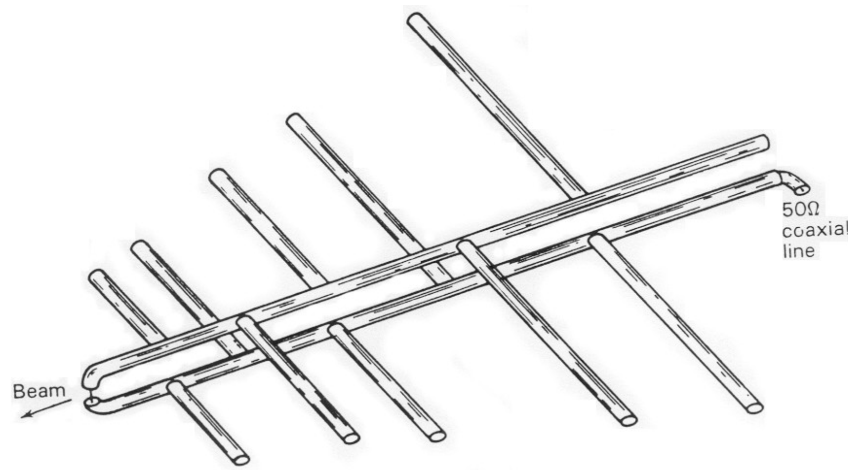
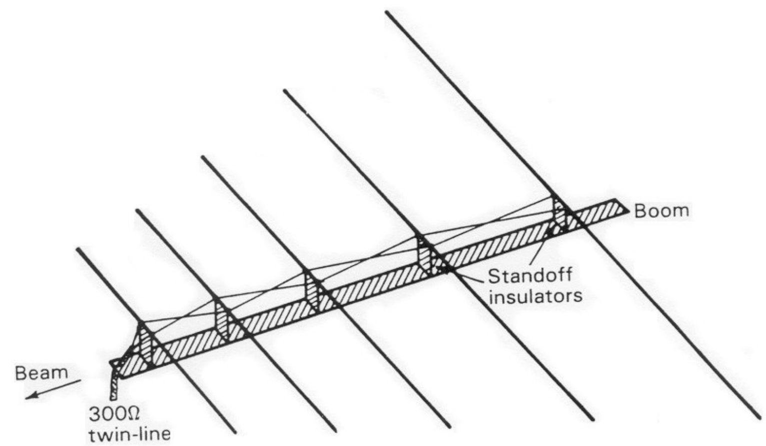
Log-Periodic Dipole Array (LPDA)

- 6.5 dBi ≤ Directivity (Gain) ≤ 11 dBi
- 50 Ω ≤ Input Impedance ≤ 300 Ω
- Input Reactance ≈ 0 Ω
- Bandwidth: $f_{\text{high}} / f_{\text{low}} \leq 30$
- Transmission line feeds: Coaxial (with infinite balun) or Twin-lead
- Optimal Design Procedure



(a)



(b)

Log-periodic Dipole Array (LPDA) with (a) coaxial feed (this is typically 50 Ω or 75 Ω) and (b) criss-crossed open-wire line for twin-lead feed (this is typically 300 Ω). [Kraus, Figure 15-13, p. 708]

