BY BILL ORR, W6SAI

THINGS TO LEARN, PROJECTS TO BUILD, AND GEAR TO USE

A Short-Boom 3-Element Yagi

An interesting antenna design that can be investigated by the K6STI Yagi Optimizer is a short-boom Yagi. A 3-element, 20 meter Yagi on a 12 foot boom sounds very attractive. A single section of 2 or 3 inch diameter tubing can be used for the boom, eliminating the boom splicing usually required for a longer boom.

Accordingly, maximum element spacing (reflector to director) of 11 feet 8 inches was chosen, and element lengths and spacing were iterated by the Optimizer program. After 803 iterations, the program provided a design which exhibited a gain of 5.07 dBd at the design frequency of 14.15 MHz, a front-to-back ratio of 23 dB, a feedpoint impedance of about 15 ohms, and an SWR figure of better than 1.6-to-1 over a range of 300 kHz. The free-space polar plot of the short-boom array is shown in fig. 1. This is not too shabby.

Antenna operating parameters are shown in fig. 2. The upper-left plot shows power gain, which runs from 5 dBd at 14.0 MHz to 5.5 dBd at 14.3 MHz. The upper-right plot illustrates the very reasonable value of SWR across the design range. The lower-left plot shows that front-to-back ratio peaks at nearly 25 dB around 14.11 MHz. The lower-right plot shows that feedpoint impedance is about 15 ohms at the resonance frequency; this value can easily be matched by any of the popular systems. Antenna dimensions are given in fig. 3.

All in all this is a good, practical design. However, it must be pointed out that reflector to driven element spacing is tight, and movement and vibration of the elements may show up as slight variations of SWR when the antenna flexes in a heavy wind.

Compared to the wide-spaced 3-element 14 MHz array on a 24 foot boom discussed last month, this little antenna has about 1.04 dB less forward gain, and sacrifices about 5 dB in front-to-back ratio.

It is interesting to compare this antenna with the 2-element Yagi discussed in an earlier column. The big advantage of this little antenna over the 2-element job is not in gain, but vastly improved front-to-back ratio!

