0.1dB and minimum stop-band attenuation of 80dB: **Fig 3** and **Fig 4.**

It will be noted from Fig 3 that all capacitors and inductors have non-standard values. Paralleled low-tolerance capacitors were measured using a pre-war 'Philoscope'. It was reasoned by PA0SE that the values of C2, C4, C6 and C8 and inductors L1, L2, L3 and L4 might not have to be very precise, as long as the frequencies of maximum attenuation in the stop-band had the correct values indicated in the diagram.

The inductors are wound in pot cores of 2.5cm diameter, probably made by Mullard and marked 'LA 2'. These have no adjustable cores and the inductances can be varied only by changing the number of turns. PA0SE writes: "I first made a test winding, putting 100 turns of 10 x 0.5mm Litz wire on the bobbin, this came out as 2197∝H. This enabled me to calculate the number of turns needed to provide the wanted inductances. For example, with C2 theoretically 1663pF, I connected two 820pF capacitors in parallel, making C2 1640pF; L1 then needed to be 32,257∝H to produce resonance at 21.88kHz. The calculated number of turns came out as 383. I put on an extra 20, then clamped together the two halves of the pot core with a large clothes-peg. The inductor was connected to C1 and the resonance frequency measured using an audio generator and valve voltmeter plus a frequency counter for greater precision. The frequency, as expected, was too low. I then gradually took off turns until the frequency was about 100Hz higher than the required 21.88kHz. The pot core was then completed using its mounting hardware. The two halves were now pressed together with greater force than provided by the clothes-peg, and this brought the inductance to the required 32,257∝H. This process was repeated for all ten inductors in the two low-pass filters. In spite of the components not having the exact values calculated, the measured frequency response follows closely the calculated theoretical response."

Fig 5 shows an example of the excellent overall response curve that can be achieved: a stop-band greater than -80dB, and filter slope virtually constant at all bandwidths.

Incidentally, PA0SE initially used a multi-section 12-position rotary switch for selection of the front-end RF filters (as recommended in the January 'TT' by G3LLL), but found that the attenuation of the Cohn input filters did not increase beyond about 60dB. It turned out this was caused by magnetic coupling between the switch decks at the input and output of the filters, in spite of a separation of some 3.5cm. He solved the problem by using relays of which there are 36 already in use, with more to be added to complete the transmitter section.

RESISTANCE LOADING OF HF ANTENNAS

THE USE OF non-inductive resistors to provide uni-directional long-wire, rhombic antennas etc, or for multi-band or broadband resistor-loaded dipole elements, has been discussed on a number of occasions in 'TT'. The technique has a long history, unfortunately sometimes brought into disrepute by, for example, exaggerated claims for the performance and operational bandwidth of the 'T2FD' (tilted, terminated folded dipole) antenna. There have also been several 'con' designs marketed, including a length of co-axial cable terminated directly with a resistor, ensuring a near unity SWR on all frequencies and a modicum of radiation / pick-up from the co-axial cable 'feeder'! As was shown in the recent 'TT' discussion on the so-called use of trees, it is often the 'feeder' rather than the 'element' that accounts for much of the limited radiation from controversial designs.

