'Beaming'...

With the Moonraker 12-element ZL-Special

Neil Taylor G4HLX, well known to readers as the originator and organiser of the *PW* 144MHz QRP Contest has been evaluating an interesting antenna which could be very useful for your own portable activities.

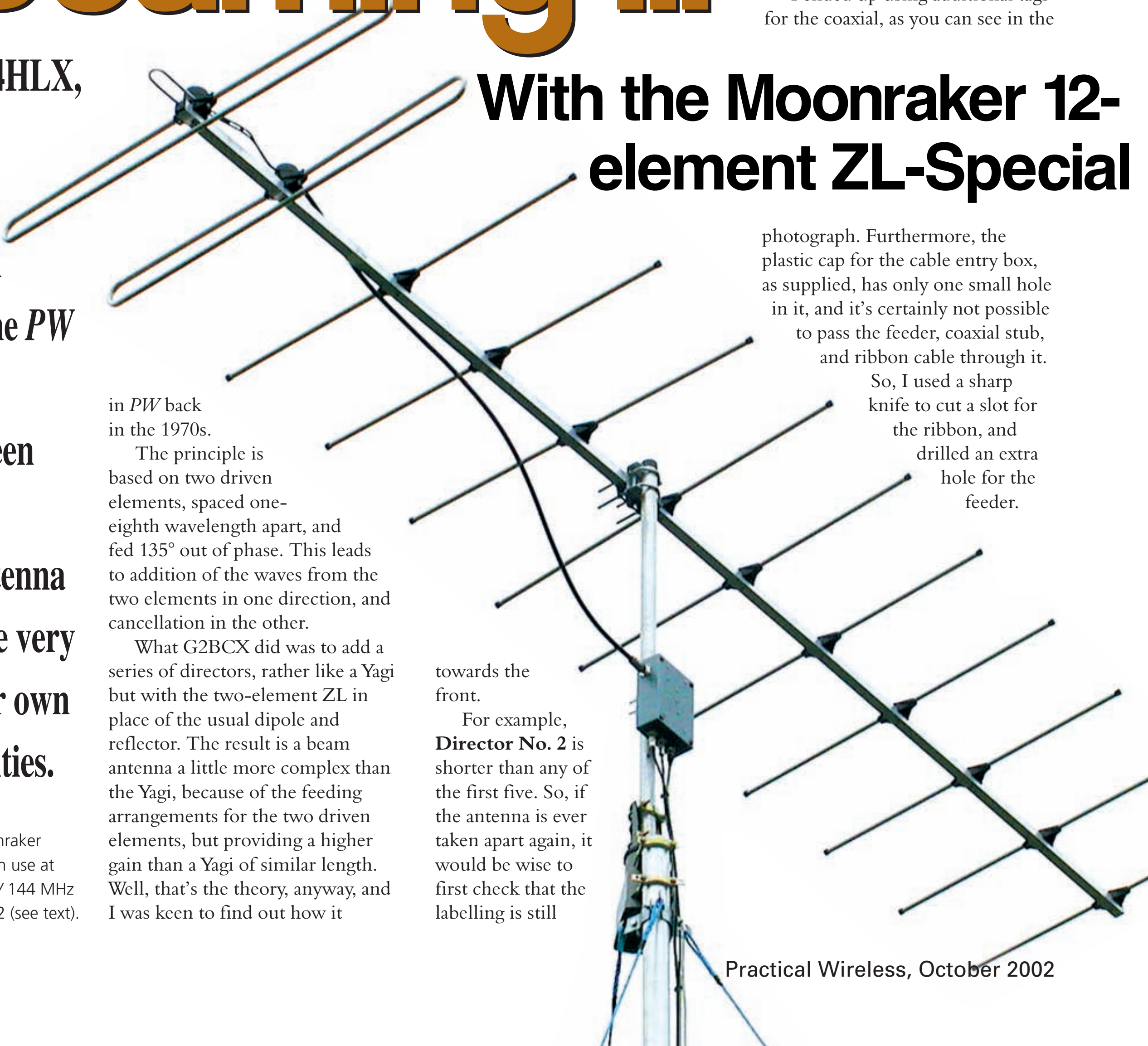

Fig. 1: (Right) The Moonraker 12-element ZL-Special in use at G4HLX/P during the *PW* 144 MHz QRP Contest, June 2002 (see text).

