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LOOP THE LOOP

John Wilson ventures into the great outdoors, well a field of sheep, to bring us the amazing steerable low frequency wire loop antenna from Wellbrook Communications. The K9AY proves to exceed both expectations and specification. Null away John...

It must have become apparent to most readers that I have become an enthusiast for loop antennas, with their very real advantages in providing a low noise floor due to the rejection of focalised E-field interference and, if rotated, their ability to use the two signal nulls to reject unwanted interfering stations.

Evidence from other reviewers around the world has confirmed the real superiority of the loop antenna over the active whip or rod antenna, and for proof of that superiority, you only have to take a look at my comparative results when I tested the Wellbrook LFL-1010 loop against the RF systems LFA-520 active whip in SWM November 2001.

I have had further confirmation of the excellence of the Wellbrook design in a letter from the calibration laboratory which a did the UKAS calibration of the Wellbrook screened l.f. loop which I use in my professional measurements at the EMC Test House. The letter said that they had been calibrating a large (1.04m dia.) unscreened loop for the BBC, and from the description it could only have been a Wellbrook.

To quote: ''Having previously had problems with unshielded loops, it came as a relief to find absolutely no calibration problems so I suspect it has good E-field rejection due to being of low impedance, balanced and suitably matched. It is easy to be wise after the event, but possibly yours could have been satisfactory without a Faraday shield''.

Noise Rejection

In other words, the Wellbrook basic design is so well balanced that it has inherent E-field rejection characteristics, and that means, to the user, rejection of near-field noise - the same noise that devastates the active whip antenna. As I said, I'm a loop enthusiast, so it was a pleasure to receive for review a kit from Wellbrook for the erection of a really large loop antenna based on the research carried out by an American engineer **Gary Breed K9AY** into the behaviour of large terminated single loops. I say 'kit' because the loops have to be made from flexible wire, which anyone can do for themselves, so there is no need to ship hundreds of metres of copper wire around the country. Actually 'kit' is the wrong expression to use, because the component parts of the **Wellbrook 'K9AY' loop** are professionally designed and fully finished units. All the user has to do is read the instructions very carefully and connect the necessary wires to the correct terminals. How green was my valley, how

large was my loop?

Gary Breed K9AY states in his original QST article that: ''The maximum circumference of the loop is a little over a quarter wavelength at the highest frequency of operation'', and goes on to say ''Smaller loops, or same size loops at lower frequencies retain the directional pattern, which makes this an excellent antenna for a.m. broadcast reception''. The final key statement is: ''Unfortunately, the received signal voltage is proportional to the area enclosed by the loop, so sensitivity decreases rapidly as the antenna becomes smaller. Unless you have a very good pre-amp, keep the loop size near the maximum''. So, the object of the exercise is to make the loop area as large as possible, whilst keeping an eye on the limitations as to maximum frequency of operation, and in order to maintain l.f. performance a very good pre-amp is recommended.

Alakazam!

Enter the genie of the loop, otherwise known as **Andrew Ikin**, the owner of Wellbrook. Andrew has been: a) making high performance loops for a long time and b) always includes a very high specification preamplifier within his loop matching system, so he is clearly the best person to design and build a K9AY loop system which incorporates every possible refinement of the original design and present it to the hobby listener in a package which is easy to install and use. The basic principle of this type of antenna is that of a wire loop that is resistivity terminated to ground at one end, with the receiver connected to the other end of the loop via an impedance matching transformer. The feed impedance and the resistive termination are in the order of 390-560 Ohms thus requiring a 9:1 impedance ratio in the matching transformer. These impedances may seem familiar to those who have considered the T2FD antenna, but the transformer design for the K9AY is made a little easier because it is working between two unbalanced feeds and does not have to perform the balance to unbalance conversion called for in the T2FD. Wellbrook have improved matters by modifying the original transformer design so that the antenna ground is isolated from the feeder, thus eliminating potential earth loop noise and feeder pick-up.

