A Simple 3 Band 2 Element Beam

BY ED MACKENZIE*, W8NGO

This low cost beam for 20, 15 and 10 meters can produce excellent results due to its method of construction. Each beam built is custom tuned according to the simple instructions and thus provides peak performance. The array, built of TV masts, bamboo and soft drawn copper wire is light and thus presents no special support problems.

FREQUENTLY, the greatest single factor that prevents many amateurs from owning a beam is cost. There is the cost of the antenna itself as well as the cost of a tower support system and rotator. If the antenna is homebrewed a considerable savings can be made and if the homebrewed antenna is light in weight, savings can also be made in the supporting structure and the rotator.

Material Strengths

Aside from direct compression, materials have their greatest strength in tension. A guyed tower or mast can be much lighter and smaller than one which is self-supporting.

The use of antenna members which are either in tension or compression, with a minimum of bending moments, can result in a much lighter structure.

Most antennas constructed of aluminum, or other tubing, require considerable strength of the element material in order not to droop, bend, sag, or break. In addition the boom may become quite heavy in order to support the elements and its own weight. All of this adds up to expense and, in many instances, rules out the beam completely. Also, the use of such materials as wire, bamboo, wood, and string, puts construction of beam antenna arrays within the reach of everyone. The little arrays to be described here make use of these structural principles.

Construction

Rather than presenting this array as a project to be built exactly as outlined, it is presented as a guide and idea source. Thus, each builder will suit his own needs and utilize the materials available. The excellent performance will be obtained by the correct adjustment and this will take into account most mechanical variations that would otherwise change the beam characteristics.

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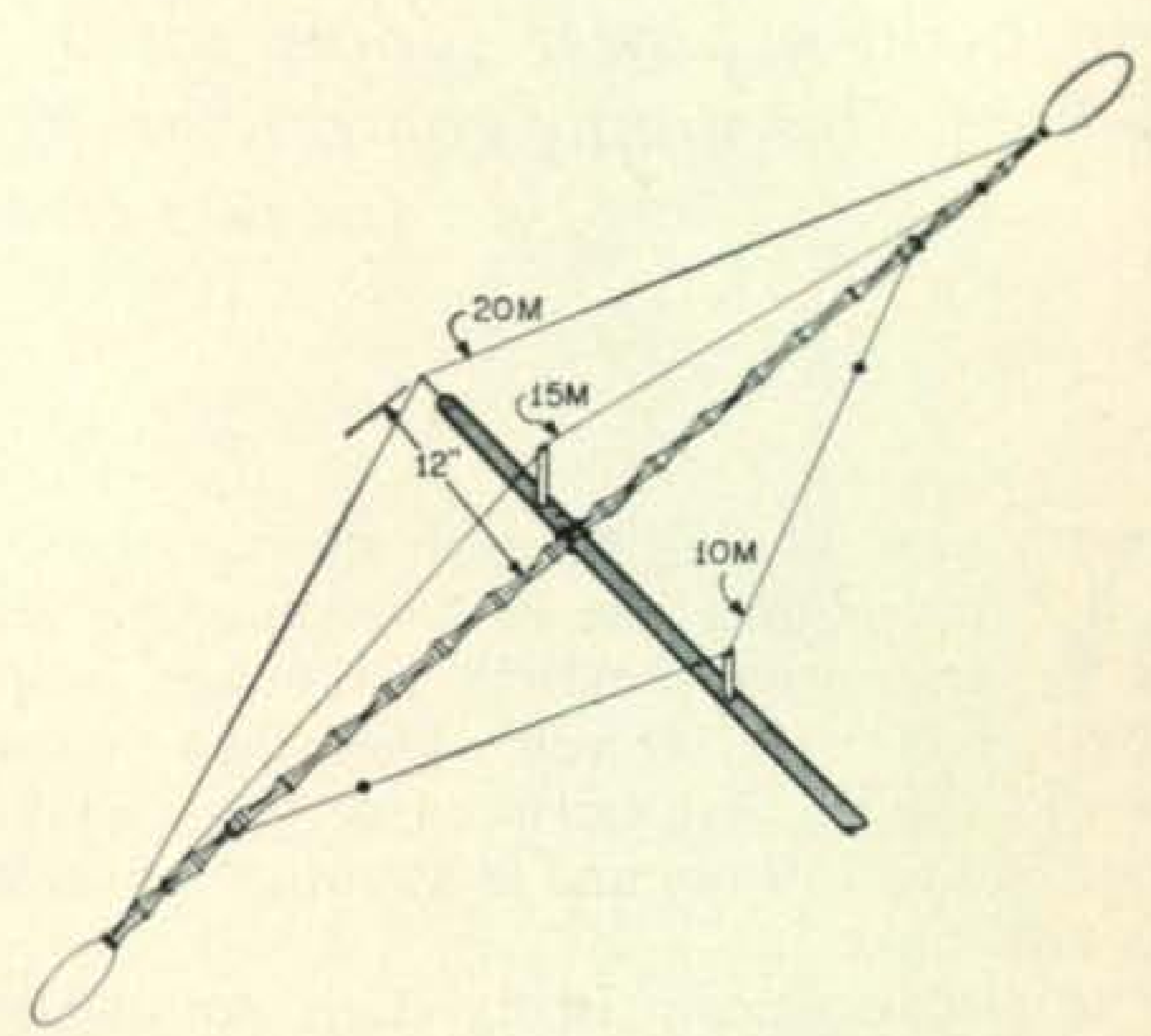

