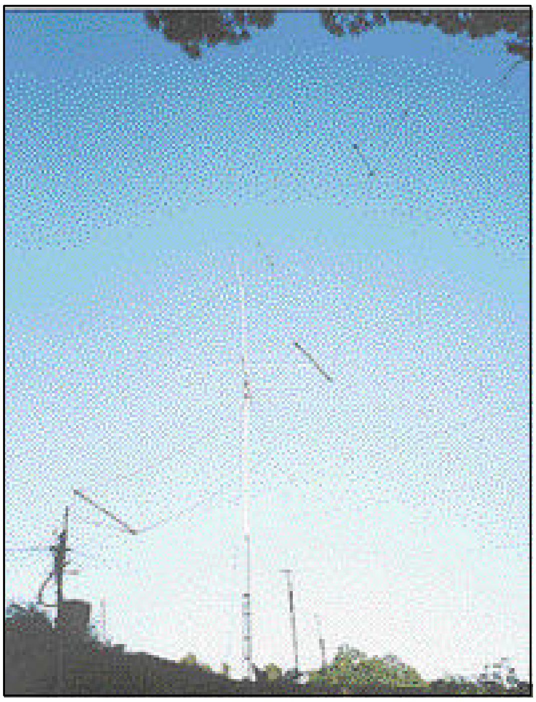
The Glen Forrest Marconi

a 'fat' trapless semi-vertical antenna for 3.5, 10, 18 and 24MHz

by Steve Ireland, VK6VZ / G3ZZD *



The VK6VZ Glen Forrest Marconi just after sunrise. The feedline choke and radial system can just be seen on the left hand side of the photo.

WHEN IS BEING FAT a good thing? Probably never, if you are trying to be a champion athlete or keeping yourself free from heart disease, but for an amateur radio enthusiast - fat is good.

Before you take this as an excuse to reach for a large block of chocolate, I am talking about antennas here. 'Fat' antennas - made from several parallel pieces of wire and giving both broad bandwidth *and* high efficiency - can really help radio amateurs throw their weight about in a DX pile-up.

Most radio amateurs specialising in HF spend a lot of time putting up extremely thin pieces of wire to work or hear DX. When the amateur band we want to use is narrow - such as the UK 7MHz band - this is fine, but in the case of most of the upper HF amateur bands something a bit thicker than a single strand of 16 or 18SWG copper is a good idea.

Those who doubt this statement should take a look at a professional HF radio installation. Normally, there are no single wire dipoles there, but large arrays of 'fat' dipoles, constructed like skeletal tubes or cages.

What the cage of wires does - compared with a single wire - is to make the resulting antenna thicker, closer to a wavelength in diameter, thus increasing its bandwidth and causing the feed impedance to remain virtually the same over a wider range of frequencies.

Making a dipole fatter in this way will have a drastic effect on its bandwidth, increasing it from several tens of kilohertz to several hundreds of kilohertz. What this means practically for a radio amateur is that it is possible to have an antenna that is a good match to its feeder over an entire amateur band, rather than just part of one.

No more messing about with expensive antenna tuning units (ATUs) or worrying about whether the SWR is low enough for the transceiver's power amplifier stage - why not consider an almost-perfectly-matched antenna that is going to make a big impression anywhere on the band you choose?

Conventional cage antennas are widely regarded as difficult to construct and unwieldy. Yes they are, but all that is needed to make an effective 'cage antenna' are two separate thin wires, spaced well apart and joined at their feedpoint. Now, that sounds easy, doesn't it?

FAT ANTENNAS AND ME

MY INTEREST IN fat antennas with a wide bandwidth was stimulated last winter when trying to work rare Pacific, Caribbean and Central American DX on 1.8MHz from my home in Perth, Western Australia. This meant that I would frequently want to try to bring stations down to topband from the 80m band.

