The Bulletin

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BVWS 40th Anniversary

The Bulletin of the British Vintage Wireless Society £5.00 | free to members ISSN 0955-9345

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Incorporating 405 Alive
Volume 41 No.1 Spring 2016

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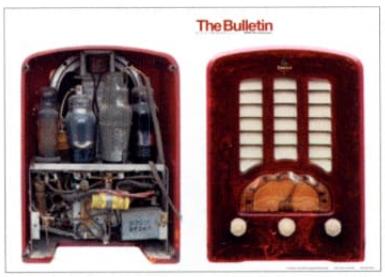


Front and rear cover: Emerson BT245 'Tombstone', 1938 USA in Ruby red catalin cabinet.

Photographed by Carl Glover
Graphic design by Carl Glover and Christine Bone
Edited by Carl Glover. Sub-Edited by Ian Higginbottom
Proof-reading by Jeremy Day and Steve Sidaway

Contents

From the Chair

Here we are! Here we are! Here we are again....

Another year, but not just that. It is 40 Glorious years of the BVWS. From the first meeting in June 1975 at Tudor Rees' Bristol shop where a handful of people gathered and thoughts of forming a vintage radio Society were discussed, fast forward to the 25th of April 1976 where in an Ealing lounge a Society was born.

Now 40 years later countless people have made good friends, collected many thousands of radios, TV and Hi-Fi etc. All benefiting from the shared knowledge amassed and passed on.

For my part, I came to hear of the BVWS in the mid 1980's but was more interested in getting radios than joining at that time. However it was not long before I was persuaded to join up. The rest, as they say is history!

This being our 40th anniversary year, the theme for the 2016 Membership card and all Bulletin covers this year will be 'Radios in the Red' Ruby red of course!

The dreaded VAT Man

We have recently been informed by our printers, Hasting Printing Co. of new legislation which came into effect in 2015 which means that any organisations that use the services of a printing company to both print and post out their publications fall fowl of being charged VAT on the whole job. Up until now this activity was VAT exempt. It was at first thought that the VAT would only be levied upon the postage content of the job, but after significant communications between HMRC and our printers, it would appear not.

The result being that the Winter 2015 Bulletin, DVD and Calendar cost the Society an extra £1,580 in VAT for no gain whatsoever. As the Society is not VAT registered we cannot get this money back. To avoid this VAT on future Bulletins (until perhaps HMRC come to their senses) we will be posting out the printed and packaged Bulletins ourselves. The reason for this legislation coming in to force is due to large advertising corporations and Charities using a loop hole to avoid paying tax.

40 Years of Collecting – NVCF Exhibition

Part of the BVWS celebrations this year is an exhibition at the NVCF with the theme of 'What you collect'. This is being organised by Jeremy Day and you will find an entry form in the centre pages of this Bulletin for items that we hope you will bring along for display. On the form you will find some descriptive text and contact details. We hope to show the diversity of the collections within the BVWS membership so please do enter something from your collection for others to see and enjoy.

We would like to thank all of those members who have diligently sent in their membership renewal forms in good time. This makes the job of processing everything prior to this first Bulletin of the year so much easier. Thank you.

Mike...

Committee meeting dates this year will be:
15-04-2016 at Fleet
05-08-2016 at BVWATM
09-12-2016 at Devizes

John L Wilson

March 1939 - December 2015

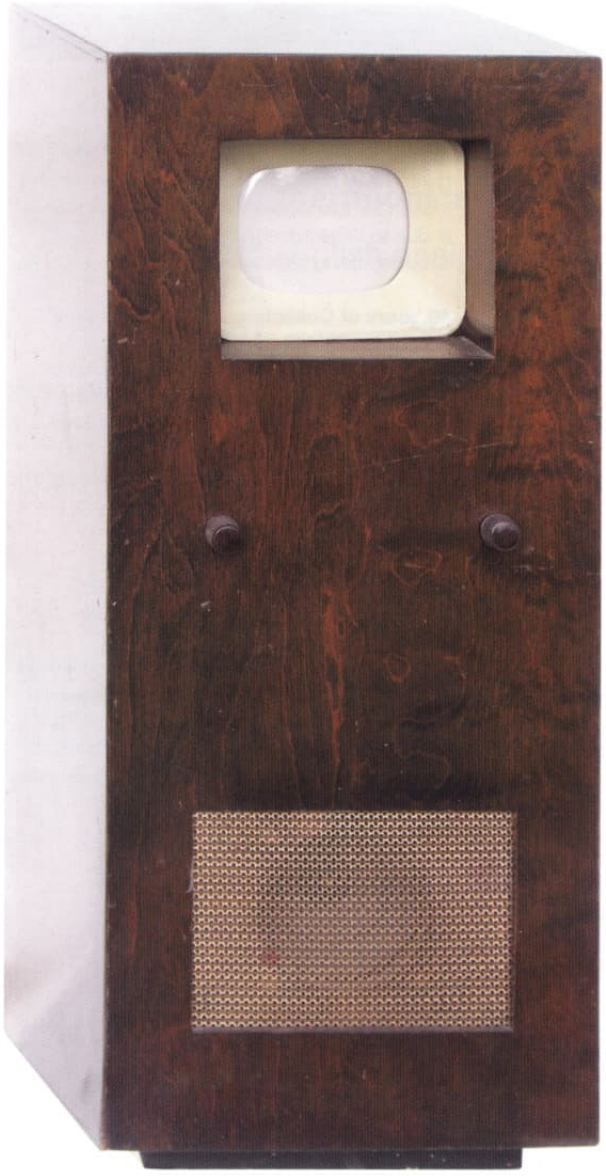
It is with sadness that we report the death on Christmas Eve 2015 of John Wilson. John was a keen supporter of the BVWS for a great many years. John and his wife Rosemary, were regularly seen at many BVWS events all over the country. There was always a mountain of gleaming restored radios on their stall for discerning customers to acquire. He will be greatly missed.

An inexpensive television using war surplus equipment

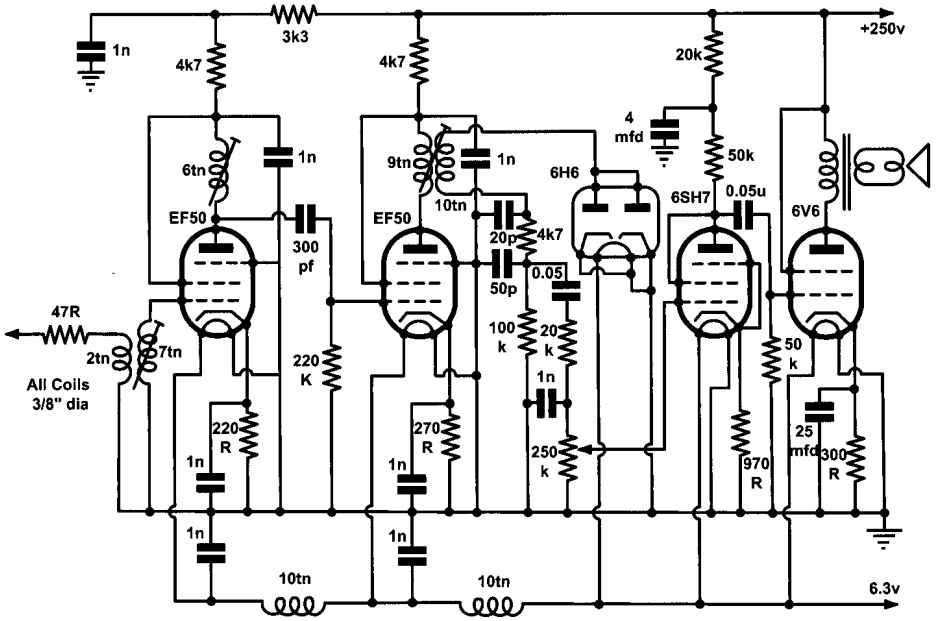
by Roger Grant

During the early 1960's in my final school years I was deeply engrossed in building the Practical Wireless double beam oscilloscope. This utilised a VCR97 green phosphor ex-WD radar tube – I had purchased one of these for 6d (2.5p) at a Scout jumble sale and intended building the rest of my scope from salvaged parts.

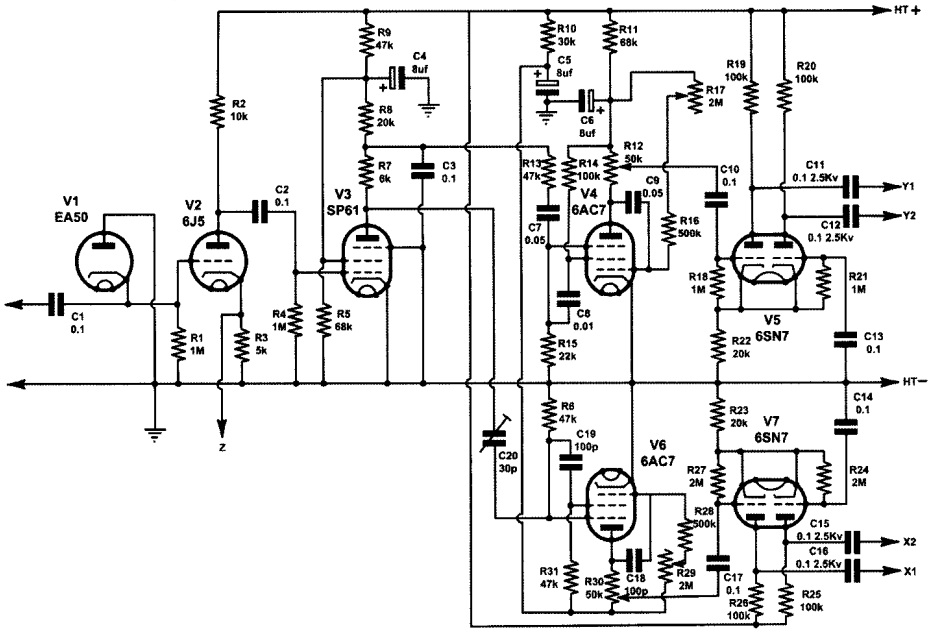
Engrossed in this project I found myself doing a detention for reading my PW during an English lesson. I argued that it was in English and I was reading it but this didn't wash and I was sent to the Geography room after school where Mr Hill the geography teacher would preside over the dozen or so kids 'doing the penance'.



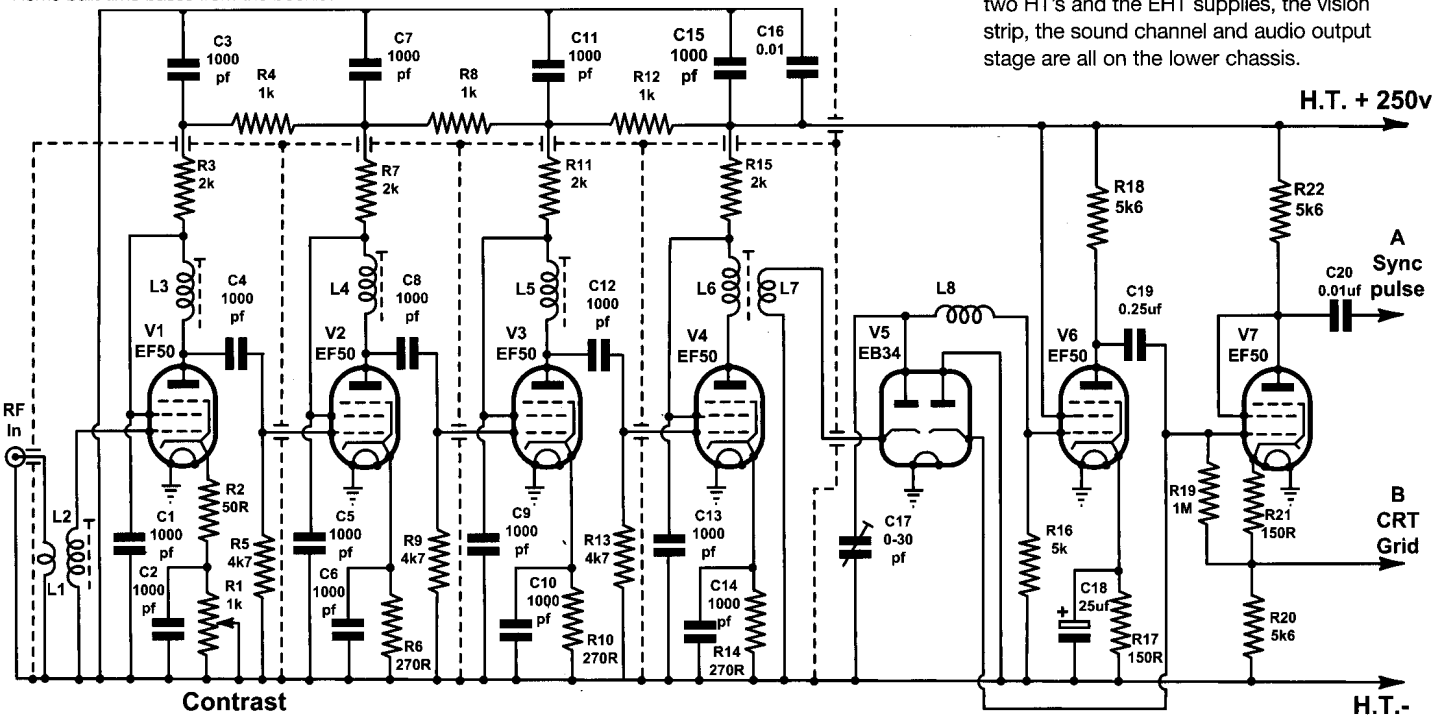
We were told to make ourselves useful (but homework was not allowed) So I once again got back into my PW. Mr Hill would pace up and down keeping an eye on what the kids were doing and when he got to me I expected my choice of reading matter to be frowned upon but much to my surprise he was very interested and asked me to keep him informed as to how I was getting on. I had built the power supplies and feeder chain to the VCR97 but couldn't get a spot to light up on the tube and didn't know if the tube I had purchased was any good. During several discussions with Mr Hill during lunch breaks he told me he had an old TV set in his shed that used a VCR97 that he didn't want. He and his brother had built a TV set some years ago to watch the coronation but it was now redundant and I would be welcome to it, with my Dads permission of course, and if I'd like it, he would telephone my dad that evening. Dad, appreciating his concern, convinced him that I was always up to my neck in old radios and he was happy for me to have this set, and Mr Hill dropped it round the following weekend. This set consisted of two chassis obviously both ex-military equipment, one just the power supplies covered in chokes and transformers and the other looking like a large oscilloscope with its VCR97 tube (almost identical to the illustrations in the Radio Constructor Inexpensive Television booklet). I removed its tube and tried it in my basic scope which still



Home built sound strip from the booklet



Home built time bases from the booklet



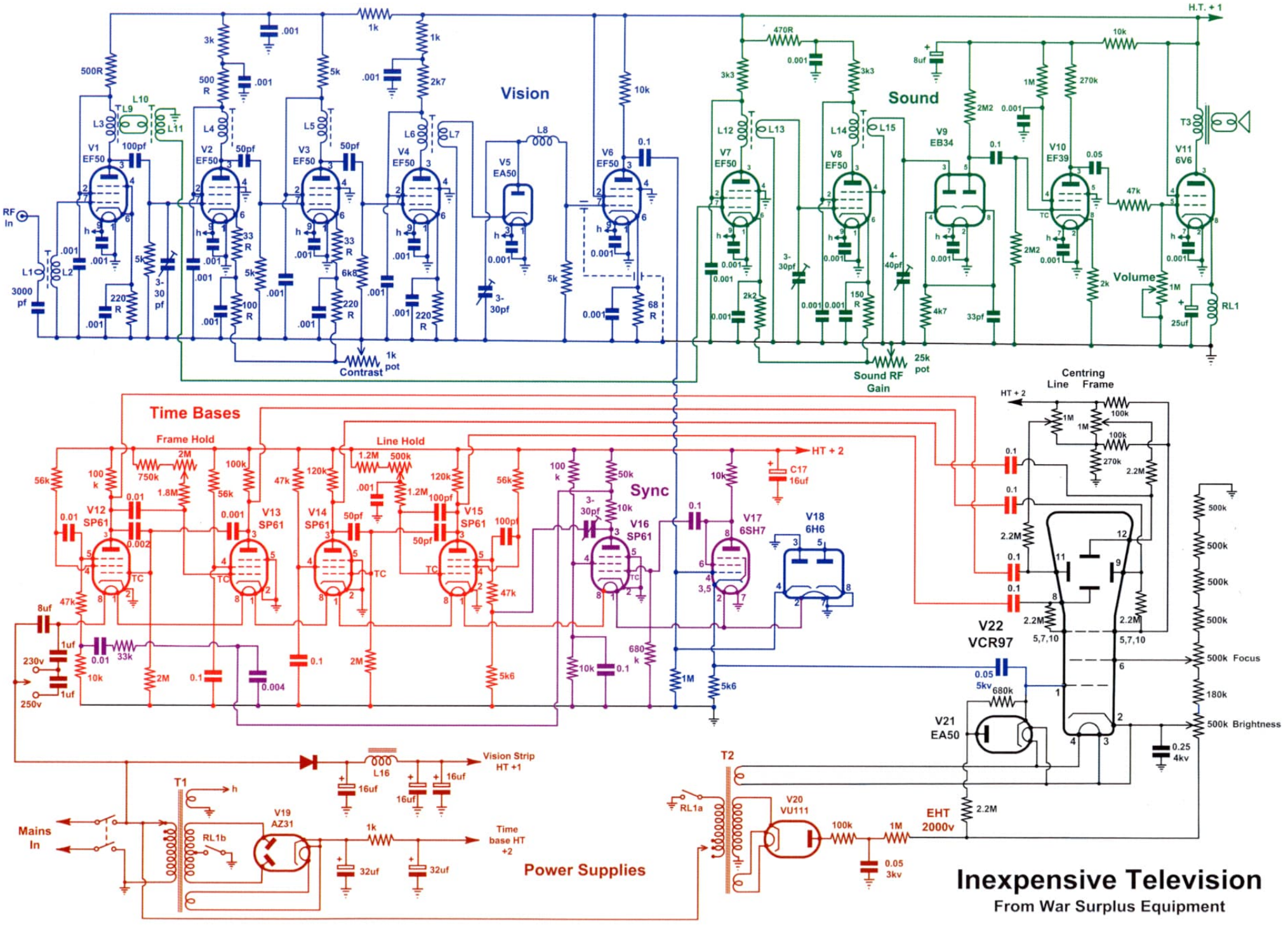
Home built time vision receiver from the booklet

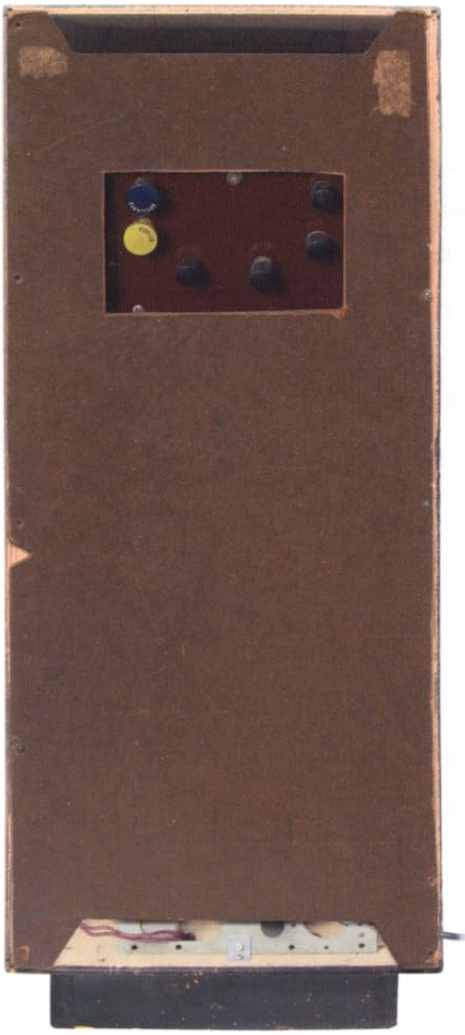
didn't work, but my interest now turned to this home built TV. I then reassembled it and with a lot of help from Dad and Harry a radio man who lived in the next road, we actually got it working. My first colour TV (it was green) but unfortunately BBC only as this was the only TV station available at the time this set was built. I eventually finished the basic stages of the PW oscilloscope with just one channel working but the waveform displayed was distorted, which I would now recognise as a mixture of external magnetic influences on the tube (one or both of the mains transformers) and a non linear time base. Both of these pieces became casualties of my new found interest in motorcycles in my late teens.

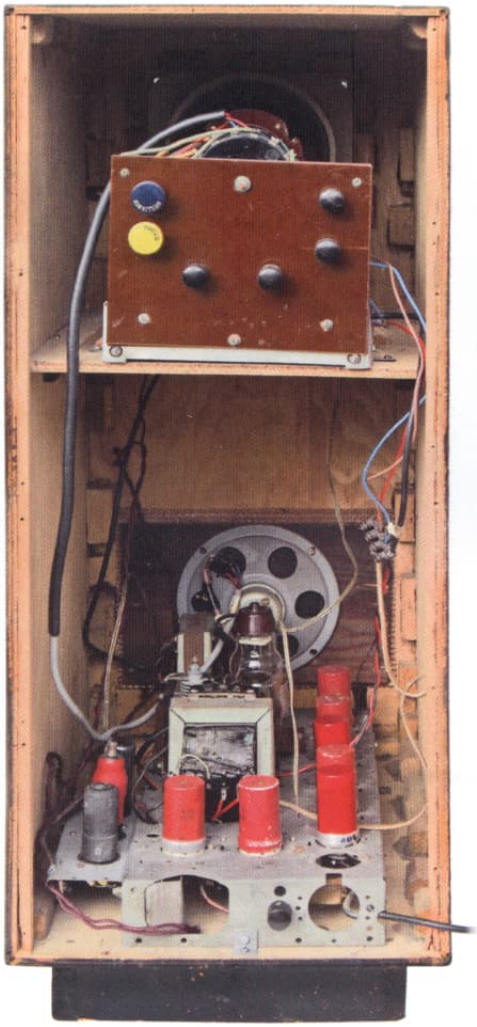
This project started like many others at one of the Harpenden swapmeets.Fellow member Howard Carlton approached me about the restoration of a home built TV from the late 1940's or early 1950's. This sounded like a very interesting project and yet another trip back in time back to my youth. Howard had quite a wait while I finished a few other projects, then with a bit of a nudge at the Cinema Museum event I couldn't wait to get stuck into this set and collected it one evening.

Reading through the 'Inexpensive Television' booklet that came with this set, it appears there were several pieces of war surplus equipment and methods of hooking it all together, three vision strips, three different ways of obtaining an EHT supply, two or three different CRT's that could be used and their supply chains and finally a very basic sound channel and no mention of any HT power supplies. The set I have before me was cobbled together odds and ends close to the booklet but none of the circuits were the same as in the set I had, but the booklet made a good guide, and a good place to start.

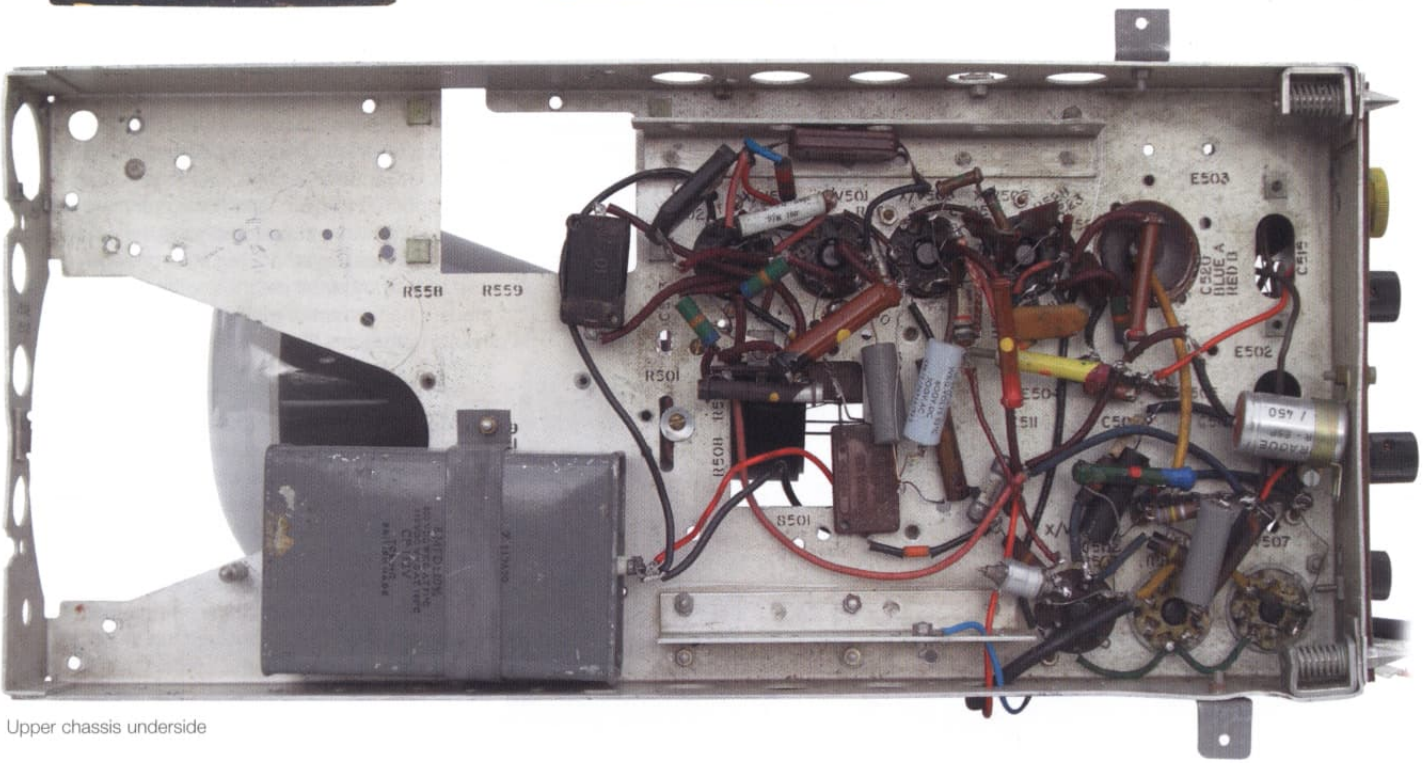
This set is also built on two separate chassis, one above the other in a console cabinet and can be divided up into sections and processed one at a time. The CRT network and feeder chain, the time bases and sync separator are all on the upper chassis. The power supplies, two HT's and the EHT supplies, the vision strip, the sound channel and audio output stage are all on the lower chassis.


Vision
Sound
Time Bases
Frame Hold
Line Hold
Sync
Centring
Line Frame
Power Supplies
Contrast
Sound RF Gain
Volume
Mains In
RF In
H.T. + 1
HT + 2
Vision Strip HT +1
Time base HT +2
EHT 2000v
V1 EF50
V2 EF50
V3 EF50
V4 EF50
V5 EA50
V6 EF50
V7 EF50
V8 EF50
V9 EB34
V10 EF39
V11 6V6
V12 SP61
V13 SP61
V14 SP61
V15 SP61
V16 SP61
V17 6SH7
V18 6H6
V19 AZ31
V20 VU111
V21 EA50
V22 VCR97
T1
T2
T3
RL1
RL1a
RL1b
C17 16uf
500k Focus
500k Brightness
180k
Inexpensive Television
From War Surplus Equipment





Dangling components everywhere!

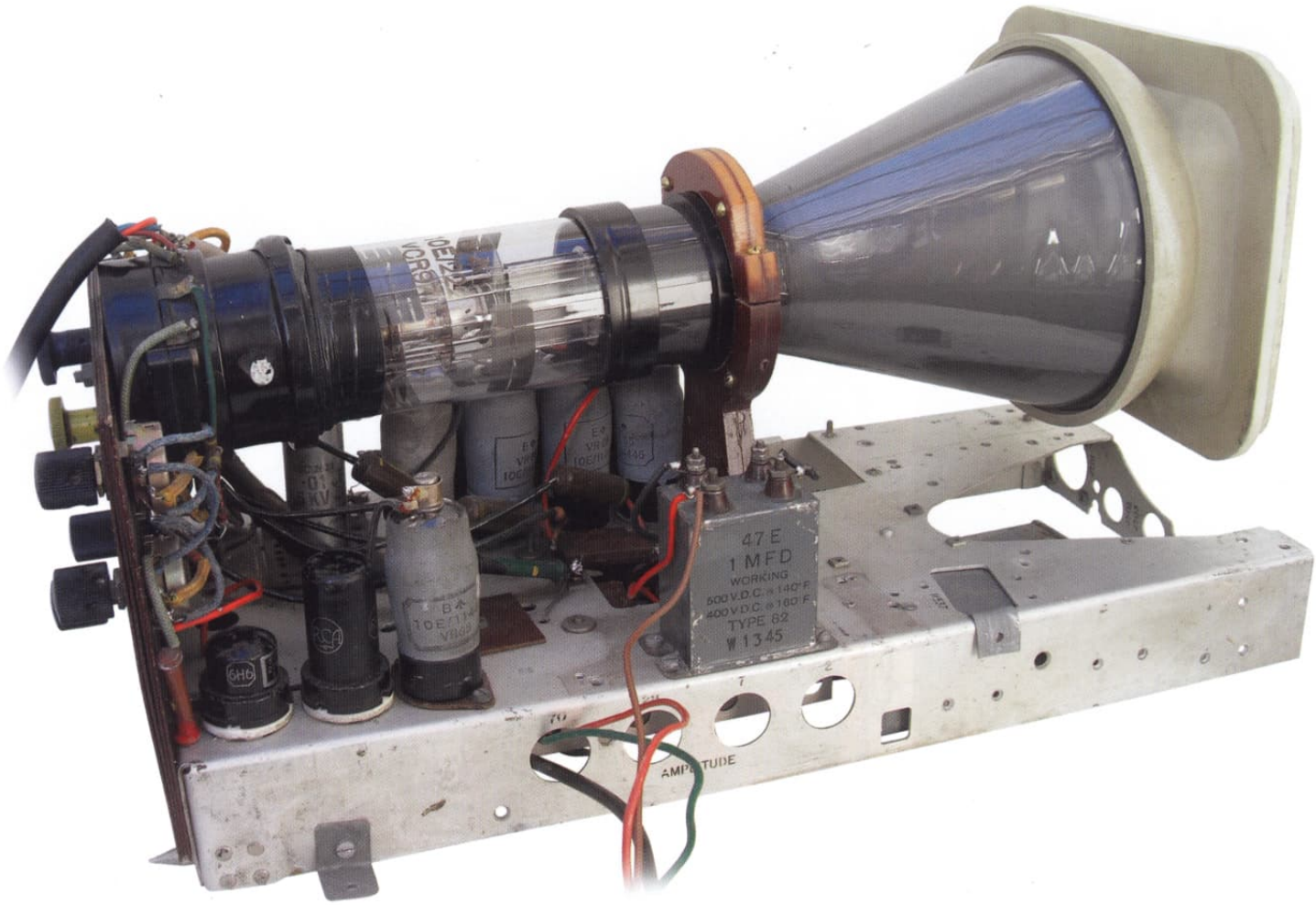


Upper chassis underside

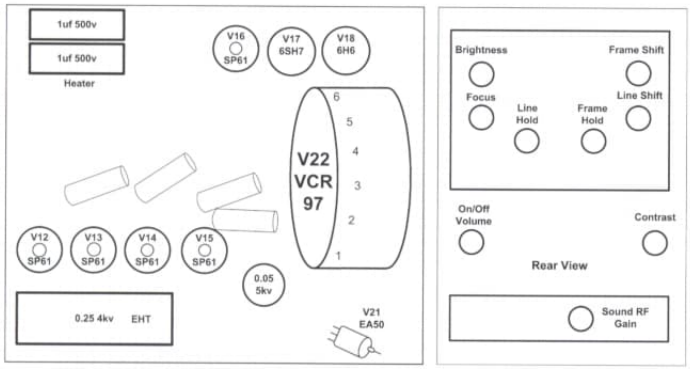
The tidy up

Before I could even think about applying any power there was a lot of tidying up to be done. This set is home constructed from a stripped war surplus chassis and rebuilt from scratch, The original constructor would only use one screw to retain anything when only one would do, leading to a lot of dangling bits and pieces, several components were hanging out of the chassis some of which appeared to be redundant. There was nothing holding the tube in place other than its socket, and this required the manufacture and fitting of a mounting cradle.

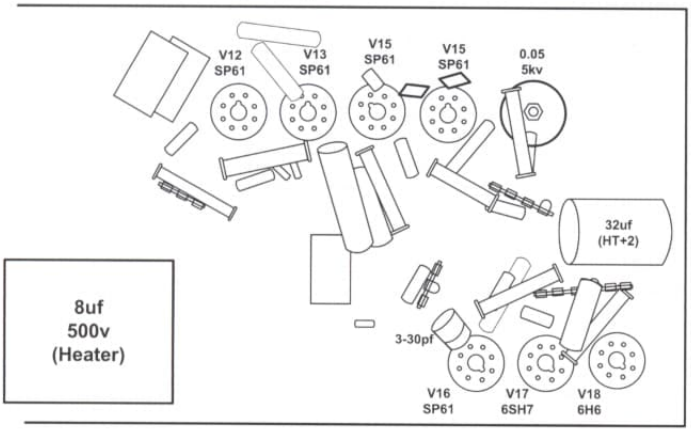
The EHT rectifier socket was fitted on a stand-off paxolin panel. This was fitted at an odd angle in convenient holes and didn't line up with the hole in the chassis underneath, new holes were drilled and this corrected. The EHT rectifier base now in line with and accessible through a valve holder hole in the



Upper chassis rear view



Upper chassis component layout (top)



Upper chassis component layout (underside)

chassis, this being less likely to arc across. There were two large block capacitors hanging on with one screw, one of these didn't appear to be connected to anything and the other had one wire connected to the upper chassis heater circuit, in this case a series chain. The EHT rectifier valve had a burn-up on its base due to arcing, a new base was fitted to this valve. Several wires had fallen off and one or two components appeared to be missing or not connected to anything. A lot of the circuitry was strung together like a spiders web and just hanging in there, this required a tag strip or two to tidy it up and for ease of test and fault diagnosis. I took a lot of photographs and made a basic map of the interconnecting wires between the chassis before any labels fell off.

The circuit.

The power supplies are located on the lower chassis and a little strange to say the least. The lower chassis heaters are supplied by a mains transformer T1, that also supplies via a full wave rectifier an AZ31 the HT supply for the CRT and time bases on the upper chassis. The upper chassis heaters are wired in series with a "wattless dropper" a large capacitor fed directly from the mains live This feeds the five VR65 heaters in series, and the last two valves in this chain, a 6SH7 and a 6H6 heaters are wired in parallel, both 300 m/A heater valves to match the 600 m/A of the VR65's. The lower chassis contains the vision and sound strips, their HT is supplied by a half wave metal rectifier fed directly from the mains but it does at least have a proper smoothing choke. Finally the EHT, this is a conventional mains transformer and half wave valve rectifier a VU111. The EHT mains transformer also supplies the EHT rectifier heaters and the CRT heater, a real good mixture of conventions. This method of EHT supply is quite lethal, much more so than the RF designs or voltage multipliers and needs to be handled with a great deal of care. The use of an isolation transformer and keeping one hand behind ones back is essential.

There's a relay RL1 energised from the sound output valve cathode, and this enables the upper chassis HT and EHT when the sound

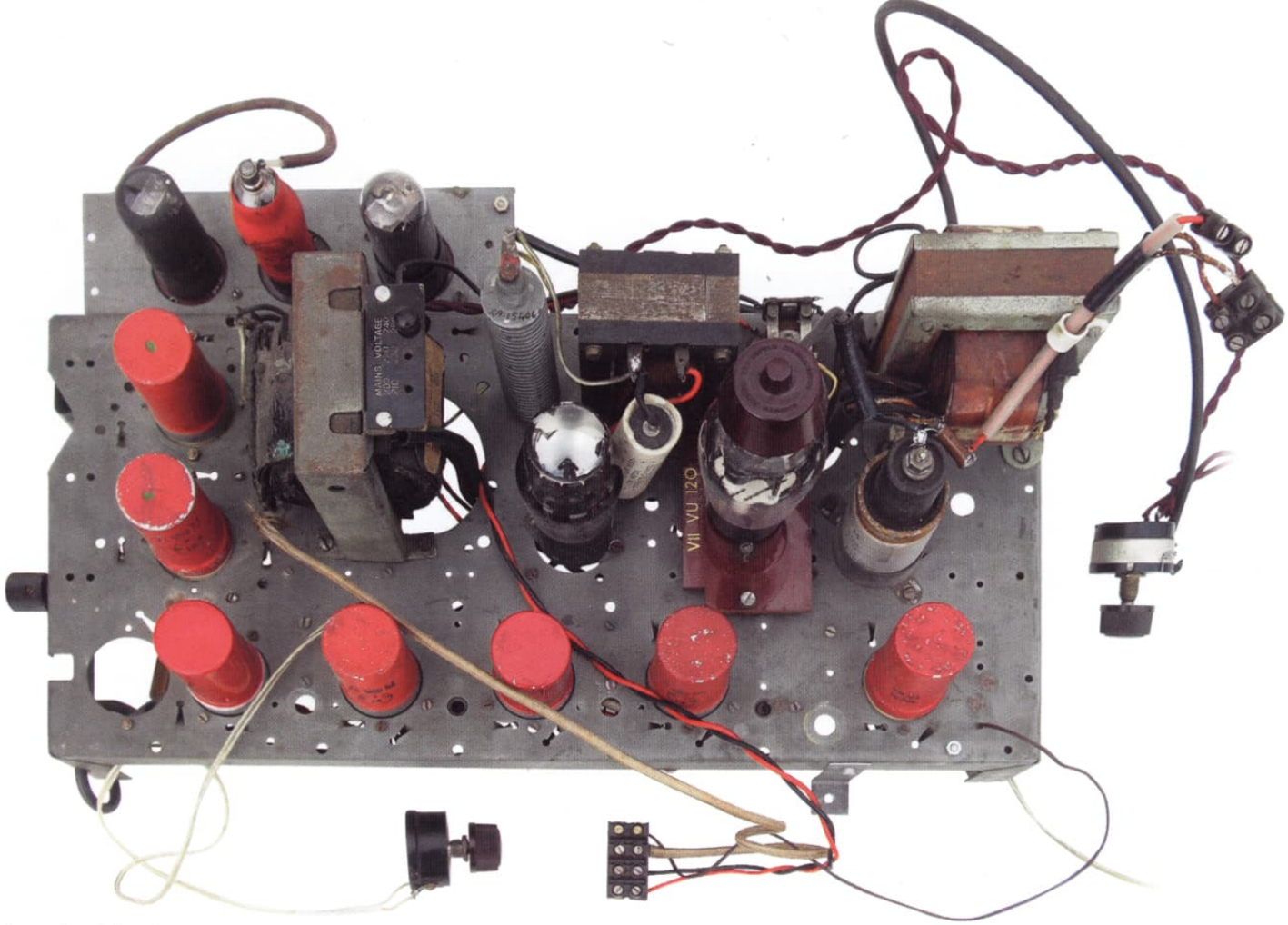
Upper chassis front view

output valve is established and drawing current. Its heater is supplied by T1 (only the upper chassis HT is switched off by RL1) and its HT is supplied by the metal rectifier directly from the mains, so there's no HT or EHT supplied to the CRT until all the valves are warmed up, avoiding a possible phosphor burn and a good reason for the mixed conventions. The time bases are a bit different from those in the booklet, they still use a Miller transitron oscillator but have another VR65 pentode as an inverter instead of a push-pull amplifier driving the electrostatic deflection plates. This is a cheaper version perhaps or more likely built with components to hand and there appears to be no height and width controls. The sync separator is very similar to that in the booklet but lacks one stage of amplification. There's a lot of minor deviation from the booklet in the vision and sound stages, so a redraw of this set is necessary before I apply any power. I'll do this at the same time as a very thorough cold check.