History or Origin of LPDAs

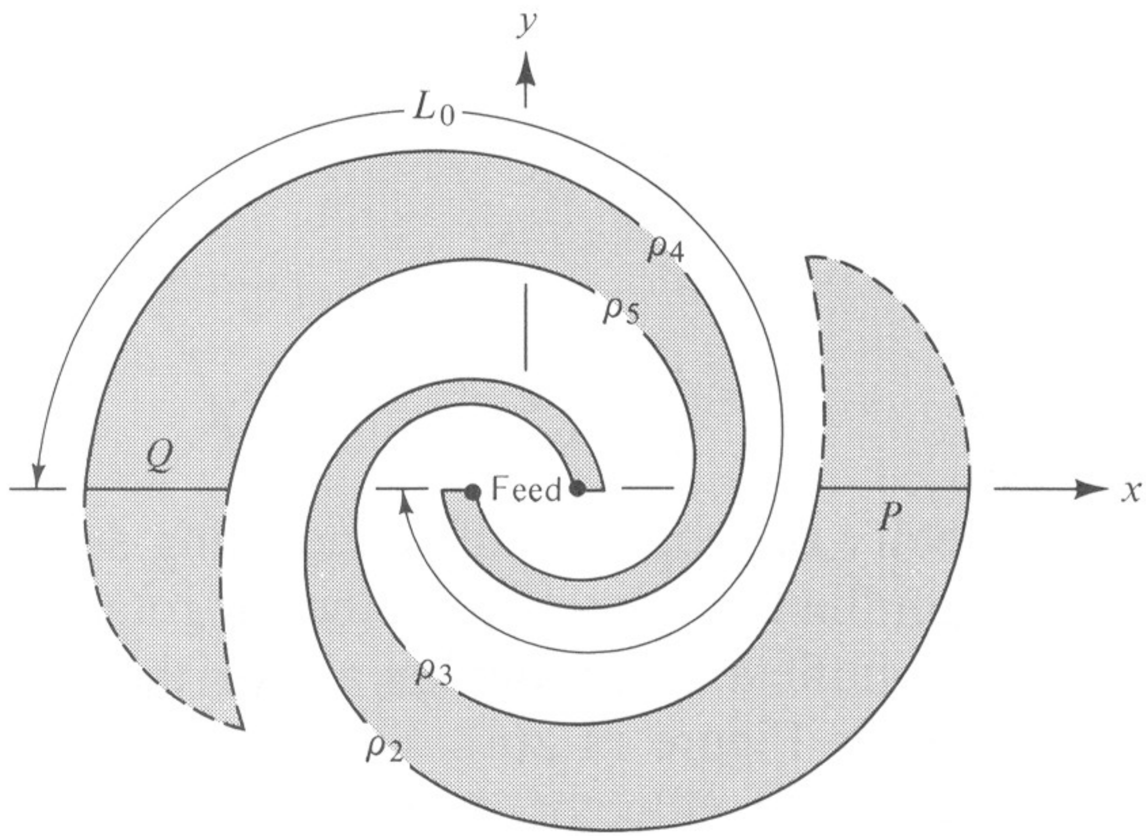
Why? Need existed for broadband antennas

