Swan 1200-W Linear Amp

I was looking for an inexpensive "desktop" linear amplifier for my shack. I looked at some new amps, but I really wanted something that I could play with and even modify. At one point I was looking into the Heathkit SB-200 amps, but their prices on eBay can be outrageous. Plus, I had a TV repair shop back in the late 60's and 70's, and I have a caddy full of sweep tubes. So, a sensible "sweeper" was a logical choice. I started looking at the Swan 1200W and X series amps.

I found this 1200W on eBay. The seller apparently thought that the 1200-W meant 1200 watts output, because he was selling it "as-is for parts or repair", stating that the output was very low and so the tubes were flat. He said it was little more than junk to him. No one bid against me, and I won it for the minimum bid of $199.00 with free shipping. I was shocked to see how clean it was when it arrived. This is a picture of the amp, just as I received it.

This amp is a prime candidate for mods, because it has lots of room inside. It produced about 400 watts PEP out of the box with the 6JE6's that came in it. Only one tube was "down" a little, and it was a Realistic brand tube.

The others tested 115-120 on my rebuilt EICO 667, where anything over 80 is "good". But I had four 6MJ6's in my caddy that measured 120 or more, and I was already planning to put them in.

For the most part, the amp was completely unblemished. The front panel was mint, as was the back. And the relay control circuit for controlling the amp switching with a "modern" rig was already set up. All I had to do was reverse the leads inside to make it work with my Kenwood TS-930S. I worked Pitcairn Island with this amp within minutes of connecting it to my TS-930S.

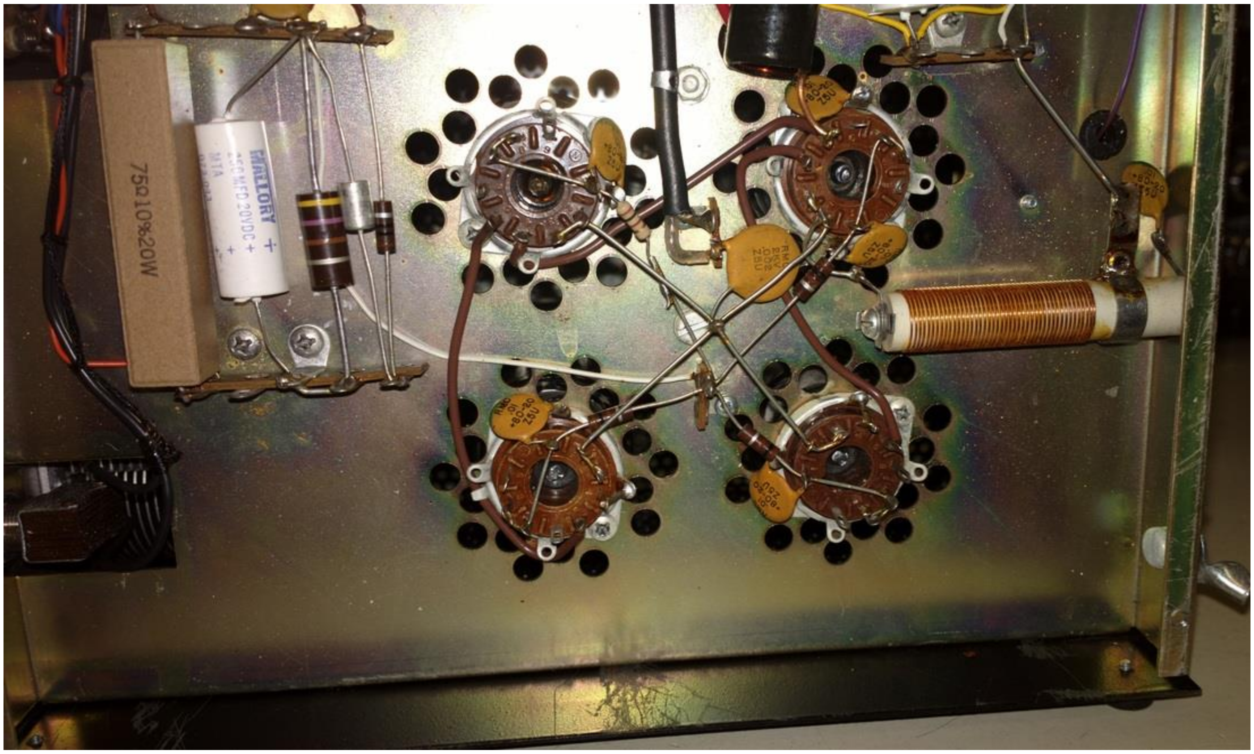
This amp stays cool all day thanks to a big, 5-inch, low velocity (quiet) high output fan from AC Infinity (eBay seller). The information and fan model number are "120mm 25mm Cooling Muffin Fan 115 V AC 2 Ball Bearing LOW SPEED 5" (LS1225A-X)". The fan typically sells for under $20, and it comes with the fan, a nice grill, a short AC plug that can be removed from the fan, four black bolts and nuts, and four rubber noise-dampening washers. By orienting the fan at a 45-degree angle, I was able to mount it using the black 4-40 bolts and nuts that came with the fan without drilling the top cover or even enlarging any vent holes. The amp runs so cool I can put things on top of it.

