A broadband rooftop dipole

There are now an increasing number of restrictive covenants which present-day house owners are obliged to observe. These can apply to such things as a restriction on hanging out lines of washing, a ban on certain pets and, more seriously for a radio amateur, a total embargo on radio masts or poles. In some places nothing can be erected that is higher than the roof ridge or the chimney stack, and even TV antennas fall within these draconian regulations.

The multi-wire dipole shown in Fig 78(b) is similar to the multiband antenna described in Chapter 1 and illustrated there in Fig 9. However, its centre is attached to the brickwork of a chimney stack and it has several wires descending and lying just above the roof to fixing points along or near the rain gutter.

If the shortest pair of these dipole wires are cut to make a half-wavelength on the highest frequency band to be used and the longest wires are made resonant on a lower band, several intermediate wires can also be set out. The more of these there are, the wider will be the bandwidth of the dipole. The antenna wires can be plastic covered and their colour chosen to match the roof colour. They can use quite small unobtrusive insulators.

A simple coaxial feeder (not the heavy ½in. diameter variety) of 75 or 50ohms impedance can be dropped down the end wall of the house, or instead taken into the chimney! This can only be done if the chimney is not in use, and fortunately these days most chimneys become redundant as other less-primitive heating systems are used to replace fires. If the cable is taken down the chimney some precautions against the trickle downwards of rainwater must be taken.

This antenna system has its high RF current point as high as is possible without the use of a mast and it will certainly out-perform most indoor antennas. The old timers' adage that "A foot of wire outdoors out-performs ten feet inside" is often true.

Subsurface (underground) antennas

Try not to laugh, for this section is quite serious! Underground antennas have a long history and were even being considered as early as 1912. They were tried during the 'twenties (see *Amateur Wireless* September 1922), and at the present time there is much secret research going on all over the world in attempts to perfect the ultimate 'invisible' antenna. A nuclear blast would destroy just about every type of above-ground antenna system so a buried radiator seems to be the only 'hardened' system which might survive such a catastrophe. So much for the dishes festooning those tall antenna towers which seem to dominate most high points in our countryside!

The author was rash enough to write an imaginary or 'spoof' April Fool article on the subject of underground antennas a few years ago. To his surprise, he received a letter from Richard Silberstein, W0YBF, who suggested that several of his assumptions were actually correct! W0YBF has been involved in research on this subject for many years and some of his conclusions can be found in the *ARRL Antenna Compendium* Vol 1 ('Subsurface Antennas and the Amateur').

The RSGB *T & R Bulletin* published in February 1927 an article by C H Targett, G6PG, who was one of the foremost British underground antenna enthusiasts. His antenna was a 60ft rubber-insulated wire about 2½ft below the ground. The wire was supported on small posts which had insulators at their tops and was enclosed within an arrangement of discarded semi-circular 'pan tiles' before the trench soil was replaced (see Fig 79).

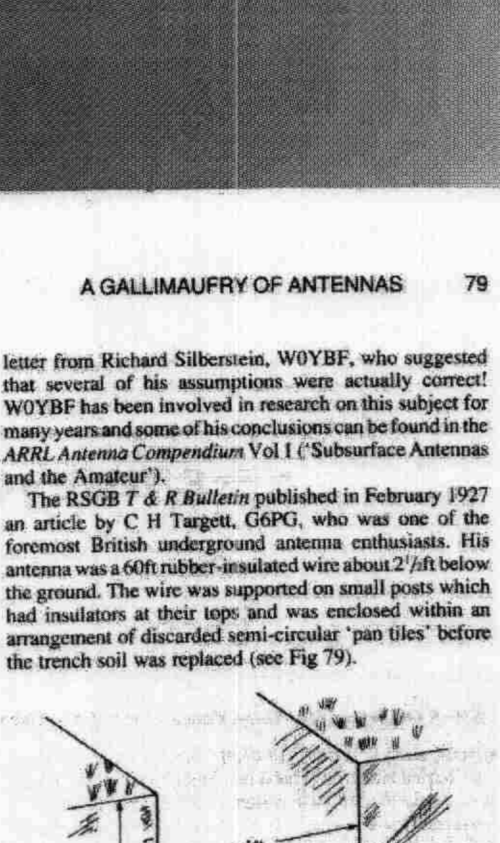

Fig 79. An early attempt at making an underground antenna. This was fully described in the RSGB *T & R Bulletin* in 1927 by G6PG

G6PG discovered that this antenna, which was end-fed and reached the surface through a length of rubber hose, reduced QRN almost to zero and allowed the reception of shortwave signals almost as efficiently as did his elevated wire. His 8W input transmitter was fed to the underground wire on wavelengths of 150-200m, 90m and 45m, and he had many contacts up to a range of about 1000 miles.

