73
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BOOK SUPPLEMENT: LOG PERIODICS

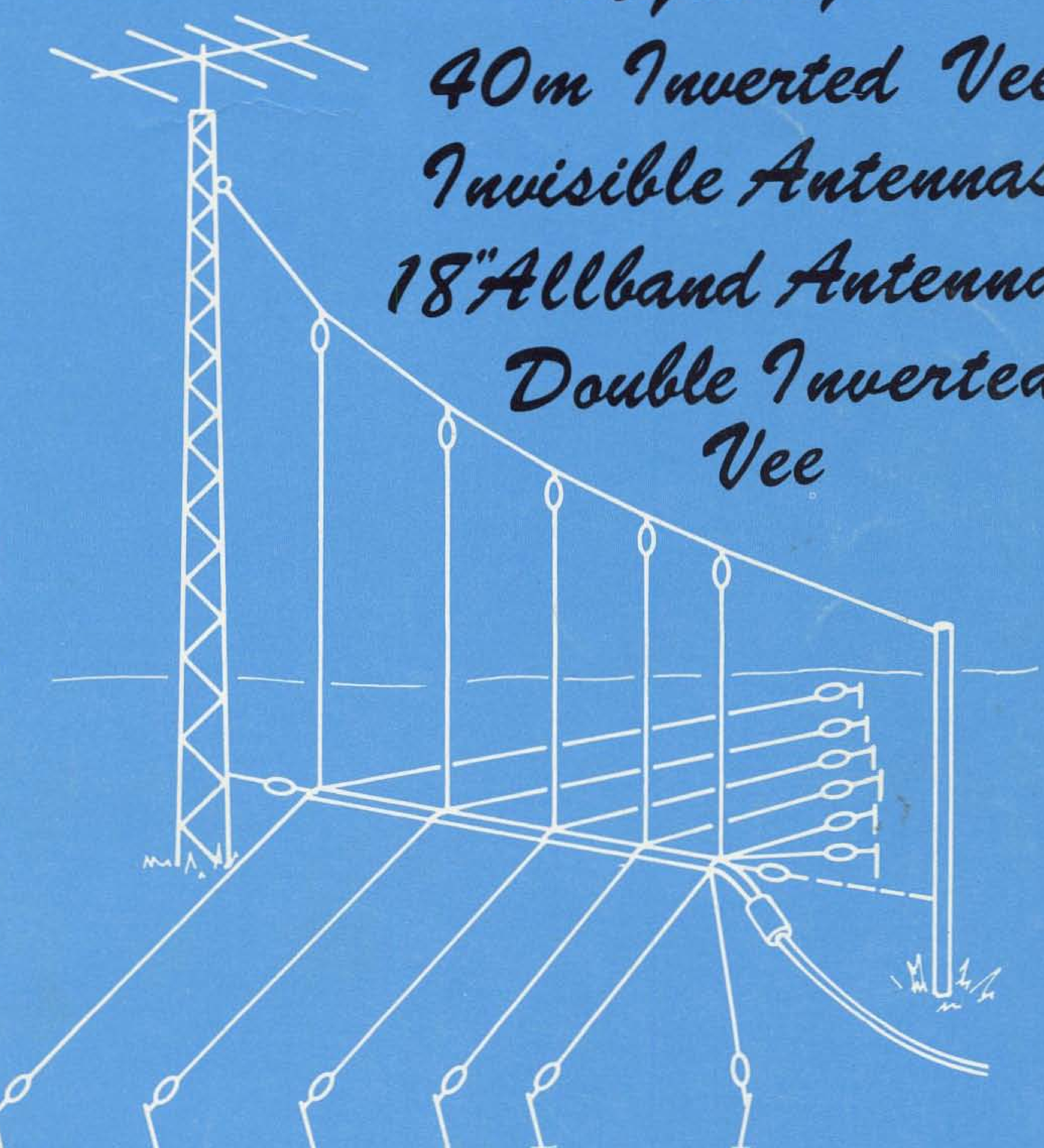
Antenna Radiation Mystery?

40m Inverted Vee

Invisible Antennas

18" Allband Antenna

Double Inverted Vee



32 Antennas You Can Build!

GIANT SPECIAL ANTENNA ISSUE

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Yes, I've Built Sixteen Log Periodic Antennas!

The broad-band, uni-directional HF Log Periodic beam antenna was originally developed about 1957 (see references at the end of article). Although these very excellent beams are used extensively by Commercial, Military and Government agencies for both medium and long haul circuits, their use has been rather neglected by amateurs.

I have assembled, erected and tested a number of fixed Log Periodic Wire Beams since 1970 with excellent results and would like to pass along some information on these very efficient beams.

It is believed the amateur fraternity may have overlooked or shied away from these antennas due to:

1) Very little information has been published on HF Log-Periodics in ham publications although there have been several articles covering these for VHF and UHF. (Listed in a previous LP article – September 73 issue of 73 Magazine, p. 42.)

2) These antennas are quite complex and are highly mathematical. Several pages of formulas, reference to log tables and four or five graphs or monographs are required for optimum design. This information was best presented to the hams in the May, 1965 issue of 73. Although this covered the design of VHF L–Ps, the formulas also apply to HF.

The antenna manufacturers producing L–Ps for Commercial and Military use, program this data on a computer. By supplying the frequency range desired, gain required, etc., the computer prints out the element lengths, optimum element spacing, boom length, etc., to provide for maximum forward gain, front-to-back ratio, minimum beam width etc.

Although these formulas can be computed manually, several days may be required to design (on paper) an L–P having optimum performance in a given space.

3) Most amateurs feel that Log-Periodics are extremely expensive, which they are if purchased. The least expensive rotatable types by one commercial manufacturer are in the \$1500 to \$3000 range for a rotary covering 6 to 30 MHz, capable of 40, 20, 15 and 10m operation. Some of these are used by MARS stations. Rotatable L–P ham antennas have recently been announced in the \$300 to \$1000 class.

The larger fixed types for the 2–30MHz range having higher gain are generally in the 10–30 "kilo-buck" range. However, by assembling smaller, less complicated wire L–Ps for the 14–30MHz range on a "do-it-yourself" basis, one having an 8–10dB forward gain (over a doublet at the same height) can be assembled for a material cost of \$15 to \$25, not including masts or coax which will vary depending on the particular site. The largest 17-element 14–30MHz L–P being used here, having a 12-13dB measured gain, should cost about \$19.50.

4) Many amateurs believe a fixed L–P requires a great deal of "acreage." This is true of the large commercial types having a 10:1 band width or a single beam covering 3 to 30 MHz. These are 63.5 – 127 meters (250' – 500') in length, some even 203 meters (800'). However a 14–30 MHz L–P for 20–15 and 10m having an 8dB gain can

be erected in a space 10.16m (40') wide by 12.7m (50') long. If the length can be extended to 17.78cm (70') the gain can be increased to 10dB compared with a doublet at the same height. By extending to 25.4m (100'), 12–13dB can be realized.

Log-Periodic Types

Log Periodic Antennas can be classified under three general types:

1) The doublet Log-Periodic (DLP) Configuration. Fig. 1 illustrates this type covering a 2:1 (plus) bandwidth suited for a ham beam for 7–14.35 or 14–28MHz.

2) The vertical monopole Log Periodic working against ground or a ground plane counterpoise. Fig. 2 illustrates this type, also covering a 2:1 band width.

3) The trapezoidal zig-zag or saw tooth configuration, Fig. 3. This type being more complicated and not too suited for HF ham applications, will not be covered by this article which will deal only with the first two types.

Before outlining the construction of the doublet and the monopole types, a brief report will be presented covering the tests conducted here over the past four years.

W4AEO Test Results on Log Periodic Antennas

During 1970 the first Log Periodic was put up experimentally here for 20m and 15m only, to be compared with doublets and also a well known "store bought" trap vertical for 40-20-15 and 10m (using separate radials for each band). The vertical had given fair results for DX, evidently due to its low angle of radiation and its 8.9m (35') height (at the base) above ground.

The first L–P was quite simple, using only 7-elements for 20 and 15m and only 9.7m (38') in length. It is supported at the rear end by the peak of the roof, 10.2m (40') above ground, and the forward end by two cedar trees about 11.4m (45') high. It is beamed South as I had been working friends in South and Central America also interested in improving beam antennas. They were capable of making good comparisons with the non-gain antennas previously used.

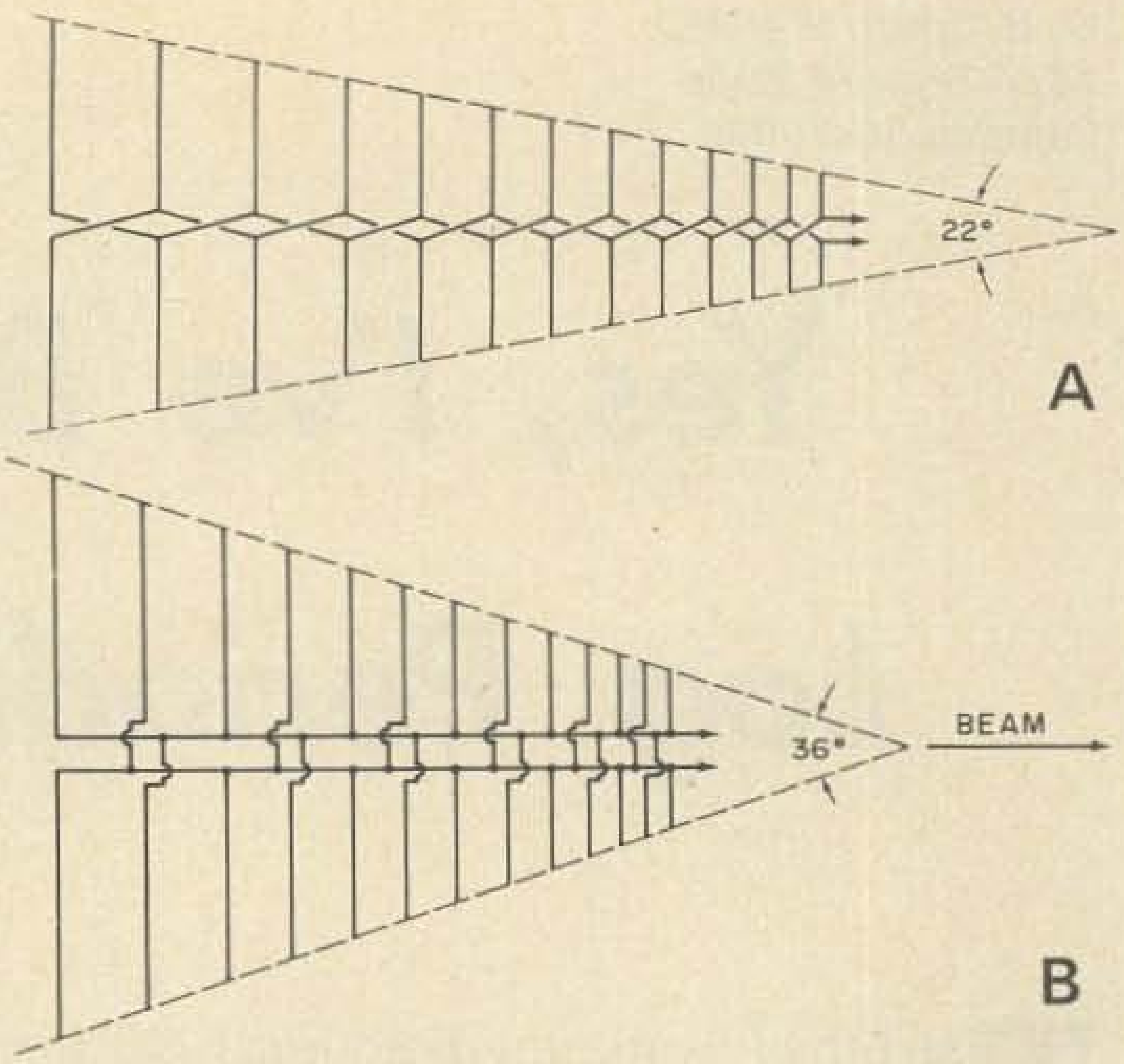


Fig. 1. Doublet log periodic configuration. This will cover a 2:1 bandwidth, say 7-14 MHz or 14-28 MHz. (a) has a 22° aperture angle and gives about 10 dB gain. Note the criss-cross method of transposition of the feeder. (b) is shorter, with a 36° aperture and about 8 dB gain. Note alternate method of transposition of the feeder.

