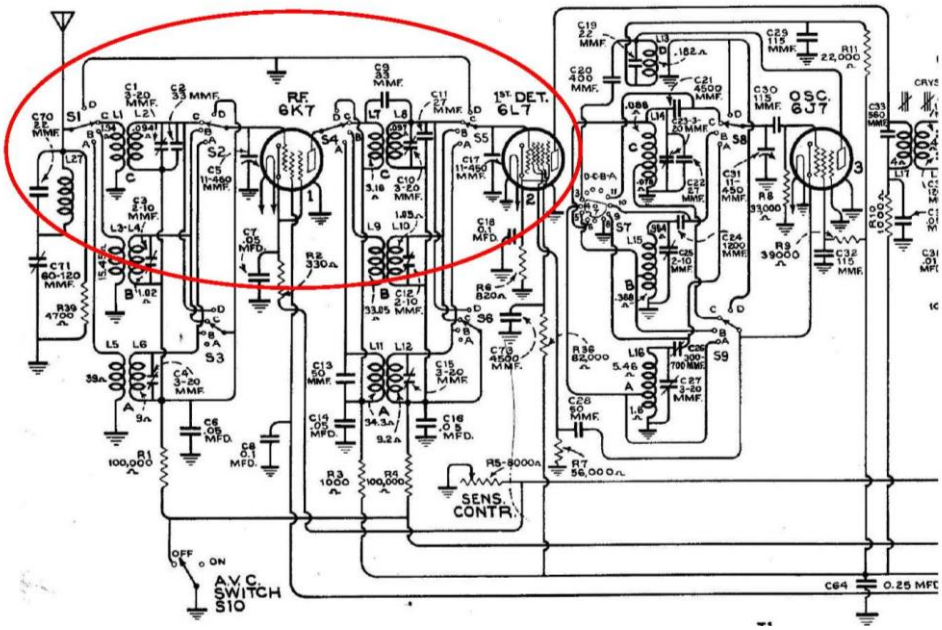
Restoration of an RCA ACR-175: a mid-1930's 'Classic' – Gerry O'Hara

I was recently asked to work on a couple of mid-1930's RCA communication receivers: an ACR-111 (fairly rare) and an ACR-175 – the latter lower cost and hence more popular/common. The owner also has a much-rarer RCA AVC-11A to refurbish – that will make for an RCA communications set 'hat trick' this year! (and its only August…). The photo, above, shows the ACR-175 on the day it arrived at my workshop.

The ACR-111 won the toss of the coin so I worked on that set first – the larger and more complex of the two. That set needed a new dial set, which has a long lead time from Radio Daze (6 weeks or so), therefore when I had completed as much work on that chassis as I could but awaiting the dials to arrive, I started working on the ACR-175.

This model (1936 model year, 11 tubes, costing $119) is almost contemporaneous with the ACR-111 (1937-38 model years, 16 tube, costing $190), and is thus a 'lower-end' model. It features only one RF stage, no noise suppressor and single-ended output, with the full tube line-up as follows: one RF stage (6K7) which is bypassed on frequencies higher than 15MHz[1] (circled in the partial schematic, right), Mixer (6L7), Local Oscillator (6J7), two IF stages (2 x 6K7) operating at



[1] I am not sure why this was done, though possibly because the highest frequency band (15MHz – 60MHz) covers such a wide frequency range and tracking of the RF and Mixer stages would be difficult and the poor performance of the 6K7 pentode at frequencies above 25MHz The bypass circuit comprises a simple (but quite effective) tuned auto-transformer arrangement.

460KHz with a single crystal filter, detector (6H6), 1st AF amplifier (6F5), single-ended output stage (6F6), BFO (6J7), eye tube (6E5) and rectifier (5Z4). The RF section is integrated onto the main chassis (no ACR-111 style 'Brain Box' on this puppy), though, it does sport a crystal filter (same as in the ACR-111). Strangely, the audio stages and BFO unit are on a sub-chassis bolted onto the side of the main chassis - looks like someone forgot about them at the design stage and were added as an afterthought(!). The BFO unit has a similar screening cover to the one fitted to the ACR-111.

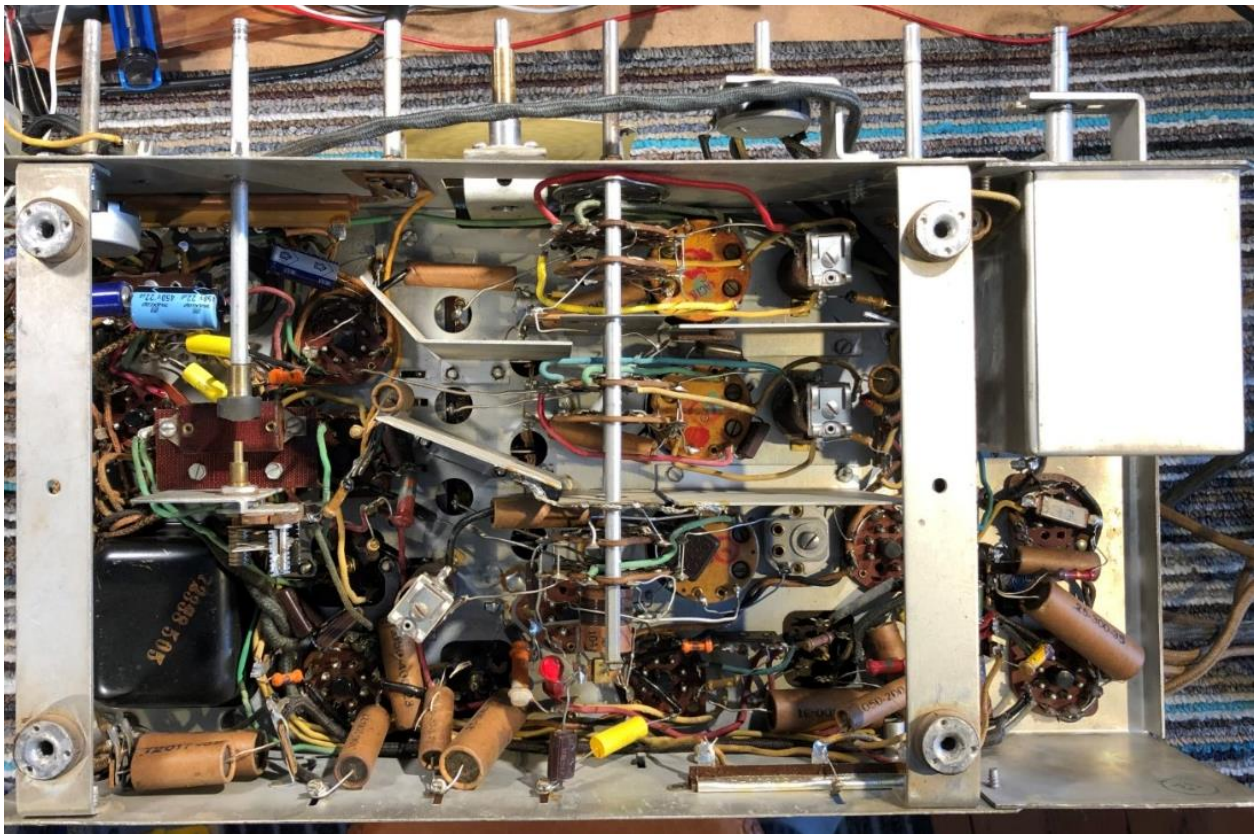
The owner of this set wanted the chassis to be restored to as similar visual appearance to how it was originally as it could be (though allowing for 'aged' look of the chassis metalwork and components) – effectively my 'sympathetic' level of restoration work. The cabinet was also supplied, and this was in reasonable shape, so the hope was that the set could be restored (almost) 'as new'. I removed the chassis from the cabinet, deciding to leave any work on the cabinet until after I had finished working on the chassis. The cabinet looked like it had sustained a drop at some point, with a slight warp on the rear panel and top rear corner that prevented the lid closing fully (photo, right).