Sometimes these stations would be in the CW DX section of the band, which was fine for my quarter-wave 'inverted-L' antenna made of very thin wire and cut for 3.510MHz. But sometimes these stations would be operating on 3.798MHz on SSB - far too high in the band for my inverted-L, whose SWR at this frequency was too great to allow my solid state transceiver to transmit. Modern HF transceivers are designed so that their power output is drastically reduced if their SWR is greater than 2:1. At 3.798MHz, the SWR on my inverted-L quarter-wave antenna was *way* above 2:1.

The usual solution to this problem is to use an ATU (between the transmitter and the antenna) but, if the antenna is fed with coaxial cable, the ATU will simply make the antenna 'look' as though it is matched. Unfortunately, although the SWR may be 1:1 at the transmitter, the mis-match between the actual antenna and the feeder still remains - along with the consequent loss of signal.

Having a broadband antenna with a good match to its feeder right across the band of frequencies used is a much better solution.

BROADBAND METHODS

WHEN I LOOKED through my large collection of antenna books and journals, there were plenty of ideas for broadbanding wire antennas, but most looked rather expensive or difficult to implement.

There was the traditional cage wire technique - see **Fig 1(a)** - but this looked both awkward to construct and very heavy. Half a dozen strands of copper wire around a circular or square spacer was going to require the skills of a skilled basket weaver to put together - and require a couple of supporting masts with the strength of Xena the Warrior Princess to keep the resulting antenna in the air.

There were other ideas, using complicated arrangements of sections of coaxial cable, and what are known as quarter-wave shunt stubs (**Fig 1(b)**). Although this had promise, it meant the antenna was going to be both relatively heavy, expensive, *and* require a matching unit [1]. Then, I finally found the technique I wanted in an old *ARRL Antenna Compendium* [2] - see **Fig 1(c)**.

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The fat antenna idea described in the compendium by Robert Wilson is a brilliant variation on the old cage dipole principle which has been around since the early days of radio. It is basically a kind of minimalist or skeleton cage antenna - in it, the cage has literally two 'bars' or walls.

What a traditional cage dipole does is to use a large number of pieces of wire that are joined together at the antenna feedpoint, but open circuit at the antenna ends. All these pieces of wire are the same length, fed in parallel and are roughly cut to the middle of the frequency band you wish to cover. Wilson's article is a practical illustration of how reducing the number of cage wires to just two can still produce excellent antenna broadbanding.

Using this simple technique, it is possible to make a two-wire dipole antenna that will cover an entire amateur band - even the almost-2MHz-wide 10m band. Using two equal-length wires spaced by only 12cm, a dipole antenna can be created that will give an SWR of less than 2:1 right from 28 to 29.7MHz, enabling easy operation in the CW, SSB and FM segments of the band. Perhaps the best thing about this is that the resulting 28MHz fat antenna is barely wider than the width of your hand.

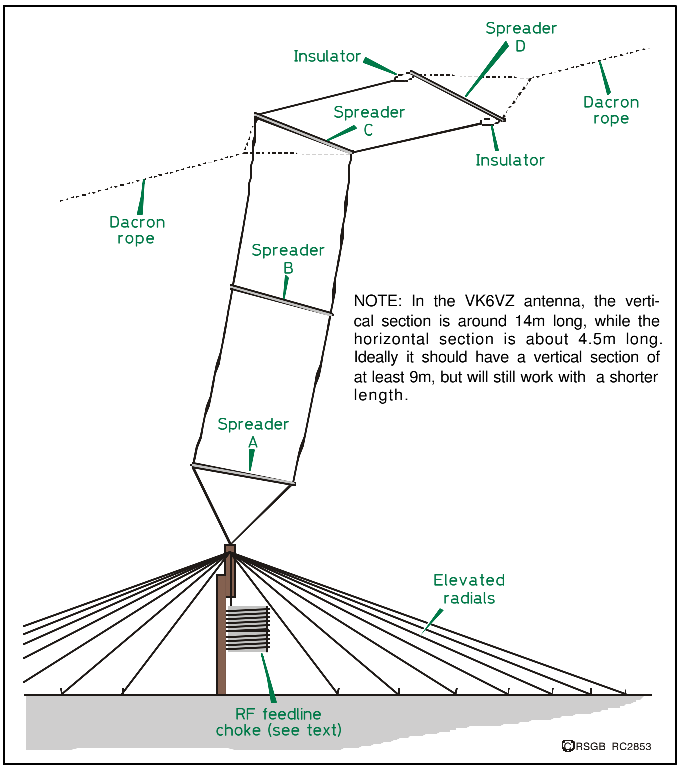

Fig 2: The Glen Forrest Marconi used at VK6VZ.

