

Rebuilding obsolete TV broadcast transmitters for 23cm EME

Modifications to Plisch / R&S TH327 cavities

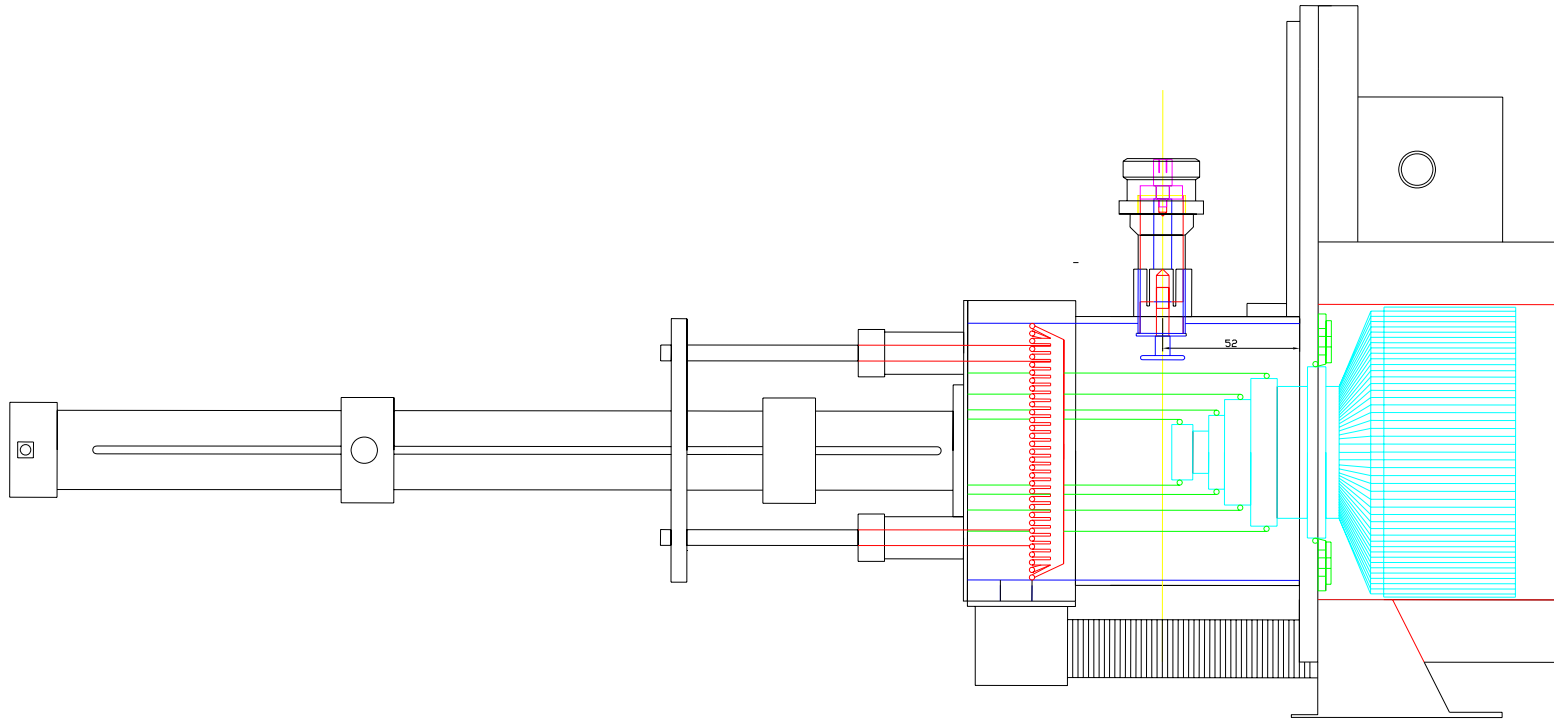
Eddy Jaspers, ON7UN on7un@on7un.net March 2008

Analogue television broadcasting is coming to an end, many countries are planning to shut off the analogue terrestrial TV broadcasting completely. At this moment, Holland, Luxemburg and Switzerland switched off their analogue transmitters. So a lot of surplus equipment will be available for us, to be used on 432 and 1296 MHz. Not all obsolete TV transmitters will be useful, the large amplifiers (10 KW and more) will be difficult to make useful, due to power line limitations). A very useful power range, however are the 500 / 1000 watt TV amplifier cavities. Most of them are used in common vision / aural amplifications, or, sometimes these cavities will be found in larger TV amplifiers, serving as Aural amplifier only (-10 dB).

In the recent years we where able to acquire a number of these cavities, and attempting several modifications to use them on 23cm for EME .The cavities also come in different flavours, and some are easier to modify than others.

The cavities in the picture below are all of the ULV273 ULV275 series used in the Plisch and Rohde Schwarz UHF broadcasting transmitters for their 500 / 1000 watt common amplification broadcast transmitters and translators, or to be used as an audio carrier amplifier in the larger transmitters.





Drawing of the cavity dimensions remain the same for older or newer cavities, only the air intake can be at the cathode or anode part. (This drawing shows the air intake in the anode compartment, and the plunger is limited to travel to the bottom.)

The ULV273 cavity the newer type, but a little more complex to modify than the old version Plisch cavities. The differences are especially in the air intake for the cathode cooling. The older style cavities have made the air intake at the bottom on the cathode circuits, whereas the newer cavities have the air intake at the side of the Anode cavity, blowing below the plunger trough holes in the G2 and G1 parts of the cavity. In these newer cavities the plunger is limited to go below a certain point, for not blocking the air intake. When the piston is at its lowest point, the cavity is not yet resonant at 1296, but slightly higher. (1320 MHz) This paper describes how to easily modify the ULV273 in its different versions, as well as the older type TH327 cavities where minor modifications are required, since the piston is not limited to travel to the bottom of the cavity.

Modifications necessary to all cavities:

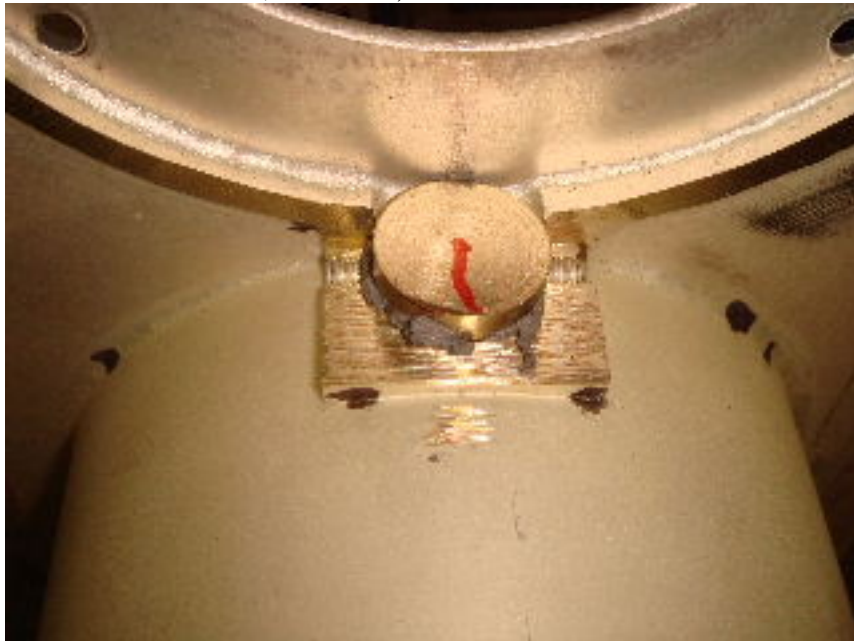
The cavities are build by a resonator part for both Anode and Cathode, and a separate output filter. This filter has been designed to have a flat response over a 10 MHz wide UHF frequency spectrum. The output filter is useless for us, so we cut off the filter part, and create a new output coupling in the Anode part of the cavity. Remove all the parts inside the filter compartment. In between the filter and the anode, there is a coupler. Remove this coupler. Disassemble the anode part by removing the screws in the side of the cavity. You can now separate the inside from the cavity. BEWARE : the finger stock will move in the air intake. (in case of the ULV 273 / 275 , no problem with the older plisch cavities) When you pull out the inside parts, the finger stock will break. Push the finger stock inside the air intake hole, by removing the plunger. You will need to have 4 hands to do this, so make sure you have somebody assisting. Now you can cut off the filter part.



When the filter part has been removed, you need to close the old outcoupling hole at the top of the cavity.



Turn down a copper piece to fit the hole, and solder in place using solder paste if available. (just plumbers solder will do also, of course).



Now we are ready to make the new output coupling. Parts coming from the filter part are very useful. The original output connector is being modified to be re used for your output coupler.

First we have to drill a hole (aprox) 52 mm mm from the top of the cavity. This is where the new output coupler comes.



Create a copper tube ID 18mm to clamp the new output coupler to the cavity



Now it is time to make the output coupler. I used the old output coupler from the filter. Remove the Teflon spacer at the far end, this spacer is difficult to remove, so just cut off and throw away. Dismantle the complete output coupler. You can screw off the connector part. The inside pin is connected to the center part of the coaxial coupler by 2,5 or 3 mm tread. (found differences is different cavities)



In the filter part you will find some very useful silver plated disk, we are using this disk in the new outcoupler.



