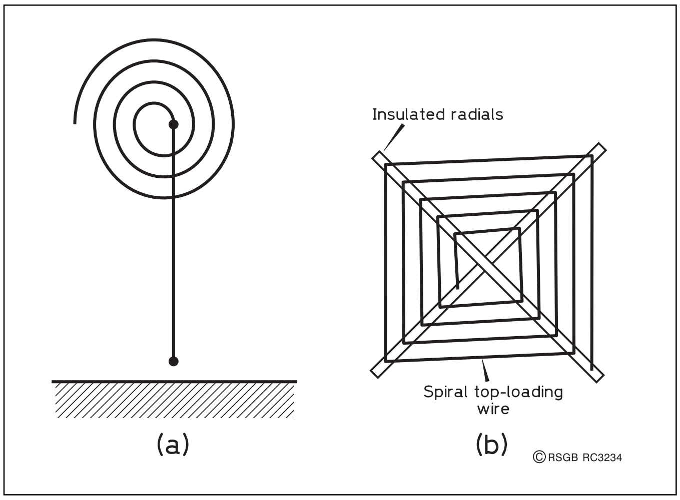

Fig 4: (a) Basic form of the spiral top-loaded antenna. (b) Practical form of using insulated cross-arms on which to wind the spiral inductance loading.

but without the 5W limit, although hopefully power moderation would prevail!"

SPIRAL TOP-LOADED LF ANTENNAS

THE LF BAND AT 136kHz is proving a fruitful incentive for experimental work on antennas, much of which can also be applied to 1.8MHz or even 3.5MHz. Alan Melia, G3NYK, writes a thank-you letter for the stimulation provided by 'TT' over many decades, enclosing details of a series of most interesting and rewarding experiments that he has carried out with Finbar O'Connor, EI0CF, a keen LF experimenter and professional operator at the Malin Head coast station. The work was based on a 'TT' item published in November 1974 (briefly revisited in May 1988) stemming from professional papers in *IEEE Trans on Ant &Prop,* May 1973, and the *Canadian Broadcasting Engineering Journal,* June 1974. These introduced the 'spiral top-loaded antenna (STLA)', **Fig 4**, as a single-mast substitute for an inverted-L antenna for VLF or MF applications. The top-loading wire of the STLA is wound as a single unbroken wire in a spiral, using, for example, an X-shaped insulated boom at the top of the vertical radiator.

The first experiments at EI0CF followed the basic STLA configuration using an 18ft (6m) bamboo mast with a 30ft download to the operating position and 189ft (51m) of wire wound on two 8ft cross-pieces (representing an inductance of some 169µH), **Fig 5**. Then a top-capacitance hat (**Fig 6**) was added. With some 100W, EI0CF made contacts with the UK and his signals were copied by G3NYK (Ipswich) at a distance of 700km. A most satisfactory result for an antenna no higher than about 22ft to the top of the capacitance-hat and capable of being erected in a 60ft-square garden.

Then, in a second series of experiments, a 'double-spiral' was formed by first winding a spiral inductor to the limit of the cross-arms clipped to the lower side, then continuing the same winding sense on top of the cross-arms back towards the centre (inductance 705µH). This facilitated adding various forms of capacitance top-loading wires - models A, B, C and D as shown in **Fig 7**. The antenna was destroyed by winter gales before detailed field strength measurements were completed (the Atlantic laps onto EI0CF's land on the west coast of Ireland, and his site is thus susceptible to Atlantic gales). Before then, EI0CF's 136kHz signals from Model D (umbrella type capacitance loading in the form of a bow-tie) were easily copied by G3NYK in daytime.

While the antenna was erected at and used by EI0CF, G3NYK provided a simple bridge design capable of quick and easy measurements, discussing the various modifications and then trying to model the results. His website (**www.alan.melia.btinternet.co.uk**) contains a detailed write-up and illustrations of these interesting experiments.

