A Wide-Band, High-Gain Antenna

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The goal of every Amateur so far as an antenna is concerned is to have one that will give a respectable gain; is relatively small in size; can be fed directly by a standard feed-line; is easily constructed without recourse to off-beat materials or parts; is cheap; and will give the same performance, especially input impedance and radiation pattern, over a wide band of frequencies.

Such an antenna is the Log-Periodic, the principles and initial design of which were first investigated by Dr. DuHamel in 1956. Other experimenters followed and one of the designs evolved was the Log-Periodic Dipole. A study of the different types brings the conclusion that his is the most practical design for amateur consideration. Basically, the antenna consists of a number of parallel, linear dipoles arranged side-by-side in a plane. The lengths of the elements, the spacing between them and the dimensions of the boom are all determined from a series of mathematical formulas. Full details on the theory and design can be found in Dr. Carrell's report, *Analysis and Design of the Log-Periodic Dipole Antenna*, and anyone wishing to adapt this design to his own needs should obtain a copy.

The finished antenna

This article will deal with a Log-Periodic Dipole that covers the frequency range of 140-150 mc, having a gain of 10 db over a reference half-wave dipole, and directly fed with 72 ohm coax cable. Over the range, the swr is less than 1.5:1, the E-plane beamwidth is approximately 47° and the H-plane beamwidth 85°. The booms are made from ¾ inch, the elements from ¼ inch aluminum tubing (recommended type 65ST6) and each element is fastened to its boom with a 3 inch TV standoff pipe clamp. There are six dipole elements and Fig. 1 a-d shows the plan of each section and how they are combined into one array. Table I gives the lengths of each element and their spacing from the feed-