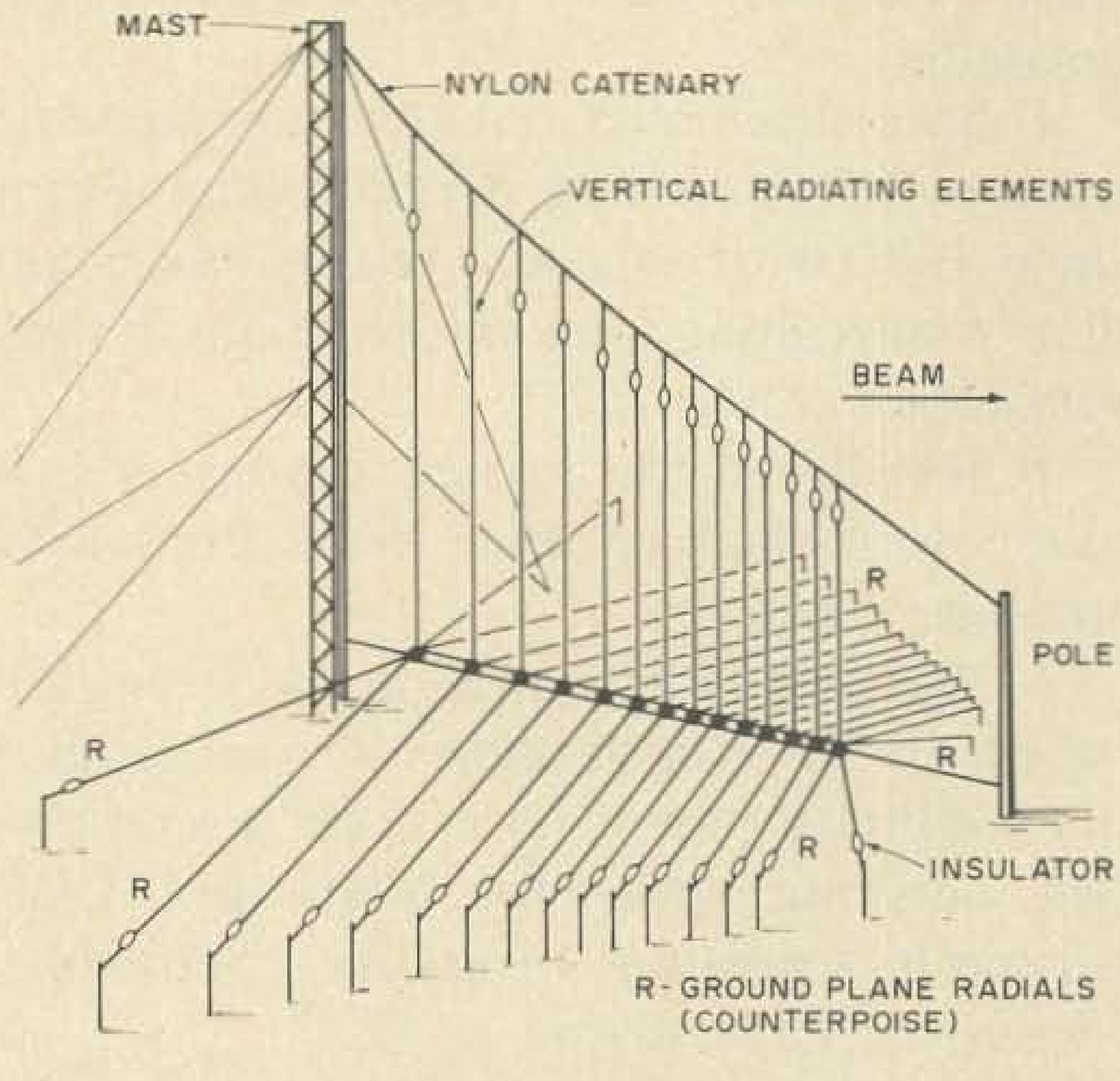


Fig. 2. Vertical monipole log periodic – 2:1 bandwidth.

The results of these first tests amazed me and also the stations being worked. Reports on the non-gain antennas (at the same height as the L–P) normally gave reports of S8–9 on 20m from these stations. I used a popular transceiver operated "bare foot." Switching to the L–P, these stations would generally report an increase of two S-units, or at least a 10 dB increase over the doublet. Usually, when the doublet was giving S–9, they would give "20 over" on the L–P. Although a 20dB gain would seem exaggerated, the "S" meter at this end

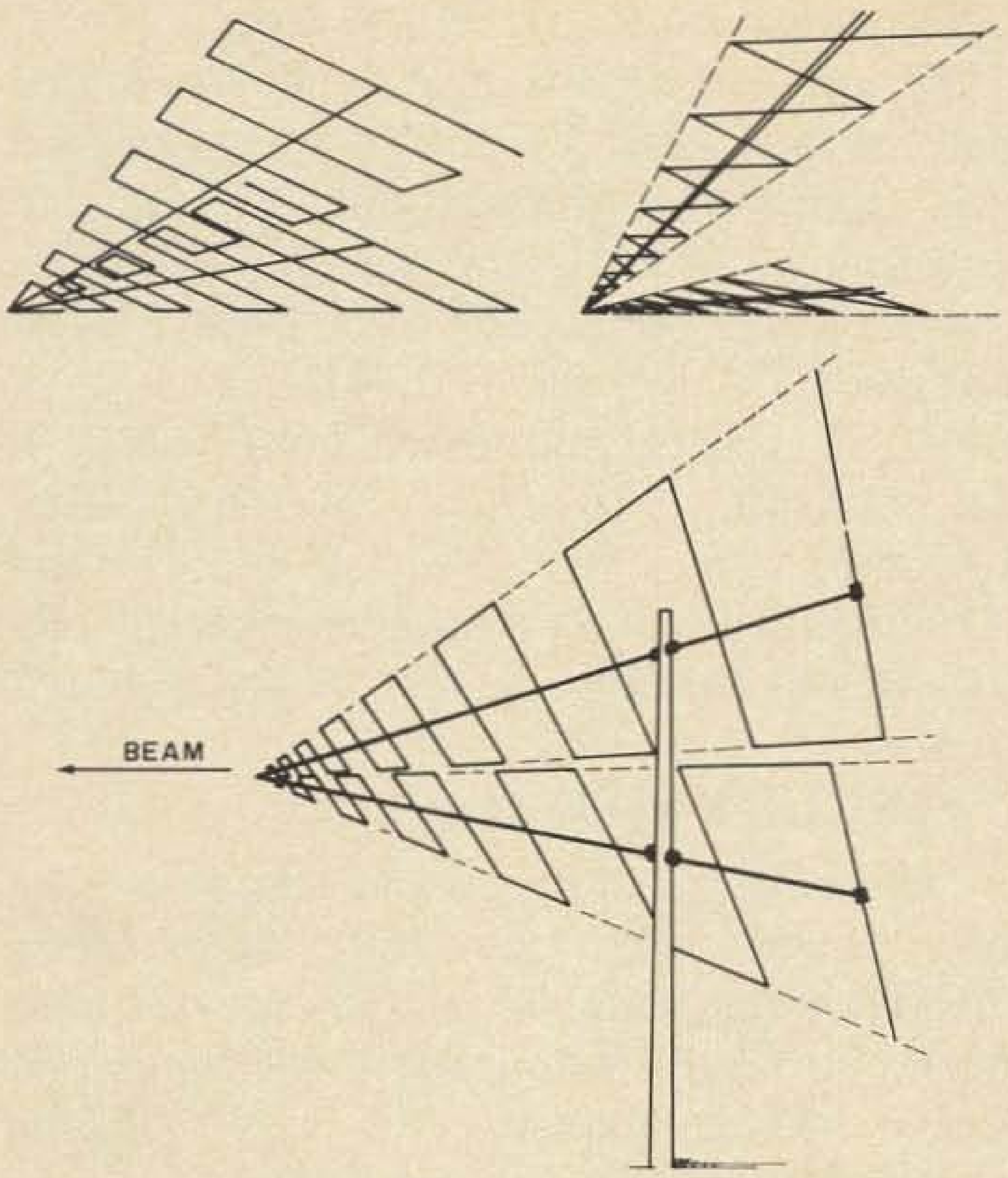


Fig. 3. Trapezoidal log periodics.

would generally confirm this increase on their signal when switching to the L–P.

It is realized that many "S" meters exaggerate but most are fairly linear and can be used for *relative* comparisons at the lower levels. Further the "S" meter here correlated very closely with the gain figures reported when switching to the experimental L–P.

Although the original L–P, Fig. 4, would only have a theoretical gain of 8–10dB, L–P gain figures are often based on VHF or UHF models tested over a line-of-sight path. It is noted that one of the large manufacturers of Commercial and Military HF Log Periodics (see reference B), rate their 10–12dB gains *"over average soil conditions."* It is therefore believed that this first experimental L–P gives an honest 8–10dB gain by averaging the many reports received from various stations to the South over the past 4 years. The "S" meter on the receiver here is quite "Scotch." Generally, if a station reports a two S-unit or 12dB increase when switching from the doublet to the L–P, the "S" meter here normally shows the same increase in his signal.

Since the original simple 7-element (L–P #1) for 20 and 15m was put up in 1970 it has continued to give excellent results and is still being used as of this writing. Several others having more elements and greater length, providing greater gain, have been put up and thoroughly tested. Briefly, these are (in the order tested):

L–P #2. 12-element, 17.8m (70') in length for 20–15–10m. Now being used for the NE beam for W1s, W2s and Europe.

L–P #3. 12-element 6.35m (25') length for 15–10–6m.

L–P #4. 12-element, 10.16m (40') length for 20–15–10m.

L–P #5. (#2 tested on edge in the vertical plane or vertically polarized for about two weeks).

L–P #6. 13-element, 22.86m (90') length for 40–20–15m. This was a "skip band" type with a portion between the the 40 and 20m bands omitted. Two of these are now being assembled for permanent North and South beams.

L–P #7. 5-element, 12.7m (50') length for 40m only. (See reference 18).

L–P #8. Two 5-element (same as #7) for 40 only; back-to-back in an inverted V configuration suspended by a single center support line. One beamed North, one South – exactly 180° difference. Put up to obtain additional and more accurate forward gain and better front-to-back data on 40m.

