

RESTORATION OF THE 1946 RCA 621TS TELEVISION SET.

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The 621TS is a remarkable television set. It represents RCA's first post WW2 production effort and incorporated the design ideas of pre war television technology. It also incorporated revolutionary new design changes such as Line Output efficiency damping, FM sound and complex Line Output transformer core metallurgy and improvements in CRT design.

The set has a 7 inch screen deploying a 7DP4 CRT. The 7DP4 has an 8KV maximum EHT voltage type, typically 6KV, uses an ion trap magnet and provides a very bright high contrast picture.

The cabinet design was created by the well respected industrial designer John Vassos in 1941. WW2 meant a 6 year delay to get it to market. The model quickly got replaced by a 10 inch set, the RCA 630TS with a 10BP4 crt.

Picture below of the 621TS:



The chassis of the set I acquired was in very poor and rusted order, typical of its age. It required a complete rebuild using similar techniques to those used in the HMV904 restoration. A photo of the chassis as received:



It became standard practice in the post war period to enclose the line output transformer and EHT rectifier in a separate cage, shown on the lower right of the chassis. The Power transformer, lower left was mounted on the chassis under

surface to keep it as far as possible from the CRT to avoid the effect of magnetic interference with the beam.

The pre-restoration photos below show the CRT removed, the superficial dust & dirt removed:



The photo immediately above shows the Tuner area. One of the tubes has a Lead shield with a spring clip holding it in place.

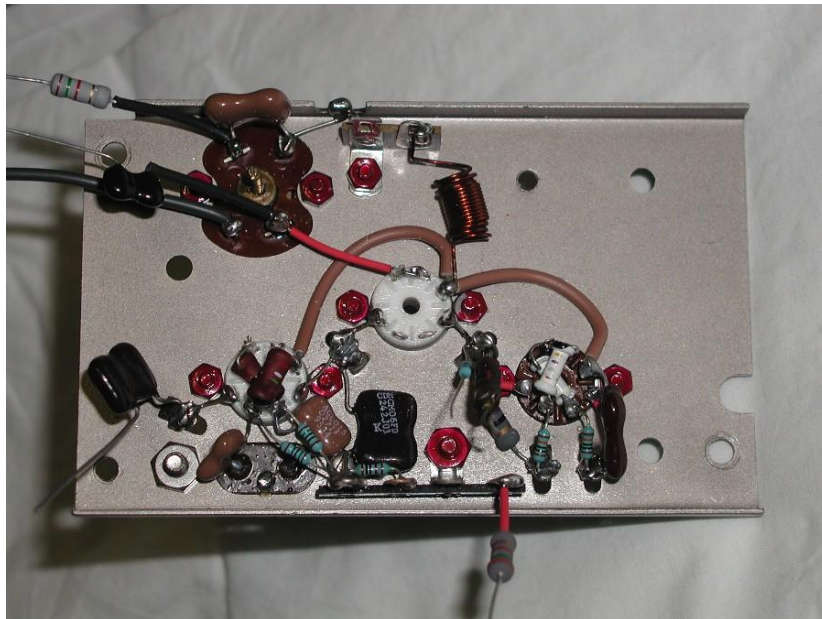
As usual the original wax paper capacitors were hollowed out and refilled with new ones, pouring polyester into each end to seal them up on alternate days. The chassis was fine bead blasted to remove all rust re-plated with Electro-less nickel and lacquer coated. The tuner rebuilt first.

The tuner in this set is "space age" sophisticated for 1946. Features include a differential input RF amp with neutralisation based on a 6J6, another 6J6 Kalitron oscillator and the spectacular large mixer coil driven by the combined anode signals from another 6J6. Also the use of a combination of both ferromagnetic materials and brass slugs to tune the coils is advanced.