48 Campbell Lane, Menlo Park, CA 94025

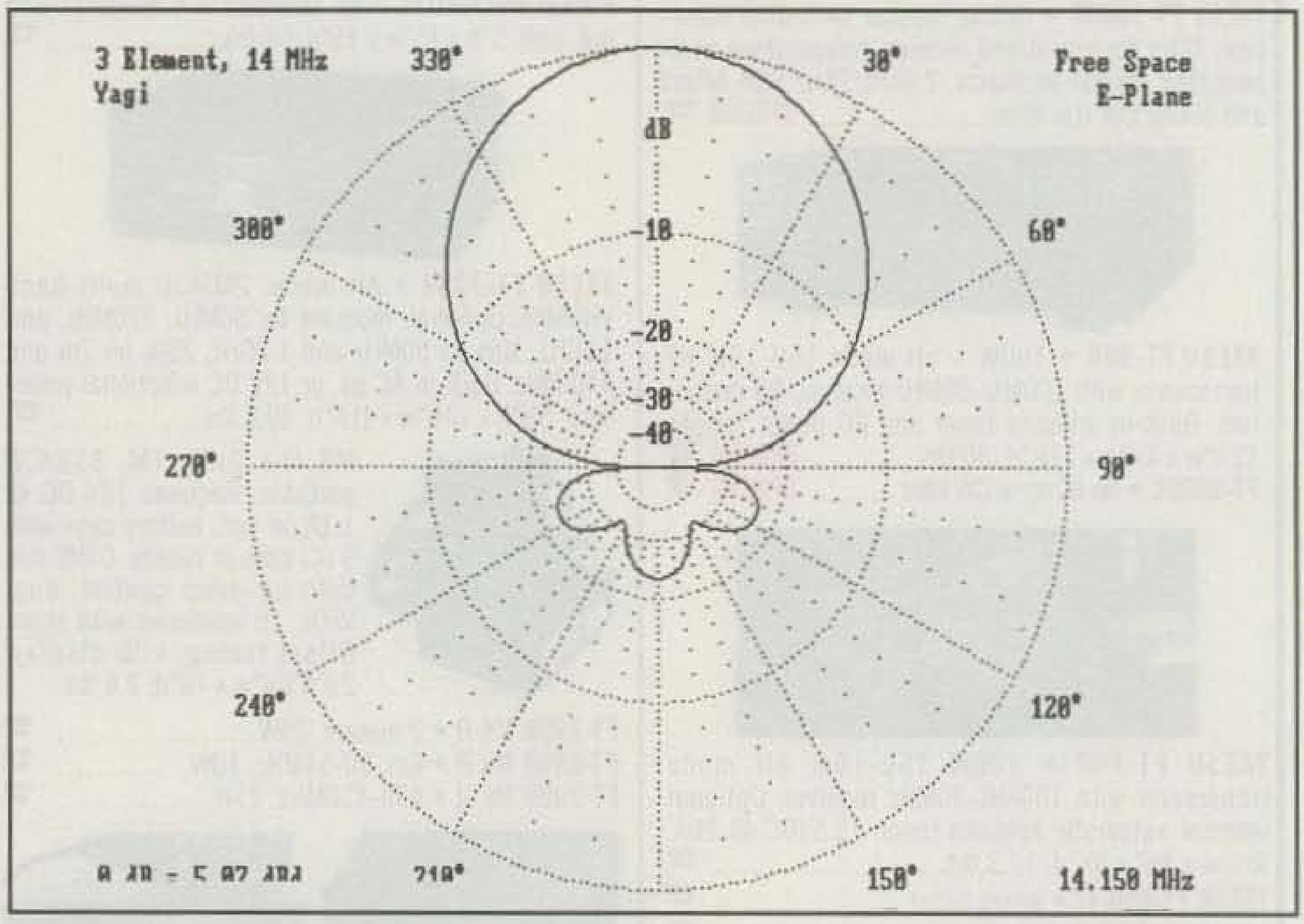

Fig. 1– Short-boom (12 foot) Yagi provides 5.07 dB gain and 23 dB front-to-back ratio.

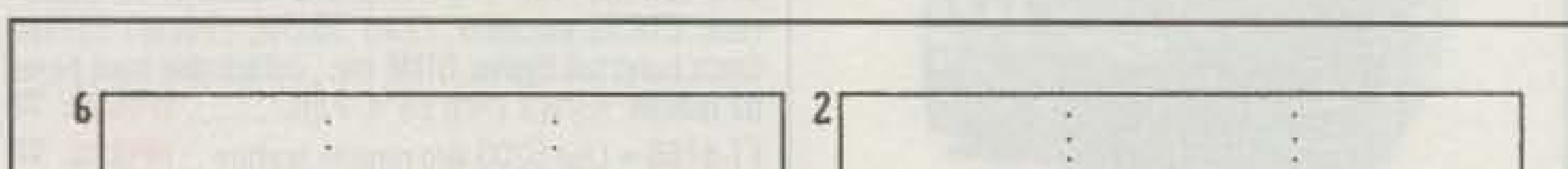

Fig. 2– Top left: gain vs frequency. Top right: SWR vs frequency. Bottom left: front-to-back vs frequency. Bottom right: feedpoint impedance vs frequency.

An Interesting 3-Element Yagi Design

The Optimizer user can spend many a happy rainy day exploring antenna parameters, playing with gain vs front-to-back vs bandwidth vs boom length vs input impedance. There are an infinite number of configurations. An interesting one I ran across is shown in fig. 4. This is a 3-element design on a 20 foot boom. The beam provides 5.86 dBd gain and 26 dB front-to-back ratio near the design frequency of 14.2 MHz.

This is a well-behaved, wide-bandwidth design, having a feedpoint impedance of about 20 ohms at the design frequency. Various operating parameters are shown in fig. 5.

Note that the element spacing is not equal (fig. 6). The reflector-driven element spacing is much less than the driven element-director spacing. This uneven spacing has shown up so many times in modern Yagi designs that it seems to be an important factor in providing optimum performance.

Where did this particular design come from? It started with a design for a 3-element Yagi given in chapter 8, section 14, of *Yagi Antenna Design* (an ARRL publication), by the late James Lawson, W2PV. Gain, front-to-back, SWR response, and input impedance derived by the Optimizer are very close to those values given in the original W2PV design. But notice the difference in element spacings and length!

