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Seven Elements on Twenty

Here's a high gain, low cost beam that will really help you get out on twenty meters. Why not join the big boys?

In antenna design, as in boxing, it is true to say "A good big 'un can beat a good little 'un". Tuning across the favorite DX band, 14MHz, proves this axiom again and again as we hear the choice DX returning to the fellows with the big beams mounted on high towers. However, the bigger they are the more they cost, and even though kind neighbors may not object, the financial strain does not allow the average ham the luxury of a big antenna. The following description of my antenna is to give some idea of a low cost approach to a large Yagi design on 14 MHz.

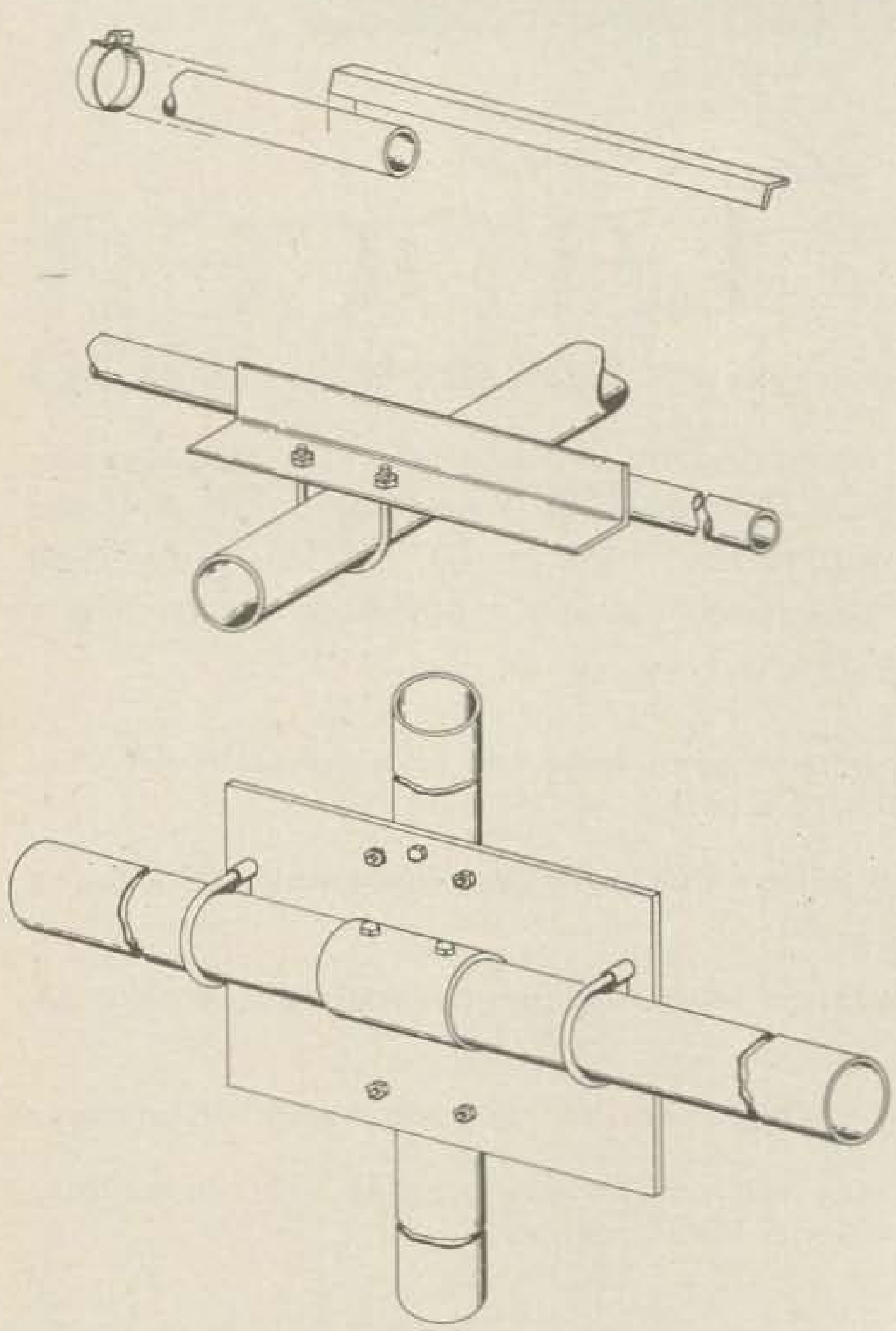


Fig. 1. Details of three parts of the antenna. From the top: Addition of extensions to the ends of the reflector for tuning. Element attachment to the boom. Attachment of the boom to the mast.