Right now, the fan is simply plugged into a switched outlet, but I'm going to put a chassis-mount switched outlet on the back. I would prefer putting the fan inside, but this is one situation where there is NOT enough room.

One of the problems with these older linear amps is that they were designed to be driven by tube transceivers or exciters that used Pi-networks to match their output stages to the antenna. As a result, all that they use is a simple high-voltage capacitor to couple the input signal to the cathodes of the output tubes. This worked great with my Kenwood TS-830S hybrid rig, but I really bought it to use with my Kenwood TS-930S. Harmonics from the cathode circuit played havoc with the 930S autotuner: It spent a lot of time “hunting” for a match, and on 10 and 15 meters, it could not find one low enough to bring the drive motors to a full stop. I began the task of designing a low-pass filter network that I could install under the deck near the cathodes to solve that problem. My goal was to create a single filter that could handle all the HF bands that this amp covers. I wanted to avoid using a switched network like the Dentron GLA-1000B's used.

Before I dove into the filter project, I decided to verify that a low-pass filter would fix the problem, so I experimented with a couple external ones. One that made a difference was a basic Drake TV-1000-LP inline filter. But the champ was a low-pass filter assembly that I had removed from a Palomar TX-5200 solid state linear amp that had blown finals. The filter board from the Palomar fit nicely into a small metal box, and I was using it for testing purposes. You can see it in the first picture of the amp. It eliminated the harmonics and allowed the Kenwood autotuner to quickly achieve a flat match with the amp on all bands, including the WARC bands. The problem was that it represented an external solution, and I wanted something that was built-in. Another issue was that with the amp in Bypass mode, the external filter was still in the signal path which in the case of the 930S meant having two LPF’s in series.

