NEWSLETTER ARCHIVES

There s Nothing Old Under the Sun
The Surface Wave Transmission Line by Stewart G3YSX

A few days ago I was at a meeting of the IEE Surrey Branch. Following the meeting Mike G3LHZ was showing me some interesting and original results from an investigation that a student of his was doing on a type of X-dipole. A colleague joined the conversation, and noted that the arrangement reminded him of a feeder system that he has once seen in the past. This had been used as a feeder for a mobile military system, but it was not clear why the design was chosen, other than the fact that the low cost and simplicity would have been of interest to the designers concerned. I was sure that I had seen this arrangement described myself (a long time ago), but could not remember where. Thus started an interesting few hours of investigation.

The arrangement concerned was the surface wave transmission line. This was invented by Goubau and patented in 1954 (US patent number 2,685,068). This is an arrangement that is not well documented, perhaps because the absence of good theory embarrasses the professionals who write the serious antenna books. I searched through all my antenna texts and could find only one reference to the design in the 1968 RSGB handbook. This was thus an arrangement that I had seen in my teens in the first amateur radio text I owned, but had always skipped over as old fashioned . The description from the RSGB handbook is shown (fig 1).

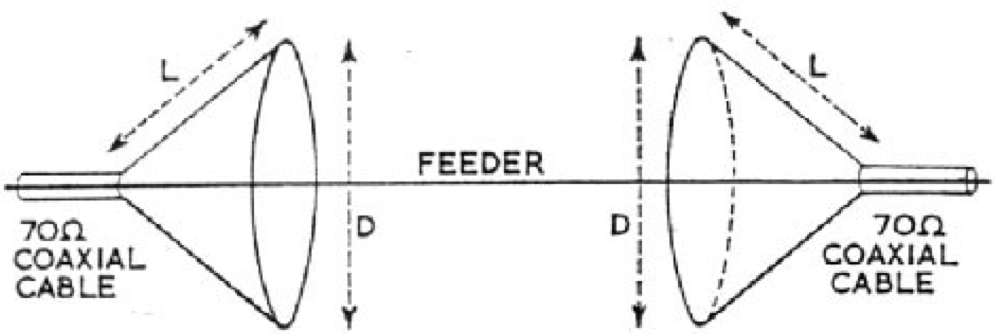
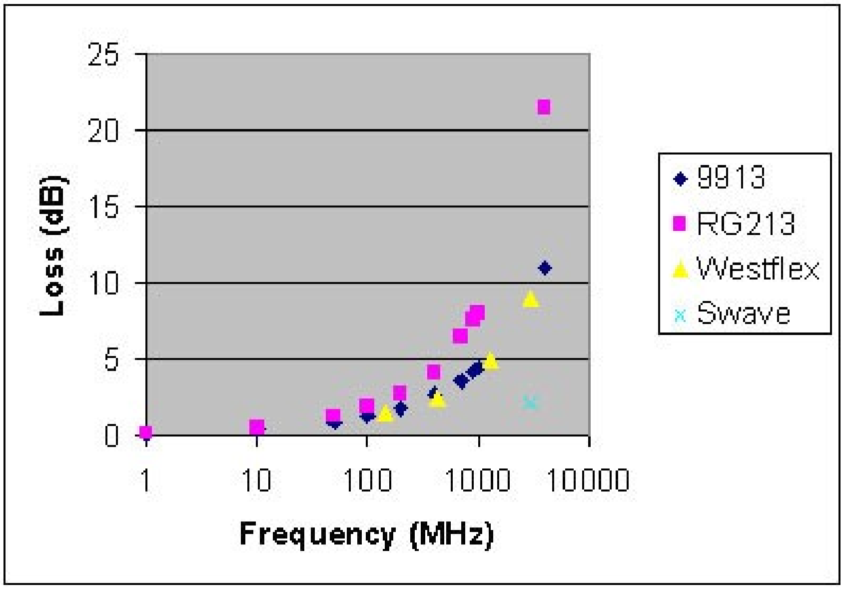


Fig. 14.5. Surface-wave transmission line. The outer sheathing of each length of coaxial cable is terminated by an open cone. The feeder itself should be of 10-16 s.w.g. copper wire, preferably enamelled; its length may be several hundred feet. The cone diameter D must be 0·6 L, but L itself may be of any length greater than 3λ.