Where? University of Illinois

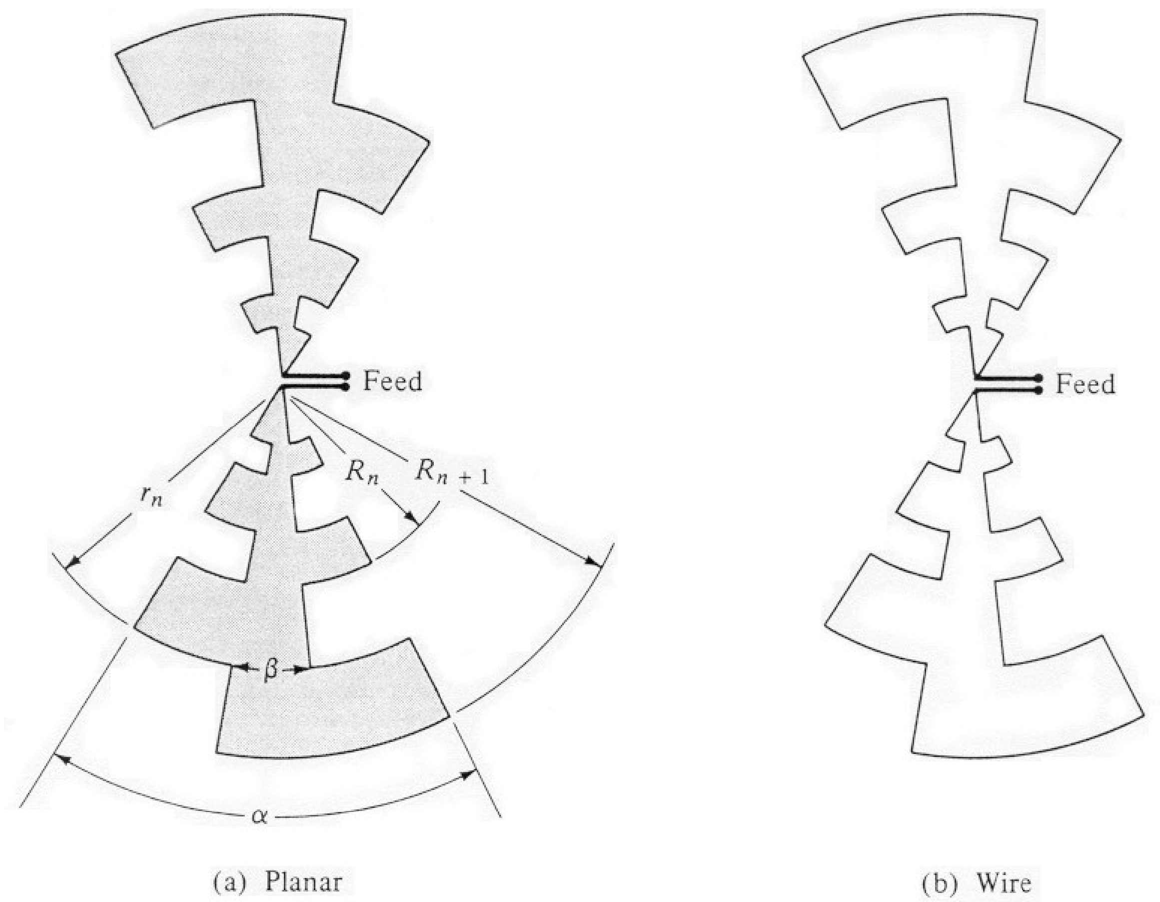
When? 1955-1961

Who? V. H. Rumsey
G. A. Deschamps
J. D. Dyson
P. E. Mayes
R. H. DuHamel
D. E. Isbell
F. R. Ore
D. G. Berry
R. L. Carrel