Those of you who have done some more reading about antennas will see similarities with the Beverage antenna, but as Bill Bridges pointed out in a follow-up article in QST, the antennas are quite different in their characteristics, and from a practical point of view, the Beverage of course is stretched out just above ground for several wavelengths and suits only those hobbyists who have a garden two metres wide and several kilometres long - not many around unless you live on the Mull of Kintyre.

The major advantage of the terminated loop antenna is that it can be made very directional, with maximum response to incoming signals from the direction of the feed point, and more importantly a deep null to signals arriving from the opposite direction - how green was my valley, how deep was my null? Very deep indeed, as I will demonstrate later. The depth of the null and the overall performance of the loop depend largely on the value of the terminating resistor, and this varies with frequency and ground conductivity, so for optimum performance the resistor bas to be variable and non-inductive. This is tricky because with the receiver located indoors (presumably), the resistor is outside at the other end of the loop, which means a trip outside when you want to make large frequency changes, and then how do you know that the resistor has been correctly set? The original K9AY design was intended for amateur radio use on 160 metres and recommends using a variable resistor of about 1 KOhm to find the best null, then measuring the value of the pot and substituting a fixed resistor. All very well, but if you want a wide frequency range and optimise performance under different values of ground conductivity, such as the variations caused by wet or dry ground - very important in the UK, then you really need to be able to vary the termination impedance from the comfort of your operating position. Enter the genie of the loop again.

Just Twiddle

The Wellbrook control unit includes the facility for varying the termination by simply twiddling a rotary control which does some secret 'electrickery' down at the far end of the loop, and in use this means you can select a station on your receiver then twiddle the control to maximise the forward lobe of the antenna, and/or maximise the rearward null to remove an interfering signal from the opposite direction. The forward antenna pattern is quite broad (K9AY states that the front/side ratio is about one 'S' point, i.e. 6dB) but the rearward null is fairly narrow, but not so narrow as to make it a 'one direction only' feature, and in practice there is a substantial reduction for all signals arriving from the rear of the antenna. This is all very well so far, but having decided to erect a terminated loop, in which direction should you point it? Well, the first thing to consider is that by reversing the positions of the terminating resistor you can reverse the front and back direction of the incoming signals, so you now have a two- direction loop. What about now considering erecting a second loop at right angles to the first one and also making it possible to reverse the feed and termination ends of that loop as well? You now have effectively made a high performance antenna which can be 'steered' around four quadrants of the compass, but let's take a look at the practical aspects of getting all this to work sensibly.

Easy Solution

You will have to design and construct a magic box in which you have a remotely variable termination impedance, together with the ability to switch between two incoming loops and also reverse the direction of feed and termination. You need wide band 9:1 matching transformers, and to make the system perfect, a low noise preamplifier with a very high intercept point performance. All this has to be completely weatherproof because it will be sitting out there in the wild and windy environment for some years. Back in the comfort of your home, you also have to design and construct a unit which will allow you to control all the outside electronics and power the preamplifier, and you have to do this with a minimum of cabling to the base of the antenna. If you think you can do all this and make it work, then go ahead, but be prepared for some failures as well as successes, because what appears simple on paper often doesn't work quite as you expected when you wind the transformers and construct the preamplifiers - many a top receiver designer has fallen at this apparently easy hurdle! For those who want the ready made solution, the Wellbrook version of the K9AY is the answer. How did I get on with it?

Erection Time

The design of the Wellbrook system follows the K9AY layout in having the loops suspended from a common single central support some seven metres high. The literature suggests that this could be a tree, but I have open land around me so I considered all sorts of options involving plastic drain pipe from the DIY store, or lengths of square section wood screwed together. In the end I was fortunate to be loaned a telescopic GRP composite mast from **Sycom** which closes down to a little over one metre in length, weighs only 1.5kg, but extends to ten metres when fully erected.

At a current price of £57.95 this was the complete answer to my central support needs, and proved to be an excellent investment for future antenna installations. The loops can be erected as a diamond shape with one point at the support height and the other at ground, but in my case I erected them as isosceles triangles with the apex at the top of the support and the base supported on electric fence insulating stakes at one metre off the ground.Incidentally, these stakes are quite cheap and I have a fancy to try out a Beverage using them, but I would have to let the sheep run riot if I removed the fences from the fields.

