with a curve that looks very much like that of fig. 4.

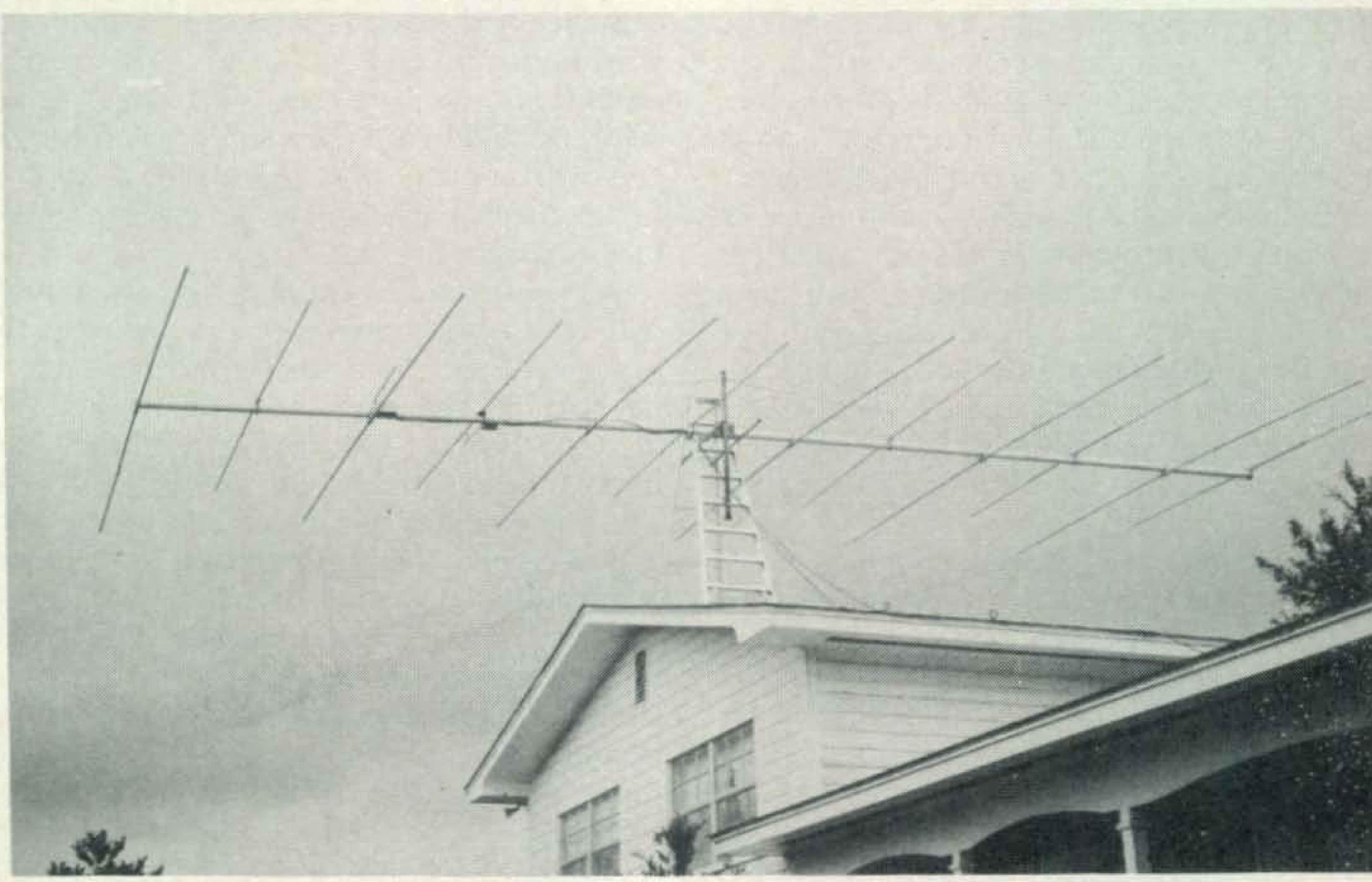
That's about all there is to it. I included an IN-OUT switch in the circuit of fig. 3 so the filter can be switched out when you want to listen to the QRM. The 3.3K resistor, R_2, makes up for the insertion loss of the filter so that there is no level change when the filter is switched in and out. This value is correct for my 200 ohm HS-30 headphones; higher impedance headphones will require a larger resistor, of course.