Initial Inspection

Preliminary inspection of the chassis showed that someone had done some recapping work previously - some electrolytics and a few paper capacitors have been replaced (photo, top of next page). The rubber isolation coupling on the crystal phasing control shaft was broken (photo, right) – easily fixed with a drop of Duco cement, but otherwise things looked in reasonable physical shape under the chassis. The speaker driver looked ok too, this being mounted on a simple wooden baffle stand, and is thought to be the original as supplied with the set.

As noted above, the owner of the ACR-175 requested the work undertaken on the chassis to be a 'sympathetic' restoration, this to include:

- Reversing the 'obvious' repairs , eg. using re-stuffed capacitor shells recovered from the work on the ACR-111 chassis to install in place of the 'modern' replacements, and removal of the 'modern' under-chassis electrolytics and re-stuffing the original electrolytic capacitor cans;



- Retaining the original 'look'/dress of the tubular paper capacitors, including the lead thickness/oxidation level where possible and where these were visible (generally thicker wire was used on components 'back in the day' compared with modern substitutes and these have oxidized over the decades); and

- Reproducing resistor bodies close to those of the ones fitted originally if any needed to be replaced.

Restoration Work

As an experiment, and to see if the technique would satisfy the owner's request, I tried an 'in-situ' re-stuff of one of the original tubular paper caps near the rear apron of the chassis. The sequence of this process is shown/explained in the sequence of six photos at the top of the next page. The technique was successful on the 'sample' capacitor, and the owner was pleased with the result, so I therefore planned to continue with this technique for the remainder of the original tubular paper capacitors. This part of the work comprised:

- Identifying a couple of cardboard capacitor 'shells' with '0.01uF' markings on them in the 'old parts' bag left over from working on the ACR-111 (it used the same type of cardboard tube capacitors, but these were not re-stuffed in that chassis), re-stuffing them, retaining the original leads, and installing them in place of the two previously replaced (yellow) caps in the BFO unit. Although these parts will not be seen when the BFO screening can is in place, the owner chose to have as 'all original' look as possible;

- Removal of a tagstrip someone had fitted to install replacement electrolytics, and the removal of all three replacements electrolytics. I then removed the three above-chassis capacitor cans (one is cardboard), re-stuffed them with fresh electrolytics (photos, right), and then re-installed them on the chassis. I had to change out one of the retaining nuts on one can capacitor spigot to one that could be soldered to as the large solder lug was missing - both of the metal can electrolytics are insulated from the chassis and their negative connections (cans) are connected together electrically;

- Doing all this work disturbed some of the wiring (it's a mixture of cloth and rubber insulated wire, as in the ACR-111), and the red and yellow insulation was brittle around the power supply section where the temperatures would be higher. Any wires that I had disturbed and lost insulation were replaced, along with some others as a preventative measure where the loss of insulation could cause a short circuit in the future;

- Testing a few resistors and most tested were out of tolerance – some quite markedly; and

- On completion of the above, I found one last tubular paper cap lurking on the chassis – a metal clad one next to the volume control on the front apron. I removed it, cut the casing with a Dremel, re-stuffed it and re-mounted it so it looks completely original (photos, right);

I then tested all the tubes and they checked good, all with >70% emission. The tubes were re-installed and I powered up the chassis for an initial test – total silence! The tubes were heating up, the HT voltages were good and the chassis was drawing around 80W of power, which all seemed ok. I tracked the problem to a bad connection on the 'phones jack. I re-made all the connections to the jack and used heat-shrink on them to keep them neat. The 2.5 Ohm resistor on the jack was broken, so I repaired that. The audio then came to life, but I could only trace a signal through the audio stages as far as the grid of the 2nd IF tube – the 1st IF, Mixer and RF grids were all 'dead' to the 'finger test'.

I started checking around on the chassis: I fixed a dry joint on the 2nd IF transformer and a second connection fault on the speaker – I found out the hard way that the plug could be inserted incorrectly, placing HT voltage onto the phones socket - ouch! The receiver then sprung to life on the Broadcast Band. A demo can be viewed here. Some observations during this initial function test:

- All controls appeared to work approximately as they should except the BFO, which seemed to not be working at all;

- It was working on all bands, though sensitivity was down on the higher shortwave bands, however, incredibly, it did receive a signal at 60MHz on Band 'D';

- I left it running for an hour or so – the power transformer reached about 35C, which was good;

- HT and screen voltages seem ok – maybe a tad on the high side, which is normal, and it consumed around 85W at 117vAC line voltage, which seemed correct for the tube count.

