Erres KY 159

Foto: Piet Blaas

The restoration of an uncommon radio set

By Jacques Hermans & Paul Bolt

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1. The acquisition

It is the first Saturday of august, 2008 and I am browsing a familiar exhibition for old technology in the small town Hoenderloo. Aside from some parts I had not yet made any purchases and was about to head home, when I laid my eyes on a radio set that I did not immediately recognize. The Erres-buttons instantly caught my attention. The set had endured a lot and the back wall of the casing was missing. The nameplate indicated that this was the KY 159 (serial number 1161) made in 1936 and after some negotiating the device changed hands.

At home, the radio set was more thoroughly inspected. This turned out to be a letdown...

Picture 1.1

The casing looked a lot less flourishing than it looked on the sunny market stand. The damage to and stains on the casing would not give in to basic cleaning and scrubbing. In some occasions furniture oil can provide a great result, which would make stripping, coloring and varnishing not necessary. Unfortunately this was not the case (picture 1.1).

A quick look at the interior did not make my heart skip a beat either. The double electrolytic capacitors were filled with holes and heavily damaged by the boron acid. The chassis had the same complications (picture 1.2).

Picture 1.2

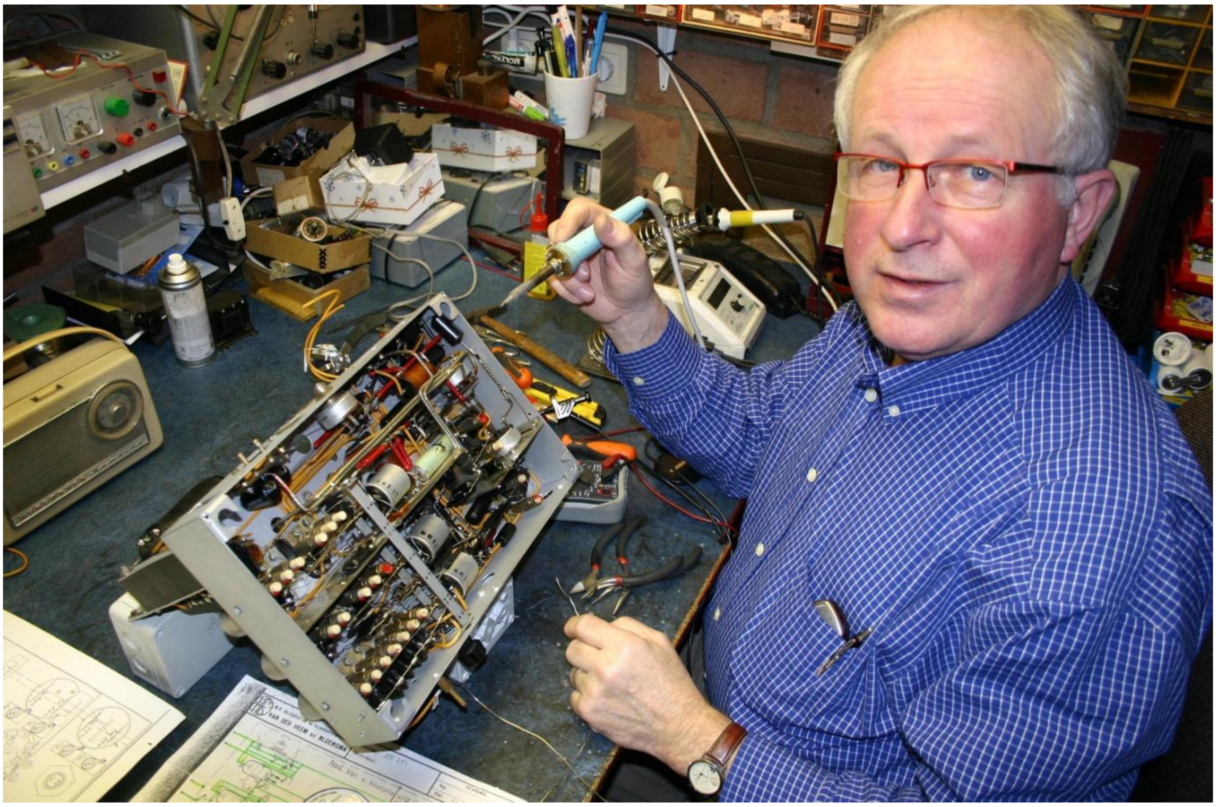
The third electrolytic capacitor had disappeared, the speaker cloth was ripped and the small celluloid glass in front of the station scale had become so opaque that the scale was unreadable. After thoroughly examining the device, many of the tar capacitors appeared have burst or worse. In other words: the ideal candidate for destruction. On the other hand, radio sets in this condition are hard to demolish any further and most adaptations turn out to be an improvement.

After the first inspection I began searching for more information on the set. A circuit diagram was already in my possession, but I did not have additional service documentation. From the small amount of information I could find on the internet, I derived that this was not an ordinary radio set.

2. To restore or not to restore?

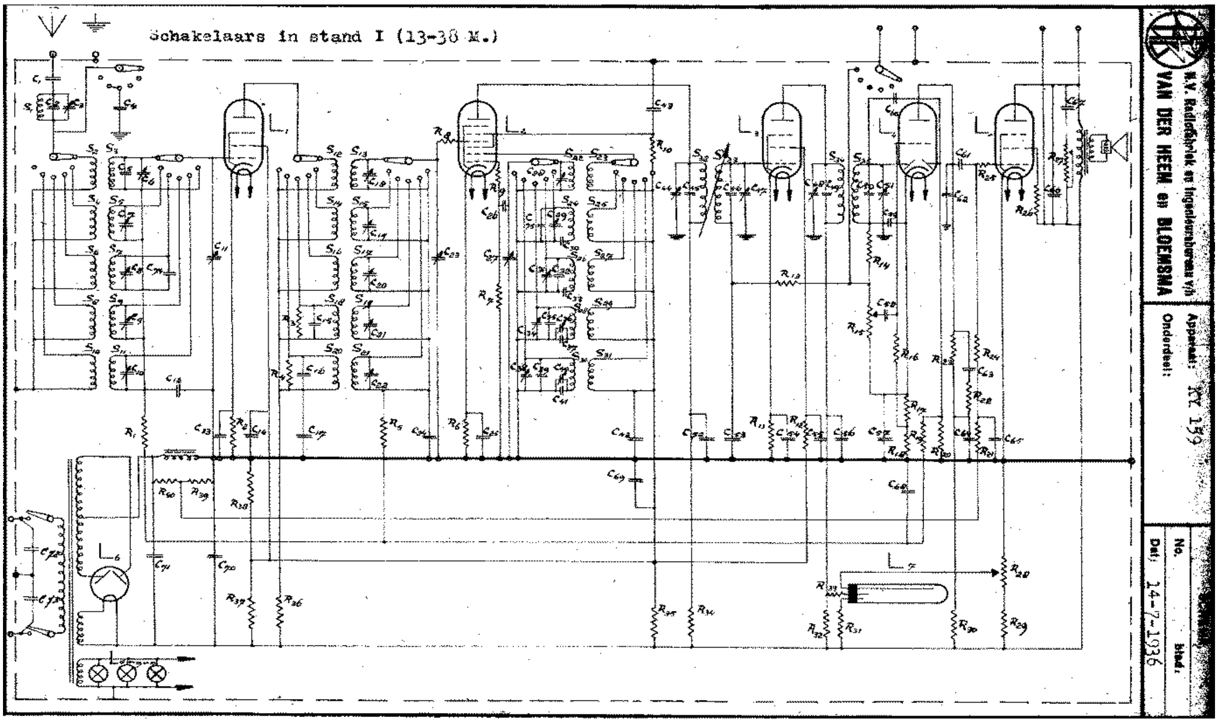
In the world of radio sets it is a common recurring question: should you fix the set or keep your hands off? The latter would preserve the authenticity. We (Jacques and I) do not consider this to be an issue. For us, saving a radio set from disaster is a reason to get started. We do have some ground rules though: it cannot be too extravagant (mostly the budget prevents this), the restoration should if possible, be reversible and after the restoration the set should operate in a safe and normal manner. Moreover, the restored device should attempt to mimic the original in both looks and operation.

With that mindset we started restoring this Erres KY159 on the 29th of october 2008. "We" are Jacques Hermans, former chairman and one of the founders of the Dutch Association for Radio History (NVHR), familiar among many through multiple exhibitions and the technical commission of the NVHR, and Paul Bolt, member of the association since 1994 and secretary of the board. My technical knowledge falls short on some subjects and besides that, it is particularly amusing to be able to enjoy the radio hobby with others, so once a week we come together to work on old radio's.


Picture 2.1 (Jacques Hermans)

3. The circuit diagram

The Erres KY 159 is a superheterodyne radio set and suited for receiving 5 wavebands: SW 1 (13 – 38 m), SW 2 (32 – 90 m), “Fishery” waveband (FW) (75 – 250 m), MW (195 – 570 m) and LW (750 – 2000m). A description of the diagram (figure 3.1) can be found below.



The highfrequency part:
The antenna signal is offered (depending on the waveband switch) through a whistle filter composed of S1 and the parallel capacitors C2 and C3, to the antenna coils S2-S4-S6-S8 and S10. The whistle filter is fine-tuned with C3 to an intermediate frequency to avoid an aggravating whistle. An inductive coupler is used for all wavebands. The first position of the waveband switch activates the ultra-short waveband of 13 – 38m. The currents generated by the antenna signal in S2 induce a voltage in S3. The signal is further enhanced by the high-frequency amplifier valves L1 (AF3). This antenna circuit is being fine-tuned by C11 and can be modified with the trimmer C6. The switch works the same for different wavebands with associated trimmers. In order to increase the selectivity, the primary coils S8 and S10 are switched parallel with C4. This can be done by switching S8 to MW and S10 to LW. The signal is provided by the second inductive couple S12-S13, via R8 onto the fourth grid of the mixing valve L2 (AK2). This circuit is fine-tuned by C23 and regulated by the trimmer C18. The switch works identically for the wavebands SW2 and FW. In order to increase the selectivity, the coils S18 and S20 have been provided with the parallel capacitors C15 and C16 for MW and LW.

The oscillator part:
For the five wavebands, the coils S23, S25, S27, S29 and S31 are activated in the anode circuit. The associated coils in the grid circuit are S22, S24, S26, S28 and S30. The tuning capacitor for the oscillator part is C27. The oscillator circuit for SW1 is regulated with C28, C25/C75 for SW2, C31/C32 for FW, C34/C35 for MW and C38/C 39 for LW. In order to correct the padding curve, The capacitors: C30, C33, C36/C37 en C40/C41 are used for the SW2, FW, MW and LW respectively. The bottom side of the anode circuit coils is disconnected by C42 on a high frequency.

The mixing part:
The antenna signal and the oscillator signal are mixed in the pentode part, which consist of the grids 4, 5, 6 and the anode of L2. In L2’s anode circuit we are able to find the sum and difference frequencies of both signals.