The first consideration is the wind load on a large structure—how strong must the beam be to withstand winds to 60 mph? Two approaches were considered. First, a rigid boom using a triangular aluminum tower. Second, a tubular boom with a degree of flexibility to "ride" wind gusts. It was decided to follow the second approach using relatively small diameter tubing, with braces to take the vertical load of the elements.

Sixty feet of boom was selected as a good compromise between cost and performance. For the operator who wishes wide band operation between CW and phone this boom length will allow ¼ wave spacing with five elements. For the phone or the CW enthusiast more elements can be added to give a narrower beam width for better QRM rejection on receive, and a little more gain on transmit. As my antenna was to be used mainly on phone SSB, a center frequency of 14.270 MHz was chosen with seven elements at .15 wave-length, approximately 10 feet spacing.

A visit to the local electrical store produced 2 inch I.D. conduit with .125 inch wall. Two 10 feet lengths were purchased, and a piece cut off each, one foot long, to be used as a coupling between boom sections which are 2 inches O.D. Four lengths of alloy tubing were purchased 2 inch O.D., two at 12 feet, two at 9 feet, wall thickness .065 inches.

Now to assemble the boom on the ground. A screw coupling is supplied with the conduit, so the two 9 feet lengths are coupled together, and two 3 inch, ¼ inch D. bolts fitted through the coupling for added me-