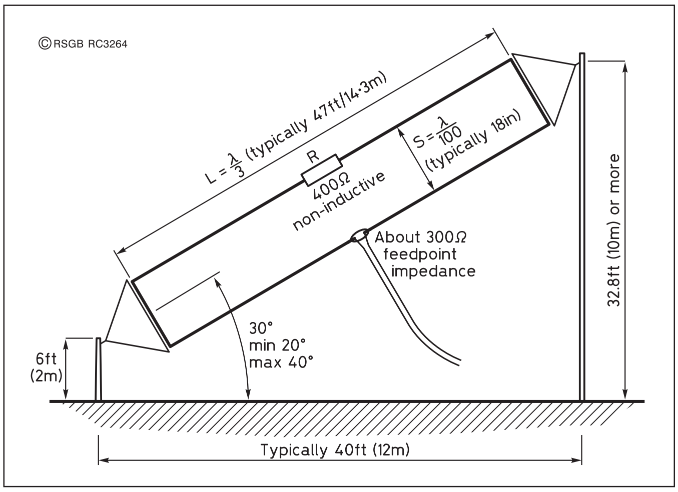

Fig 6: T2FD (tilted, terminated folded dipole) antenna. Although controversial, it has, for many years, found supporters. In this implementation it was claimed that, with a span of only about one-third of the wavelength of the lowest band of interest, it covers a frequency range of some 4:1 and often more (3.5MHz design suitable for use up to 14MHz or higher). RF power lost in the resistor may be up to about 3dB at some frequencies.

But, used correctly, resistance-loading of wire elements can play a valuable role in amateur radio. The tilted T2FD (**Fig 6**) is based on an established WWII design often claimed to cover several octaves. In 1971 Bill Conkin, K6KA, reported in 'TT' that the T2FD measured some 6dB down on a dipole and was intended by the US Navy to increase bandwidth by only a few hundred kilohertz. It is perhaps more accurately termed an aperiodic multi-band antenna than a broadband design. But it remains a popular design found satisfactory by users. **Fig 7(a)** is the 'Australian Dipole' due to Guertler and Collyer, an effective multi-band design (see 'TT' June 1974, September 1984). **Fig 7(b)** is a modified form developed for military communications in South Africa by Dr Brian Austin (ZS6BKW / G0GSF) and André Fourie, covering the entire band 3 to 30MHz with good efficiency. It forms a convenient, if undeservedly seldom-used, single-pole, inverted-V antenna fed from 500Ω line ('TT' June, 1987 and in more detail September 1987, see also *TTS, 1985-89*).

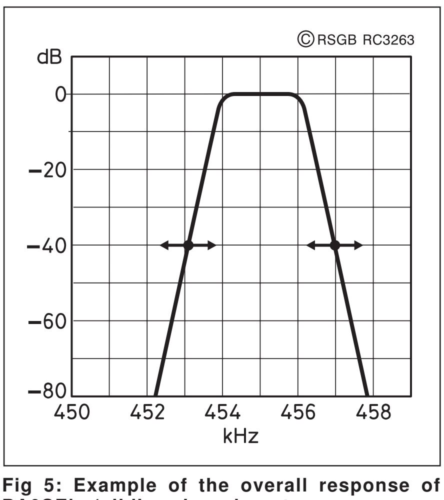

Fig 5: Example of the overall response of PA0SE's 'sliding doors' system.

D A Bundey, FIEE, G3JQO, writes: "An antenna I came across professionally many years ago was the 'Terminated Delta Loop'. It was used for ionospheric sounding work and radiated towards the zenith. Since near-vertical-incidence-radiation (NVIS) has become fashionable recently in professional circles, as though it were a new discovery, I decided to put up a near copy (**Fig 8**) of this ionosonde antenna and compare it with my multiband dipole, which is about 120ft long.

"As expected, it performed in a comparable manner, provided the delta leg length was at least λ/2, but not so well if only λ/4 or λ/8 long - not surprising, since the laws of physics apply particularly to untuned systems! However, there were two possible advantages. Firstly, the VSWR excursion was less than three within three octaves, and hence capable of being matched by the in-built tuners found in modern transceivers. Secondly, noise pickup, particularly on 7MHz, was at least 6dB down, making many signals clearer on the delta.

"It is, of course, a matter of horses for courses, but the terminated delta loop may be worth a thought for those who work predominately at short to medium ranges. Finally, it is a balanced configuration which in my view is always an advantage in the urban environment."

