ANTENNAS FROM THE GROUND UP

36. Phased and Phased Again
or The Dual Expanded Lazy-H for 80-10 Meters

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In the last episode, we examined the expanded Lazy-H as a multi-band antenna. There are actually 2 versions for HF use. With 44' elements spaced vertically by 22', we have a good multi-band antenna for 10 meters through 40 meters. With 88' elements spaced 40 to 46 feet apart, we have an antenna that will cover 80 through 20 meters. The 4:1 frequency ratio represents the limits for ensuring that our pattern is always broadside to the wire. As well, we need to get that antenna as high as possible so that on the lower bands in the covered range, the elevation angle is as low as feasible.

I have received correspondence with an interesting question: Can I combine the two versions of the expanded Lazy-H and cover all of the HF region from 3.5 ro 29.7 Mhz? The answer is a qualified "yes." You can combine the antennas with the smaller centered inside the area occupied by the larger. Because the Lazy-H has so little vertical radiation, the two antennas will not interfere with each other significantly.

However, there is a right way and a wrong way to feed the combined array. If you feed the system correctly, you will lose little or nothing from the individual phased pairs of elements. If you feed the system incorrectly, you will lose the broadside radiation on virtually all of the upper bands. It is often as important to understand why something does not work as it is to understand why something else does work. Therefore, let's take a look at both the right and the wrong way to set up the Lazy-H array. And letşs begin with the tempting wrong way.

Getting it Wrong: **Fig. 1** shows a tempting way to connect the parallel feedline to a combined large and small array.

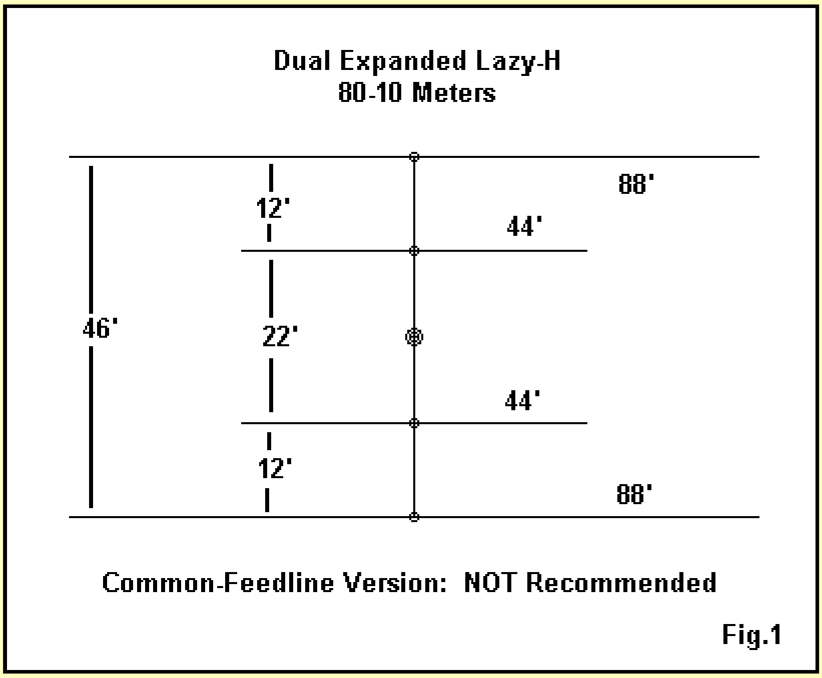


Fig.1

The sketch shows the basic wire spacing. For the test case, I modeled the antenna with the long wires at 32' and 78' up and the short wires at 44' and 66' up.

The shortcut that tempted us was to connect the 450-Ohm phasing line from the top long wires to the top short wire and then to the center point between wires. We also connected a feeder from the bottom long wire to the bottom short wire and then to the center junction. Unfortunately, this configuration lets the longer wires dominate the radiation patterns on all bands, not just those from 80 through 20 meters. In fact, we might just as well have set a single 88' wire at the top wire height of 78' and fed it like any other doublet.

