The PHQFH Quadrifilar Helix Antenna.
Construction manual

History

The original QFH was made from 10mm copper tubing only because I had some left over from my caravan renovations. This proved to be false economy, as just the 10mm elbows and tee cost more than all the the material for the 15mm (1/2 inch) job! The original 10mm (3/8 inch) version was tested in the loft and I immediately noticed a huge improvement over my crossed dipole. Over a period of about 2 weeks testing I was convinced that the 10mm design was almost perfect except for the odd null here and there. I then checked all the calculations, and made slight changes to the dimensions of both loops and balun. After trying various types of balun, I decided to stick with the trifilar wound version.

Final design

I then made up the 15mm (1/2 inch) version of the antenna and installed it on my chimney stack about 45 feet from ground level. This extended my horizon considerably in all directions. I was receiving clear signals from elevations down to 0 degrees from the South. However, noise appeared in the north earlier than I would have expected. and I noticed that the QFH was leaning slightly to the South.
Was the QFH directional, I wondered? If so, it was back to the drawing board. I tried tilting the QFH north and checked the results. The South part of the pass increased in noise and the North part became clear. This result *not* being what I expected, it was up with the ladders again, and all dimensions were re-checked. Everything appeared to be correct. This phenomenon perplexed me for a considerable time, so I decided to make further changes to the loop dimensions. By the time Mark 5 came around and I repeated the tilt test, I found that tilting made no difference to signal strength, so I installed it vertically and then Eureka!

Other experiments carried out included the use of different types of cable. I found in my case that 17 metres (18.6 yard) of RG 059 straight from the QFH connecting block (no preamp) directly into my receiver gave the best results.

A Warning

If you are not going to use a preamp, but you have been feeding DC down the coaxial cable to power a preamp, then beware; the QFH is dead short to DC. You may need to disable the 12 volt feed either via switch or some other means.

Some observations

At this point you will probably have seen pictures of the PHQFH, the version described here is made from 15mm (1/2 inch) copper tube. there have been suggestions made that perhaps a model made from 22mm (7/8 inch) copper tube would be more suited to the centre resonant frequency of 137.50, but I would need prove that it would perform better than the 15mm version. Let's face it, it can be quite a chore bending even 15mm copper pipe, so unless you are another Mr Universe or you are prepared to anneal the 22mm tube I would stick to the 15mm version!

A Note from Judd Jensen: The diameter of the copper pipe has nothing to do with the resonant frequency of the antenna. Changing the diameter changes the resonant frequency only a little. More importantly, it changes the *impedance* of the antenna. We have made many loops with different diameters and, for example, an 8 mm pipe diameter antenna shows an impedance of about 21 ohm, whereas a 15 mm antenna is about 30 ohms impedance . Our results , how and why will be published in the next RIG.
With regards : Ruud Jansen PA0ROJ, Chairman of the Dutch workgroup KUNSTMANEN.

My solicitor (The other alf) has just pointed out to me that although I am freely offering practical advice I should also mention obvious safety requirements. I am a member of RoSPA (Gold advanced Driver) and I should mention **general safety rules** but I would hope that anyone undertaking this project will seriously consider the safety aspects involved whilst using Blowlamps, Chemicals etc, Please read instructions carefully.

Please note that I will *NOT* be held responsible for any injury or damage sustained whilst attempting to make the PHQFH.

Tools and material requirements

Tools

1) Bending spring for 15mm copper pipe, 1metre long (or for piping you are using in your country)
2) Joiners Vise (flat table mounted vise), Black & Decker Workmate, or similar
3) Propane torch, gas supply.
4) Solder, and soldering flux paste. Rosin core preferred
5) Power or hand Drill with 4mm (5/32) drill
6) Tapered round file, 15mm mid diameter or deburring tool on pipe cutter.
7) Fine grain sandpaper for cleaning copper oxidisation
8) Pipe cutter or hacksaw
9) Tape measure in mm
10) Wooden template: One circle at 340mm Radius (13 3/8 inch) for small loop and one circle at 363mm Radius (14 5/16 inch) for large loop. You can make both from the same piece because you only need half circles.