For those interested in the 3.5MHz band like myself, a two-wire dipole antenna can be made for 3.5MHz that is relatively light, but will cover both the SSB DX window and the CW section of the band and have equal performances in both. All that is needed is to cut the antenna for a centre frequency of 3.65MHz and space the two equal length wires about around one metre apart.

In my case, I was interested in adapting the Wilson technique for a quarter wave 'inverted-L' antenna. After doing some calculations, I also realised that the wideband properties of the resulting 3.5/3.8MHz antenna - around 0.5MHz with a 1.8:1 or better SWR - could be used to produce an antenna that should provide excellent performance and a low SWR as well on all three WARC bands without an ATU.

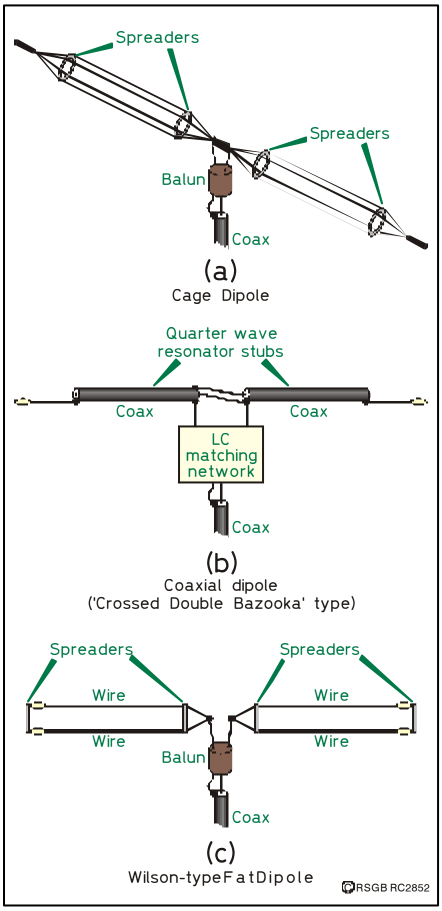

Fig 1: Different methods of broadbanding dipole antennas.

FAT HARMONICS

THE USE OF a half-wave dipole or quarter-wave Marconi-type antenna on odd harmonically-related frequencies is a time-honoured broadcasting and amateur radio technique. This is most popularly used in amateur radio in the form of a 7MHz dipole being used on its third harmonic frequency of 21MHz.

However, a dipole or Marconi antenna will also work well on its fifth, seventh and ninth (etc) harmonics, often offering a match at the antenna's feedpoint that is almost as good as that on its fundamental frequency.

Now the so-called WARC bands at 10, 18 and 24MHz are reasonably closely harmonically related to the 3.5 - 3.8MHz band, being roughly the third, fifth and seventh harmonics. With the narrowness in bandwidth of conventional single wire dipole and Marconi 3.5MHz antennas, their harmonic relationships to the WARC bands are a somewhat 'hit and miss' affair, with the antenna's SWR at the WARC frequencies often poor.

However, with the wide bandwidth of the fat Wilson-type antenna at its fundamental frequency, the performance/SWR bandwidth of the antenna at harmonic frequencies is much more useful than a conventional one. The third-harmonic bandwidth of a 3.5 - 3.8MHz Wilson dipole is at least 0.9MHz, whilst the fifth harmonic bandwidth is around 1.5MHz and the seventh harmonic is about 2.1MHz!

In practical terms, this means that the 18MHz (18.068 - 18.168) and 24MHz (24.890 - 24.990) bands lie well within the fifth (17.5 - 19MHz) and seventh (24.5 - 26.6MHz) harmonic antenna bandwidths.

