Ben Nock G4BXD's Antenna Workshop
PW Publishing Ltd., Arrowsmith Court, Station Approach, Broadstone, Dorset BH18 8PW
E-Mail: antennas@pwpublishing.ltd.uk

The QRM Buster

In this Antenna Workshop, Ben Nock G4BXD describes a receiving antenna that can help cut out local noise.

It seems that more and more of us are suffering from QRM these days. In other words, mostly man-made interference of one sort or another. I'd not really noticed what has been a gradual increase in my background noise when listening to the 3.5MHz band. That was until I started to notice that while I was getting 5 and 9 reports on my signal I was only giving out 4&6 or 5&7 reports to the received stations.

While I was in conversation with a friend on the 3.5MHz band, he pointed out that it may not be the fact I'm receiving a 5&7 signal but that due to the higher background noise it only sounds like a 5&7. My friend also had problems with various noises, television line timebase noise, the dreaded power line transmission (PLT), and even broadband devices such as the BT Home Hub.

Some of the solutions described in the conversations we had, included filters and a device called a 'Null Steerer' which combines wanted signal and an out of phase received noise in an attempt to reduce the overall received noise. He had also contacted the relevant agency, Ofcom, and instigated a formal enquiry into his local noise problem.

Fig 1: The R1155 receiver and its loop antenna.

One contributing factor to the noise problem here in my shack, and probably with many other listeners is, I suspect, the end-fed long wire antenna that I use at this QTH. Unfortunately due to space limitations it's exceedingly difficult to use any form of dipole or other balanced antenna. Another suggestion that was suggested, was to try a loop antenna.

A Loop Antenna

A loop antenna has a very useful property in that it can be rotated to greatly reduce, even completely null out, any unwanted signal. As this seemed an easy option to try, I decided to experiment further.

The kind of loop I am discussing here is not the physically larger or 'Mag-loop' types of antenna used for transmitting, and currently finding a great deal of popularity amongst those amateurs with small gardens, but rather the framed receiving loop for indoor use. Many broadcast station listeners will be familiar with frame loop antennas, as these have been used for many years on those bands where very long outside wires are just not possible.

A search on the world wide web threw up hundreds of pages on loops and their use and operation. Indeed there really was too much information to get a clear idea of the best type of loop to use or try. But after reading a few basic facts and ideas, I decided to plough on though and give it a try.

While giving thought to the loop construction I remembered I had a spare loop antennas as used with the R1155 installation on the Lancaster bomber. This loop, **Fig. 1**, is constructed from a coil of 15 turns, covering a 60mm length and with a diameter of some 273mm. This seemed an ideal starting point and I first tried the simplest of loop types. Connecting the loop across a length of coaxial cable I attached it to the receiver.

Amazingly, while stations were considerably weaker there was the great satisfaction in the fact that as I rotated the loop around the vertical axis the noise did indeed drop with the loop in one particular direction. This proved

the loop could indeed 'null' out an unwanted signal and gave great faith in further research.

Using the whole of the loop as an untuned loop or simple coil is one way to use the antenna. Another way is to use a tuned loop, that's one that is resonant on the frequency being listened to and which has a further coupling loop to feed the receiver with the signal captured by the tuned loop.

Luckily, with the R1155 loop I found that a variable capacitor of around 20–100pF connected across the loop allowed the loop to resonate within the 3.5MHz band. I added a further single turn loop around the outside of the main coil and connected this to the coaxial cable and hence to the receiver.

Now, while listening to the background noise on the receiver the variable capacitor is rotated to peak the noise, there was a very pronounced peak as the capacitor was rotated. Once again, by rotating the whole loop assembly I could find a considerable dip in the noise being received thus indicating the local QRM was coming from a definite direction.

The received signals were better than those received using the untuned loop, but of course were still considerably down on those received from the main antenna. Some sort of radio frequency (r.f.) amplifier was called for between the loop and the receiver and another web search was undertaken.

