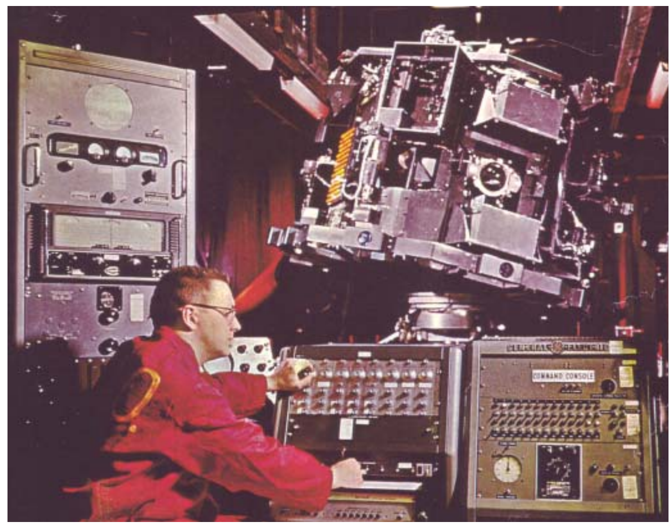
"You must be Nuts…" – Restoration of an Ebay Left-over Eddystone S.770U MkI – by Gerry O'Hara, VE7GUH/G8GUH

Eddystone's Early VHF and UHF Receivers

Eddystone's experience of designing and building VHF radios (transmitters and receivers) dates back to pre-WWII with the S214 receiver, used as part of a duplex police VHF radio network. Development work continued through WWII, with the production of the S440 VHF transmitter and S450 receiver (WS57)[1]. Post-WWII, Eddystone started to develop VHF surveillance receivers for the British Ministry of Defense at the time of the Korean War. The original specification was for a receiver covering 20 to 250MHz for aeronautical monitoring. Eddystone proposed this as the S770M, which appeared at the 1951 Radiolympia show, where it was billed as a double-conversion superhet. However, this design failed to work satisfactorily as the tuning gang developed self-resonance around 200MHz[2] and the S770M therefore never entered production. Subsequent development work at the Bath Tub culminated in the S770R, a single-conversion superhet (5.2MHz IF) covering 19 to 165MHz, being brought to the market in 1953, while work continued on a separate receiver specification to cover the higher-VHF and lower-UHF bands. This later specification would become the S770U, launched in 1955, covering 150MHz to 500MHz. Although superficially similar in appearance to the S770R, the S770U represented a fairly radical rethink of the earlier S770R design, the S770U being dual-conversion (IF's at 50MHz and 5.2MHz) and with a completely re-designed 'miniature' turret tuner mechanism. The S770U was designed for wideband FM and AM reception only (no BFO



Above: Testing the stabilization and control system for the NASA Orbiting Astronomical Observatory (aka 'Hubble Lite') at General Electric's Missile and Space Division. Note the Eddystone set in the rack to the left - the EUG website notes this as an S770U, but if you look very carefully it is actually an S770R, as per Issue 44 (p21) of the EUG Newsletter. The photo was likely taken in early-1966 as this satellite was launched on April 8 of that year, however, it remained active for only 3 days. Now, if NASA had let Eddystone build the satellite it would probably still be operational, providing Space Shuttle crews had replaced the 'Red Hunts' and 'Rat Droppings' capacitors… and maybe the odd valve from time to time.

'EddyStar'

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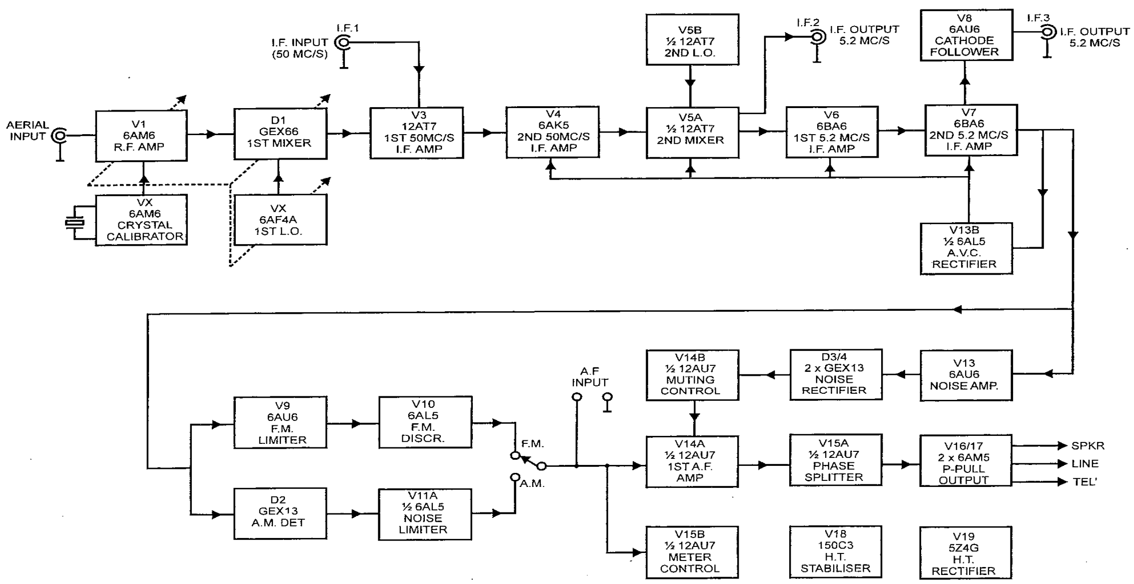
[1] The Cooke Report, Bill Cooke, 1998/9.

[2] After The Ultimate Quick Reference Guide (QRG), 2nd Ed., Graeme Wormald, 2002.

present), whereas the S770R also provided for CW and NBFM reception. At the time of their initial production, it is claimed that the S770R and S770U represented the only commercially-available fully-tunable VHF/UHF coverage receivers, and therefore ended up in some unusual and prestigious places world-wide, such as university research labs, various arms of the military, GCHQ, the G8GUH/VE7GUH shack (ok, after a 50 year hiatus) and even NASA (well, sort-of – see caption on previous page). So, why was Jodrell Bank apparently using US-made Nems-Clarke VHF receivers at that time for satellite tracking? (like the model 1906 shown above - what a dull-looking receiver). If so, shame on you Sir Bernard![3].

The S770U Design

While the manual for the S770U MkI offers a brief explanation of the circuit, owners should also obtain the S770U MII manual as it provides a much more detailed explanation of the circuit operation – in particular regarding the muting and metering circuits. The following text provides a brief summary of the circuitry, and the manual



and schematics should be referenced for more detail. The block diagram for the S770U MkII is shown above, and differences between this and the MKI are described below.

The RF amplifier (V1) is a UHF triode (6AJ4 or 6AM4) in a grounded-grid configuration to provide stability and a low noise figure. Range switching is via a 6-position coil turret arrangement. The signal is then fed to a germanium diode 1st mixer, D1, a GEX66[4], along with the output of the 1st local oscillator (V2), a 6AF4 in an 'ultraudion' circuit.

[3] EUG Newsletter, Issue 48, page 7, notes the S770U was used at Jodrell Bank, however, as far as I can tell, the Jodrell Bank website contains no references to support this claim. Of course it is still possible…

[4] See EUG Newsletter Issue 44, page 19 for info on the germanium GEX66 diode per Tor Marthinsen.

The 1st local oscillator tracks 50MHz high of the received signal on frequencies below 330MHz, and 50MHz below the received signal above 330MHz (ie. on Ranges 1 and 2) to improve frequency stability of the receiver front-end.

The output of the GEX66 mixer is fed to a two stage 1st IF amplifier (50MHz): the first, V3, is a cascode (12AT7), the second, V4, a pentode (6AK5) – the gain of the latter being adjustable by the IF gain control (R17). Standby switching is achieved by introducing a resistor (R34) in series with the IF gain control, biasing V4 off when in standby mode. The amplified 50MHz signal is fed to the 2nd mixer, V5A, where the 2nd local oscillator signal from V5B (12AT7), operating at 44.8MHz, is mixed to produce the 5.2MHz 2nd IF.

The 5.2MHz 2nd IF signal is fed through two stages of amplification (V6 and V7, both 6BA6's). AGC is applied to V4, V5A, V6 and V7 in AM and FM modes. A Germanium diode, D2, a GEX34, acts as the AM detector. In FM mode, the 5.2MHz IF signal is fed to a limiter (V9), a 6AU6, then to a Foster-Seeley discriminator (V10), a 6AL5. V8, a 6AU6, is a cathode-follower used to feed the 5.2MHz IF to external devices.

Audio from either the AM or FM detector is switched to the audio stages via the AF gain control (R54) and first AF stage (V12B), half of a 12AU7. V13B is the second AF amplifier, half of another 12AU7, which feeds the AF output valve, V17, a 6AM5. V11, a 6AU6, serves as a noise amplifier, the rectified output of which (via D3 & D4, both GEX34's configured as a voltage doubler) operate the muting gate[5], V12A, half of a 12AU7, which controls the bias on the first AF stage (V12B), half of a 12AU7. This biases the AF valve to cut-off when noise levels are high, the level at which this occurs being adjustable via the pre-set resistor R53. One half of a 6AL5 (V14) serves as the AGC rectifier for AM and FM reception, and the other half is switchable as a noise limiter for AM signals. V13B (half of a 12AU7) functions as a cathode-follower meter control valve, input to which is switched to either the FM discriminator or AM detector. AGC delay voltage is derived from the potential divider formed by R59, R85 and R86.

The power supply is a conventional arrangement, with a 5Z4G (V16) providing rectification and a VR150/30 (V15) supplying a stable 150V supply to the RF section. A small positive bias is applied to the centre-tap of the heater supply to V14 to minimize hum, and provision is made for use of an external power supply via an octal plug on the rear panel of the receiver. Extensive filtering is applied to the HT and LT circuits to mitigate stray coupling between stages at RF and IF frequencies. The MkII circuit is very similar to the MkI, with the following primary differences:

- A 50MHz crystal calibrator modulated is fitted, with a solid-state tone oscillator;
- A re-designed audio output stage (push-pull), with a reconfigured first AF stage to suit (one half of a 12AU7 dual triode acting as a phase splitter);
- The AGC delay is derived from the cathodes of the push-pull output stage;
- A low-level, wide bandwidth 5.2MHz output socket (for use with a panadapter (Eddystone Model EP14);

[5] Some MkI sets were supplied without the muting circuit (per Ian Batty's set described in *Radio Waves*).

- Absence of the rear panel octal socket for external power supply operation;
- Replacement of GEX34 diodes with GEX13 types in the noise rectifier and AM detector; and
- The mains transformer has plug-switchable input ranges.

Mechanically, the MkII sported the new-style grey cabinet, front-panel, fingerplate, knobs and that very useful 'fudgit', the scale adjuster, as used on the S730 and S830, allowing the curser to be re-positioned to coincide with the nearest calibration point[6].

In addition, some component types changed, with a welcome absence of the 'grub-like' ('rat's droppings') capacitors in the MkII and the addition of some polystyrene capacitors.

The Dangers of ebay.ca Watching

I must admit that I am a bit of an 'Ebay watcher' – particularly regarding Eddystone items. It is a bit of a self-tease for me though, as the vast majority of Eddystone sets and paraphanalia that come up for auction are located in the UK and the costs of shipping to Vancouver, Canada are generally prohibitive, if, indeed the seller is willing to pack and ship overseas – not always the case. So, while I watch all those lovely old sets going for a song to the lucky folks residing in the UK and them paying just a few bob for shipping, I sit here in Vancouver drooling… Of course, there are occasional sets that come up for sale on this side of the 'pond' also, but they are relatively few and far between – particularly of late I have noticed. Anyway, when they do appear, and if they are a model I do not have in my modest collection (and would like to have), I track them particulalry closely as the shipping is much more reasonable. Also, if the set is in the US, I can ship to a post box on the US side of the border (for even cheaper shipping) and pick it up in a 1 hour or so cross-border trip from where I live in Canada.

As part of my 'watching' I noticed an S770U MkI come up for sale earlier this year in the US with a starting price of $99 (about £45). It did not look in particularly bad shape from a glance at the photos, though I could see that the cover over the turret tuner was missing. However, I was not really looking out for this model – thinking that there was probably not that much to listen to on the higher-VHF and UHF bands these days, and recalling a comment made to Mike Cassidy that anyone attempting to restore an S770U "must be nuts" given the lack of stations, together with the age-related and mechanical wear issues of the turret tuner in these sets. Anyway, on the closing day of the auction I was in the SPARC radio museum workshop and was chatting to my friend, Pat (another Eddystone

[6] The QRG notes on the S770U MkII comment that a 'linear dial bar' was another addition fitted to the MkII sets 'to even out the read-out' (see Appendix I).

enthusiast) and mentioned that the S770U auction was closing imminently. Now, Pat has an iPhone and we decided to take a peek at Ebay "just to see what the set would go for" during the last minutes of the auction. Well, there were no bidders, so on an impulse, and feeling rather sorry for the poor old set (oh, the embarassment of being an Ebay auction left-over Eddystone!), I entered $99 and won the auction, with shipping at a very reasonable $45 (memo to self – do <u>NOT</u> buy an iPhone!). So, with the touch of an iPod screen I became the proud owner of a 1957 vintage piece of high tech purchased on a 2009 piece of high tech – aaah, if only those good folks at the Bath Tub could see 50+ years into the future (maybe if they could they would not have used 'red Hunts' and 'grub' capacitors? and maybe, just maybe, they would have made some of their sets, the S770U included, just a little easier to access for servicing – I am thinking of things like the resistors in the S940 cascode front-end and, of course, the audio stages in the S770U. I cannot complain too much, as each servicing challenge keeps my brain active and my fingers supple… (as well as my tea-drinking prowess and cursing repertoir up to scratch).

When I penned my S770R article back in 2006, I noted that the SPARC museum's collection here in Coquitlam, BC, Canada included several Eddystone receivers, including an EC10 MkI, an S680X, an S840/4, an S770U and two S770R's (one de-acquired into my collection for a donation to the museum), as well as an S640 in nice condition, the latter located in 'pride of place' in the display cabinets near the entrance to the museum. I have restored the museum's S680X (a very fine example of this model) and am awaiting the go-ahead to restore another – preferably the S640 (it would be a bit of relative light relief - my last restoration for the museum was two Racal RA-117s – complete re-capping, all new resistors, clean-up and re-alignment - big job!). The museum's S770U[7] is in slightly better condition than the one I 'won' on Ebay, having a complete set of coil biscuits and all the compartment covers in place – this allowed me to use the Museum's set as a template for some of the restoration efforts on my S770U.

Initial Inspection, Clean-up and Safety Checks

My new Ebay impulse purchase arrived a week or so later – reasonably well-packed in a double carton. It had survived the vagaries of the US postal service quite well – dial glass intact, no bent handles (that's a first for me), chassis unbent and all the valves still in place. The S770U case is a match for my S770R: 'polychromatic grey wrinkle' according to the manual – unfortunately now more aptly described as a 'grubby, scuffed, scratched and very tired-looking grey wrinkly' (or maybe that's me?). For some reason the grey wrinkle finish on Eddystone sets does not seem to have weathered the passing years as well as the black wrinkle finish. I plan on having both sets re-finished by powder-coating either in grey wrinkle (if I can locate some) or in black wrinkle.

I removed the case and was confronted with the open turret tuner compartment (cover missing) and noted that the small silver-plated covers were also missing from the 2nd local oscillator compartment (both above and below the chassis). Looking inside the turret compartment, I noted that the Range 2 coil biscuit was missing and the Range 1

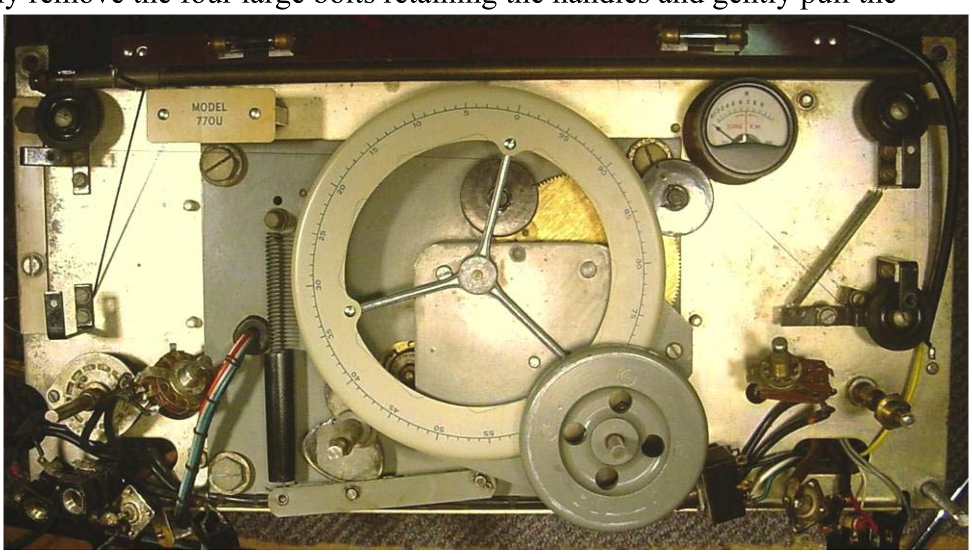
[7] Serial Number 'BLO735', dating from February, 1960 – around three years younger than my set.

biscuit was broken into three pieces. On closer inspection I observed that several of the contacts[8] on the other coil biscuits were missing or damaged, or had been replaced rather cack-handedly with small bent pieces of brass. The remainder of the set looked to be in reasonable shape, though very grubby and 'tired-looking'. Apart from the turret issues, I could only see one obvious repair to the electronics – a single replacement capacitor in the AF section, not bad for over 50 years, but what condition the remaining parts?

I vacuum-cleaned the chassis and case, using a small paintbrush to penetrate nooks and crannies. I wiped the case and front panel with a cloth/cotton wool wipes and warm soapy water, and wiped the chassis with alcohol (using Q-tips and cloths) to remove grime. The IF section of the main chassis is silver-plated brass (seems a bit of design overkill and extravagance at the 50MHz 1st IF, never mind the 5.2MHz 2nd IF). Some local discolouration of the silver plating is present, likely where minor imperfections in the plating have eventually resulted in spot-corrosion of the underlying brass.

When removing the knobs, I found that the grub screws were rusty and the slots were gnarled. I managed to remove them all with a little penetrating oil and cleaned them with a wire brush, applied a little light oil and reinstalled. The more badly-gnarled grub screws were filed down and their slots re-cut or new grub screws fitted in some cases.

The fingerplate was removed next: to do this remove the retaining nuts on the switches and controls, and ease off the front panel – it had been stuck down as usual using a black (bitumen) adhesive, but came away quite easily. Having removed the knobs and fingerplate, which was in remarkably good condition and black (unlike the one fitted to my S770R which is a strange bronzy colour), and showing only minor wear, I next removed the front panel to allow access to the scale plate, rear of the dial glass, parts of the turret tuner's Geneva drive, flywheel/friction drive and chassis front for inspection and cleaning. This is easily done on an S770U: once the knobs and fingerplate have been removed, simply remove the four large bolts retaining the handles and gently pull the front panel casting away from the chassis. I then removed the dial glass from the front panel and cleaned it with warm soapy water and then lens-cleaner.



[8] See Ian Batty's article in Radio Waves and Appendix II for additional information on the nature of the coil turret contacts.

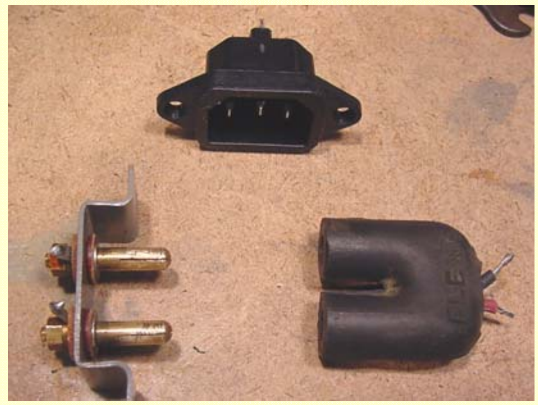
Next I removed the scale plate (photo, base of previous page), flywheel and vernier dial. Note that the scale plate screws on one end also fix the mounting plate for the six range indicator lamps: two spacing washers are included on the screws on the opposite end of the scale plate to compensate. I cleaned the scale and vernier dial very gently using warm soapy water and cotton wool pads. Minor local wrinkling of the scale plate finish was noted at one end, likely attributable to decades of heat from the indicator lamps.

I cleaned the dial drive-train gears with alcohol and Q-tips. I needed to use lighter fluid for some of the more stubborn solidified lubricant on the Geneva drive. I applied light machine oil (not '3-in-One') very sparingly to the various metal bearings, avoiding the plastic pulleys and the metal dial cord, and then smoothed a light film of molly grease onto the sliding parts of the Geneva drive.

The power cord entry on this set had been modified for a captive cord rather than the more typical standard two pin and side ground socket ('kettle connector'). The modification looked quite professional and could have been a factory modification for the US market. However, I do not like captive cords on radios so I decided to install a similar solution as I have done on several of my other Eddystone sets, ie. installation of a 'modern' IEC mains power connector, as found on modern rigs and computer psu's - sometimes called a 'Euro' connector. This can be done at very low cost (eg. rob the connector from an old computer power supply) and with no butchering of the chassis - see sidebar. It works very well and has the advantage that it can be reversed easily in the future if required. I also re-wired one of the two fuseholders into the mains transformer centre-tap as an extra protection for the power transformer as I had done in my S770R. Placing a fuseholder in this location also provides an easy means of measuring the

Replacement Mains Connector

I do not like using older electrical connectors if they are the least suspect (eg. frayed or perished insulation). The photo below shows the usual type of mains connector parts used in Eddystone receivers (bottom), together with a modern mains 'euro' connector (computer type).



The modern connector (male socket) can be fitted into some Eddystone sets directly behind the chassis cut-out for the older ('kettle') connector. Simply unsolder and remove the old connector and fit the replacement with a 4BA nut, washer and bolt at the bottom and similar at the top, the latter with a large washer or plate cut to cover the small gap. Solder in the new male socket and that's it. You will find that the female connector (plug) fitted to the mains lead will fit snugly through the chassis cut-out and mate with the chassis connector.

HT current draw of the set with the fuse removed.

I then checked the general electrical safety of the power supply section and tested the power transformer for continuity and insulation (all good). With all the valves removed I applied power to the mains transformer and checked its secondary voltages – all were in order.

I wiped the grime off all the valves and cleaned-up their pins with crocus paper and 'De-Oxit'. I also cleaned up the valve sockets using 'De-Oxit'.

Time to see if the set works…

Stage 1 Electronic Testing and Repairs

Resistance checks on the two 50uF psu filter caps indicated some leakage – but not too bad considering these were both marked as 'Feb 57'. I decided to try to re-form these rather than install replacements (for authenticity). The caps were re-formed over a half-day period by slowly increasing the applied AC voltage from my variac supply sufficient to give around 25VDC measured on the caps, while monitoring the set's HT current draw (all valves still removed except the rectifier) - increasing the voltage in 25VDC steps, holding for up to half an hour and also switching off/on a couple of times at each step, up to the full HT volts of ~250V. Leakage current at the end of re-forming was acceptably low on the two power supply filter caps (a few mA) and their cans were cold to the touch. I then undertook a resistance check on the HT line – looked ok, around 12KΩ – time to power-up the set properly, first checking that the links in the plug interested in the octal socket on the rear panel were in place and correctly wired – all present and correct.

I re-installed the remaining valves and rotated the turret to Band 6 (lowest frequency range, this biscuit having a full set of contacts and which I thought may be the best to test the set with as if anything the front end would most likely work at the lower frequencies). I slowly brought the set up to full mains voltage on the variac over around 15 minutes. After a few seconds audio was heard – well, a fairly loud hum and some crackling. Touching a finger to the AF gain control produced a nice loud buzz, so the AF stages seemed to be working ok (apart from the hum). Rotating the IF gain control produced some noises – more cracking and a hiss – things were looking promising…

The operation of the AM and FM meter controls (pre-set pots), as well as the Muting control (Squelch) was very erratic. On checking with an ohmmeter, the resistance of each was found to be jumping all over the map. So these were removed from the chassis and either dismantled (AM and FM pots), or a small hole drilled in the case where the control would not come apart easily (Muting pot), and De-Oxit squirted inside (photo, base of previous page). The controls were then rotated a few times, re-assembled and re-fitted. These all now worked ok – marvelous stuff that De-Oxit.

The set was then configured for voltage checks as per the handbook and a few spot check measurements carried out - I found most that I checked were within or close to tolerance. The HT current draw was also checked and found to be 115mA – close enough to the 110mA cited on page 17 of the manual (actually page 7 of the manual cites 115mA). I now felt comfortable for the set to be 'soak tested' for a day to see if any components failed – all seemed to be ok, at least there was no smoke or significant over-heating.

Next I tried injecting a signal at 150MHz – no response at all, but running the signal generator through 50MHz (1st IF frequency) gave a good-sized kick of the S-Meter and a deafening sound from the speaker (I had left both gain controls full-on). Looked like the 1st and 2nd IF stages were working ok but the turret front-end was not working. Given that the turret looked to be in a bit of a state I was not too surprised. I decided to remove all the coil biscuits for checking and to decide how to repair/replace the broken/missing ones. I contacted Ian Nutt, who advised that he had contacts in stock for the coil biscuits as well as some 'new old stock' (NOS) Range 3 biscuits. He did not have any Range 1 or Range 2 biscuits left in stock that were in serviceable condition. I decided to re-manufacture the Range 1 and Range 2 biscuits from two NOS Range 3 biscuits and to replace missing or damaged contacts in the remaining (Range 3 to Range 6) biscuits.

While awaiting the parts from Ian, the set resided on my one of my workbenches while I restored a couple of domestic (Canadian manufactured) sets from the mid-1930's – an interesting interlude. One of these was a 'Farm Set' [9] – a rather large battery-operated RCA-Victor 5-band console I received 'free to a good home'. The other project at this time was a small 'table top' set manufactured by Rogers Majestic, offered a new lease of life by yours truly for $10. Both sets are now restored to something close to their original good looks and are in fully working condition – I even made a mains power supply for the 'Farm Set'.