Next, I decided to work on the BFO problem:

- Checked the BFO output on the 'scope – it was actually generating a nice sine wave at 480KHz, but the frequency could not be changed by turning the BFO pitch control (coil slug);

- I removed the BFO coil and with the slug adjustment screw fully out the can rattled when shaken, indicating a loose powdered iron slug;

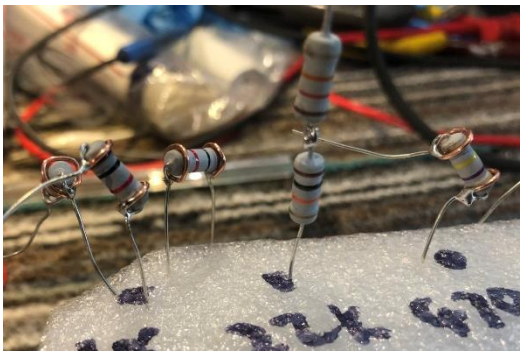
- I disassembled the BFO coil (not easy!) and sure enough, the adjustment screw had detached from the end of the slug, and part of the slug had disintegrated (photo, right);

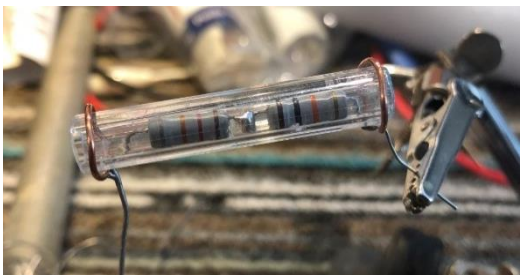
- I used J-B weld to re-attach the slug to the adjustment screw, setting up a circular mould using masking tape (photos, right, show the masking tape mould (top), and repaired slug (bottom)).

Once the J-B Weld attaching the BFO adjustment screw and the powdered iron slug was set, I trimmed it up and epoxied the threaded brass bushing back into the end cap of the BFO coil former. I lubricated the adjusting screw with ROCOL Kilopoise high viscosity grease and it now had a nice smooth feel when rotated. I checked the 100KOhm resistor that is installed in the can and it was well within tolerance (within 1%!), so I left it in place. I then re-installed the coil assembly into the can and reconnected it into the circuit. It now worked well, with around +/-5kHz frequency swing, plenty of room for adjustment of centre frequency, and it has a good injection level.

I checked all resistors (mostly in circuit, but with one leg detached where appropriate). I found that twelve were >20% (or very close to) tolerance and should be replaced. The resistor types are a mix of larger and very small dog bone types, and therefore can be reproduced reasonably well:

- The original resistors are a bit of a mix of styles, so rather than try to reproduce each one exactly, I made 10 of them a 'generic' dog bone style with the wire-wrap ends, and two hex-body larger ones to match the two like them being replaced exactly (a 22Kohm and an 82Kohm part);





- The photos, left, show the fabrication of the wire-wrap dog bone style resistors: the leads were bent to 90 degrees, a loop of copper wire made and wrapped around each end of the resistors, and then soldered to each of the resistor leads to secure in place. The ends were then re-shaped using epoxy putty and then painted with the 'body-end-dot' colour code using acrylic paints. After painting the resistors, they were given a coat of amber shellac to give a semi-gloss 'aged' finish.

- I then fitted the repro resistors in the chassis (I decided to use un-modified resistors in the tuning eye socket and 3rd IF can where they will not be seen);

- Two of the 1Kohm resistors that measured out of tolerance were, when looked closely at the

originals, 1.2Kohm parts (different from the schematic) and so were actually well-within tolerance, so I left them in (they are plate load resistors and are not critical anyway);

- I removed the 3rd IF can and replaced both resistors in it (only one was out of tolerance, but removal of the transformer from the chassis is a pain and it made sense to replace both while it was removed).

Following the resistor replacements, the set was placed back on soak test. There was no discernable change in performance – to be expected as none of the replaced resistors were 'critical' in value – nice to know that everything was now within original specs though. The sound quality both on speech and music was good, though lacking in bass response compared with the ACR-111, likely due to the small speaker/baffle on the ACR175;

Re-alignment

Following an extensive soak test over a weekend, the HT voltages were within normal tolerances: with no signal, ie. no AGC action, the reservoir cap was at 335vDC (290vDC), the smoothing cap at 265vDC (250vDC), and the screen supply at 130vDC (120vDC) – values in brackets are those in the manual. Power consumption remained at around 85W. I did not fit a fuse or safety cap on the power transformer primary as this would detract from the originality of the set – which the owner considered paramount. I therefore recommended running the set from an external fused supply somehow (2A fuse). Also, for the same reason, I left the original line cord and plug in place – they were in reasonable shape.

With a successful soak test under its belt, I was ready to re-align the receiver, starting with the IF stages as follows:

- I followed the IF alignment procedure as outlined in the manual – effectively a 'rough' alignment on 460KHz, without the crystal in circuit, switching the crystal in, and with the phasing control midway ('Max' selectivity), finding the resonant frequency of the crystal and re-aligning the IF transformers to that;

- This went ok until I tried to adjust the 2nd IF transformer primary – it adjusted , but with a very shallow peak compared with the others and the adjustment screw was almost fully into the coil former at the peak;

- Suspecting another broken (or detached) slug, as in the BFO coil, I removed the IF transformer, but no rattle this time, so rather than pull the former apart to check, I cleaned things up, checked the silver mica caps (both ok), checked continuity of the primary and secondary windings (both ok), and replaced the transformer;