The 12 ohm resistor on the input is to properly load the audio output stage of the receiver; Some output stages do not like working into a high impedance.

Cascading

If you really groove on c.w. operation you will probably want to cascade two or more of these filters for improved performance. The response curve for two double-tuned transformers in cascade will be very much like fig. 4 with all the db values doubled. That is, 10 db down will be 20 db, *etc.* A suggested method of cascading by "top coupling" is shown in fig. 5. The value of the coupling capacitor may have to be adjusted slightly for best results.

Alternatively, you can cascade your double-tuned transformers using a tube or transistor between transformers. Just remember to keep impedances above 50K ohms to avoid excessive loading. ■



A 10 & 15 METER INTERLACED BEAM

BY DOUG GAINES,* W4AXE

WHAT a dilemma. For contesting, I would like six elements, wide-spaced, on each of the high bands, 10, 15 and 20 meters and at least two elements on 40 meters, plus what dipoles, low frequency arrays and other assorted garbage I can hang on my tower. Unfortunately, I do not like to be distracted by the thunder of falling steel and aluminum resulting from stacking too many, too heavy antennas on too long a mast sticking out of too high a tower, in too high winds. I either had to lower the antenna height or reduce the number of elements, and reduce the resultant gain. Neither of these alternatives

*1226 Rolling Wood Lane, Lakeland, Florida 33803.

See page 102 for New Reader Service

appealed to me, so I set out to conjur up something that would give competitive gain and yet, keep the wind and torque loads down.

Now, I consider Ol' Thunder, my six element 20 meter beam, inviolate and untouchable. No tinkering allowed there. But I wondered if I could fudge a little and decrease the stacking space between the 10 meter and 15 meter beams to a minimum, maybe even to zero. The results of this cerebral meandering is two beams built on the same boom. *Voila!* A six element wide-spaced 10 meter Yagi, and a six element wide-spaced 15 meter Yagi, interlaced.

Results? A measured forward gain approaching the theoretical maximum for single-band, six elements, typical six element radiation patterns, wind area about equal to a four element 20 meter beam and a total weight under 75 pounds. Oh yes, and one of the funniest looking antennas to threaten a neighbors peace of mind. Interested? Okay, here's how.