L–P #9. Improved 5-element, 40m only at increased height for additional forward gain data. Aimed South. Gave consistent 10dB gain over doublet "standard" at same height.

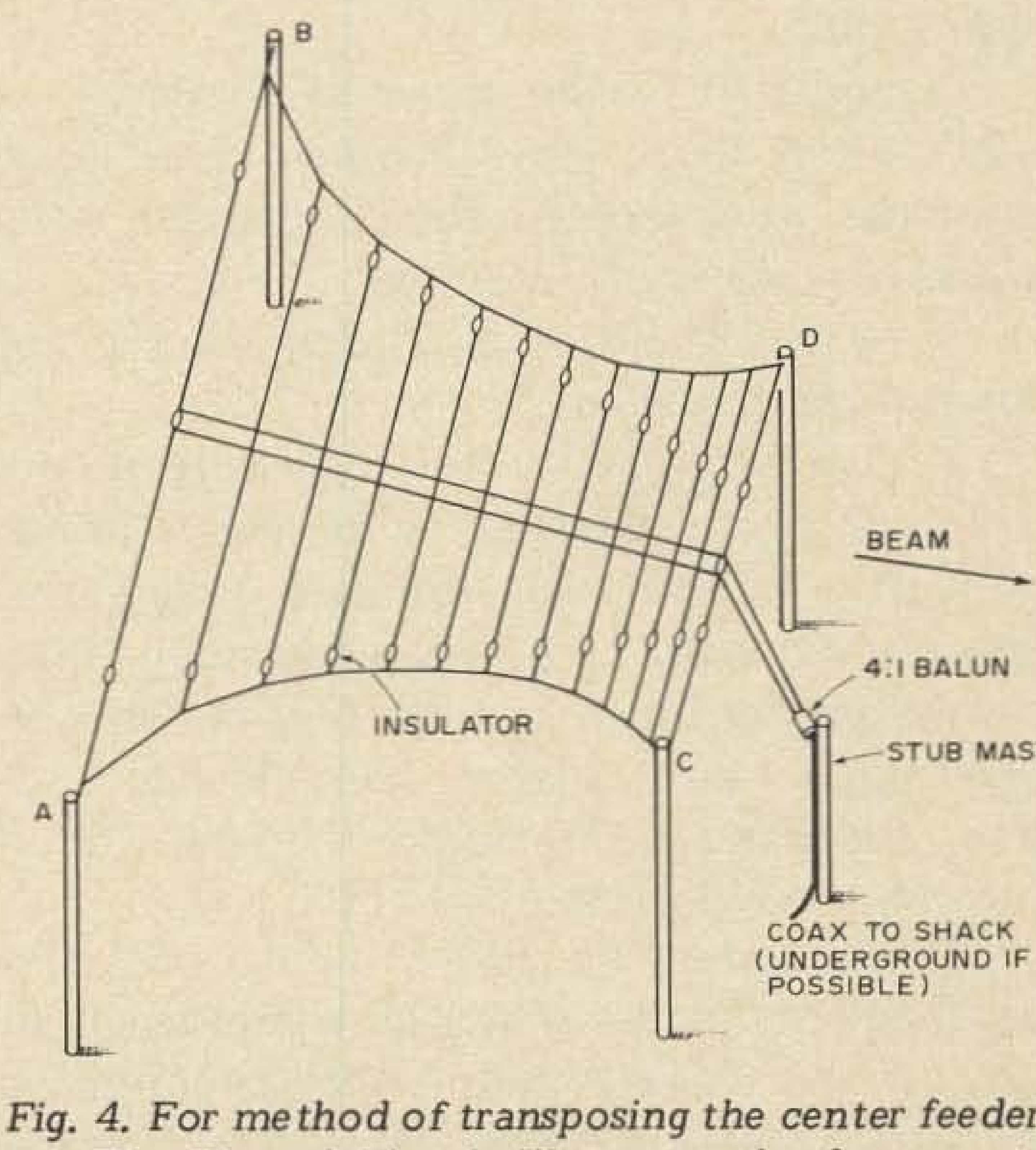


Fig. 4. For method of transposing the center feeder see Fig. 1b and Fig. 6. Illustrates the four masts used to support the antennas.

L–P #10. 5-element 10m monoband L–P. (See reference 18.)

L–P #11. 17-element, 25.4m (100') length for 20-15-10, 15.24m (60') above ground. This is the permanent West beam which has a measured 12–13dB forward gain to the West. By far the best and highest gain L–P installed here to date. Side attenuation is down 25–30dB.

L–P #12. 6-element, 12.7m (50') length. Experimental for 20m only. 10dB gain. Four additional forward parasitic directors (non-driven) were added later but little if any increase in gain could be noted.

L–P #13. 5-element vertical monopole Log-P for 40m only, using ground plane radials or counterpoise. Although this L–P gave a 10dB gain, it had an extremely low angle of radiation. Was good for DX but horizontal doublet type. L–P #7 or #9 was better for normal operation.

L–P #14. Same as #13 except inverted as an "up-side-down" inverted ground plane. Strictly an experimental antenna to try for an even lower angle of radiation.

L–P #15. 5-element vertical monopole Log-P for 80m only. Results similar to 40m monopole, L–P #13. Good for DX but poor for close by stations. Gave 10dB gain (over 80m doublet at 11.43m, 45') from stations greater than 1500 miles.

L–P #16. Trapezoidal L–P for 20 and 15m only, both the zig-zag and the saw-tooth types tested.

In addition to the above L–Ps designed and tested here, several other directional antennas were erected for comparison with the L–Ps. Some of these were:

1) A 6-element 15m "Long John" yagi mentioned below.

2) A 20m phased beam consisting of two 1/2λ's in phase, collinear with two collinear reflectors and two collinear directors beamed toward Europe. Although this showed approximately a 10dB gain, the lobe was much more narrow than the NE L–P and the band width quite narrow. At ± 50kHz, the SWR exceeded 1.5:1.

3) A 5-element Bruce array on 20m beamed for Caracas. The gain was lower than any of the L–Ps tested in that direction or possibly, being vertical, the angle of radiation may have been too low for this distance. It was only tested a few weeks.

In addition to the ham L–Ps assembled here, several other L–Ps have been designed "on paper" for friends and others, one covering 12–24MHz for several MARS frequencies as well as 20 and 15m. Several commercial L–Ps for 3–30MHz, 2–4, 4–8, 6–12, 8–16MHz and several VHF and UHF for 30–50, 140–145, 150–470 MHz, including two for TV: 174–215 and 475–750MHz. Several have been completely assembled for others on "custom built" orders.

YV5DLT – W4AEO Tests

The most accurate 20 and 15m tests have been made with my long time friend YV5DLT (ex-W5DLT) of Caracas. We have been constantly testing the L–Ps for several years. He is able to give very accurate readings on any changes made here.

During the original testing of the first three L–Ps, schedules were kept daily between 1200 and 1400 local time here as these hours gave the worst case conditions on 20m. Other schedules were kept on 15m.

It was during this period that the 17.78m (70') L–P #2 and the 15 and 10m L–P #3 were put up for comparison with the original L–P #1 which had performed so well on both 20 and 15m. L–P #3 was especially good during the 15m tests, generally showing 5 dB over L–P #1 and even slightly better than L–P #2; however #3 was aimed at approximately 165°. Caracas is 149° true, 1854 miles Statute. The other two L–Ps were approximately 180°. All three were about the same height above ground.

After several months of 15m tests on #3, we wished to make a direct comparison with a good yagi aimed in the same direction. I assembled a 6-element "Long John" Yagi per (see reference 20, p. 104). This was erected to the side of L–P #3, exactly parallel and aimed in the same direction; both 11.43m (45'), or about a full wave above ground.

Several weeks were spent comparing these two beams. Invariably YV5DLT would report L–P #3, 3–5dB better than the yagi. The "S" meter readings here confirmed this.

40m L–P Tests

Most of the 40m tests were conducted

over a period of several months with old friends, W4QS and K4FBU in Florida at the same time daily. During this period four different 40m L–Ps were beamed South for Florida at various times for comparison with a good 40m horizontal doublet at 11.43m (45'). One 40m L–P #8 was also beamed North for comparisons in that direction. All of these L–Ps produced 8–10dB gain in these directions over the dipole; however, many of the tests indicated as much as a 20dB improvement which was confirmed by the "S" meter at this end and a number of other stations in various parts of Florida.

Since the usual 2-element 40m yagi or two extended 1/2λ's in phase collinear do not normally exceed 3–4.8dB gain, the 10dB average gain of the L–Ps tested is worth considering; especially because of their low cost and ease of construction.

75 or 80m Vertical Monopole L–P Tests

A 5-element vertical monopole L–P, #15, was assembled for 75m. Since the mast height limited the longest rear element (the reflector) to 16.51m (65', ¼λ +5%) this L–P was limited to 3.8 – 4.0MHz, and all tests were within this range.

It was soon evident that this vertical beam was strictly for longer range communications, due to its lower angle of radiation. The ½λ 80m dipole up 45° (not an inverted V) used as the "standard" was better for distances from 400–500 miles. Beyond this range the vertical L–P was better in the forward direction. At night the doublet was better to about 1000 miles; beyond, the monopole L–P would show its increase, giving a good gain over its beam width.

For ranges greater than 1000 to 1500 miles, the 75m monopole, L–P #15, showed at least a 10dB gain over the dipole. However, for the normal working range on 80m or 75m, the doublet was better for the shorter distances.

A similar test using a 5-element 40m vertical monopole, L–P #13, was conducted with similar results as the 75m test. The horizontal doublet type 5-element 40m L–Ps #7, 8 or 9, being better for normal operations and the vertical monopole for DX. This beam was aimed NW.

During a pre-dawn 40m test with L–P#13, a W7 (working a VK on phone) in the NW about, 2000 miles from here, was monitored. On repeated "S" meter readings taken, the monopole was consistently 2 "S" units or 12dB better than on the 40m dipole when receiving the W7 in line with the monopole beam.

Receiving Advantages of the Log–Periodic

In addition to the excellent forward gain of the L–P which is quite apparent to those being worked, the received gain is also quite noticeable. Another plus factor of the L–P is its excellent diversity or "capture" effect during reception.

When QSB is bad on the dipole used as the "standard," switching to the L–P reduces fading considerably, since the "readability" on the L–P is much better.

Evidently the number of elements and its "boom length" produces the diversity effect due to its size and length compared with the doublet or even a smaller 3 or 4 element beam. The greater the number of elements and the greater its length, the better it performs for reception in addition to the increased gain apparent on both transmission and reception.

For those more acquainted with the yagi, the L–P can be considered as a multi-element, uni-directional end-fire array having a driven (rear) reflector, a ½λ driven "active" radiator and a number of forward driven directors.

L–P theory implies that for a given discrete frequency within its bandwidth, 5-elements are generally excited or driven as an "active cell." However, while testing the 17.78m (70'), 12-element, L–P #2, it was excited with low power on 20m. Rf voltage could be detected (using a neon bulb) on *all* elements except the long rear (reflector) element. The second or ½λ driven element (on 20m) was quite "hot" at the ends as would be expected. The rf voltage on the following driven director elements 3, 4 – 11 and 12, decreased gradually toward the forward end. Some rf could still be detected on the short forward element #12.

Evidently these multi-element, driven directors add gain and also possibly help lower the angle of radiation in the E plane and concentrate the forward lobe in the H plane. This may be the reason the apparent gain generally exceeded the theoretical during tests.