A significant fact was that this antenna was very directional: all the stations worked lay within an angle of 30° from its far end. This is similar in fact to the performance of a terminated non-resonant wire antenna or a Beverage antenna.

Fig 80 shows an underground antenna which was used for tests by W0YBF in 1965. With this he received signals from WWV on 5MHz when that station was located at Beltsville, Maryland. All soils differ in their attenuation of

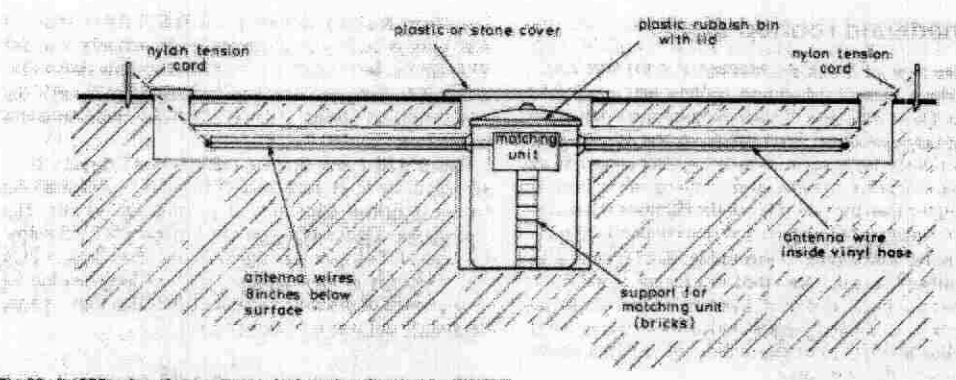

Fig 80. A 1965 subsurface antenna designed and tested by W0YBF

signals, and the term 'skin depth' is used when working with buried antennas. The skin depth of a soil is the depth at which the electric field is attenuated by 1 neper (8.68dB). Fortunately soil is a dielectric and a very poor conductor at radio frequencies; at 5MHz a radio wave when penetrating an average soil is attenuated by about 1.87dB per metre of depth.

Do not get excited by this, for in addition there is also some reflection and refraction loss: Silberstein's antenna, which was 8in. (20cm) below the ground, had an average signal loss of 16dB when it was compared with a standard half-wave dipole at 0.3 wavelength above ground.

The length of a resonant wire when it is buried is much shorter than a similar wire that is surrounded by air as a dielectric. The 5MHz antenna used by W0YBF had to be shortened from the normal 93.6ft (28.53m) to only 46.6ft (14.2m). This means that the velocity factor was influenced by the earth's dielectric properties and measured 47.4% at a depth of only 8in. At greater depths velocity factors as low as 25% have been recorded. The centre impedance of the buried dipole was low, and a special matching unit was used at the antenna centre to allow a good match to a standard coaxial feeder.

W0YBF admits that in 1965 he did not have very good insulating materials (they did not exist), and suggests that experimenters should try dipoles in wide-diameter PVC water pipes or plastic sewer pipes. Some internal supports for the wires would be needed if these were to be used. He resonated his antenna with the help of a dip oscillator when the lid of his waste bin at the dipole centre was removed!

The author's ideas for a similar antenna are shown in Fig 81. Here a wide plastic pipe is suggested, with a large quantity of expanded polystyrene 'chips' surrounding the pipe (this material is used for packaging) and just a thin top layer of soil: say, 2 to 3in. (5 to 7cm). The centre of the antenna could be made accessible for tuning and the coaxial feed would of course be buried. The underground antenna is perhaps the last ray of hope for the amateur in a zone where the rule is 'strictly no antennas'.

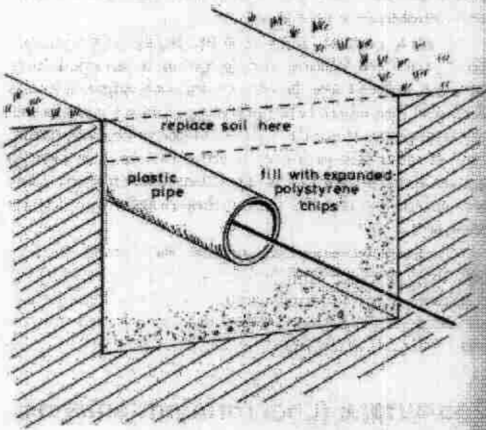

Fig 81. How an underground antenna system might be designed using modern materials

If only buried a few inches and with a lot of polystyrene chips, the attenuation on transmit and receive could be as little as 10dB as compared with a properly set up half-wave dipole. This power loss could be easily made up at the transmitter end of the system. On receive, although signals would be down, there would be very little external noise pick-up.

Chapter 7

Anten

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