ZL SPECIAL 2m BEAM

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In my article "Aerial Performance Test Set", (*Practical Wireless, January 1978*) readers may have noticed the photograph of a 12-element beam aerial. This is one of the "ZL" series, developed from the ZL Special, details of which were published in *Practical Wireless*, May 1977. At the time, the principle of employing two driven elements to produce 'end-fire' arrays was examined. The ZL Special two-element system is in fact an end-fire array but with a difference. The element lengths are cut to produce a reflector/director action which gives increased forward gain over that normally obtained with two half-wave elements spaced $\frac{1}{8}\lambda$ and driven 135° out of phase.

The ZL Special, apart from being a small beam aerial in its own right, is also a very useful primary driving system for relatively compact multi-element beams of higher gain. In this respect, the reader may find the article "Three and Five-Element Compact Beam Aerials for 2 Metres" (*Practical Wireless*, May 1977) of interest. The same arrangement can be used for ZL beams of up to five directors—i.e., six or seven elements total.

Beyond this however, if the gain is to be increased by additional directors and the size contained, the construction of the ZL Special as described in the above article must be modified.

The 12-element ZL beam to be described was developed nearly three years ago and up to the present time has been in use in two quite different locations. One of these was my former address in London and the other my present home in the lovely countryside of Norfolk. It has been the means of establishing over 600 direct contacts with more than 10 countries outside the UK on 2 metres f.m. Operation into a number of continental repeaters, as well as distant UK repeaters, has been achieved with only slight tropospheric lift.

The basic ZL Special has a forward gain of about 6dB over a dipole, which is much higher than can be obtained with a single driven element and reflector, the basis of the well-known Yagi. A ZL beam with directors does not require a reflector, as there is nothing from the rear to reflect. With the modified primary driving array and 10 directors as shown in Fig. 2 a forward measured gain of 13·5dB can be obtained with a beamwidth at the 3dB down points of approximately 36°. The theoretical gain was 14dB but calculated parameters are rarely, if ever, realised. For the sake of comparison with the dipole and other ZL beams however, the radiation pattern of 12-element version is shown in Fig. 1; the field intensities are relative.

At this point it should be realised that if a high-gain beam is used the increase in effective radiated power (e.r.p.) over a simple dipole is considerable. For example if 10 watts of actual radiated power is applied to a beam aerial having a gain of 13dB, it will produce an e.r.p. of close to 200 watts (assuming no losses), 13dB being a power ratio of approximately 20:1.

Before the constructor begins to build this aerial

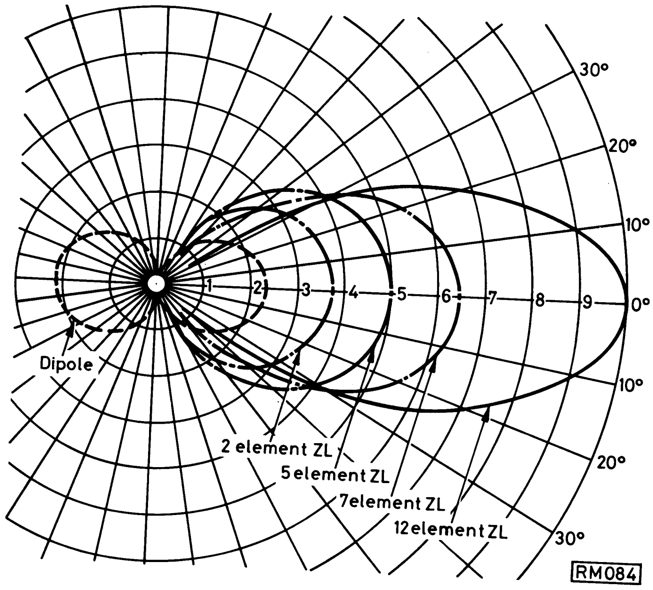


Fig. 1: Field intensity patterns of the 12-element ZL Beam and other ZL Series for comparison. Intensity levels are all relative to each other and a dipole

it should be stressed that only the materials specified must be used. As with most projects of this nature if the text is not followed closely, it is unreasonable to expect the results to function properly. The dimensions are fairly critical, and a tolerance of about one per cent should be aimed for in the longer lengths. In other words, about 2·5mm in 254mm. For shorter dimensions, 1mm is adequate.

Construction

From Fig. 2 it can be seen that the overall length is some 3·2 metres but if the elements are made as described from 6·3mm diameter aluminium rod or tube, a boom of 20mm square aluminium is adequate for the purpose. The prototype built exactly as described in this article has withstood gale force winds and gusts approaching 90m.p.h., suffering nothing more than one broken director.

The diagrams should be fairly self-explanatory. The layout of the two driven elements, the 300Ω ribbon phasing line, the rear tuning stub and the small coaxial capacitor across the feed point are shown in Fig. 3.