I started the program by inputting the W2PV data to the Optimizer program. As the program ran, I could see on the monitor the driven element moving steadily closer to the reflector and the element lengths changing. Very interesting. The end results were the same as derived by W2PV, but the Optimizer provided a different set of element dimensions and spacing.

Well, that's what makes the ball game interesting. The K6STI Optimizer is calibrated against NEC, the accurate antenna analysis program used by professionals. My opinion is that the results obtained from the Optimizer program are very close to real-life data obtained in the field on a well-calibrated antenna range. So there you are.

Trans-Atlantic Reception Without a Receiver!

Sounds impossible, doesn't it? But it was done back in 1920 by Harold Beverage (ex-2BML), after whom the so-called "wave antenna" was named. In 1978 Beverage wrote a letter to Thorne Mayes (ex-6AX) in which he described his amazing feat. The letter is described in the

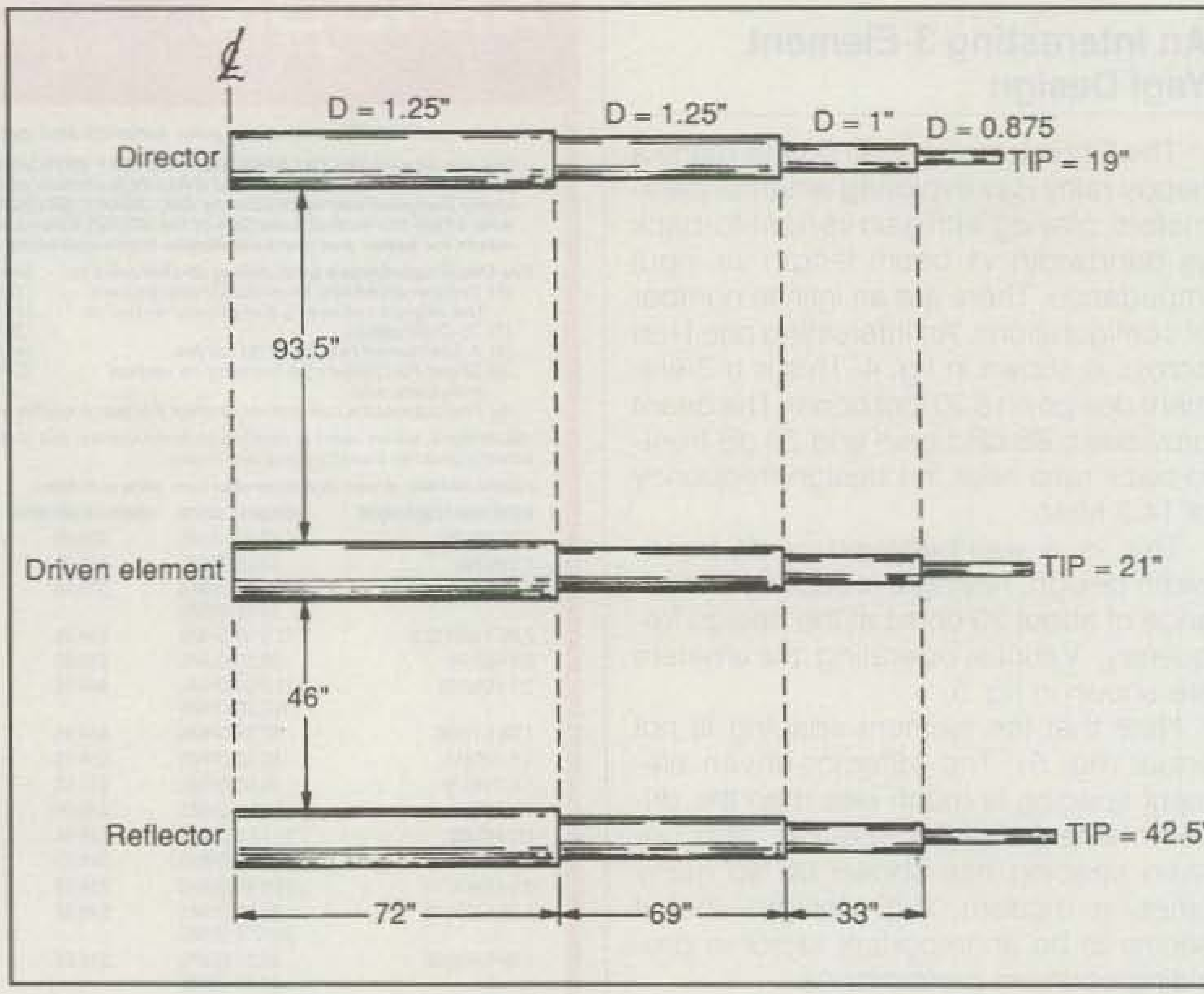

Fig. 3– Half-element lengths, spacing and diameters of short-boom Yagi.

book *Wireless Communication in the United States*, by Thorn Mayes, published by the New England Wireless and Steam Museum, 697 Tillinghast Road, East Greenwich, Rhode Island 02818.

In the letter Beverage tells that in 1920 he erected a wave antenna on Long Island. It was 9 miles long, running from Riverhead to East Moriches. He recounts that one day he connected headphones between the wire and ground and heard a very high-pitch tone sending code. He listened carefully to the tone, which was a frequency of about 14,500 cycles (Hz). He identified it as the super-power station LY, the 1000 KW arc station near Lyons, France, transmitting on 14.5 kHz!

Trans-Atlantic reception without a receiver! I wonder if that astounding feat has been duplicated since then. With a very, very long, low wire antenna you might try to hear the VLF stations around