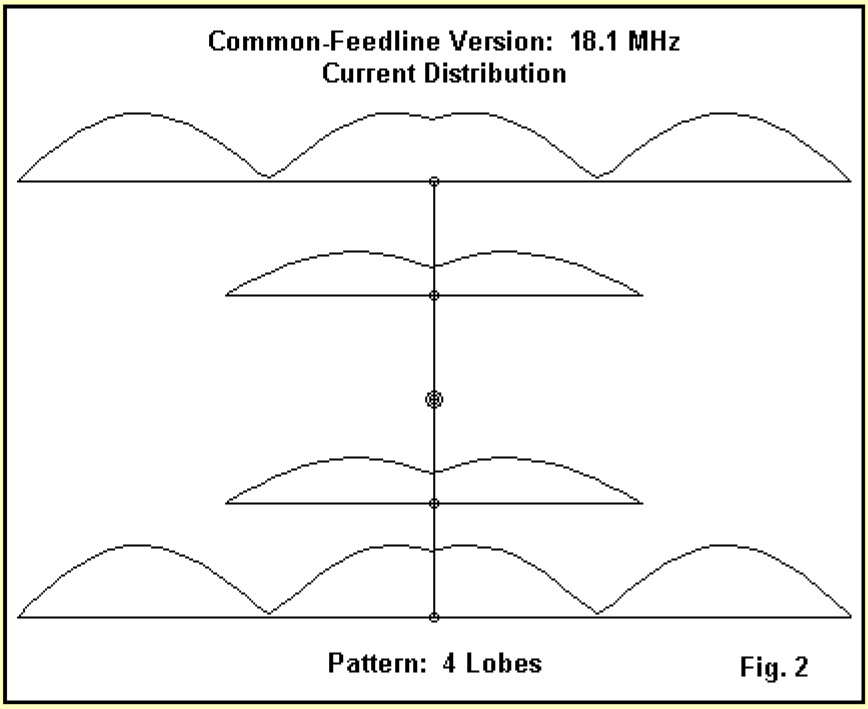


Fig. 2

Fig. 2 shows us why the patterns go to pot on the upper bands. In 17 meters, the band selected to illustrate the point, we can see that the longer wires have a higher current level (magnitude) than the shorter wires. Yet. It is the shorter wires that we wanted to do the work of providing a pattern that is broadside to the array wires.

The following table summarizes the potential performance of the mis-connected array.

Freq Mhz	Gain dBi	TO Deg.	Feed Z R+/-jX
3.6	**5.64**	**67**	**8 - j 75**
7.15	**8.28**	**27**	**15 - j 125**
10.1	**7.10**	**25**	**20 + j 125**
14.1	**11.97**	**15**	**55 + j 445**
18.1	**10.22**	**13**	**115 + j 540**
21.1	**11.55**	**11**	**1700-j1005**
24.95	**10.75**	**10**	**40 - j 45**
28.5	**12.58**	**8**	**445 - j 580**

At first glance, the table seems to say that the antenna performs quite well. However, tabular data can be misleading if we do not have all of the labeling information that helps us make sense of the information. For example, in the table of modeled performance, we no where saw an indication of the azimuth angle at which the antenna provides its maximum gain. In fact, that angle is broadside only up through 20 meters.

At 17 meters and higher, the antenna creates clover-leaf patterns. For 17 and 15 meters, the patterns are essentially 4-leaf clovers, with the main lobes about 40 degrees off of the broadside direction. In the desired broadside direction, the signal strength is down from the maximum value by 7 to 12 dB. Hence, the entire reason for having the dual Lazy-H is completely defeated.

On 12 and 10 meters, we end up with 6-petal azimuth patterns (with a few extra weaker lobes thrown in). The strongest lobes happen to be those which are broadside to the wire, but they are very narrow--perhaps 20 degrees wide or less. The broadest lobes are those pointed in directions far off the broadside headings.

Not only does the azimuth pattern go to pot compared to what we want, but as well, the elevation pattern also suffers significantly. On the upper bands, the combined effects of having current on both the short and long wires yields considerable high angle radiation. On the upper HF bands, we want as much radiation as possible at lower angles to catch the DX skip.