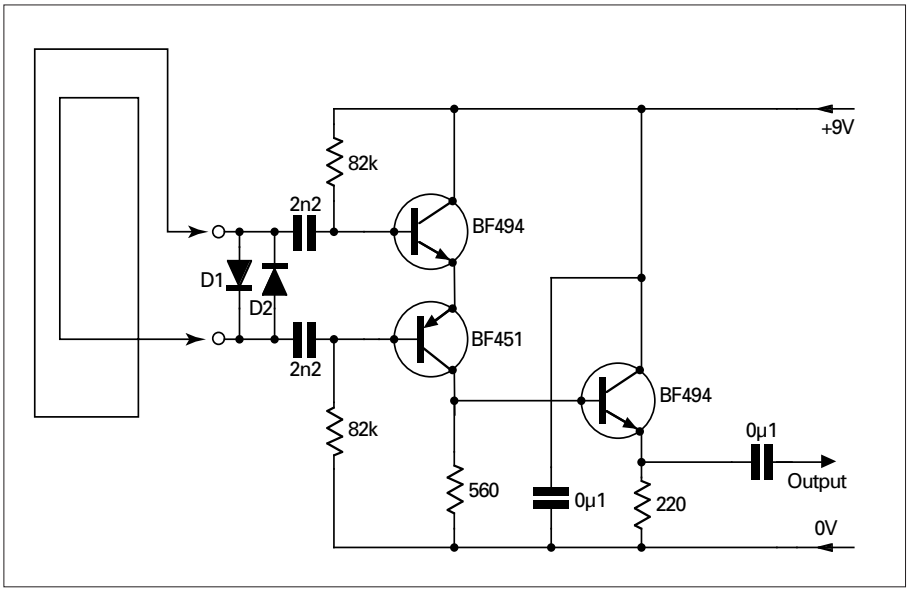

Fig 2: The circuit of the loop amplifier.

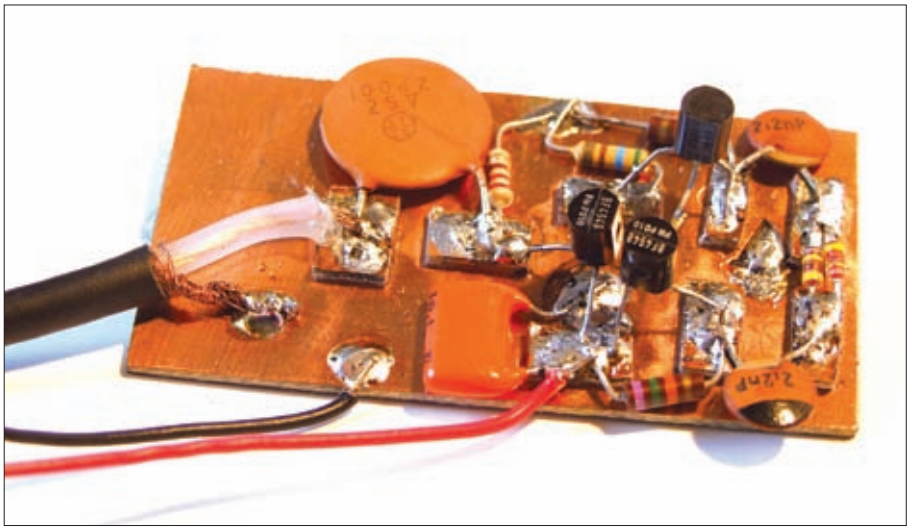

Fig 3: Showing the construction of the amplifier in best 'kichen-table' method.

The Antenna Circuit

After viewing many web sites I decided to try the circuit in **Fig. 2**. The original circuit used an untuned loop and acted as a broadband amplifier, or active antenna, for general short-wave listening. I intended to use the tuned R1155 loop with 1 turn coupling to give a degree of selectivity.

The only addition I made to the circuit is the pair of back to back diodes across the inputs to the amplifier. If I transmitted with the loop attached to the amplifier I felt the signal pick up by the loop would be enough to damage the transistors.

I constructed the amplifier, 'Manhattan-style' on a small sheet of copper clad board, **Fig. 3**, forming the connection points by using small pads cut from another piece of board and then glued to the main board. I connected the single turn pick up loop winding to the amplifier input and the output via a length of coaxial cable to the receiver.

The little circuit certainly increased the sensitivity on receive with reception during the evening being especially good. The directivity of the loop allowed the signal to be either peaked for maximum reception but more effectively the unwanted noise could be very much reduced to increase readability.

I felt though that the small size of the R1155 loop was rather a draw-back so, a slightly bigger loop was constructed. The new loop is a compromise between signal pickup (the bigger the better) versus manageability in the shack to experiment with. I settled on a loop diameter of 600mm (about 2ft).