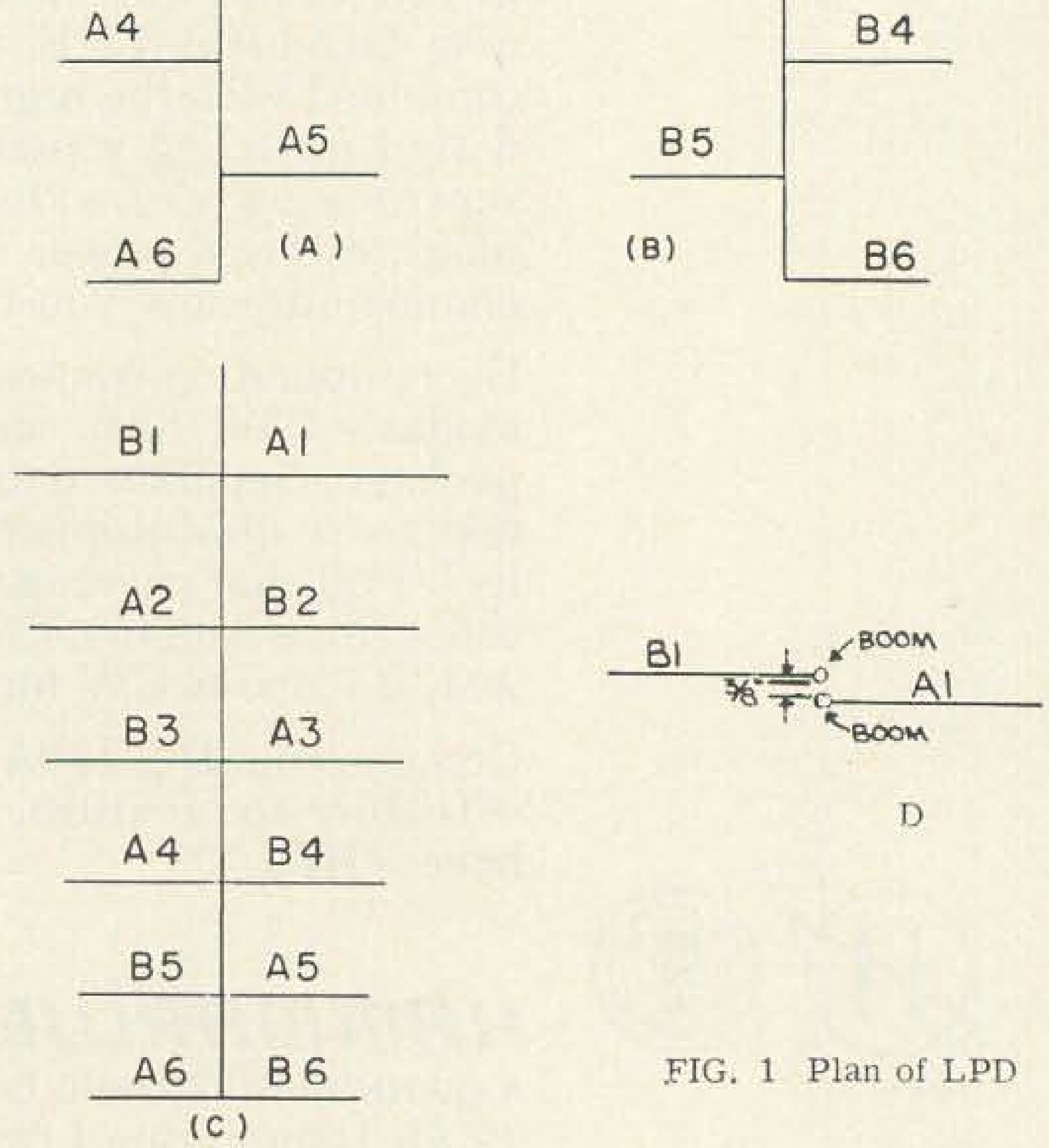


FIG. 1 Plan of LPD

