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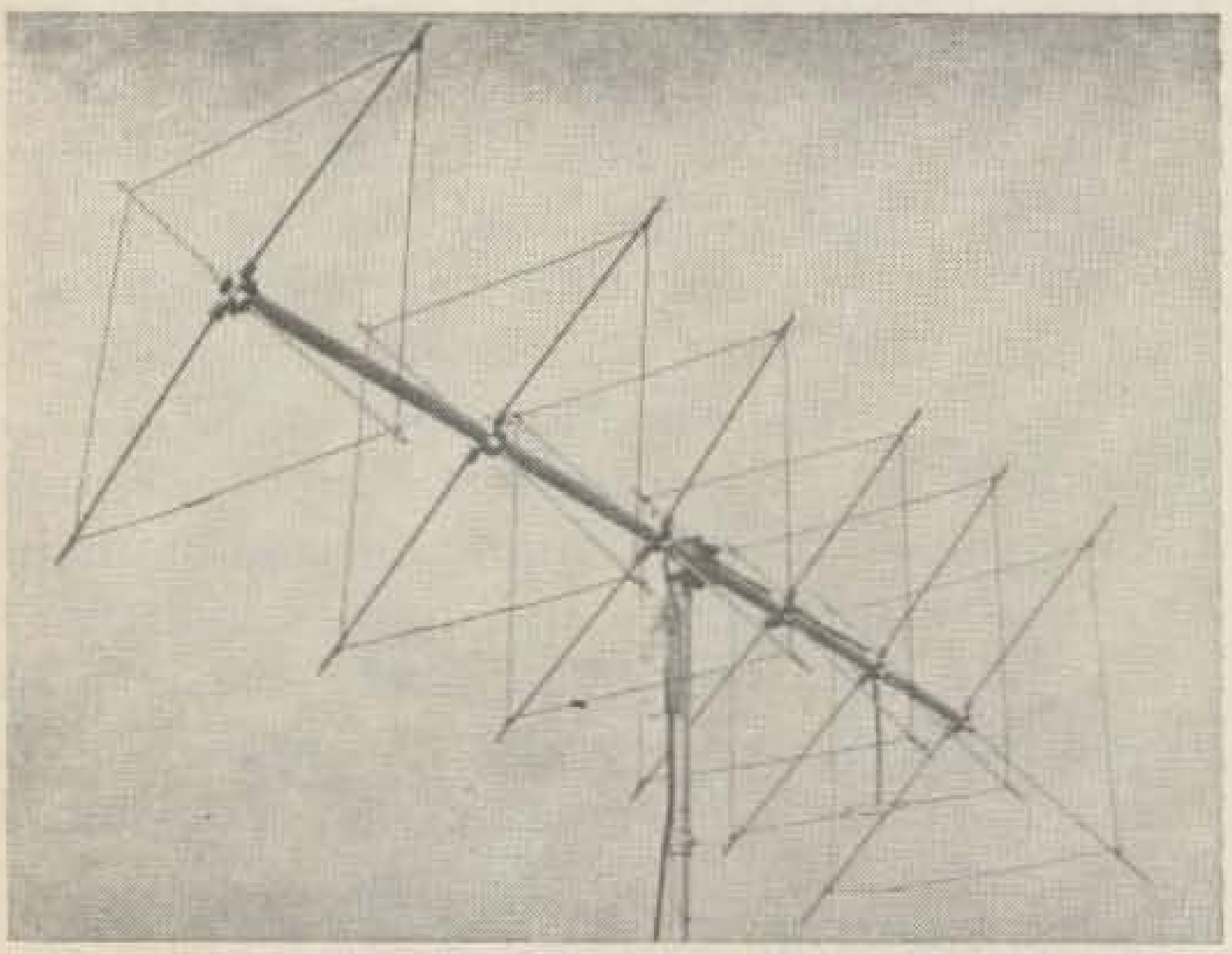
Experiments with Quad Antennas

Over the past few years I have constructed a number of antennas, largely based on data collected from the various ham magazines. In most cases however, I wasn't completely satisfied with the results; also, the dimensions varied from one article to another and the gain figures given by the authors seemed to be somewhat excessive.

I decided that the only way I was going to get a proper answer was to conduct a little basic research. With the few instruments that I have at my disposal, and a lot of cut and try, I think I can now provide some useful information on the construction of cubical quad antennas.

My first experimental quad antenna was designed for 145 MHz. This antenna was designed in such a way that I could vary the dimensions, spacing and height from the ground. Since I didn't have a lot of exotic antenna testing equipment, I made do with what I had. The resonant frequency of the elements was found with the aid of a grid-dipper and a communications receiver; the front-to-back ratio, minimum radiation angle and attenuation off the sides of the antenna were determined with three separate field strength meters. In addition, an antennascope was used to measure the input impedance to the quad and an SWR meter used to check the match.



