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Antennas

WELCOME to the 'Antennas' column. As you are all aware, the single most critical item determining the performance of an amateur radio station is the antenna. The main purpose of the column is to address problems readers may have installing and adjusting antennas from suburban sites that may be regarded as a challenge; although any antenna subject that is considered to be of interest to readers will be discussed or described.

MOXON RECTANGLE

THE YAGI antenna is probably the most effective way of obtaining gain and directivity. However, the 10m + 'wingspan' of a conventional Yagi for 20m can be a problem for many locations and many attempts have been made to make a more compact antenna. These include using loading coils or by simply bending the elements.

With antennas there is very little that is actually new and a two-element Yagi with bent elements certainly falls into this category. A configuration, where the elements of a two-element beam were bent so that the 'wingspan' was halved, was first suggested by John Reinartz, W1QP, way back in October 1937. Burton Simson, W8CPC, constructed such an antenna [1], the elements of which were supported on a wooden frame. This allowed the element ends to be folded towards each other. The 14MHz antenna was constructed from 1/4in copper tubing with brass tuning rods that fitted snugly into the ends of the elements for tuning.

A wire edition of the W1QP / W8CPC two-element antenna was described in 1973 by VK2ABQ [2]. In this configuration the tips of the parasitic and driven elements support each other in the horizontal plane. The insulators are constructed so that the tips of the elements are 6mm (1/4in) apart.

Les Moxon, G6XN, did a lot of experimental work with the two-element Yagi with bent elements [3], particularly in optimising the element spacing. However, some of these structures are complex and difficult to reproduce. A simplified, although slightly larger structure, was devised by L B Cebik, W4RNL (see WWW. below). This he named the Moxon Rectangle, and it is shown in **Fig 1**.

The remarkable characteristic of this arrangement is its very high front-to-back ratio. It also has a feed impedance close to 50Ω. The dimensions for the Moxon rectangle for 40 to 10 metres are given in **Table 1**. The dimensions are not perfect scaling because the length-to-wire-diameter ratio changes for each band.

The antenna has a feedpoint impedance between about 56 and 58Ω, a close match to the standard amateur 50Ω coaxial cable. Free space gain and front-to-back ratio are consistent for all the models, averaging 5.8dBi and greater than 30dB in free space, respectively.

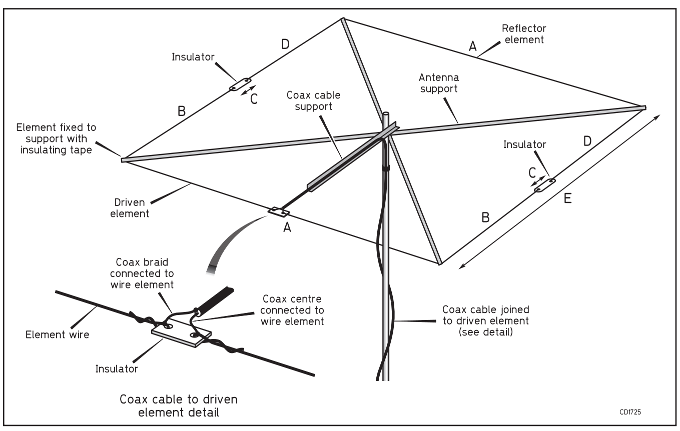

Fig 1: Perspective view of the Moxon Rectangle showing the general construction. The element supports can be made from weather treated cane or fibreglass.

Freq MHz	A	B	C	D	E	A+B+B	A+D+D
	Dimensions, metres (*mm)						
29.50	3.79	0.59	125*	0.74	1.45	4.97	5.27
24.94	4.33	0.67	140*	0.84	1.66	5.67	6.0
21.20	5.00	0.80	158*	0.99	1.95	6.6	6.98
18.12	5.96	0.94	180*	1.16	2.28	7.84	8.28
14.17	7.62	1.22	219*	1.48	2.92	10.06	10.58
10.12	10.66	1.71	305*	2.07	4.08	14.08	14.8
7.15	15.10	2.75	405*	2.93	5.73	20.6	20.96

Table 1: Dimensions for the W4RNL-designed Moxon Rectangle beam. Refer to Fig 1 for dimensions A to E. These dimensions have been calculated using *EZNEC* for a non-critical design to give a free-space gain around 5.8dBi and a front-to-back ratio greater than 30dB. The elements are constructed from 1.6mm diameter copper wire. A+B+B is the driven element total length and A+D+D is the reflector total length. Remember to add additional wire for fixing the elements to the insulators.