The medium frequency part:

In the anode circuit of the mixing valve L2 we find the first medium frequency transformer (MW-transformer) with the coils S32 and S33. The primary side of this MW-transformer is tuned to a 451 kHz frequency by C44. This ensures that the same frequency is transmitted to the secondary coil (C47), which is tuned to the same 451 kHz frequency.
The inductive coupling between these coils is variable by varying the distance between the coils. This makes the bandwidth adjustable between 7 and 15 kHz. The coils can be shifted relative to each other by a camshaft. The remainder of signals (e.g. the sum frequency) is drained to earth via C52 and C53. The signal is then amplified by the medium frequency valve L3 (AF3). The second MW-transformer (alongside the coils S34 and S35) is integrated in the anode circuit of the medium frequency valve L3 (AF3). These can be regulated with the tuning capacitors C48 and C51. The secondary coil of the second MW-transformer is connected to the signal diode of the detector valve L4 (ABC 1).
The HF-signal is offered to the detector valve. Due to diode detection, the valve becomes conductive during the positive part. This causes potentiometer R15 to be under pulsating negative direct current. The high frequency remains in the detected signal are removed by the capacitor C59, which produces an LF signal. This signal is offered through the running contact to the control grid of ABC1 and thus strengthened. The negative grid voltage is generated over R17.
According to the data the tuning indicator is a neon valve type 4662. It is possible that this has been replaced in the past, because the radio set was fitted with a valve from the manufacturer D.G.L., a company from the former East Germany. The anode of the valve is integrated in the anode grid of the MF-amplifier valve. The anode current has the lowest current when properly tuned. This increases the voltage drop over the resistor R32. Because the cathode is connected to earth through R28, the voltage difference between anode and cathode of the neon valve will be even greater and thus the valve produces more light.

<u>The AGC:</u>
The HF signal that is offered through the detector diode is also offered via C60 to the second AGC diode of L4. The AGC-diode becomes conductive when the signal voltage is positive, relative to the cathode voltage. Because the diode will only reach conductivity after a certain voltage, we have an AGC with a voltage threshold. The negative part of the signal is sent via R19 to the control grids of L1 (via R1) and L2 (via R5). The resistors R1 and R5 prevent L1 and L2 from affecting each other. The AGC voltage is disconnected by the capacitors C68, C24 and C14, respectively.

<u>The low frequency part:</u>
The low frequency part consists of the triode part of the ABC1, the power pentode AL5 and the speaker circuit. The negative grid voltage of the end pentode is decreased from the voltage divider R39 – R40. This becomes possible due to the voltage difference on the Electrical ballast. The electrical ballast can be found in the electro-dynamic speaker. Equalizing can be done with potentiometer R27.

<u>The power supply:</u>
The full-wave rectification is provided by the AZ1. The smoothing is done by the two double electrolytic capacitors C70 and C71, each 2 times 16 µF, in combination with the previously mentioned electrical ballast in the speaker. The two ratchet capacitors C72 and C73 are switched for the power transformer over AC.

4. The casing

The amount of work that the casing requires primarily depends on the current state of the radio set, what you want it to become and the (im)possibilities that come up regarding available materials.

With a case that has little to no damage, furniture oil is a great product to get good results. Light scratches and stains become near invisible when treated with this oil. Our casing wasn't just damaged (deep scratches and bald spots), it also appeared to have rested on one of its sides for a long period. One of the sides had a nasty damp stain (picture 1.1). Furthermore, small pieces of veneer were missing (picture 4.1 and 4.2).

Picture 4.1

In order to make the casing presentable once more, we were forced to strip the casing, remove the damp stain and refill the veneer where possible. This made the work order very clear.

After taking of the casing, it had to be stripped first. The copper ornaments have been taken off together with the speaker shelf and cloth. This was followed by a treatment with stripper, and the old paint layer was removed. We then proceeded properly cleansing and drying both the inside and outside of the casing. Drying the casing afterwards is done to minimize the amount of liquid seeping into the wood, which could potentially disband the veneer or curve the wood.

Removing the damp stain proved to be a difficult task. At first, we tried removing the stain by slight sanding the surface. It is however, important to stop this in time due to veneer's thin body. The stain had apparently seeped into wood to great extent, for sanding did not provide much improvement. The treatment continued with and oxalic acid based cleaner, which provided acceptable results after a few treatments.
This was followed by sanding the casing, a very precise challenge we might add. The sanding always goes by hand, for that allows you more feeling and control. When sanding with a machine it is very easy to inflict damage that cannot be reversed. The sanding is always done from rough to refined and most of the time we end with a fineness of 600 to 800. Sometimes the casing requires local recoloring due to the sanding. We use water based wood stain; by adding multiple layers you can gradually make the bald spots the same colour.


Picture 4.2

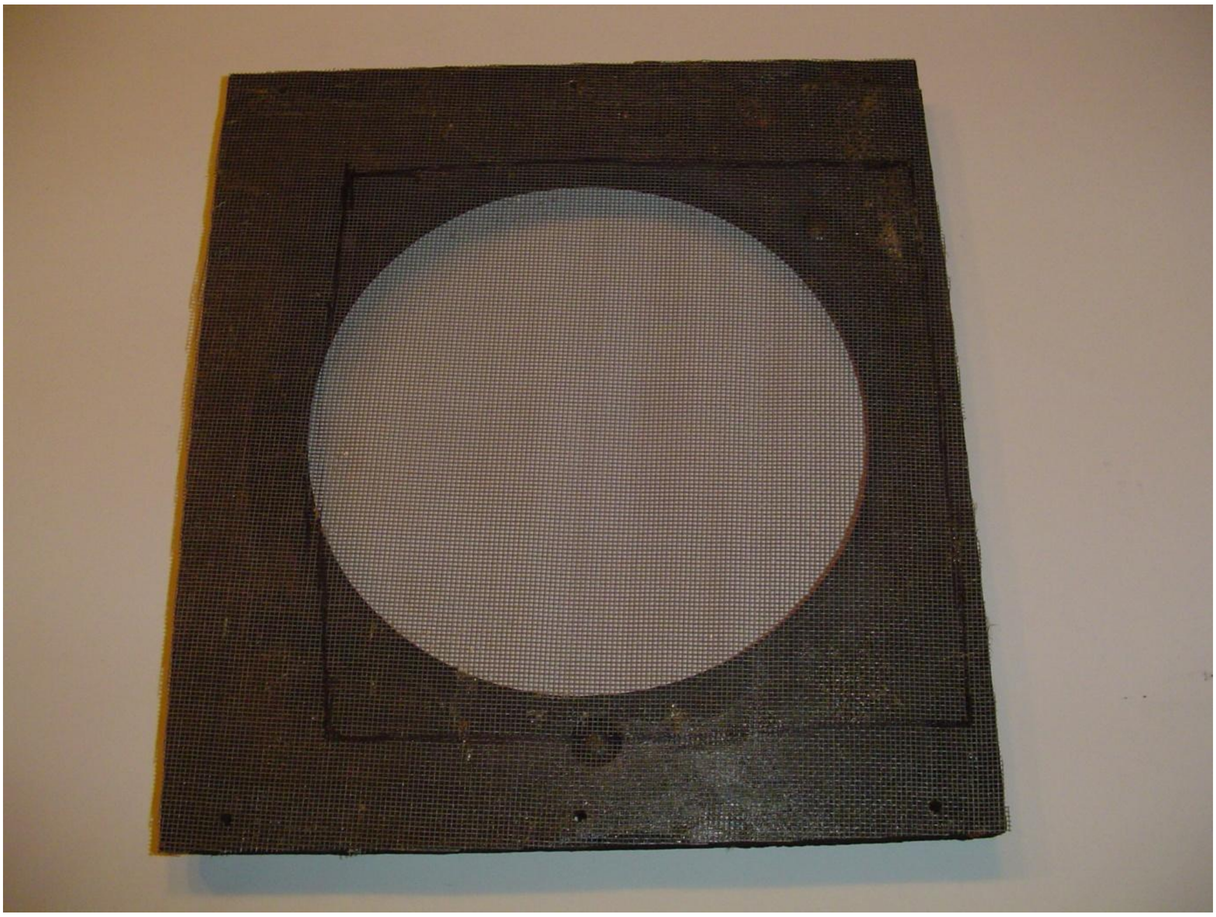
Now the casing has to be varnished. The original varnish is often unavailable, but nowadays a wide range of transparent varnishes are available. We used poly-urethane for our casing; the old varnish did not look like high gloss but rather something between high and satin gloss (picture 4.3).


Picture 4.3

The type of gloss is often pictured in the old Erres-prospects. Unfortunately, a high quality picture of the KY 159 was not in my possession, so we chose to use a picture of the KY 158 (the smaller brother of the KY 159) as an example. We then composed a mixture of high and satin gloss varnishes and spray painted the casing.

This brings us to the speaker cloth; there was a tear in the bottom of the cloth, just above the edge of the casing. Usually this is a good spot, for most cloths are slightly larger than the hole they are supposed to cover. Thankfully, this was the case; the cloth still looked pretty decent. In order for it to come off, we soaked it in water just below room temperature for half an hour. We then put the cloth in body temperature water and soap so the dirt would come off. Finally, we rinsed it with cold water a couple of times and laid it out to dry between two layers of paper towels.

Many of the cloths of pre WW2 radio sets have lost a lot of strength; a piece of mosquito net can be glued to the speakershelf to provide extra support. This can be done firmly and is always removable if needed. The cloth can then be added on top with thick wallpaper paste. Before we start we usually mark the hole in the casing on the shelf using a pencil (picture 4.4), to ensure that the cloth is placed correctly. The result is that the cloth looks tight and is somewhat protected against piercing fingers of curious little children.