Having calculated the total length of the loops, I cut two 30 metre lengths of insulated antenna wire (which I had plenty of, having had to buy 3000 metres of it for my T2FD project) and connected the middle of the lengths to the top of the

fibreglass mast. I took care to mark the ends of the wire, realising that once I had hoisted the whole lot into the air I could easily lose track of which loop was which.

Bringing the centre of the base of both loops to the base of the mast, I installed the Wellbrook 'box' at one metre off the floor and prepared to fix up some sort of ground system, since the loops will not work without a ground connection - or will they? Having been forced to erect the loops over an existing wire fence, I decided to try using this fence as a counterpoise, but at the same time drove a length of 15mm copper tube into the ground as an alternative. The loops had to be aligned NNE to SSW and WNW to ESE because of the fence. In a free installation the exact alignment could be chosen to suit particular listening interests, but my results were very good indeed with my own arrangement.

Impressive

From the outside 'Head Unit' I ran a single coaxial cable back to my test lab, together with a two wire control pair for which I used cheap light duty intruder alarm cable - simply because I had it to hand. Any low current twin flex will do the job. The internal control box and power supply were placed next to a receiver and off we went. The whole installation was completed in an afternoon and looked most impressive - but did it work?Oh Boy, did it work. The signals came pounding in, but always standing above a low noise floor which is a characteristic of loop antennas.

The specification for this antenna says it works from 60kHz to 2MHz, but in my installation I could hear and see (using a spectrum analyser) signals all the way down to 16kHz, and above 2MHz with these lengths of wire in the sky, the antenna carried on working but with the null control having less and less effect. Using the rotary switch on the control unit to select North, East, West and South directions made stations from those directions appear and disappear, and adjusting the null control seemed to 'tune' the loop notch to knock out stations at will. I don't know how the variable termination manages to achieve this, but believe me it works. Let me show you an example of the null control in action.

Long Wave Beam!

Take a look at **Fig. 1** which shows the (as usual) heavily modulated signal on 252kHz from the station previously known as Atlantic 252. You can clearly see the sideband energy extending well outside their allocated bandwidth, and the station is notorious for 'sideband splatter'. A quick twiddle of the 'null' control on the Wellbrook control unit and the effect can be seen in **Fig. 2**, with '252' and its nasty sideband reduced by some 30dB. Note the signal at 243kHz which only drops by 5dB when '252' is nulled out. That's how sharp the apparent tuning is, and it is this null feature which makes the Wellbrook loop such a powerful listening weapon.

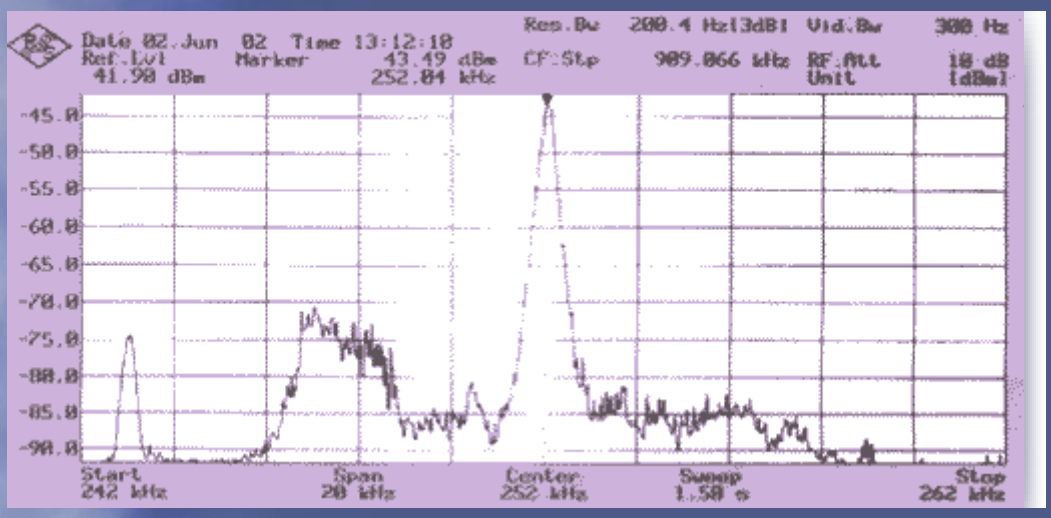

Fig. 1: The heavily modulated signal on 252kHz.

