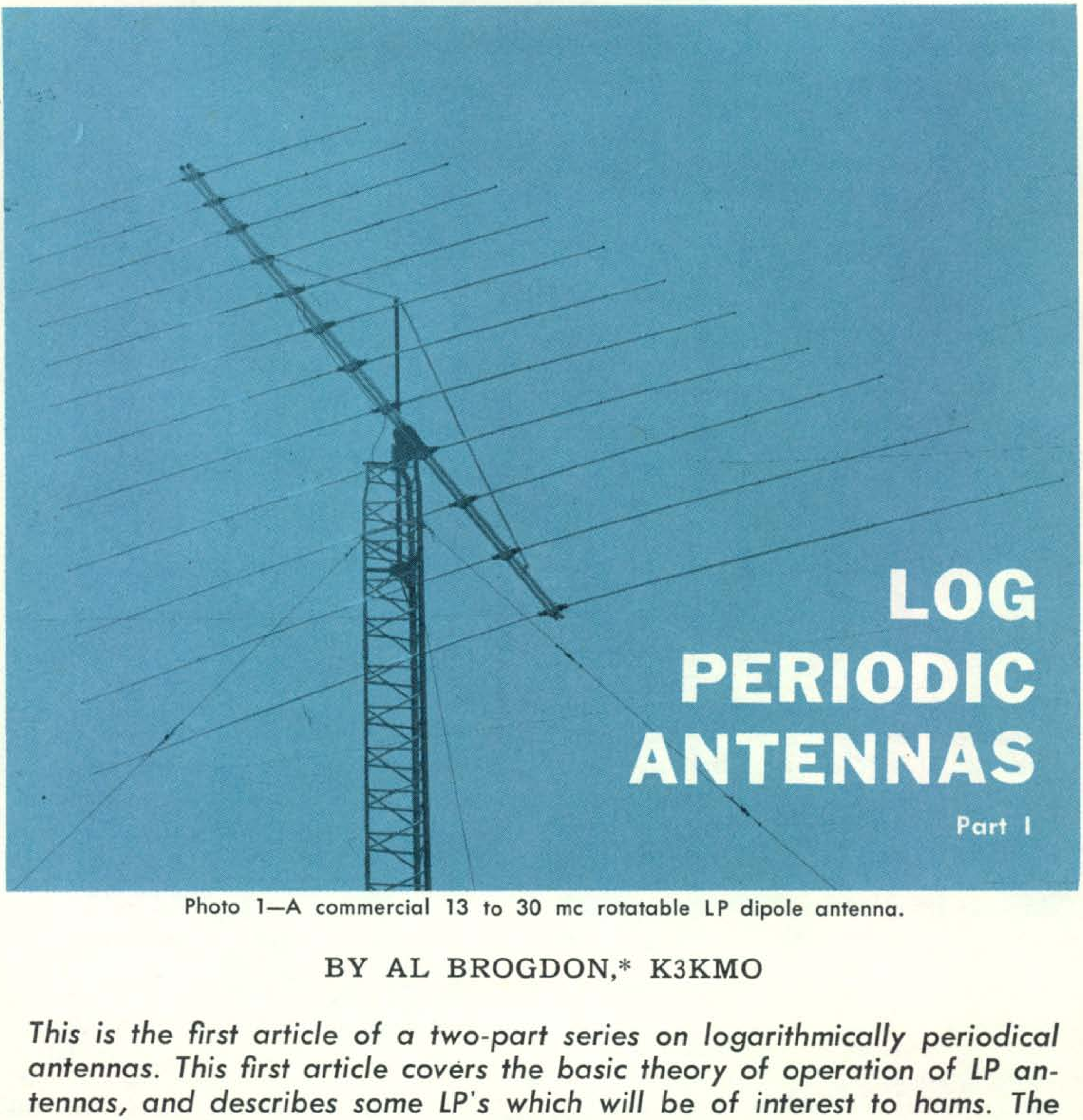

LOG PERIODIC ANTENNAS

Part I

Photo 1—A commercial 13 to 30 mc rotatable LP dipole antenna.

BY AL BROGDON,* K3KMO

This is the first article of a two-part series on logarithmically periodical antennas. This first article covers the basic theory of operation of LP antennas, and describes some LP's which will be of interest to hams. The second article will consider the design parameters for LP dipole arrays, and will work through the design data for a typical LP dipole array.

UNTIL recently, a broadband antenna with reasonable gain and directional characteristics was not available. The problem centered around the fact that all antennas had their dimensions specified in terms of frequency—that is, they were frequency dependent. If an antenna were designed for one frequency, its performance would be best at this frequency, and would deteriorate as the operating frequency was moved to either side of the design frequency. If the antenna were designed for high gain and narrow beamwidth characteristics (as, for example, is the Yagi-Uda antenna), its bandwidth would be even more restricted. In such cases, it might even be impossible to build a practical antenna that would cover an entire amateur band without a serious degradation of performance at one or both ends of the band.

Then a group of scientists and engineers at the University of Illinois, led by R. L. Carrel, D. E. Isbell and V. H. Rumsey,

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developed a family of antennas whose dimensions could be stated in terms of angles, and whose shapes repeated logarithmically. Such specifications resulted in true frequency-independent antennas—antennas that would perform equally well over a wide band of frequencies. It is quite common for such antennas to cover a 10:1 bandwidth (for example, 10 to 100 mc), and it is possible to cover even more.

An important characteristic of the log periodic antenna is that its performance is the same throughout its design range; there are no holes in its frequency response. Figure 1 shows the gain and v.s.w.r. of an experimental LP antenna designed for 1100 to 1800 mc. You can see that both parameters remain well within acceptable limits over the entire range.

The characteristics of the LP antenna make it an ideal antenna for the military and many commercial applications, where it is necessary to have continuous frequency coverage over a wide band. Amateurs, on the other hand, are allocated only a series of relatively narrow slots in the frequency spectrum. Therefore, in most cases, the amateur is better off with a series of single-band antennas, or some type of compromise antenna such as the "trap tri-bander" for multiband coverage.

In some cases, however, LP's can be put to good use by hams. An LP would enable a v.h.f. operator to cover an entire v.h.f. band, or two or more v.h.f. bands, with good performance. An LP could be designed to cover all bands from 20 meters to two meters. It would be big, but no bigger than some single band 20 meter beams. For the ham who has lots of time, patience and money, it would even be possible to have a rotary LP for 40 meters through six or two meters, or a family of fixed LP antennas to cover the 80 meter band on up.

LP Structures

There are many types of LP structures, ranging from the familiar LP TV antennas to very weird shapes which are almost unrecognizable as antennas. The following discussion will deal with only one type of LP structure—the planar log periodic dipole array. As the name suggests, this array is made up of a number of dipoles, all lying in the same plane, whose length and spacing vary logarithmically. This type of LP is perhaps the easiest to understand and best