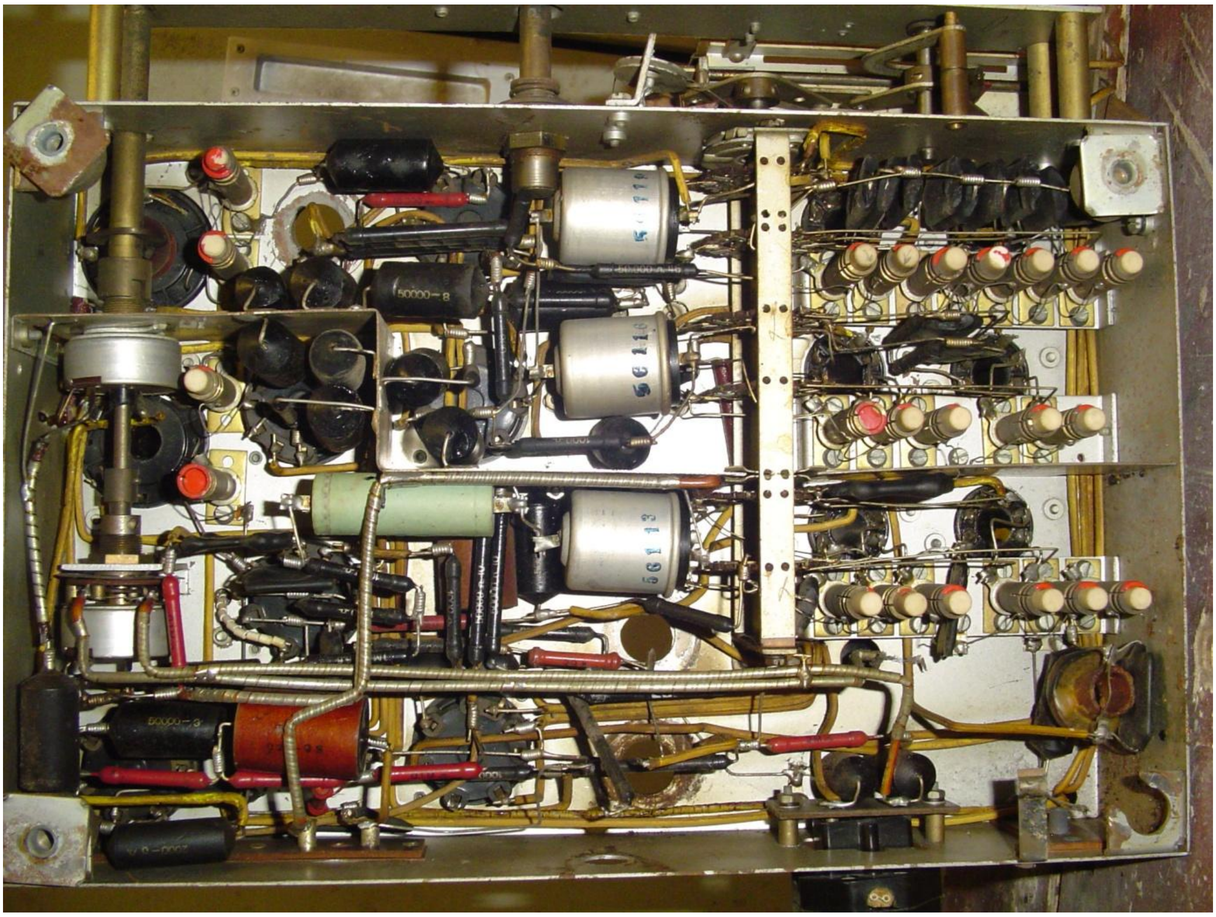

Picture 4.4

The end result (picture 4.5).

Picture 4.5

5. First-class demolition

In the 1st chapter we have already made a note about the miserable condition of the radio set. Therefore we did not have to think long about what we were going to do with the device, as there was only one choice left. If we wanted to make the chassis look good, we had to at least strip it. We agreed to take the inside apart in as many parts as possible, which wasn't easy as there was quite a lot of content (picture 5.1) and the wires were crossed. Each time a part was removed a picture was taken, later enabling us to rebuild the device into its original state as much as possible.

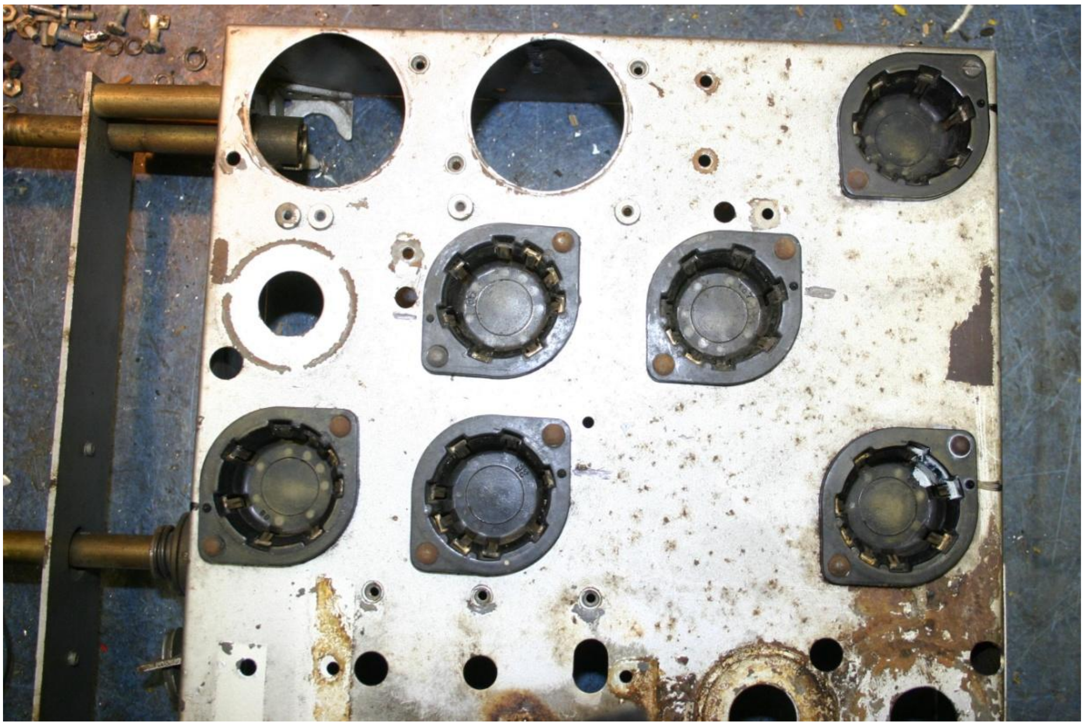


Picture 5.1

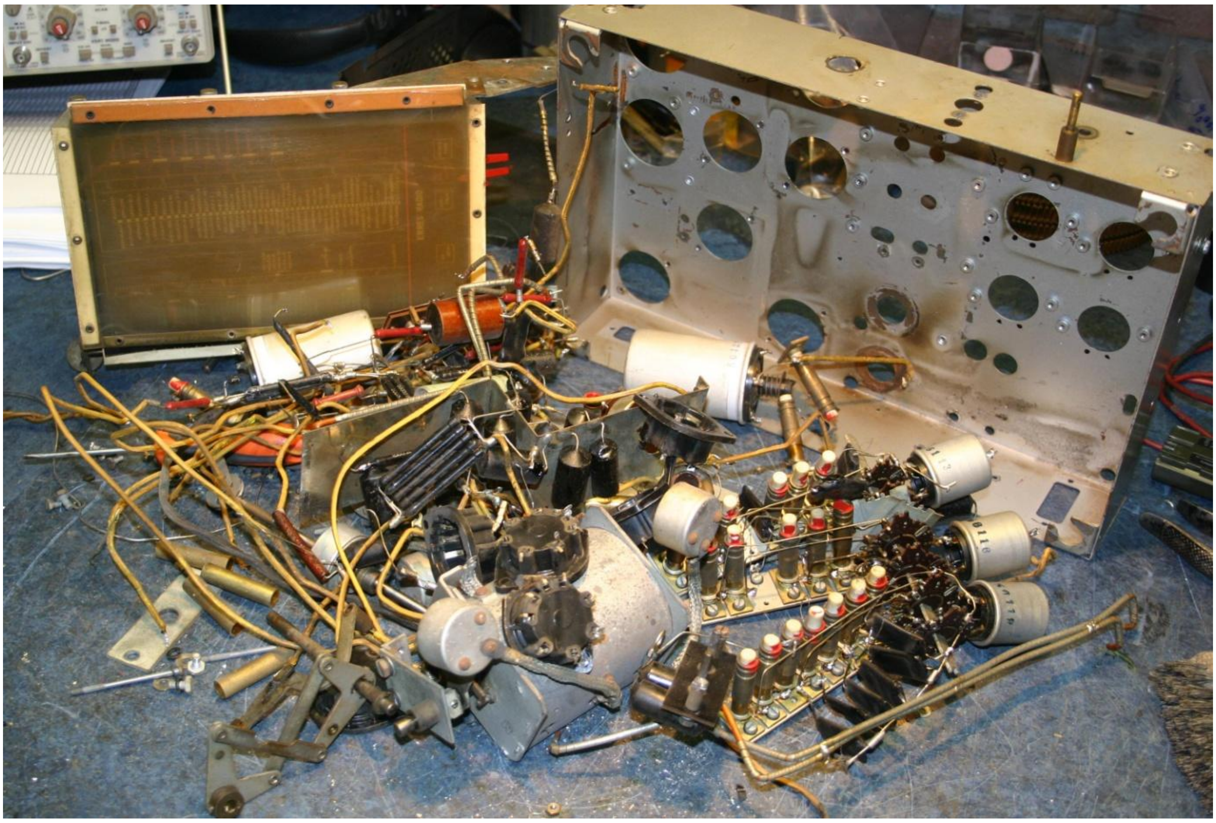
Removing the tuning scale was simple, the position of the capacitor disc and the cables were well documented. Subsequently, we demolished as much as possible from the bottom, but with policy of course. The capacitors, trimmers and coils for the short wave (picture 5.2) were easily accessible and we could reasonably leave it together.


Picture 5.2

This enabled the removal of the other waveband coils. As the device started to become more and more barren at the bottom, we could also remove the necessary parts from the top. The transformer and capacitor were removed followed by the intermediate frequency transformers. Finally the valve feet were removed (picture 5.3).


Picture 5.3

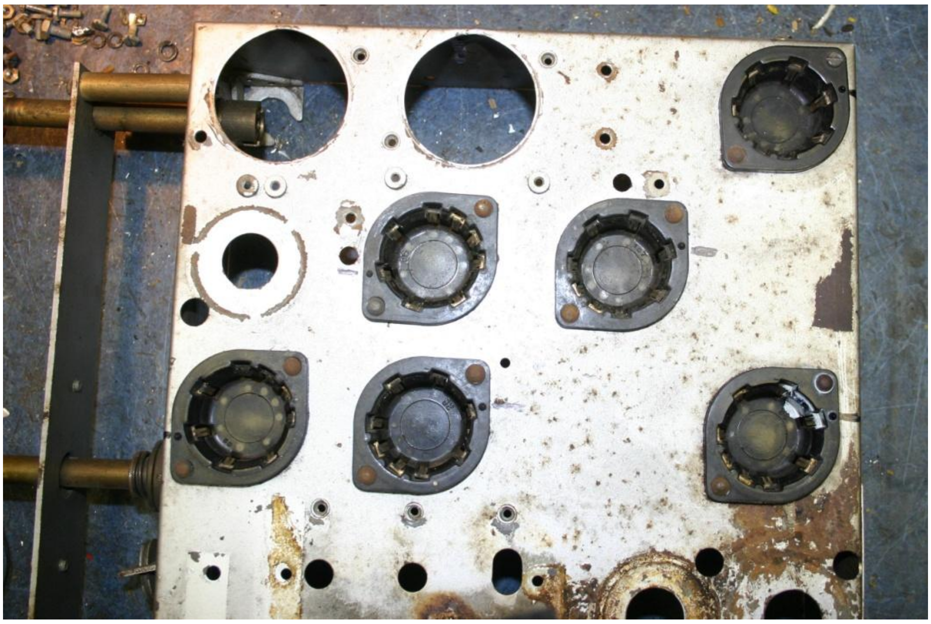
The remains were a pile of parts and a bare chassis (picture 5.4).