Front-to-Back Ratio

The front-to-back of the L–P is generally less than a well designed mono-band yagi. The L–P seems to be 14–15dB maximum with 10 to 13dB as typical. From the tests made here, the front-to-back improves as the L–P is raised to at least a ½λ above ground (at its lowest cut-off frequency).

The front-to-back of the 40m dipole L–Ps (DLP) tested appeared to be better for the horizontal than the inverted V configuration, as would be expected and the forward gain also better.

The Forward Lobe

The forward lobe of the L–P is generally wider (about 90–100° beam width) than that of a well designed yagi; however, for a large fixed beam this is good as it can be aimed to cover a certain part of the country or a particular DX continent. For example the NE (L–P #2) covers Europe quite well and the 30.48m long, 17-element West beam (L–P #11) seems to cover all of Australia. The side attenuation of this long L–P is down 25-30dB.

A W1, -2 or -3 could use one or two L–Ps to cover most of the states. A W6 with an L–P beamed East would cover most of the East Coast. At this QTH 4 L–Ps will cover most continents of interest: NE, Europe; East, Africa (and Australia long path); SE or South, Southe America; West, Australia; and NW – Alaska, Japan, etc. One for SW may be tried later for long path to Europe.

Fixed Beam Antennas vs Rotaries

An advantage in using several fixed beams over a single rotary is that they can be switched instantly from one to the other (and to the doublet used as a"standard"), whereas, it takes some time for the rotary to swing, making quantitative readings difficult, especially when QSB is bad.

Another item noted during the first year these L–P tests were started: about half the stations worked during the winter of '70–'71, using rotaries, would come back "Sorry OM I can't swing my beam, it is frozen up for the winter." I noted less of this problem the second winter. Evidently better rotators are being used.

The following comments are comparisons of the L–P with several other beams.

Compared with the Yagi

As more hams no doubt use yagis than other beams, these will be compared first. A well designed and properly adjusted 3 or 4-element mono-band yagi should give about the same gain as a moderate size 20-15-10m L–P when both are at the same height above ground. The L–P will, of course, cover all frequencies 14 and 28MHz and can be operated with a comparatively flat SWR any place in the three bands. The band width of a high Q yagi may be limited to a portion of a band as the band width at resonance may be only 2.5%.

Compared with a tri-band yagi for 20-15-10m, which is generally a compromise antenna, the L–P should give the greater gain.

Of all the contacts made while testing these L–Ps during the past four years, not a single station worked (most using yagis for 20, 15 and 10) had a doublet for use as a "standard" or test antenna for comparison with his beam. Many have been most cooperative in rotating their yagis the full 360° to demonstrate the front-to-back, but none were able to demonstrate its forward gain. The front-to-back on some of the mono-band yagis was quite good, while others were very poor.

One MARS station worked had both a rotatable L–P and a yagi. He obliged by rotating the L–P 360° which gave a good demonstration of its pattern. When both antennas were beamed in this direction, the L–P showed greater gain; however, he did not have specifications on the yagi.

An advantage of having several fixed beams for various directions is that they can be selected instantly by a coax switch or relay. This allows for more accurate data in comparing antennas. Even under fading conditions a fair comparison can be made by switching rapidly and averaging the readings.

Compared with a Rhombic

Anyone having room for a rhombic certainly has room for several L–Ps for various directions and is then not limited to one direction as is the rhombic.

The TCI engineers (Technology for Communications International of Mountain View CA) advertise their "Extended Aperture" L–P which is only 60.98m (200') in length and has a gain of 17 dBi. A rhombic to produce this gain requires a length of 518.29m x 228.66m (1700' x 750') width according to the TCI ads.

Further, the gain of a rhombic generally decreases at its low frequency end (less wavelengths per leg), whereas, the gain of the L–P is approximately the same over its bandwidth. If anything, at least from the tests here, the L–P seems to give slightly better gain at the low frequency cutoff end. The forward lobe of the L–P is generally wider than the rhombic, requiring less accurate aiming than the latter.

Compared with Phased Arrays

To date I have only made comparisons with two phased arrays on 20; a 5-element Bruce and a 6-element collinear array mentioned above, both strictly single band antennas. Neither gave the performance of the L–Ps. I do plan to test the L–P vs a multi-element Sterba curtain or similar stacked arrays later.

The SWR of Log-Periodics

As a general rule the SWR of a L–P does not exceed 2:1 over the band width for which it is designed, i.e., 14 – 28MHz. From the tests here, the SWR over an entire band, 7.0–7.3; 14.0–14.35 or 21.0–21.45 does not exceed 1.5:1. Table 1 gives some of the readings taken from several of the L–Ps tested. (Also see reference 18 for SWR readings taken on the mono-band L–Ps.)

Log-Periodic Site Selection

The first step is to determine if space is available for the L–P when beamed in the desired direction. The second step is to decide the desired band width or the bands it must cover and the gain desired. These will, of course, determine the size (length) of the L–P and if it will "fit" the space available.

The long rear element (reflector) must be at least 5% longer than the lowest cutoff

Table 1

SWR Readings

kHz	LP #1 7-element 20 & 15	LP #2 12-element 20–15–10	#11 17-element 20–15–10	kHz	#9 5-element 40 only	LP #15 5-element monopole For 80m only
14.0	1.1:1	1.4:1	1.4:1	3.5	NA	1.2:1
14.1	1.1:1	1.5:1	1.4:1	3.6		1.2:1
14.2	1.02:1	1.6:1	1.3:1	3.7		1.1:1
14.3	1.02:1	1.7:1	1.2:1	3.8		1.2:1
14.35	1.01:1	1.7:1	1.1:1	3.9		1.4:1
				4.0		1.25:1
21.0	1.01:1	1.1:1	1.3:1	7.0	1.05:1	
21.1	1.01	1.2:1	1.15:1	7.1	1.05:1	
21.2	1.05:1	1.3:1	1.05:1	7.2	1.01:1	
21.3	1.15:1	1.4:1	1.01:1	7.3	1.1:1	
21.4	1.25:1	1.4:1	1.02:1			
21.45	1.3:1	1.5:1	1.1:1			
28.0	NA	2.0:1	1.5:1	*Also see SWR readings for mono-band L-Ps, Aug 1973 issue of 73 Magazine, p. 23 and 24.*		
28.2		1.5:1	2.0:1			
28.4		1.6:1	2.25:1			
28.6		1.6:1	2.0:1			
28.8		1.8:1	1.3:1			
29.0		2.0:1	1.01:1			
29.2		1.6:1	1.5:1			
29.4		1.6:1	2.0:1			
29.6		1.4	2.0:1			
29.7		1.3	2.7:1			

frequency. The short forward element should be 50% shorter than the high frequency cutoff. The pages of math required for their complete design will not be presented here. (See reference 2, 3, 4, 5, 8, 11 and 13.)

To simplify the design and eliminate the formulas entirely, Table 2 presents in tabular form some of the doublet type L—Ps (DLP) assembled and tested here for the ham bands as mentioned above. (Dimensions for single band L—Ps were given by reference 18.)

This tabulation gives frequency band width, element lengths and element spacings, overall (boom) length, apex angle, etc. of each.

Similar information on the vertical mono-pole L—Ps for 40m and 80m is supplied by Fig. 10.

If space is available for a L—P at your QTH, at least one of these can be tried.

Fig. 4, is sketch illustrating four masts used to support a typical DLP for 20-15-10m. These masts can be inexpensive 12.20m (40') collapsible guyed TV masts, power poles, towers, trees (as used here) or other supports if available.

Fig. 5, illustrates two high and four stub masts for an inverted V-Log-P which I call my "Λ-Log-P" configuration.

Fig. 6, illustrates a simple 5-element mono-band L—P which requires the least space. This is especially adapted for 40m. (See reference 18 for complete information.)

Fig. 7, illustrates an "acreage saver," using a DLP on edge in the vertical plane. This only requires one high and one lower mast and little width.

This one is only suited for the higher bands due to the rear mast height. The vertical DLP will usually have a lower angle of radiation than an equivalent horizontal DLP. It will generally not be too good for

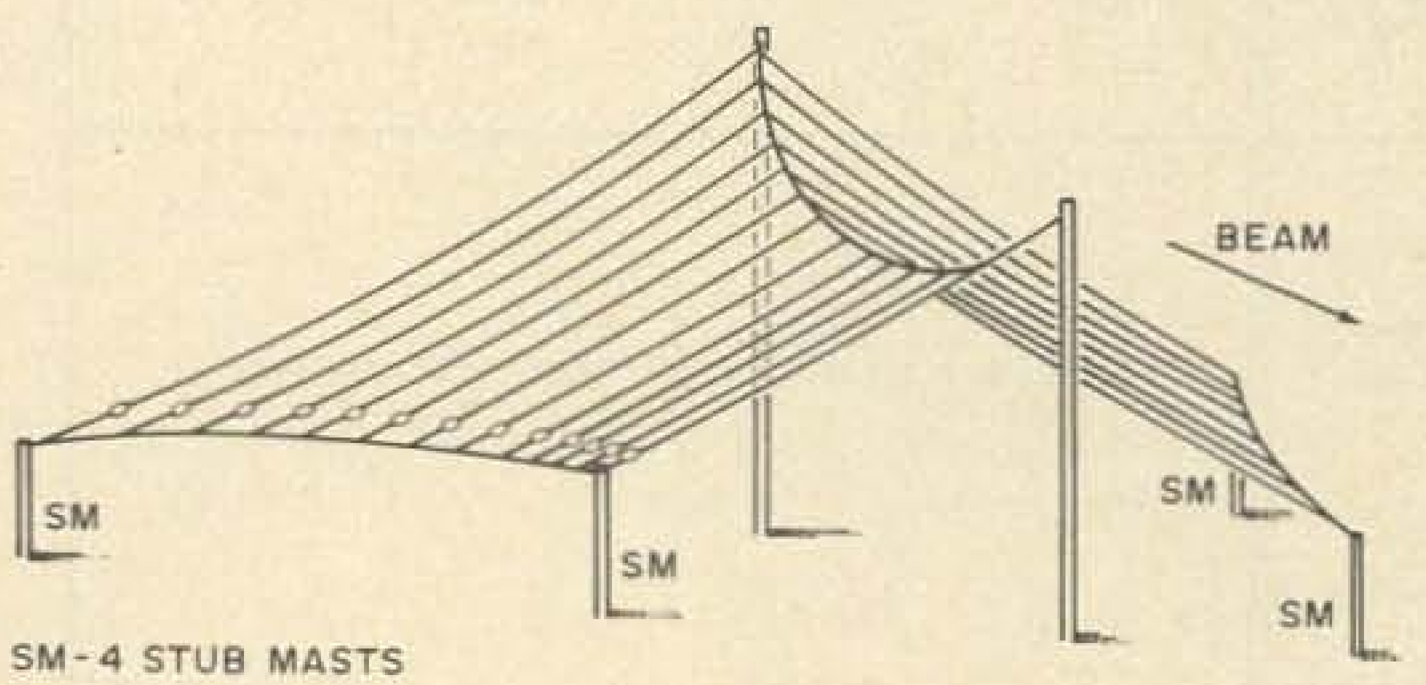


Fig. 5. W4AEO inverted Vee log periodic.