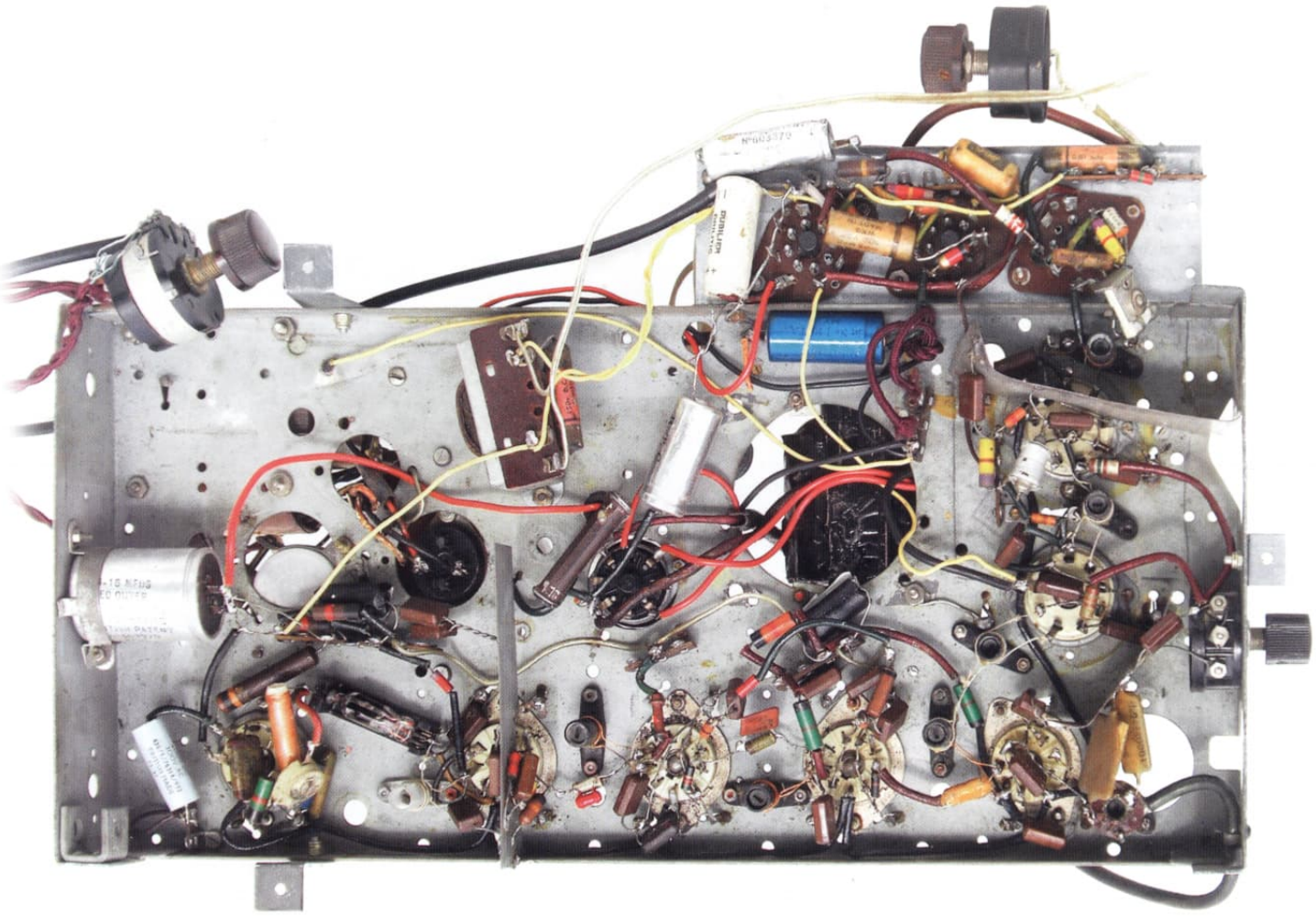
On test

On the cold checks all of the transformer windings read ok on the AVO. I've replaced the electrolytic and paper capacitors as necessary and all of the relevant resistors were within the 20% margin. The remains of the wattless dropper capacitor circuit appears to consist of two capacitors, a 7.5uf power factor correction

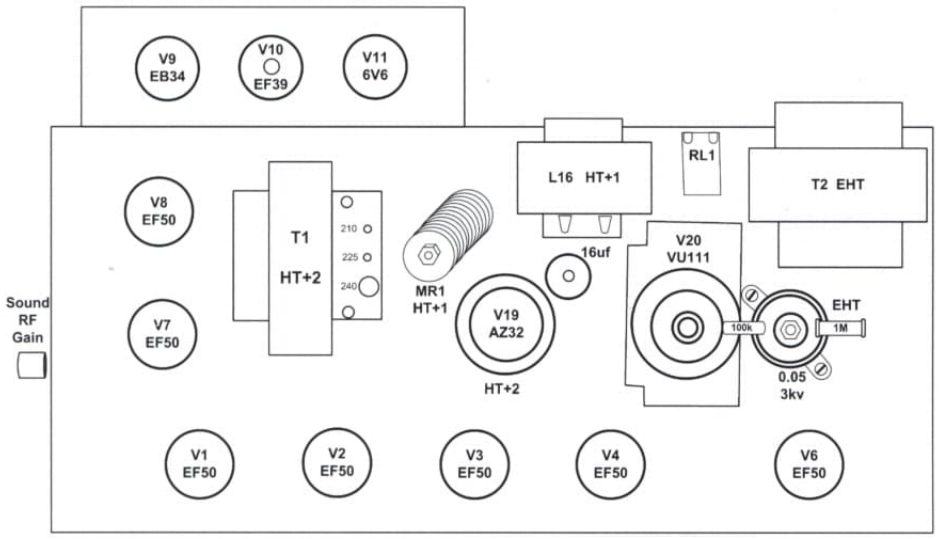
Upper chassis rear panel



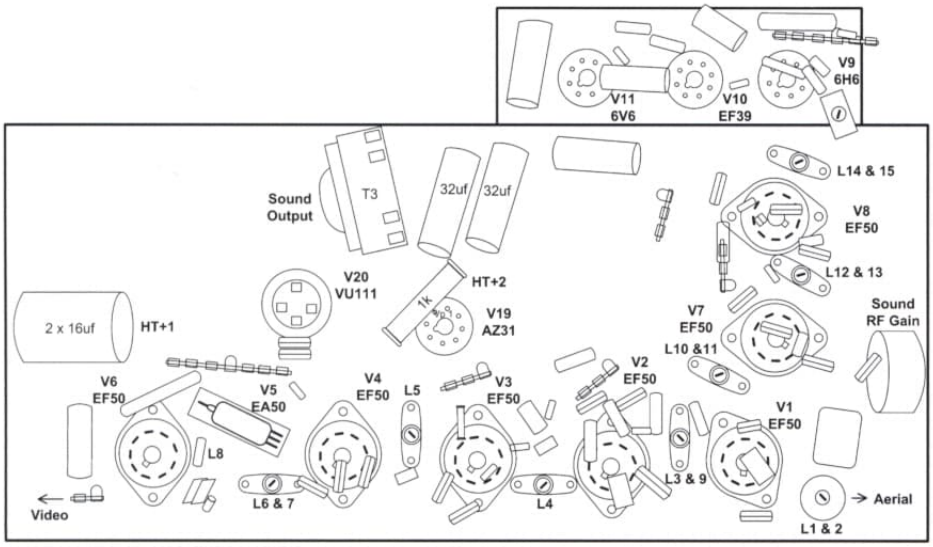
Lower chassis top view



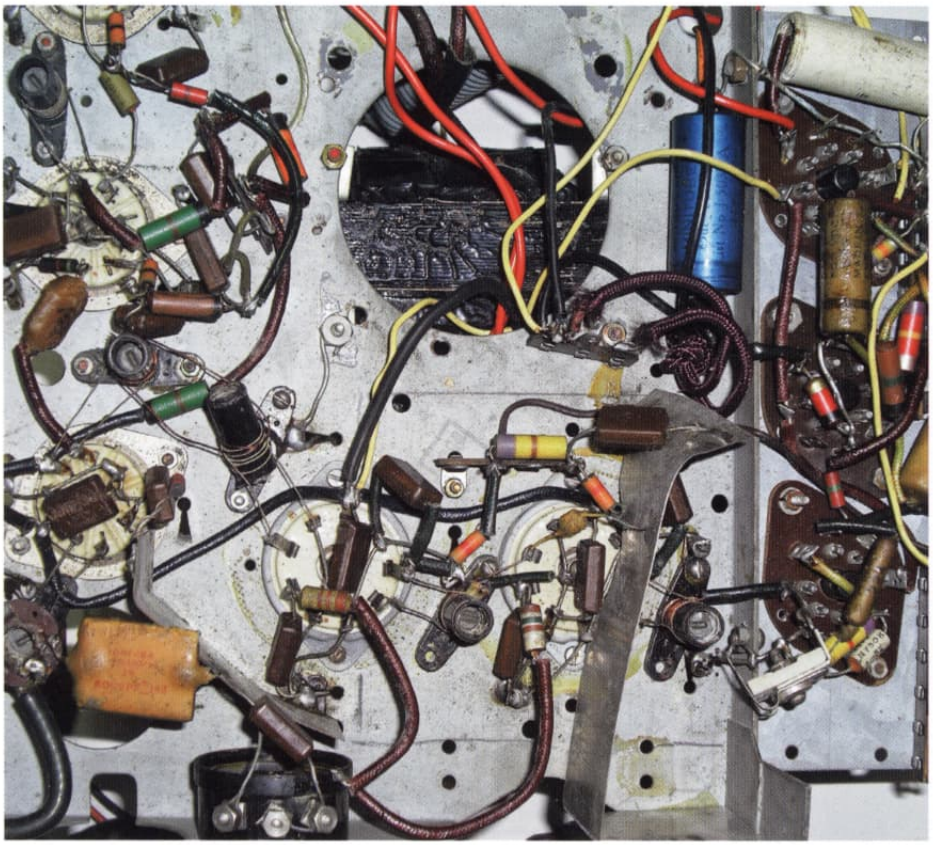
Lower chassis underside view



Lower chassis component layout (top)



Lower chassis component layout (underside)



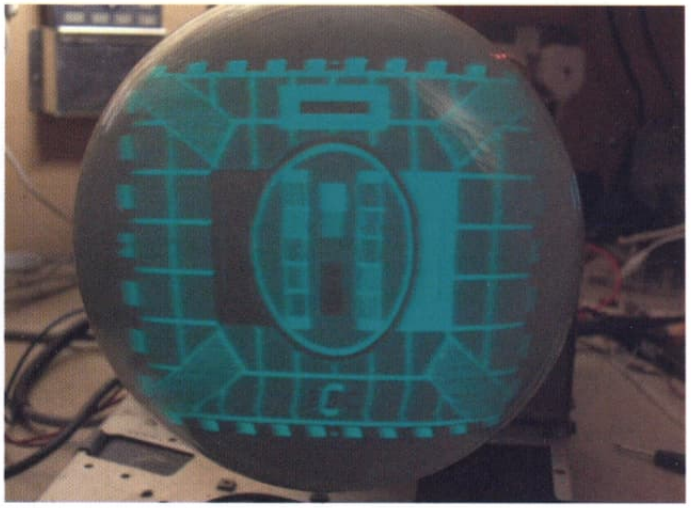
Lower chassis showing broken sound coil

capacitor completely disconnected and a 1uf 500v. The heater chain is connected to this 1uf only, the wiring suggests this is a replacement for the 7.5uf the original that is now open circuit. Obviously this is not going to be good enough, the six VR65 / SP61 valves are very heater hungry, 6.3 volts at 0.6A, so the capacitor needs to be quite meaty, so its dig deep among the stock of more obscure components, (a box of components that I'm not likely to use but couldn't bring myself to throw away). I found an 8uf at 500v, an ex-AM type that's meaty enough and even looks like a tin of corned beef. I jury rigged this up to the heater chain and Variac for a bench test, at 250 volts I have 33 volts across this heater chain, this drops to 28v at 230 volts mains. At 250 volts mains, each valve is getting about 5.5 volts, not ideal. Looking for alternatives I found a 6.3 volt transformer with two windings of 1.8 amps each, perfect, if I have any problems I'll parallel the heater chain and fit this. It then dawned on me that the 1uf capacitor may have been wired in parallel with the 7.5uf to boost each heater to more than 5.5 volts, and this proved to be the case. At 250 volts mains this raised the voltage on the chain to 41 volts, 6.8 volts per valve, a bit high. I reduced the Variac to 230 volts this reduced the chain to 38 volts, perfect at 6.3 volts per valve. In my obscure components box I had 1uf capacitor exactly the same type as the one fitted, and with this in series with the original 1uf reduced the chain voltage to 37 volts at 250 volts mains. This was more suitable for my mains supply and it makes this heater chain mains selectable.

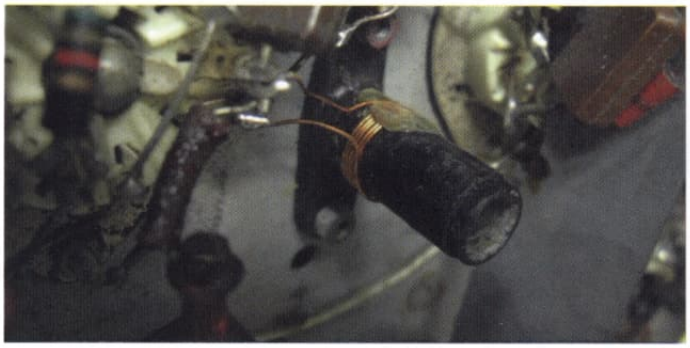
The lower chassis

With the upper chassis heater circuit sorted out I then moved on to the rest of the power supplies. I just worked on the lower chassis with the upper chassis disconnected. Leaving out the EHT rectifier as I don't need the hot stuff just yet, my first check was HT +1 from the metal rectifier. This gave an output of 220 volts,and I then monitored the cathode volts on the 6V6 sound output valve, as it rose through around 7 volts the relay cut in and enabled HT +2 and the EHT transformer, HT +2 gave an output of around 180 volts. This was very low, measuring the output of the transformer gave me 275-0-275, replacing the AZ31 bought this up to 330 volts, a bit more like it. Using the 2500 volts AC range on my bench AVO 8 (I don't remember ever using this range before, but then again I don't remember coming across a mains driven EHT supply before) the transformer output read 2400 volts. Next I monitored the anodes and screen grids of the vision and sound strips, all ok. I then applied a 45 Mc/s signal from a standards converter to the aerial plug, and much to my surprise I could trace the RF signal all the way along to the vision detector, although there wasn't a lot of gain along the vision strip and there didn't seem to be much happening around the video amp. I'll look at this more closely when I get it connected up to the tube. I next hooked up a speaker, the sound channel didn't seem to be doing much, I turned the volume

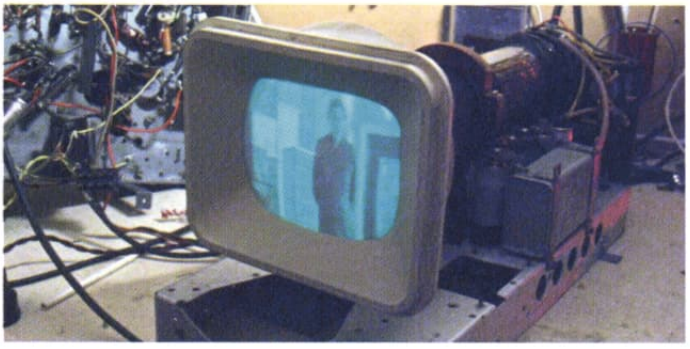
Burned–out EHT rectifier



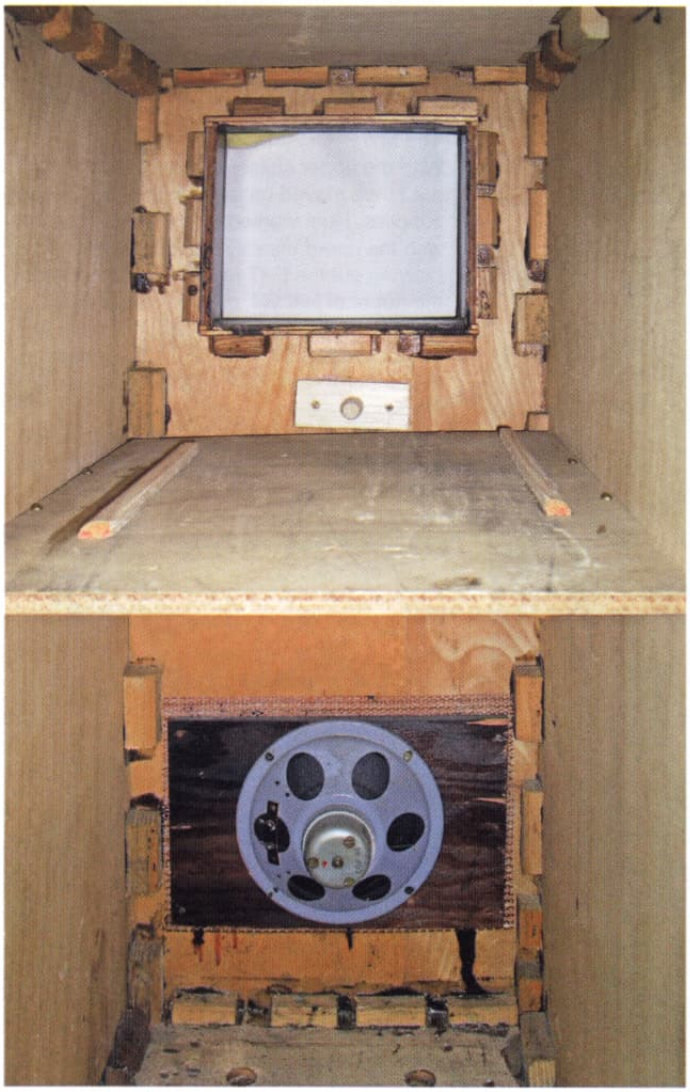
An early picture



One of the vision RF coils



Off–air picture



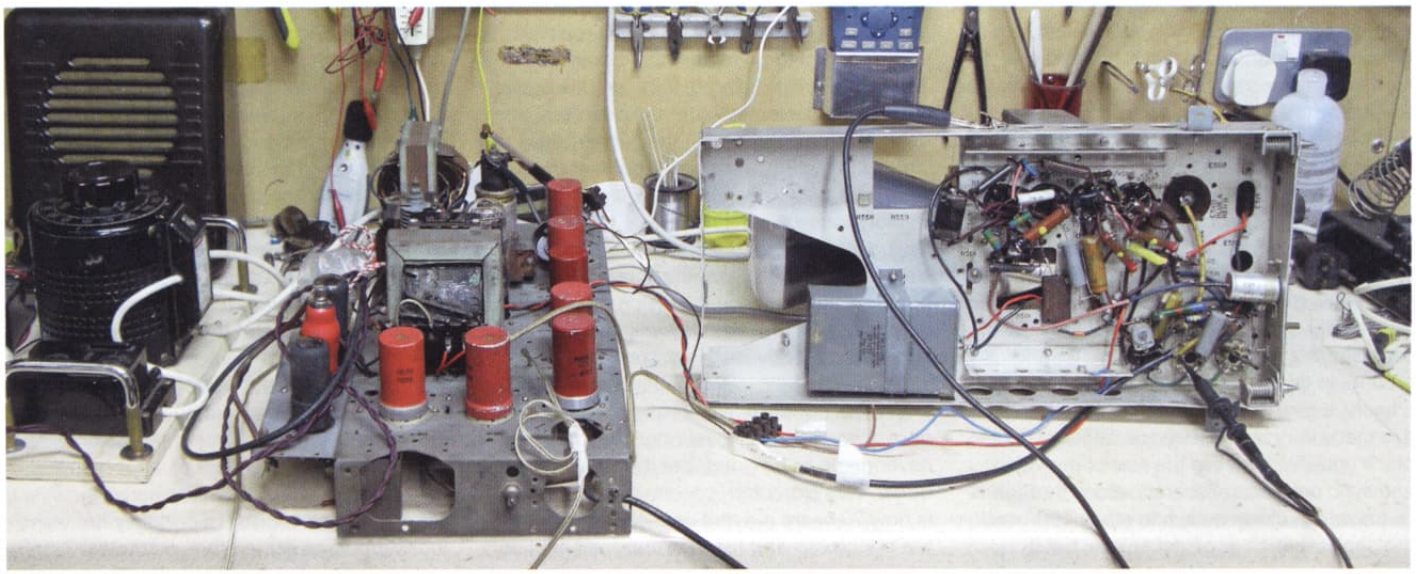
Inside the cabinet

and sound RF gain pots to max, not much more than a low purring. The audio buzz test, a screwdriver touched on to the audio amp grid, an EF39 wired as a triode and the audio stage checked out ok. A check of the anode and screen grids of the sound RF amp voltages proved them all ok and I then noticed a broken sound coupling coil, it had been snapped off at its base but all the connecting wires were still connected. I slid the remains of the coil former out of the coils, the primary of this coil is 2 turns and the secondary 5 turns, so this was quite easy. I then removed the screws retaining what was left of the base, all of the RF coils in the sound and vision strip appear to have about the same number of turns, now out of the chassis I could see this had previously been glued. The glue had migrated into the threads of the tuning slug which was now stuck fast, this is a standard Aladdin coil former of the day, about 3/8" or 10.5mm diameter. I have salvaged a few of these and have some in stock, I just needed to remove the original redundant coil and slide it into my windings and return the retaining screws, job done. On power up there was now very faint sound with a bit of video buzz, tweaking the newly repaired coil improved it a bit, peaking the other sound coils improved it a bit more but its still very faint with video buzz. The most effective adjustment was the 4-40pf trimmer across the coil feeding the detector, this was very critical. I could get a lot more gain by tuning into the 45 Mc/s vision signal for a loud video buzz, this with the low gain of the vision strip I suspected this might not be an Ali-Pali London set, and this was confirmed when I connected up to my RF signal generator and swept from 45 Mc/s upward. As I passed through 51.5 Mc/s the vision strip sprang to life, looks like a channel 2 set. I also enquired as to where Howard had got the set, he said at an auction somewhere near Oxford, a channel 2 region. The only way to run this set from Howard's standards converter or my Test Card generator is to convert it to Channel 1 on 45 Mc/s, this means a rewind of all of the RF coils, not too difficult and can be done in situ as they're only about 5 - 6 turns each. I compared the coils in this set to the coil winding instructions in the IT booklet, all of the coils in this set were half a turn less than those described for the Ali Pali transmitter. Most of the coils are just single tuning coils of five or six turns of 26 SWG enamelled wire so the re-wind was achieved with relative ease. On power up and with a lot of tweaking gained a modest output from the video amp and a reasonable level of sound supplied from the Domino standards converter connected to a Freeview box.

All together

I connected the two chassis together– there are three well insulated wires feeding the EHT and CRT heaters. These are well separated from the rest, the other four wires are the common chassis ground, mains live for the time base heaters, HT+2 for the upper chassis and the vision signal from the video amp output. Still with the EHT rectifier removed I powered up and checked that all the heaters including the CRT were up and running, all ok. Next I scoped the time base anodes, they all had a good sawtooth wave form from both frame and line. With everything ok I'll replace the EHT rectifier to see if I could get a raster. The EHT supply is negative with respect to chassis and supplied directly to the CRT cathode, the CRT final anode is grounded, the EHT positive. The output from the EHT transformer was 2400 volts, the output from the rectifier is around -1800 volts and by the time it got to the CRT cathode it was down to about -1000 volts. At this point I couldn't see anything on the tube face, the workshop lights are quite bright so with the bench Anglepoise lamp pointing at the ceiling I turned them off. I now saw a faint defocused raster with flybacks, adjusting the brightness and focus controls much improved this raster, I found these controls very interactive but with a bit of tweaking got a better level of brightness and focus. This further improved as the set warmed up but still needing very subdued lighting. It looked like the tube is a bit soft, not surprising as it's 70 years old, but it's just about good enough to move on and get some modulation. The raster was a bit offset in both X and Y but I'll come back to this when I get some sync.

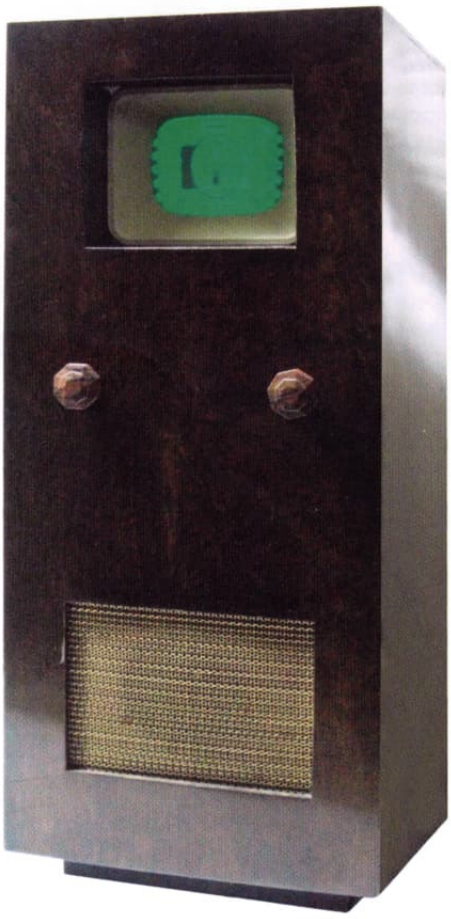
Returning to the lower chassis and the video amp I re- checked the vision strip. On my oscilloscope I could see RF all along the four TRF amps but not much gain was happening along these amps ending with a low video signal through the detector, a lot less gain than I was expecting. This is a very primitive and basic circuit and all I could do was to re-tweak and peak all of the five RF coils in the vision strip. This improved it a bit but nowhere near enough. Having drawn out a circuit diagram of this set of what I've actually got in front of me I compared it to the circuits in the booklet, and its very similar to the circuit referred to as the "home built vision strip" in fact its almost identica. Most of the component values are about the same except the coupling capacitors, in this set they're 50pf, in the booklet they're 1000pf, with this I jumped the 50pf's with 1000pf's as a stop gap measure and now I have a workable level of video and sync's. With the circuit and component values now the same as the home built vision strip in the booklet, I made this mod permanent. Back on the tube I could just make out an unlocked picture behind the flybacks, at this point there were a few loose ends around the tube to sort out. I had left this until now when I'm better acquainted with its circuitry and had a better chance of finding out what was going on. There's a B3G valve holder on the paxolin back panel, without a valve, its cathode is connected to the CRT grid and a 680k resistor wired across this diode to its anode and there's a 2 Meg resistor also connected to its anode going nowhere. I assumed this 2 Meg resistor to be the CRT grid leak and connected this to the EHT "-" supply, the ground as far as the CRT cathode is concerned and fitted an EA50 diode. Now with a stable grid the brightness level is much more controllable and can be reduced to a level below the flybacks. The X and Y shift pots had little effect, the top end is connected to the HT+2, the bottom end was connected to chassis via a 270k resistor, the EHT + as far as the CRT final anode is concerned, the shift pots are by-passed by a potential divider for the final anode. There was little voltage difference across the pots, grounding the



On the bench

bottom end solved the problem and gave me back the shift controls but there's still a bit of an offset. In the booklet circuit the bottom end of the controls is connected to the first resistor in the CRT feed chain applying a small "-" voltage, when I connected this set likewise the small "-" voltage went positive to the voltage on the pots. I then checked the value of the pots, one was 50k and the other 100k. All now became clear, I replaced both of the shift pots with 1 meg pots, as in the IT booklet, this solved the problem and the 270k reconnected to ground.
The picture is very dim and over sized, looks like the EHT at just over 1000 volts might be a bit low, most of the EHT voltage is lost across the 1meg smoothing resistor in the EHT circuit. This checked ok, I paralleled it with another 1 meg, this only raised the voltage by about 100 volts, looks like something is drinking the volts. The suspect, was the 0.5uf final EHT smoothing capacitor, this was found to have a 6 meg leakage so it's back to the obscure components box. I found another ex-WD canned capacitor (another tin of corned beef) 0.25uf at 4kv, (the value in the home built circuit is 0.1uf) so this one will be just the job. This was fitted and the EHT is now up to 2kv, the picture now much brighter and about the right size. The next problem is to improve the focus, the focus pot is hard up against the high voltage end stop and doesn't quite make it. The next in the chain is a 180k resistor followed by the brightness pot. The brightness pot has been replaced with one about three decades later (in years) than the rest of the components in this set and reads 1 meg. This is about 500k too high, replaced with a 500k pot the focus control now shifted along the chain, voltage wise now passes through a focus, the best focus is still not that sharp but I put this down to the soft tube.

The next problem is to improve weak sync's, the set has difficulty staying in lock, line a lot worse than frame. The scope signal on the sync output shows the line syncs quite low and reduce with video content. A closer check of the components in the sync separator proved the grid leak 680k (hidden behind other components) reading 3 megs. On replacement the locks improved considerably, but still requires very fine adjustment to get the set to lock, but the set now does stay in lock. The contrast level is a bit low and there's a small amount of hum on the video signal. This tends to pull the line sync's, the only decoupling on the vision strip consists of 0.001uf capacitors, most of the hum dis-appeared when two 4uf electrolytic's were added to the HT +1 rail decoupling. The frame now stays in lock ok but the line is still weak and it still tends to want to lock at the wrong point and pulls the verticals with video content. The home build circuit shows a 3-30pf variable capacitor between the video detector and ground. In this set it's a fixed 15pf. I fitted a beehive trimmer in its place but trimming this made very little difference, I'll leave it in place until I've resolved the rest of the video and sync problems. Several passes through re-tuning the vision coils had much improved the contrast to an acceptable level but it looks like there's still a small amount of video getting on to the sync's occasionally pulling the verticals. Adjusting the 30pf beehive trimmer in the line sync circuit reduces the sync amplitude, this improved this problem but failed to eliminate it completely. The line hold control appeared to be sensitive to hand capacity (even through its bakelite knob). Grounding the case and shaft along with adding a 0.01uf de-coupler to the line hold control wiper eliminated this but didn't improve the sync situation. The line time base seems to be sitting on a knife edge and a lot of trial and error to improve this made little or no difference. Any improvement in sync control came at the expense of a reduced picture width, this basic circuit "as is" was found to be the best compromise. The only way I'm going to improve this is to add a sync pre-amp stage and push-pull deflection amplifiers as in the suggested circuits in the inexpensive TV booklet.



The finished set in action

Performance

Owing to the sets very basic circuitry and slap-dash construction, the screening between the stages in the vision strip, much emphasised in the booklet was missing and with relatively long interconnecting wires, I wasn't expecting too much. With a tube built prior to aluminising of the phosphor, the black level / contrast was never going to be good, but it was a lot better than expected, considering the tube is now 70 years old and unused for decades the brightness and focus in subdued lighting were acceptable. I was reluctant to re-age the tube through fear of damaging it, but it very much reformed with several hours of use. Operating this set reminded me of early 1920's radios where much tweaking was required to obtain and maintain best results. In this set re-adjustment of brightness, focus and line hold is frequently necessary, although the drifting did settle down after the set had been running for 20 minutes or so. Lacking the refinements of a commercially produced set I was very tempted to modify it by adding some push-pull deflection amplifiers with height and width controls. This alone would improve the line oscillator circuit sync control, but in the interest of only doing enough to make it work and keeping it as close to "as was" as possible I resisted the temptation. If I ever gather enough components to build one of these sets from scratch I would like to add in a few of these refinements and make a much better job of it.

The cabinet

The cabinet looks home–made and possibly made from plans. There's an upper shelf for the CRT chassis and the rest of the set chassis fits in the bottom. There's a purpose made TV style rubber shroud fitted to a recessed aperture in the top half of the cabinet, with no attempt made for an implosion screen. The speaker is fitted in the bottom half and two controls on/off volume and contrast in the middle. There is no provision made for clamping either of the chassis down, making transportation difficult, also the shelf for the top chassis is loose and needed securing. This was achieved with four brass wood screws securing it to its runners. The upper chassis has some convenient holes in the front, about 3/4" in diameter. A front locating pin was manufactured from a piece of 3/4" dowel, this was glued and screwed to a strip of plywood and in turn screwed to the front of the cabinet. The front of the chassis being otherwise inaccessible, two brackets were made and fitted to the rear of the chassis securing it to its shelf. The lower chassis just required four brackets manufacturing and fitting. The chassis is fitted at a slight angle to avoid the EHT transformer hitting the speaker. The set even came with a hardboard back complete with a large aperture for easy access to the controls.

This has been a very interesting restoration of an early home made TV, one of many of the construction projects and kit sets of the time. I had to do a lot of replacement of 'It'll do' components; simple modifications like adding tag strips, better placed ground points and de-coupling required to even get the set in a workable state. Not a set one would want to watch but a first class item to restore with plenty of off the beaten track circuitry, a little different from that encountered with commercially manufactured televisions and an excellent example of what home constructors got up to in the early TV days in the 1950's. I'll certainly be looking out for some other examples.

The Phoenix rises. The restoration of North 3 by Steve Harris

It is November 2011, and I am sitting at the production desk of a 40 year old outside broadcast truck, at the back of BBC New Broadcasting House in Oxford Road, Manchester. In a few seconds, Dave Guest, senior reporter on North West Tonight, will do his piece to camera and interview me. He will be telling the viewers how this vehicle, which last stood in this yard nearly 30 years before, came to be restored and be taking part in the last programme to be broadcast live from these studios. Cue Dave: "Owner Steve Harris has restored this monstrous vehicle and brought her here tonight. (pause) Why?"

The Birmingham Crew on an OB in CMCR9 during the 1970s. Pic- John Abbott

Setting off from Dunkeswell airfield on the low-loader

I had about 20 seconds to answer that tricky question, but am fortunate to be able to give a more detailed account here. Why indeed? I can't provide a logical answer in a thousand words any more than fifty, but I can tell you how I got to that point, and beyond.

Although all human beings are remarkably similar in construction, the wiring patterns of the brain seem to have infinite variation, and we can develop intense interests in particular directions which range from the mild term 'hobby', through the spectrum of dedication to 'all-consuming obsession', verging on requiring psychiatric help. I will leave you to position me along this gradient.

It became apparent that I had a particular attraction to electrical and mechanical things at an early age, possibly when my drawings in primary school included electric lights; maybe not that unusual - but with both conductors shown and a circuit diagram of the switching arrangements included? When my school friends were playing football, I was dragging home radios from jumble sales and at 14 cobbled together our first family TV set on a tea trolley from parts found in a ditch.

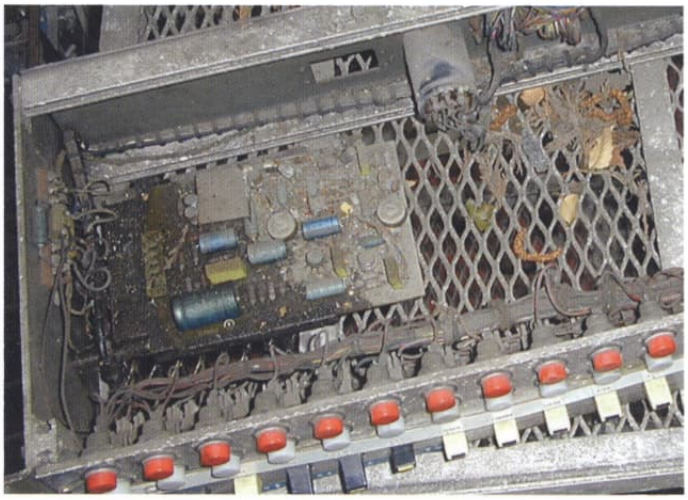
However, my interest in technology did not develop in a way that fitted in with the school curriculum or indeed a career. Although interested in science, maths defeated me completely, and my talents, such as they were, appeared more evident in English and Art. I went to Art College after school, doing a degree in Sculpture. Perhaps unsurprisingly my work was not chiselling stone but making electro-mechanical creations, incidentally learning how to weld and use a lathe. I am sure you don't need my entire CV, but it included repairing crashed cars, dealing in Government surplus, TV studio technician, part time University teaching, and then ITV lighting director. In this job, one has responsibility for both the technical and aesthetic quality of the pictures leaving the studio or location, so I suppose my BA in Fine Art at last had some relevance.

When the TV industry began to shed jobs in the 1990s I went onto the freelance market but also started my present business dealing in vintage technology, and fulfilled a long held desire to set up a museum of broadcasting. It was entirely a business venture with no help from grants or sponsorship, which again provided a steep learning curve and another job – museum curator. Most collectors have a part of them which wants to start a museum, but as well as collecting and displaying the artefacts, which is actually the easy part, my role also included dealing with fire regulations, disability requirements and tourist organisations, as well as designing publicity material and graphics. We had to get paying visitors through the door, which is probably the hardest job I have ever done, and for the least financial reward. I discovered that people who are willing to pay £5 to park their car are often unwilling to pay £2.50 to look round a museum, especially when there are many excellent museums you can see for nothing. This meant that to subsidise the museum, I had to run the shop, selling books and key rings, as well as repairing a constant stream of radios, gramophones and telephones to generate the profit that paid the rent, rates and wages.

A chance encounter with the Head of BBC Heritage was to have unexpected results. He was very impressed with what we had done and wanted to work towards setting up some sort of permanent broadcasting history exhibition within the BBC. He had begun saving historic pieces within the Corporation and was trying to stimulate interest at the very highest levels to take advantage of their unique heritage. I went to Broadcasting House and looked at the BBC Experience exhibition which was then in the basement, met the director and viewed some of the artefacts I had provided on show in the historic areas such as the Governor's Boardroom and even the DG's office.

In 2000 the lease on the premises ran out and I closed the museum, and the BBC offered to buy the collection. However, within a few months of the sale, the head of Heritage tragically died at a young age, and shortly afterwards there was a change of D.G., the new incumbent having little interest in the history of the Corporation. The BBC Experience closed, and any plans for displays or museums faded away. Most of the collection now resides at the

The start of the vehicle restoration in the haulage company workshop



Decades of corrosion and water damage have taken their toll

In the spray shop, with all the glass and trims removed

The signwriter at work

National Media Museum, some of it on public display. Part could eventually end up at Alexandra Palace, if the competing factions ever agree on what to do with it.

I turned another corner, dispensing with the loss-making museum to concentrate on setting up a new centre for 'On The Air' later that year, now purely as a showroom and workshop for buying and selling vintage equipment. This entailed buying and rebuilding a derelict funeral parlour a few miles away over the border in Wales, a story in itself. After total refurbishment we reopened as the Vintage Technology Centre, and I concentrated on sourcing and selling the best examples I could find of radios, TVs and mechanical music, and producing my catalogue /magazine Airwaves. I was very glad to be relieved of the financial strain of the museum and city centre shop but continued to collect TV cameras and studio equipment, mainly for my own interest. A desire to own a TV outside broadcast vehicle had lingered from the museum days but reluctantly dismissed as impractical, even by my standards. But the idea just wouldn't go away.