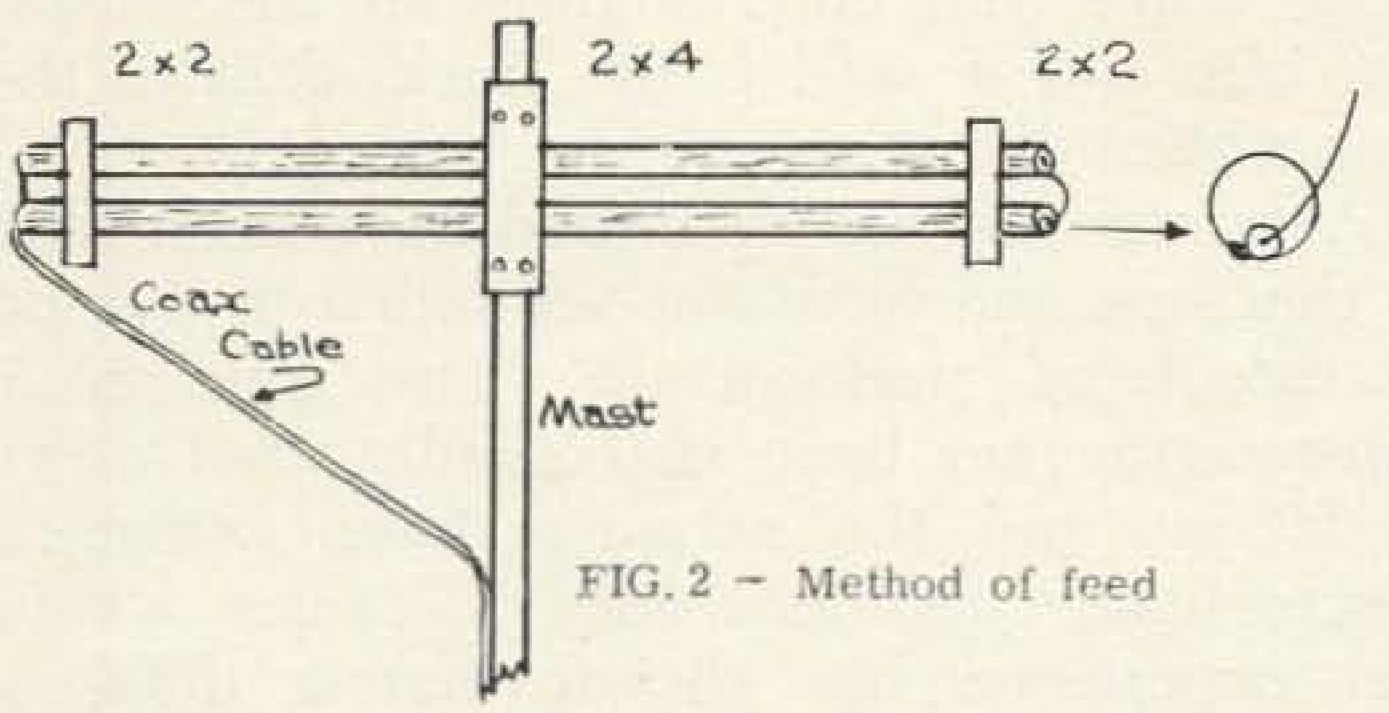


FIG. 2 – Method of feed