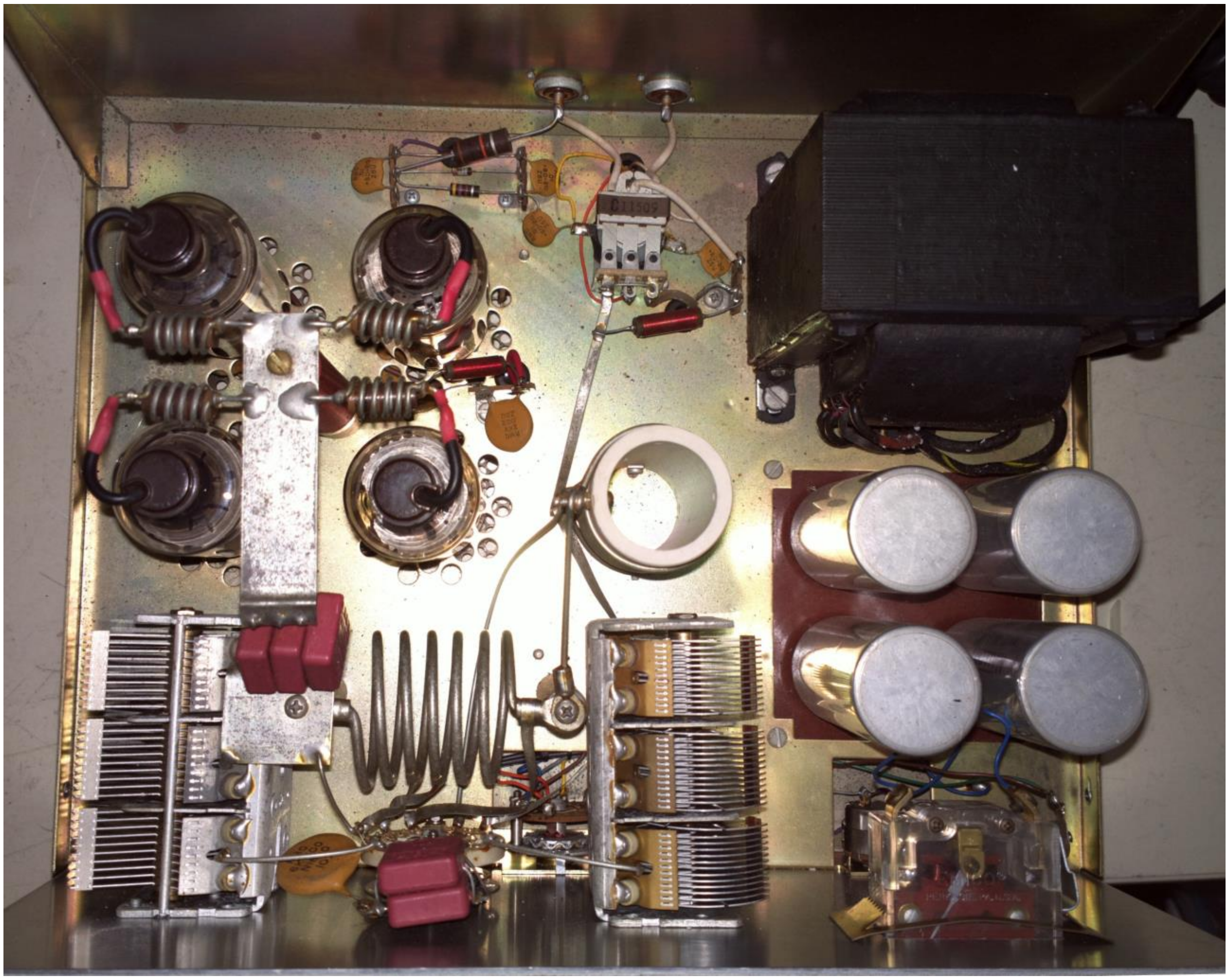
The input circuit for the Swan 1200W, using just a basic 2KV capacitor.



The Swan 1200W with four 6MJ6 Tubes installed

Some More Views

Top View: Easy to work on, but no room for a fan without cutting a large hole in the back panel



