VK3RGC Repeater Aerial Setup.

The original VK3RGC repeater was installed, many years ago at Montpelier, a reservoir site 115m above sea level, overlooking the city of Geelong. At that stage, two separate aerials were used, but one aerial was on a wooden pole, eventually that deteriorated to the point where it was condemned, and removed. The second site, VK3RGL at Mt Anakie 400m above sea level, about 30km north of the city was in operation, and working well. A new installation for VK3RGC would have to use transmit and receive via the one aerial.

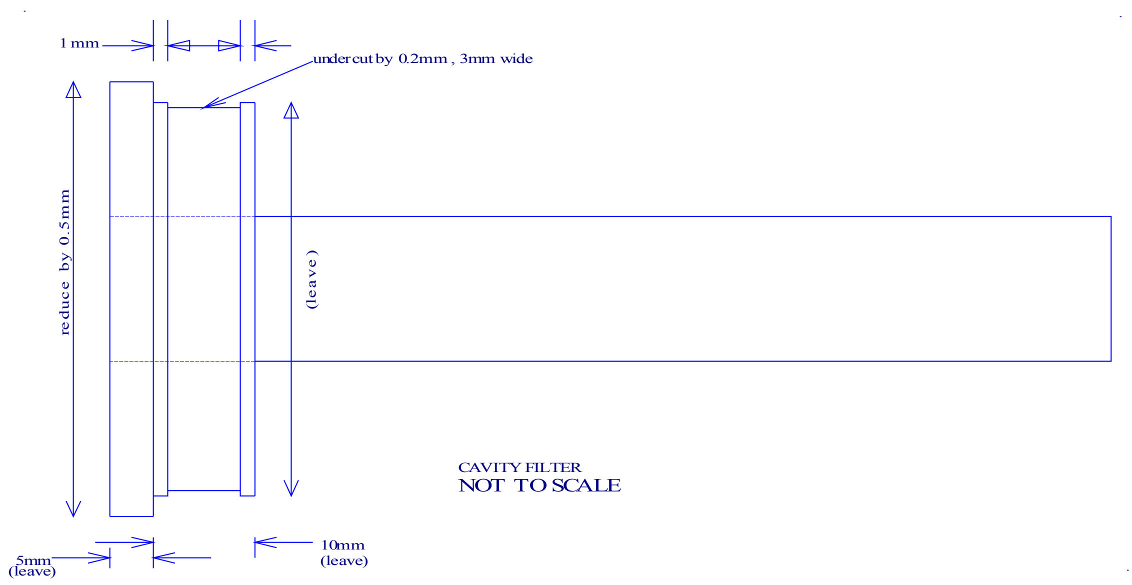
We had a diplexer made by a ham some years ago, to the ARRL design from QST July 1972 page 22-26, & 47. ARRL members can down load this article from the ARRL web site. The problem with this was that as it was constructed, the performance was inadequate to allow the repeater to work correctly. The term diplexer is quite correct, as the two frequencies 147.125Mhz transmit and 147.725Mhz receive are filtered and combined to operate via the one common aerial.

The purpose of the receive filter is to prevent the RF output of the transmitter from “swamping” the receiver, causing de-sensitizing of the receiver, and the transmit filter is to remove the transmit noise sidebands that appear on the actual receive frequency, also masking weak received signals. With the repeater we used, a surplus Philips 828 mobile, this separation needs to be at least 100db

This diplexer consisted of six coaxial cavity resonators, arranged to pass one frequency and reject the other. Three cavities, connected in series, passed the transmit frequency and rejected the receive frequency, and the other three had the frequencies reversed. Each cavity was made of brass tubing, and the joint between the inner conductor and the “top plate” short circuit end of the resonator was soft soldered.

Also the joint between this top plate and the outer brass tube was made by four 1/8 inch brass screws through an overlap of about 10mm. When tested, there was inadequate separation of the two frequencies, and some “drift” in the tuning characteristics. The frequency separation of the cavities was 0.6Mhz, which as a percentage of the signal frequency of 147Mhz is 0.4%, however the actual required tuning accuracy is much more critical than this.

The inner conductor of each cavity is a ¼ wavelength long, so at 2m is about 510mm, and we noticed that the tuning accuracy needed to be within 1/16 of a turn of the adjusting screw, approximately 1/20 of a millimetre. This means in fact that the length of the resonant cavity needs to be controlled to that accuracy.



With a 10mm overlap, and four screws, the cavity length had a possible variation of several millimetres as to exactly where the outer short circuit was located, so the set frequency of the cavities could wander by about 100 times the precision we needed to maintain. Within our club we had some members with expereience in this technology, so a suggestion was made to machine the top plates as shown.

