RADCOM TECHNICAL FEATURE

An Effective DX Vertical for 80m

by Ron Stone, GW3YDX

IN THE CONSTANT SEARCH for a good DX aerial for the 80m band, anything was tried except for a vertical. Delta loops, high dipoles, half and full slopers all gave reasonable results but did not seem to match the results enjoyed by users of big verticals on the band. The reason for avoiding verticals was pure sloth. The thought of ploughing in miles of radials had always put the author off, but one weekend, in an unusual fit of enthusiasm, out came the spade to dig a hole for the ground post for a vertical and to slit the soil for a system of radials.

To judge the effectiveness of all this work, an 80m delta loop (lower corner feed) [1] was used as a reference aerial. Because of uncertainty about the eventual results, the vertical had to be a low-budget exercise, using on-site materials, costing less than £50. In the event the project cost just £1 - the cost of a suitable scrap piece of steel section from a local scrapyard.

A full size quarter-wave vertical for 80m is about 68ft high at the CW end of the band. Such a structure, made out of 2in tube, would need two sets of guys as a minimum. Although there are no neighbour problems at my country QTH, XYL opinion meant that only one set of guys was acceptable, so a design about 45 to 50ft high seemed indicated. Experience with shortened yagis over the years had shown that a mixture of capacity hat and inductive loading seemed to give the best results in terms of retaining usable bandwidth whilst physically reducing the size of the structure.

Experimentally, the design shown at **Fig 1** was evolved. The capacity hat above the loading coil is formed by 6 ft long steel wires that form the top section of the three guys. The wires used should be stranded, galvanised for protection, and not less than 0.125in diameter. They are electrically connected to the vertical just above the coil at about 33ft from the ground. The remainder of the guys consist of 5mm diameter polypropylene or nylon rope down to ground level, where they are made off to galvanised steel pickets which should be set into the ground so that at least 3ft of the picket is underground. The three guys thus fitted have held the aerial up for five years now with no problems.

Physical construction of the ground post and the radiating element posed few difficulties. The ground post is an 8ft length of T-section steel, 3in across the top of the 'T', and made out of 0.25in thick material. Anything will do provided it is reasonably strong and is wide enough at the top of the 'T' to take 2.5in exhaust clamps. The post was drilled at one end and at the midpoint to take exhaust clamps. A hole was dug and the post hammered in so that the drilled holes at the midpoint were about 3in above ground level.

The bottom 20ft. of the radiator is a 2in OD dural scaffold tube. The next 13ft is 1.5in OD tube - 16SWG - which is a good fit into the scaffold tube. Tubing shims were then cut so as to accommodate 1.125in OD fibreglass tubing into the upper tube. A good source of high quality fibreglass tube is Sandpiper Communications [2]. The fibreglass section is about 18in long. Six inches of it goes into the lower part of the aerial, a coil is wound on the central portion and the upper portion fits into the tubing which makes up the rest of the vertical element. Above the coil the remaining 20ft of the element is made out of telescoping sections of 1.25in and 1in OD alloy tube. The loading coil is 50 close-wound turns of 16SWG enamelled copper wire, the turns being held in place by three coat of marine varnish. If the antenna is to be used on both 3.5 and 7MHz, a 7MHz parallel resonant trap could be used instead of a simple coil thereby giving the configuration of 'half a trap dipole fed against ground'. All assemblies are held secure by either self tapping screws or hose clamps as appropriate. All hardware should be stainless steel and it is particularly important to use stainless steel washers in screwed connections between copper and aluminium to avoid corrosion caused by the cathodic process.

A triangular plate was made up out of 16SWG alloy scrap, with three 0.25in holes drilled at the apex points, and a 1.25in hole at the centre. This plate was slid over the end of the uppermost tubing sections and positioned to rest on a hose clamp on the tubing just above the coil. Braid from RG58/UR43 cable was fitted as a short strap to ensure a good electrical connection between the loading wire assembly and the upper part of the radiator. This strap should not be omitted as the contact between the plate and the radiator is not in itself sufficient to assure good electrical continuity. A bad or intermittent contact at this point may give rise to intermodulation products from the transmitter or RFI. The loading wires and guys are made off to steel plated thimbles and attached to the triangular plate with galvanised shackles. All physical connections should be checked for physical integrity and given protection against the weather by a liberal coating of a proofing compound such as Maplin Flexible Rubber Sealant.