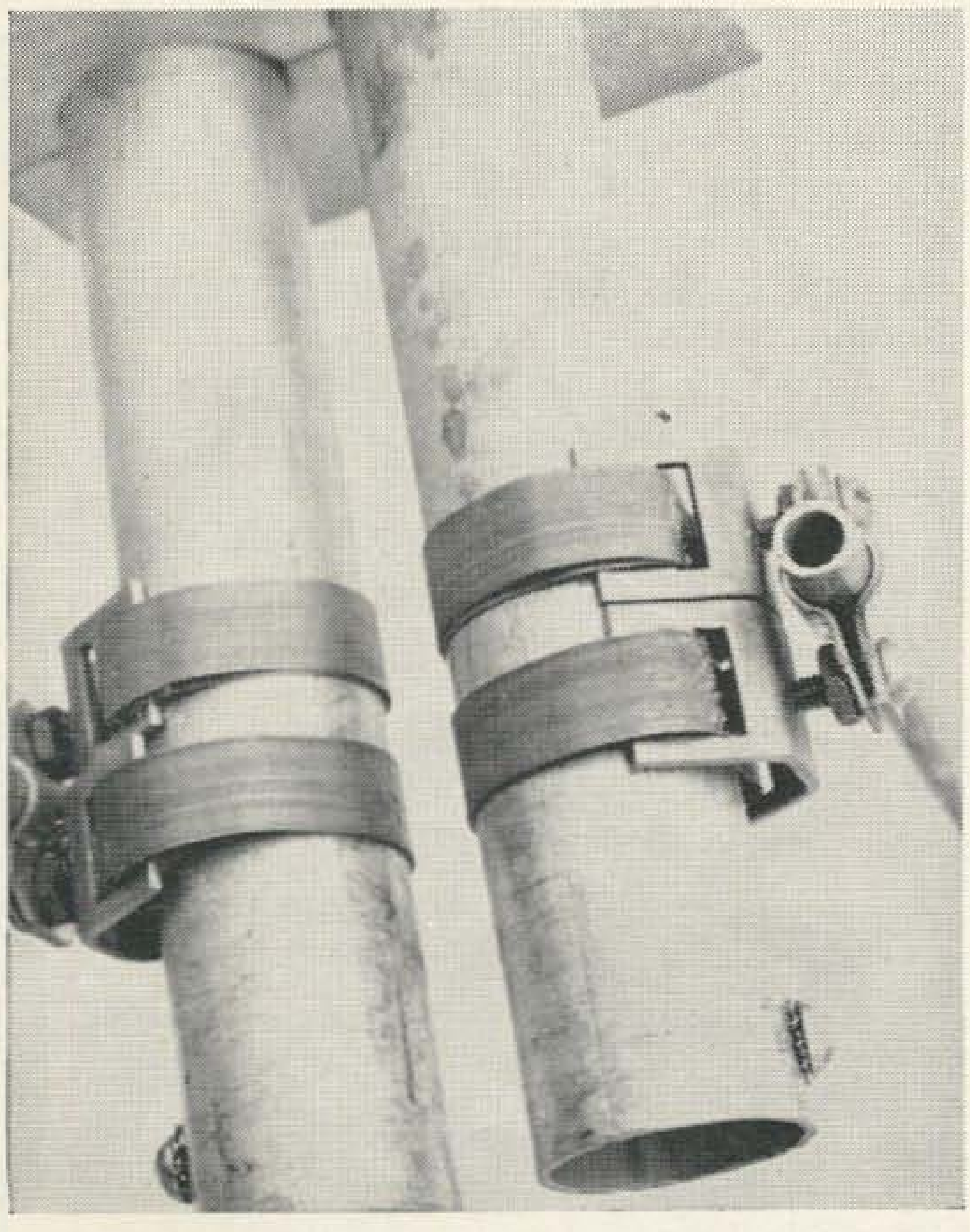
point which is the end with the No. 6 element.