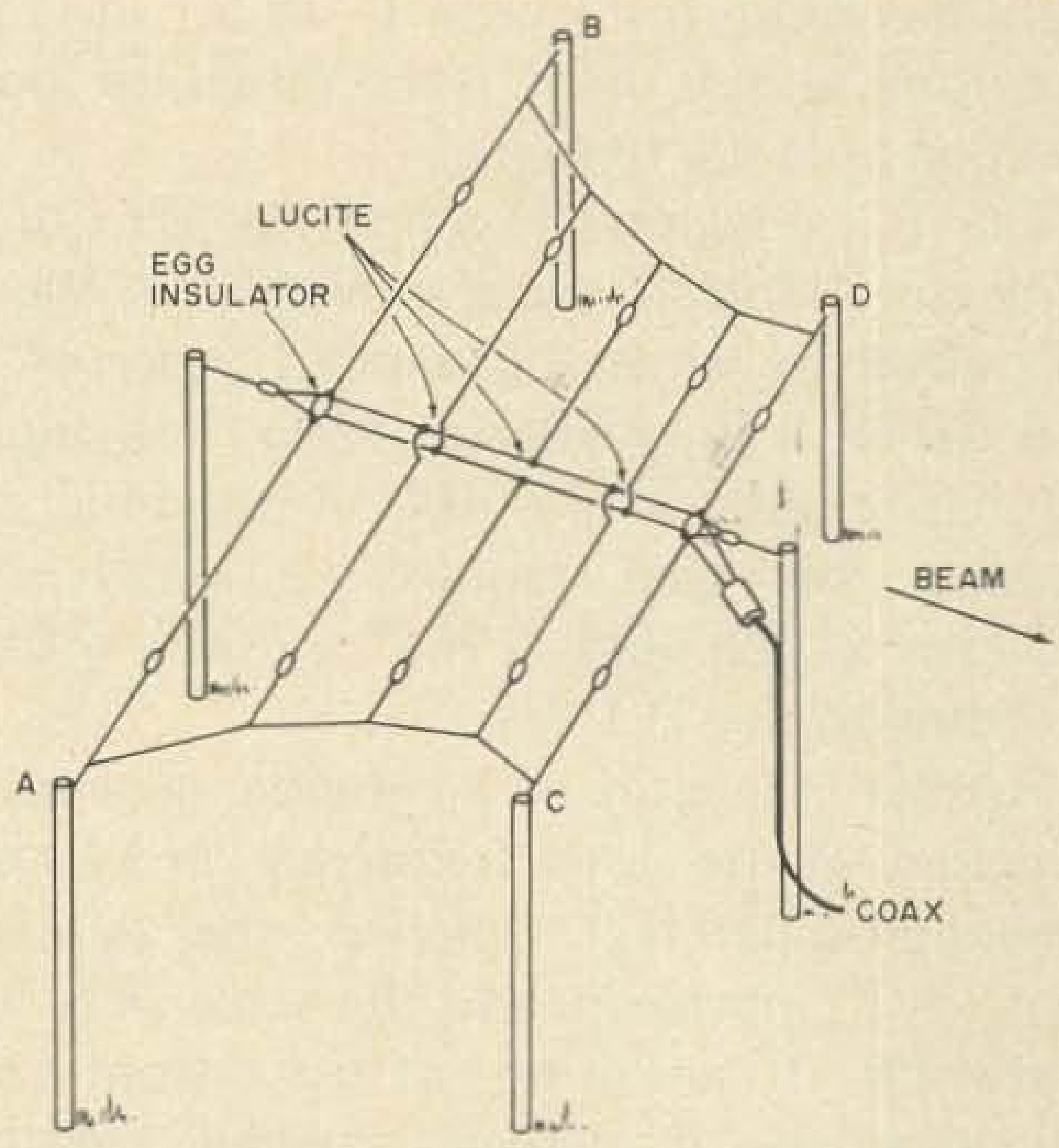


Fig. 6. Five element monoband log periodic — fine for any band 10 thru 80m — see the Aug. and Sept. 1973 issues of 73 Magazine for details.

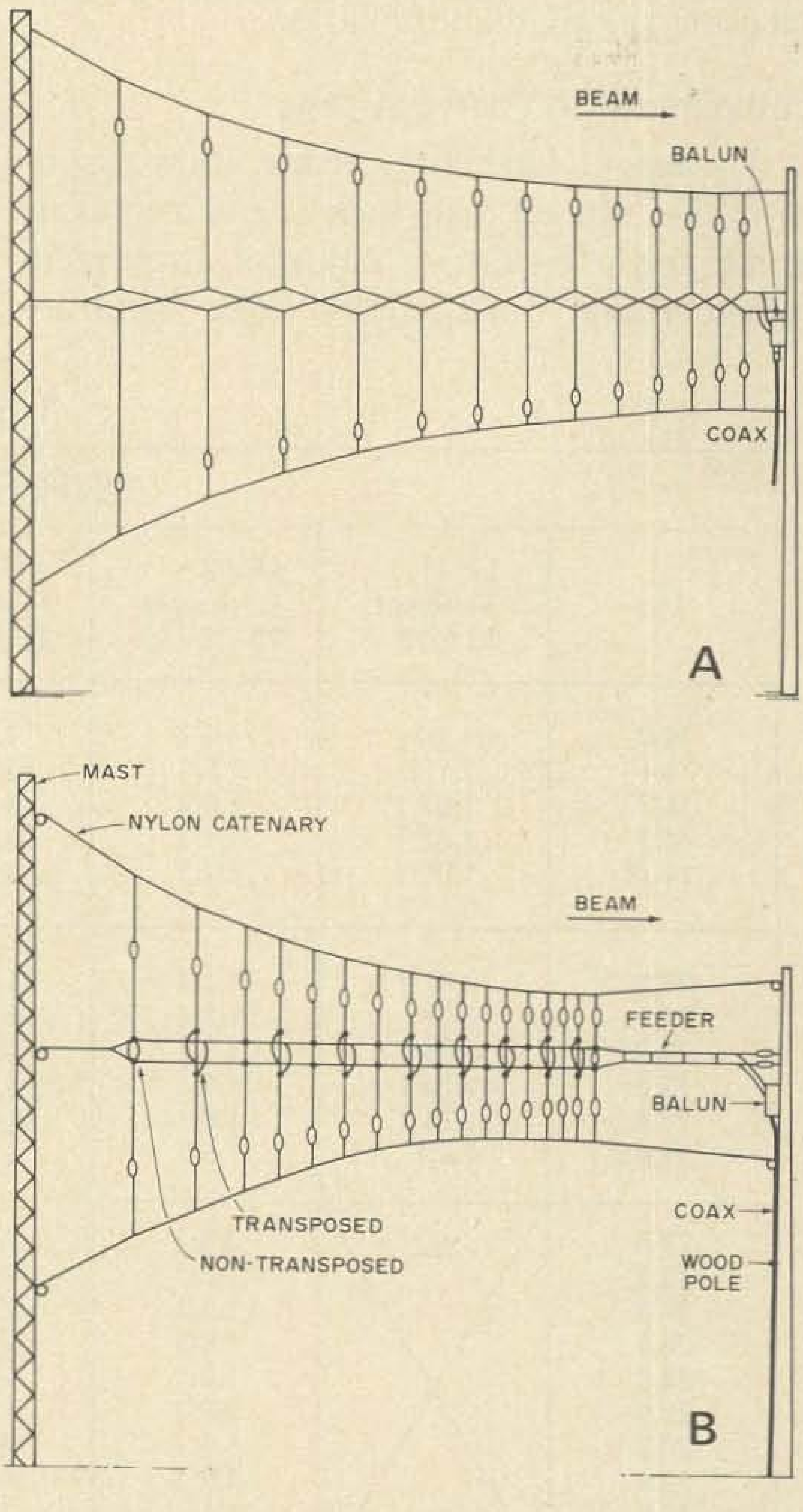


Fig. 7. Vertical dipole log periodic — acreage saver model.

Table 2

Element Lengths and Element Spacing Distances

LP # & Length Bandwidth	LP #1–38' 7-element 14–22 MHz	#2–70' 12-element 14–30 MHz	#4–40' 12-element 14–30 MHz	#7–50' 5-element 40 only	#11–102 17-element 14–30 MHz	Exp 25' 5-element 20 only
Element #1 (Overall Length)	36'	36'	36'	70'	36'	35'
2	32	32	32	64	34	33
3	28	29	28	56	31	28
4	24	26	25	49	29	24.5
5	21	22.5	22	40	26.5	20.5
6	18	20.0	20		24.0	
7	16	18.0	17.5		22.0	
8		16.0	15.5		21.0	
9		14.0	13.5		18.5	
10		12.0	12.0		17.0	
11		11.0	10.5		16.0	
12		10.0	9.5		14.5	
13					13.0	
14					12.0	
15					11.0	
16					10.0	
17					9.5	
Total Wire For Elements	175'	246.5'	231.5'	279'	345'	141'
Spacing #1 Distance	8'	10'	6'	14'	14'	7'
2	7.25	9	5.4	13	10	6.5
3	6.25	8.25	4.5	12	9	6.0
4	6.0	7.2	4.25	9	8.5	5.0
5	5.5	6.9	3.6		7.5	
6	4.25	5.7	3.5		7.0	
7		5.35	3.2		6.5	
8		4.8	2.8		6.0	
9		4.3	2.5		5.5	
10		4.0	2.0		5.0	
11		3.4	1.8		4.7	
12					4.2	
13					3.8	
14					3.5	
15					3.3	
16					3.0	
Boom Length	37.25'	68.9'	39.55'	48'	101.5'	24.5'
X2 Feeder Wire Required	74.5	137.8	79.1	96	203.0	49.0
+ Element Wire	175.0	246.5	231.5	279	345.0	141.0
Total Wire	249.5	384.3	310.6	375	548.0	190.0
Apex Angle	29° (∝ = 14.5)	22° (∝ = 11°)	36° (∝ = 18°)	32° (∝ = 18°)	16° (∝ = 8°)	32° (∝ = 8°)
Approx. Gain	8–10 dB	10 dB	8 dB	10 dB	12–13 dB	10 dB
For Bands	20 + 15	20–15–10	20–15–10	40 only	20–15–10	20 only

Also see mono-band L-Ps for 10, 15, 20, 40 and 80 Aug 1973 issue of 73 Magazine, p. 25.

short-haul on 20m or 15m but might be better on longer, multi-hop circuits. The one tested here worked extremely well on 10m.

Being vertically polarized, it is more subject to man-made QRM. This type is only suggested as a space saver or possibly mounted on the roof of a building where length may be available but with insufficient width for a four mast horizontal DLP.

Fig. 8, illustrates a single band vertical monopole L–P using ground radials suited for a 40m or 80m beam.

The advantage of the monopole is that only a single high rear mast is required (which might be the tower for a rotary beam) and a shorter wood pole for the forward mast. As the vertical radiating elements are only ¼λ, the rear mast can be approximately one half that required for a vertical DLP, Fig. 7, for the same frequency. A rear mast height (for Fig. 8) of 15.24m (50') is required for 40m and 22.87m (75') for 3.8-4.0MHz or 24.39m (80') for 3.5–4.0MHz.

The disadvantage is that at least 30% more antenna wire is required for the monopole L–P using ground radials compared with a DLP.

A vertical beam of this type should have an open area in the direction of the beam. Aiming toward a hill, heavy wooded area, etc., should be avoided due to its low angle of radiation. From the tests made here, a two or three story dwelling in the beam's path seems to give about 5dB attenuation. No doubt the plumbing, electrical wiring or air conditioning ducts either resonate or give sufficient screening to cause this attenuation. It is, therefore, suggested that vertical beams be used only on open terrain, having good ground conductivity. Avoid trees or other obstacles in the path of the beam.

