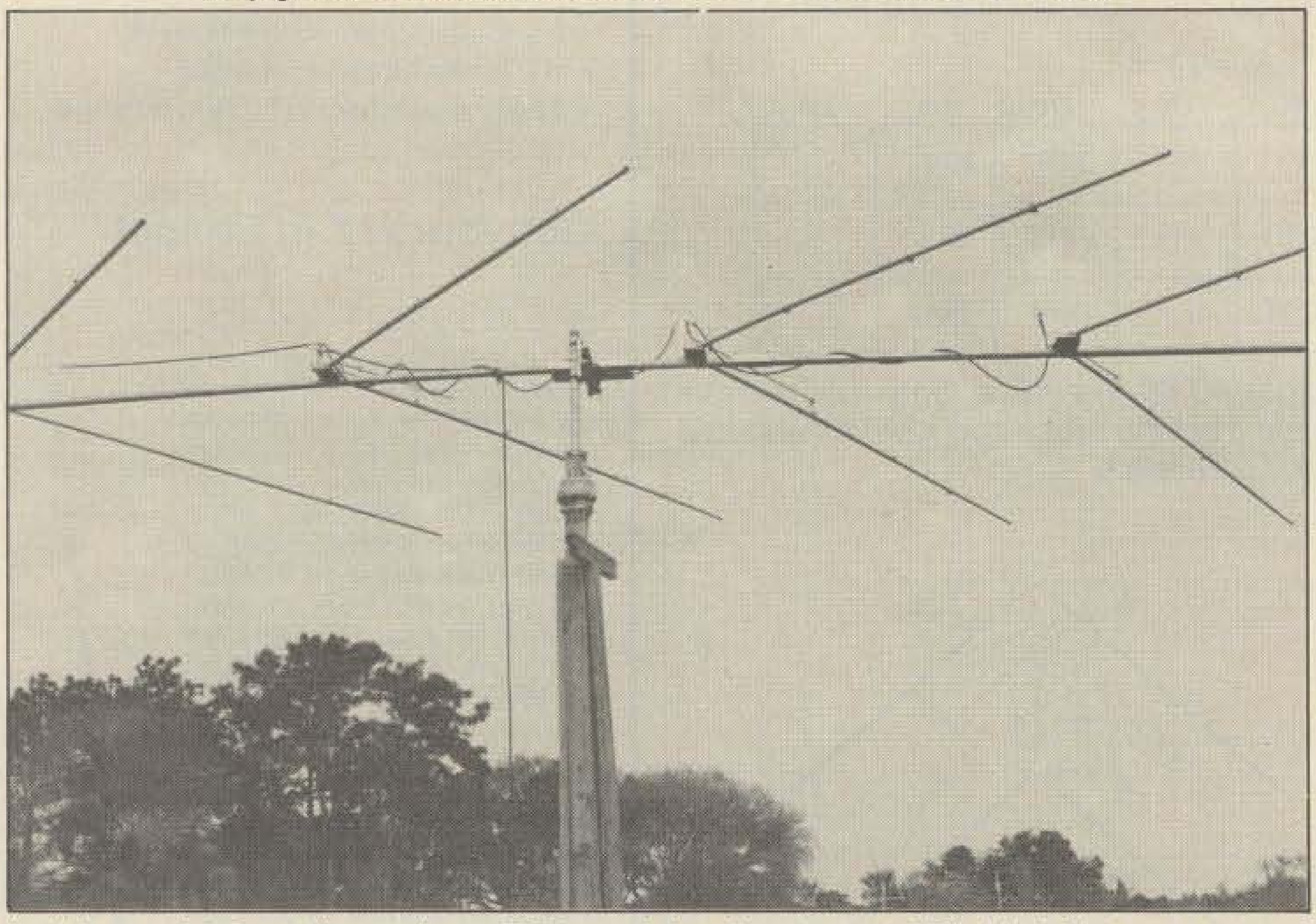


Fig. 2– An added reflector with phasing of 225° (180° plus 45° of poly RG8U).



Here we have the reflector phased at 225° and the directors in phase. The gain was very good, but the front-to-back ratio was only 12 to 15 dB.



In this model the reflector is at 225°, and the directors at 90°. Note the coax wound around the boom. The gain was very good, plus the front-to-back ratio was 30 + dB.