In his report, G3NYK writes: "Is there an advantage to be gained using this type of [STLA plus extra capacitance loading] antenna? To my mind, the greatest advantage is that, in a limited area of 'real estate', we were able to construct a relatively small antenna which only required a loading coil of about 2mH to resonate at 137kHz. This size of coil is considerably easier to construct than the 5-6mH coil that would be required by a strapped 3.5MHz dipole or a 126ft end-fed wire. Also, because it requires less wire, the coil losses should be considerably reduced. The series of experiments has also demonstrated the effect, flagged up by G3AQC, that when there is no more to be gained in reduced ground losses by running more radials or ground spikes, increasing the capacitance top-loading to cover fresh ground can be very productive. This effect can be seen on all types of vertical, inverted-L and T antennas. Thus if you have 100Ω loss resistance with 300pF,

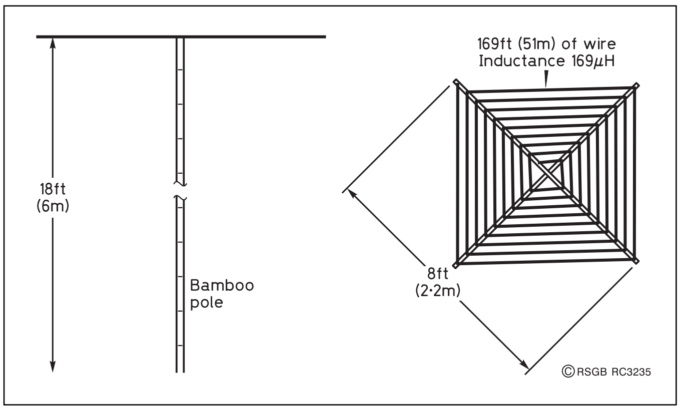

Fig 5: Basic STLA as erected at EI0CF for use at 136kHz.

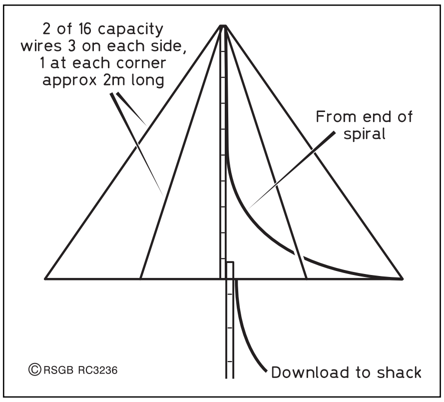

Fig 6: The original capacitance hat added to the basic STLA.

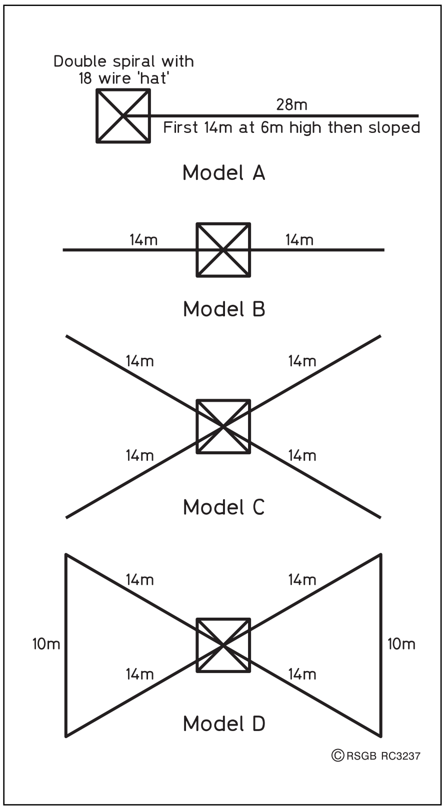

Fig 7: Various forms of top capacitance loading used with the 'double-spiral' described in the text to form Models A, B, C and D. Detailed measurements of ground losses can be found on G3NYK's web site (see text).

you could reduce this to 50Ω by increasing the capacitance to 600pF. It does support the old adage of 'filling the sky with wire'!"

EARLY EDDYSTONE PRODUCT DETECTOR

I TEND TO ASSOCIATE the frequency-changer (mixer) form of product detector with the 1950s or 1960s. However, Graeme Wormald, G3GGL, has brought to my notice an article on the little-known WWII Eddystone Model 400B LF/MF receiver in *Lighthouse,* Issue 71, February 2002, pp36-39. Model 400B was one of the series of communications receivers comprising Models 358, 358X, 400 and 400X (the X denoting the inclusion of a dual-gate crystal filter). While the 358 covered 90kHz to 31MHz with an IF of 465kHz, the 400 was LF / MF only, 130 to 2200kHz with an IF of 110kHz. It seems likely that the 400 models were designed specifically for use in the RAF Air / Sea Rescue service (confirmation of this would be welcome).