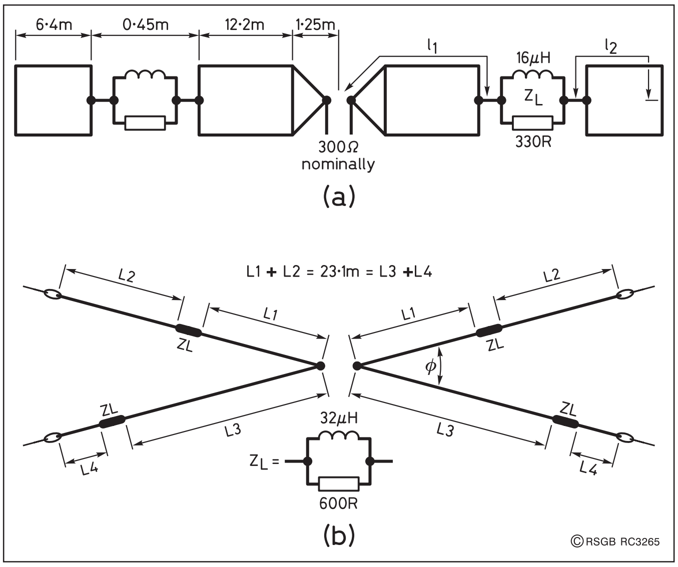

Fig 7: (a) The 'Australian Dipole' developed in the 1970s and suitable for erection as a horizontal or inverted-V broadband travelling-wave dipole antenna. With the dimensions shown, it was claimed to provide a VSWR of less than 3 over the range 2 to 30MHz and less than 2.5 above 3.5MHz. The 1.8m spacers are 25mm diameter aluminium tubes (ie non-insulated spacers).
(b) Broadband inverted-V form of HF antenna developed in South Africa covering 3 to 30MHz with good radiation efficiency when fed from 500Ω line. Unlike the Australian dipole no aluminium spacers are required. Key dimensions:
L1 + L2 = L3 + L4 = 23.1m
L1 = 13.5m (hence L2 = 9.6m)
L3 = 17m (hence L4 = 6.1m)
The included angle, φ, does not markedly affect the VSWR, but the feedpoint impedance is dependent to some extent, 5° optimum yields 500Ω, reducing to about 400Ω at near-zero spacing. A range of 3 to 30MHz with a VSWR of less than 2.5 can be achieved.

As the above notes were being compiled, there arrived from John Pegler, G3ENI, a copy of an article he has written for the *Thames Valley ARTS Newsletter* entitled 'The Resistor-Loaded Folded Dipole', providing an informative and interesting review of the early development of this form of antenna. He notes that in the mid-1930s, a French company, Société Anonyme des Industries Radio Electroniques of Paris, designed a resistor-loaded folded dipole and submitted a patent specification in France on 10 June, 1937, granted on 8 June, 1938, and in the UK on 10 June, 1938 (granted as Patent No 500,162 on 3 February, 1939). G3ENI writes: "The seven-page French specification covered the subject in great detail, including a vertical, earthed-monopole version, a two-element bi-directional version and a direction-finding version."

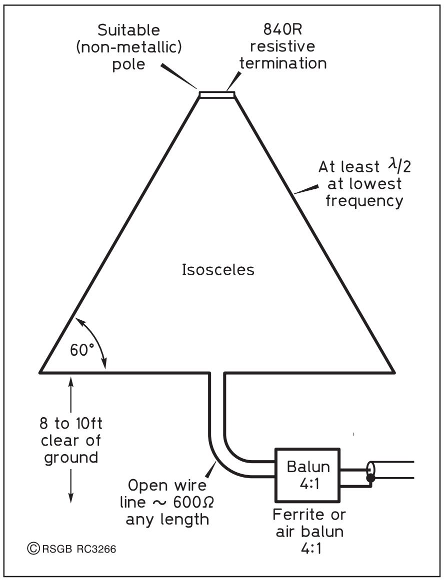

Fig 8: The broadband Terminated Delta Loop HF antenna with maximum radiation towards the zenith. The 840Ω resistive termination can comprise 24 2W resistors in four strings of six (each 560Ω) inside a 2in plastic pipe open at the ends (100W RF limit). Higher-rated termination needed for use with QRO linears. Termination value and balun match may be varied to optimise VSWR excursion over range of frequencies used.