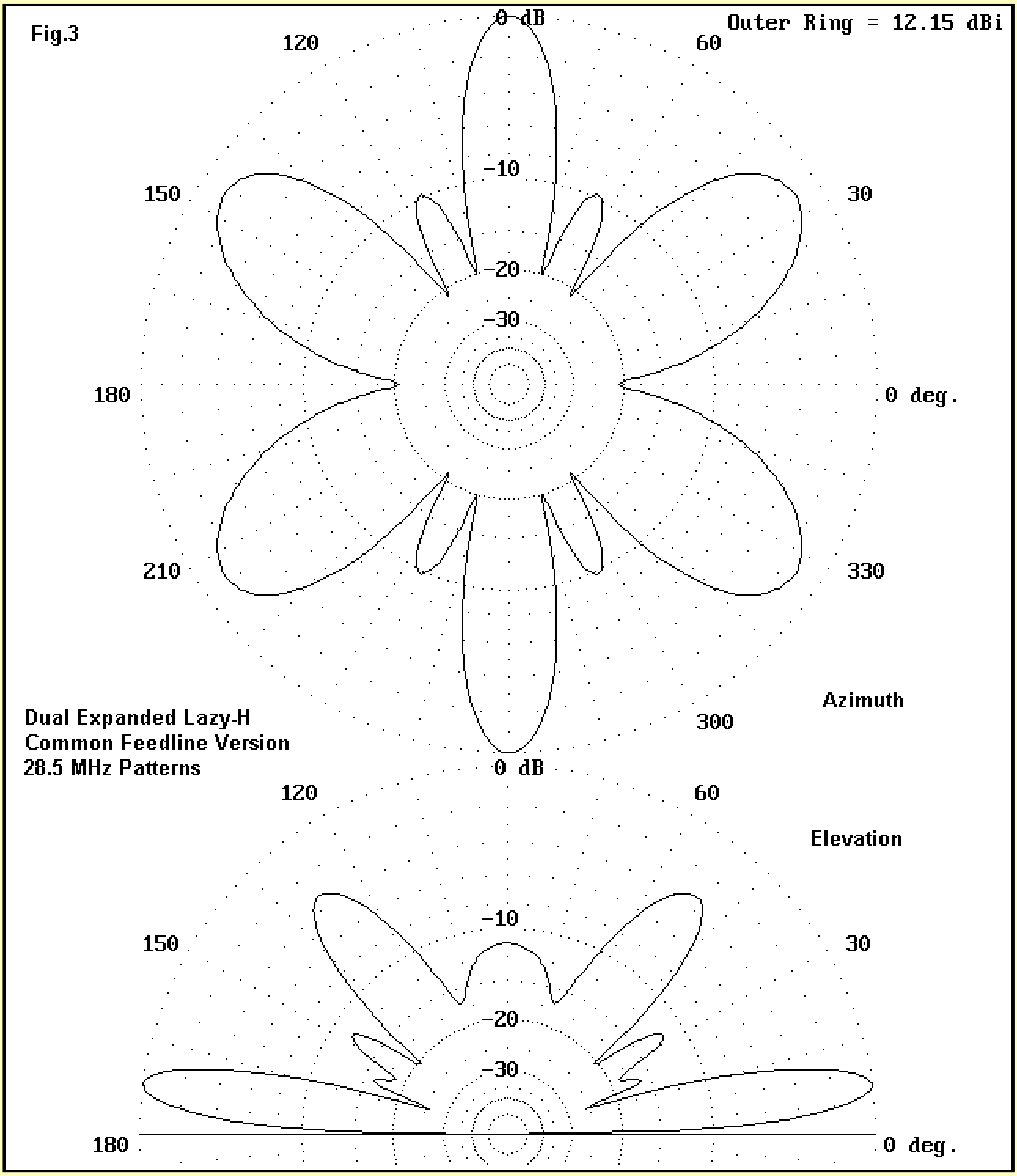


Fig. 3 shows the 10-meter azimuth and elevation patterns for the dual Lazy-H with a combined feeding and phasing line. The narrow lobes broadside to the wire would make aiming very difficult.

As well, the antenna wastes considerable power at high elevation angles, where it does not do much to aid communications. In short, our tempting simple feed system has ended up defeating our ultimate goal of having broadside radiation throughout the HF range.

The Right Way: If we are willing to overcome temptation and rethink the way we feed the dual expanded Lazy-H, we can achieve our objectives with pretty fair ease. The trick is to use separate phasing line pairs for each of the two Lazy-Hs, as shown in **Fig. 4**. Note that nothing has changed with respect to the wires. The only change is to the feed system by which we get power to the 2 antennas. The two feed lines must be separated by a couple of feet at their center junctions. A length of CPVC or similar light weight material will do this job well. Somewhere down the line, in the shack or remotely, we can add a switch to shift between the two arrays.

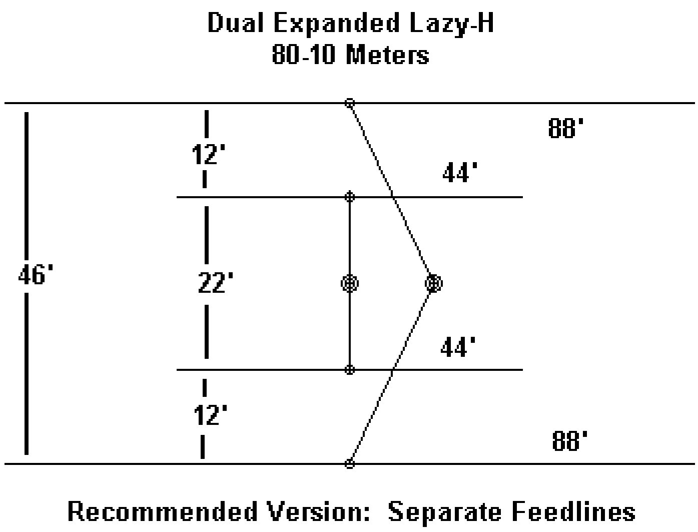


Fig.4

The key question is simply this: will separating the phase-line pairs improve array performance? The answer is a solid yes, as the modeled performance table below indicates. All gain figures are for major lobes broadside to the wires of the array.