Fig. 1—The sketch above does not show the electrical details but only the positioning of the dipoles for each band. The 15 meter dipole acts as the umbrella guy while the 20 and 10 meter dipoles, when properly adjusted, hold the relatively light bamboo poles straight. The umbrella guy is supported off the boom by a 12" to 15" upright.

Figure 1 shows how a relatively light piece of bamboo can act as a spreader or strut while the wires perform as both the antenna elements and guys. The booms used (several antennas have been built) ranged from 1¼" TV masting with wooden dowel reinforcements to 1⅞" tubing with 1¼" × 1¼" aluminum angle to support the bamboo.

In all the antennas, the hardware used to secure the boom to the mast and the cross-members to the boom was of the TV type available at most radio parts suppliers and hardware stores.

Boom

An overall boom length of 9 foot, measured between the centers of the 20 meter elements, is about optimum. The bamboo spreaders or cross-members are one foot in from each end.

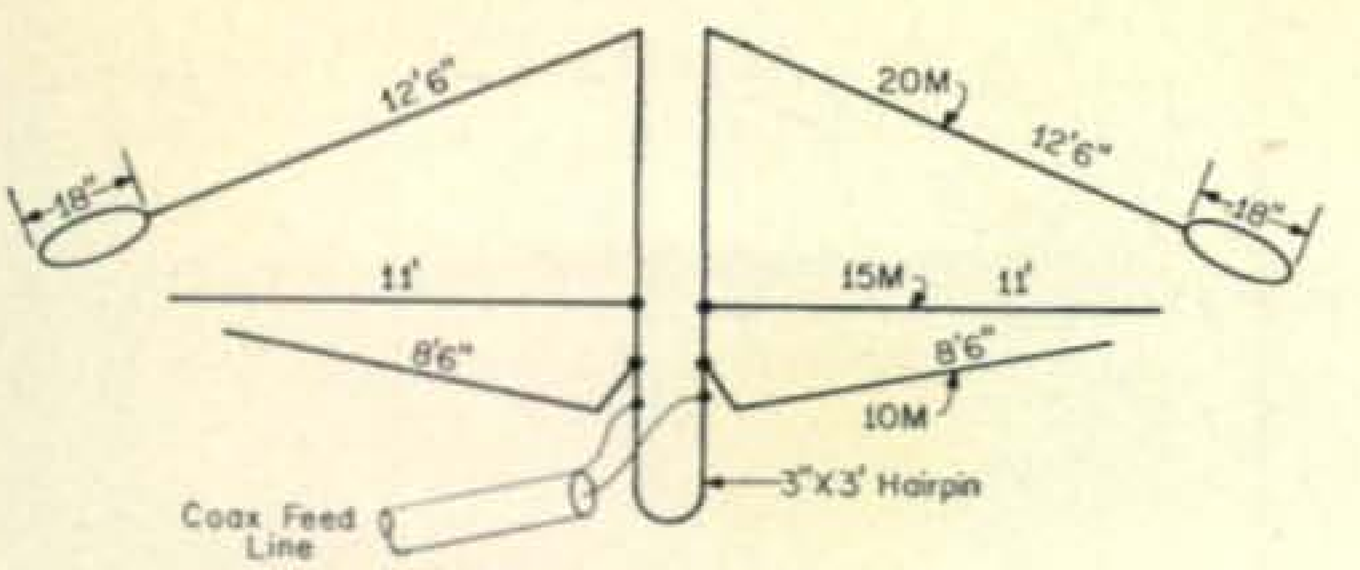

Fig. 2—Electrical connections for the driven elements. The lengths and dimensions shown are approximately the finished sizes after tuning. However, for peak performance the starting sizes given in the text should be used and the tuning procedure outlined will bring them to the exact size for your array.

The boom, may be as short as 7 feet. This would allow a 5' length of TV mast plus two one foot extensions. However, the larger boom is more desirable.

Element Lengths

