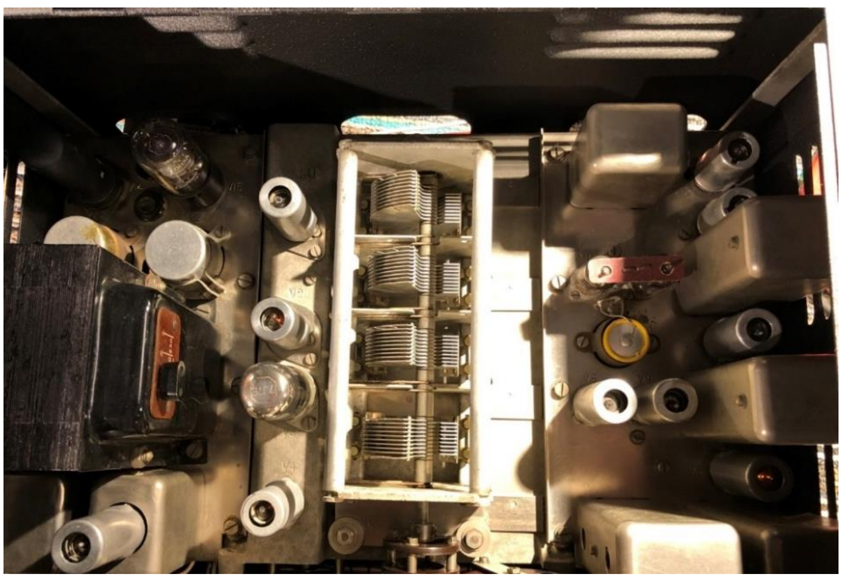
My S680/2 Revisited in 2020 – Gerry O'Hara VE7GUH

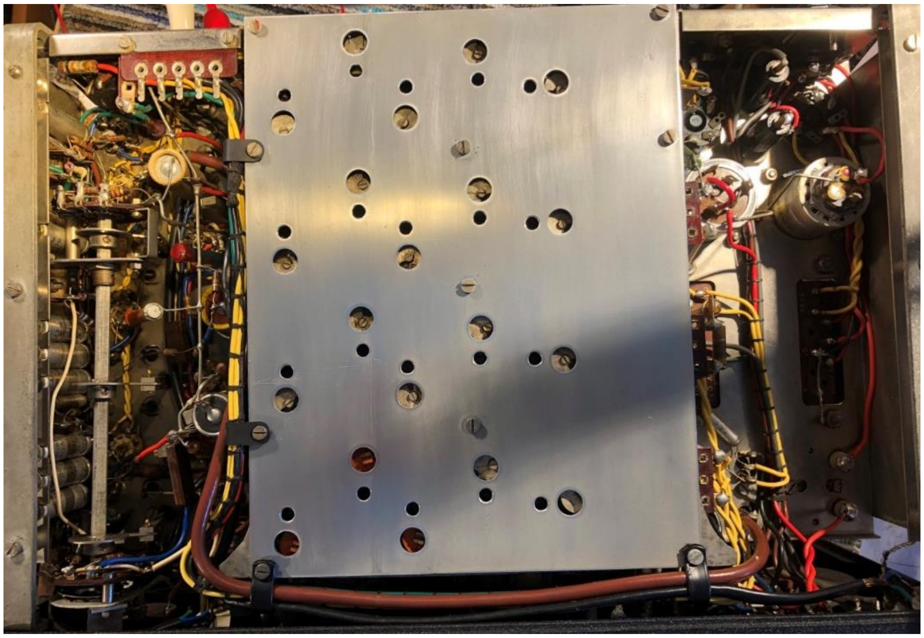
Background

My Eddystone S.680/2 had, with most of my other Eddystone sets, been in storage in boxes in garages since 2015 due to house moves, etc. Several of my Eddystone sets, along with most of my other larger communications receivers, have been passed on to new custodians during this time, and the S680/2, due to its rarity and classic silver half-moon dial, S-Meter and sexy logging scale, was deemed to be one of the 'keepers' in my dwindling collection…

I bought this S.680/2 back in 2010 and spent some time restoring it that year. The work at that time focussed mainly on the set's cosmetics as it was looking a bit 'down at heal'. Two articles detailing the work done in 2010, plus background to the introduction of the S.680[1], can be found here and here. The cosmetic work included making a reproduction (laser printed) fingerplate and powder coating the case and front panel in black wrinkle finish. Electrical restoration was minimal - I replaced the power supply choke with one that would fit into the correct choke shroud as, on arrival, the S.680/2 was fitted with a 'mongrel' replacement choke (so arguably that was also cosmetic work), and replaced the BFO tuning capacitor, both removed from a scrap S.750. Apart from replacing the original choke with the 'mongrel' I removed, someone had previously replaced both power supply electrolytics, added a small disc ceramic capacitor across the 6pF coupling capacitor from the BFO to the last IF transformer to increase the BFO injection



[1] The S.680/2 was actually marketed as the S.680, however, the original S.680 had overheating problems due to the use of a poorly ventilated and smaller than suitable case, plus a marginally-rated power transformer, so was never put into production. The S.680/2 was manufactured for two years before being succeeded by the very successful S.680X (article here)



level, replaced the power switch with one marked 'Japan', and changed the Mixer valve, a Loktal type 7S7, to a 7J7[2]. No other re-work was obvious to me.