The 400 model was described by Eddystone as a 'double superhet' with a second IF of 1kHz. It added: "The second frequency-changer circuit has a mean oscillating frequency of 110kc/s, which can be varied above and below this to produce an audio frequency of up to 1000 c/s". In more current terminology, this set would be considered a single-conversion superhet with a CW product detector (**Fig 8**) of the type widely used later for SSB!

HIGH-GAIN PREAMPLIFIER

JACK PATERSON, in the June 2001 issue (p466) of *Electronics World*, shows how a general purpose, self-biasing pre-amp with a medium power MOSFET (VN10KM) input device can provide medium to high gain (300 to 400 adjustable or -50 to72dB), a high input impedance (about 10MΩ) and a bandwidth of 10Hz to 100kHz: **Fig 9**. It should prove suitable for many audio applications. Output voltage can be up to 8V p-p. A 2N7000 could be used instead of the VN10KM.

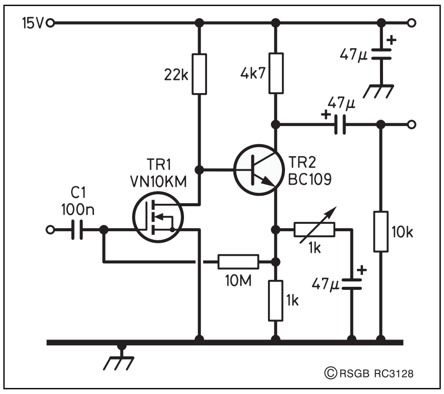

Fig 9: High-gain general purpose pre-amplifier using medium-power MOSFET and BC109. (Source: Jack Paterson, *Electronics World*)

HERE & THERE

TWO MORE PIONEERS of radio communication have departed. Dr John Pierce of Bell Telephones died 2 April 2002, aged 92. With engineer-turned-space-fiction writer, Arthur C Clarke (happily still with us), he shared the title of 'Father of the communications satellite', forecasting the possibilities and leading the teams responsible for the first communications satellites Echo and Telstar and much else. Dr Rudolf Hell, inventor of the electromechanical Hellschreiber in the early 1930s, died in Kiel on 11 March, 2002, aged 100 years. One had thought that the QRM-resistant Hellschreiber-mode had run it course, but is presently again enjoying a revival as a popular software system on the amateur bands. Dr Hell was responsible for many other mechanical, cryptographic and electronic inventions.

DESPITE THE ALMOST universal belief that we had passed the peak of Solar Cycle 23 during 2000, it is clear that this cycle has again taken the form of a double-hump. *QST.* admitting, like most of us, that it had got it wrong, has commented that the "2001-2002 season was the most spectacular in the history of the six-metre band. It is possible that more DX was worked on this band by more amateurs between mid-October and late-January than had ever been worked before". My DK0WCY log shows that the solar flux stayed above 200 throughout December 2001, reaching 275 on a couple of days. Not a record peak, but one that has provided excellent conditions on the HF bands!

A VOTE IN the European Parliament in April foreshadows that all electrical and electronic equipment sold in Britain after 2005 will have to be recycled at the manufacturer's expense. Under new European legislation, householders will not be allowed to throw away unwanted electrical or electronic goods but will have to sort them out ready for collection and recycling. It is forecast that prices are likely to rise by up to 5%.

THE 639-PAGE BIOGRAPHY *Schonland: Scientist and Soldier*, by Brian Austin, G0GSF, has been given an enthusiastic full-page review in the prestigious science journal *Nature* (4 April 2002). An article by him, 'Lightning and the Ionosphere: Some Reflections from an Earlier Era', appears in the URSI *Radio Science Bulletin* (No 300, March 2002, pp6 - 11). It shows how B F J Schonland (1896 - 1972) was investigating the interaction between lightning and the ionosphere some 60 years ago. This interaction is currently undergoing a revival of scientific interest as a result of the discovery within the last decade of so-called red sprites, blue jets and elves. All are optical phenomena occuring above the tops of cumulo-nimbus clouds, typical of thunderstorms, but seemingly having their roots in the lightning activity taking place beneath them. Recent evidence suggests that sprites may actually emanate even higher up, within the ionosphere, and that they link up with lightning to provide a momentary short-circuit between the ionosphere and the earth beneath. "Such ideas seem astounding and, if true, their implications could be profound." Brian Austin shows how reports of upward-striking lightning date back many years to the work of Scottish physicist C T R Wilson (1869 - 1959), who interested Schonland in such phenomena. Pioneering studies of the interaction between lightning and the ionosphere were made in lightning-prone Australia and South Africa in the 1930s. ♦