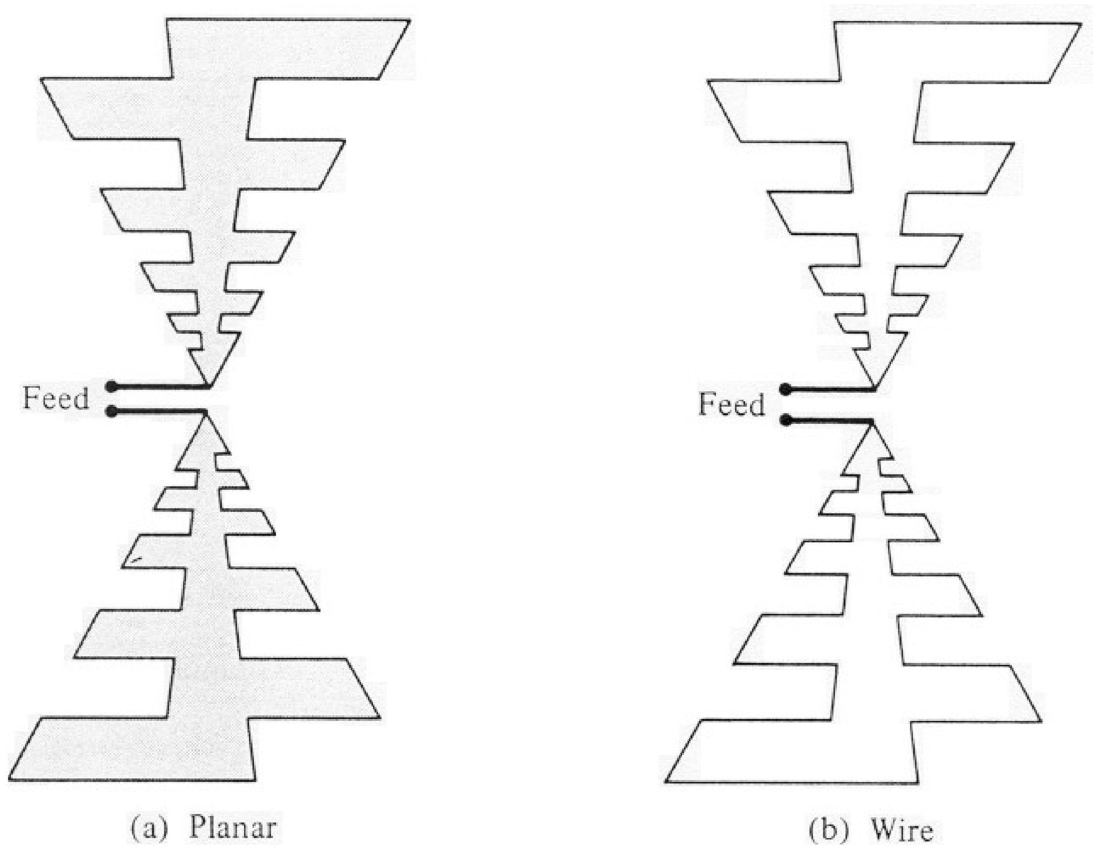
Development Sequence



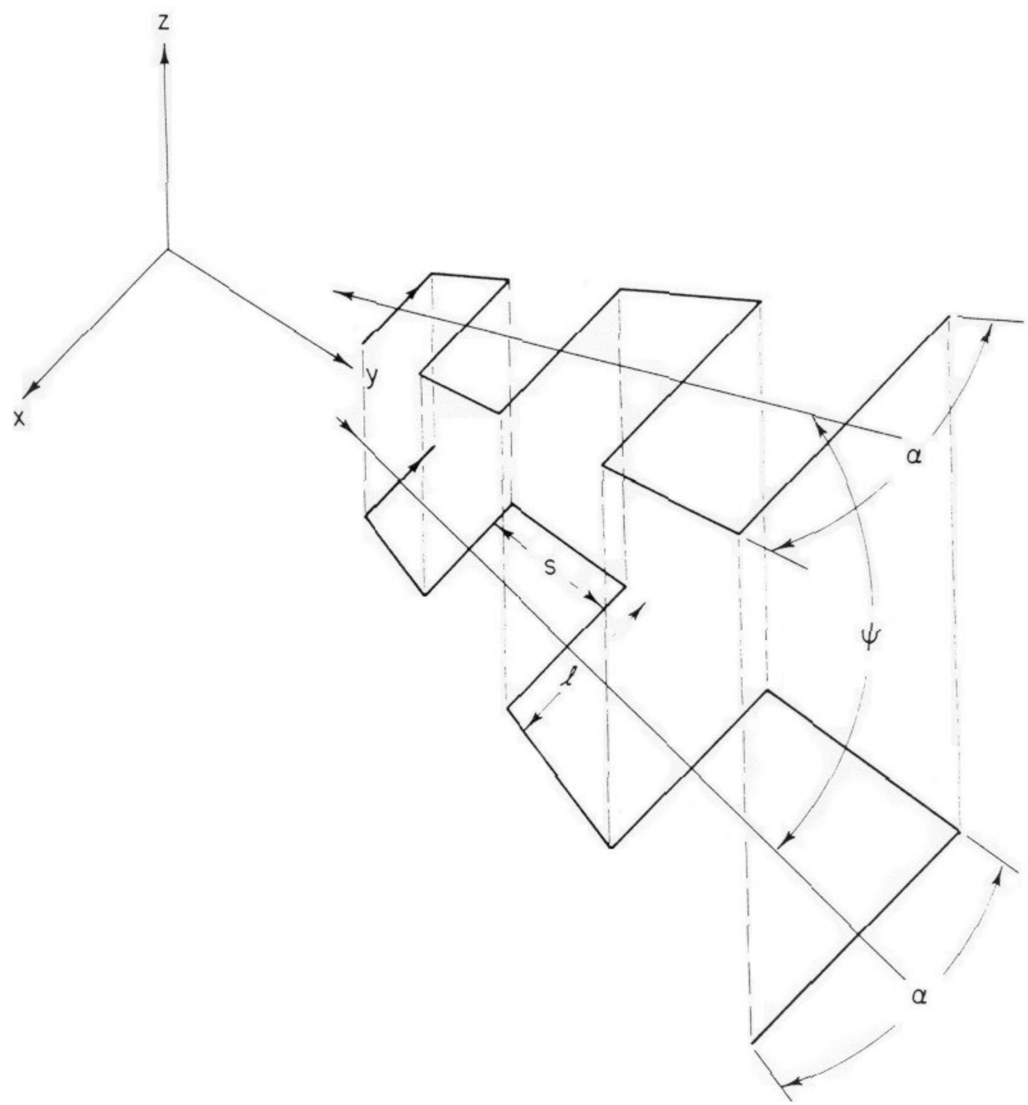
Dyson- Spiral Plate Antenna [Balanis, Figure 11.2 (a), p. 548]