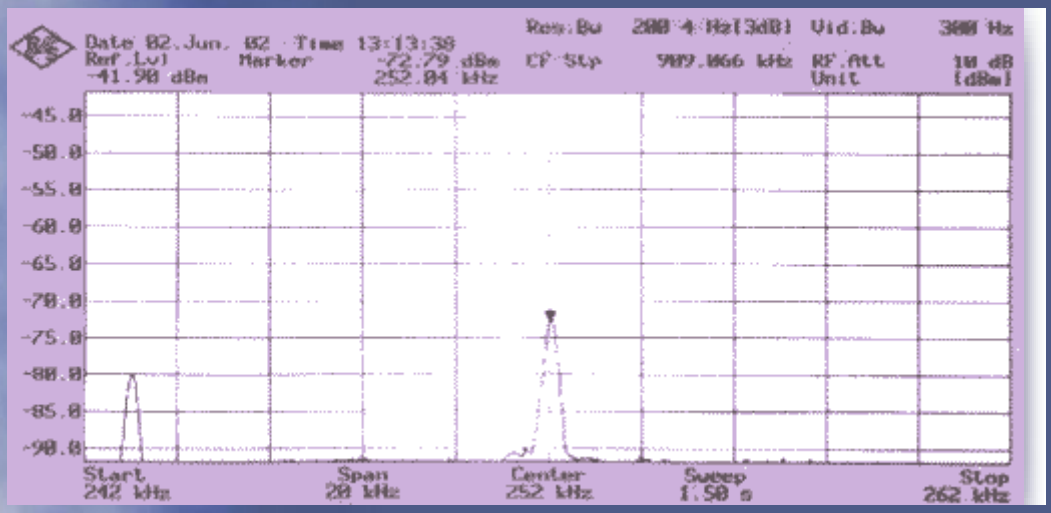

Fig. 2: The station on 252kHz and its nasty sideband reduced by some 30dB.

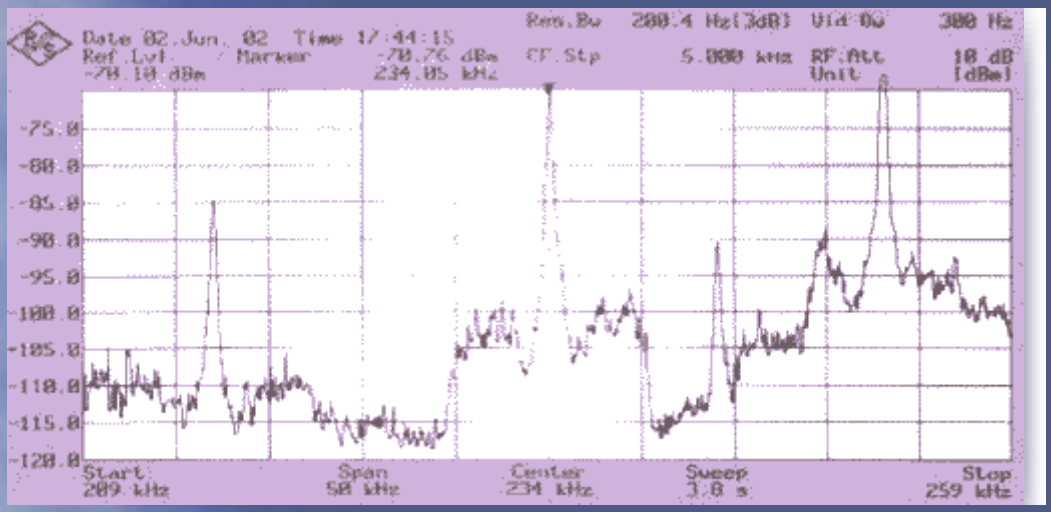

Fig. 3: The display centred on a signal at 234kHz signal pre-nulling.