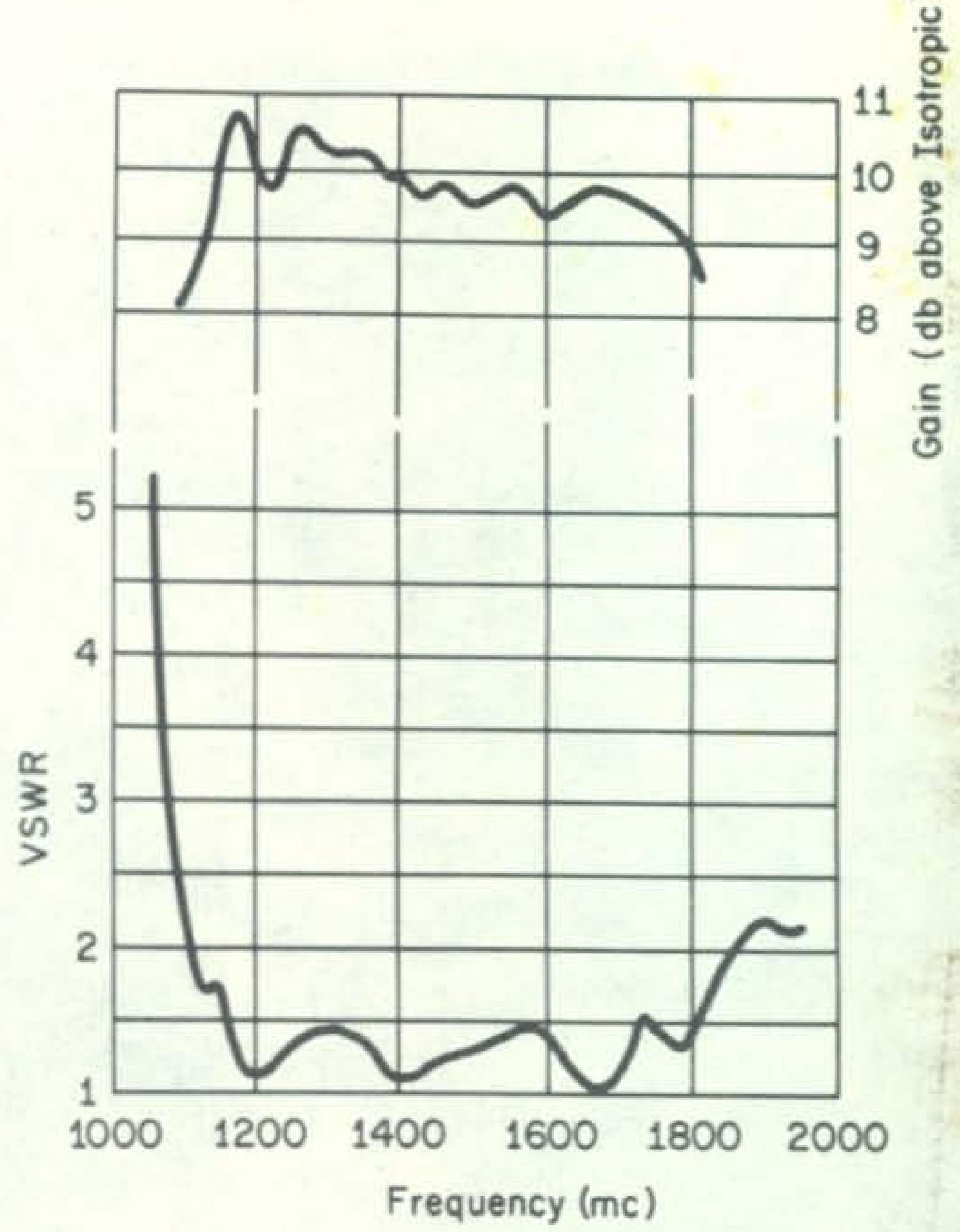


Fig. 1—Gain and v.s.w.r. of an 1100 to 1800 mc LP dipole antenna.

for visualizing the principle of the LP antenna. Also, it is mechanically the simplest to construct as a ham project.

Figure 2 shows a sketch of an LP dipole antenna. The lengths of the dipoles and the spacings between them are logarithmically related. To visualize its operation, let us assume that the antenna is excited at a frequency near the center of its design range. The dipole nearest a half-wavelength will accept the most power; those on either side of this dipole will accept lesser amounts of power but will contribute to the over-all radiation. As the frequency is raised, the elements doing the work will be closer to the front of the antenna; as the frequency is lowered, the phase center of the array will move towards the rear. Note that the adjacent dipoles are transposed on the feedline to obtain the proper phase relationships. Also note that, except in the case of very large arrays, the two-wire feedline is constructed of tubing or channeling, and is clamped together with insulating spacers to serve as twin booms for the antenna.

No matter what other shape is used to develop a log periodic antenna, the same principle applies. In a properly-designed and constructed LP, the active region of the antenna passes smoothly from one element to the next, resulting in a nice flat frequency response over the entire design band. Thus the LP will produce essentially the same gain and v.s.w.r. characteristics anywhere within the design frequency range.

Construction Types

Since we are considering log periodic dipole arrays, photos 1 through 4 will illustrate types of construction techniques which can be used with this basic design. Photo 1 is a commercial LP array manufactured by Hy-Gain. It is designed for the 13 to 30 mc range, with the longest dipole about 35 feet long, and the boom length also about 35 feet. Obviously, the size and weight of such an array are comparable with antennas considered common in ham radio today. It would be possible for the home constructor to build a similar antenna using good beam construction materials and techniques.

Photo 2 shows an antenna built by the author for military use in the 20 to 60 mc range. It was built as a field expedient until a permanent antenna could be procured, and was made from normal hardware store materials. Copper tubing was used for the booms and elements, with bakelite strips as insulating boom spacers. A wooden pole was used as a dielectric support mast, and an oak 2″ × 2″ was mounted to support the front end of the boom and the coax feedline. The antenna was constructed in true ham fashion, and, with the exception of being non-rotatable, would be well suited for ham use.

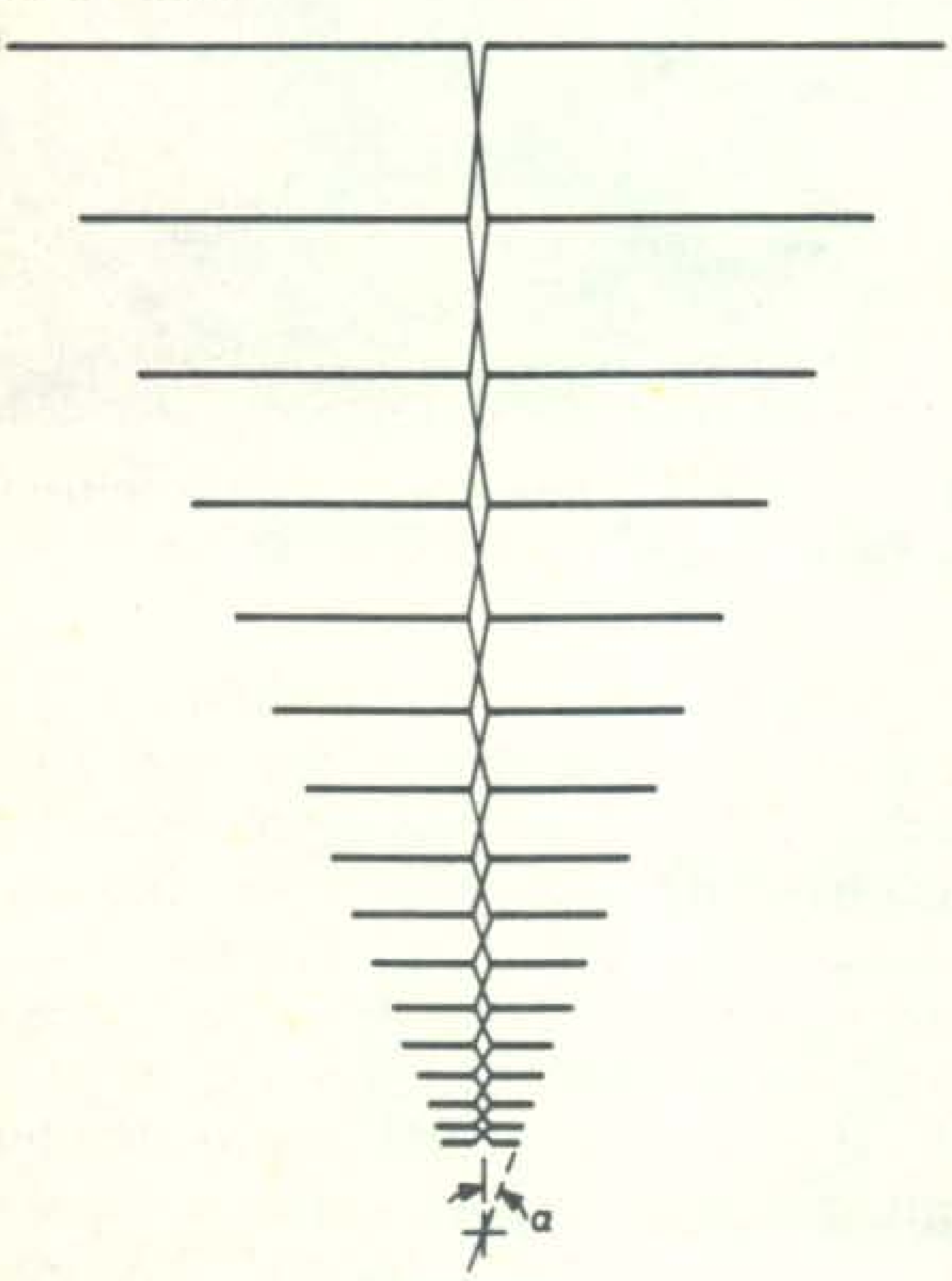
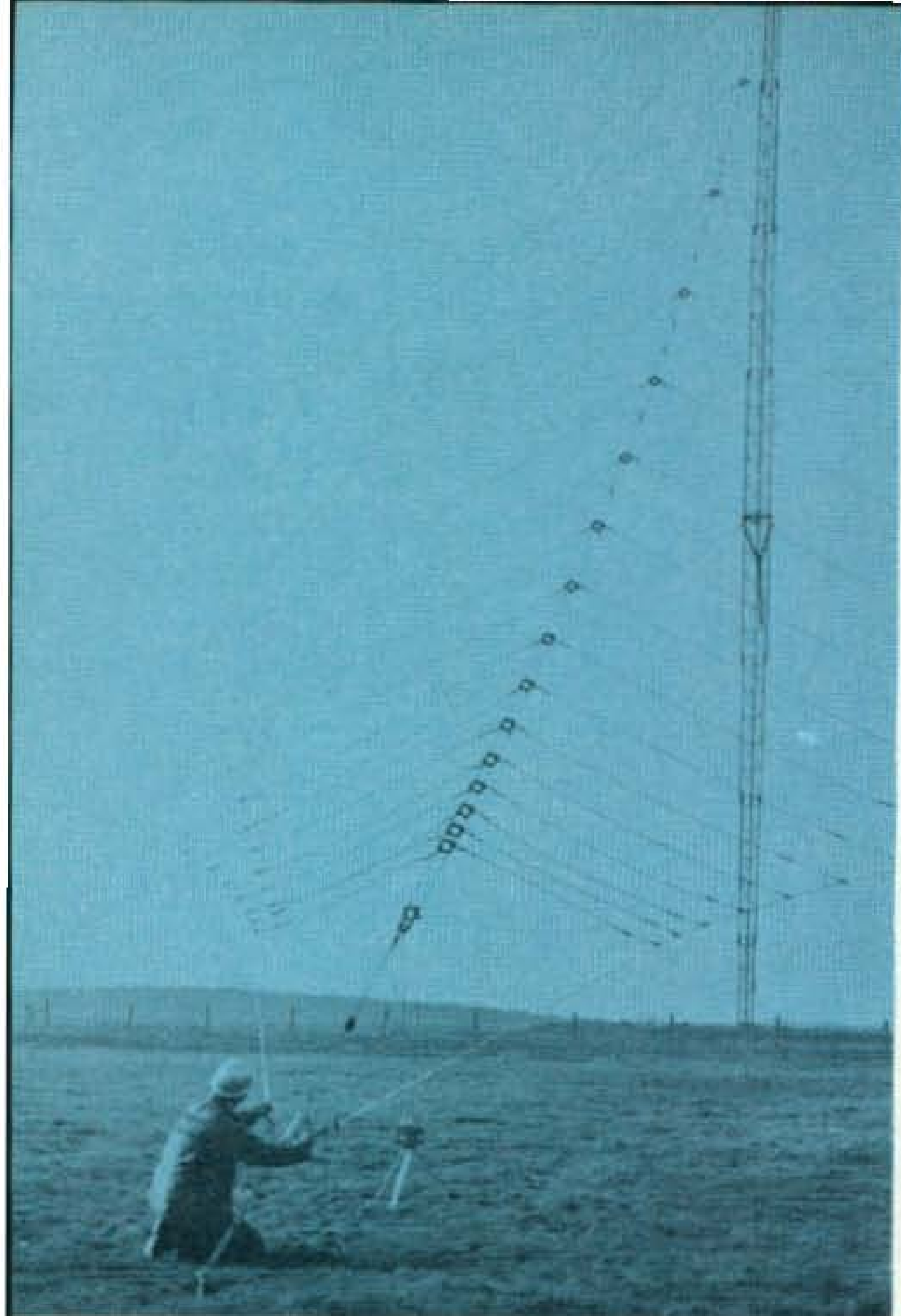