Note that the ribbon feeder forming the phasing line is somewhat longer than the actual spacing between elements and this will lie slack within the protection box. The box may be of pvc or built from hardwood. In the latter case it is advisable to fit sleeves of a good insulating material over the elements and the rear stub where they enter the box.

The small rear stub is made from 6·3mm diameter aluminium rod or tube. The lower parts of the elements run underneath the boom. They must not come into contact with it but extra support could be given with small spacers of Perspex or pvc located between the centres of the elements and the boom.

The small capacitor is formed from a short piece of 50Ω coaxial cable, trimmed at one end by about 20mm for connection to the feed point and with about 12mm of screening braid removed at the far end to prevent short-circuit or r.f. flashover.

The boom is 3·234m long and 20mm square. All the directors are secured to the boom at their exact centre points. For this purpose small clips could be used or holes drilled through the boom to take the 6·3mm diameter rods, which can ultimately be secured by bolts or self tapping screws. Whichever method is finally decided upon it will be necessary to establish that the electrical contact is good.

When the aerial is finally tested, the slots where the elements enter the protection box can be filled with Plastic Padding or similar to prevent the ingress of water. After the lid has been fitted the box should be painted or varnished.

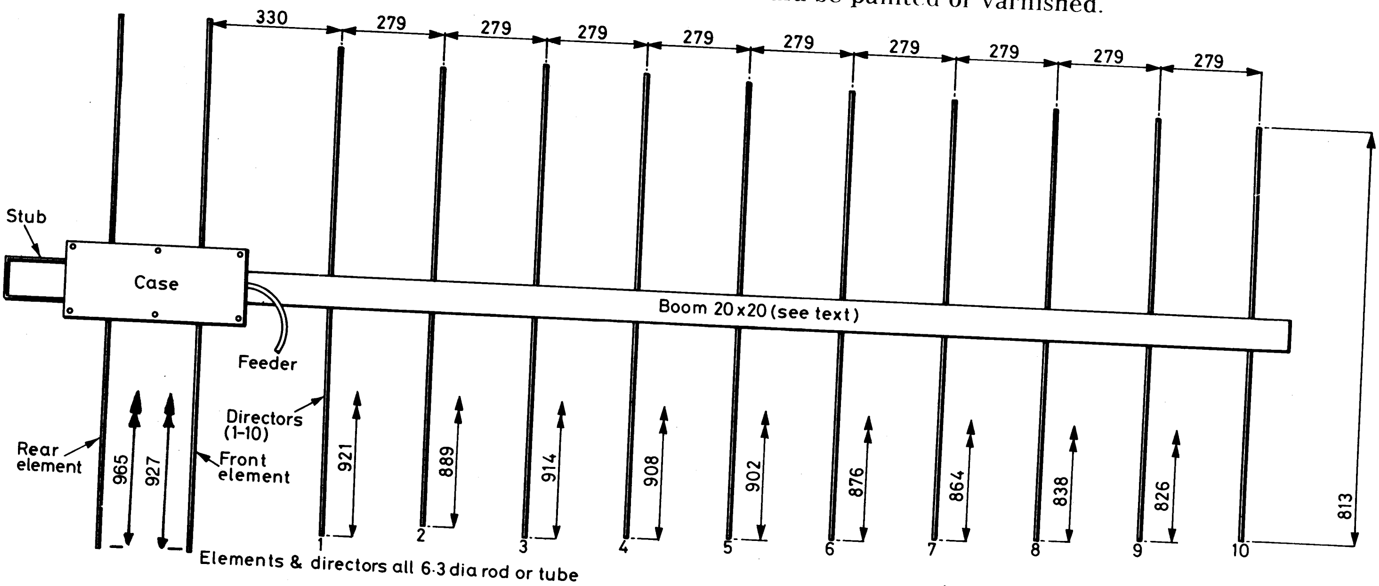


Fig. 2: Details of element and director lengths etc. These are critical and should not be altered in any way