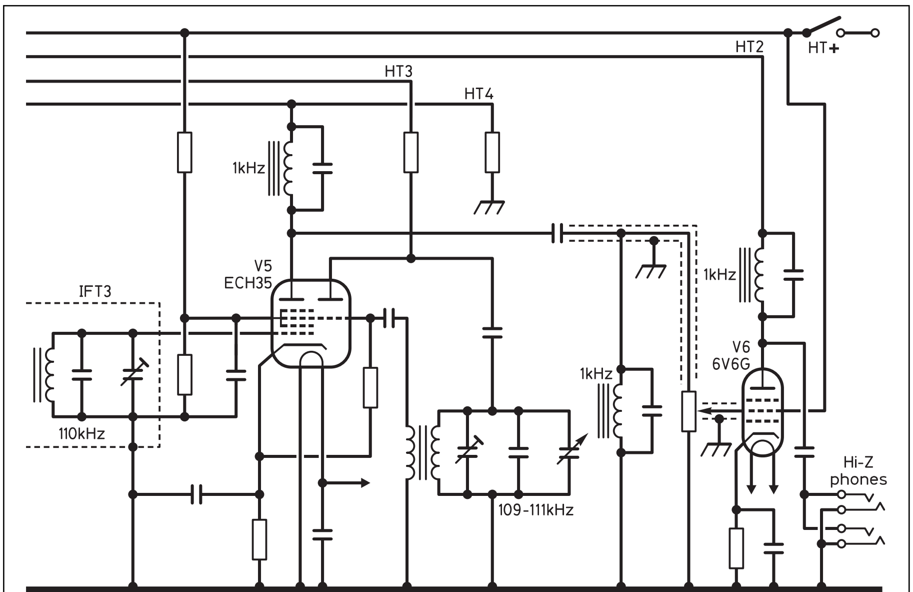

Fig 8: Outline of an early form of CW product detector as fitted to the Eddystone WW2 Model 400 which covered only 130-2200kHz with an IF of 110kHz and described by the firm as a "double superhet" with a "second IF" of 1kHz. Models 400 and 400X are believed to have been used by the RAF in their Air/Sea Rescue Service.

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Antennas

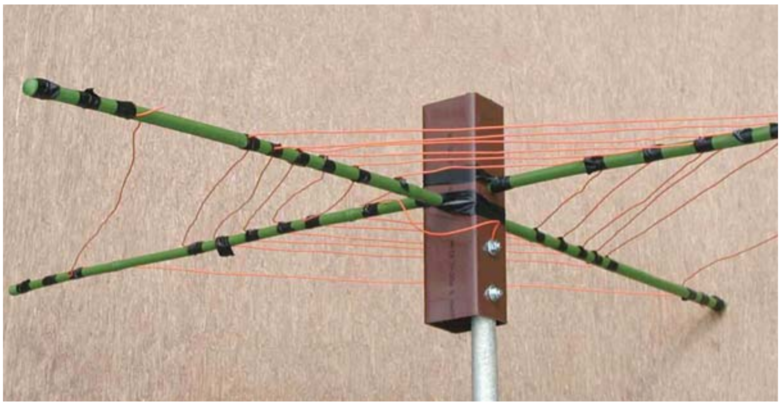
I decided to try to replicate the loaded vertical described by Des Vance, GI3XZM, in the June 'Antennas' column. You may recall that he used a length of aluminium tubing, which was resonant at about 15.7MHz. Top loading was added and the resonant frequency fell to 10.8MHz. By adding a five-turn helical coil the resonant frequency became 6.4MHz. By including the variable capacitor in series with the connection from the centre of the coax to the bottom of the pole the system was easily tuned to 7MHz.