I was pleased to have an opportunity to try out the Moonraker 12-element ZL Special, **Fig. 1**, antenna for the 144MHz band. Pleased...both to find out how the ZL-special design performs, and to see the standard of construction of the Moonraker series of antennas.

The ZL-special beam concept is an alternative to the conventional Yagi designs for directional v.h.f. antennas. Moonraker offer a wide range of antennas, including both ZL and Yagi types. I gave this 12-element ZL-special a good trial at a portable site during the *Practical Wireless* 144MHz QRP Contest this year, as well as testing it at my home QTH.

The ZL-Special

The concept of the ZL-special design goes back a long way. Basically a two-element end-fire array, it was adapted for use on v.h.f. by the late **Fred Judd G2BCX**, in articles published in *PW* back in the 1970s.

The principle is based on two driven elements, spaced one-eighth wavelength apart, and fed 135° out of phase. This leads to addition of the waves from the two elements in one direction, and cancellation in the other.

What G2BCX did was to add a series of directors, rather like a Yagi but with the two-element ZL in place of the usual dipole and reflector. The result is a beam antenna a little more complex than the Yagi, because of the feeding arrangements for the two driven elements, but providing a higher gain than a Yagi of similar length. Well, that's the theory, anyway, and I was keen to find out how it worked in practice!

The Moonraker construction of the 12-element version is substantial and sturdy. Tubular aluminium elements are held on to the 3.2m long square-section boom with large black plastic mounts and stainless-steel bolts.

The antenna has a chunky, robust feel about it, and it weighs 3.6kg. Not an antenna for backpacking! A mast clamp is included, suitable for fixing to a pole up to 55mm in diameter. The photo **Fig.2**, shows the parts as the antenna is supplied, and the basic assembly is straightforward. The instruction sheet is rather minimal though, and I would have liked to see more explanation of the feed arrangement in particular, which could be puzzling to a beginner.

Each director element is labelled with a number, and of course care must be taken to get them in the right order. This isn't quite as obvious as you might think because, unlike a Yagi, they do not just get progressively shorter towards the front.

For example, **Director No. 2** is shorter than any of the first five. So, if the antenna is ever taken apart again, it would be wise to first check that the labelling is still legible (it seems to have been done with a felt-tip pen).

An 8mm spanner is needed to secure the directors, and a 10mm size is required for the driven elements. The boom is divided near the middle, the two halves being held together by one of the element mounting bolts. For ease of assembly at a portable site, I would like to have a wing-nut on this but since the bolts seem to be standard M5 size, one could be obtained from a hardware store.

Phase Reversal

A piece of 300Ω ribbon cable is also provided, which must be cut to the specified length and connected between the two driven elements, with a 180° twist in it to give a phase reversal. The connections onto the elements are achieved with two small solder tags.

At the front driven element feed point, the coaxial able feeder is connected, as well as a short RG58 coax stub in addition to the 300Ω ribbon. All this is rather cramped in the small cable entry box (see **Fig. 3**), and not really feasible using just the small solder tags provided.

I ended up using additional tags for the coaxial, as you can see in the photograph. Furthermore, the plastic cap for the cable entry box, as supplied, has only one small hole in it, and it's certainly not possible to pass the feeder, coaxial stub, and ribbon cable through it. So, I used a sharp knife to cut a slot for the ribbon, and drilled an extra hole for the feeder.

This wasn't difficult, but needed some thought and I felt that the instruction sheet could really have provided some guidance.

The instruction for the coaxial stub, which is to be connected in parallel with the feed-point says "RG58 coax stub, start @ 128mm, cut for best SWR". It wasn't clear if this should be an open or closed

Fig. 2: The antenna as it arrives from Moonraker, ready for assembly (see text).

stub, **but experimentation showed that it must be an open**.

Incidentally, the original G2BCX article describes the stub as a coaxial capacitor. To trim it, you'll need to have the antenna set up in the clear and connected to a 144MHz transmitter through an s.w.r. meter. However, so that I could see what was going on, I used an MFJ Antenna Analyser to look at the match over a wider range of frequencies.