I knew about an ex-BBC Colour Mobile Control Room (CMCR), fleet identity CMCR9, (North 3) which was in preservation, as it had been offered to me ten years previously. I had already followed up another one (CMCR7, North 1), which surfaced after lying in a yard for 25 years but was too far gone to consider restoring. I ended up buying much of the equipment from it, as I could see it's most likely future being the scrap metal yard. I got in touch with the owner of North 3 to see if he wanted any of the parts, or to see if he wanted to sell it. He was storing it in an old aircraft hangar, intending to include it in a planned museum project, which had yet to get off the ground. He was still hoping for this to happen, and declined my offers, so I sold much of the equipment I had removed from North 1. Eventually, he decided the project was not going to happen, and offered it to me in 2008. The timing was not ideal. I had a business to run, and had sold most of the unique spares that might help in the restoration. I had to go and see it, but obviously couldn't contemplate actually buying it.

Let's just run through a quick list of the problems: It had not been on the road for over 20 years, and had been stored either in the open or in a damp wartime aircraft hangar. Everything electronic and mechanical was corroded, the brake pipes had rusted through, as had part of the engine, so although it did actually start with no great difficulty, the clutch did not work, it would not hold water, and the brakes were seized on. It was over 250 miles away, and at 35 feet long would only just fit on the biggest articulated low-loader. If I could even get it back, there was nowhere to keep it, there was a huge amount of work that would take years and cost thousands, and I didn't have an HGV licence to drive it, even assuming it could ever be made roadworthy, and anyway it would use a gallon of diesel every ten miles.

What could I do with it anyway? Even if I could restore any of the dozens of corroded electronics units, the chance of getting much of it working seemed low. The cameras take at least two men to lift them, and originally were carried along with several tons of other gear in another truck, with a crew to unload it. The cables alone weigh several hundredweights. In the BBC, an army of highly qualified engineers had full time jobs maintaining it, even when relatively new. They would have been on manufacturer's courses and know the equipment inside out, and anyway would not be tackling years of damp and decay. Perhaps it would be best to forget the whole idea.

Well, I had been told before that my plans were impossible; Generally, it was sound advice, but usually ignored. Perhaps I should just store it somewhere, and consider it as a 'retirement project'? Don't get involved with it now. Maybe if I thought about it for a while, I might come to my senses.

Of course the seller had other ideas - he was paying storage charges, and it had to go. There were some valuable bits in it, and a lot of potential scrap metal. Did I want it or not? A price was negotiated. I sounded out a feasible (though expensive) means of moving it, having made contact with a local Albion enthusiast, who is a director of a haulage company - who have a low-loader. I also looked into possible storage locations. A home could be found for it in a barn rented by a friend for his classic commercials. A lorry mechanic who worked near the location in Devon agreed to go and try to get the brakes freed and the clutch working so it could be

g for the last programme from Oxford Road in 2011

Retired cameraman John Chester recalls his days on OBs

North 3 outside the BBC studios at Media City, 2013

The production gallery

driven on to the trailer. It looked more and more like I was going to be the new owner of North 3, so I began to research its history.

Colour television had already been broadcast in America since the early 1950s, but the BBC and IBA had been unsure of which system to go for, resulting in no decision having been made, as late as 1966, when three rival methods were still under consideration. The NTSC system the USA had adopted had problems with colour stability in transmission, and any system had to be compatible with the existing 625 and even 405 line service, which ruled out any completely new format. The price of receivers was likely to be prohibitive for most viewers, and manufacturers were unwilling to commit to production if take-up was low.

In 1967 the decision was finalised to adopt the Phase Alternating Line system. It was stable and compatible with the existing monochrome service, which was gradually to be switched to 625 line UHF only. Test transmissions in colour had been tried since 1958 but now studios at Television Centre were being equipped with EMI 4–tube colour cameras and vision equipment for the start of a scheduled colour service later that year.

Outside Broadcasts were seen as important for the new colour service, as high-profile events would attract viewers to demonstrations or to buy sets. The BBC development engineers worked with Pye to build three Colour Mobile Control Rooms to spearhead colour OBs - they were slightly

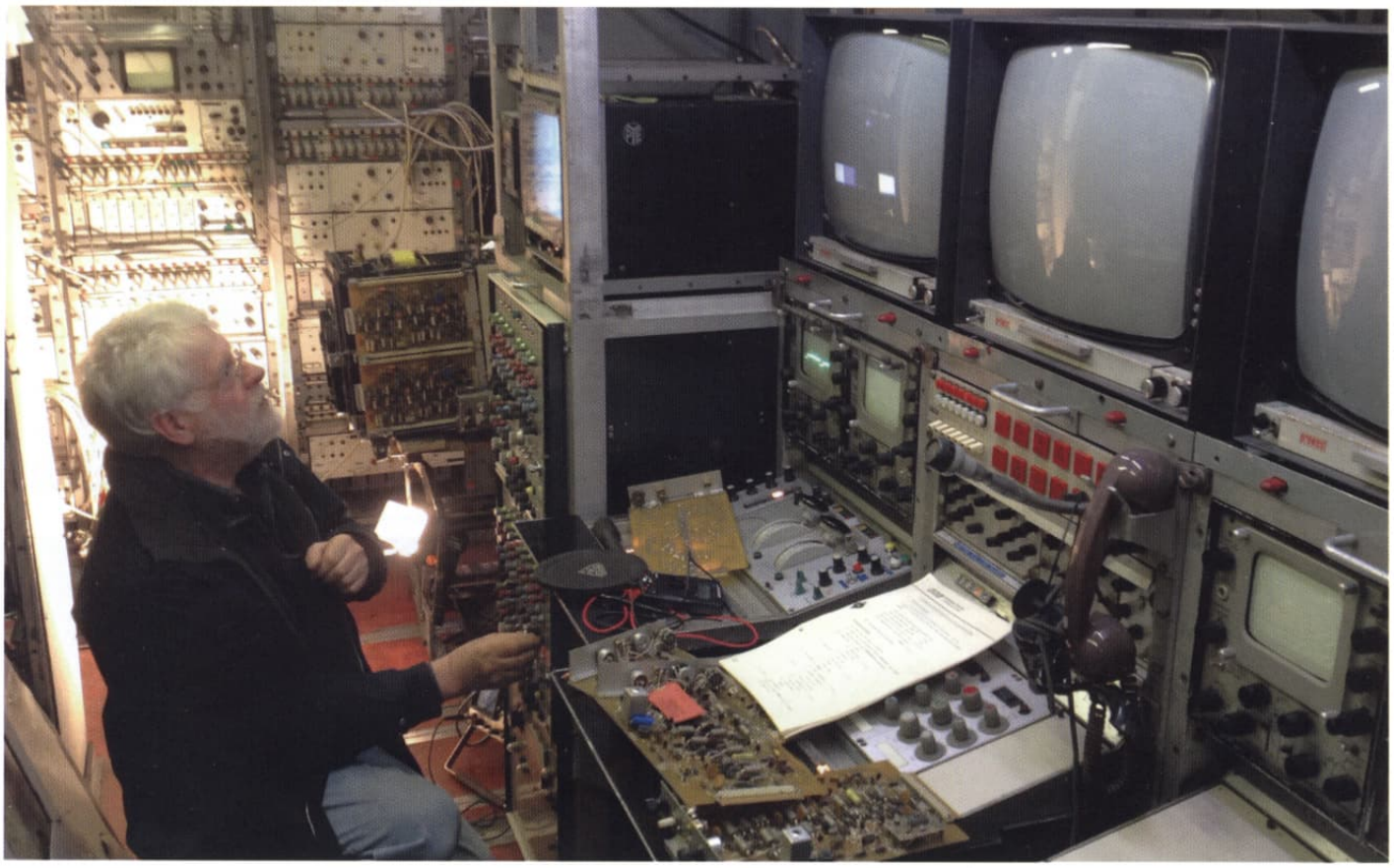
Checking the signals in Vision Control

larger than the existing MCRs and used Philips LDK3 3-tube cameras which were badged Peto-Scott. The reason for this was that the BBC had a 'Buy British' policy, and Philips was a Dutch firm. (Peto-Scott was a subsidiary of Pye, but later cameras carried the Pye name.) The Pye/Peto-Scott cameras were called the PC-60, and used two camera cables of a type already in use by the BBC. Later model PC-80 as used in the Type 2 used a single, inch diameter 101 way cable, the same as was used with the EMI cameras.

These semi-prototype units were known as the Type 1 CMCR, and were used on the UK's first scheduled colour broadcast, tennis from Wimbledon (other trials had already been done, but were not announced as being in colour). As soon as it was seen that the system was going to work, and a move to full colour inevitable, Pye were commissioned to construct nine units of an improved design on the longest wheelbase Albion Clydesdale chassis available. The Type 2 would have four cameras as standard, with an option to extend to six. It was divided into Vision Control, Production and Sound areas, with three air-conditioning systems. Electrical load was up to 50 amps at 240v, with technical mains controlled by electro-mechanical regulators.

It was a huge contract, worth over £3 million, Pye even renting another factory on the outskirts of Cambridge to complete the assembly. Pye wanted to supply their PC80 cameras, but the BBC were heavily committed to the EMI 2001 in the studios, and liked the idea of compatibility - despite the often repeated observation by some of the leading BBC engineers and directors that the PC80 gave the best pictures of any camera in the world at that time. A compromise was reached that three units would have Pye cameras, and six had EMIs.

Initially two of the Pye units (CMCRs 7 & 8) went to Manchester as North 1 and North 2, the other one being based at Kendal Avenue in London. It is not clear why they did this, as it was the only Pye camera unit there. (When the Type 2s came into use,



Working on the camera control units

the Type 1s were sent to Bristol, Wales and Scotland.) One advantage was that the PC80s would operate over longer cable runs, and this was employed early on when CMCR9 (London Unit 5 at that time) was used on the Anglesey Climb, the first colour OB of rock climbing which was transmitted live over a whole Bank Holiday Monday in August 1970. I have the original Radio Times, where the cover and a colour main feature were devoted to the programme, showing climber Joe Brown in action. I contacted him and spoke to him about the programme (he was then 83), but unfortunately the BBC has not preserved the original recording. In 1970 CMCR9 was used for many big OBs, including the Royal Variety Performance.

After a couple of years CMCR9 was exchanged with Birmingham, for EMI equipped CMCR6, to maintain compatibility in London. CMCR9 then served at the newly opened Pebble Mill studios, and featured in a promotional film the BBC made to show off the new centre - sadly, like Oxford Road, now demolished. (The film can still be seen on the Internet.) Regular programmes were the original 'Come Dancing', and 'Gardener's World', from Percy Thrower's house near Shrewsbury, as well as motor racing from Silverstone, 'Match of the Day' and Test Matches from Edgbaston. If you watched British television from 1970-1982, you will have seen it's output at some time.

In 1979 it was transferred from Birmingham to Manchester, as there were now more demands for OBs from the North. Regular shows were 'The Good Old Days' from Leeds, and 'It's a Knockout'. The Birmingham crew sprayed the inside of the production gallery with fake cobwebs when it left, and swapped some of it's good equipment for faulty units. Some of the Manchester crew called the new North 3 'The Phoenix', after it was revived and put back into service. It was to stay in use until 1982, producing hundreds of programmes, one of its last jobs being the Open Golf from Troon.

It was sold to a company who removed the PC80s, presumably to fit more modern cameras, but went bust before the modifications were done. It was bought at auction by an enthusiast who had four EMI 2001s, and intended to get it operational again. However, as we all know, projects can stall, and he never completed the installation. It was then sold to an ex-BBC cameraman, who wanted to preserve it, and arranged for it to be transported and stored at the former USAF base near Honiton, Devon, from where I collected it as described earlier. So far, it had just slowly deteriorated, while costing its owners time and money. In my hands, would the Phoenix finally rise from the ashes, or would it be an albatross round my neck?

Having made the decision to buy the rusting hulk, and transport it 250 miles home, arrangements were made to go down with a low loader and bring it back. The air brakes were leaking but were just about working, and the engine would run for a few minutes with no coolant without doing any damage- we hoped. We set out at 4 am, and I had a few moments of panic when it looked as though the 35 foot long, 14 ton leviathan might be too long to fit on the trailer. There was only about four inches to spare on each side, with a five-foot drop, only partial brakes, intermittent clutch operation and a time limit as the engine rapidly heated up. It took two attempts, but I managed to reverse it on, with no clearance at all - the ramps touched the bumper as they locked.

On the way back, we found the road to the farm where I was going to store it was closed for resurfacing. The driver had no time left on his tacho, so we took it back to the haulage yard. This was probably the single most important event in the story, as had the road been open, CMCR9 would possibly still have been lying there, rusting away. As it was, when we got back, Mark, the Albion enthusiast, suggested I kept it in one of their workshops for a while, working on it when they were not busy. When I got it roadworthy, it could go to the farm under it's own power. It seemed like a plan, although not the one I had envisaged.

Mark had restored several commercials from absolute wrecks, so in his eyes there was not that much to do. In the event, his help was invaluable, both in practical terms and for reassurance that nothing was impossible when I found things were worse than expected - inevitable in any restoration project. However there was a limit on how long it could stay there, so I had to pitch straight in and start work. It was probably twenty years since I had done much mechanical work other than tinkering with classic cars, and this was big stuff on a big vehicle. However, bearing in mind the Zen saying that a journey of a thousand miles starts with a single step it was time to get my overalls on, and my hands dirty.

In a little over six months, North 3, as we can call her from now on, was just about fit for the road. Most of the air brake lines had been replaced, brakes dismantled, freed off and checked. The radiator was both blocked and leaking, and the water pump and a plate behind it were corroded beyond repair. These parts had now been rebuilt or replaced. Part of the interest in doing this sort of thing is the contacts you make, the things you learn, and the people you meet.

North 3 on the road. Pic- Chris Globe

Lining up a Pye PC80

I found that a surprising number of new parts could be sourced, if you knew where to look - and that doesn't mean just on the Internet. Yes, eBay and the like can be useful, but like vintage radio or any other interest it's no substitute for getting up early, driving a hundred miles to a classic truck show, and chatting to people who know what they are talking about and maybe have sheds full of bits that you will never find online. I even got some vital parts from a bus museum.

Initially I concentrated on getting the vehicle sorted. It seemed the most daunting part, and circumstances had pushed me into doing this first. The electronics could wait until I could get the truck somewhere where I could get to grips with the systems. I knew the general layout of the video and audio systems, had a pile of manuals and even original factory drawings that I could study, but a lot of it was unfamiliar territory. The original design was rather eccentric to fit in with the ideology of the BBC, and it had been modified over its time in service, and then partly altered to fit the EMI camera units.

I had made contact with some of the crew who had worked on North 3 at Manchester, and a couple of people volunteered to help on the project. Already, North 3 had found me some new friends, and has continued to do so, which has been an unexpected benefit. We now have a little 'crew' who come to the events and help to show visitors round, and help with the restoration- I can honestly say that without their help, North 3 could easily still be rotting in a barn waiting for me to get round to doing it. I have been to enough house clearances now to recognise the familiar pattern of 'I'm going to do it one day' - which never comes.

Another priority was to be able to drive it. I had already had two unsuccessful attempts at doing an HGV course. Since passing my car test, a doddle by today's standards, I had acquired four decades of bad habits, and it is undoubtedly harder to learn new things as you get older - even worse, things you already think you know. (The pass rate over 40 is less than 30%.) The test involves a medical, two hour-long theory and hazard perception tests on computer screens, then sessions of up to four hours driving a modern HGV on all sorts of roads, from rural to town centres. You are constantly reminded of the potentially devastating consequences of mistakes.

Now North 3 was driveable I could get some practice. With a Class 1 qualified friend to accompany me, I was able to drive North 3 on the road, with 'L' plates, and drove to our first classic commercial show in 2010, only a few miles away. In fact, it made driving the modern truck feel easier, the pathetic acceleration and scary brakes making sense of why you have to drive so differently than in a smaller vehicle. With the extra experience and better tuition in shorter sessions over a longer period, I passed quite creditably.

When the time came to move the truck from the haulage yard, I had been unable to find a suitable place nearby to keep North 3 where I could get there easily to work on the inside, with mains electricity available. There was room in the yard behind the shop, and although the access is very difficult I found that with care I could reverse in, with literally inches to spare on each side. Once at her new base, we could start on the electronics.

Looking at the whole of the equipment was a depressing experience. Every unit pulled out of the rack looked as if it had been left outside in the rain - not far from the truth, as water had been getting in through the ventilation cowls on the roof and the air conditioning outlet. Most of the modules were full of germanium transistors, which were green with damp, and many would just fall off if touched as the wires had corroded through. Electrolytics oozed white powder, and some switches were immovably rusted. Some vital bits were missing, although I had a shed full of spares, mostly from North 1.

Most amplifiers, coders or monitors could be taken out, components checked or changed and rebuilt as required, tested and returned, one at a time. The boards are mostly sparsely populated by modern standards, the builders at the time being happy to enclose a circuit with ten or so active components in a box the size of a brick- and fortunately, few chips. Some units used germanium transistors, but silicon was on the way in at that time, and although many of them were obscure types that probably cost a fortune in 1969, the majority could be replaced with standard components.

Hardly anything worked, but some of the more common modules could still be found - some of the worst looking were put to one side and via contacts, eBay or just luck, some clean replacements that had spent their life in a nice dry studio rack turned up. By 2011, we had the vision mixer, several monitors and some other vision equipment going, and the sound monitoring working so we could play some audio through the speakers. We made a short DVD about the history and restoration, and found some interesting archive footage, including a section from an Open University programme on politics from 1976 which we discovered was actually filmed in North 3 during its time as Birmingham's CM1.

One of our crew kept a growing newsgroup, comprising mainly ex-BBC staff, informed of progress, and our appearances at various events. A number of present and retired staff from Manchester, Birmingham and London came to see us at shows, amazed to enter the scanner they had last seen thirty years ago, and thought had probably been scrapped. One of the rigger-drivers who had driven it thousands of miles around Britain was delighted to sit in the cab again and start her up, while engineers, a floor manager and a director all had stories to tell of their escapades on OBs in the 'good old days' of television.

It was announced in 2010 that the BBC studios in Manchester, home to North 3 in the early 80s, was to close with the transfer of facilities to Salford Quays. 'New Broadcasting House' in Oxford Road had been a landmark in the city centre since the 1960s, employing hundreds of staff and producing countless hours of TV and radio, including 'Red Dwarf', 'Life on Mars' and many others. Some of the staff had worked there for most of their working lives. One of the last regular programmes still produced from there was North West Tonight, the regional opt-out slot after the national News at Six. One of the production team was aware of North 3, and contacted us to ask if we could bring her to Oxford Road for the final programme from the studios.

Well, I couldn't turn down the opportunity to take part in such a historic occasion - it took place in November 2011, and would be the longest journey yet made in North 3. We arrived on the Friday around lunchtime, and set up a working camera (not one of the originals) and signals to most of the operational parts. Throughout the afternoon staff came to look round, and bring tributes of equipment and spares from the stores and workshops. The wastage was incredible, numerous skips had been filled with equipment, records, tapes and office furniture, and a lot of fixtures would be left behind - the building was due to be demolished by the developers who had bought the site.

We wandered round the deserted building, looking at the empty studios and ransacked equipment bays. (Needless to say, North 3 was a lot heavier going back.) After the transmission was over we had a quick drink in the pub with the crew, for most, the end of an era. It was the last full programme to come from New Broadcasting House; a few months later, it was a pile of rubble. However, a year later we were to be outside the new studios at

This article continues on Page 58

Pictures from Wootton Bassett

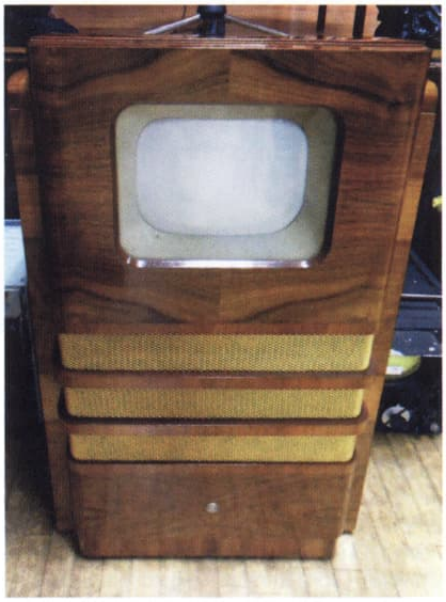
by Greg Hewitt

Their purpose is crystal-clear

Heathkit SB102 with speaker

An excellent as-original Ekco A22 in black and chrome, which sold for £750.00

GEC BT2147



Baird 'Townsman' in beautiful condition

Baird T18C of 1938

A restored Baird T164

Amplion 'Delegate'

Philips 834A 'Super Inductance' receiver

Dansette Conquest auto record player

Restoration of an Alba C112 Midget Radio

by Stef Niewiadomski

Having just completed the restoration of a hefty Derwent table radio, I looked around on my shelf of 'those in need of repair' for something lighter to tackle next. A midget radio seemed like a good choice, but rather than going for one of the American midgets on the shelf, I went for a British midget, namely the Alba C112, a very neat AC/DC three-band radio, released in 1947. Figure 1 shows my white cabinet C112, in moulded plastic, which has yellowed a little by now, in its restored condition. Once the white version had established itself in the UK market, the radio was released with a choice of pink, green, blue, ivory, walnut and black cabinet, all of which are very desirable today. Figure 2 shows a Christmas advert for the C112 – colour unspecified – taken from the January 1949 issue of the *Electrical and Radio Trading* magazine.

Figure 1: The Alba C112 in its restored condition. To get a sense of scale, the blue-centred knobs are just over ½-inch in diameter.

The radio came my way at Harpenden in March 2015 and had a cabinet in very good condition. The full complement of B8B loctal valves could be seen via the backless view. No mains lead was fitted and the 'throw out' aerial (which could be stored coiled onto clips fastened to the back panel, if fitted) had been chopped off within an inch of the back of the chassis. It was fitted with three knobs, each of a different style. Close examination of the photograph on the C112 *Wireless and Electrical Trader* service sheet, and other pictures on the internet, show a very small diameter knob with a coloured insert, one of which was present on my radio. One of the other two knobs was possibly from the later C114 model, and the third knob possibly from some other small-ish radio.

The Alba brand

Alba was a brand used by A J Balcombe Ltd, founded in London by Alfred Balcombe at the end of World War 1. Over many years it produced radios (domestic, portable and car), radiograms and record players, tape recorders, and TVs, and successfully made the transition from valve technology to transistors in the early 1960s, a process which many British companies did not survive. The Alba trade mark was adopted as the company name in 1960, and sadly the company went into receivership in 1982. However this was not the end of the company and it was bought and resurrected as Alba plc, acquired Bush in 1988, and Goodmans in 1994.

The Alba brand still survives today, now being used by Argos on its range of low cost TVs, and FM and DAB radios. Interestingly, Argos also sees value in keeping the well-known Bush brand alive on TVs, radios, mobile phones, and various domestic appliances.

An excellent photo of happier times in the company was published in the Spring 2007 issue of the Bulletin, and is reproduced here as Figure 3. I can see maybe ten C112s on this stand dedicated to the model, and from the various shades of grey of the cabinets, the full range of colours is being shown. I wonder how much this selection of radios would be worth today? A cabinet-less chassis can also be seen, no doubt to impress prospective buyers with the way the innards have been packed in. The cover of this edition of the Bulletin shows full colour shots of the various cabinets used for the C112, and is well worth referring back to.

Mullard 'Continental'

The Trader service sheet for the C112 refers to the B8B loctal valves as the 'Mullard Continental 21 series'. Philips first produced these valves in Holland in 1941, and they were used initially in radios produced in the Axis countries, those they occupied, and Switzerland. The use of a pair of UCH21s for the front end stages of the C112 was ingenious, but by no means unique. The Philips 209U, of December 1946 vintage, and many other radios, used a pair of UCH21s, along with a UBL21 and UY21. The B8B series was not particularly successful, being quickly superseded by valves in the much smaller B7G, B9A and B8A formats as they became available.

Reference 1, originally published in Dutch in 1942, is a very interesting document describing the valves developed during 1940 and 1941 at the Philips Eindhoven plant, then under German occupation of course, and therefore not available to most of the world's radio designers and manufacturers. The 100mA heater current UCH21, UBL21 and UY21 (and the UF21, used sometimes as an RF or IF amplifier) are described in the document. Several other '21' and '22' series valves are described, including a range of 1.4V battery valves, again used in occupied Europe during the war.

Many of these valves were mounted on the newly developed 8-pin loctal base, which the Philips document refers to as 'Miniwatt key valves'. Although the base nominally has eight pins, with the centre spigot acting as a locking mechanism in the socket, this spigot can also be used as a signal pin, as in the case of the UCH21 where it connects internally to the common cathode of the triode and heptode sections. The metal skirt of the valve is connected to this central spigot, and so it is at the same potential as the cathode: this means that a suitably insulated socket needs to be used to prevent the skirt from being shorted to chassis. In my C112, I can see that the sockets used for V1 and V2 are different from the other two, and are designed to keep the skirt away from the chassis.

The document also contained application data, and amongst others, a three-valve plus rectifier superhet was described, using a pair of UCH21s, a UBL21 and a UY21, identical to the Alba C112. I presume that soon after the end of the war the Alba designers managed to get hold of a copy of this data, and with an assurance from their Philips/Mullard rep that they could be supplied with sufficient quantities of the valves, they went ahead and put their design into production in 1947.

The design

Figure 4 shows the schematic of the radio, taken from the *Trader* service sheet. V1 is a UCH21 triode-heptode in the frequency changer stage, covering the medium and long waves, and a short wave band of 50m-16m (6MHz – 18.75MHz) ; the heptode section of V2, a second UCH21, is the IF amplifier at 455kHz (strangely following American practice with the choice of frequency, although the original Philips data had shown an IF of 470kHz), and its triode section acts as an audio amplifier, fed from the audio detector diode inside V3; the second diode inside V3, a UBL21 double-diode / pentode, generates the AVC voltage, and its pentode section is the output stage; and finally V4 is a UY21 half wave mains rectifier.

The 100mA heaters are connected in series, and the voltages of the four valves add up to 145V, implying dropping about

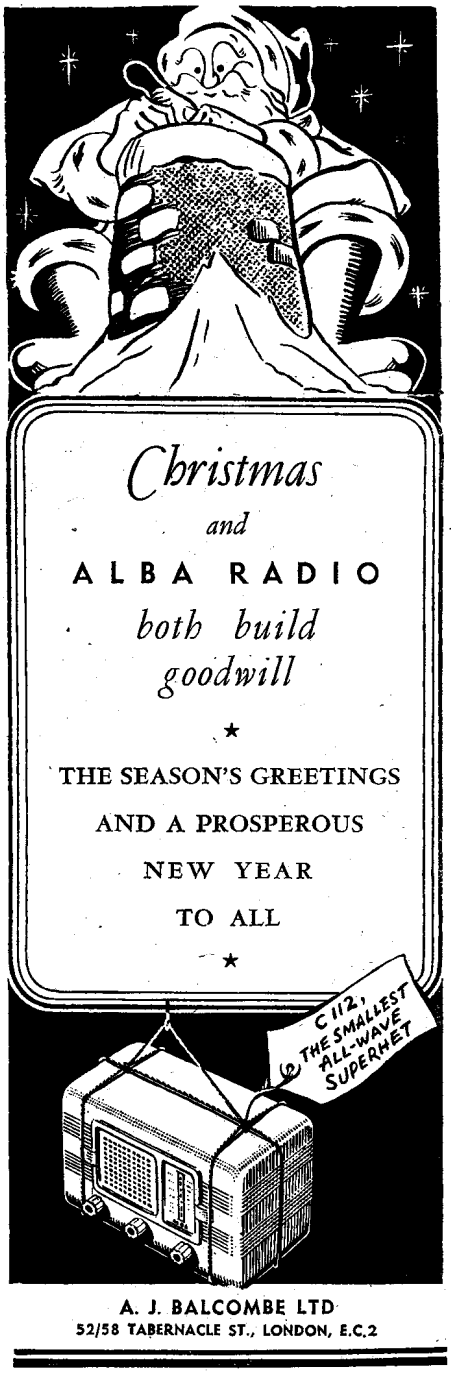


Figure 2: A Christmassy advert for the C112 - 'the smallest all-wave superhet' - as published in the January 1949 issue of Electrical and Radio Trading.

95V from the nominally 240V UK mains, via a 680Ω mains line cord. Taking the data for the anode and screen currents from the Trader sheet, the HT currents of the four valves add up to about 38mA. Adding this to the 100mA heater current, we get 138mA flowing through the 680Ω line cord, which gives a dissipation of about 13W. The radio was specified for operation from between 200V and 240V, without any adjustment being necessary, so it would seem that the valves used were tolerant of a fairly wide range of heater and HT voltages.

My original intention was to run the radio from a nominal 115V via an autotransformer, but the heaters would be rather underrun at this voltage, and the HT voltage would be lower than ideal, and so another solution needed to be found. For initial testing I used a Variac set to 145V, but set to a lower voltage for switch on, and then gradually ramped up to the 145V level once the heaters had warmed up.

In 1951 the C114 (the successor to the C112, and using the same cabinet) was released, which was designed to use a UCH42, UF41, UBC41, UL41 and UY41 B8A-based valve line-up, with 100mA heaters. The heater voltages of these valves add up to a more convenient 117V, which made the line-up very suitable for use where the radio is operated from 115V/120V or 240V mains. For the latter, a heater ballast resistor was switched into circuit, which was removed for 115V/120V operation. In fact the C114 was equipped with a third setting of 130V-150V which was the mains voltage at some places on the continent. This capability to operate from many different mains voltages was very laudable, and opened up the potential for exports, much needed by the country at this time.

Restoration

Rather unusually, the chassis is not held into the cabinet by screws on the underside, but by the back panel, and since this was missing, after removing the three knobs, the chassis slid out backwards. As it slid out, two flat springs mounted on the chassis disengaged from two projections moulded into the cabinet. The neat chassis came out complete with the 3½-inch diameter Elac speaker and the diminutive tuning scale assembly.

The compact cabinet (8-inches wide by 4¼-inches deep by 5-inches high) was in excellent condition and I stored it away somewhere safe so that it would stay that way. Interestingly, the speaker grille was not moulded directly into the cabinet, but was an insert moulded separately and pinned and glued into place from the inside. The two 'feet' of the cabinet are also separate plastic mouldings which are screwed into the base of the cabinet via 4BA countersunk screws. These were removed for cleaning, along with the cabinet itself. I also removed the intact, if a little faded, plastic vertical tuning scale, fixed to its backing plate via four 8BA countersunk screws, and put this away, to ensure I didn't damage it during the restoration process.

Figure 5 shows a rear view of the chassis before restoration. The plated steel chassis was endowed with dust and cobwebs, but was rust free. There were no obvious signs of anyone else having tried to get the radio going, just as I like to see. As you can see, all four valves

Figure 3: The Alba stand at a radio show in about 1950, taken from 'The Alba Story' by Jeremy Balcombe. I think I can count about ten C112s, including the one being held by the attractive lady.

were present, so I removed them in turn and measured the resistance between pins 1 and 8 for each of them to check their heaters. Three out of four were good, but the UY21's heater was open circuit.

The UBL21 was marked 'Valvo' and I decided not to re-fit it back into the radio: Figure 6 shows its base (on the right of the photo) alongside the Mullard valve I fitted instead. The Valvo version's base seems to have a Bakelite plate through which the pins project - I presume this gives some extra support to the pins to stop them from bending close to the glass, and potentially breaking the seal thereby destroying the vacuum. It also has rusty pins which seems to indicate bad plating when they were manufactured.

Valvo was a Germany-based valve manufacturer, eventually owned by Philips. The Valvo brand was well known and trusted in Germany, and so Philips retained it, although it's likely that many of the valves marked with the Valvo brand were produced in the Philips factories in Holland. It looks like the Valvo UBL21 from my C112 is different in its base design,

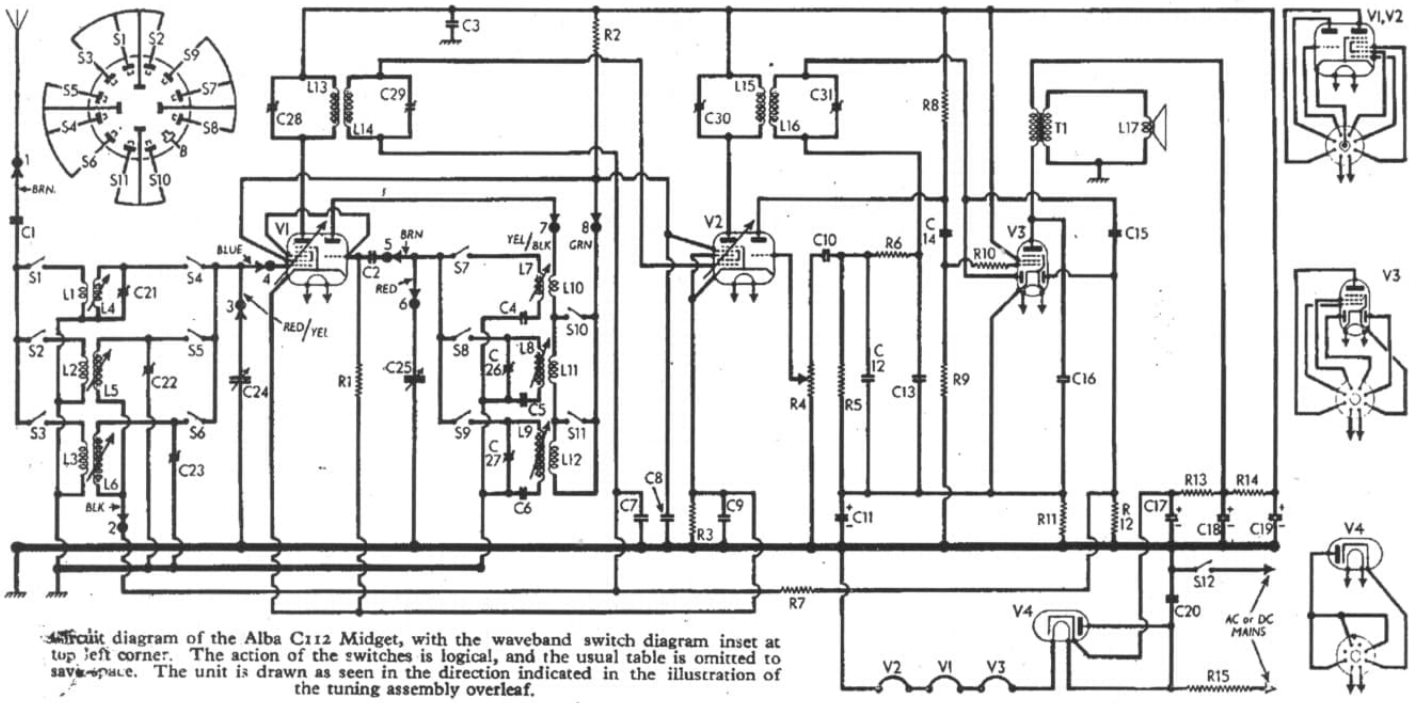


Figure 4: Schematic of the radio, taken from the Trader service sheet.

and so I presume it was produced in a Valvo, rather than a Philips, factory. The Mullard UBL21 was printed with 'Pentone' and 'Binode' branding on its envelope.

Empty holes

There was an obvious hole in the chassis, I presumed where the smoothing capacitor can was originally fitted, which was nowhere to be found. There was also a smaller empty hole, the purpose of which I wasn't sure of, to the left of the big hole. There were a few unconnected wires around the socket of V4, which looked like the connections to the 'lost' smoothing capacitors. The wiring and components are packed in very tightly, and make it quite tricky to trace connections and check the soldered joints.

The tuning mechanism worked, but the pointer did not move. A look at the service sheet revealed that the radio was fitted with two cords: one coupled the shaft of the tuning knob to the drum on the tuning capacitor (this one was intact); and a second cord should have driven the pointer up and down, from the drum. I could see that this cord was missing. The white paint on the tuning scale backing plate was flaking, and the red paint on the pointer had seen better days.

I unsoldered one of the connections to the speaker and measured its resistance – 2.6Ω indicated an intact 3Ω impedance coil. The resistance across the leads from the secondary of the output transformer measured 0.6Ω and by measuring 214Ω between pin 2 of V3 and the HT rail, I could see that the output transformer was in good condition.

Figure 7 shows the bottom view of the unrestored chassis: the components are crammed into the restricted space, but the designers managed to use a reasonably-sized output transformer.

Working through the chassis I checked all the resistors, which measured close enough to their nominal values to be left alone. I paid particular attention to R13 and R14, the HT smoothing resistors, which were both dog-bone in shape, but which were both OK and showed no sign of overheating. The switch on the volume control was working, and the potentiometer itself (nominally 1MΩ, and measuring 880k) worked over its full range of travel.

Figure 5: Rear view of the chassis before restoration. You should be able to see one of the flat springs that hold the chassis in the cabinet, and the empty hole for the missing smoothing capacitor can.

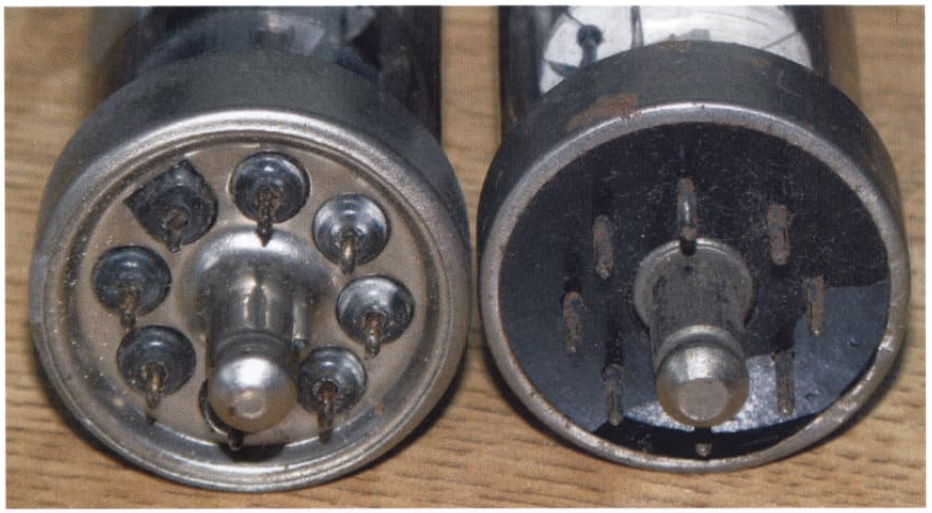


Figure 6: Base of the Valvo UBL21 (on the right of the photo) alongside the Mullard valve I fitted instead. The Bakelite base of the Valvo version can be seen, along with its rusty pins and skirt.

Power supply

I needed to re-instate the missing parts in the power supply before I could switch the radio on. At this stage I didn't have the correct 8μF + 16μF + 16μF electrolytic can (for C17, C18 and C19) and so I fitted three 22μF electrolytics on flying leads to the appropriate loose wires, and fitted a two-core mains lead with a UK-style plug fitted with a 1A fuse, being very careful to ensure that the chassis of the radio was connected to mains neutral via the on/off switch.

I chopped out the anti-modulation hum capacitor C20, which I would replace at a later stage. I connected a few metres of wire to the aerial lead. After making sure that the on/off switch was in the on position, I set the voltage of my Variac to about 60V to limit the switch on surge through the cold heaters, and switched on at the mains. I had already connected a DMM set to its 600V AC range between the chassis and mains earth, and this confirmed that the chassis was connected to the neutral side of the mains.

