W4UW presents us with a project that we could probably put together over a weekend and could have us on the WARC bands by Monday. A little time, a little money, and a little bit of wire can go a long way.

40 Plus WARC
A Multi-Band Dipole Antenna

BY RICHARD A. GENAILLE*, W4UW

A few years ago I decided to trade in my old transceiver for one of those "new-fangled" jobs with all the bells and whistles, including the WARC bands.

*719 Quarterstaff Rd., Winston-Salem, NC 27104

I spent quite a lot of time becoming acquainted with the various controls and their functions, figuring out various features on the analog side of my new toy's front panel and learning something about the digital side of the control panel. Figuring out how to store my favorite frequencies into memory and setting the digital clock, calendar, and display also kept me busy for quite awhile. I also learned quickly that the newer transceivers with transistor amplifiers don't take too kindly to SWR excursions much greater than 2 to 1. Solving that problem without an antenna tuner wasn't too big a chore, but it did keep me busy for awhile.[1] Finally, one day I decided it was

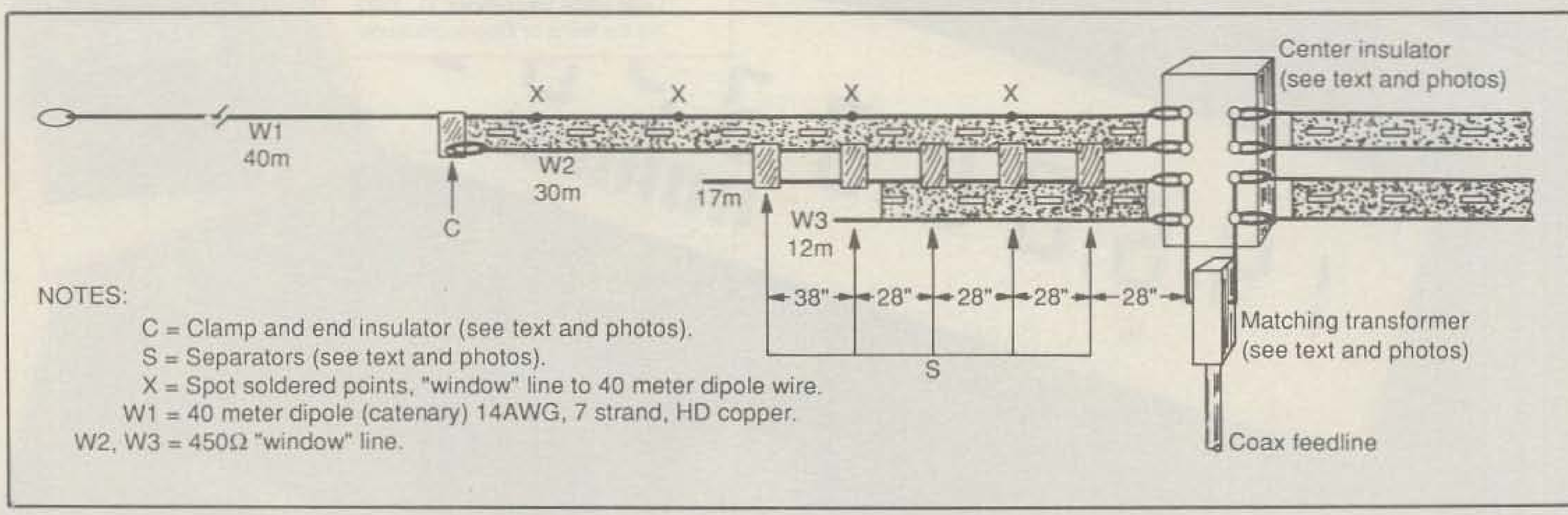

Fig. 1– A multi-band dipole antenna using 450 ohm "window line" for 40 meters plus the WARC bands.

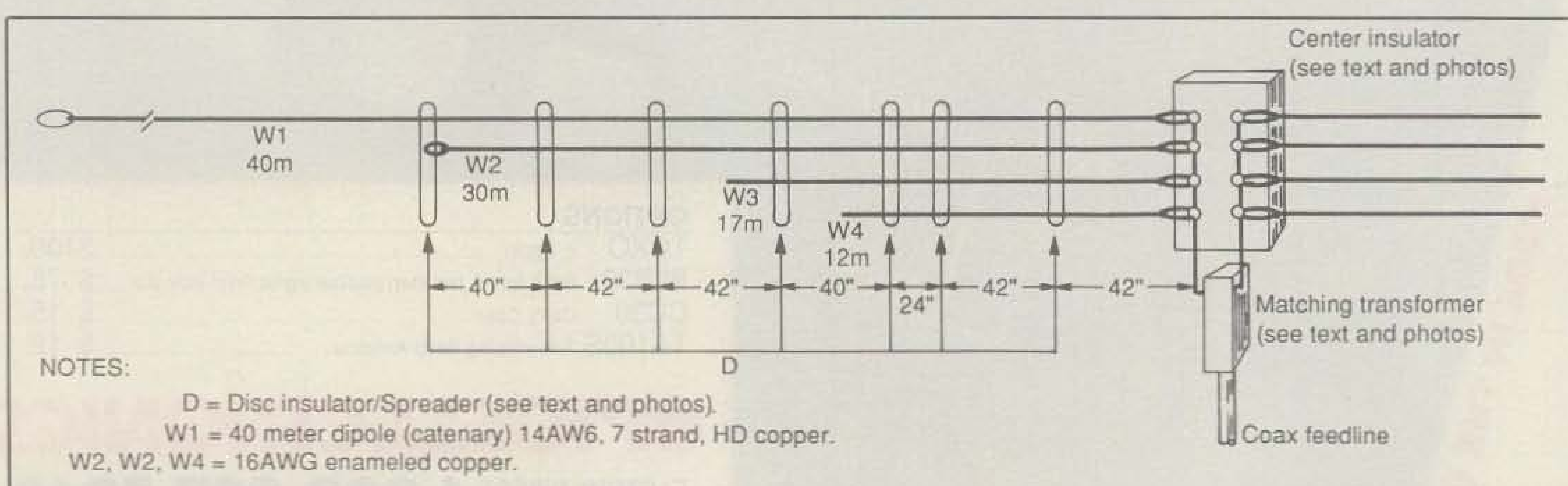

Fig. 2– Similar antenna to the one in fig. 1, but utilizing individual wires for each band.