Fig. 2—Example of an LP dipole antenna design.

Photo 3 shows a Granger Associates transportable LP antenna for the 4 to 30 mc range. It is novel in that it directly compares with the familiar inverted vee dipole, with the ends of the elements closer to the ground than the centers. This LP uses a single tower for support. A cable reaching from the tower to a ground anchor near the man in the foreground supports the centers of the wire element dipoles. Cables from the front anchor to two side anchors support the ends of the dipoles. Although the antenna is in effect aimed down into the ground, its vertical take-off angle ranges between 32° and 50°. The most amazing thing about this particular antenna is its extreme portability. Unbiased tests have proven that the manufacturer's claimed erection time can be met and even surpassed. Starting with an open field and a five-man crew (with only a moderate amount of prior training), it takes one hour to set the required anchors, and another hour to erect the tower and antenna—two hours from packing cases to full operation! Wouldn't one of those be great for Field Day?

Photo 4 shows a vertically polarized Granger LP designed for the 3.5 to 32 mc range. A 100 foot tower at the rear and a 35 foot wooden pole at the front support a cable which holds up the top ends of the antenna elements. In this antenna, quarter-wave elements are fed against a ground screen in a manner similar to the usual ground-plane vertical antenna. Although the directivity of the array is obviously fixed in azimuth, the 3 db beamwidth of the antenna is 120°. Therefore, from the east coast of the US, one of these antennas could be used to cover Asia, Europe and most of Africa with a gain of 7 to 10 db (the maximum forward gain being 10 db). A ham with a good-sized field and a few dollars to spend could install a family of three of these mounted around a single tower for full 360° azimuthal coverage, 7-10 db gain, vertical polarization, and coverage of all h.f. ham bands. Now wouldn't that be great?

These examples will give you an idea of the applications of LP antennas to frequencies in and around the ham bands. In the h.f. range, one advantage of the LP antenna is its coverage of not only the ham bands, but the frequencies between the ham bands. The same antenna can be used with equal effectiveness for the amateur frequencies, MARS frequencies, SWL'ing on the inter-



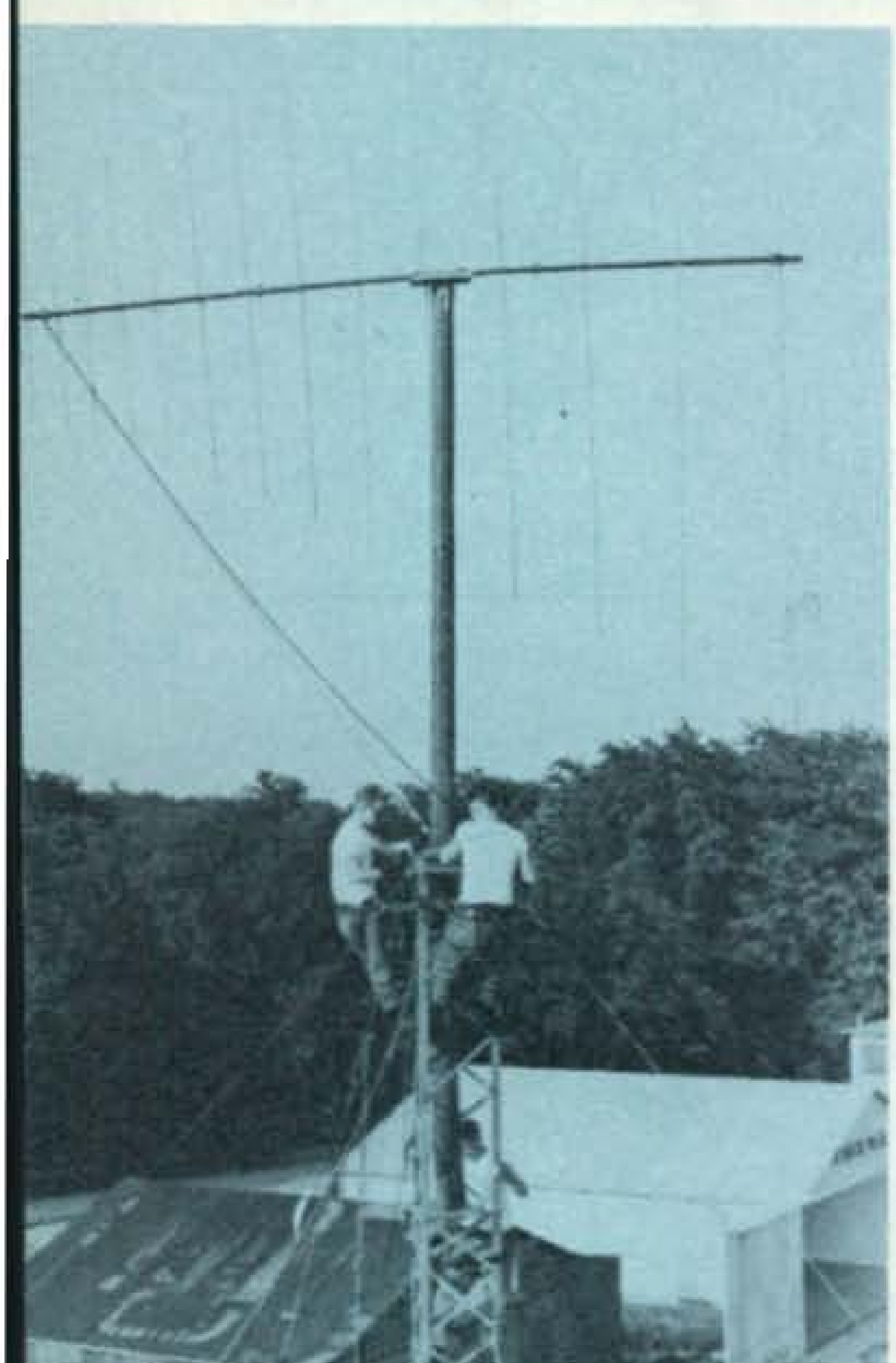


Photo 2 (bottom left)—A 20-60 mc LP dipole antenna, vertically polarized. Photo 3 (top left)—A Granger Transportable LP dipole for operation from 4 to 30 mc. Photo 4 (right)—A 3.5 to 32 mc vertical LP antenna.

national broadcast bands and other frequencies.