If the wires of the 80m Wilson-type antenna are spaced about one metre apart and are cut for a centre frequency of around 3.65MHz, the antenna should have a (better than) 2:1 SWR bandwidth of around 0.5MHz. This brings the lower operating limit of the antenna to down to at least 3.4MHz - and into a relatively close harmonic relationship with the 10MHz (10.1 - 10.15MHz) band.

CONSTRUCTION

THE ANTENNA I built is of the classic inverted-L shape and should work effectively with a vertical section as small as eight metres in length. The longer the vertical section, the better the antenna will work on the 3.5MHz band. My antenna has a vertical section of around 14 metres, making it the best 80m DX antenna ever used at this QTH.

As with all Marconi-type antennas, a good earth and radial system is important for the antenna to work at maximum efficiency. The soil conductivity is very poor at my particular QTH, and I used an existing earth system of around 50 radials made of 0.8mm soft-drawn copper wire, ranging from about 6m to 22m in length and elevated about three metres above the ground.

In the past, in the UK where the soil conductivity is generally relatively good in comparison to Australia, I have found that a buried (or preferably elevated) radial system consisting of a minimum of 16 radials of 7m to 10m in length has been an effective 'earth' system for vertical antennas covering the 3.5MHz to 28MHz amateur bands. The greater the number of radials, the lower are the ground losses from the antenna.

In order for the inverted-L antenna to be as robust and light as possible, it is best to construct at least the top part of the inverted-L from 14 or 16SWG hard-drawn copper wire. Hard-drawn copper wire - made from steel wire coated with copper - is springy and will not stretch when it is taut.

My 'Glen Forrest Marconi' (see **Fig 2** and the photograph) has a top section made from two pieces of 16SWG hard-drawn copper and a vertical section made from two pieces of a single conductor of plastic-covered 'figure-of-eight' copper wire (24/0.2mm or 24 strands of 0.2mm wire), available from hardware stores. If plastic-covered wire is used for any antenna, don't forget that using this type of wire will make the antenna three to five per cent shorter (electrically) than if it was made from bare wire [3]. In Australia, you can buy figure-of-eight cable in grey and brown colours, which is much less visible than the more readily available white type.

If the antenna is made of bare copper wire, the two pieces of wire making it should each be around 18.5 metres long, for a centre frequency of 3.65MHz. Adding or subtracting around half a metre of wire will lower or raise the centre frequency of the antenna by about 100kHz. My advice would be to start with both pieces of wire around 19 metres long and shorten them so the lowest antenna SWR (at the transmitter end of the feeder) occurs at 3.65MHz.

Four 1m-long pieces of 12mm-diameter wooden dowel are used to space the two parallel wires that make up the antenna - one close to the feedpoint, the second in the centre of the vertical section, the third at the top of the vertical section and the fourth close to the antenna's far end.

Over each end of the first three spacers are slid 10cm lengths of 'split' 10mm diameter PVC reticulation tubing, which serve as insulators. The fourth spacer has a plastic/nylon egg insulator attached at each end using a 5mm-thick cable tie, which serves to insulate the far ends of the antenna.

The dowel spacers should be varnished with marine-grade varnish in order to weatherproof them, before attaching the antenna 'insulators'. The antenna wires are attached to the spacers using cable ties in a cross configuration - see **Fig 3**.