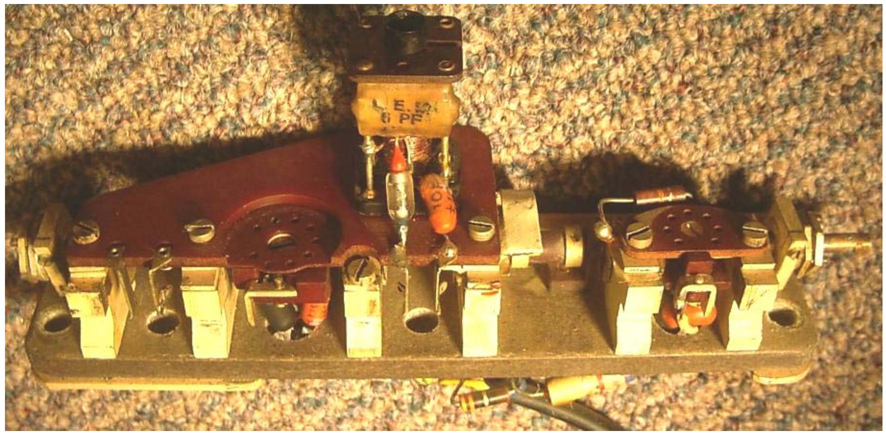
The ordered parts for the S770U duly arrived from Ian, promptly and well packed as usual, and I set to work on the coil biscuits. I borrowed the Range 1 and 2 biscuits from the Museum's S770U as a pattern for the missing and broken biscuits. Details of my work on the biscuits, and on the turret/biscuit construction is provided in Appendix II.

Stage 2 Electronic Testing and Repairs

Having repaired the coil biscuits, these were installed in the turret carrousel and checks made on each range, injecting appropriate frequencies into the aerial socket to suit each range. No response on any range – oh dear! I decided to disassemble the turret and

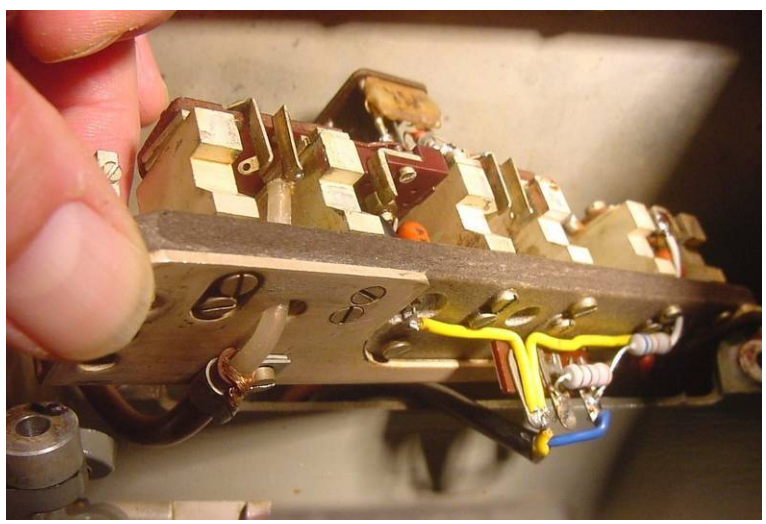
[9] 'Farm Set' is a commonly-used term for vintage battery sets in Canada – especially those designed for the home rather than as portables. The reason was that many remote farms in the 1920's through 1950's did not have mains electricity supplies.

undertake some resistance checks: apart from the individual coil biscuits for each range, the turret compartment contains a sub-chassis for the front-end/fixed contacts to mate with the biscuit contacts, and another sub-chassis for the cascode 50MHz 1st IF amplifier.



The front-end of the receiver (RF stage, 1st mixer and 1st local oscillator) is constructed on Paxolin and 'Frequentite' insulating sheets (see Appendix II) mounted on a silver-plated sub-assembly, along with the main tuning gang and fixed contacts (photo, above – RF stage to the left, local oscillator to the right, GEX66 mixer diode visible in the centre). The valve bases are bespoke assemblies with silver-plated contacts installed in the Paxolin sheets. This entire sub-assembly can be removed for inspection and access to the components by:

- removing the bottom cover from the turret compartment (take care with the wire-loom retainers fixed by the retaining screws and make a note of where they were mounted);
- un-soldering the 150V HT (blue) and 6.3V heater (yellow) supply wires from the feed-through capacitors on the turret compartment wall;
- loosening the two grub screws affixing the flexible coupling to the tuning gang shaft (mark these so they can be aligned easily on re-assembly);
- remove the two screws holding the sub-assembly to the turret compartment;
- with the sub-assembly loose, turn it over and un-solder the coaxial aerial input and 50MHz IF output leads (photo, right).



Above: the front-end sub-chassis removed, cleaned and fitted with new resistors, ready for re-installation

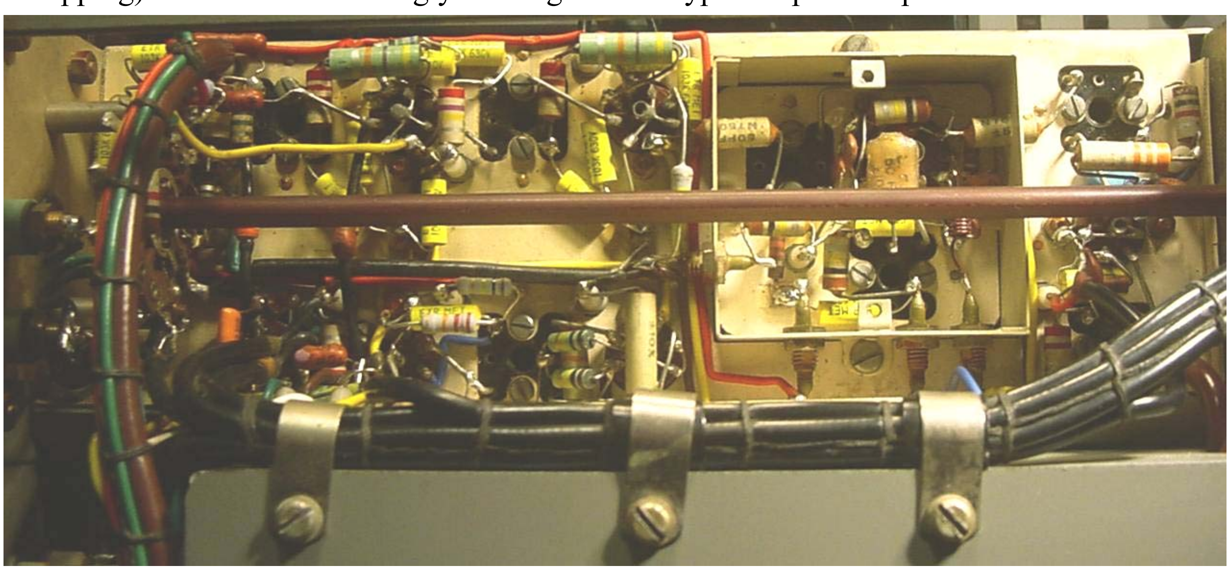
The front-end sub-assembly can then be lifted free of the turret compartment for inspection, cleaning and testing/replacing components.

The front-end unit in my set was found to be quite heavily tarnished and with lots of grime present. I cleaned it meticulously with alcohol and a little 'Silvo' where the silver plate was completely blackened. On checking the resistors, I found them all to be out of tolerance, so they were replaced (I used metal film types). The discrete capacitors on this unit are all silvered ceramics and tested ok, so I left them in place.

The 50MHz 1st IF amplifier can be serviced easily in-situ from the bottom of the turret compartment. This unit was populated with nasty little 500pF 'grub-like' tubular paper capacitors manufactured by TCC[10]. During some resistance checks I noticed that one appeared leaky, so I un-soldered one end for checking – sure enough, it was reading 250KΩ or so and had a capacitance value of 25pF. I checked another – this one had a 1MΩ leakage resistance and a capacitance of over 4500pF, and yet another a leakage resistance 300KΩ and a capacitance of <1pF. So I decided to replace all these capacitors with 500pF, 1000Vw disc ceramics. I also replaced a couple of out-of-tolerance resistors in this unit (photo above).

Once the turret was re-assembled, I again tried feeding some VHF signals into the front end – hey presto! - it was now working after a fashion on all bands – albeit not that well – some spurii present and quite a bit out of alignment. Still, progress was being made.

Next I took a closer look at the IF strip on the main chassis (photo, below – after re-capping). There were some ugly-looking 0.01uF bypass capacitors present in the IF



[10] I seem to recall Graeme Wormald referring to these in *Lighthouse* as "rat droppings with wire leads" (or similar) – a highly-accurate description: same looks and as much use after 50+ years!

stages and one on the AGC line – these were slightly leaky (>1MΩ) and so were replaced with new 630Vw polycarbonate axial types (yellow bodies in the photos). I also noticed more of the 500pF 'grub-like' capacitors in the 2nd 50MHz IF amp and in the 2nd local oscillator compartment – these were all replaced.

Above: The AF compartment after replacement of electrolytic capacitors (black and blue cases) – a bit like my fingers and the air in my shack after the work… (only kidding)

Time also to fix the hum, which was becoming rather annoying, so I checked-out the AF stage compartment. Servicing this in-situ is a real treat for the masochist – but only for those masochists with some orthodontic and keyhole surgery training. The unit appears to have been pre-assembled on a steel sub-chassis, then fixed in place and the connections from the wiring loom soldered-in (the silver-plated IF sub-chassis appears to have been assembled and installed in the same way). The AF unit could have been made so that it may have easily been removed or tilted-outwards to aid servicing, but the way the rebates and flanges are located on the chassis does not make for easy removal. So I decided to try out my orthodontic and keyhole surgery skills… There are five electrolytic capacitors in the AF section of the S770U: two large 4uF 350Vw units mounted under a retaining clip on the rear chassis wall, and the other three are much smaller, low-voltage capacitors (a 5uF and two 30uF units) hidden beneath these. Checking and replacing parts in a space two inches wide, three inches deep and six inches long (similar dimensions to an average politicians mouth – when closed) and with an HT bus-wire running through the middle, requires the following:

- a calm and patient demeanor;
- dexterity, supple fingers and a clear head;
- a brain adept at 3-D spatial manipulation;
- copious supplies of tea;
- a selection of suitable tools (see photo on next page), including: long-necked wire-cutters; long, thin needle-nosed pliers; thin, locking tweezers; hemostats; soldering tools (picks, hooked picks and miniature wire brush) and lastly, but by no means least, an Antex 15W pencil soldering iron[11] (a <u>must!</u>);

[11] Most soldering irons these days seem to be modelled on fire poker handles. I have a very expensive temperature-controlled Weller iron that is great for 95% of the work I do – it has a range of readily-interchangeable tips that can cope with anything from surface-mounted components through to changing-out large wire-wound resistors in 1930's radios, however, the shaft of this (continued at foot of next page)

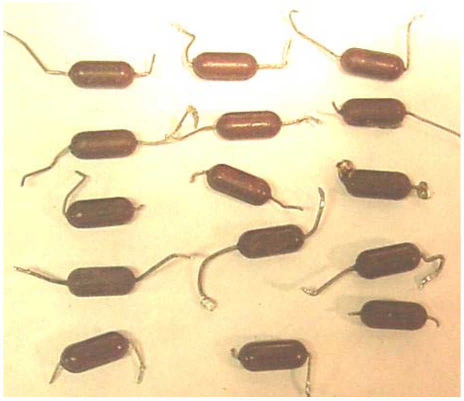
- good lighting: my bench is equipped with an overhead flood, two 'Anglepoise' spots, and I have a small 'Maglite' torch for peering into small spaces;
- a plan – work out what needs to be moved/temporarily de-soldered to access the part(s) to be checked/replaced and then work methodically towards your goal. For example, to replace the small electrolytics located at the bottom of the S770U AF compartment, first remove the two larger electrolytics mounted on the rear panel (in my case these were to be replaced anyway), un-solder one end of the HT buss wire and push the wire back out of the way, thus making some room to insert the tools to remove/replace the capacitors;

Above: Selection of tools suitable for working in politicians mouths er, I mean S770U AF compartments – hemostats (straight and curved), locking tweezers, long-necked cutters, needle-nosed pliers, angled soldering pick and that all-important 15W Antex soldering iron (this baby is 38 years old – well the handle is at least…)

- use the right techniques and don't be afraid of destroying the components to be replaced if that aids removal. The 'lay-on' soldering technique generally used by Eddystone usually allows easy de-soldering of components, however, if de-soldering looks like it could damage/loosen other components, eg. when on a chassis tag) and you cannot get the wire cutters in to snip off the component's leads, use your needle-nosed pliers to twist one wire on the component until it snaps, then wiggle the component until metal fatigue sets in and the other end disconnects. Modern replacement components are usually smaller than the parts

tool immediately above the tip is 3/8" in diameter and makes the iron useless for applications where access within a tight space is needed – as in the S770U AF compartment. Antex make a range of low-wattage irons that have a long, thin tip that slides over a thin heating element – ideal for use in restricted spaces. I have had a 15W Antex iron since I was 16 years old (well, at least the handle is the same! – the element and tips having been replaced several times over the years – a bit like Triggers's road sweeping brush on '*Only Fools and Horses*'). Amazingly, Antex still make (almost) the same iron and replacement parts fit the old handle (I buy from http://stores.shop.ebay.com/Antex-USA). There are probably other suitable irons on the market, but the Antex units are readily available, low-cost, reliable and work great. In addition, the 15W size packs much more 'punch' than you would expect from such a low-wattage iron.

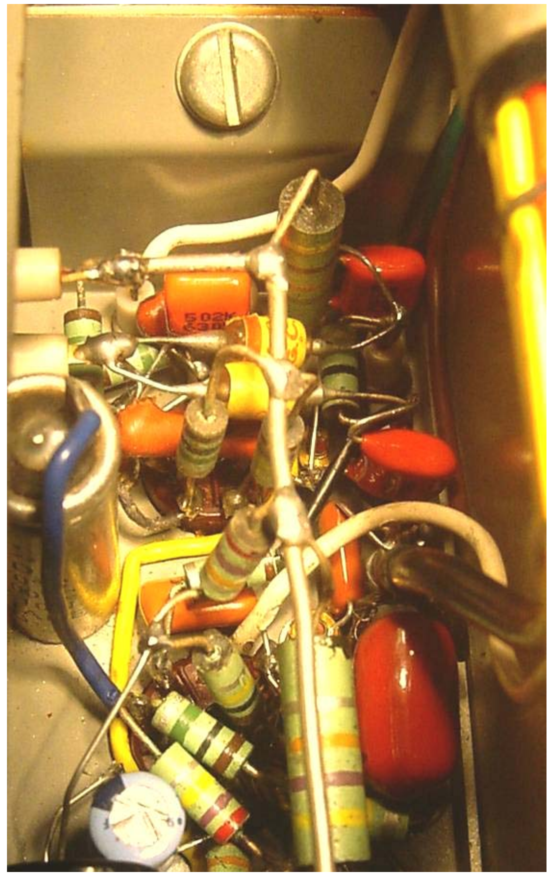
being replaced, so installation of the new part in the vacated space is usually not that difficult. However, taking the time to pre-dress (cut and bend to shape) and 'tin' the leads can aid installation, especially if you want to retain that neat 'regimented' look by the components being arranged in a linear pattern that is the hallmark of most Eddystone products. Also, for the most part forget all you have ever learned about soldering techniques (wrapping wires around tags and pins on valve bases, heating the joint and then applying the solder etc). For a successful soldering job in confined spaces try this method:



Above: I am not sure what the collective term is for TCC 'Rat Droppings' capacitors – maybe a 'poop' or 'mess' of them?

- trim, pre-dress, clean and pre-tin the component leads and leave a small glob of solder on the ends;
- clean the tag/existing joint to be soldered onto (they usually have a dirty or dull/tarnished look) – use the miniature wire brush for this;
- hold one of the leads of the new part in the locking tweezers, hemostat or needle-nosed pliers as appropriate, and carefully manipulate the new component into place such that one of the leads is pushed against the tag/existing joint to be soldered onto;
- take a slurp of tea, deep breath and, in one slick action, clean the soldering iron tip (wet sponge), melt some fresh solder onto the tip and quickly (while the flux is still smoking) apply to the tag/existing joint and component lead, holding it there long enough to re-melt the existing joint and the glob of solder on the component lead – done (sacrilege I hear you shout! – effective though). Take care not to touch other components and insulated wires with the soldering iron during this operation – if necessary a tinfoil 'guard' can be inserted to mitigate this possibility. Breath out and take another slurp of tea;
- do the same for the other component lead and then, if necessary, and if access is possible (now that the tweezers/hemostat/pliers have been removed from the working space), apply more heat and solder directly to the joints. This step is not always necessary or possible, however, each joint should be inspected closely and checked for mechanical soundness by tugging slightly on the component leads;
- gently adjust the component's body location and leads to look neat.

Sometimes, the new component cannot be installed where the old one was located (not enough room or no access to solder one end of the component – usually occurs for those pesky chassis ground tags buried beneath many other components/wires). In this case, plan an alternate location for the replacement component – the centre spigot of the valve holder is usually grounded and can be used as an accessible and convenient ground point in such cases, alternately, look for (or fit) a more convenient ground tag to the chassis. Bear in mind that at higher frequencies, long component leads can be an issue because of their self-inductance and stray capacitances, and thus the original component lead lengths/positions should be replicated if possible.



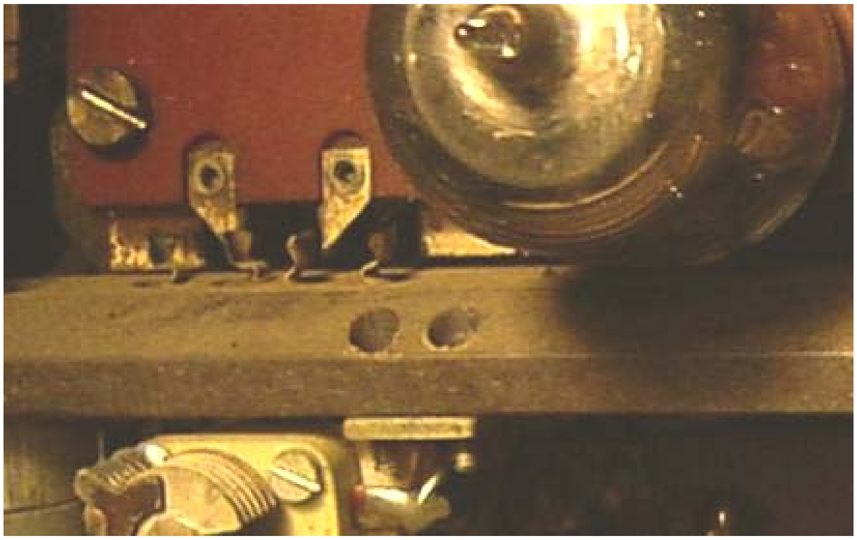
Above: The muting and first AF stages after replacing 'Rat Droppings' capacitors. Access is, to say the least, a little restricted…

So, using the above techniques I replaced all the electrolytics in the AF section (took about an hour) – I did not bother testing the old ones before removal as 50+ year-old electrolytics are always suspect and replacements are so cheap. I did test them after they had been removed though – out of curiosity. Surprisingly, both of the 4uF ones were almost at their correct value, though rather leaky, and the low voltage types were double their indicated values! – again rather leaky. I used 105C temperature-rated replacements as things get a little warm in that AF compartment. On testing the set afterwards, much of the hum had gone, though there was a little remaining. I checked that this was not due to the main smoothing capacitors being weak by temporarily placing a 33uF capacitor in parallel with the ones fitted – no improvement – the remnant hum was coming from elsewhere. The usual suspect in these cases in Eddystone sets of this era is a 6AL5 duo-diode (AGC rectifier and noise limiter in the S770U) - these are renowned for introducing hum due to their heater/cathode construction. Eddystone circuit design frequently includes some circuitry to mitigate this – as in the S770U, where R68 and R69 form a potential divider across the stabilized 150V supply, providing a small (3.8V) positive bias voltage that is applied to the centre-tap of the heater supply to this valve (V14). On checking these resistors, I found that R68 (270KΩ) had increased to over 450KΩ, and R69 was right at tolerance, reducing the bias to a negligible value. Replacing these resistors cured the remaining hum issue.

I felt that the set was now working well-enough to warrant a preliminary re-alignment.

Preliminary Alignment Checks

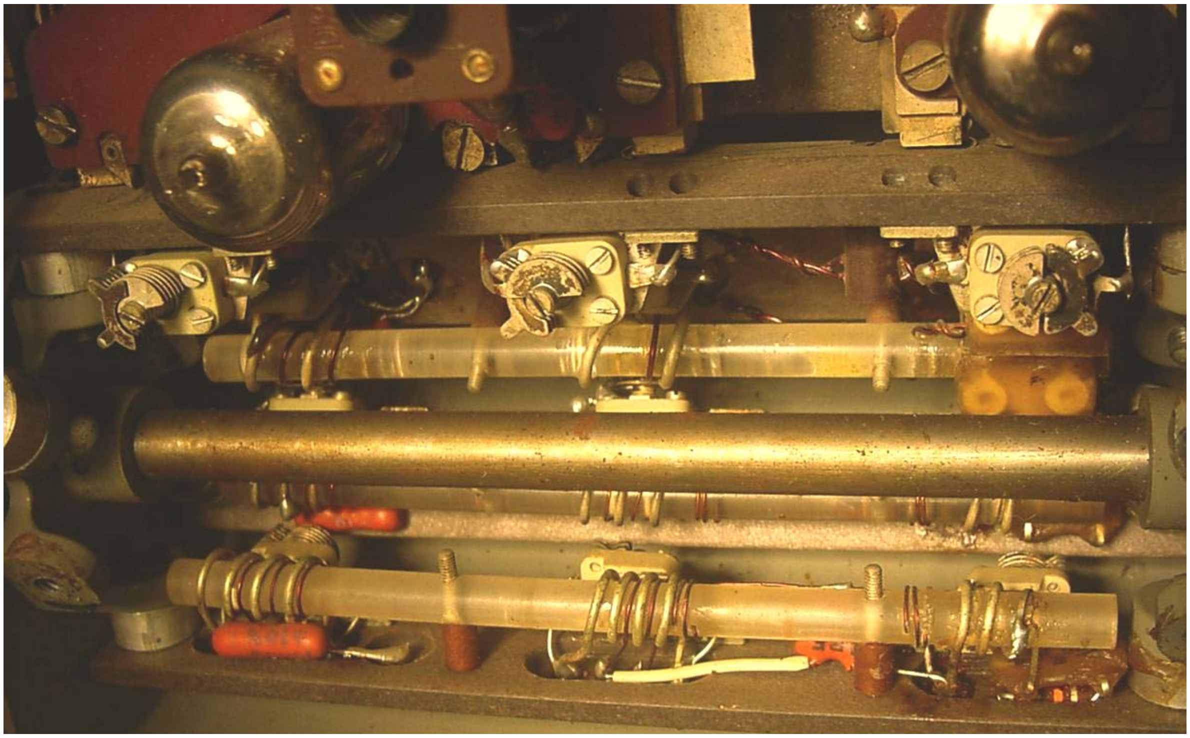
First I checked the IF alignment as described in the manual, followed by the discriminator transformer settings - without using a wobbulator for the moment – just an output meter and signal generator. I mentioned in my S770U article – penned 3 years ago – that I was planning in building a wobbulator. Well, I finally got around to it earlier this year intending to use it on both my S770U and S770R sets – see Appendix III. All of the IF transformer cores were easily adjusted (no 'binding' in their formers) and every one in both the 1st and 2nd IF stages provided a useful increase in receiver sensitivity, and as a bonus, the discriminator set up easily first time. On completion, I noted a great improvement, and the tuning indicator now worked (almost) properly on AM and FM settings. So far so good.



I then turned my attention to the turret again. First, I installed NOS valves in the front-end – a *Dumont* 6AM4 in the RF stage, and a *Sylvania* 6AF4A in the local oscillator. I then checked all of the contacts were mating correctly (photo, right – taken before clean-up), each with a small amount of 'spring' (deflection) as contact was made, and adjusted where required (slight pressure on the spring neck using a solder pick). I also cleaned the contacts with De-Oxit and a Q-Tip and applied a small dab of De-Oxit 'Gold'. It takes some time to complete this task as there are 72 contacts in total. However, taking time and care to do this well will pay dividends in the future by avoiding misalignment of the contacts such they they make good contact and do not bind (or worse, bend or snap off).

I then adjusted the trimmers on each coil biscuit according to the instructions in the manual. This takes a bit of time – the manual notes that for each one, the preceding coil biscuit in the carousel needs to be removed temporarily to allow access to the trimmers on the biscuit that is engaged in the turret – not the best piece of design… Anyway, I found one trim tool in my kit that was able to do the job without removing the preceding biscuit and that did not affect the tuning significantly during adjustment due to stray capacitances (photo, below) – note the chamfered end on the right and small metal blade.

Adjusting the tracking on a 'normal' receiver usually consists of adjusting the slug (or 'padder' capacitor) in the local oscillator tuned circuit at the low end of the dial and then adjusting the corresponding trimmer at the upper end of the dial on each range. In the



Above: The turret carrousel with Range 1 and Range 2 coil biscuits removed (before cleaning)

S770U, however, there are no slugs, only trimmers: the dial markings for each set was reportedly drawn out individually at the time of manufacture for each set to match the coil biscuits for that set, thus only the trimmer was to be tweaked at the upper end of each range. The only way of adjusting the lower end of each range is to physically alter the inductor – either lengthening/shortening the wound inductors on Ranges 4 to 6, or lengthening/shortening the 'hairpin' inductors on Ranges 1 to 3 (shortening/wider spacing lowers the inductance, lengthening/closer spacing increases the inductance) – not too easy in the case of the S770U coil biscuits (but possible – see Appendix II). The best tracking I could manage at this stage was to within 7MHz on Ranges 1, 2 and 3, and to within about 3MHz on Ranges 4, 5 and 6 – I was quite happy with that (now I knew why the MkII was fitted with a curser adjuster and 50MHz crystal calibrator!). I may re-visit the front-end calibration in the future (I am certain I will!).

Stage 3 Electronic Testing and Repairs

While checking the receiver out I had noted that the muting did not seem to work correctly – on de-tuning a signal (on FM) it took several seconds for the background noise to mute. On checking the receiver schematic, I began to suspect the capacitors on the noise gate (V11) – more of those 'grub-like' tubular paper types. These were all replaced (deep in the AF sub-chassis - photo on page 15) and I decided that while I was at it I may as well replace all the remaining capacitors of this type in the set… this took quite a while but I feel was well worth the effort. I checked the removed parts and they were all over the map in terms of capacitance and all were quite leaky. Changing C124 on the meter amp grid improved the meter operation and lowered the dissipation of the anode load resistor of V13A significantly (this resistor had been leaking wax out of its body). This work effectively completed re-capping the entire radio apart from the silver mica, tubular ceramic and silver ceramic types, which all tend to be relatively stable and reliable compared to electrolytic and paper-based dielectrics. While changing-out the capacitors, I took the opportunity to check a selection of resistors - most were well within tolerance and were therefore left in place, though I changed a few that were out of spec.

