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antenna workshop

John Heys G3BDQ continues his experiments with Slinky toys as antennas.

Professional radio engineer **H. H. (Harold) Beverage W2BML**, invented his low noise receiving antenna in 1921. During the First World War, signallers using very simple crystal sets discovered that if their long wire antennas (which were often shot down by enemy fire) were laid out on the ground, that good low noise reception off both ends of the wire became possible. Beverage improved upon this but raised the height of his very long wires to about three metres above ground.

The optimum length of a Beverage antenna lies between one and four wavelengths at the frequency of operation. So, on the 1.8MHz (160 metre) band it's a physical impossibility for most Radio Amateurs to have a full-sized Beverage antenna in their gardens.

Even though a full sized Beverage antenna needs considerable signal gain at the receiver, it still delivers a superb signal-to-noise ratio at the input. Because of the low signal level, an additional stage of r.f. amplification is often needed. This shouldn't be a problem as many modern transceivers now employ two r.f. gain stages in their design.

The classic Beverage antenna is usually grounded via a non-inductive resistor at the end farthest from the feed-point and this greatly reduces any pickup of noise or signals located away from the run of the antenna wire towards the terminating resistor. My version of the Beverage doesn't have a terminating resistor as I wanted good DX reception from most directions.

Too small

Although I'm fortunate in having a 70m long garden it's still far too small to accommodate even a one wavelength Beverage for 1.8MHz. But having read that some American Amateurs were having great success with physically shorter Beverages made up from two to four Slinky coils in series pulled out to total lengths of 50–70m (150 to 200ft approximately), I decided to try my hand with some spare Slinky toys that I had in my 'junk' cupboard.

Readers of *PW* must, by now, be familiar with my use of the Slinky toy for a variety of antennas and I'm now becoming very used to employing them in antenna projects. Having 70m of garden length I decided to use four of the Slinkys to form the antenna. I'm also fortunate in having a garage wall with a useful fixing point for the antenna at the house end and a 4m aluminium pole tied up against a sturdy tree at the far end of the garden.

My resolve to go ahead was strengthened when I acquired a copy of *DXing On The Edge, The Thrill of 160 Meters* by **Jeff Briggs K1ZM** and discovered a simple design for a Slinky Beverage antenna. There's another metal coil toy very similar to the original American Slinky and it is called 'Springy'. They're very similar to – and perform just as well as – the Slinky does. The vital statistics for both types are as follows:

Diameter:
Slinky, 69.5mm,
Springy, 68mm

Number of coil turns:
Slinky, 87
Springy, 76

Conductor length:
Slinky, 19m (60ft)
Springy, 16m (52ft).

Both the Slinky and the Springy types can be soldered, after their surfaces are abraded with sandpaper or file. You'll also need to use an hot heavy duty soldering iron too.

Antenna Construction

Slinkys (or the Springy toy) are very 'bouncy' things and a stout catenary rope is needed to support them. I used a 75m length of rope with a 5mm diameter, which is usually used to support the masts of small yachts. It's made with man-made fibres and is rot-proof and long lasting. It dries out rapidly after rain.