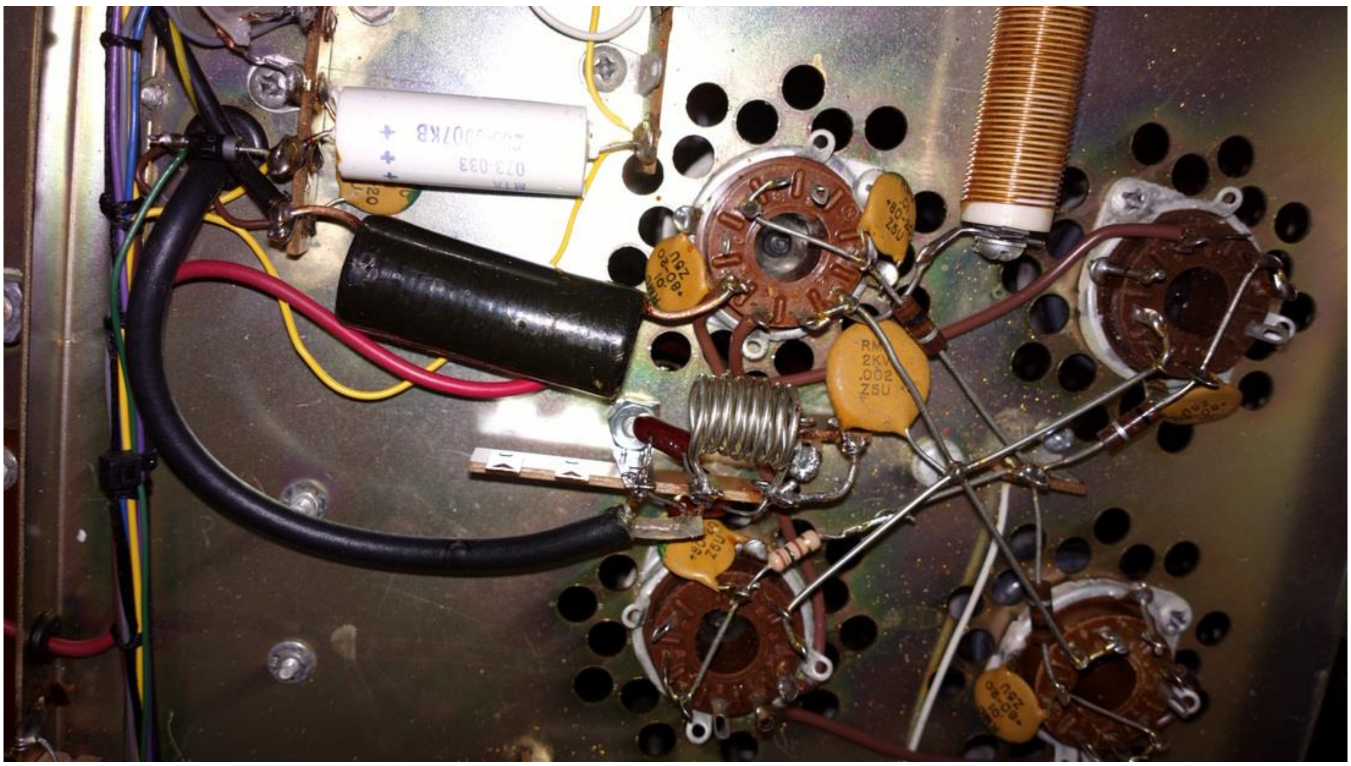
I thought long and hard about putting a filter network on the top of the chassis between the switching relay and the tank coil. A hole and grommet could be put in the deck, and the filter could go in a small metal box. However, voltages run high there, and I was worried about arcing, feedback, etc. I decided that under the deck was best.

My first order of business was to perfect a filter network that would work with an impedance of 50 ohms, have a cutoff frequency of 30 MHz, and fit underneath. Naturally, I had to buy one of the new LCRs that have multiple test frequencies up to 100KHz for the filter design. The one I chose was the CEM DT-9935.

FIRST EFFORT: A simple single-section LC filter

I found three web sites that allow someone with no advanced tools to create very effective filter networks. One allowed someone to predict the inductance of a coil (home-made or otherwise), based on the diameter, the number of turns, and the overall coil length. The inductance values that it created agreed closely with those that I obtained with my new LCR. The second site let the user choose the L-C components needed to create Butterworth or elliptical filters with a cutoff frequency of your choosing, and/or ripple in the case of ellipticals. The third site let you input your values, and it would output not only the cutoff frequency, but also a graph. I conducted tests with my signal generator, scope, and frequency counter and the cutoff frequencies that I measured were close to those that the web program estimated. Sites 2 and 3 let you choose the number of section in the filters also.

Armed with these tools, I designed this simple filter. It worked well on 15 through 80 meters, but not 10.