Hardware

1) Two lengths of three metre long 15mm copper tubing, **OR**
   Three lengths of two metre long 15mm copper tubing.
2) Ten 15mm endfeed elbows, these are cheaper than 'Yorkshire' type.
   If you do use the 'Yorkshire' type, allow for this when marking lengths. All my measurements are for the endfeed type. You can also use compression and chrome plated piping if you fancy.
3) One 15mm "T" piece
4) One 22mm to 15mm copper reducer.
5) 22mm plastic waste connector
6) 150mm long 22mm waste pipe.

Notes for those who don't live in the United Kingdom

Most of the components specified here, such as the copper piping, elbows, and T-pieces are available worldwide. However, much of the time the commonly used pipe diameters vary from country to country. The only advice I can give is to make any substitutions as close as possible in physical dimensions and electrical specification to the original specified. Bear in mind that radical changes in pipe diameter mean radical changes in antenna impedance, so try and get as close to the 15mm pipe diameter as possible. Where elbows have different seating dimensions, you will have to recalculate overall dimensions from the 8.5mm assumed in this article. Improvise!!

Acknowledgements

Project creator **Paul Hayes**

Original QHA design : **Bob Thorpe G4UNU**

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And Now for the best Bit!!

I will assume you are using end feed elbows and a T piece, for which we will allow 8.5mm per joint.

Short Loop:
Cut two one metre lengths of 15mm copper tubing, and mark with insulation tape or permanent marker at 752mm. This leaves a good bit at either end for gripping and helps to get the bends smoother. Clean the burrs from the ends of the piping, I use a round file because I find this easier and better than the de-burring tool that usually comes with the cutter. Don't skimp on this bit otherwise you will have problems later.
Cut two pieces of 15mm copper tubing at 343mm. There's no need to de-burr these.

Large Loop:
Cut two one metre lengths of 15mm copper tubing, and mark with insulation tape or permanent marker pen at 804mm. De-burr as above. Cut two pieces of 15mm copper tubing at 175mm and one at 367mm. There's no need to de-burr these.

Assembly NOTE:
Ensure you purchase the correct size 22mm to 15mm reducer. There are at least two different types. You need the one that is 22mm outside diameter {FIG 1}. If using self cleaning flux then flux one end of each of the two 175mm lengths of tubing and solder to the 'T' piece joints. This should give you a *total* length of 367mm to match the other pipe length you cut. I find it easier to do this first rather than cutting pipes after the loops are soldered together. {FIG 2}.

Bending the large loop
Now for the bending: We will start with the large loop just to get you in 'bending mode'. Take one 804mm length of pipe. Sit on a bench or similar, and make yourself comfortable. Insert the bending spring into the pipe until about 50mm of spring is left protruding. If you require more grip for removing the spring attach some sturdy string or wire to the ring at the end of the spring. Ensure you have marked the middle of the pipe so that you don't bend beyond the length of the spring. Start by gripping the pipe with one hand at the end of the pipe {FIG 3} (this is on the left for me because I am a 'lefty').

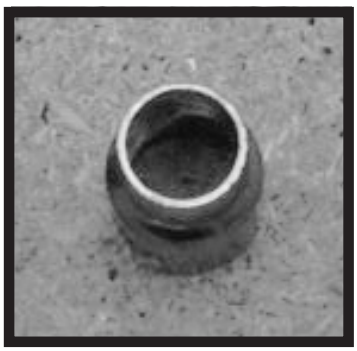
Figure 1


Figure 2


Figure 3

With a gap of about 200mm, grip the pipe with the other hand. You would have more leverage with a bigger gap, but I find I don't have the fine control..

Now place the pipe against your knee, about 60mm in from the end mark. If you start the bend any nearer the end you will find it difficult to manoeuvre the elbows later. (no not *your* elbows, the copper one's!). Slowly and gently pull both hands towards your body until you see the pipe bend slightly. Once you have made the first bit of bend, move the pipe around by about 50mm each time you bend. You can now increase the gap between your hands to about 400mm for extra leverage. {FIG 4}


Figure 4

Once you arrive at about 50mm past the centre the check against the large loop template and make any minor adjustments (if you could not be bothered making a template then draw a circle on the floor and stand in it for two hours saying what a fool you are:-) No, seriously, you can use the circle on the floor - because you should *not* be using the template as a jig, only as a guide.