Using a length of Pine strip some 18x6mm, from the local d.i.y. store I fabricated a hexagon frame, see **Fig. 4**, on which to hold the loop. I chose flat strip but dowel would work equally well, it's just easier to work with flat strip than round. The mounting points were simply drawing pins pushed into the soft wood. A single turn of single core hook-up wire was wound around the pins and anchored to the main arm with more drawing pins.

The Tuned Loop

The tuned loop shown in the photograph, consists of three turns of the same single core pickup wire terminated by wrapping around two more pins and I soldered the wire to them for good measure. A small plastic bracket was pinned to the main arm and a variable capacitor mounted on the plastic bracket then wired across the three-turn loop contacts.

The small variable loop-tuning capacitor came out the junk box but it must be capable of covering some 20-150pF. The small amplifier used on the R1155 loop was pinned to the mast, **Fig. 5**, and connected to the one-turn coupling loop.

With this set-up completed the cable from the amplifier was connected to the receiver and with the set tuned to the 3.5MHz band the capacitor was rotated looking for a peak in noise. Amazingly, even though the turn count and capacitor selection had been guesswork the loop actually peaked on the band at around the middle of the capacitance swing.

If you construct the loop and can't find a 'peak' on the 3.5MHz band – you should tune your receiver to around 5MHz and try again. If there's still no peak try 7MHz. With a three-turn loop of about 600mm and a capacitor around 50-80pF or so there should be peak somewhere between 3 and 7MHz.

If your loop does peak at say 5MHz with the turns and capacitor selected then you'll need to to do one of two things. Either add another turn of wire to the tuned loop side or increase the capacitor value. The easiest way is an additional fixed capacitor across the variable, which will now hopefully peak in the 3.5MHz band. Once you have the loop tuned you can investigate the noise in your location.

Camera Tripod

I mounted the assembled loop on a camera tripod head. This gave me the ability to rotate the loop around the vertical axis and to tilt the loop at the same time. With the loop connected to the R1155 receiver, I proceed to 'DF' my local noise.

I found that at a certain heading the noise dropped considerably and that, by tilting over the loop to around 20° from the vertical, I found an even deeper null in the noise. With the reduction in noise, weak signals suddenly appeared where before there had just been noise! Indeed I was now able to hear my old problem, TV line time-base harmonics, that I hadn't heard for quite a while. (My shack is in the attic of the house and I have the usual Velux window in the roof.

I mounted the loop through the open window whilst listening to a QSO on the 3.5MHz band and noticed a marked improvement in signal strength

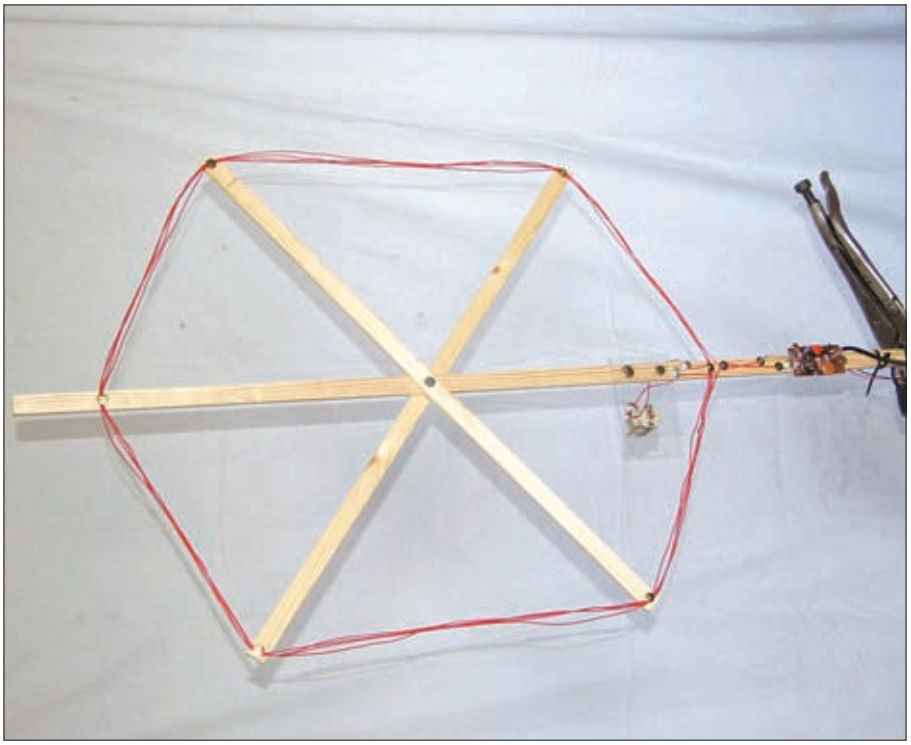

Fig. 4: How the loop and its frame fit together.

received with the loop outside and above the roof line. With the reduction in noise, when moved outside the building and the need to rotate the loop itself, this implies that the best place to mount the loop would be fitted on the chimney with a rotator.