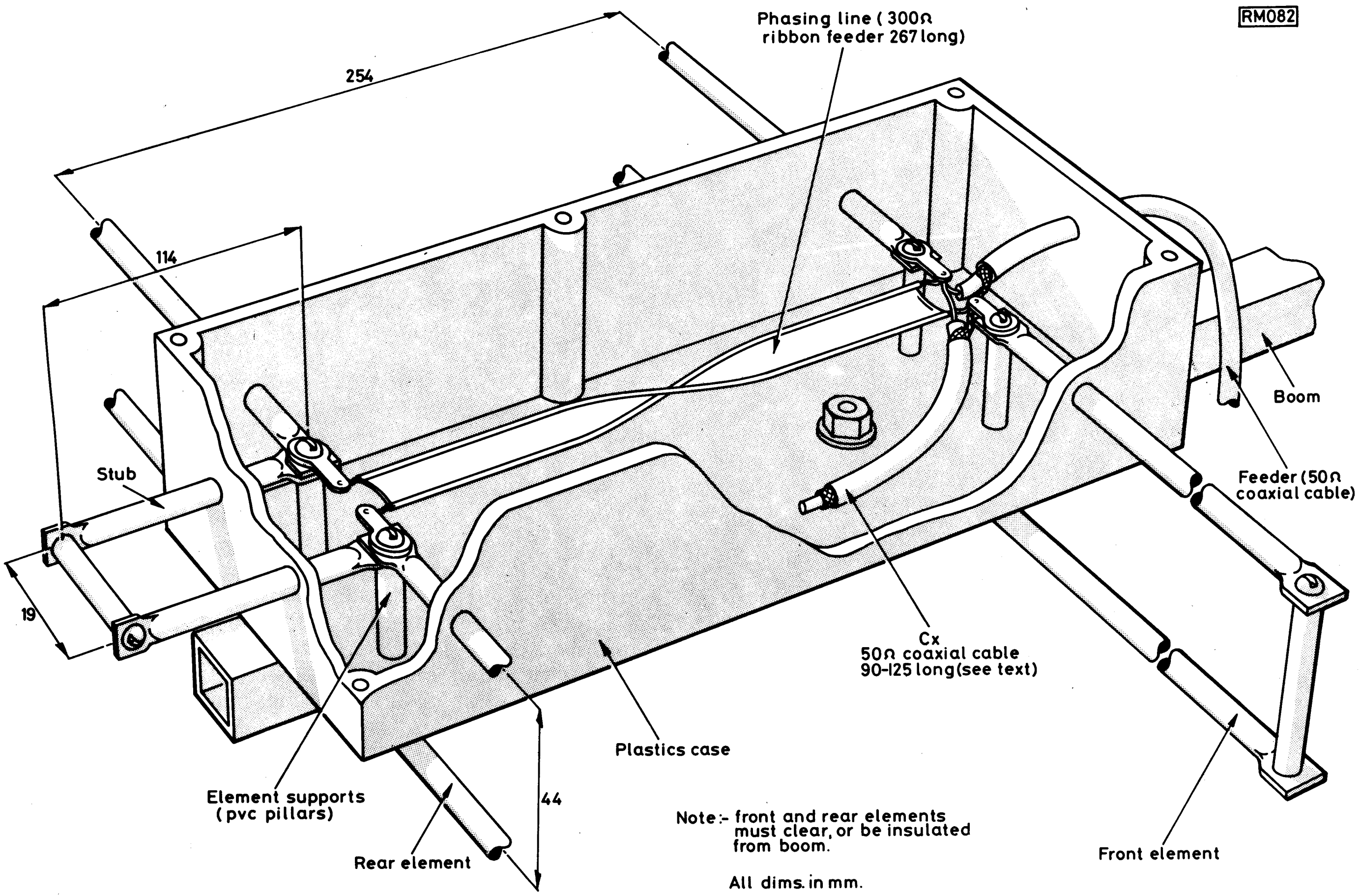


Fig. 3: Details of the driven element assembly

Checking and Operation

This aerial will only operate with 50Ω coaxial cable which should be of good quality. Type UR67 is recommended for long runs but UR43 may be used for lengths of up to 10 to 12 metres without too much loss. It is advisable not to use old cable (eg cable which has been in use outside) as losses develop, usually due to moisture absorption and this will degrade the performance of the aerial.

Before fixing the lid to the protection box make sure all connections are secure. Large soldering tags, say 2BA, clamped under the element ends, are best for good soldered contact of the main coaxial cable, the phasing line and the coaxial capacitor. For testing, the full length of 50Ω cable should be connected. Set the aerial up in the garden, balanced on a pair of steps so that it is about 1 to 1½m above ground. If a v.s.w.r. meter (or power meter) is available and/or fitted to the transmitter, check at mid band (145MHz), that the v.s.w.r. does not exceed 1·5:1. If it is higher then a problem, perhaps with connections, is indicated. If the v.s.w.r. is below 1·5:1 then leave well alone! However, adjustment can be made to the coaxial capacitor length for minimum v.s.w.r. It may mean trying two or three pieces of say 90mm, 100mm and 125mm but the trouble will be worthwhile. If you have available a 6 watt fluorescent tube it should light brightly when touching the ends of the driven elements and most of the directors when 10 watts or more of r.f. is present.

If the v.s.w.r. is plotted across the band the curve should approximate that shown as (b) in Fig. 4 provided the feeder cable is not too long. For runs of 20m or more the curve will tend to flatten out as (c).