In *Backyard Antennas* [4], I stated that the Moxon Rectangle could be made into a multiband antenna by simply interlacing the elements for the different bands on a common support structure. This was based on the diagram shown in Fig 12.11 of [3]. VK2ABQ [2] also describes this method of multibanding his antenna.

Some time after [4] was published I decided to build a *multiband* Moxon Rectangle and ran into some difficulties. I had previously built a multiband Double-D antenna (another antenna with bent elements, see [4]), which worked fine, so I had not expected any problems. No amount of playing with element lengths resolved the problem. I found I was not alone with this difficulty. From the L B Cebik, W4RNL, web site I found the following regarding this antenna: "I have had a number of inquiries into multi-banding the Moxon Rectangle. The compact antenna seems to beg for nesting. However, to the present time, I have had no success in developing a workable model of the antenna for any HF band combination in the nested configuration. In Moxon's book, *HF Antennas for All Locations*, G6XN notes a detuning system that he uses with his wire version. However, the wire spacing required by the system makes for a bad model. Consequently, I cannot say whether or not the system would work with aluminium rectangles, each of which has been optimised for its band."

W4RNL describes a number of solutions to multibanding the Moxon Rectangle but none of these is simple. I feel that the reason that, while multibanding works fine for the VK2ABQ and the Double-D, the parasitic element / driven element coupling on the Moxon rectangle is much more critical and is more easily disturbed by antenna elements of adjacent bands.

The antenna would probably work as a multi-band antenna if the element supports, shown in Fig 1, are set 90 degrees to each other; so that the antenna is a square rather than a rectangle. This arrangement would only work provided that the bands are an approximate octave apart (14, 21, 28 or 10, 18, 24MHz). The element lengths shown in Table 1 (A+B+B and A+D+D) are a good starting point. The driven elements can all be connected together and fed with one feeder.

I should point out, from the experiments that I have done, that the Moxon Rectangle is an excellent single-band antenna.

I would be pleased to hear from any readers who have built a multi-band antenna similar to those described above.

FURTHER READING

[1] 'Concentrated Directional Antennas for Transmission and Reception', *QST* October 1937, John Reinartz, W1QP and Burton Simson W8CPC.

[2] 'VK2ABQ Antenna', Fred Caton, VK2ABQ, *Electronics Australia*, October 1973.

[3] *HF Antennas for all Locations*, 1984 Edn, Les Moxon, G6XN, RSGB.

[4] *Backyard Antennas*, Peter Dodd, G3LDO, RSGB. ♦

WWW.

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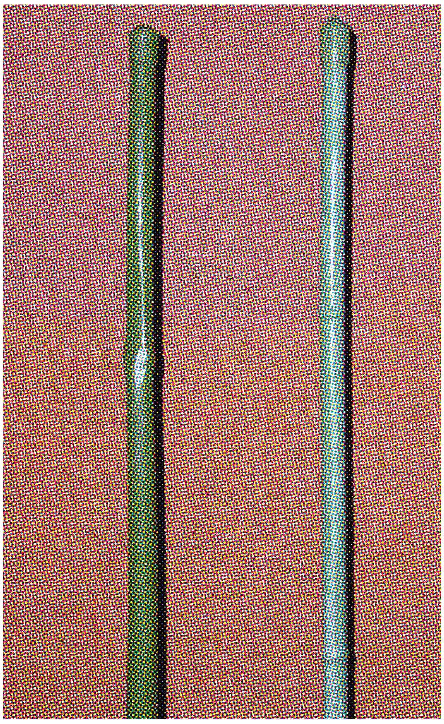

On the right, plastic-covered aluminium tube to be used as a durable alternative to cane for horticultural purposes. It even has annular ridges that make it look like cane. To the left is plastic-coated *real* cane.

PETER Martinez, G3PLX, e-mailed me with some interesting facts about the EWE antenna [1] of which I was unaware. He says: "Your item on the EWE antenna was most interesting. I had never heard of it before under this name, but recognised it immediately. If you scale it right down in size to a few millimetres high and a few centimetres long, it's the sensor element in one of the classic SWR bridge designs. It's therefore possible to think of such an SWR bridge as being a directional antenna rather than a directional power sensor - it's just DFing the electromagnetic field within the coaxial cable in which it's placed! The plug-in sensors of the well-known Bird Thruline power meter is one of these, so it's really a tiny DF antenna that you poke into the line to see which way the energy is 'radiating' inside the line.

