connecting one winding end to the beginning of another) structure takes place but never in defiance of normal transformer rules.

The top frequency limit for transmission line transformers is decided by their operating conditions. Where the integral transmission line is perfectly terminated between source and load of characteristic impedance, then there is, in theory, no upper frequency limit on operation. In practice, the wire insultation of twisted pair bifilar windings becomes rather lossy.

Where a mismatch exists, the upper frequency limit will be dependent on the winding length. Generally speaking, the winding length ie, the length of the bifilar pair stretched out flat, should never be greater than 1/16th of a free space wavelength. This also dictates the lower frequency limit incidentaly. Since the amount of transmission line wire is finite, the low frequency inductance is strictly limited depending on the characteristics of the core. With the right combination of core and winding length, it is quite possible to design efficient transformers which operate over the range 1 to 200MHz. Note that the core material for such a device will probably only be specified for operation to around 5MHz although, in conjunction with a transmission line winding structure, the losses in the transformer will be unnoticeable up to and beyond the 2m band.

Wind-up with a drill

The easiest way of producing transformer transmission line wire is to double up a length of 22 to 30 SWG wire with the loop end over a door knob, and attach the free ends into the chuck of a hand drill. With both wires stretched taut, the wire is wound up on the chuck until the required number of twists per inch is achieved. **Table 1** offers guidance about the relationship between twist pitch and characteristic impedance. A third wire may be added for trifilar transmission lines.

General purpose balun

I have a very fine piece of aerial tuning gear, the Yaesu *FC-902*. I use it conjunction with a 400W output home brew transceiver and a number of HF wire aerials, the longest being over 100m long. The only trouble is that the *FC-902's* output is single ended — that means that one of the two terminals on the back is connected to the case of the ATU while the other is connected to the hot end of the matching network — with the implication that it won't work with balanced aerial systems.

One could go to a number of suppliers and purchase a balun (**bal**anced to **un**balanced) with an internal circuit diagram along the lines of **Fig. 4.** These work fine provided that the aerial system with which it is used is perfectly balanced. The thing about nearly all these commerical balun units is that they divide the signal precisely into two (antiphase) parts even though the real world aerial may contain degrees of unbalance. For instance, if one end of a dipole is nearer the ground, or nearer to a house than the other end, this will set up imbalances in the aerial.

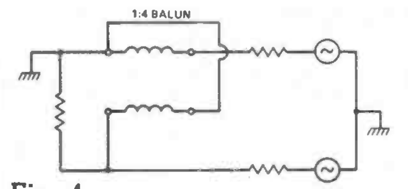

Fig. 4

The best arrangement is to wind a **sortabalun.** This is, in effect, a bifilar wound choke or 1:1 transmission line transformer. Fig. 5 shows the construction. The unit that I made for use in my FC-902 comprised a heavy guage, PTFE twisted pair of wires wound as 20 turns on three stacked TVI rings of the sort available from a number of different manufacturers. The 20 turns on the three cores virtually ensures that no out of balance condition can exist even though the aerial system with which it used may be all over the place. This type of balun provides a straight through path (down the twisted pair) to the aerial while blocking off any common mode currents in the feeder system. Now I think there is no other kind of balun system having used one of these on a large number of different aerials.

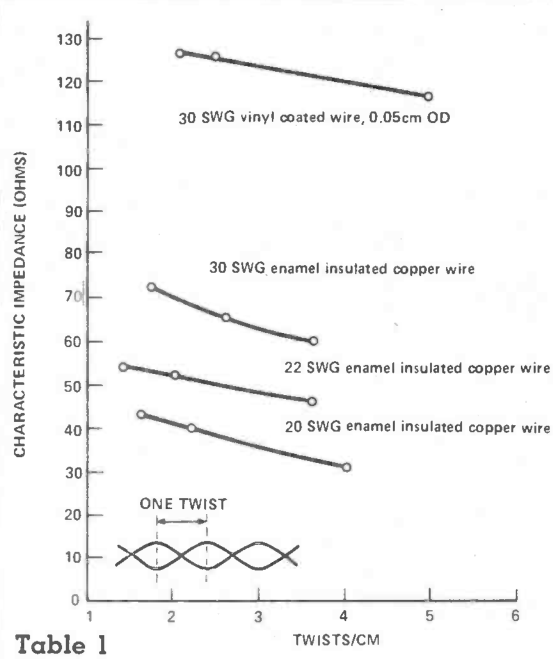

Table 1

Table 1. This series of graphs shows the effect of twist count, measured as twists/cm, on the characteristic impedance of a twisted pair transmission line. Note that tightly twisted wire has a lower characteristic impedance than twists of longer pitch.

Although the graphs shown here were drawn for enamel covered wire, the modern, self fluxing polypropylene covered single copper wire tends to be just as low loss for RF usage while withstanding a higher RF working voltage. However, twisted pair transmission lines can carry no more than about 10W at HF and rather less at VHF where the losses increase rapidly. For higher powers/higher frequencies, it is strongly recommended that PTFE insulated copper wire is used.

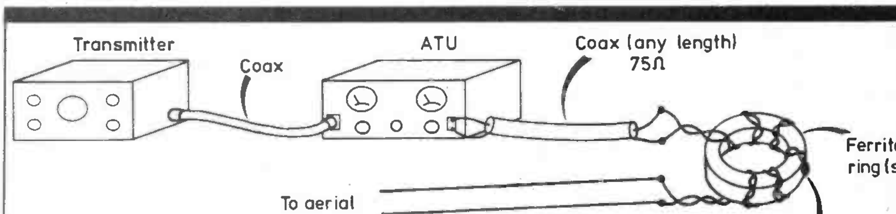

Fig. 5

Since most balanced aerials exhibit a degree of unbalance, the SORTABALUN is often a better performer than the true balun. It is, in fact a 1:1 transmission line transformer.