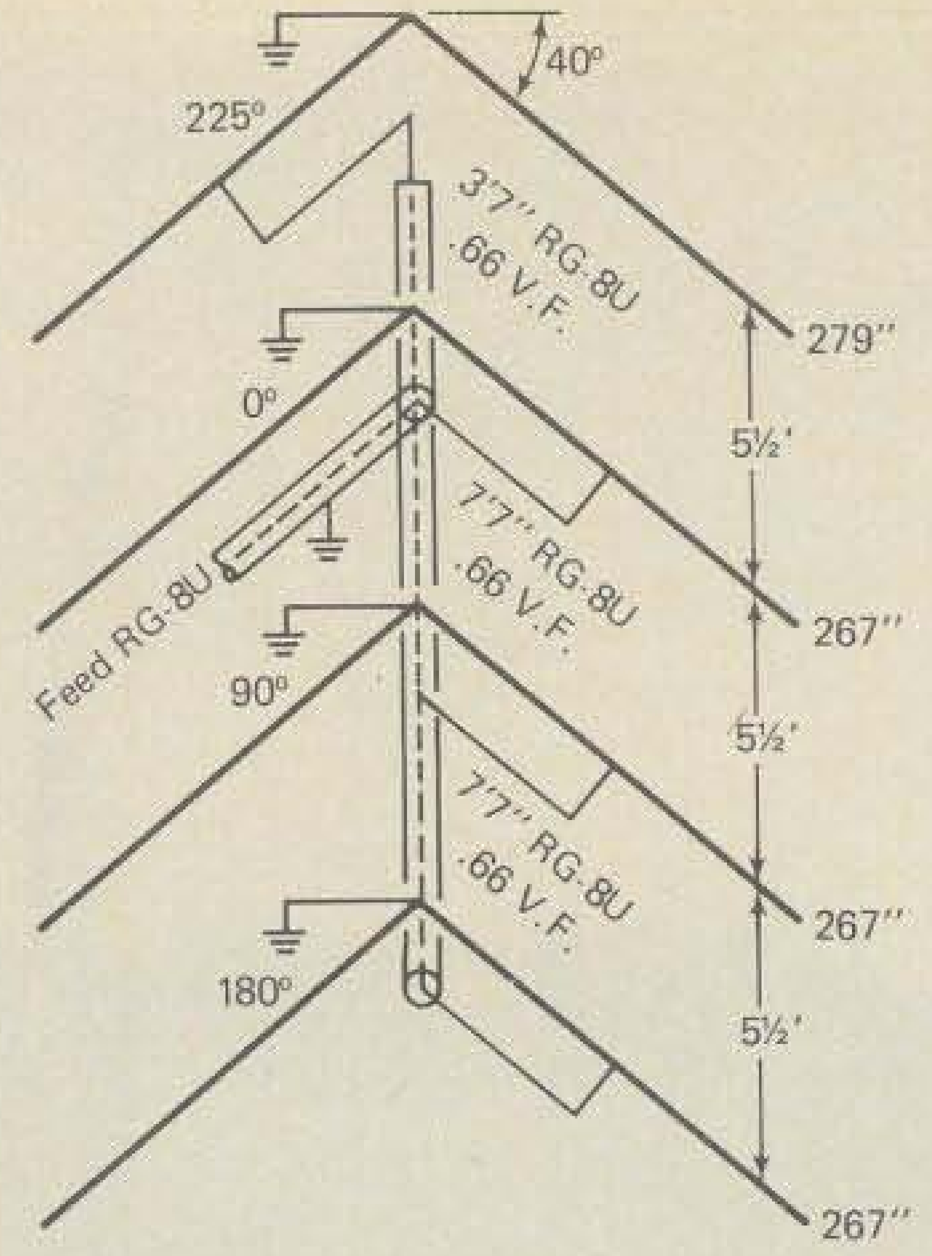


Fig. 3– The reflector at 225° and 279" long. Each director is at 90°.