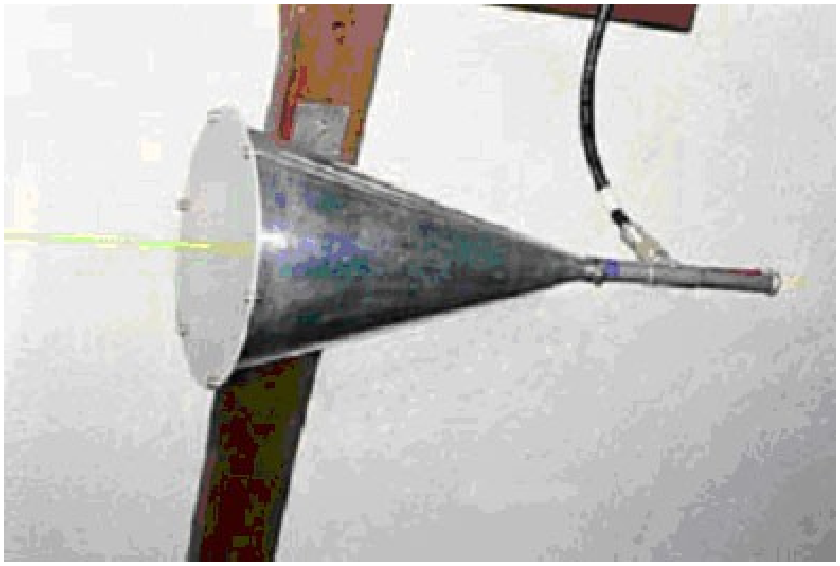
Now to quote Andersen Consulting This is where it gets interesting . Typical losses measured at a frequency of 3300 MHz using horns 21 long and 13 diameter and 14SWG bare feeder are 1.35db per 100 feet + 0.4db per horn. The graph (fig 2) shows the 100 foot loss of Westfex, 9913 (claimed to be the best US 0.5 feeder) and RG213. Notice how much lower the surface wave feeder loss is in the graph. Also note that the major component of the lost is actually a fixed term, so if we were to take a 200 foot run the all the other feeder types would double their loss, whilst the surface wave feeder would only talk a marginal increase. The RSGB article notes that at 430Mhz the field is 20db down 8 from the wire. It does however warn of the difficulties of going round corners with this feeder, and the need to make bends very gradual. The RSGB text also suggests that the use of a dielectric coating on the wire reduces the field strength near the wire and hence losses. However, I have some concerns as to whether this improvement is actually greater that the dielectric loss that results.



In both professional and amateur installations this feeder type would seem to have a lot going for it. It is cheap, it s low loss, its low weight and in very high power applications it has the advantage over wave-guide that you do need to fill it with high-pressure gas to avoid flashover. However it does have the problems that it is not flexible like conventional feeder. You cannot just install it up the side of a crank up tower and then choose an operating height, because the feeder has to be taught. In professional applications leakage from the feeder will also be a problem in terms of health and safety, side lobes and eavesdropping (there are applications where the neighbourly response to inadvertent radiation is a mortar rather than a visit from the RA). Since radiative leakage is a reciprocal process, the feeder will also pick up thermal radiation from the surroundings, increasing the noise temperature of the system and lowering the noise figure. For receive a mast-head pre-amplifier can be installed to overcome the losses of coax feeder. For transmit however the feeder loss cannot easily be overcome in this way, and here the surface wave feeder would seem to have significant advantage.

According to Derek G3GRO, there has been some use of this technique in the past in local amateur radio clubs. One club used to use this on their VHF NFD set-up, and you can see that on 23cms it would have significant advantage. Looking on the web I found a couple of commercial references. One was a patent application for a train movement detector that used a directional coupler, that coupled into a SW feeder that ran along the side of the track.

The second application was more interesting. There is a US company called Rubytron based in Port Chester NY who are marketing a system for in-building transmission of UHF (430 MHZ) and ISM band (2.4 GHz) signals. Here the claim is significant efficiency improvements compared to strip-line or coax techniques. This seems to reinforce the idea that losses are through radiation rather than through dielectric loss. A picture of the Rubytron coax transition horn is shown below (fig 3). Notice that they have included a dielectric face on the horn to improve its alignment with the feeder wire, which reduces transition loss.



The interest in this technique for members of this club is in the 24cms ATV experiments that are be being carried out. Anyone who has their antenna on a fixed heading to the Crawley repeater might well consider this arrangement both as a cost saving and power boosting technique. The cost savings are obvious, and whilst you can compensate for the degradation of noise figure on receive by including a mast-head preamplifier, on transmit, with the PA installed near the shack, the feeder loss detracts directly from the ERP.

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