Design Variations

There are two interesting design variations which have appeared in recent years in LP dipole arrays. One is the use of inductive loading for the lower frequency dipoles to keep their length down to a more manageable size. The usual practice is to have no loading in the shorter elements, so their length increases logarithmically from one element to the next. Then past a certain length, each succeeding dipole remains the same physical length, with increasing amounts of inductive loading to resonate it at the correct frequency. The principle is the same as any inductively loaded antenna elements, with the loading coils normally located about halfway between the midpoint of the dipole and each end of the antenna. Such loaded dipole arrays may be reduced in size and weight as much as 40%, with only a slight degradation in gain at the lower frequencies.

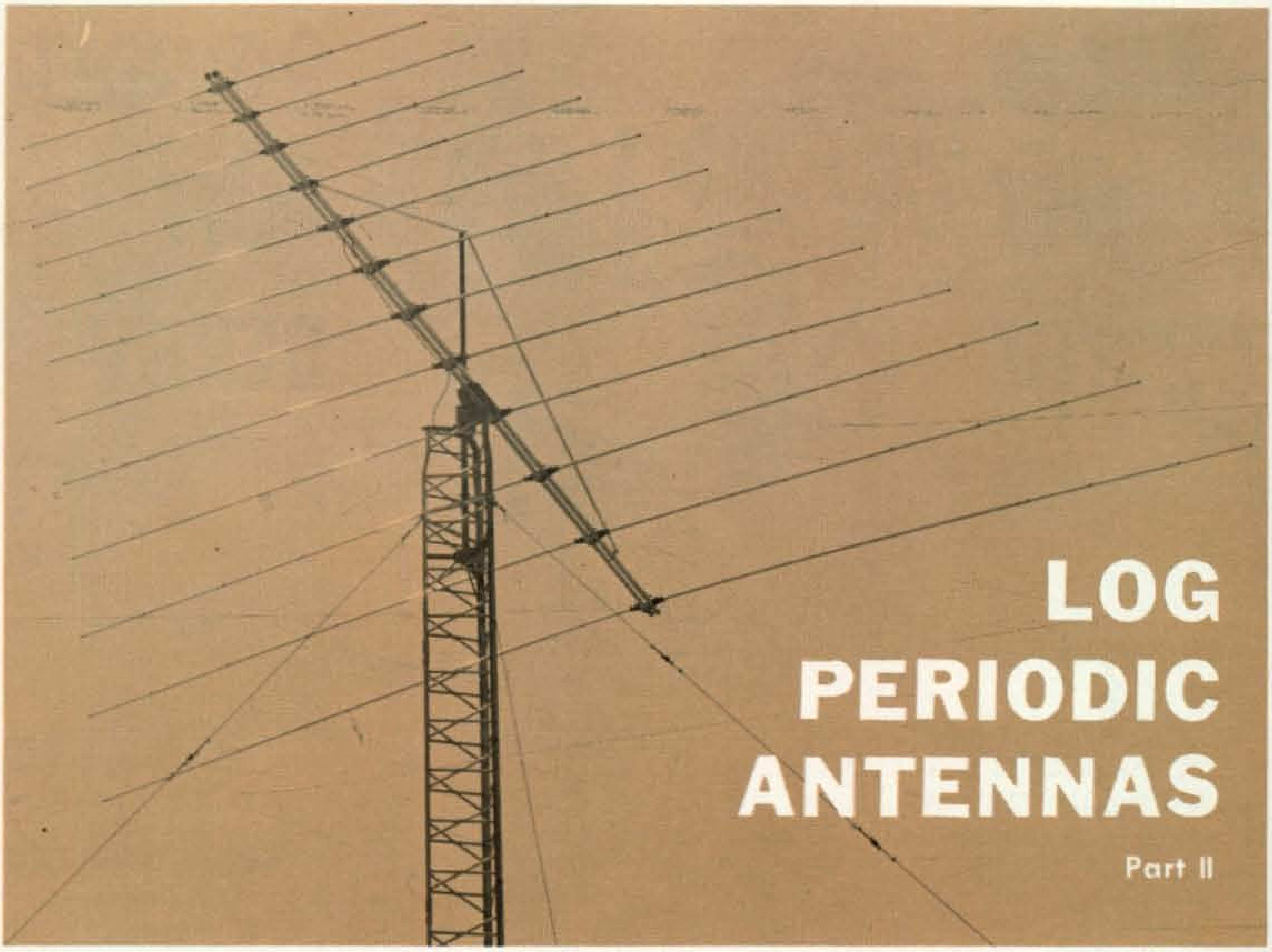
The other interesting gimmick which has appeared on LP dipole arrays for the TV bands is the use of swept-forward vee elements. Such antennas are designed so that their elements are used in 3/2 wavelength or 5/2 wavelength modes at the higher frequencies instead of the half wavelength mode of the normal LP dipole antenna. If you will recall the horizontal radiation pattern of a 3/2 wavelength dipole, the main lobe has split so that there is a null at right angles to the antenna with two major lobes at angles of 45° from the antenna. If the radiating element is bent into a vee shape, the split lobe (on one side of the element) is merged back into a single lobe, with slightly more gain than a halfwave element. Thus, an LP dipole array with elements operating in the longer wavelength modes can be designed to have a little greater gain than a straight dipole array.

However, there is one distinct disadvantage to this type of antenna. At the lower frequencies, the array may be operating in the one-half wavelength mode, and at the higher frequencies in the three-halves wavelength mode. At some frequencies in between these two modes, the elements will be approximately a full wavelength, and the antenna will not function properly. This means that the antenna will have continuous coverage of a "low" band and a "high" band of frequencies, with a big hole in the middle where the performance drops. With the TV antennas, this hole is conveniently placed in the frequency gap between channels 6 and 7, so the discontinuity does not affect any TV channel. In such applications, where a frequency discontinuity is not objectionable, the LPV antenna has some advantage over the usual LP dipole array.

Part II

The second article in this two-part series will present complete design information to enable you to design your own LP dipole arrays, together with some mechanical construction tips. This article will also work through the design data for a v.h.f. antenna which covers the v.h.f. TV band, the f.m. band, and several ham bands. A good all-purpose antenna—provided you don't want to watch TV and ham at the same time.

(To be continued)



LOG PERIODIC ANTENNAS

Part II

BY AL BROGDON, *K3KMO

This is the concluding article of a two-part series on logarithmically periodical antennas. In last month's exciting episode, the readers of CQ were introduced to the log periodic antenna and the basic principles of its operation. In this month's thrilling episode, we will consider the design parameters for LP dipole arrays, and work through the design of a 50 to 450 mc general purpose log periodic.

As in Part I, we will continue to consider the planar log periodic dipole antenna. Figure 7 illustrates this type of antenna, and shows the notations of design parameters which will be used with this article.

Note the fact that the phasing of adjacent dipoles in reversed in fig. 7. This is easily accomplished mechanically by having twin booms (insulated from each other) mounted one above the other. Then the left end of one dipole is mounted on the upper boom, and the right end mounted on the lower boom. This is reversed for the next dipole in line, and so on, resulting in each half of the antenna looking like the sketch of fig. 8. The two halves of the antenna are built exactly alike, then one of the halves is flipped over upside down and the two booms mounted together to make the complete antenna.

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Design Procedure

Referring back to fig. 7, both the element length (l) and spacing (R) from the point of origin (O) of the array are related to the preceeding element by the scale factor (τ). That is:

$$\frac{R_n}{R_{n-1}} = \frac{l_n}{l_{n-1}} = \tau$$

Another ratio we will deal with is the spacing ratio (σ), where:

$$\sigma = \frac{R_n - R_{n+1}}{4\,l_n}$$

A third term to be used is the angle (α) enclosed between the line through the centers of the dipoles, and the straight line connecting one end of each dipole.