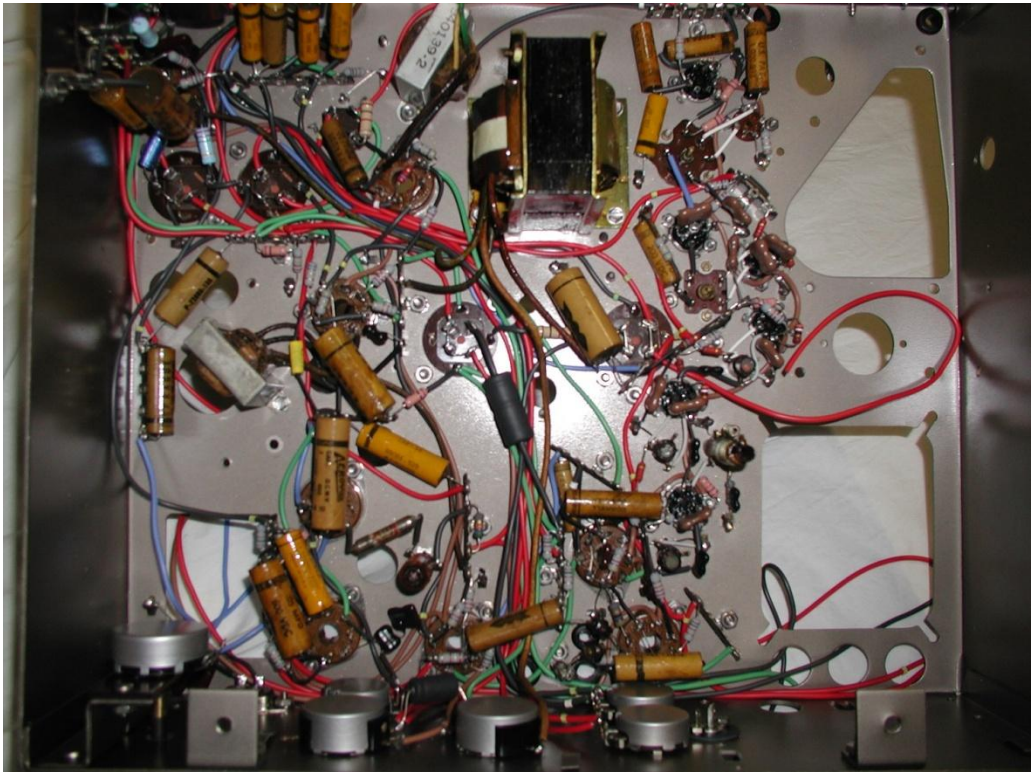
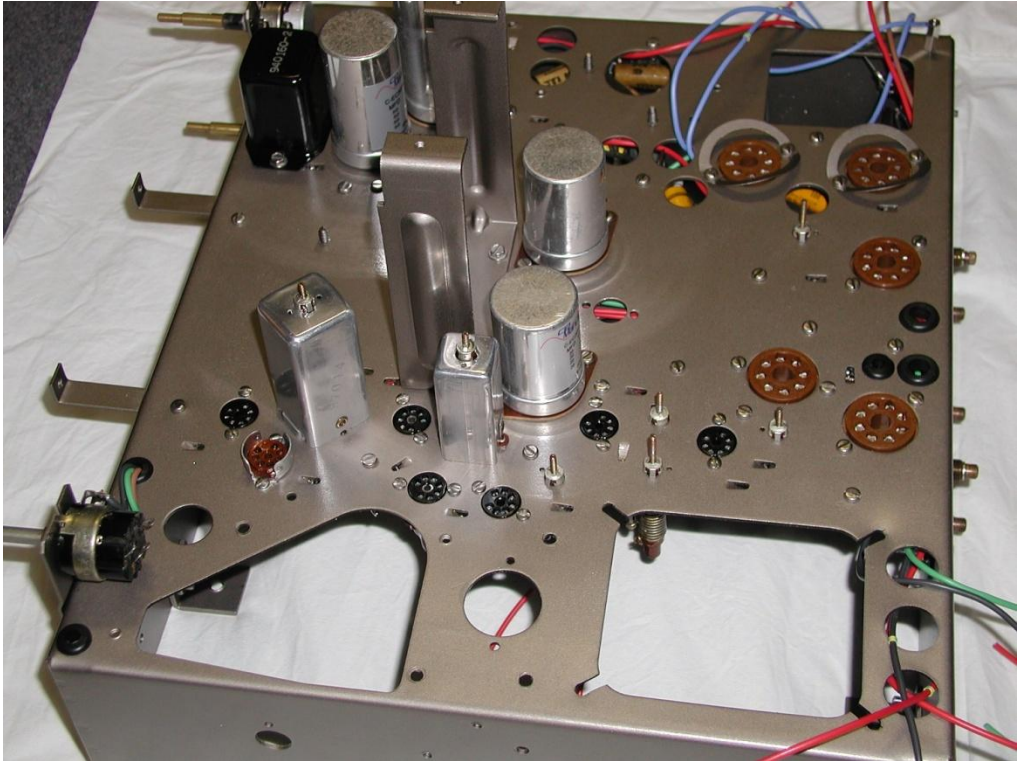
(The idea behind the large mixer coil (seen on the top of the tuner panel photo below) is to create a very high Q loosely coupled selective sound take-off. The large sound IF coil is spaced away from the former to avoid it being tuned by distributed capacity, it is largely tuned by the "high Q" 62pF dog-bone ceramic capacitor across it. The mixer anode coil for the video is broad tuning and loaded by a 10 K resistor and the plate resistance of the 6J6 mixer tube).