After thirty seconds or so, I slowly ramped the Variac up to 145V, and after a further period of waiting, the radio started emitting a buzzing sound which wasn't affected by the volume control setting. I quickly checked the voltages across the temporary capacitors fitted for C17, C18 and C19, and they seemed reasonable at 122V, 104V and 90V. I switched off, unplugged from the mains and started looking around the densely packed chassis for any obvious problems. Fairly quickly I could see that the bottom end of R11 (V3's cathode resistor) was floating because the tag strip it was attached to should have been connected to chassis by one of the smoothing capacitors' fixing screws, which were missing.

I could also see that R11's bypass capacitor, C11, was missing. This was the capacitor that should have occupied the empty smaller hole in the chassis. I fitted a modern low voltage 47μF electrolytic for C11 and bolted R11's tag strip to the chassis. On switching on again, the buzz had gone away, but tuning around the three bands, the radio was very silent.

The next thing to check was whether

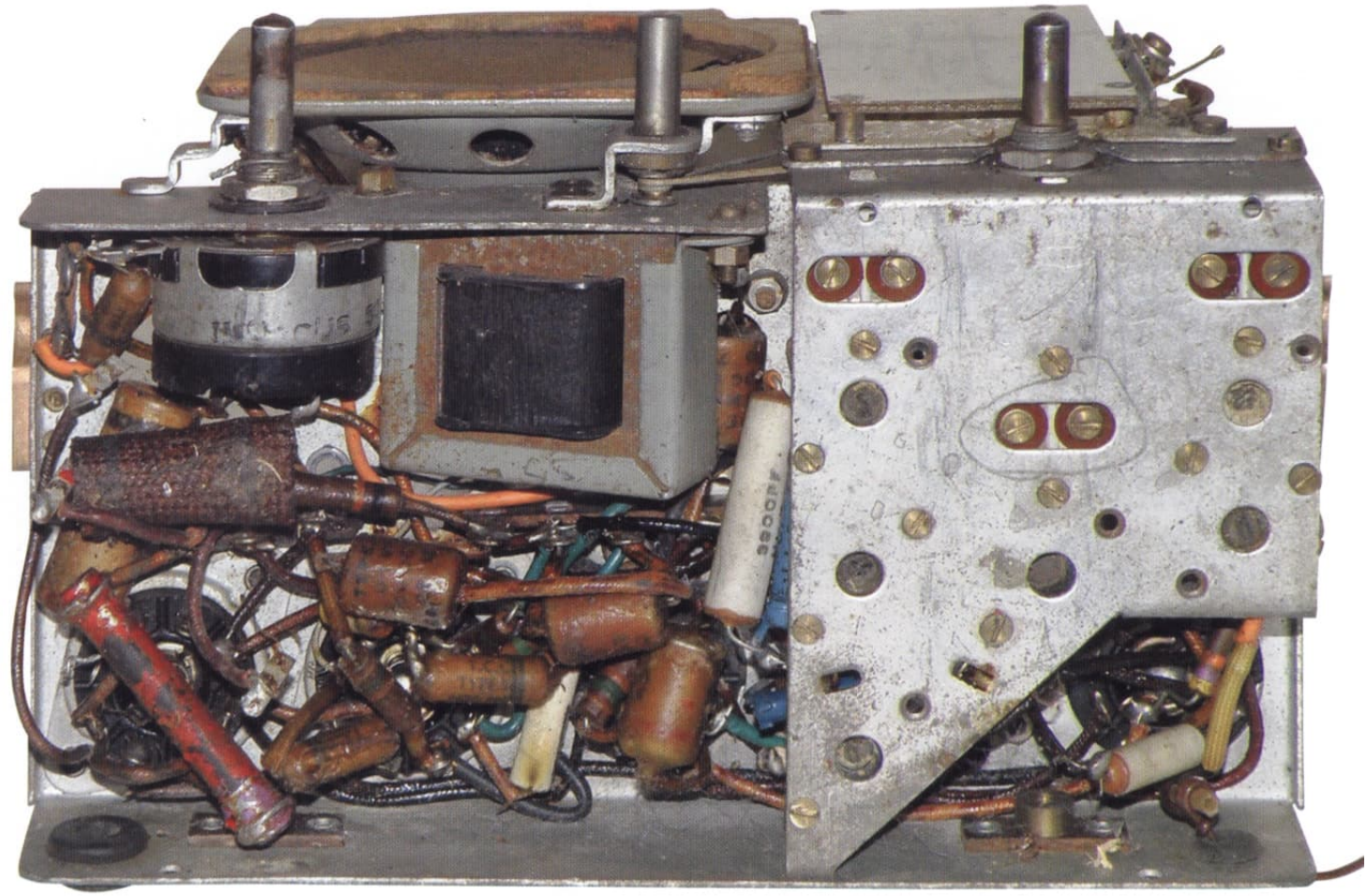


Figure 7: Bottom view of the unrestored chassis. C21, the faulty short wave aerial trimmer, is at the centre of the coil pack, to the left of an unused trimmer which is not shown on the Trader service sheet. Note that they are both circled in pencil: perhaps a previous owner suspected a problem in this area?

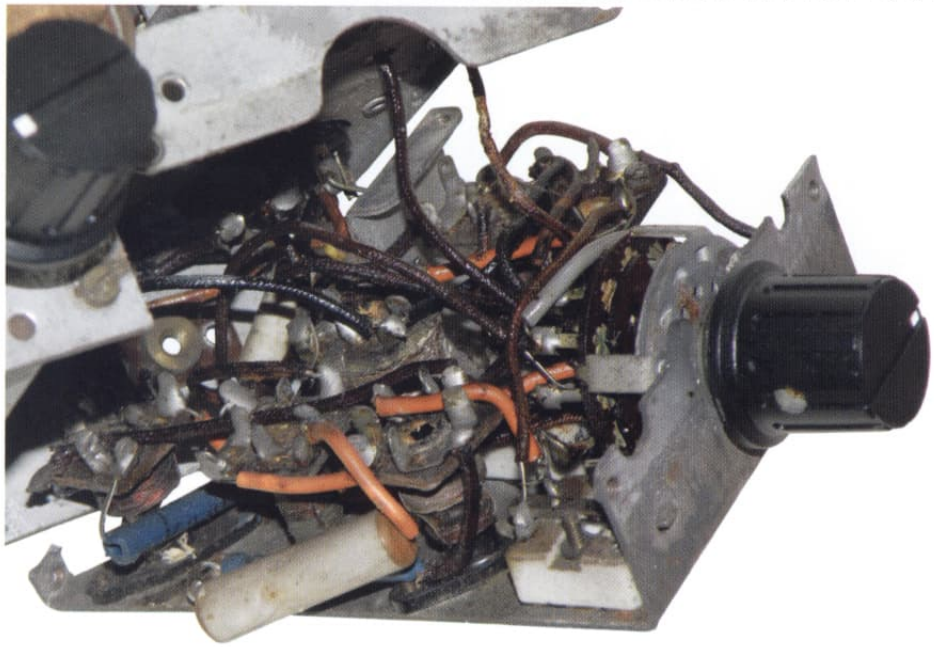


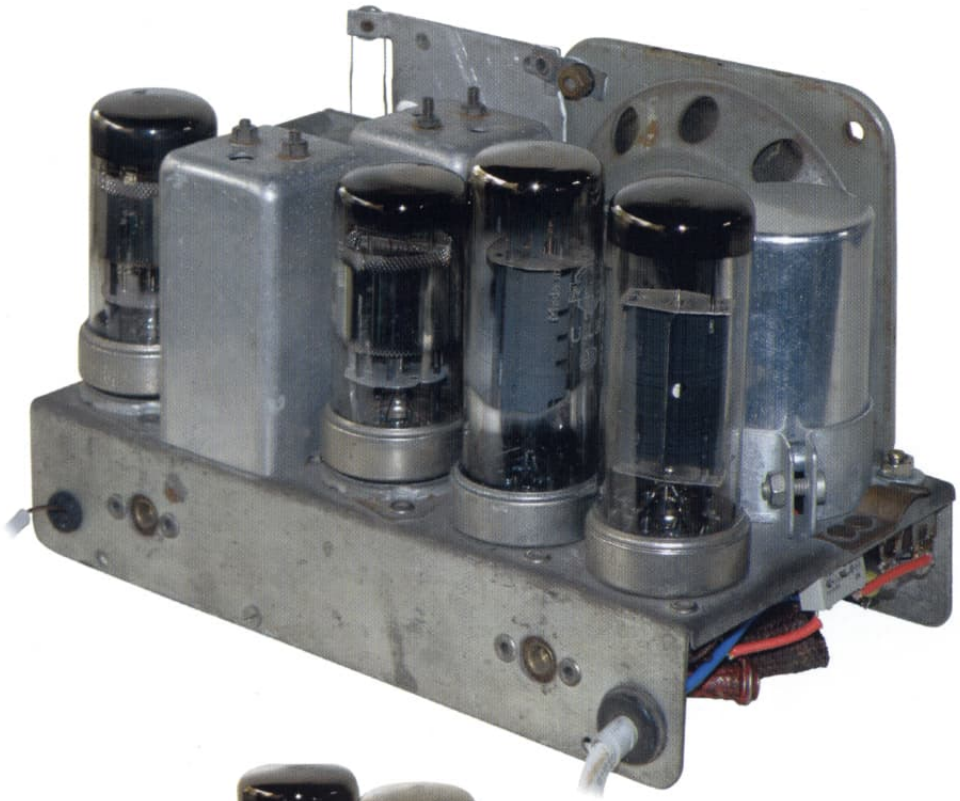
Figure 8: The coil pack, dropped down from the chassis, but still attached by its wiring.

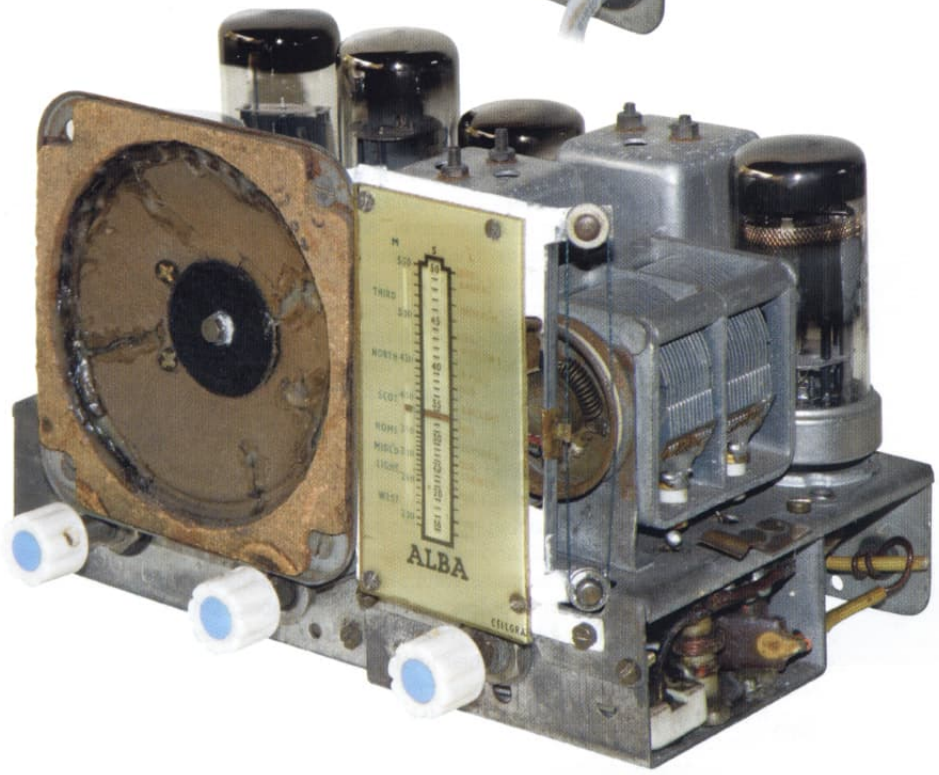
the local oscillator was running. Setting the radio to the long wave and tuning a nearby radio to 650kHz, I tuned around the Radio 4 frequency and could hear nothing on the monitoring radio. I changed the UCH21 frequency changer and repeated the experiment: now I could hear the local oscillator, and Radio 4 came in faintly and distorted, but not with the local oscillator set to 650kHz. Radio 5 Live could also be heard on the medium wave, again rather faintly and distorted. I connected my workshop's long wire aerial, and I could still only hear these two distorted stations.

I now suspected the audio coupling capacitor, C14, and so I probed the grid of V3, and it measured a few volts positive, rather than being at chassis potential. I changed C14 for a new 4.7nF polyester capacitor, and this resulted in much less distortion and a better tone to the audio output. The number of audible stations had also increased considerably.

I changed the 0.1µF AVC decoupling capacitor (C7) and while the C7 location was vacant, it was easy to change C8, the HT feed decoupler. I also changed C10, the audio coupling capacitor at the 'top' end of the volume control. I thought the radio was still not as good as it should be, and a new UCH21 in the IF amplifier / audio preamplifier position and a new UBL21 improved matters considerably. The old valves were probably good enough to be used again and so I stored them away, for use in another radio at some point. At high volumes the speaker rattled somewhat, and I suspected this was due to the tears it had in its cone.

Radio 4 seemed to be spread across a wide portion of the long wave and I could definitely hear the station peak at two points on the band. I suspected that the IF transformers were not aligned correctly and so I injected a modulated 455kHz signal as per the service instructions. A few twiddles of the IF transformer trimmers corrected the mis-alignment, brought the signal strength up, and narrowed the range over which I could hear Radio 4, and I could now hear two more stations on the band. I estimate that one of the IFTs was originally tuned to about 430kHz and the other somewhere closer to the correct value. The medium wave was now also stronger and sharper in its tuning.





Top - Figure 9: Rear view of the restored chassis. The replacement smoothing electrolytic fits perfectly into the available space.

Above - Figure 10: Front view of the restored chassis. To fix its numerous tears, the speaker cone needed several dabs of Copydex and is just about presentable. Hopefully, the new drive cord that operates the pointer up and down the dial can be seen.

Coil pack

I was happy now that the medium and long waves were working, but I could still hear nothing with the wavechange switch in the short wave position. Perhaps the local oscillator wasn't running on this band? Again listening on a monitoring radio, I could hear the local oscillator at about 6.5MHz and 14.9MHz, at opposite ends of the tuning capacitor setting.

I suspected the wavechange switch and to get access to it I had to get into the coil pack. Four 6BA screws needed to be removed from various places in the front, rear and top of the chassis, and once this was done the coil pack dropped down, revealing the coils, capacitors and the switch. This can be seen in Figure 8. The service data states that eight connecting wires need to be unsoldered to allow the pack to be completely removed, but I didn't do this and simply sprayed the switch contacts and rotated the switch several times, and refitted the coil pack back into the chassis. But still no sign of any stations on the short wave.

Apart from the contacts on the wavechange switch and the use of the relevant coils, there is a difference in the way the radio works on short waves. On medium and long waves, AVC is applied to the control grid of the heptode section of V1. When the wavechange switch is in the short wave position, this control grid is connected to chassis via the secondary of the aerial coil, L4 on the schematic. V1 therefore relies on the slightly positive cathode potential (1.2V in the service sheet, which it shares with the cathode of V2) to generate sufficient negative bias (with respect to the cathode) on its grid to operate correctly.

I monitored the voltage on the control grid of the heptode section of V1 (pin 6). In the medium and long wave positions of the wavechange switch, the voltage varied between about 0.9V (not tuned to any broadcast) and -0.6V, with respect to the chassis, when tuned to a strong station. On the short wave setting, the voltage was firmly at 0V, indicating that the wavechange switch was doing its job correctly. The cathode of V1 (the central spigot of the valve) was at about 2.0V – a little higher than the service sheet states, but probably OK. The voltages on the anodes and screen of V1 looked OK, so I was at a loss for what could be wrong.

Tuning around the short waves with the volume turned up, I suddenly noticed that there was a very faint signal, which, by beating it with my signal generator, I confirmed to be at about 10.3MHz. Maybe the front end of the radio was working correctly, but the aerial tuning was badly out of alignment? Checking the schematic, C21 is the trimmer in the coil pack which sets the aerial coil tuning for the short wave. From the service sheet I located this trimmer on the cover of the coil pack and gave it a twiddle. Its adjustment screw was very loose and after I had unscrewed it by a couple of turns, the radio burst into life and I could hear a loud broadcast. Tuning around I could hear many more stations, but the adjustment of C21 was very susceptible to vibration, and the radio would go louder and quieter simply by touching C21 with an adjuster. I could get the same effect by tapping certain areas of the coil pack's metal covering. The mechanical condition of this trimmer, and perhaps other things inside the coil pack, were definitely suspect and so I removed the coil pack (again) to take a look.

From the inside of the coil pack I couldn't see anything obviously wrong with C21, but some of the soldered joints to the coils and the switch looked suspect. I resoldered as many of these joints as I could (this area is even more densely

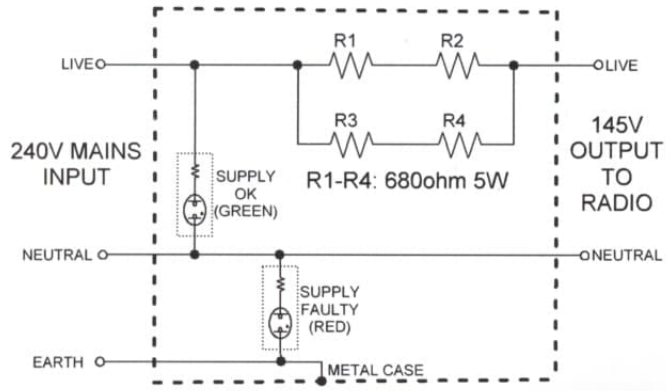


Figure 11

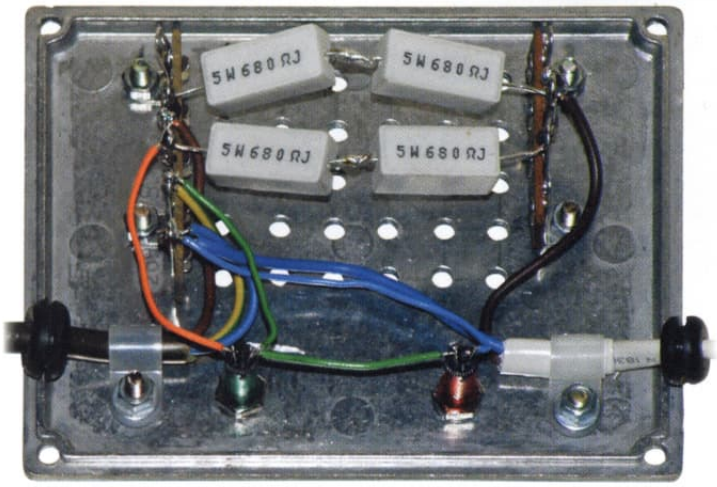


Figure 12

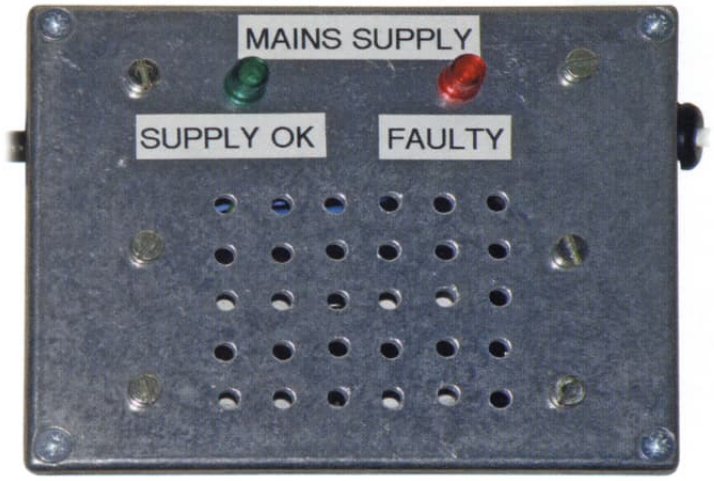


Figure 13

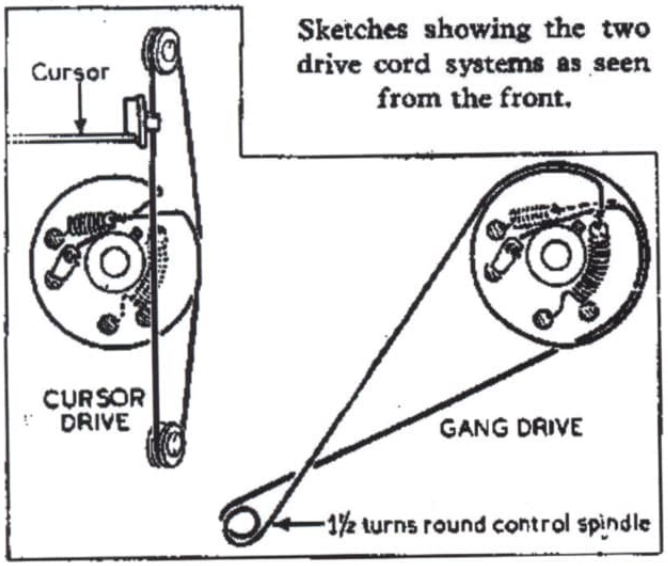


Figure 14

Figure 11: Schematic of the mains dropper unit.

Figure 12: The inside lid of the 'virtual' line cord, showing the positioning of the resistors, neons and the cable clamps and grommets.

Figure 13: The top of the earthed box containing the mains dropper resistors. As labelled, the green neon indicates that the 240V mains supply is wired the correct way round, and the red neon indicates that it is the wrong way round. To allow free circulation of air into and out of the box, holes have been drilled into the top and bottom of the box, and feet fitted to the bottom.

Figure 14: The stringing details of the two drive cord system.

packed than the rest of the chassis), re-assembled the coil pack, and switched on again. Now things were much better: I peaked the aerial tuning with C21, and tuning around, signals were very strong and unaffected by tapping the chassis. Whatever the exact nature of the problem had been, I seemed to have fixed it.

Tuning around the short wave band, the radio was very sensitive, although it was tricky to accurately tune into some broadcasts because of the relatively low ratio of the slow motion mechanism, which I worked out to be about 7:1. At this stage the knob I had fitted was about ¾-inch in diameter, and I anticipated an even trickier experience once I had re-fitted the correct, and even smaller, knobs.

Mike Barker supplied me with a Plessey 16µF + 16µF + 16µF 450V electrolytic can, which was the right size for the C112 chassis. The extra capacitance for C17, the reservoir capacitor, would not be a problem as the UY21 is rated at a maximum capacitance of 60µF. I fitted the can, after removing the volume control to get access to the right area of the chassis - which needed me to loosen the speaker to get the volume control's shaft out of its hole. I also took the opportunity to apply some dabs of Copydex to repair the cone of the speaker, which was ripped in several places, including around its fixed edge. Once this was dry, the speaker definitely rattled much less at high volume levels, but it didn't look too attractive – see the photo of the front of the restored radio. I think I'll keep an eye open for a similar speaker in better condition.

Mike also kindly supplied me with the two small C112 knobs with blue inserts that I needed to complete the set of three.

At this stage, I fitted a new 47nF class X2 275V AC metallised polyester capacitor for C20, the anti-modulation hum capacitor, which I had removed earlier. I also took the opportunity to re-route the audio connection to the volume control via C10, which I thought was running rather close to the mains neutral wiring to the on/off switch and could have suffered some induced hum.

Even with the mains voltage set to 145V, at 20 seconds or so, the warm up time of the valves was quite long. On switch on, the UCH21s light up with an alarming brightness, then settle down and gradually reach their final brightness after about a minute.

Figures 9 and 10 show rear and front views of the restored chassis.

Mains dropper resistor

Now I had to deal with how to operate the radio from the UK mains voltage, without fitting a dropper resistor internally, which would have been a tight squeeze and whose dissipated heat would soon ruin the plastic cabinet. The radio originally ran with a 680Ω line cord, and so my plan was to emulate this with a resistor (or combination of resistors), safely tucked away in an earthed metal box, in series with the live mains feed to the radio. As mentioned above, the line cord dissipated about 13W, and so four 5W 680Ω resistors, connected in series / parallel, would handle the power, as long as the heat could convect away.

I also wanted to incorporate a way of indicating that the 240V UK mains supply was connected the right way round, ensuring that the chassis of the radio was always connected to neutral. Figure 11 shows the schematic of the unit I built. Two neons (one red and one green, fitted with integral current limiting resistors, and obtained from Maplin) indicate to the user that the connections to the 240V mains are correct. If the green neon lights and the

red neon does not light, then the live, neutral and earth connections to the 240V mains are correct. If the red neon lights and the green neon does not, then the live and neutral connections are swapped over, and the radio's chassis is live and therefore dangerous to touch.

If both neons light up, then the earth connection has come adrift. In this condition the metal box of the dropper unit settles to mid-mains voltage - about 115V - fed from live and neutral via the neons and their limiting resistors. I tried this, but didn't try to touch the box, but I would expect it to give you a tingle when in this state. The safe condition is therefore indicated when only the green neon is lit.

It's generally not recommended to return live current into the mains earth connection, but we are only talking about a few µA here, and it should not trip your house or workshop's supply's RCCB. No doubt this is not 100% fool-proof, but I think it covers most cases of mis-wiring the mains plug, or the socket into which it is plugged.

Figure 12 shows the inside of the lid of the perforated earthed box containing the resistors and neons, and Figure 13 shows the lid fitted onto the box. Make sure that the perforated material, or the series of holes you drill in the case, are fine enough so that small prying fingers can't get into the box and touch the mains connections. The three core 240V mains cable should enter the box via a grommeted hole and be clamped to the box, as should the two core cable to the radio. The four resistors are mounted clear of the metal surface on tag strips. Four rubber feet were stuck onto the bottom surface of the box so that air can pass into the box via a series of holes drilled in the bottom.

Mains earth is connected to the metal box, but of course the radio only has two connections, and its chassis is not earthed. You should keep the metal box far enough from the radio to ensure that its surface can't accidentally touch the radio's chassis. After an hour's running, my box runs warm to the touch, but not too hot.

The use of this 'virtual' mains cord effectively restores the radio back to how it was powered when it left the factory. Because a single pole on/off switch, located in the mains neutral lead, is used in the design, this means that the radio's chassis is live – fed via the valves' heaters – when it is switched off. In order to prevent this from happening, I soldered a link across the on/off switch, so that the radio cannot now be switched off via its own switch, and has to be switched off at the mains. I think this is a good move: it's probably not a good idea to rely on a sixty year old component to switch the mains, and it's now impossible to land up with a chassis live to the mains.

Cabinet and tuning scale

The scale backing plate was secured to the speaker with a 4BA screw and nut, and the chassis with a 6BA screw and nut and so was very easy to remove. I removed the tuning pointer from its guide by slightly prising open its clamp and removed the last small portion of its cord. I rubbed down the backing plate and primed it with a grey primer I had to hand. A couple of coats of a brilliant white satin finish top coat gave the plate a factory fresh appearance. The pointer was rubbed down and painted with the brightest red paint I had.

The pointer has its own cord, separate from that which drives the tuning capacitor, as shown in Figure 14. Instructions in the service sheet, which I chose to ignore initially, point out that a thinner cord should be used for the pointer than for the tuning capacitor. I tried to thread the cord using 'normal' cord, but it would not stay on the two small pulleys which guide the cord, and I could not complete the task. On eBay I found some 0.35mm diameter cord (also advertised as 50lbs breaking strain) and this did the trick, though I must admit that this was a very fiddly operation.

Close examination of the cabinet with the chassis removed confirmed my original impression that it was in very good condition, with no cracks or major scratches. A thorough wash in warm soapy water and a quick polish brought it back to almost ex-factory condition. The knobs received the same treatment. I was very pleased with its performance and appearance.

Conclusions

The Alba C112 was a British superhet radio, covering three bands and first being released in 1947, whose small size made it a true midget. The small size achieved by the designers is all the more remarkable when you consider that they used 'full sized' valves, IF transformers and audio output transformer, and that it covers three bands. In the Trader service sheet, the tuning capacitor is specified as being 370pF, rather than the more normal 500pF, and so this saved some small, but significant, amount in the final size of the radio.

One truly miniature item in the radio is the coil pack, specially designed to fit into the minimum of space, with a depth of only 1¼-inch. I don't think I'm exaggerating when I say the radio is exquisitely constructed using good old 8BA, 6BA and 4BA screws, which make it a pleasure to take apart and re-assemble. Great skill is exhibited in its mechanical design, and this reminded me of a clock mechanism, rather than of a typical radio of the era. Probably the fiddliest task was replacing the scale pointer cord, which operates alongside the cord which drives the tuning capacitor.

The small diameter knobs make tuning on the short waveband, and operation of the wavechange switch, rather tricky. I presume that when the radio was new, the switch was a little freer and didn't need such force to turn it. I wonder if this force needed to operate the wavechange switch, and the generally fiddly nature of the small knobs resulted in this very small format not being replicated by many other manufacturers.

So that a heat-generating dropper resistor did not have to be accommodated inside the very small cabinet, the radio originally used a mains dropper cord, which had been lost from my radio. The use of four Continental 21-series valves made it impossible to simply convert the radio for 115V operation (unless you don't mind under-running the heaters) and so I constructed a virtual line cord so that the radio could be operated from the UK 240V mains. I've also incorporated a safety feature so that the user can be sure that the mains socket that the radio is plugged into is correctly wired, and therefore that the radio is safe to use.

References

Reference 1 'Data and Circuits of Receiver and Amplifier Valves (1st Supplement)' published in English by N V Philips in 1949, can be found at: *http://frank.pocnet.net/sheets/046/suppinfo/Philips_ElectronicValves_BookIII_1949.pdf* . It's well worth taking a look at this 213 page document on line to see what was going on at this location during these early years of the war.

A Heimfunk two double-triode set ca.1927

by Gwyn Griffiths

For my sixtieth birthday my old and dear friend Nigel presented me with this 1920s set, which, from a label on the inside of the wooden case, was made by Heimfunk GmbH, Hamburg, Germany. A work colleague had given Nigel the set around 1980 when he worked in Hamburg. The set had been well looked after, but not touched for decades. Bringing it back to a working condition was to be a real pleasure.

Identifying the radio

I soon began to search for information about the set, particularly from the Radiomuseum website, which is strong on sets made in Germany. I had two clues: the Heimfunk nameplate, and the use of two unusual valves. Unfortunately, at the time, Heimfunk was only represented on Radiomuseum by two sets, the one-valve Fernempfänger Holz from 1927/8 and the three-valve Heimfunk 7 also from 1927/8. However, the distinctive finish to the front panel of these two sets, especially the Fernempfänger, was very similar to this "mystery" Heimfunk.

The Radiomuseum site also lists valves, and the two in this Heimfunk are rather unusual; both valves are double triodes, an HZ420 for the RF and detector, and an NZ420 for the audio amplifier and output. For the NZ420 only six sets were listed, covering 1926 to 1928, and of those six, only one used two double triodes, the Standard D2 from Lumophon, Bruckner and Stark, Nürnberg. The photographs of the Standard D2 showed a set that was identical to the Heimfunk in: the layout of the front panel; the arrangement and type of components above the baseplate; the use of an ebonite baseplate, including, what I'd not seen before, the use of individual valve pin sockets directly inserted into holes on the appropriate matrix on the baseplate itself for the audio amplifier double triode; and the arrangement and type of components beneath the baseplate, including what must be a purpose-made wave-change switch mechanism.

However, there were observable differences between the Standard D2 and the Heimfunk: the lack of a decorative transfer for the maker on the inside of the lid; the lack of a type label of any description on the front panel; and the material and finish of the front panels were quite different. One possibility is that Heimfunk "badge engineered" the Lumophon, Bruckner and Stark Standard D2 with their distinctively worked front panel and discrete label on the

inside of the case. But, any information to the contrary would be much appreciated.

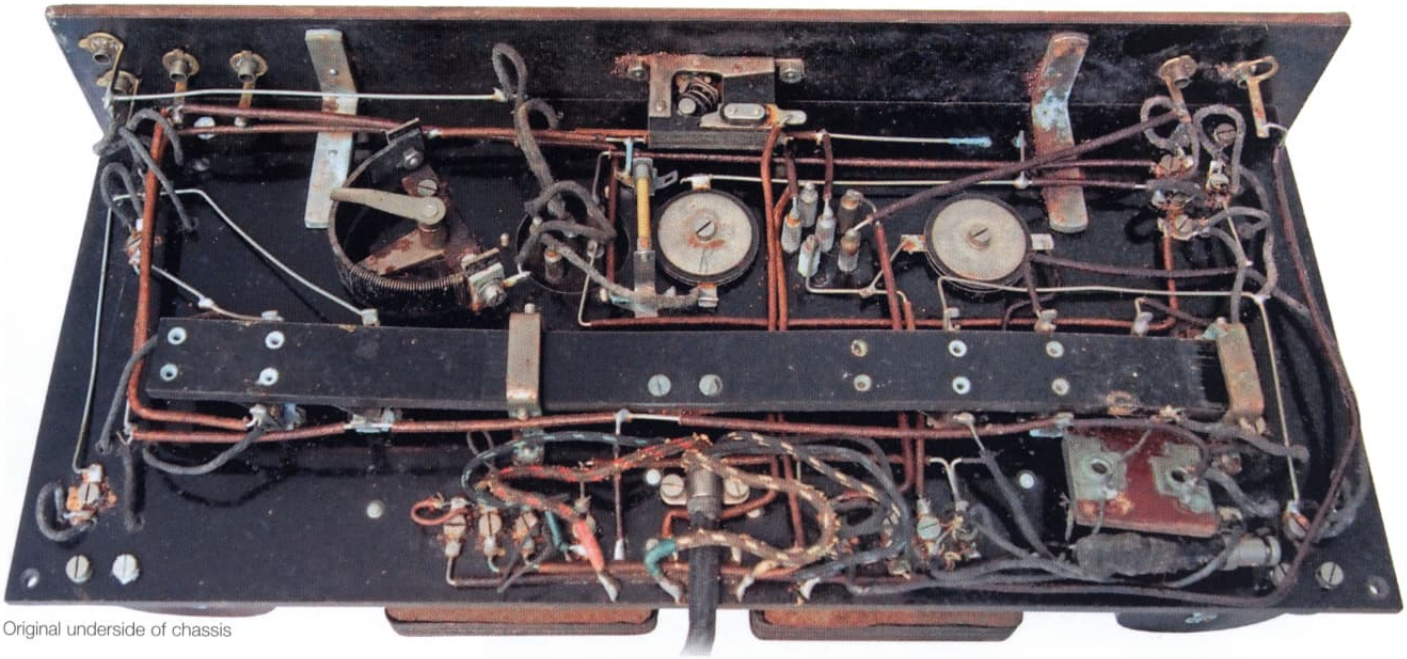
The set as received

The set was in pretty decent condition when received. It had been kept in a dry space for at least 30 years. The wooden case was in very good condition, although it may have been revarnished at some time. The front panel and knobs were in excellent condition. Inside, the ebonite baseplate was dusty, the upper shrouds of the two audio inter-stage transformers had some patches of light rust. There was what I then took to be green/blue verdigris (copper carbonate) on some of the non-ferrous metal parts, clearly seen in the photograph of the left-most rear coil bracket, and on sections of tinned copper wire, for example where the wire from the variable capacitor passes through the ebonite baseplate. The aluminium foil on the rear of the front panel, there to minimise hand-capacity effects when tuning, was nibbled at the edges, and generally ruffled. No attempt has been made to replace the foil.

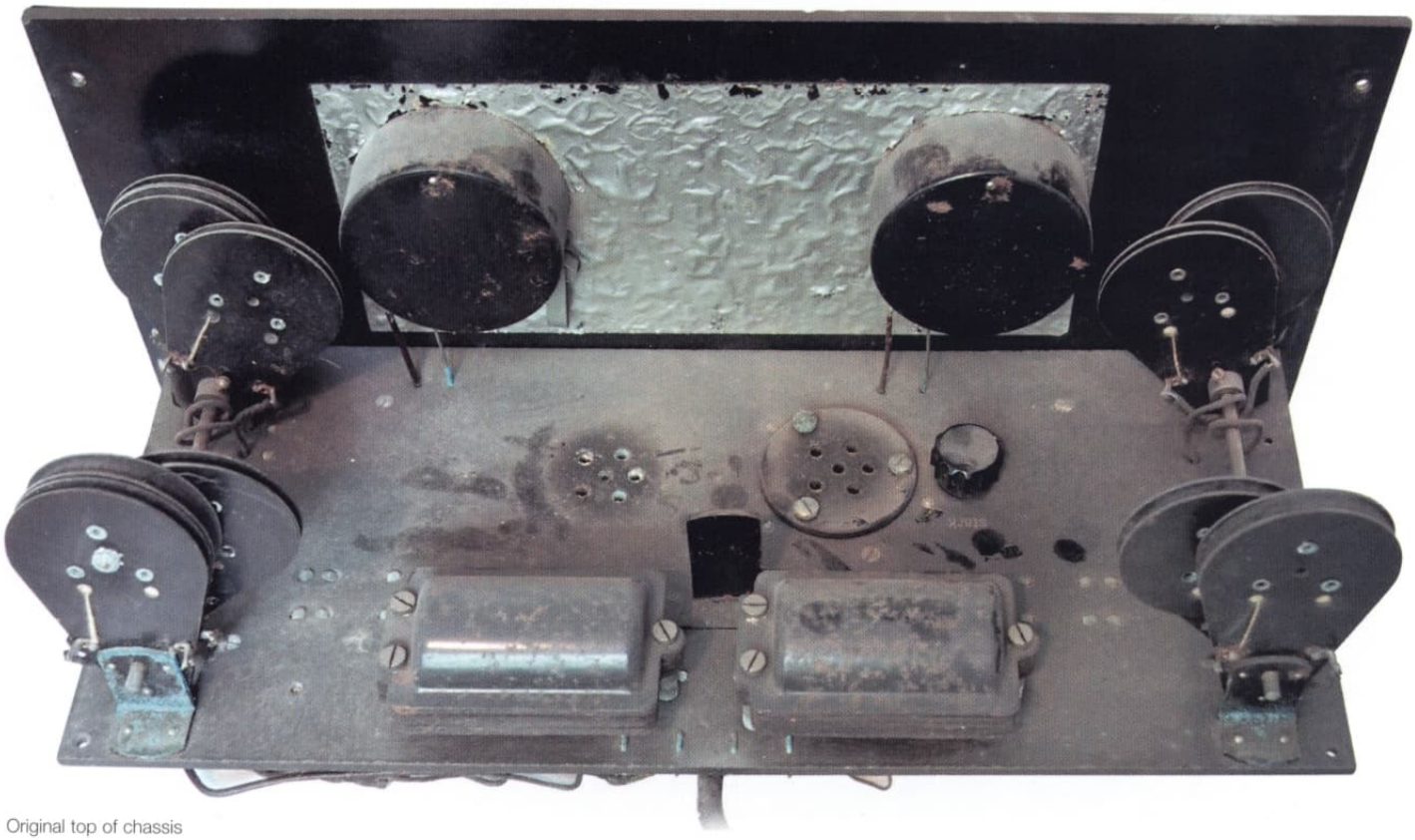
The underside was clean, although with some rust on several ferrous parts, particularly the brackets between the ebonite baseplate and the front panel and the base of the filament rheostat. Many of the two-hole solder tags were also rusty.