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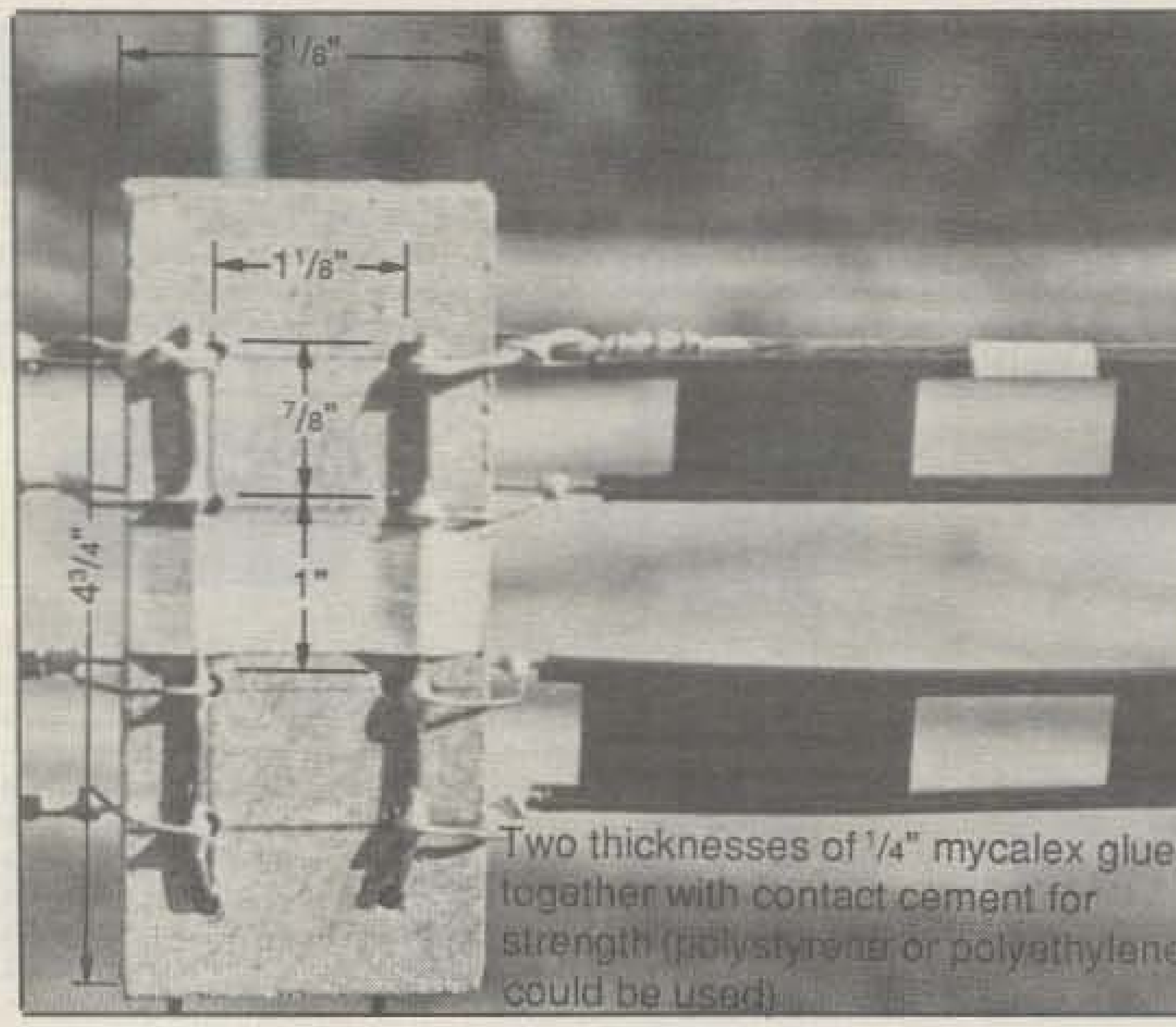

Photo 1– The center insulator showing the 40 meter dipole (catenary) wire and the window line connections.

about time to find out what the WARC bands were all about. After all, they were one of the reasons why I purchased my new toy!

I have only one good location in my backyard where I can erect simple wire antennas. Some years back, in my more agile days, I climbed part way up the two 60 foot oak trees that are on either side of my property and installed some large screw eyes and pulleys with ample footage of ⅜ inch Samson Stable Braid at about the 45 foot level. I did this in order to hoist up a variety of wire antennas from time to time, mostly for 40 meters. To the existing 40 meter folded dipole I added a 12 meter folded dipole in tandem. I also had to add another coax feedline and provide another opening in my cable entry box to the shack. Everything had worked out fine, so far!

When we were given permission to operate the 17 meter band, I hastily threw up a 17 meter dipole between two smaller trees and had a ball trying to work all states as fast as I could. The WARC bands seemed to be pretty good ones. Of course, I had to play games with another transmission line and the subsequent switching arrangements in the shack. Then I got curious about 30 meters, but the backyard was getting to look like a power sub-station with all the wires strung between the trees and feedlines hanging down. The more I looked at what I had and the more I thought about it, the more I came to the conclusion "enough already."