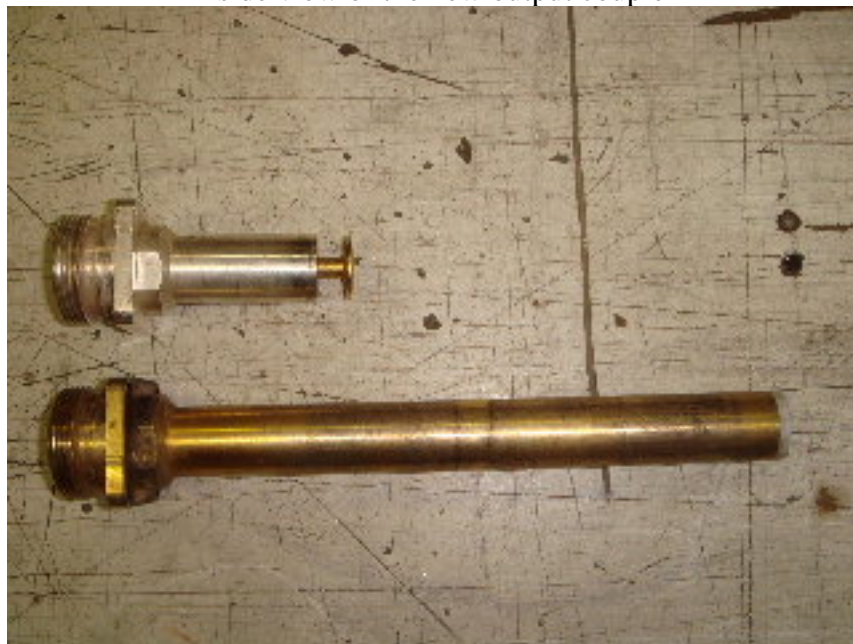
Cut off a part , turn down the shaft and cut new M5 tread on the shaft (as per drawing below)
You are now ready to make a new output coupler.



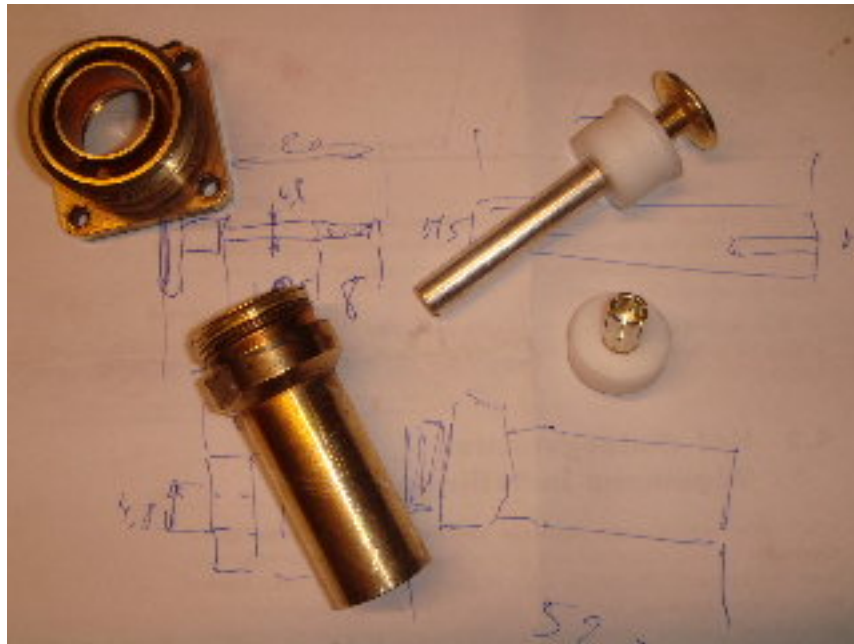
These are the new output coupler parts



Inside view of the new output coupler



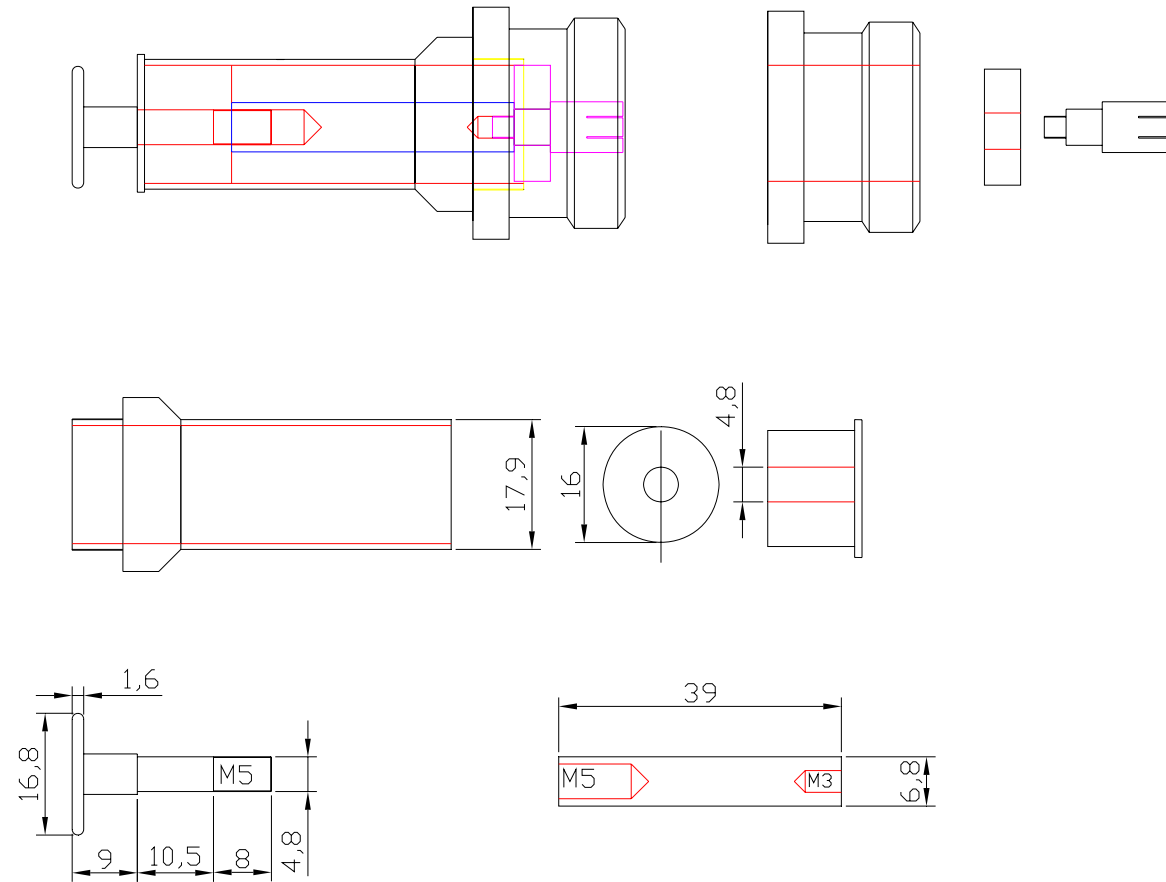
New and old output coupler.