Freq Mhz	Gain dBi	TO Deg.	Feed Z R+/-jX
88' Array			
3.6	**5.58**	**65**	**9 - j 90**
7.15	**7.53**	**29**	**250 - j 355**
10.1	**10.84**	**20**	**20 - j 20**
14.1	**12.76**	**15**	**80 + j 505**
44' Array			
7.15	**6.39**	**32**	**8 - j 91**
10.1	**8.33**	**23**	**55 + j 110**
14.1	**9.26**	**17**	**395 - j 375**
18.1	**11.25**	**13**	**435 - j 125**
21.1	**12.35**	**11**	**23 - j 15**
24.95	**14.65**	**10**	**20 + j 115**
28.5	**14.97**	**8**	**70 + j 425**

I have shown the performance for all bands on each antenna. From the table, you can see that the array of choice for 20 meters and below is usually the 88' H. However, on some occasions, the wider beamwidth of the 20-meter azimuth pattern of the 44' array might come in handy. Having an A-B switch to try each antenna on a desired path is a wise practice.

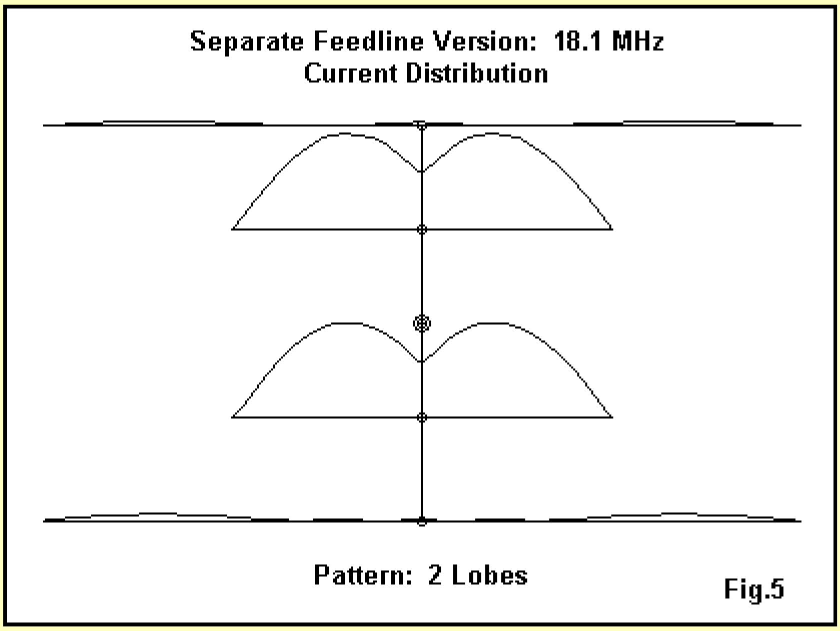
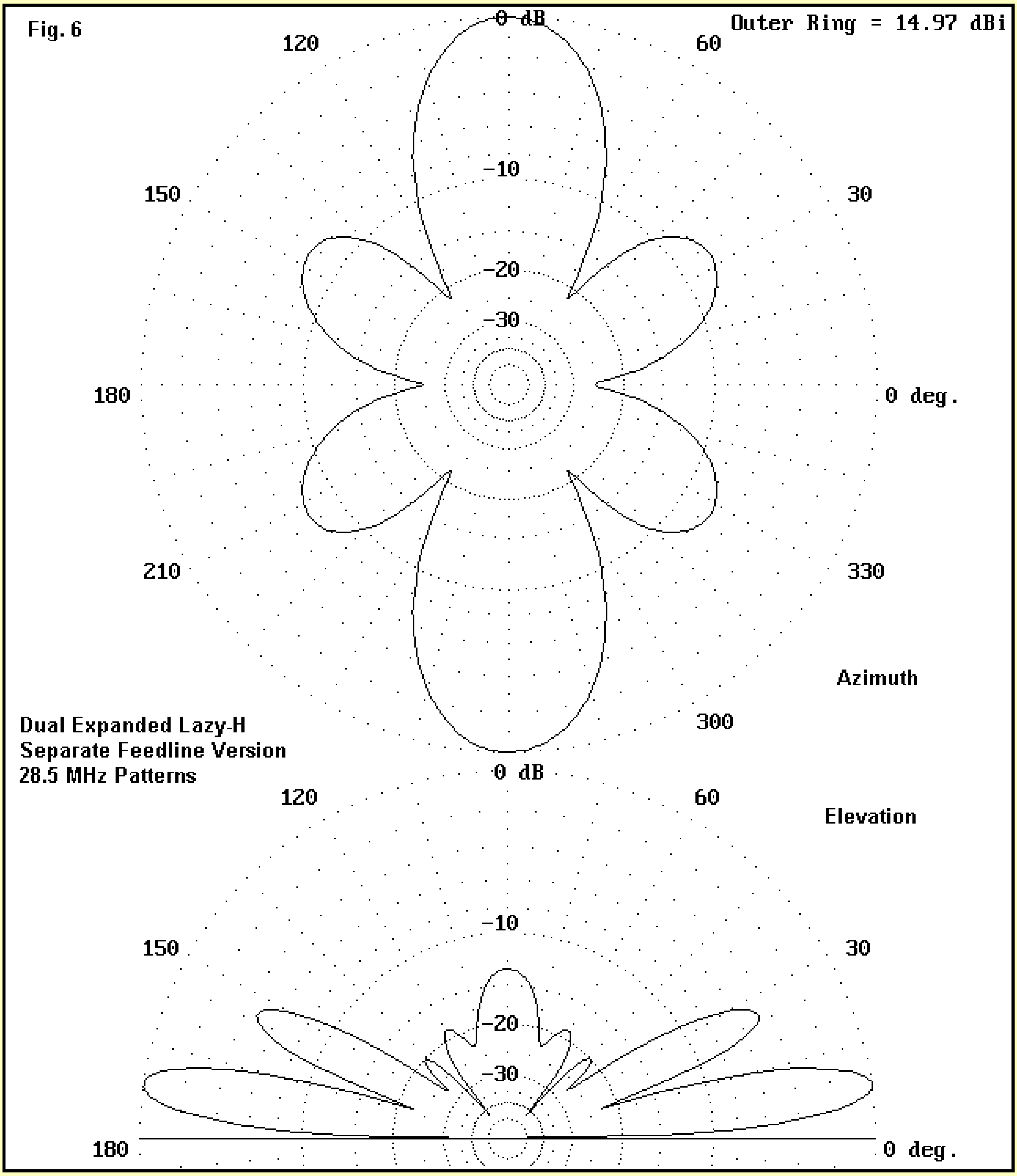