Remove the spring If it is tight, then pull and twist and it should come out OK provided you have not kinked the pipe. Do exactly the same from the other end.


Figure 5

If all went well with the last stage, you are now ready for the end lift. If not, then have another go until you are happy with the bend. and how it fits the jig {FIG 5}.

Now for the tricky bit, the "End Lift" for the large loop.

I would normally use a joiners vice to assist with this stage, but you could try a Workmate or as shown in the illustration, even a garden bench!


Figure 6

Insert the bending spring again until about 50mm is left protruding. You need to clamp the pipe so that it is firmly gripped for about 25mm past the centre. Starting from the left hand end, grip the end of the pipe with your left hand close to the cutting mark. Place your right hand about 75mm away from the cutting mark towards the middle of the pipe. {FIG 6}. Pull with your left hand and at the same time push with your right hand (you may find taking a deep breath and holding it helps) until the pipe bends

about 10mm then move your right hand a little further towards the middle of the bend and repeat. Continue until your right hand is close to the middle of the pipe.

When you complete this stage, you should have about 86mm of offset in the bend. If so, then remove the spring and insert it into the other end and do the same. Ensure you make the end lift as per instructions otherwise your QFH may be polarized the wrong way when complete.

Figure 7

Repeat the same procedure with the 1 metre piece of tubing that you marked for the long loop. Cut the loops to length (i.e. 804mm). If you did everything correct and did not bend the pipe to close to the end, then the end of the pipe should still be a 15mm diameter circle, and not a oval shape. If it is oval then you will have some problems ahead with the elbows and alignment and will have to "Circularise" the pipe again.

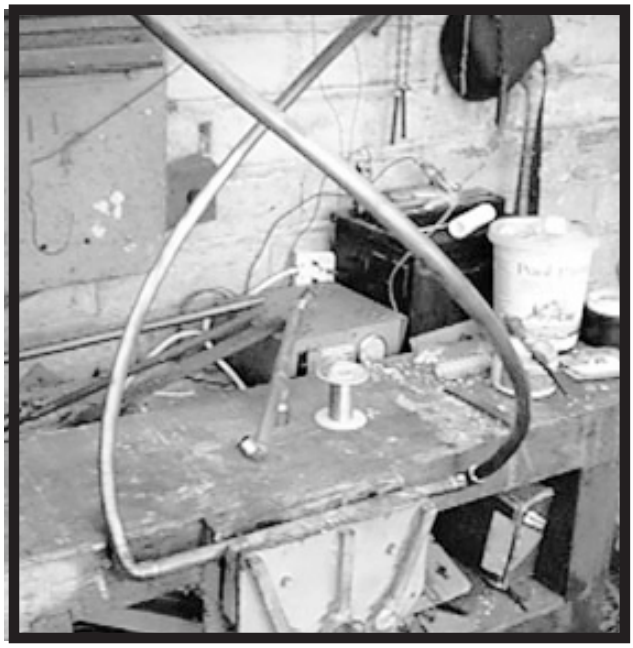

Figure 8

Safety Note!
If you have not already done so, I suggest that now you start breathing again.

Bending the Small loop
This stage is almost identical to the last stage except for a tighter bend and less end lift. The lift should be about 80mm at each end.

Soldering
Now for the burnt fingers. We will do the long loop first because this is probably the hardest. Take the 367mm length of copper tubing and brush some flux on each end for about 15mm.

Fasten the tubing in a vice close to the top (if you are using a workmate then you will need to clamp it with packing pieces). Place 15mm elbows on each end, the left one leaning away from you and the right one leaning towards you. {FIG 7}

Take one long loop clean and flux ends fit into left elbow with loop facing away from you then clean flux other long loop and fit into right elbow loop facing towards you, then fit elbows to the other ends. {FIG 8} Now clean and flux the other 367mm length of copper tubing and fit at the top of the loops. {FIG 9}

Figure 9

Notice all the short pieces of copper pipe, I have got bags of them, if any one has any uses for them then let me know Now for the soldering. I bet you wondered what you needed the bucket of water for didn't you? Well now you know. For *Safety* in case you get carried away with the blowlamp, or in my case, get distracted and set fire to my shirt! As for the apple, you will just have to wait.