"If you scale it up it becomes a proper Beverage antenna. At an intermediate size you can make it square and balanced rather than build it over a groundplane, and have the resistor halfway along the back edge and the feedpoint halfway along the front edge. You could probably therefore improve the performance, particularly the front / back ratio, by adding a counterpoise wire between the two earth-points as shown in Fig 1 [1]. You can replace the resistor with a second feedpoint and bring a second feeder back into the shack, via a matching transformer of course, and then swap the resistor and the receiver between the two feeders to reverse the direction."

G3PLX adds: "If you do the maths, the required value of the resistor (and indeed the feed impedance, which is the same), is equal to the characteristic impedance of the wire above the ground. You can therefore make this lower by having more wires in parallel. If, instead of a wire you had a flat plate of width D and placed it at a height of D above the ground, the characteristic impedance becomes equal to that of free-space, namely 377Ω. From this you can see that practical versions of this antenna are always going to be rather high impedance.

"I recently saw this same principle used in a set of field-strength measuring antennas made by R&S. The Radiocommunications Agency field engineers have recently been issued with them. They are square loops made of broad flat sheet. Incidentally, because the directivity depends on the electric field and the magnetic field being in a specific amplitude ratio (the magic 377Ω number again), these antennas will only give a sharp null in the far field where this ratio holds true. I note reports from various people who suggest that loops are much better at rejecting local QRM than whips, which might mean that local QRM is predominantly E-field. If this is the norm, then I doubt if an EWE antenna could ever be very effective in nulling-out local QRM, and the same imbalance would apply if the local QRM field was predominantly magnetic."

MOXON RECTANGLE MATERIAL

"HELLO DEAR, I've bought you a present - could you help me unload the car?" XYL Erica had been on a retail therapy session at a local garden centre. Amongst the hanging basket construction kits, flower pots, potting compost and other miscellaneous bits was my present, a bundle of green canes. These turned out to be 8ft (2.4m) canes coated in green plastic. Cane is often suggested as a material for any antenna that uses non-conducting wire element support structures, such as a quad or a Moxon Rectangle. While cane is cheap, lightweight and strong, its main disadvantage is that it is affected by weather unless adequately protected. On the face of it plastic-covered cane will overcome this disadvantage.

But beware. Some years ago I constructed a Double-D antenna [2] using what I thought was plastic-covered cane. I found it impossible to tune the antenna for either low SWR or directivity. I later discovered that the material was plastic-covered aluminium tube. The antenna performance (and my sanity) was restored when cane element supports were substituted.

As you can see from the photo there is very little visible difference between the two types of material. However, there are several clues. Plastic-covered cane is very rarely perfectly straight and the diameter tapers along its length. Plastic-covered tube *is* straight, has a constant diameter and gives a metallic sound when dropped on a hard surface.

The plastic-covered tube, shown in the photo, has languished in my antenna material junk pile for many years in all weathers and shows hardly any sign of deterioration except that it has become lighter in colour. This implies that the plastic-covered cane should make a durable wire element support.

I am constructing a Moxon Rectangle using this material and will give details of how it worked out in a later 'Antennas' column.

I have also included some construction and information on this antenna on my website (see WWW. below). Other references to this antenna are to be found at [3] and [4].

Plastic-coated bamboo canes were available in two of the many garden centres in my locality and from what I can gather they are imported from China. My canes were obtained from Country Fayre, Littlehampton Road, Ferring, West Sussex BN12 6PN (who regret they have no facilities for shipping canes). They were priced at £2.50 for a bundle of five canes, 8ft long. A rather more posh emporium, less than a mile away from my source, is selling the identical product for £4.99. Before you buy, inspect the canes to ensure that there is no damage to the plastic coating and that the end caps are securely in place.

REFERENCES

[1] 'Antennas', *RadCom* January 2002.
[2] *The Antenna Experimenter's Guide* by Peter Dodd, G3LDO (RSGB).
[3] 'A Superbeam Experience on 24MHz', Vic Westmoreland, G3HKQ, *Practical Wireless* October 1996.
[4] 'The VK2ABQ Antenna Revisited', Vic Westmoreland, G3HKQ, *Practical Wireless* August 2000. ♦

WWW.
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