Antenna Workshop

Guitar Quad-Loop Bea

Strum along with John Heys G3BDQ, as he tunes up his 'Guitar-quad loop' beam for the 144MHz band!

The word 'Serendipity' has the definition: "The faculty of making happy and unexpected discoveries by accident". Well this 'guitar-quad' must be serendipity, as it came about by accident when I was chasing a nice low s.w.r. by changing the shape and spacing of the elements.

The shape of the antenna I'm describing here has a different shape from the original quad-loop antenna that was created in the early 1940s by **Clarence Morre W9LZX**. The development took place when he was employed at the Missionary Radio Station HCJB in Quito, Ecuador.

At Quito's high altitude, there had often been serious corona discharges from the tips of the Yagi antenna that was being used for transmitting the signals from HCJB. In suggesting the use of a quad-loop antenna, Clarence had taken into consideration that a quad-loop's two high voltage points are at potentials considerably lower than those present at the element tips of a Yagi beam.

An additional advantage is that the quad-loop's bandwidth is also considerably better. A quad-loop beam also has a theoretical 2dB gain over a Yagi antenna with the same number of elements. Taking all the quad-loop's plus points into account, the quad-loop antenna has become popular with amateurs for both h.f. and v.h.f. work.

So, with the quad-loop in mind, in the autumn of 2004 I decided to return to some c.w. and s.s.b. operation on the 144MHz band. I began using just a simple indoor antenna, as it wasn't to be a 'serious' return to the band. I settled for a two-element quad-loop arranged to beam north-west from my location on the Sussex coast.

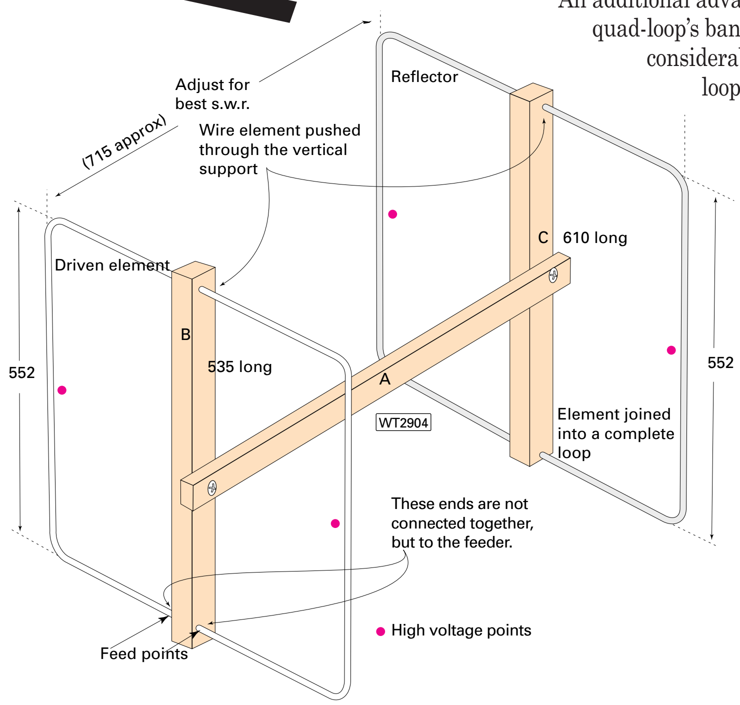

Fig. 1: The quad-loop beam before the driven element was distorted into a 'guitar' shape.

Antenna Library

A look through my antenna 'library' revealed a design that has appeared in the *ARRL Antenna Handbook* for over 30 years, a fact that suggested it being a 'sure-fire' design. The 'not-to-scale' drawing, **Fig. 1**, shows the simplicity of the beam's construction, which involves a few lengths of timber, a few screws and the two quad-loop elements.

The driven element is 2108mm (83in) long overall and the reflector is 5% longer at 2210mm (87in). Some very thick insulated domestic earth wire (coloured green and yellow) was used for the driven element and a length of thin 5mm wide brass strip from my junk cupboard made up the reflector loop. I used the brass strip because it was on hand but as an alternative, more normal thicker wire, copper or aluminium tube will be ideal.

The antenna is arranged to be horizontally polarised, which means that the mid-points at the top and bottom of both loops are at very low impedance and there is no need for careful insulation at these points. The conductors simply pass through holes in the vertical timbers. I've shown the ends of the driven element as sticking in the vertical support. **It's important to remember that they do not touch each other**, but are connected to the feeder.

I used a small rectangle of clear plastic or similar insulating material with a couple of holes just large enough to allow the conductor ends to go through tightly. And instead of the commonly used 50Ω coaxial cable feeder, I used a length of white double-screened 75Ω cable. A 'clamp-on' ferrite Balun was added to prevent unbalanced currents flowing in the feeder and antenna 'squint'. (Antenna squint can happen when r.f. currents run along the outside of the coaxial feeder rather than on the inside).