Now let us gaily skip past the involved theory necessary for full understanding of the LP antenna—lest we stumble and fall by the wayside—and jump right into some practical design procedures. References are given at the end of this article for the reader who wishes more in the way of a technical discussion.

The gain of an LP dipole antenna is determined primarily by τ and σ. These two variables and the angle α are related as expressed by the formula $\sigma = \frac{1}{4}\ (1\text{-}\tau)\ \cot\ \alpha$. Figure 9 is a nomograph of this relationship which makes it possible to make preliminary parameter selection without having to resort to laborious calculations.

Experimental work has shown that σ should be in the range of 0.1 to 0.15 for maximum gain, although satisfactory performance can be obtained with values between 0.05 and 0.22. This deviation from optimum values might be dictated by other considerations, such as size and weight restrictions. Maximum gain for the dipole array will usually lie between 5 and 8 db, with a horizontal beam width (for horizontal polarization) of 40 to 100 degrees.

The value of τ eshould be greater than 0.75 for end-fire frequency-independent patterns. Once the values of σ and τ have been been selected, the value of α can be determined from the nomograph of fig. 9.

The length of the longest dipole ($2l_{max}$ or $2l_1$) is calculated as a starting point for the array, and should be $0.47\lambda_{max}$ for proper operation at the low frequency end of the design range. Similarly, the shortest dipole must be no longer than $0.38\lambda_{min}$ for proper high frequency operation. These limits have been obtained experimentally, and apply for mid-range values of τ.

One more consideration in the design of the LP is that the boom length should be at least one-half wavelength at the low-frequency end of the design range ($\frac{1}{2}\lambda_{max}$) for best performance. If this is mechanically impossible, it can be made shorter with some degradation of antenna performance.

Figures 10 and 11 are useful nomographs for roughing out the design of an LP dipole.

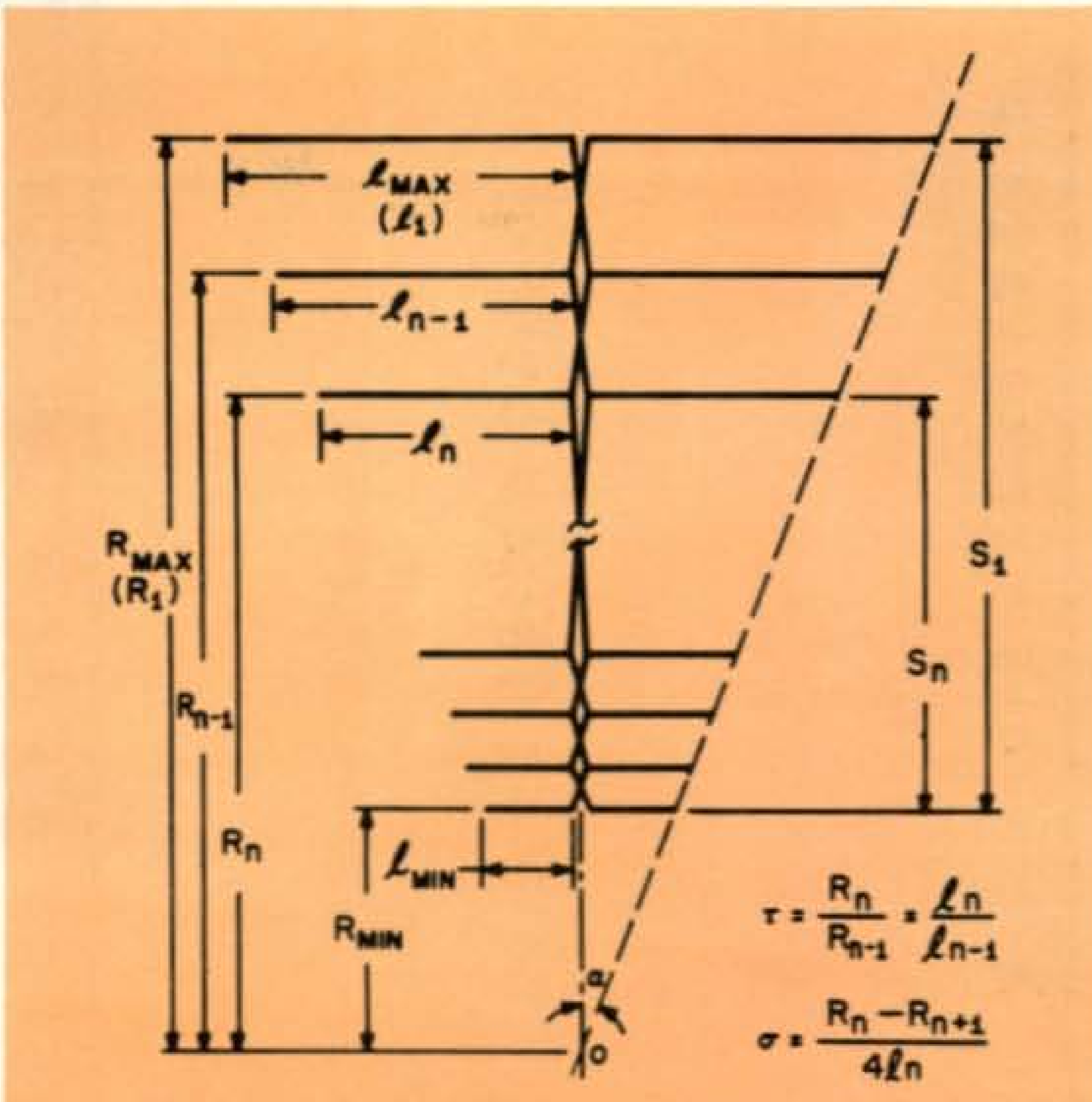

Fig. 7—LP dipole antenna and design nomenclature.

Figure 10 indicates the approximate number of dipole elements which will be present once τ and σ have been chosen. Figure 11 similarly indicates the approximate boom length after these parameters have been selected. The value of these nomographs lies in the fact that they will indicate bad choices of τ, σ and α after only a few preliminary calculations have been made. If you have made bad choices, the nomographs will indicate the fact that the antenna would be a white elephant, too large and with too many elements to be practical.

Once these preliminary choices, calculations and checks have been made, simple trigonometric relationships allow the lengths and positions of the individual dipoles to be calculated. The value of l_1 was calculated