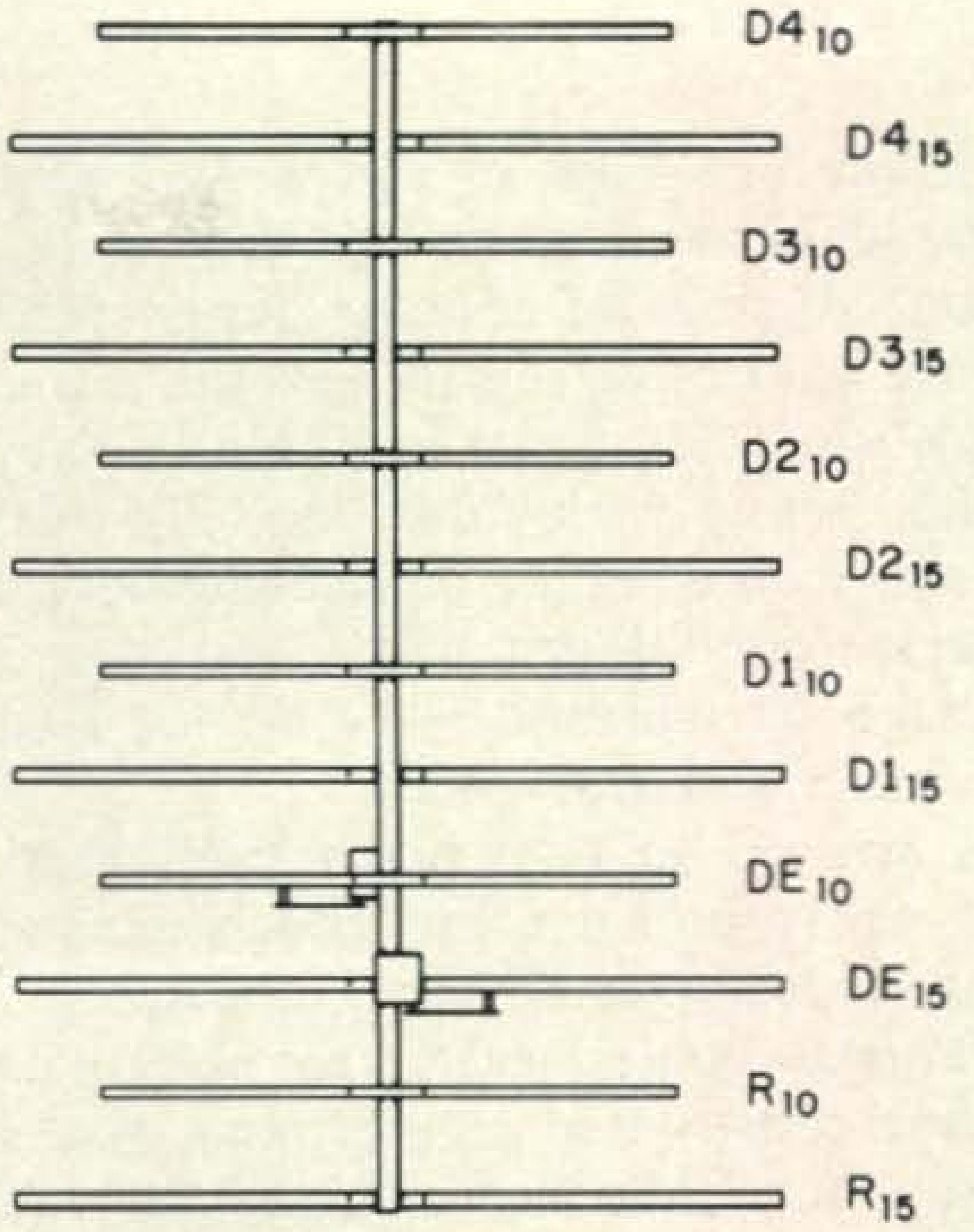


Fig. 1—Element arrangement for the 10 and 15 meter beam. The 10 meter elements are mounted on top of the boom, the 15 meter elements on the bottom. The gamma matches are staggered, one left and one right, for minimum interaction.

Design Description

Total boom length is 36 feet, but actual boom length for each antenna is 33 feet. Spacing of all elements for each beam is 6 feet, 6 inches, or approximately 0.2 λ on 10 meters and 0.15 λ on 15 meters. The elements are arranged, as shown in fig. 1, so that the 15 meter reflector is mounted at the rear of the boom, the 10 meter reflector is 3 feet 3 inches ahead of it and so on, down the boom for the rest of the elements, ending with the 10 meter 4th director at the front end. To reduce interaction between the matching sections, a problem I had encountered in an earlier design, I mounted the 10 meter gamma rod and capacitor on the lower left, and the 15 meter gamma rod and capacitor on the upper right side. Both antennas are matched to 50 ohm coax using the conventional gamma match.

Construction

I used a light weight boom and small elements to reduce weight and wind area, within reasonable limits. The boom is 3 inch O.D., 6061ST aluminum tubing of 0.062 wall thickness, thinner than I would use again. With this many elements on a 36 foot long boom, the flexibility is a little spooky. I would recommend 0.084 wall thickness for this application.

The elements are 1 inch O.D. in the center section, sleeving down to 7/8 inch tips with wall thickness of 0.034. The 10 meter elements are mounted on top of the boom and the 15 meter elements are mounted on the underside, using commercial clamps by Kirk Electronics. The boom is reinforced at the center with a short section of 3 inch I.D., 1/4 inch wall pipe. This adds stiffness at the point of maximum bending, and provides a rigid area on which to clamp the boom-to-mast mounting plate. This is a 14 inch square steel plate, 1/4 inch thick, drilled for 2 inch U-bolts for the mast and 3½ inch U-bolts for the boom. As fast as I like to turn my antennas in a contest, (often better han 2½ r.p.m., 55 volts on a modified prop-pitch motor!) I figured this was no place to spare the strength. The boom is guyed with a single diagonal backstay to pull out vertical sag.