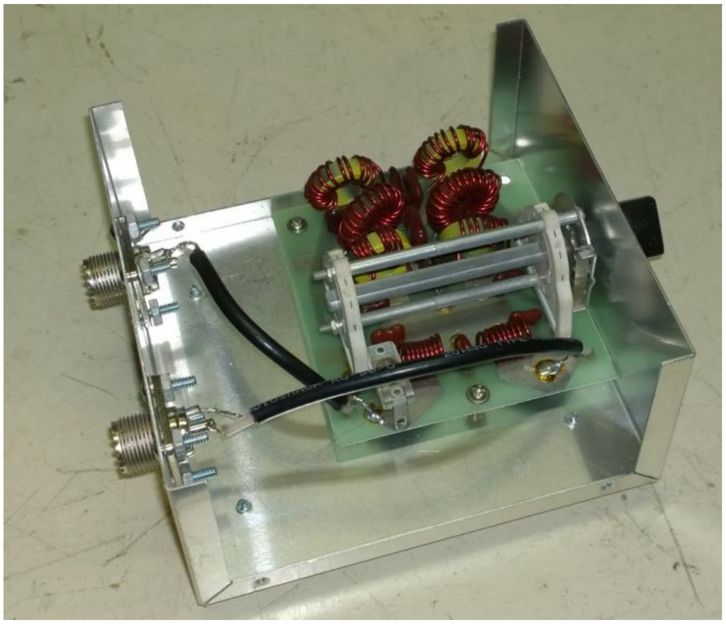


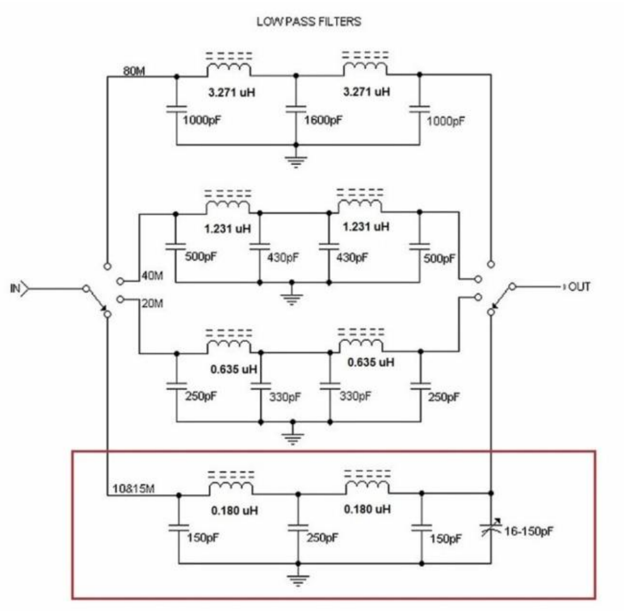
The sites predicted that this filter would roll off before the frequency reached 10 meters, and interestingly, after my 930S tried repeatedly to tune up on 10 meters, the inductor was hot.

Some of my designs worked great. The problem was that the greater the number of sections, the greater the effectiveness, but also the greater amount of signal attenuation. I've reached the conclusion that this is because I was using air inductors instead of toroids. Since I would be driving this with only 80-90 watts instead of the typical 100-125 watts for which it was designed, I needed to conserve every dB. I decided to cheat and buy or copy a commercial filter.

The Palomar LPF was a good starting point. With the filter switch set to the 10-15M position, I could tune in every band, plus 12 and 17 meters.

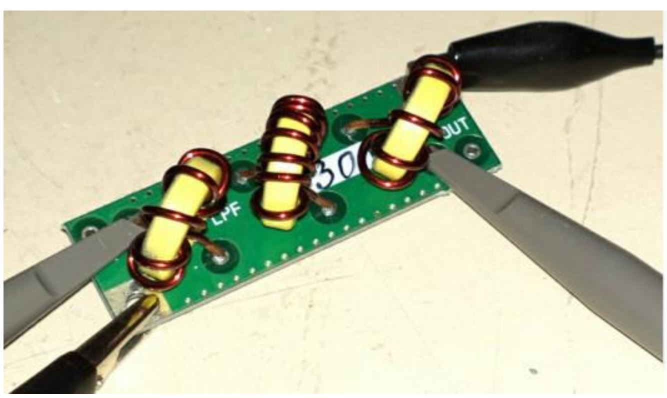
The inside of my box and the published schematic are below:

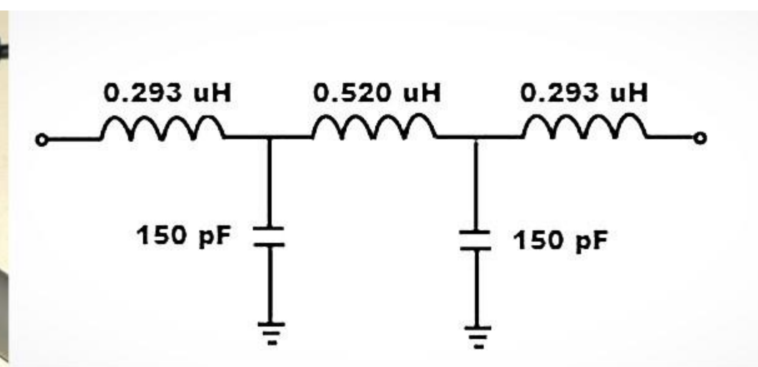




Note that the 10-15M filter portion of the Palomar LPF uses air inductors, and the rest are toroidal. The picture below shows my copy of this filter. I didn't have the correct adjustable trimmer in my parts bin, so I measured the value of the trimmer in the Palomar filter using my LCR and installed a fixed capacitor instead. This worked, but not as well as the one in the Palomar LPF, and it reduced my output. So, I decided to keep looking

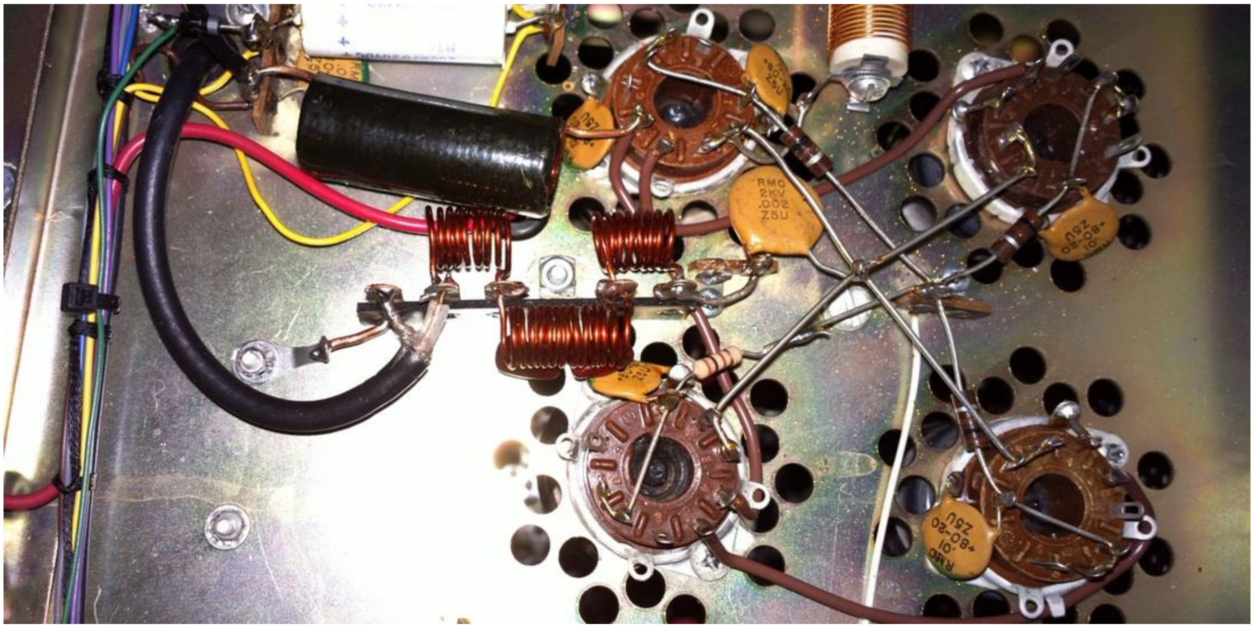
I bought the filter below from a Russian eBay seller, R3KB04. This is a 2-section T-Filter, especially well-suited for low impedances. I was testing it in this picture. Note the cutoff frequency, marked on the filter. This worked so well, it became the "one to beat". My plan is to install this in another small linear that I have that also lacks an input filter.