With regards to the tuner restoration, I replaced most of the bypass / coupling caps with silver mica ones, except the local oscillator feedback capacitors, these were replaced with 500V 4.7pF mil spec dog-bone ceramic capacitors with the same tempco which match the originals, the same goes for the 1.5pF neutralisation capacitors on the 6J6 RF amp. Also I used mostly metal film resistors. This helps keep the noise down a little. The tube sockets are NOS, including the original push on shield type for the local oscillator tube. I replaced the push on shield, identical to the rusted original. The rivets and the original screws have been replaced with 4-40 and 6-32 stainless steel screws (avoids future rusting). Although there are stainless locking washers, never hurts to apply varnish to the threads

The photos below show the tuner under restoration:



The following are some photos of the chassis restoration:



The underside of the chassis is re-wired, all new resistors, wiring and tube sockets. The resistors are now all 2 watt metal film, but yet the same size as the original 1/4 or 1/2 watt types. 500V Silver mica caps were used to replace the original molded micas, and the wax paper caps re-built with poly's with twice the voltage rating.

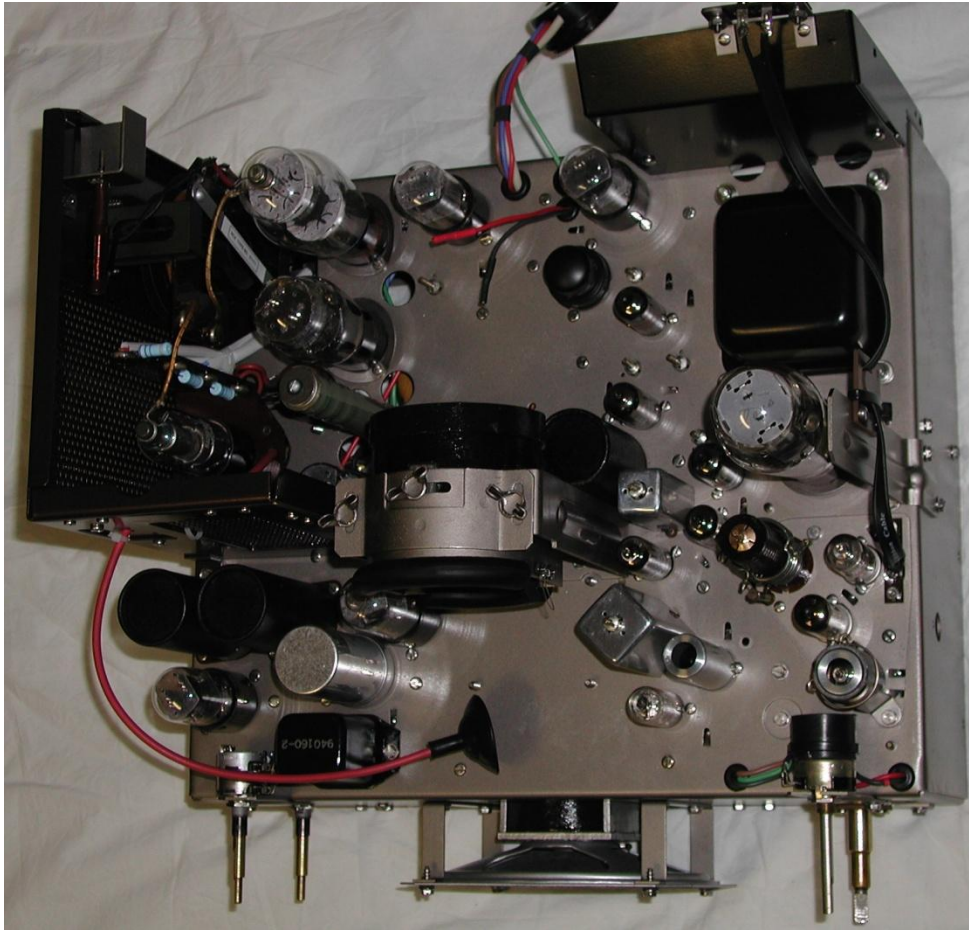
The cardboard shells of the wax paper capacitors had all the wax cleaned off and were varnished with marine grade varnish, so they look excellent but the surface is not tacky to touch and won't adhere to so much dust as is the case with wax.

The octal sockets were replaced with American mil spec brown phenolic sockets with wrap around pins and stainless steel saddles. The 7 pin sockets replaced with American phenolic sockets from AES. Antique Electronic Supply (USA) have supplied all the new capacitors, including the micas, electros and poly's and also a good number of NOS tubes for the set as well as the 300BX power transformer and new tag strips. They always send me excellent tubes and parts at competitive prices I find.