The concept of multiple-dipole antennas has been around for quite some time. The one I have constructed to solve my particular problems of too many separate antennas and too many feedlines came from an antenna book circa 1964.[2] In those days WARC bands did not exist, and the multiple-dipole antenna design was primarily for 40, 20, 15, and 10 meters. The antenna I have constructed, and am using quite successfully, has been designed for 40 and WARC. The beauty of it is that only one

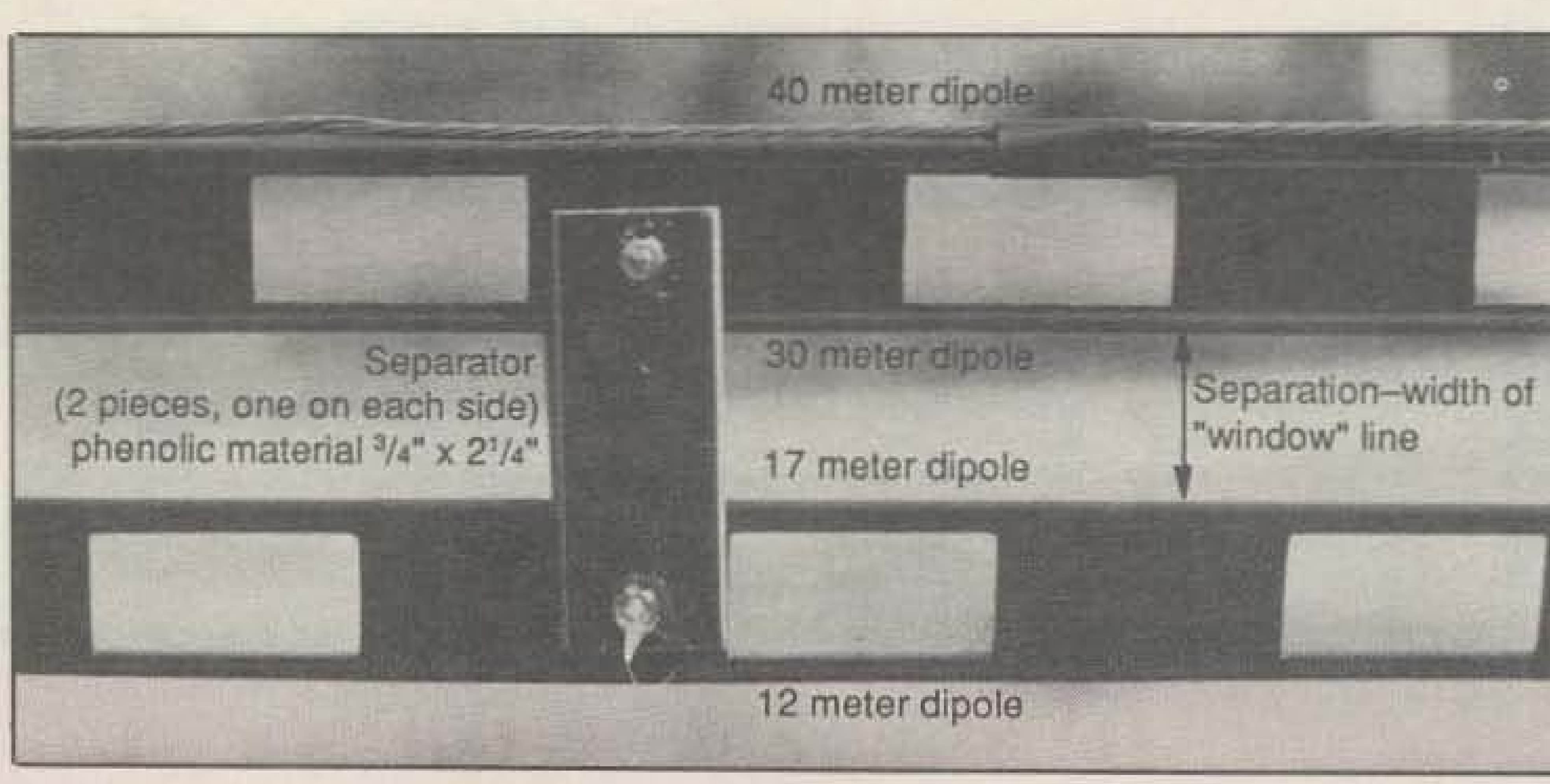

Photo 2– A section of the multi-band dipole antenna showing a separator.