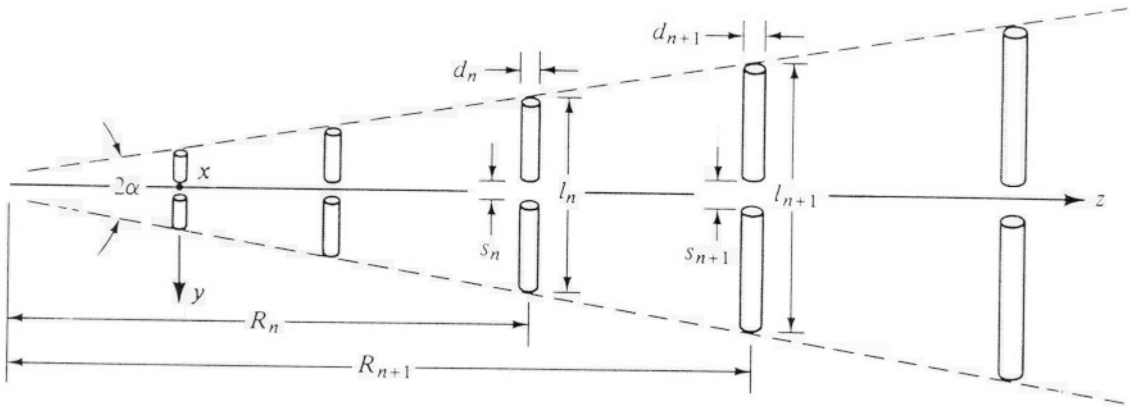
DuHamel & Isbell- (a) Planar and (b) wire logarithmically periodic antennas [Balanis, Figure 11.6, p. 552]



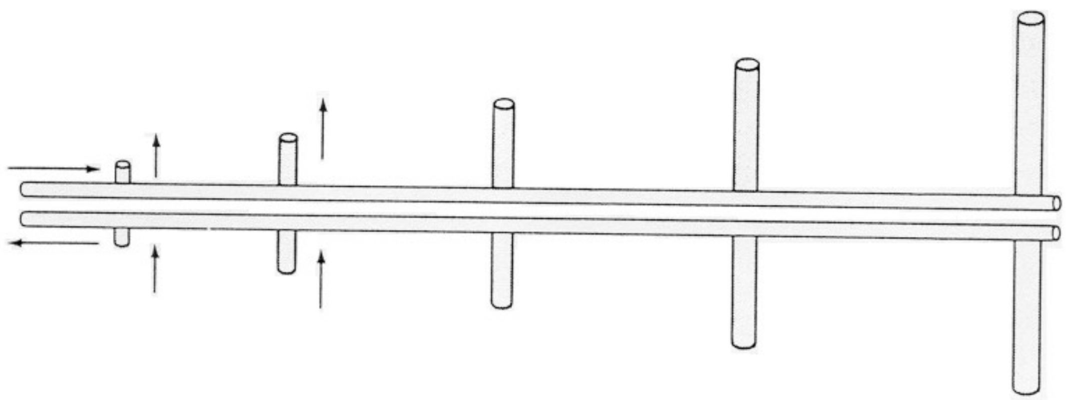
DuHamel & Isbell- Planar and wire trapezoidal toothed log-periodic antennas [Balanis, Figure 11.7, p. 553]



Trapezoidal wire antenna in Vee configuration [Rumsey, Figure 5.9, p.64]