The adjustable IF coils had very rusty spring mounting clips so they were all replaced with new ones as they are a common standard part on many NOS coils. The originals were soldered to the chassis on the top, presumably to prevent capacitive effects varying and altering the IF tuning. In this case I simply soldered them to the nearest earth lugs under the chassis with a short link wire to avoid soldering to the chassis on the top surface.

The new wiring is medical grade silicone rubber covered hook-up wire which looks exactly like old fashioned covered rubber wire, but is extremely heat resistant and this insulation never melts back near the solder joints (even if the iron is on 480 degC). The wire is pleasant to handle and flexible, but stays where it is put on the whole. It is about 2.5mm outside diameter and has 16 strands. Once you have used superior wire like this it is very hard to go back to PVC covered wire or anything else. This silicone rubber wire is available from RS components.

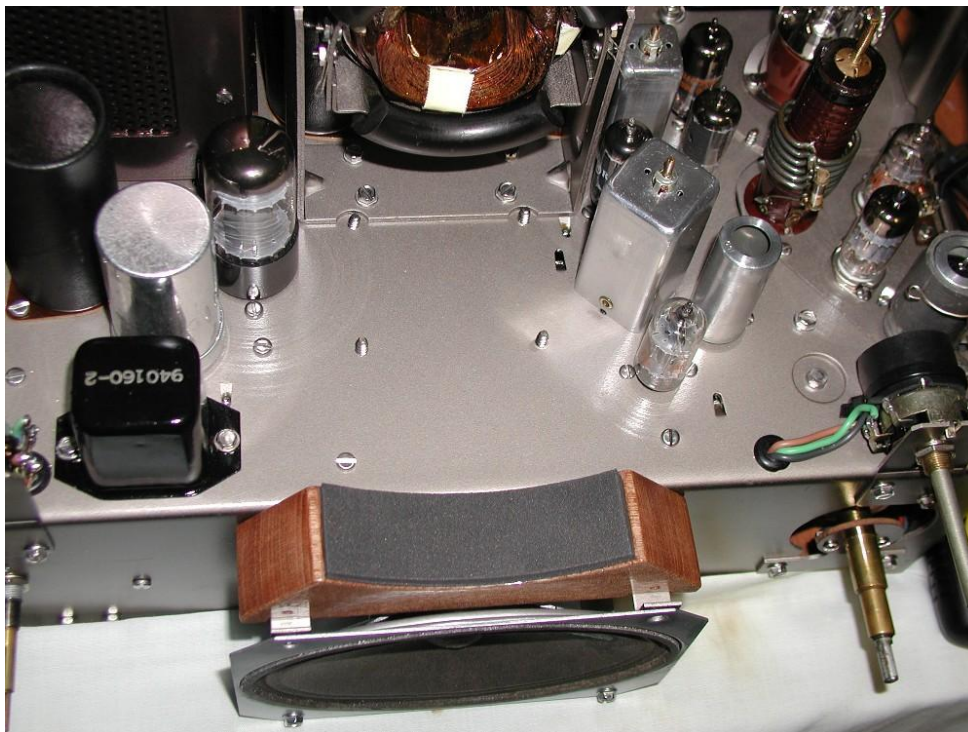
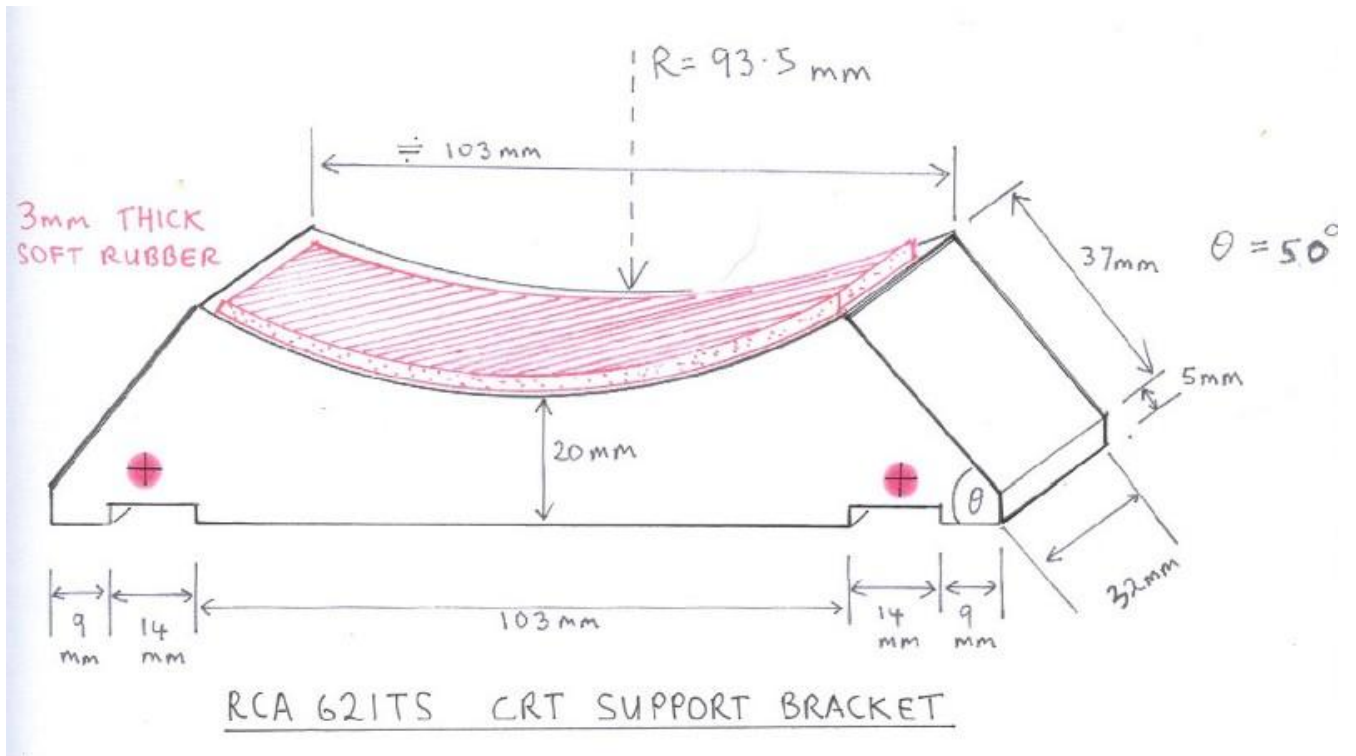
I stuck to the color scheme on the wiring diagram where possible. Fabric covered wire is available, though I suspect it would meet the same fate as the original wire over the next 60 years. The silicone rubber wire will outlast it I'm sure. Ideally I want the restoration to look about the same 50 years later, the chassis, as well as having the 20 micron thick nickel, also has a good coat of protective lacquer. This also avoids corrosion and finger marks.



