Jonathan Hare, G1EXG

1 The Copse, 50-52 Princess Road, Brighton BN23RH.

E-mail: jj.hare@ntlworld.com

A tube-Yagi for portable work on 144MHz

This cheap, compact and simple-to-construct five-element Yagi is ideal for low power backpack portable operation. The antenna elements pack up by sliding into the boom tube for easy storage. The antenna is light-weight and quick and easy to assemble in the field.

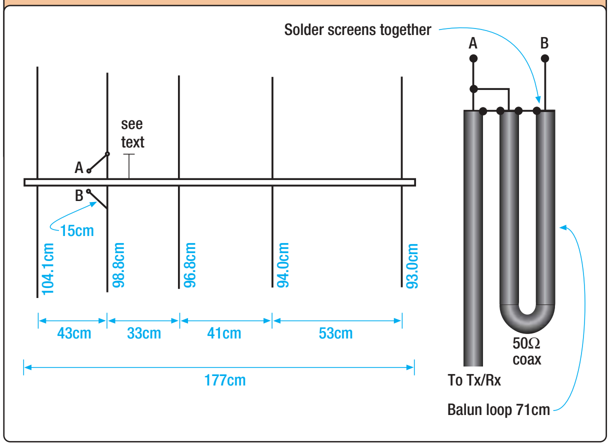
A 177cm length of 19mm diameter plastic waste water pipe was used as the boom for the tube-Yagi. This needs to be carefully marked and drilled to make sure the elements will be parallel when they are inserted.

Start off by drawing a straight line down the tube. There might be a seam on the tube that you can use, otherwise try laying it on a flat surface and run a marker pen alongside using the surface as a guide. Next, wrap a piece of paper around the tube and use the straight edge as a guide to mark an accurate circle around the tube where the elements will go. Then cut the paper to the length of the circumference and find the halfway mark. By aligning one end of the paper with the line, the middle point will act as a marker for the holes on the other side of the boom.

Don't try to drill through the whole boom in one go. Instead, drill the two holes separately. In this way you can correctly mark out, and then drill, the 10 holes on the boom that will take the five elements. You might need to open up the holes a tiny amount, but try to make the fit tight enough so that the elements slide in with a little friction.

The reflector and director elements are made from 3mm aluminium rod (welding rod or similar). An off-centre blob of epoxy resin (or small circular push-on metal clip) acts as a stop for the rods so that they will be correctly positioned when inserted. A label can be added (to tag each element clearly for easy identification in the field) to this side of the element so that you will never try to put the element in the wrong way. Once the rods have been fitted into the boom, a small rubber grommet is pushed on from the other side to fix the elements in place (see the photograph). Tube of 6mm diameter was used for the dipole element, and a few turns

FIG 1 © RADCOM 555



of tape were used on one side to locate this.

The antenna is matched to the coaxial feeder using delta arms and a 4:1 coaxial balun to the dipole. The balun was constructed in the standard way (see **Fig 1**) using a loop of about 71cm. All the screens are soldered together at one point. The balun joints were covered in rubber solution glue to waterproof them and wired to solder tags to attach to the 15cm delta arms (which should be made of the same thickness tube as the dipole). The balun and delta arms were fixed to a sheet of plastic to provide support, as shown in the photograph. The other end of the delta arms were attached 11.5cm either side of the dipole centre using 3M bolts and butterfly nuts. (For a really quick and easy connection, I have successfully used large crocodile clips instead of bolts and butterfly nuts (see photograph). However, this is only really suitable for low powers).

To pack up the antenna, the elements of the Yagi slide into the plastic boom. Rubber bungs stop the ends – you now have a Yagi-in-a-tube. I also found that it was possible to slide the tube-Yagi within the centre of my portable telescopic mast so that only one item then needed to be carried besides the backpack.

Fig 1
Schematic of the 5 element Yagi and balun (dimensions taken from the ARRL article, see 'Reference'.

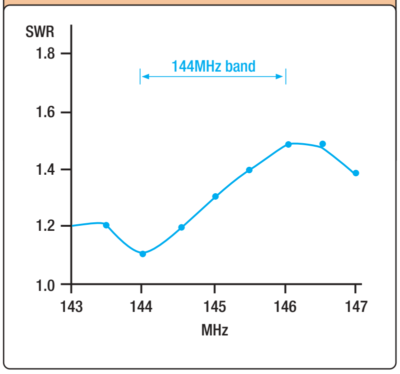
Fig 2
Typical SWR measurements for the tube-Yagi (horizontally mounted).

SETTING UP AND ADJUSTING THE SWR

On unpacking, the elements are fixed to their correct places on the boom and the rubber grommets used to secure the parasitic elements in place. The delta arms attach via the bolts and butterfly nuts either side of the dipole centre. When using the beam for horizontal polarisation, let the balun hang down away from the plane of the Yagi and tape the cable to the mast as shown in the photograph. Adjustment of the SWR is possible by changing the lengths of the delta arms and where they attach either side of the dipole centre. I found that a good SWR was achieved over the whole of the band when the 15cm delta arms were attached 11.5cm either side of the dipole centre but some experimentation may be needed here depending what materials you decide to use.