Picture 5.4

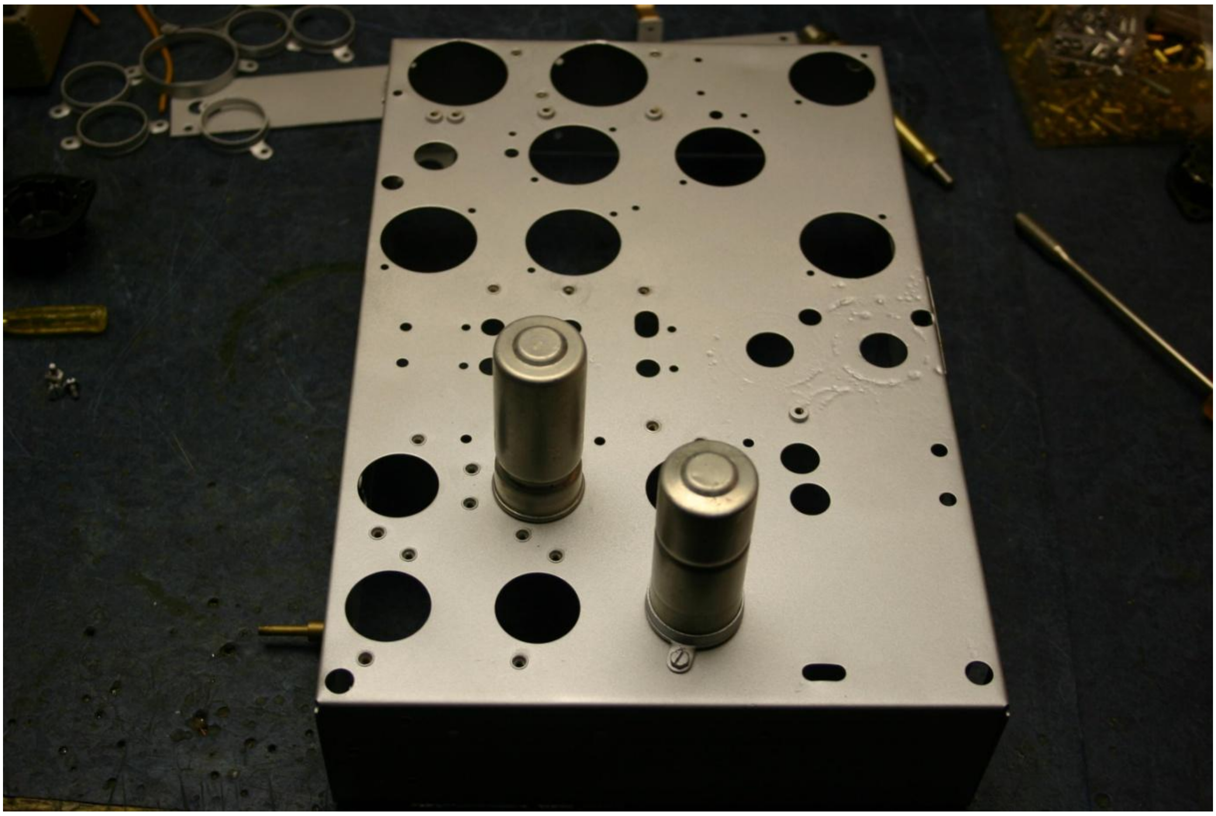
6. Rejuvenating the chassis

In many of her pre-war devices Erres did not plate the chassis, but simply treated it with a silver paint. Pictures 5.3 and 6.1 clearly show that the paint has come off on multiple spots. The boron acid damaged the paint even further.



Picture 6.1

Because the chassis was heavily eroded on the spots where the electrolytic capacitors used to be, the chassis is first blasted with glass beads and afterwards coated with silver coloured paint. In this case an aluminium-zinc spray is applied (picture 6.2).



Picture 6.2

7. Repairing the electrolytic capacitors

The radio set has a number of electrolytic capacitors; the most striking capacitors have to be the two stacked capacitors (picture 7.1).

Picture 7.1 Foto: Piet Blaas

These wet electrolytic capacitors don’t last a lifetime and have the nasty habit to start leaking boron acid after a certain period. Boron acid is a rather aggressive substance that can cause serious harm to metal parts that lack protection. In this case, not just the chassis was damaged but the electrolytic capacitors also showed damage from this acid (picture 1.2 and 7.2).

Picture 7.2

Separating the electrolytic capacitors without damaging the small parts between them turned out to be quite the hassle (picture 7.3).

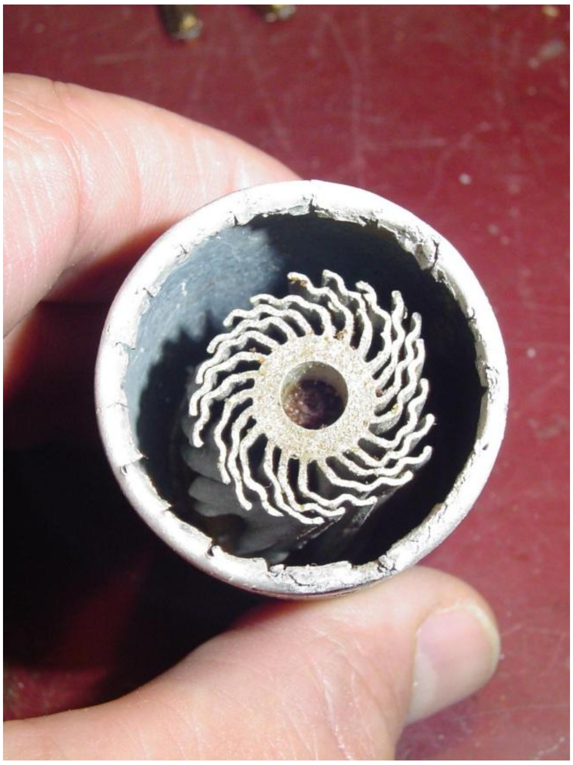
Picture 7.3

We eventually managed to separate the lot without causing visual damage. We did not particularly like what we saw. Both capacitors were damaged to an extent where both of them had to be replaced. One of them was in the bottom position. The replacement had to be “decapitated” first and then emptied in order to place a new capacitor. Removing the hood is best done by using a little grinder to make two incisions (picture 7.4) and bending the aluminium away.

Picture 7.4

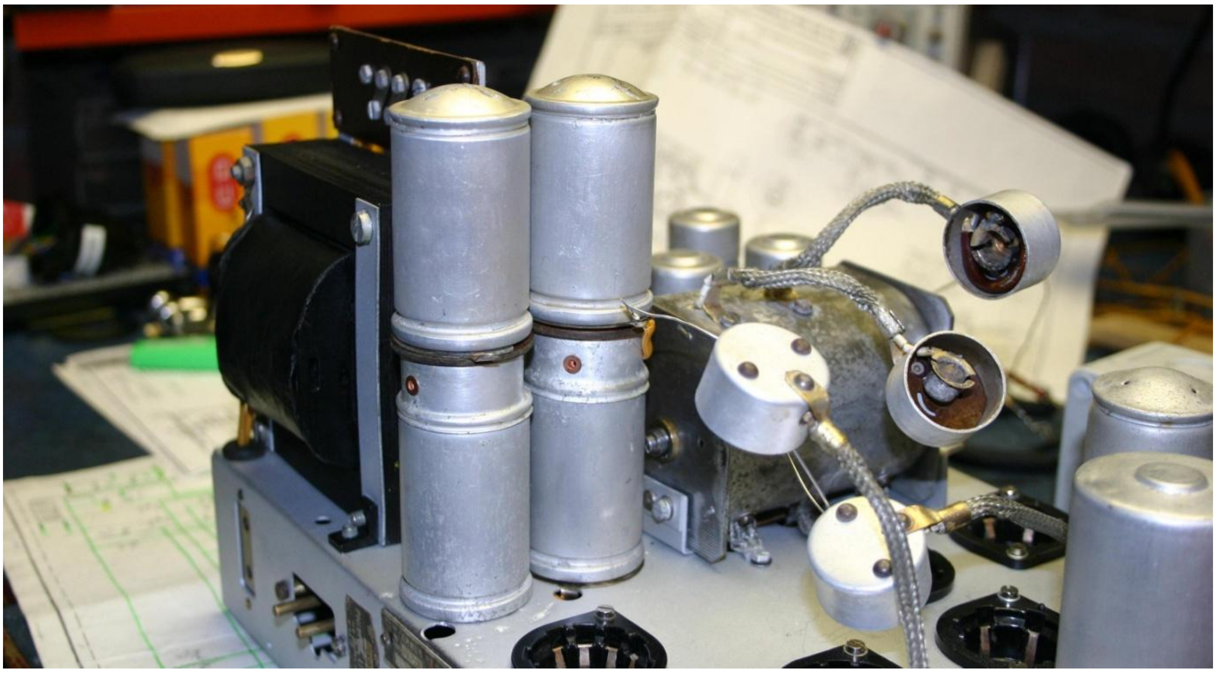
The hood contains wood-pulp to absorb leaking boron acid. This means that the electrolytic capacitor is sealed from the top from the space beneath the hood and that a hole had to be made above the electrolytic capacitor. Then the old content must be removed before a new capacitor can be placed. The star-shaped element first had to be bent before it could be removed (picture 7.5 and 7.6).

Picture 7.5



Picture 7.6

Afterwards the new capacitor could be placed. The corroded aluminium cannot be hidden. However, by placing the electrolytic capacitor in such a way that the damage is not visible, the overall picture looks quite fine after all (picture 7.7).



Picture 7.7

There are roughly two methods that can be used to replace the content of an electrolytic capacitor. The capacitor can be opened from either top or bottom. Nonetheless, in this case we chose to open it from the top, sawing through the capacitor right under the hood (picture 7.8).

7.8

Additionally the inner edge (the sawn-off part) is removed from the hood and, after placing the new capacitor, the hood is glued back on the capacitor. One advantage is that the mass of the new capacitor can be attached to the casing by a screw and nut (picture 7.9), so that there will always be a good connection.