Now let me show you the same thing in reverse. The analyser plot **Fig. 3** shows the display centred on a signal at 234kHz signal with '252' banging away on the right hand side. Re- tuning the null control reduces the 234kHz signal and its sidebands by 26dB whilst hardly affecting '252' as can be seen in **Fig. 4**. One reason for the null being so effective is that '252' and Radio Luxembourg on 234kHz are in different directions from me, and each station can therefore be dropped into a null by selection of the appropriate antenna direction - hey, I've got a rotary beam antenna on the Long Wave!

An even more powerful demonstration of the null effectiveness can be observed by nulling out 'Atlantic' on 252kHz, whereupon you can suddenly hear Arabic music.

This is coming from Radio Algeria, and it is quite easy to listen to this in the presence of 'Atlantic' providing that you carefully 'null out' the Atlantic signal. It works at even lower frequencies as well I . Plot **Fig. 5** shows a spectrum of signaIs centred on 19.6kHz from which I have nulled out a signal on 24kHz - you may be able to see the marker at the right hand edge of the display. Twiddling the null control I then took

out a signal at 20.33kHz as you can see in **Fig. 6**, with the original 24kHz signal back up, but the three strong signals between 19.6 and 24kHz being virtually eliminated without affecting the 19.6kHz.

Absolutely wonderful for the l.f. DX enthusiast, and so easy to use.

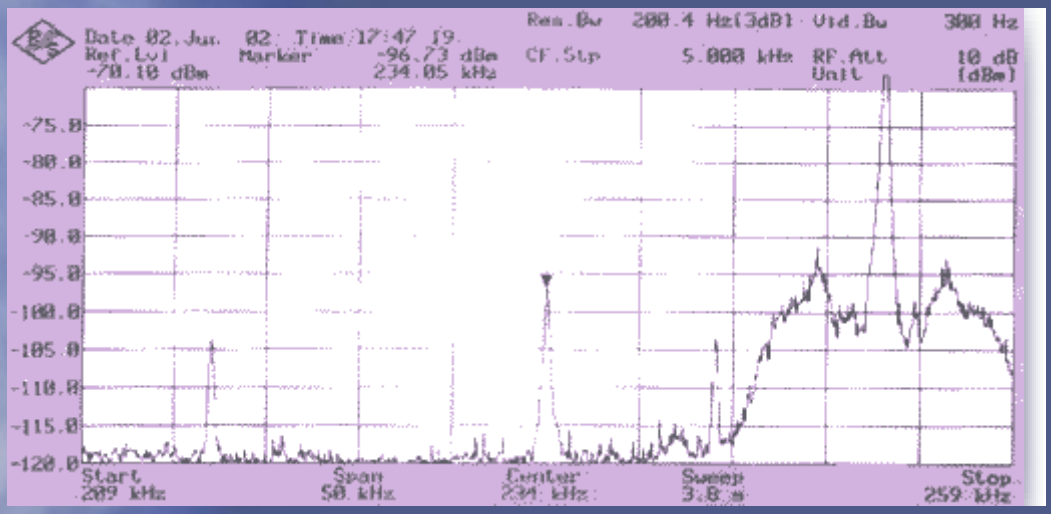

Fig. 4: The 234kHz signal and its sidebands reduced by 26dB whilst hardly affecting the 252kHz station.