First investigations

The circuit diagram for the Lumophon, Bruckner and Stark Standard D2 essentially agreed with this set except for the use of equivalents for the HZ420 and NZ420 and the inclusion of a 4.5V bulb across the filament supply. One triode of the HZ420 is an RF amplifier with a tuned grid circuit, with provision for the aerial to connect directly to the grid or via swinging coils, with separate windings for medium and long waves. Untuned coils couple the signal from the anode to the tuned grid of the second triode of the HZ420, which



Original underside of chassis



Original top of chassis

acts as a leaky grid detector. Feedback is controlled by swinging coils and a rheostat in the valve's filament circuit. The NZ420 is arranged as a straightforward two-stage, transformer coupled AF amplifier. The set is therefore a two valve 1-V-2 TRF.

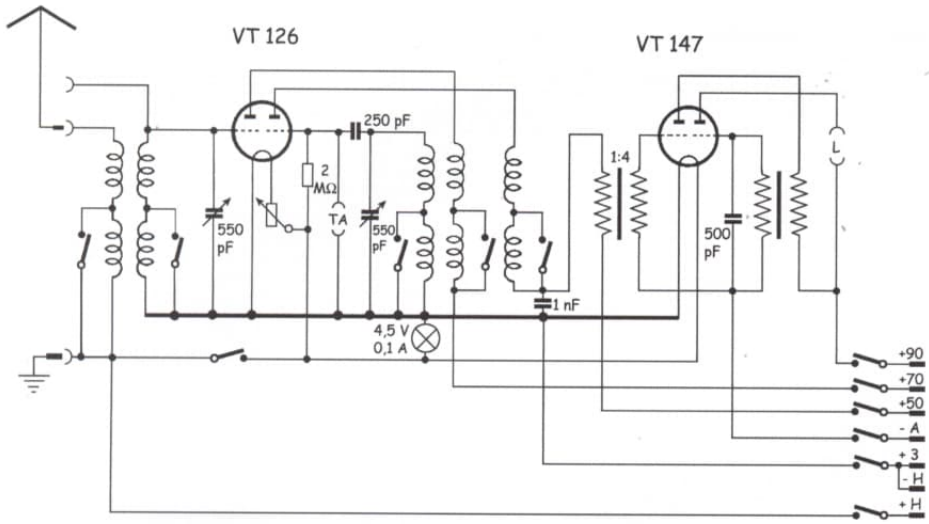
My first tests were on the two valves, the HZ420 and NZ420 double triodes. If these valves were not working, I needed to be on the lookout for them as soon as possible. Thankfully, when tested on my home-built valve tester, both sections of the HZ420 RF and detector valve were fine, with excellent emission. Both sections of the NZ420 were also working, although the emission was half that expected. These tests confirmed that a grid bias voltage of 3V would be appropriate, at an anode voltage of 90V, for the audio double triode to be operating in a reasonably linear region. These two precious valves were put away in a drawer with plenty of bubble wrap while the next stage of the investigation was underway.

The on-off switch

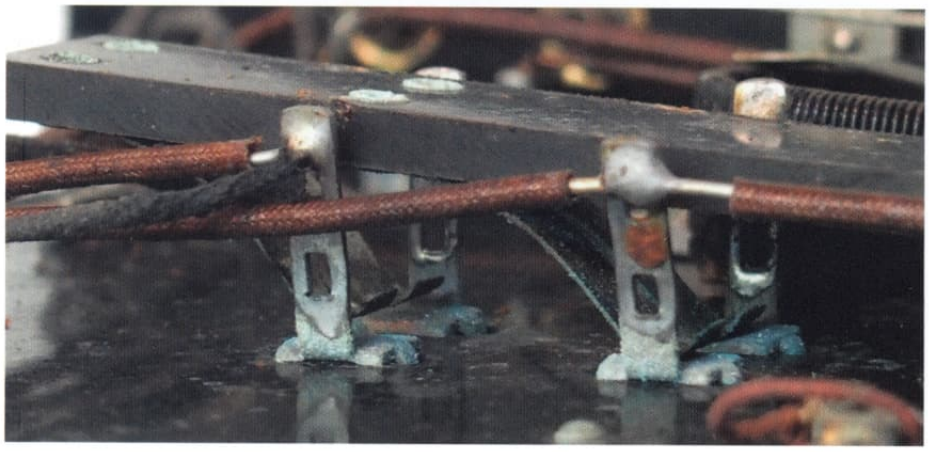
The open-frame toggle switch was not working. The mechanical action seemed adequate, but the switch was not quite closing and the contacts were rather dirty. As parts of the body were rusty the switch was removed for cleaning. As in all dismantling, written notes and small diagrams were made for reference, especially, as in this case, the switch had to be dismantled. What was a little curious was that the rust was not just confined to the exposed parts of the switch, but was also present on the face tight up against the back of the front panel. A curiosity at the time, it was not until later than a possible reason became clear. It is likely that there was a dolly of some material affixed to the metal activating bar of the switch, but it is missing.

The audio frequency transformers

Resistance checks showed that the secondary of the first AF transformer was open circuit. This solved the puzzle of two components in the set that were not present on the Standard D2 circuit. These were not connected in a professional manner, a



The switch-bar



Switch-bar detail

silver mica capacitor and a tubular resistor with screw terminals at each end, with one end wrapped in old-fashioned black tape. They have the look of late 1920s or early 1930s components. It appears as if, at some time during the set's early working life, when the first AF transformer secondary went open circuit, the set was inexpensively "repaired" by converting the coupling between the detector and first audio stage from transformer to choke (the primary of the transformer) and a capacitor and resistor. It was now obvious that this set would not be simple to repair properly.

The second AF transformer also had an open circuit winding, in this case the primary. However, with one intact winding on each transformer I could measure the resistance of each winding: primary 580Ω secondary 6800Ω. Both transformers were removed from the baseplate, the intention being to see if the other parts of the set were working by temporarily using clip leads to two good AF transformers from the spares box.

Inspired by articles on coil winding machines in recent issues of the Bulletin I took on the task of rewinding the two AF transformers. The outer metal shrouds were easy to remove, exposing the bobbin. The protective outer layers of paper were removed by cutting with a scalpel, then peeling back carefully; the paper being quite brittle with age. My intention was to reuse this paper, especially as it was marked "B S N", surely for Bruckner and Stark, Nürnberg (the maker of the Standard D2). The wire on the bobbin was removed by cutting with a scalpel, retaining the original lead-out wires.

From the length and depth dimensions of the bobbin winding space, and choosing to use wire no finer than readily available 0.1mm enamel, accounting for the enamel thickness as 10% of the wire diameter, and allowing a 15% addition on this wire diameter for random winding, I calculated that for the 1:4 ratio the primary would be 5,000 turns and the secondary 20,000 turns. The calculation of turns in the space available worked out well. However, the DC resistances of the primary and secondary (606Ωand 3630Ω) were somewhat different to the original (580Ω and 6800Ω). Perhaps the secondary winding of the original was wound with finer wire than the primary?

The radio frequency coils

Another fault showing up after testing with a multi-meter was that the rear section of the (fixed) right hand rear RF coil was open circuit. Repair was straightforward. The turns of cotton thread wound over the wire were unwound, the wire to the open circuit coil unsoldered from the cheek contact, and then unwound onto a temporary storage reel to minimise kinking. Fortunately, the break was found after some 40 turns had been taken off. The original wire was reconnected, rewound, and new cotton thread overwound.

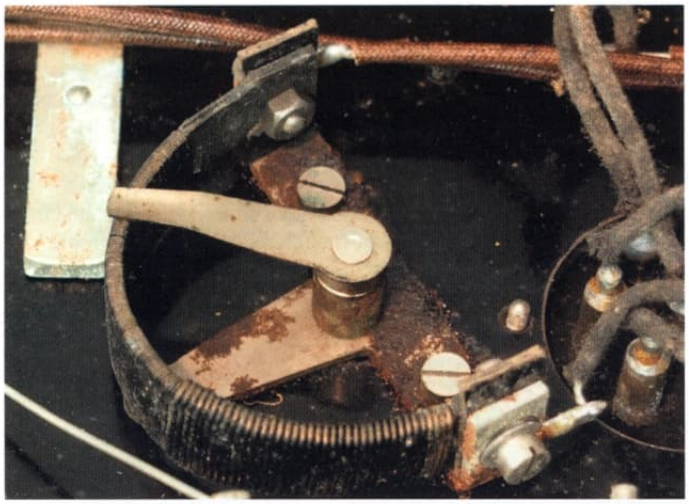
The wave change switch

A trickier problem was the wave-change switch. This comprises an ebonite strip, with five riveted pairs of contact fingers, which, in the medium wave position, are meant to make contact with pads inserted into the ebonite baseplate. In the long wave position, all the contacts are open. Near the centre of the strip, a vertical actuating bar passes through a rectangular slot in the baseplate, with an escutcheon to show long and medium wave positions, and a very small retaining split pin. On the underside, two square "U" brackets, just to the left of centre and at the extreme right, hold the switch strip in place, each bracket being fitted with a roller on a spindle, the spring pressure being provided by the contact fingers.

In fact there were four problems:

- The ebonite strip was far from straight; it had taken up an "S" shape dictated by the two brackets and the actuator.
- Because of the shape of the contact strip, the left-most contact set was not able to connect with the appropriate baseplate contacts (see close-up image).
- The finger contacts and the baseplate contacts were corroded
- The actuator could not be moved at all. It was completely jammed.

Having dismantled the wave-change switch, the corroded actuating lever was cleaned, as was the slot through which it passed. The bent ebonite bar with the switch contacts was placed in boiling water, rapidly removed, and clamped against a wooden batten with "G" clamps. Ebonite softens at ~80°C, and this procedure did succeed, at least partially; when later refitted the bar did take up some of its old bend. In truth, some bending is inevitable given the arrangement of how the bar is constrained at three points. The switch contacts on the bar were cleaned with 800 grade wet and dry abrasive, then with contact cleaner, as were the more badly corroded contacts on the baseplate.



Filament rheostat

Filament rheostat

Not necessarily a problem, but certainly needing attention, was the filament rheostat for the first valve's filament. The resistance element itself was intact. Interestingly it is in two sections, the first, spanning a little less than 90°, is of heavy gauge wire, with a total resistance of 1Ω, the remainder, of smaller gauge wire, is about 16Ω. The mounting plate was very rusty, and the contact plates were also corroded. It was removed and cleaned.

Mica fixed capacitors

Two out of the three mica disc capacitors were fine, with <100nA leakage at 90V and capacity within 10%. The third, the 1000cm HT decoupler between the RF coil and the AF transformer to ground at the detector anode, measured about 300pF (note 1000cm=1100pF). A miniature 100V 1000pF polyester capacitor was fitted across and under the original, this is not visible except on close inspection.

Disassembly and the probable cause of the corrosion

Further disassembly was generally simple and trouble-free, although several of the screw threads were so badly corroded that they had to be drilled out. When the three circular mica capacitors were unscrewed from the baseplate, extensive corrosion on their undersides became obvious. This was unexpected, given the almost pristine condition of their exposed surfaces. Taken together with the corrosion on the bottom of many of the solder tags, and other metal parts that were in contact with the ebonite baseplate, including the tinned copper wire, I looked further into what might be the cause.

A plausible explanation is that some of the sulphur within the ebonite, in the presence of moisture, was oxidised to sulphurous or sulphuric acid, leading to corrosion of parts containing iron, and the formation of copper sulphate (and not verdigris as first thought) once the tinned copper wire had lost its protective tin coating. This could explain why the wave-change switch was impossible to move, passing through a slot in the ebonite baseplate exposed the actuating lever to attack. All of these parts were cleaned using abrasives, a sonic bath, a rust-removing gel and Brasso.

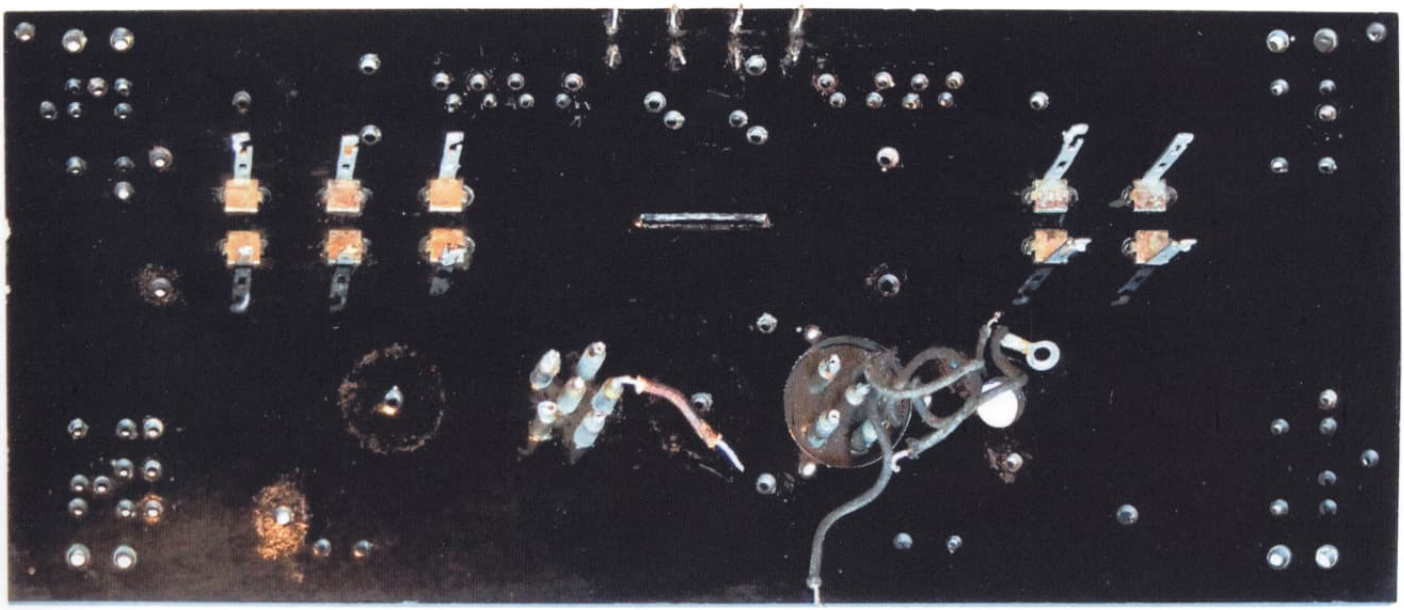
Reassembly and testing

Reassembly was straightforward, making use of the photographs and notes made earlier. The first tests were with only the first valve (HZ420) in place, using two lead acid Cyclon cells for the 4V filament supply and a series string of 9V PP3-size alkaline cells for the (nominal) 45V and 63V HT supplies. A pair of high resistance headphones was temporarily connected to the secondary of the first (rewound) AF transformer, accepting that there would be an impedance mismatch. With an outside aerial of about 15 metres connected, the set worked well on both medium and long wave bands. Reaction using the swinging inductor was smooth, though quite different filament settings were needed on the two bands, necessitating lifting the lid, as this control is inside the set. On long wave, virtually no resistance was needed, whereas about 1Ω needed (the first section of the rheostat, some 90° rotation) to avoid oscillation at the extreme outward end of the coil swing on medium wave. So far so good! Plugging in the NZ420 valve, to test the complete set, it quickly became clear that the 90V HT current, at 15mA, was greater than it should be. Moreover, this current was drawn when the set was switched off. The on-off switch only switches the filament, the very reasonable assumption being that no HT current can be drawn with the filaments off. With the NZ420 valve removed, there was no HT current drawn with the filaments off.

A simple test showed that there was an anode-to-grid short-circuit in the output section of the NZ420, which was not present when the valve characteristics were measured several weeks earlier. The current path was via the loudspeaker (~2kΩ), the anode-grid short, the secondary of the second AF transformer (~3.6kΩ), to ground. Thankfully, the 15mA was just slightly greater than the accepted current-carrying capacity of 0.1mm enamel wire (14mA).

Inverting the valve or tapping the envelope made no difference, the short persisted. I had previously, successfully, restored a 1920s triode with the same symptoms. The method was to pass a short pulse of a high current between anode and grid, on the assumption that the short was down to a whisker of wire. The short pulse came from a 10,000μF capacitor charged to 40V. The "zap" was also successful in this case. The characteristics were rechecked at an HT of 90V and all was well.

The NZ420 was refitted, and nothing. No anode current. All of the valve pins and socket contacts were cleaned, still no anode current. With a sinking heart, back to the valve tester, and the filament was open circuit. The "zap" was nowhere near the filament, and so should not have resulted in damage. Another lesson from previous



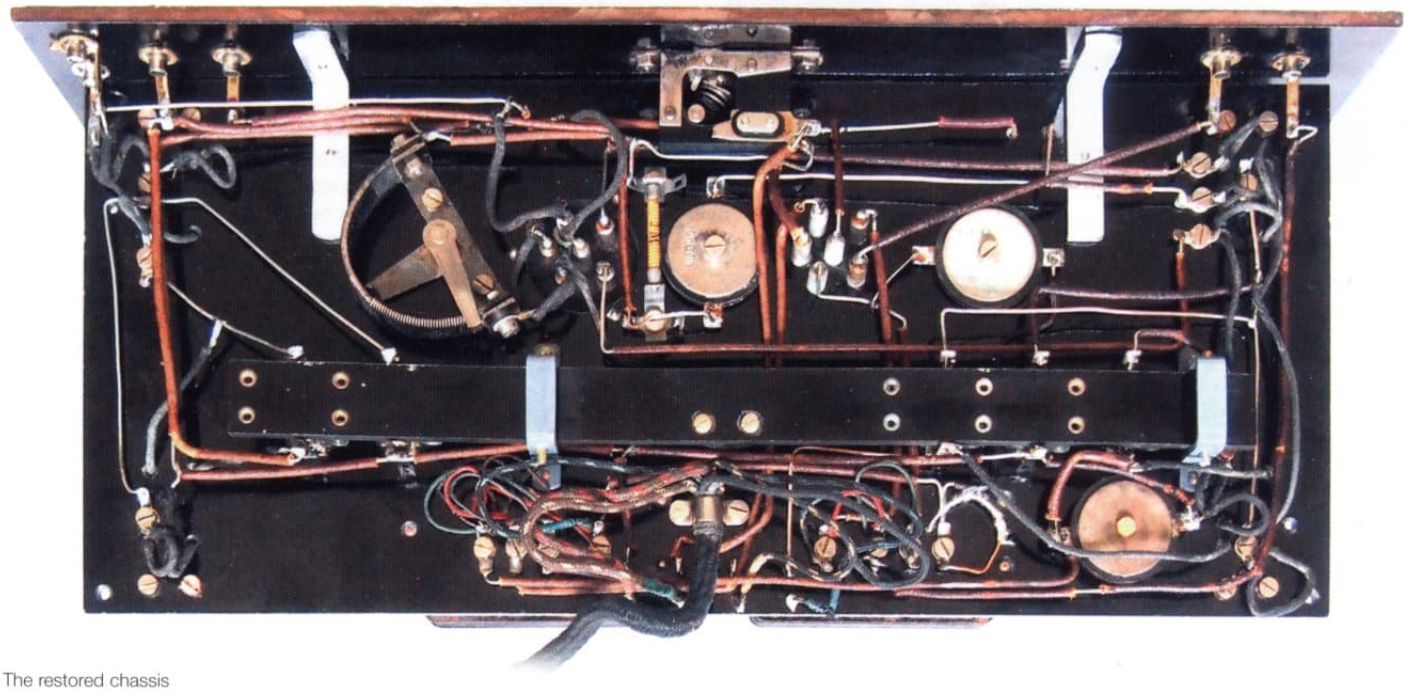
Almost completely stripped base-plate

1920s triodes was to resolder the wires inside the hollow valve contact pins if there was any sign of problems. Thankfully, resoldering the pins worked. The valve has now been trouble-free for a year.

In use

The Heimfunk offers two aerial sockets: A1, which is via the variable coupling coil and A2, which is direct to the first tuned circuit. For A2, the capacity to ground of the aerial is in parallel with the tuning capacitor for the first tuned circuit. Consequently, the highest frequency that can be received is dependent on the aerial capacity. Using my outdoor long wire the highest frequency when directly connected to A2 is 1089kHz, whereas 1600kHz is possible when connected to A1. Careful adjustment of the variable coupling coil is needed when using A1, in conjunction with the reaction variable coupling and the first valve filament rheostat. On a winter evening, with the outdoor aerial connected to A2, medium wave stations from France, Spain, Italy and Romania were heard in addition to UK stations.

This was a very satisfying restoration of an unusual set. Of course, there is more that could be done if I had the right skills.



The restored chassis

A trip down Memory Lane, the final part

by Keith Fishenden

In the Finalé of my previous article, about 'A Beginner's Constructional Course' by Mr E V King', published last year in the BVWS Bulletin; I indicated that there were a number of enhancements that could be carried out by the experimenter. I tried all sorts of modifications to see what affect these would have on the performance of the set, in keeping with the original spirit of Mr King's design.

The changes I made to the HF and Anode Bend Detector stages we interesting but did not actually result in more gain or sensitivity. The ability to bring the set to a peak of gain just before oscillation by adjusting the reaction control R2 of the HF stage, could not be improved. You would have to add in another RF amplifier to actually realise an improvement. The ATU that I designed for the wireless in 'Project of a Lifetime' Sequel, did improve sensitivity, but that is because the aperiodic function of the aerial coils is altered to become a tuned input, or bandpass filter. That is the good bit, the downside is that tuning across the waveband is prevented by the attenuation of any frequencies above or below the narrow pass part of the filter (no good for a schoolboy with his first wireless!) The gain and selectivity of the current design of detector, could be altered by adjusting the value of R7 which biases the screen grid of the Anode Bend Detector. The optimum value in this set for R7 was 680kΩ, whereas the value in the original design was 1MΩ. This would undoubtably be different in other similar sets by dint of component and valve tolerances.

What I did try and ended up with, was a 6SN7 cascode (low noise) audio preamplifier and a 6V6 main amplifier output stage with simple top cut tone control from R14 and C18. The volume control was provided by R13 that controls the voltage input into the grid of the first 6SN7 cascode triode. A cascode like this can provide a lot of amplification, like 30dB, when decoupling with C19 is included. The input and output impedances are high, it is inverting, but without significant phase shift between the two triodes, so amplification is inherently stable. When there is no decoupling, there is inherent Negative Feedback. The whole amplifier in this wireless circuit, has a very effective Negative Feedback loop from the tap A of the output transformer secondary to the cathode bias R12 of the first cascode triode, which improves fidelity. The tongue in check bit, is the use of the number 2 tapping on the output transformer to provide an ultra-linear type voltage input to the screen grid of the 6V6. The winding ratios of the output transformer are nowhere near what they should be to enable ultra-linear operation, but the number 2 tap in series with 100Ω did have an effect on the bass balance of the audio sound. Well it sounded better to me anyway! Because at my age I cannot hear much of the high end or the audio range. Pentode valve output stages have a tendency to emphasise the high end of the audio range at the expense of the low frequency end, so the usual compensation network of C23 and R22 is used to give a flatter audio response.

On the circuit diagram of the finished wireless, the original numbering is used for the components as per the circuit diagram published in 1958. I carried on with numbering from where the original parts list ended.

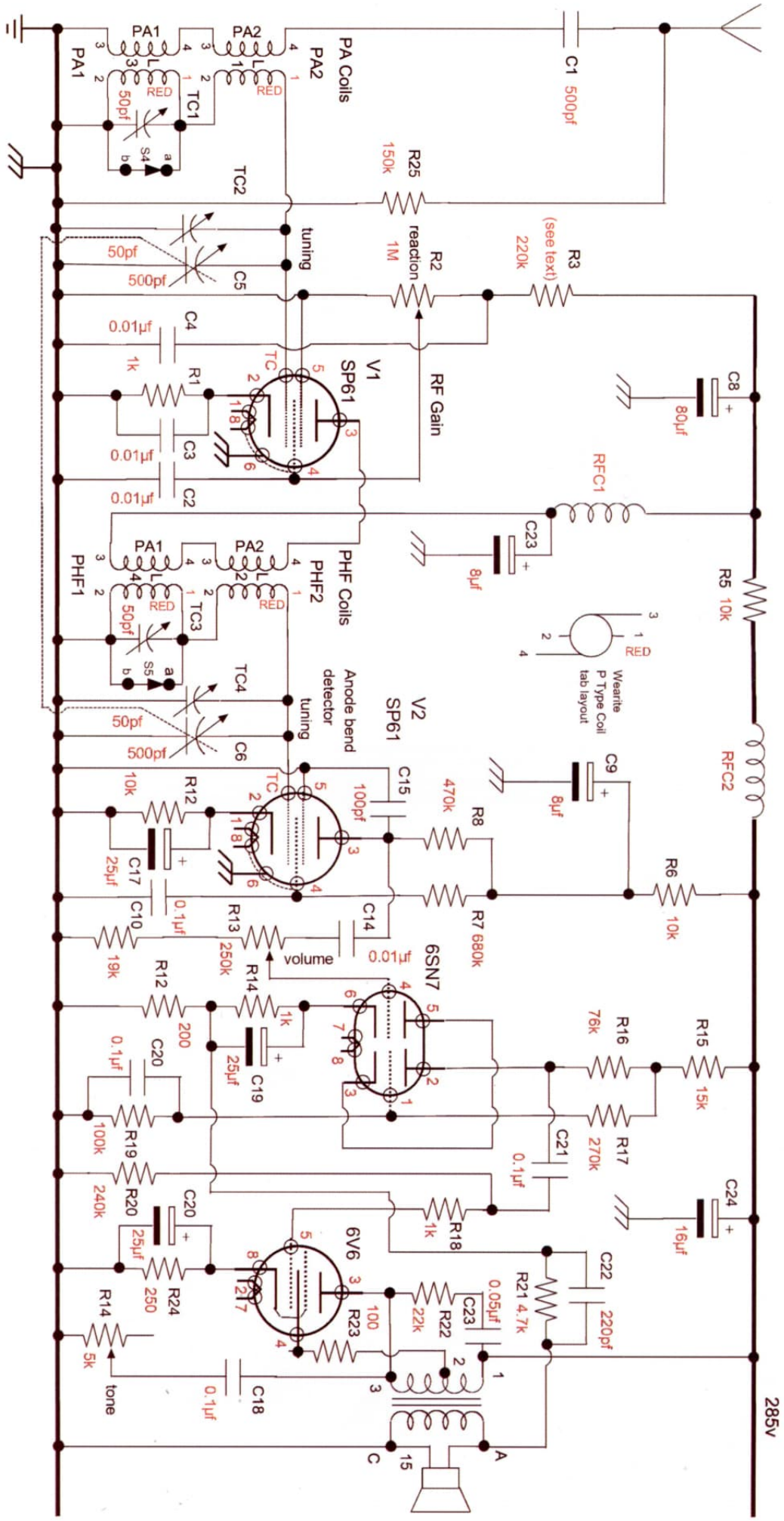
If anyone wishes to use my design,

which is freely given to anybody who would like to try it, I would just point out that the power rating of resistors and voltage working of capacitors must be correct for their application.

Please note that I do not claim that this amplifier has any particular linearity and fidelity performance. It would be interesting to put it through an audio sweep frequency test to graph the results. I don't have an electronics development laboratory at home to do this.

In my researches to enable me to try different modifications for this set, I came across a few ideas that I could try in my previous design, 'Project of a Lifetime' that should be fun. More about this coming adventure, perhaps early in the New Year.

If you decide to build this wireless, you will not be disappointed. Happy Days.



The Murphy A98 from 1945 by Gary Tempest

What to do on a dark wet winter's afternoon? It would be an idea to clean some of the radio collection and go through them finishing off things that still needed doing even after previous work.

This Murphy, when lifted onto the bench, was an odd one as I restored it back in 2004 and did little with it. The styling is not to everyone's taste and I'm not sure it is to mine but my wife likes it. It is certainly not as pretty as the SAD 94S (unfortunate nomenclature) but to me is a better radio having a mains transformer and not being AC/DC. But I have looked at it over the years, trying to convince myself, and one thing is certain that it's very tactile. There are curves everywhere which are pleasant to the touch. Made of super thick and strong Bakelite it has no chips or cracks and a great shine, not a trace of rust and only a little corrosion on a few brackets that I obviously treated and spray painted. The dial is excellent and even the grill cloth is original. Looking at other models, and on the Radiomuseum, Murphy used a variety of grille cloths; what they had I suppose with post WW2 shortages. It must be one of the best examples around and I probably paid over the odds for it but to me now that's always worth it. I have done my share of rust buckets and 'dogs' but whilst learning a lot the result is never as good as starting with an exceptional original. Why did a compulsive writer like me not do an article on it? I can only think that I thought it was nothing special, being by now a standard circuit 5 valve Long, Medium and Short wave Superhet. But looked at afresh, after taking the chassis out, I was once again struck by just how well it was made and this alone seemed to justify a few words and some pictures but it actually turned out more interesting than this and so a longer article.

What's inside a very big and heavy cabinet?
There is a large and deep chassis of some four inches. This, along with a vertical tag panel for most of the passive components makes working on it very difficult. Unfortunately I don't have a picture of the chassis as it was but remember that the panel was crowded out with large Hunts dirty wax covered capacitors. Back then, and for this set, I didn't 're–stuff' and simply soldered in new yellow poly. items which was best as they comfortably fitted the panel and made rewiring easier. I say simply but it wasn't really as I removed and cleaned the tag panel and rebuilt it on the bench before reinstallation. A compelling other reason for doing this was that much of its rubber insulated wiring had crumbling insulation. Looking at my notebook, of the time and the radio now, it confirms that I pretty much stripped the chassis and rebuilt it. In the notebook there are diagrams detailing removing the mains transformer, the tuning gang, the tag panel and much more.

There are new dial cords and a small modification by me (it shows in the chassis top side picture) for that associated with the vernier dial. This has 5 turns of cord around its shaft and the additional small lined bracket must be there to apply pressure to the cord and stop it climbing over the end or turning back on itself and jamming. Most A98 verniers were chain driven, according to the excellent Service Data, so that was probably the makers cure to the problem.

The speaker is quite small being only 6 inches diameter and uses an electromagnet but nicely the makers had provided a plug and socket to the chassis which eases its removal. The Paxolin, of the socket, had tracked over at some time and I sourced a new old stock (NOS) one from Mike Barker.

What else did I do to it?
Looking inside the cabinet, I can see it must have had the speaker housing cleaned and re-sprayed and had a new black muslin bag made for it. In the bottom is a neatly bent aluminium screening plate that can't have been original and was probably, like most of these, a piece of card covered in foil and now very tatty. It's strange, as I have no recollection of making the item.

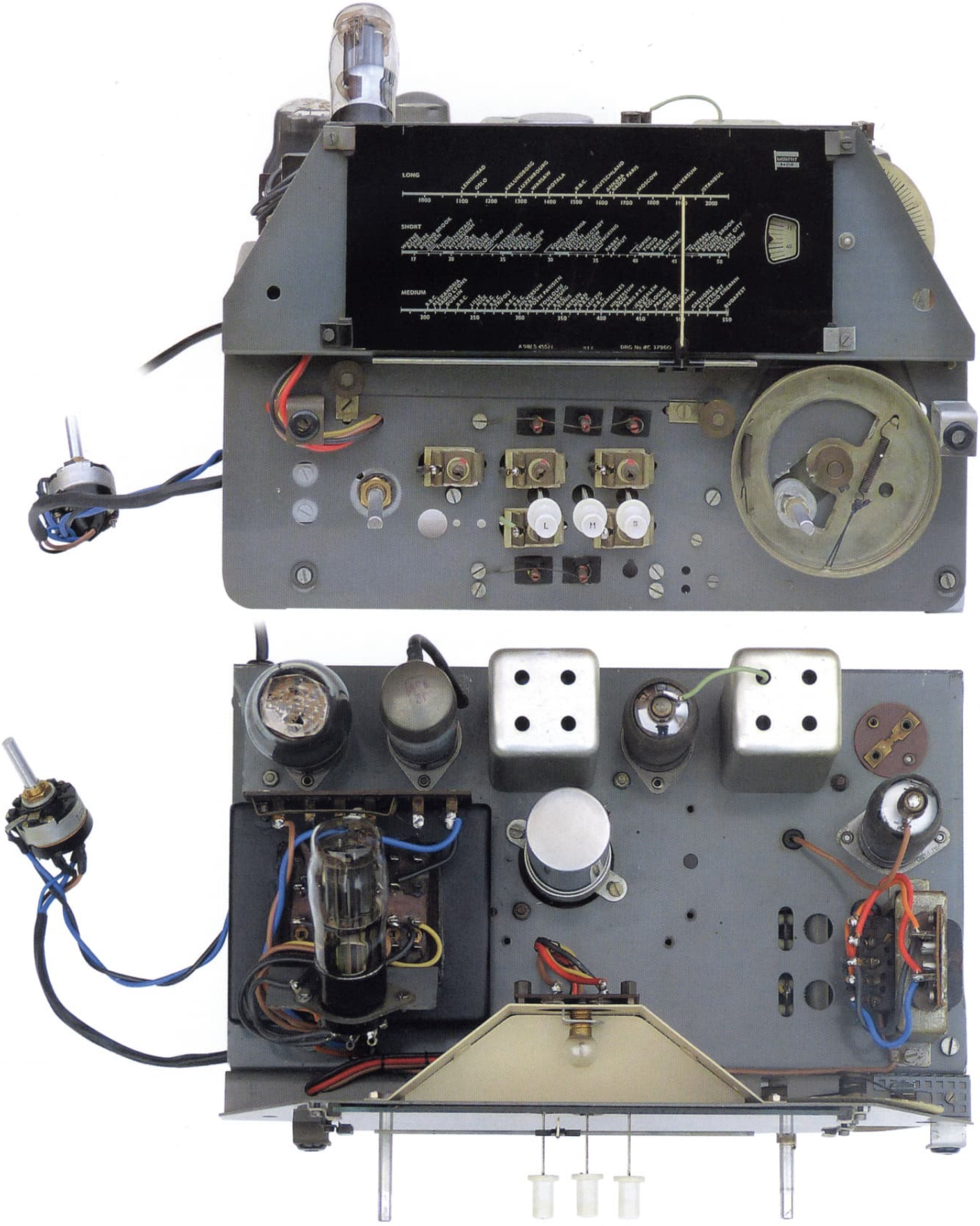
The can of the electrolytic reservoir and smoothing capacitor was cut through where the middle of the clamp is and re-stuffed.

Oh! Yes! I remember taking off the lamp housing for the three bulbs that indicate the waveband in use. This had flaking yellow paint and was stripped and re-sprayed. The wavebands are selected by push buttons and the notes say "... work flawlessly"; now they did need another spray with DeOxit.

Of the resistors a couple were found 50 and 100% high and replaced although looking at it several more were changed possibly because they had to come off when changing capacitors. For the capacitors, the infamous Hunts were mostly down to 2M Ohm at 100V but the audio coupler was a mere 100K.

A full re-alignment was done whether it needed it or not. Note how readily placed all the adjustments are to do this.

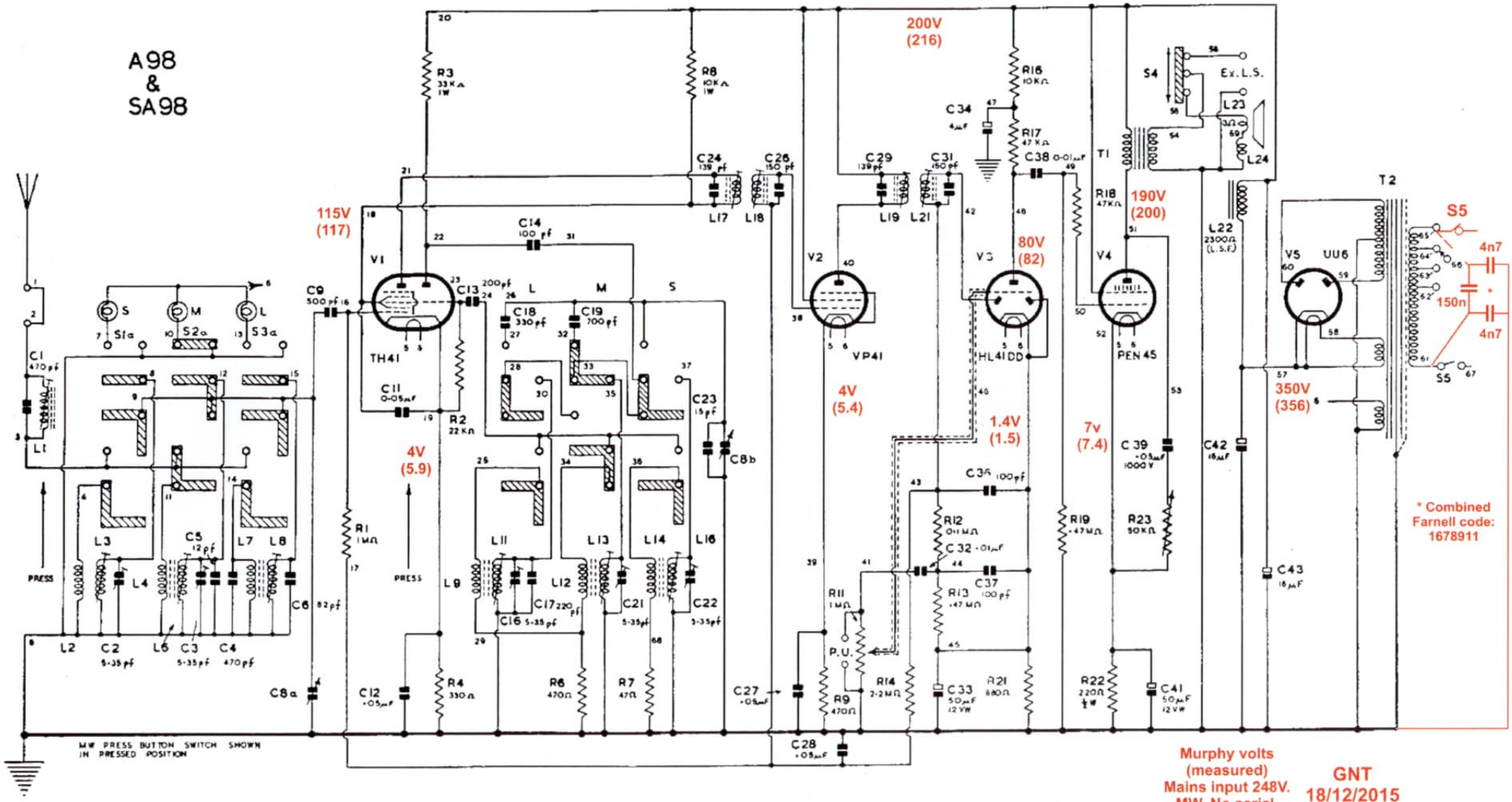
Testing and performance
The only thing I can remember about this was that in the Den, on a 20 ft indoor aerial, it seemed about par for the type of radio.



But in the dining room, for listening at breakfast time, it still had a poor signal to noise ratio on the 50 ft garden aerial and suffered from inter-modulation distortion. It was not good enough when used with my MW valve house transmitter for listening to re-broadcast Classic FM; the choice of the lady of the house. This is not surprising really as most of the radio aerial lead is outside and disappearing into the distance. For radios having a tuned RF stage, with some tone top cut, it is borderline adequate and more so if they have an indoor aerial. So the A98 was rapidly withdrawn to spend the next decade on a shelf.