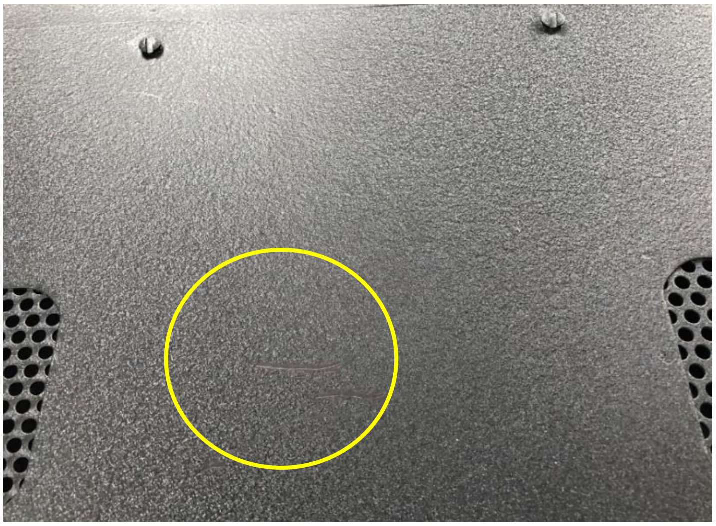
Check-Up

Cosmetics

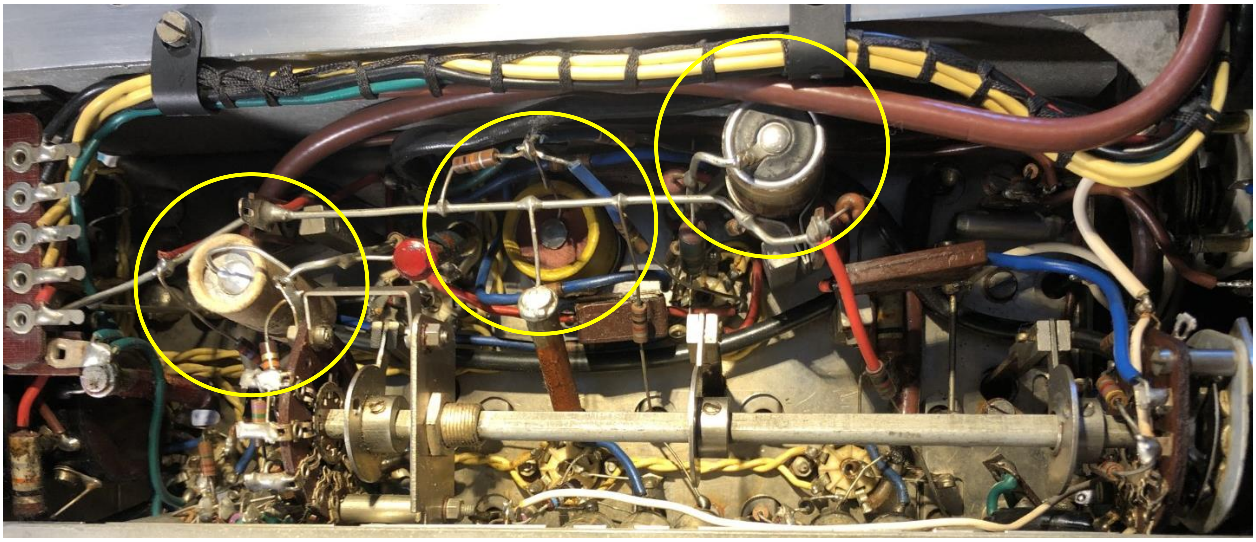
The S.680/2 survived the storage and house moves pretty well, save a minor score mark on the top of the case (circled in photo, below) – only visible in strong light at a certain angle, but annoying nevertheless given that the case had been powder-coated and looks in pristine condition otherwise. I have no idea how this happened as the radio was wrapped in bubble wrap and was double-boxed. One of life's mysteries…

Electronics

I powered the set up slowly using a Variac and it sprang to life at around 90vAC on the power transformer primary. Overall it was still working quite well, save scratchy RF and AF gain controls, though the audio volume seemed a bit on the low side given that it has a push-pull output stage. Under the chassis is remarkable for its originality (apart from the few component changes noted above), and it even included three 'period-looking' replacement tubular electrolytics in the audio stages. I decided to check out critical resistors and replace (likely re-stuff) the tubular electrolytics as a minimum, as well as clean the AF and RF gain pots with a squirt of Deoxit, investigate the lower than expected audio output, and check alignment. Also, the power supply electrolytics had been replaced with older-style can types – one looking like a typical 1960's service replacement (a four capacitor unit, with only two sections in use), the other older, possibly a late-1940's - 1950's vintage 'spigot' type, sporting 'Made in Canada'.