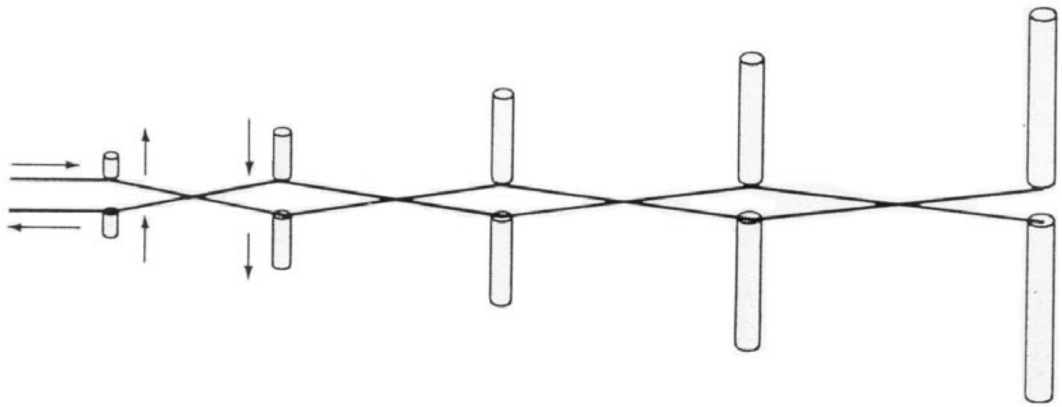


a) Dipole Array

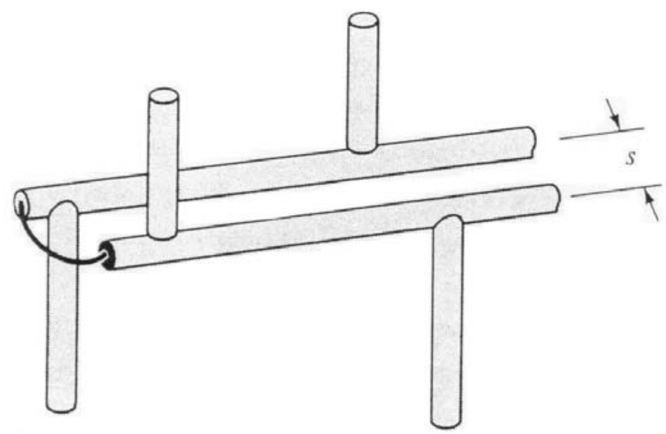


b) Straight connection

Log-periodic Dipole Array (LPDA) with various connections. [Balanis, Figure 11.9, p. 555]

