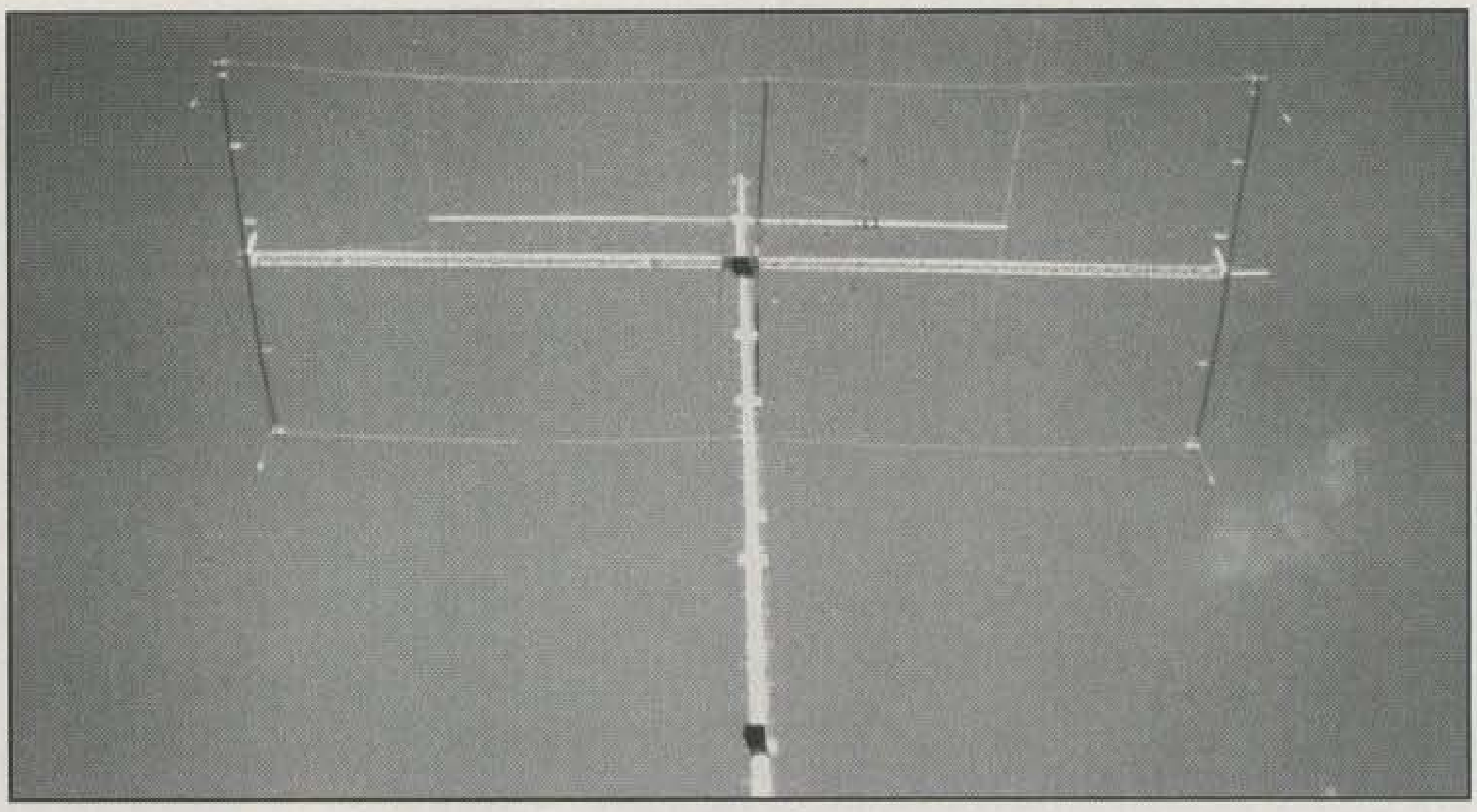
When it comes to 80 meters, many of us never look beyond wire antennas for very practical and logistical reasons. While reality may put a crimp on our dreams, it's certainly nice to see some of us make our dreams come true.

How To Build A Relatively Small 2-Element, 80 Meter Yagi

BY DALE HOPPE*, K6UA

I have been active in numerous facets of amateur radio for many, many years. No matter what I try, however, in my eyes nothing matches the fascination and challenge of DX and contesting. These two competitive arenas have drawn me into their clutches on a regular basis since my early days in the hobby. As a result, I have explored and tried every concept, technique, and equipment I possibly could to improve my performance and my success. Fortunately, I have a very understanding and supportive wife, Sue, who has rarely, if ever, objected when new equipment crossed our threshold, or when new towers started to rise behind our home, or if I spent excessive time installing and integrating these items into my radio station. Her constant support extended through this antenna project and is thoroughly appreciated.