Initially the antenna was rather sharply resonant at about 157MHz, and the s.w.r. on the 144MHz band was over 3:1. As I trimmed more and more off the coaxial stub, the resonance dropped in frequency, but only slowly, while the bandwidth opened out.

I reached a point where the s.w.r. was acceptable in the 144 - 146MHz range (less than 1.5:1), although the resonant frequency (1:1 v.s.w.r.) was still well over 150MHz. So I carried on trimming. It got better and better until eventually I had cut off the coaxial stub completely! At this point the match was excellent - less than 1.1:1 across the entire band 144 - 146MHz (and well above this, too).

I found it curious that the optimum length of the coaxial stub was zero, and of course a little annoyed that I had struggled to get it installed in the small cable entry box, and drilled an extra hole in the cap which was now not needed! **But presumably the stub is needed in some cases, maybe depending on the type of feeder used** - I had a short length of URM67.

My experience suggests that **it is worthwhile** going on cutting pieces off the coaxial stub in the search for an optimum match, even if this means going past the optimum and having to replace the coaxial stub again with a longer piece to start again. In my case the outcome was very satisfactory. **I just wish I'd checked the s.w.r. before bothering to connect the coax stub in the first place!**

Up The Hill!

Having set up the antenna, it was time to take it up the hill and try it out in real operation. I operated the first few hours of the QRP Contest with my trusty 13-element Yagi that I have used for many years. This gave me a point of reference when I later lowered the mast and replaced the yagi with the 12-element ZL-Special, Fig. 1**.**

Just before and after the change I checked the strength of several beacons. Within the margins of error of this measurement, I could see no difference in the signal strengths between the two antennas. **This impressed me, because the ZL-special is significantly shorter than the Yagi**.

Of course, I wouldn't have noticed a difference of a decibel or two, but I expect that the Moonraker antenna probably gets close to the theoretical 14dB gain over a dipole for this design. (The 3dB beam width should be about 36°).

I used the antenna for a couple of hours, and had some good contacts. Towards the end of the contest I heard a few EA stations, probably via sporadic-E propagation, so the antenna was certainly doing its stuff. Overall I would say that it performed at least as well as I expected.

Permanent Installation

If I was using the Moonraker beam in a permanent installation, I would want to be careful about weather-proofing the cable entry. A good coating of varnish on the solder connections would be a good idea, to avoid corrosion.

I also believe in providing a small drain hole to let water escape when it gets in. This is more realistic than trying to provide a completely sealed enclosure, as experience shows that some water ingress is inevitable. (This is another area where some advice would be useful in the instruction sheet).

In conclusion, my only reservation about the construction of this antenna is the cable entry arrangement, although with care, this can be done well enough. An improvement in the assembly and set-up instructions is certainly called for, especially in the light of my experience with trimming the coaxial stub.

Fig. 3: The cable entry box, before Neill G4HLX had discovered that the optimum match appeared to be with the coaxial stub removed! (See text).

Otherwise, I think that the Moonraker antenna is a sturdily built type which performs well, probably better than a conventional yagi of similar length. My thanks go to Moonraker for the loan of the review antenna.

PW

Product

Moonraker 12-element 144MHz ZL-Special

Company

Moonraker

Contact

Tel: (01908) 281705
FAX: (01908) 281706.

Pros and Cons

Pros: A sturdily built type which performs well, probably better than a conventional Yagi of similar length....I expect that the Moonraker antenna probably gets close to the theoretical 14dB gain over a dipole for this design. (The 3dB beam width should be about 36°).

Cons: My only reservation about the construction of this antenna is the cable entry arrangement although with care, this can be done well enough. An improvement in the assembly and set-up instructions is certainly called for, especially in the light of my experience with trimming the coaxial stub

Price

£74.95 + P&P

Summary

I used the antenna for a couple of hours, and had some good contacts. Towards the end of the contest I heard a few EA stations, probably via sporadic-E propagation, so the antenna was certainly doing its stuff!

Supplier

The review antenna was loaned by **Moonraker (UK) Ltd., Unit 12, Cranfield Road Units, Cranfield Road, Woburn Sands, Buckinghamshire MK17 8UR.**