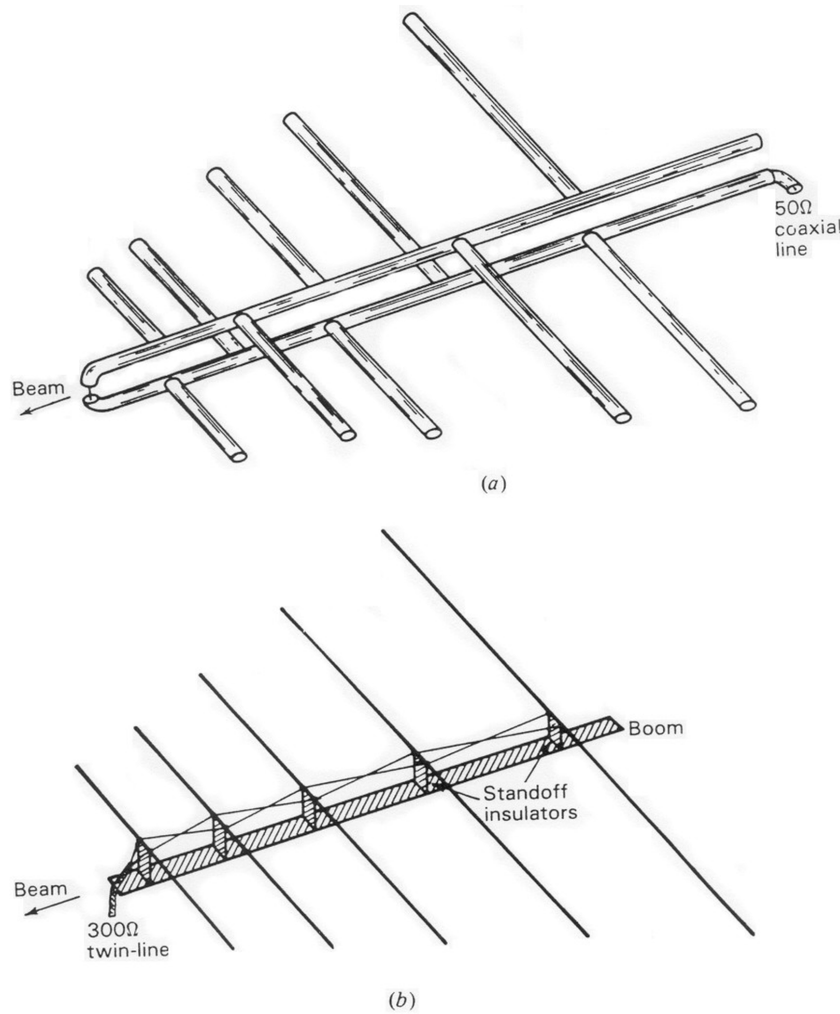


c) Crisscross connection

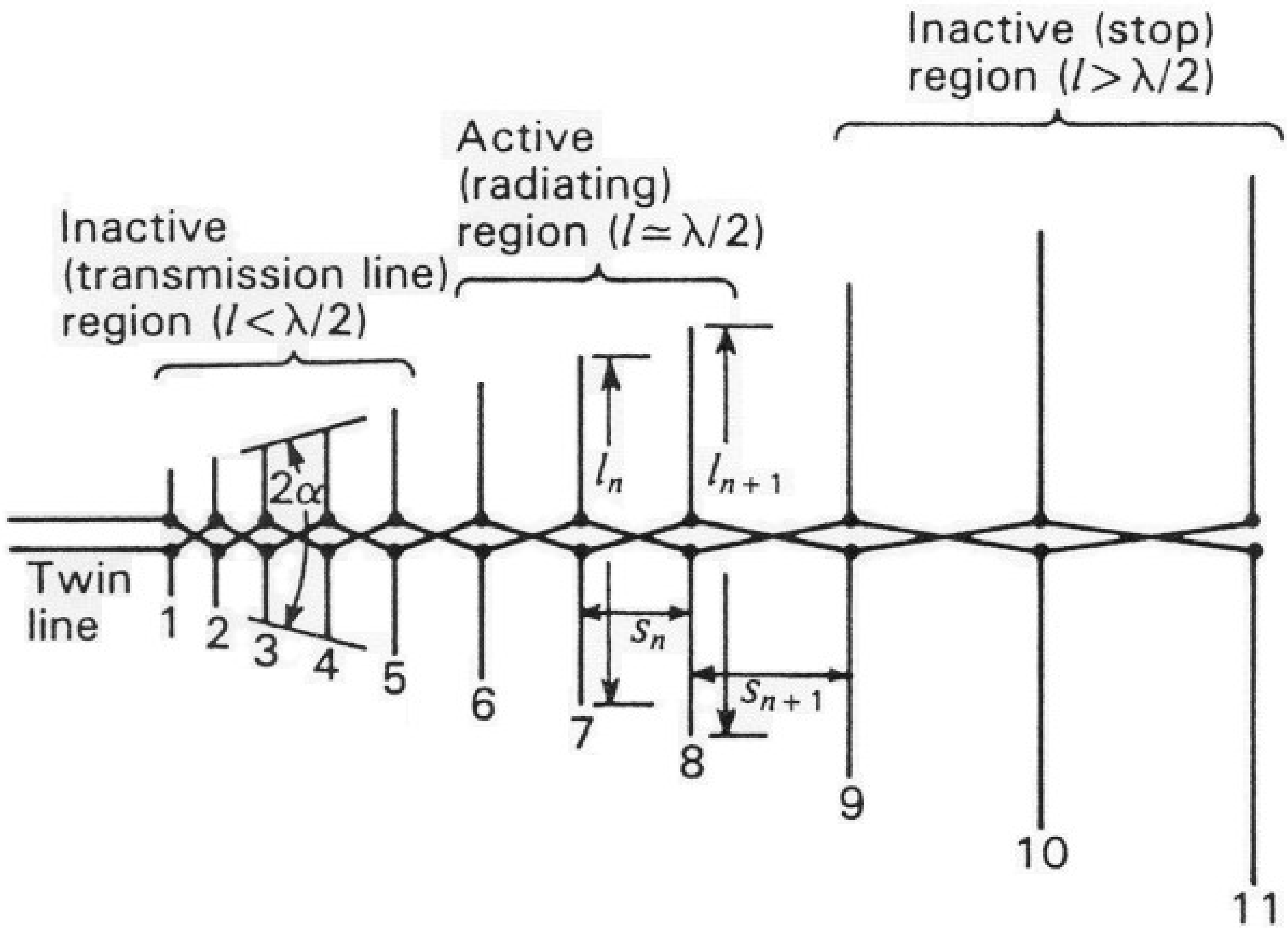


d) Coaxial connection

Log-periodic Dipole Array (LPDA) with various connections. [Balanis, Figure 11.9, p. 555]



Log-periodic Dipole Array (LPDA) with (a) coaxial feed (this is typically 50 Ω or 75 Ω) and (b) criss-crossed open-wire line for twin-lead feed (this is typically 300 Ω). [Kraus, Figure 15-13, p. 708]