On-Air Checks

I do not yet have a wideband VHF/UHF aerial (I promised myself one three years ago when I acquired my S770R!), so I plugged in a wideband 'rubber duck' removed from a defunct Radio Shack scanning receiver. I was pleasantly surprised at what I could pick up (bear in mind that although my house is near the top of a hill, my workshop is located deep in the basement). Stations received included several radio amateurs working the 2M band (on the uncalibrated lowest end of Range 6), local shipping weather reports between 160MHz and 163MHz, some sporadic VHF walkie-talkie traffic and four local UHF broadcast TV audio channels between 180MHz and 200MHz, plus another at around 490MHz (not sure about that one) - yes, there is still analogue broadcast TV here! I am sure that with a decent aerial I could pick up much more. Now I felt that the restoration effort was maybe worth it after all…

However, I noticed a strange effect when tuning through strong stations on Ranges 5 and 6: crackling noises were heard (similar to that generated by a poor electrical connection or a dirty gain control) and the tuning meter, while generally working as expected on both AM and FM, jumped around erratically while tuning though the signal. My first suspicions were that something was not making good contact in the front end – this sent me on a bit of a wild goose chase checking mechanical components, tightening grounding lugs, applying De-Oxit/De-Oxit Gold to the tuning gang bushings etc, however, the problem would not go away. So, was I correct in my suspicions? I decided to investigate with a little more rigour:

Symptoms:

- the crackling was most prominent on stronger signals, noticeable on Ranges 5 and 6, and the intensity seemed to increase as the signal strength increased;
- when the receiver was set to a particular frequency and the signal generator tuned across the receivers passband, no crackling was heard (this was the symptom that lead me to a preliminary conclusion that the cause was a mechanical issue);

- the loudness of the crackle could be varied by both the AF and IF gain controls, indicating that the problem was in the RF amplifier, 1st mixer/local oscillator or the cascode 1st IF amplifier stages; and
- on listening carefully, a tunable hum could be heard either side of the signal, the presence of which was affected by the position of the muting pot. This made me suspicious that there could be a secondary fault in the muting circuit responding to the varying signal and noise strengths as the incoming signal was tuned across the receivers passband – worthy of investigation should the problem prove not to be originating in the front end circuits.

Fault-finding process:

- a form of 'reverse signal tracing' is appropriate in a circumstance like this (using the unwanted cracking as the 'signal'). The S770U MkI conveniently provides front-panel access to the output of both the 50MHz (at 'S2') and 5.2MHz IF stages (at 'S3') that can be used for this purpose;
- the first step was to confirm that the crackling was originating in the RF amplifier, 1st mixer/local oscillator or the cascode 1st IF amplifier stages as suspected;
- to do this, I first fed the 2nd IF output (5.2Mhz) to an external receiver used as the detector and audio stages – actually my S830/4. The crackling was heard loud and clear from my S830/4, confirming that the problem was in the RF/1st mixer/1st IF/2nd mixer stages and not in the subsequent stages of the S770U;
- next, the 1st IF output (50MHz) was fed to another external receiver – my S770R this time (the only receiver I have that tunes this frequency). The crackling could be heard from the S770R, confirming that it was originating in the RF/1st mixer/1st local oscillator section of the S770U – but what was causing it?
- the likely suspects remained mechanical, although I had experienced similar effects when silver mica capacitors break down, however, the only silver mica capacitor in the front-end sub-chassis is C8 (6pF, tuning T1), which only has signal voltages across it and therefore not too susceptible to 'silver mica disease'[12] - and why would it only appear on the two lower-frequency ranges? Well, there are also silver mica capacitors present on the Range 5 and 6 coil biscuits: C102, C107 respectively (both wax-coated 25pF in my set) and I suppose that the silvered ceramic types are not beyond reproach… although all I had tested had been fine. So, I changed the silver mica ones out – no improvement. The crackling persisted – back to seeking a mechanical source/cure;
- after much experimentation, I found that improved grounding of the two sub-chassis in the turret cured the problem. The biggest improvement was made by cleaning tarnish from under the 50MHz amp sub-chassis and its mounting points, screwing it back into place tightly, and replacing the old coax cables connecting the aerial socket to the RF stage, the RF/1st local oscillator sub-chassis to the 50MHz IF sub-chassis, and that sub-chassis to the main receiver chassis.

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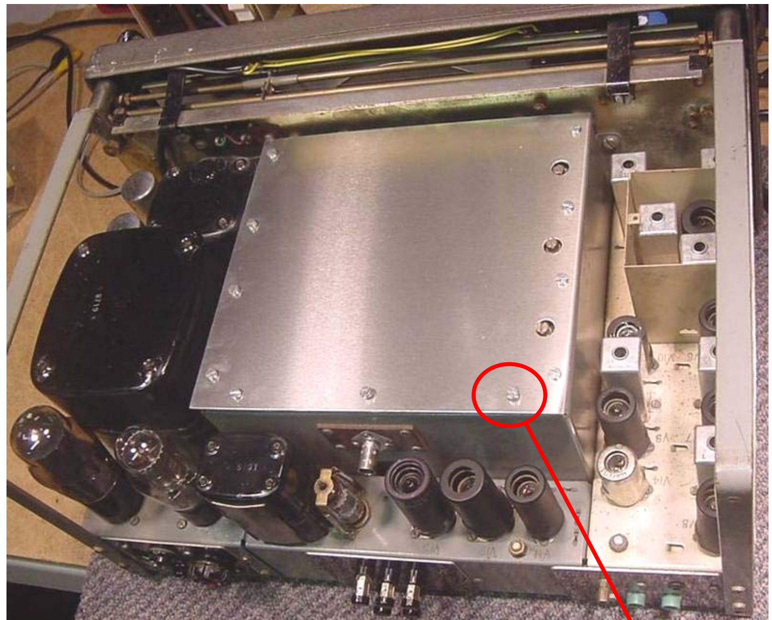
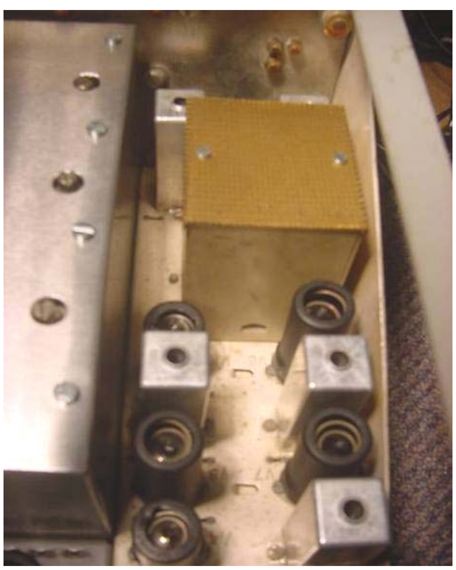
[12] An age-related migration of the silver coating to form shorting paths in the capacitor, often intermittent. See: http://www.canadianvintageradio.com/phpbb3/phpBB3/viewtopic.php?f=6&t=76

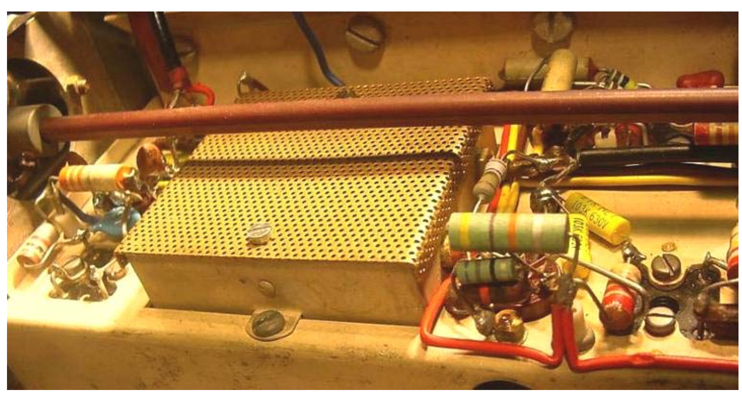
Metalwork and Cosmetic Touches



Using the turret compartment cover from the SPARC museum S770U as a pattern, I fabricated a replacement from 16 gauge aluminium (for ease of working rather than steel as per the original), installing 11 'nutserts' (a sort of threaded hollow pop rivet – photo, right) to act as captive spacers. I decided not to paint the cover, at least for now, but did scan the various labels from the SPARC museum set and reproduced these for the replacement to enhance its appearance once painted.

The missing covers for the 2nd local oscillator compartment were fabricated from a perforated steel loudspeaker grill rescued from a scrapped Raytheon VHF transceiver (photos below left and right) – not exactly identical to the factory fitments, but look ok and are perfectly functional at keeping harmonics from the 44.8MHz 2nd local oscillator out of the receiver front end (ie. at 179.2MHz, 224MHz, 268.8 MHz, 313.6MHz, 358.4MHz, 403.2MHz, 448MHz and 492.8MHz).





I washed the outer case in warm soapy water and dried it with a hairdryer. Slight scratches and scuffs on the front panel and case were touched-up with metallic coloured markers, a painted-on identifying number was carefully scratched-out with a darning needle (though can still be seen) and the case was buffed up slightly with metal polish. It still looks dull and tired though and will be well worth powder-coating. The finger plate was cleaned with alcohol, the few minor scuffs toned down with a marker pen, and then polished with Novus #1. The knobs were cleaned with a scrubbing brush and soapy water, polished using Novus #2 and then Novus #1. Also, two broken (AF input) connectors were replaced with 4mm Wanda sockets (until direct replacements are found).

Closure

For now, that's as far as I intend to go with restoring my S770U – an interesting project and I learned a lot about the receiver. I will be taking the case and front panel off again and doing the same on my S770R to have them re-finished in wrinkle-finish powder coat in due course (and will post photos to the EUG site when I do). In the meantime, I am all out of 'new' Eddystone projects but will be keeping an eye on Ebay and local fleamarkets as usual… you just never know what will come around the corner, and, of course I will be restoring more communication sets and domestic receivers to fill the void.

73

Gerry O'Hara, VE7GUH/G8GUH (gerryohara@telus.net), Vancouver, BC, Canada, September, 2009 – now 'completely nuts'…

Above: A handy little gadget for measuring voltages on valve bases in that cramped AF compartment– here shown fitted to the noise amplified stage (V11) – no need to poke around amongst the cramped components under the chassis (photo, right). Right: Some very delicate surgery being performed in the AF compartment… flux swab please nurse!

References
For the S770U in EUG Newsletter and Lighthouse (per 'Super Index'):

	Issue	Page
advert	2	4
	3	4
	11	6
aerials	46	7
coil contact problem, 770U (Brian Cauthery)	77	40
drive cord, replacement & plan	37	3
	48	5
eBay	92	19
faults, common	6	10
featured receiver	48	7
full description and pictures	83	9
hard wired mains, NZ	78	6
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panadaptors, use with	28	20
range lamps, intermittent	12	13
sensitivity, low	7	6
turret tuners	33	10
	36	14
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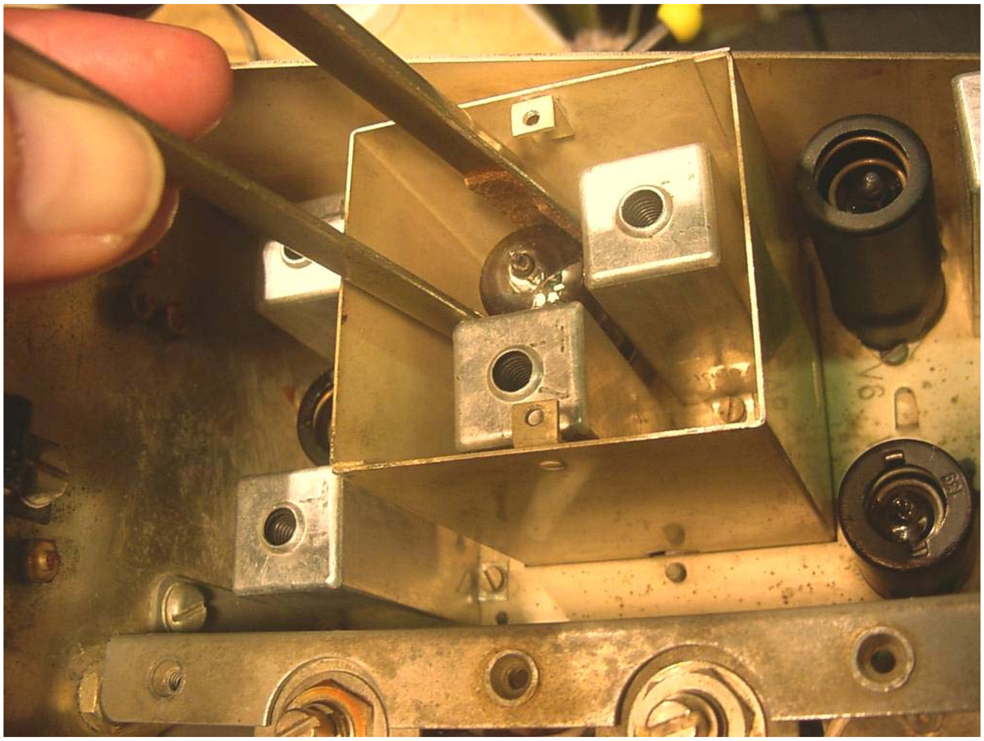
variations	33	22

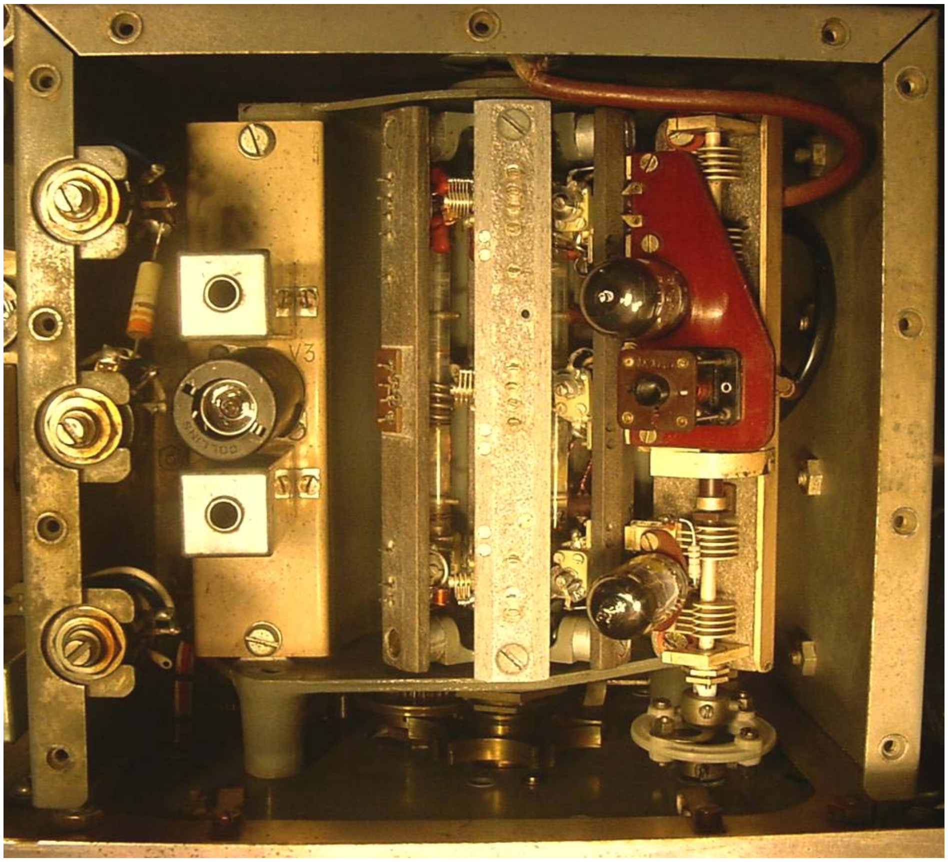
Web:
http://www.eddystoneusergroup.org.uk/ (King of sites)
http://seds.org/~spider/oaos/oaos-l.html (space observatory satellites)
http://watkins-johnson.terryo.org/History/Nems-Clarke/1906.htm (Nems-Clarke)
http://www.jb.man.ac.uk/history/tracking/part1.html#Ablestart (Jodrell Bank)
http://www.gchq.gov.uk/history/index.html (GCHQ)
http://www.radiobygones.com/issues.html (wobbulator article)
http://www.norcalqrp.org/fcc1.htm (DFM kit)

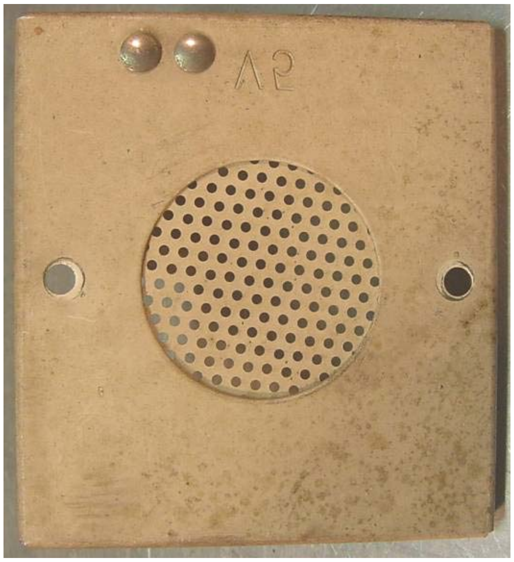
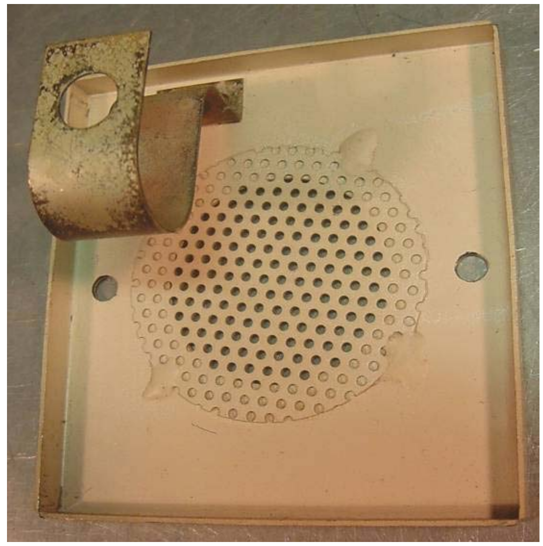
Journal:
The Eddystone 770U MkI/II, Ian Batty, Radio Waves (Journal of the Historical Radio Society of Australia), April, 2008, pp 5-10[13] (cover photo, right)

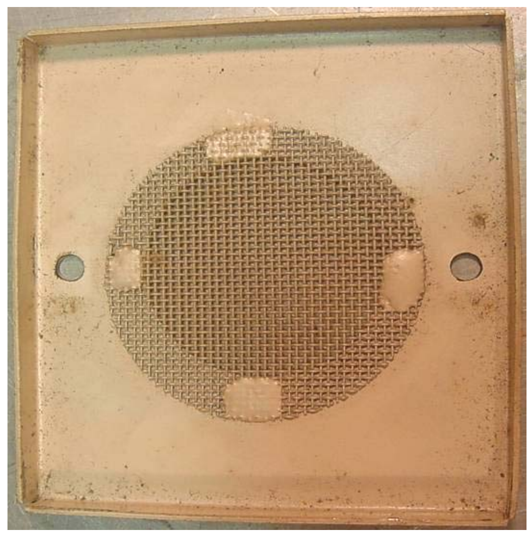
[13] Ian raises some very valid points regarding the construction of the S770U turret in his article. His suggestion that a radical re-design to the set's front end (cascode RF stage and introduction of radial contacts) should have been undertaken for the MkII version is a good one, however, the MkII was essentially just a 'face lift' of the MkI, in line with similar MkII models introduced into the Eddystone line-up in the early-1960's. The introduction of a 50MHz crystal calibrator and 'scale shift' (as suggested by Ian) went a long way to assist operational issues with scale calibration. However, to completely re-tool for a new turret design and a revised valve-based front end (eg. using acorn or nuvistors valves) likely made questionable commercial sense in the mid-1960's with the rapid advance of solid-state receiver design – and I am pretty that sure this was where Eddystone's main R&D effort was going. By the time the MkII was introduced (1964), the MkI was into its 9th year of production with ample time for any serious issues in the turret to appear – particularly in light of the professional applications the set was in use for (surely if they were that bad, the set would have been withdrawn early in the production run?). The MkII was in production until 1969, overlapping with its replacement, the solid-state S990S. Although the peripheral-contact turret is far from ideal, it must have worked quite reliably for the expected operational lifetime of the sets, say 10 years. However, it would be interesting to have some additional feedback on this issue from those involved with their use and servicing – any offers? (post to the EUG forum or email me).



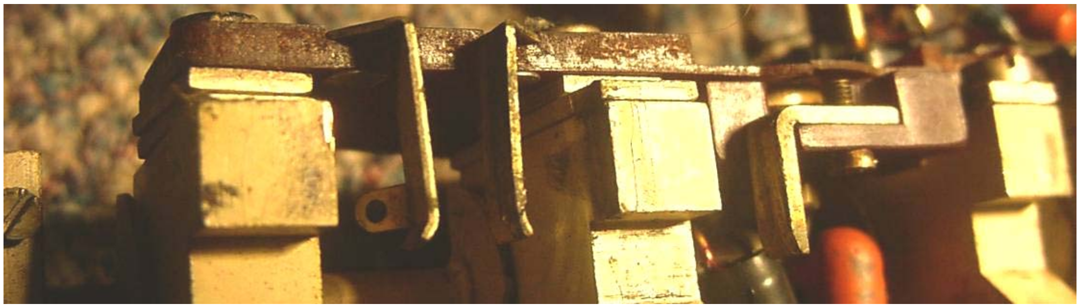
Above: Another handy tool for working on the S770U is a valve extractor – here being used to extract V5 (12AT7) from the 2nd local oscillator compartment. Below: restored turret tuner compartment (Range 1 biscuit to the left, Range 2 biscuit at top and Range 3 biscuit engaged with the fixed contacts on the RF sub-chassis at the right-hand side). Part of the Geneva drive is visible in the lower-centre of the photo

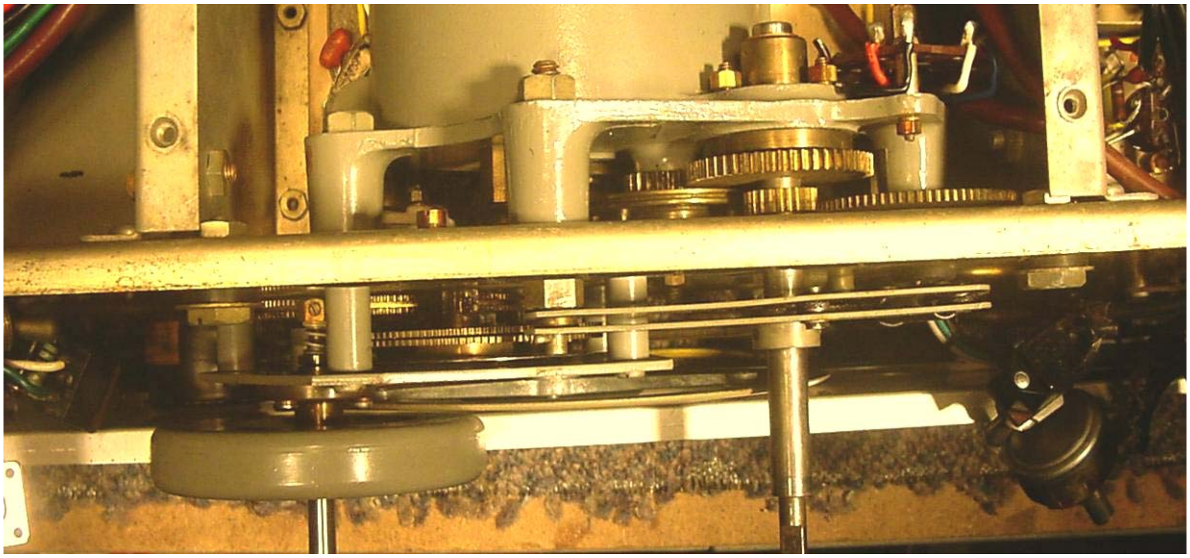


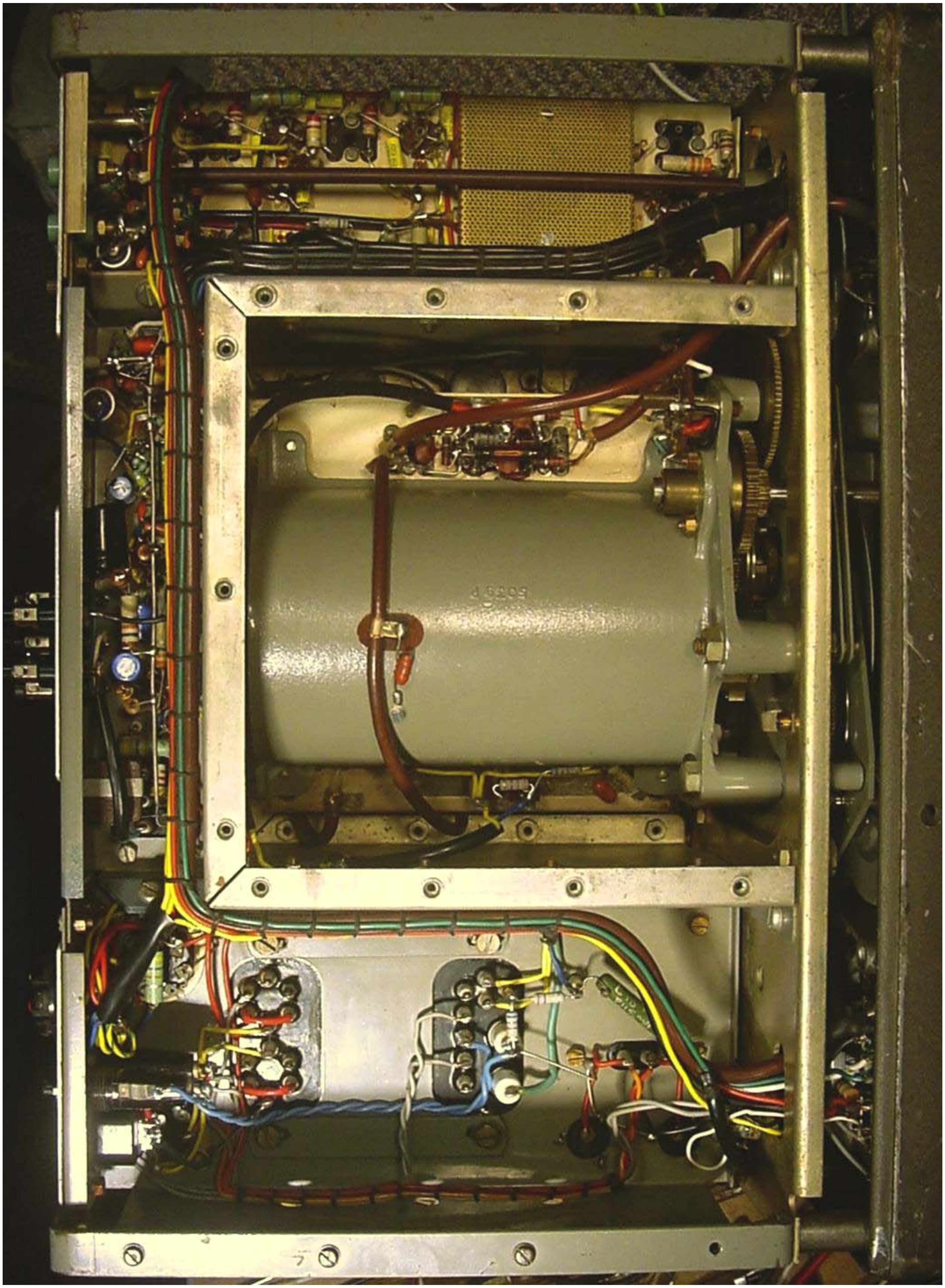
Above: The 'real' 2nd local oscillator compartment covers (borrowed from the S770U at the SPARC museum). The one fitted to the upper compartment is at the top (note the valve-retaining spring for V5). The top cover has a perforated metal ventilation screen, whereas the lower cover is a metal mesh screen. Below: close-up of the fixed contacts in the RF stage of the turret tuner before cleaning