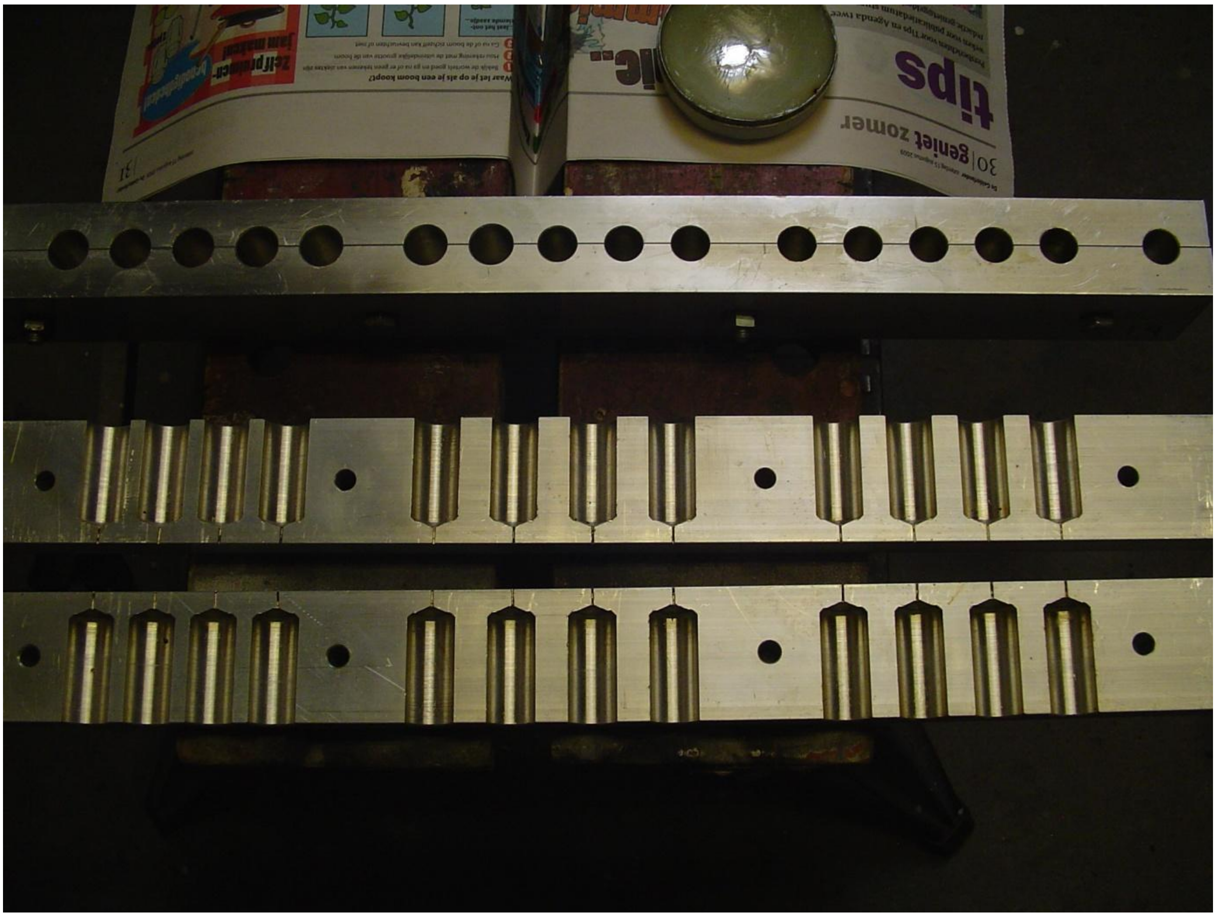
Picture 7.9

Another advantage is that the electrolytic capacitor looks undamaged. Furthermore, the electrolytic capacitor can later easily be opened in order to replace the capacitor. A disadvantage is that the capacitor has got a little shorter after repair.

8. The tar capacitors

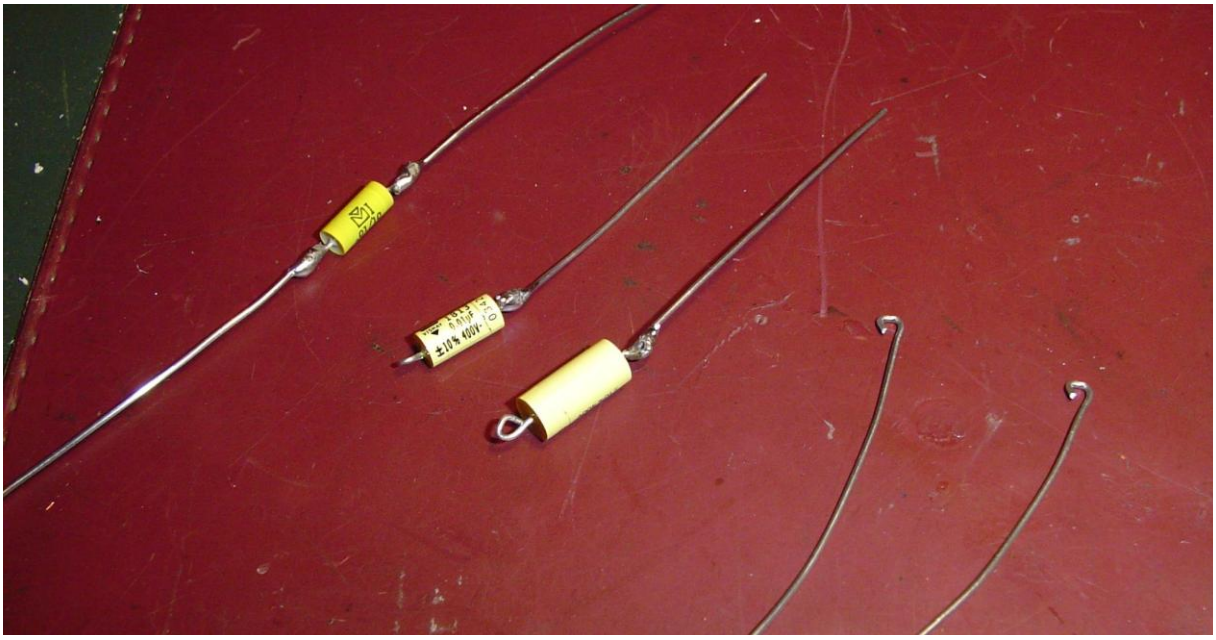
Replacing the tar capacitors is a story by itself. Here too remains the question whether or not all capacitors should be replaced or just a part of it. When we start measurements they almost always seem to be leaking. However, this does not mean that such device is no longer able to play. In most cases damp is the killjoy. If the radio set has been dry it could still play with cracked capacitors, because at the end of the day the tar is merely a protective layer.

There are many descriptions how to copy tar capacitors. Personally, I believe that originality is best approached by pouring a modern capacitor in tar again. At that moment two problems arise: there is no tar available and the capacitor has to be cast in a mould. An alternative for the tar is bitumen 110/30. The numbers mean that the bitumen will soften by 30 ºC and is fluid by 110 ºC. Bitumen is often confused with mastic, which is a mixture of sand, bitumen and filler. It is used for roofing and asphalt, but is useless on capacitors.
The second problem is the moulds; however, we have had them made in the past. Each mould consists of two aluminium strips that are attached to each other by bolts and have a diameter of 10 to 24 mm (picture 8.1).



Picture 8.1

The pouring itself is an entire process. It starts with finding the right capacitors and extending the wires. To prevent air inclusion in the bottom of the mould, bitumen needs to be poured in first, and then the capacitor can be pushed in. Because of a 0.8 mm hole in the bottom of the mould the wire needs to be in it before the pouring. At the beginning the capacitor cannot be in the way, as it will cause trouble during pouring. That is why the wires need a certain length. The extension wires need to be soldered carefully to the wires, so that they will not get loose during montage (picture 8.2).

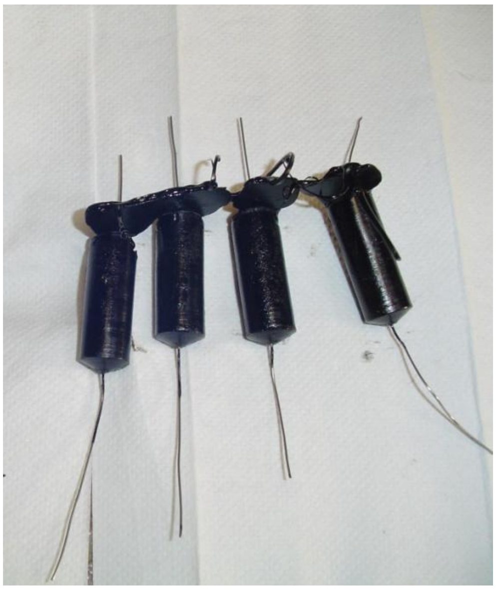


Picture 8.2

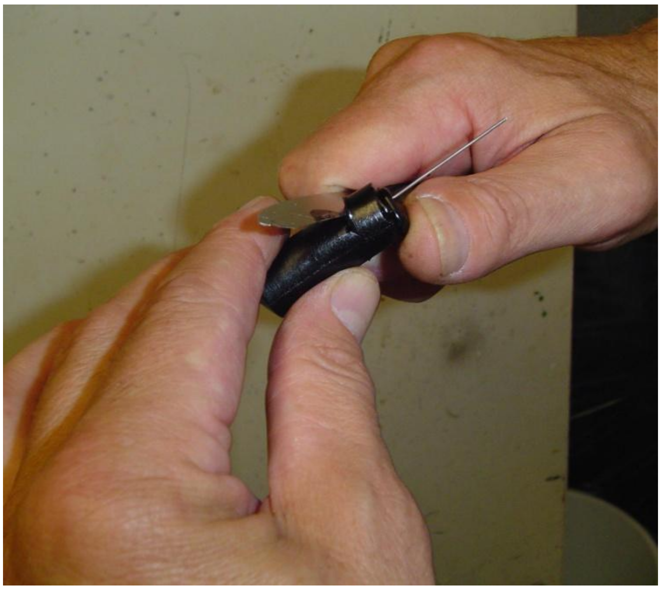
After cooling off, the two halves will be taken apart and the castings can be taken from the mould (picture 8.3).

Picture 8.3

The bottom of the new tar capacitor already has the right shape, but has yet to receive the top. First the unnecessary part of bitumen is cut off, as much in the right cone shape as possible (pictures 8.4 and 8.5).