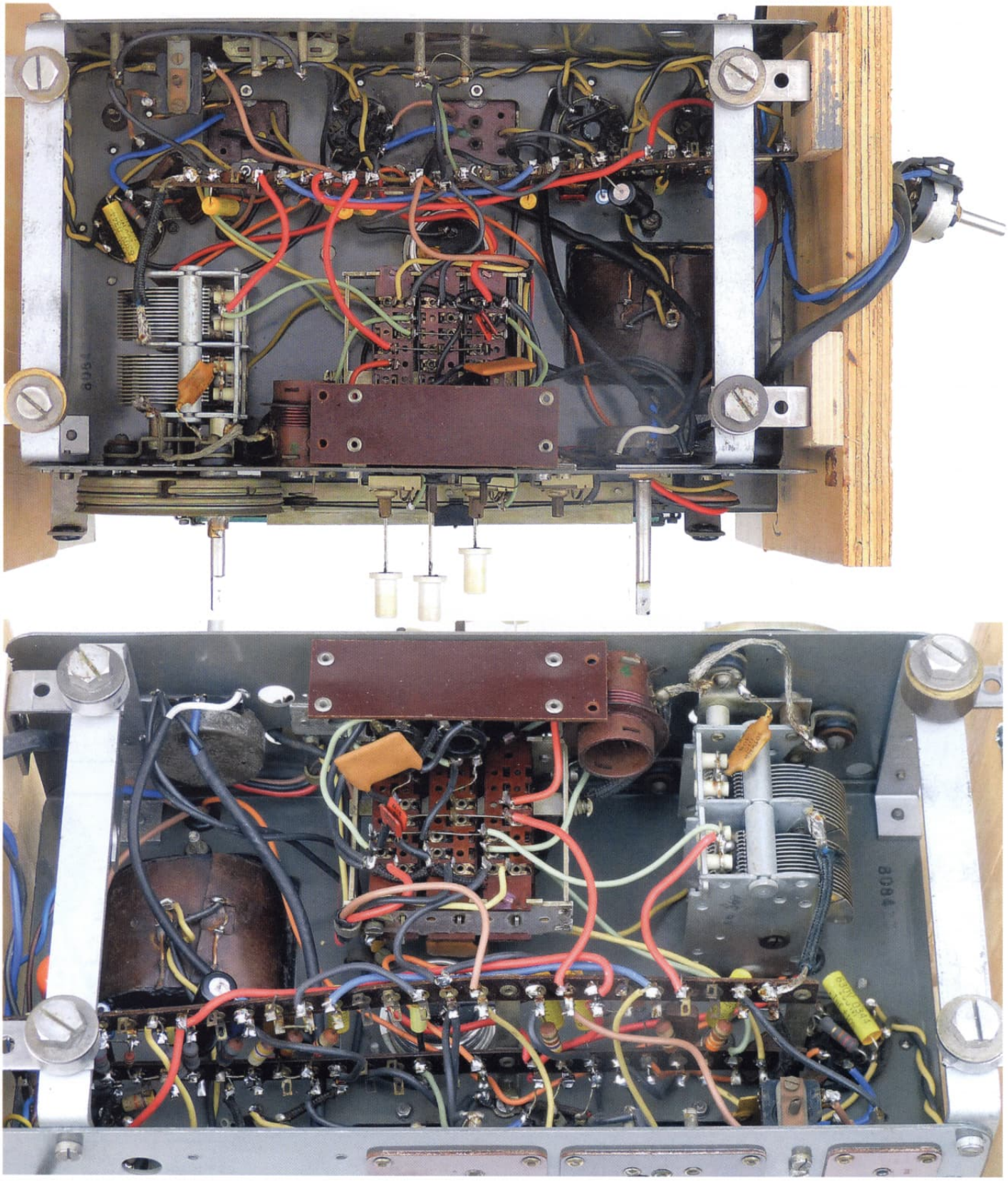
But now, with the chassis out of the cabinet again, I would try fitting a mains inter-modulation capacitor after the mains switch; a new old stock (NOS) 2 pole type combined with the tone control (the old mains cable had also been replaced for a 3 core type giving an earthed chassis). The capacitor I used was a delta configuration type of X2 (150n) and 2 off Y2 (4n7). These

A98 & SA98



RESISTANCE OF COILS

Coils	L1	L2	L6	L7	L8	L9	L11	L12	L13	L17-21	T1 Prim	T1 Sec	T2 Prim	H.T. Sec	T2 Screen
Ohms	3	0·6	1·2	24	13	1·0	2·4	0·9	1·6	6	300	0·15	6 + 10 + 2 + 3	160 + 165	2·5



The tag strip

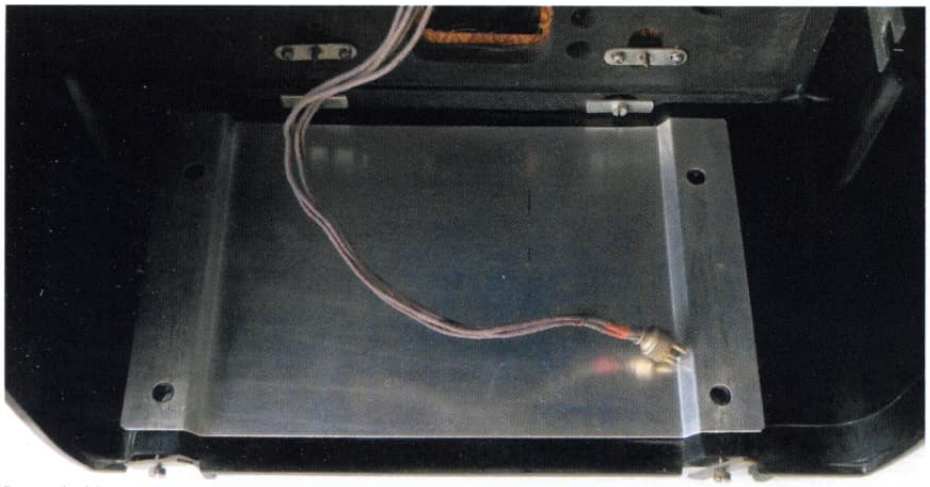
capacitors are good as the 3 leads make them reasonably self supporting with quite long leads. This one could be conveniently mounted on the mains transformer terminals.

The idea behind capacitors effectively decoupling the mains lead is to stop RF or IF picked up from inside the radio being radiated by it and back to the aerial input. They may as well shunt off some interference from the mains supply although these days there is so much of it that it is probably wishful thinking. Some old experts say that these inter-modulation caps are unnecessary the thinking being that there is enough stray capacitance from the mains transformer itself.

I have added the capacitor, Farnell code 1678911, to the circuit diagram. What a pleasure Murphy schematics are to read, even the highly complex A40C, on a sheet of A4 paper, can be easily followed.

Some may think it would have been better to try the radio again before doing the modification. But against this was the possibility of carrying the Murphy down and possibly up again to add it. As with many, well past retirement, my back won't stand the abuse it once would so I try to avoid carrying heavy radios up and down stairs which are the worst. With EMI 10 valve sets I take out the top power chassis before doing this to lighten the load.

I tested all the valves; this had probably been done before but I had no notes of it. Fortunately all were good and so the radio could be tried again and initially it worked and then after a while developed a paralysing



Screen inside

50Hz hum. With the volume at minimum it wasn't present but was still there with the IF amplifier pulled and the volume turned up. It could only be heater to cathode leakage in the AF pre-amplifier, an HL41DD. I put it back in my AVO valve tester and after a nice warm up a tiny leakage could be seen on the "C/H.ins" position (on the 10M Ohm mark) and so small it would be easy to miss. A good test was to increase the heater voltage to 5V and then the meter pointer crept upwards eventually reaching 500K. In stores I had two others, one almost looking like new but that had similar leakage. Fortunately the remaining valve was good with no leakage even with 5V on the heater.

It seemed a shame to have two otherwise perfectly good valves but a fault like this is just as major as say low emission. I did wonder if this was a weakness of this valve but found nothing on the Internet about it. Could the insulation be improved, maybe dislodging whiskers or particles, if I zapped between the heater and cathode? How about a large electrolytic charged to say 500V? I tried it and all that it achieved was to make the leakage worse and down to 150K. Just for fun I opened one valve up and took a picture of the quite conventional tube cathode with the coiled heater inside.

But what about the circuit?

As said there are 3 wavebands with short wave covering from 16.7 to 50 metres. The radio does have two speed tuning and the slow motion drive would have been particularly useful on this band along with a separate vernier scale beside the main dial.

The aerial input is transformer coupled, on all wavebands, to the heptode section of V1. The triode part is used with transformer feedback as the oscillator. Following is an IF amplifier and then a double diode triode with one diode being used for detection and the other AVC. This will have delay due to the voltage developed across the cathode resistor R21. It is applied fully to the heptode grid of V1 and the IF amplifier, which isn't always the case. But there isn't an RF amplifier and so it overloading on local stations is unlikely. Audio is straightforward using the triode section of V3 as a pre-amplifier before the power amplifier V4 which has a simple top cut tone control. It was pointed out to me that Murphy had omitted to fit an RF bypass capacitor to the screen and anode supply. The electrolytic C43 is relied on for this but as it ages it may not be so good at RF. This is apparently a fairly common problem that shows up a tendency towards IF instability. I expect with the modern electrolytic replacement it will be some time before trouble occurs but if I ever take the chassis out again I will add a 0.1 uF bypass.

The power supply uses a full wave rectifier that is indirectly heated giving less HT surge on switch on. It uses the speaker field coil as an effective HT choke for the modestly sized electrolytic capacitors. It seems odd to me that Philips had been using permanent magnet speakers for at least 10 years by this time. But as a friend said to me our makers didn't have Krupps steel then although we can expect that the formula and manufacturing method was soon known as a spoil of war.

Conclusions

I put the chassis up on a stand and re-measured all the pertinent circuit voltages and these were very close to those given in the service data. No doubt this was helped because the set was fitted with a mains transformer having a 250V tap; very forward thinking. Of course after hours of use it runs cool to the touch.

Performance in the Den was about what I would expect, and probably much the same as before: plenty of stations on MW but smothered in interference; LW good with easy to listen to R4 and French stations and lastly SW that was lively with stations but nothing of interest. On MW and LW the performance was better than the only other radio of this period I have a Beethoven U2038, from 1947. This is a short Superhet (double diode pentode output valve and so no separate audio preamplifier) but that shouldn't really make any difference to the RF performance.

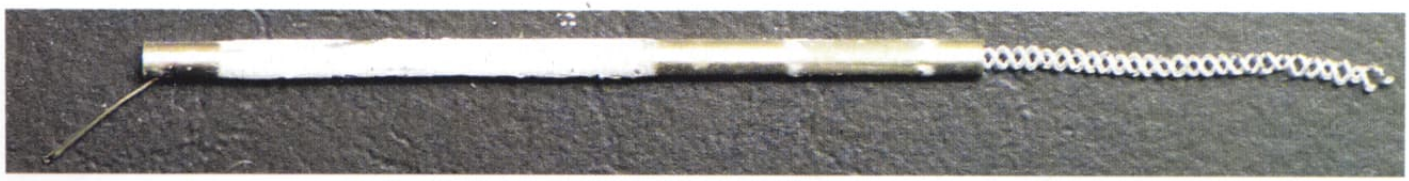
But how did it now work in the dining room on its better aerial and with the MW house transmitter? On a 50 ft garden aerial it was as good as any radio with the same specification but had a somewhat better MW performance compared to the Den aerial, with no sign of inter-modulation distortion. The main problem is the high level of interference on this band and the only major improvement for this is a Wellbrook Magnetic Aerial (they have a website) that I will write something about in a future article.

Classic FM from the MW transmitter was, as expected, no better to listen to than before; it was now time to cheat a little. This used a 12 foot length of coaxial cable from the radio to the cupboard housing the FM tuner and valve transmitter. About 4 inches of the inner was stripped back at both ends and taped to the aerial input lead at the radio and the transmitter aerial at the other; about 5 pF at each end. This made a workable setup with the station clear and above noise. Doing it this way still allowed the radio to be tuned to other stations including R4 on LW which is received with reasonable quality. I used coax as the cable has to run past the TV, its cable receiver, a DVD player and a lamp with a dimmer plus the hoards of mains cable that builds up behind such installations. The outer screen of the cable is connected to the radio earth but with the modern appliances switched off it doesn't make much difference if it is disconnected.

So am I now putting much more signal from the MW transmitter on to the longish garden aerial and broadcasting to the neighbours? It's doubtful as there isn't an over large signal from the transmitter as input to the radio. But does anyone care nowadays even if this was the case? Recently we replaced our car and the salesman demonstrating the features of the new one showed us the complex touch panel radio. "This is the DAB and here is FM and I don't know what LW and MW stand for but they're rubbish and you won't want to use those". "Yes! Right".

The build standard of the radio is very high and there are so many nice touches. For example the speaker connection is long enough to work on the chassis with it connected once one has released it from a sprung clip on the baffle board. Then there is the ribbed removable Bakelite front panel. This is secured with 4 screws that access floating metal plates that give some movement of the panel allowing perfect alignment of the holes for the push buttons.

My final thought is that if Frank Murphy had still been around, (he left the company in 1937 according to an Internet source, he would have said about the radio, "A First Class Job".



HL41DD heater cathode assembly

An Australian Hotpoint Band-Master radio

by Stef Niewiadomski

Although Hotpoint is a well-known brand in the UK for domestic appliances, such as washing machines, irons, and so on, it is not generally seen on radios. Because of this fact I was attracted to a medium wave only radio in a Harpenden auction recently, which was advertised as being an Australian Hotpoint. Seeing that the radio was fairly small, housed in a painted Bakelite cabinet still in a reasonable state, and with an intriguing dial, I decided that I would buy it. A peek into the back revealed a full set of valves and a chassis in good, original condition. There wasn't too much interest in the radio in the auction, and it became mine for a very reasonable fee. I notice that there's a photo of the radio in the winter 2015 issue of The Bulletin: Carl thought it sufficiently unusual to capture it in his small selection of auction lots.

Figure 1: The Hotpoint radio fitted with a new speaker cloth, and with its painted Bakelite cabinet cleaned up.

Australian geography

The radio broadcast network in Australia was, and still is, influenced by one major factor – the sheer size of the country, which needs lots of relatively low power stations to cover the population. Figure 2 is a map of Australia, taken from my Philips' New School Atlas, published in 1956. To show the scale of the area covered, the publishers have inserted a small map of England and Wales, at the same scale as the map of Australia, in the bottom right hand corner: the area of Australia is more than 31 times that of the UK. The distance from the south of Tasmania to the extreme north of the subcontinent is something like 2,300 miles, and from east to west, the country measures about 2,500 miles.

Although the area of Australia is very big, on average the country is very sparsely populated, and most inhabitants live in the narrow coastal strip. More than half the total population of about 23.9 million (a 2015 estimate – in 1948, the year of introduction of my radio, it was about 7.7 million) lives in the five major cities of Sydney, Melbourne, Perth, Adelaide and Brisbane.

The Hotpoint Band-Master G64MEX

Markings on the dial show the radio as a Hotpoint Band-Master (in literature you'll see the name spelt with and without a hyphen: I've spelt it here as it appears on the radio itself), and the rear of the chassis revealed the model number as a G64MEX, and a serial number of C0001531. Band-Master was commonly used for many types of radio, including table models, portables and radiograms, and so is not restricted to the G64MEX.

The Swiss Radiomuseum gives the G64MEX's year of introduction as 1948, and the chassis as being identical to the AWA Radiola 517M, the schematic of which is reproduced in Figure 3. The component values are shown in Figure 4. The schematic is rather American in style, and the valve symbols are shown as you would view the bases from underneath. This is probably more useful to a service engineer (to whom the schematic is targeted, trying to fix a fault), probably measuring the voltages on the pins,

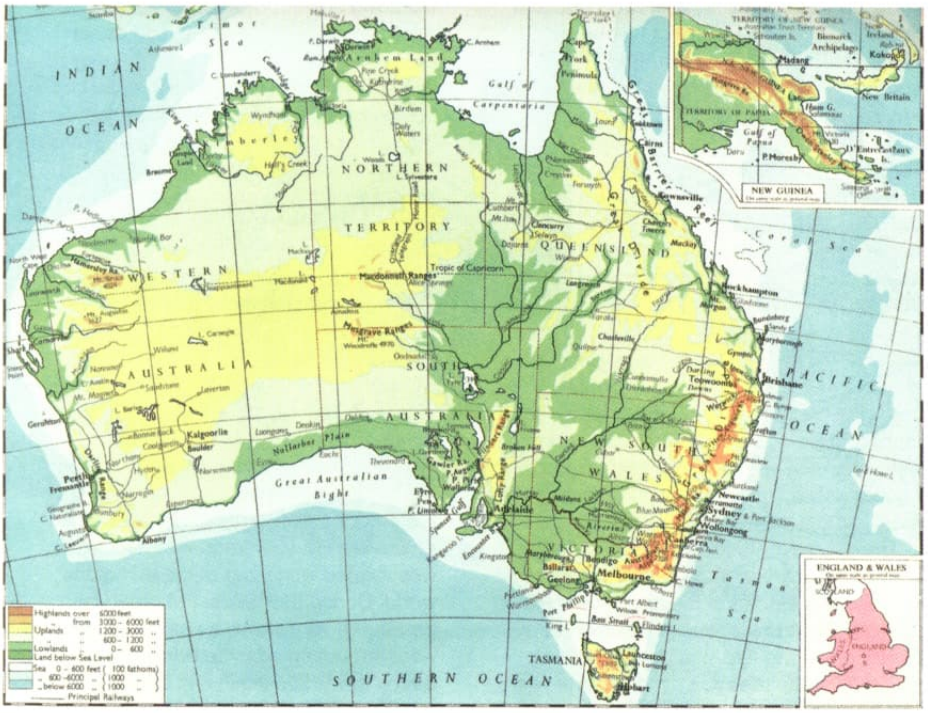


Figure 2: Map of Australia, taken from my Philips' New School Atlas, published in 1956.

rather than to someone who is trying to understand the exact functions in the radio.

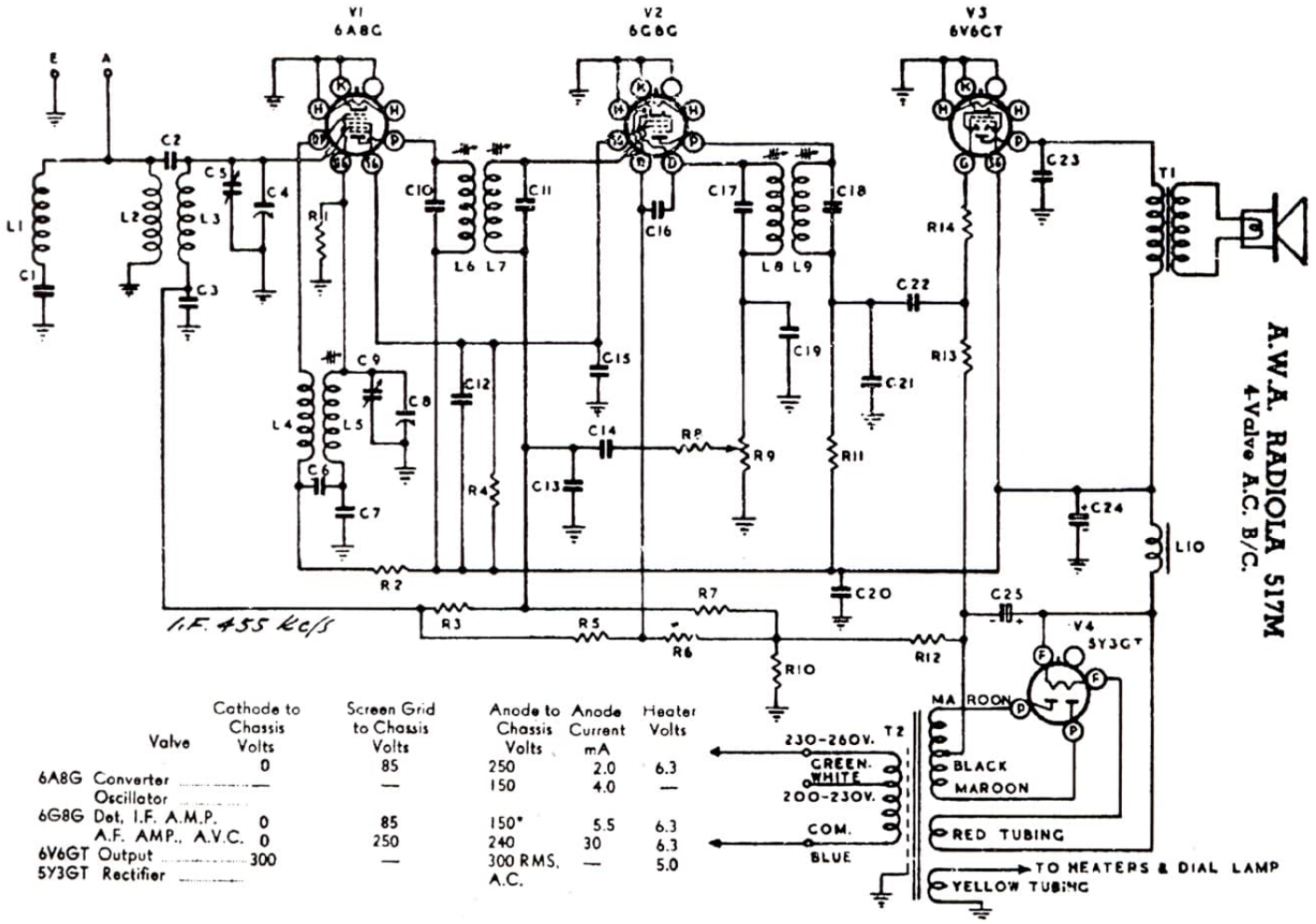
AWA - Amalgamated Wireless Australia Ltd – was based in Sydney and had long roots reaching back to Marconi and Telefunken just before the First World War. It manufactured radios and TVs, as well as the valves, transistors and ICs needed to produce them. It also operated broadcast radio stations, and eventually even had its own TV station.

The Hotpoint brand originates with the company of the same name, which was founded in 1911. The name of the company comes from the hot point of the first electric iron of 1905, invented by the American Earl Richardson who formed the Pacific Electric Heating Company. It was known as the Hotpoint iron, with its hottest point at the front and not the centre. In the 1920s the company became a division of General Electric, but the Hotpoint brand was maintained and applied to more types of electrical appliances. The Hotpoint brand must be one of the longest lived, and more than a hundred years after its invention, it is still used over much of the world.

Photographs of the chassis of the 517M show great similarity to my G64MEX, except that my radio has a two-pole on/off toggle switch mounted on the back of the chassis, whereas the 517M seems to have no on/off switch at all. The mains wiring on my radio looks like it has been replaced relatively recently, but the hole for the switch, and its labelling, look original.

The radio has external aerial and earth terminals, and L1/C1 form a trap at 455kHz in front of the aerial coupling and tuning coils. A 6A8GT is the self-oscillating frequency changer stage, followed by a pentode-dual-diode 6B8G IF amplifier at 455kHz, and audio detection and AVC diodes. The pentode section of this valve is then used again in 'reflex' mode as an audio amplifier stage; a 6V6GT is used as the audio output stage; and finally a 5Y3GT is the full wave mains rectifier. At first sight, by only having three valves in the signal path, the radio appears to be a 'short' superhet but because the 6B8G's pentode is used as both an IF and an AF amplifier stage, it has all the stages expected in a 'full' superhet.

The 455kHz intermediate frequency



Valve		Cathode to Chassis Volts	Screen Grid to Chassis Volts	Anode to Chassis Volts	Anode Current mA	Heater Volts
6A8G	Converter	0	85	250	2.0	6.3
	Oscillator	—	—	150	4.0	—
6G8G	Det, I.F. A.M.P.	0	85	150*	5.5	6.3
	A.F. AMP., A.V.C.	0	250	240	30	6.3
6V6GT	Output	300	—	300 RMS. A.C.	—	5.0
5Y3GT	Rectifier					

Figure 3: Schematic of the AWA Radiola 517M chassis, identical to my Hotpoint G64MEX.

shows a strong US influence, as you also find in Japanese radios. The 6B8G is shown as a 6G8G on the schematic: the 6G8G seems to be a rare valve, and data on it is hard to find, except that the 6B8G is an acceptable substitute. The valves in my radio were an eclectic mix manufactured in the UK (the 6A8GT and 6B8G, both made by Brimar), the USA (the 6V6GT, made by Sylvania) and Australia (the 5Y3GT, made by Radiotron).

The total 6.3V heater plus dial lamp current works out at 1.3A, and the directly-heated filament/cathode of the 5Y3GT takes 2A at 5V, supplied from its own winding on the mains transformer.

The dial

The colourful dial of the radio can be seen in the front view of the chassis shown in Figure 5. As you can see, no station names are used: station callsigns are printed at various sizes in white, green and yellow. These are a little evocative of the early days of radio in the UK when 2MT, 2LO, 2ZY, etc. identified broadcast stations. The green markings may not show up too well in the photo. Counting the number of callsigns on the dial gave me a total of 124 (give or take one or two).

A full list of the callsigns marked on the dial is shown in Figure 6. By checking Reference 1, I have identified the locations of most of the stations, and some of these are shown in the table. The callsigns are all formatted as a number-plus-two-letters, the number indicating the Australian state in which the station is located. For example, 1 (and some beginning with 2) stands for the Australian Capital Territory (which doesn't show up well on maps, as it is an enclave enclosing the capital city of Canberra, within the state of New South Wales); 2 stands for New South Wales, outside of the Australian Capital Territory; 3 stands for Victoria; and so on up to 8 for the Northern Territory. [For those of you with an interest in New Zealand, a similar callsign system used to be used there, but it has now been largely replaced by station names].

The prominent white callsigns (2SM, 2CH, 2UW, etc) in the upper segment of the dial are all located in the Sydney area, which is Australia's most populated city. In the lower segment, the white callsigns (3AR, 3LO, 3UZ, etc.) are all stations located in Melbourne (the second most populated city) in Victoria State. I guess these two cities were where most radio sets were likely to be sold.

The centre of the dial pointer is moulded with the stylised initials of 'AGE', standing for Australian General Electric. Australian General Electric Ltd was jointly owned by General Electric (USA) and Associated Electrical Industries (UK). In the early years, radios sold by AGE were manufactured by AWA and carried the 'Band-master' brand. 'Hotpoint' was used later on, and as you can see on the dial, my radio is branded with a combination of the two names. The company was later known as Australian Electrical Industries.

Figure 7 shows a well-worn label stuck onto the rear of the chassis, explaining in legal language the license granted for the manufacture and domestic use of the radio, and a reminder that a Post Office license was necessary to listen to broadcasts.

No Long wave

Australia is in ITU Region 3, and rather like in the US (Region 2), there was (and still is) no long wave public broadcasting frequency allocation for Australia, hence the lack of long wave coverage on my radio. The band was occupied by navigational beacons and other non-public services. It seems a shame that a few high-power long wave stations weren't built and operated in Australia. They would have coped well with the enormous area having to be covered.

FM broadcasting

FM radio broadcasting in Australia has a strange history: it started in 1947 in the range of 76MHz to 90MHz, but did not catch on and was shut down in 1961 to expand the band used for television broadcasts. FM broadcasting resumed in 1975, when Australia's FM VHF frequency allocation was aligned with most of the rest of the world. During the 1980s, FM broadcasting developed very slowly as many frequencies were still occupied by television transmitters, but by the 1990s these had been reallocated to other bands. During this time many AM stations transferred to FM because of its superior sound quality. Today, as elsewhere in the developed world, much Australian broadcasting is on FM - although AM talk stations are still very popular.

With a few exceptions, FM stations were given a number-plus-three-letters callsign, so for example one of Canberra's AM stations is 2CA, and one of its FM stations is 2JJJ. To show an exception to the rule, ABC's Classic FM station on 102.3MHz is 2ABCFM.

As in most of the world, DAB broadcasting

A.W.A. RADIOLA 517M
4-Valve A.C. B/C.

INDUCTORS.

L1	I.F. Filter Choke (including C1)
L2, L3	Aerial Coil 1600-540 kc/s
L4, L5	Oscillator Coil 1600-540 kc/s
L6, L7	1st I.F. Transformer
L8, L9	2nd I.F. Transformer
L10	Loudspeaker Field Coil, 1000 ohms

RESISTORS.

R1	50,000 ohms ½ watt
R2	20 000 ohms 1 watt
R3	3.2 megohms 1 watt
R4	25,000 ohms 2 watt
R5	1.6 megohms ½ watt
R6	1.6 megohms ½ watt
R7	2.5 megohms ½ watt
R8	0.1 megohm ½ watt
R9	0.5 megohm volume control
R10	56 ohms 1 watt (wire wound)
R11	16,000 ohms 1 watt
R12	250 ohms 3 watt (wire wound)
R13	0.25 megohms ½ watt
R14	50,000 ohms ½ watt

CAPACITORS.

C1	50 uuF mica
C2	4 uuF mica
C3	0.05 uF paper, 200 V working
C4	12-430 uuF Tuning (ganged)
C5	3-25 uuF spiral trimmer (on gang)
C6	0.05 uF paper, 400 V working
C7	420 uuF padder ±2½%
C8	12-430 uuF Tuning (ganged)
C9	3-25 uuF spiral trimmer (on gang)
C10	70 uuF mica
C11	70 uuF mica
C12	0.1 uF paper 400 V working
C13	1000 uuF mica
C14	0.01 uF paper 600 V working
C15	0.1 uF paper 400 V working
C16	50 uuF mica
C17	70 uuF mica
C18	70 uuF mica
C19	200 uuF mica
C20	0.1 uF paper 400 V working
C21	1000 uuF mica
C22	0.01 uF paper 600 V working
C23	0.01 uF paper 600 V working
C24	8 uF 525 P.V. Electro
C25	16 uF 525 P.V. Electro

TRANSFORMERS.

T1	Loudspeaker transformer
T2	Power transformer 50-60 C.P.S.
	Power transformer 40 C.P.S.

Figure 4: Component values used in the Radiola 517M.

Figure 5: Front view of the chassis. The stylised AGE script may just be visible at the centre of the pointer.

is being rolled out and is gaining in popularity. There are currently no plans to switch off analogue radio transmissions in Australia.

Chassis

The two knobs came off easily, and after removing the two fixing screws under the cabinet, the chassis slid out from the cabinet, complete with the speaker and dial. It was generally in good condition, with plenty of dust but no signs of rust. Figure 8 shows a rear view of the chassis. I removed the four valves in turn and checked the continuity of their heaters, all of which were good.

The chassis contains two high voltage electrolytics: C24 (8µF) and C25 (16 µF). I changed both for modern equivalents, leaving C25 in place above the chassis to maintain the original appearance. All the resistors checked out close to their original values, none were discoloured, and they were all left alone. Figure 9 shows an under chassis view of the radio. There was only one obviously waxed paper capacitor: the others were black paint / tar coated components - including the low value silver mica types - and I thought it worthwhile to try the radio first, rather than to go around the chassis changing them all.

The moving coil speaker is 5-inches in diameter and has a field excitation coil which forms part of the smoothing circuit in the power supply. The output transformer is fixed to the top of the speaker assembly. All of this looked to be in good condition, and so I didn't attempt to check this before switching on.

I fitted a 13A plug, with a 1A mains fuse, connected a long wire aerial and switched on - no life at all, not even a glow from the valves or the dial lamp. I turned the chassis over and checked that the mains voltage was getting through to the mains transformer's primary, which it seemed to be, but there was no output from the secondary side. I unplugged from the mains and checked the resistance of the transformer's primary winding, and it was open circuit, which was not a good sign. I removed one of the side covers of the transformer, which was easily accessible from the side of the chassis. The rubber-coated wire which terminated on a solder tag was perished and dangerous, so I unsoldered and removed it. The resistance from the tag to the other side of the primary still measured open circuit, and this threatened to be terminal for the transformer. However, there was another primary tapping, for use with a lower mains voltage of 200V-230V, and this measured OK to the neutral side of the winding. As far as I could see, there was no evidence of overheating of the transformer, so I made the live mains connection to the 200V-230V tapping, replaced the side cover, and switched on.

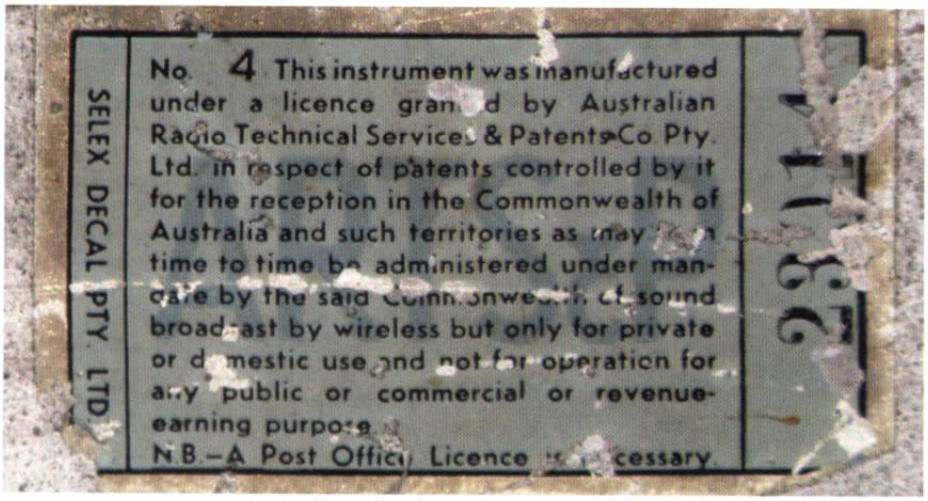
The dial lamp lit up and after ten seconds or so, the radio came to life. The LT voltage was 6.7V – a little high, but not too bad for a radio that will only be used occasionally. Tuning around the medium wave, the radio was lively on my long wire aerial, and I could hear lots of stations at good audio quality. I checked the temperature of the mains transformer: excessive heat would be a sign of shorted turns which could have been the cause of the open circuit of part of the primary. It seemed to be running quite cool, and even after running the radio for a couple of hours, the transformer was still cool. This was a great relief: it would have been difficult to find a replacement transformer, with the correct HT, and 5V and 6.3V heater windings, that would fit into the available space. The chassis is connected to mains earth via the three-core mains cable, and since it does not trip my earth leakage current breaker, it looks like the insulation inside the transformer is still good.

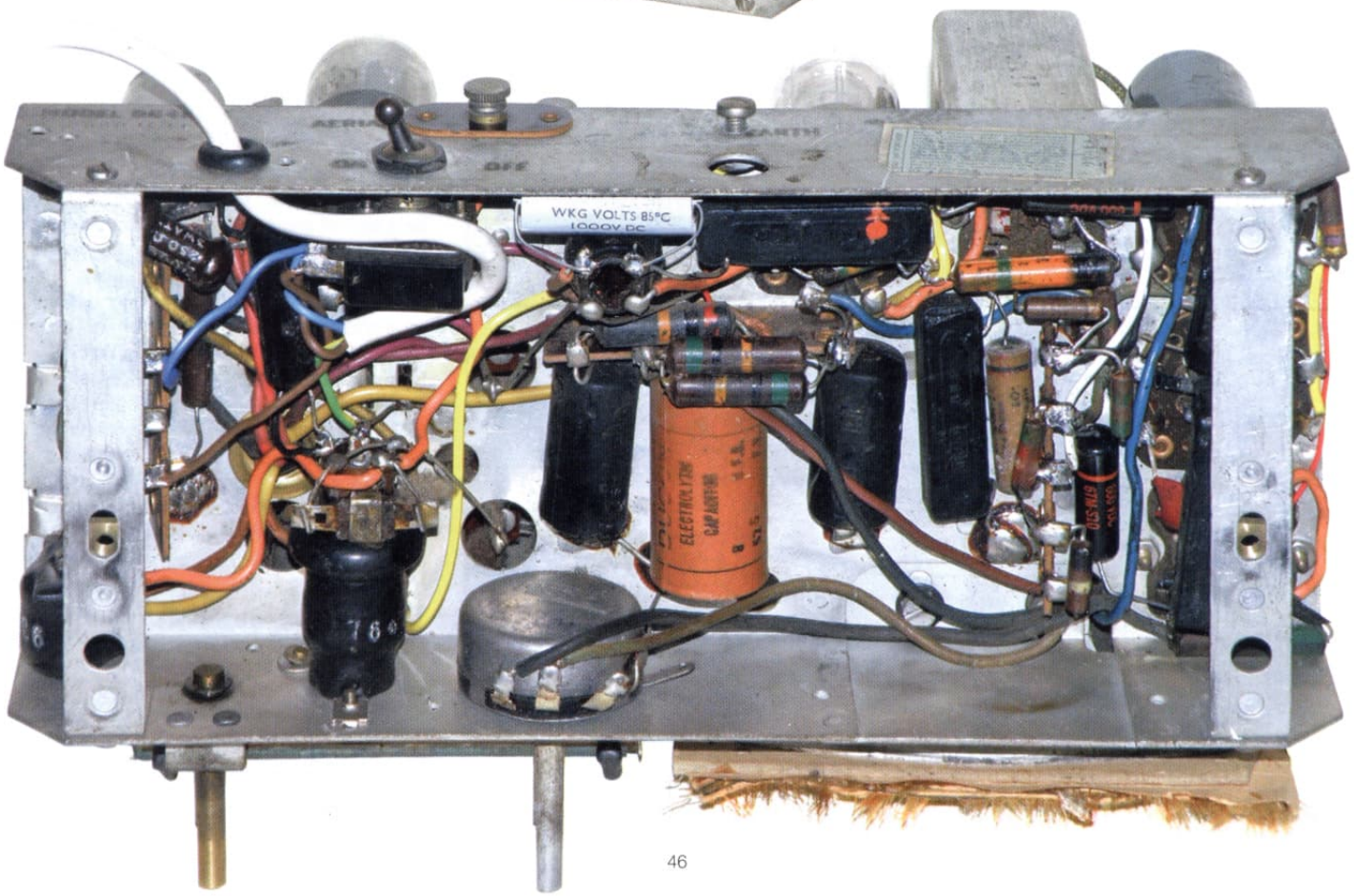
Section of the Dial	Colour	Callsign	State / Station Identity
Top Section	White	2SM 2CH 2UW 2KY 2UE 2GB 2BL 2FC	New South Wales All Sydney stations
	Yellow	2MO 2GN 2PK 2KO 2WL 2MG 2ON 2AY 2BS 2CK 2NA 2BE 2TM 2LF 2NZ 2HD 2NC 2DU 2GF 2WG 2RG 2CA 2KM 2GZ 2XL 2LM 2CY 2KA 2NR 2NU 2BH 2CR	New South Wales eg 2MO=Gunnedah, 2NA=Newcastle
	Green	4BU 4GY 4AK 4LG 4SB 4CA 4AY 4RK 4GR 4QB 4WK 4TO 4QS 4KO 4AT 4QN 4QL 4MK	Queensland eg 4BU=Bunaberg, 4GY=Gympie
	Yellow	4BK 4BC 4QR 4QG	Queensland All Brisbane stations
	Green	5SE 5AU 5PI 5RM 5CK	South Australia eg 5SE=Mount Gambier
	Green	6TZ	Western Australia 6TZ=Bunbury
	Yellow	7LA	Tasmania 7LA=Launceston
Bottom Section	White	3AR 3LO 3UZ 3DB 3KZ 3AW 3XY 3AK	Victoria All Melbourne stations
	Yellow	3GI 3WV 3UL 3BO 3HA 3LK 3CS 3SR 3YB 3BA 3MA 3GL 3SH 3CV	Victoria eg 3GI=Sale, 3WV=Western Victoria
	Green	6WA 6GF 6GN 6AM 6WB 6MD 6KG 6GE 6CI	Western Australia eg 6WA=Wagin, 6GF=Kalgoorie
	Green	7BU 7NT 7AD 7EX 7BU 7DY	Tasmania eg 7BU=Burnie, 7EX=Launceston
	Yellow	7ZL 7HO 7ZR 7HT	Tasmania All Hobart stations
	Green	4VL 4QY 4IP 4QA	Queensland eg 4VL=Charleville, 4QY=Cairns
	Yellow	6WF 6WN 6PR 6PM 6IX 6KY	Western Australia All Perth stations
	Yellow	2LT 2AD	New South Wales 2LT=Lithgow, 2AD=Armidale
	Green	5MU 5DR	South Australia eg 5MU=Murray Bridge

Figure 6: Table showing the station callsigns on the dial, and the Australian states in which they are located.