A view of the 80 meter antenna mounted on a Telrex pole. The "smaller" beam above is a 5-element, 20 meter Yagi at 110 feet.

Through the years I have found that the best way to maintain an effective station is by installing and using efficient antennas. In this respect, I am very fortunate in having a 10 acre ranch in the country, which provides plenty of space to experiment. As a result, I have developed a farm (i.e., antenna farm) within my ranch. My setup, six towers with stacked Yagis on all bands, has been a source of pride.

The band which has always troubled me, however, is 80 meters. Last year I decided to design and build an efficient effective 80 meter antenna. The objectives I established were small in size, rotatable, efficient, good gain and good front-to-back ratios, wide bandwidth, inexpensive, and easily constructed. I met all of these requirements with a rotatable 2-element Yagi.

Before going into construction details and performance results, let me explain why I selected the design approach I used. I was determined to avoid the use of loading coils because they introduce losses which would fundamentally eliminate, or at best minimize, any possibility of achieving efficiency. I decided to try linear loading even though I knew that some antenna manufacturers were having difficulty making their linear-loaded antennas work properly. An appropriately designed linear load introduces very little loss, will not impair radiation patterns, and can achieve a low enough Q to allow reasonably good bandwidth. These points alone were almost enough to reach my overall objectives.

Fortunately, I had outstanding support and technical help from two very good friends. One, Rod Mack, W7CY, used his AO computer program to project performance, and the other, Wayne Lorance, W6ZA, used some of his exotic programs (NEC2) to confirm Rod's calculations. Their guidance was instrumental in making the antenna work properly almost at the outset.

Construction

An overall top view is shown in fig. 1. The boom is a 73 foot triangular aluminum tower, 13 inches per side, with a 3 foot horizontal extension (2 inch aluminum angle) at each end used for back bracing. It also includes a 3 foot vertical extension at each end (not shown in fig. 1) to provide vertical bracing. Attached to the boom are six 16 foot pole-vaulting poles (rejects I purchased a number of years ago from the manufacturer for $2.00 each). Two each are fastened at each end to provide a 30 foot spread for the antenna wire, and two are fastened to the center of the boom to maintain the 30 foot spacing.