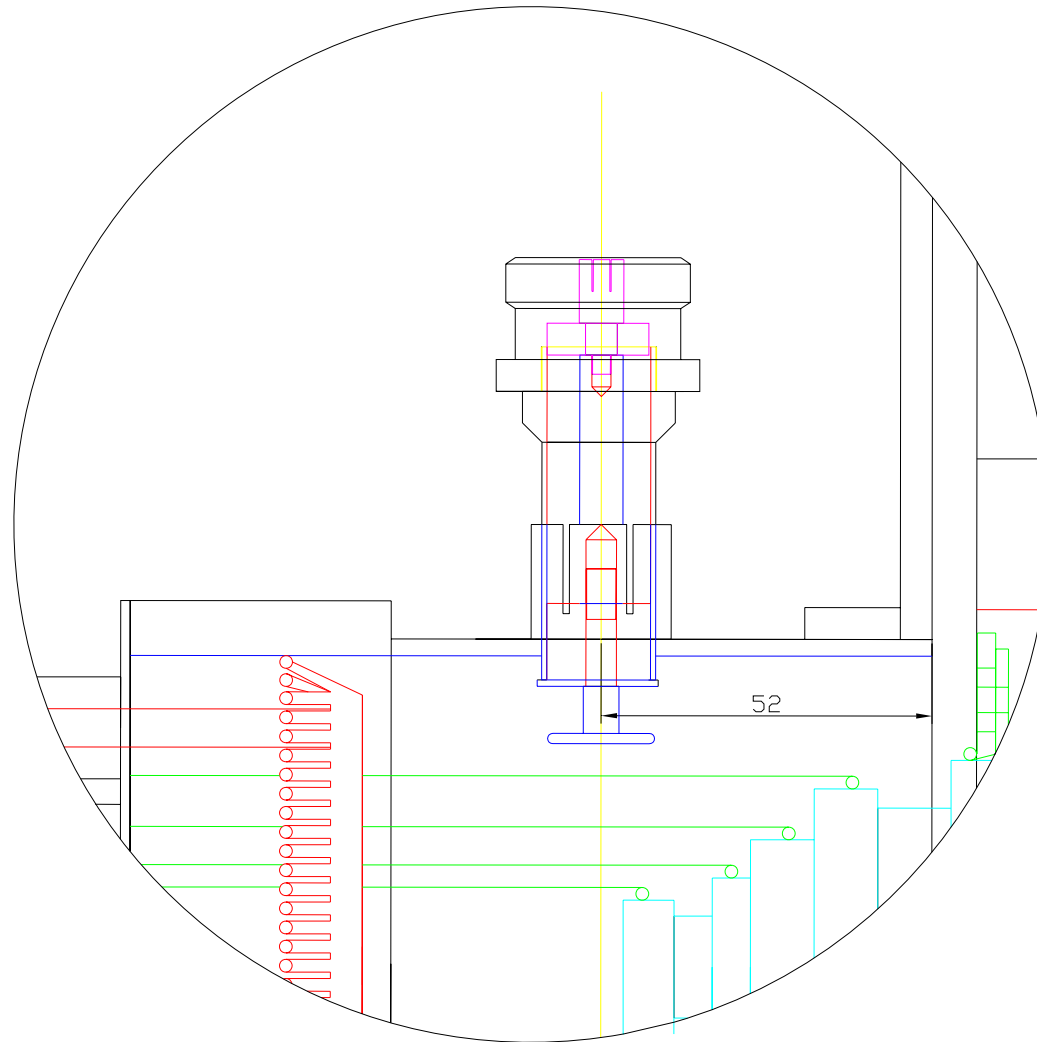
New parts being made



Cavity with the old outcoupling closed and the new one created

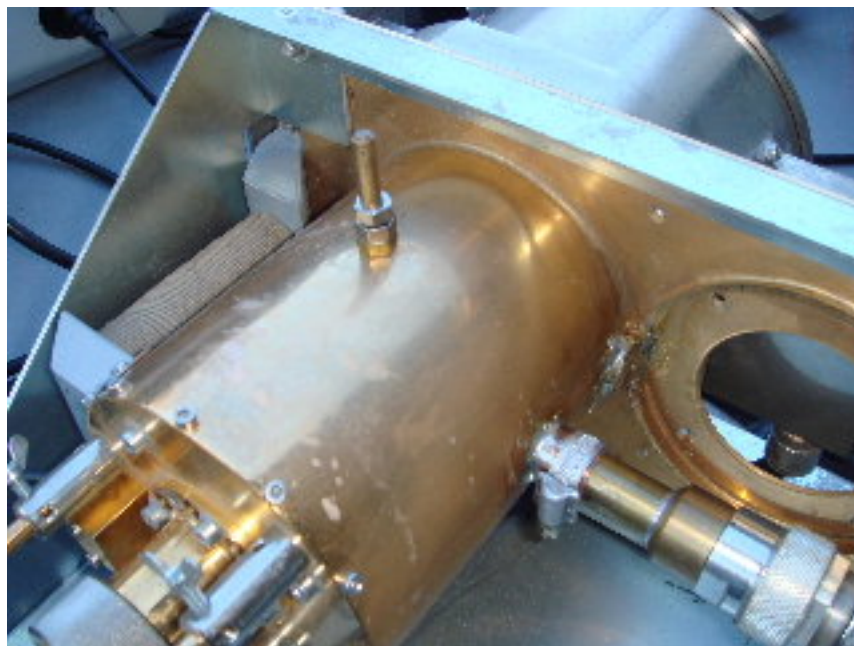
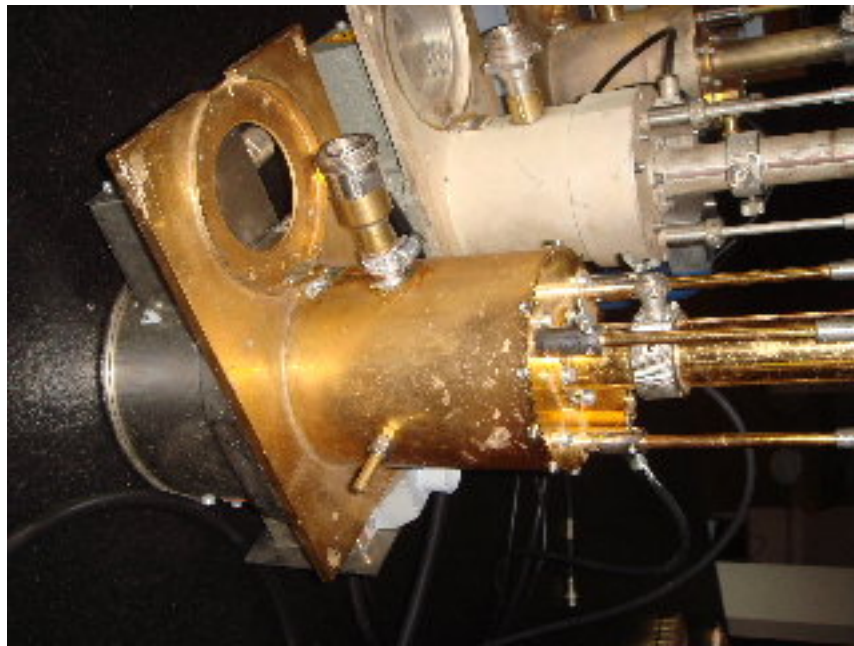


Output coupling parts all dimensions in mm



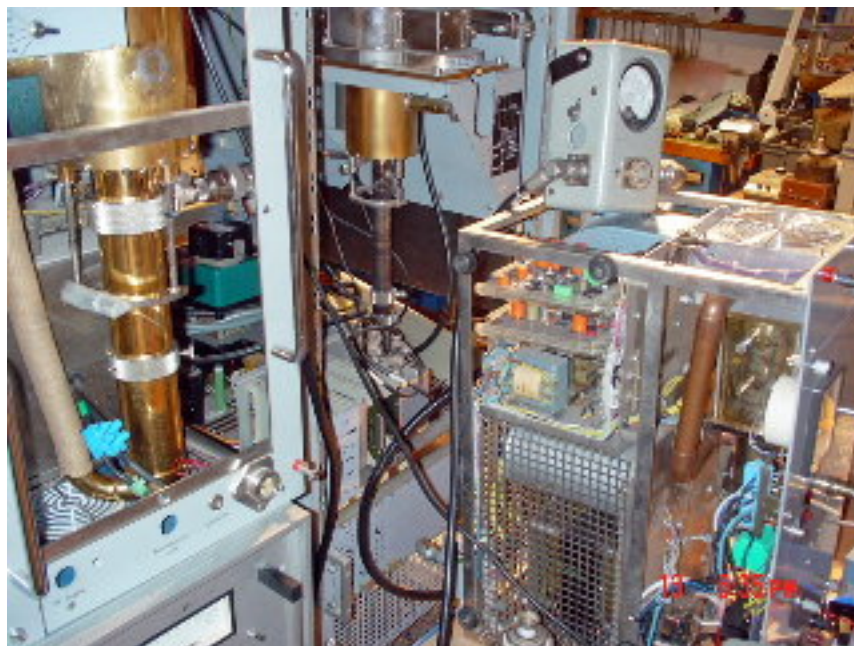
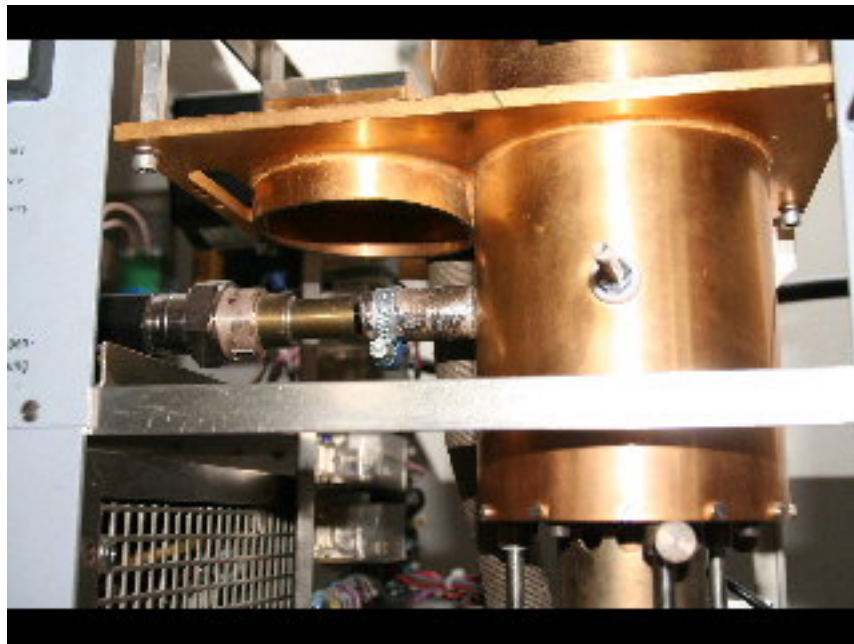
Outcoupling is being made aprox 52 mm from the top of the cavity.

Some people made a tuning screw at 52mm from the top of the cavity, at about 90 degrees from the output coupler. We tried this in one cavity. I do not find this really necessary, although it is a nice “fine tuning” to the tuning of the output coupler (loading)



When you are using the older plish amplifiers, with the air intake below, you are now ready to switch on the DC and AC voltages and tune the cavity on 1296 . The plunger can go low enough and is able to be moved another 8 mm lower, when tuned on 1296.

