Antenna Workshop

The Holiday Quad

John Pears W4/G0FSP describes the antenna at his winter hideout in Florida. Picture the scene, the sun's shining, the temperature's around 25°C, you've only got shorts, sun hat and sun block, and you're playing antennas.

This article is about the development and construction of a three-band quad antenna for the 14, 21 and 28MHz bands, an antenna that's been in service for the last two winters in Florida. Not that I profess to be an antenna expert, I just like constructing antennas and seeing how they work and this antenna performs very well.

So, this article doesn't present new or original ideas, despite this it should give you an idea what fun you can have playing with antennas. However, before I describe the antenna itself, I hope you'll tolerate a little history lesson!

Short History

First a short history of the cubical quad antenna! In 1939 a missionary radio station, HCJB in Quito, Ecuador, brought a new 10kW transmitter into operation, feeding a four-element Yagi array. The combination of the 3000m elevation, low air pressure associated with storms, and raindrops accumulating on the ends of the antenna elements, all combined to produce some spectacular firework displays.

Coronal discharge at the antenna ends were common, and occasionally a metre long standing arcs where produced. The resultant heat would melt the ends of the radiators, and de-tune the system. The station engineer at the time, Clarence J Moore W9LZX, worked out a partial, but temporary, solution by installing hollow copper balls as used in flush toilets at the ends of the elements.

The smoother ends decreased the number of firework displays. Continuing to work on the problem Clarence, finally developed the concept of bending the ends of the elements towards each other, until they touched, creating the quad loop. Further tests and experiments led to the classic cubical quad antenna of today.

My Quad

Now for the shorter history of my quad. Since I retired some years ago I have been 'wintering' in south western Florida, and always go on air with the callsign W4/G0FSP. The holiday home has on its northern, rear, boundary a row of pine trees about 20m high. These have provided, over the years, support for the various dipoles, and verticals that I have built. The radio room is located on the same side of the property.

My interest in quad antennas started after I had read a copy of - *73 Vertical, Beam and Triangle Antennas* by Edward M Noll W3FQJ. Another very useful book, from which I learnt a great deal, was *Cubical Quad Antennas*, by **William Orr W6SAI**, and **Stuart Cowan W2LX**.

After some consideration of the space available, I calculated that I could hang a 14MHz 2-element quad from one of the pine trees. Rotation was by cord from the shack. I recall from W3FQJ's book, that a parasitic quad director is easier to match, giving higher gain and a better radiation pattern, than a driven element and reflector combination.

The limited space also determined the maximum element spacing that I could achieve. It worked out at about 0.1λ, which was not a problem, as the gain of a 2-element quad is relatively constant with element spacing of 0.08 to 0.22λ, the radiation resistance being around 40-140Ω as element spacing increases from 0.07 to 0.25λ. I could find a reasonable match to coaxial cable. The top of the quad could be no higher than 10m, though not a problem, as the quad antenna is less sensitive to being near ground.

Bamboo Patch

I have a neighbour with a fine bamboo 'patch' at the rear of the property, who told me to "help myself", which I did! The canes are up to 12m long, and provide a source of building material for the next few years! Element wire, cord, rope and cable clips were acquired from the local hardware store, and the coaxial cable was already in stock.