Table I—Dimensions of LPD array

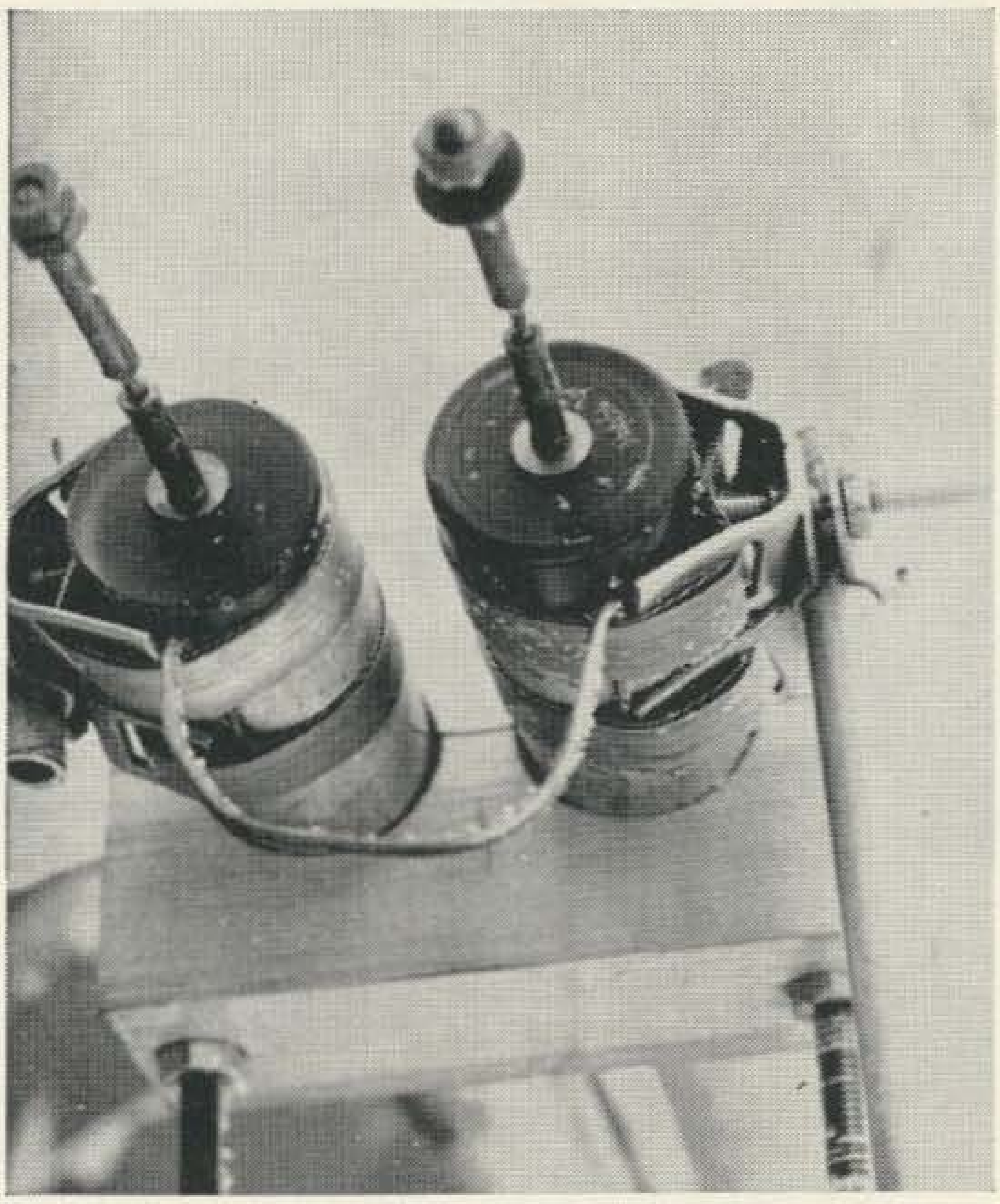
	Length of Element	Spacing from Feed-point
A1 = B1	20.8 in.	60.3 in.
A2 = B2	19.0	46.0
A3 = B3	17.4	33.0
A4 = B4	16.0	21.0
A5 = B5	14.6	10.0
A6 = B6	13.3	0