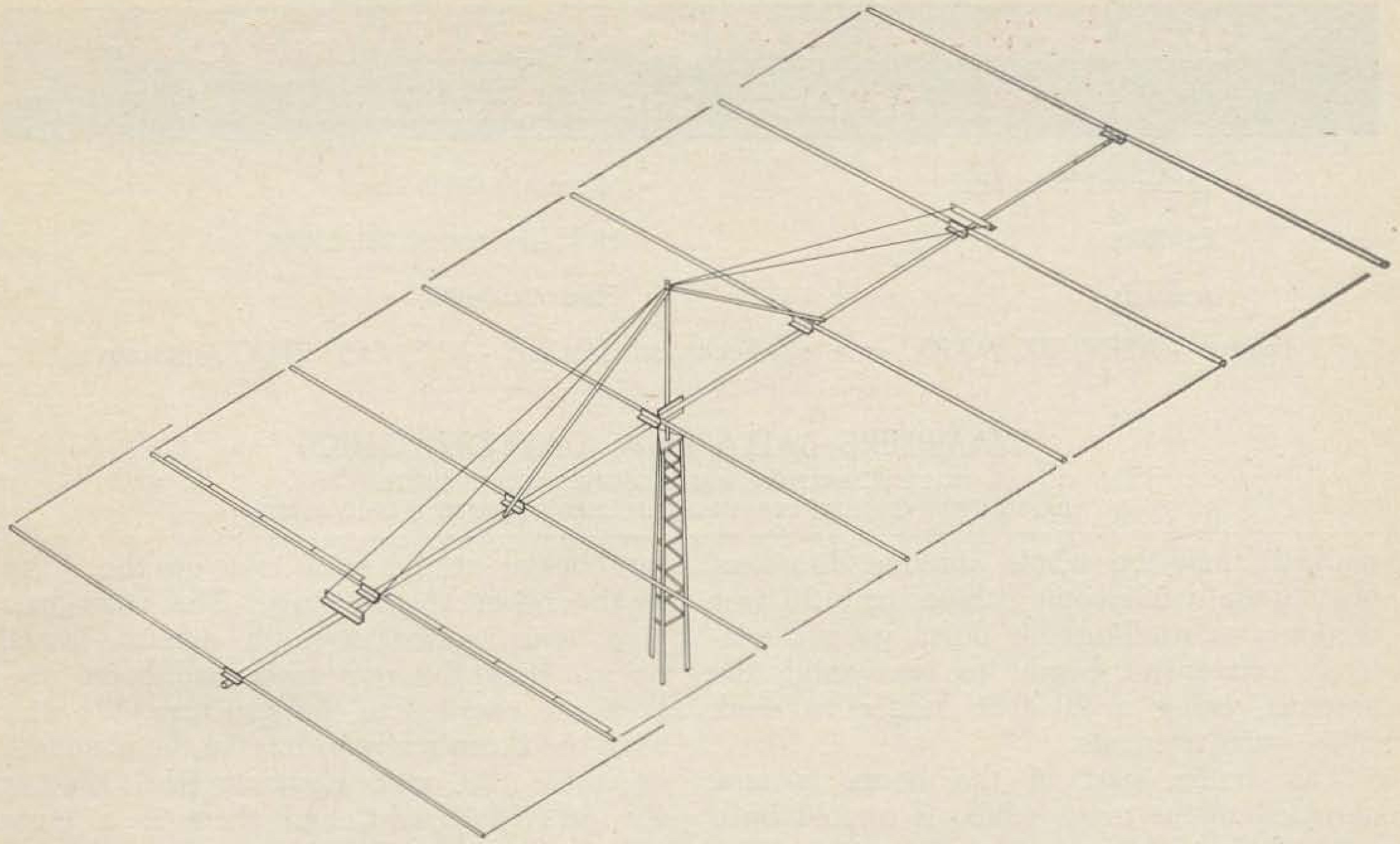


Fig. 2. WA4WWM's seven element twenty-meter beam. Dimensions are given in the text.

chanical security. At either end of the conduit a 3 inch cut is made with a hack saw. Now, a 12 foot length of 2 inch O.D. alloy tubing is inserted in either end of the conduit and a strong joint assured by a 2¼ inch muffler clamp. These muffler clamps are very strong and cost less than 25 cents each. Six at 2 inch and ten at 2¼ inch were bought from the local auto accessory store. The remaining two 9 feet lengths are joined to both ends of the construction using the two one foot sections of conduit which have been previously slotted with the hack saw for 3 inches either side. This coupling is now made tight with two 2¼ inch muffler clamps. We now have a 60 foot boom lying on the ground looking extremely flimsy especially when picked up at the center!

Each element is made from alloy tubing. The center portion is the standard 12 foot of 1 inch O.D., .058 inch wall, with another 12 foot of ⅞ inch O.D. cut into equal parts, inserted at either end, and still another 12 foot length of ¾ inch O.D. tubing cut in half and inserted into the ⅞ inch sections. Now, the beam element is 34 feet long, allowing 6 inches insertion for each joint. Holes were drilled and self-tap screws used to ensure a rigid mechanical coupling. The 34 feet length is sufficient to allow trimming of the driven element and directors, but extra length is required for the reflector, approximately 9 inches at either end. Two strips of aluminum 1 inch x 12 inches were bent to make ½ inch angle and fixed to either end of the reflector with a hose clamp bought from the auto store. This makes an easily adjustable tuning device.

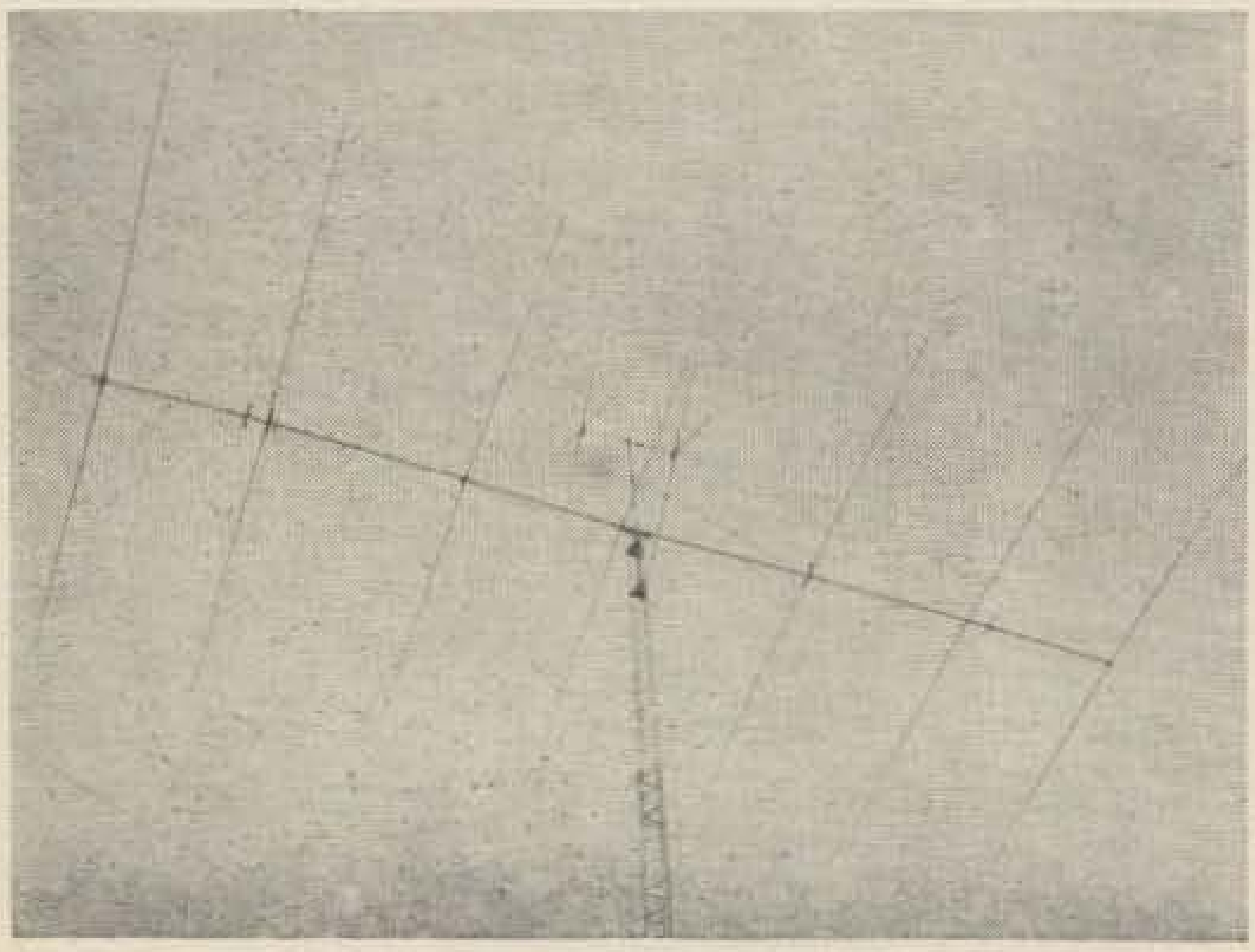
Various methods of feeding the driven element can be used, but, as K200 UHF twin line was available it was decided to try a folded dipole. Aluminum clothes line wire was spaced 4 inches from the driven element and gave a 200 ohm match to the line. A length of 150 feet of line is used at my location, terminating in a ½ wave coax balun to give 50 ohms to the transmitter. The length of the driven element is obtained from the antenna handbook as 465/F in feet when F is in megahertz. Director #1 was found optimum at 445/F, #2, 3, 4, and 5 progressively shorter to make #5 a 430/F. The reflector should be about 490/F but it is highly recommended that this element be tuned for best front to back ratio.