After sliding the Slinky onto the

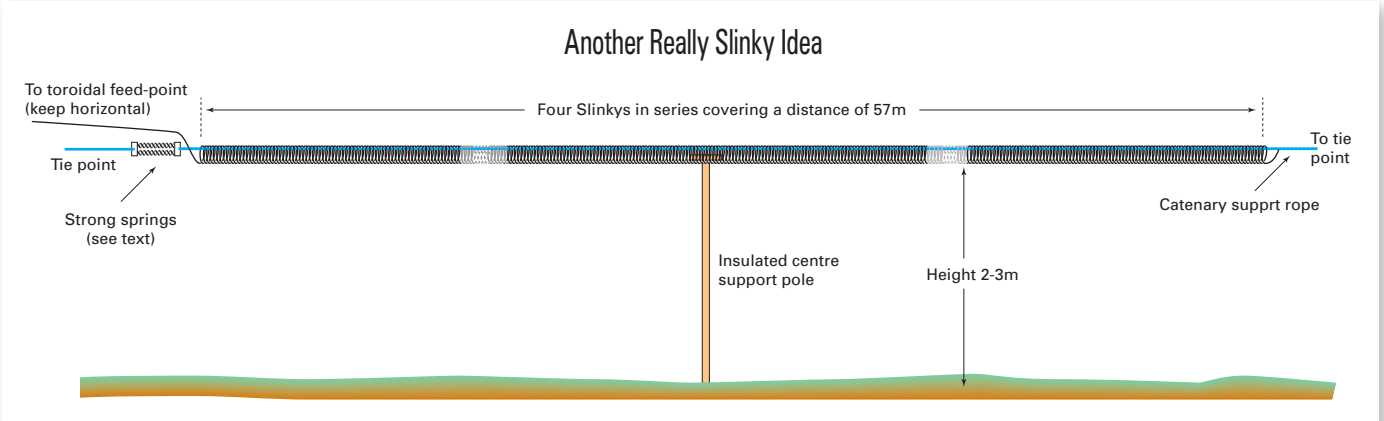

Fig. 1: The overall layout of the Slinky Beverage (not to scale) made and used by G3BDQ. The short connections from the matching box should run as near horizontal as possible.

rope, to reduce sag, I used a couple of strong springs (salvaged from an old 'Anglepoise' lamp) arranged in parallel, at the house end of the rope to put tension on the rope. I then used nylon cable ties keep the ends of the Slinkys in place.

Other ties were positioned at 2m intervals along the catenary rope to give anchoring points for the Slinky coils. To further help in reducing sag in the support rope, I put up a lightweight fibreglass pole as a support in the centre of the antenna. The antenna runs in a straight path, which is important, with an average height of 3m above ground and overview of the antenna is shown **in Fig. 1**.

The characteristic impedance of a long wire 3m above ground lies between 400 and 600Ω and it behaves like a two wire transmission line. I have assumed the line impedance of the Slinkys to be very similar. The Beverage pundits say that a slight 'dog leg' of no more than 30° (in the run of the antenna) is acceptable if such a deviation cannot be avoided.

Must Be Matched

The impedance of the feed-point of the antenna must be matched to the low impedance coaxial feeder. So, assuming that the average impedance of the line of Slinkys is about 450Ω, this would require an impedance step-down of nine times to achieve a match. Such a 9:1 impedance step-down is relatively easy to create and is achieved by winding a simple auto-transformer with a few turns on a toroidal core.

The matching toroidal transformer must present an impedance of 450Ω at 1.85MHz so I experimented by using a toroidal core that was bought from the RSGB for EMC purposes. The transformer is shown in **Fig. 2** and its seven turns has an inductance of 40μH which is needed to match the 450Ω antenna impedance.

My Multimeter has an inductance range, which simplifies the determination of the number of turns required. If the toroid you have to hand is different, you'll need to do some experimenting to achieve 40μH, or at least close to this value.

The toroidal core must be of an high permeability type material, so that only a few winding turns are needed for the coil. The winding is tapped one-third of the way from its 'earthy' end, this gives a turns ratio of 3:1, which therefore has an impedance ratio of 9:1. This tap point is suitable for either 50 or 75Ω coaxial cable feeder.

The Matching Box

The toroidal transformer must be housed in a screening box and I used a small diecast aluminium box that had been used for an earlier project.