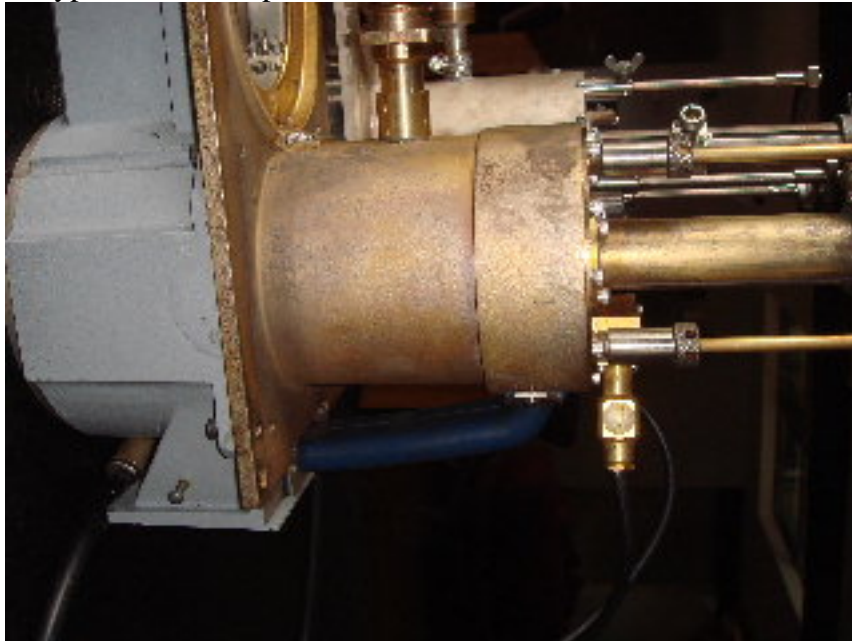
Below is a picture of the older style cavity (picture credit Zdenek OK1DFC)



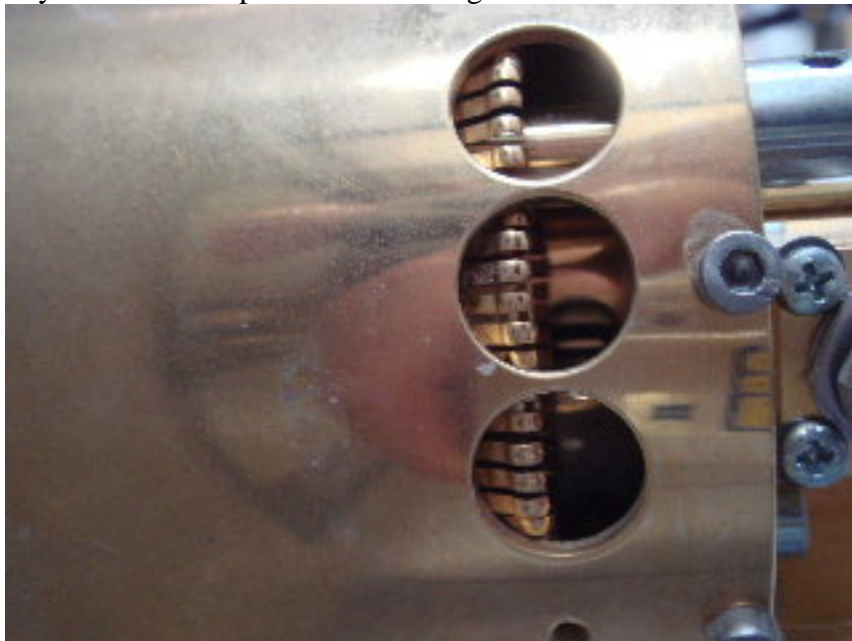
A few of Dominique's HB9BBD amplifiers. The left cavity is the old style, the cavity in the middle is the newer Plisch version with air intake at the side of the anode cavity.

Additional modifications to the newer ULV273 cavities:

Most of the recent surplus amplifiers are using the ULV273 cavities. When you find a silver plated version, it is most likely the ULV273 although I have seen also gold plated versions. Below you see a typical ULV273 picture:



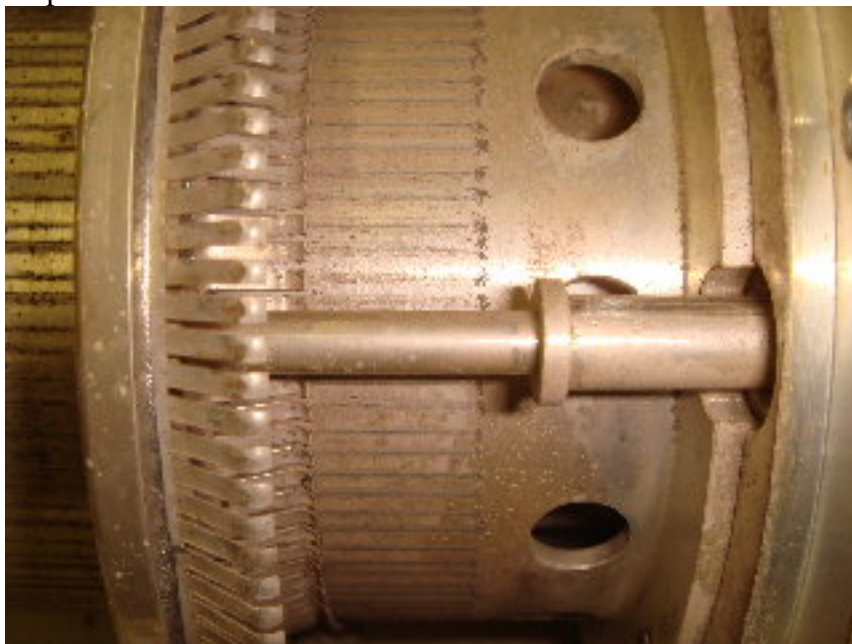
With the plunger at its lowest point, this cavity is not yet resonant at 1296 and the cathode cooling is already blocked for a part due to the finger stock.



The plunger has to go down another 3 mm, so the finger stock will block the air intake by half. I do not really see a problem for cooling, these cavities have been designed for continuous duty cycle of 1 kW output power, we are using them for less than 50% duty cycle for our SSB / CW contacts. You will also find 2 different air intakes, above you see the 3 hole air intake, more recent cavities have one oval hole air intake, as you can see in the picture below (with the air intake closed, to make an additional air intake in the bottom)

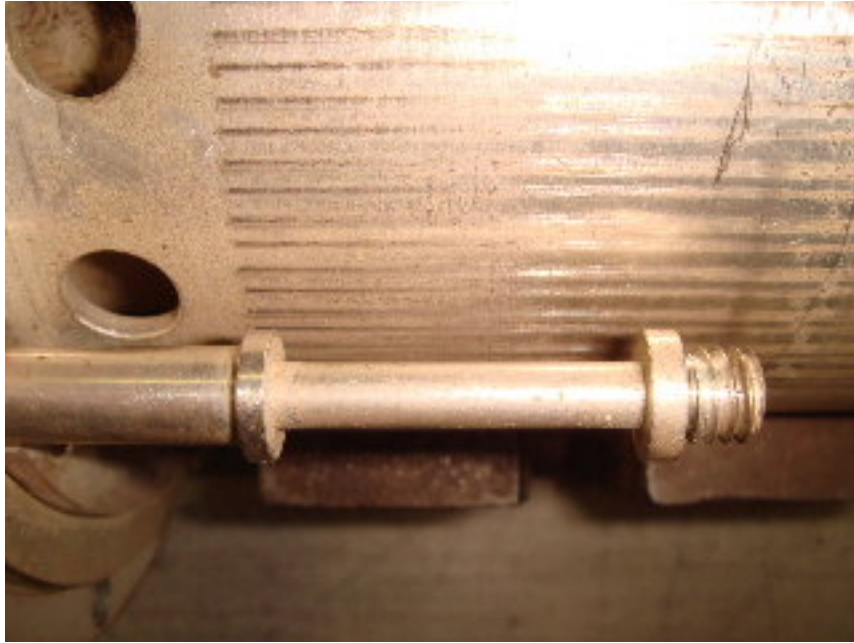


The plunger is mechanically blocked, so it can not move any lower. In the ULV273 it is done as you see in the picture below :



You can see on the marks what the lowest possible point of travel is, we need to go 3 mm lower !

Dismantle the 3 tuning shafts as seen below: (the easiest way to take them out, is unscrewing the 3 feed trough parts at the bottom of the cavity, you then can unscrew the shafts and take the out at the bottom, without removing the plunger. Removing the plunger is possible, but be careful re-installing the plunger back in the cavity. Take care about the inner finger stock.