Picture 8.4

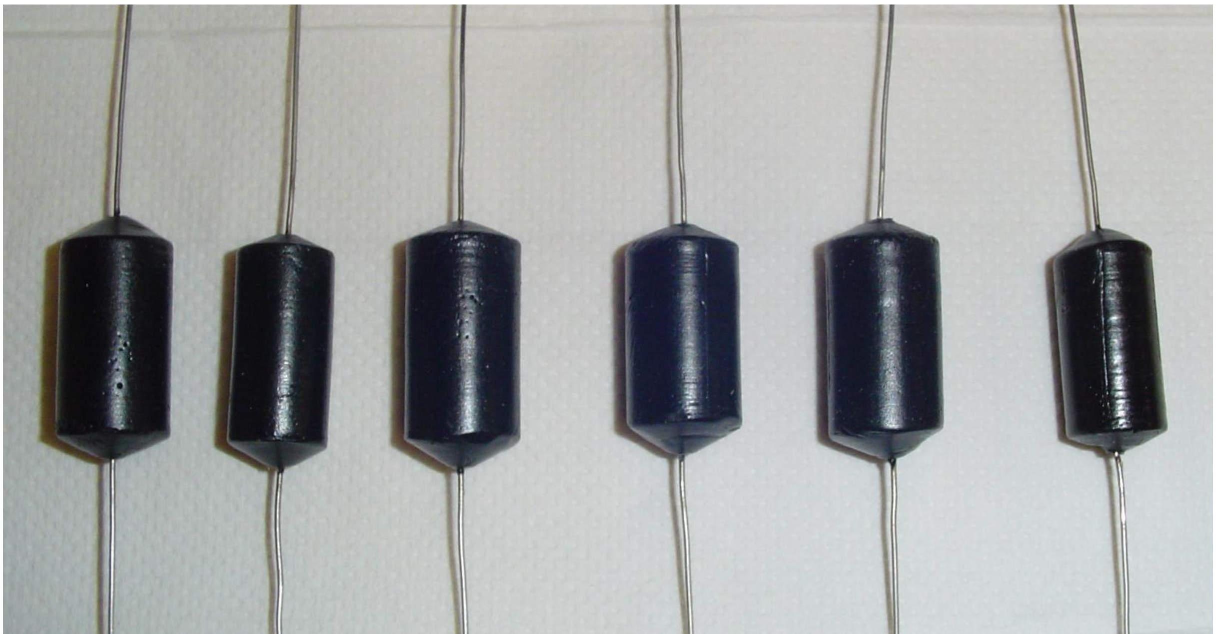


Picture 8.5

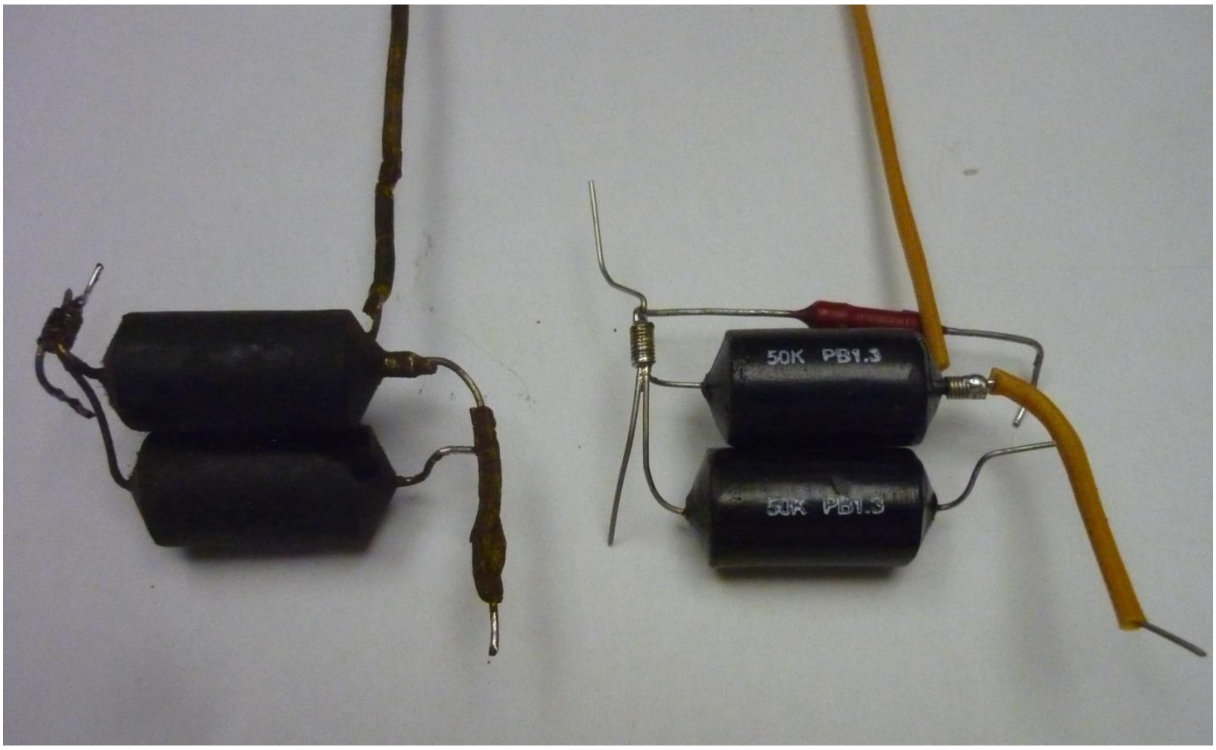
Then the end will be reheated and with a special mould (picture 8.6).


Picture 8.6

The top of the tar capacitor will be turned in the right shape. After this, most of the time an edge remains that needs to be removed. Because the bitumen is still soft the edge can be easily removed by powerfully rolling the capacitor between two slices of wood.
Bitumen has the characteristic of being sticky for a long time, especially when it’s warmer. To solve that problem they are sprayed with clear lacquer, preferably satin or matt, as gloss doesn’t give a nice effect (picture 8.7).


Picture 8.7

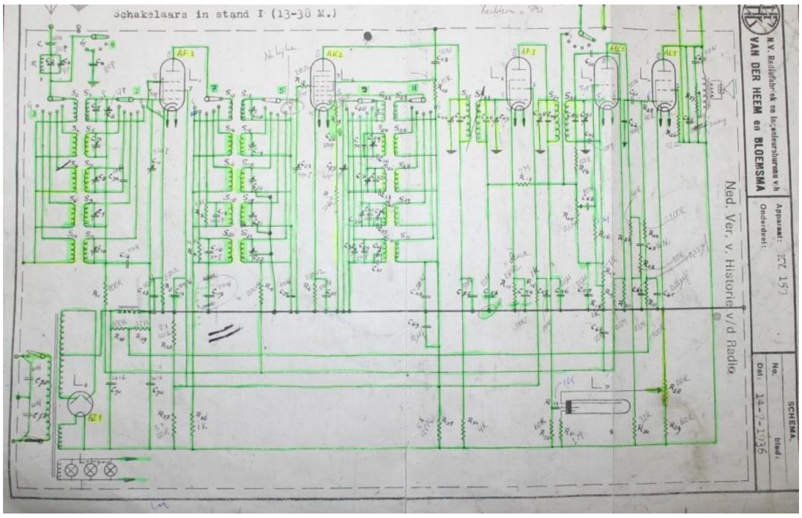
What remains is the applying of the encoding, for which we invented a new procedure. The encoding itself has been modified, so that it is always possible to pick up that it is a replica (picture 8.8).



Picture 8.8

9. The build-up

One of the most fun parts of the restoration of a device is the build-up. The chassis is as new, the parts have been cleansed and the puzzling can begin. In total we took about 350 digital pictures, but even then you come to face surprises. It is meant that the device is built into its original state as well as possible. This means that the wires are running the same as before the restoration and all parts are placed at the correct place. The bigger parts are not a problem, but for position the resistors and capacitors we regularly had to consult the pictures. Every now and then it looked like an archaeological research. Every part that was placed and connected was then signed off the circuit diagram with a marker (picture 9.1). This makes it easy to see whether everything is connected and with this system the job could safely remain untouched for one or two weeks.



Picture 9.1

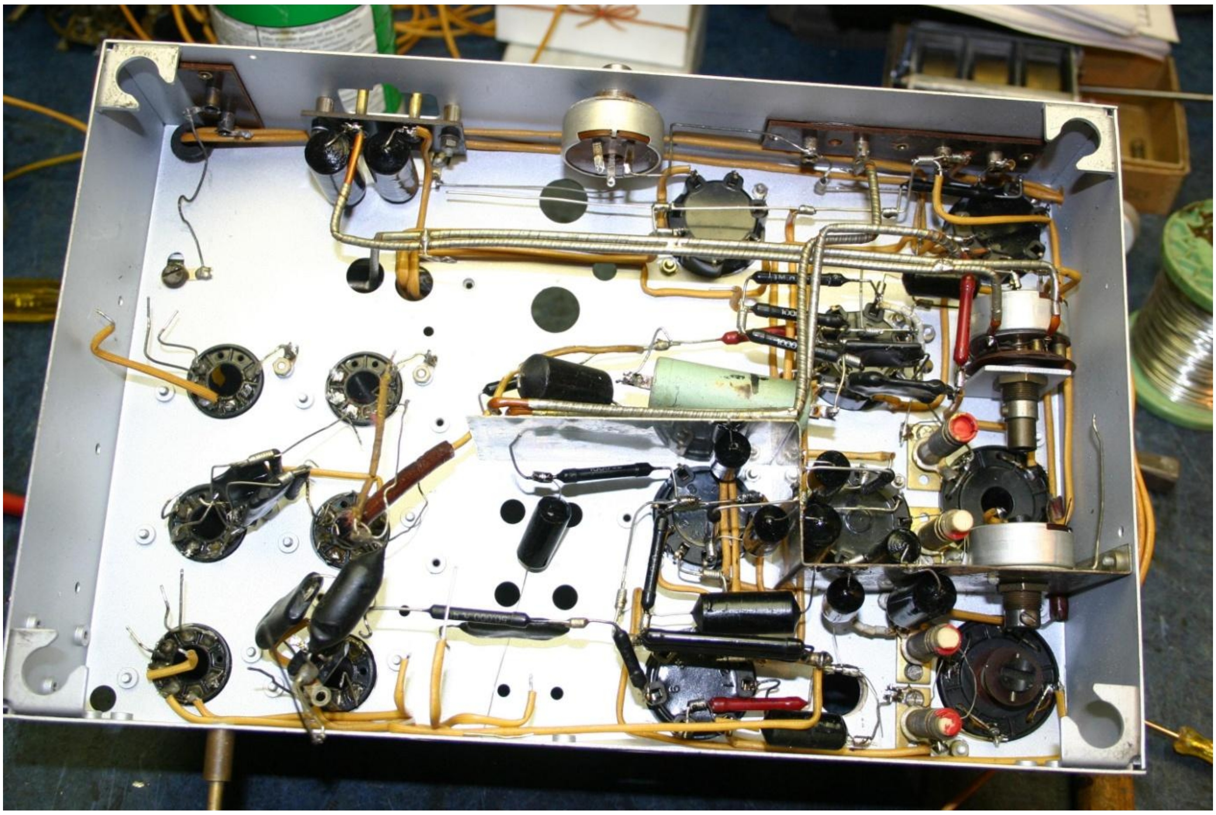
First we replaced the coils, together with the valve holders and the entrances (picture 9.2).


Picture 9.2

Then the first connections were made. Where possible we left the connection wires attached to the parts and we also left the parts itself attached as much as possible. This seemed to be quite handy during the build-up, because we could be assured that the set of parts was placed back correctly (picture 9.3).