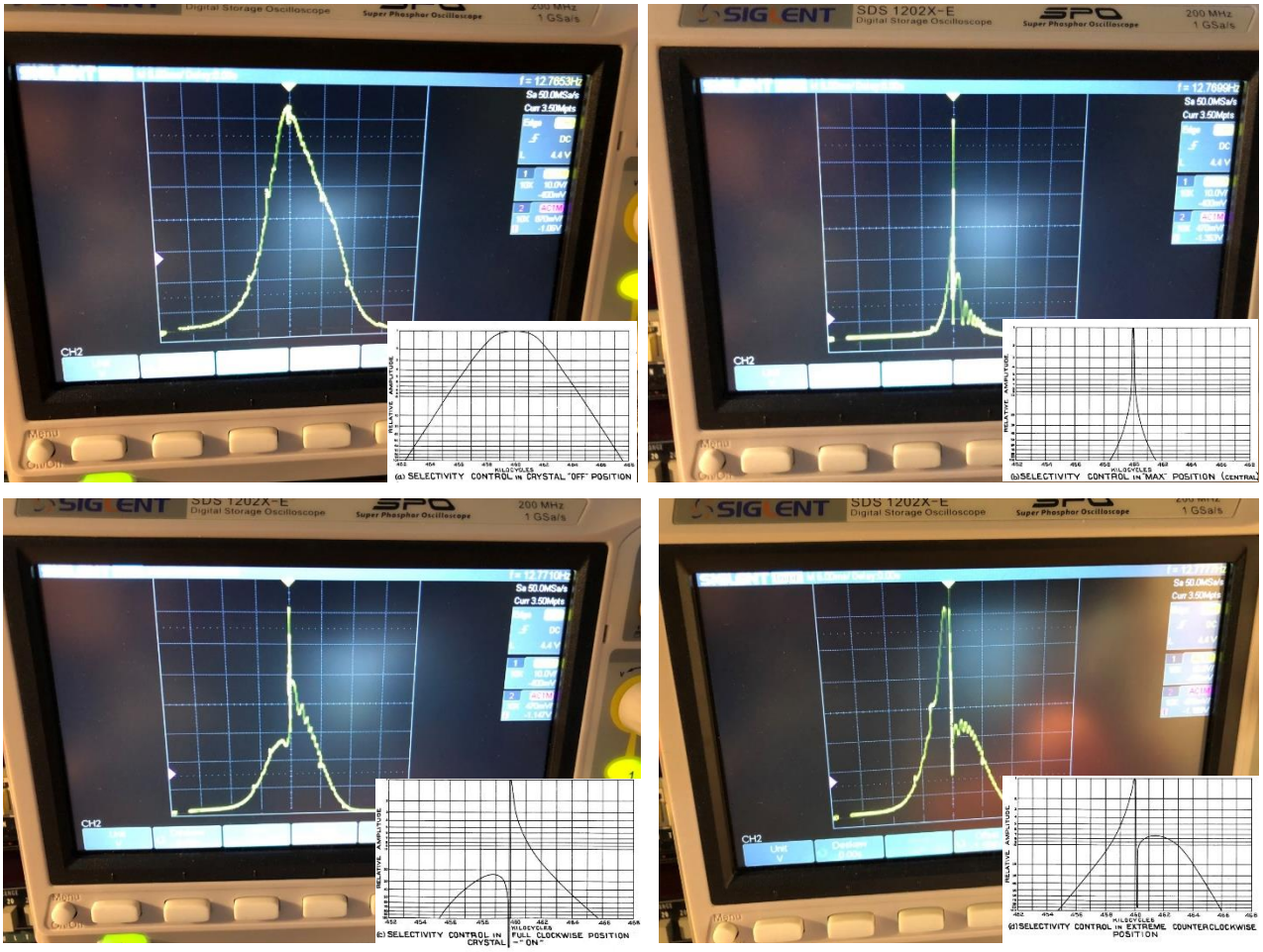
- As I was re-wiring the transformer into the circuit, I noticed that the 0.01uF (re-stuffed) capacitor that connects to the AGC lug on the bottom of the transformer (to ground) had been connected to the adjacent (plate) lug instead – this of course was the problem. Not only was it grounding out most of the signal (the set was working remarkably well considering!), but it also dampened the primary tuned circuit. This was one of the few capacitors that I had not used both original leads on (I cannot recall why - likely because it was too short), so a problem of my own making… (oh boy!);

- Connecting the capacitor correctly resolved the issue and the IF tuned up very nicely at the crystal centre frequency (a tad over 460KHz);

- I replaced another wire where the insulation crumbled and broke away as I was removing the IF transformer;

- one final tweak of all the IF transformers.

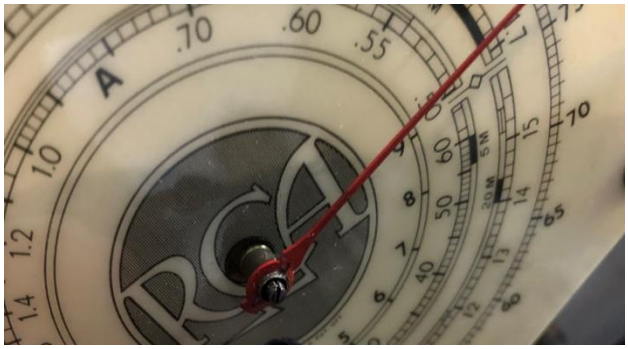
I then did a preliminary re-alignment of the RF stages without any issues. The set was then generating over -18v AGC on a strong local signal on the Broadcast Band and was sensitive on all bands with good dial accuracy – remarkably, good to beyond 60MHz!. Next, I hooked the ACR-175 up to the HP8601A/HP8600A sweeper/DFM/digital marker generator and 'scope to check the IF response curves with/without the crystal filter. It looked very good (and amazingly similar to the ACR-111, but then again the circuit is very similar too).



Above - photos of the IF response curves as follows: top left - without crystal filter (with and without 20KHz marker pips; top right - crystal filter in, phasing control centred ('max selectivity'); bottom left - crystal filter in, phasing control fully clockwise; and bottom right - crystal filter in, phasing control fully counter-clockwise. These closely match the 'ideal' response curves provided in the manual (shown on the inset figures above on each photo for comparison). With the crystal out of circuit the response is sharper than the manual shows, which, in my opinion, is much better-suited to a receiver intended for communications use

Above: photo of the HP 8601A sweep generator (top left) and its matching HP8600A digital market generator/DFM underneath. This pair of units date from around 1980 – I was given the HP8601A several years ago and always puzzled as to why its frequency readout method was so crude (mechanical counter) – then I realized it was designed to work with the HP8600A, which includes a DFM. I was lucky to snag this HP8600A for a reasonable price, and it works ok too. The unit at the top right is an HP400E AC voltmeter I use as an output indicator during standard set alignment techniques