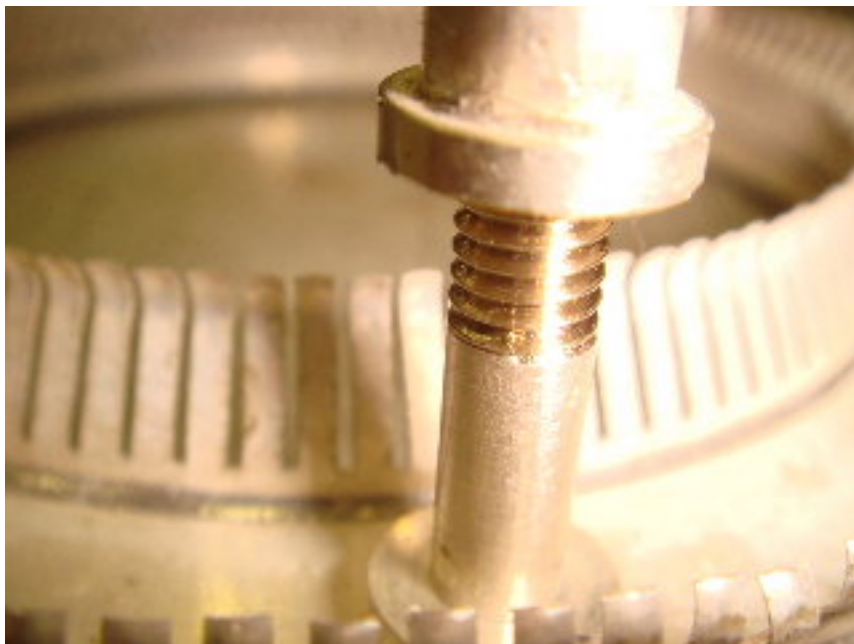


Cut off the top part, drill a hole in the bottom shaft and cut 5mm tread inside. On the remaining part, turn M5 tread. You now can screw the top inside the bottom part, and fine tune the lowest possible point of travel of the plunger.

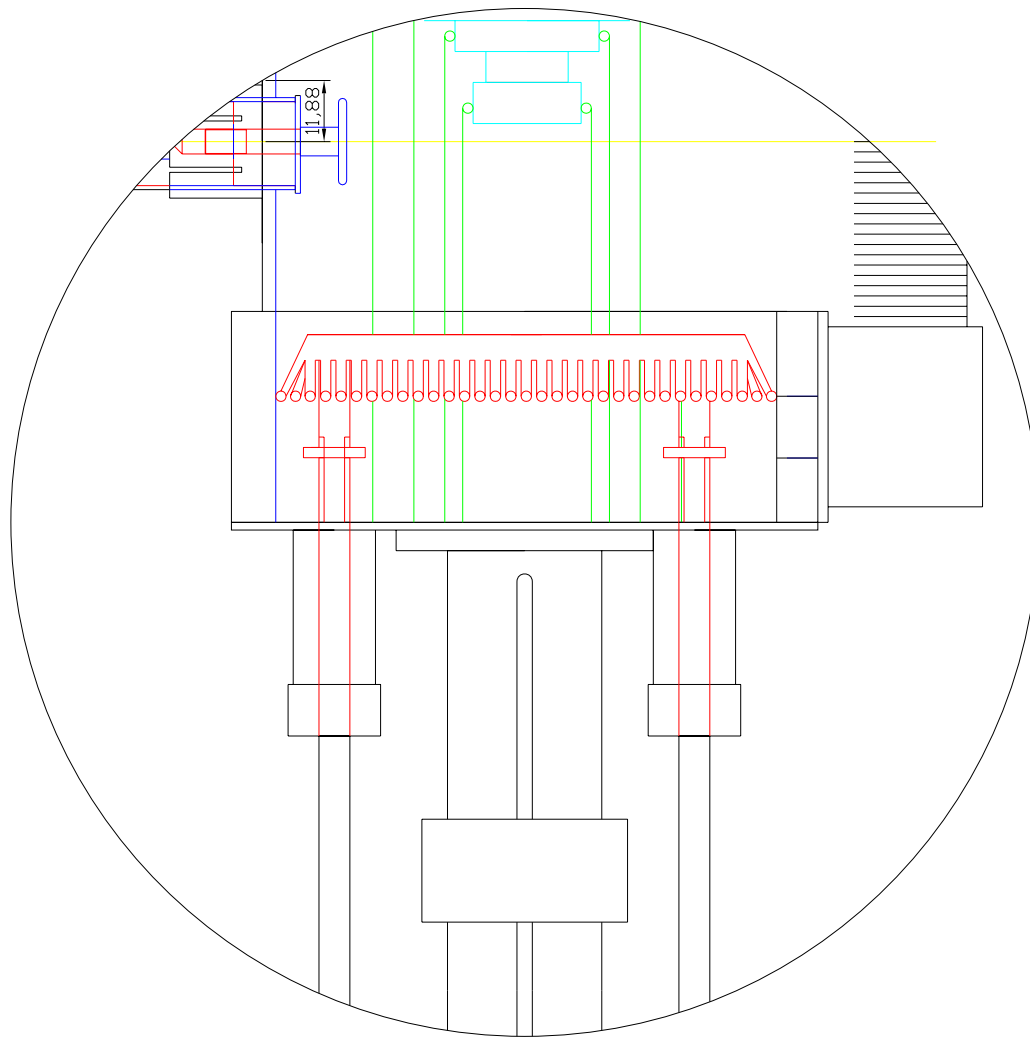




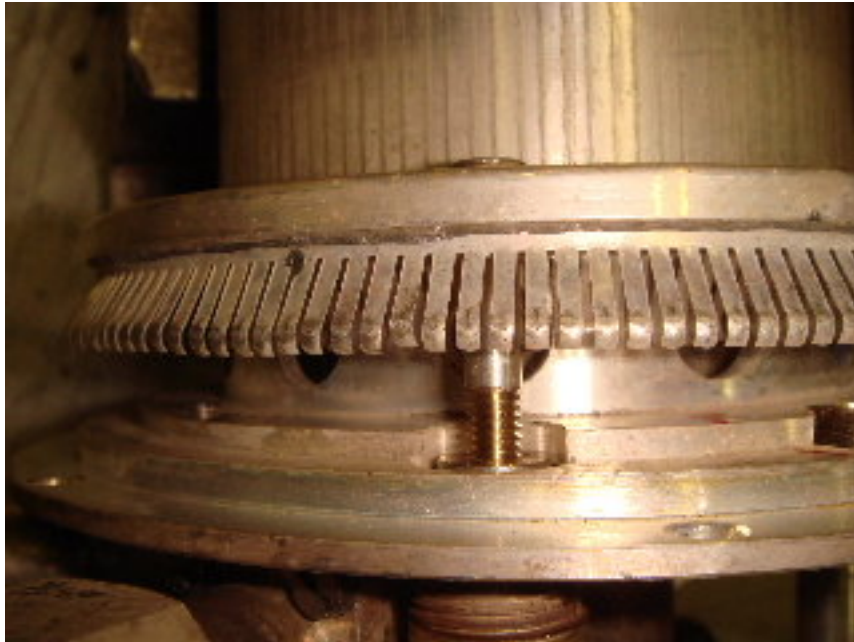
The tuning shafts are now ready to be re-connected to the plunger



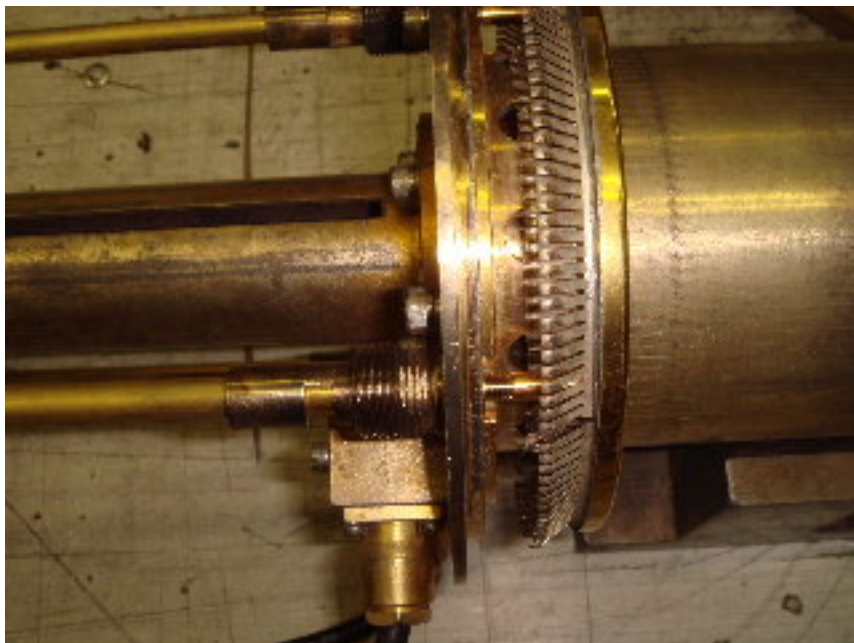
In this picture you see the plunger taken out of the cavity. The feed trough parts where “glued” in the cavity, impossible to take them out. In that case, remove the plunger from the top of the cavity. It is tricky to re-install, since you have to open all fingerstock by doing this. A picture is not taken, since we needed 4 hands to re-install the plunger. Make sure you have somebody assisting.