Assembly of the wire elements is reasonably straightforward. The top view is a

*450 Yucca Rd., Fallbrook, CA 92028

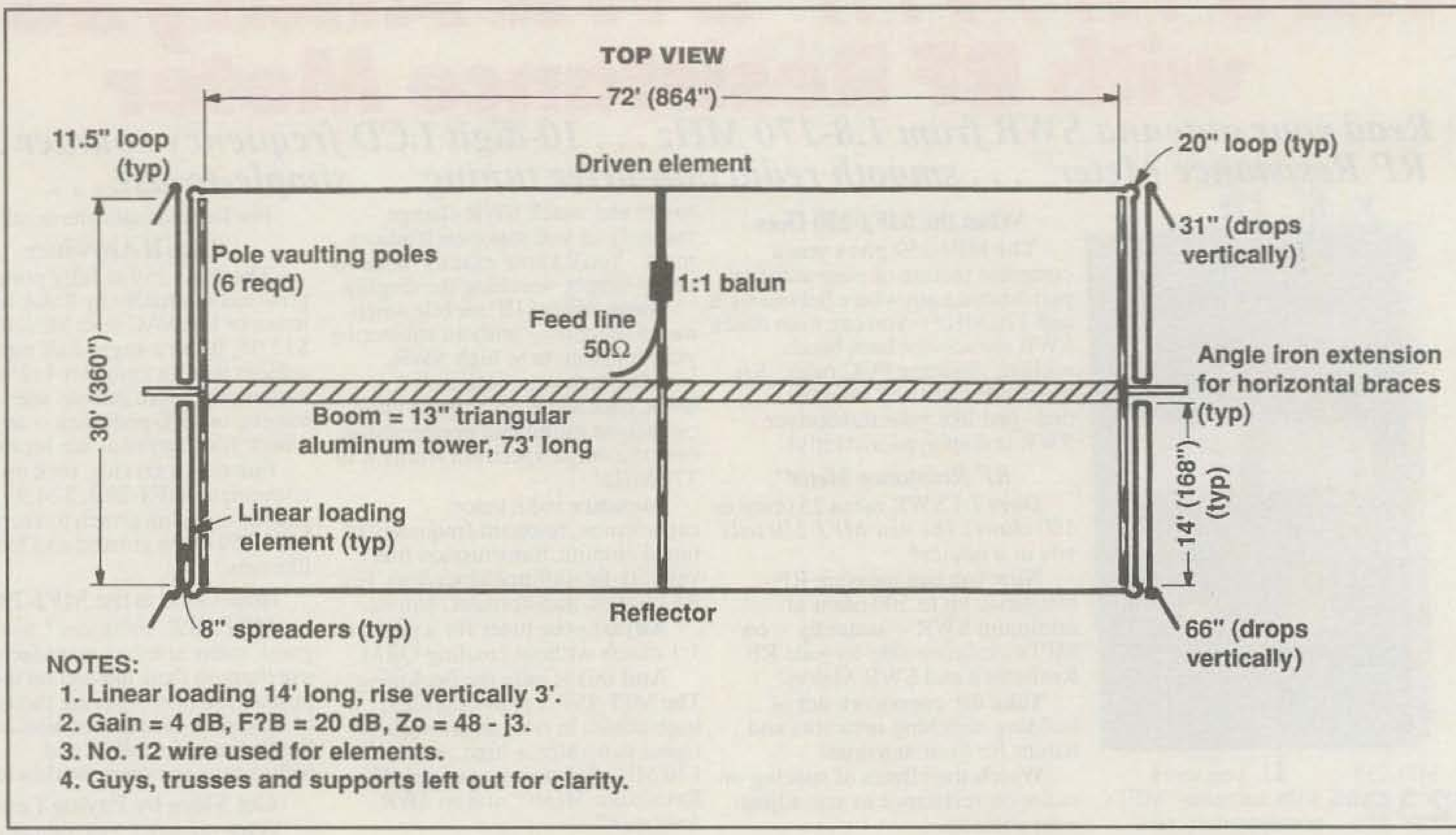


Fig. 1– The 80 meter, 2-element Yagi, top view.

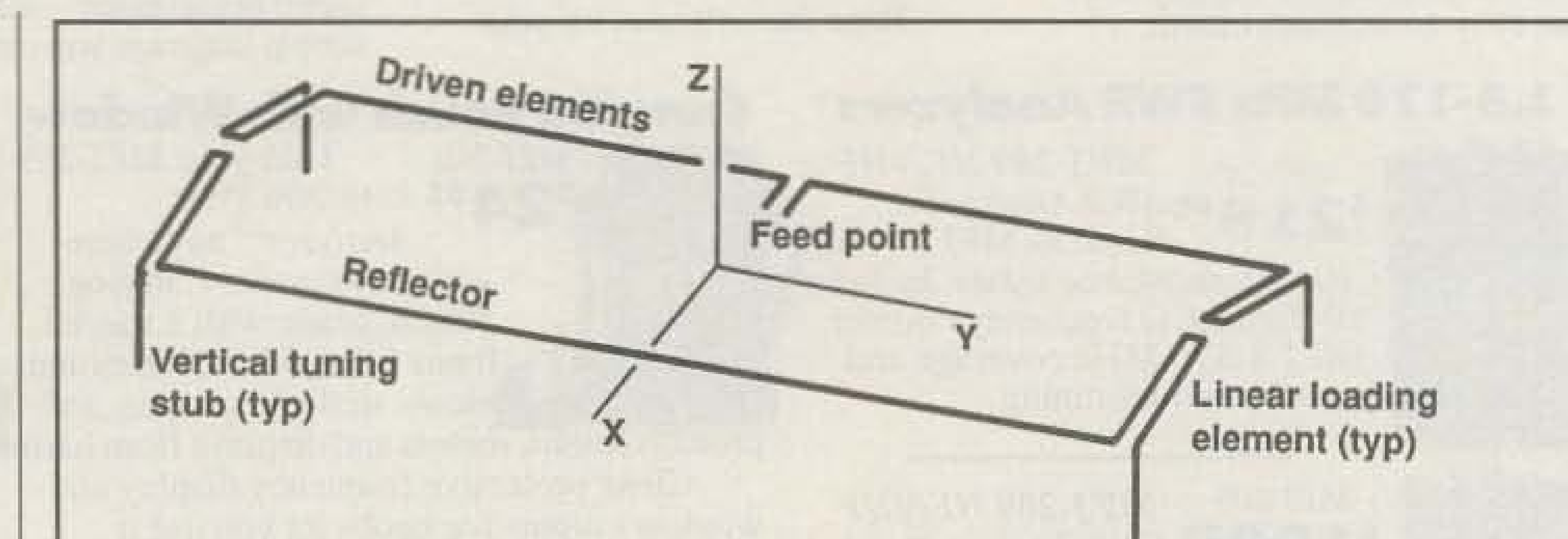


Fig. 2– Antenna in free space.