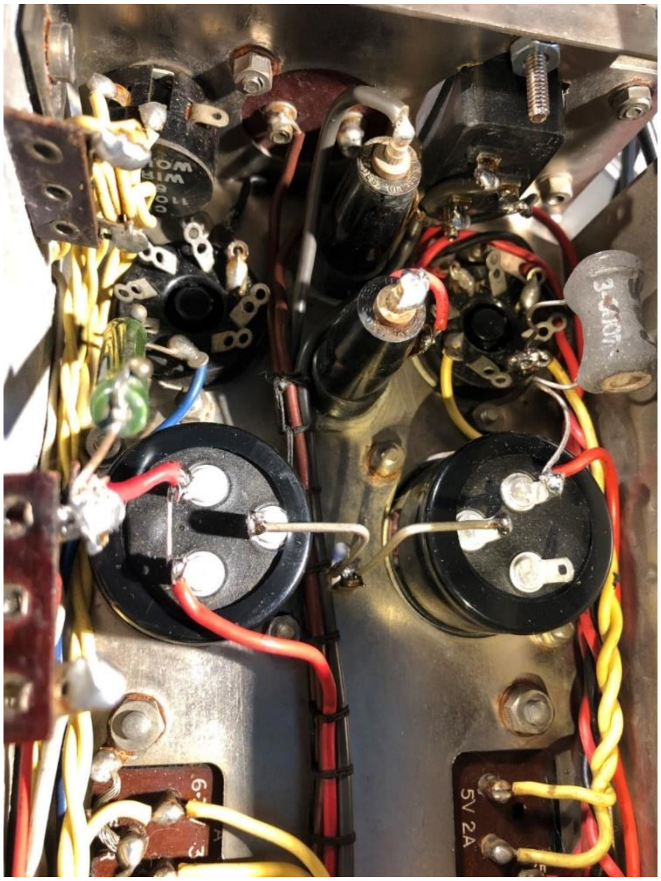


[2] The 7S7 and 7J7 are both triode-heptodes. They have very similar characteristics and identical pin-out. The 7S7 was the successor valve to the 7J7. The use of a Loctal valve in this set may reflect on post-WWII availability, or lack of, of the miniature 7 pin equivalent, the 6BE6



First, I checked the three tubular electrolytics in the audio section, circled in the photo, above. Without looking too closely, I had thought these were original, but removing them revealed that they were not: 'Made in Canada' on one and 'Cornel Dubilier' on the other of the two cardboard-sleeved valve types. These were likely replaced in the early-1960's (or at least used parts from this era). Amazingly, one of these, the output stage cathode bypass capacitor (C87: 25uF, 25vw) tested ok, with >1Mohm leakage and 40uF capacitance, as did the other, the plate supply bypass capacitor common to the 1^{st} AF/phase splitter stages (C74: 8uF, 350vw). The third tubular electrolytic (C85: 0.4uF, 350vw – yes, a 0.4uF electrolytic!) screen bypass capacitor, again common to these two AF stages, had been replaced with a plastic-sleeved metal-bodied 8uF 450vw part sporting a military part designation: this had turned into a 100Kohm resistor with zero capacitance. Even though the two cardboard-sleeved capacitors tested ok, given their age, it was prudent to replace all three. I decided to re-stuff two of them, but not the plastic-sleeved metal can one. Instead, I re-stuffed a paper capacitor body from another radio with a 0.47uF 630vw plastic film part. Although these capacitor bodies are all of North American origin, I decided they reflected some of the sets history, ie. it's a British 'expat' – like me – and has started to develop some 'foreign ways' (like me now having a taste for cold beer…). The re-stuffed capacitors are shown in the photo, right.