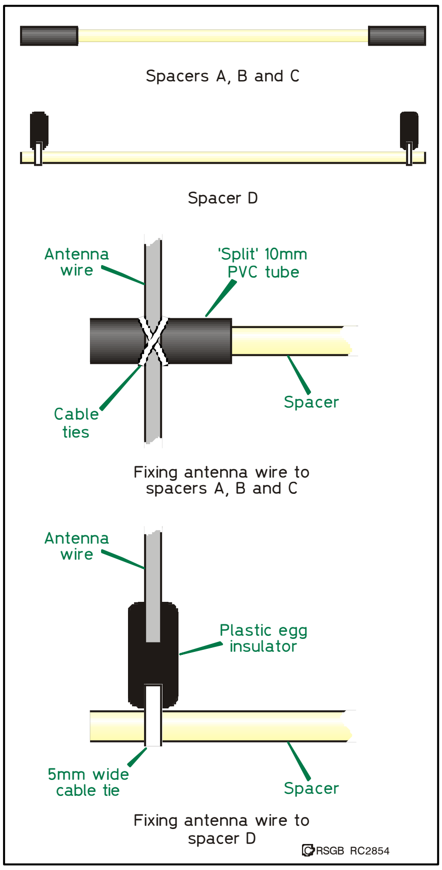

Fig 3: Constructing the spacers.

A 2.5-metre length of 1cm-diameter Dacron rope is attached to the ends of the far end antenna spacer (Spacer D), and the far-end antenna halyard is attached to the centre of the piece of Dacron rope.

The antenna is fed with a length of RG-213 50-ohm coaxial cable, via an RF feedline choke consisting of 20 turns of RG-213 cable wound on a 20cm diameter plastic former (made from an empty chlorine bucket). This choke helps to prevent feedline radiation, in particular on the 3.5MHz band. A more expensive alternative would be the use of ferrite beads at the feedpoint; however, no trace of series resonance has been found on the four bands.

ADJUSTMENT

ONCE THE Glen Forrest Marconi has been erected, it is easy to adjust if necessary. Using a few watts of RF and with the transceiver tuned to the 80m band, plot the SWR curve of the antenna, to find the lowest SWR. If the antenna shows a SWR curve with a lowest SWR at around 3.65MHz, no adjustments ahould be necessary. In these circumstances, if the antenna has similar vertical/horizontal dimensions to the one used at VK6VZ, it should show an SWR of around 1.8:1 at 3.8MHz and an SWR of around 1.6:1 at 3.5MHz - the results obtained at this station.

If the antenna needs trimming, remember that adding or subtracting about half a metre from each wire will lower or raise its resonant frequency by around 100kHz. Take care to add or subtract equal amounts from each wire when making adjustments - unequal amounts will change/distort the broadband qualities of the antenna.

With regard to the 10, 18 and 24 MHz amateur bands, as expected the SWR curves are very flat. The VK6VZ antenna shows an SWR of around 1.5 to 1.6:1 across the 10MHz band, 1.3 to 1.4:1 across the 18MHz band and 1.1:1 across the 24MHz band.

CONCLUSIONS

THE GLEN FORREST Marconi gives a no-compromise performance on the four amateur bands 3.5/10/18/24MHz, with an SWR of 1.8:1 or better across them all.

The performance of the VK6VZ version of the antenna seems in practice to be virtually omni-directional on all four bands, although no antenna radiation pattern plots have been made. If more of the antenna is horizontal than vertical, the antenna will tend to become directional in the direction of the horizontal part of it, in particular on 18 and 24MHz.

On 3.5 and 10.1MHz, contacts have been made by VK6VZ with stations all over Europe, Asia and North America, while its DX performance on 18 and 24MHz is as good as any single-element type of antenna I have used on these bands. 24.8 MHz produced a QSO with the TO0DX DXpedition on the St Pierre et Miquelon Islands (a very difficult area to contact from VK6) for an all-time new country - through an enormous pile-up of Europeans.

The total cost of the antenna (less the RG-213 feeder/feedline choke) is estimated at around £25 sterling.

The antenna has been up now for around 12 months and deals well with the strong winds that can be experienced at this location at Glen Forrest, near Perth in Western Australia. ♦

REFERENCES

[1] *ARRL Antenna Handbook*, ARRL 1988, 15th edition, p9-5.

[2] 'Fat Dipoles' by Robert C. Wilson, *ARRL Antenna Compendium Vol 2*, p106, ARRL 1992, available from RSGB Books.

[3] 'A Compact Supergain Beam Antenna' by Dick Bird, G4ZU/F6IDC, *Amateur Radio Action Antenna Book No 5*, published in Australia.