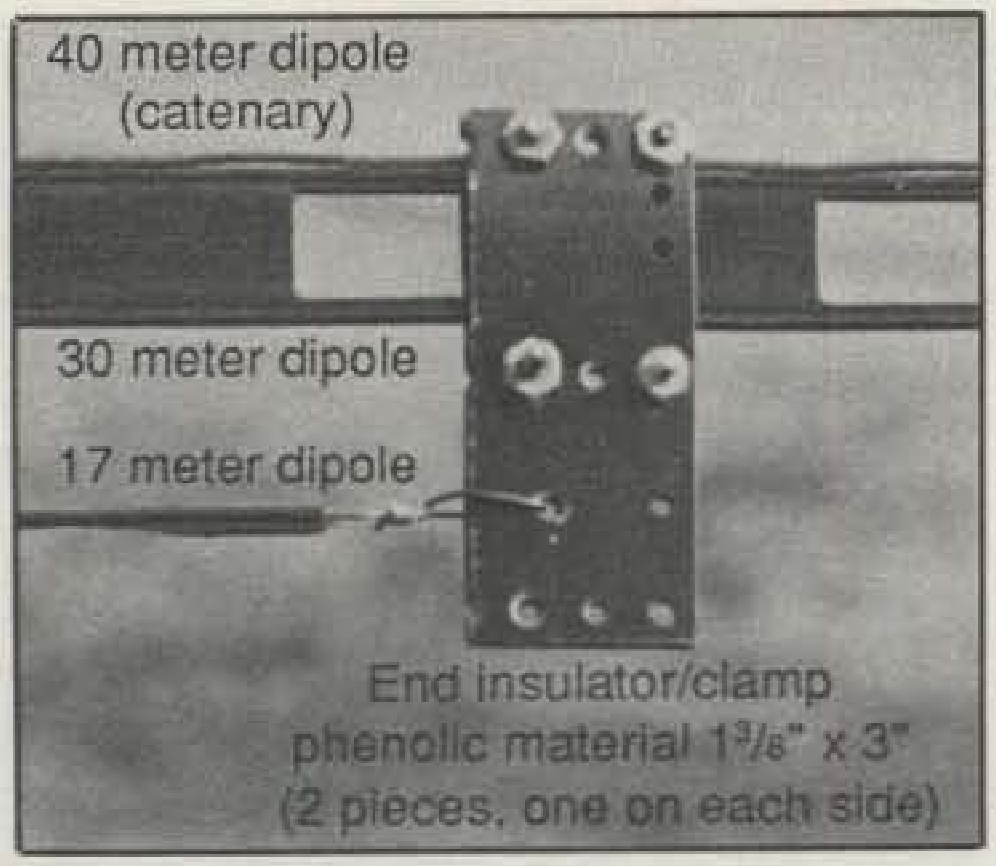

Photo 3– Detailed shot of the end insulator/clamp for the 17 meter dipole.

feedline is required, and consequently you have four bands at your disposal in the shack without having to switch anything except your transceiver's band switch, if it has one! If you can have a 20, 15, and 10 meter beam using only one feedline, why not another system serving four bands or more with one feedline?

The materials required for the 40 plus WARC multiple-dipole are quite inexpensive. Most of the material, with the possible exception of the wire, can be found in the average junk box.

I constructed several types of multiple-dipoles for 40, 30, 17, and 12 meters to learn something about the characteristics of this type of antenna, and some of what I learned was quite surprising. First of all, there is interaction between the dipoles, but the effect of the other dipoles on the feedpoint impedance of the particular dipole being used is minimal.

Two different types of construction are shown in figs. 1 and 2. Either type will perform satisfactorily, although physical dimensions are somewhat different. Both construction techniques make use of a main 40 meter catenary for supporting the dipoles for 30, 17, and 12 meters. The positioning of separators or insulators/spreaders is shown in figs. 1 and 2. Photos 1 through 4 should provide sufficient details for the prospective constructor to do a reasonable job of duplicating either of the two antennas.

Photos 1 through 3 show constructional details for the multiple-dipole antenna using 450 ohm window line. The center anchor block was made of 2 blocks of ¼ inch thick mycalex glued together with contact cement to provide sufficient strengths for the pull exerted when the antenna is stretched out. Polystyrene, polyethylene, or other low-loss material could be used, but bear in mind that certain materials can be adversely affected by sunlight. The piece of masking tape shown across the block is not required! I used it to hold the wire assembly still for soldering and then I forgot to remove it before the photo was taken. The separators shown help to keep

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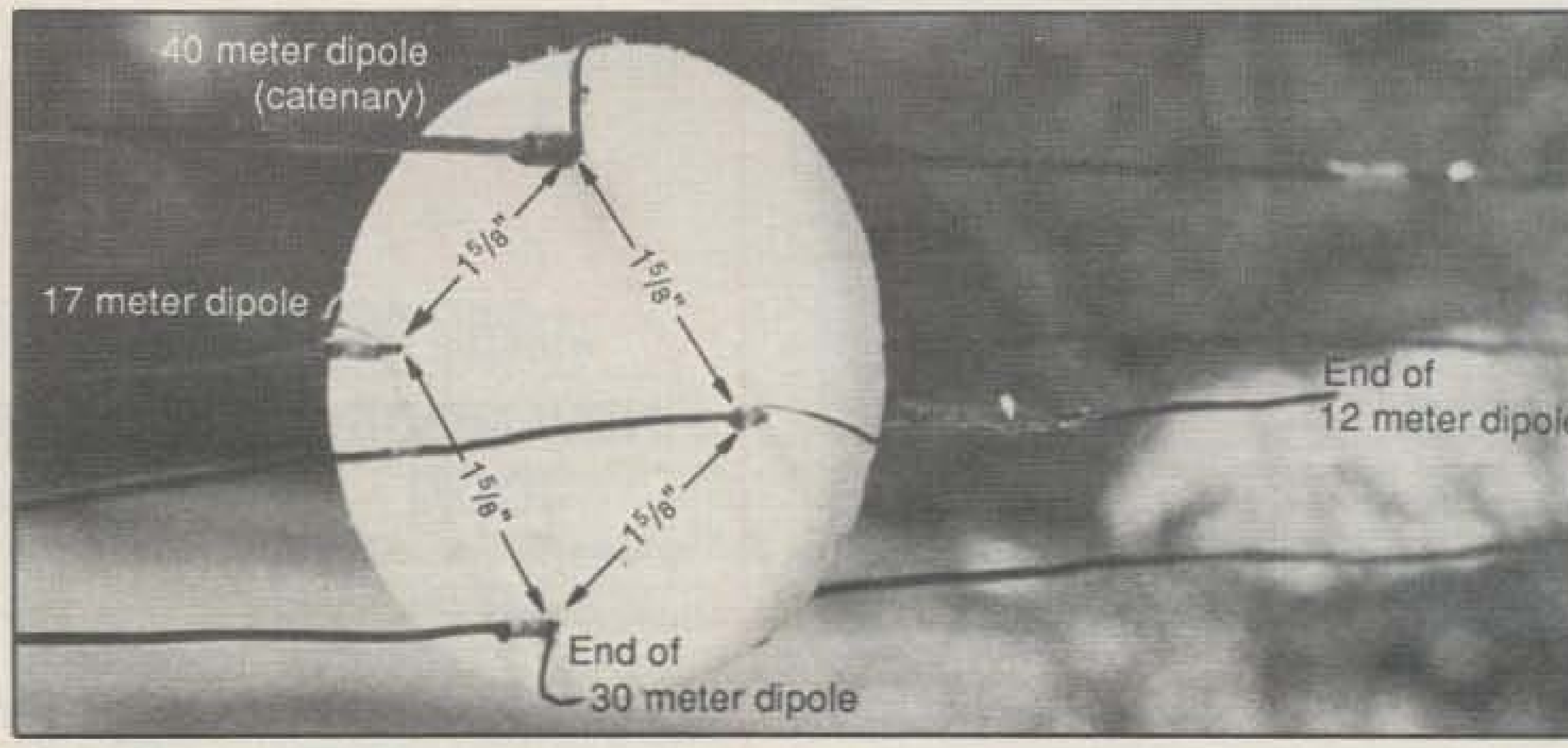

Photo 4– In the all-wire version a polystyrene disc insulator/spreader is used.