For comparison, an average v.s.w.r. curve for a long Yagi is shown in (a) and the increased rise at each end is due to the fact that such aerials are sharply resonant. The ZL series are broad-band hence the flatter v.s.w.r. curve. The beam width at 3dB is about 36°, as in the polar patterns of Fig. 5 which were taken from the prototype. The solid line is for horizontal polarization and the broken line for vertical, but note that the spurious lobes in the vertical pattern, due to reflection from nearby conductors,

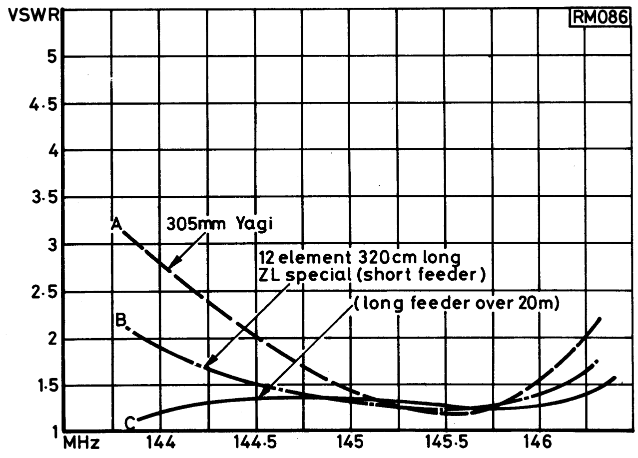


Fig. 4: VSWR plots, ZL Beam by comparison with long Yagi

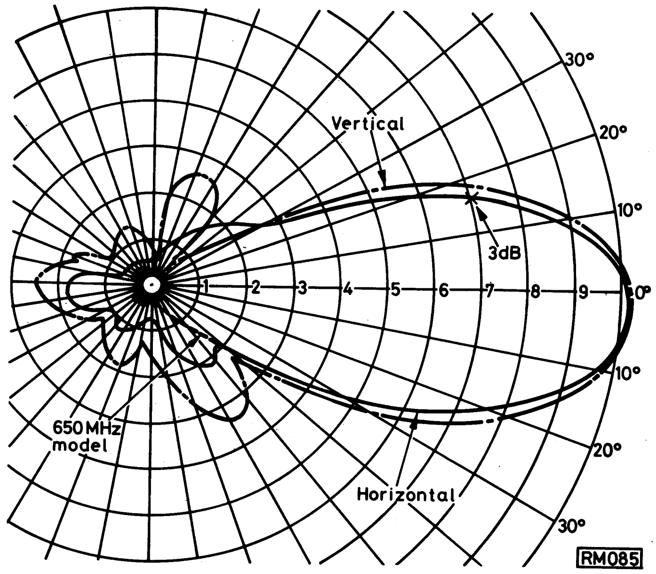
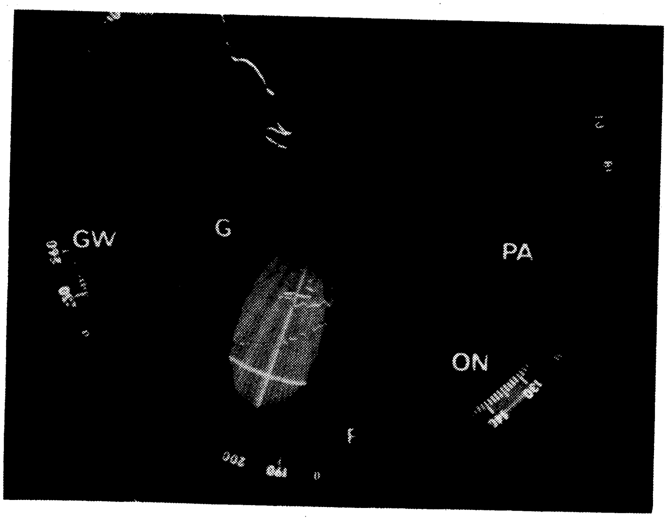


Fig. 5: Measured vertical and horizontal radiation patterns of the 12-element ZL Beam, taken at 145MHz

are fairly typical when a high gain aerial of this nature is used in a built-up area.

The polar pattern from a 650MHz model of the aerial compared almost exactly with the 2 metre version and this is shown in the photo taken from a polar scan display unit which I have recently built to operate in conjunction with a model antenna performance measuring system.



Installation

A beam aerial of this nature obviously needs a 360° rotator but being quite light in weight does not need a high powered device. In the photograph of the aerial, can be seen a small oblong box (at the centre) and this is a vertical to horizontal rotator which allows the aerial to be operated vertically or horizontally, or at any intermediate angle. Such a rotator is not difficult to make and really all that is required is a reversible d.c. motor, some Meccano or similar gear wheels and a little ingenuity to arrange an auto-stop (micro-switches) and a reversing and stop control box. ●