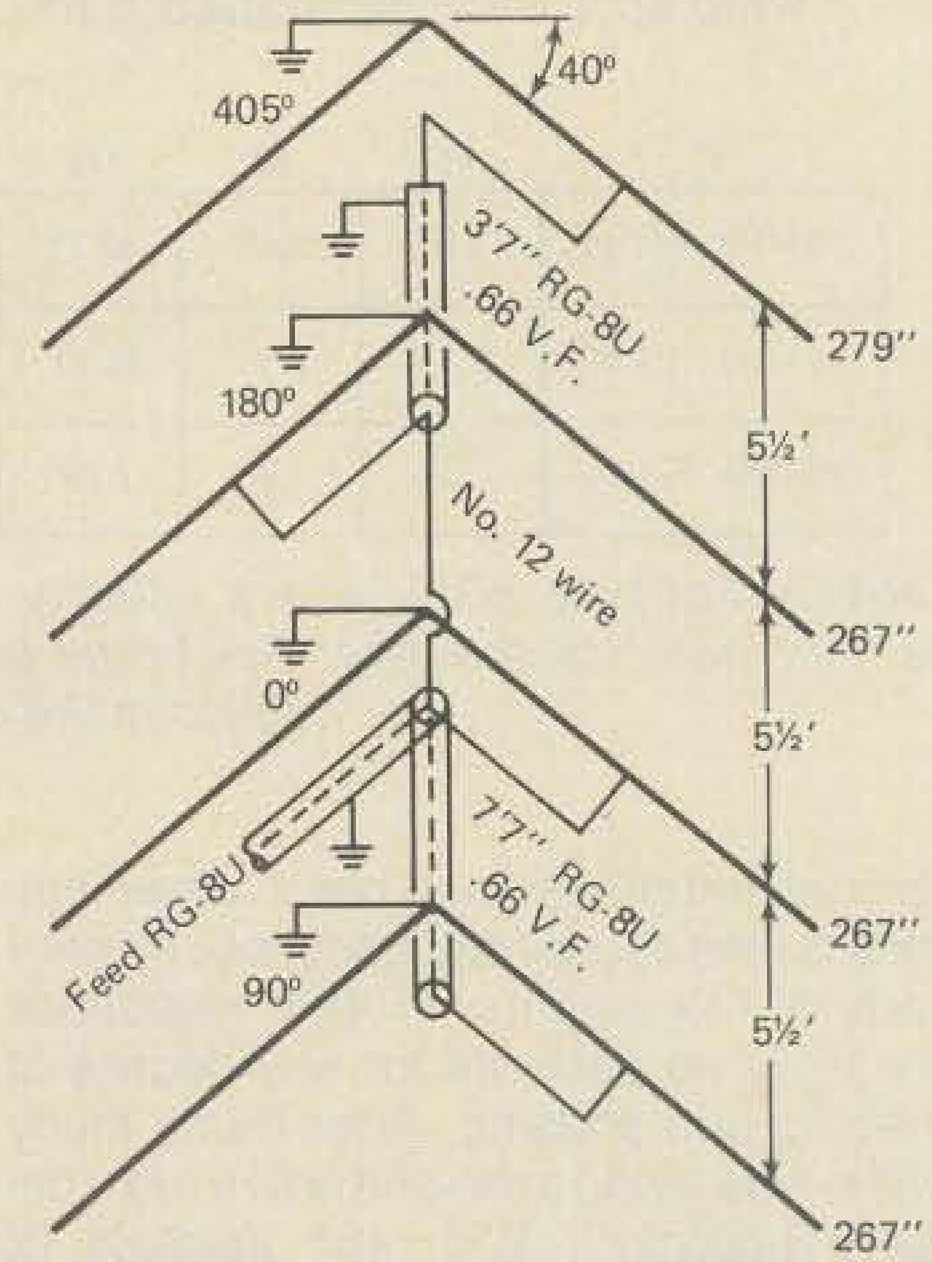


Fig. 4– The reflector is at 405° from the feedpoint, but only 225° from the preceding element.

A fourth element (as in fig. 3) was added with 225° phasing to reflector and 90° phasing to each director. The spacing between each element was 45°, or 5½'. The gain was very good and the front-to-back ratio was 18 to 20 dB, but it was increased to 30 + dB by changing the reflector element length from 267" to 279". This had the effect of increasing the phasing. All other element lengths were left at 267". The s.w.r. was less than 2 to 1 across the 21 MHz band.

On-the-air checks were made with HC8GI and OZ2PG, and they both reported 10 dB difference between the four-element monobander at 50' and this phased four-element antenna at 12' high. I believe the phased antenna would be far better than the monobander if it were at a 50' height. Both of these antennas can be classified as super gain antennas.