The 621TS relies on the CRT to be mounted properly only when the chassis is in the cabinet. This is very inconvenient when the chassis is out of the cabinet. So I designed the support as shown in blow, it is attached by lengthening the two upper speaker screws and adding two spacers, and it sits on the speaker brackets. The screw holes are best marked out after the bracket is sitting in place so they are not measured out on the diagram. The CRT sits on it and you can strap the CRT to the bracket with a large sized (Industrial) nylon cable tie when the chassis is out of the cabinet. The added wooden bracket is such that it can stay put when the chassis is re-fitted to the cabinet, and the CRT mounted in the usual way.

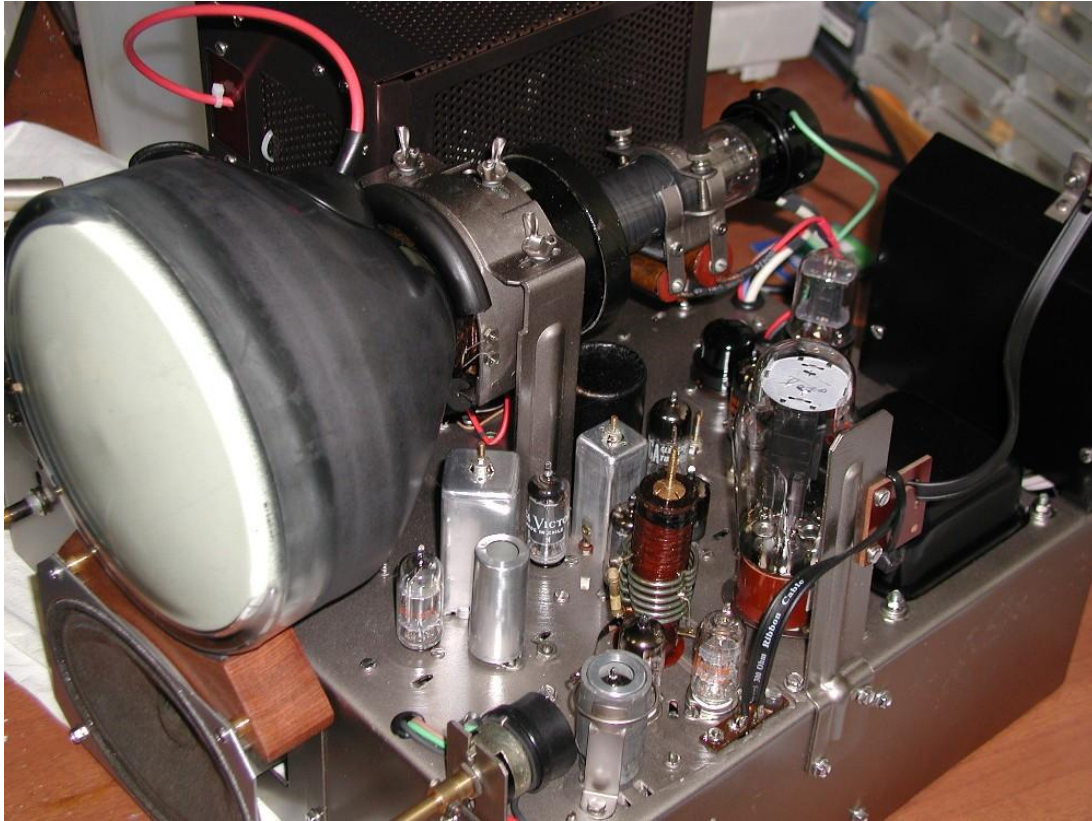
The radius of curvature of the cut-out in the wood is 93.5mm, and this reduces to 90.5 mm when the rubber cushion is added to hug the CRT curvature. The bracket geometry ensures the CRT neck is very close to level with the chassis surface. No

