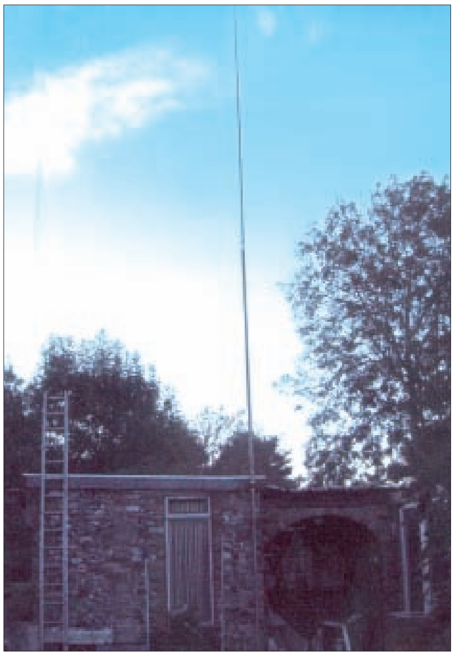
Antenna Workshop

The PW Needle
a vertical antenna for 1.8MHz



Ian Keyser G3ROO pulls the threads of his vertical antenna for the 1.8MHz band together, and explains how it has enriched the tapestry of his 'Top Band' logbook!

For several years on the lowest frequency Amateur band, known affectionately as 'Top Band' (though no longer, as we've now got 137kHz!), I've been using a Marconi T antenna with an 18.5m vertical section. This, combined with a good earth system, has proved to be a winner.

Unfortunately, there are very few of us that have the space to accommodate such a system so excluding many from the excitement of working DX on this great band. What is needed is a practical system that many more could erect in the more commonly sized garden.

In practice large number of guy wires make any tall, potentially unobtrusive systems, very ugly. What I felt was needed, was an extremely strong self-supporting 'needle'. The antenna is designed for 1.8MHz, but by altering the number of turns, it can be made to function on any other of the lower frequency bands.

Fig. 1: The top three metres of the roach pole are wound with a turns pitch of 12-13mm, and the lower two metres are close-wound with wire. This is the change over point. Note the use of masking tape to hold the wire temporarily in place.

Important Aspect

Probably the most important single aspect of any vertical antenna system is the antenna ground. Here it cannot be stressed strongly enough that any work done on the earthing system will pay off in the long term. And it will also make apparent an improvement in the performance of the overall system.

With this antenna, **or indeed any antenna system**, it's important to take into account the 'windage', or sideways pressure, it will have to tolerate due to winds. In practice, the forces experienced on this 'needle' antenna are a lot weaker than you may imagine.

If you have a long scaffold pole you can carry out an experiment. When there's a windy day in your area, stand the pole on the ground supporting it at shoulder height and as upright as possible. You'll find that you can hold it with relatively little effort.

In fact, it's harder to keep yourself upright without the pole! The antenna described here takes advantage of this effect and is supported at a point 2.5m high on the facia of an outbuilding. The remaining nine metres are fully exposed to the south-westerly winds that are predominant here in Kent where I live.

I live some five kilometres from the White Cliffs of Dover, and about125m above sea level and we experience severe winds, sufficient to cause damage to our house roof every year. Though causing building damage, these winds deflect the top of the vertical antenna little more than two metres or so. During last year, the antenna suffered no damage whatsoever.

Relatively Simple

Construction is relatively simple. For the top section, you'll need a five metre roach pole and remove and retain the base screwcap and its plug, but leave the sections inside. It's essential to leave these inside as the large sections **cannot be inserted later** through the finished assembly.

Next take a 300mm length of 25mm diameter Dural tube (salvaged, say, from an old beam antenna) and apply layers of pvc tape to increase its diameter to make it a snug fit into the base of the roach pole.

Then, add another ring of tape, around the middle of the tube so that when it is inserted into the base of the glassfibre fishing pole there is no free movement of the pole on the alloy tube. Anyone who has used a good quality pvc tape in antenna systems will know how well it sticks. After a year or so, it's necessary to carve it off, not unwind it!