Above: The tuning (lower-left) and range-changing gearboxes viewed from below with the front panel removed. The tuning arrangement is the standard Eddystone design of the period, however, the range switch features a gear-driven Geneva drive (see Appendix II). Below: the first 50MHz IF stage (12AT7 in cascode configuration), here with the screening cans removed from the coupling transformers (T2 and T3) for inspection

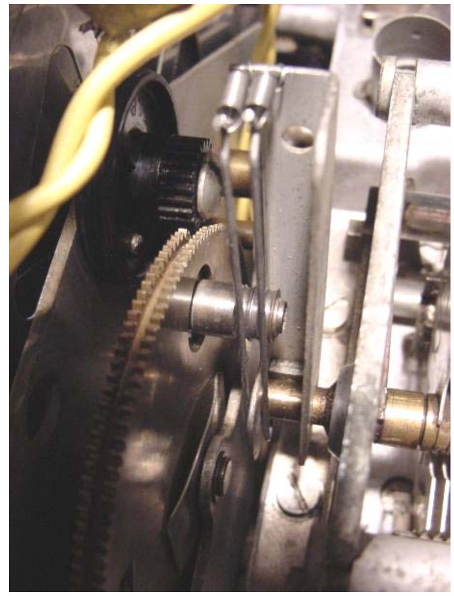

EDDYSTONE
MODEL 770U
TUNING
I.F. GAIN
WAVECHANGE
A.F. GAIN
MUTING
STAND BY
MAINS
Mc/s
MADE IN ENGLAND



Above: Chassis viewed from beneath with lower turret compartment cover removed. Modifications/repairs to the psu can also be seen (discussed in text)

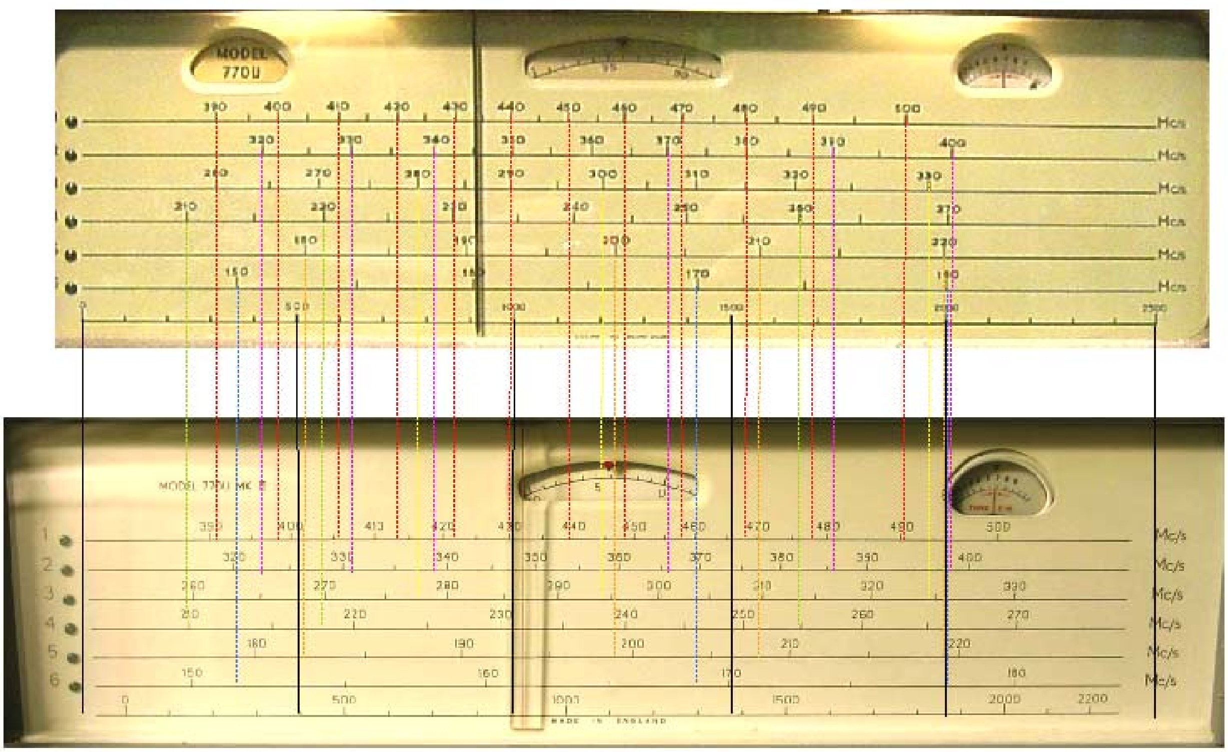
Above: Chassis viewed from rear with the restoration nearing completion

Appendix I – Scale Plate Comparisons Between S770U MkI and MkII

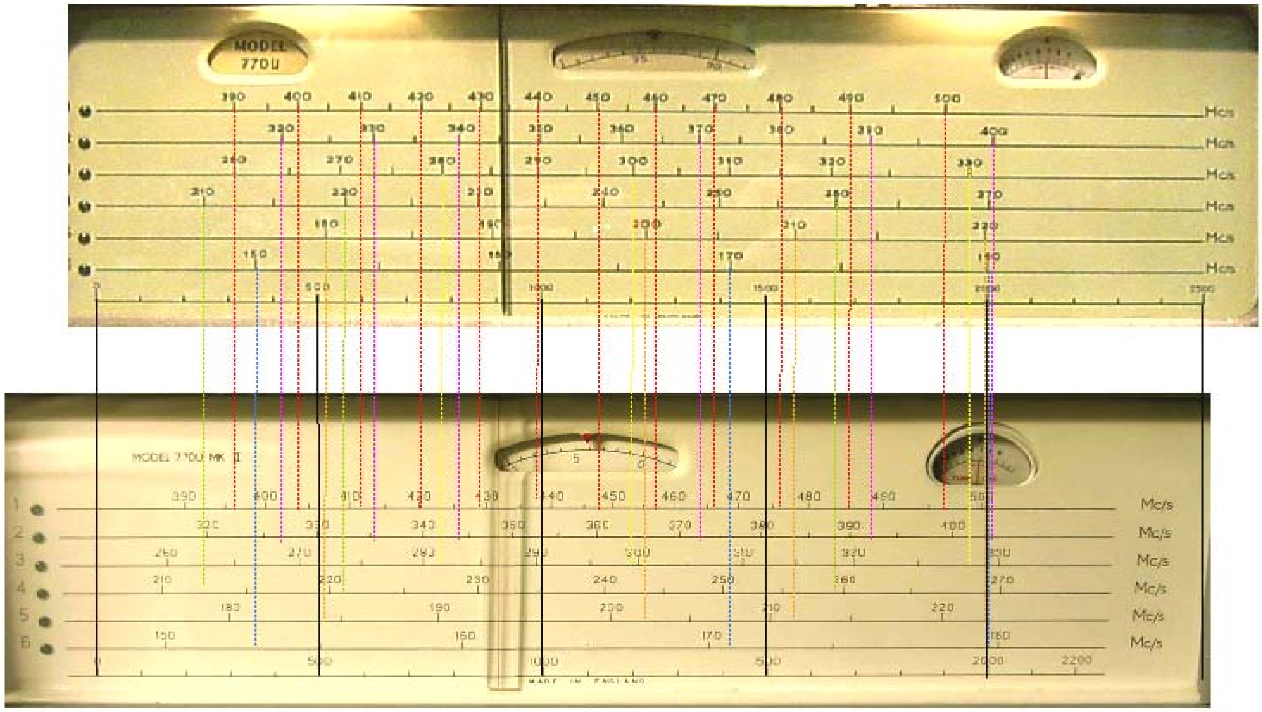


As noted on page 4 of the main text, the Quick Reference Guide (QRG), 2nd Ed. (page 33) notes that the MkII includes a "…linear dial bar (to even out the read-out)…". I initially thought this meant a 'ratio-arm' was included in the tuning drive, as fitted to the S750 (photo, right) and some other models (an innovation so simple and effective that I cannot understand why it was not included on all models).

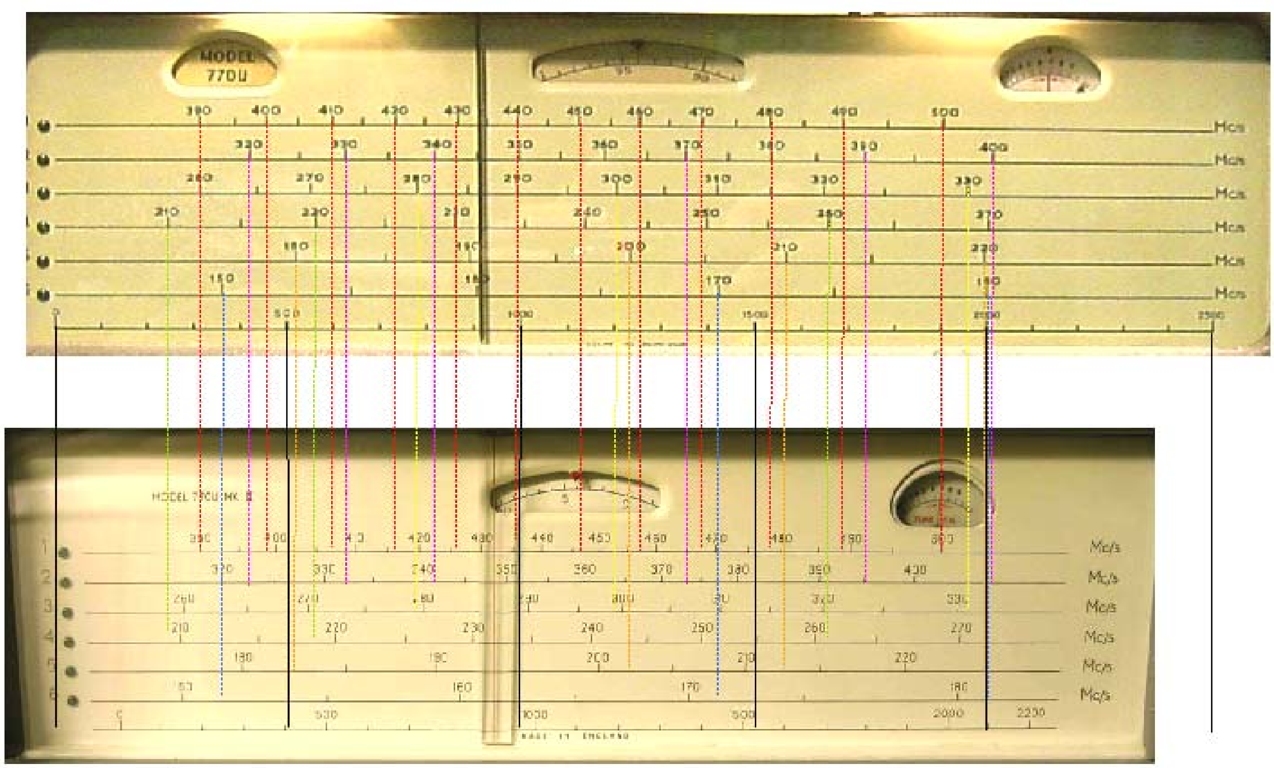
To confirm this, I asked Mike Cassidy to take a close look his S770U MkII and he reported that there was no ratio arm present (or anything other than the 'standard' Eddystone tuning drive system). So, I decided to check the MkI and MkII scale plates to see if there is a difference: there is (see the following figures for comparison), though to me it appears more like the MkII scale is 'stretched' than more linear (actually, both scales look reasonably linear). This could have been obtained through a slightly different tuning gang characteristic or gear ratios (see below for discussion on this).



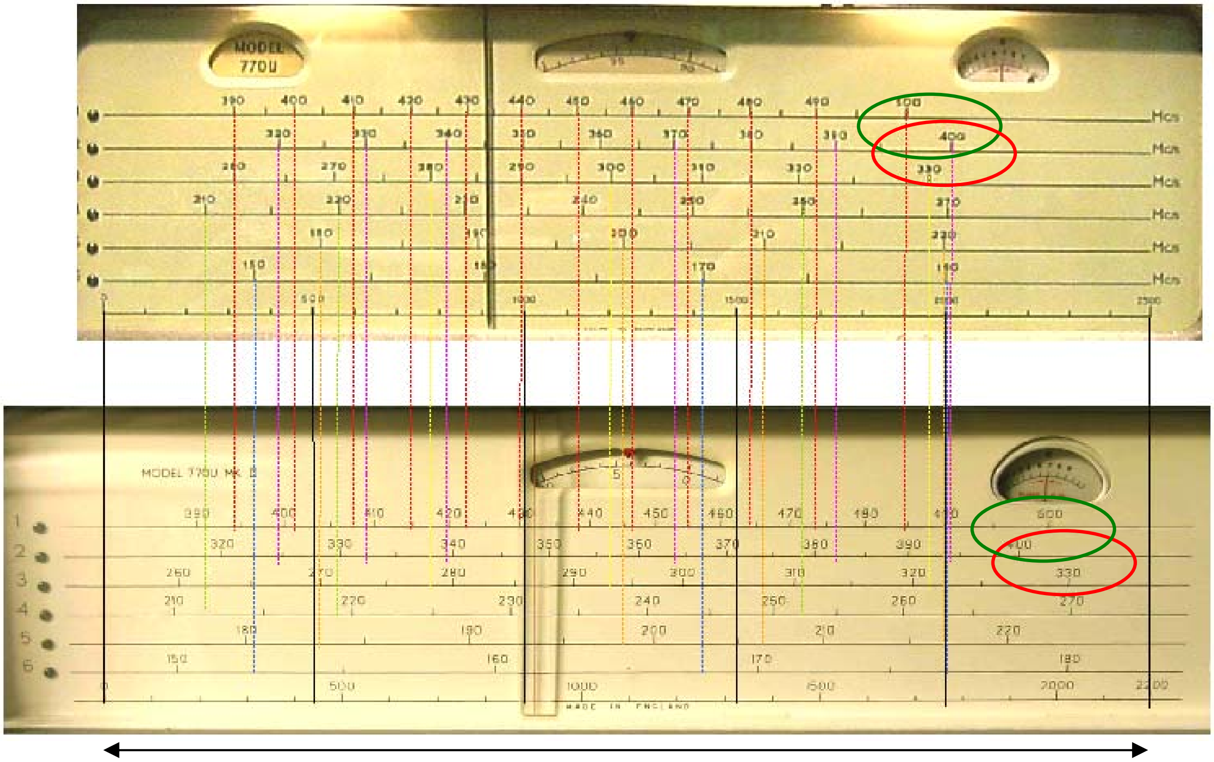
Above: Comparison between the scales of an S770U MkI (top) and MkII (bottom). Using the MkI's scale as a reference relative to overall scale length (visual), vertical lines drawn are black (logging), and at select 10MHz points for each range: red (Range 1), violet (Range 2), yellow (Range 3), green (Range 4), orange (Range 5), blue (Range 6).



Above: Comparison between the scales of an S770U MkI (top) and MkII (bottom). Using the MkI's logging scale as a reference, vertical lines drawn are black (logging), and at select 10MHz points for each range: red (Range 1), violet (Range 2), yellow (Range 3), green (Range 4), orange (Range 5), blue (Range 6). Note: the logging scale is 12" (205mm) long from 0 to 2500 on the MkI and from 0 to 2200 on the MkII.



Above: Comparison between the scales of an S770U MkI (top) and MkII (bottom). Using the MkI's Range 1 scale (10MHz markers) as a reference, vertical lines drawn are black (logging), and at select 10MHz points for ranges: red (Range 1), violet (Range 2), yellow (Range 3), green (Range 4), orange (Range 5), blue (Range 6).



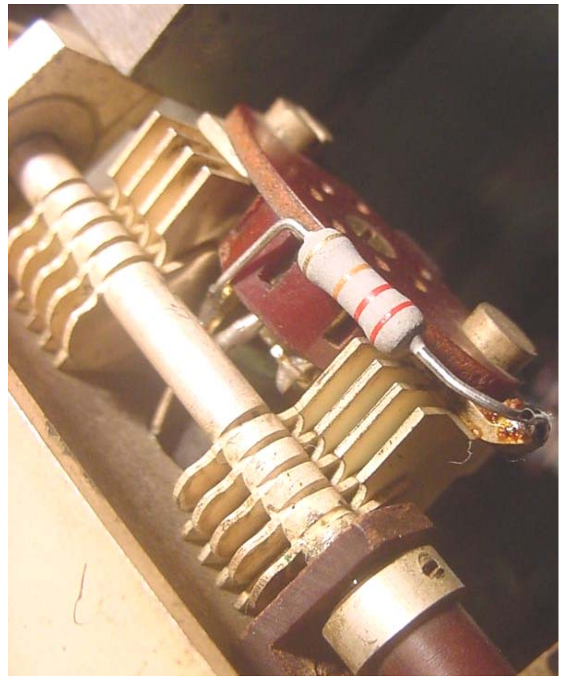
12” measured on each scale between these points

Comparison between the scales of an S770U MkI (top) and MkII (bottom). Using their logging scales as a reference, each set to coincide at the measured 12” between 0 and 2500 on the MkI and 0 and 2200 on the MkII, vertical lines drawn are black (logging), and at select 10MHz points for ranges: red (Range 1), violet (Range 2), yellow (Range 3), green (Range 4), orange (Range 5), blue (Range 6).

Of the above comparisons, the final one, with the same measured travelled length of 12” on each logging scale would seem the most valid. On this comparison, the scale markings on the MkII can easily be seen to cover a much longer distance (around 2”), with the MkI looking rather cramped by comparison (but not much less linear).[14] Also of note is that the ranges relative to each other are different on the MkII when compared with the MkI, eg. the upper ends of Ranges 1 and 3 on the MkII scaleplate are ‘stretched’ such that the 500MHz and 330MHz markers on these ranges respectively extend significantly beyond the 400MHz marker on Range 2, this being the opposite of the MkI scaleplate (highlighted with the red and green ellipses on the above figure).

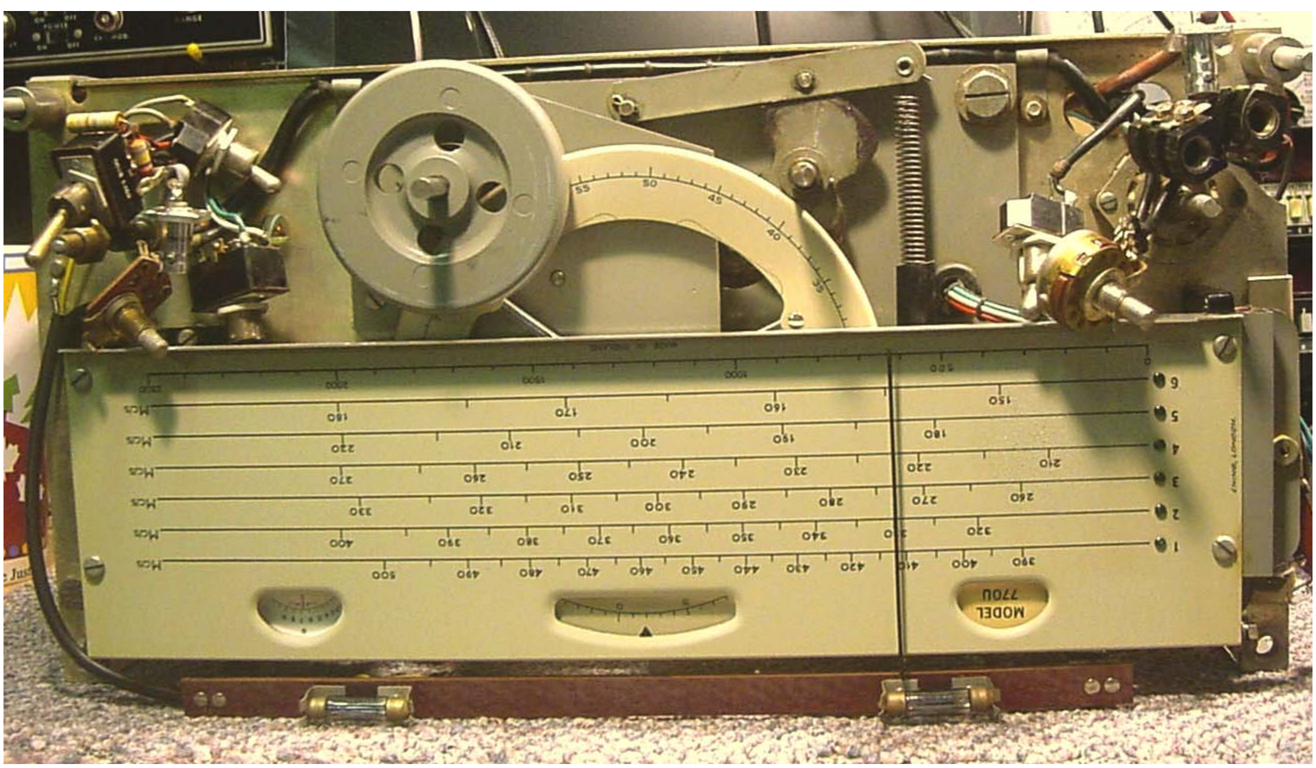
The different logging scale markings between the two scales raises yet another question: were the gearbox reduction ratios changed? - the MkI and MkII manuals both note this as being 140:1 (as measured between the tuning knob shaft and the tuning gang) - or was the

[14] During preparation of this article, Graeme Wormald kindly confirmed with Bill Cooke (Chief Engineer at Eddystone during the time of development and manufacture of the S770U) that a scale ‘linearizing’ device was indeed not fitted to the S770U (MkI or MkII). Bill noted that instead, the tuning capacitor gang in the S770 was specially-designed to render the scale essentially linear, with the scaleplate of each set being individually drawn to cope with minor variations between units – many thanks for the info Bill!



vernier gearing altered to suit the revised number of divisions/scale length? I thought I would investigate: the logging scale (vernier) has approximately 208 divisions/inch on the MkI and 183 divisions/inch on the MkII. It takes 25 tuning knob revolutions for each 1000 logging scale divisions on the MkI set, ie. a total of 62.5 tuning knob revolutions for 0 to 2500 (12" of pointer travel). On the MkII set it takes 28 tuning knob revolutions for each 1000 logging scale divisions, ie. a total of 62.5 tuning knob revolutions for 0 to 2200 (again, 12" of pointer travel). This indicates that the gear ratios driving the tuning gang are the same for both models but that the gear ratio driving the vernier wheel is different, ie. 2.5 turns of the tuning knob per rotation of the vernier scale on the MkI and 2.84 turns on the MkII ("…but 62.5 revolutions of the tuning shaft to 0.5 revolutions of the tuning gang is a reduction ratio of only 125:1 not 140:1…" I hear you mutter… well, this is explained by the tuning gang not being rotated through a full 180 degrees in 12" of travel of the scale pointer).

Above right: Close-up view of two sections of the specially-designed tuning gang (this section is the local oscillator). Below: "…for goodness sake Gerry, I know its all probably for the good, but please leave me alone as I really have had enough for today!")



Above: Front panel of my S770U MkI. Below, front panel of Mike Cassidy's S770U MkII – note differences in the scale and front panel layout when compared with the MkI, in particular the location of the limiter grid and phones socket, inclusion of the 'Cal' switch and 'scale adjuster' (upper right of panel), and absence of the 'IF out' socket (moved to rear panel). Also, the cut-out for the model nameplate is absent in the MkII, with the model number being silk-screened directly onto the scale plate. The scale frequency designations are in 'Mc/s' on both – not a 'MHz' in sight…

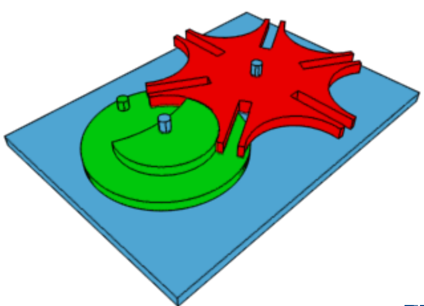
Appendix II – The 770U Turret & Coil Biscuits – Construction, Checking and Repair

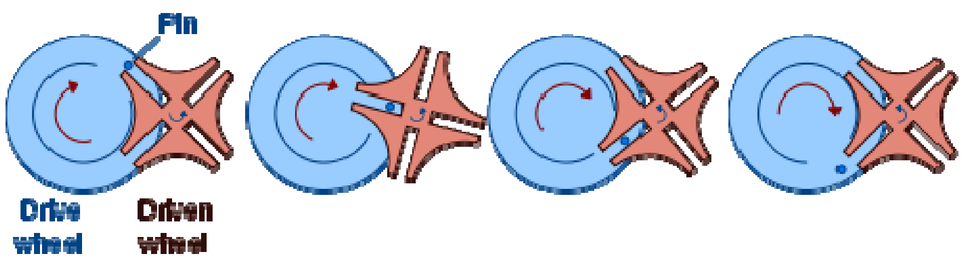
Construction Details

The coil turret in the S.770U uses a completely different mechanism to that used in its VHF sibling, the S770R. The S770U employs a Geneva drive[15], controlling the rotation of the carousel to which the various tuned circuits for the RF, 1st mixer and 1st local oscillator stages are mounted.