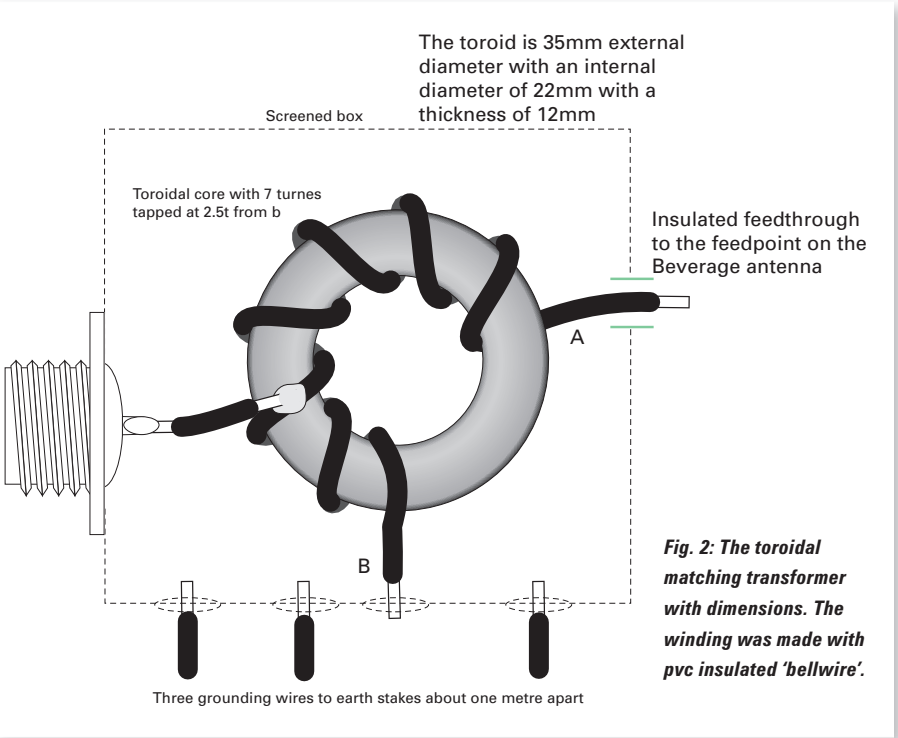

Fig. 2: The toroidal matching transformer with dimensions. The winding was made with pvc insulated 'bellwire'.

Because of its previous use, it had to have several large holes covered to maintain the screening. The toroid should be held in position but away from the metal box wall and a common earth point connects to the coil winding and the braid of the outgoing coaxial feeder.

As shown in Fig. I, the wire marked 'X' should run horizontally to the end of the first Slinky in the line. You should also try to avoid vertical wiring for this will degenerate the low noise characteristic of the Beverage. The box connects to grounding point, which in my case was made with three copper rods into a 'flower border' just below the box.

The grey, painted box can be seen in the photograph of **Fig. 3** mounted against my garage wall and level with the run of the antenna. To try to avoid, or at least minimise, earth line inductance, I used the copper braid from some scrap thick coaxial cable for the connections to the ground rods. If, as is prefereable, you use more than one earth rod, then you should space them at least one metre apart and preferably one and an half metres apart.

The coaxial cable I used to go from the feedpoint to the shack, is the double-screened 75Ω impedance variety as used with TV antennas and is white in colour. Ordinary 50 or 75Ω coaxial cable may be used, for the matching isn't a critical factor.

A Beverage receiving antenna has a very broad-band characteristic because it's an 'aperiodic unresonant' wire. The Slinky coils with their relatively high ohmic resistance will also contribute in making the antenna broad-band. Each Slinky has an end-to-end resistance of around 2Ω.

The figure of 2Ω is an ohmic resistance and isn't to be taken as the r.f. resistance. This is perhaps why, antennas made with the toy coils work so well. The bandwidth extends to the 3.5MHz (80m) band and I find that my antenna is very good on that band.

Initial Test

An initial test of the antenna's performance is to tune to a local or semi-local station using sideband mode while using the main station antenna. Then switch over to the Beverage antenna. The rig's S-meter reading will fall, often by several

points, but the signal will be loud and clear with little or no background noise.

The advantage of a Beverage antenna is that the attenuation of the background noise is greater than the attenuation of the wanted signals. This advantage is fortunate because it allows the reception of weak stations that are almost unreadable on the station transmitting antenna - even if the signal strength is much higher.

My Slinky Beverage seems to show little directivity in the reception or radiation pattern. The greater all-round reception capability of this antenna, is no doubt because I don't employ a terminating resistor at the antenna's far end. I have been able to contact c.w. DX signals that come in broadside to the antennas length, directions that would display nulls with a terminated wire.