Checking around for something that might be the cause of the low audio volume, I found the main HT voltage was only 180vDC. This was traced to a low emission 5Z4 rectifier valve – it had been fine when I was using the set several years ago, but each diode section was now showing only around 30% emission – very odd. I found some NOS 5Z4 and a 5Z4G in my stock, and replacing the dud rectifier with one of the 5Z4s brought the voltage back up - actually to a higher-than-desirable value when the set was powered from a 117vAC supply. I decided to replace the two power supply filter capacitors as, although

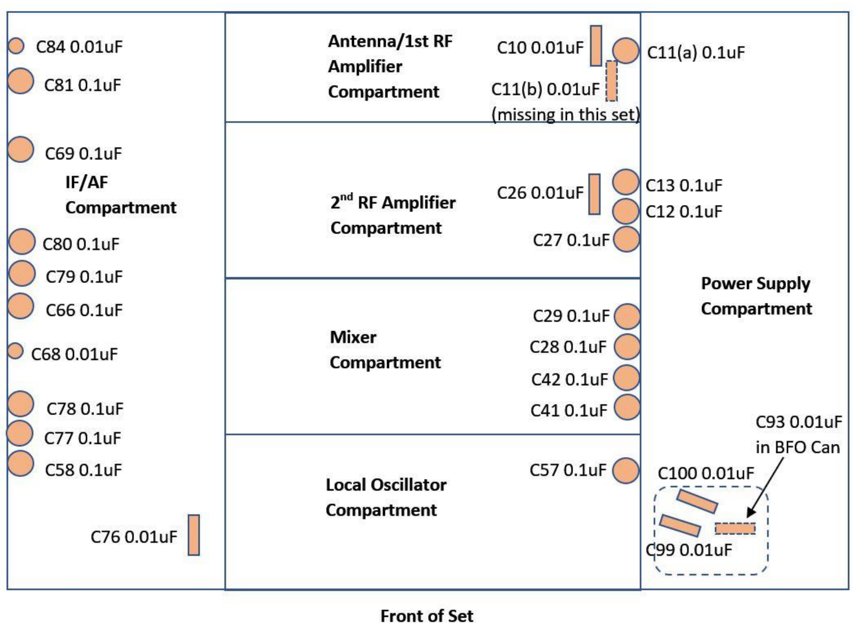


these seemed to be functioning ok, they were of unknown age and provenance, and could have been the cause of the failed rectifier if one of them had excessive leakage after several years in storage, even though I brought the set up slowly on a Variac. The two chassis holes for the capacitors are suitable for cans up to around $1^3/_8$" diameter. The most readily obtainable/economical can capacitors of this size are dual 32uF 500vw parts manufactured by 'JJ', and I had two of these in stock. Before installing these I experimented with the new capacitors and a dropper resistor. I used one section (32uF) of one JJ can capacitor as the reservoir with a 300 Ohm resistor between the rectifier cathode and the capacitor (to afford some surge protection of the rectifier from the use of a 32uF reservoir capacitor), and paralleled the second JJ capacitor 32uF sections (ie. totalling 64uF) as the smoothing capacitor after the choke. This gave voltages within 10% of those in the manual's voltage table with a 117vAC supply using a 1000 Ohms/volt meter for the measurements, which is the voltage tolerance specified. On removing the previously-fitted capacitors, I found that the 'spigot' one, used as the reservoir, was dated 'Sept 1951', so it was only a couple of years younger than the set! The other, though undated, was likely a decade or so younger, judging by the construction style. The replacement JJ ones look the part, if a little diminutive from above the chassis (photos, above and right), and work very well. I used a 'period' style wire-wound 5W resistor as the dropper - it dissipates around 2.7W, so I 'looped' the leads and left them fairly long to aid cooling (it can be seen to the upper right in the photo, above).

I then replaced the 5Z4 with the NOS 'mil. spec.' 5Z4G (photo, right) and found that the HT voltages rose slightly, but still within the 10% tolerance of nominal. Then, just as I was thinking the set was running fine with the upgraded power supply, I smelled that distinctive aroma of burning electronics… I switched the set off immediately, and upended the chassis again. On switching it on, I saw a wisp of smoke float out of the rheostat that is used to dim the dial lights. After some poking about I found the problem – I had nipped one of the leads going from the rheostat to the dial lights beneath one of the bolts that hold down the can capacitor clamps – it cannot have been making good contact, but turning the chassis the right way up must have been just enough to instigate a short. A sleeve of yellow heat-shrink soon fixed that problem and, thankfully, the rheostat still worked just fine (good old 'Colvern' – I think their motto must have been 'We may be scratchy and rough, but we're also solid and tough!'…).