Geneva Drive

The Geneva drive mechanism in the S770U is a precision 6-position unit constructed from brass. The input shaft of the mechanism is rotated by a 2:1 gear drive from the Range Switch on the front panel of the receiver. The Range Switch also rotates the range indicator lamp Yaxley switch by a 1:3 gear drive. The Geneva drive can be rotated in either direction and operates very smoothly. The turret carousel is held firmly in place at each position of contact engagement by the blocking disc located on the input shaft.

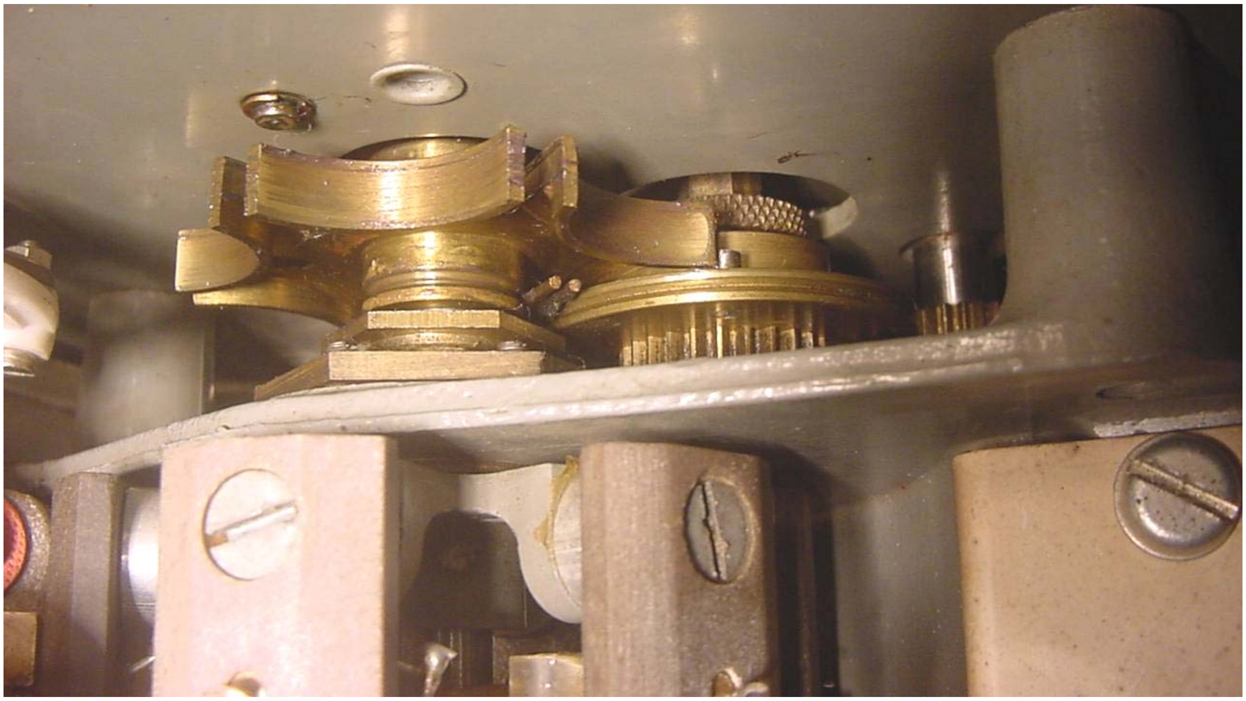




[15] The **Geneva drive** or **Maltese cross** is a mechanism that translates a continuous rotation into an intermittent rotary motion. It is an intermittent gear where the drive wheel has a pin that reaches into a slot in the driven wheel and thereby advances it by one step per revolution of the drive wheel. The drive wheel also has a raised circular blocking disc that locks the driven wheel in position between steps.

In more detail, the mechanism pre-positions the input shaft of the drive to effect incremental rotation of the output shaft of the drive, upon rotation of the input shaft. The Geneva drive has an input shaft rotatable in opposite directions through active angles which respectively effect rotation of the output shaft. The pre-positioning mechanism comprises a member, coupled to the input shaft, and having a pair of spaced, oppositely directed abutment surfaces. A locating pawl is selectively moved to a position to be engaged by one abutment surface when the input shaft is rotated in one direction and the other abutment surface when the input shaft is rotated in the opposite direction to angularly pre-position the input shaft at a location from which rotation of such input shaft through its respective active angles is accurately predictable. The locating pawl is thereafter moved to disengage the engaged abutment surface so that the input shaft is rotatable through such respective active angle to incrementally rotate the output shaft at a predictable time based on movement of the pawl (*Wikipedia*).

The mechanism was most commonly found in film projectors, where the film is advanced one frame at a time (in rapid succession) and held momentarily behind the lens, and also in high-quality mechanical watch mechanisms.

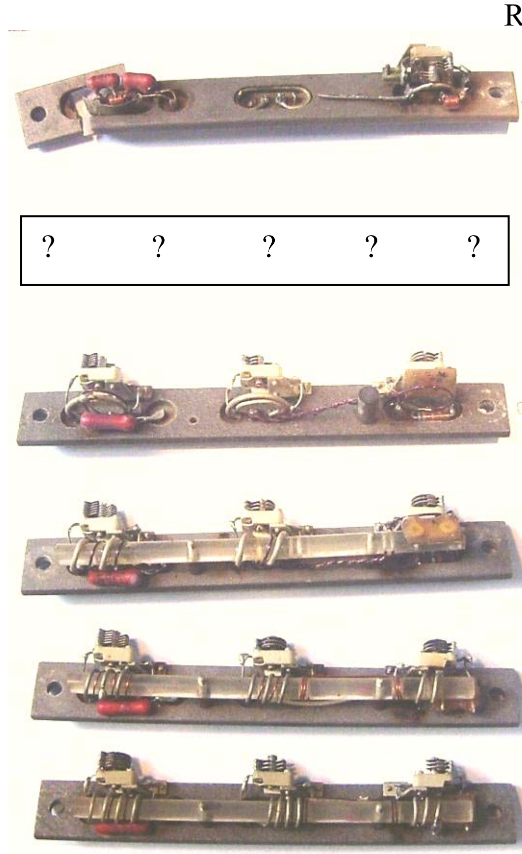


Above: Geneva drive mechanism viewed from above – input (drive) wheel to the right, output (driven) wheel to the left. Compare with the sketches on the previous page

Coil Biscuits

Each set of three tuned circuits are mounted on a stone-like insulating substrate ('biscuit') that I understand (from Ian Nutt) is termed 'Frequentite'. I am not sure of the exact composition of this material but it appears to be composed of compacted mica flakes in some form of cement, giving the appearance of a 'schist' type of metamorphic rock in texture. It could possibly include other insulating minerals as filler – possibly asbestos fibre (?), so some precautions should be taken when working with this material as it produces a fine dust when filing/drilling etc. The material is generally stable, however, poor storage conditions (eg. high temperature and humidity) can cause the biscuits to swell and disintegrate, as well as become somewhat conductive. It is also brittle and susceptible to breaking if dropped or if stressed by rough-handling during working or over-tightening of fixing screws etc. I note that the same material is used for mounting the tuning capacitor in my S820 FM tuner.

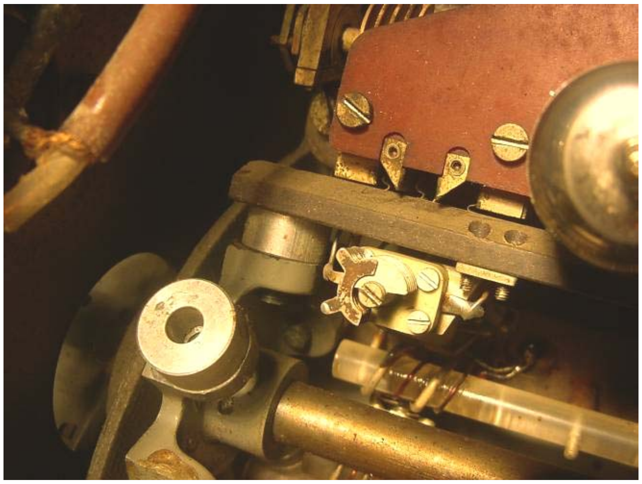
Range



1
2
3
4
5
6

The biscuit substrate is machined to take mounting screws for trimmers, insulators, contacts etc, as well as rebated to allow installation of some of the hairpin coils, capacitors and resistors for the RF and local oscillator circuits. The machining varied slightly between the biscuits for different ranges, however, not sufficiently that a biscuit designed for one range cannot be adapted to suit the coil configuration of another range.

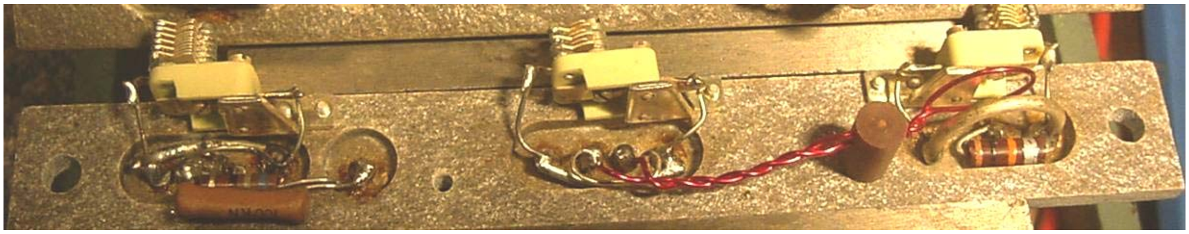
Assembly



Each of the biscuits is mounted on the carousel with two chamfered-head 2BA screws and a thick round metal spacer (photo, right). When assembled, the trimmer capacitors on the biscuits cannot be adjusted easily without removing the adjacent biscuit (not the best piece of design) unless a thin, insulated yet substantial trim tool can be found – I was lucky that I found one. In reality though, it only takes a few seconds to remove/replace the biscuits – just be careful not to tighten too much to avoid over-stressing the biscuit around the screw (and make sure you install the biscuits the correct way round to avoid damaged/broken contacts!).

Biscuit Configurations

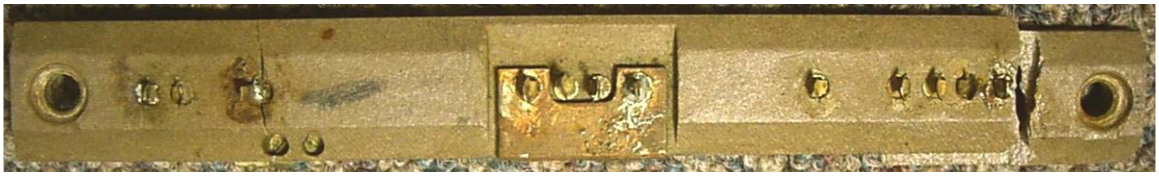
Given the range of frequencies covered, each of the coil biscuits varies in design and construction technique: those on the lower frequency ranges employ coil inductors wound around a Perspex rod. Inductors for the higher frequencies comprise 'hairpin' (single or part-turn) coils. Coupling between the local oscillator and mixer is effected with an un-tuned coupling loop arrangement (Ranges 2 through 6), or, on the Range 1 biscuit, via a simple wire (rod) extending from the local oscillator tuned circuit towards the mixer circuit. The photo on the previous page shows biscuits for all the ranges from my set on arrival – Range 1 at the top through Range 6 at the bottom (note the broken Range 1 biscuit and that Range 2 is missing), the photo below shows the coil arrangements for the Range 2 biscuit (local oscillator tuned circuit at right, mixer centre and RF stage at left). Note the enamel-coated wire coupling loop between the local oscillator and the mixer.



Re-Manufacturing Range 1 and Range 2 Biscuits

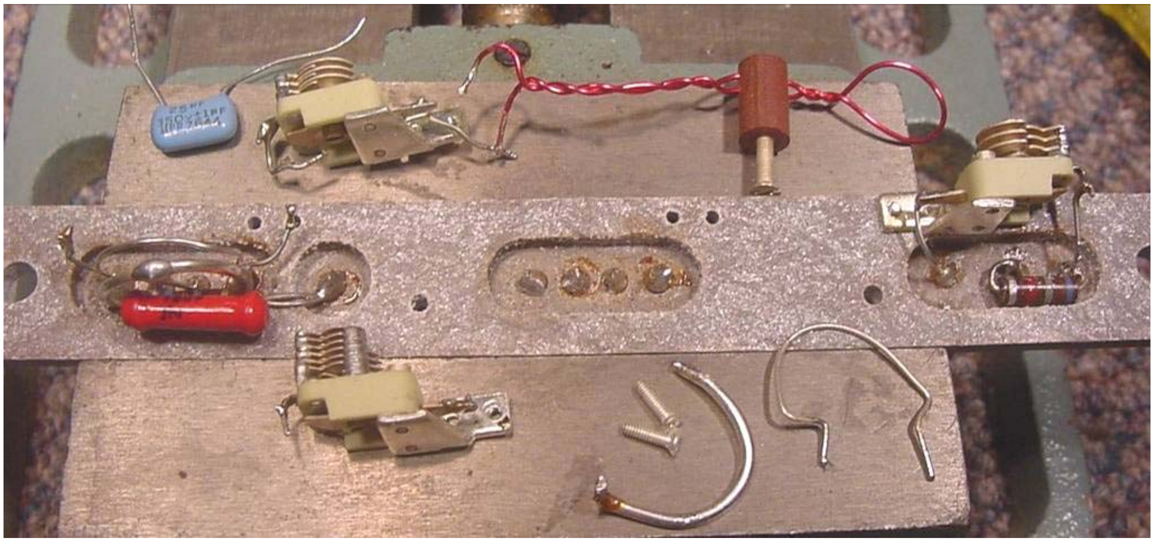
Range 1

The Range 1 biscuit in my S770U was broken into three segments and several of the contacts were broken (someone had replaced one with a piece of bent brass plate!) – photo, below. The Range 1 biscuit differs from all the other biscuits in having a rebate machined into the top of the biscuit to accommodate the brass strip inductor for the mixer coupling circuit (centre of the biscuit). Also, some Range 1 biscuits have a trimmer capacitor installed in the RF tuned circuit, tuned for image rejection rather than to peak at the received frequency, and others do not (my original one did not) – I decided to install a trimmer on the re-manufactured biscuit. Considering the very poor condition of the Range 1 biscuit from my set, I borrowed the Range 1 biscuit from the SPARC museum's S770U as a template to make sure I assembled the replacement biscuit correctly.

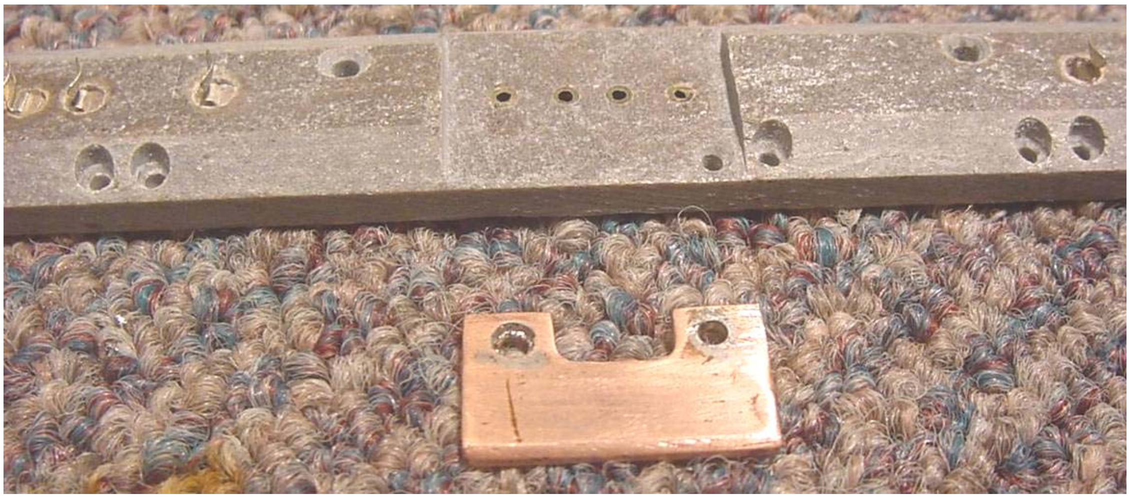


The first job was to salvage all the hardware from the broken Range 1 biscuit – quite a simple task with a screwdriver, pliers and soldering iron. Once removed, the hairpin coils were cleaned and re-tinned, as was the local oscillator trimmer capacitor. The brass strip mixer inductor was cleaned of stray solder and flux residues using a fine warding file, 1200 grit 'wet and dry' paper and then superfine grade steel wool. None of the contacts were salvaged from the biscuit as they were in such poor repair, although a couple of the small mica washers from the contacts were recovered for potential re-use.

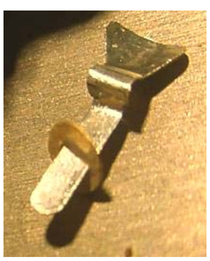
The next job was to prepare the 'donor' NOS Range 3 biscuit by removing all of the (Range 3) components (photo, below). One of the 1-5pF trimmers was retained for use in the RF stage tuned circuit and all the contacts were retained except in the mixer (middle) section – these had to be temporarily removed to allow the rebate to be cut to accept the



brass strip inductor. The biscuit was placed in a heavy drill press vice (a very useful 'third pair of hands' on the workbench I find) and carefully marked-out where the rebate was to be cut. I contemplated using a Dremel tool for this but decided that hand tools may be the safest – both in terms of generating less air-born dust (of unknown composition) and reducing the risk of inadvertently damaging the biscuit substrate. I used a medium-cut flat file to remove the bulk of the material and fine warding files to complete the job. The photo below shows the slot in the process of being cut to accept the mixer brass strip inductor. This method unfortunately also removes part of the brass bushings that pass through the biscuit substrate – I had considered avoiding this by



carefully filing around them, but decided against this both in the interests of expediency and to obtain the flattest surface possible to fix the brass strip onto. As I approached the correct depth, I tested the fit in the turret assembly by temporarily supergluing the brass strip in place, mounting the biscuit in the turret and carefully testing its passage through the fixed contact set. Once sufficient clearance was obtained (<1mm or so), I glued the inductor down and set about installing the two contacts that connect to it.



The contacts (part No. 5025P, photo, left – note mica washer) must be positioned precisely in terms of height above the biscuit and angle (the shank of the contact must be vertical and aligned such that the contact face is parallel to the fixed contacts when rotated through the turret)[16]. Great care is needed in securing the contacts to the brass strip: the contacts and brass strip must be soldered together. To do this reliably, considerable heat must be applied to the strip (I used a 260W Weller solder gun) and, at the right time, just sufficient solder introduced to effect the joint but without flooding the small well in the brass strip surrounding the flexible part of the contact shank (photo, right). If too little solder (or heat)

[16] The manual notes that small mica washers should be fitted to the contact shank before installation (part No. 5153P). Ian Nutt does not have any of these in stock and I found no detrimental effect by not fitting them. The purpose of these washers is a bit of a mystery anyway – one suggestion (Brian Cauthery) is they are to prevent solder running up the contacts during installation... other suggestions are most welcome.

is applied, a poor contact will result and if too much is applied, the well at the base of the contact may flood with solder that can solidify the flexible part of the contact shank – this is undesirable as the moving contact must flex each time it mates with the fixed contact during turret rotation. I managed to get the first one right first time, but it took me two attempts to get this just right on the second contact. Also, before soldering contacts into place, make sure that the contact surfaces are facing the correct way!

The brass strip having been secured in place, I then installed the other part of the mixer inductor (L1) – a simple hairpin fitted into the recess on the opposite side of the biscuit substrate. A 1-5pF trimmer was fitted to the RF end of the biscuit and the 68Ω resistor (local oscillator cathode), the two fixed capacitors, chokes and remaining hairpin coils were then soldered into place. The local oscillator coil on the Range 1 biscuit is of interesting construction, this being a 'double-linear' or 'butterfly' arrangement, with the trimmer and tuning gang capacitors across its centre. The local oscillator signal is injected into the mixer by a short straight wire extending from this tuned circuit.

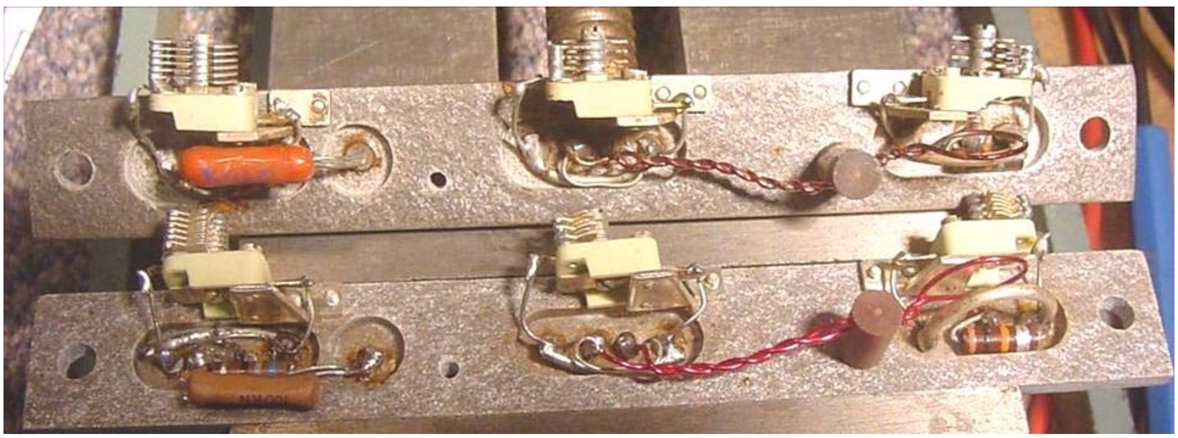
Above: the Range 1 biscuit from the SPARC Museum set (top), my re-manufactured Range 1 biscuit (centre) and the stripped-down broken Range 1 biscuit (bottom)

Once all parts were assembled onto the new biscuit, I checked contact alignment, cleaned off surplus flux (using acetone) and installed the biscuit into the turret for checking. Amazingly it worked first time and was less than 10MHz out of alignment without any adjustment.

Range 2

This was quite a bit simpler to fabricate than the Range 1 biscuit. I used the Range 2 biscuit borrowed from the SPARC museum's S770U as a template.

The first job was to prepare the 'donor' NOS Range 3 biscuit by removing most of the (Range 3) components. This time, the two 1-5pF trimmers and 2-12pF trimmer were all retained on the biscuit, the 100pF capacitor tested (ok) and set aside for re-use, and all the contacts retained in place for re-use with the new hardware. The biscuit was placed in the drill press and the new (carbon composition) 68Ω and 10KΩ resistors installed. Next, replica hairpin inductors were fabricated based on the template Range 2 biscuit and soldered into place (Ian Nutt provided some silver-plated wire in various gauges for this, although suitable wire can be recovered from the donor biscuit if needed), followed by the installation of the coupling link (enamel-coated wire), support pillar and 100pF capacitor.



Above: the Range 2 biscuit from the SPARC Museum set (top) and my re-manufactured Range 2 biscuit (bottom)

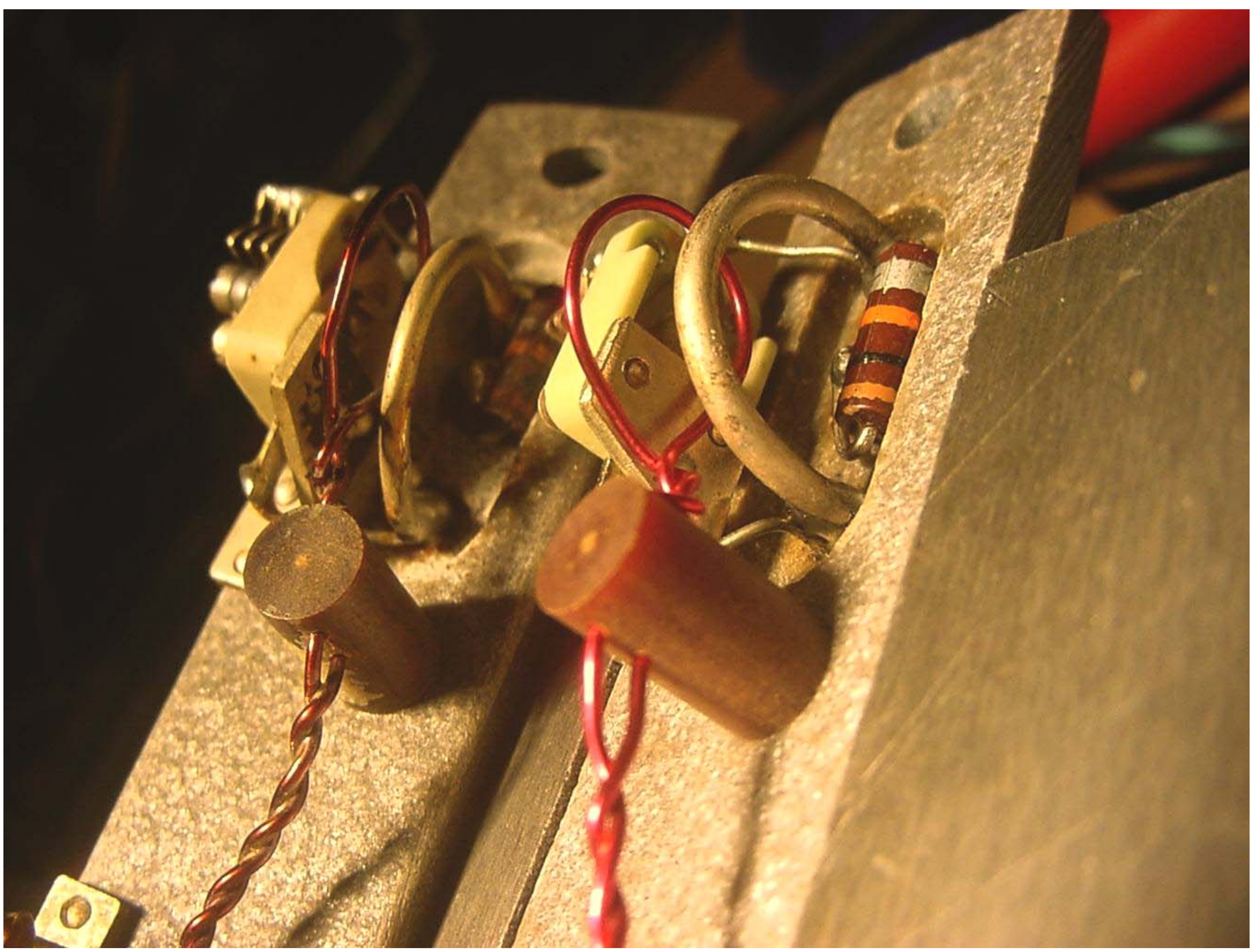
Again, once all parts were assembled onto the biscuit, I checked contact alignment, cleaned off surplus flux (using acetone) and installed the biscuit into the turret for checking. This biscuit did not work first time, but the fault was quickly traced to a tiny sliver of solder wedged in the recess beneath the local oscillator coil causing a short. Once this was removed, the re-manufactured biscuit was easily adjusted into alignment (within 5MHz or so at either end of the tuning scale).