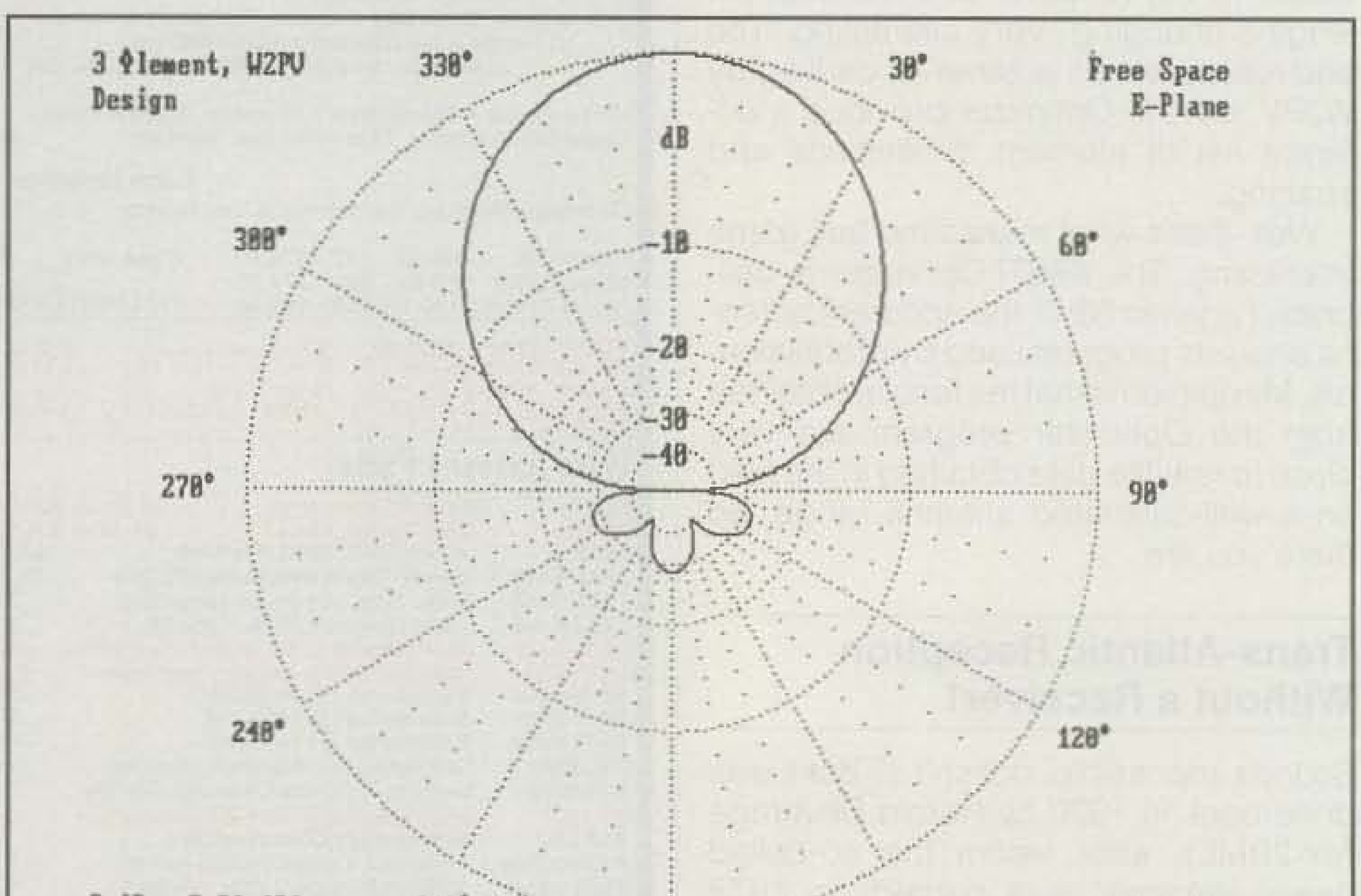

Fig. 4– Polar plot of modified W2PV-style 14 MHz Yagi on a 20 foot boom.