You'll then have to mix up a quantity of epoxy-based car body filler before withdrawing the dural tube so that the end padding pvc ring is only just inserted in the glassfibre pole.

While slowly inserting the dural tube back into the glassfibre pole, pack the intervening space with the body filler. When the second ring of pvc tape is securely within the glassfibre pole, finish off neatly with more filler and clean up.

The screw-on end cap that you retained earlier has a rubber insert that may be removed. Carefully increase the diameter of the hole, left in the base of the cap to allow it to pass over the dural tube. Then feeding the screwcap back onto the roach pole base, screw the it back onto the bottom of the fishing rod, thus making a very neat final assembly.

You can then pull out the inner sections of the roach pole, pulling each of the overlaps to make them secure. Using more pvc tape to wind around each of the joins of the roach pole. Lay the first couple of layers on the smaller tube, hard up against the 'shoulder' of the larger tube. This ring you've just created would be the first line of defence against the pole telescoping back into itself.

Keeping the tape under some tension, you should then make several more turns over the joint area to ensure waterproofing and increasing the strength of the joint, five or six layers of tape should be adequate. Finally, cover the taped area with a layer of masking tape, as the whole assembly will be painted after tuning.

Top Section

Winding the top section of the antenna can be exceedingly tiring, especially on the fingers. I suggest that you find a comfortable place to sit with plenty of room to accommodate the five metre pole.

I'd also suggest, that you have a roll of masking tape to hand, preferably in a tape dispenser, to make temporary fastenings to hold the wiring in place while you take a rest. The only other requirement is the wire for the coil. I used a 100m roll of pvc covered wire 24/0.2mm (RS 356-684).

The wire you use is not really important, but I favour pvc covered wire as enamelled insulation can easily get damaged. To reduce resistive losses, it is advisable to use a reasonably heavy wire ... and 24/0.2mm is a reasonable compromise.

Feed the end of the wire through the small eye at the top of the roach pole and make secure with pvc tape. Then twisting the pole with the left hand and gripping the wire and the pole with the right hand feed the wire on with a spacing of about half an inch. At intervals, it's advisable to fasten the windings with a layer of masking tape in case the pole is dropped!

When there's about two metres of pole remaining, securely tape with masking tape and commence close winding until the end of the pole is reached, securing it with masking tape again. The photograph, **Fig. 1**, shows the point at which the wide spacing becomes tightly wound turns.

Finally, when you come to the base of the roach pole stop winding the wire just above the point where the metal tube is inside the pole. Secure this point in the winding with temporary layers of pvc tape leaving a good length of wire free. Note: adjustments to the number of turns may be needed later, when the wire is clamped to the scaffold pole.

Fig. 2: The alloy joining tube fitted into the top of the scaffold pole, using four clamping bolts. The alloy tube has been strengthened with wire mesh and car body filler.

Bottom Section

For the bottom section of the antenna I've used a 6.5m dural scaffold pole, although the most commonly available ones are a little under 6m this will make little difference. I purchase my poles when required from the local scaffolding firm and pay about £3 per metre (£1 per foot).

Four holes are drilled at the top end of the scaffold pole, to form a clamp for the dural tube. Start by drilling a pair of holes some 15-25mm from the top of the pole, and spaced about 45° apart around the circumference. At a point 100mm lower down the scaffold tube, and directly in line with the first pair of holes, make a second pair of holes.

The four holes that you've drilled need opening out and suitably tapping for 8mm diameter bolts. These bolts are used to clamp the one inch dural tube to the inside of the top of the scaffold pole. (This point is shown in the photograph, **Fig. 2**.).

As this scaffold pole forms the bottom part of the antenna, a further 3mm hole is drilled and tapped between the top and bottom pairs of fixing holes. This will be used to provide an electrical connection to the top section.