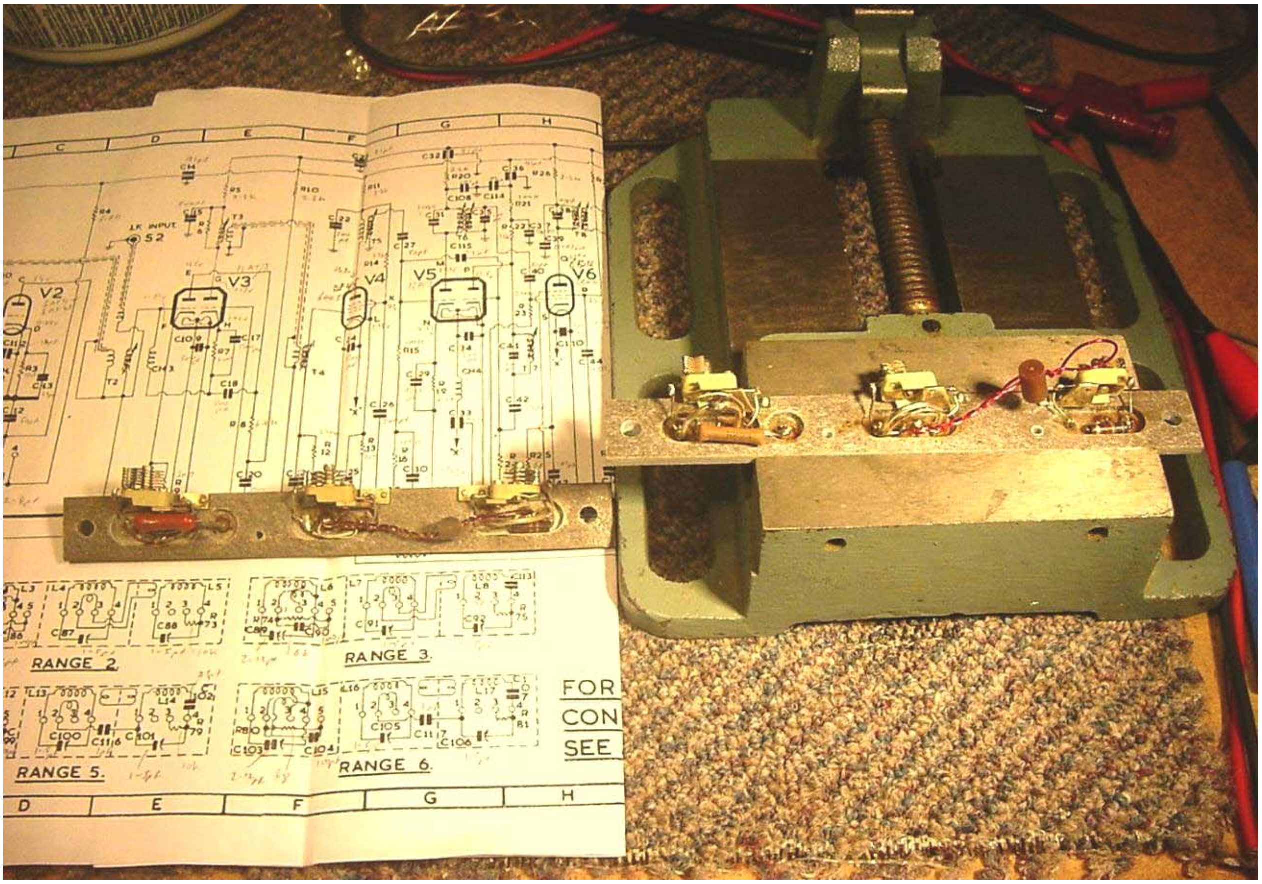
Overhauling the Remaining Biscuits

The remaining biscuits were overhauled while out of the set: their substrate was cleaned with acetone (also cleans-off flux residues), original contacts checked, cleaned and re-set or replaced where required, some resistors were replaced where found to be out of tolerance, all fixed capacitors were checked (all ok), heavy tarnish cleaned off the trimmer capacitors and hairpin coils (with 'Silvo' and alcohol), and then the re-furbished units function-checked while out of the receiver with a GDO . My Millen GDO is only calibrated through to 300MHz (though oscillates up to around 330MHz), so only Ranges

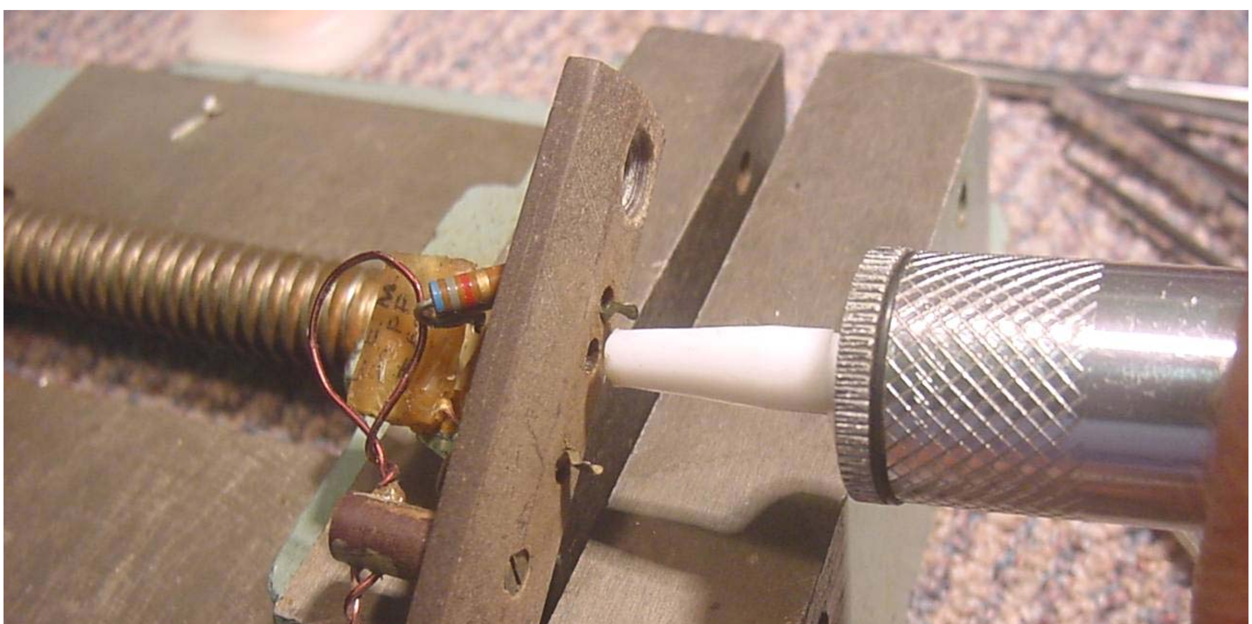
3 through 6 could be checked this way. One or two of the tuned circuits failed to resonate – a problem found to be due to either misaligned (shorting) trimmer plates - slight adjustment needed to cure - or Silvo residue (removed with alcohol-soaked Q-Tip and stiff fine bristle brush).

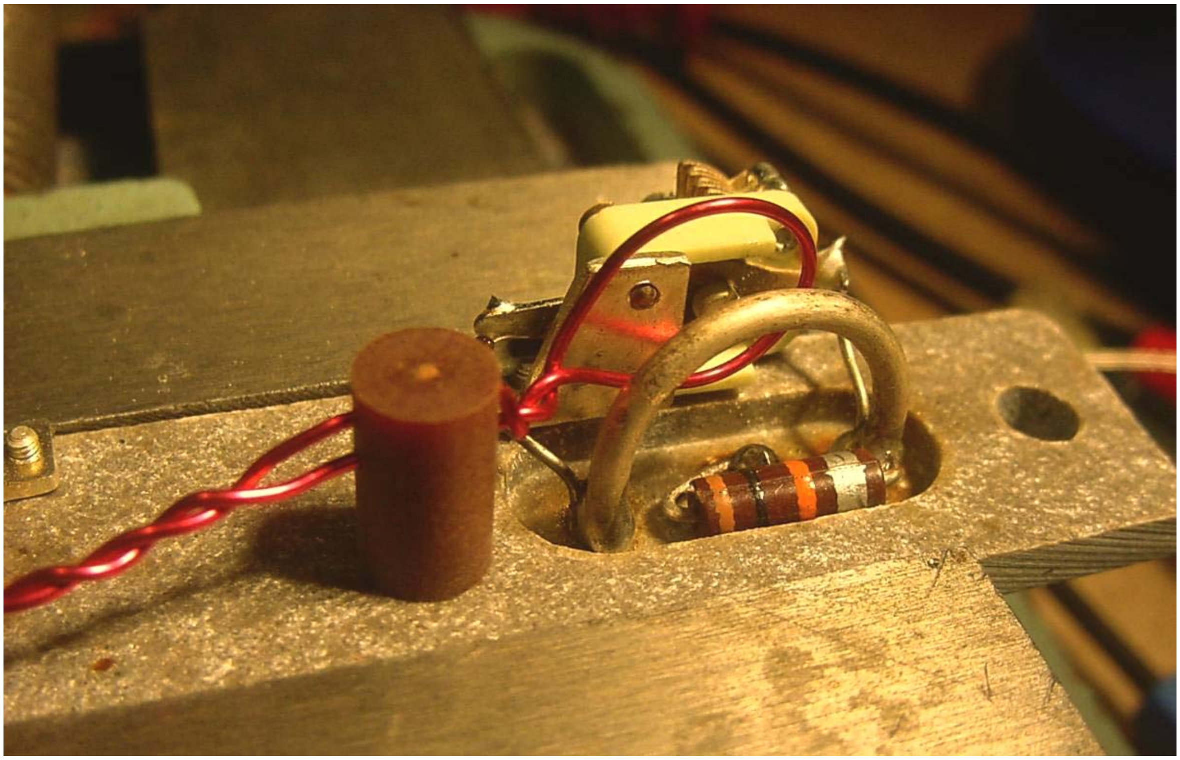
Right, using a GDO to function-test a coil biscuit, Below: Close-up of the Range 2 oscillator tuned circuit (remanufactured biscuit on right)



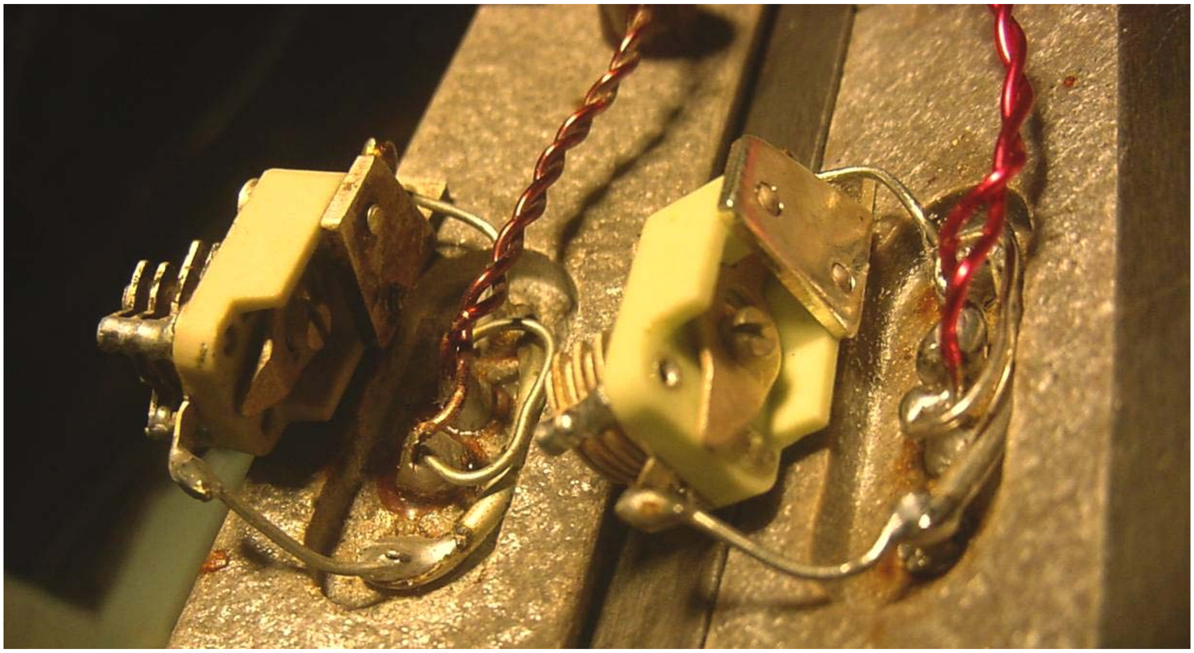


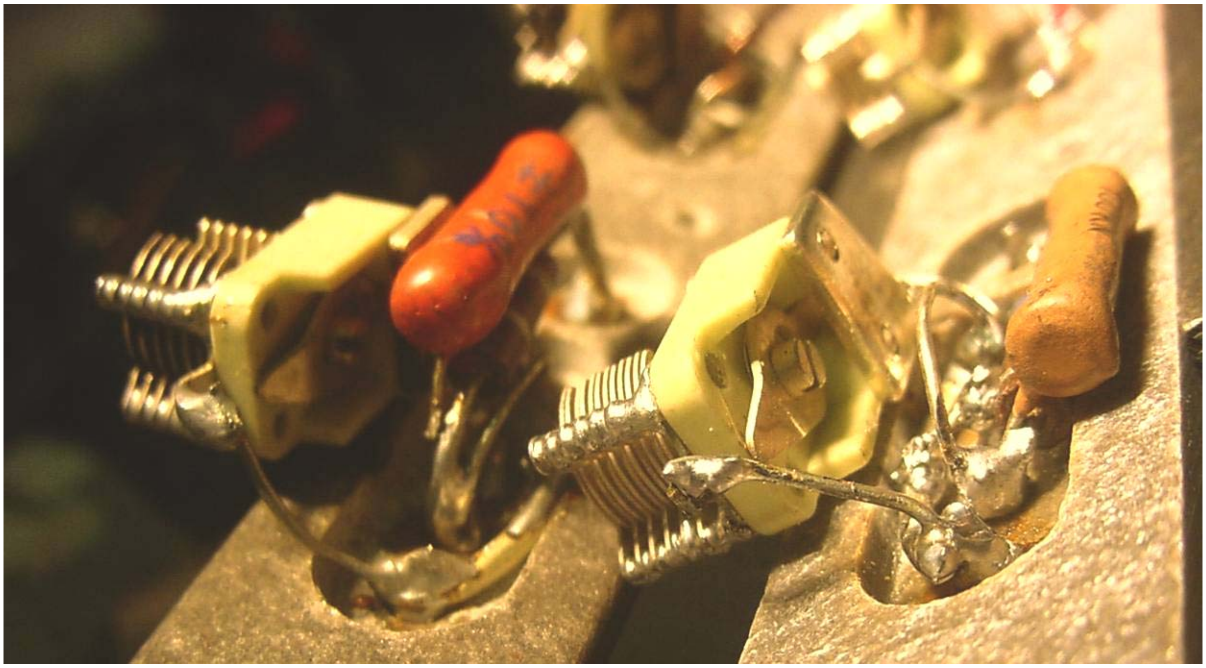
Above: Part-way through the Range 2 biscuit re-manufacture. Below: using a de-soldering pump to suck solder from the contact recesses during contact replacement in the local oscillator stage of the Range 3 biscuit



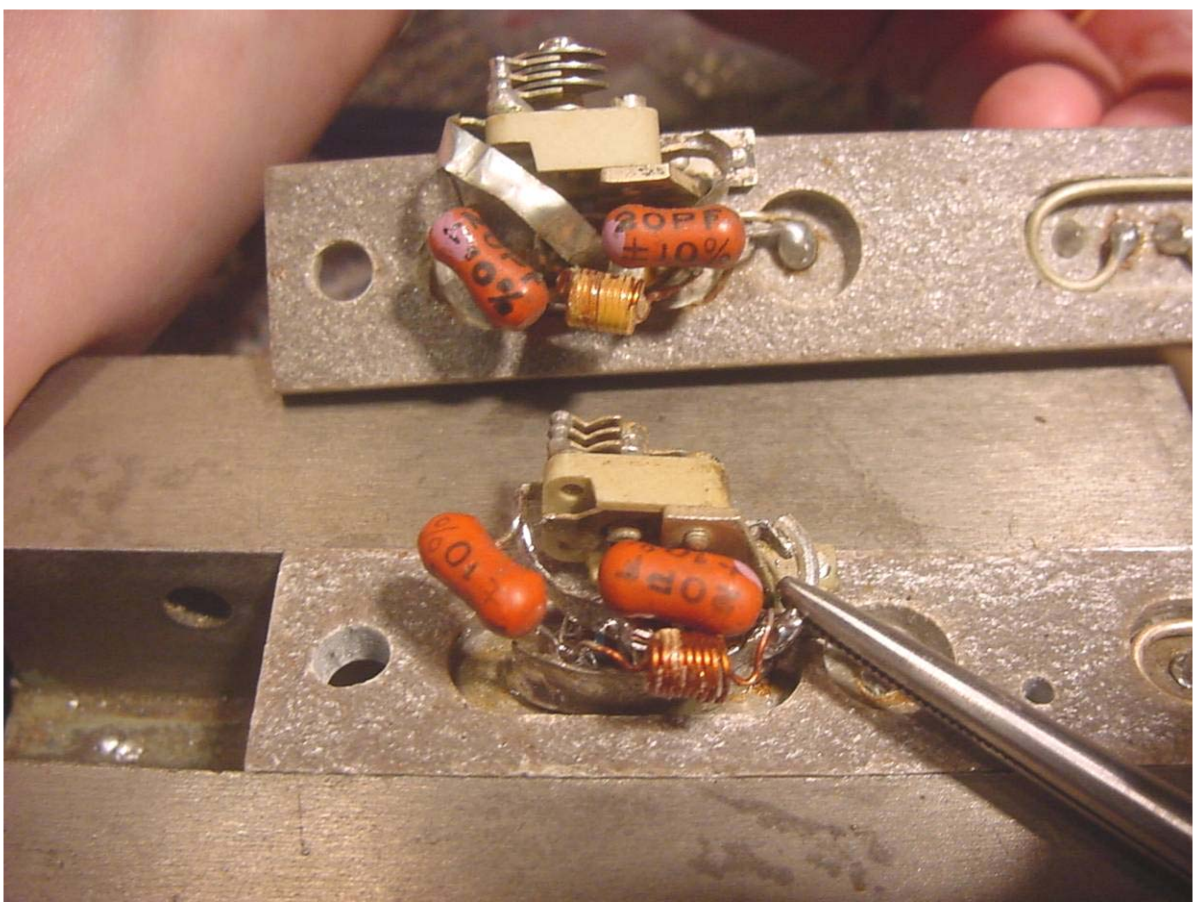


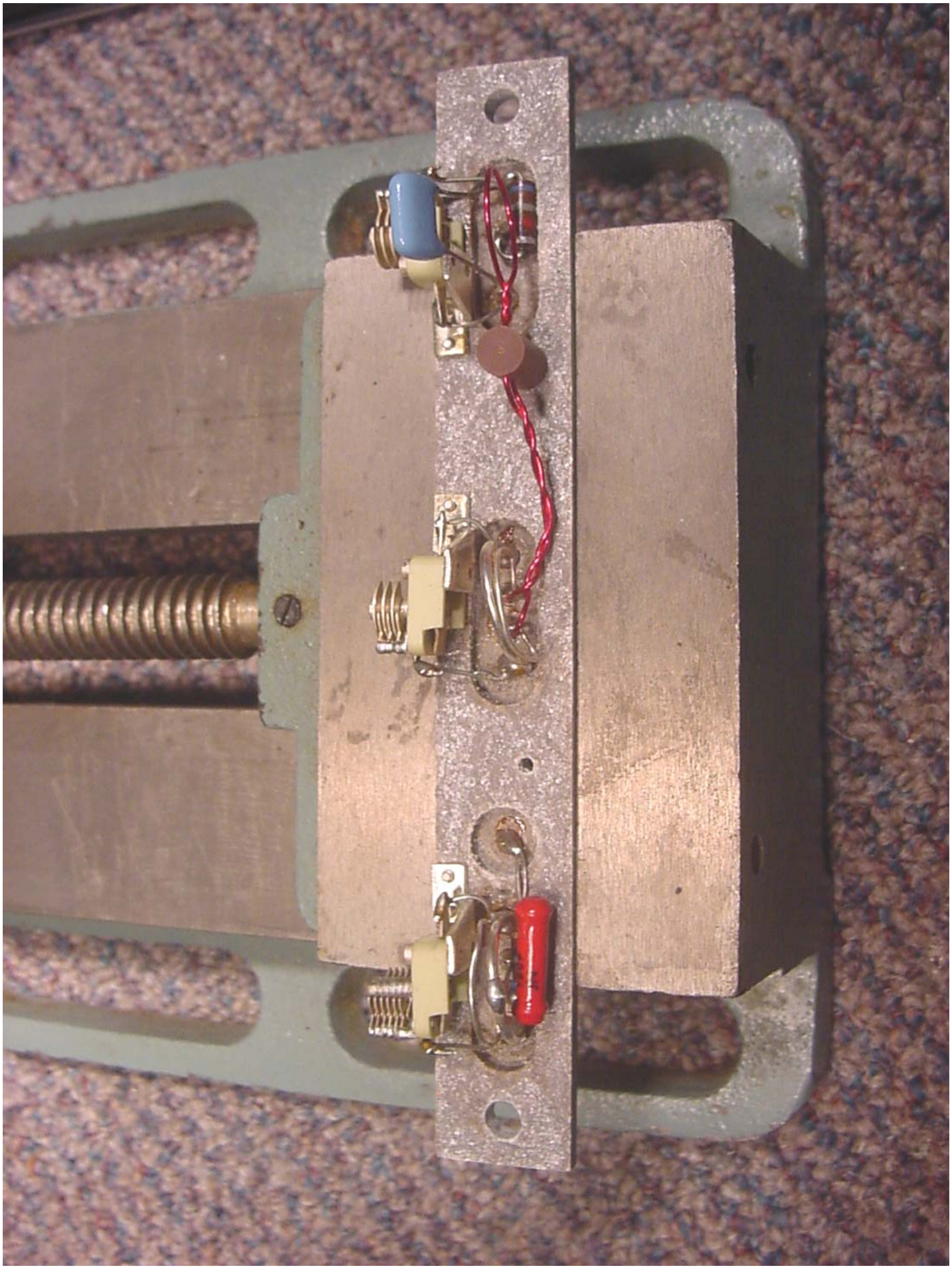
Above: Another close-up view of the re-manufactured Range 2 local oscillator tuned circuit – note the enamel-covered coupling wire supported on a Paxolin post.
Below: Close-up of the Range 2 mixer tuned circuit (re-manufactured one to the right). Note the enamel-covered and twisted coupling loop wired to the local oscillator section. All other wire in the tuned circuits is silver-plated to improve 'Q'





Above: Close-up of the Range 2 RF tuned-circuit under construction (re-manufactured one to the right). Below: The Range 1 RF tuned circuit under construction (the re-manufactured one below)





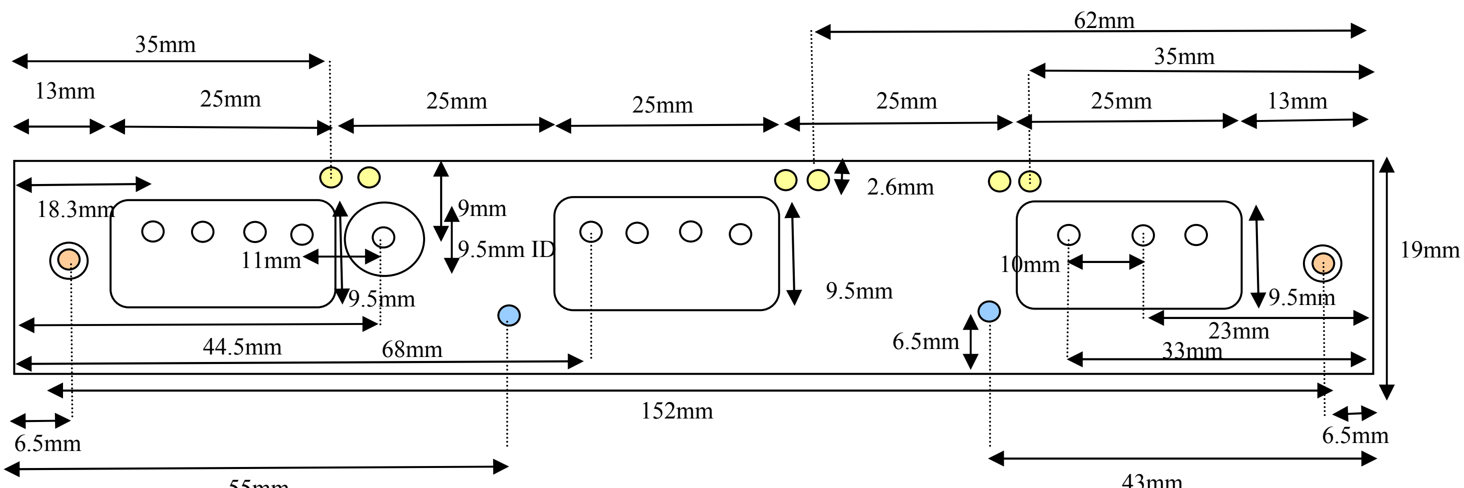
Above: One of the NOS Range 3 coil biscuits before disassembly. The RF tuned circuit to the left, mixer in centre and local oscillator to the right. Note the twisted enamel-covered wire coupling loop between the local oscillator and mixer sections

Construction Details for Coil Biscuits

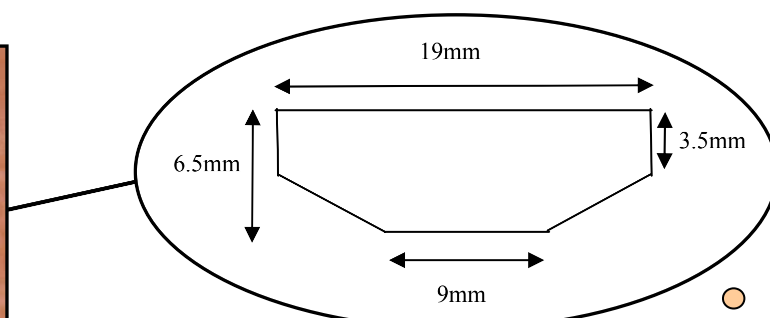
The following diagrams provide basic construction data for all six coil biscuits. The dimensions of the coils are taken from my restored set and minor variations can be expected between sets. This information may prove useful for anyone having to re-construct a coil biscuit(s) from scratch without the benefit of a template from another set.