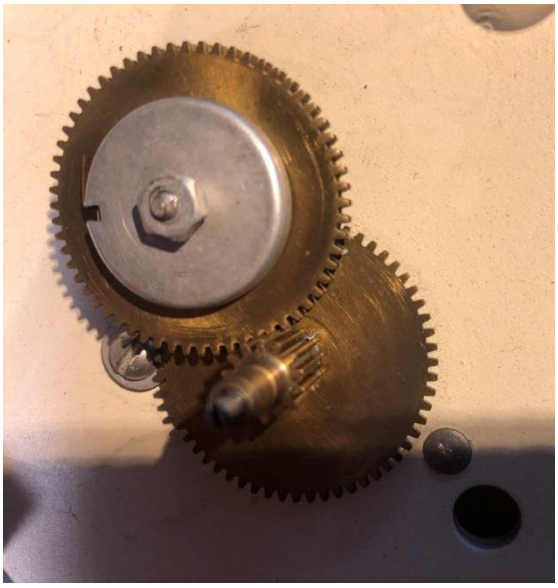
Mechanical Issues

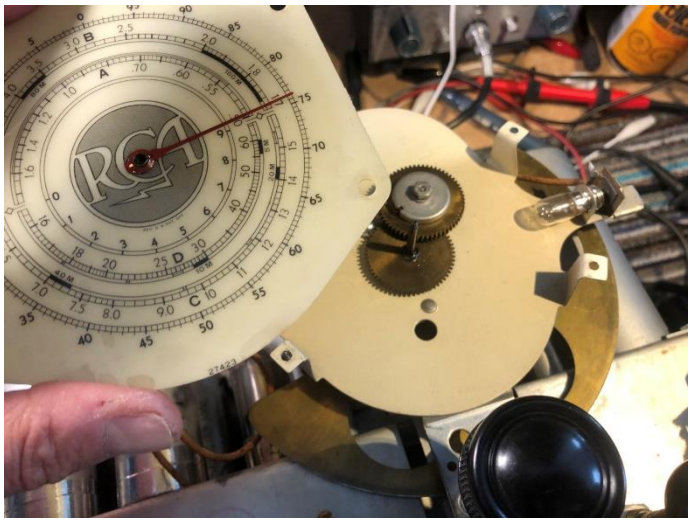


I cleaned and lubricated the tuning gang: there was a mechanical issue with the dial mechanism in that the logging scale pointer (the red one that should turn rapidly -photo, right) did not turn as the gears/pinion driving it were not engaging properly. This also made the main tuning feel 'lumpy', so needed to be fixed. To access these gears required the dial to be removed, and to do that, the pointers had to be removed first. Unfortunately I found that I could not move the screw at the centre of the pointers to do this - it was really tight. I tried every 'watchmakers'

screwdriver I have and even honed a couple up to be an exact match for the screw head, but it still would not move.

I next placed the chassis facing towards the ceiling with a few drops of penetrating oil placed on the pointer retaining screw hoping this would help to loosen the screw – I left it like this overnight. The screw would not budge the next morning – I then tried applying heat, cooling, tapping, etc as well. Nothing worked: and for good reason – its not a screw! It's actually the end of the tuning shaft, which is split and gives the appearance of a screw. The pointers are simply a friction push fit over the concentric shafts[2]! Anyway, once I realized this, I had the thing apart in minutes (photo, below right). The problem with the tuning was a mixture of wear and a loose anti-backlash spring housing bell. I had to bend the idler gear shaft slightly to ensure reliable mesh of the worn gear/pinion, engage and re-tension the spring, and use a new star washer to prevent its housing bell from rotating (photo, below left). I cleaned everything, lubricated it and it was then very smooth in operation. Instead of the split rivets that were falling apart, I mounted the dial (after cleaning) using screws. A short video of the fixed dial operating can be seen here (it looks a bit jerky on the video, but it's very smooth in reality).





Following the above, I completed a final RF alignment and then did a few more mechanical tweaks, including:

- Cleaning all switch contacts with Deoxit using a Q-tip;

- Repairing two knobs (one new spring and one set screw);

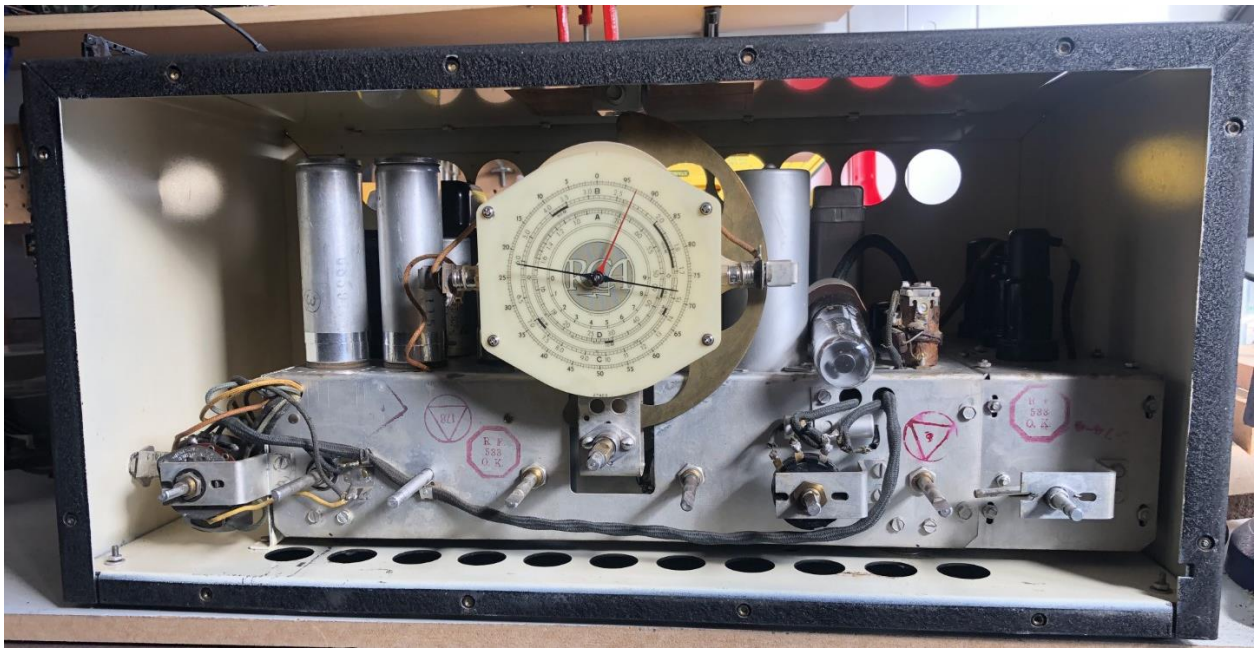
- Touching-up the paint on the black pointer;