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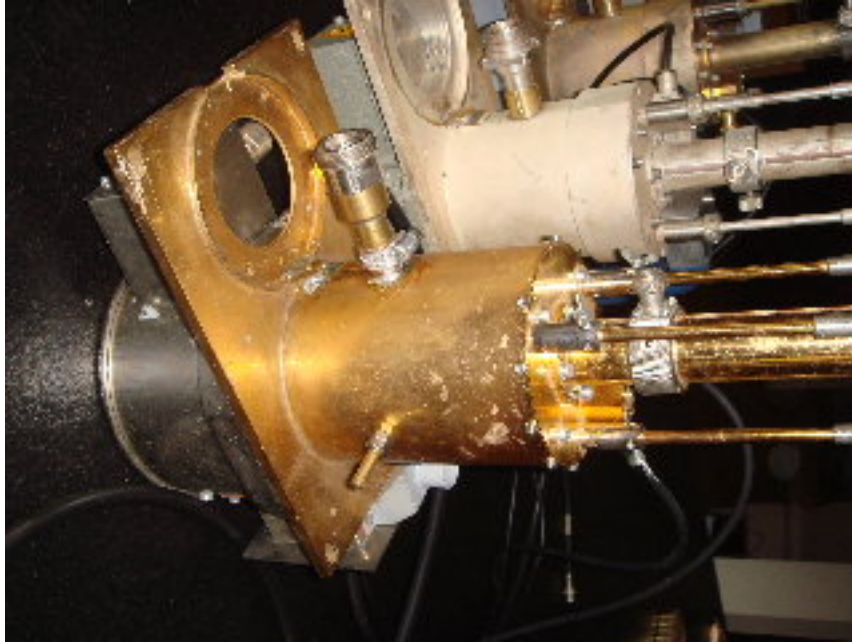


In this picture you see the modified tuning shafts. We lowered the plunger by 5 mm, and still have some margin to lower it further by turning the tuning shafts. Practical, we only need 3 mm maximum to tune the cavity to 1296 . At this point this cavity can be tuned down to 1262 MHz.



Additional modifications to the newer ULV275 Cavities:

You can recognise the ULV275 as a gold color cavity, where the anode part goes straight down. The ULV273 is thicker at the bottom of the anode cavity. The air intake is also at the site of the anode compartment. This is a picture of the ULV275 :

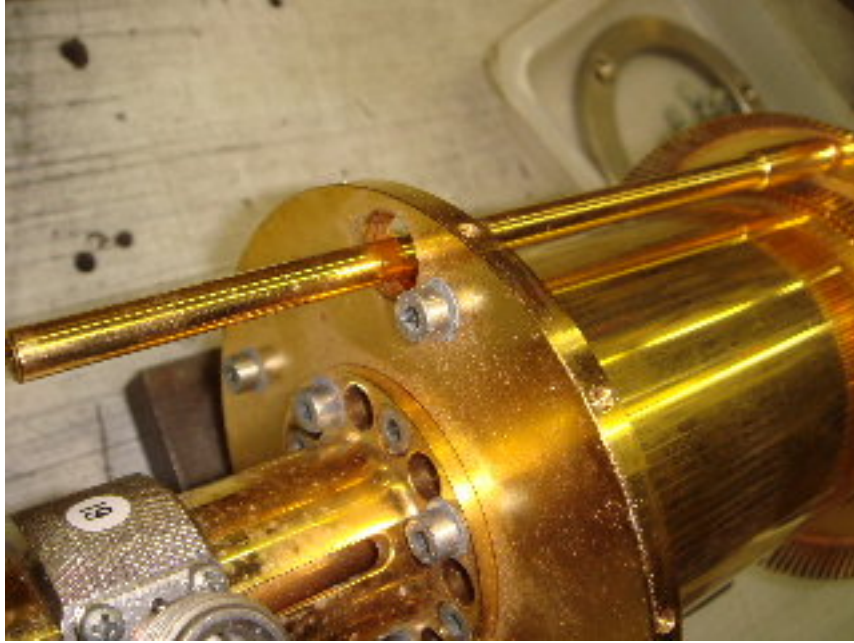


Without the bottom plunger modification, the cavity will tune to 1310 MHz or so, when used on 1296 it will “start” to deliver some power. The plunger down modification is very simple with this one.

On the tuning shaft you will see a thicker part at the side of the plunger. This thicker part is preventing the plunger to go lower.



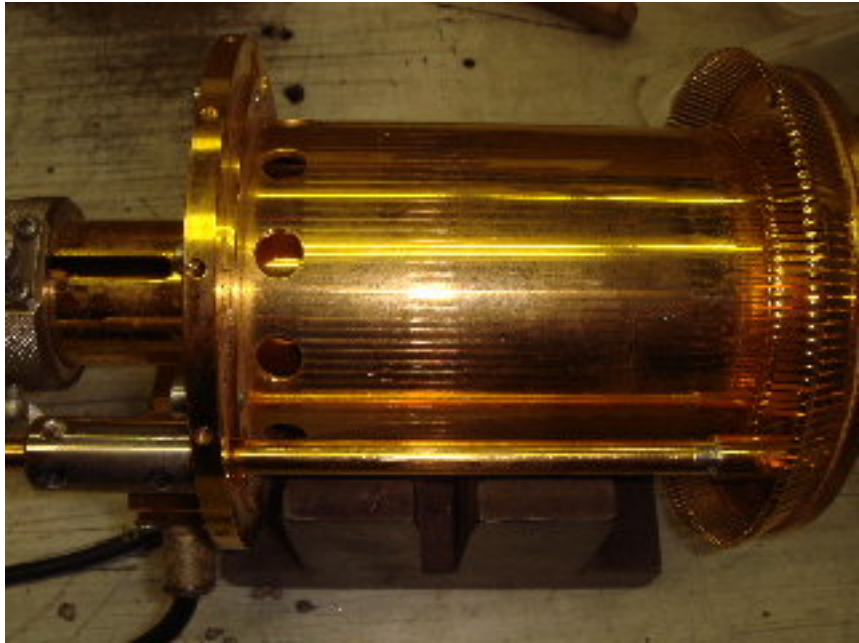
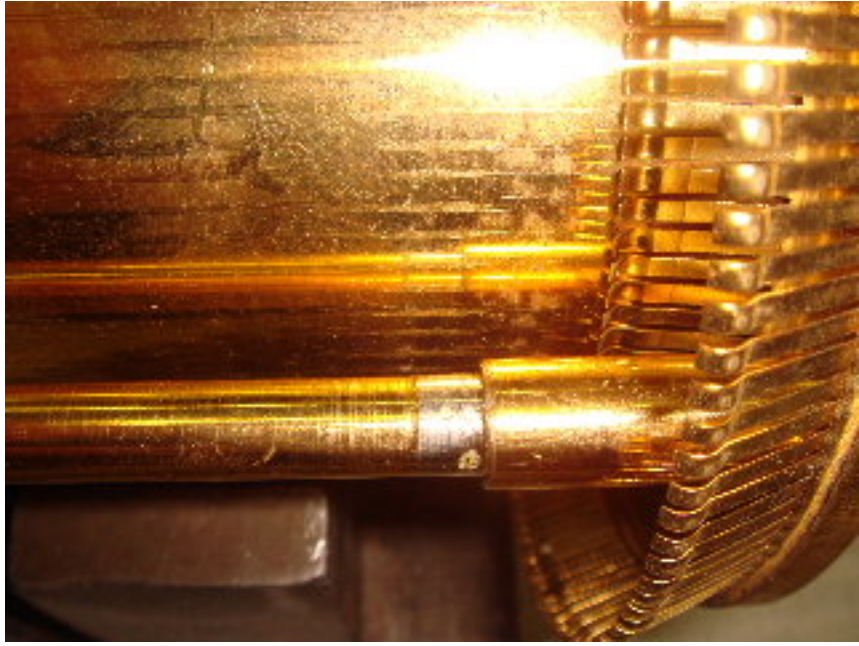
Take out the feed trough parts at the bottom of the cavity :