Substrate

A stripped-down biscuit substrate is shown below along with a sketch annotated with approximate dimensions (note: the original was dimensioned in imperial units, I have used metric for ease of measurement and typing, so minor discrepancies may occur). The biscuits vary slightly between ranges as noted elsewhere in this document. The sketches are not to scale and are not construction-quality drawings. All dimensions provided are indicative of typical dimensions only.



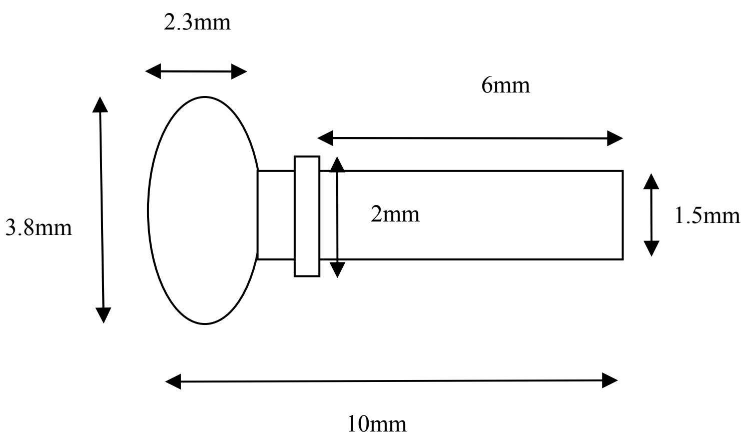
Contact spacing (4.8mm unless indicated otherwise)
Depth of rectangular and circular contact rebates is 3mm

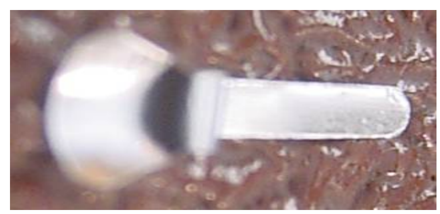


5mm (carousel mounting)
2.8mm, 5mm spacing (trimmer mounting)
3mm (contacts)
3.5mm (support pillars)

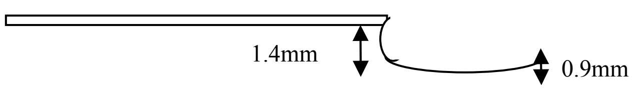
Contacts

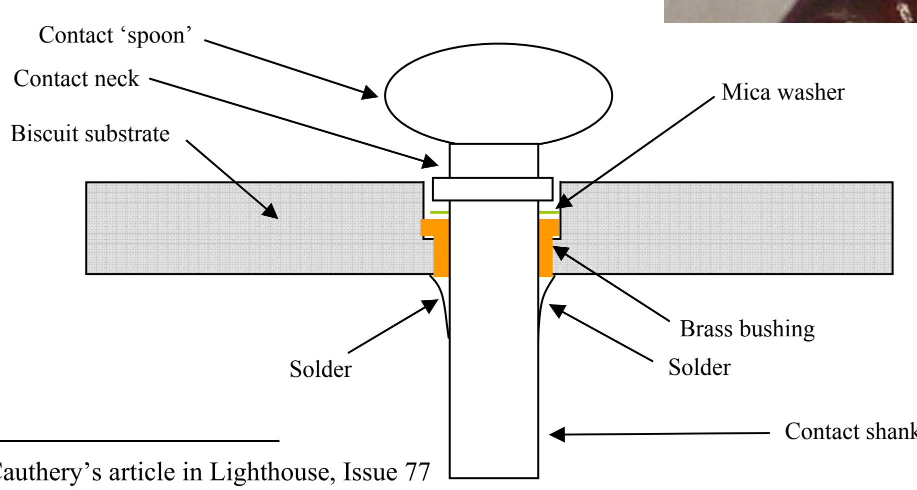
The contacts are a critical element for correct operation of the turret tuner. While it may be possible to fabricate something that would work[17] (at least for a while), it is unlikely that the correct 'spoon' shape and other dimensions could be reproduced with sufficient accuracy to ensure long-term reliable operation. It is essential that the neck of the contact remains springy once fitted (avoid excessive solder). At the time of writing, Ian Nutt can supply the genuine article for 20p (40¢) each, so why bother trying to make them? Just in case the supply dries up, I provide some further details below, together with photos and sketches showing approximate dimensions and installation details.





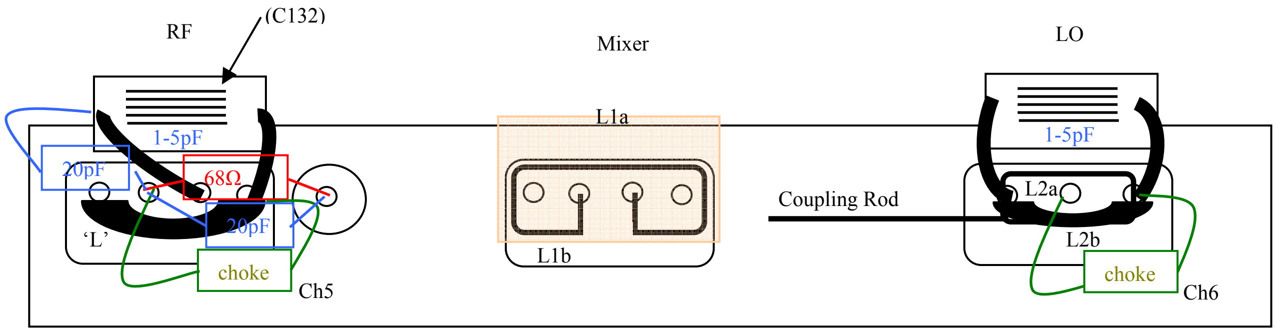
Material: 0.2mm thick silver-plated spring steel

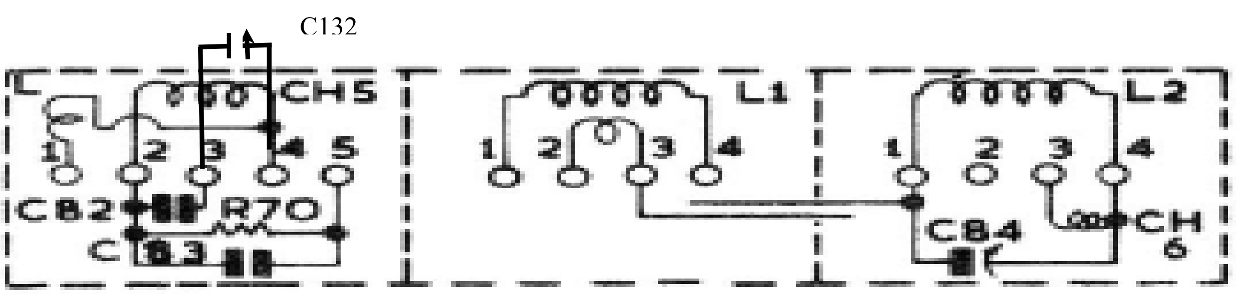




[17] Brian Cauthery's article in Lighthouse, Issue 77

Range 1





Notes on Range 1 Coil Biscuit

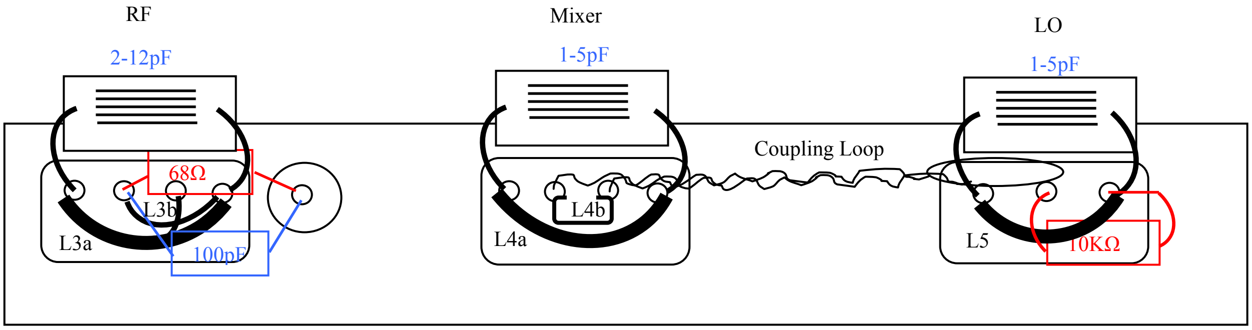
'L' – curved silvered brass strip linking contacts 1 and 4. Form from 6mm x 25mm strip

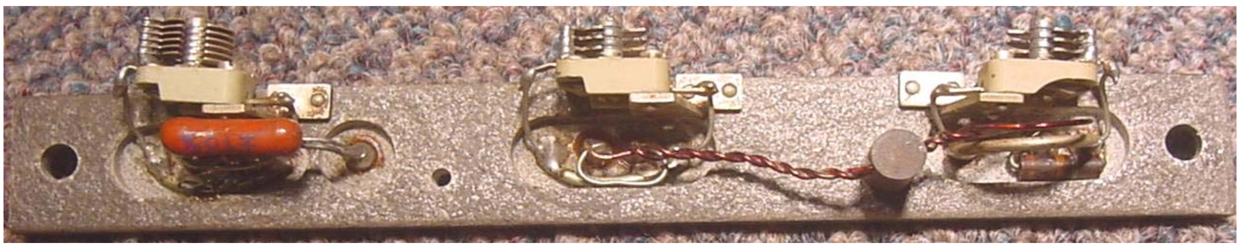
L1 – L1a is 14g brass, 12.8mm x 22.3mm with notch 8.9mm x 4.3mm cut on one long edge, chamfered on opposite edge (see photos on p33), drilled to suit contact spacing (5.6mm centres), 3mm holes. L1b is 18g silvered copper wire formed within rebate per photo (form from 62mm length) – note that the coupling rod shown on the schematic extending from pin 3 of the mixer section is not present on the coil biscuit

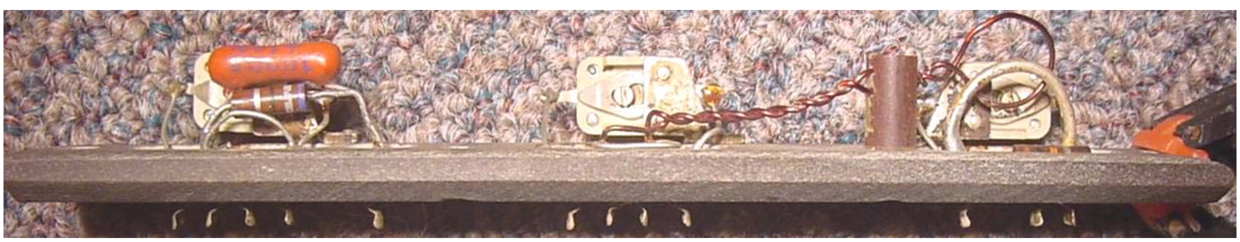
L2 – 18g silver plated copper wire: L2a = 17mm long x 8mm sides formed in rebate. L2b = 33mm long formed into semi-circle. Coupling rod 26mm long (form entire L2 assembly from single 90mm length)

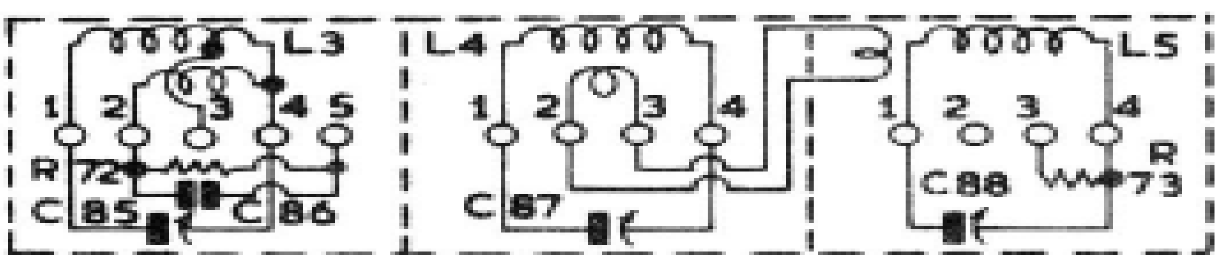
Ch5 & Ch6 – each comprises 9 turns close-wound, 3mm ID, 22g enamelled copper wire

Range 2



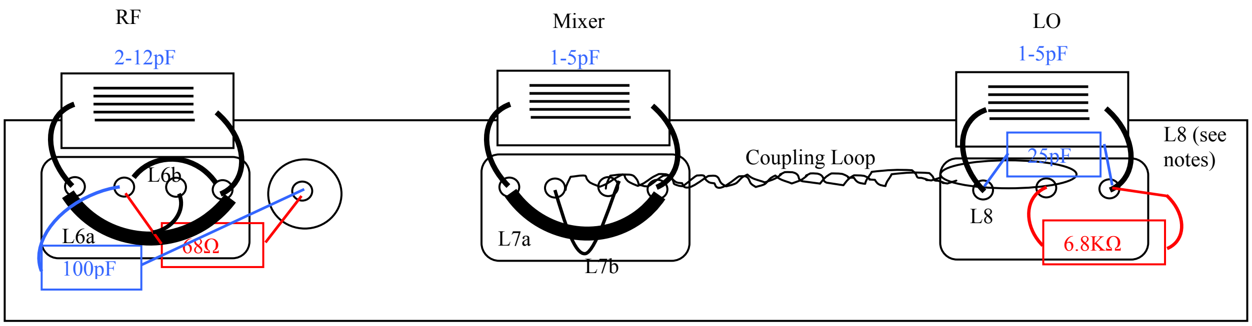


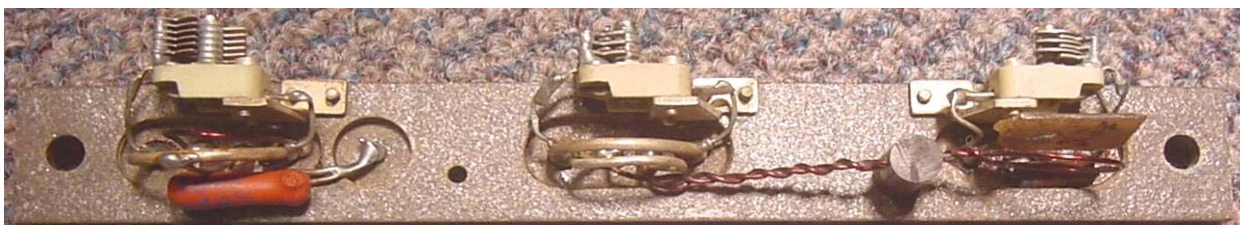


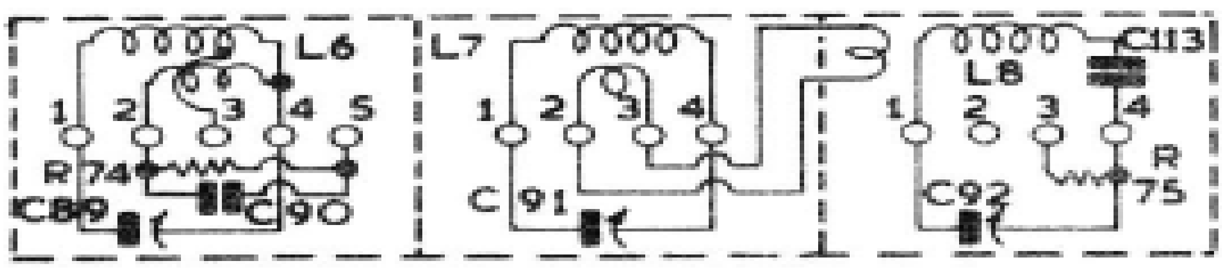


<u>Notes on Range 2 Coil Biscuit</u>
L3 – L3a is 16g silver-plated copper wire, use 22mm length shaped in a shallow curve linking contacts 1 and 4. L4a is tapped around a third-way along its length from contact 4, linking to contact 3. L4b is 22g silver-plated copper wire, use 22mm length linking contacts 2 and 4 shaped into a half-loop normal to the biscuit
L4 – L4a is 16g silver-plated copper wire, use 22mm length shaped in a shallow curve linking contacts 1 and 4. L4b is 22g silver-plated copper wire, use 24mm length shaped into a loop in the same plane as and above L4a, linking contact 2 and 3, spaced from L4a by 0.5mm.
Coupling loop - 22g enamelled copper wire, use 135mm length, forming a 13mm loop in the centre and twist the remainder tightly, scrape enamel off the ends and connect to contacts 2 and 3 in mixer section. The support post is 11mm of 6.4mm diameter Paxolin rod. Locate the loop between L5 and the 1-5pF trimmer (C88)
L5 - 14g silver-plated copper wire, use 30mm length shaped into a half-loop connecting contacts 1 and 4

Range 3







Notes on Range 3 Coil Biscuit

L6 – L6a is 16g silver-plated copper wire, use 36mm length shaped in a shallow half-loop linking contacts 1 and 4. L6a is tapped about half-way along its length (slightly further from contact 4), the tap, made from 22g silver-plated copper wire, linking to contact 3. L6b is 22g enamelled copper wire, use 28mm length linking contacts 2 and 4 shaped into a half-loop normal to the biscuit, spaced nominally 3mm from L6a, located between L6a and the trimmer (C89)

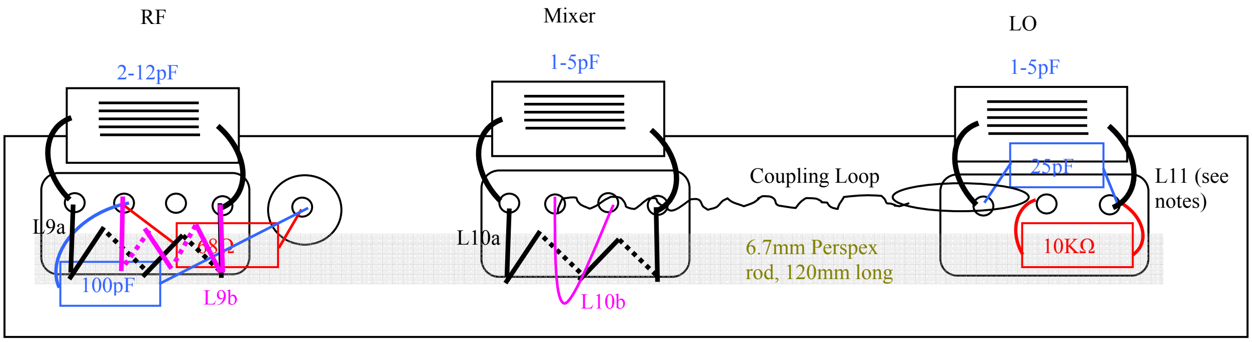
L7 – L7a is 16g silver-plated copper wire, use 36mm length shaped in a half-loop linking contacts 1 and 4 in a plane normal to the biscuit. L7b is 18g silver-plated copper wire, use 32mm length shaped into a loop in same plane as L7a linking contacts 2 and 3, spaced from L7b by 1mm.

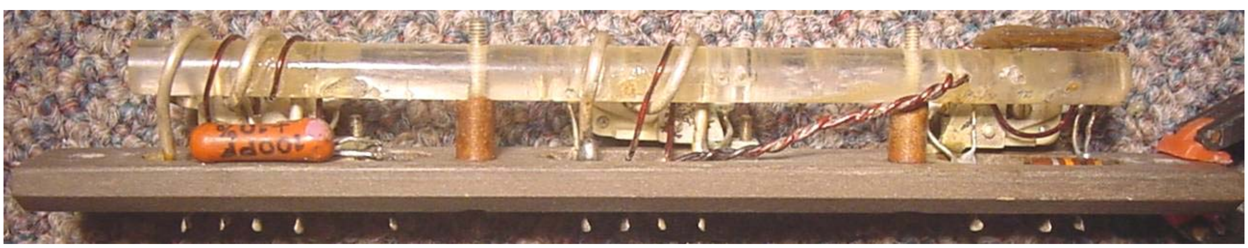
Coupling loop - 22g enamelled copper wire, use 135mm length, forming a 13mm loop in the centre and twist the remainder tightly, scrape enamel off the ends and connect to contacts 2 and 3 in mixer section. The support post is 11mm of 6.4mm diameter Paxolin rod. Locate the loop on opposite side of 25pF silver mica capacitor (C113) to trimmer (C92).

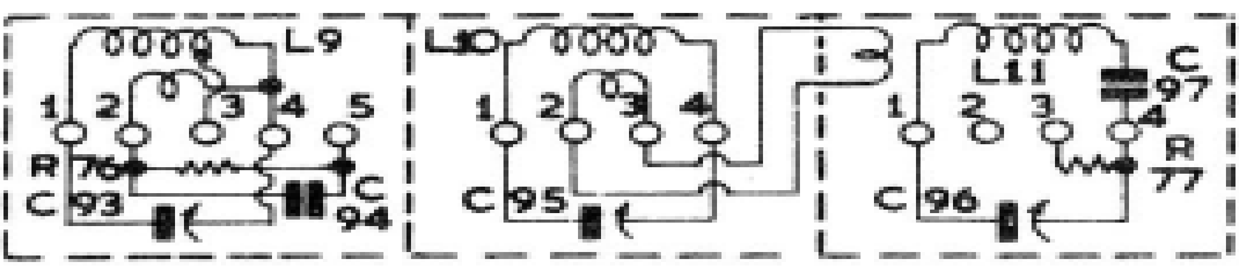
L8 - the leads of C25 form L8 (supplied 16mm long on NOS biscuits) and require trimming to align (see below).

Mike Cassidy and myself corresponded on installing a NOS Range 3 biscuit. The biscuit as-supplied did not work at the correct frequency – the leads of the 25pF silver mica capacitor (C113), comprising L8, had to be trimmed to bring the local oscillator within range. In my case the leads were trimmed from a supplied length of 16mm in 2mm increments until they were 8mm long, whereupon the trimmer (C92) could tune as required to align the set on Range 3. Mike also noted that the position of the capacitor affected the frequency (bending the capacitor body at right angles to its leads decreases the resonant frequency).

Range 4







Notes on Range 4 Coil Biscuit

L9 – L9a is 16g silver-plated copper wire, use 68mm length shaped in two turns around the Perspex rod, spread over 16mm, linking contacts 1 and 4. L9a is tapped about a fifth way along its length from contact 1, the tap, made from 18g silver-plated copper wire, linking to contact 3. L9b is 22g enamelled copper wire, use 64mm length linking contacts 2 and 4 shaped in two turns around the Perspex rod, spread over 16mm, located between L9a turns

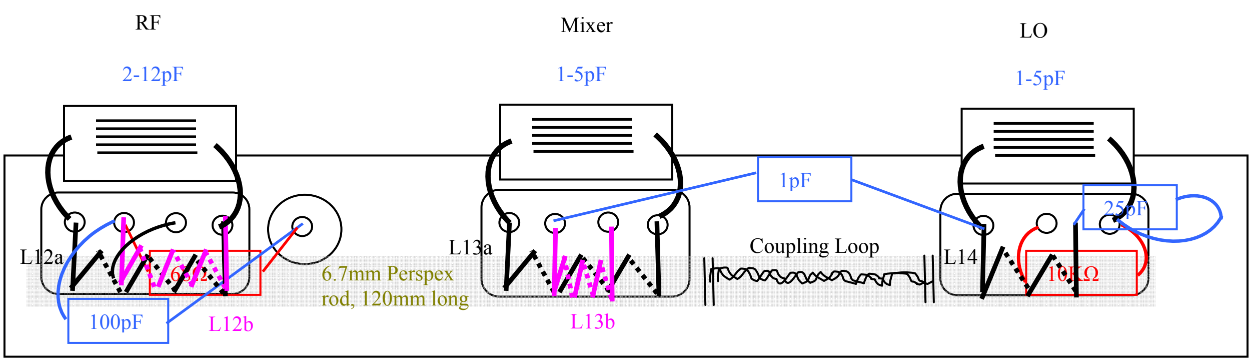
L10 – L10a is 16g silver-plated copper wire, use 68mm length shaped in two turns around the Perspex rod, spread over 16mm, linking contacts 1 and 4. L10b is 22g enamelled copper wire, use a 34mm length linking contacts 2 and 4 shaped in a loop around the Perspex rod, located between L10a turns.

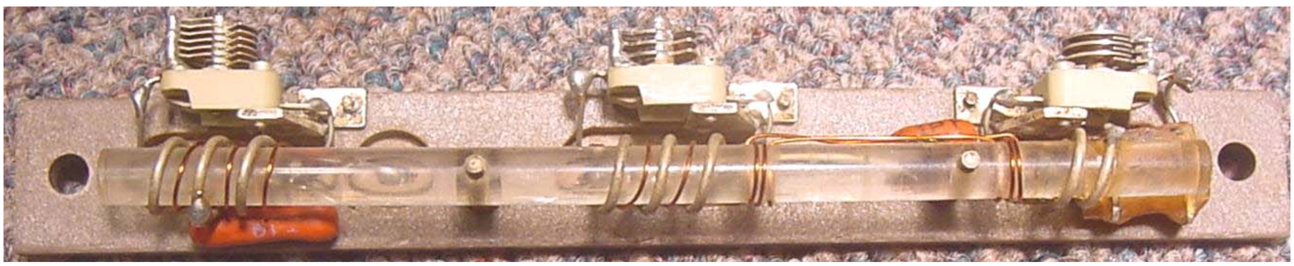
Coupling loop - 22g enamelled copper wire, use 135mm length, forming a 13mm loop in the centre and twist the remainder tightly, scrape enamel off the ends and connect to contacts 2 and 3 in mixer section. The support for the coupling loop is the Perspex rod (two holes drilled through it 22mm from the local oscillator end). Locate the loop on the same side of the 25pF silver mica capacitor (C97) as the trimmer (C96).

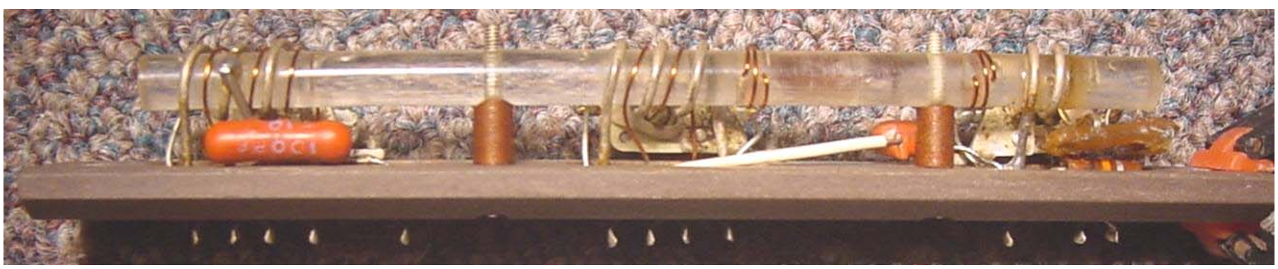
L11 - the leads of C97 form L11 (these are supplied 18mm long on my Range 4 biscuit).