Freq. (MHz)	450 ohm "Window Line"		
	Length of Each Half		
	Meters	Feet	Inches
7.15	9.98	32	9
10.125	6.725	22	¾
18.108	3.79	12	5¼
24.940	2.86	9	4¾

Freq. (MHz)	Individual Wire Dipoles		
	Length of Each Half		
	Meters	Feet	Inches
7.15	9.98	32	9
10.125	7.29	23	11⅛
18.108	4.07	13	4½
24.940	2.94	9	7¾

Table I– Dimensions for multi-band dipole antennas.

the two sections of window line separated by the width of the window line. The material is phenolic, about $\frac{1}{16}$ inch thick, held together with small screws. One such separator is shown in photo 2. Photo 3 shows an end insulator/clamp supporting the end of the 17 meter dipole. The separators and end insulator/clamps should be made from low-loss material.

A partial view of the all-wire multiple-dipole with a disc insulator/spreader is shown in photo 4. The disc wafer was cut from 3 inch diameter polyethylene stock obtained from a local plastics outfit. It is $\frac{3}{8}$ inch thick; however, the thickness is not a magical value. Solid plastic coasters, used under drinking glasses, could probably be used, but the thicker material provides greater rigidity for separating the individual wires. Note that small tie wires were used to hold the dipole wires in place.

Initially, the dipole lengths were determined by the usual formula of 468/f MHz. However, except perhaps for the 40 meter dipole, some pruning may be required after the multiple-dipole antenna is raised into operating position and tested. The lengths shown in Table I are my final lengths, but yours may be slightly different, depending on height above ground, surrounding objects, and other factors. I was fully expecting that the final lengths of the three higher frequency dipoles would be shorter than what was determined from the formula due to the dielectric of the window line. The dimensions for 30 and 17 meters were somewhat shorter than formula length, but the 12 meter length was just about the same. Different spacing between the two sections of window lines would more than likely affect the final lengths of the various dipoles. I was surprised to find that all of the lengths of the higher frequency dipoles of the all-wire multiple-dipole antenna were somewhat longer than the calculated value.

If you find that some pruning of dipole lengths is necessary, work from the lowest frequency to the highest, since lengthening or shortening the lower frequency elements has more of an effect on the higher frequency elements than vice-versa. Lengthening or shortening the dipoles is easy to do, but remember to change each

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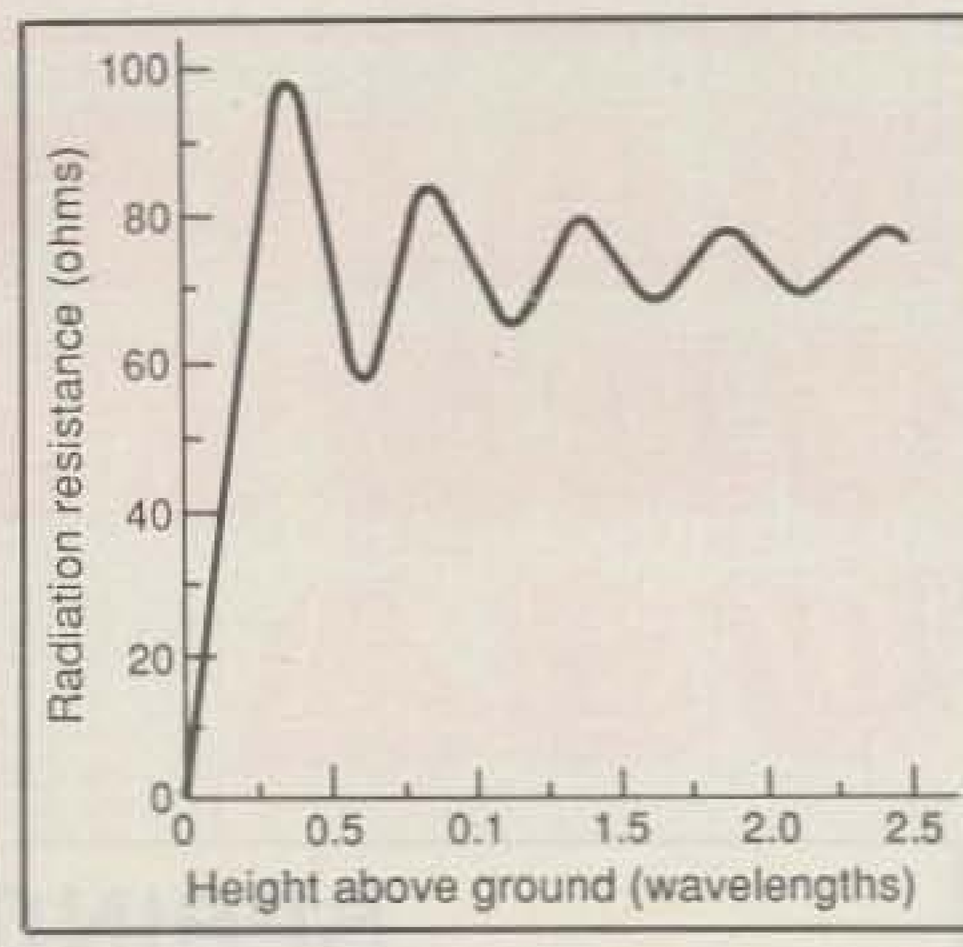

Fig. 3– Plot of radiation resistance of a half-wave dipole at various heights above ground.