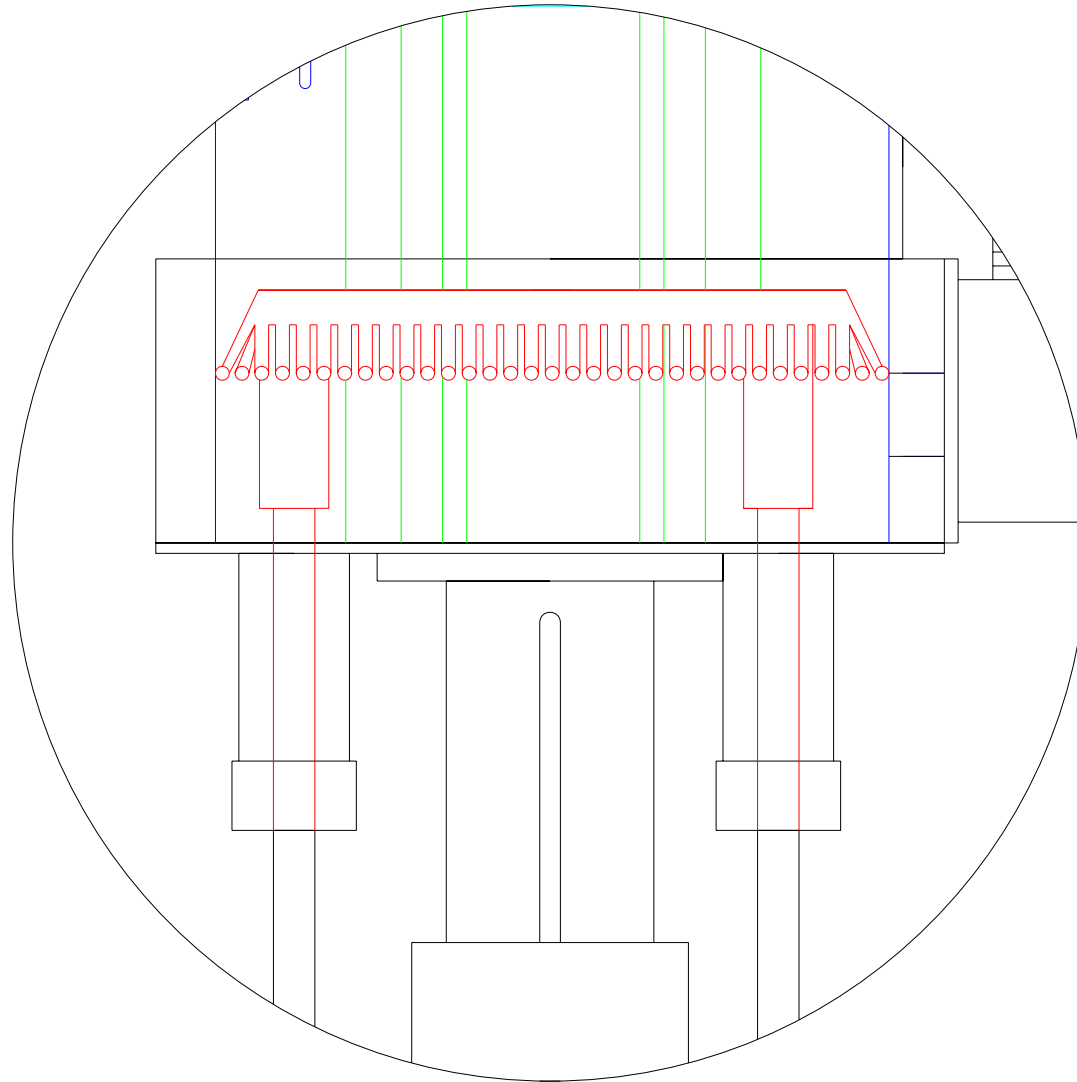


You can now un-screw the tuning shaft from the plunger



Turn down the around 5 mm of the ticker part, re install and you are ready to go !



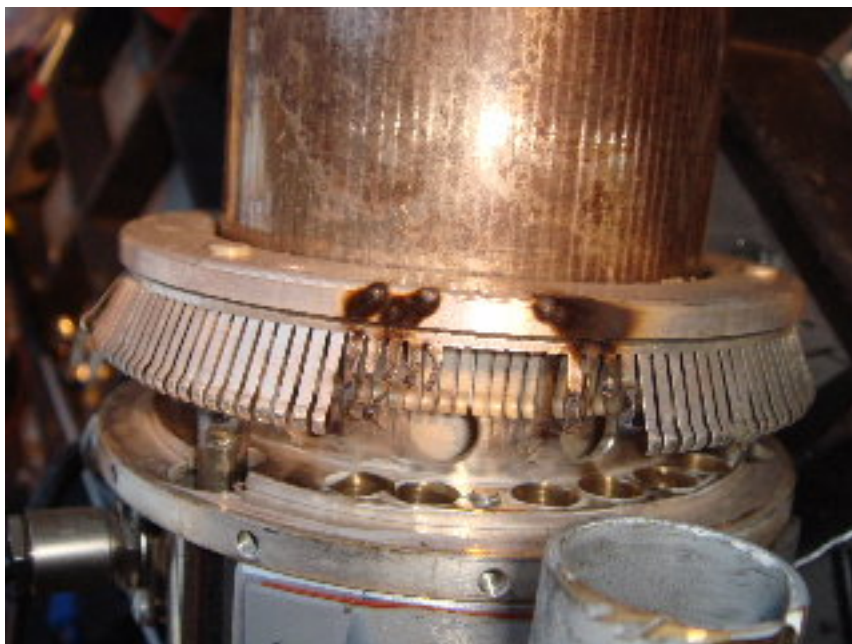


Lower Air Intake:

It does not seem to be necessary to perform this modification, but for those who are concerned about the blockage of the cathode air intake, I might have some precautions for you.

When I modified my first ULV275 some years ago, I moved the air intake to the bottom of anode compartment, as described below. After some years of operation, had a problem with the Anode Capacitor. By opening the cavity, I discovered the damage I had done.

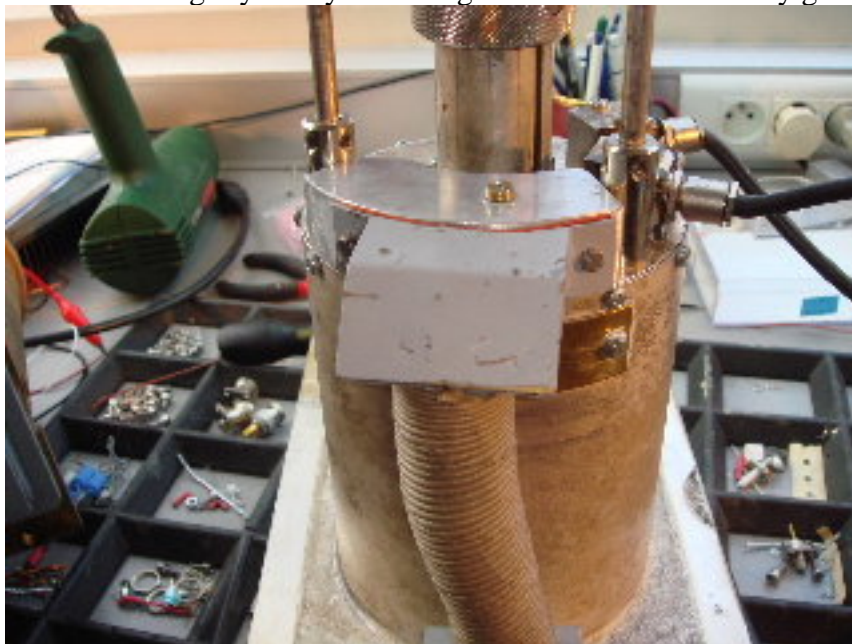
Closing the old air intake should be done very careful, using silver plated material. In a recent modified cavity we used material of the cut off filter, to be soldered in the old air intake. In the first cavity we did, we were using (lossy) brass material to close the 3 intake holes. This is the result :



In a more recent modification, the oval air intake of the ULV273 has been closed using silver plated parts of the obsolete output filter :



Now a new air intake needs to be created. At the place below the old air intake, there is not place to install the new air intake, since it is used for the G1 G2 supply. The bottom of the cavity needs to be rotated to a point where we have room to drill the new holes at the bottom of the cavity. After doing so, the new air intake will differ a little from the original point, so the new air intake will be slightly off by a few degrees. This does not really give a problem.



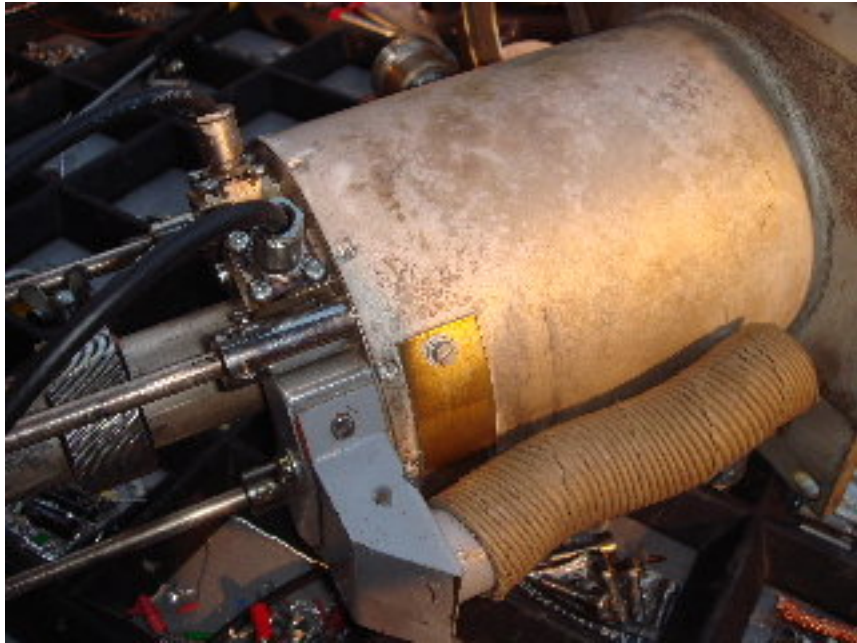
Lowering the air intake means a new air inlet needs to be machined following is the new air intake on the ULV275 :