Shown in **Fig 2** are typical measurements for the SWR of the beam mounted horizontally. I used about

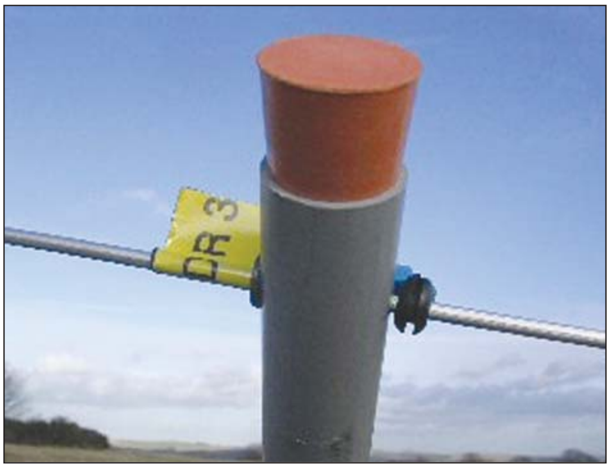
FIG 2 © RADCOM 556



Top: The 5-element Yagi unpacked from the tube and set-up on the portable mast.

Middle: Detail showing the last director with its labelling, the position of the stop and the grommet used to secure the element

Bottom: View of the balun and delta arms. The view shows the croc-clip connections around the dipole center used for initial testing, ideally these should be replaced with bolts and butterfly nuts.



7m of RG-58A/U coax for this beam; lower-loss cable will probably change the curve slightly. The Yagi delta match and the balun are both resonant devices, so two peaks in the SWR can occur if the two resonances don't coincide exactly. A good SWR over a part of the band is easy and, with experimentation, an SWR of less than 1.6 over the whole144MHz band is possible.

For vertical polarisation, it is best to use a non-conducting mast. There is no natural position for the delta match / balun in the vertical position. I tried them fixed along the boom (toward the first director) and also perpendicular to the beam and each gave slightly different SWR results, but I found the whole assembly still gave very usable SWR results over the whole band, even with a metal mast.

ANTENNA GAIN

The antenna gain of the Yagi was determined in a very simple manner. The GB3VHF beacon in Kent (JO01DH), roughly 60km distant from the test site (IO90WU) was used as a reference signal and received firstly on a dipole and then secondly on the 5-element Yagi (at the same height and with similar coax feeders).

A VHF RF attenuator (0 – 40dB in 1dB steps) was fitted between the antennas and the receiver. The S-meter was used to measure the signal at the dipole. When the Yagi was measured, the attenuator was adjusted until the S-meter read the same as that obtained using the dipole. The change in attenuation thus gave a guide to the Yagi gain compared to the dipole. These experiments gave a gain of 7 – 8dB with a front-to-back ratio of 10 – 11dB.

Note: I used about 7m of RG-58A/U coax for convenience, as it is much easier to pack away. However, less loss would be obtained using the more bulky RG-213, but it is a heaver load for the antenna to support and so some support tape for the cable needs to be provided.

FINAL COMMENTS

A standard TV / FM aerial mast clamp was used to attach the Yagi to the mast. It is worthwhile replacing the nuts on these clamps for (butterfly) wing nuts; using them is quicker and cuts down on the number of tools you need to carry when out-and-about on the hills.

The antenna is based on an old ARRL design [1] that I have used with excellent results over many years. The antenna seems to have a good combination of gain and bandwidth for its size. I have used the antenna singly, in twos and even in fours using a light weight open-wire phasing harness and universal stub, as described in the original article. Because the packed-up tube-Yagi is so compact and lightweight, it opens up the exciting possibility of being able to get further gain by using two (or perhaps even four!) of these antennas for backpack portable work. ♦

REFERENCES

[1] *The Radio Amateur's Handbook*, (ARRL), 1972, Chapter 22 – 'VHF and UHF antennas'.

PARTS LIST

1-off	plastic µpvc waste water pipe (eg 'osma 5') 19mm.
1-off	~1m, 6mm diameter aluminium tube (for dipole, see table).
4-off	~1.1m, 3mm diameter aluminium rod (for passive elements, see table).
2-off	rubber bungs (to fit the ends of the boom).
1-off	TV / FM antenna clamp & wing nuts.
	labels for element identification,
4-off	small rubber grommets & four cable ties.
2-off	solder tags and nuts & bolts.
2-off	3M bolts and butterfly nuts (or car battery size croc-clips, see text).
	50ohm coax (RG-58A/U convenient for portable use if short <10m lengths) and RF connector for radio.