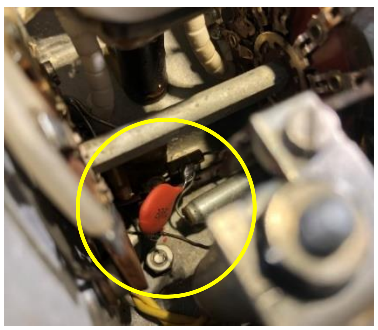
Before I moved on to checking other passive components, I decided that I should probably test the valves – I had not done this in 2010, rather, after cleaning the chassis I had simply re-installed the valves that came with the set and, as it worked reasonably well, left them in. However, given the very weak 5Z4, it was now appropriate to spend a little time with the tester… Most valves tested ok, with the weakest being the Mixer, where a 7J7 had been subbed for a 7S7 - the heptode in the 7J7 valve having only 35% emission (the triode section is unused), the Local Oscillator (6AM6) with 52% emission, the 1st IF amplifier (6BA6) with 52% emission, and the 1st AF amplifier (6AU6) with 50% emission. The 6BA6, 6AM6 and 6AU6 were replaced from my stock with NOS valves, plus an 'upgrade' made to a higher emission NOS 6BA6 for the 1st RF amplifier. Both a 7S7 and 7J7 were ordered as I had neither of these valves in stock (I ordered both as I wanted to compare the two types). I did consider replacing this Loctal valve (photo, left) with a 6BE6, as some S.680/2 sets were fitted with this as standard, and I dislike Loctal valves. However, this would involve removing the Loctal valve base and making an adapter plate for a 7 pin valve socket (not easy!), so, as the Loctal valves were readily available at a reasonable price, I decided to keep to the original configuration.

The remaining tubular paper capacitors in the S680/2, used for bypass applications, are all metal-encapsulated paper dielectric types manufactured by TCC[3] and, in my experience these generally have high-reliability, especially the type that bolt to the chassis (0.1uF 'Metalboss' types). Even so, it is critical that some of these have very low leakage, eg. if used on the AGC line - and some of these are the smaller 'Metalmite' types. I spent some time 'mapping' which capacitor was which on the chassis (figure, right). All those tested showed some leakage, ranging between 2Mohms and >30Mohms, with the most leaky being the 0.01uF 'Metalmite' types. However, the AGC line peaks at almost -16v on a strong local signal and is good at all the AGC-



[3] The 'Metalboss', 'Metalmite' and 'Metalpack' types made up the TCC 'Super Tropical' range of capacitors. These were described as fully tropic-proofed with synthetic rubber end seals, and had been developed for use in high humidity and high temperature conditions "such as were encountered in jungle warfare". Temperature range is described as -30 to +100 degrees C. The 'Metalboss' was the bolt-on type with the can acting as a shield. The 'Metalmite' was designed for small size and was slightly more expensive than the 'Metalpack' which appears to have been the standard version. Some sources note that these capacitor types were impregnated with oil ('Visconol'?) which may contain PCBs

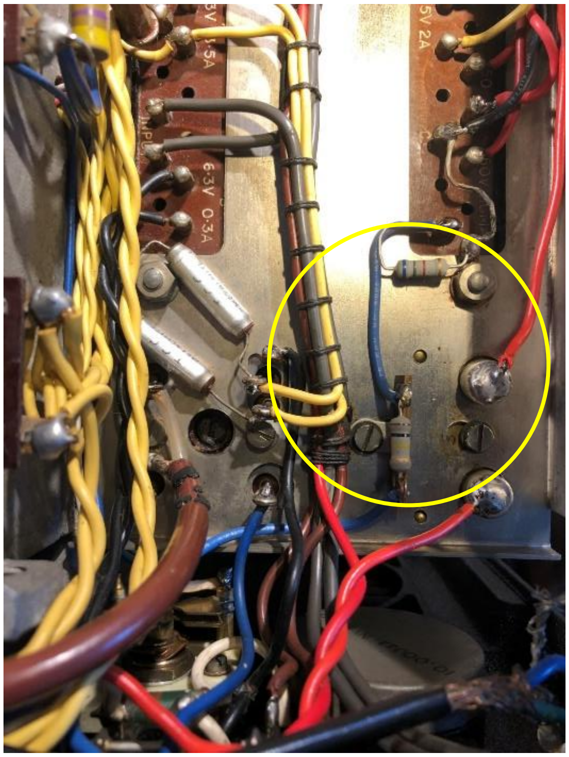
controlled valve grids, so I was not concerned at the AGC bypass caps being overly-leaky. All the 0.1uF 'Metalboss' caps tested were an order of magnitude less leaky than the 'Metalmite' ones, and so even the plate and screen supply bypass caps were not causing issues such as lowering voltages or overloading resistors, and, of course, those used as cathode or heater bypass caps were also fine at these very low leakage levels. All the caps tested were close to the marked capacitance values, so, for now at least, I decided to leave these capacitor types installed in the set. I have some thin-bodied 0.1uF 630vw plastic film caps that will enable the 'Metalboss' caps to be stuffed in the future if the leakage worsens significantly – not an insignificant task though, especially given the possibility of PCBs being present… While I was in 'capacitor mode', I installed a couple of Y-Class 0.01uF mains filter caps on the IEC power socket, and installed C11(b), a 0.01uF cathode bypass cap in parallel with the 0.1uF 'Metalboss' one in the 1st RF stage. These are both marked 'C11' on the schematic and parts list, and the 0.01uF part was missing in my set – it was likely a later revision introduced during the production run of these sets and is shown on the schematic as being located right at the valve socket, likely to improve bypass efficiency at higher frequencies (a similar cap was added to the 2nd RF stage cathode in the S.680X[4]). I used a disc ceramic cap as these are relatively low-inductance, especially if the leads are kept short, and are thus very suitable for RF bypass applications. Also, their compact size allows relatively easy installation in the rather cramped space available adjacent to the 1st RF amplifier valve base (circled in photo, left).