The parts values you see in the schematic aren't marked on the filter. I used my new CEM LCR to find the values. I unsoldered one end of each toroid to accurately read its value. This filter worked great in my 1200-W, but the large diameter coils made it too tall to fit under the deck. I decided to duplicate their filter using air-core coils.

My 2-Section T-Filter.



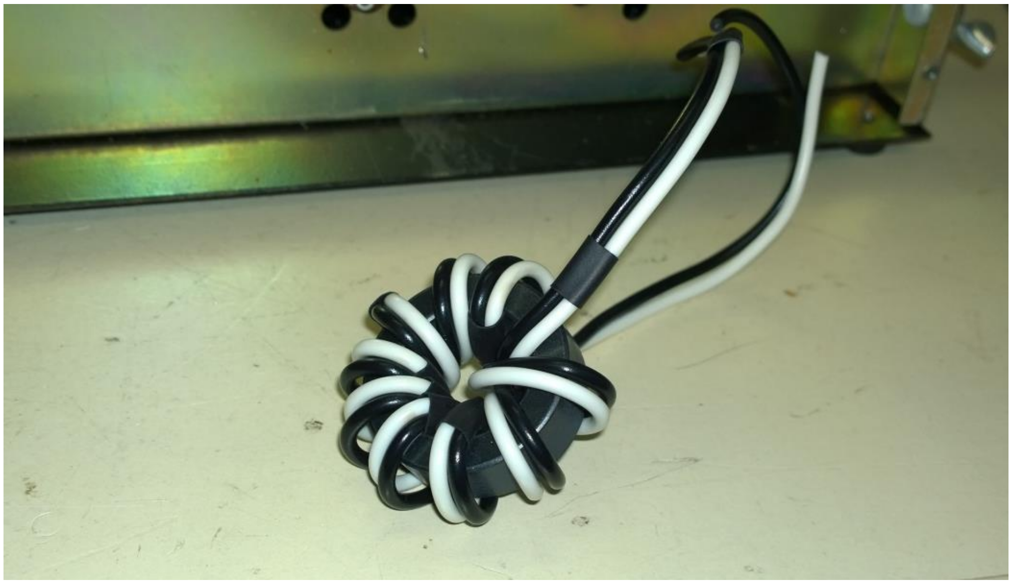
This filter worked very well, allowing my Kenwood tuner to work with all the bands from 10M to 80. The only problem was that the air-core design resulted in significant attenuation of the input signal. I lost at least 50 watts output.

During this time, I was kicking around ideas with Wayne (W4TZB), who is a retired professor of electrical engineering from the University of Tennessee. He suggested that a 4:1 balun might provide the match that I needed without attenuating the input signal. The only problem was that the balun would be even more difficult to mount under the somewhat shallow deck of the amp.

