30 minute J-pole

What is it?

The J-pole antenna, more properly known as the J antenna, was first invented by Hans Beggerow in 1909 for use in Zeppelin airships. It consisted of a single element, one half wavelength long radiator with a quarter wave parallel feedline tuning stub. This was typically trailed behind the aircraft (for HF: no VHF back then!).

Figure 1 shows the basic way the antenna is configured. In effect, we have an end-fed omnidirectional half-wave antenna that is matched to the feedline by a quarter wave parallel transmission line stub. Being a half-wave antenna, it provides a small gain over a quarter-wave ground-plane antenna, typically 2.2dBi. Interestingly, the 2m J pole will work effectively on 70cm!

The J-Pole is very sensitive to conductive support structures and will achieve best performance with no electrical bonding between antenna conductors and the mounting structure. It is influenced by outside factors so should be kept away from other conductors including drain pipes, metal window frames, flashing, etc by a distance of two to three times the spacing between the parallel stub conductors. DO NOT USE A METAL MAST.

Feeder

The J-pole antenna and its variations may be fed with a balanced line or coax feeder. If a coax feed line is used it can be beneficial to include a means to suppress feedline RF currents. Generally, three to six turns of the coax feeder close wound either on a former or air wound will work. In **Photo 1** you can see how I used the 40mm plastic pipe 'mast' as the former for the feeder choke.

The feed point of the J-pole is somewhere between the closed low-impedance bottom and open high-impedance top of the J stub. Between these two extremes exists a match to any impedance between the low to high impedance points. However, you must consider that this will have to be matched at the radio end to 50Ω.

Construction

Photo 2 shows the main parts I used for the prototype – 15mm copper pipe, a pair of right angle elbows (Yorkshire or plain type), two copper saddle clamps (for fixing the feed points), two 5mm bolts, nuts and washers, plus a SO239 socket.

As you will have noted from Figure 1, all the dimensions are calculated as fractions of a wavelength for the frequency of interest. The bandwidth of the antenna is reasonably broad but, as most vertically polarised operation takes place in the upper 1MHz of the 2m band, we'll choose 145.500MHz as the design centre frequency. But – and it's an important but – the simple calculation doesn't take into account velocity factor and any odd 'strays' so I recommend you add 5-10mm or so to the dimensions you calculate. It's easy enough to trim a bit off later if necessary but the converse is not true.

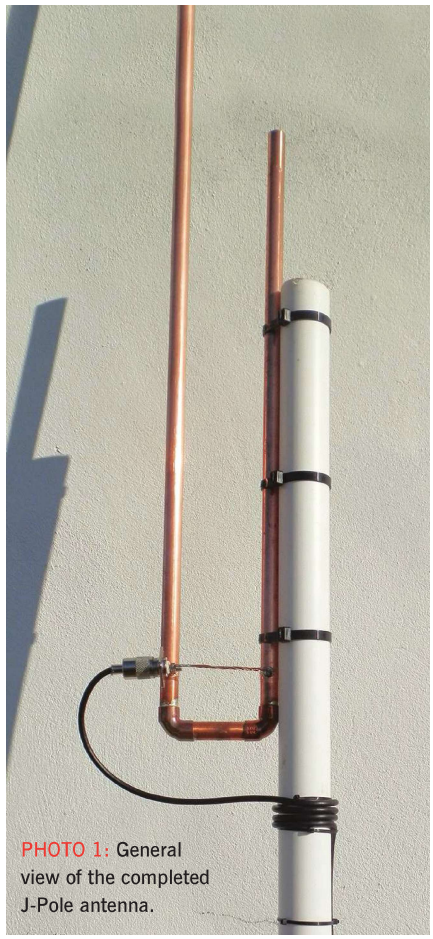

PHOTO 1: General view of the completed J-Pole antenna.

For the radiator section we need ½ + ¼ wavelength at 145.500MHz, which is 1485mm. The matching stub section is ¼ wavelength at 145.500MHz, which is 495mm. The element spacing is about 45mm, but this is not critical.

As mentioned earlier, the feed point can match to just about anything you want. However, the 50Ω point is about 49mm from the base. The construction method described here allows for the feed point to be adjusted for best match. The only thing worthy of note at this stage is that the braid and centre should each be at the same height from the base.