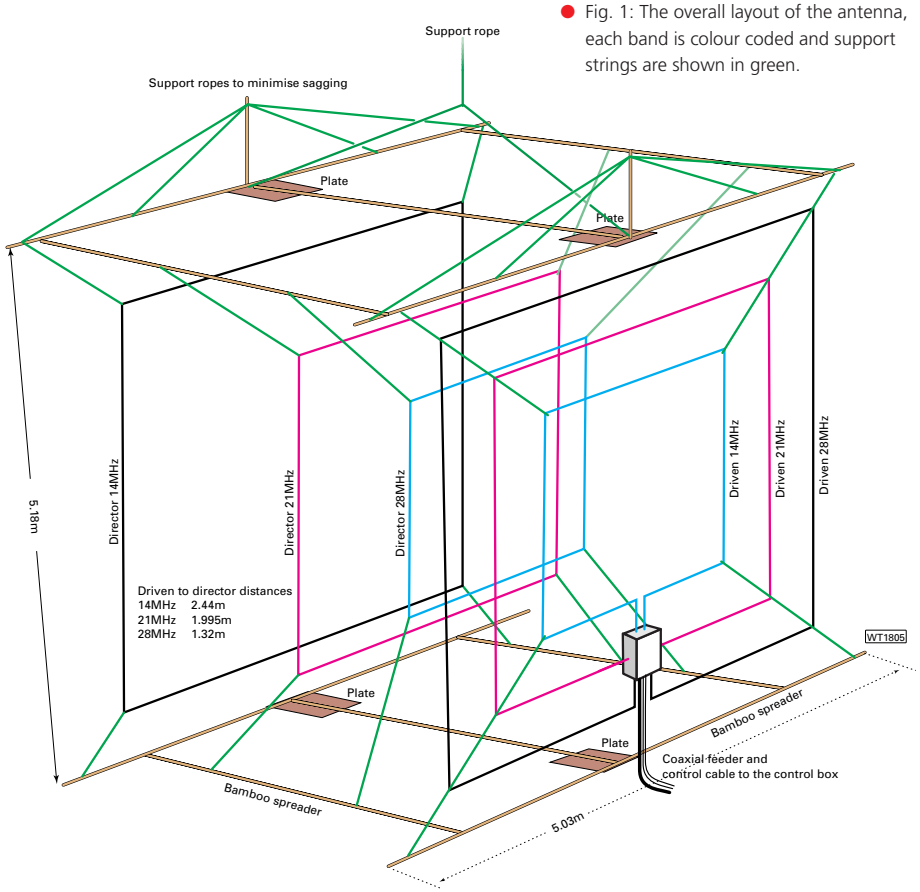
It was a pleasure to shop in the Ace Hardware store, all the assistants were about my age, and very knowledgeable about the products on offer. It's the sort of place where you could buy a single nut and bolt, or 1lb of nails in a brown paper bag.

The 14MHz quad worked very well, giving me up to three S-point gain over my G5RV. I was so pleased that I then built a second quad, this time for 21/28MHz, with band switching achieved manually (a switch operated by light-weight cord). I tried feeding this antenna with only one feed point but I found it very difficult to obtain a usable match. So, this idea was abandoned. At the end of the holiday both antennas were taken down and stored away for the next year.

Multiple Band

The following year as I set up the radio station, I decided to create a multiple band antenna and combine both quads. I added smaller elements to the bamboo frame work that supported the original 14MHz antenna. A two-relay circuit was used for band switching, the 12V d.c., heavy duty (10A) DC relays and the balun were purchased at the Ft Myers hamfest, and were built into an old plastic box.

The new quad construction is outlined in **Fig. 1**. The two top fixings have an additional short vertical length of cane, to provide the support for a cord preventing the ends of the main canes from drooping. All nuts and bolts used were stainless steel.

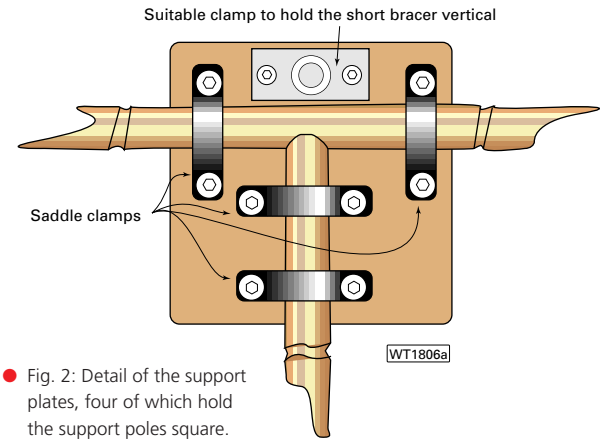


● Fig. 1: The overall layout of the antenna, each band is colour coded and support strings are shown in green.

The four main fixing plates are made from painted plywood along the lines of **Fig. 2**. Light cord and a short section of elastic, helps to keep the elements nice and square, (I have to admit that I am one of those people who thinks that if it looks right it has to work well).