The ideal location for a vertical beam of this type would be at a coastal area as near the shore line as possible with the beam aimed seaward toward a DX continent. Those lucky enough to have such a location would no doubt have excellent results with a monopole L–P having a 10dB gain on 40m or 80m. One aimed across a lake might also be good.

A vertical monopole for both 40m and 80m of the "skip band" type is not out of

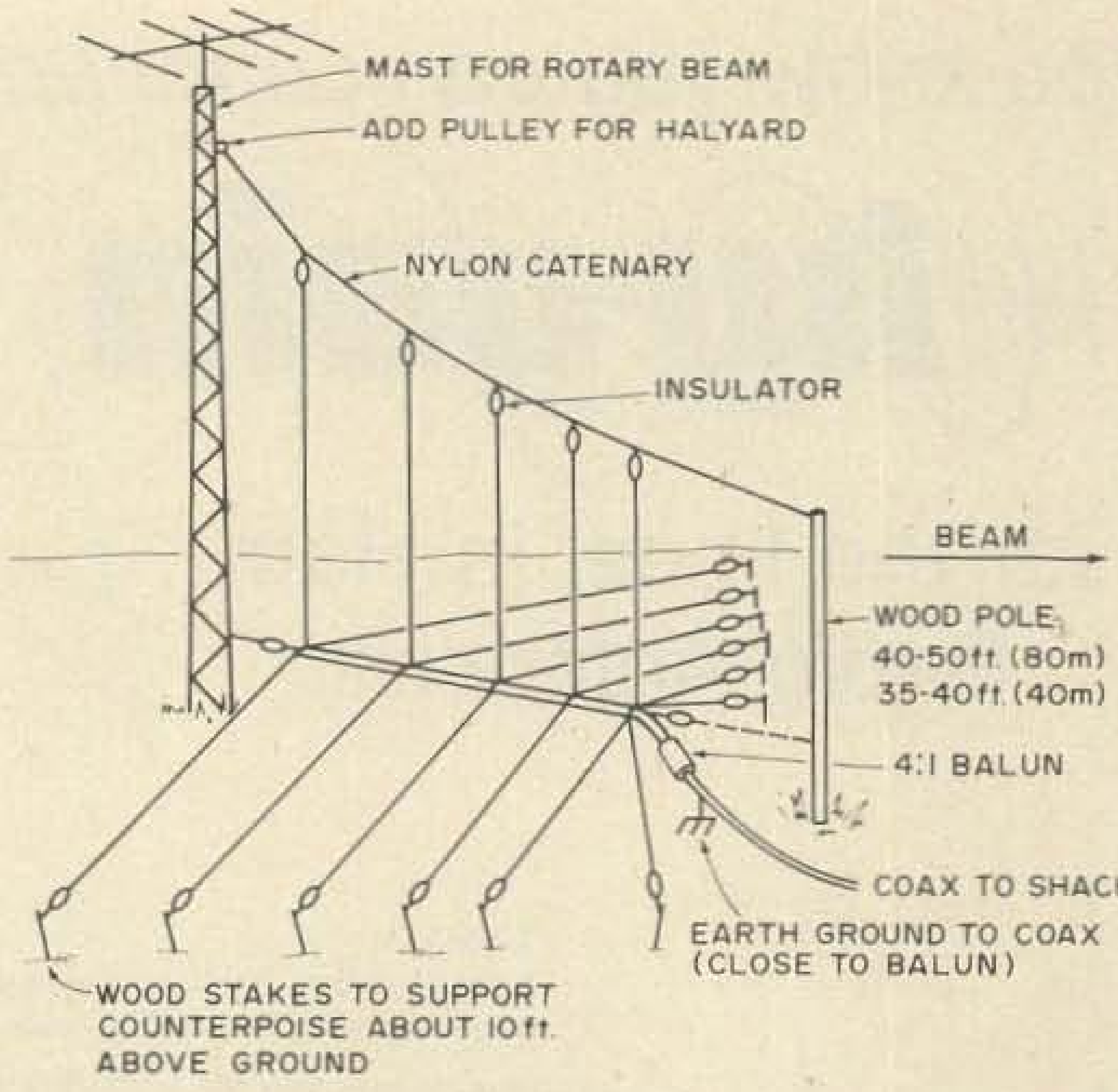


Fig. 8. Single band vertical monopole – for 40 or 80m. About 10 dB gain.

reason but would require at least 45.73m (150') in length by 42.68m (140') or 6,042.44m^2 (21,000 sq. feet) of open space which is quite an area except for one lucky enough to live on a ranch or farm.

The following is a step-by-step procedure for assembling simple, inexpensive 2:1 bandwidth DLPs for 20-15-10m, single band L–Ps for 40m or 20m and 40m or 80m vertical monopoles.

Log-Periodic Assembly Procedure

After determining if there is sufficient area for the L–P when aimed in the desired direction, it is suggested that a scale drawing be made showing the proposed mast locations for the L–P as it will be when suspended from the masts. By drawing this to scale, it is quite easy to determine any needed or unknown dimensions.

Next procure the necessary material for the L–P selected. Fig. 9 illustrates the construction or assembly of a typical DLP and Fig. 10, the monopole L–P configuration.

Note that for the long rear element (#1) and the short forward element of a horizontal DLP, small ceramic egg type compression insulators are used as these two end elements carry most of the load or strain of the center 2-wire open feed line and its center insulators or spacers. The latter are home made from .64m (¼") thick Lucite or Plexiglass. This can usually be purchased at hardware, building supply or radio stores.

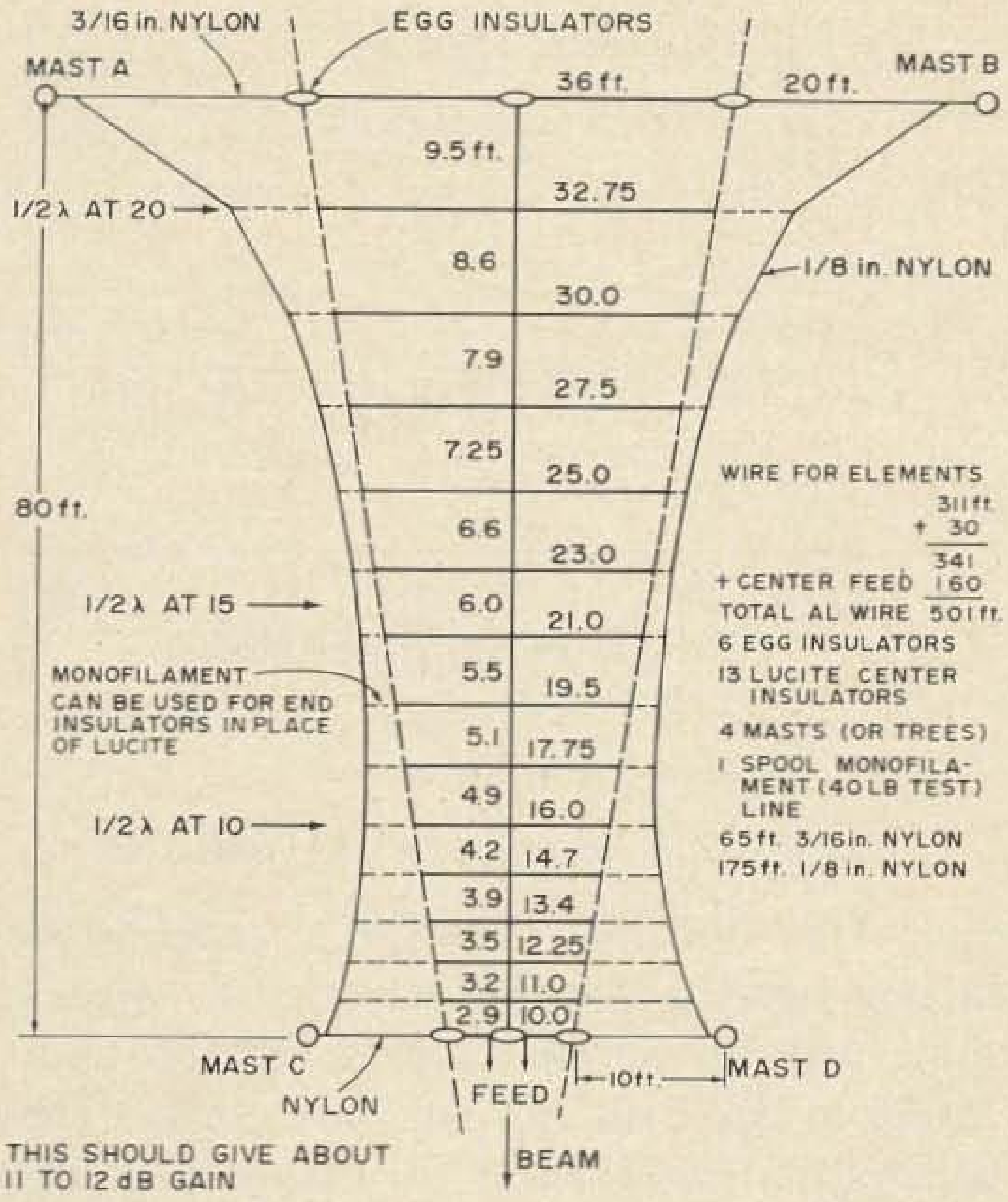


Fig. 9. 15 element 20/15/10m periodic.

The Lucite is cut into strips 1.59cm wide x 15.24cm long (5/8" x 6"). These are then drilled to make three type insulators for the L–Ps, which are:

1) End insulators for all elements (except the front and rear as mentioned above). Two holes are drilled in this type.

2) Center insulators for the DLP center feeder which serves as the center insulator for all elements (except front and rear), also supporting and spacing 10.16cm (4") the 2-wire center feeder. 4-holes drilled.

3) Center insulator for the monopole L–P. Same as the DLP type except these have an extra center hole for securing to the ¼λ vertical elements. For this type the two outside holes are for securing the ¼λ ground radials or counter-poise.

The hole spacings for above are illustrated in Fig. 11. These are all the same size to simplify production.