The boom length is 72 inches so that the boom will project past the last element 11.7 inches. The two booms are shorted together at this point (see Fig. 2).

The antenna is fed with 72 ohm coax cable at the feed-point, with the center conductor attached to one boom and the outer sheath to the other boom. It is recommended that the coax be inserted in the lower boom as shown in Fig. 4 but it can be taped under the lower boom with only a slight decrease in performance.



Our first attempts at securing the elements to the booms were very satisfactory but more costly than the method outlined in the article



Feed point of the antenna and view of the first element and separator block.

The two booms are separated by a distance of ⅜ inches throughout their length. This is done by making two separators and one mounting block. Wood, preferably hardwood, can be used for this. Two pieces of 2 x 2 lumber, 3½ inches long and one piece of 2 x 4 lumber 6 inches long, are required. Two ¾ inch holes are drilled centrally in each block, spaced 1 ⅛ inches center-to-center in the 2 inch face. Two additional ¼ inch holes are made in the blocks so they can be clamped together when sawed apart, as shown in Fig. 3. The boom is clamped by the three blocks, and holes are drilled in the center 2 x 4 block to accommodate two TV mast U-clamps on the 4 inch face. All the wooden parts are then coated with 2 to 3 coats of exterior varnish.

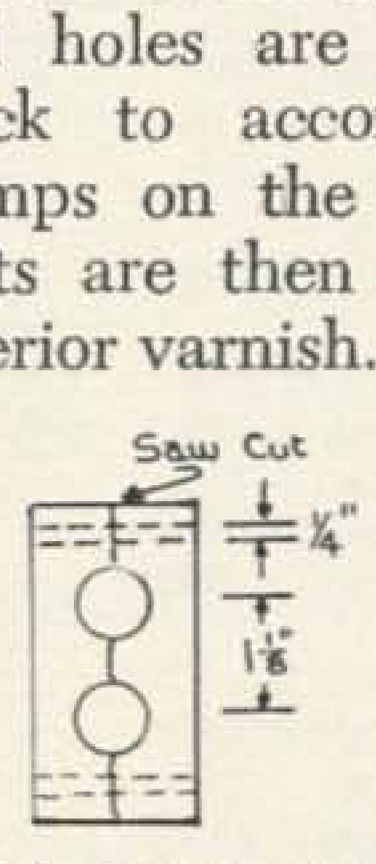


FIG. 3 Separator block

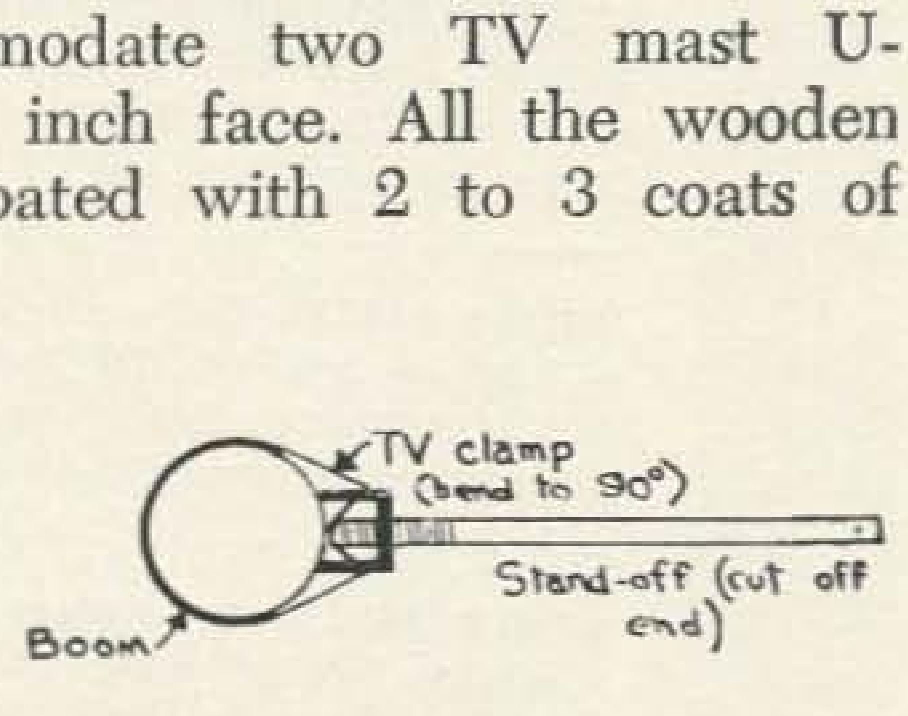


FIG. 4 Attaching Stand-off

The elements are held onto the boom as shown in Fig. 4. The 3 inch TV stand-off is threaded to the pipe clamp on the boom. The end is cut off and the ¼ inch element is put on over the stand-off extension. If 0.035 inch wall tubing is used, you can now thread the tubing over the ½ inch or so of thread that projects past the clamp. If thinner wall is used, crimp the ends slightly so the thread will bite and if wall is too thick, drill to the proper diameter.

Antennas built as described have been built in this area and have not yet failed to live up to calculated performance. The mechanical construction has been successfully used down to 50 mc and the antennas have withstood severe icing conditions and gale force winds. But experience has shown that a different method of clamping tubing to the booms is necessary below this frequency. One approach might be to drill the boom and insert the element through the boom with some suitable method of clamping, but no research has been done as yet in this direction. I have calculated the dimensions of a tri-band beam for operation in the 20, 15, and 10 meter bands, fed with 72 ohm coax, to give a gain of 7 db on all frequencies within the bands with a swr less than 1.5:1. This would be constructed using 1½ inch tubing for the booms—each 20 feet long—and ¾ and ½ inch tubing for the elements with longest dipole element 33.5 feet long.

The Log-Periodic principle, in practice, will give an antenna that is frequency independent over large bandwidths with frequency ratios of 10:1 being easily obtained. One antenna constructed and in use has a gain of 8 db over a frequency range of 50 to 250 mc, a boom length of 10 feet, and is fed with 300 ohm twinlead with an swr of less than 1.5:1. This has been used for amateur operation on the 6, 2, and 1 ¼ meter bands, and for TV (all VHF channels) and FM broadcast reception. Unfortunately it worked too well and is now used as the family's TV antenna!

I wish to thank Dr. Carrell of Collins Radio for his assistance and permission to use certain parts of his reports and the gang in Kingston who rendered invaluable assistance in trying out these designs.

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