The wire element lengths are not critical, the main problem being one of attaining maximum wingspread on 20 meters. Two 12' lengths of bamboo were assembled for each crossarm, and located one foot in from the end of the boom. The 20 meter element was then made of two lengths of #12 or #14 soft drawn copper wire approximately 12½' long, positioned as shown in fig. 1. "Eggbeaters," made of aluminum clothesline are fastened to the end of each wire to provide an additional 18" of length on each end. The eggbeaters are fastened to the copper wire with aluminum ¼-20 screws and nuts. After the electrical connections are tight, some varnish or liquid rubber, liberally applied, will help to prevent corrosion.

The hairpin, shown in fig. 2, measures 3" by 3' and is also made from #12 or #14 wire as are all other elements. The 3" spacing is maintained by plastic spacers mounted on 3/16" × 4" bolts which are secured to the boom.

The 20 meter reflector is made in exactly the same manner except that the hairpin terminates in a three or four turn coil which is grid dipped to 13,520 kc and later adjusted for the best front to back ratio.

Matching

After the 20 meter wires are strung it is necessary to match the array to the transmission line before proceeding any further. When matching, it is desirable to support the array as far off the ground as possible.

The only two instruments needed to tune the array are the simple impedance bridge and a signal source (a grid dip oscillator or signal generator).[1] These are set up as shown in fig. 3. Be sure that the length of coax between the bridge and the hairpin is not a ¼ wavelength or a multiple and is as short as possible. Connect

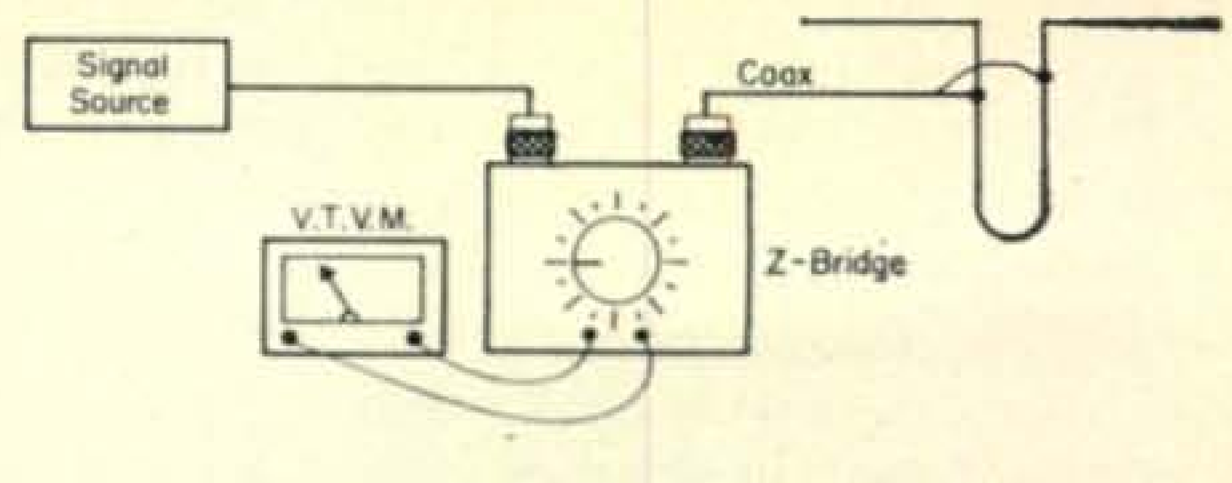

Fig. 3—Set up for tuning the driven elements. The signal source may be a signal generator or grid dip meter. The Z-bridge can be of the inexpensive type made by most kit manufacturers. The text gives the details of the tuning procedure.

two alligator clips to the antenna end of the coax and clip them on the hairpin near the open end.