complete picture of the electrical elements of the antenna. If it is difficult to envision any portion of the antenna, see fig. 2 for a sketch of the antenna wires in free space. The 20 inch loops and the 11.5 inch loops were established to permit fastening elements together using compression fittings installed by a *Nike Press™*, but any other method of assembly is acceptable. Be sure to keep the vertical tuning stubs longer than indicated at the outset. These will be trimmed to tune the antenna as described later.

Details of the linear loading elements are shown in fig. 3. The 11.5 inch loops are attached to the vertical tuning stub, and the 20 inch loops are attached to the 72 foot horizontal elements. To calculate the length of wire used, include the vertical stubs, linear loading elements, *all loops,* as well as the horizontal radiator and reflector. On that basis the driven element is 139.75 feet long (1677 inches) and the reflector is 145.583 feet long (1747 inches).

The center of the linear loading element is elevated 3 feet above the pole-vaulting pole cross supports (as shown in fig. 4) by attachment to the top of the 3 foot vertical support. That elevation is a critical dimen-

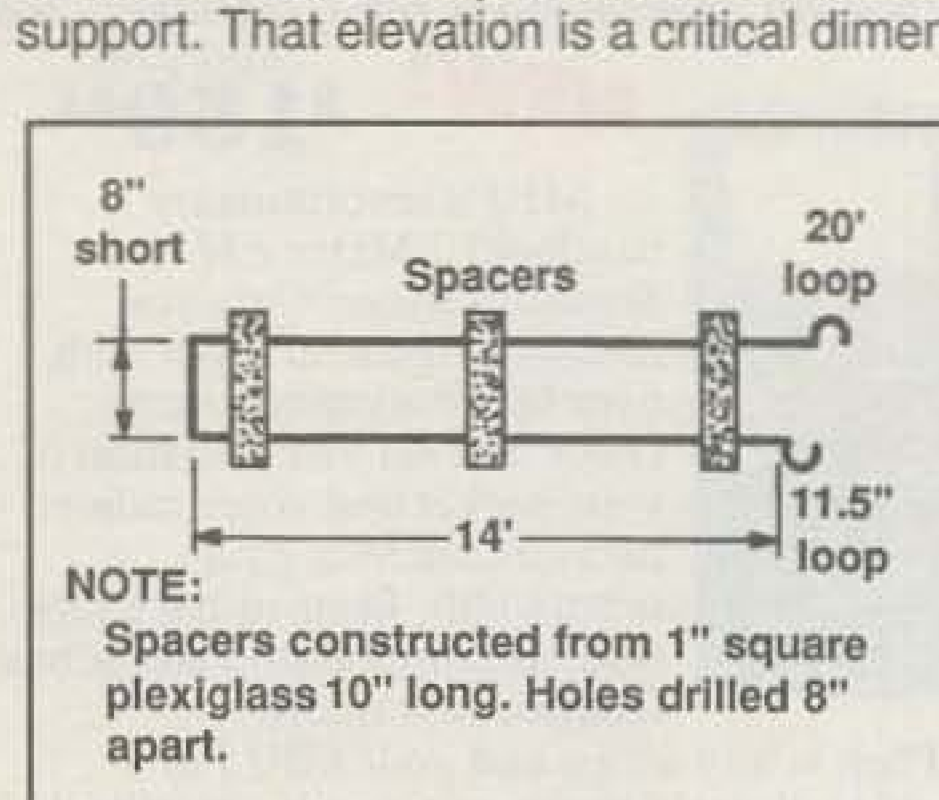


Fig. 3– The linear loading element (four required).