Revised Version

With the success of the prototype, I'm now working on a revised version, possibly made from plastic piping to enable a waterproof version to be constructed. Further experimentation in loop diameter, turns and capacitance ratio and tuned or untuned amplifiers could be undertaken.

I shall also try and locate the source of my local noise but connecting the loop to one of my h.f. manpacks while walking around the local streets. I have the bearing on the noise from the shack, if I take a couple of further bearings from different locations I might be able to pinpoint the source.

What has been apparent though throughout this project is the fact that the noise problem on the bands is increasing and we might not just realise it. I was quite convinced the bands were just in a poor state of 'fettle' and that was the reason I was hearing so little. Once the noise was reduced it became clear the bands were working but that signals were simply being masked by this persistent noise problem. Good reception to you all!

PW

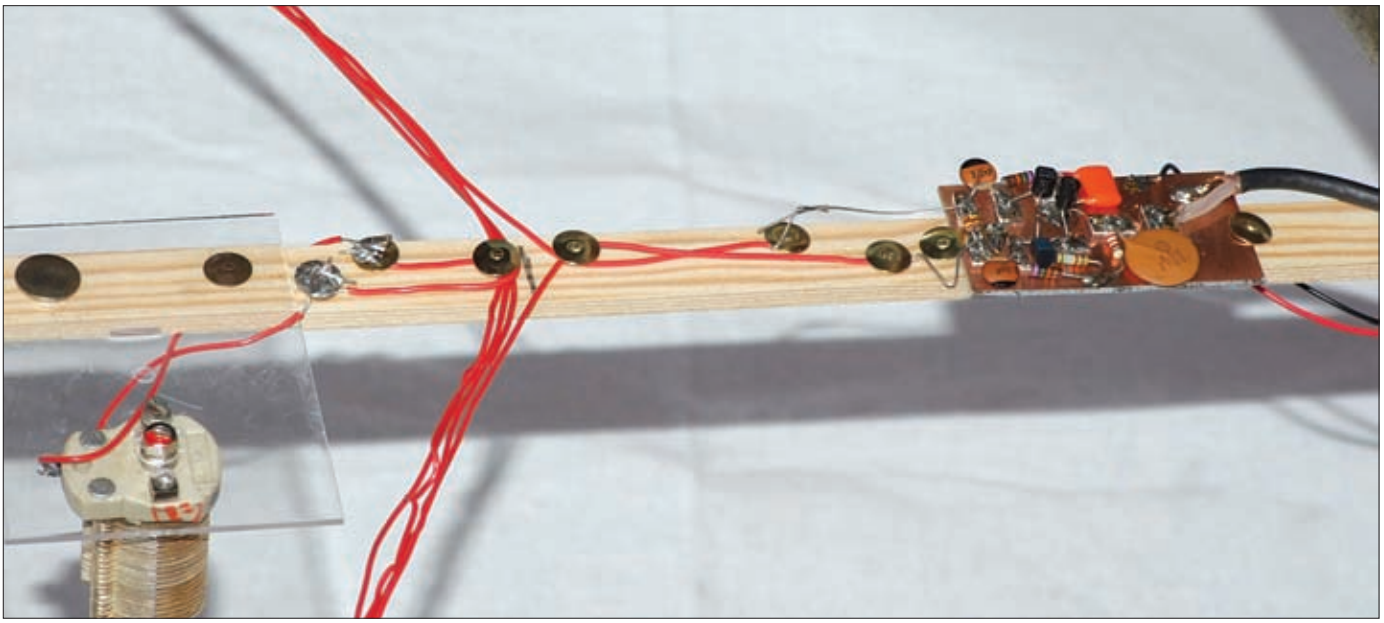

Fig 5: Mounting the amplifier, that's built Manhattan-style on a piece of p.c.b. material.