- Final cleaning of the chassis underneath and on top;

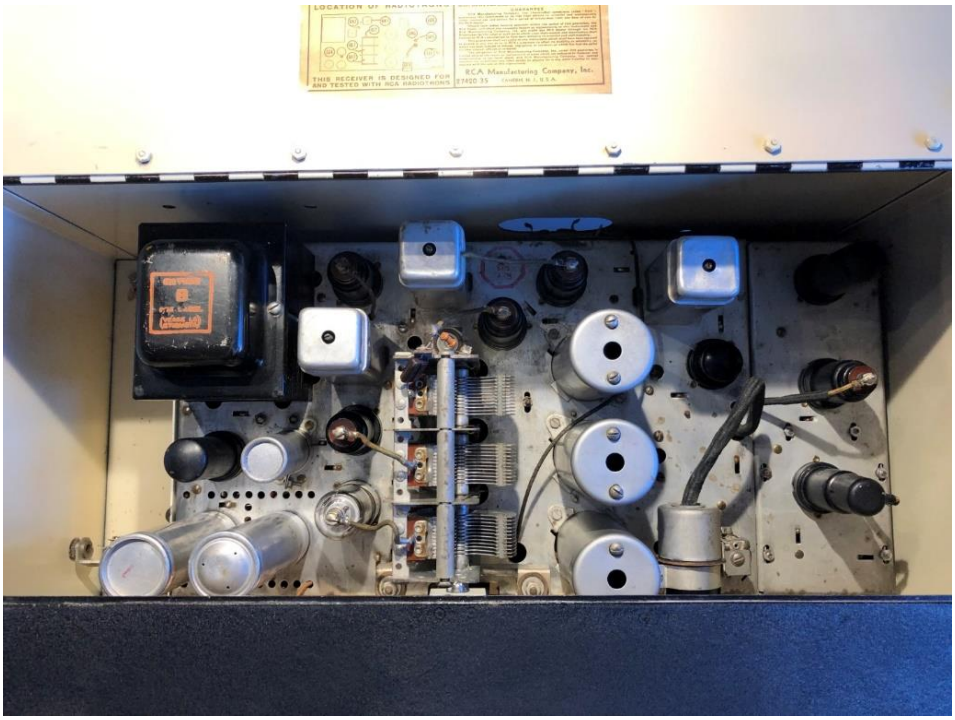
- Some minor 'metal bashing' on the bent cabinet corner – not perfect, but it was now better than it was and the lid now shuts correctly (almost);

[2] The clue was in an ARF post from 2008. Yes, it pays to do your homework: "*.....Eureka!! Paul with the RCA 143, take note. That was not a screw head. It is the top of the shaft. With all the liquid wrench, I was able to twist the pointer on the shaft. With a strong tug upward the pointer came off. The slot in the top of the shaft looked like a screw head, but was not. Appreciate all the advice, it kept me thinking. Thank goodness I gave it one more look before resorting to the file.....*". I figured RCA may have used the same disguise on the ACR-175, and sure-enough, they had.

- Doing some minor paintwork touch-up on the cabinet/front panel and cleaning it inside and out;



- Installing the chassis into the cabinet (photo, above – without the front panel fitted, photo, right – the chassis viewed through the cabinet lid): I noted that two of the front panel screws had been sheared-off sometime in the past and the threads are stuck in the holes (and, of course, the heads were missing). I found a couple of similar-looking screws, sawed the heads off and epoxied the heads into the holes as 'dummy' screws, then painted them black to match the others;



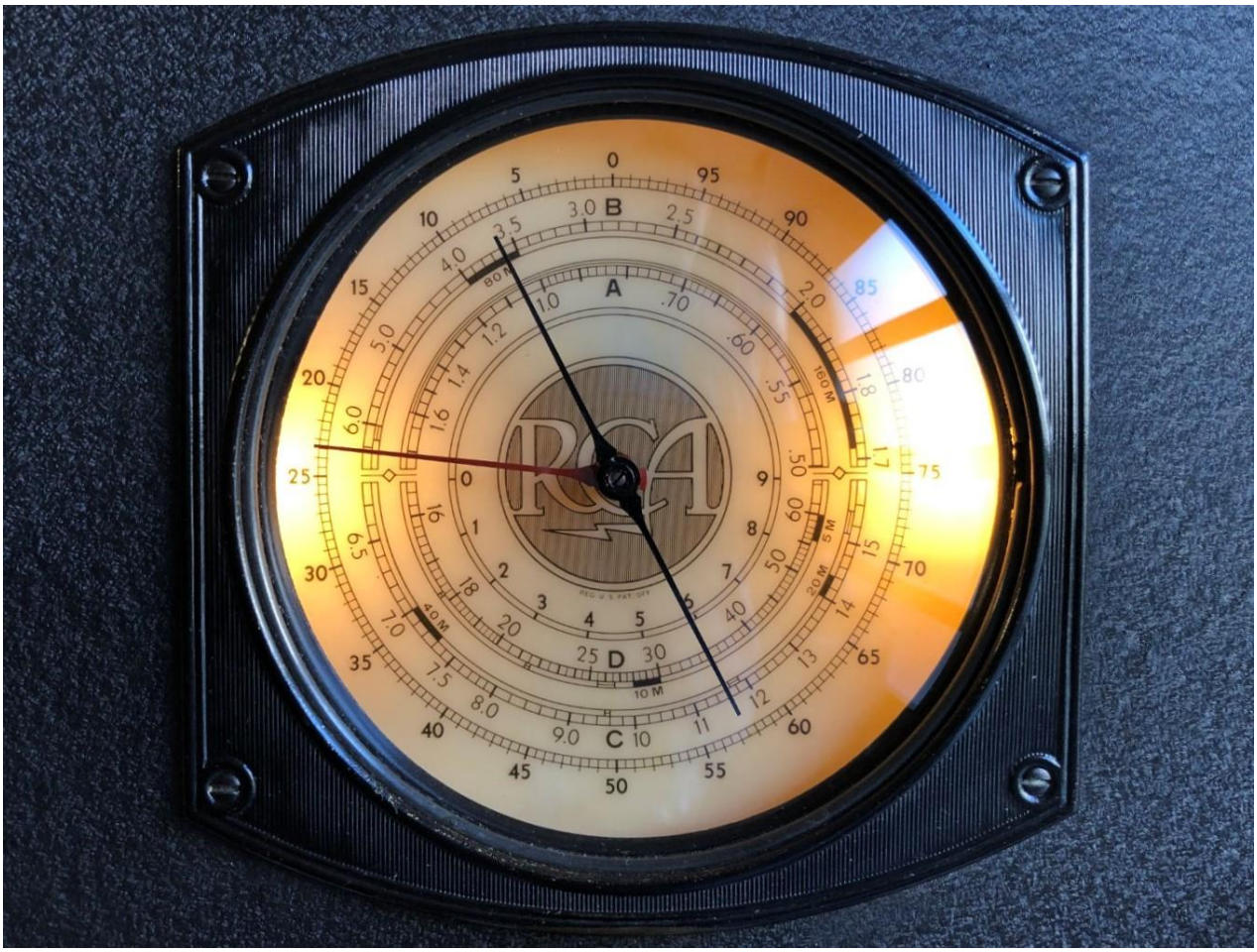
- Cleaning the knobs and re-installing them;