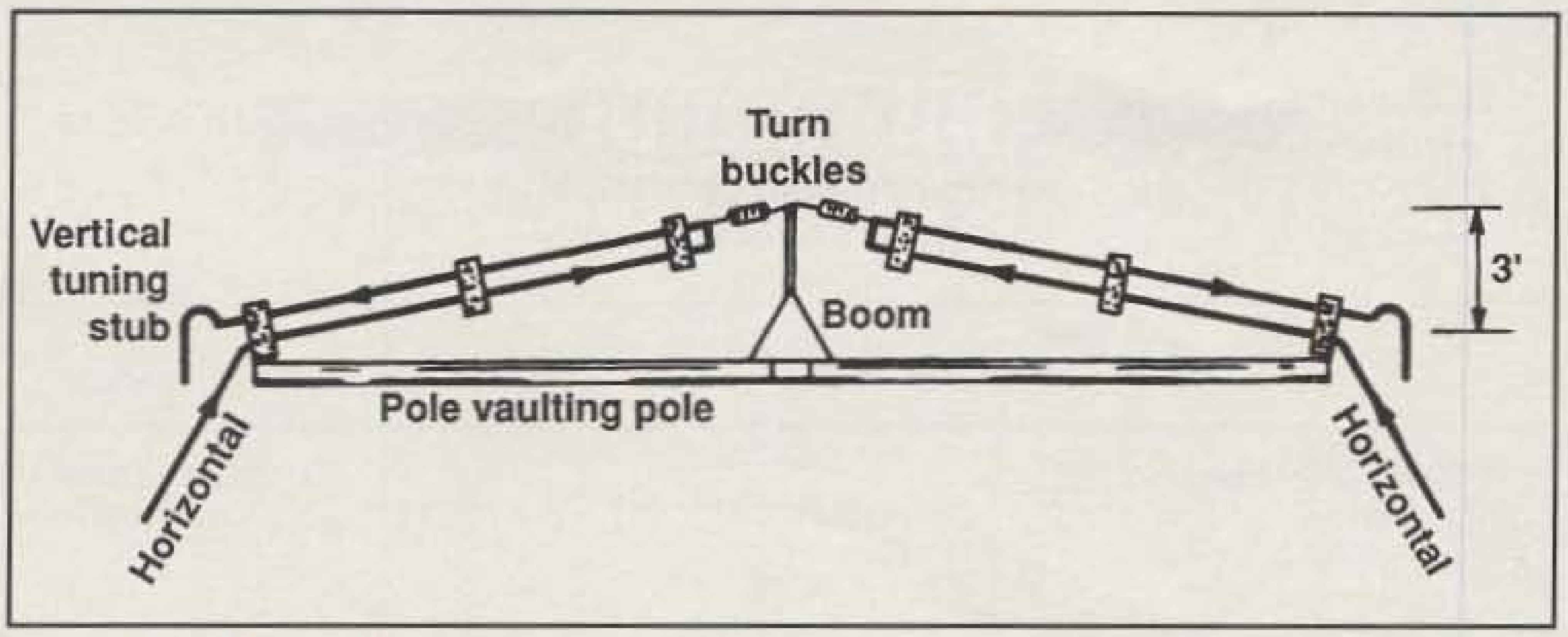


Fig. 4– End view.