The neatest way to cut copper pipe is with a proper pipe cutter [1]. These are small hand-operated devices that have a sharp wheel and adjustable jaw grips. These are used by rotating it around the pipe and repeatedly tightening it until it cuts all of the way through. They are inexpensive, starting at about £3. The alternative is to use a hacksaw or, if you have the facility, a metal-cutting bandsaw or similar. Whatever method you use, take all necessary safety precautions.

Cut 1490mm of 15mm copper pipe to form the radiator section, 500mm for the matching stub and 30mm for the bottom section. (Remember that the elbows will add a bit to each of these lengths). Clean the ends with emery paper or wire wool to remove any oxidation, leaving bright shiny copper. The radiator and matching stub will need at least 75mm or so cleaned up, not only so that they will solder cleanly but also to ensure a good electrical connection to the saddle clamps.

I assume that anyone building this 'plumber's delight' will be reasonably familiar with soldering copper pipe to elbows using a blowtorch or similar but is important to point out that of you're using Yorkshire (pre-soldered) fittings, the ends need to be smeared with a little flux to help the solder flow inside the joint. Failure to do so will result in a mechanically weak joint.

Assemble the three pipes and elbows on a fire resistant surface and heat the pipes and fittings evenly. They do not need to be cherry red, but just to the point where the copper starts to 'rainbow'. If using Yorkshire joints and flux, you should see the solder appear as a ring. At this point remove the heat and allow the assembly to cool. DO NOT MOVE ANYTHING WHILST IT IS HOT or you'll result in mechanically weak joints.

If using non pre-soldered joints, heat as before and, when the joints are hot enough, apply electrical solder to the joint and as it melts you'll see the solder sucked in by capillary action. As previously noted, allow the joints to cool before moving the assembly.

Whilst waiting for it to cool, use emery paper or wire wool to clean the copper saddles. It's particularly important that the inside should be clean, as this will be making contact with the elements.

Once the pipes are cold enough to handle, slide the saddles onto the radiator and stub. Wrap the ends round so that the holes line up – this will take some force. Use the 5mm bolts through the holes, position the saddles 49mm from the base of the tube, then tighten the nuts just sufficiently that they won't slide whilst testing. It will likely be necessary to move them a bit for best match so there's no point doing them up tight yet. **Photo 3** shows the general arrangement.

Now it's time to measure the radiator and stub and cut to final lengths. Place the base of the antenna on a flat surface and measure 1485mm for the radiator and 495mm for the stub. Trim the pipes to length. A couple of mm either way is close enough.

The final steps are down to you to decide. In the example shown in **Photo 3**, I mounted

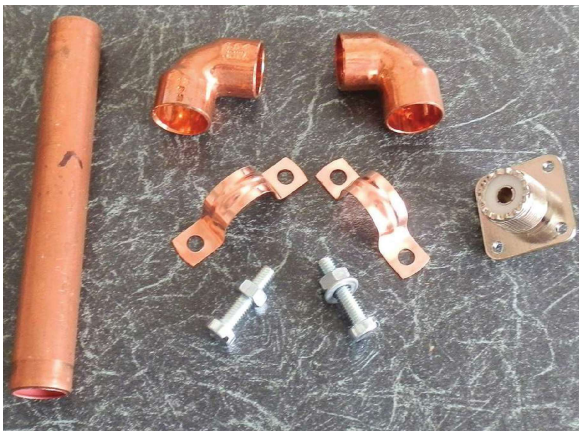

PHOTO 2: Main parts used to make the J-Pole antenna. You will, of course, need rather more copper tube than is shown here.

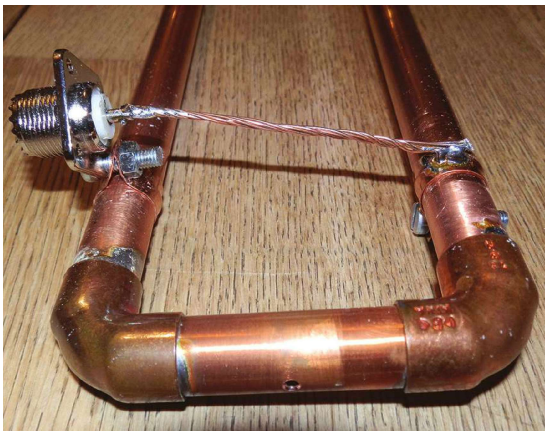

PHOTO 3: Completed base section and feed. Note the drain hole drilled in the bottom of the spacer.