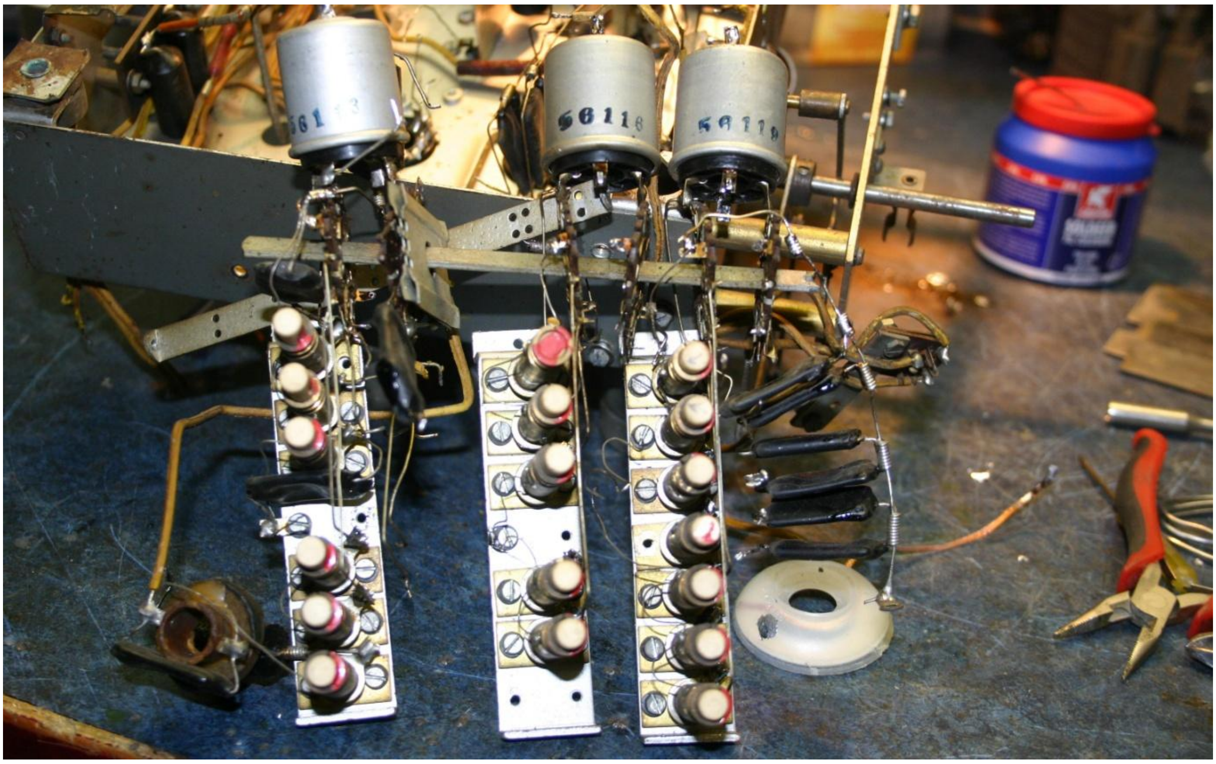
Picture 9.3

The wires are provided with new insulating sleeves. The rubber isolation that was wrapped around the old wires was crumbled or cracked in many places and you shouldn't take risks with safety. Slowly but surely the whole started to look like a radio again (picture 9.4).



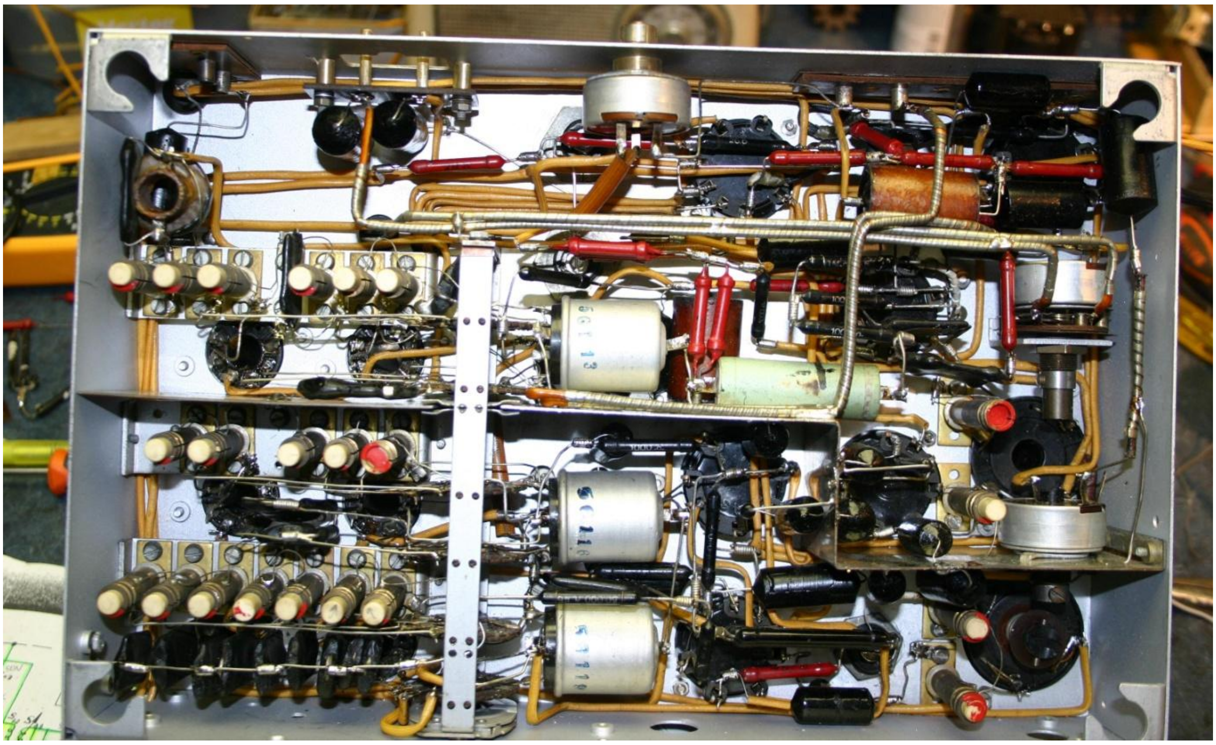
Picture 9.4

A separate problem was the shortwave coils with including trimmers and waveband switch. It seemed handy to keep the set intact as much as possible (picture 9.5).



Picture 9.5

In order to achieve this we had to disassembly the waveband switch. The replacing was not easy, as we often had trouble wiring these and other components. However, using the necessary "creep by, sneak by" technique all was well in the end (picture 9.6)

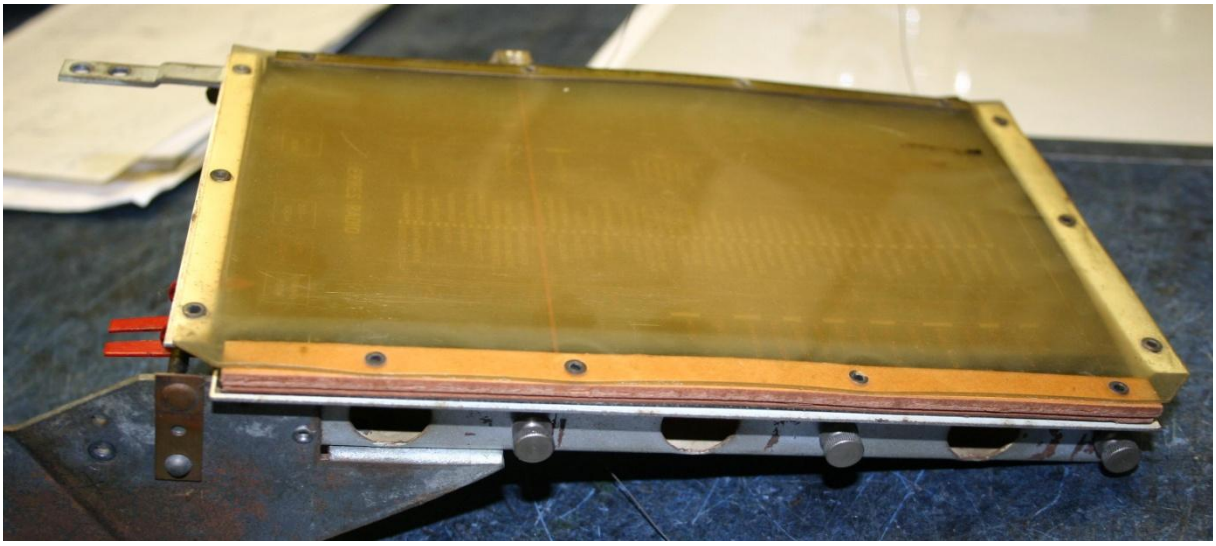


Picture 9.6

Before the channel scale of the chassis was removed we carefully drew down the run of the scale strings, as well as the turntable with respect to the tuning capacitor (picture 9.7).

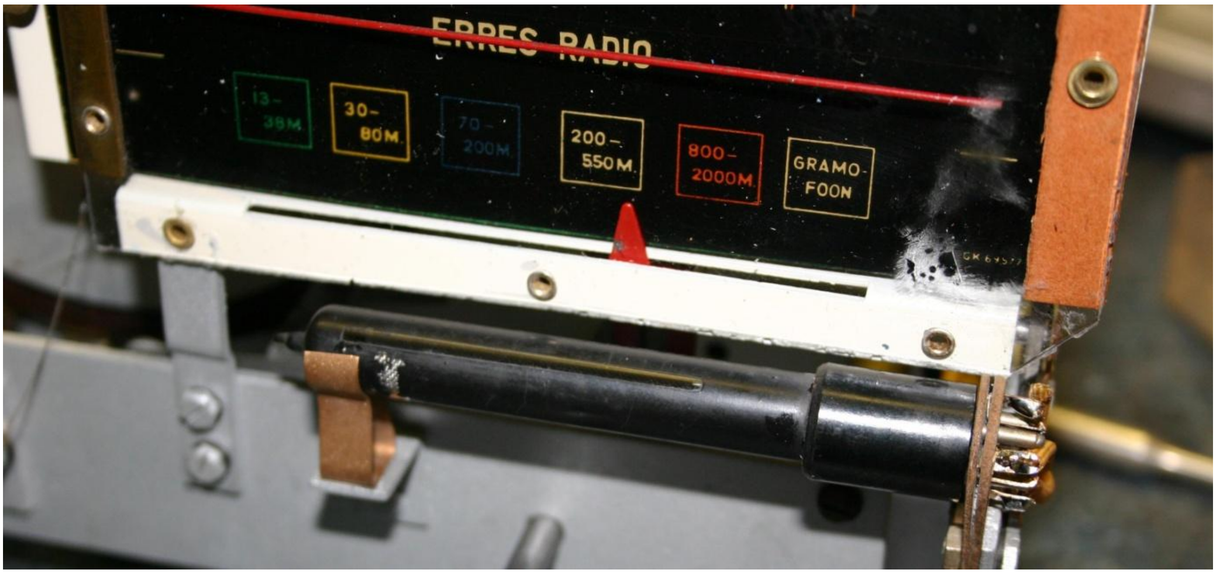

Picture 9.7

The celluloid pane which was used to supply the channel scale was foxed over the years in such a way that the stations were barely readable (picture 9.8).