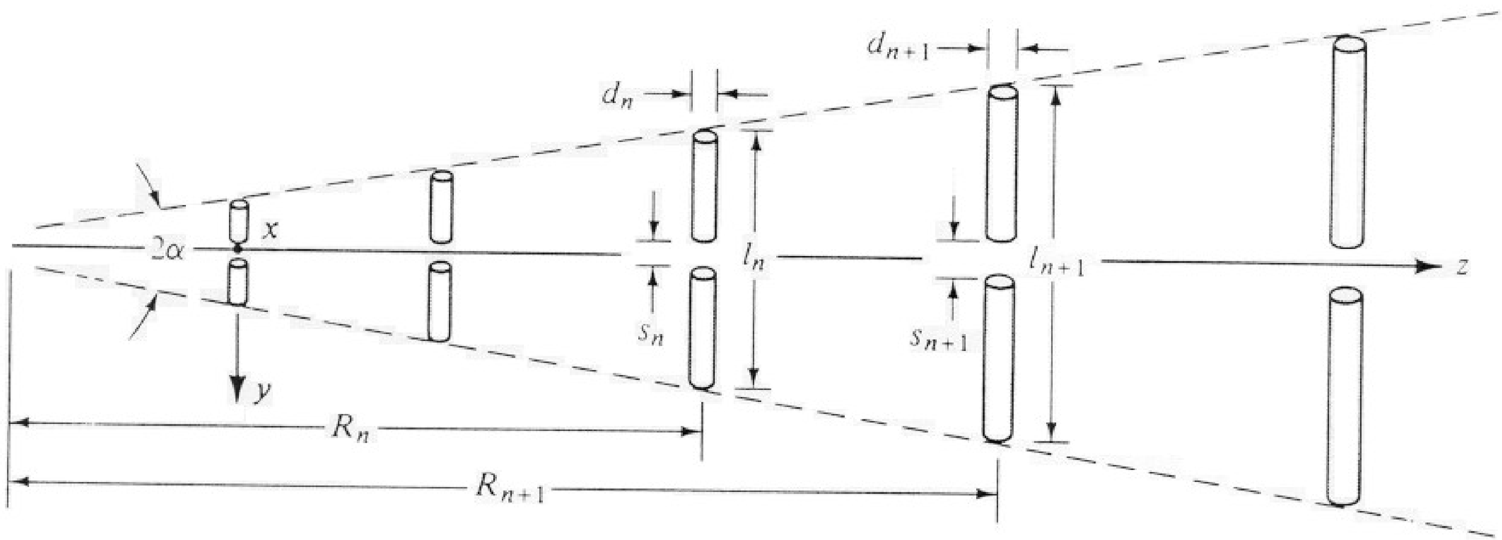


7 dBi LPDA with 11 dipoles showing an active central region and inactive regions. [Kraus, Figure 15-10, p. 704]

Notes

1) The lengths l_n, locations R_n from apex, diameters d_n, and gap spacings s_n of the dipole elements increase logarithmically as $1/\tau$, where τ is a LPDA design parameter called the scale factor.

$$\text{e.g.,}\quad \frac{1}{\tau} = \frac{l_{n+1}}{l_n} = \frac{R_{n+1}}{R_n} = \frac{d_{n+1}}{d_n} = \frac{s_{n+1}}{s_n}$$



Notes continued

2) Another LPDA design parameter is the spacing factor σ.

$$\text{e.g.,}\quad \sigma = \frac{R_{n+1} - R_n}{2 l_{n+1}}$$

3) By drawing straight lines through the ends of the dipole elements of the LPDA, we see that they intersect at a point called the apex and enclose an angle 2α.

$$\text{e.g.,}\quad \alpha = \tan^{-1}\left[\frac{1-\tau}{4\sigma}\right]$$

Typically, $10° \le \alpha \le 45°$ with $0.95 \le \tau \le 0.7$ where α and τ are inversely related.

<u>Notes continued</u>

4) The LPDA is a **backfire** array. i.e., the maximum radiation occurs at the feed side (small end) of the antenna.

5) For a compact LPDA, larger values of α (smaller τ) are used. This leads to fewer dipole elements. A trade-off is larger variations in the input impedance and lower directivity (gain).

6) Smaller values of α (larger τ) LPDA designs have more elements that are spaced more closely. This yields a larger LPDA. A benefit is that more elements fall in the active region with the result being smaller variations in the input impedance and higher directivity (gain).