Antenna Workshop

David Butler G4ASR takes his turn in the Antenna Workshop to bring you an omni-directional horizontally polarised antenna for the 144MHz Band.

A Big Wheel Antenna

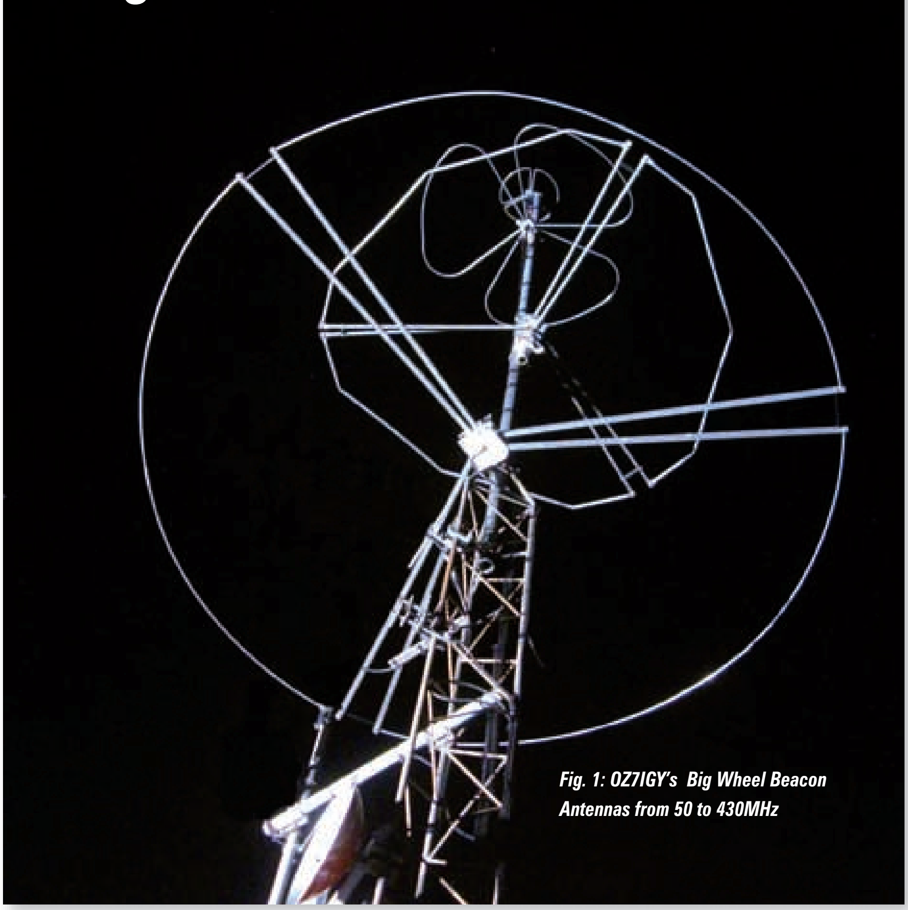

Fig. 1: OZ7IGY's Big Wheel Beacon Antennas from 50 to 430MHz

Hello and it's my turn again in the Antenna Workshop. Sometimes, I have difficulty deciding what antenna to describe and such was the case this time around. Then, I remembered that last month I had written about the Danish **OZ7IGY** beacon units in my VHF DXer column. The beacons use separate Big Wheel antennas for the 50, 70, 144 and 430MHz bands as shown in the photograph, **Fig. 1**. These have proved to be very reliable in service and that's the reason for describing one this time around.

Point-To-Point

It is common for high-gain directional antennas to be used for point-to-point v.h.f. or u.h.f. communication. The gain of a directive array magnifies the radiated energy towards the desired direction. Or it can reduce interference from signals in other than the desired direction. However, the directional characteristics of a beam antenna are not always an advantage or desirable. Normally, a beam stays directed into the general direction of most radio activity, so some possible contacts may not be heard.