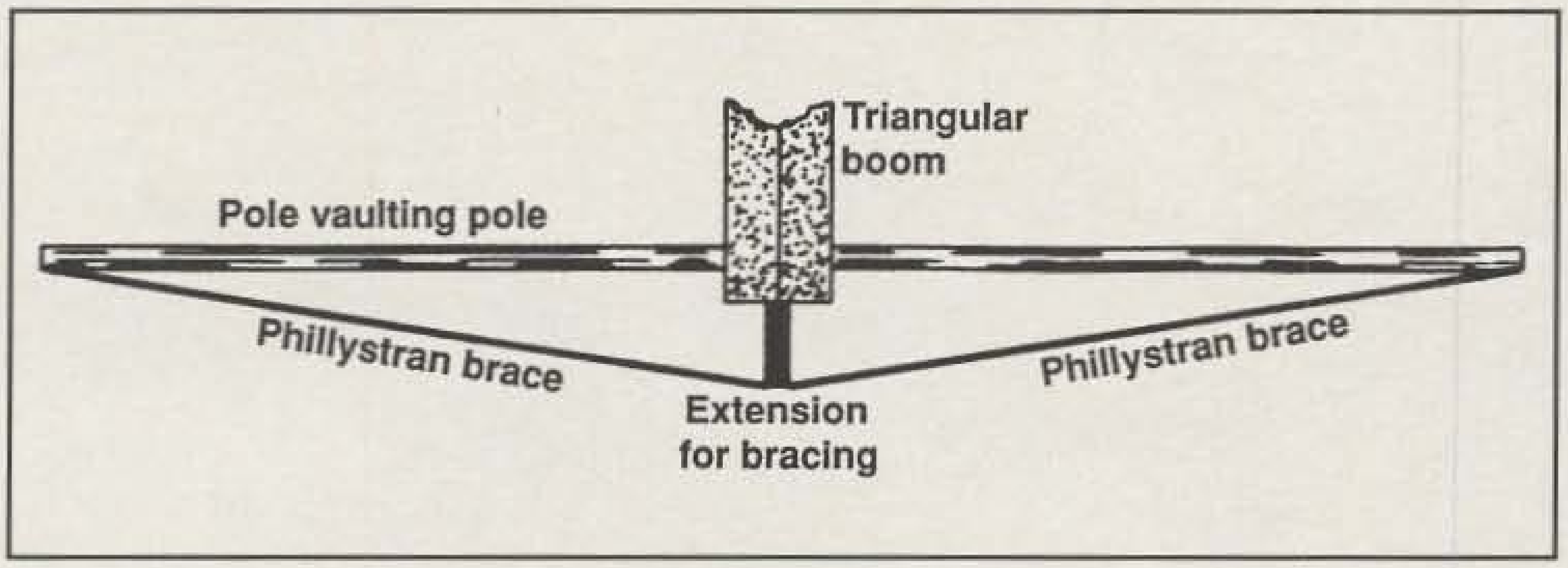


Fig. 5– Top view showing horizontal bracing.

sion. The linear loading element also serves as a vertical brace supporting the tips of the pole-vaulting poles. It is tightened by turnbuckles as shown in fig. 4.

The end poles are also braced in the horizontal plane as shown in fig. 5 to prevent the poles from flexing towards the center. Phillystran(R) was used to provide the support because of its strength and light weight.

The antenna is fed with RG8 via a 1:1 balun attached to the center pole-vaulting pole about 7 feet from the boom as shown in fig. 1. The balun is homemade and construction details are shown in fig. 6. For the final assembly the 15 Amidon™ beads were covered by plastic tubing and the entire assembly was sealed.

Installation

My antenna is mounted on a rotating Telrex pole at a height of 100 feet. The actual installation is shown in the photo. Just above the 80 meter antenna is a 5-element 20 meter Yagi at 110 feet. There is no interaction or degradation between these two antennas. The entire tower is rotated by a one-third horsepower motor located at the base of the pole. An electrical winch is mounted on the side of the Telrex pole and is used to raise and lower

Fig. 6– Balun for 1:1 match.