The six element quad for two meters is centered on 145 MHz. This antenna has a boom length of 144.5 inches, just a hair over twelve feet, and has provided excellent results on two meters.

With this simple test equipment I closely examined a three element quad for two meters and the effects of element spacing, height above ground and various elements dimensions. To insure that the results were not just casual but repititive, the tests were conducted over a three month period and have been repeated three times; in each case the entire antenna was completely disassembled and re-assembled. After I had completed all the tests on the 145 MHz quad, I used the experimental data to develop a three element three band quad for 14, 21 and 28 MHz.

Obviously, to construct an antenna for three different bands, I had to make compromises to obtain optimum results on all three bands. During the course of my experimentation I was able to establish that when a reflector was adjusted by means of a stub on the lower part of the square, the antenna became asymmetric and lost considerable gain in the horizontal plane. Therefore, two stubs should be used to adjust the reflector and other parasitic elements; one on the upper side of the reflector and one on the lower side. In addition, these two stubs should be adjusted together. This solution practically precludes adjusting an antenna for 14, 21 and 28 MHz, so I completely removed the stubs and made all the sides of the quad perfectly symmetrical. I also found in the course of my experiments that the alignment between the wires of the various elements is very important.

After completing the experiments with the model antennas, I built a full size three element quad for 14, 21 and 28 Mhz. This antenna has been placed on a support projecting 5 meters (about 16½ feet) from the roof of my house. This antenna is fed with a single transmission line; two relays mounted in a water-tight box switch in the proper radiator when I change bands. It is highly advisable to use a ¼ wavelength of transmission line (or an odd multiple) between the relay switch box and the radia-

Quad Dimensions

Band	10 Meters		15 Meters		20 Meters		2 Meters	
			Total Length of Wire used in each element					
Reflector	1079 cm	(424.8 in)	1470 cm	(578.7 in)	2204 cm	(867.7 in)	216 cm	(85.0 in)
Radiator	1029 cm	(405.1 in)	1403 cm	(552.4 in)	2103 cm	(828.0 in)	206 cm	(81.1 in)
Director	978 cm	(385.0 in)	1333 cm	(524.8 in)	1997 cm	(786.2 in)	197 cm	(77.6 in)

Spacing between elements: on the tri-band beam for 10, 15 and 19, and 20, the director is spaced 260 cm (102.4 in) from the radiator; the reflector is spaced 230 cm (90.6 in) from the radiator. For the six element two meter quad all spacings are in reference to the radiator and are as follows: reflector, 31 cm (12.2 in); 1st director, 29 cm (11.4 in); 2nd director, 63 cm (24.8 in); 3rd director, 96 cm (37.8 in); and 4th director, 148 cm (58.3 in).