extra holes need be drilled to fit it.



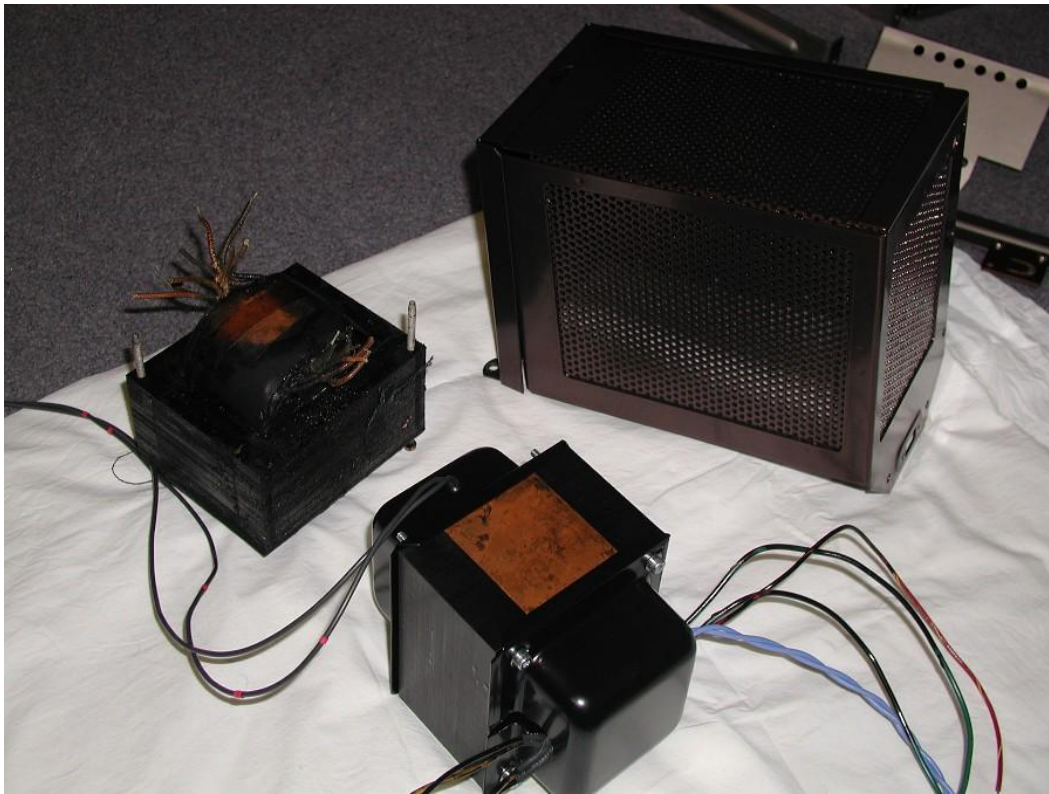
The

following photo shows the CRT fitted to the chassis with the assistance of the bracket for lab testing and adjustments:



Shown in the photo below is the original power transformer. I took the copper flux band from it and the restored covers off it and added them to a new Hammond 300BX transformer and discarded the Hammond covers which are quite different. The two transformers have very close to the same geometry stack, with the holes placed only a little differently.

The original brackets were blasted free of rust and black powder coated and the finish looks very similar to the original and is corrosion and scratch resistant. The two wires for the 120V configured primary windings have to exit via an additional hole in the top bracket.