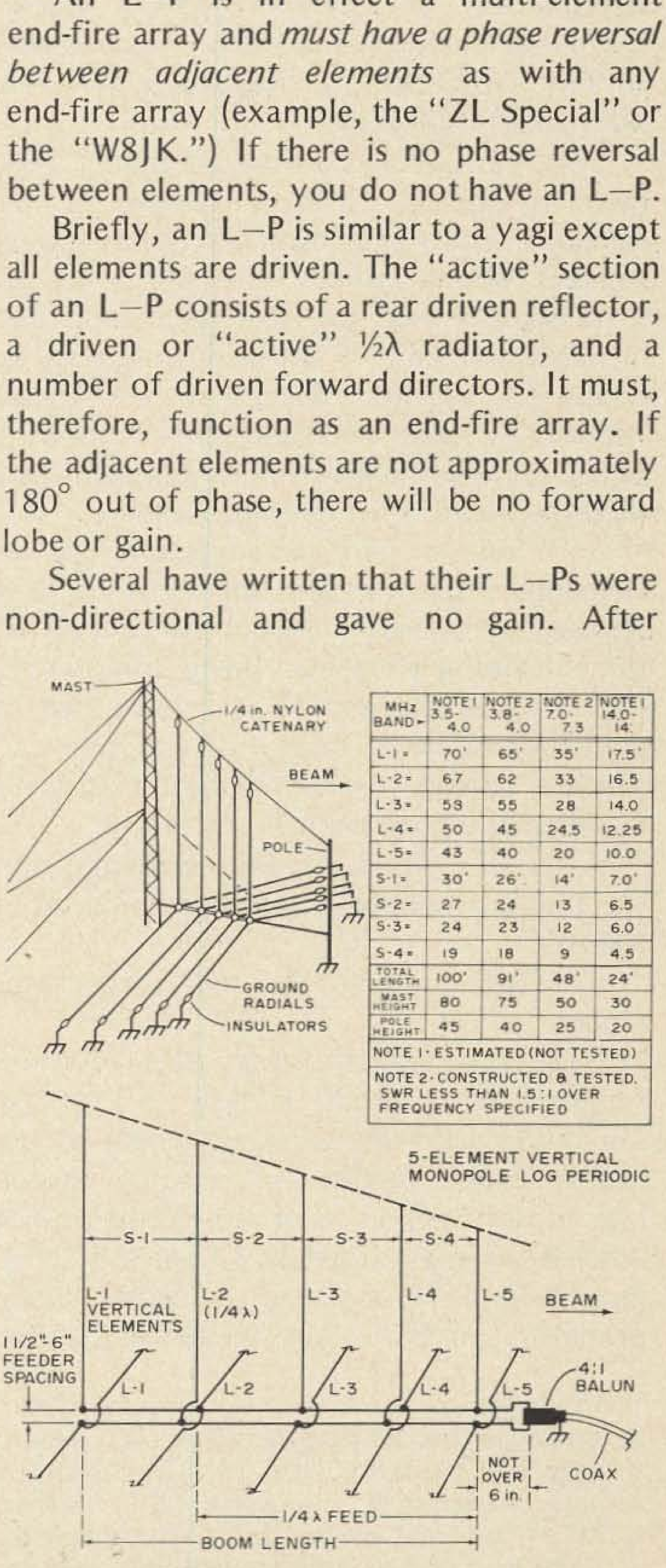
Lucite is used for these as it is difficult to locate a ceramic insulator of this type. The Lucite is light in weight, easy to cut and drill, low loss and less expensive than commercial insulators. They average 10 to 20¢ each. Hundreds of these have been used on the L–Ps here. Only one has broken after four years of use.

The importance of transposing between elements can not be stressed enough. This is accomplished either by criss-crossing the feeder as illustrated in Fig. 1a or by transposing the feed to the elements as illustrated in Fig. 1b. Both work equally well in providing phase reversal to alternate elements. The latter method is better suited for wire beams from a construction standpoint as shown in Figures 6 and 10. This method has been used here for all but one L–P. It is the method generally used for the large commercial L–Ps.

An L–P is in effect a multi-element end-fire array and *must have a phase reversal between adjacent elements* as with any end-fire array (example, the "ZL Special" or the "W8JK.") If there is no phase reversal between elements, you do not have an L–P.

Briefly, an L–P is similar to a yagi except all elements are driven. The "active" section of an L–P consists of a rear driven reflector, a driven or "active" ½λ radiator, and a number of driven forward directors. It must, therefore, function as an end-fire array. If the adjacent elements are not approximately 180° out of phase, there will be no forward lobe or gain.

Several have written that their L–Ps were non-directional and gave no gain. After



MHz BAND→	NOTE 1 3.5-4.0	NOTE 2 3.8-4.0	NOTE 2 7.0-7.3	NOTE 1 14.0-14.
L-1 =	70'	65'	35'	17.5'
L-2 =	67	62	33	16.5
L-3 =	53	55	28	14.0
L-4 =	50	45	24.5	12.25
L-5 =	43	40	20	10.0
S-1 =	30'	26'	14'	7.0'
S-2 =	27	24	13	6.5
S-3 =	24	23	12	6.0
S-4 =	19	18	9	4.5
TOTAL LENGTH	100'	91'	48'	24'
MAST HEIGHT	80	75	50	30
POLE HEIGHT	45	40	25	20

NOTE 1 - ESTIMATED (NOT TESTED)

NOTE 2 - CONSTRUCTED & TESTED. SWR LESS THAN 1.5:1 OVER FREQUENCY SPECIFIED

Fig. 10. 5 element vertical monopole log periodic.

checking, it was found they failed to transpose.

Antenna Wire

Because the forward and rear elements and the 2-wire center feed line are the only portions requiring a strain type wire, these should be #7/22, #7/24 or #14 copper or copper clad.

All of the other elements can be #16 soft drawn bare copper, enameled or tinned (hook up) wire. This can be purchased economically in 304.88m (1000') spools. Even #18 has been used here which seems entirely satisfactory; at least to 500W. This saves weight and cost.*

Since an L–P has a lower Q than a yagi, there is not the high rf current in the elements. The yagi generally requires tubing whereas wire is entirely satisfactory for an L–P. Wire is used for the large commercial or military fixed L–P antennas (reference A, B and C). Further, since there are several "active" elements per band, the rf current is no doubt distributed over several elements, therefore, wire is entirely satisfactory.

Soft drawn wire is suggested for all elements except #1 and the short forward element since there is practically no pull on the remaining elements. Being soft drawn, the wire will not tend to coil up or kink as does hard drawn or some of the copper clad. There is enough tension on the forward and rear elements to prevent this problem.

After all material has been collected, and the Lucite insulators fabricated, proceed as follows:

1) First assemble the two wire center feeder.

Select two sturdy posts, trees or other supports with about 1.53cm (5') greater separation than the required length of the center feeder for the L–P selected. Secure one end of the pair to or around the post at a height of approximately 1.83m (6') above ground level. Now thread the center Lucite insulators on the 2-wire feeder at the free end. This end may now be secured to the second post or tree. Stretch the two wires so they will be parallel and separated about 20.32cm (8") at the support ends. They will tighten to 10.16cm (4") separation after the center insulators/separators are spaced. They should be at about shoulder height to make for easy assembly. If necessary, two turnbuckles can be used temporarily at one end to tighten the two parallel wires and to adjust them for equal tension.

* A number of the L–Ps here have been constructed entirely of aluminum wire (#15 electric fence wire, Sears Cat. No. 13K22065). This is quite inexpensive compared with copper; 402.44cm (1320') roll at $8.70. The aluminum is also used here to reduce weight since trees are used as the "masts."

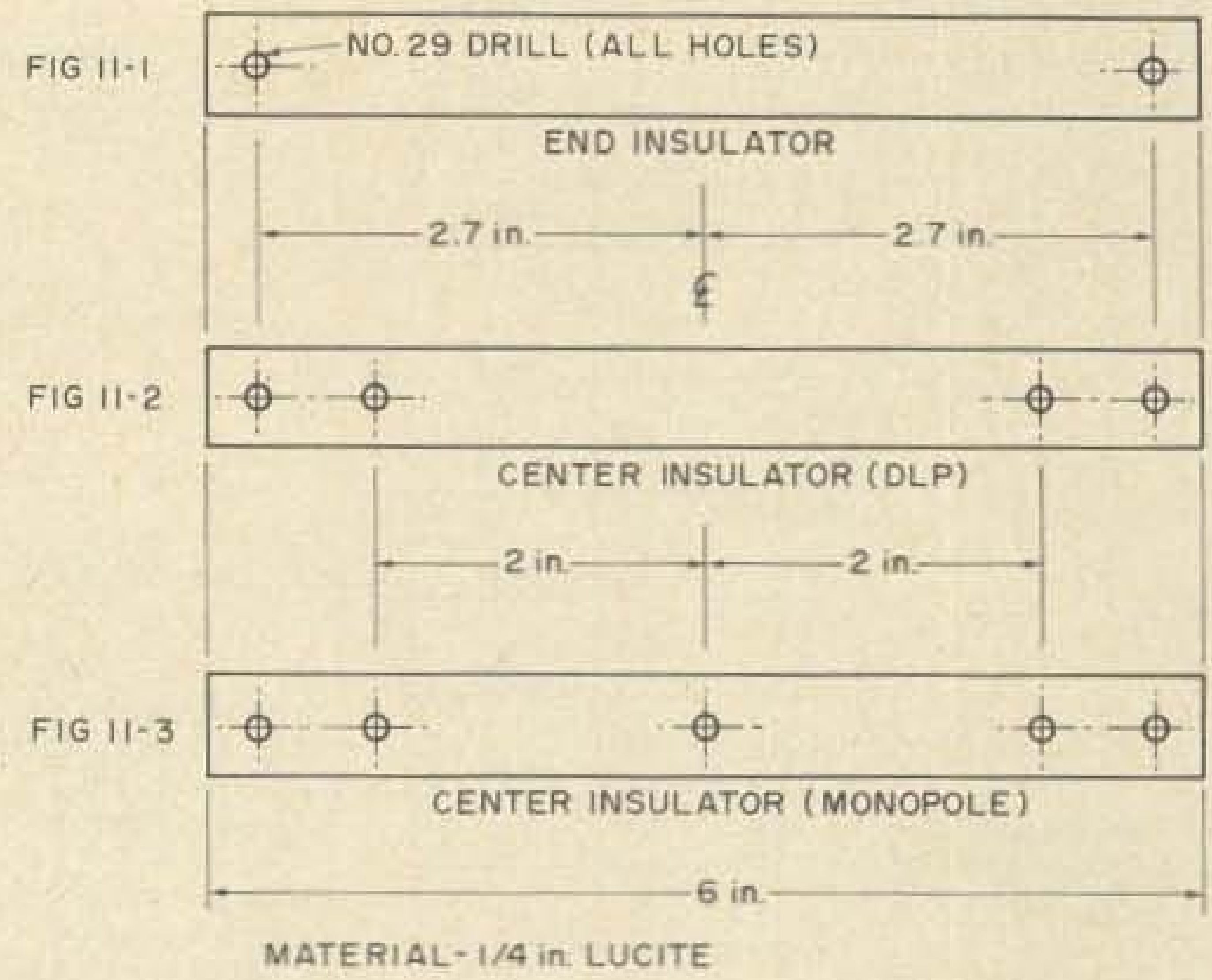


Fig. 11. Hole spacings for the insulators.

Now slide the center insulators (spacers) and distribute along the feeder in their approximate locations as given in Table 2. Starting at one end mark or indicate the location where the 2-wire open feeder will be attached to the center of the long rear element #1. A piece of 2cm (3/4") masking tape can be used on each of the two wires to indicate this starting point, which should be about 30.48cm (12") from one of the end supports. The #1 element will be located at this starting point.

Now measure from this point with a steel tape the first spacing distance, S1 which will separate Elements #1 and #2. The first Lucite center insulator will be located at this point (location of the second element, #E2). This insulator is held in place between the 2-wire feeder by means of a few turns of 2cm (3/4") masking tape served on either side of the Lucite insulator on both wires. Allow a slight distance or "play" on each side of the insulator so the tape will not be snug against the insulator. The wires should be able to turn free in the insulator holes. This helps keep the 2-wire line from twisting after the antenna is completed. The masking tape hardens after a few days in the weather and prevents the center insulators from sliding on the wires, which would alter the correct spacing of the elements.

Next measure the spacing distance, S2 and secure the next center insulator. Continue measuring and securing the insulators until all are in position. Then measure the last spacing distance and mark with tape as was done for the starting, #1 element. This last marking will be the location of the shortest end element (egg insulator) and will also be the feed point to the L–P.