Now, adjust the Z bridge dial to 52 ohms (or 72 ohms if you are using 72 ohm coax) and set the signal source to the desired frequency in the 20 meter band. Note the meter reading and adjust the coax connection points up or down the hairpin until a null or minimum reading shows on the bridge indicator. Remove the clips and solder the coax in place permanently. Be sure to remove any enamel from the hairpin if you hope to accomplish this.

The 15 Meter Elements

The 15 meter elements may be strung now as shown in figs. 1, 2 and 4. This element will require some "cut and dry" techniques as it cannot be tuned by moving the coax along the hairpin as in the case of the 20 meter element.

To begin, cut two lengths of wire, each 11 feet long for the driven element. Connect the alligator clips to one end of each wire and tape down the other ends about ten feet out on each side of the bamboo. Cut a length 23'6" and string the reflector as shown in fig. 4. Set the bridge up again at 52 ohms (or 72) and set the signal source somewhere in the 15 meter band preferably at the frequency which you intend to operate. Position the wire elements as shown in fig. 1 and bring the alligator clips down to the hairpin; connect them about 5" to 6" from the open end.

Move the alligator clips up and down the hairpin looking for a dip; a null is not likely. By varying the frequency of the signal source after a dip is found a complete null will then be located but not at the frequency you want. If the frequency at which the null is found is lower than the desired frequency, you must shorten the wires and if higher in frequency lengthen the wires. Since the initial length is made longer than needed, the wires will have to be shortened.

Reset the signal source to the desired frequency and correct the wire lengths by folding the free ends over a few inches at a time. Also move the alligator clips along the hairpin until a combination of both methods produces a null at the desired frequency.

The 10 Meter Elements

If 10 meter operation is desired, the same procedure is followed as for 15. First cut your re-

[1] Geiser, D. T., "The Instrument Deluxe," *CQ*, October 1962, p. 47, Exercises 10, 11 and 12.

flector to a length resonant below the band, about 17'6". String it up as shown in fig. 1. In order to have all the elements attached to the bamboo at one point, extend the 10 meter wire elements with nylon cords (which act as insulators).

Make up the driven element using two 8½' wire lengths. Clip to the hairpin at about 6" to 8" from the open end. Now follow the same tuning procedure as for 15 meters but with the signal source somewhere in the 10 meter band.

Once the matching points and lengths are determined for 10 meters the wires can be soldered to the hairpin, all ends pulled taut and secured to the bamboo.

Reflector Tuning

The final tuning of the reflectors should be done with the array and the tower at the height it will be used. The over-all performance may or may not be materially affected by doing so, but if the beam is reasonably accessible, it may be worth while.

Absolute measurement of gain over a band of frequencies is most difficult and too many variable factors can be introduced. The front-to-back ratio, however, is relatively independent of power input, receiving antenna variations, and receiver variations, etc.

The front-to-back ratio can be checked using a stable, remote, signal source a mile or so distant and results read off the receiver S meter as the array is rotated. Conversely a "friend" can be pressed into service to make the S meter readings while the antenna is used for transmitting.

For example, a chart can be made over the 14 mc band as follows:

Frequency	*F/B Ratio*
14,000	20
14,100	15
14,200	10
14,300	5
14,350	2

In this instance it is apparent that the reflector is reflecting best at the low end and should be shortened to improve things the phone end. After removing a turn from the coil, another run might look like this:

Frequency	*F/B Ratio*
14,000	15
14,100	20
14,200	20
14,300	15
14,350	12

This would be about the optimum one could hope to obtain. The driven elements will be affected very little by slight "touching up" of the reflector, if it has been correctly adjusted to begin with.