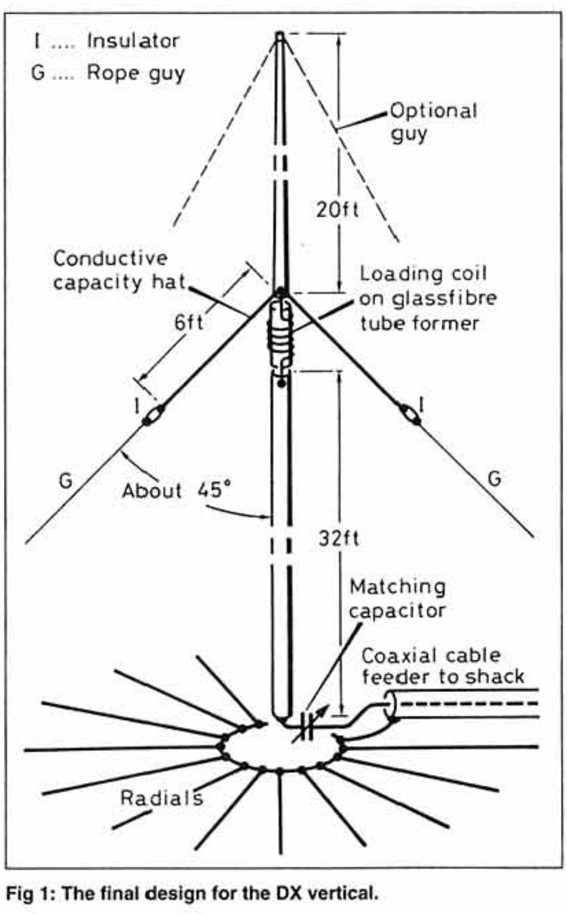

Fig 1: The final design for the DX vertical.

RAISING THE ANTENNA

HAVING PUT A BRICK at the base of the ground post so that the mast radiator would be kept an inch or two from the ground, the mast was raised. Exhaust clamps were inserted into the prepared holes in the ground post, and the mast attached temporarily to the post. The mast needs to be insulated from ground and to achieve this, 3in lengths of PVC drainpipe were slit along their length. The insulators thus formed were folded around the scaffold tube to go between it and the exhaust clamps. As the exhaust clamps are tightened, so the PVC will overlap. That doesn't matter. PVC tube as used has a puncture voltage of many kV, and as the insulators are at a low RF voltage point, they are more than adequate.

With the exhaust clamps tightened, the supporting brick can be removed, and the guys made off. The general configuration is shown in Fig 1.

SAFETY RULES FOR ERECTING LARGE ANTENNAS

THE MAST IS a heavy structure and before and during its erection the following safety rules *must* be observed [these could be usefully applied to other large antennas - *Ed*]:

1) A rigorous check should be made that there is no risk of the mast coming into contact with any overhead electricity distribution wiring. All possible directions of toppling should be considered.
2) Before erecting the mast, the job must be carefully planned. Planning will include consideration of where each part of the structure will be at each stage of the lifting process. There should be no possibility of tripping on ropes or any lifting equipment. Enough personnel should be available, and all should wear boots, gloves, and safety helmets during the mast raising process. The operation should not be attempted in strong winds or when it is getting dark. Also sufficient guiding ropes should be provided.
3) Prior to raising, all components used in construction of the mast should be double checked for being fixed firmly and safely, as should any extra equipment provided for the lifting operation.
4) The base of the mast must be firmly fixed to prevent slippage.
5) Everybody shall have their role specified. Those not needing to assist should be kept clear. This rule applies especially to children. If any children are nearby, a person should be 'detailed' to keep them clear of the operation or anywhere the mast may fall. Animals should be kept under control.
6) One person (preferably with experience of such operations) should be in charge, and not given any part of the lifting operation proper. Instructions given by the person in charge shall be clear and concise. eg "Up, Down, Inch up, etc", and not long sentences.
7) Risks must never be taken, - there is always enough time for safety. A First Aid kit should be available, together with someone who knows how to use it. All those involved should be familiar with the procedures for summoning emergency assistance.
8) The observance of safety precautions as above must be continued until all the mast fixings and guys are secure, and until the temporary ropes etc are safely coiled and stored away. All those who normally have access to the site should be reminded of the presence of the new structure, and not to touch any part of it, as RF energy may be present.
9) After erection, the mast should be regularly inspected for tightness of bolts, physical and electrical continuity, and for the integrity of any weather protection coverings.The static leakage resistor should be tested with a meter, and the spark gap adjusted if necessary. Every three years (more often in seaside locations) the mast should be lowered in a safe manner and all connections checked.