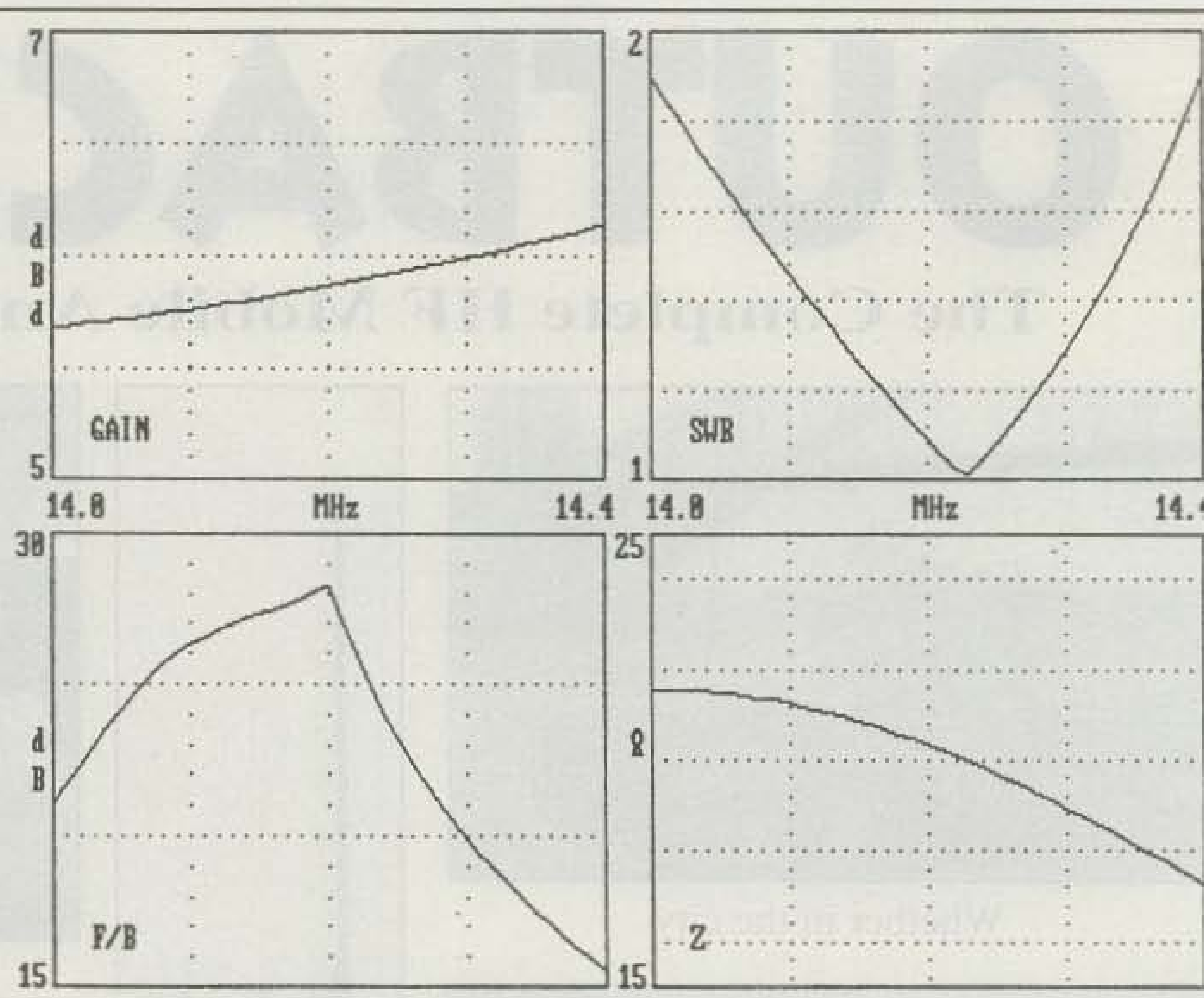

Fig. 5– Top left: gain vs frequency. Top right: SWR vs frequency. Bottom left: front-to-back vs frequency. Bottom right: feedpoint impedance vs frequency.

8 to 12 kHz. Headphones only, please. Keep me posted!

The Groundplane Loop Antenna

A low-profile, vertically polarized loop antenna was described by Hans Wuertz, DL2FA, in the German publication *cq-DL*, issue 5/83. The article has been translated and appears in the August 1983 issue of *Radio Communication*, a publication of the RSGB.

The design comprises half of a full-wave loop antenna with the other half formed by the ground image (fig. 7). With