It was claimed that "the antenna can be used in a variety of shapes, including horizontal, vertical, inverted-V, and flat-top beams in addition to the tilted version." The useful bandwidth claimed was from 0.8 to 3 times the frequency given by the length of the half-wave dipole, with the lower frequency limited by the drop in radiated power and the upper frequency limited by loss in the resistor.

"During and after WWII, this type of antenna was used by the Royal Navy at shore stations and there are several both horizontal and vertical terminated folded dipoles listed in the Naval Handbook on antennas for powers up to 10kW, and receiving masts as high as 55m (180ft) were used with 600, 70 or 50Ω feeders as required.

"The patent specification claimed that, when two similar conductors are arranged in parallel with their ends joined and with small spacing are terminated by an impedance substantially equal to the characteristic impedance of the two conductors, they are traversed by travelling waves only, permitting the element to be used within a wide range of wavelengths with substantially constant radiation characteristics. An example showing curves with a 20m span folded dipole fed and loaded by 600Ω, from experiments by W L McPherson is shown in **Fig 9**."

G3ENI traces in some detail the evolution of the US Navy antenna into the amateur radio 'T2FD', principally by W3HH between 1949 and 1951. He notes wryly that, on August 31 1981, Elmer R Bush of the American firm Barker and Williamson Inc filed a specification for a Broad Bandwidth Folded Dipole (US Patent No 4,423,423 granted 27 December 1983) with an 'abstract' and 'background to the invention' substantially identical to the French UK patent of 1939! The preferred terminating resistor was given as 600Ω with the antenna fed by 50Ω cable with a 1:12 balun at the antenna feed point.

G3ENI also notes that Serge Montagnon, F5HUP, has recently described in *REF Technique* a folded dipole based on W3HH's design (390Ω resistor) in which he referred to W3HH as the inventor. "Perhaps he was not aware of the original French work!"

HERE & THERE

GODFREY MANNING, G4GLM, provides the following tip on encapsulating EHT connections: "Even double-insulated multimeter wire is not able to withstand a few thousand volts, but the polythene inner of large-gauge coaxial cable (eg UR67, RG8) is. After connecting, the joint may be insulated by casting it in epoxy resin, but this is brittle. How about more polythene? Hot-melt general-purpose glue (*not* the woodworking variety) is the same material."

JAMES MILLER, G3RUH, noted my reference in the April 'TT' to the OptiVisor Model DA5 hands-free binocular magnifier made by the Donegan Optical Company of Kansas, USA. He writes: The Donegan Optical Company Inc was founded in 1952, is still going strong and the DA5 visors remain in full production. They can be obtained in the UK from RS Components as part 290-1539 priced at £37 + VAT (or for about $37 in the USA). I've had mine for a couple of years, but they have proved so utterly indispensable that I wish I'd had them in the days when my eyesight was perfect! As essential as a good soldering iron." ♦

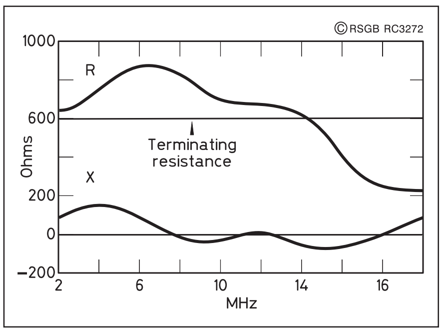

Fig 9: Resistance (R) and reactance (X) curves over the frequency range 2 to 17MHz of an experimental 20m-long terminated folded dipole fed and loaded by 600Ω, as reported by W L McPherson.