The distance from the back side marking to the last forward marking will be the overall length (boom length) of the L–P and will total the spacing distances, S1 + S2 +S3. . .etc. It is suggested that this total length of the center feeder be measured to make certain no errors have been made in any of the spacing distances. This total length is given in Table 2.

2) The next step will be cutting the various elements (or doublets) to length; L1, L2 etc. It is suggested that the rear element #1 and the short forward element be cut last as these will not be connected to the feeder until all of the other elements are cut and secured to the center insulators; thus leaving the feeder attached to the supports for convenience until all except the forward and aft elements are in place, connected and soldered to the feeder.

In addition to the actual element lengths, allow several centimeters for connecting to the end insulators and about 25.4cm (10") extra for the center connections from the element center ends to the 2-wire feeder, as *every other element is transposed* as illustrated in Fig. 1b and 9. By using a continuation of the element centers, it eliminates an extra splice.

An odd number of elements is recommended since this allows the 2-wire feeder to be connected directly (non-transposed) across the center (egg) insulators of the end elements. (Reference 18.)

Also note that the rear of the center feeder is "fanned" or separated at the rear element (reference 18). This helps in keeping the two feeder wires separated on the longest rear (S1) span, especially important for lower frequency L–Ps. This precaution helps prevent the two feeder wires from becoming twisted or from touching during a high wind. Additional Lucite spacers between S1+S2 and possibly S2+S3 may be necessary for 40m, or even 20m L–Ps. This can usually be determined after the L–P is finally assembled at the 1.83m (6') level.

3) After the elements are cut to the various lengths, they can be attached to the center Lucite insulators, starting with element 2. The connections from the elements to the feeders can be made after all elements (except the rear and forward elements) are secured to the center insulators. *Note that every other element is transposed*, i.e., Element 1, non-transposed; #2, transposed; #3, non-transposed. . .etc.; or *all even number elements transposed* and *uneven numbers non-transposed.*

Fig. 11 illustrates the Lucite center insulator, the transposed and non-transposed method of connecting the element center ends to the feedline and the method of connecting the feeder to the short forward element and the long rear elements which use the egg strain insulators.

4) After the elements (except forward and rear) are attached to the center insulators and in turn connected to the feeder, all joints can be soldered while the center feeder is still elevated 1.83m (6').

The ends of the center feeder can now be removed from the 1.83m (6') supports and lowered to the ground. The feeder can now be attached to the rear and forward elements and soldered. Spread the complete L–P on the ground at its approximate location (when aimed in the desired direction) between the four masts (DLP type) from which it will be suspended.*

Nylon Catenary Support Lines

The DLPs used here are supported by two catenary side lines shown in Figures 4 and 6. These are stretched between masts A-C and B-D and the L–P suspended between these. Nylon line, .32cm (1/8") is used. .48cm (3/16") nylon is used for supporting the

* For some of the L–Ps, I have used monofilament fish line (40 or 50 lb. test) in place of the Lucite end-insulators to reduce weight, cost and fabrication time for the Lucite insulators. The line used was Sears Cat. No. 6KV32232 (40 lb. test).

long rear element, #1 and the short forward element as shown in Fig. 4, 6 and 9. Nylon does not shrink when wet or stretch when dry as does most rope. Further nylon will not rot and should last several years. After four years in constant use here none of the nylon line has broken.

The next step is to suspend the L–P between the two catenary side lines.

At this point the L–P has been assembled and is spread out on the ground between the four masts or other supports, aimed in the beam direction. It should now be raised 1.83 – 3.05m (6 – 10') above ground level and suspended at this height between the masts to be used in its final full height position. By using these masts, all angles and distances will be the same as when the L–P is hoisted to its maximum height.

The long rear element, #1, and the short forward element are attached to the .48cm (3/16") nylon line which supports the rear element between supports A & B. The short element is stretched between C & D.

The .32cm (1/8") side catenary lines or bridles are now stretched between A & C and B & D. Actually these are supported A–B and C–D, however, these splices will be near the masts; the .48cm (3/16") lines carry all the load and will be tied to the mast halyards.

Next, add the Lucite end-insulators to all elements except #1 and the short forward element. These use the egg strain insulators.

Now, starting with element #2, tie short lengths of #18 (165 lb test) nylon cord to the end insulators. These will in turn be tied to the side catenary lines, A–C and B–D. Element #2 will then be suspended between the side bridles.

When first tieing these element support cords to the catenaries, make a knot which can be easily untied. It may be necessary to adjust the tension on the various elements several times before they are correct and the catenary lines start taking their proper "suspension bridge" shape as shown by Fig. 4, 6 or 9.

Elements #1 and #2 should be parallel, by making certain that their end spacings are equal to the center spacing, S1. After element #2 has been attached and adjusted parallel with #1, proceed to suspending and adjust element #3 and the following elements, #4, #5, etc., until all are suspended between the side bridles. As these are attached, the catenaries will start taking on the shape of a commercial L–P.

Adjusting the tension of the elements between the side lines is the only "cut-and-try" procedure required for the L–P assembly. When constructing your first L–P it may require several tries but it will soon assume the correct shape illustrated by Figures #4, #6 or #9.

Note: All elements other than the rear #1 and the short forward element will have some sag. This does not seem to affect the operation. If the elements are pulled too tight between the side support lines (to try and level the elements), too much strain will be placed on the side lines, possibly requiring larger line and even sturdier masts.

There will also be some sag of the center feed line sagging toward the center. This shows no ill effect in the L–P's operation. Some sag or "give" in all elements (except the long #1 and the short forward element) is desirable. If all lines are too tight, they might break during heavy icing conditions.

None of the L–Ps here have come down over the past four years. During this time there have been three heavy ice storms. The L–Ps sagged almost to the ground from the ice build-up. As soon as it melted they returned to their normal height. They have also withstood several high winds without damage.

After all element support cords (#18 nylon) have been adjusted (and readjusted) several times so the sag of these are approximately the same, all elements parallel, and the side lines appear identical and have a similar catenary "curve" as in Fig. 4, the cords can be secured permanently to the side lines.

I suggest that a few turns of 2cm (3/4") masking tape be served on the .32cm (1/8") side lines on either side of the #18 nylon support cords. This will prevent the latter from sliding out of place along the side lines after the antenna has been raised.

Before raising the L–P to normal height on the masts, an SWR should be run while the antenna is still 6 to 10 ft above ground. Proceed as follows.

Feeding the Log-Periodic

The simplest method of feeding the L–P is to connect the high impedance balance winding of a 4:1 broad band balun at the feed point (short element end). The coax is then connected to the balun. Two other feed methods will be presented later but the 4:1 balun method is the easiest for running the initial SWR before raising the L–P to full height.

A low powered transmitter or transceiver should be placed on a box or table directly under or a short distance in front of the short element feed end. Connect a short length of coax from the 4:1 balun to the SWR meter and another short length to the transmitter or transceiver.

An SWR run should be made over each of the bands for which the L–P has been designed to cover. Readings should be taken at least every 100kHz over each band. Record these for comparison with a second SWR run to be made after the L–P has been hoisted to full height and the final length coax used between the antenna and the shack is positioned.

While the L–P is still at a workable height it is interesting to check the element ends for rf voltage on each of the bands. Either a small ¼ watt neon or a "sniffer" can be used. This test will give one a better idea as to the operation of the L–P.

If the SWR readings are 2:1 or better, the L–P should be O.K. after it is raised to full height. Generally the SWR readings will improve after being raised higher above ground. They should then be similar to the SWR examples given by Table 1 (and reference 18).

Other Feed Methods

The feed method mentioned above using a 4:1 balun directly to coax is the simplest and is recommended; however, two other feed systems can be used:

1) Tuned open line from shack directly to the L–P feed point. This, of course, requires a tuner at the shack which must be returned when changing bands. The tuner with open line is O.K. for a mono-band L–P but is a nuisance when more than one band is used.

2) 300Ω TV flat line can be used from the L–P feed point to the shack, then the 4:1 balun and coax to the set. This is the method used here. Since trees are used as "masts," RG-8/GU or RG-11/U coax is too heavy, causing the L–Ps to sag. The 300Ω TV line seems entirely satisfactory for low power "bare foot" operation. Further the TV line has extremely low loss if properly terminated and is quite inexpensive for long runs. Some of my L–Ps use over 107m (350') of TV line between the L–P feed point and the 4:1 balun.

After the final method of feed is selected, it can be connected permanently to the L–P feed point.

The beam is now ready to be hauled up to maximum height by the mast halyards. After the L–P is in place, another SWR should be run over each band and compared with those run at the lower level. They should not exceed 1.5:1 over any band (or any frequency within its band width, if necessary test equipment is available to make measurements outside the ham bands).

A doublet at the same height and broadside to the L–Ps beam should be used as a "standard" or test antenna for comparing gain in the forward direction.

Monopole Log Periodic Assembly

The assembly and erection of the monopole L–P configuration is similar to the DLP. Fig. 8 illustrates the general construction for either a 7.0-7.3 or 3.5-4.0MHz monoband monopole L–P. Fig. 10 gives element lengths and spacing distances for 40m and 80m.

A single catenary line is run from the high rear mast to the shorter forward mast, .64cm (¼") nylon line is suggested. The 5 vertical elements are suspended from the support line. Note the "suspension bridge" shape of the catenary illustrated by Figures 2 and 8.

The short forward mast should be a wood pole or any other non-metallic support since it is directly in the line of fire of the vertical beam.

Note that the ground radials decrease in length from the rear end (below the longest rear vertical reflector, element #1.) to the #5 forward element, the radials being the same length or slightly longer than their ¼Ω vertical elements.

The radials should be about 3.05m (10') above ground to allow access under them. Although the radials can slant down from the center feeder, the ends should be high enough to prevent contact as some are quite "hot" with rf.

The 2-wire feed line is identical to the DLP type; however, the elements connected to and supported by the Lucite center insulators (Fig. 11) are arranged differently in that the two outside holes are for the two ¼λ side radials and the center hole is for the ¼λ vertical element. Actually the center insulator and the 2-wire feeder are suspended by the 5 vertical radiating elements and they in turn by the single catenary line. Fig. 10 illustrates these elements, showing the jumper connection between the two side radials. Transposition or the "criss-cross" feed is accomplished as illustrated in Fig. 10.

The suggested method of feed is by the 4:1 balun, then to coax. Be sure the coax shield is grounded to an earthground as near the balun as possible.

For these mono-band monopole L–Ps, the #2 or ¼λ "active" radiator is approximately ¼λ from the balun feed point. This ¼λ line provides a matching stub between the low impedance feed point of the #2 element and high impedance at the feed point which is probably in the order of 200-300Ω, making a good match to the input of the 4:1 balun.

Summary

I believe anyone having observed the gain of the L–Ps used here will agree as to their effectiveness. When using the 17 element 20-15-10m West beam, (L–P #11) on 20m, W6's often report "strongest W4 on the band at this time." Considering that many of the other W4's are using the legal limit with rotary beams, a report of this type is encouraging.

I wish to thank the many hams who have assisted by reporting the readings taken on the various L–Ps tested here over the past four years and hope these tests will be beneficial to others. I especially wish to thank YV5DLT for his many reports on the 20m and 15m L–Ps; also, W4QS and K4FBU for their observations during the 40m tests for the past year.

I would appreciate hearing from any others trying these beams. . . .W4AEO

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