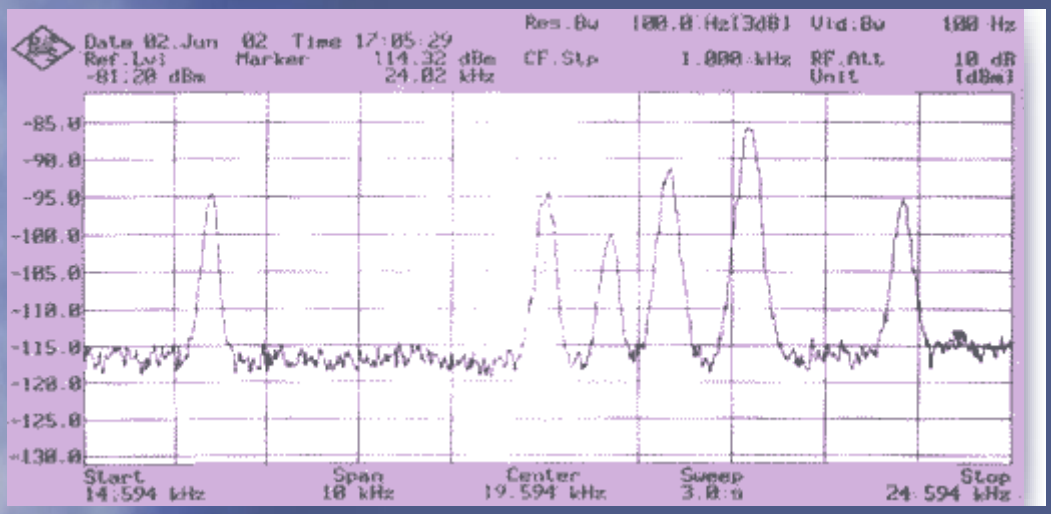

Fig. 5: The spectrum of signals centred on 19.6kHz with the one on 24kHz nulled.

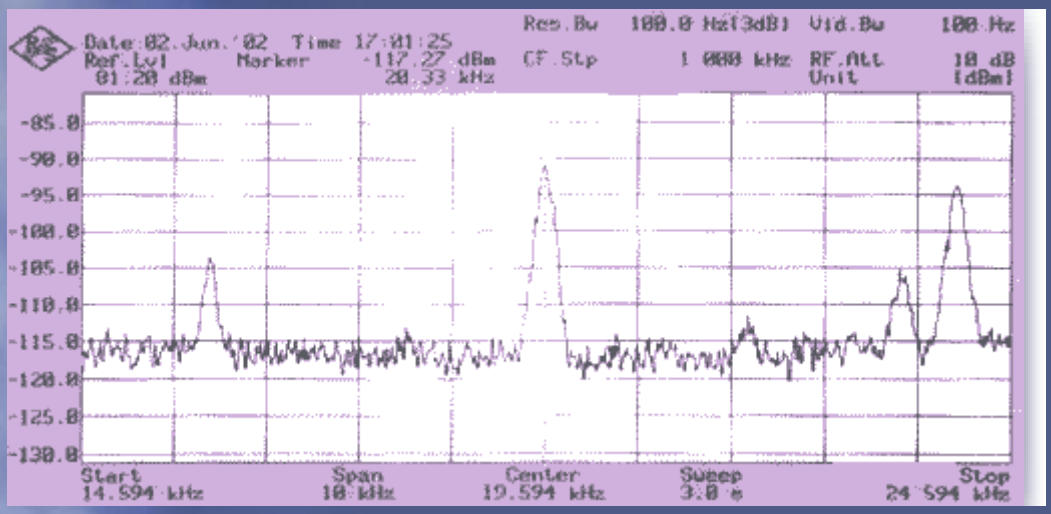

Fig. 6: The signal from Fig. 5 at 20.33kHz significantly nulled.

Essential Earth

I mentioned earlier that I tried out the antenna with a counterpoise and with a ground rod (the recommended method), and began by listening to weak beacon signals on 346kHz. I could hear three call signs, LHO, LN and RS, and by using the direction switch and null control could pick them off one by one. With no ground connection and no counterpoise the signal levels were at -1O5dBm. Connecting the counterpoise raised them by 7dB to -98dBm, and removing the counterpoise and connecting the copper ground rod raised them by another 2dB to -96dBm. Trying the same thing on the 60kHz signal from Rugby raised the signal level by 11dB from 'no ground' to 'copper ground' conditions, and yes, I tried connecting both the counterpoise and the ground rod at the same time but this did not improve the signal above that using the ground rod alone. Therefore, the moral seems to be Use a decent ground connection which is, after all, exactly what Wellbrook say in their instructions. However, since you have the unique feature of being able to adjust the termination impedance using the 'null' control, at least you can compensate for different ground conditions.