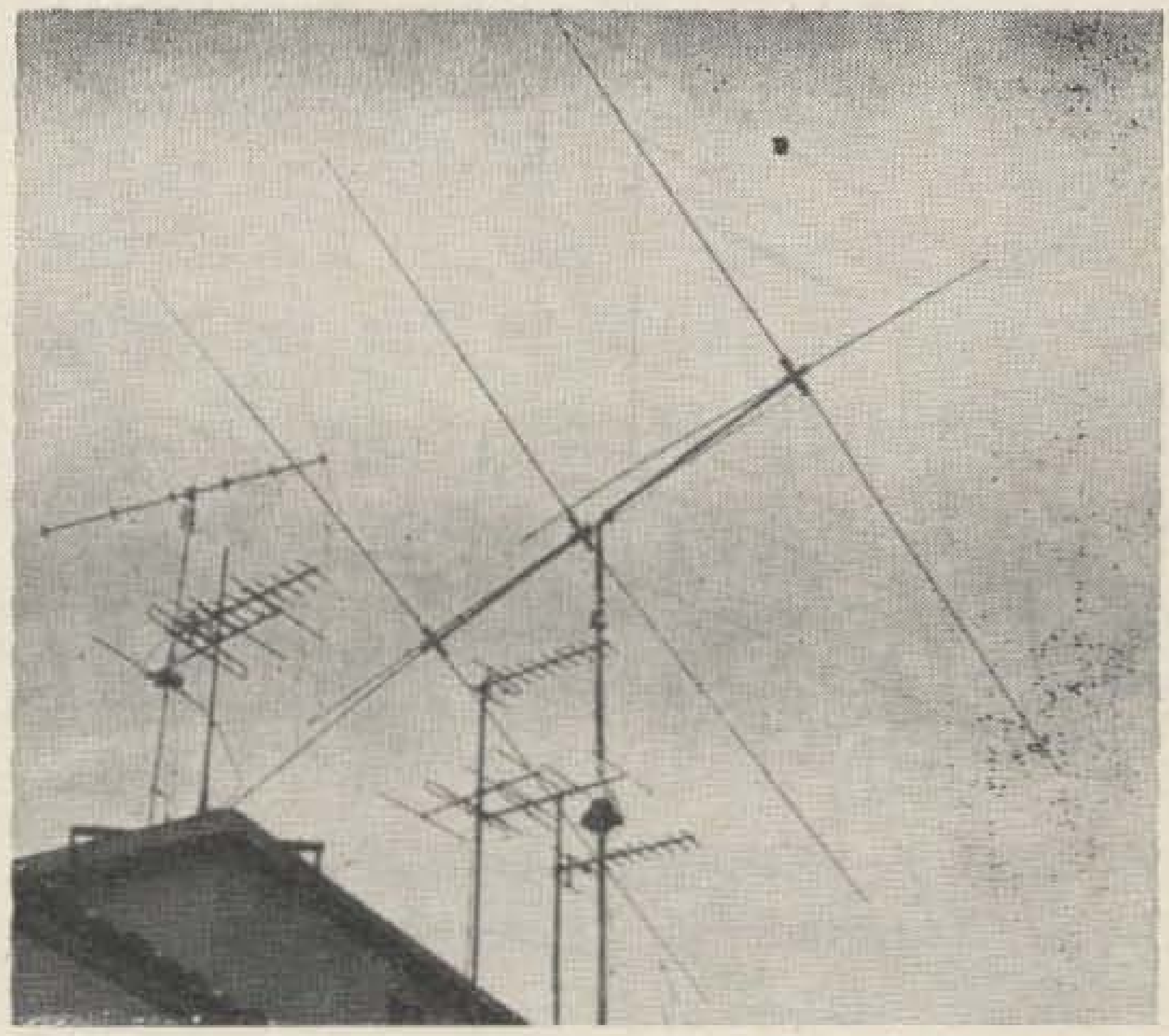
tor element. You definitely should *not* tie the three radiator squares together to facilitate feeding by a single transmission line; the gain and directivity are completely destroyed.

Mechanically the beam was constructed by using a boom of extra-light steel tubing on which three cast aluminum cross-pieces are threaded. Bamboo poles were used to support the wires. At the points where the wire squares are fixed, stainless steel springs have been mounted to keep the wires taut and in alignment without subjecting the bamboo supports to flexing. These springs also compensate for the lack of symmetry of the poles after they are mounted on the boom. After the wires and stainless steel springs were mounted, all the bamboo poles were given a coat of protective paint.

Where the poles are attached to the cross-arms, a small sheet of thin rubber 6 mm thick (about ¼ inch) has been inserted to make the joint more elastic. The poles are then fixed in place with galvanized U-bolts. The preparation of the wire squares requires the utmost in accuracy; the data shown in the following tables should be followed as closely as possible. The easiest way to accomplish this is to unwind the wire, measure a length 20 cm long (8 inches), form a small eyelet in the wire and solder it so it provides a reference point for the subsequent eyelet. Each side of the square is carefully measured until the whole square has been made; the first length of wire is used to close the last side with a solder joint. Close attention to this procedure greatly facilitates the final assembly, and permits easy installation of the eyelets at the corners over the stainless steel springs. The same method may be used for the construction of a 144 MHz quad, but for the two meter version the bamboo should be replaced with a material that has better rf characteristics.

The results obtained with this antenna are best illustrated by comparing it to a multiband commercial unit. The front-to-back ratio is not maximized because of the compromises made in dimensions to permit optimum operation on three bands. However, on 20 meters the front-to-back ratio is on the order of 22 dB. The vertical angle of radiation appears to be lower than that of a two element quad, but unfortunately, comparative tests are difficult to evaluate in terms of radiation angle and front-to-side ratios. The actual operating results have been excellent; with only 16 watts input on 14, 21 and 28 MHz, I have had excellent results working DX stations.

I have also been extremely pleased with the results obtained with the six element two meter quad; this antenna has consistently out-performed large commercial antennas installed by local amateurs.



The three element quad for 10, 15 and 20 meters. The SWR on all bands is less than 1.5:1, even at the band edges. On 14.00 and 14.35 MHz for example, the SWR is 1.4:1, at 14.18 MHz it is 1.2:1; at 21.00 and 21.45, the SWR is 1.2:1, at 21.23 it is 1.1:1; and on 28.2 and 29.5 the SWR is 1.4:1, at 28.8 it is 1.2:1. SWR checks with both Heathkit and Jones Micromatch bridges provided almost identical results.

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