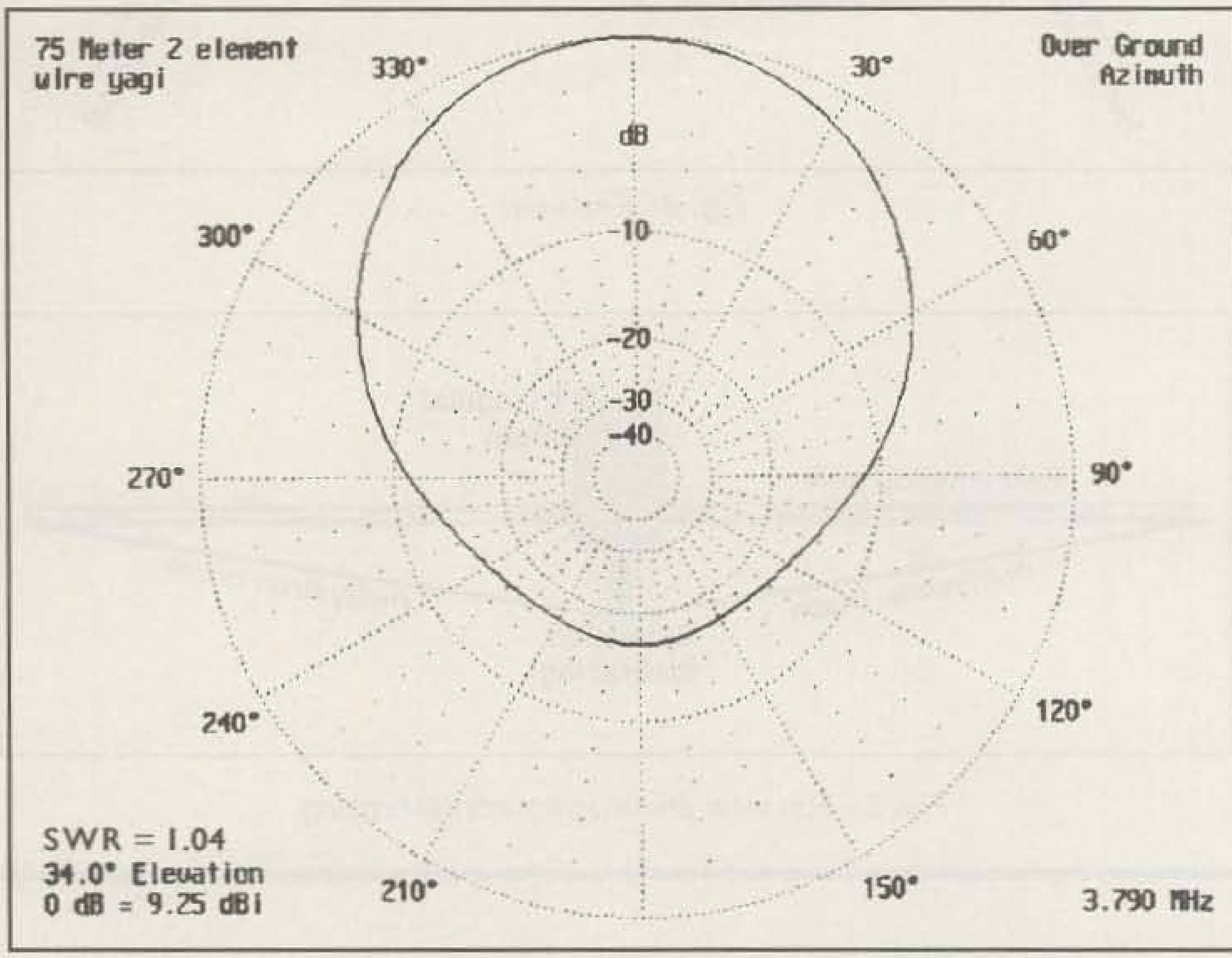


Fig. 7– Radiation patterns from 3.790 MHz to 3.960 MHz.

the antenna. This feature of my installation was a god-send when it came to tuning the antenna, since the performance at ground level changes significantly at altitude. In fact, the characteristics are very different at 70 feet and at 100 feet.

Tuning

The tuning process is tedious but relatively simple. Because of the change in performance at different altitudes, for me the entire process was cut-and-try. The only test equipment used was an MFJ Analyzer to verify SWR and a Yaesu FT1000D to measure front-to-back ratios. The front-to-back ratio was checked at ground level and then checked at 100 feet to determine the direction and amount of change which occurred.

The antenna was lowered and the vertical tuning stubs were trimmed slightly. It was noticed that a change to the driven-element stubs affected the performance of the reflector and vice-versa. The antenna was raised and lowered five times before I achieved the current level of performance. It is important to make small changes to the vertical tuning stubs and to determine the extent of the change after it is elevated. A pattern of differences can be established which may simplify the overall process.

The dimensions shown in fig. 1 are the ones currently used in my prototype installation. If you make an installation on a different type of tower and/or at a different height, these dimensions probably will be different.

It is conceivable that instead of using wire for the vertical tuning stubs, telescoping aluminum tubing could be installed. This would simplify the trimming and tuning process. I will not be surprised to hear of an enterprising amateur out there installing a motor-driven tuning capability for these stubs.

Performance

The antenna was designed to have an impedance of approximately 50 ohms. This parameter was verified by actual measurement. Thus, the 1:1 balun was acceptable.

Radiation patterns projected by Rod Mack and Wayne Lorance for a range of frequencies are shown in figs. 7 and 8. The center design frequency was 3.790 MHz, and at that point the SWR was 1.04 and the gain 9.25 dBi (or 6.75 dBd, if you prefer). My measurements showed the front-to-back ratio to be at least 18 dB and sometimes 20 dB on all frequencies. From 3.790 MHz to 3.960 MHz the SWR changed from