Picture 9.8

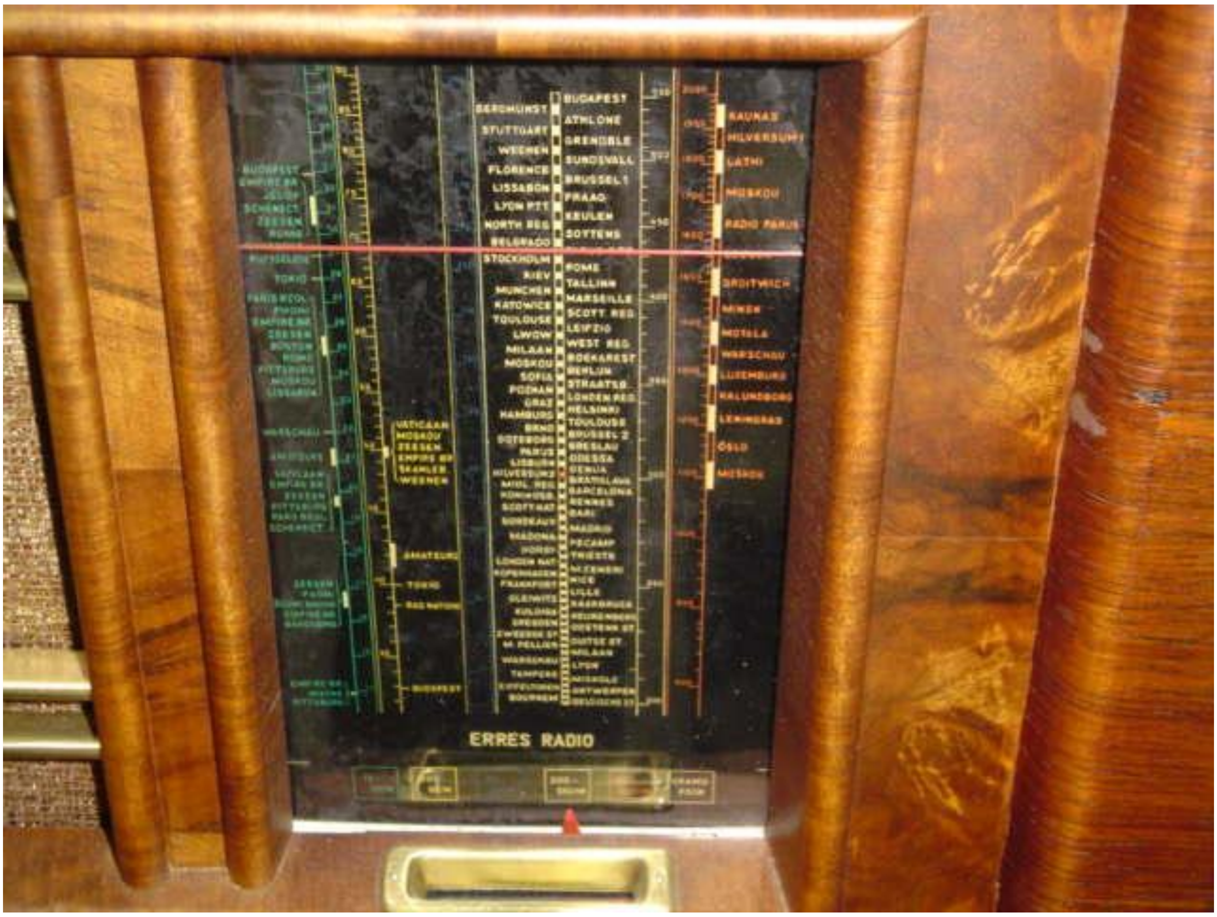
A problem was the thickness of the celluloid (1mm), as replacing materials like polymethylmethacrylate (brand names are amongst others Perspex or Plexiglass) or polycarbonate (brand names such as Makrolon and Lexan) are only sold as from 2mm thickness in the stores. Nonetheless, through an acquaintance we eventually found a good supply of polycarbonate of the right thickness.

After removing the celluloid it appeared that there occurred five colours on the channel scale (picture 9.9).



Picture 9.9

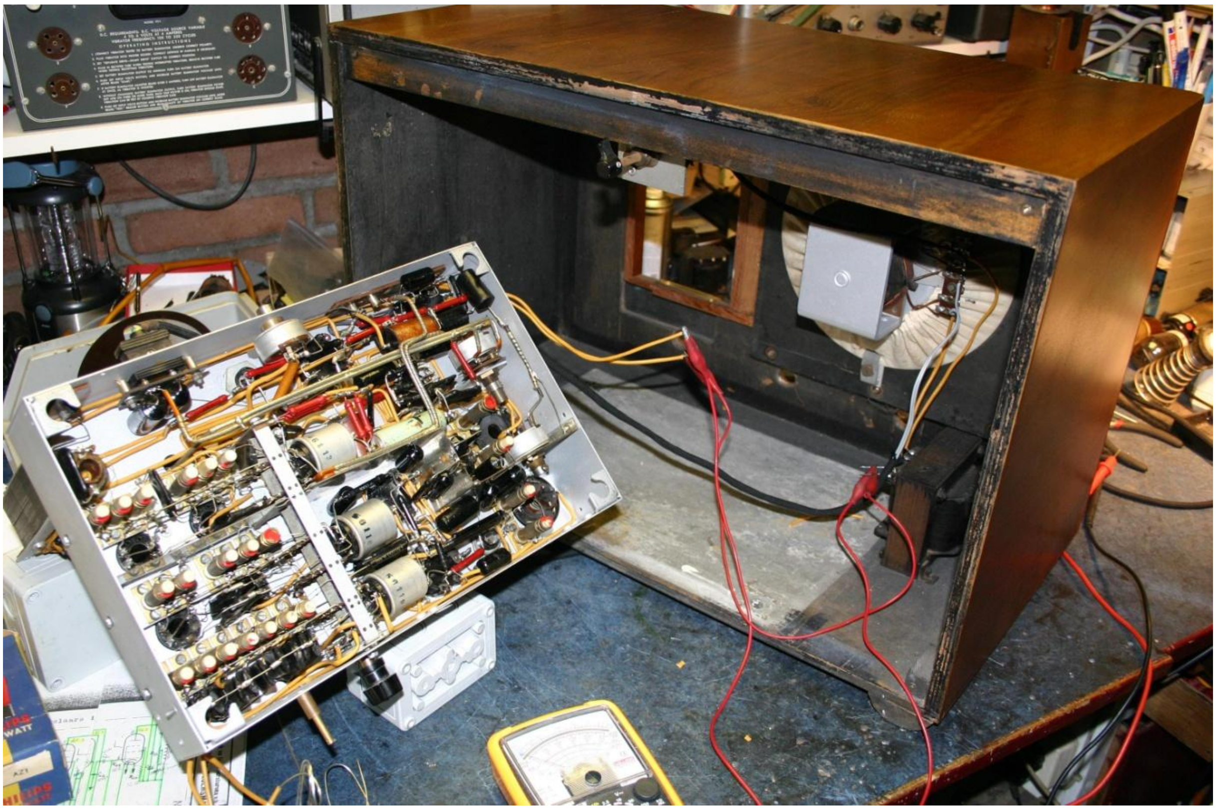
Once placed in the cabernet it gives a nice picture (picture 9.10).



Picture 9.10

10. *Voltage, current, music!*

Eventually the device could be put under voltage again after a long time (picture 10.1).



Picture 10.1

It is always a nice moment when the first creaks and squeaks are coming from the speaker. In this case we had to wait for it for a while.
First we put the power on without valves. There were no smoke signals, so the rectifier valve could be placed. The measured power appeared to be more than 300 volts, but that was of course unloaded. The measured filament voltage carried a neat 4 volts. After the power valve AL5 was placed, we measured again and after a while it did began to smell and to smoke. Because the L1, L2 and L3 were still missing the resistance R38 got quite warm. Additionally, the other valves were placed one by one and everywhere the right tensions were measured. Yet, there wasn't much life in the device. Turning on the waveband switch produced a modest creak, but further it remained silent.

Touching the PU-exit made a sound, but not the growl you would expect with such a powerful device. After another measurement it appeared that the filament voltage remained with only 2 volts. After searching for a while it seemed that the winding on the transformer had a centre tap of 2 volts.

The filaments were hooked up to the 2 and 4 volt pens, instead of the earth (chassis) and 4 volts. Only 2 volts of filament voltage remained. Because the first measurement was done with only one rod connected to the chassis and the other accidentally connected to the 4 volts connection, the faulty connection wasn't obvious. After re-attaching the wires, the well-known station "Radio Maria" blasted through the speaker.

Additionally, the second short wave wasn't operating. We remembered that during dismantling one of the oscillator coils was not connected according to the circuit diagram. A number of connections were still untouched and we chose to build it back the way it was connected before. If that was wrong, it would mean that the radio did not work properly in the past either. To prevent that possibility we decided to re-attach the coil according to the circuit diagram. This meant that a certain part had to be expanded. While we were trying to find a solution, the earth connection of trimmer C29 (of the oscillator coil S24) appeared to have disconnected. After reconnecting everything accordingly, the short wave still did not operate. So we proceeded to take a step back and reconnect everything to its previous state and earthed C29; the short wave now worked like a charm! The only possible answer was that the inside of the coil differed from how it was originally stated on the circuit diagram.
Finally, we used a measuring transmitter to check the medium frequency of 451 kHz, which turned out to work fine.

The third problem involved the inability to turn the volume to zero. Even in the lowest position the windows were shaking. A quick measurement with the volume potentiometer revealed that even in the lowest position, the resistance was still 16 kΩ. We decided to take out the potentiometer and replace it with a new resistor disk. On the lowest position, the resistance remained high; it was still at 12 kΩ. There was nothing we could do mechanically, but the small carbon resistor disk solved the problem after slightly twisting it, so a solid 100 Ω of resistance remained. After the potentiometer was reset the volume turned out to be perfectly tuneable from high to low. On the 30th of December 2009 the chassis was put back into the casing and the restoration was completed (picture 10.2).


Picture 10.2 (Paul Bolt)

Ultimately, we replaced the old valves by new ones. Especially the AZ1 with gauze anode made a significant improvement to the sound quality. ☺

11. Summary

Overall the number of mistakes was considerable. One wrong connection and a loose solder point. It could have been worse, keeping in mind that the device has been completely disassembled. The methodical build-up and precise measuring contributed to this success without a doubt. The many pictures and colouring of the grid were indispensable.
If you are busy with such a hobby it often goes unnoticed how much material is used, especially when all materials are there to take. However, when you put everything together it becomes clear that the restoration did not just give a lot of pleasure, but also cost quite a bit.

The used materials for this project were:
7 electrolytic capacitors
21 capacitors
14 resistors
2 potentiometers
1 piece of mosquito net
75 cl lacquer
10 ml copper polish
8 sheets of sandpaper
25 ml wood stain
Some wood glue
A dash of black paint
1 spray can of aluminium-zinc paint
1 litre turpentine
48 solder springs
0,06 m2 polycarbonate
2,5 meter solder
12 meter insulating sleeve
356 digital photo's
11 litre coffee (with biscuits)
2 kilo cheese
2 tablespoons of mustard
5,5 litre orange juice
4 beers and
2 glasses of red wine

Fortunately there is no budget to a hobby.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