Additional Elements

Using the same principles of construction, a longer boom could be constructed and directors added for each band. In spite of the over-all light construction, this would require a heavier and stronger boom with additional technical

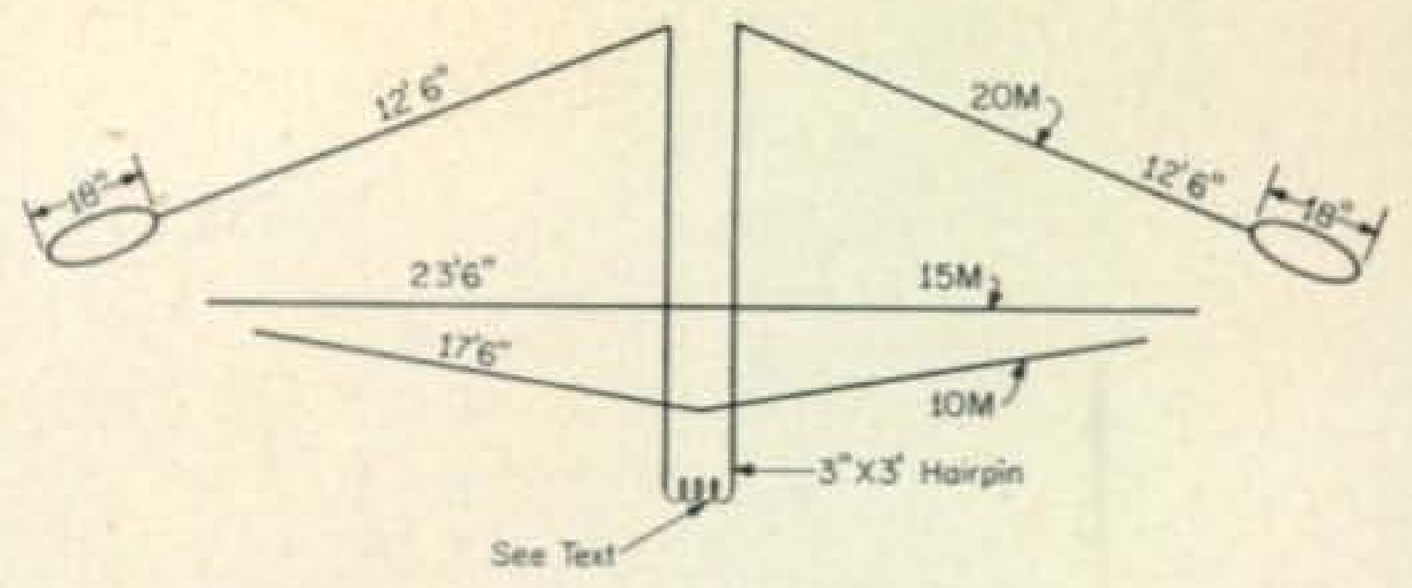

Fig. 4—Electrical details of the reflector assembly. The overall length for 20 meters 33', for 15 meters 23'6" and 17'6" for 10 meters. Final pruning for best front-to-back ratio is done with the antenna in place, if possible, as explained in the text.

problems in matching and tuning. Anyone making a parasitic antenna for the first time would do well to stick to the simple 2 element version for a start.

This type of construction has some definite advantages over coil or trap loading of the elements. Very little compromise is made in spacing by placing the center sections of the lowest frequency elements farthest apart on the boom. The hairpin in the driven element, and the small coil in the 14 mc reflector are the only portions not involved in useful effective radiating. The over-all efficiency is not appreciably affected.

Results

No remarkable results can be expected with a small array such as described here other than the well known qualities of any 2 or 3 element parasitic array. The beam width between the half power points will be 50 to 60 degrees. The apparent front to back ratio will be about 15 db. So far as the vertical angle of maximum radiation is concerned, height above ground and the nature of the ground itself are the determining factors.

Comparison of antenna performance by signal reports, perhaps with another station only a few miles away, is not necessarily valid, but comparison with your own results with the old dipole or vertical are. Try it and see if such a simple rotatable array does not open up a whole new world of signals, both DX and domestic. ■