As we're dealing with signals up at 144MHz, the choke balun doesn't need be

m for 144MHz

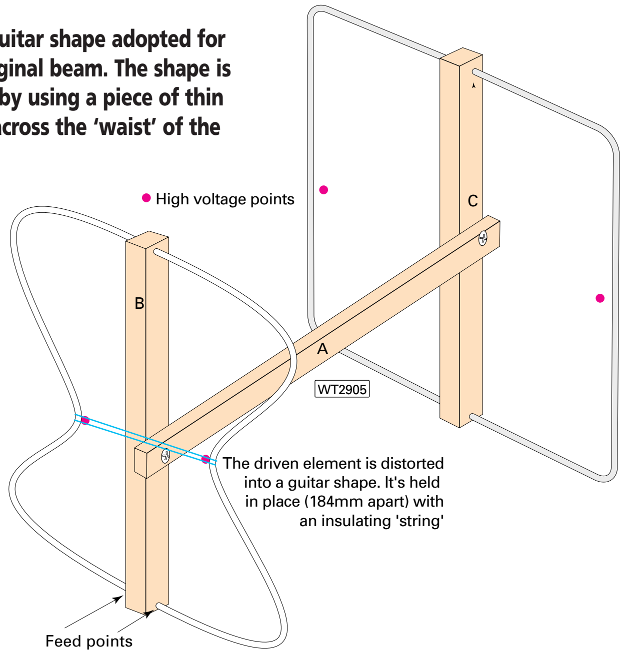

Fig. 2: The guitar shape adopted for G3BDQ's original beam. The shape is maintained by using a piece of thin nylon cord across the 'waist' of the shape.

very big. A suitable balun can be made by forming a three turn 50mm diameter choke coil from the feeder just below its connection to the driven element.

The vertical support (C) for the reflector loop should not be screwed into position until all the final tests and adjustments have been made. The spacing between the driven and reflector elements will lie somewhere between 0.15 and 0.25 of a wavelength; the actual spacing can be adjusted to allow the use of either 75 or 50Ω coaxial cable as the feeder.

When my antenna was initially assembled, to test it, I rested it on top of wooden stepladders set up in the landing just outside the shack. The s.w.r. right across the 144MHz band was at first very high (I used only 5W or less when making these initial tests) so the reflector loop was moved to and fro along the boom in an effort to adjust the matching.

Eventually, I found a spacing position that reduced the s.w.r. to about 2:1 at the higher band edge. But this figure rose as the transmitter was tuned towards the lower band edge.

I don't know why, but I then pushed the vertical wires of the radiator loop towards one another, changing the antenna's geometry away from the square shape. To my surprise this new shape, resembling the outline of a guitar, now gave the antenna a much more respectable s.w.r. By alternately adjusting the element spacing and the positioning of the sides of the driven element I achieved a near unity s.w.r. over most of the band.

To preserve the final spacing between the vertical wires of the driven element a short length of nylon cord was tied into position. The reflector loop was also held into position with a screw through the boom and into the vertical part labelled 'C'.

It was, after these successful tests, rather late at night so, the next day found me in the roof space putting the antenna into position by hanging it from strings attached to the roof joists. The photo, **Fig. 3**, shows the antenna in its position, together with numerous odd bits of string dangling down. These extra strings are 'echoes' of antennas experiments long past.

An Explanation

I've searched in vain through all my relevant antenna books for an explanation of the effects arising from the distortion of the normal quad-loop shape, but I've found nothing relevant. Perhaps I am looking through the wrong books! In my opinion there seems to be two factors that can arise from the bending of the sides (when at high impedance) of the radiator loop.

The first factor that comes to mind, is the change of feed-point impedance at resonance. A conventional square quad-loop has a feed-point impedance of 100Ω or so, but if it's flattened out to make a folded dipole the impedance rises to around 280Ω. A 'guitar' shape should therefore have a higher feed impedance than a square full wave loop.

A second factor effecting the s.w.r. may be a change in the natural resonance of the loop when the capacitance between the two high impedance sides is increased. This capacitance will lower the resonant frequency. Whichever of these suggestions, or combination of them is responsible for the measurements I found after the change in the square quad-loop's normal parameters I cannot determine.

By the way, the square quad-loop's 100Ω feed impedance will be brought down to about half this value when a second element is introduced in close proximity. The gain of the guitar quad-loop element will be slightly less than a square loop, because the gain of a full wave loop diminishes as the enclosed area is reduced.

Performed Well

The antenna has worked well and under 'no lift' conditions gives me solid QSOs with stations up to 250km away when using 80W of transmitted power. The broad main lobe allows contacts with stations away from the main beam heading. I've found that the front/back power ratio is not brilliant and from experiments I reckon that to the rear everything is some 15dB or so down.

The loop front-to-back ratio, though distinct, is not deep and allows me to work French stations some distance away across the Channel with ease. This is even when not 'pointing' in their direction. As expected there are good nulls off to both sides of the antenna, but during a 'lift' in conditions I could easily contact stations on the Isle of Wight and in the Netherlands without changing the antenna's direction.

Adjustment of the spacing between the driven and the reflector elements can give a better front-to-back ratio. But the forward gain will very likely to reduce and the s.w.r. will go up or be more difficult to reduce.

The antenna as described is fine for indoor use but if a version is made for use out of doors the normal weatherproofing precautions should be taken. The woodwork will need treatment to prevent rot. Yacht varnish is probably a good treatment if not the best to use. Brass screws must be used throughout for joints and the end of the coaxial cable should be well covered with silicone-rubber sealant.

So, there you have it, a simple guitar-shaped quad-loop antenna to accompany your signals on the two-metre band!

PW

Fig. 3: The completed beam installed in the G3BDQ roof space.