It's to counteract the directional disadvantage of beam antennas, that the the Big Wheel comes into play. For general coverage purposes a horizontally polarised, omni-directional pattern is very useful and allows the operator to scan in all directions at once for signals of interest. And, of course, it's great for use as an antenna as the OZ7IGY beacon group can confirm.

The Big Wheel

The Big Wheel antenna design has been around since the early 1950s and it resembles a skeletal three-bladed clover-leaf. The three phased horizontally polarised loops with a common feed-point create an omni-directional pattern. The radiation pattern is not perfectly circular though, the gain being determined to be 3dBd when aligned with the flat sides of the driven element, reducing to 1.5dBd in the directions of the 'feeders' of the three elements.

The elements themselves are each one wavelength long for the band of interest as shown in the diagram, **Fig. 2**. The outermost side of the element is effectively half-wave long; therefore there are three half-wave dipoles each set at 120° to one-another around the perimeter of a circle. These dipoles are then 'stood off' from the centre hub by quarter wavelength sections at each end of the dipole. The dipoles are then fed at the ends of each element rather than at the centre as in a conventional dipole.

Each 'leaf' of the antenna will exhibit a terminal impedance of 36Ω and therefore, by paralleling the three sections results in a combined impedance of 12Ω. A stub (a strap of metal less than one quarter wavelength in size) is employed at the centre hub to increase the terminal impedance back up to 50Ω.

Antenna Construction

The antenna is constructed from three sections of aluminium tube or rod, each formed into a 120° clover-leaf shaped segment. In the centre of the antenna is an insulating block sandwiched between two aluminium fixing plates One side of the clover leaf element is screwed to the upper fixing plate and the other end of the element is screwed to the lower fixing plate. The lower fixing plate also facilitates attachment to the antenna mast via a 'U' bolt.

An adjustable tuning stub made from aluminium strip is attached centrally between the upper and lower fixing plates. An r.f. connector (of your choice) is fitted between the two plates into which the 50Ω feeder cable is connected. Although the following construction dimensions are specifically for the 144MHz band the Big Wheel antenna can be scaled for use on any v.h.f. or u.h.f. band.

Bending To Shape

Start the construction by bending to shape of the three elements, which are made from 10mm aluminium rod or tubing each 2032mm (80in) in length. Mark 508mm (20in) in from each end and bend them at these points with a 152mm (6in) radius to form one of the elements, which will look like the skeleton of a single clover leaf. The roundness of the 1016mm (40in) portion that is in between the two end sections may be formed by hand.

With tubing, the strength and stability of the antenna are both improved if lengths of hardwood dowel rod are driven into the element ends. Drill two M4 holes perpendicular to the plane of the element, 10mm in from each end and 20mm apart. Do this to both ends of all three elements.

Now, the central hub and plates need to be constructed. The bottom plate, made from 3mm (1/8in) thick aluminium is marked out and drilled as shown in the diagram, **Fig. 3**. The plate is bent at 90° to which is attached a suitable size 'U' bolt. Drill a hole centrally for a bulkhead socket of your choice and attach it to the plate. The upper plate is also made from 3mm thick aluminium sheet. It can be square, circular or even triangular as long as it corresponds to the holes drilled in the bottom fixing plate.

The two plates are spaced 38mm (1.5in) apart using a suitable insulating material such as nylon or ceramic pillars, solid nylon, Tufnell or Plexiglass. Solder a 50mm length of threaded brass rod to the r.f. socket centre conductor and attach it to the upper plate using a nut either side of the plate. Alternatively, you could use a short piece of stiff wire and a solder tag.

The matching stub shown in the diagram, **Fig. 4** is fashioned from a 127mm (5in) length of 25mm (1in) wide, 1.5mm (1/16in) thick aluminium strip. Drill an M4 hole at one end of it, on centre and 6mm (1/4in) in from the end. Only the stub length is critical and since it is merely a strip of aluminium all you need to do is create a slot with the mounting hole in one end of the stub so that its electrical length can be adjusted.