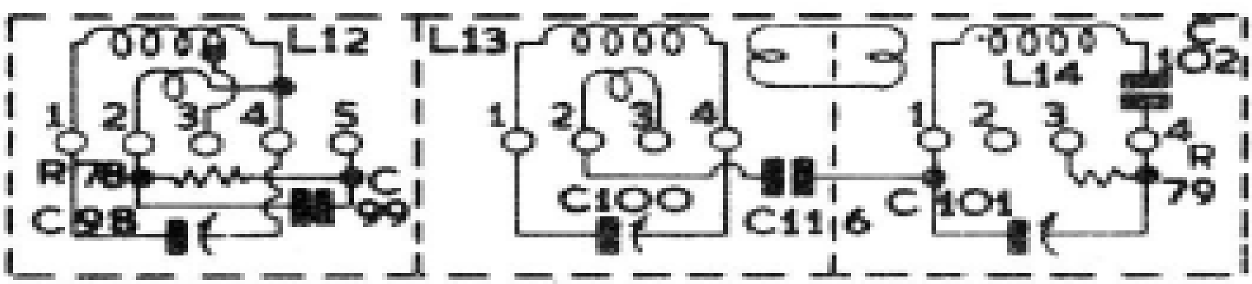
The Perspex rod is supported by two 7.5mm high 4.7mm diameter Paxolin spacers.

Range 5









Notes on Range 5 Coil Biscuit

L12 – L12a is 18g silver-plated copper wire, use 104mm length shaped into three turns around the Perspex rod, spread over 16mm, linking contacts 1 and 4. L12a is tapped about half way along its length, the tap, made from 18g silver-plated copper wire, linking to contact 3. L12b is 22g enamelled copper wire, use a 100mm length linking contacts 2 and 4 shaped into three turns around the Perspex rod, located between L12a turns.

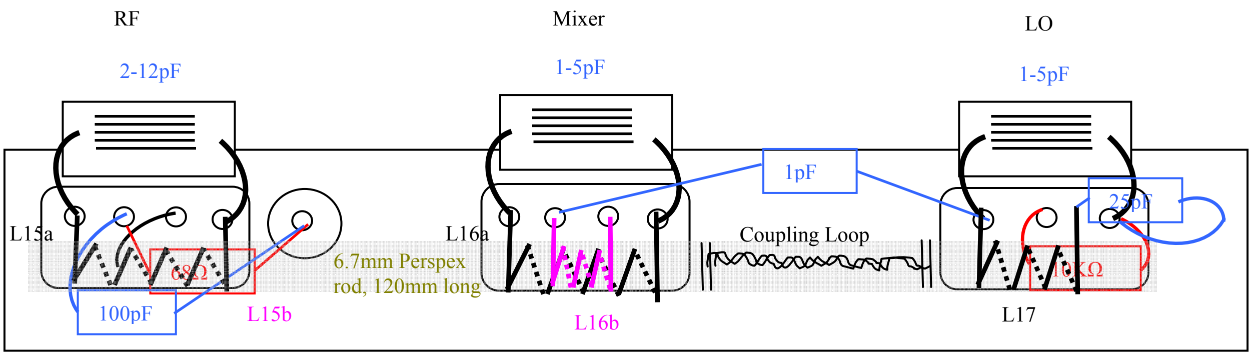
L13 – L13a is 18g silver-plated copper wire, use a 104mm length shaped into three turns around the Perspex rod, spread over 16mm, linking contacts 1 and 4. L13b is 22g enamelled copper wire, use an 80mm length linking contacts 2 and 4 shaped into two turns around the Perspex rod, located between L13a turns.

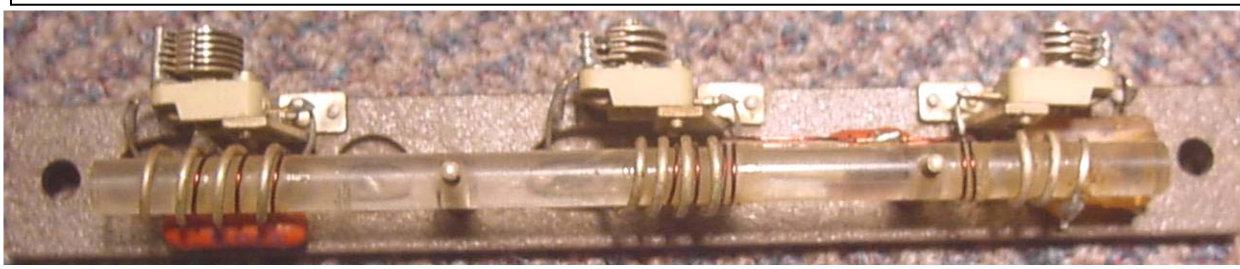
Coupling loop - 22g enamelled copper wire, use sufficient wire to form two two-turn coils wound around the Perspex rod, separated by 26mm and spaced 4mm from L13 and from L14, the ends of the wire being soldered together to form a loop. The support for the coupling loop is the Perspex rod, four horizontal holes being drilled in it for this purpose.

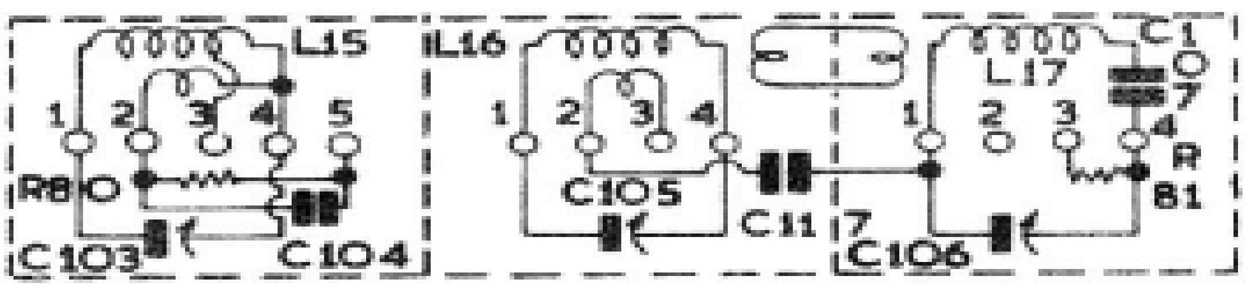
L14 - is 18g silver-plated copper wire, use a 60mm length shaped into two turns around the Perspex rod, spread over 7mm, linking contact 1 and one end of the 25pF capacitor (C102) in the mixer section.

The Perspex rod is supported by two 7.5mm high 4.7mm diameter Paxolin spacers.

Range 6







<u>Notes on Range 6 Coil Biscuit</u>

L15 – L15a is 18g silver-plated copper wire, use 130mm length shaped into four turns around the Perspex rod, spread over 16mm, linking contacts 1 and 4. L15a is tapped about a third way along its length from contact 1), the tap, made from 18g silver-plated copper wire, linking to contact 3. L15b is 22g enamelled copper wire, use 105mm length linking contacts 2 and 4 shaped into three turns around the Perspex rod, spread over 16mm, located between L15a turns

L16 – L16a is 18g silver-plated copper wire, use 125mm length shaped into four close-spaced turns around the Perspex rod, spread over 10mm, linking contacts 1 and 4. L16b is 22g enamelled copper wire, use 100mm length linking contacts 2 and 4 shaped into three turns around the Perspex rod, located between L16a turns.

Coupling loop - 22g enamelled copper wire, use sufficient wire to form two two-turn coils wound around the Perspex rod, separated by 29mm and spaced 0.5mm from L16 and 3mm from L17, the ends of the wire being soldered together to form a loop. The support for the coupling loop is the Perspex rod, four horizontal holes being drilled in it for this purpose.

L17 - is 18g silver-plated copper wire, use a 72mm length shaped into two and a half turns, around the Perspex rod, spread over 10mm, linking contact 1 and one end of the 25pF capacitor (C107) in the mixer section, this capacitor lead extending around the Perspex rod to complete the third turn on L17.

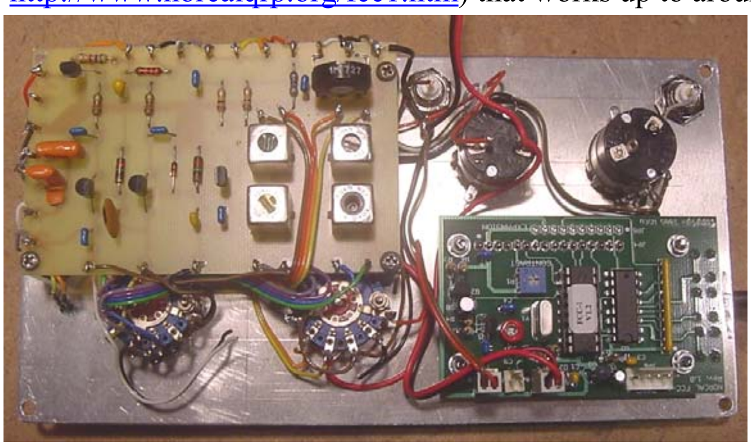
The Perspex rod is supported by two 7.5mm high 4.7mm diameter Paxolin spacers.

Appendix III – Wobbulator and Its Use in Checking the Alignment of the S770U

Building a Wobbulator

I recently constructed a combined wobbulator and digital frequency meter (DFM) unit to assist in the alignment of sets[18]. I have been using a Wavetek Model 164 sweep generator for this purpose - a very nice and versatile instrument - but found it not to be very stable on the higher IF frequencies (eg. 5.2MHz and 10.7MHz).

Looking out for something more suitable, I found a simple but versatile wobbulator circuit designed by Raymond Haigh in the April/May 2003 issue of 'Radio Bygones' magazine (back-copies and printed circuit boards available from http://www.radiobygones.com/issues.html), and so I decided to construct it, adding a frequency counter into the same box for convenience. The standard wobbulator circuit ranges for this design cover from below 400KHz to over 14MHz, but could be modified for lower or higher frequencies (eg. I needed a range around 37MHz for another project I am working on – see below). I had previously made-up a DFM from a kit (an 'FCC-1' from Norcal, http://www.norcalqrp.org/fcc1.htm) that works up to around 50MHz or so, and this seemed ideal for the purpose of setting the centre frequency of the swept oscillator.



The two circuit boards, controls pots, sockets and switches were built into a small cast-aluminium instrument case I had picked up free at a CVRS meeting (photo, previous page). As-constructed, I found that the wobbulator oscillator had more than adequate stability for the type of service I have in mind and the DFM works a treat. Incidentally, the FCC-1 unit has facility for

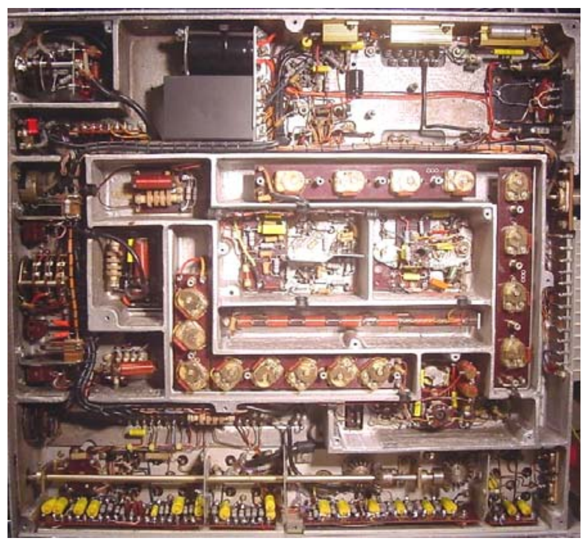
[18] A wobbulator is a swept-frequency oscillator, the centre-frequency of which is set at the nominal IF of the receiver under test, and that sweeps across the full receiver passband such that the IF response curve can be displayed on an oscilloscope screen. This wobbulator/oscilloscope set-up can be used as an aid in the accurate alignment of a sets IF stages, and can also be used for aligning FM discriminators (Elements of Radio Servicing, Marcus & Levy, 2nd Ed. Ch. 26.).

programming-in different frequency offsets (plus many other features) and so can be used as a digital frequency display on virtually any receiver by connecting the DFM input to the set's local oscillator (not bad for $40, including shipping) – it took only an evening to construct and set-up.

After using the wobbulator for a while, I undertook a few modifications to the standard circuit to increase the span of each range slightly and to improve tuning precision, stability and repeatability as follows:

- replaced R4 (22KΩ) tuning pot with 20KΩ high-quality 10-turn pot;
- replaced R3 (1KΩ) fine-tuning pot with a high-quality 220Ω pot;
- replaced R2 (4.7KΩ) with a 3.3KΩ resistor;
- replaced R5 (33KΩ) with 15KΩ resistor

I also tried adding a 37MHz to 40MHz range to see if the unit could be used to align the bandpass filters in a Racal RA-117 receiver I recently restored (photo, below). This was attempted by using a small tapped coil mounted directly on the wobbulator's range switch, but I found that the maximum frequency obtainable was only around 25MHz due to self-inductance of the leads from the circuit board to the range switch and various stray capacitances. In order to reach higher frequencies I think you would have to replace one of the coils directly on the circuit board and use very short leads to the range switch or alternatively, build a single-range unit. In the end I used a borrowed a HP spectrum analyser to set the RA-117 bandpass filters up – a piece of cake… (!)

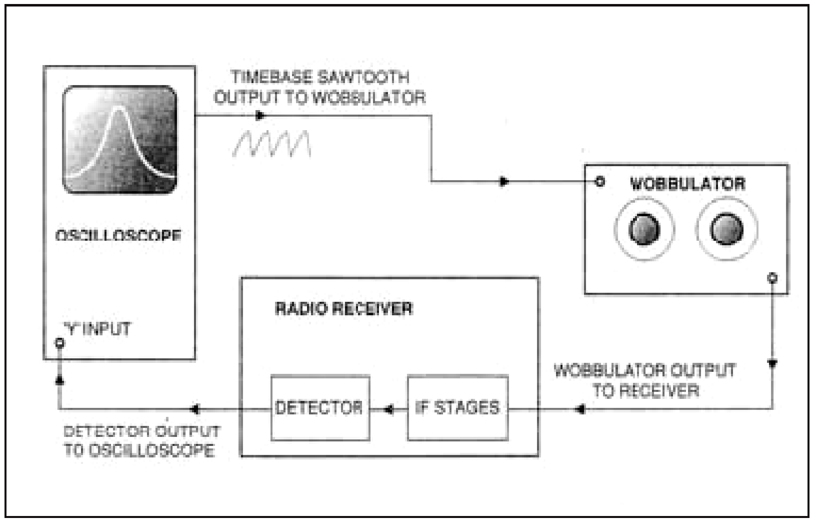


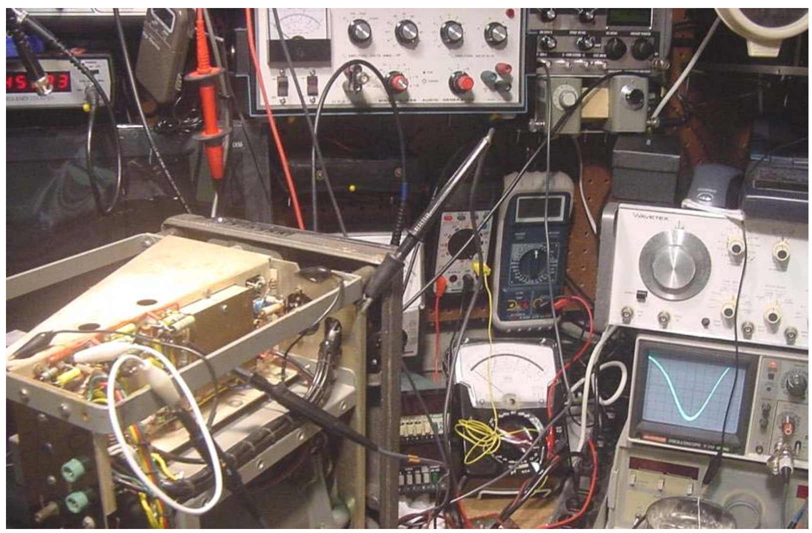
Using the Wobbulator

I decided to use the wobbulator to check the (2nd) IF response curve of the S770U after I had already re-aligned it using the standard procedure outlined in the manual. The set-up needed is quite simple:

- a connection from the oscilloscope timebase (ramp) circuit to the wobbulator 'ramp input';
- a connection from the wobbulator (swept) output, centered at 5.2MHz, the sweep width set to be slightly wider than the full IF bandwidth (say 100KHz), via an attenuator to the input of the 2nd IF stage: either the anode of the mixer section of V5 (pin6) for observation of the full 2nd IF response, including T5, or alternately, the grid of V6 (pin 1), excluding T5;
- a connection from the AM detector to the scope Y input (I connected to the junction of C53, R32 and R35 in the S770U).

The figure below, right and accompanying photo show the above arrangement. In the photo, the S770U can be seen on the left side (IF strip uppermost), the wobbulator is located top right and the scope is on the lower right. Note that the scope trace is inverted due to the sense of the S770U detector diode.

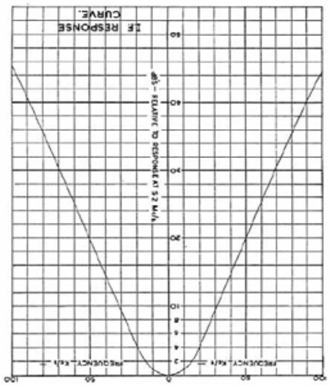


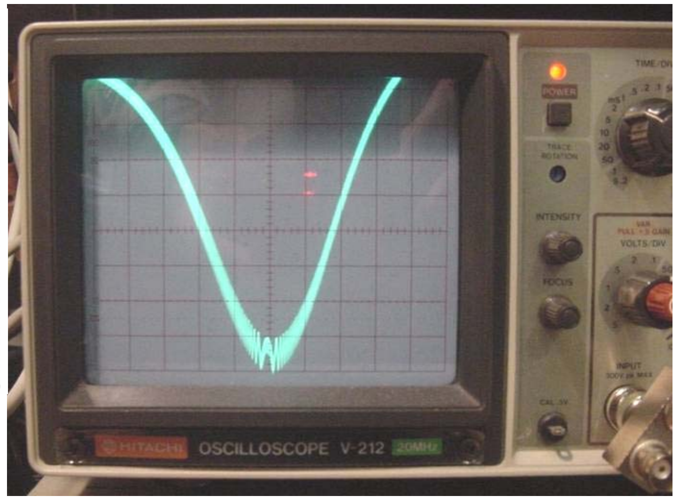


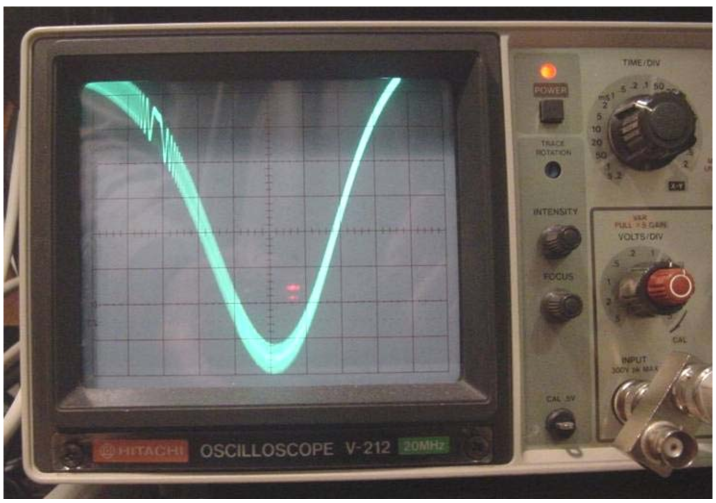
I also connected a signal generator and DFM to the 2nd IF input (via a 1MΩ resistor) to provide a tunable marker 'pip' on the response curve. The photos on the next page show typical responses observed: the marker was first centered on 5.2MHz (as measured on the DFM) and the wobbulator centre frequency adjusted to the same frequency. The wobbulator sweep width and output level, together with the oscilloscope Y-gain, timebase and trace position controls were then adjusted to show the entire response curve on the screen, the Y-gain being adjusted in conjunction with the attenuator to provide a crude db calibration of the vertical scale. The marker oscillator was then used to provide calibration of the oscilloscope X-axis. In this case, the setup gave approximately 10KHz per division (horizontal scale) and around 4dB/division (vertical scale).

The scope traces obtained were very encouraging, both symmetrical about the centre frequency and showing that the bandwidth specifications provided in the manual were almost being obtained - a bit narrow if anything (which could be corrected by stagger-tuning the second IF tuned circuits) - but not enough for me to be concerned about Given this performance I decided not to re-visit aligning the 2nd IF stage of the receiver.

Right: The 2nd IF response curve from the manual (inverted) alongside the oscilloscope trace of same for comparison (again inverted due to the sense of the detector diode). Note the 5.2MHz marker 'pip' on the 'nose' of the curve (marker frequency zero-beating with the IF signal).

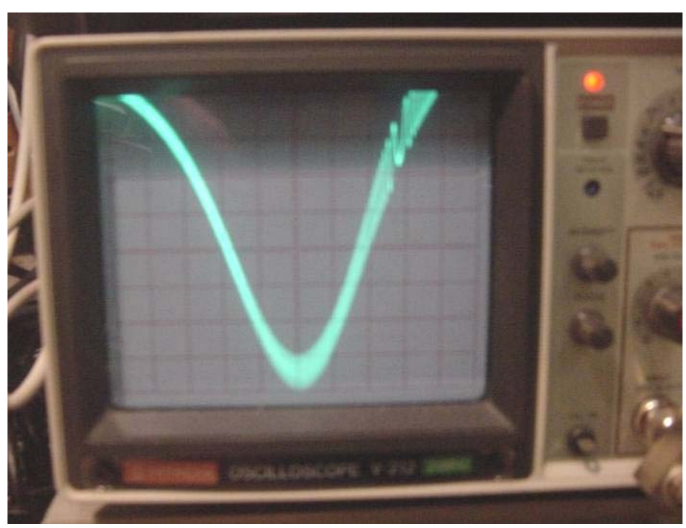




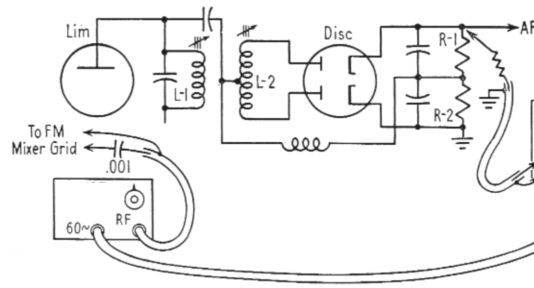


Left: The 2nd IF response curve, marker 'pip' set 30KHz low of the IF centre frequency (5.17MHz).

Right: The 2nd IF response curve, marker 'pip' set 30KHz high of the IF centre frequency (5.230MHz).

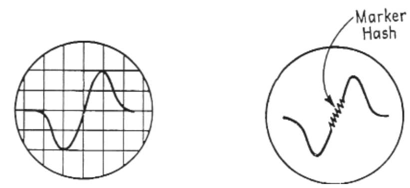


The alignment of the Foster-Seeley discriminator was also checked using the wobbulator and oscilloscope following the alignment procedure outlined in Elements of Radio Servicing, Marcus & Levy, 2nd Ed., pp508 (diagram, right) – basically the same set-up as for the IF response curve, but move the scope Y-input to pin 1 of V10.



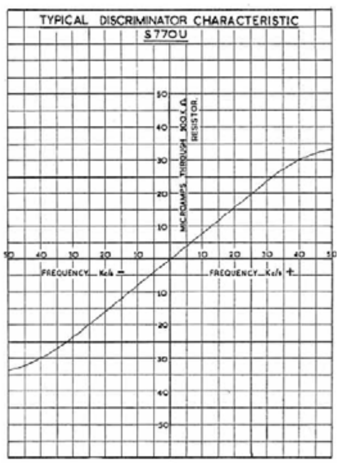
('scope Y-input to Pin 1 of V10)

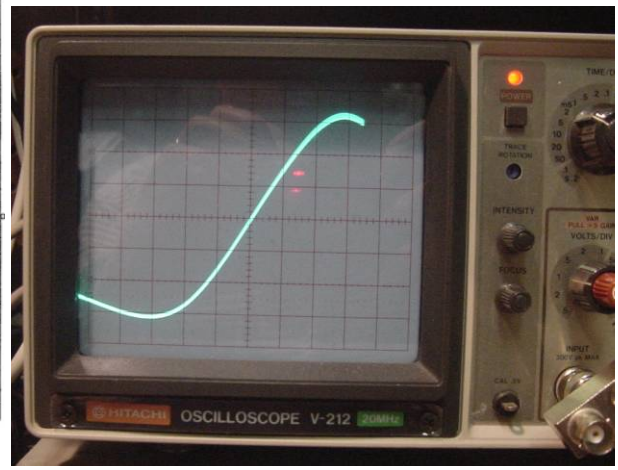
Aligning the Foster-Seeley discriminator.

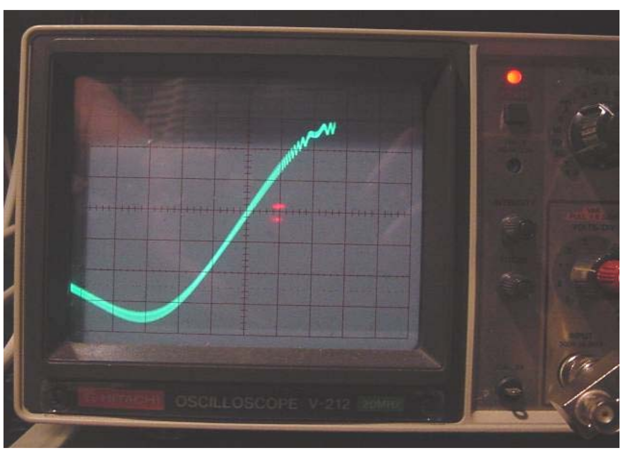


The discriminator appeared to be working satisfactorily and in accordance with the specifications (see photos below).

Right: The FM discriminator response curve from the manual, alongside the oscilloscope trace of same for comparison, centred on the 2nd IF (5.2MHz).







Left: The FM discriminator response curve, marker 'pip' set 40KHz high of the IF centre frequency (5.240MHz).

Right: The FM discriminator response curve, marker 'pip' set 40KHz low of the IF centre frequency (5.160MHz).