Resistors were generally checked in-circuit, allowances being made for parallel resistance paths where applicable, though opportunity taken if one end was disconnected when checking capacitors, or where in-circuit testing gave ambiguous results. I eventually ended up replacing 17 resistors. The worst drifting had occurred in three of the cathode resistors (1st RF, 2nd RF and 1st IF amplifier stages), where these were 150 – 400% higher than their marked values. The others replaced were either marginally outside their marked tolerance or were in the BFO can: the two resistors in the BFO can tested ok, but were replaced anyway as I took the unit off to replace the paper bypass cap inside (photos, right). This is a prudent thing to do as removal/replacement of the can takes a while[5]. On checking the receiver after the cathode bypass resistors had been replaced there was noticeably more gain.

[4] The 'Quick Reference Guide' (QRG) notes that "The only circuit difference [between the S.680 and the S.680X] is the frequency changer valve." This is incorrect – there are several minor differences between the two circuits apart from the use of the 6BE6 in place of the 7S7 in the S.680X (and the 6BE6 was used in later S.680s also). These differences include improved RF and AF amplifier stage cathode bypass arrangements, separate screen supplies in the 1st/2nd AF amplifier stages, a slightly increased BFO injection level, changes to the IF gain equalization circuit for different bandwidths, and a modified 'phones output circuit.

[5] The BFO design is very similar to many other Eddystone sets of this period, however, this was the first one I had come across where the base of the can had been soldered on – they certainly did not want the BFO signal to leak out!



While I was checking through the circuit and comparing with the component layout, I noticed that the positive bias circuit on the heater of the 6AL5 dual-diode valve used as noise limiter/S-Meter diode was missing – it had never been installed. This comprises a potential divider (100Kohm and 6.8Kohm resistors) between the 150v HT+ supply and ground, with the junction of the two resistors connected to the centre tap of the heater winding on the power transformer supplying just this valve (V13). This circuit provides an approximate +10vDC bias to the heater of the 6AL5 to reduce hum pickup from the heater in this valve[6]. Instead, in this set, the centre tap of that heater winding was simply grounded. I had not noticed any hum present, but decided that I should install the two resistors anyway to conform with the schematic (circled on photo, left), the 100Kohm one mounted on a small tagstrip. As to why this circuitry had not been installed in this set is a mystery – maybe it was an improvement that was introduced during the production run like C11(b) noted above? – we will likely never know. Anyway, the bias circuit works just as it should.

I felt this was as far as I would take things for now with the S.680/2 – maybe I will get around to re-stuffing those TCC by-pass caps when we are all buttoned-up when 'Covid-21' sets in a couple of years from now… The set was then placed on 'soak-test' (a demo video here), and the checks on alignment postponed until I had a new 7S7 Mixer valve installed and 'burned in' for a couple of days. The NOS 7S7 made a significant difference to the set's sensitivity – I also tried a NOS 7J7, and although it was much better than the low-emission 7J7 that was in the set previously, it was not a patch on the 7S7.

Alignment Checks

I had made quite a bit of effort back in 2010 to get the IF and RF alignments 'spot on', even so, almost a decade had elapsed, so it was definitely due for a check-up.

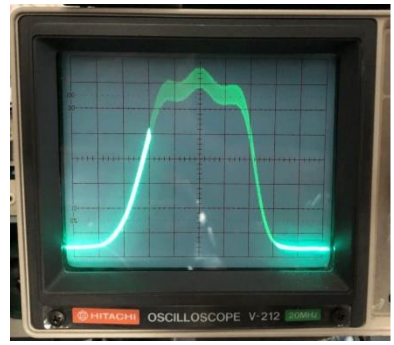
IF Alignment

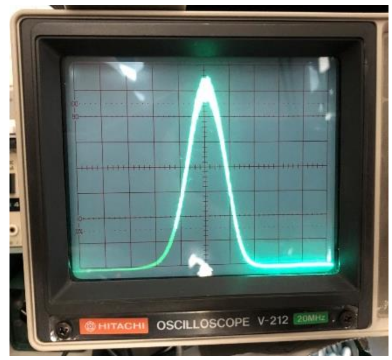
I used a similar wobbulator set-up as described in Part 2 of my 2010 article