The cabinet

The 11-inch wide by 7-inch high by 6-inch deep cabinet was painted a light blue onto brown Bakelite, as were the knobs. The paint was rather chipped, especially on the knobs, and the cabinet had a faint crack at the rear of the top (above where the 6V6GT





was located) and I debated a while whether to strip and repaint it. In the end I decided just to give it a good wash, and leave the paint finish honest and 'as found'. However the speaker cloth was frayed and let the side down, and so I changed it for a new one.

The dial cord looked as if it had been changed fairly recently and there were even some fragments of the old one tucked into the nooks and crannies. I could just about see two drive drums behind the dial, and so I carefully removed the dial so I could take a closer look at the arrangement. Figure 10 shows the strange two drum arrangement, driving the dial pointer and the tuning capacitor. The right hand drum has a protruding shaft that passes through a hole in the glass dial, onto which the pointer is mounted using a grub screw, and the left hand drum is mounted on the tuning capacitor's shaft. This allows the tuning capacitor and the dial pointer to be non-concentric, which perhaps was the consequence of an existing chassis design being mounted into a new design of cabinet. I've never seen this before, and it's a clever – though rather complicated – way of offsetting the centres of the dial and tuning capacitor.

The way in which the cord is tensioned is interesting: rather than being via a spring

Figure 7: (top left) The label stuck onto the rear of the chassis, explaining in legal language the license granted for the manufacture and domestic use of the radio.

Figure 8: (left) Rear view of the chassis. The left hand valve is the 5Y3GT rectifier; then comes the 6A8GT frequency changer; next is the 6V6GT; and the 6B8G is located inside the metal screen between the IF transformers. The mains on/off toggle switch can be seen below the aerial socket.

Figure 9: (below left) Under chassis view of the radio.

located inside one of the tuning drums, as you normally find, a spring located close to the tuning shaft tensions the cord by use of a pivoting arm and an idler pulley.

In removing the glass dial, I had also removed the pointer and now had to replace it and set it to the right position on the dial. I looked up the frequency of 2SM (1269kHz), set my signal generator to this frequency, tuned in the radio, and rotated the pointer to point to 2SM at about 11 o'clock on the dial. I then looked up 2FC (576kHz), reset my signal generator, and tried to retune the radio to this frequency, hoping that it would correspond to 2FC at about 2 o'clock on the dial. But the radio tuned up in frequency as I moved towards 2 o'clock, rather than down as I had expected. I tried starting at several points on the dial, and the pointer always moved in the wrong direction as I tried to tune to the second calibration point. I can only assume that the restringing had been carried out wrongly, and one of the drums is strung in the wrong direction. Of course, being an Australian radio, perhaps I could fix this by fitting the dial upside down!

Through the UK Vintage radio Repair and Restoration Forum, Joseph Bogatek – located in Mareeba, North Queensland - very kindly provided me with the service data for the AWA 517-M. This confirmed my suspicion that the 517-M dial cord arrangement is very much simpler than it is on my G64MEX. The 517-M tuning capacitor's shaft and the dial pointer are concentric, and so the offset arrangement of two drums is not needed.

The radio covers the full medium wave from 535kHz to 1650kHz, and so for the time being at least I would leave this alone, and just make my own mental notes of where to find various UK stations on the dial.

Figure 11 shows the chassis mounted back in the cabinet. The dial lamp only illuminates the top segment of the dial, and although it's definitely of the correct rating, I must admit it's not very bright, acting more like an on/off indication than helping the user to see the dial markings.

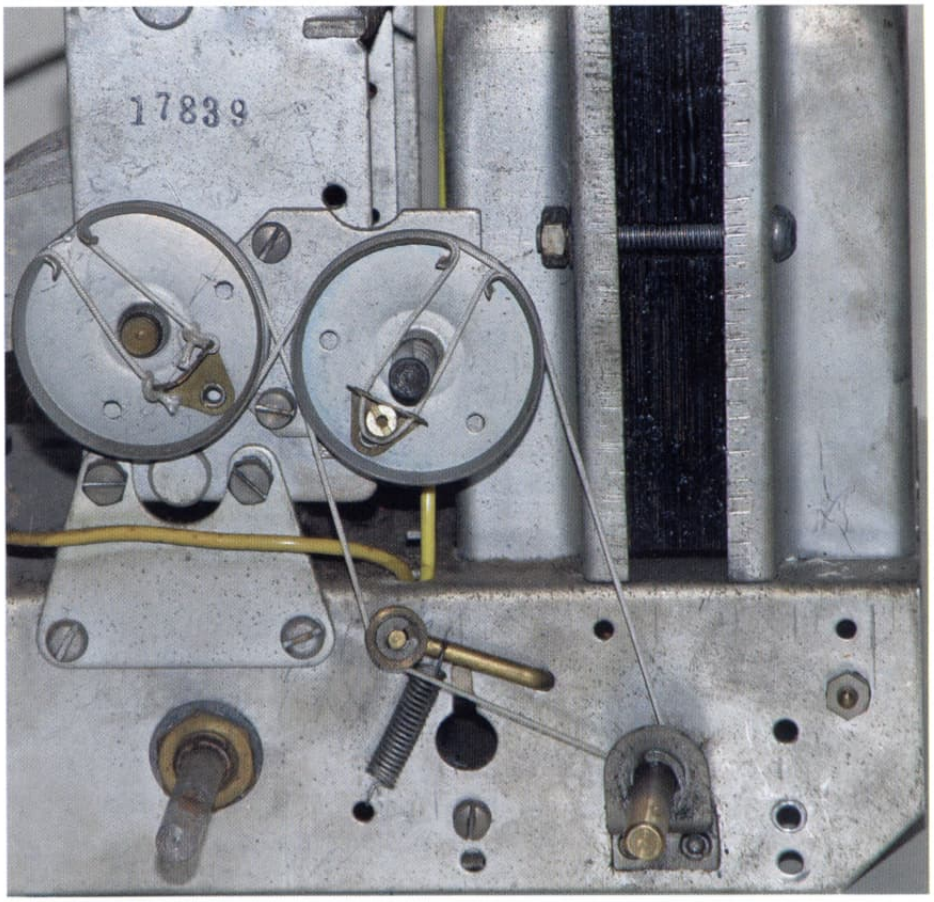


Figure 10: The two drum arrangement, driving the dial pointer and the tuning capacitor. The good-looking mains transformer, with part of its primary winding open circuit, is mounted to the right of the tuning capacitor.

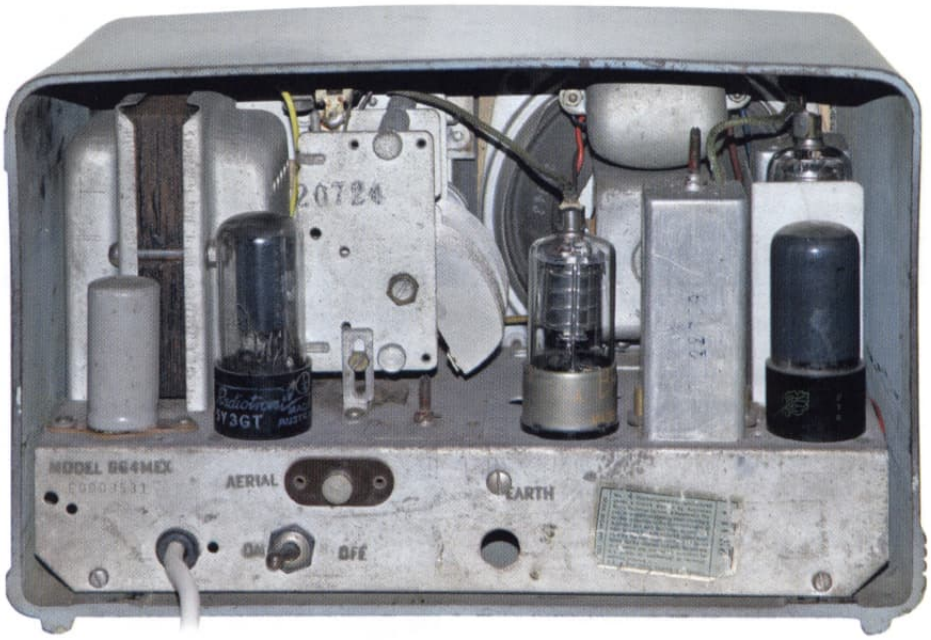


Figure 11: The chassis mounted back in the cabinet. There seem to be no fixing holes in the cabinet for fixing a back panel, so I assume that the radio was never fitted with one.

Conclusions

Although I'm sure that this sort of radio is relatively common in Australia, judging by how infrequently they come up for sale in the UK, I'd say that it's rare over here, and it would be interesting how this particular example found its way here. The colourful dial, full of station callsigns, rather than names, was intriguing and it was good fun to spend a couple of hours on the internet tracking these down. The radio design itself was unusual in that it used a reflexed IF/AF amplifier stage, thereby saving a valve and some cost. Luckily a broken connection inside the mains transformer, which could have made the restoration very difficult, could be bypassed, and the radio brought to life.

Unless some miracle of propagation occurs, I am of course very unlikely to hear an Australian station on my radio. By the wonders of modern technology, I can hear stations via the internet. At the moment I'm listening to ABC's 8AL located in Alice Springs in the Northern Territory (not actually marked on my radio's dial, but receivable of course if you were close enough), which transmits on 783kHz. On a cold December evening in the UK, the chat and pop 8AL is playing Christmas pop classics, and expecting the temperature to rise into the high thirties Celsius.

The radio stimulated some research into the geography of Australia and the history of its broadcast industry. I've also just become the latest listening fan of 8AL in Alice Springs, but sadly not via my Australian Hotpoint radio.

References

Reference 1: Radio callsigns in Australia can be found at: https://en.wikipedia.org/wiki/Call_signs_in_Australia. This list includes callsigns currently in use, and some which appear on the dial of my radio, and are now defunct.

See www.itu.int/en/ITU-R/terrestrial/broadcast/Pages/Bands.aspx for frequency allocations for the three ITU Regions.

You can listen to 8AL in Alice Springs at: http://tunein.com/radio/ABC-Alice-Springs-783-s9441/

Not your average Record Player

The Rowe AMI JAN 200 *Diplomat* Jukebox by Michael Gohl

I have always wanted a jukebox but the hefty price tag that comes with a visible playing machine has always put me off - you don't get much change from £4000! Whilst I was working at a local school some people were remodelling the former youth club and had to take away one of the arcade machines, I had a chat with them and they mentioned that they had jukeboxes for sale at prices starting from £300.

In December I decided to visit them and within a store room at the rear of a plastics factory in Hull were many machines ranging from the 1960's to the 1990's. I was shown two jukeboxes from 1965, one of which I acquired, namely a Rowe Ami model JAN *Diplomat*. It is not a visible–play machine, and can hold 100 seven–inch singles which gives you 200 selections. The machine had a valve amplifier in the rear and was in a sorry state, with wood rot and decay. However, the jukebox looked complete, apart from the white plume at the top of the valves which were obviously broken. We agreed a price and it was delivered to my home address. I then set about locating a service manual which came from the USA, being an American jukebox it runs on 110V but had a 240–110V transformer installed in the base and modifications to the motor for it to work on our 50Hz mains.

People tend to forget the main reason for an establishment to possess a jukebox was to make money; you never had a jukebox out of action on a Saturday night. They were designed to be fixed on site. Everything internally is modular, with connecting plugs and sockets which are easy to replace and get it making money again. The manuals were very good with illustrations to show you every stage from putting your money in, to selecting a record and playing it. They had fault-finding charts which really helped with this machine as it seemed to have been got at by gremlins.

Jukebox overview

These machines are very complicated, I will give you an overview of the basics. There are two types of jukebox: electromechanical (most machines up to the early 1980s), and computerised (most machines after the 1980s – less mechanical, featuring sensors similar to those found in a modern car). My machine is electromechanical and quite complex inside.

The machine can be broken down into nine separate units:

1. The power supply for all the voltages to the motors/relays/lighting/amps
2. Selection/search unit, also called a write unit for selecting record to be played
3. Read unit for record selection
4. Transfer assembly (gripper) for selecting the record and placing it onto turntable
5. Mute circuit for silencing amplifiers between record change
6. Amplifiers for driving bass/ midrange/tweeters/Line speakers
7. Credit control/coin mechanism to accept coins and register credit
8. Stepper unit to convert signals from wall boxes to auto changer
9. Wall box for remote operation.

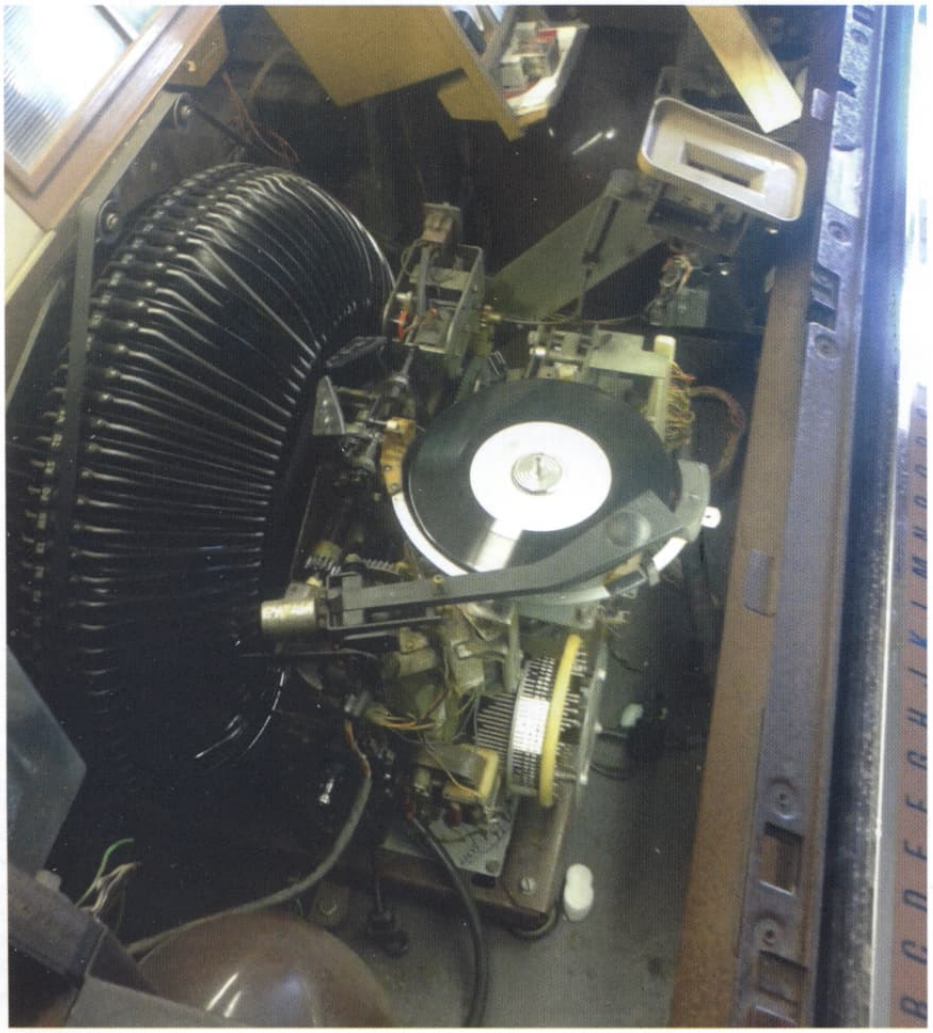
First things first

When my machine arrived I couldn't get inside it as you need a key, which I later purchased. Whilst consulting the manual I began stripping down the machine. I removed the auto changer which is built on a very strong chassis with four coiled springs for suspension, next I tried to open the door to remove the amp but the piano hinge was rusted so I administered some WD40 which finally did the trick. I removed the power amplifier and transformer chassis followed by the heavy front panel, top assembly and speakers. I turned the jukebox upside down and inspected the cabinet which appeared to have been through the wars. I managed to replace the damaged wood and applied five star wood treatment to the cabinet. The chassis and amplifiers were removed and placed inside my house for safe keeping. I also inspected the amps they had been bypassed with a home–made affair but the previous bodger had put DC across the bass speaker burning out the speech coil.

The other speakers had a capacitor so the DC was blocked.So I needed a 12 inch 4 ohm speaker. A friend had such a speaker from a hammond organ he was breaking so £10 pounds and it fitted like a glove… I cleaned all the muck out of the cabinet and had to replace some of the 110v sockets on the wiring loom. There is a company in Northolt, London which sells jukebox parts and they had the 110v sockets plus many other parts which I needed for the auto changer…

Rebuilding

I rebuilt everything in reverse and switched the jukebox on. The 240/110v transformer hummed and that was it, the on/off toggle switch was open–circuit so I made another order for replacement parts. I switched the jukebox on again and this time we had light (flickering because the fluorescent tubes and starters were shot). The service switch did nothing so I got the manual out and discovered that it was open–circuit too. This discovery was followed by a big bang as one of the power supply caps exploded. I am an electrician by trade, so am used to such occurences. I changed the defective cap and checked the 30v DC rail which



was showing a short circuit as the control relay under the auto changer had burnt out. After a short break of a week or two I decided to buy another machine as it would be a useful donor. I'm glad I did this as I was able to use a lot of parts from it.

Useful advice

I remember Gerry Wells saying sometime ago that if a troublesome radio was a 'dog' it should be put down, if we replace the problem radio with this particular jukebox then it should have been shot. Luckily, I like a challenge and this has given me something to get my brain working overtime.

I have a friend named Phil who has six jukeboxes and he was telling me that he sold one to a chap who asked for a guarantee with it and Phil's reply was "I can guarantee that it will go wrong".

I will fix this if it's the last thing I do

After using a donor control relay from the other jukebox, I powered up the machine and attempted to play a single, the record magazine spun but it stopped when the record was beginning to turn over for the A or B side selection. I got the manual out and learned about the record transfer system with its eight micro–switches on a cam. The cam has raised parts and as it rotates each switch works in turn to provide a different function. The fault–finding charts in the manual were extremely useful, and by this point I got the the jukebox to actually play a record! However, whilst playing the record, the magazine would start spinning, then stop, and when the record reached the end of the groove the mercury reed switch would not be activated in order to remove the record. I carefully went through the entire operation of the cam by fitting an Allen key to the cam drive shaft with the power off. I found that when the mercury reed switch was activated at the end of the record, the associated micro switch was 180 degrees out of step with the cam. I thought I would try something so I undid the circlip on the cam, rotated it 180 degrees then I refitted the circlip and tried again. This time the micro switches were all in sync. I turned on the power and it put the record onto the turntable, played it and placed back in the magazine afterwards. At last we were getting somewhere!

The selection unit

I will provide a more detailed account in part two of this article in a later issue of *The Bulletin*, which will also include wall box control and amplifier/mute circuit.

The selection unit has two banks of buttons that light up, the first is letters from A-V and numbers 0-9. The record titles are arranged in groups so an A side is A1 and the B side B1, the next C1 is the A side, and D1 is the B side etc. The rear is connected via a multi cable to the search unit which has many relays and a big drum with 200 selector pins, 100 being A–sides, and the other 100 the B–sides. Here's how it's supposed to work: you select 'A1', the search unit spins round, it has two solenoids at each end of a rotating arm. One solenoid is for the 100 outer pins (A sides) whilst the other the 100 inner pins (B sides). The relay controls stops

at your selected pin A1 and pushes it out. The mechanism start–relay fires and the magazine rotates, the magazine drives a gear wheel, which in turn drives a read–unit mounted on the back of the drum with the 200 pins. When the read unit locates a pin the magazine carries on and opens a gap between the selected pin which activates a microswitch on the read–unit which resets the pin selected, locks the record magazine and starts the record transfer cycle as explained above. I have included extracts from the service manual showing fault finding charts/circuits/machine parts. Certainly more complex than your average record player…

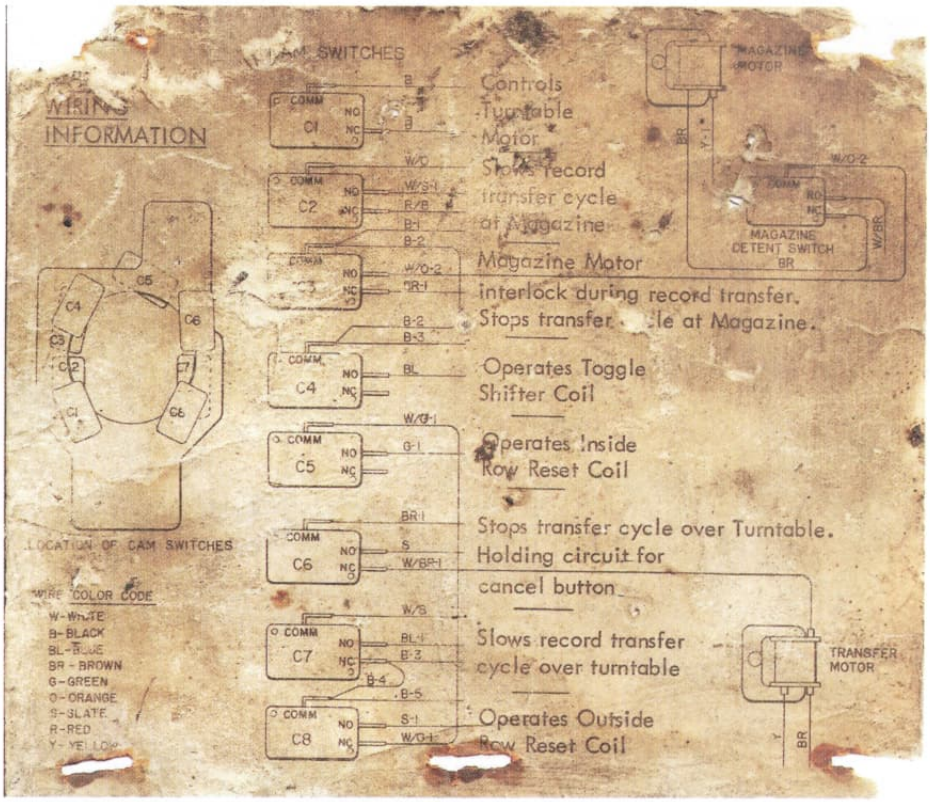
Hearing is believing

This is all very good but we still have not made the jukebox play any music as the amplifiers are not working. The amplifiers are connected via RCA phono jacks. The cartridge used is a Shure N77 with a separate stylus, these are still available for the modest price of £18.00 via the internet. The cartridge is a magnetic type and is mounted backwards as the tone arm is on the left hand side of the turntable. The jukebox only plays 'dinked' records (large centre hole), thankfully you can get a cutter. I connected an amplifier after I replaced the bass speaker to test how things were going.

The speaker system is well designed but there was a lot of wow. So a new pinch wheel was ordered and the motor serviced.

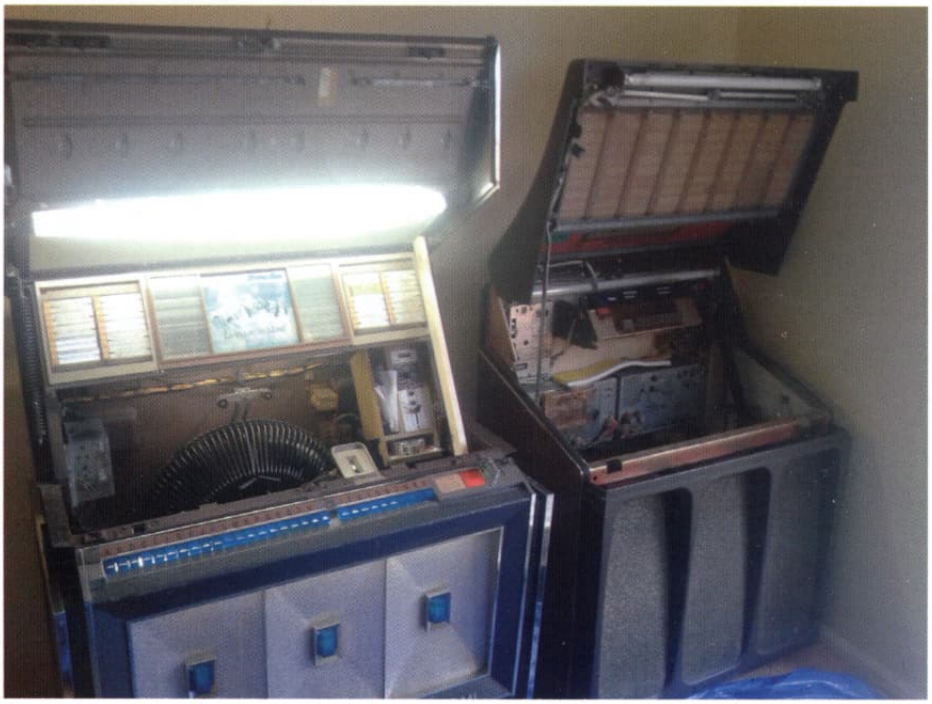
The jukebox now plays lovely music as she was made to back in the nineteen sixties. As I am writing this the search unit has gone wrong and refuses to stamp out pins due to a dirty contact, luckily I have a spare search unit and that works. I use contact–cleaning strips on the relays and special jukebox oil on the auto–changer, which must be applied sparingly.

One good thing about owning a jukebox is that people keep giving me seven–inch singles to play on the machine as they don't have anthing to play them on these days.



Original printed diagram from the inside of the jukebox showing functions and locations of Cam Switches

The wall–mounted remote selector



The restored jukebox on the left, with a Rockola Max 2 machine on the right

Stanley Mullard's Reminiscences

J. Patrick Wilson

Stanley Mullard started writing an autobiography in about 1967, possibly in anticipation of the Jubilee of the founding of the company in 1920, and wanted this to be a personal account and not an official Philips' history. He would record a section on reel-to-reel tape and hand a spool to David Dewdney whose first wife, Shirley, typed it up in the evenings. David would then return the tape and transcript to Stanley when they next met and receive a new tape in return. David was my brother-in-law and gave me a copy of this transcript in 1995 with the intimation that Stanley never got any further with this project. As the account starts in France it is possible that somebody else was involved for the earliest years and, just possibly, the years following the founding of Mullard. I thought no further on the matter until I received a bundle of Mullard information from David's second wife, Gilly, following his death, when I realised that this might be of interest to Bulletin readers. David started in the Mullard Research Laboratories in Salfords, Surrey, later moving to Mullard House, Tottenham Court Rd, where he became involved with publicity and exhibitions for Mullard and Philips. He got to know Stanley quite well and would visit him at his retirement home in Hurstpierpoint. After his retirement he became a Conservative County Councillor for Sussex.

The Mullard Jubilee in 1970 showing Stanley with, I believe, his daughter on the left and brother on the right, and David Dewdney, extreme right. On the lower tier of the cake is, presumably, one of the Admiralty silica transmitter valves which effectively started the company

The transcript contained many blanks where the word or name was not clear, and some repetitions and references to copies of letters of appointment, etc. which, of course are not included. I have removed major repetition but did not want to compromise the spontaneous style by extensive editing. Obviously he would have edited it more thoroughly himself. I have, however, filled some of the blanks and done minor editing and inserted subheadings. For a concise history of Mullard see BVWS Bulletin Vol.11 (4) and a more comprehensive account in The Setmakers by Keith Geddes and Gordon Bussey. Briefly Stanley Robert Mullard was born in 1883, started with his father in electric lamp manufacture in 1899, moving to other companies, and finally forming the Mullard Co. in 1920, selling 50% of shares to Philips in 1925 and the remainder in 1927. He retired from active management in 1929, but remained as a director until the company's jubilee in 1970, and died aged 95, in 1979.

Return from France

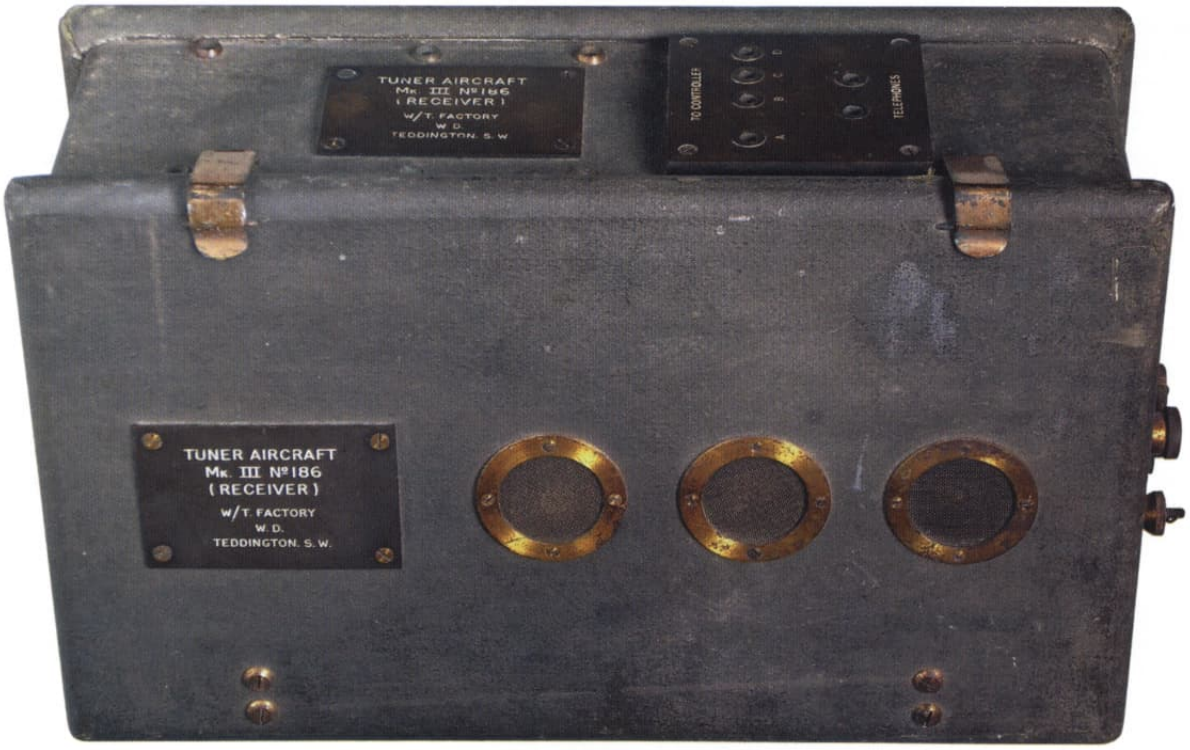
When I left ..... sur Seine for London, my temperature having fallen to normal, the doctors told me that I must not do any work for at least three months. I arrived back in Buckinghamshire where my wife and small child were staying with my wife's stepmother, and as soon as they saw me they sent post-haste for a doctor, as no doubt I looked very ill, but was feeling very much better following the fall of my high temperature, from which I had suffered for at least fifteen days. The local doctor examined me and confirmed the view expressed by the French doctor and told me it would take at least three months for a normal recovery. However, after six weeks I became rather bored with having nothing to do and there was the question of earning some more money, more than I had been able to collect from the French factory during my short stay. However, this had been more than I had been receiving from my English employers.

Electric light bulbs

Therefore, I wrote to one or two lamp factories and electrical engineering works with a light engineering department, and from these I received a reply from the Ediswan Company, whose director I had met on a few occasions at meetings of the IEE. After a short talk he offered me a position as an assistant to the manager of the Special Lamp Dept. at a salary of three pounds ten per week, increasing by ten shillings per week each year for the next two years. I accepted this and as soon as possible moved to a small house in Enfield town, about three miles from Ponders End. I bought a bicycle and started work about one week after moving in. My job was in a large room containing several other engineers, younger in fact than I, and who had been trained in the production of ordinary lamps, which were manufactured in the main works. The hours were eight in the morning to five thirty at night, and eight to twelve thirty on Saturdays, and fourteen days holiday by arrangement with the manager of the Special Lamp Dept., after one year of service.

I soon made a number of friends, and got on very well with my chief, who lived in Enfield town, where we frequently met in the morning, and at six o'clock at night, and walked home together. He suffered badly from bronchial trouble and was on a strict diet. He apparently had been trained at a technical college and was very well liked by the rest of the staff.

We had our own staff canteen where the food was cheap and of good quality. I had not been there very long when I was told by my colleagues, both senior and junior, that what I knew about manufacturing lamps, and other high vacuum apparatus, they had forgotten many years ago. I was not surprised at this view because I had heard that the Ediswan Co, who were the original manufacturers of lamps in this country, had obtained the patent rights from both Edison and Swan for their production and, for about thirty years, had failed to produce anything new or made any developments of note. Indeed I doubt if any of the senior staff troubled to



A WW1 aircraft receiver as possibly used in the experiments witnessed by King George V and Prince Albert at Cranwell

keep up to date with the information by the American Institution of Electrical Engineers, and from other parts of the world, on the improvements that had been made in the production of high vacuum apparatus, and the machines which were used for the rapid production of lamps, glass blowing, etc.

I had occasional visits from my director and told him that I had seen several processes, and pieces of apparatus, which I felt sure I could improve, and particularly one process for the treatment of carbon filaments for use in gun sights and Post Office indicator lamps. These were miniature lamps sold in quantity to the GPO and to the Navy and the Army on their gun sights. I learnt from the testing department that the average good lamps received were not higher than 45% and felt sure, by adjusting and improving some of the early treatment of electrical apparatus, I could considerably improve this. My director seemed to doubt the wisdom of letting me spend up to £25 to prove the correctness of this statement, which was based on almost elementary knowledge of testing apparatus. However, after a further six months of losses, he came to me and said he would agree to my leaving my present work and concentrating on the design and establishment of a unit for the production of these special lamps, and admitted they had been losing orders to our competitors due to their high cost.

To get the bits and pieces together I visited the engineering section of the Ediswan Co, and collected, and set up, the apparatus in the lamp factory. The result surprised me, for the first batch that went through, although outside the specification, were almost identical in performance on the test chart and photometric test. It was quite easy for me to readjust the apparatus and hit the centre of the target laid down by the Government Depts. This I did within about a week, to the amazement of the testing department, who were responsible for all the photometric tests of all the lamps. Within a month the percentage had risen to 60% and followed with an increase up to 90%, and thereafter this average was maintained for the whole period of my employment in the works.

I do not remember receiving any acknowledgement of this development, which must have saved the company many thousands of pounds, and given them a considerable increase in the production, and the orders received for these lamps. It was natural for the news of these results to go round the works and to be heard by foremen and other members of the workers right up to the managerial staff. At that time I had been with the company nearly two years and was then asked to take over the lamp laboratories with a small staff. There were one or two girls and an electrical assistant, plus the cooperation of other departments and the chemist.

The sealed arc lamp

In the offer which was made for me, to work in the laboratories, the director told me that the company had not produced anything of great notice since it was founded, but if I were able to produce something which received fairly wide publicity, I would receive a substantial sum of money. I had noticed for some time, the effect of the electron discharge from one limb of a filament to the other, which was considered to be due to a low vacuum. This often caused short circuiting across the leads, fusing the glass and smashing the lamp, and was generally considered to be due to a small leak via the leading-in wires making an imperfect seal with the glass. I therefore decided to try some experiments in which this arcing wire was deliberately developed, but controlled by an external circuit, thereby heating one or both of the electrodes over which the arc passed. In other words an arc lamp, but this time to be in an inert gas such as nitrogen, and the arc itself to be contained in an ordinary sized lamp bulb. To do this the first consideration in this experiment was to ignore all filaments as the current passing between the electrodes should heat one or both of them to a luminous temperature, thereby providing the source of light. The above can be shown by varying the electrode current in the three electrode valve, by controlling the p.d. of the grid, provided the electron source is large enough, and the anode voltage and current is sufficient. It is possible to fuse the anode by bombardment of the electrons from the cathode when these are accelerated by increasing the p.d. between the grid and the earth point on the cathode. In other words an arc is formed between the anode and the cathode. For more than 150 years, arc lamps were experimented with, but not until 1881 or 1883 were carbon filament lamps, the incandescent lamps, brought into commercial use. At the time of these experiments, the metal filament lamps had been introduced, and the lamps made with drawn tungsten wire were rapidly getting into a leading position and coming into general use.

In 1913 I was appointed as the head of the Ediswan Lamp Research Laboratory at their lamp works in Ponders End, Middlesex, and experiments were started with the object of making small arc lamps with the illumination coming from one or two electrodes forming the arc. The first lamps were made with the electrodes in contact using a bimetal strip heated by a filament on one side, and which moved the electrodes apart. Sometimes these electrodes tended to stick together and were then difficult to strike after the lamp had cooled. It was decided that these difficulties in striking could be overcome, with possibilities of obtaining a satisfactory source of light, the whole of the light emanating from a source of very small dimensions, subject to the ionisation of the gas nitrogen or argon in the bulb, thus forming a path between the cathode and the anode.

It is well known in the experiments of JJ Thompson, Dr Fleming and others, that the filament in an incandescent light emits strong negative discharge. If an additional electrode sealed adjacent to the filament is charged to a positive potential, the current passes between the filament and this electrode. This principle seemed to offer the way to overcome the difficulties in making the development of this lamp. It was on these lines that a successful lamp was constructed with external switching arrangements for its control. The whole of this work was shown in a paper published in the IEE Journal, by EA Gimingham [the text gives this each time as Gillingham] and SR Mullard, the author, submitted in October 1915 [A new high efficiency incandescent lamp, JIEE, 54, 15-19 (1916). This lamp was, I believe, later marketed under the name Pointolite].

From the paper it will be noted that lamps were made with a life of 500 hours, and soon afterwards the life of the lamps reached 800 hours. The average increase in candlepower was about 10%. One other note of observation was the comparison between the new lamp and the original carbon filament lamp and also the new recently introduced metal filament lamps. The intrinsic brilliancy from the globule of tungsten approximately one tenth of an inch in diameter was 10,000 candle power per square inch. By varying the voltage and current applied to the lamp, a range of brightness can be obtained up to a very intense white light when the lamp is run to the sputtering point of the electrode. These limits range from approximately 400 – 30,000 candle power per square inch.

Photographs of the various spectra are also illustrated which show the comparison between the spectrum of the new lamp and other sources of light including the [tungsten?] filament 1¼ drawn wire lamp and the half watt gas filled drawn wire lamp. There is also the spectrum for the [Nernst?] lamp and it will be noted that the visible spectrum extends from the left of the photograph, the red, to the letter L, the limit of the violet. Comparisons of the above clearly show the continuity and strength of the visible spectrum of the new lamp. The other sources of light show weakness in the green and at other points. The great advantage of the lamps of this type is their adaptability for altering the shape and position of the electrodes, so varying the light distribution as to make it most suitable for the particular purpose for which the lamp is required. Its suitability for projection work is obvious, as the whole of the light comes from a source of less than a tenth of an inch in diameter. The bowl of the lamp does not become as hot as those of the half watt metal filament lamps. Moreover it requires no attention whilst burning, so that the whole of the operator's time is free to attend to the apparatus. It has constant uniform screen illumination, there is no flickering. After publication of the paper in the IEE the technical and daily press published articles and hailed it as a new development in lighting. Unfortunately, as will be noted its publication was in 1915 [1916?], and very little could be done in its further development at that time.