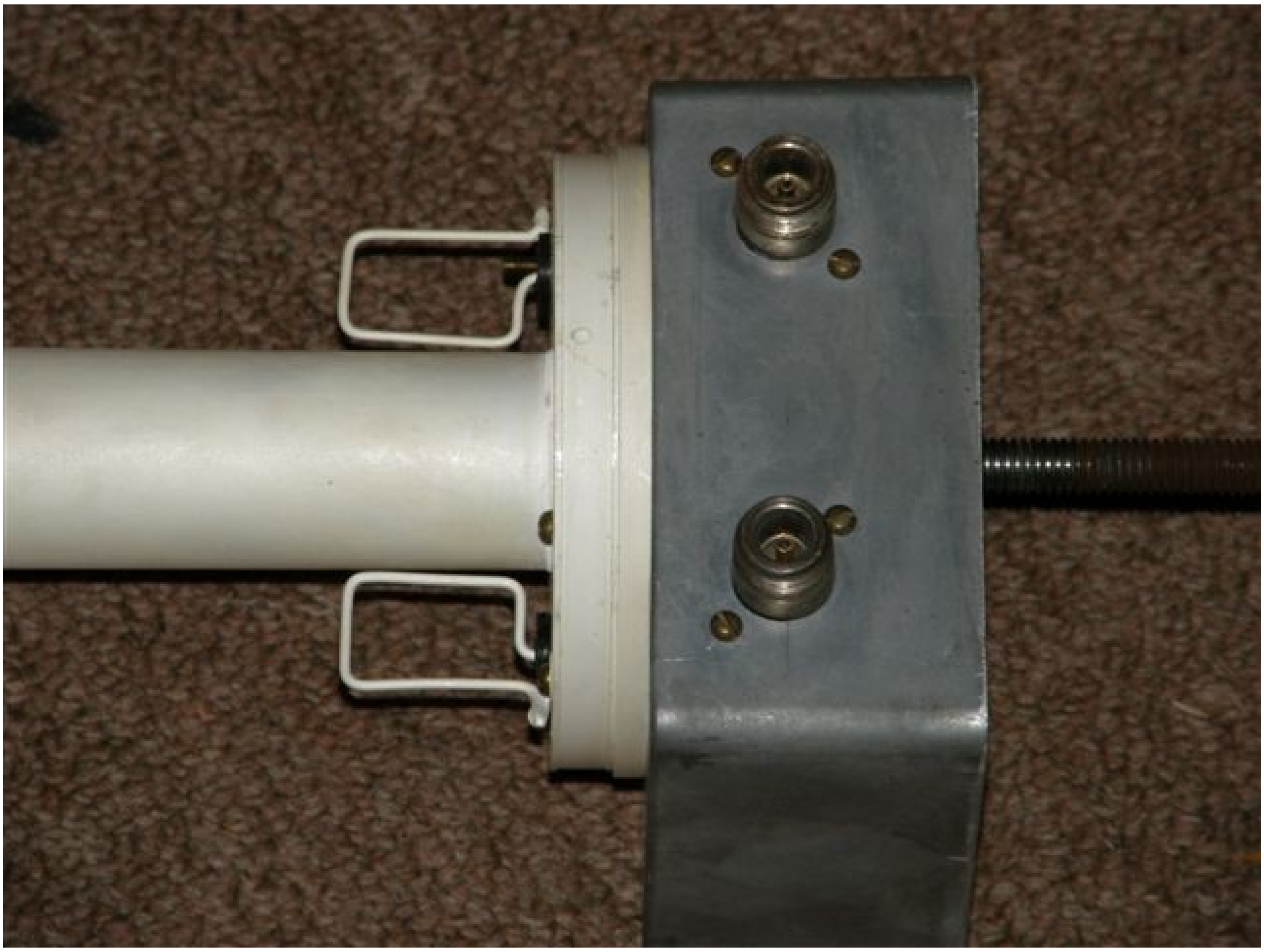
The effect was to force the short circuit to be over the 1mm rib left after machining away the undercut shown on the drawing. After the silver plating, a trial assembly, then dismantling showed the marks on the silver plating where the contact was made. Note that the silver plating is not polished, as it does not help the performance, but actually increases the oxidation.

We found a friend who could do the machining to the required precision, and we slotted the outer tube in 8 places with a hacksaw for 2 inches (50mm), being careful to remove the burrs. This meant that when assembled and clamped up with worm drive hose clips, the outer cavity length was much more closely controlled.

The next problem to be addressed was the brass tube and soft solder. The RF current in things like this flow only in the surface layer of metal about 5 microns thick. As constructed the RF losses in that surface layer (especially the solder) were so high as to drastically reduce the cavity Q, and so the pass band loss was too high, and the null depth not nearly high enough. De-sensitizing was between 10 and 20db, not good enough for our membership.

Replacing that surface layer with silver plating seemed to be the answer, but great care is needed here. Most firms that do silver plating do "decorative" silver, for spoons, jewelery etc. and this process uses what they call "brighteners", that is about 5% of the plating is nickel. The effect of this on RF circuits is to ruin the performance.

We had to find a plating firm that did pure silver plating, for electrical contacts etc., with NO brighteners. Once this was done and the cavities adjusted & tested we had a completely different performance. For 20 watts of transmitter input, we had 18 watts output, a very low loss, and no discernible de-sensitizing with the receiver tuned to a 0.15uV signal, when the transmitter was turned on.



The cost of the plating was about $600, but the cost of a commercial diplexer would have been in the thousands. The repeater is now installed and running under test at its intended site, while we check its reliability and any possible intermodulation or other interference, and we hope to be able to add CTCSS and an IRLP node soon. Watch this space!

One further note, during the adjustment the positions of the coupling loops needed changing from where they were when the photographs were taken. If we were doing this again, we would not use the spring contact material, as a thin layer of teflon or polyethelene around a larger diameter plunger, would have sufficient capacity, at that high impedance end of the cavity, and save cost as well as work.

Peter Ward, VK3ZAV. 11th December 2008