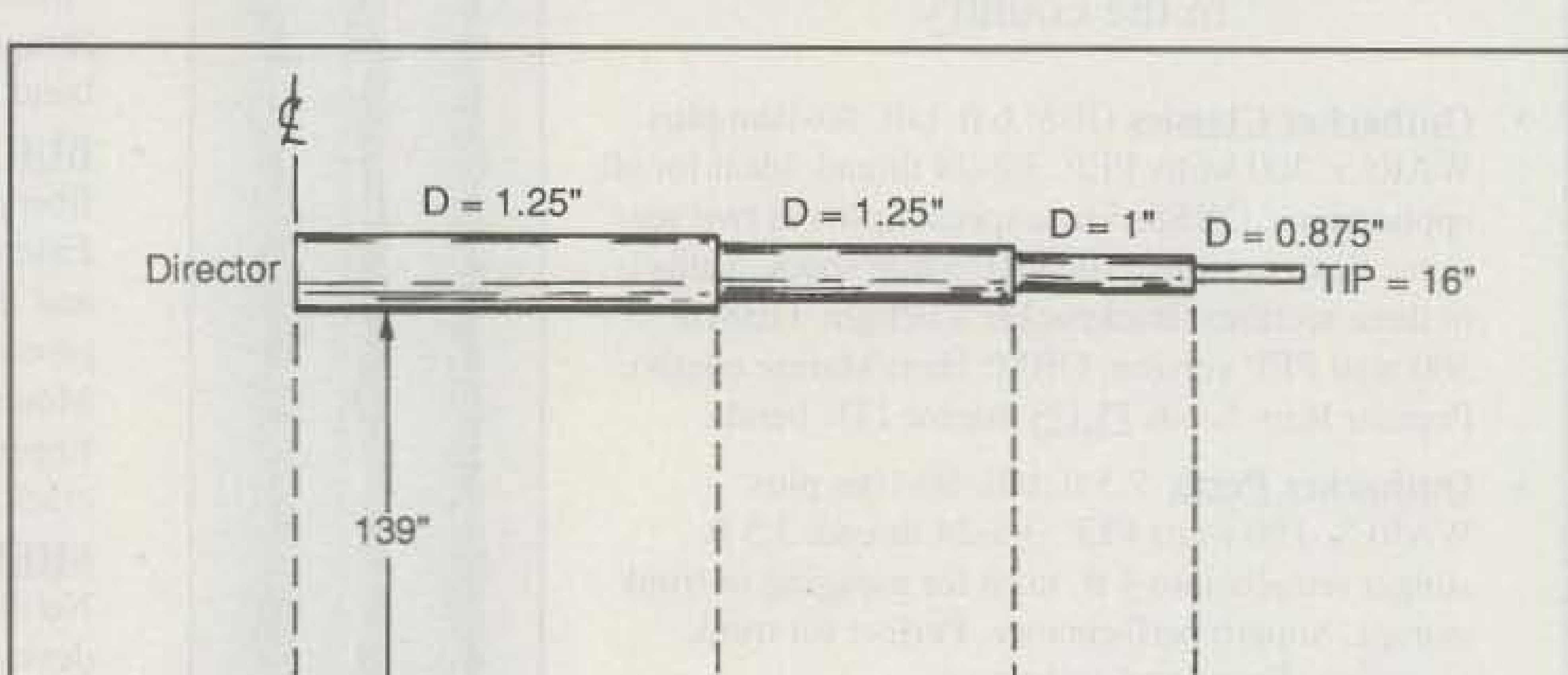

Fig. 6– Half-element lengths, spacing, and diameters of W2PV-type Yagi.

a 0.2 wavelength semicircular half-loop for the lowest frequency, DL2FA claims the antenna can be tuned to cover a 2-to-1 frequency range, 3.5 to 7 MHz, for example. Bandwidth of the loop, without retuning, however, is quite narrow.

For low loss the antenna is made of 1/4 inch diameter copper tubing. The ground return is also made of copper tubing, soldered to a chicken-wire ground screen (dimensions not given). DL2FA predicts that loop efficiency is high, being only 2 dB down in field strength as compared to a full-size 1/4-wave vertical antenna, and only 0.5 dB down on the higher frequency band.

The antenna may be fed by a capacitive match, inductive coupling, or a form of Gamma Match, as shown in the illustration. Radiation efficiency and vertical radiation pattern will probably be affected by ground conductivity over the surrounding area.