The elements are now attached to the boom by a 12 inch length of 1½ inch alloy angle fixed to the center of the element with two 1½ inch ¼ inch D. bolts, then the angle drilled to take a 2 inch or 2¼ inch muffler clamp to suit the boom, the three inner elements with 2¼ inch clamps, the four outer with 2 inch clamps.

The element positions should now be

marked, then the whole antenna disassembled. I use a telescoping tower with 20 foot sections, so winding this down gave a relatively convenient height to reassemble the antenna, using a 20 foot ladder to work at the outer elements.

The center part of the boom is now mounted to the mast, which is rotated by a rotor 3 feet down inside the tower. The mast is 10 feet long so 7 feet remains above the tower. The boom is mounted to the mast, again with muffler clamps on a ¼ inch steel plate 18 inches by 12 inches. A ⅝ inch hole is drilled through the mast and plate and a bolt used here for added strength. Two 12 feet lengths of ⅞ inch tubing are now used to support the ends of the inner 18 feet from the top of the mast, again using muffler clamps. Next, the two 12 feet lengths of 2 inch tubing are assembled to the conduit as before. The ends of these are now supported by cable from the top of the mast. A 2 foot cross bar of 1½ inch alloy angle was mounted with a muffler clamp and the ends drilled to take the two cables from the mast to either end. Two



A shot of the beam with a small quad over it.

turnbuckles at the mast take up the droop in the boom at this stage. The cross bars give some added strength against lateral forces. Now the remaining two boom sections are coupled to the structure. We now have the boom ready to receive the elements. Assemble the outer elements first, keeping the array balanced, and there is—a seven element beam on a 60 foot boom.

Some remarks on tuning are appropriate. The director lengths quoted are close to the optimum but some trimming of the driven element may be necessary to ensure 200 ohms. It is best to measure this with an antennascope and a 4:1 bolun to read 50 ohms. This is a balanced system, hence the balun. The reflector can be adjusted with the aid of a small oscillator located a few hundred yards away, or by getting a local ham a few miles away to give S-meter readings. The antenna handbooks will supply details.

Finally, a beam of this size helps tremendously in reception, as the half-power bandwidth is 45 degrees. The gain in theory is about 12 db, but signal reports would suggest that this figure is low, especially when optimum conditions suit the vertical angle of radiation. It is highly recommended that a height of at least 70 feet should be used with any beam antenna, especially after the expenditure of time and energy on a large array.

The antenna described has been in use for a year and has withstood winds of 60 mph with no sign of damage. The cost is much lower than the commercial versions available. Some of the ideas in this article may also be of some use in the construction of smaller Yagis at a relatively low cost factor.

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