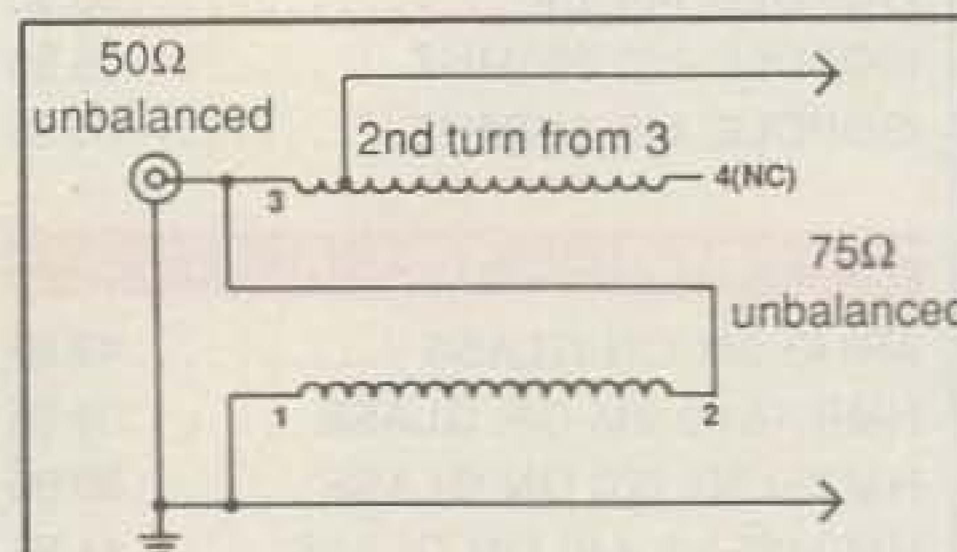

Fig. 4– A 1:1.5 unbalanced-to-unbalanced (unun) transformer.

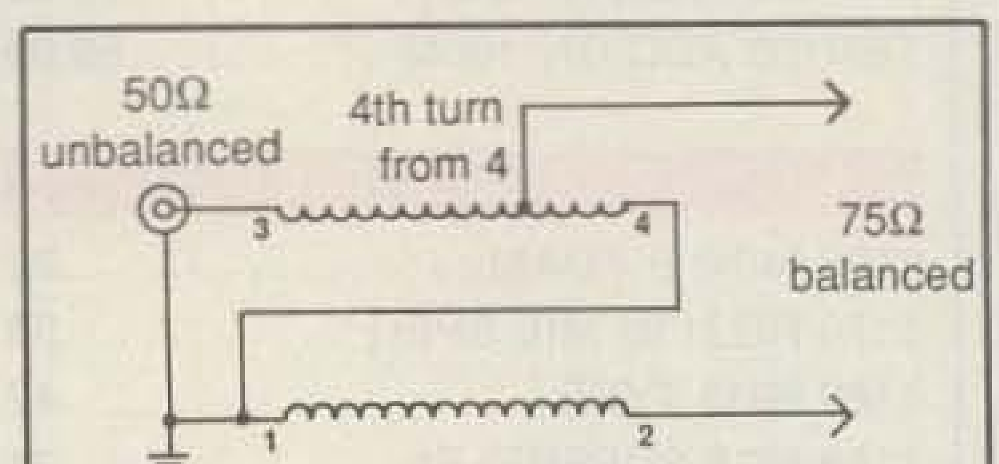

Fig. 5– A 1:1.5 balun.

half of the dipole by the same amount.

Fig. 3 shows what variations in radiation resistance you can expect when using a half-wave horizontal antenna at different heights above perfectly conducting ground. It might appear that with four dipoles all connected together at the center, a big matching problem could be encountered. However, such was not the case in my installation. My system is 45 feet above the ground level with a house full of wiring and plumbing underneath it. I found that the feedpoint impedance ran between 50 and 85 ohms for the four bands of operation. You could use a 75 ohm coax feed line or 70 ohm twin lead to feed the