Support Points

Now let me turn to the support points for the antenna. You will see from the photograph of **Fig. 3,** that the clamping to the facia board is made using a 'saddle' of 1.5-2mm thick steel plate and a section of plastic tube taped to the pole as an insulator.

The base support is formed from a 900mm length of 12-15mm diameter (0.5 inch) bolt or spike set into a slab of concrete. If you have a suitable block of concrete, then you can drill a suitable hole to embed the spike in. Otherwise set the spike in a new section of concrete. Either way leave it so that around 200mm is still showing above ground.

As the system is a vertical antenna **it must be insulated from ground at all times** so, a conical chunk of plastic is drilled and fitted over and around the steel rod. This plastic 'lump' acts as the base insulator, **Fig. 4**. The impedance at this mounting point and ground is low, so insulator requirements can be lax and almost any non-moisture absorbing insulator may be used.

The roach pole and alloy tube can now be mounted in the top of the scaffold pole, clamp off securely with the 8mm bolts. **Note:** do not over tighten these bolts, as they are just to hold the alloy tube securely, but needn't form an electrical join.

Make a temporary connection between the end of the coil and the 4mm connection to the scaffold pole and check continuity between the ends. Now make a four turn coil of hook up wire and connect this to the base of the scaffold pole and the ground system.

The pole is then lifted to the vertical and mounted in position. Next using a g.d.o. check for resonance (mine came out at 1.7MHz at first attempt). Then adjust the number of turns on the top section so that the point of resonance is in the section of the band that is of primary interest. Of course, if you are using an antenna analyser, it's likely that you can couple directly to the antenna without the coil.

Earthing Systems

The various methods of antenna earthing systems is a subject so wide that a book could be written just about it! Arguments for buried or elevated radial systems, buried copper tanks or multiple rods abound.

However, I think buried radials are a pain to layout and insert, elevated radials

Fig. 3: The support 'saddle' around the lower section of the scaffold pole, has a short section of plastic water pipe fitted around the pole to act as an insulator with pvc tape holding it in place.

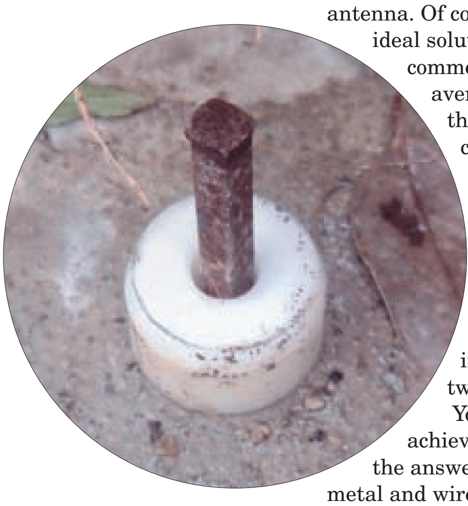


Fig. 4: The base mounting insulator around a metal spike set into a block of concrete. See text for more details.

get in the way of almost everything and everybody. My own technique and the one I'm in favour of, employs a system of multiple earth rods. Not only earth rods close to the antenna, but also some, which are connected together ... but placed as far away as possible from the base of the antenna.

For lowest angle of radiation, the 'earth' must be a good many wavelengths long from the base of the antenna. Of course, a huge earth-mat would be the ideal solution and is one that many commercial transmitter sites use. But the average Radio Amateur cannot excavate the vast area of ground and lay a chicken wire earth mat and replace the soil.

However, I've found a way that is a very good compromise. With the co-operation of my neighbours, I have a 1.5km of earth radial to the south, 600m of radials to the west and 200m to the north and installing the whole lot only took me two days!

You may ask how did I manage to achieve this effective earth system? Well, the answer is that I used my neighbour's metal and wire fences!

During a visit to the local scrapyard I found a huge amount of 22mm copper tube in 900mm lengths and a coil 7/22 bare copper wire. I came away with a trailer full for £20. Onto the top of each tube I wound a 450-500mm length, leaving some of the copper wire free, around the top of the pipe and soldered it in place using plumber's flux and a blowlamp.