The original POWER transformer (shown in photo upper left above) is not a safe proposition to run again especially here in Australia with our 50Hz supply frequency. The transformer has very aged and cracked insulation and runs an excessive magnetization current on 50Hz.

For example, off load, the RMS current on 115 to 120V 50Hz is 1.5amps (compared to 47mA for the Hammond 300BX transformer configured for 120V which is designed for 50/60Hz). In general old 60Hz American transformers run very hot here on 50Hz. Also there are significant stray magnetic fields generated. So the Hammond transformer solved the problem. The windings on the Hammond are close to exact:

Two 1.2 A 5V, parallel to 2,4A to run the 5V4G Damper diode. One 5V 3A, for the 5U4G and one 6 V 6A for the main heaters and one 800Vct for the HT.

There is only one winding "missing", a small 6.3V one for the CRT heater, but I'm adding a small auxiliary transformer for that, there is a convenient place to mount it, and only one hole needs to be drilled to fit it.

(On Hammonds website, their data sheet says the 300BX has only one 5v at 1.2A winding when in fact it has two of these).

I've wound a small 1:1.17 ratio isolating transformer which gives 6.3 to 6.3V rms at 0.6 amps load to provide the heater supply to the CRT from the power transformer's 6.3V winding.

Important points about tube heater supplies:

At turn on from cold, the heavy loading of all of the TV's low resistance cold heaters results in a good slow rise in initial heater currents due to the limited current delivering ability of the power transformer. In that sense the larger tubes protect the smaller ones at turn on. In series heater chains, resistors or thermistors (Brimistors) are needed as the internal resistance of the mains power supply is very low and the initial surge current in the cold heater chain is very high. The smaller tubes warm up first (due to lower thermal inertia) and more voltage is developed across their heaters without current limiting.

However it is interesting to note that the same problem described above will occur "within" in any indirectly heated tube, if you connect the heater pins across a power supply of very low internal resistance. The part of the heater, close to it's internal connections, warms up first as there is less thermal inertia there than the part in contact with the cathode or the weld to the pin connection, and you will get an initial bright flash from that area of the heater at turn on. In fact you can get this effect if you unplug nearly all of the LARGE tubes in your TV, except for a small one, at turn on you'll also get a bright flash, as the large power transformer is, under these circumstances, able to maintain the 6.3 volts across the single small tube's pins without the voltage collapsing under load.

LINE OUTPUT TRANSFORMER:

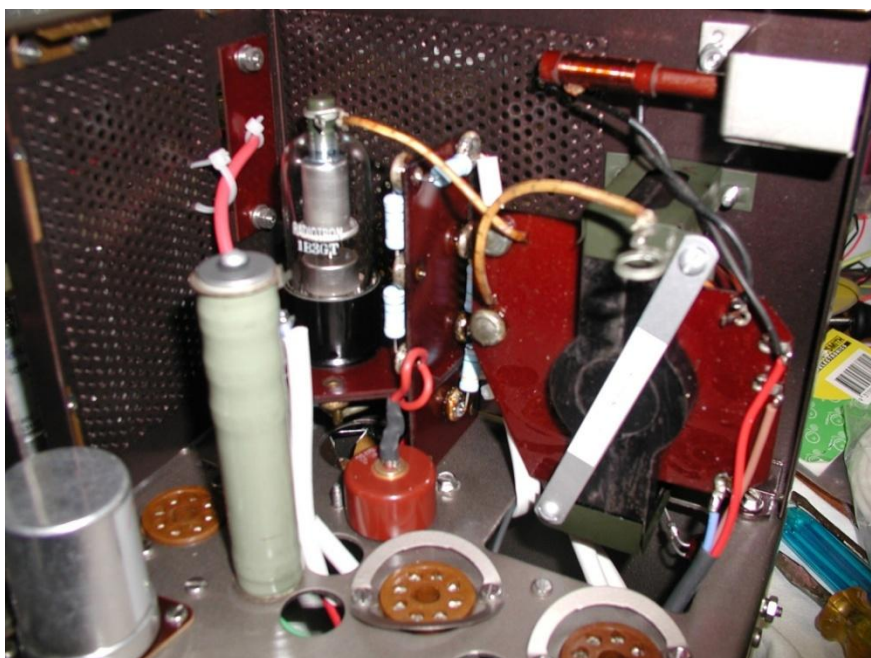
The Line output transformer in this set is very interesting with a sophisticated molded iron core made of 3 parts. The core appears intermediate in appearance between a ferrite dust core and iron. This type of basic design set the standard for practically all line output transformers to follow, complete with the 2 turn winding for the EHT rectifier. The circuit uses energy recovery damping (with a damper diode). See article on Evolution of the Damper Diode on the www.worldphaco.com site.