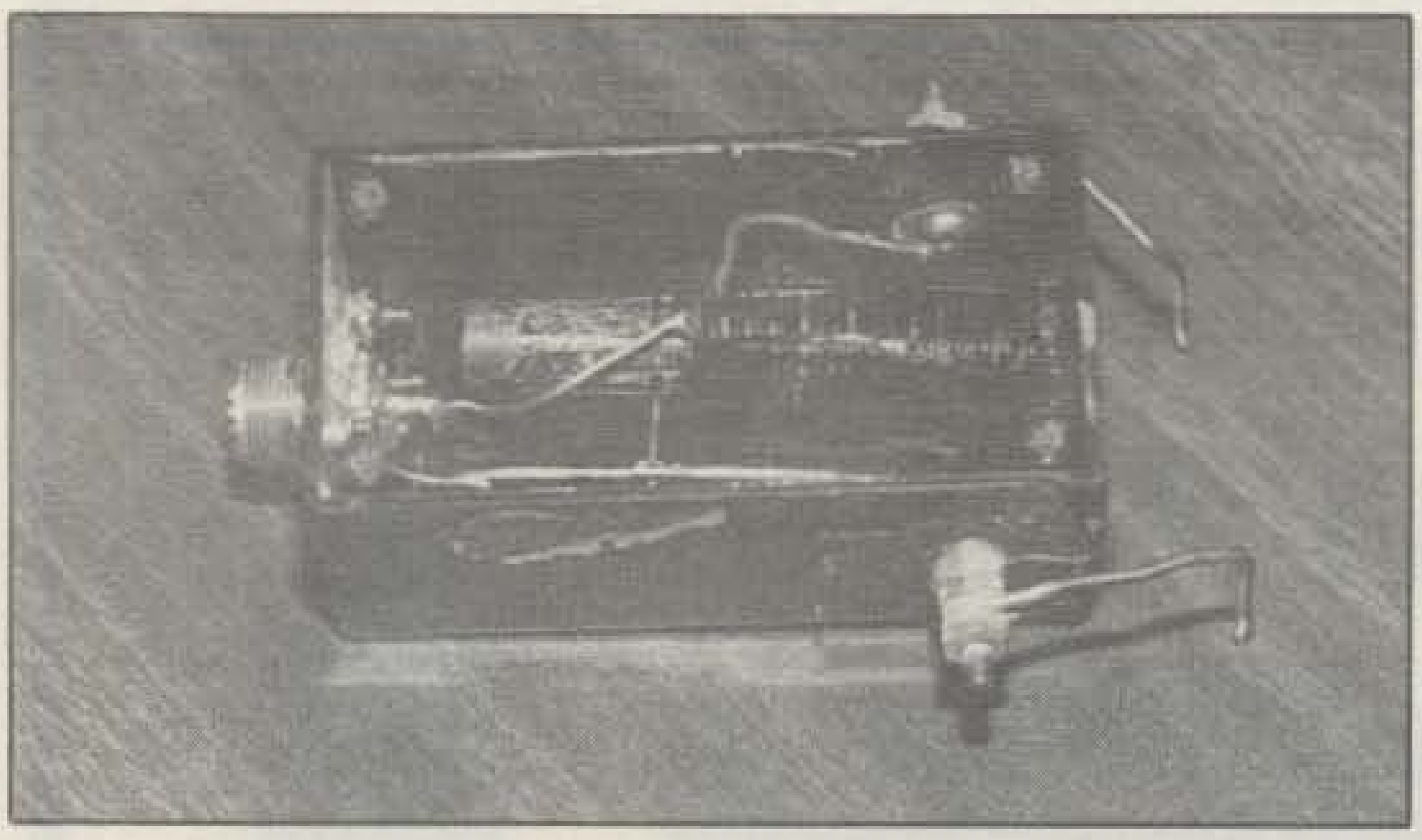

Photo 5– The unbalanced 50 ohm to unbalanced 75 ohm matching transformer.

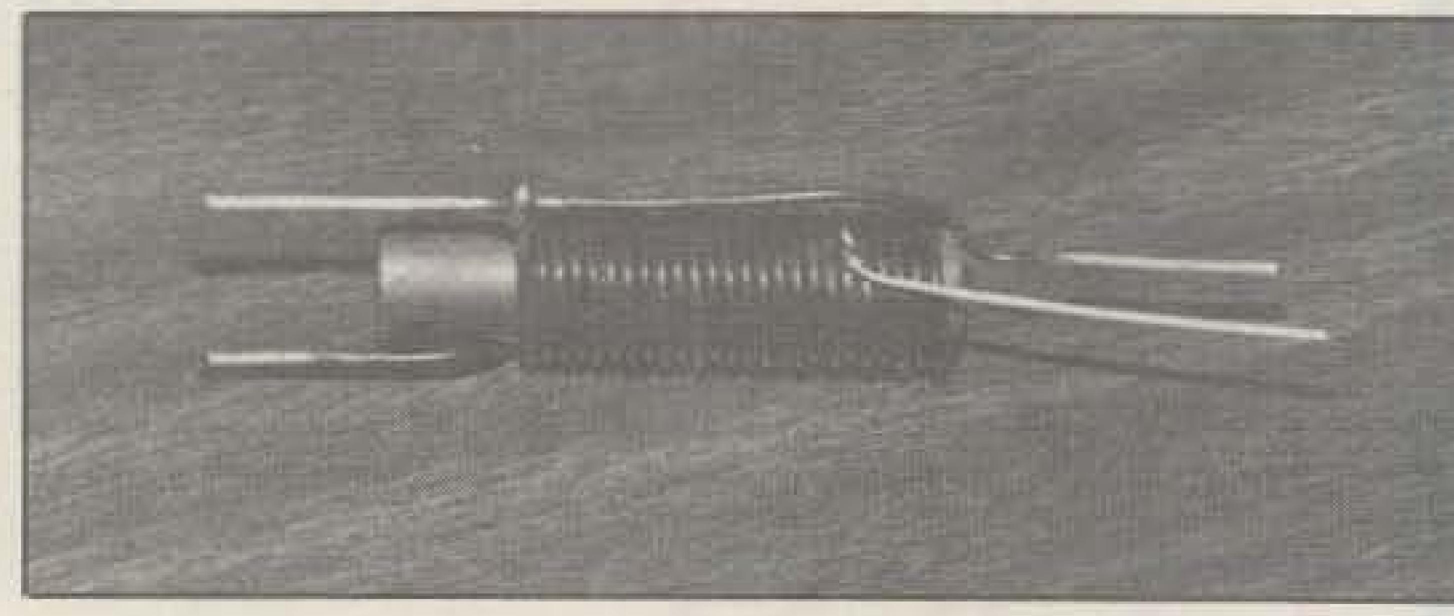

Photo 6– The unbalanced 50 ohm to balanced 75 ohm matching transformer.

antenna, but if you do not want different varieties of feedlines with different impedances around the shack, then use a simple 1:1.5 balun and 50 ohm coax and that should work just fine.

To determine the feedpoint impedances of the multiple-dipole antenna at the various frequencies shown in Table I, I used a modified SWR bridge remotely controlled and connected at the feedpoint of the multiple-dipole.[3] By using this arrangement I was also able to determine the resonant frequency of each dipole without resorting to the use of sections of transmission line as suggested by numerous experimenters. Grid dipping an antenna in mid-air to check resonance can be a problem, and doing it at waist level, near the ground, is a waste of time!