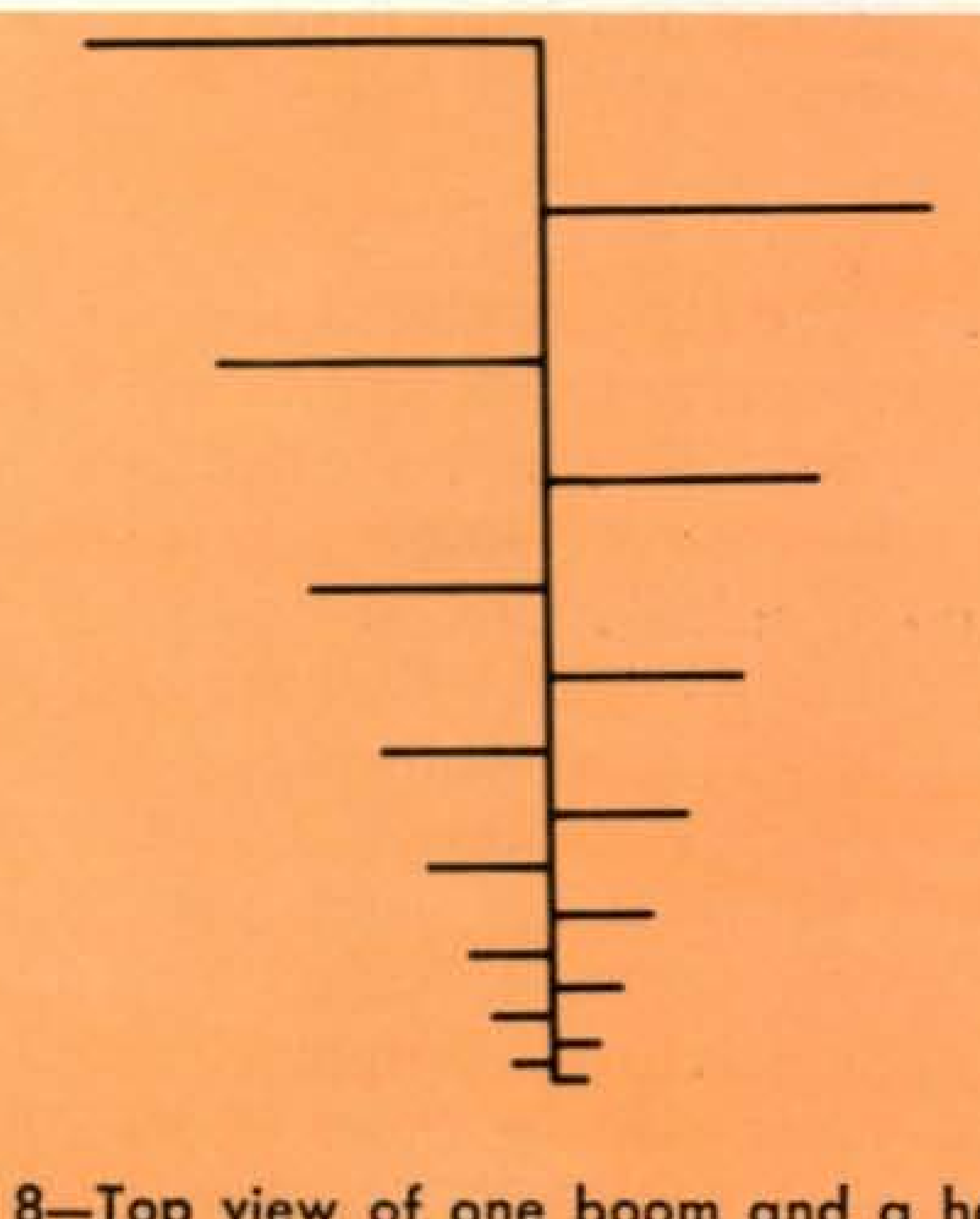

Fig. 8—Top view of one boom and a half of the LP dipole antenna.

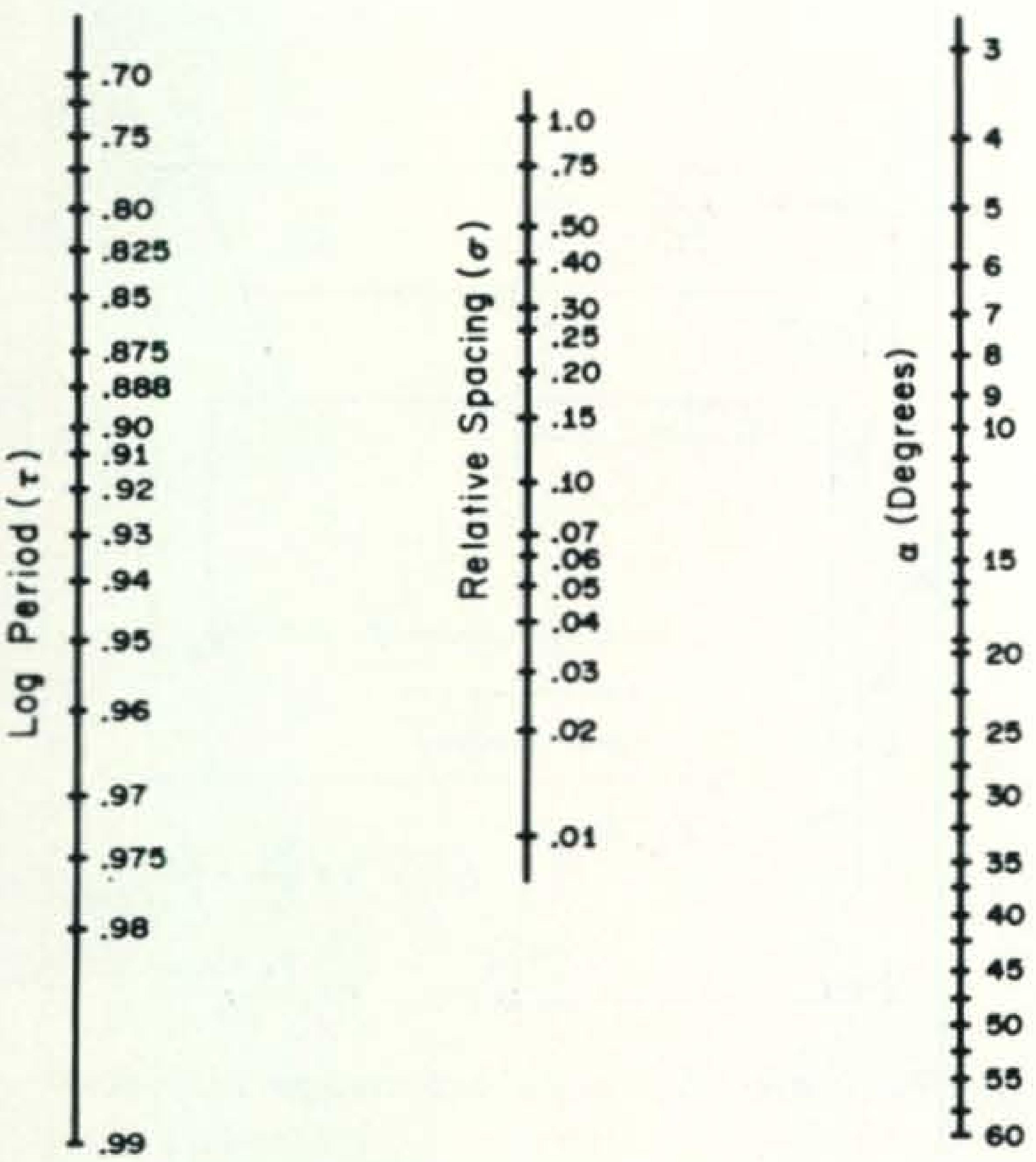

Fig. 9—Nomograph of $\sigma = \frac{1}{4}(1 - \tau) \cot \alpha$.

earlier. Its spacing from the point of origin may be calculated with the formula $R_1 = 2l_1 \cot \alpha$.

Once we have the values of l_1 and R_1, we may calculate all other values of l and R. To do this, two basic formulas are used: $R_{n+1} = \tau R_n$ and $l_{n+1} = \tau l_n$.

However, these formulas may be modified slightly so as to base successive calculations on the *first* values of l_1 and R_1, rather than the preceeding value of l and R. The advantage to this procedure is that if you make an erroneous calculation of one value of l or R, this error will not be carried through and affect all the following calculations. Basing each calculation on the preceeding value would allow a snowballing series of errors once the first one had been made. These two modified formulas which we will use then become:

$R_n = (\tau)^{n-1} R_1$ and $l_n = (\tau)^{n-1} l_1$

We have already calculated the values of l_1 and R_1, and using these formulas, all other values of l and R can be calculated. But (you ask) how do we know when we have made enough calculations to reach the final values of l and R?? Aha! You remember we calculated $0.38\lambda_{min}$ a while ago? Well, all we do is calculate values of l and R until we reach a value of l_{min} such that $2l_{min}$ is equal to or less than $0.38\lambda_{min}$. This means that we now have the length of a dipole calculated which will be short enough to go to the top end of the design range. When this value is calculated, the originally calculated value of $0.38\lambda_{min}$ can be discarded and will not be used further. Its purpose was only to serve as a guide, and once the actual value of l_{min} has been determined, the guide is no longer needed.

One final set of calculations is made subtracting R_{min} from all other values of R. This serves to refer the element spacings to the position of R_{min} rather than the imaginary point of space, O. With that, the design calculations are finished.

Design Check

At this point, it is useful to plot the calculated values of element lengths and spacings on linear graph paper (to scale) to obtain a scale drawing of the proposed array. This will give you a good feel for what you have just designed, to again make sure you haven't designed a mechanical monster. If at this point, you do decide the size of the array makes it impractical to build, then you will have to choose new values of τ and σ, and start all over again. Experience is the best teacher in finding out how variation of these parameters will affect the size of the array.

Another check which can be made with your scale drawing of the array is quite simple. Because both the lengths and spacings of the elements vary logarithmically, the ends of the elements should describe two straight lines, with an included angle of 2α. Check and see if this is true. If some elements seem to be too short or too long, go back and check your calculations for both their length and spacing. Also, the spacings between elements can be roughly checked by eyeball. There should be a logarithmical increase in the spacing as you move from the front to the rear of the array. You can usually tell if a given spacing is very far from what it should be, by judging the logarithmic progression of the spacings on the scale drawing.