- Marking the speaker plug/line socket with arrows to indicate orientation as it is possible to insert incorrectly (making the phono plug 'live' if you do, so be careful – it bit me once!). I did glue the line socket blanking plate on to make incorrect insertion harder (it was loose and rotated), but the arrows help a lot.

Closure

I checked that the receiver was working in the cabinet and things were all good. I tweaked the orientation of the eye tube so the shadow pointed down and left it running for an hour before packing it ready for the owner to collect.

This ACR-175 is a surprisingly good receiver with good sensitivity, dial accuracy and frequency stability. The crystal filter is very good in operation, providing remarkably good CW operation. The overall good cosmetic condition of the set, in particular its dial and front panel, make it a real piece of 'eye candy' to the 1930's communication set connoisseur, but more than that, the original appearance of the chassis and its top performance – likely as good, if not better, than when new, is a real bonus, and the set should give many years of operating pleasure to its enthusiastic owner. Yes, one of those sets that you are loath to part with when the jobs done…

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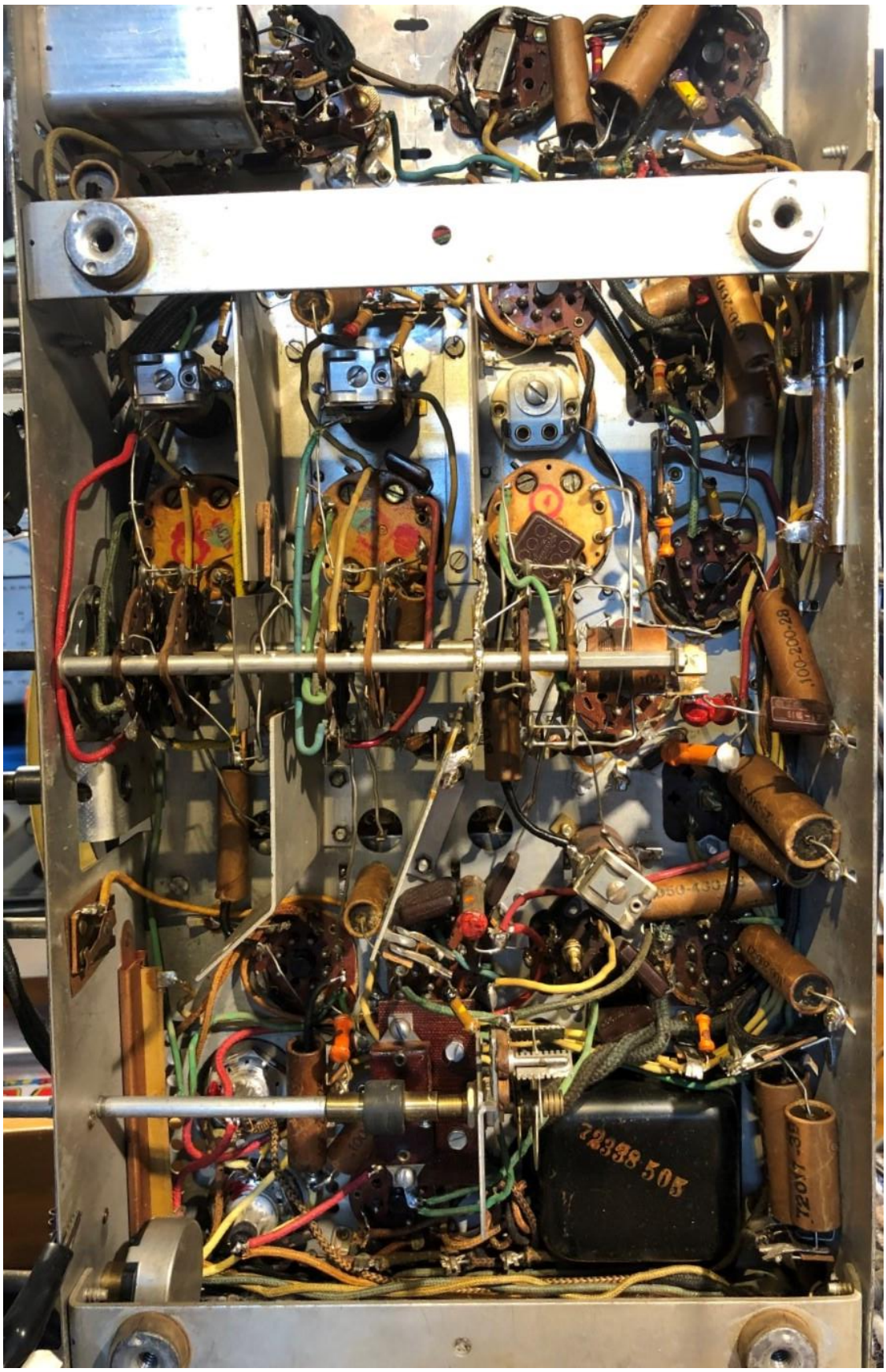
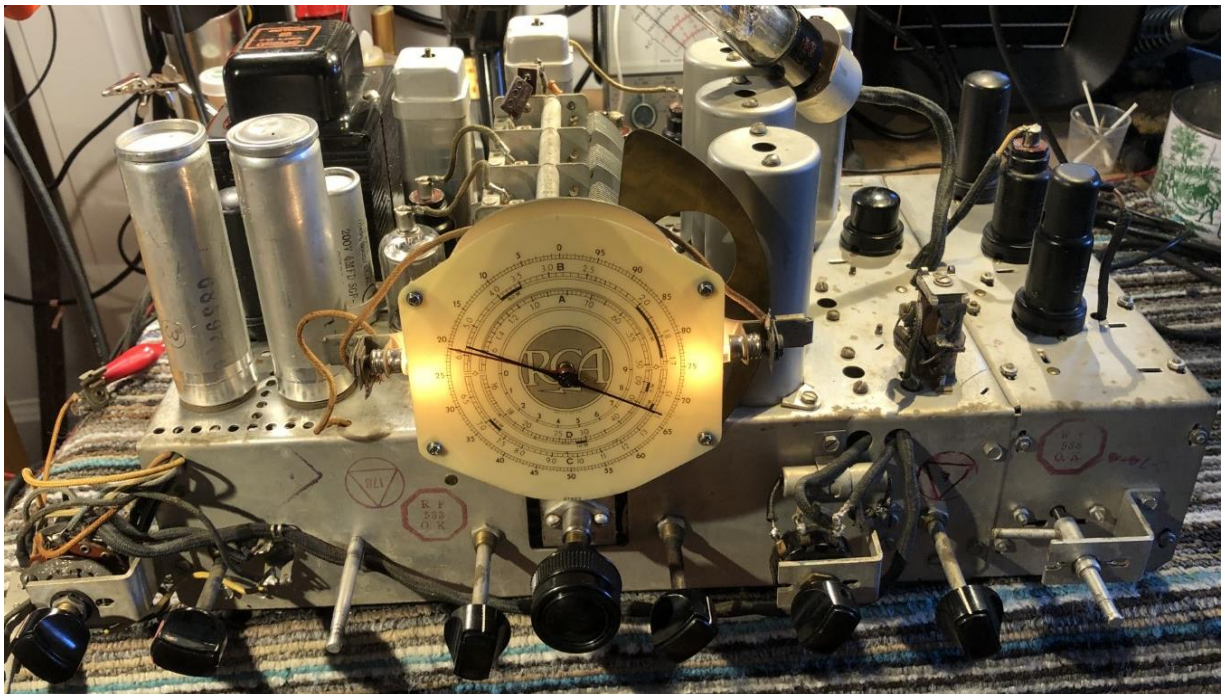
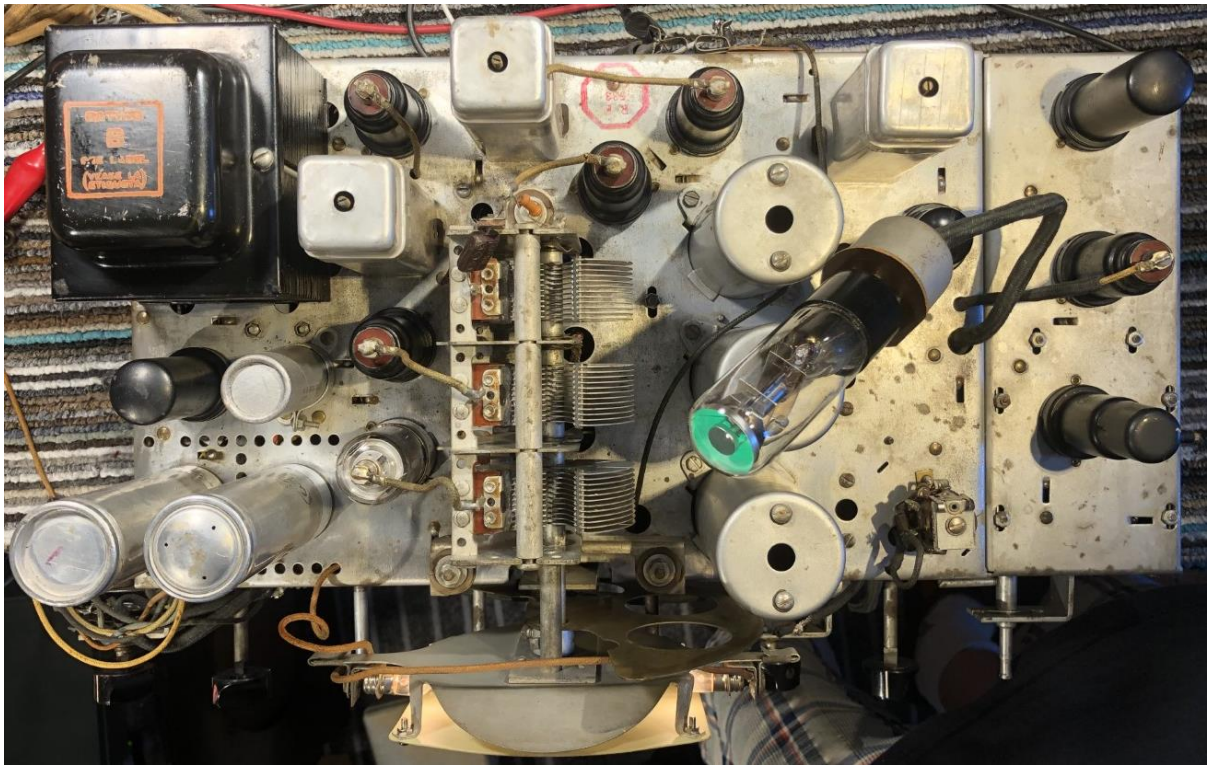


Underside of the restored chassis



Above: completed ACR-175 chassis on final soak test. Below: 'birds-eye' view of the restored chassis



The finished ACR-175 receiver with its 'matching' speaker during its final workout – a real mid-1930's 'classic' communications receiver. The dummy eye tube on the left is the 'standby' indicator lamp. The cabinet is several inches too wide for the chassis – was this meant to impart more 'gravitas' to the owner's reception bench? (see the photo of the chassis mounted in the cabinet without the front panel fitted on Page 11), or maybe it was meant to store headphones in, or spare tubes, or lunch… it would certainly keep a pasty nice and warm next to the transformer and rectifier tube.