Element	15 m	10 m
Refl.	23′ 8″	17′ 9½″
Dr. Elem.	22′ 3″	16′ 8″
Dir. #1	21′ 2″	15′ 10″
Dir. #2	21′	15′ 8½″
Dir. #3	20′ 8½″	15′ 6¼″
Dir. #4	20′ 6¼″	15′ 4½″
Gamma Rod	19″	16″

Table I—Element sizes for the interlaced beam. The gamma rod spacing is 6″ for both bands.

Tuning and Testing

There are a lot of old wives' tales about interaction and stacking, just as there are about all areas of antenna design. This beast either ignores or refutes several. All element dimensions are given in Table I. They agree quite closely with those used by this writer in many other single band beam designs. The interlocing did not affect resonant lengths enough to warrant retuning, as is demonstrated by the tests below.

I wanted to convince myself that I was not compromising too much performance with this approach, so I constructed good reference dipoles on 28.6 mc and on 21.3 mc. I first constructed single band, six element beams for both bands, using the same elements and boom length. Reasonably careful gain measurements were made with the help of a local amateur across town. Both beams demonstrated about 12 db forward gain over the reference dipoles. Please note, I said "about." The reference dipoles were probably not perfect and I do not believe in Santa Claus when it comes to antenna gain figures. However, these numbers made a good reference for comparison after the beams were interlaced.

Interlaced, the antennas demonstrated the same gain over the same path. No apparent degradation of gain or pattern was noted, except for a decrease in front-to-back ratio on the 15 meter section. Lengthening the 15 meter reflector to that shown in Table I corrected this.

Tuning of the two gamma matches was affected in what appears to be dissimilar ways. In the 15 meter beam, the R component of the feedpoint impedance was increased by the interlacing, as evidenced by the need to shorten the gamma rod from 28 inches to 19 inches. The 10 meter rod did not require changing, but the capacitor required about a ten percent decrease in capacity. Lab type interpretation of this assymmetrical effect is beyond the scope of this article. The antenna was matched to the coax while mounted on a step ladder on the roof of my house, approximately 25 feet above apparent ground. Only minor tweaking of the gammas was required after the monster joined the 20 meter and 40 meter beams on top of the tower.

An earlier experiment with this type antenna with closer element spacing and probable severe coupling between matching sections created wierd tuning effects. I was not able to match the 10 meter section at all using many combinations of gamma rod, capacitor and driven element length, but found that tuning the 15 meter gamma section grossly affected the s.w.r. on the 10 meter beam. I suspect that the two driven elements, only about 16 inches apart, acted as one inefficient broad-band element. I was doubtful of the validity of any measurements taken on such a setup.

Performance

Forward gain figures do not tell all the story about the performance, but this antenna *feels* good. Okay, I know that is not very technical, but it is at least as accurate as some of the claims of antenna manufacturers, and I made the same judgement about my six element beam when I put it up 125 feet high. This "feel" seems to be justified by the measured gain figures (I still stick to my guns with the 12 db figure), a nice narrow frontal lobe of about 45 degrees between 1/2 power points and a low angle of radiation, and a front-to-back ratio of 24 db at resonant point. Bandwidth is *good* and this surprised me. I suspect, once again, that the interlacing with wide spacing actually broadbands the whole works. All of 15 meters, phone and c.w. can be operated with less than 1.6:1 s.w.r., c.w. and the first 500 kc of 10 meters can do the same. Verrry interesting! My I/O factor (time Into and Out of contest pile-ups) is also excellent.

Conclusion

I estimate that this design has eliminated approximately 11 square feet of wind area, at least 6 feet of mast stacking height and about 40 pounds of dead weight. This adds up to a lot of strain eliminated from my rotor and the top section of my tower, to say nothing of my sleep on windy nights. I believe this antenna could be fed with single feedline but this would be a disadvantage for contest work. Besides, I am not sure I am up to the Chinese fire drill this matching procedure would be.

However, since I have had success with this design approach on ten and fifteen, I wonder if Ol' Thunder would mind a few 40 meter elements hung off its backside? Hmmmmm. ■

See page 102 for New Reader Service