Typical Design

We have covered the basic design techniques for an LP dipole array. It's time to work through a typical problem and see if we can really make a complete design that works. This design problem is summarized in Table I. Let's design a planar LP dipole array for 50 to 450 mc, with design parameters of τ=0.85 and σ=0.1. This antenna serves well as a first construction project in LP antennas, since it is small enough to be built easily and economically, and can be

$$f_{min} = 50 \text{ mc} \qquad f_{max} = 450 \text{ mc}$$

$$\tau = 0.85 \qquad \sigma = 0.1 \qquad \alpha = 21°$$

$$B = \frac{450}{50} = 9 \qquad \text{Boom length} = 0.58\lambda_{max} \qquad \text{No. elements} = 16$$

$$2l_1 = (0.47)\left(\frac{11808}{50}\right) = 111.0'' \quad l_1 = 55.5''$$

$$2l_n = (0.38)\left(\frac{11808}{450}\right) = 10.0'' \quad l_n = 5.0''$$

$$R_1 = {}_1 \cot\alpha = (55.5)\ (2.6051) = 144.577$$

$(\tau)^1 = 0.85000$	$(\tau)^5 = 0.44370$	$(\tau)^9 = 0.23159$	$(\tau)^{13} = 0.12088$	$(\tau)^{17} = 0.06308$
$(\tau)^2 = 0.72250$	$(\tau)^6 = 0.37714$	$(\tau)^{10} = 0.19685$	$(\tau)^{14} = 0.10274$	$(\tau)^{18} = 0.05361$
$(\tau)^3 = 0.61412$	$(\tau)^7 = 0.32056$	$(\tau)^{11} = 0.16732$	$(\tau)^{15} = 0.08732$	$(\tau)^{19} = 0.04556$
$(\tau)^4 = 0.52200$	$(\tau)^8 = 0.27247$	$(\tau)^{12} = 0.14222$	$(\tau)^{16} = 0.07422$	$(\tau)^{20} = 0.03872$

$l_1 = (55.5)(1.0\ ) = 55.5''$	$R_1 = (144.577)(1.0\ ) = 144.577;$	$s_1 = 131.999''$
$l_2 = (55.5)(0.85\ ) = 47.173$	$R_2 = (144.577)(0.85\ ) = 122.890;$	$s_2 = 110.312$
$l_3 = (55.5)(0.723) = 40.125$	$R_3 = (144.577)(0.723) = 104.529;$	$s_3 = 91.951$
$l_4 = (55.5)(0.614) = 34.076$	$R_4 = (144.577)(0.614) = 88.770;$	$s_4 = 76.192$
$l_5 = (55.5)(0.522) = 28.970$	$R_5 = (144.577)(0.522) = 75.469;$	$s_5 = 62.891$
$l_6 = (55.5)(0.444) = 24.641$	$R_6 = (144.577)(0.444) = 64.192;$	$s_6 = 51.614$
$l_7 = (5.55)(0.377) = 20.923$	$R_7 = (144.577)(0.377) = 54.505;$	$s_7 = 41.927$
$l_8 = (55.5)(0.321) = 17.815$	$R_8 = (144.577)(0.321) = 46.409;$	$s_8 = 33.831$
$l_9 = (55.5)(0.272) = 15.095$	$R_9 = (144.577)(0.272) = 39.325;$	$s_9 = 26.747$
$l_{10} = (55.5)(0.232) = 12.875$	$R_{10} = (144.577)(0.232) = 33.542;$	$s_{10} = 20.964$
$l_{11} = (55.5)(0.197) = 10.933$	$R_{11} = (144.577)(0.197) = 28.482;$	$s_{11} = 15.904$
$l_{12} = (55.5)(0.167) = 9.268$	$R_{12} = (144.577)(0.167) = 24.144;$	$s_{12} = 11.566$
$l_{13} = (55.5)(0.142) = 7.880$	$R_{13} = (144.577)(0.142) = 20.530;$	$s_{13} = 7.952$
$l_{14} = (55.5)(0.121) = 6.715$	$R_{14} = (144.577)(0.121) = 17.494;$	$s_{14} = 4.916$
$l_{15} = (55.5)(0.103) = 5.716$	$R_{15} = (144.577)(0.103) = 14.891;$	$s_{15} = 2.313$
$l_{16} = (55.5)(0.087) = 4.828$	$R_{16} = (144.577)(0.087) = 12.578;$	$s_{16} = 0$

Table 1—Summary of design data for the 50 to 450 mc LP dipole antenna.

used for several purposes when it is finished. It will cover the 6, 2, 1¼ and ¾ meter ham bands, the v.h.f. TV channels, the f.m. broadcast band and various other v.h.f. communications services. It can be easily rotated, and will deliver about 7 db gain over its design range.

With the preliminary choices of τ=0.85 and σ=0.1, we find from fig. 9 that the angle α=21°. The bandwidth ratio B is equal to f_{max} divided by f_{min}, or 9 for this antenna. This value of B and the value of α can be used with the nomograph of fig. 11 to determine the boom length. For this antenna, it will be approximately $0.58\lambda_{max}$, or 137 inches.

Using the values of B and τ with the nomograph of fig. 10, we find that there will be approximately 16 elements in the array. The equations for the longest and shortest element lengths are used to determine in this case that the longest dipole will be 111 inches long, and the shortest one must be no longer than 10 inches.

All of these dimensions sound reasonable, so let's continue with the design calculations.

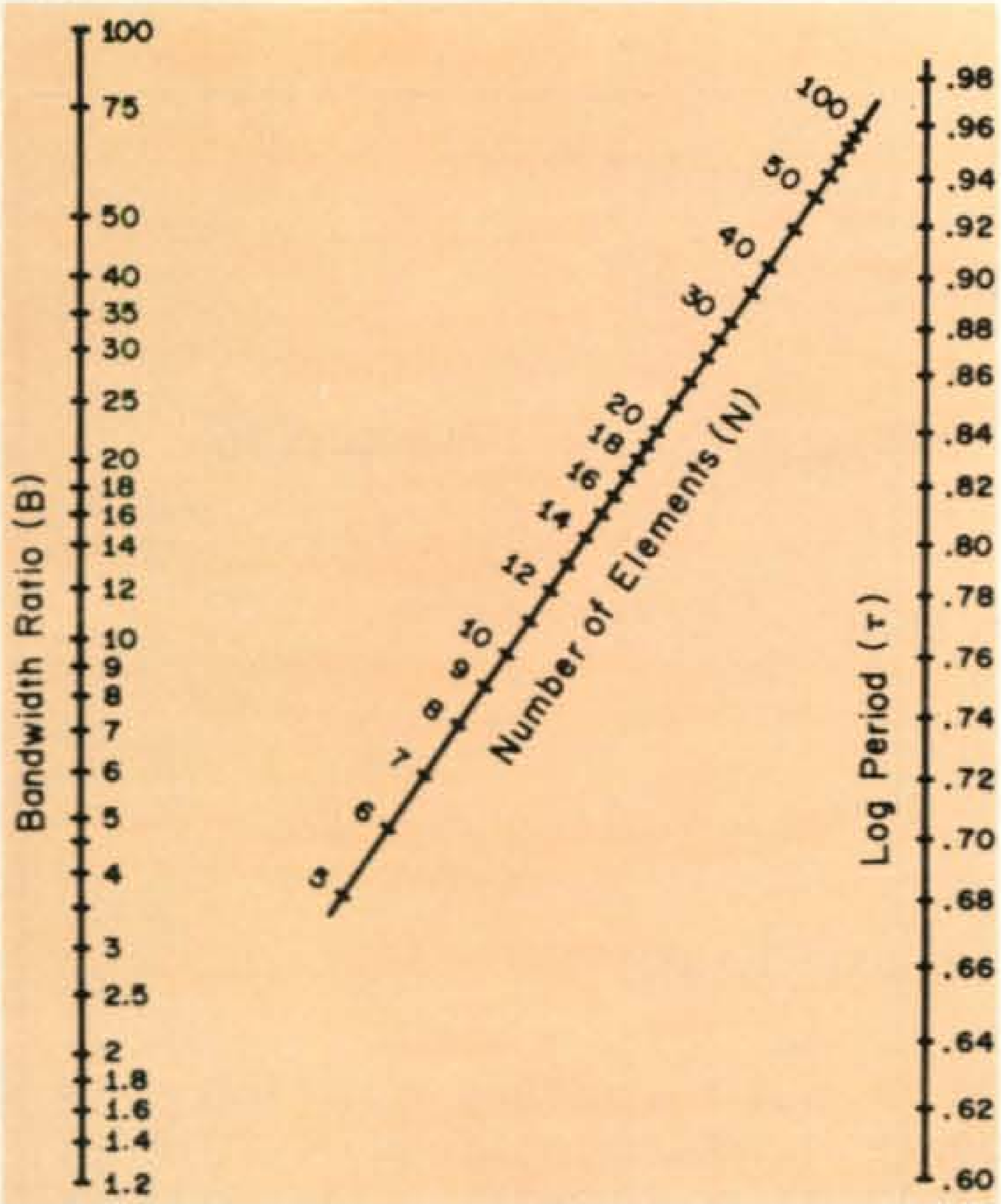

Fig. 10—Nomograph of $N = 1 + \frac{\log 1237\,B}{\log (\frac{1}{\tau})}$

The distance (R_1) of the longest element from the origin (O) of the array is calculated using the formula presented earlier in this article, and in our case will be 144.6 inches. We now have the basic values we need to calculate the values of l and R for all dipoles. In both sets of these calculations, we will need the values of $(\tau)^n$ for values of n from 2 to 16 (since we anticipate 16 elements in the antenna). It is best to go ahead and make these calculations in advance, so as to have them readily at hand when they are needed.