Fig.5

You may also wish to compare the performance figures with those for the independent 44' array we discussed in the last episode. The slight differences in numbers will reveal that we have not eliminated all interactions, but we have reduced them to a very low level. As an example, I fed the short array on 18.1 Mhz, just as I did for the combined feed system. However, this time, as **Fig. 5** reveals, the long wires did not directly receive energy from the feed system. The vary shallow current level lines on the longer wires reveals how very low the level of interaction is on 17 meters--barely detectable. In contrast, the shorter carry virtually all of the current that yields radiation. A similar picture emerges on all of the upper bands. Hence, we can expect the array to provide broadside patterns on all bands if we feed the two arrays with separate pairs of phase lines.



If we examine the azimuth and elevation patterns for 10 meters, we can confirm what the current distribution graphic has told us. In **Fig. 6**, we see the typical 10-meter EDZ pattern. The main lobes are both stronger and wider than those for the simple-feed version of the array. The elevation pattern is virtually indistinguishable from the one for a single 10-40-meter Lazy-H. The high lobes of **Fig. 3** are totally missing. Instead, we have two low angle lobes, and the weaker, higher one may prove useful for sporadic E skip. In short, we have a successful array.

For someone with the tall pines or firs to get the longer array up high enough, a dual expanded Lazy-H may prove useful. The triangle array of arrays can also be used effectively with these antennas in order to cover as much of the horizon as possible with the least investment of antenna materials. Perhaps the only complexity will be to the suggested switching scheme that we explored 2 episodes back in connection with a simple 44' or 88' doublet.

Nevertheless, a triangle of dual Lazy-Hs will turn out to be far less expensive than a beam, rotator, and tower that covers only 20-10 meters. On many bands, the gain will be significantly higher than for all but the longest-boom beams on the market. Never sell wire short.