Remember we are working on the long loop, the one with the pre soldered "T" connector. I would suggest you solder the top of the loop first, so clamp the bottom of the loop in the vice. Using your blow lamp, warm up one of the top elbows (in my case I start with the top left only because I am left handed).

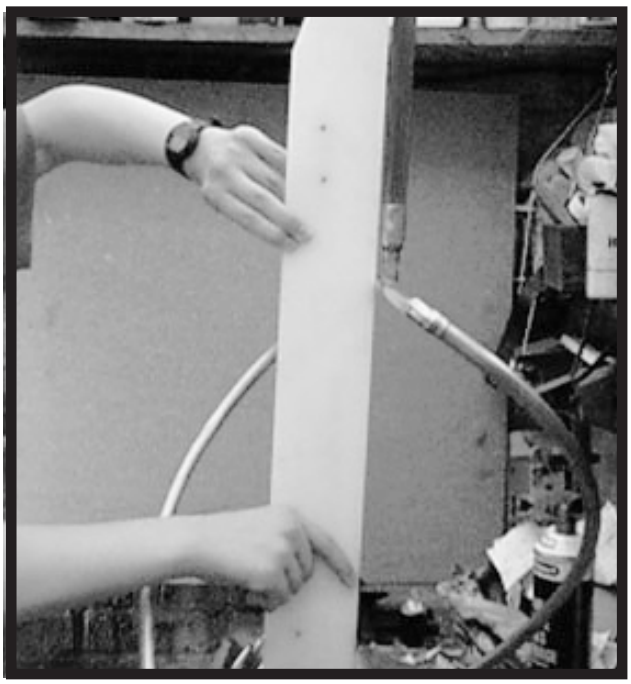

Figure 10

Keep the blowlamp moving slowly back and forth to evenly heat the joints. Then move the flame away, but be wary where you are pointing it. Place the solder next to the join between the elbow and the pipe. If the solder doesn't melt and flow into the joint, then move the solder away and continue heating the joint. Try again until the solder flows.Repeat the procedure with the other joint (the right one in my case).

Figure 11

Let it cool a little, then place the top of the loop in the vice with the "T" pointing up. You will need to ensure that the "T" is vertical with the loop before you solder it. At this point don't worry to much if the loop top and bottom pipes do not seem to be parallel, as you can twist them later. {FIG 10}

The short loop procedure is the same as the long loop, only this time we are not using a "T" piece, and so I will leave you to get on with it.

Checking dimensions
The illustrations should help here

Check that the top and bottom pipes are parallel. {FIG 11}.

Check the length of the loop (in this example, the large loop {FIG 12})

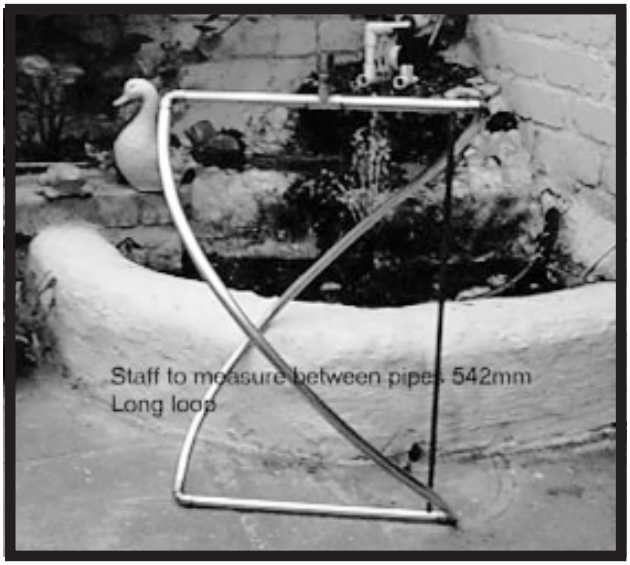

Figure 12

FIG 13 shows how to twist the loop to correct dimensions.