Once the values of $(\tau)^n$ are determined, the previously mentioned formulas may be used to calculate all values of l and R. The values of l should be calculated first, with the calculations ending when a value is found where l_{min} is less than or equal to 5 inches (satisfying the condition of a minimum length for this last dipole). Then the corresponding values of R are calculated. The value of R_n is then subtracted from all values of R to come up with the values of s (the spacing of the elements from the highest frequency dipole). Table I lists the calculated values of l, R, and s for our 50 to 450 mc LP antenna, which were arrived at by these calculations.

Mechanical Consideration

Now that we have completed the electrical design, let's take a look at the mechanical considerations in building this array. Normal beam-building techniques should be used for the construction of this antenna. Aluminum makes a good workable material for the array. Either tubing, or square tubing or U-channel may be used for the twin booms. Smaller sizes of tubing serve as elements. The elements should be mounted to the booms with good mechanical rigidity as well as firm electrical contact. The size of the tubing used is not critical, and is usually chosen to provide the necessary mechanical strength. However, the use of larger diameters of tubing for the elements will result in slightly narrower beamwidth.

Metric System

One hint which has turned out to be a real time-saver is the use of the metric system for antenna measurements, especially with the LP antenna. When using the good old American system of feet, inches, furlongs and cubits, you work out a length for an antenna element which comes off the slide rule as feet and a decimal fraction. Then you have to convert this decimal fraction into inches—which also leaves you with a decimal fraction of an inch which must be converted into a fraction of an inch which you can find on your ruler. Whew!

If you use the metric system, you figure out the length once and it gives you the decimal fraction which can be read right off the ruler. What could be easier! So the author invested in both a folding carpenter's rule and a reel type tape measure calibrated in both feet and inches and meters. All antenna calculations are made using the metric system, and then measured right off the rulers with no extra conversion processes. You should consider the same. Once you get used to the metric units, and get a feel for their size, it makes antenna work a lot easier.

Phasing

To get back to the mechanical construction of the LP antenna, you must remember that adjacent dipoles must be mounted with opposite phasing. This means that the two halves of the antenna must be built as shown in fig. 8. One of the halves is flipped over, and the two halves mounted together to make the array. The two halves of the antenna must be insulated from each other, and mounted so that the two booms (to which the dipole halves are fastened) are parallel, and the two sides of each dipole line up with each other to make the complete dipole.

Feeding

Let's consider how to feed this array. It must be fed from front of the antenna—that is, the end with the shortest dipole. The impedance of the feedpoint can be calculated, but this gets into what is known in technical circles as a knotty problem. For all practical purposes, either 52 or 75 ohm coax can be used to feed the antenna. For best results, the diameter of the boom should be large enough to run the coax down the middle of it. If this is possible, the coaxial cable is run through from the back end of one boom to the front of the antenna, where it is connected to the feed point. At the front of the boom, the braid of the coax is connected to the boom through which the feedline was run, and the center conductor of the coax is run over to the other boom and connected to complete the feed.

If the boom is not large enough in diameter to contain the coax, the coax line can be run to the front of the boom and connected as described above, without going through the boom. If this is done, the s.w.r. may be slightly higher than the case with the coax run through the boom, but it will still be within acceptable limits.

Boom Mounting

When mounting the array, the booms must be insulated from the mast. The array should be mounted at its center of gravity, which will be off-center toward the rear of the antenna. If the antenna is vertically polarized, a dielectric material should be used for the mast as it passes into the antenna array, so as not to degrade the antenna performance.

Conclusion

Hopefully you now have all the information you need to design and build your own LP dipole arrays. If further information on the subject is desired, please consult the list of references following this article. It might be noted that the author's first experiences with the design and construction of LP dipole antennas was on a quick-reaction requirement, and a number of different antennas were built with good results using less information than has been presented in this series of articles. If, *as a last resort,* you must write to the author for more information, please keep your questions brief, and include an s.a.s.e. for convenience.

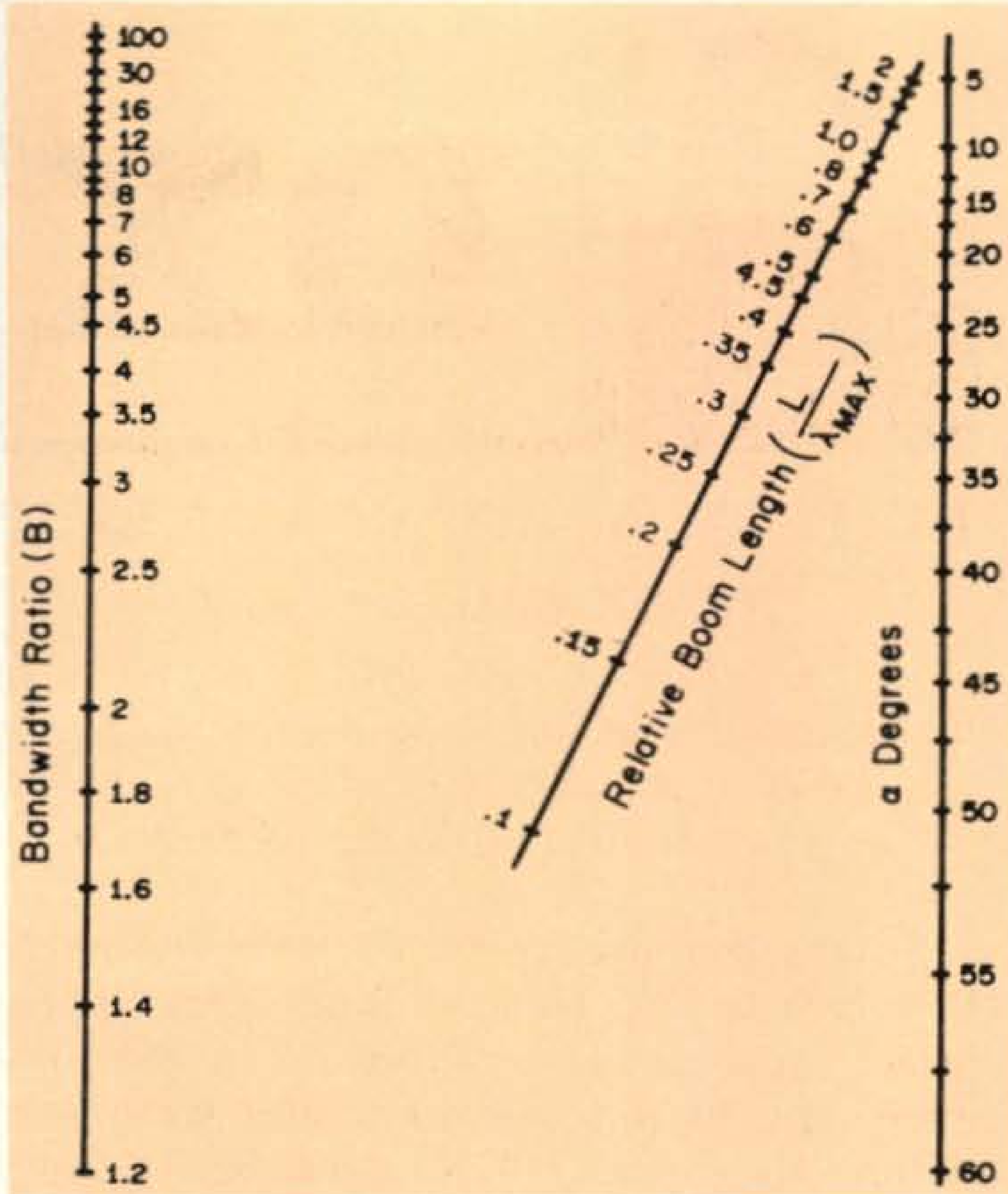

Fig. 11—Nomograph of

$$\frac{L}{\lambda\ max} = \frac{1}{2}\left(0.47 - \frac{0.38}{B}\right) \text{Cot}\ \alpha.$$

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