The matching arrangements can be accomplished through the use of either an unbalanced-to-unbalanced transformer or balun as shown in figs. 4 and 5.[4] Photo 5 shows the transformer of fig. 4, which while looking a bit messy from experimenting, worked well and provided the 1:1.5 transformation covering 7 through 25 MHz. Photo 6 shows the balun of fig. 5 which is currently in use, and hopefully proves that I can wind a neat coil if needed! Photo 7 shows the balun enclosure and the method of connecting the balun to the feedpoint of the multiple-dipole antenna.

While I might be accused of having "low-SWR mania"[5], I feel that time spent in impedance matching at the feedpoint of the dipoles is well worth it. It means not having to have an antenna tuner in the shack to have to adjust and switch simply because I didn't know how to determine the feedpoint impedance of my antenna or because I was too lazy to do the job.

As constructed, the 40 plus WARC multiple-dipole antenna presents a very desirable load to my transceiver on 40, 30, 17, and 12 meters from one end of the band to the other. It has resulted in my spending more time on the WARC bands, and I hope that it will do the same for you and help to keep these bands populated. As for 40 meters, there aren't too many antennas that can perform much better than a good old dipole considering the price and ease of construction!

Good luck with your 40 plus WARC multiple-dipole!

Footnotes

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2. *The ARRL Antenna Book*, Tenth Edition, ARRL.
3. Genaille, Richard A., "A Remotely Controlled Bridge For Impedance Matching," *CQ*, August 1991.
4. Sevick, Jerry, *Transmission Line Transformers*, ARRL, 1990.
5. Maxwell, M. Walter, *Reflections, Transmission Lines and Antennas*, ARRL, 1990.

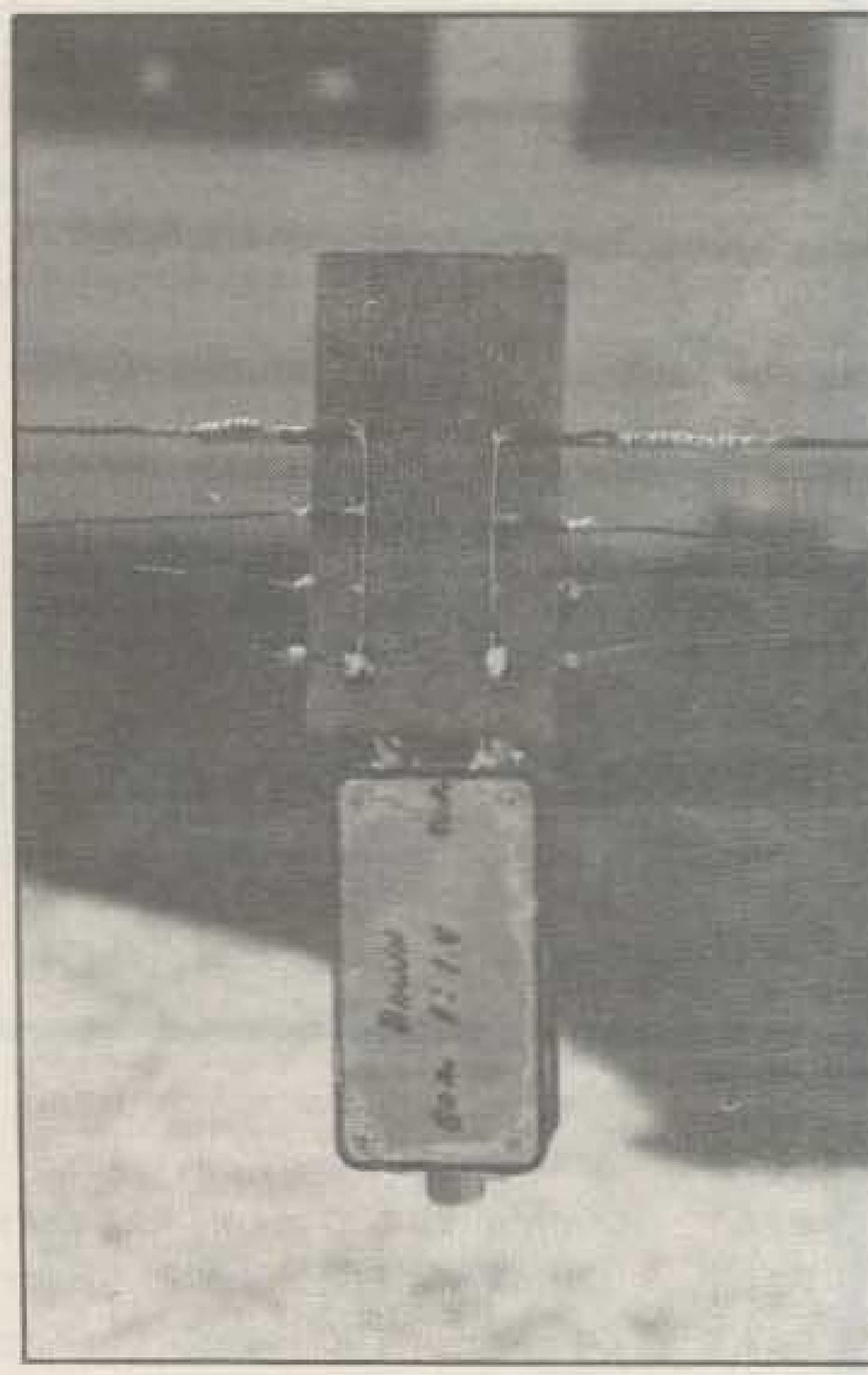

Photo 7– The center insulator for the all-wire version of the 40 plus WARC antenna. This view shows the matching transformer connections. The transformer is housed in a 1⅝" × 2⅝" × 4" project box (Radio Shack 270-231).

Suggested Sources For Material

Wire: Certified Communications, "The Wire," Landrum, South Carolina. CQ51 450 ohm 18 AWG Cu-Clad, Poly-Clad "Window Line." 541-CQ 14 AWG HDS, 7 Strand Hard Drawn Copper. See your local motor rewinding shop for 16 AWG copper wire.

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