PHOTO 4: Version built for 70cm.

a SO239 socket to one saddle clamp, with a wire extending to the other saddle clamp. Alternatively, the coax or balanced feeder can be soldered directly to the saddle clamps, which is what I did with my experimental 70cm version, seen in **Photo 4**.

Drill a hole of about 3mm in the base cross pipe (see Photo 3). Even if you cap the ends, capillary action will still 'wick' moisture into the pipework.

How you attach the aerial to the mast is again left to you. As you can see from Photo 1 I simply cable-tied the stub to the plastic mounting pole, which worked well enough.

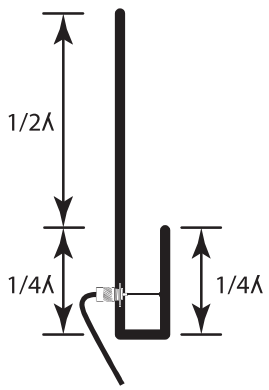

FIGURE 1: General arrangement of the J-Pole antenna.

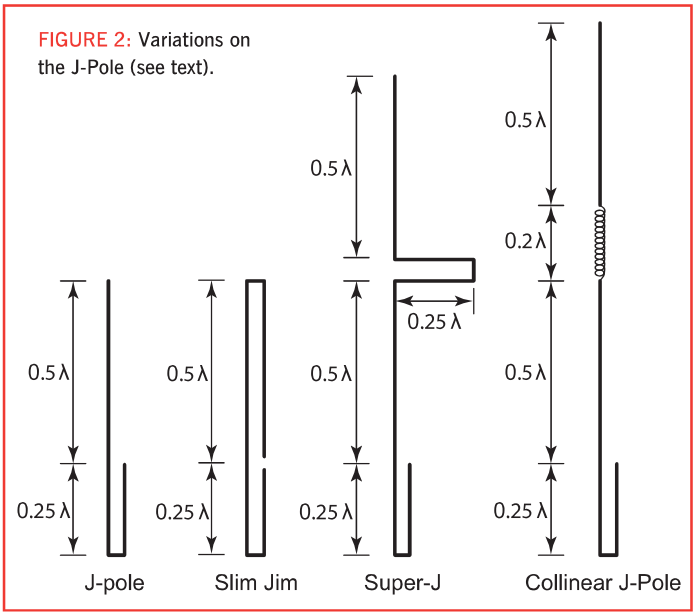

FIGURE 2: Variations on the J-Pole (see text).

Final tuning

There are many variables at this point depending on where the J pole is mounted. If you set it up in the shack or workshop and then install in its final place, I can guarantee that re-tuning will be necessary. But, in its final place it's just a case of moving the clamps up or down the pipes until you have a best match at 145.500MHz, then tightening the nuts.

I do suggest you add a choke to the feeder at the antenna end to suppress feeder RF currents. As mentioned earlier, three to six turns of coax will suffice. And, once again, only use a PLASTIC mast.

The weather

I haven't mentioned anything about waterproofing. If you mount the antenna in a sheltered position (eg in a loft) this obviously won't be a problem. Another straightforward possibility is to mount the assembly inside a larger diameter pipe, ideally with a cap to keep the rain out, if you can contrive an arrangement that's not too heavy. Otherwise, simple measures like a good coat of paint over the saddle clamps, joints and electrical connections (including the back of the SO239 socket) will provide quite a lot of protection. So-called 'liquid electrical tape' is even better still. Don't forget to put something like self-amalgamating tape over the PL359 plug too, because otherwise moisture will definitely get into the coax over time.

Variations

The J Pole has many 'cousins', which opens up a rich vein of avenues for the intrepid antenna experimenter to explore. **Figure 2** shows some of the common types. From left to right we have the J-pole we've built here, the co-called Slim Jim, which has similarities to a folded dipole. The Super-J increases gain by adding a further half-wave radiating section above the main radiator, phased using the 2 x 0.25 wavelength 'kink'. Finally, the collinear J-Pole achieves a similar effect by means of a phasing coil and physically separating the elements. There is a more detailed discussion of these alternative types at [2].

Websearch

[1] eg www.screwfix.com/p/3-28mm-manual-multi-material-pipe-cutter/49428
[2] https://en.wikipedia.org/wiki/J-pole_antenna

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