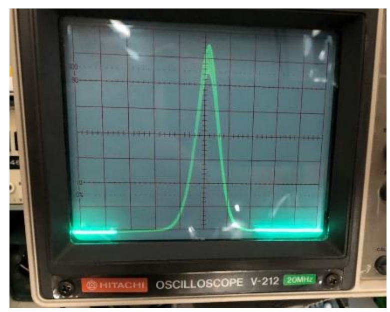
[6] This circuit was further refined in sets such as the S.888A and S.830 series, where a ~30uF electrolytic is used to bypass the 'floating' heater centre tap to ground at AF frequencies. I later decided I may as well use the 'spare' 32uF capacitor in the power supply for this purpose

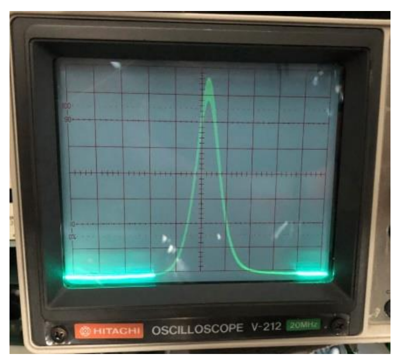
(see pages 10 – 16, here) and found that the alignment was still pretty good, though the widest IF bandwidth setting showed a slightly asymmetrical top to the flattened response curve. A very slight tweak of the slugs in the primary core of T1 and secondary cores of T2 and T3 corrected that.

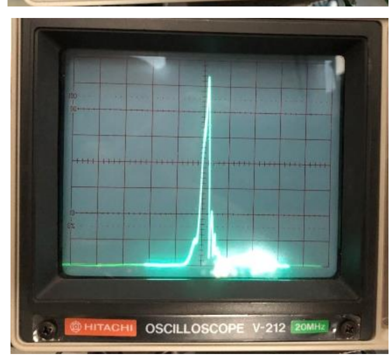
I also noticed that the amplitude of the response curve in the widest bandwidth setting was around half of that on the other three settings. Checking the schematic, I noted that the gain of the 2nd IF amplifier stage is controlled by varying the cathode resistor between each bandwidth setting. In the widest setting, an 8.2Kohm resistor is switched into circuit. This had drifted a little high in value (8.9kohm), but was within tolerance. I experimented a little with different resistor values and found that a 2.7Kohm resistor equalized the amplitude of the response curve with the other bandwidth settings. On comparing with the S.680X schematic, I noted that only the second-widest bandwidth setting in that circuit contains a resistor (560 Ohms), the others are simply shorted out. Given this, I thought I may as well leave the 2.7Kohm resistor in circuit – an easily reversed tweak if anyone ever wanted to revert to the original value. The upper four photos, right, show the IF responses, from 'Minimum' at the top, to 'Maximum', the bottom photo showing the response on 'Minimum' with the crystal filter switched in.









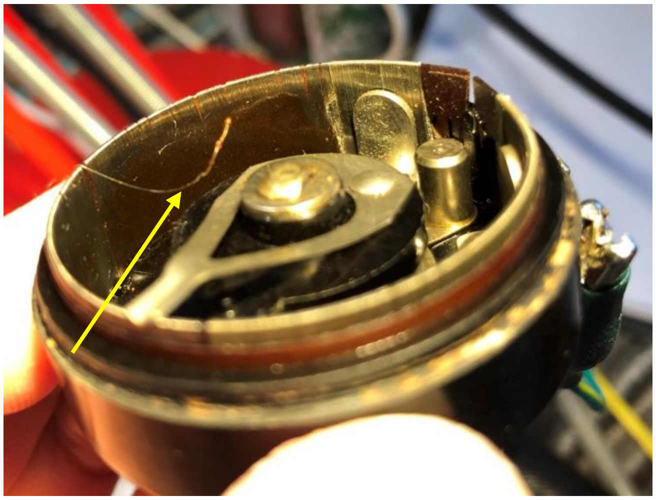


RF Alignment

All bands required a slight tweak to the Local Oscillator slugs/trimmers and the Mixer and RF stages slugs and trimmers to bring the receiver to optimum performance. The only issue encountered was that whoever drilled the adjustment holes for the slugs in the coilbox cover did not align them correctly with the slugs beneath, thus requiring more than a little patience to locate the trim tool into the slot in each slug. I think I adjusted the slugs with the coilbox cover off back in 2010 because of this issue and only tweaked the trimmers after the cover was installed. Anyway, I managed in the end and I am pleased with the results.