To create the slot at the other end, instead of making one hole, make a series of holes over a distance of about 30mm and with a needle file or saw, 'join' the holes up to make one long adjustment slot. Then bend this strap into a 'U' shape so that the open ends are approximately 38mm (1.5in) apart. Attach the stub to the upper and lower plates using M4 screws, **Fig. 5**.

The first element should be installed onto the central hub, placing one end of this element onto the bottom plate and secure it with M4 screws through the holes that you've made. The other end of the element should be secured to the top plate in the same manner.

The first end of the second element should be secured to the bottom plate right below the end of the first element's connection to the top plate. Then the free end of the second element will attach to the top plate at the holes provided. Follow suit with the third element.

Testing & Adjusting

Testing and adjusting the system is relatively simple, as the Big Wheel possesses a fairly broad bandwidth and will not require much tuning. Attach a convenient length of 50Ω cable to the coaxial connector and temporarily mount the Big Wheel antenna about two metres above ground.

Tuning (or matching really) is carried out by using your transmitter and v.s.w.r. bridge. Adjust the transmitter so that it runs just a few watts output on 145MHz. The transmitter should be keyed when the v.s.w.r. should be around 1.5:1. If the s.w.r. is still high, then stop transmitting and adjust the aluminium strap, in or out, to get an optimum match. Once the stub has been adjusted for a perfect match at 145MHz, the v.s.w.r. should be negligible over the entire 144MHz band.

That's all there is to it. Now get building! ●

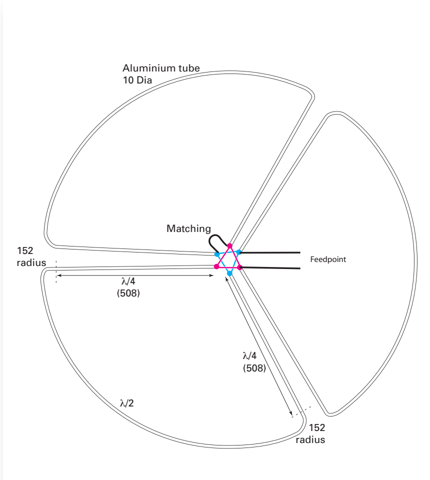

Fig. 2: Big Wheel layout, each 'leaf' has a feedpoint impedance of 36Ω, giving a combined impedance of 12Ω.

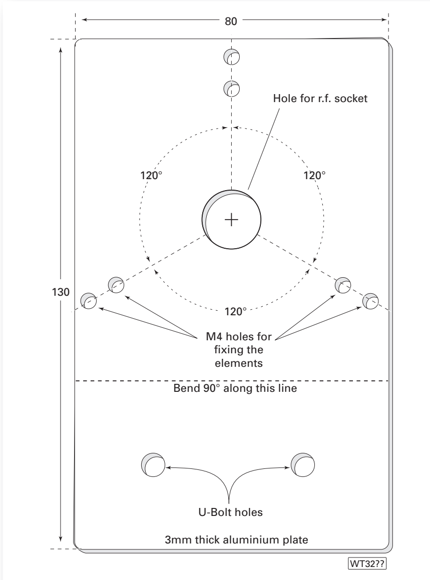

Fig. 3: Lower fixing clamp plate, it's bent along the dotted line to make an 'L' shape. The top plate is similar, but without the U-bolt area.

Fig. 4: Matching Stub The strap is formed into a 'U' shape to attach it to the top and bottom plates.

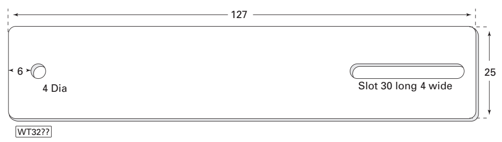

Fig. 5: The centre clamping plate and 'hairpin' match.