Marking and cutting the top pipe for elbows
(large loop) Referring to FIG 14, cut 22mm from the middle and save this bit for later. Repeat this with the small loop

Connecting the loops
You will need a 85mm length of 22mm plastic 2 overflow pipe. Mark and drill a 15mm hole, 15mm in from the end. Now mark and drill a 17mm hole at 90 degrees from the 15mm hole, at 50mm from same end, {FIG 15}

If you had the presence of mind to make this at the beginning then you only need to cut a split to the 17mm hole. If not then cut splits at both ends to allow it to go over the copper pipe. If you did prepare it earlier, then you should have inserted the small loop pipe through the 15mm hole before you soldered the loop up. Don't ask how many times I have forgotten. It reminds me of the old molded mains plugs where you had to insert the flex before connecting!. I bet if you are honest with youtselves, you probably did the same and could not be bothered undoing the connection so you cut a split in the plug top! I know I am waffling again but what do you want for nowt?

Please note how the quality of the photos has suddenly deteriorated. My photographer took a break-he said I work him too hard..

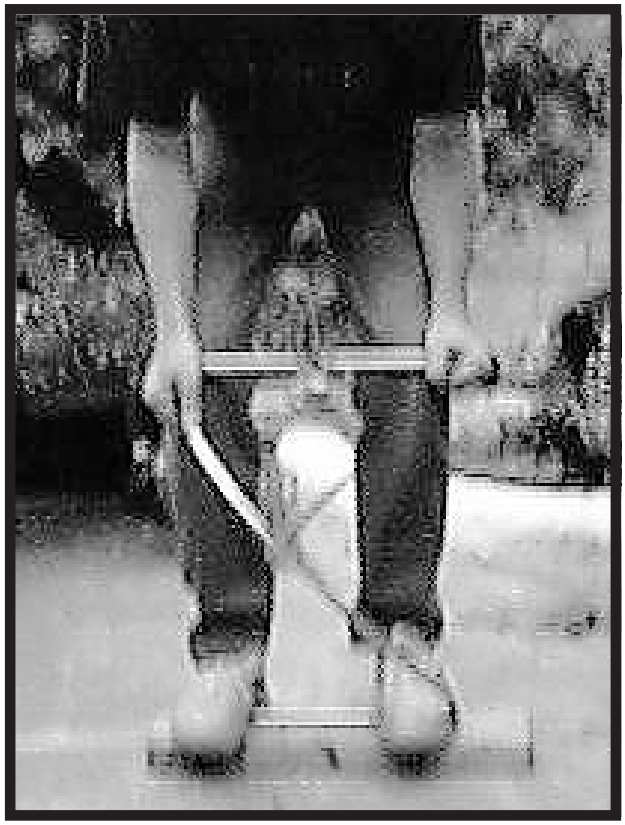

Figure 13

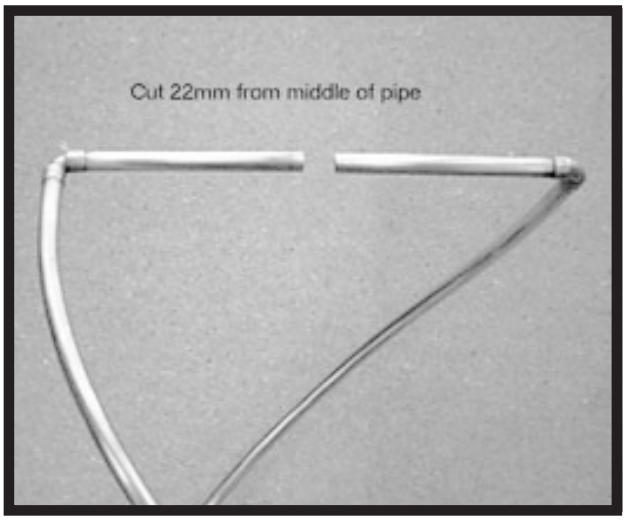

Figure 14

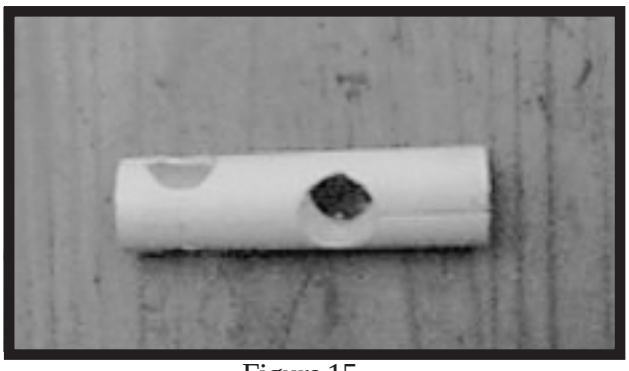

Figure 15

Fit the 85mm spacer and then solder the top elbows, ensuring the large loop connects to the small loop to the left {FIG 16}.