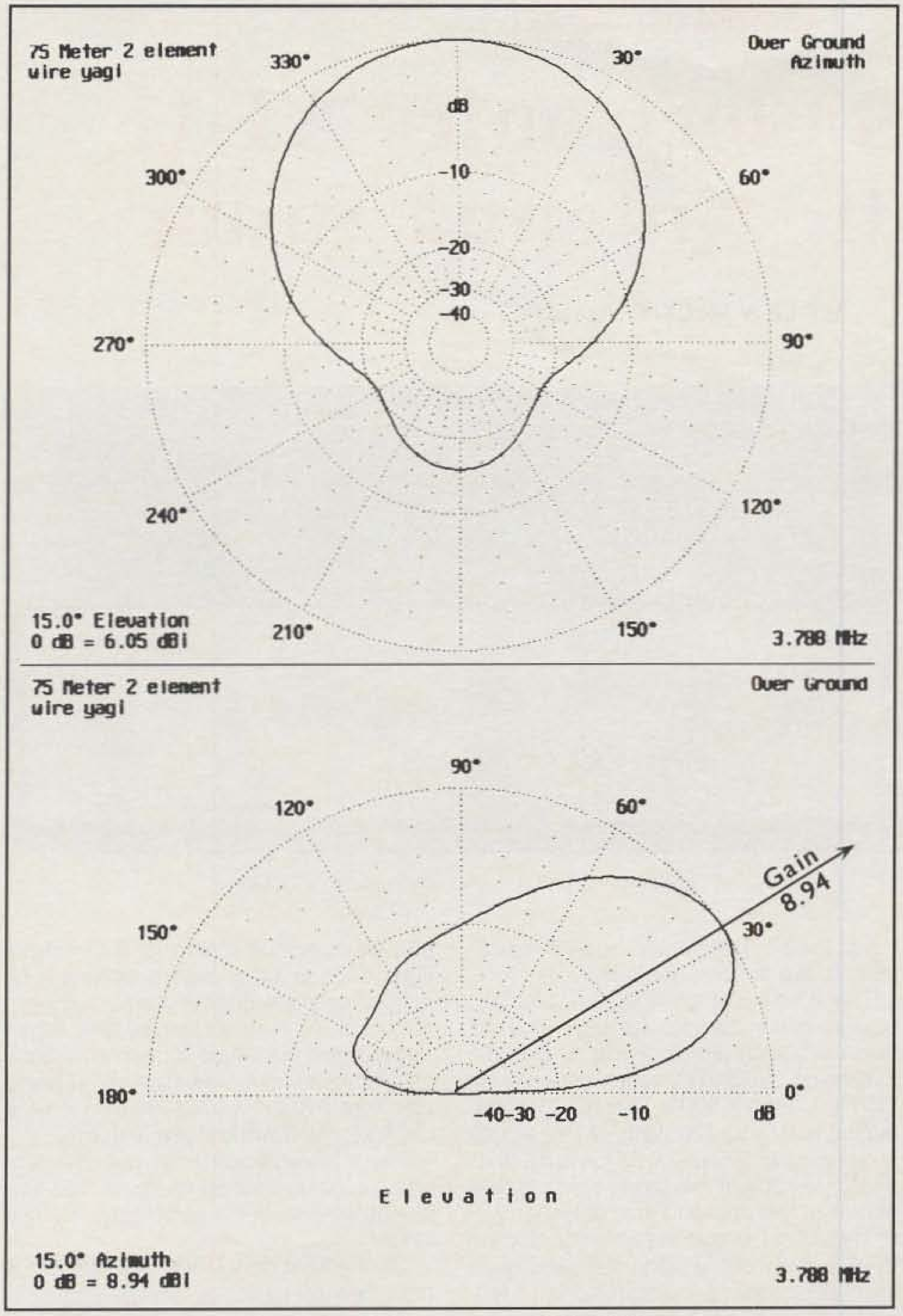


Fig. 8– Radiation pattern at 3.788 MHz.

1.04 to 1.88 and the gain went from 9.25 dBi to 7.76 dBi. This is "short" antenna performs beautifully. Fig. 8 shows the radiation pattern at 3.788 MHz.

Conclusion

I can only say that the 80 meter Yagi is wonderful. It has the gain, bandwidth, and front-to-back ratios I had hoped for and matches 50 ohms directly. I have no trouble working Europe from my California QTH even when they transmit on 3.725 and listen on 3.870. I can bust pile-ups with ease, and every contact asks for details on the antenna. I highly recommend this design to anyone interested in 80 meters who has the tower and the real estate required.

To summarize the primary points:

- It is a small, rotatable 80 meter Yagi (one-half size)
- Good gain
- Good F/B (18 to 20 dB)
- Great bandwidth
- Inexpensive
- Easy construction

I wish you luck if you decide to build it. I cannot imagine anyone not being able to achieve the same performance levels I did. If you do try it, let me know how it works. If you hear me on 80 meters, give me a shout. I'd be glad to discuss this great antenna with you. ■