I had to replace the 2 turn heater winding for the 1B3 rectifier as the original had degraded insulation. I found some identical geometry wire inside the red sheath of some modern 25Kv anode wire. All of the large Allen Bradley resistors in the focus chain were open circuit. They were replaced with 10Kv rated Philips focus grade resistors. Also the doorknob capacitor has been replaced with a 1000pF 15 Kv (same physical size as the original 500pF) and this help to allow for the CRT if it has no external Aquadag. I'm not 100% sure if the original doorknob capacitor is ok, it only reads 375pF and I've read reports of them failing in the 621TS.

The photo below shows the detail of the Line Output transformer:

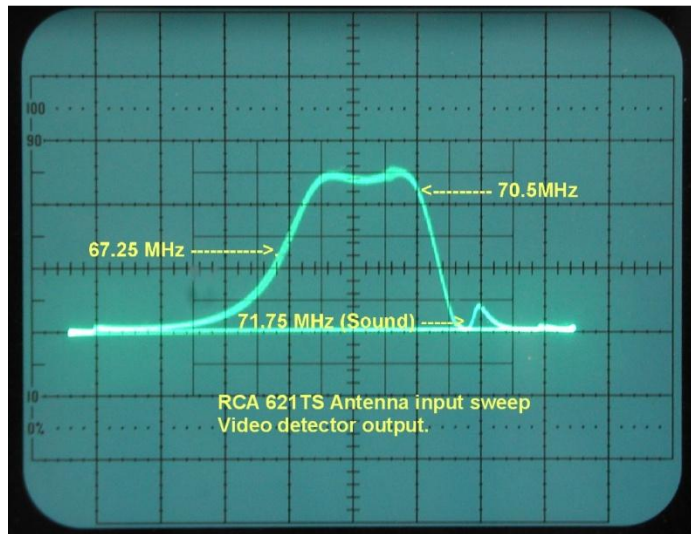


The photo below shows the transformer assembled in the EHT cage area.



Electrical alignment:

The set was aligned in the usual way according to the manufacturer's instructions, also with the aid of a sweep generator. The sweep blow shows the overall response from the antenna to the video detector:



The photo below is an un-touched up screen image via a camcorder on still frame and a RF modulator. The broad grey vertical band at the top is an artifact of the exposure time of the camera versus the scanning frame rate of the picture.

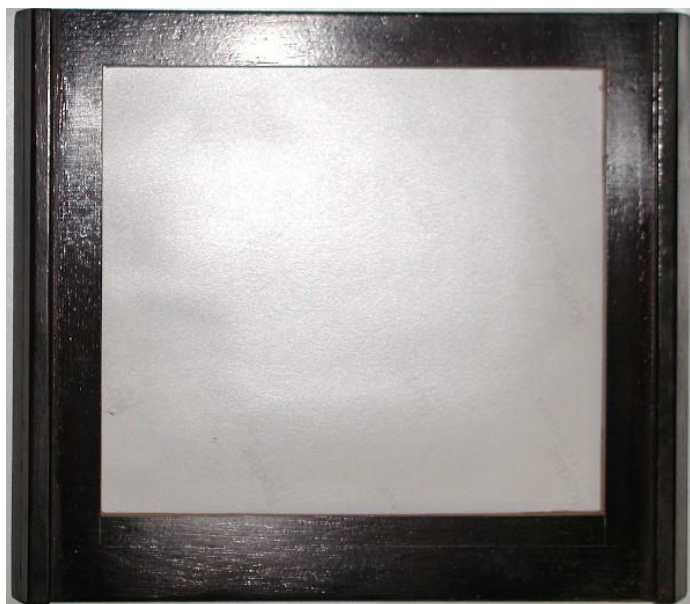


Cabinet restoration:

One problem was the cabinet section over the CRT face had been cut away to enlarge the viewable area of the CRT. Perhaps one previous owner wanted a bigger picture! So some wood was missing:



To repair this I cut out a square area and glued in some Tasmanian Oak:





This was then varnished shaped to match the original design and fit the curved CRT face. Applying varnish initially helps with getting the geometry right as the wood is filed away by hand:





Finally I lacquered it to match the original part:



The photo below shows the restored cabinet & final result:



Summary:

The 621TS is an extraordinary television set marking a major milestone in commercial television set manufacturing. The entire design is futuristic and the performance absolutely outstanding, and amazingly released for sale in 1946.

The FM sound became the gold standard for Television audio after WW2 and the Line deflection energy recovery system too. Any similar sized monochrome television set made decades later would not have out performed it.

From the perspective of industrial design, Mr. Vassos created yet another Art Deco masterpiece.