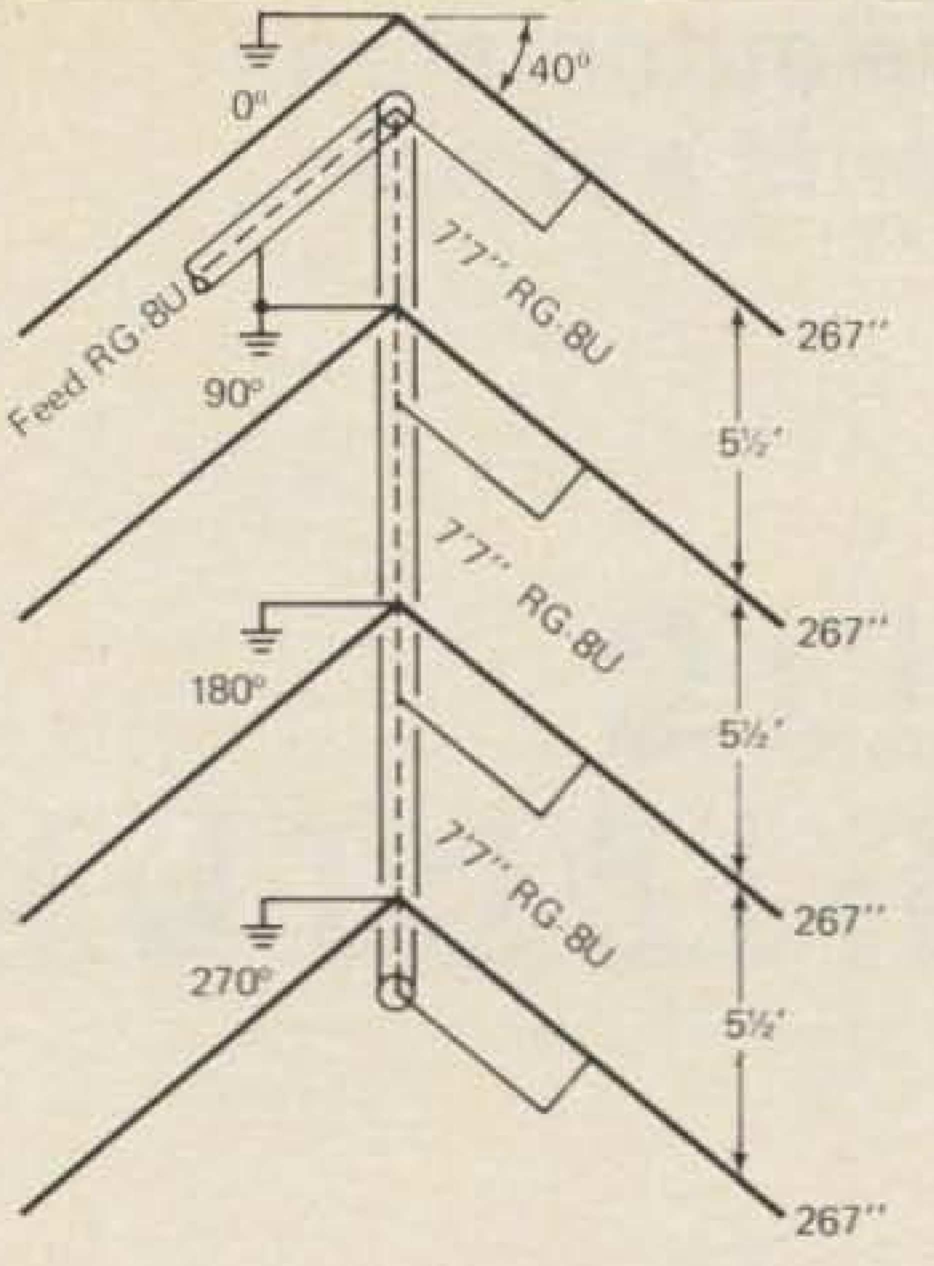


Fig. 5– Back-feeding with all elements at 90° from preceding element.