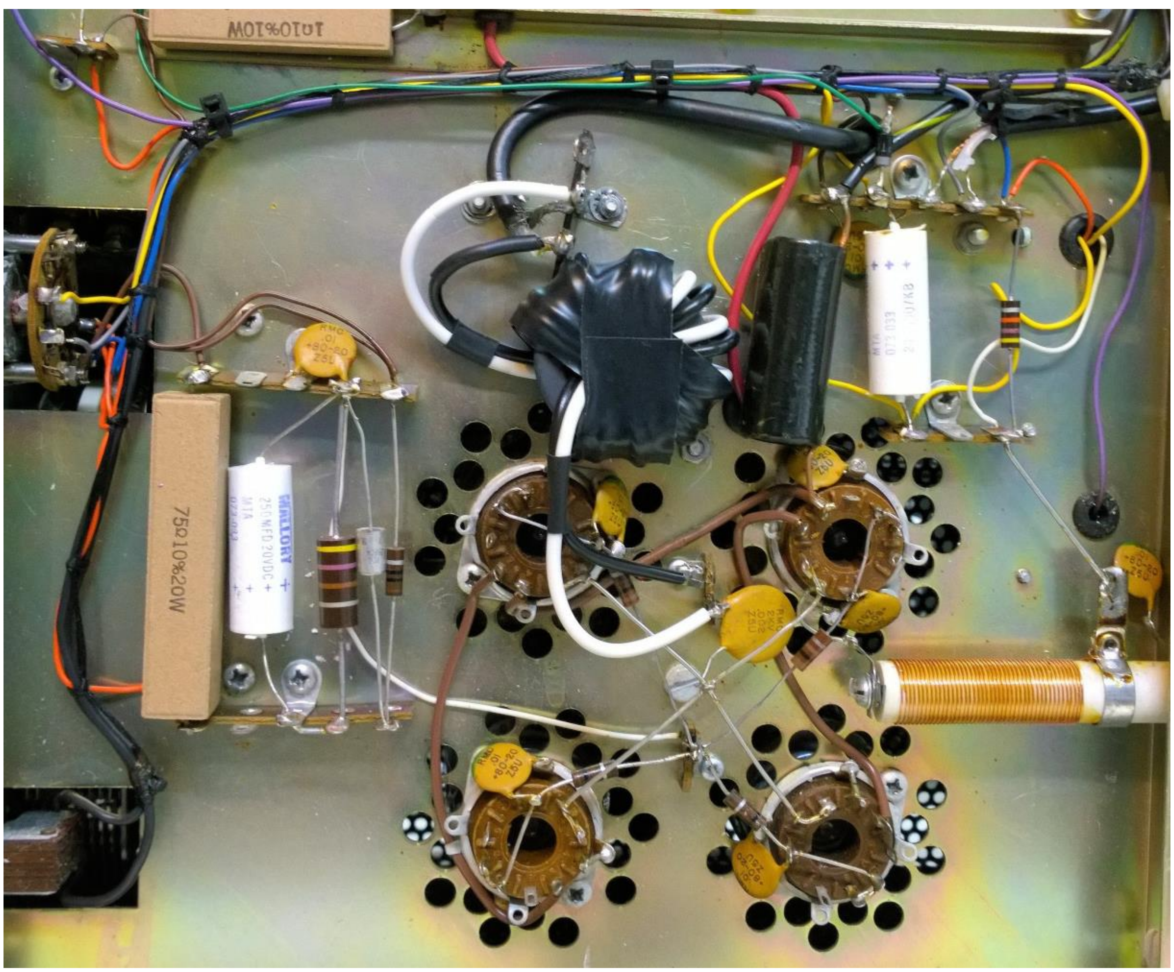
At this point I decided to "cheat' again. I bought a 4:1 balun kit made by Palomar. It is meant to be used with a dipole antenna. The model number is BA-4-250. As the model number suggests, it's designed to handle 250 watts PEP. This doesn't come assembled. It's just a spool of wire, the toroid, and the connector. The connector ended up in my parts bin. This picture was taken from their ad.

The hardest part was winding the wires tightly enough so that the balun would fit. At one point, I considered installing metal stand-offs and long bottom screws to shift the amp's bottom plate downward to create more space underneath. I even bought some stick-on lead shielding to try to reduce interactions between the chassis and the balun.

To keep the wires from spreading apart, I used heat-shrink tubing to hold them in place.



What you see below is what I ended up with. It works well so I haven't installed the lead shielding yet. The match isn't quite as good as it was with the 2-section T-Filter, but the power output is higher - about the same as it was with the basic blocking capacitor. I wrapped the assembly in black tape to keep the windings tight and stuck it to the chassis using a piece of that super-strong double-sided tape. The bottom of the amp just fits, and it helps hold the balun in place. Note the polarity of the wires. The near end of the black wire is the center conductor of the input, while the far end of the white wire goes to the tube cathode assembly. The opposite end of each wire is grounded.



I plan to add a section here showing the various filters that I created, plus some new ones I'm going to make using toroids. If anyone needs information immediately, feel free to send me an email at w3afc@aol.com.