DOWN TO EARTH

NOW COMES THE HARD work. The radial system was put down 'in instalments', as set out below. The type of wire used is not critical. Gauge is not a significant factor if many wires are used, as the ground currents are shared between them [3]. The wire is preferably copper or aluminium. Even steel is acceptable, but corrosion will be worse than with the other materials suggested. Insulated wire is best as corrosion is much reduced.

The length of the wires is not critical, but the longer they are, the better. However, many short radials are better than a few long ones. Current suggestions are that elevated ground planes of resonant radials give a better performance than most amateur buried radial systems. However, elevated radials would have caused an unacceptable obstruction and were not tried. In this design, 40 radials were laid, varying in length from 50 to 80ft. The need to bury the wires is a myth. On the surface will do, but in this installation the wire is buried down about three inches so that the goats on the land (curious, nosey animals) do not chew the wire and destroy it.

To put the radials in - and it is long, hard work, the ground is slit with a spade, and the wires pushed in. A useful tool for this is an old screwdriver with a 'V' notch filed into the end of the blade. It is a lot better than using the fingers. All the radiators are brought together at a common point at the ground post and weatherproofed with compound. The next step is to fit the 50Ω feedline, matching system (see below) and static / lightning protection assemblies to the aerial. Protection against receiver damage by static build-up is afforded by a 1MΩ, 5W resistor (five 4M7 Carbon film 1W resistors - eg Maplin C4M7 - in parallel) from the base of the mast radiator to ground. Lightning protection is implemented by an adjustable spark gap with the gap adjusted to 2mm. The spark gap is implemented by a simple lock-nut and bolt arrangement at the base of the mast radiator.

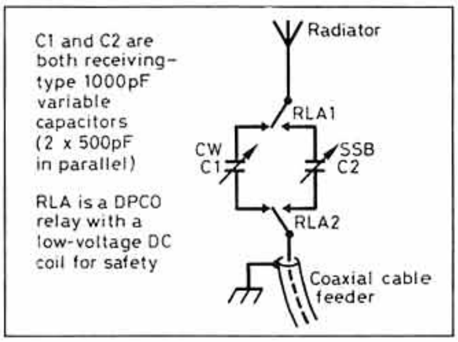

Fig 2: Both ends of 80m can be covered by using remotely controlled switched capacitors.

FINAL ADJUSTMENTS

WHEN CHECKED WITH A GDO, the aerial system resonated at about 3.2MHz, ie it had an electrical length of about 80ft or 0.3 wavelengths. To match the system to the feedline all that was required was a capacitor to tune out the excess inductive reactance at the desired operating frequency. As the capacitor is present at a low voltage point, a receiving variable is quite up to the job, even at full legal power output.

The author mainly uses CW, but now and again goes up the band to 3.8MHz on SSB. Using the aerial at both extremities of the band was a design requirement. The aerial did not have enough bandwidth to work over the entire band with a low VSWR, so to make operation possible on both 3.5 and 3.8MHz, a simple switching arrangement was used. All that is required is a relay and two variable capacitors in a weatherproof box at the base of the aerial, the relay being remotely energised from the shack.

The circuit is shown at **Fig 2**. There is a slight amount of residual VSWR using just a capacitor. A neater solution would have been an L-match network [4], but the ice-cream box used to house the relay and capacitors was not big enough. In any case the VSWR of the system is less than 1.5:1 at the operating frequencies, which is quite low enough.

COMPARISONS AND CONCLUSIONS

AS FAR AS RESULTS and comparisons with the delta loop were concerned, as an experiment the radials were put down in instalments, tests being made at each stage. Initially, only four 60ft. radials plus a single 3ft earth spike were used. After a week of testing the general conclusion was that the vertical was, on average, one S-point down on the delta loop to DX. The 'break-even point' came at the 16 radial level. At that stage the two aerials were giving roughly the same results to distant parts, with the vertical responding less well to European signals, in itself quite a benefit.

At the 40 radial level, (some 2,500 feet of wire) the author's back was sending S9 signals that it was time to stop, and reports from the vertical were usually one S-point better, and sometimes even more, compared with the delta loop. When you consider that the apex of the delta loop was over 90ft from the ground, that was a very rewarding result.

REFERENCES

[1] 'Loop aerials close to ground' L Mayhead, G3AQC, *RadCom* May 74.

[2] Sandpiper Communications, Unit 5, Enterprise House, Cwmbach Industrial Estate, Aberdare, Mid Glamorgan CF44 0AE.

[3] 'The W2FMI ground mounted short vertical' J Sevick, W2FMI, *ARRL Antenna Anthology*.

[4] 'The Apartment Dwellers Dilemma' McCoy, W1ICP, *ARRL Antenna Anthology*.