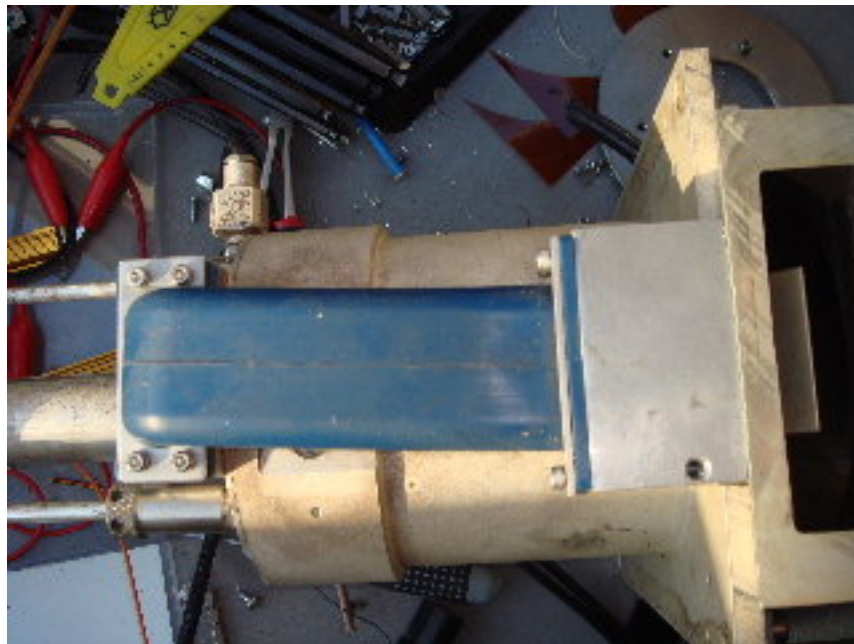
Now it is time to drill some extra holes in the bottom of the cavity, to create a new cathode air intake :



After re-installation the cavity looks like this :



On the ULV273 the flexible is oval and fix, to extend this, a machined part at the top is created :



And for the bottom part, a new air intake is being made :





Credits, References :

Most of the credit goes to the people who inspired us to challenge the extreme pat-loss and the poor reflection the moon surface is giving. The challenge of being “one of them” was a cost of many hours of building, but also many hours of joy and fun. Special thanks go to :

ON5OT , Mark : for his mechanical skills, his workshop and his ideas, and the late night hours making these modifications possible

HB9BBD , Dominique : who inspired us, where I got my first EME amplifier from. Dominique makes a perfect low noise EME preamp. Thank you for pushing us in this challenge !

OE9PMJ (SK) Peter, who published the first modifications to the Pisch amplifiers. His modifications were the guidelines to our cavity mods.

Appendix A : DC / AC voltages :

The question has been asked many times, “how much voltage on the plate” “how much voltages on the grids “ .

In our amplifiers we use a 4KV plate supply, 3 phase 400 VAC primary. This is the original R&S / Plisch power supply. After some “incidents” the original HV connector got shorted. Even with the 4000 volts to ground for a minute or so, the supply was suffering, but not blowing up. After resolving the technical problem, the HV supply was back on line !

For housekeeping, we use the G3SEK (GM3SEK) tetrode board. The board is modified (modification : www.on7un.net) to deliver higher G1 and G2 voltages.

Following are the working parameters:

UA : 4000 VDC

UG2 : 550 VDC / grounded during RX

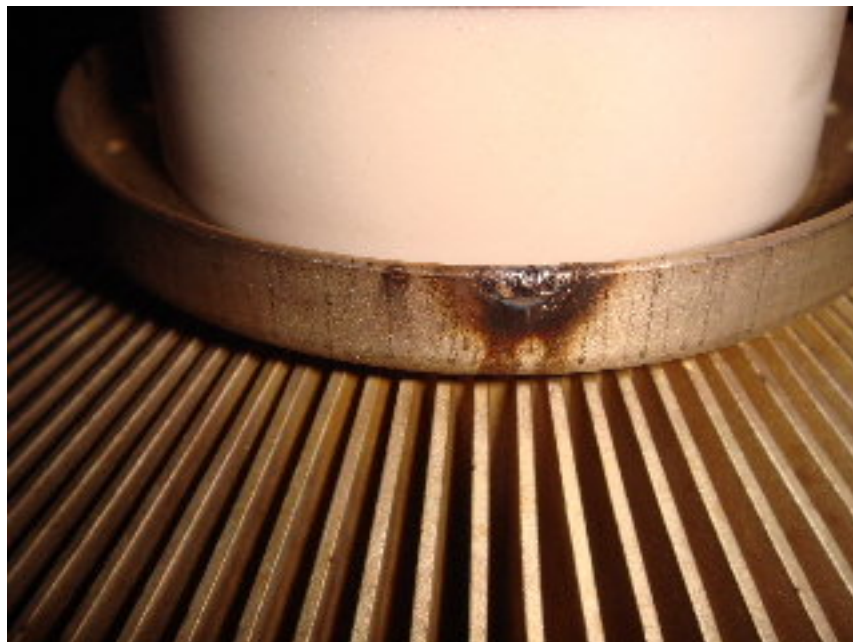
UG1 : -140 in Cut Off - 90VDC during transmit

UF : 6,1 VAC

These DC parameters give us a IA idle of around 150 mA . Using a brand new tube, IG1 is almost 0 , IG2 goes up to around 10 mA for 1 kW output, 20 mA for 2 kW output ... and up it goes ;-)

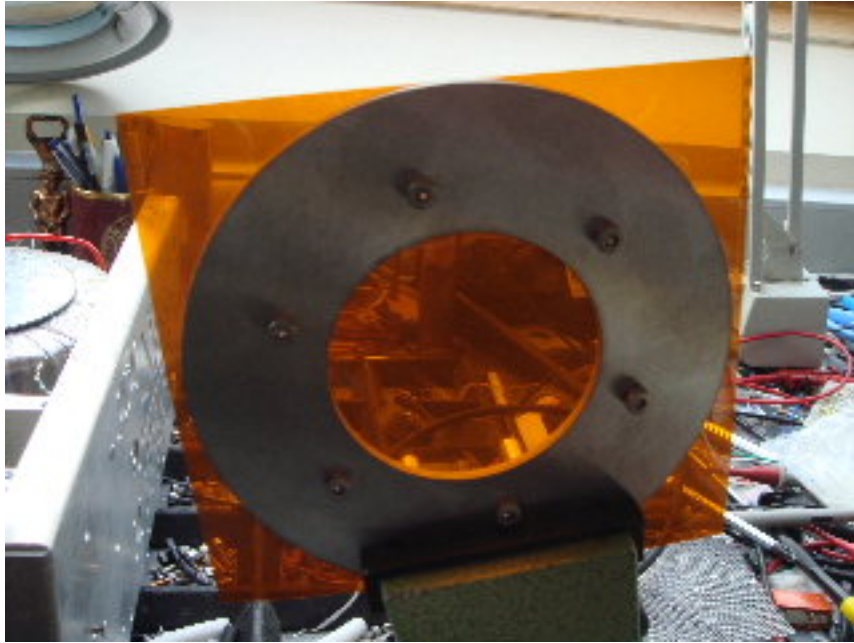
Appendix B : Blow up the anode capacitor

A few months ago, I blew up the anode capacitor. The root cause is not yet known but I got a flash over between the anode and screen inside the cavity :

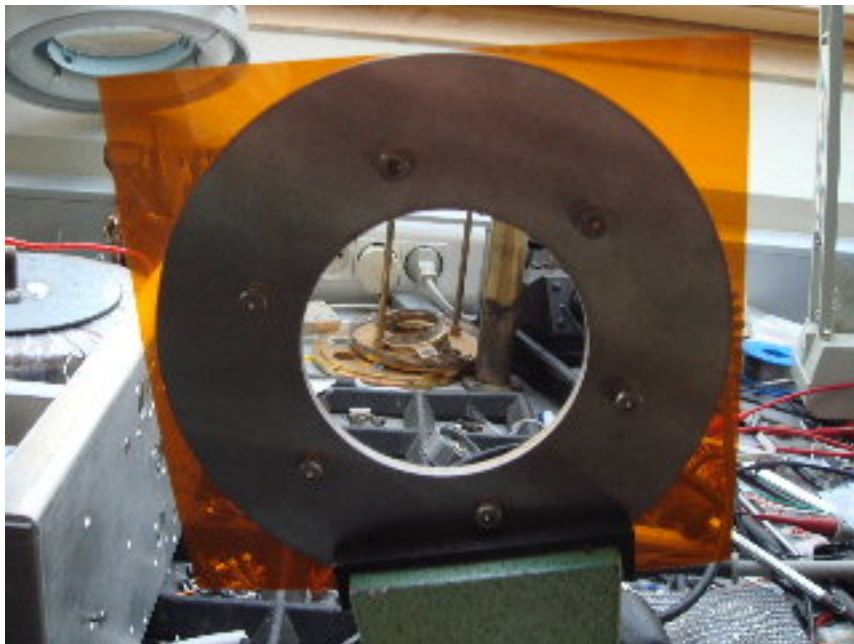




Beside the DC supply damages, the cavity suffered some Kapton burn outs. A new Kapton cavity isolator has to be made. At first sight this would not be a problem, until I started to search the 5 mil kapton sheet (12,5 microns) . Finally I found some raw material and have cut some stainless steel rings to re-create new anode capacitors. Following are the kapton ring (template) dimensions :



The template and the 12,5 micron Kapton sheet



With the middle part cut out



New kapton sheets cut out.