Prepared Tubes

Armed with the prepared tubes, blowlamp, solder, flux and a club hammer, I set about modifying my neighbours' fences. And to start with, the bottom run of wire along each of the fences, was cleaned every 10m or so.

At the cleaned-up points, one of the prepared tubes was driven into the ground with the club hammer. The free length of copper wire was then used to join the bottom wire of the fence to the driven in post.

Note: as you progress along the fences, check all wire joints between the separate sections of the fence. Solder a copper strap across them if you are at all unsure of their connections. It really is quick, especially if the galvanising of the wire is good. In one case, the complete section of fence was so bad I replaced the bottom strand with new wire.

The antenna has really proved its worth, giving world-wide QSOs on the 1.8MHz band. But as I've mentioned before, the ground is really important and this shows up at this location during dry weather. We have a light loam soil on top of 200m depth of chalk rock. This drains very quickly so, that in dry weather DX is just not workable!

Other Bands

To modify the antenna for other bands, you must reduce the number of turns on the close wound coil for resonance and set-up using test equipment such as a grid (gate) dip oscillator (g.d.o.). (*I can recommend an antenna impedance meter such as the MFJ-259 as possibly better still.* **Editor**)

To create an antenna suitable for the 7MHz band, a single wire will suffice. Another alternative is to use the helically wound 160m vertical and an automatic matching unit (a.m.u.) at the base to enable it to work on all bands.

For mono-band operation, a simple L-match network at the base will enable the antenna to be matched across the band. The feed impedance of the basic antenna will be very low, in the order of 10Ω or so requiring this type of feed matching.

For the 1.8MHz band and with a good earth, I've found that a 1.5μH coil in series with the antenna and a 3000pF variable capacitor to ground will be ideal. Although to cover a variety of antenna lengths and feed-point impedances, I've shown the inductor in **Fig. 5** as a variable 2.5μH component.

In practice due to earth losses, an antenna analyser may perhaps show a near perfect match to 50Ω without the matching network. In this case, the antenna will still work, but will be indicative that the earthing system could do with yet more work!

See you on 'Top Band'! *PW*

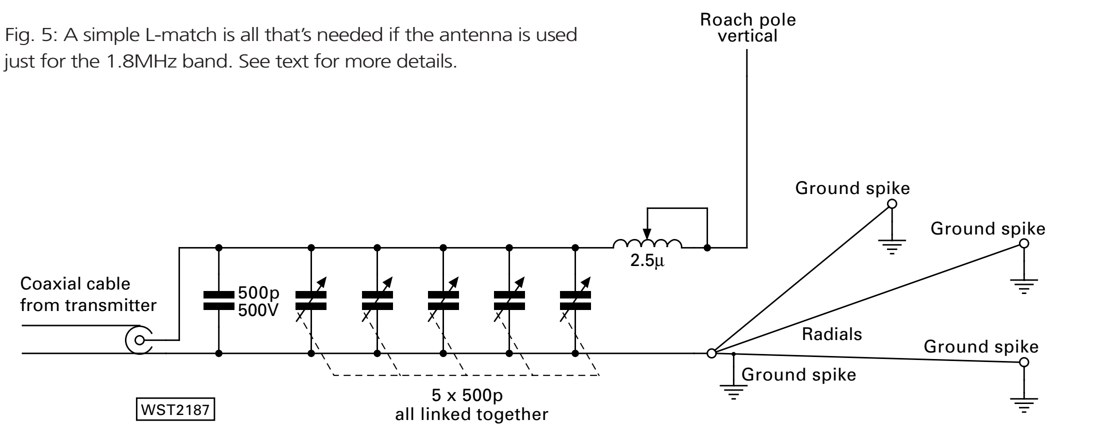


Fig. 5: A simple L-match is all that's needed if the antenna is used just for the 1.8MHz band. See text for more details.