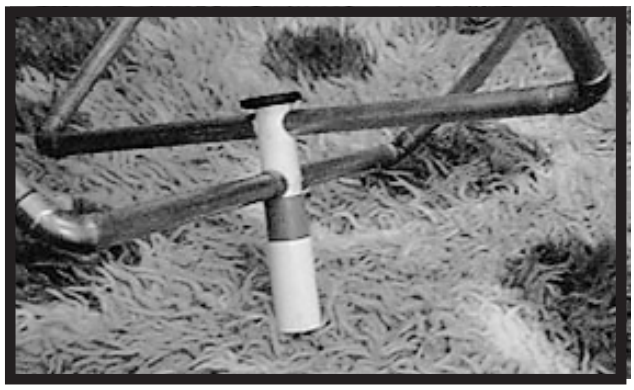

Figure 16

Take a look at the QFH bottom complete assembly {FIG 17} To complete the bottom, saw a 22mm overflow straight connector in half, clean any burrs from inside and place it over the 15mm to 22mm reducer, trapping the 85mm spacer.

Then take a complete 22mm overflow straight connector and tap this on until the first piece is home. Remember the straight connectors have a tapered fit, so it will get tighter the further you knock it on.

Drill 4mm holes in the top elbows, then fit the balun. Don't use a spacer on top of the loops between the balun and the elbows, because the nuts have to tighten onto the copper to make a good connection. Don't forget to seal the complete balun assembly and nuts after connecting the coax.
Don't waste money on expensive low loss cable, RG59 or RG 58 is as good as any.

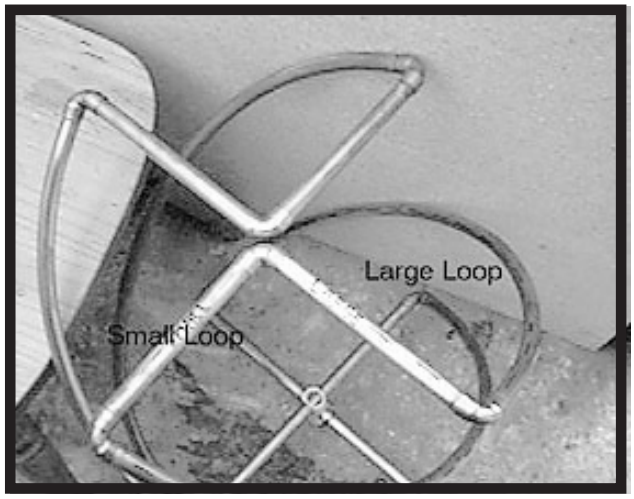

Figure 17

Final notes
Well, that's it.
I may do a trouble shooting guide but I am taking a short break for now. How is everybody getting on? I have not had much construction feedback, so I can assume either nobody is attempting it, or the one's that are built are doing ok?

Any constructive comments will be welcome, I will go over everything when I complete it.

Bad news; I noticed my wife Anne has bought a gallon tin of paint and is talking about new Kitchen Units. Never mind, I may get my son Neal to practice his DIY skills! or perhaps I may have a funny do. It worked! They are both doing the decorating so I can carry on with my DIY guide. I may need to take a break now and again whilst they paint around my computer :-)))

It's been nice working with you all. Don't be afraid to continue experimenting and trying new ideas- some of the best ideas have come through mistakes. If you would like to see what the finished product looks like, look to the right.

Then you might understand why having green fingers, good potting compost and a relaxing environment helps. Please don't over water the QFH.

Now all your suspicions have been proved correct, yes I am mad, but I am happy!