As there's some coupling between the driven elements, I've found it very important to keep them as far apart from one another, as possible within the given space. I used light rope for the main verticals, the anti-droop supports, and the hanging support. Lengths of heavier anchor rope are used for the main rope, as the quad weighs in at about 18kg.

The main support rope passes over a pulley, making lowering and raising easier (if it got too windy). The pulley support rope also of anchor rope being left in place during the holiday. The switch box and any thing else that I have not talked about, was fixed in place using cable ties (**Fig. 3**).



● Fig. 2: Detail of the support plates, four of which hold the support poles square.

Nice & Square

As you can imagine it does take time to set the quad up nice and square, and I have found that to counter balance the weight of the coaxial feed and switch box, a one litre plastic bottle with the contents (water) carefully adjusted until the quad sits square, but do leave the cap on or else the contents will escape when the quad is lowered. The main support rope goes through a clip on the bottom section, and is attached to a concrete building block.

All the canes were taped using electrical insulation tape to keep out the weather, and the main canes have been in use for several years and are still in good shape. I use the very latest in antenna rotating technology (string to the bottom corners), the only problem was that I only had 180° coverage, great for Europe and North America, but I've got a G5RV if I wanted to work other directions. Being a member of FISTS and the G-QRP club my main working mode is c.w. so, I trimmed the driven elements accordingly, using an antenna analyser at the radio room end of the coaxial cable. The quad is fed with about short length (8m) of RG8 coaxial cable, giving a perfect match on all bands.

I had over 100m of insulated stranded antenna wire to hand, and this was used for the quad elements. The elements were cut using using the formulae.

$$\text{Driven} = \frac{285}{f\,(\text{MHz})}\,(\text{m}) \quad \left(\text{or } \frac{948}{f\,(\text{MHz})}\,(\text{feet})\right)$$

$$\text{Director} = \frac{271}{f\,(\text{MHz})}\,(\text{m}) \quad \left(\text{or } \frac{935}{f\,(\text{MHz})}\,(\text{feet})\right)$$

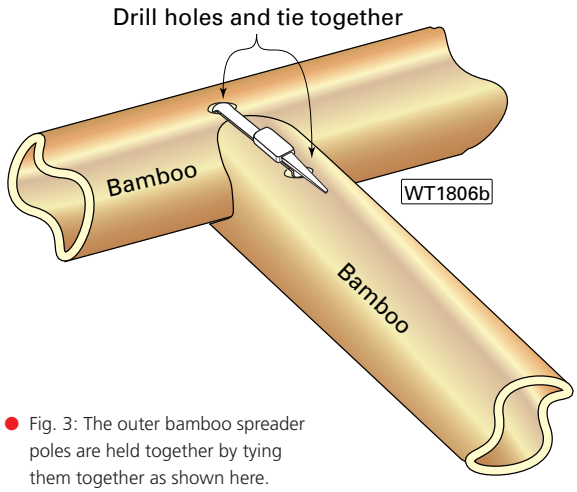
The driven elements were cut just a bit longer than calculated, as it's easier to cut bits off than to solder pieces on.

The old carpenter's maximum of measure twice and cut once also applies to cutting wire for antennas. I had great problems getting a good match on 21MHz, and after a lot of head scratching found that I had cut the director 3m too long. It must have been all that sun.

There is some reaction between elements and I've found the best away to cut for resonance, is to creep up on it, cutting only a small amount on each element at a time. Slow and sneaky, but it works! I had no problems in getting a good match on all three bands, and the 1:1.5 bandwidth was 170kHz on 14MHz, but 280kHz on 21MHz, rising to 470kHz on 28MHz.

The quad always out performed the G5RV configured as an inverted vee at a height of about 15m. In fact the quad was lower overall, but benefits with its directivity. I suspect the conditions at the QTH might help propagation, in that the holiday bungalow is built on sandy soil, only about 1.5m above a salt water canal.

One of the best signal reports I remember was during the G-QRP winter Sports, a 599 on 28MHz, from **George GM3OXX**, both of us running QRP. You don't need to be in Florida to use this quad, it just makes operating far more pleasant! PW



● Fig. 3: The outer bamboo spreader poles are held together by tying them together as shown here.