Practical Guide

This, article has been written as a practical guide to the making of a low noise receiving antenna for 160 metres and I've not gone into the principles of how and why Beverage antennas work. The reader will find some quite lengthy explanations of their performance in several standard antenna books. I can recommend *The ARRL Antenna Book 20th Edition* and *Low Band DXing* by **John Devoldere ON4UN**, which has a very comprehensive section devoted to Beverage antennas.

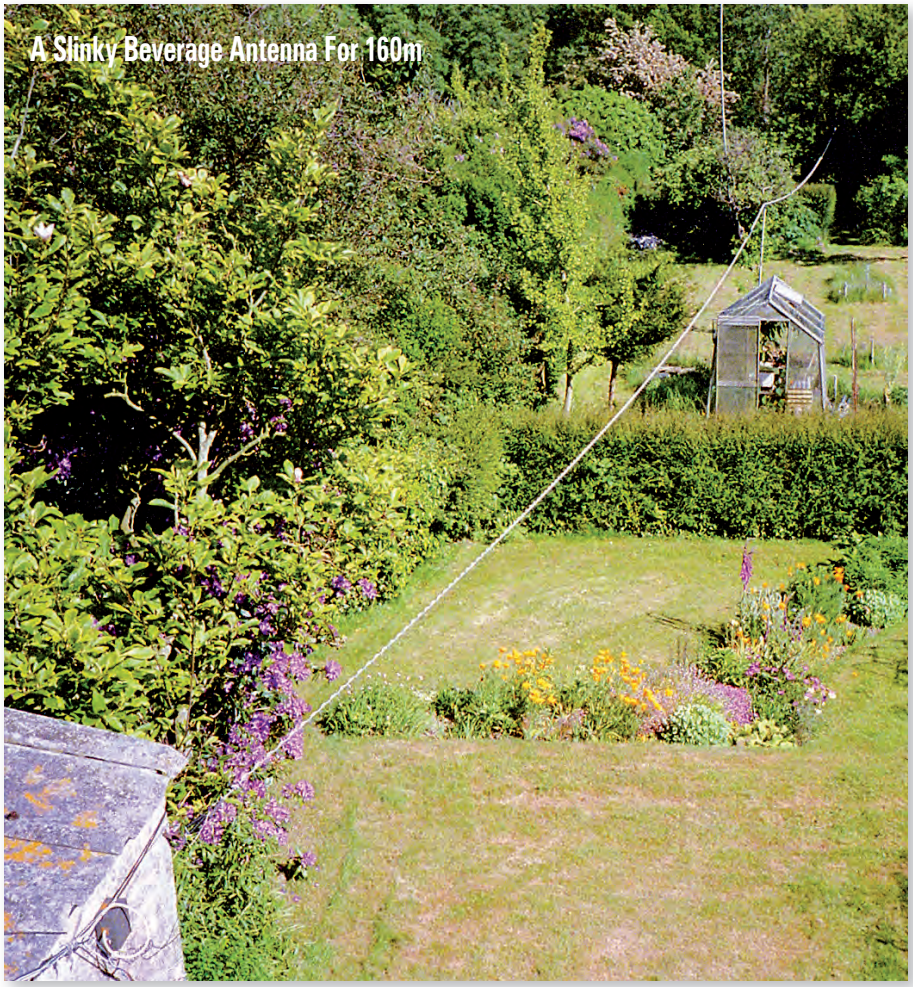

Fig. 3: looking down the garden and out onto the feed end of the Beverage antenna, mounted on the garage wall. The earth return lines go to three ground rods located directly underneath the feedpoint.

My simple Slinky version has let me work DX that, when listening on the main station antenna, was wiped out by local electrical noise. Although much weaker on the Beverage antenna the DX signal was usually good readable copy.

The Springy toys can be obtained from **TOBAR LTD., St. Margaret, Harleston, Norfolk, IP20 OTB**. As they make a mini-sized version – so make sure you order the larger type.

E-mail: **tobar@ukonline.co.uk**