My aluminium pole was a similar length but I used a simpler method of constructing the loading unit. It comprises a short off-cut from a square section of plastic ducting (as used to run coax cables along the side of the house) and two lengths of 1.2m (4ft) green plastic-covered canes from the garden centre (see photo). Holes are made in the plastic ducting for the plastic-covered canes which are held in place by black plastic tape. I used thin plastic-covered wire for the coil, also held in place with plastic tape.

I have an area of wire netting under the lawn so I used this as a counterpoise. The resonant frequency of my antenna was around 6.8MHz so I used a series variable capacitance at the feedpoint to bring the antenna into resonance. The SWR at 6.8MHz was around 1.1:1 and at 7.02MHz was 1.4:1. It looked good.

However, according to the antenna modelling program EZNEC, the feedpoint of a full-sized vertical fed against a good horizontal ground is around 45Ω (depending on the nature of the ground). With an electrically short loaded antenna the feedpoint is much lower and in my case should have been around 20Ω. The fact that it was nearer to 50Ω meant that there was additional series resistance, which in this case turned out to be earth resistance. Although the antenna had a nice low SWR it had a lot of loss. By adding radials, as described by GI3XZM, the feed impedance dropped to below 30Ω reducing the earth losses considerably - and the SWR shot up to 2:1. It just goes to show that a low SWR doesn't necessarily mean that the antenna is good. The characteristics of an antenna are often displayed using an SWR plot relative to frequency and as you can see this can sometimes be misleading.

A useful indication of antenna characteristics can be obtained using a plot of impedance relative to frequency, as shown **Fig 1**. This can be done using an SWR analyser, such as the MFJ-248 or one of the Autek instruments, such as the RF-1. This measurement should be done at the feedpoint of the antenna (which is not usually a problem with a vertical antenna) to avoid complicating things with transmission line impedance transformation effects.



Top loading arrangement constructed from a square section of plastic ducting and two lengths of plastic-covered canes.

Ideally the curve should pass through the zero reactance, 50Ω resistance intersection (SWR 1:1) at the frequency of interest and is usually achieved with a matching device such as a gamma match. The GI3XZM method is to use a variable series capacitor at the feedpoint to raise the impedance of the feedpoint and positioning the curve through the 1:1 SWR intersection at 7MHz.

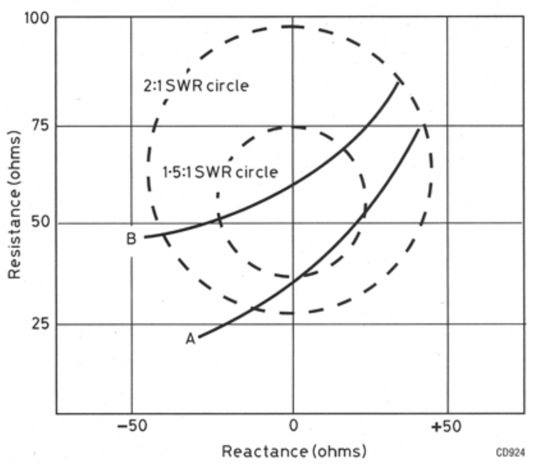


Fig 1: Antenna impedance variations over a frequency range; A is for a vertical with a good radial system and B is my antenna with the chicken wire ground. The lowest frequencies are at the lower left of the curves.

EH / CFA ANTENNAS

You might find the URL www.eh-antenna.com headed 'Welcome to the Wonderful World of EH Antennas' interesting. It contains the following statement: "For more than 120 years all antennas have been Hertz antennas, except the Crossed Field Antenna. In the future all antennas will be EH Antennas. Fortunately, any antenna can be converted to an EH Antenna with a minimum of effort. We have filed an additional patent clarifying the scope of the original patent, extending its coverage such that any antenna can be converted to an EH Antenna and be under the umbrella of the patent."

John H Davis, KD4IDY, in an e-mail on the LF reflector, notes: "You should be careful how you construct your plain everyday 'Hertz' antenna or it may infringe a patent. Perhaps it would be too much to ask of our patent offices to require proof that an invention actually works. I wish we could at least return to the days when it was not possible to patent and re-patent techniques already known to the state of the art (in this case, electrically short verticals and dipoles), simply by virtue of sticking a new name on them or claiming a new theory of operation." ◆