Final Problem

I was using the receiver following the alignment work when I noticed something wrong with the RF gain pot (used as a rheostat). As in other Eddystone valve receivers, this is a 'bespoke' wire-wound 10Kohm anti-log law part. This particular example was a little rough, in that you can feel each time the wiper passes over a change in the Nichrome wire it is wound with: to obtain the correct law, the winding is actually a combination of several windings of different resistance value Nichrome wire, these 'segments' overlapping, to provide continuity. I have felt this effect in some other RF gain controls on Eddystone sets, though not as pronounced, but now I noticed when this RF gain pot was backed-off

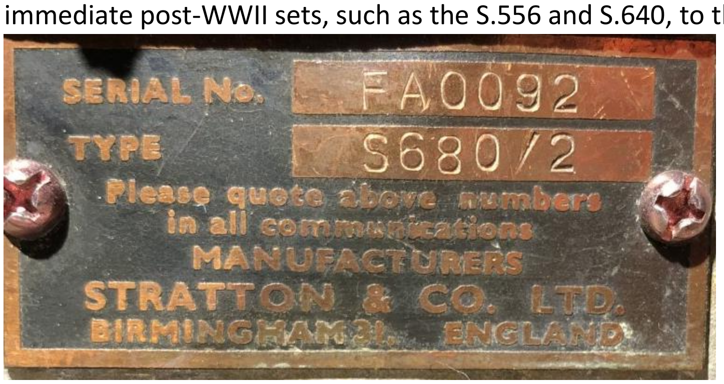


around two-thirds of its travel, the signal cut out. I decided to remove the control, open it up and inspect it. The problem was obvious – a piece of Nichrome wire from one of the winding segments had detached and was not making connection with the adjacent segment (arrow in photo, left). Nichrome wire does not take solder well, so I decided to effect a repair using glue and electrically-conducting paint (the type used to repair rear window defoggers in cars). I trimmed the loose wire, cleaned it and the adjacent winding segment with IPA, then held the end of the wire down against the cleaned section with a dab of epoxy glue. When the epoxy had set, I applied four coats of the conductive paint over where the wire was held against the adjacent segment. When dry, I applied a coat of clear varnish over the conductive paint to provide additional physical stability/protection, plus a little silicone grease to the wire track for lubrication (photo, right). The control was tested (and worked ok), before re-assembling and re-installing in the receiver. It was now working as it should again – phew! (these pots are 'unobtanium', and a linear-law pot does not work well, cramping all the 'action' into a quarter of the rotation).

Closure

The S.680/2 'revisited' has been an interesting project. My recollection was that I had done more work on the electronics than I actually had – it is remarkable how well the set was performing with most of its original passive components, ie. only the electrolytics had been replaced (with one failed again), no resistors replaced, and with several 'marginally ok' valves installed.

Working through the set has been educational too, as this is a sort of 'transition' model from the immediate post-WWII sets, such as the S.556 and S.640, to the more established and more sophisticated Eddystone stalwarts introduced in the 1950's (such as the S.680X, its military derivative, the S.730 series, and the S.888/S.888A amateur band models), and the early-1960's (such as the S.830 series, S.940 and EA12). This particular S.680/2, S/N FA0092, dates from June, 1949 (photo, left), and was therefore from an early, possibly the first, production run of



this model. While many of the basic circuit elements of these later receivers were deployed in the S.680/2, several refinements were not yet present, eg. grid stopper resistors on the RF amplifiers and improved decoupling throughout, or, in a couple of cases identified in this article, even if present on the schematic, some circuit elements were absent in this particular set, such as the bias voltage applied to the noise limiter valve heater. This demonstrates 'learning on the go' at the 'Bathtub' and Eddystone's engineers striving for continuous improvement and applying this to later production runs of the same model. A comparison of the S.680/2 and its successor, the S.680X, shows the introduction of some of these circuit refinements, as does comparison with later models through the 1950's and 1960's, some of which were carried through to the last Eddystone valve sets, the S.830 series, produced into the early-1970's.

As I noted earlier, after 2010 my life became a bit hectic - at work and elsewhere, culminating in packing away much of my radio stuff back in 2015 followed by 'decluttering', preparing to downsize, ie. getting rid of stuff (including radios!), extensive house and apartment renovations, a house sale and purchase, and eventually moving to Victoria BC full-time after I retired from consulting engineering in 2017. Its taken more than a couple of years to get around to unpacking some of my Eddystones, but they are all now released from their bubble-wrap and cardboard prison cells!

Waiting to get onto the bench for a check-up next is my S.830/4 – I last worked on that set in 2011 and it was working great before I packed it away in 2015, so it will be interesting to see how its performing now. I am of the firm opinion that radios should be used regularly – years, even months, of not being used is harmful to a receiver's health and well-being!