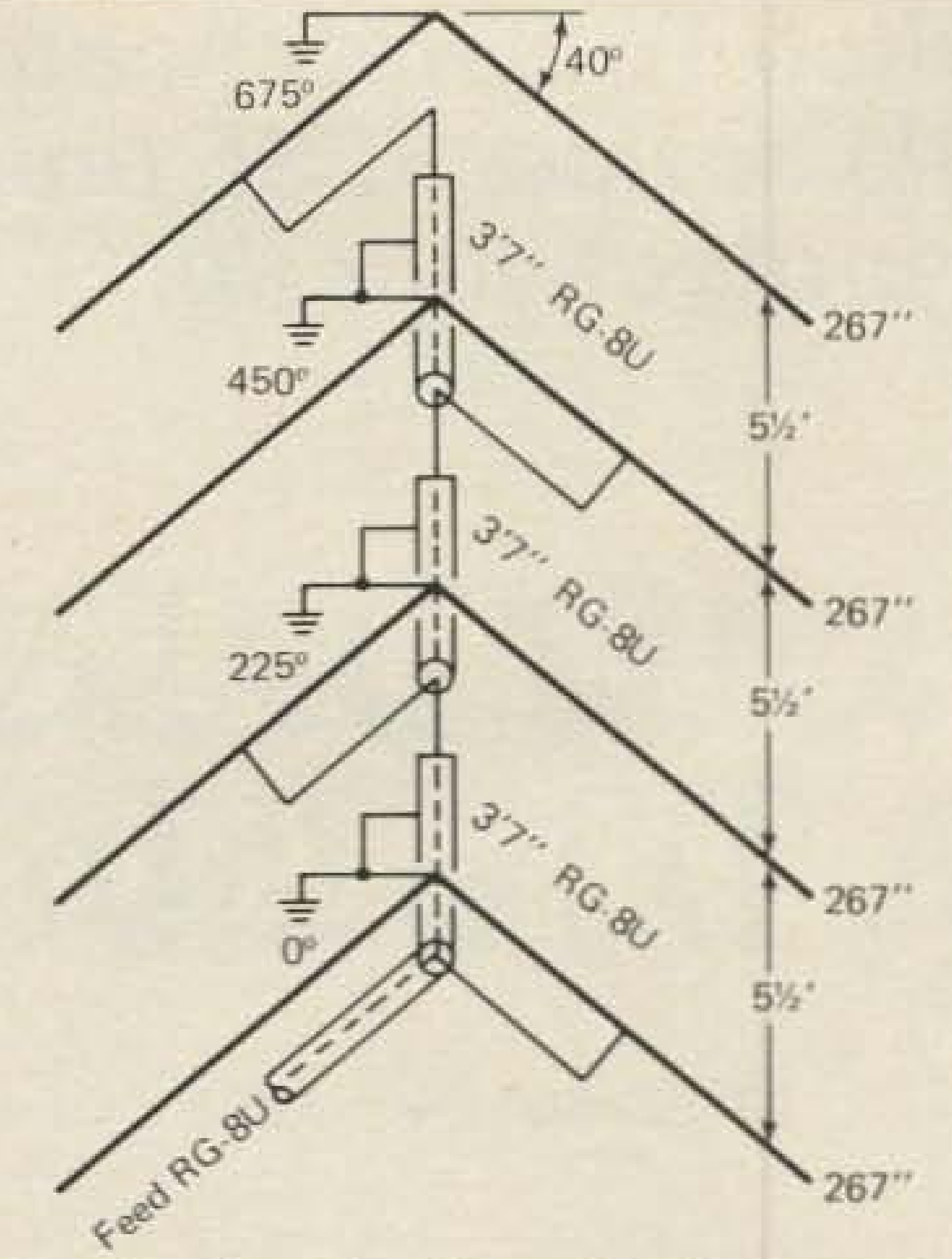


Fig. 6– Front-feeding with all elements progressing 225° all the way up to 675°.

A total of 11 different designs were tried. They all had merit, and in addition to the one already described, I shall cover two others that I found to be outstanding. In fig. 3, the reflector is 225°, the first director is at 90°, and the second director is also at 90°. In fig. 4 the reflector is 279" at 225°. The next two elements are 180° out of phase with each other. The four-element is phased 90°. All spacing is 45° or 4½' on 21 MHz. This puts four elements on a 17' boom.

In fig. 5 the antenna is fed at the back with all elements progressing by 90°. In fig. 6 the antenna is front-fed with each element at 225°.

These last two designs were tried only briefly, and although they showed merit, I did not test them as thoroughly as the others. I shall get back to them at an early opportune time. The construction details are as described in a previous article, so I will not go into detail here.

I have had many reports on the preceding antenna designs and comments from all over the world. OZ2PG built and reported on the first five-element beam which was described in the January 1983 issue of *CQ*. He measured the gain of, as he said, the best three-element tribander made in Germany at 5 dB better than a dipole. Also, he found my five-element antenna 7 dB better than the tribander. That makes his measured gain of the five-element beam at 12 dB better than a dipole or 14.14 DBI. As he reported, with 200 watts p.e.p., he now has no problem with pile-ups, and is reported to be the strongest signal out of Denmark. I can attest to his strong signal, as we have worked several times on 21 MHz.

On the original five-element design I have run more tests and found that to achieve the maximum gain figures the spacing between DE 1, DE 2, and DE 3 must be increased to 5½' rather than the 2' originally stated. Also, the antenna will not work with less than 2' spacing. I found this out the hard way. I built a seven-element job with 1½" spacing and the gain went down the drain; when it was increased to 3' it again was a real super-gain antenna. The antenna was described by an amateur overseas as a "Super-Gain Antenna," and in thinking it over, I guess the description fits.