Higher Frequencies Too

Performance all the way up through the medium wave and into the low end of the h.f. bands is maintained well, and with the squeaks, bleeps and groans which plague l.f. listening being so easy to eliminate, it becomes a pleasure rather than a pain to go back to winkling out the rare ones. Even on 80 metres it was possible to knock out interfering stations from Europe when listening to UK stations in the various nets, but let no-one inadvertently forget that this is a receiving only antenna and you won't get much sympathy from Wellbrook if you send a box back which has had 400 watts of lower sideband stuffed into it - it wasn't me sir, it was a nearby lightning strike! Between 4 and 30MHz, the antenna still provides excellent low noise reception.

My Conclusions

The Wellbrook interpretation of the original K9AY can be strongly recommended to serious listeners. Wellbrook have taken every optional aspect of the design and combined them all into an easy-to-use package which produces outstanding results all the way down to 15kHz and much higher than the quoted 2MHz, in fact to much higher frequencies as a general antenna. The directional control, which gives the effect of having a steerable beam antenna for low frequencies, is a new experience for me, and I played for hours up and down the bands becoming increasingly impressed. The erected antenna fits in an area of about nine metres square, which is very compact, and all the advantages of having a low impedance loop with the

inherent rejection characteristics of locally generated noise make it work well in urban environments.

Towards the end of my tests I had to erect an electric fence around the bottom of the antenna so as to keep out my wife's inquisitive sheep, and was surprised to find that the loop did not respond to the resultant multi-kilovolt discharges as badly as I had anticipated. In fact, I was able to continue listening comfortably in the presence of the one second blasts from the fence. The Wellbrook package is not a low cost item, quality never is, but believe me there is a lot of painstaking design and assembly effort in it, particularly in the selection of semiconductor devices when building and testing the built-in high performance preamplifier, all of which makes the Wellbrook K9AY an antenna which the listener can rely on to provide outstanding, even unequalled performance in the l.f. spectrum. The user will have to provide a centre support, the antenna wire, the coaxial feed cable. A 12V d.c. regulated power supply is supplied for UK and Eire users. Anyone outside those areas will have to provide a p.s.u. that can supply about 100mA.

Wellbrook sees to all the hard technical bits. I cannot wait for the autumn listening season to really get to grips with this amazing antenna - if Wellbrook and Sycom will let me hang on to the kit. Must further mention the Sycom ten metre telescopic mast. It bends like a fishing rod when you wave it about, but just like a fishing rod, it is extremely strong, and took the stress of 60m of heavy antenna wire hanging from it without any signs of distress. The whole experience was, for me at least, another nail in the coffin of the active whip antenna. Loop de Loop man!

Antenna Wire

Finally, a small commercial. I mentioned the antenna wire that I had made to my specification for an aborted T2FD project and which I used for this test of the Wellbrook K9AY. I still have this in stock and would be quite happy to supply it for anyone who wants to make a really good job of a wire or loop antenna. The wire is made up of seven strands of 0.67mm pure copper, covered overall in a clear sheath (to reduce visual impact) and has an outside diameter of 3.4mm. This is excellent antenna wire, made to my own specification and I can sell it at 29p per metre plus any carriage charges. I'll measure and cut it in multiples of 10m, so if you are interested in the best, drop me a line to ShortWave Magazine, or E-mail me at johnwilson@freezone.co.uk

My sincere thanks to Wellbrook Communications and Sycom Ltd. for letting me have such a good time with their products.

Happy listening

SWM

NB John's review activities with the K9AY antenna were conducted before Team Talk (ex-Atlantic 252) on 252kHz went off air. Please see *Off the Record* (p15) for more details on the station closure - Editor.

The K9AY active loop antenna can be obtained from:
Wellbrook Communications,
The Farthings,
Beulah,
Llanwrtyd Wells,
Powys,
Wales, LD5 4YD,
UK,
Phone 01591 620316

Sycom, PO Box 148, Leatherhead, Surrey, KT22 9YW
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Email: robin@sycomcomp.co.uk

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