When I accepted the appointment to the laboratory I was told by my director that I should receive a substantial sum of money if I was successful in producing a new lamp which would have wide publicity, as they had not produced anything new since the formation of the company some thirty years earlier. At the time I was working under an agreement, by which I obtained an increase in my salary every year, the terms of which are published in this autobiography, together with the letters I received from the Admiralty inviting me to take on the work of establishing and operating a laboratory at Imperial College of Science at South Kensington to which further reference will be made. In connection with the agreement I had with the company I knew in 1915 that I should do very little more towards the production of the new lamp and certainly nothing in connection with its sale. However, it was completed and the manufacture had started, following the wide publicity it had received throughout the public and technical press, and the paper published by the IEE. I therefore decided to ask the director if he could now pay me something on account to the substantial sum of money I was promised, when I was appointed as head of the laboratory. He replied that business was very bad and that he could do very little in this respect. I pointed out to him that this had nothing to do with me, and that his promises should be kept, and offered him my agreement to endorse with what he thought I ought to have, by way of remuneration. This was handed back to me with a ten pound a year increase covering the next three years. I cannot describe my feelings on this miserable result of the work that I had done, and the poor view that he, as a director, took on technological progress, and those responsible for them.

I had earlier in my contract with the works and offices, understood that the method employed in this company was for the director concerned, to call for a report of the progress made in the work undertaken by a subordinate and, following that, occasionally patents were taken out in the name of the director without any reference to the original inventor. This occurred in my own case in connection with the new lamp, and all the documents together with my personal agreement with the company, was published in this autobiography.

From the very beginning of my apprenticeship I had negotiated with my employers, from a state of fear that I might offend them, and that I should lose the continuity of my work and perhaps be dismissed. This feeling was intensified after my retirement return from Paris, and my approach to the company and acceptance of the low salary that they then offered of three pounds ten per week. However, the situation had completely changed, in a very short time, for immediately I had produced the new lamp and read from the press cuttings, the manner in which it had been received, by all journals from the Times Supplement to articles in Nature, Illuminating Engineering Society Journals, Institution of Electrical Engineers and the main electrical papers here and abroad, that this was something exceptionally good, and that for the first time in my life I need no longer negotiate from fear, but on the basis that people came to me, including representatives of the Admiralty and other government services, to ask me how this or that worked, and to describe in greater detail than the publications contained. I should add that I am 99% justified in claiming this work, for I was always quite certain that my director knew very little of the subject, and indeed was ill-trained in the basic principles, which would enable him to understand more detail of the work that had been done in the lamp laboratories.

Among my friends at the Ediswan works was Mr CR Belling, who was a year or two younger than me, who became famous as the founder of the Belling Heating Engineers, electric furnaces, ovens and fires. It was not long after work on the new lamp was completed, before he came to me and asked me if I had £500 as he wanted me to become a partner with him, in starting an electric fire company, where his uncle, a director in Messrs Barker & Co, had some influence. I told him that with two children and wife, I had not been able to save more than a few pounds, and I doubted that it was more than 500 shillings. It is something to remember that I watched Belling fire business grow from a small garage in Enfield town, which I helped him wire during the evenings, when we could get away for a few hours, and which was his first workshop. When he died two years ago [1965], he left approximately £5,000,000. Now I have never wanted large sums of money, but my continuous contacts with Belling, and the others that were successful in their own business, while never making me envious in any way, made me realise the necessity of being aware all the time, of the dealings with finance houses, financial people and sales executives, whose outlook on life was very different to those which existed between technologists and scientists. From the latter, one obtained thanks and the truth, and the former, nothing other than an attempt to exploit and snatch as much as possible of benefit, of the advances made by the technical staff.

On the same day that I received my agreement endorsed by my director, for the £10 increase spread over the next three years, I went over to his office and told him exactly what I thought of him, and that I would never trust him anymore, and that I would not under any circumstances stay with the company. He seemed very perturbed at this attitude, and asked me to leave my agreement with him, and it was re-endorsed as it will be noted, by a larger figure.

After I left the company to take up my appointment with the RNVR, as a lieutenant attached to the RNAS, I was asked to meet the director again, and the chairman of the company, who asked me to accept a retaining fee of £200 a year for the period of the war, provided I would return to them and offer my services to them at the end of the war, when they would pay me £1000 a year, and make a five year agreement. As my service pay was 11/- [55p] a day this was of tremendous benefit, and enabled me to send my wife and two small children, one of two the other of six, into the country, away from the raids and terrors of the Zeppelin, for the period of the war. We were able to obtain a

small cottage on a large estate in Chalfont St Giles. Their comparative safety relieved my mind considerably as to their welfare.

Admiralty work

At the outbreak of war I received visits from the officers connected with the Flying Corps, the Admiralty, and the Army, who suggested that I should visit them as soon as I had working models of the new lamp available for demonstrations. My first visit was to Farnborough, where I met some senior army officers who, however, did not appear to show great interest in the new lamp. Some few months later, with an improved model, I visited the Signals School at Portsmouth, which at that time was housed in three wooden ships lashed together, and moored in Portsmouth Harbour. This was the Torpedo School in addition to being a Signal School. I arrived on board and met an officer, who I was to know, and with whom I was to remain friends for many years after. He was then a Commander, Charles Kennedy Purvis RN, and his invitation was to go into his office which was also his cabin, where we mounted a drawing board, and we discussed the details of the new lamp from first principles. He showed considerable interest, and said he would keep in touch with me to see and mark any further progress. I reported the result of these visits, and those I received at the laboratory from other officers.

Early in 1916 it was suggested that I met Commander Hyde-Thompson RN, who suggested that I should join and accept a commission in the RNVR, and be attached to the RNAS, with the object of opening a larger laboratory in the Imperial College of Science in South Kensington. I asked what I should be wanted to do there, and outlined my work. He gave me this in another letter which is included in this paper.

In due course I attended the Admiralty for my medical examination, and having gone through the exercises required, I noted that the medical officer was very worried at my condition, and this did not surprise me, for I had been working for long hours without a break for week after week. He examined some papers which were no doubt copies of the correspondence I had with the Admiralty, and then we entered another room, and he invited another officer of high rank to confirm his examination. He told me that I had had a very bad attack of rheumatic fever and that my heart was in a very poor condition, and also referred to my right leg, the calf of my right leg, where a vein had expanded and was protruding rather heavily. This vein had given me a tremendous amount of pain, which I put down to neuritis, which no doubt was due to too little rest, and standing for long periods during the long extended time I spent on my experimental work in the laboratories. I told him it was a purely temporary matter, and everything would go well if I were able to rest for a week or two, during which I could read and continue to examine apparatus, provided I rested my leg. However, after further discussion a letter came from Commander Hyde-Thompson saying they had refused to pass me for any kind of service. Naturally I was very depressed, as I wanted to get away from the laboratory, and be more actively engaged with one of the services, either as a civilian, or in uniform, with closer contact with the war. I therefore sat down and wrote a letter to the Admiralty, a copy of which is included, asking them if they could not reconsider their decision, as the work which I was expected for was very little different to that which I had been doing for several years, and which I felt quite able to continue, and efficiently, provided I gave my right leg a rest. I should add that during the medical, the officer told me that I should have considerable trouble in that leg in the near future, and during the rest of my life. I waited for three weeks and then my parchment came, as Lt RNVR attached RNAS, and with instructions to report to Imperial College of Science, where I would be given a large floor in the Electrical Laboratory, to organise and start a Laboratory Testing Station for the Navy.

Wireless Telegraphy

Soon after I arrived, before starting to organise the laboratory, I was asked to make myself familiar, with as little delay as possible, with the apparatus which the Navy were then using for wireless receiving and transmitting, and relays used for line work. All this was installed at Wormwood Scrubs Prison, where the RNAS were based for stores and instruction of officers. I found a willing Petty Officer, and made friends with him, so that he was ready to work late in the evenings. Within ten days I was familiar with the gear which was then in use. I was joined by a Lt RNVR Smith who had come over from Edmonton, Alberta, where he was Assistant Professor of Electrical Engineering at that university. He was a delightful companion, and although a few weeks senior to me, we had no difficulty in planning our work together as he was, throughout the time he was with me during the war, a most congenial and pleasant companion. Afterwards we became very restive, as there seemed to be several delays and frustrations in getting the laboratory at South Kensington started. In the meantime I had met a Mr Russell Clark who was a KC, and an expert patent lawyer, and for the period of the war, joined us as a member of the Admiralty Intelligence. He asked for me at Ediswan, and found out where I had gone from there, and paid me a few visits whilst I was studying the Naval gear at Wormwood Scrubs. He then requested to release me for spell with him at Pandy in Wales, where he had a house, large garden, and had erected a large transmitting station with receiving apparatus operated by two or three ratings in the Navy. He had been able to obtain a large Lanchester car, and drove me there, telling me he had heard that I had wanted to rest, and a weekend stay with him would benefit me. All the strenuous work that I had to do was, to rise at 8.30am for breakfast, roll the tennis lawn with his help, and then go on watch on the transmitting and receiving station, returning to the house for lunch. After lunch, a strenuous game of tennis, and then back to the transmitting unit until dinner. After dinner I went back to the transmitter. So by the time I was put on the train back to London, I was in a poorer condition than when I started. However, it was great fun and of the greatest interest, especially on the details of the construction and working of the transmitter and receiving apparatus.

The grid leak

It is interesting to note that at about that time, which was 1916, the use of the grid leak was discovered, and this was of great value on a receiving set, which was to rub a pencil on a paper, making successive marks until the right point had been reached for the regulation on the valve. In other words the correct rate of leakage, which merely meant the correct control of electrons, on the most sensitive part of the characteristic of the valve.

During one visit I paid to Pandy I had received a signal to say that Mullard was to be immediately released, and returned to the College of Science South Kensington, where he would meet up with other officers, and commence work on the foundation of the laboratory. Naturally I caught the next train back to London where I was joined by a few ratings and Lt Smith. To start with we had to organise for a steady flow of valves coming from several manufacturers, in different parts of the country, which had to be tested by men, and later by the equivalent of today's WRENS, before being passed to Admiralty. In addition we opened a small section for the experimental construction of elemental valves, with a view to increasing the power of output, which at that time, for glass valves, did not exceed 100W.

In addition to my work in the laboratories in South Kensington, I had many visits to several of lamp factories, sometimes alone, and at other times with various civilian representatives from Signals School, and their technical staff, to instruct in detail how valves should be best manufactured, and to hasten and improve methods of construction, as there was a shortage of valves for overseas use. We were fortunate enough to have a liquid air plant installed in the engine room in the Imperial College of Science, and I was able to obtain on loan the 3.5A 3,500V DC dynamo to supply the anode voltage and current for the higher power transmitting valves which we wanted to construct. The liquid air was useful for use in conjunction with the diffusion pump which was then in use in the Ediswan works.

After I had been in the service for about three months I was asked by the Director of the Engineering Dept. of the Ediswan Co, if I could agree to try and obtain release from the Admiralty, by surrendering my commission, and going back to the works as the works manager of the whole of the lamp department, which had apparently been in trouble with some of the technical operation of the works. I of course declined this and was rather surprised at the suggestion, but they were in a terrible mess. In many ways I was not surprised at this, especially in knowledge of the essential things that one requires for the production of special glass from their glass works, and in other matters they were hopelessly short of technical staff, and practically without it.

Indeed when I examined their methods of manufacture in special glass, like ruby bulbs and blue bulbs, made in a special density for

Admiralty use, I found no reliable records in their books, so that when they succeeded in doing this special work, they were trying a shovel full of this, or that, or the other, and other hit and miss methods, and after considerable waste, they would get the quality they required. Indeed it was quite apparent that the director of the lamp works was really concerned at keeping everything so secret, and had been in this state of mind for so many years, that he could not bear anyone with any knowledge under his control, or capable of controlling any technical work, for which he had to be responsible. So far as the glass manufacture was concerned, I had noted a very slack method was used for checking the important variables, which invariably occurred in any heat process, such as temperature internal to the furnace, and external of the air outside and inside the building, especially out of doors, which were so frequently opened and shut.

The Naval Laboratory at Imperial College of Science grew rapidly, yet we had to add to our staff by appointing other officers, two Sub-Lt and later a Dr Mc..... who joined us as a Lt RNVR, and whom gave us a tremendous help, as he had been for some years, a lecturer at different universities, after obtaining a BSc at Oxford. Indeed he was a working library of knowledge, and I had been pressing for the appointment of such a man who would help us in this direction, for example when we received a problem from the war front, we realised what might have to be done, but that we lacked the information of what had gone before, and the result of any experimental work, in fact the origin and the result of experimental work that occurred in earlier days. He and Lt Smith together, who was from Edmonton University, obtained this information without a delay, which was so necessary for our purpose. In the same way, we produced reliable resistances for use in overseas wireless sets for use as a grid leak, and after my visit to Dunforth on this subject to examine this difficulty caused in sets, we started and made several hundreds of these, which we shipped across to France, as they came off the line. The RNAS patent officer took out a patent for this in my name and that of the head of department.

A few months after I had joined and taken my commission, my CO, Commander Hyde-Thompson, was killed in an aeroplane crash at Dover. One realised on that occasion, one was even more sad because his brother, who had been blinded as an army officer, was also there. Hyde-Thompson's place was taken by Commander Warrington-Morris who came back after doing sterling work in keeping in touch with the radios in the oceans around, and I understand he was able to get into touch with ....., which led to the British fleet destroying it. He had been an international rugger player, and was a great fellow, and I treasure my service with him, and the time after the war when we frequently met at the Royal Air Force Club, which we were both members of. Indeed we both tried to get there on a Tuesday when he would lunch with me. To my great regret he died about four years ago at the age of 78.

Our work at the Imperial College of Science laboratory covered many long hours through every week, and each week ended with us submitting a report of our doings, to our Senior Officer at the Admiralty. There was no question of hours, we just went on each day ..... of the officers and ratings, men and women doing their utmost to produce and take every care, that the product that we were passing on was first class, and I with some pride I can remember we never received a single complaint on a failure, during the whole of the time to the end of the war.

French visit

During this period I met Prof Townsend from Oxford University, and we travelled together to France,, where we met Gen Ferrier the head of the French experimental establishment at ....., Paris. We had the closest cooperation with him and his staff who were dedicated to the service of their country. On one occasion I asked a soldier from the ranks if he could not continue to discuss the technical subject in the mess, then he with a smile said "I am only a simple soldier and not an officer" and I said, knowing his professional status, why had he not received a commission, and he said "I prefer to be a simple soldier". This was indeed the spirit of all these people working under Gen Ferrier. Many of these men were of the highest status in physics and science generally.

Radio takes to the air

I also visited Cranwell which was then a series of huts between the "heavier than air" aircraft and "lighter than air" balloons or blimps. There were two separate camps, "lighter than air" being controlled by the Royal Flying Corps, and the "heavier than air" by the RNAS. There were many days when no flying was allowed, due to the bad weather, which was when the young pilots began to get rather out of hand although they behaved quite well.

At Cranwell, Prince Albert, who became King George VI and who is father of our present Queen Elizabeth, was referred to as the PA, and had no objection to this title. Indeed I doubt very much if he had any expectation of becoming King of England, since his brother, the Prince of Wales would follow his father George V as Edward VIII. In 1917 test trials were made with two way telephony from the air to the ground. King George V came to Cranwell to see a demonstration of this then remarkable trial. A blimp was put up and station No 2 was a tent in a field. When the King arrived, a young Lt was at one end of the line, and Lt Lee at the other, in the blimp. He was calling out to the ground, for PA to come to the telephone. The King, hearing the noise coming from the ear piece, put it to his head and heard this request "ask Lt Ree" and asked Lt Ree who the PA was. Ree replied I think there must be some crossed talk. It kept on too long because Lee kept shouting to Ree to tell the PA to come to the phone. Then Ree confessed that the PA was Prince Albert and the King was much amused and laughed loudly. When the demonstration ended and the King departed, the press correspondents, who were kept well away from the tent, rushed in and with the Americans predominant, asked what he was laughing at, but they were never told. I believe that this is a service secret to this day, just what happened on that day.

Direction finding

Another officer that I met, and whose company I was to enjoy, was Dr Robinson, who started a system of direction finding by wireless. He was a delightful chap and had received a signal during his duty in Malta, to come over and see me. We had a long talk together, and this finally resulted in a simple coil method which he had developed, which was continually kept sweeping round, to pick up signals coming from German boats on the coastline of Belgium, which had been invaded. With other stations round the French coast they were able, by this method, to obtain sufficiently accurate results, to notify torpedo boats when the German submarines came up to recharge their batteries.

One of these stations was ..... who also used to send us a signal when we were in the sand dunes, making trials outside Dunkirk, that he had to notify us that a shell was on its way from somewhere on the coast, and we had about half a minute to get to our dugout, or take cover, as we considered necessary. However, in those days long range guns were very inadequate, and although I understand they were firing at Dunkirk, they never seemed to hit it, at least not in our time, and the shells would scream away and finish up in the sea, or in sand dunes, where they did no harm.

During my visits to Dunkirk I met Lt Commander Hamilton, known to us all as Hammy, who was a great character and a most pleasant companion and most helpful in every way, as indeed all my fellow officers were, to provide all the technical assistance and general knowledge to ease our work there and in the laboratories in London. The same remarks apply to the petty officers and ratings throughout 1916 and 1917. I was in close contact and worked with several of the technical staff from the Signals School, and commissioned officers which included Prof. Townsend at Oxford University. I occasionally was invited to stay at his house at New College Oxford where I met Prof. Lindeman, later Lord Cherwell, and other well known personalities resident in Oxford.

I made frequent treks to France and attended conferences with Gen Ferrier, and also visited the headquarters of the Royal Flying Corps at Haydon, making other trips to Dunkirk, the headquarters of the RNAS nearby. I also visited some of the lamp manufacturers in Britain to help them in the production of the standard receiving valve for supply to the services. A large number of these came to our laboratories, where they were sorted out for use, before returning to stores for issue to the Navy.

In 1918 the two arms of the Flying Service, the Royal Flying Corps and the RNAS, became the Royal Air Force on April 1st and we were then one service and changed our uniforms from navy blue to khaki. My rank was changed this time from Lt RNVR to Captain Royal Air Force. The higher ranks following army procedure, Major, Lt Col, Col, etc. Many of the RNAS Officers regretted this change, as they had taken us away from some of our friends

and fellow officers in the Navy, and involved us in a complete change in the messing and living quarters. However, we were under the command of the officers of the unit to which we were attached, our chiefs, having changed their ranks in accordance with RAF procedure.

Armistice

So we continued throughout this year to Armistice Day on the 11th of November. On this day we were ordered to attend Biggin Hill for a meeting, the notice having reached us in the ..... and we were taken down by ..... and other means from London. On the way we passed a number of boys with cheering ratings, cars with other officers of other units, all proceeding in the direction of London. Many of the boys lorries were filled with small trees and floral decorations. We realised that the Armistice was near and having arrived at Biggin Hill at 11 o'clock, our CO was cheered when he got up to address us. All formal business was scrapped and we were dismissed and proceeded to London by the best means available. When on arrival we found the whole of the population had gone crazy with delight, and the streets were crowded with pedestrians marching too, with traffic disorganised.

The following day we were back on duty under normal conditions, and this continued for a few weeks when I was posted to Biggin Hill for duty. There I was able to rent a house so I was able to transfer my wife and children, but lived in small metal huts on the aerodrome at Biggin Hill. I was instructed to clear up my work at the laboratory after a month, and after negotiations for peace had made some progress, and there was no doubt about the permanence of the arrangements, with the complete defeat of Germany and its allies. This condition continued semi-actively until February 1919 when I was demobilised, which was not fixed until early 1919.

I was told [by Ediswan] that I should have to work under the direction of the works manager, whom I had met on frequent occasions during the war, but I had to tell them that I could not agree to this as I had been more or less independent, in the laboratories and works, prior to my leaving the company for service in the RNAS. However, they had apparently made arrangements with the new manager for this, which gave him complete control. I had therefore to tell them that my agreement called for six months' notice, and to terminate my agreement to rejoin them. After some discussion it was mutually agreed that I should leave without this condition.

The Z-Electric Lamp Manufacturing Co

I had several meetings with the East Indian merchants who owned Z Co and although they only offered the maximum of £600 per annum, I was prepared to accept this as I would have a seat on the board of directors, and a percentage of the profits made by the joint manufacturing and sales departments. On examination of their report I found that they had not made profits during the last four years. The works I was told was a drag on the total profits and quality, and if I could improve the output and quality, and reduce breakages, the total profit should give me an increase comparable to the £600 which I was earning as a standard income. Therefore, before demobilisation, I obtained leave of absence for a few days to visit the factory, which was then at Southfields near Wimbledon, and make myself known to the staff and the work people generally. I recognised during my first few visits that the technical faults were made in the production of lamps and the methods of manufacture, which I was confident I could increase to much larger output. I therefore agreed to join the company under an agreement of three years, and after difficulty with some members of staff, whom I had to dismiss, I won the confidence of the others, and in about two months we were all hard at work improving quality of production and output. With complete control of the manufacture, which they willingly gave me, within a year my share of the profits and £600 salary, exceeded the amount I should have received from Ediswan at a £1000 a year, although this was for a five year agreement. Among other things that I organised were evening concerts and dances in the local hall, where new and old employees could get together and know each other, and also obtained the presence of the directors and sales management, which proved most successful. The result of this confirmed my belief that, provided I was left alone and given full control, I could manage to overcome any of the difficulties of manufacture and works organisation that I had to face, and this feeling had grown upon me since the production of the arc lamp, which I had produced at the Ediswan works, and which had brought to my door, enquiries from the Government services, with special emphasis from the Navy, just before the outbreak of war. This gave me the feeling of confidence, and made up my mind that I would not have to negotiate for future service agreement with any industrial concern. For the first time in my life people were coming to me for information, whereas prior to that I had negotiated my services in a state of fear, in case my demands lead to dismissal. This was the experience I had had in the agreements with the Ediswan Co so I was determined to avoid repetition of this state of mind.

The lamp cartel

We made ..... on the sales of Z lamps, which I had been able to improve the quality of, and our sales were increasing rapidly. However, the owners of the lamp factory and the business, were a firm of East India merchants, who had had one sole object at that time, to recover their investment and make a profit. To this end they negotiated with the GE Co, who agreed to purchase the works, and manufacture lamps at their lamp works, and these with the Z trade mark. It was a time of mergers and take-overs in the lamp business. The big manufacturers were getting bigger by such methods of purchase of the smaller makers, and out of this came the lamp manufacturers cartel, which persisted for many years thereafter.

It was by this method the whole world was carved up into spheres of influence and division of sales. In other words a worldwide monopoly, which was later disbanded under the Monopolies Commission, by the Labour Government after the war, the second world war. With memories of the cut-throat prices which persisted prior to the first world war, and prior to my apprenticeship, I became a strong advocate of continuing the cartel. Indeed I had seen the effect of cut-throat prices which persisted among all manufacturers in every country, when the company with which I was employed failed to get contracts which they desired to maintain their manufacturing standard. This meant that immediately they heard the large contract had been lost, the workmen had to be dismissed at very short notice, although in some cases they had been employed by the company for several years.

The despair written on the faces of such men has remained in my memory ever since. I knew of two who had been employed for five years continuously, and had settled with their young families in the district, with their children going to the local school. The parents made up most attractive gardens and keeping the home in good shape, and this all had to be left, and other employment sought, without them having the slightest idea of where this would be.

After the establishment of the cartel in Britain and overseas, the manufacturers concerned were able to establish a production of their products which fitted demands. Furthermore, they were companies like the General Electric Co, and similar organisations, with established large research laboratories. Prices which were fixed, permitted them to do this and ensure continuity of employment for their work people, and technical and administrative staff. In other words their workmen were ensured security of tenure, yet were free to move from one organisation to another, although some firms were manufacturing outside the cartel and selling at lower prices. This action was ignored unless it became seriously competitive, when the companies concerned in the monopoly had lamps marked with a new name, which were sold in the area where competition was keenest, at prices under those quoted by the intruders.

Some such controls were obviously necessary, but it is extraordinary today that the government, who are against monopolies, themselves run large powers of monopoly in the supply of gas, electricity and similar major products, which are essential to all users. They can raise the prices far higher than need have done, and which would not have been so inflated, had they been under the control of private enterprise, the representatives of the government, or the public, or those having public interest to prevent exploitation. Today we have no such controls, and parliament and these large government monopolies are free of criticism by the parliamentary representation, although they are the undertakings of the property of the public.

Valve manufacture

Whilst reorganisation of the Z Co had been going on, we had been manufacturing valves from the date of demobilisation, which bore my name, the name of Mullard, and the notepaper used was headed SR Mullard at the address of the works. This arrangement was made in collaboration with the owners

The Mullard Jubilee in 1970 showing Stanley Mullard with, I assume, SS Eriks who succeeded him, and the head of Philips on the right?

of the works and the whole valve production occupied only a small space in the factory. An agreement was made that any profits from the valve manufacture and sale, were to be divided equally between the owners of Z supplies and myself, thus my total income increased by approximately £500 from the spring or summer of 1919 to the summer of 1920.

The production of valves was started, that were experimental, on which I had been working whilst employed by RNAS before demobilisation, and while the number of receiving valves for amateurs was small, sometimes only a dozen or two per week, we also made small transmitting valves which were supplied to the Army, Navy, etc., and together with a small trickle going over to France, to the French experimental establishment at Les ..... . I was inspired to tackle the valve manufacture by the enthusiasm of my service friends, including Prof. Townsend of physics at New College Oxford, and of course this arrangement increased the profits of Z electric lamp supplies, which was also pleasing to them.

The silica valve

The arc lamp which I designed at Ediswan was patented under the sole name of the director, EA Gimingham, and has specifications dated 12 Nov 1914, complete specification, 10 May 1915, granted 12 Nov 1915 as No.22,437. A later one, No.104,350 described the use of the arc incandescent lamp for therapeutic and other purposes. In fact I made these lamps in fused quartz prior to this date, and both of these specifications were based on the report which I wrote at the request of my director, Gimingham. While the paper communicated to the IEE journal was in our joint names, the patent specification had made no reference to me for any of the work done for them, and therefore illegal as Gimingham was not the true inventor.

During this period the high power valve in silica was rapidly being developed, in collaboration with the technical officers at Portsmouth, but it was not until early 1920, that the first valve was made and sent to Signals School for final tests. [Compared with glass, silica, or fused quartz, is tougher, has a higher melting point, a lower coefficient of expansion (a disadvantage with metal lead-in wires), and transmits UV light]. This valve was assembled at the Z works by me, and the technical staff, but had been sent to the Osram works at Hammersmith to be exhausted. This was owned by Marconi, and at that time we were under threat of patent litigation from them. However, Mr Christopher Wilson, the managing director of the GEC Osram works, was willing to help me in every way, agreed to exhaust this, and to set up the apparatus for the exhaustion of the valve. However, this took seven months and we were charged £140. When sent to the Signals School for tests it lasted ten minutes, the failure being due to the mysterious appearance of residual gas in the tube. I attended a conference at the Admiralty with representatives of Signals School, and the senior officers in the service asked my opinion on what we should do now, after this unexpected failure. I told them that I had seen experimental things made with the crudest materials, and had been developed in time, to articles which were now being produced by the million. In other words, I advised them to go on. We had done so much towards getting this valve, this badly wanted valve, into production that it would be a mistake to drop it.

Admiral Kennedy Purvis, who was in the chair, said he agreed, and that they all agreed with this view. It was then arranged for a small group to investigate the failure, which was found to be leakage of hydrogen to the hot silica, when sealing off the valve, from the pump with an oxy-hydrogen blowpipe flame. I hurried back to the Signals School to make a carbon arc which ran off a supply of 300V. The next valve which was pumped, this time at the Signals School proved satisfactory and there was no leakage. We continued at the Z works to make more silica valves, in close collaboration with the Signals School, and slowly developed an increased production of both small and large, glass bulb transmitting valves, plus an increased number of receiving valves. [a silica transmitter valve took pride of place on the cake for the Mullard Jubilee celebration]

The foundation of the Mullard Co

About the middle of 1920 I was asked to attend a meeting at the Admiralty, at which several high officers of the Navy were there, together with the director of naval contracts. I was asked what I had been getting out of the work that I had done since demobilisation, and I replied that I had enjoyed working with the Signals School technical staff and would like to continue doing so if possible. I was then asked if I could manufacture the valves for the Admiralty, and replied that I had no money, and saw little hope of raising the money while a threat of litigation existed from the Marconi Co. They then asked if I could claim finance if I received a substantial order from the Admiralty for these quartz silica valves. I replied that I thought I could, although at that moment I had no idea whether this would be forthcoming. However, they agreed that I should receive an order for 250 of these valves at a price of £6/10/- each, the contract to be priced and vetted by the Admiralty Accountant. To this I agreed. Parallel with this I should receive a commercial licence from the Admiralty for the patents required to start production. This too was agreed.

During this time we had received enquiries from a shipping company who desired to have a supply of valves, which the Marconi Co had refused to sell, unless apparatus on which the valves would be used, was supplied as well. The shipping company considered the terms offered by Marconi to be onerous and they were therefore very interested that I contemplated starting a valve works with the help of new finance.

From the discussions there were two companies, plus the East India Merchants which owned the Z Co, to put up sufficient to start a factory with more modern apparatus, and go into production on a larger scale. Again, parallel with these negotiations and operations, the owners of the Z Co had made an agreement to sell their lamp production to GEC in return for which they received, from the Osram lamp works at Hammersmith, supplies of lamps marked with their Z trade mark, and were given a quota in the profits for the sale of these. This meant that we should have to find other accommodation for the new valve units and we bought a small factory, which had consisted of stabling and stores in the Fulham Palace Rd, Hammersmith. The works cost us £4,000 and we spent another £1,000 to £2,000 on altering the floors and the layout, wiring, etc.

[Unfortunately this account ends at this point. It would have been interesting to hear his account of the huge growth of the company and its diversification into other electronic components and products, and particularly the reasons behind the sale of the company to Philips, and how much control Stanley Mullard retained afterwards. Clearly it would have been an enormous advantage in obtaining access to Philips patents, research facilities, markets, and finance for expansion].

Letter

Dear Editor,
As always I spotted the excellent magazine as soon it was dropped on the floor by the postman. In the letters pages there was the story of the Lodge Family. I presume it's better to make the story complete as Tom Lodge sr. is no longer with us. He took part in the Radio London RSL for Radio Caroline in the London Docks, which was in 1995. He was in marvelous condition at that time. In the years to come he not only went into Zen but also into writing. Among other things he published his 'Radio Caroline Story' as well as 'The ship that rocked the world'. He died on March 25th 2012 in Santa Monica USA. A photo I took in 1995 is enclosed.

best greetings and good luck
with the Magazine
Hans Knot, Media Historian

The Phoenix rises. The restoration of North 3 continued from Page 19

Media City, invited by Salford University to take part in the Manchester Science Festival. We also had a display inside the 'Semaphore to Smartphone' exhibition, showing the development of television with some working TV sets and cameras.

By then, North 3 was looking a lot smarter than the previous year. I had arranged for a major refurbishment of the bodywork to be done by a commercial body shop near Shrewsbury, and had taken the opportunity to tackle some serious issues that had been put off. The back mudguards were steel, and had been attacked by electrolytic corrosion in contact with the mainly aluminium body. These were removed, and sent to a specialist for shot blasting and new metal to be welded in. All 50 metres of alloy trims down the side were removed, along with the cab windows and frames. New toughened glass was made for the windscreens, one being cracked and the other discoloured, meanwhile I removed decades of dirt and oxidation from all the frames with abrasive mops. The rear light units were badly rusted, and were hard to find as they were used on some buses. I managed to get them rebuilt by a local steel fabrication company. The trims were polished, and replaced using over 300 new stainless steel screws.

A final flourish to the appearance was the signwriting. With the aid of a lot of old photographs and forensic investigation of the paintwork, we were able to reproduce all the original graphics. At first I went to vinyl sign makers, but eventually decided that although more expensive, it would be best to have it done exactly as the original - by hand. I found a master signwriter, who does a lot of heritage work for churches, preserved railways and the like. He was reluctant to do vehicle work, but this project caught his imagination. It turned out that his mother, who had also been a graphic artist, at one time worked for the BBC and had painted the grey scales on the Test Card! He took careful measurements and using various reference points re-created the original lettering in the exact style. The BBC logos were done using 20 books of real gold leaf, and the effect was well worth the extra cost. There is still work to be done on the exterior, such as fitting 20 new chrome lock covers, but it is looking a lot better.

We have since spent many, many hours on rebuilding and testing the sound desk, the vision matrices and dozens of other units. The monitors are a continuous process like the legendary painting of the Forth Bridge - as soon as they are all working, another one needs repair. However, they will hopefully become increasingly reliable as faults are rectified. We have two PC80 camera channels, ex-North 1, and plan to install them to make two of the channels completely as original. One of the PC80s and one of the EMIs (ex-BBC Glasgow studios) are now producing pictures, but again is at the 'two steps forward, one back' stage.

An interesting aside concerns the sync pulse generation system. On the original Type 2 design, there were dual SPG units with a changeover panel, but the master synchronisation was derived from a complex pulse system invented by the BBC to provide video synchronisation across the entire UK network. This used audio tones sent down telephone lines to pull the remote subcarrier frequency exactly into synchronism, although with the advent of digital frame stores in the 80s, the system became obsolete. The apparatus to do this took up most of a rack bay, and had been removed when the first buyer had it.

If it had been still there, we would have kept it for authenticity, but it serves no useful purpose now, and as the original SPG units were missing we put in a more modern one for reliability. However, I had the sad remains of the one from North 1, and another one for spares, but put them aside as of low priority. By one of those fortunate coincidences we got in contact with Prof. Richard Ellis, who was formerly Head of Engineering at Pye TVT. He turned out to have worked on the Type 2 projects, and in fact had designed the SPG. He offered to take the units and restore them - no mean feat as one looked like it had been brought up from a shipwreck. Positioned directly under a roof vent and a window that had been open to the elements for nearly 30 years in North 1, it had suffered badly. Rain had trickled down into it, dead leaves had blown in, and various woodland creatures had made nests in the racks. I did not even know why I had bothered to bring it back, and it had nearly been scrapped as useless.

After some time and over 100 replaced transistors, not to mention other components, he had them working. Other parts have gradually surfaced, and slowly North 3 is getting back to as near original condition and working as possible. We are still going to the vintage shows and steam fairs, but there are other possibilities - people are fascinated to see the workings of an OB scanner and how the programmes were made. It is such a fast moving area of technology that the equipment of ten years ago is history, so that of 40 years ago is almost palaeontology. In a few years there will not be many people in the industry who remember anything other than digital file based systems – although no doubt the viewers will still be watching repeats of 'Dad's Army' and 'Fawlty Towers', shot on EMI 2001s and recorded on 2" Quads - on their 60 inch 8K resolution screens.

After embarking on this labour of love, you would think that I would have had enough of OB trucks, so when I had a call to say that one of the last BBC built scanners still in use was on it's way to the scrapyard, I wouldn't possibly be interested. Of course, I had to investigate, and like the mad old cat lady who can't see a stray put down, another scanner is sitting in the yard.
Twenty years newer, Type 7 London 23 is also receiving attention alongside North 3. So again I am looking for parts to refurbish it, and looking into its history. It was used to cover events from Prince Edward's wedding, to the inauguration of the President of Georgia in Tblisi, and the Queen meeting David Cameron after the 2010 election. It was first displayed at the IBA in 1990 and in 1999 it was converted to digital wide-screen video, at a cost of getting on for three-quarters of a million pounds. I know very little about digital video, having not encountered it professionally, but am quickly catching up. I doubt I will find the equipment repairable to component level, but it seems reasonably reliable. It's a different sort of project.

There is still a lot to be done on North 3, never mind the new project, and it is a never-ending process. It is at once very satisfying, yet endlessly frustrating, and has taken over any spare time that I had to a greater extent than I expected.
But, it has also brought me new friends, a lot of new experiences, and is continuing my education beyond what would have been retirement age had I still been working for ITV.

It was also a great surprise to be awarded the Duncan Neale trophy for Excellence in Preservation from the BVWS in 2014, quite an honour and very gratifying to see that others appreciate the work we have done to preserve this important piece of broadcasting history. Hopefully restoration will continue, although the more we get working, the more there is to go wrong, so actual progress slows down.

As to the question 'why?' - I suppose this has been the answer, in a little more detail than my ten second sound–bite allowed.

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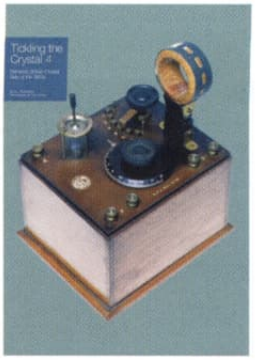

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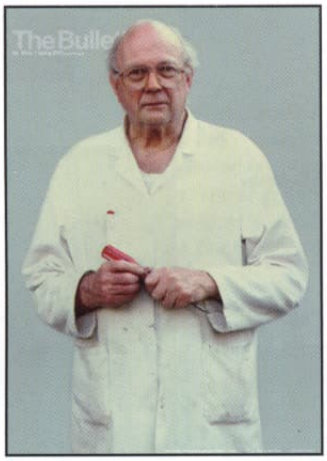

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Events Diary

2016 Meetings

February 7th Special auction at Royal Wootton Bassett
February 21st Audiojumble
March 6th Harpenden (Auction & AGM)
April 10th Golborne
May 15th NVCF
June 4th Garden Party at BVWATM
June 5th Cinema Museum London
July 3rd Royal Wootton Bassett
August 14th Punnetts Town
Sept 11th Murphy Day (to be confirmed)
Sept 25th Harpenden
October 2nd Audiojumble
November 6th Golborne
December 4th Royal Wootton Bassett

GPO Numbers

Martyn Bennett is the custodian of the BVWS GPO Registration Numbers list. As many members know, the project of assembling this list was started in the early days of the BVWS and was carried on by the late Pat Leggatt. Members are strongly urged to help build the list, whenever they get the opportunity, particularly as it is something that will help with the identification of vintage wireless in years to come. The list is by no means complete and the GPO no longer have a record of the numbers granted to wireless manufacturers. The BVWS Handbook contains the current listings - one in numerical order and one ordered by name. Please let Martyn have any additions, or suggestions for corrections, by mail or over the phone.

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The British Vintage Wireless and Television Museum:
For location and phone see advert in Bulletin.
Harpenden: Harpenden Public Halls, Southdown Rd. Harpenden. Doors open at 9:30, tickets for sale from 09:00, Auction at 13:00. Contact Vic Williamson, 01582 593102
Audiojumble: The Angel Leisure Centre, Tonbridge, Kent. Enquiries, 01892 540022
NVCF: National Vintage Communications Fair
See advert in Bulletin. www.nvcf.co.uk
Royal Wootton Bassett: The Memorial Hall, Station Rd. Wootton Bassett. Nr. Swindon (J16/M4). Doors open 10:00. Contact Mike Barker, 01380 860787
Golborne: Golborne: Golborne Parkside Sports & Community Club. Rivington Avenue, Golborne, Warrington. WA3 3HG
contact Mark Ryding 07861 234364
Punnetts Town: Punnetts Town Village Hall, Heathfield, East Sussex TN21 9DS (opposite school)
Contact John Howes 01435 830736
Mill Green Museum: Bush Hall Lane, Mill Green, Hatfield, AL9 5PD
For more details with maps to locations see the BVWS Website:
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