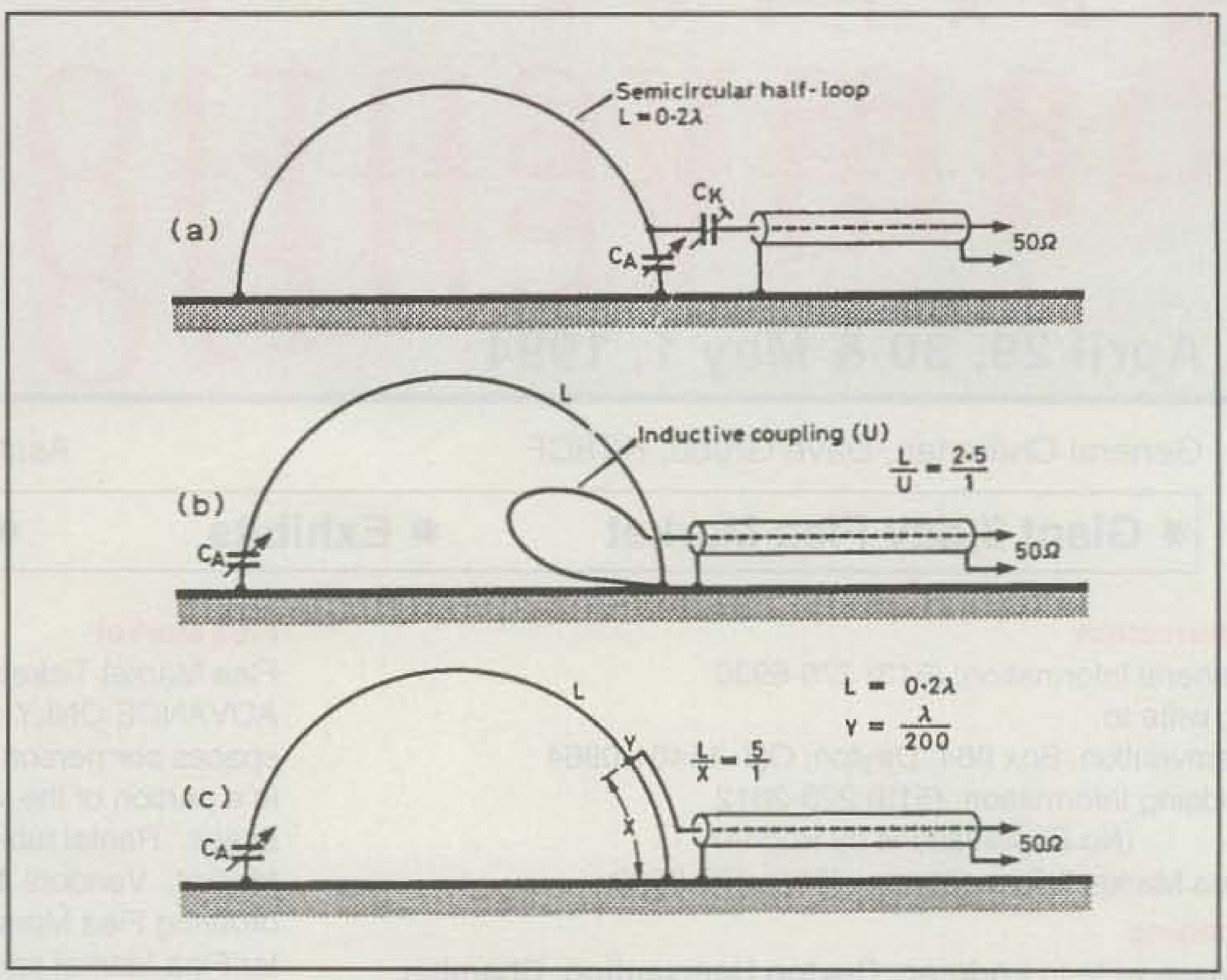

Fig. 7– DL2FA ground-plane loop antenna: (a) capacitive feed; (b) inductive feed; (c) gamma feed. (Drawing via RSGB)

Aluminum, Anyone?

Finding aluminum to build a Yagi can be a time-consuming and frustrating experience. Gone are the days when surplus-metal junk yards sold the stuff for pennies. Some home-improvement stores sell small lengths of tubing, but 12 foot telescoping lengths, necessary to build 20 meter beams, for example, seem to be hard to come by unless they are ordered from a large metal-supply store. Unfortunately, many of these big stores have a minimum quantity order, or refuse to deliver a small individual order of tubing.

Tubing is generally sold in 12 foot lengths in standard diameters and various wall thicknesses. Any diameter tubing will telescope into the next larger size if the larger size has a .058 inch wall thickness. Thus, a 1 1/4 inch diameter length of tubing will telescope into a 1 3/8 inch diameter tube if the latter has a wall thickness of .058 inch.

Drawn aluminium tubing in various diameters and in 6 and 12 foot lengths can be obtained from Texas Towers, 1108 Summit Ave., Suite 4, Plano, TX (214-422-7306). In addition, extruded tubing up to 3 inches in diameter and as long as 24 feet (suitable for booms or masts) is also available. Texas Towers will ship tubing via UPS truck or air freight collect.

Fiberglass Spreaders, Anyone?

Quad spreaders can be a pain. It's not easy to get suitable material for these important components. I've found a company that stocks fiberglass rod, plus round and square tubing suitable for HF and VHF antennas. And they will ship UPS. You can obtain a price list, tips on spreader construction, and info on obtaining long life from your spreaders.

If you are a Quad enthusiast and want this important information, write to R. Allen Bond, Max Gain Systems, 221 Greencrest Court, Marietta, Georgia 30068-3825 (404-973-6251 before 9 PM EST).

The W6SAI Mailbag

Many thanks to the following who have written to me with regard to this column. I appreciate hearing from you! W7JTR, AB6PY, KD4KOX, W7GW, K5IU, W6NSU, W1PN, K4WV, VK5BR, W0QLU, W8TFB, K2OR, W4LGK, WU2J, W1IAF, W5PSA, KW1L, I4AFQ, W6OAL, K6YO, DK5VP, and VE1KD.

73, Bill, W6SAI