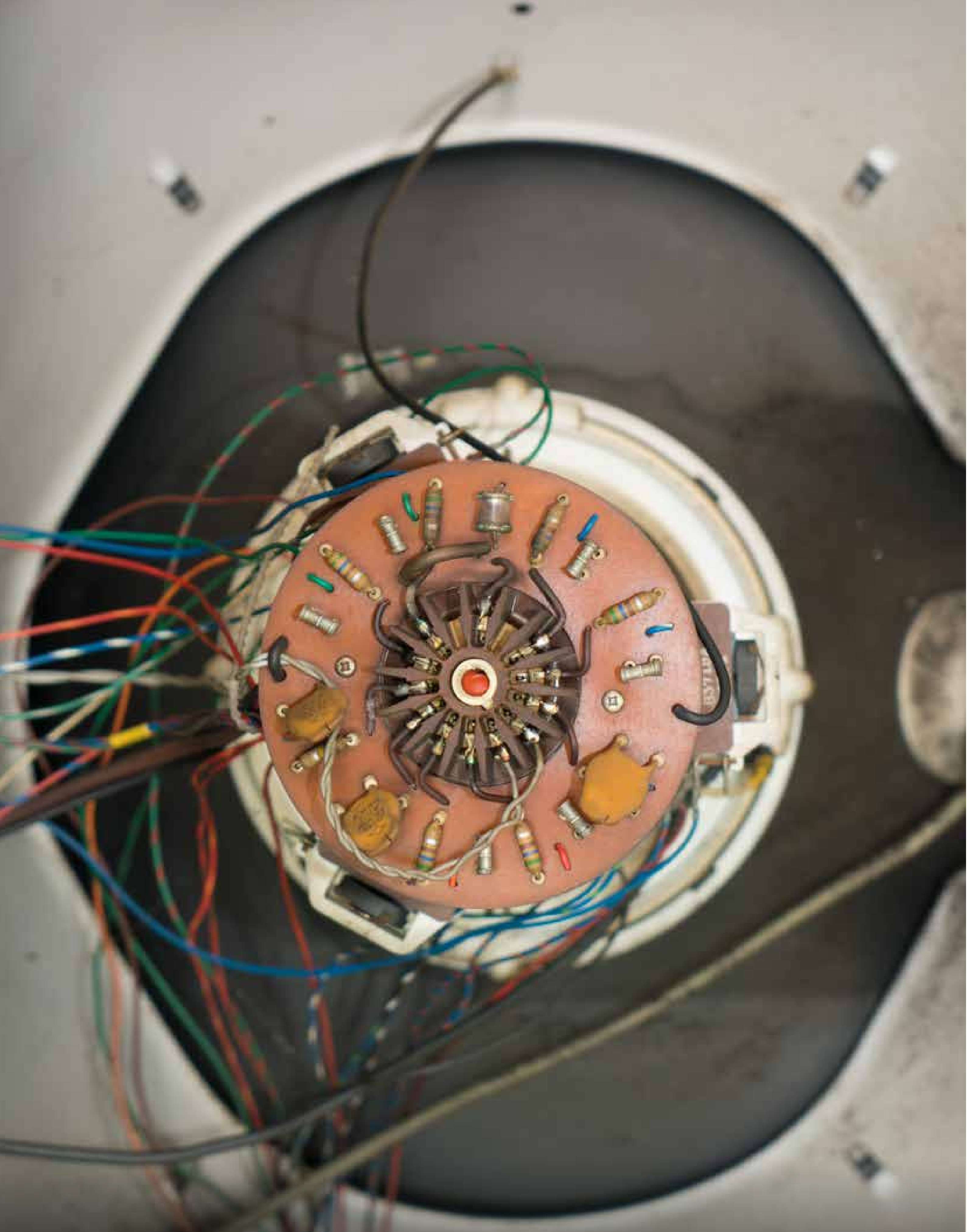

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BULLETIN

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Cover Images
A festive stack of colour televisions courtesy of Pete Dolman
From top to bottom:
Sony KV1310UB Portable
DECCA 60
Philips 21KX102A experimental

Photographed by Alex Hewitt
Edited by Alex Hewitt
Proof–reading by Mike Barker and Steve Sidaway

From the Chair...

Following the request for articles in the Autumn issue, I would like to thank you for responding to our plea! The Bulletin Editor has already started work on the Spring issue. But the flow of articles needs to be consistent, so do please continue to send anything in that you think might be of interest to the wider membership. Alex has provided some ideas of what might be suitable on the inside back page.

I have to report to you that in April this year the Society was subjected to internet fraud. The Treasurer started to receive emails from the 'Chairman' asking for amounts of money to be transferred to other accounts. It is not unusual for the Treasurer to be asked to do this since we handle the disposal of some quite substantial and valuable collections via our auctions and swap meets and consequently payments have to be made to individuals, benefactors or estate lawyers. It later transpired that the emails were not from the 'Chairman' but from a fraudster who had somehow obtained the identity of my AOL email address.

Four transfers amounting to £20,400 were made before the fifth one failed and the Treasurer contacted me to let me know. It was only at that stage that we became aware of what had happened. The Police were immediately informed and engaged their Operation Falcon Department who specialise with online crime. The fraud department at the bank used by the BVWS was also informed. The accounts, all UK based, to which the money had been transferred had been cleaned out by the fraudster(s) on receipt of funds and closed.

The investigation was closed when the Police Operation Falcon realised that they could not pursue it further. The following quote is from the final letter received from them:

"AOL is an email service provider based in the USA and as such they do not have to comply with law enforcement requests from outside their jurisdiction – from experience, we know that AOL will not provide us with the information needed to create further lines of enquiry in this case…."

The period of the Police investigation has been a stressful time for both the Treasurer and myself. We take on these voluntary committee tasks for no other reason than we enjoy the hobby and want to help others to do so. When a perpetrator takes advantage of our busy and obliging nature and we find ourselves involved in police investigations, it does make us think why we bother to take on this additional responsibility when our private and professional lives already burden us with enough. However, we are made of stronger stuff and will recover and continue to work hard for the Society to the benefit of all the members.

The Society remains in a solvent position. The Committee has looked at the financial arrangements and have agreed a new set of operating procedures designed to ensure that this cannot happen again.

In September, it was with great regret that I received the resignation from the committee of our Membership Secretary Martyn Bennett. Martin had held this office for 5 years, having served on the committee for 11 years in total. Together with his wife Anne, they dealt with all the annual membership renewals, new member applications, updating the database and everything else that this entails. On behalf of the Society, I thank them for their many, many hours of hard work and dedication.

The role of Membership Secretary is currently being handled by both the Treasurer and myself until we find someone who can take over the position. If you are interested and would like a chat about what is involved, please drop me an email and we can arrange a call.

Our Auctions Agent Mike is frequently travelling about the country bringing in collections which we are asked to dispose of, all too often after a fellow enthusiast has sadly passed on to the big workshop in the sky. It was a Swiss watch manufacturer who stated that "You never actually own it, you are merely looking after it for the next generation". Well the same is true of our collections. Consequently, the stores are at bursting point again so we'll be having an auction only event at Royal Wootton Bassett on Sunday 11th February, you'll find more details on page 61.

Your membership renewal form is enclosed with this Bulletin and you'll notice a few changes, you can now renew by debit/credit card or PayPal via the secure payments page on the BVWS website. The cost of paying by card/PayPal is now the same as paying by cheque, from January 2018 surcharges for card payment fees can no longer be applied.

We hope you enjoy the 2018 BVWS calendar. We have not produced a complimentary DVD this year - we don't have sufficient material of good enough quality or free of copyright issues. If you have any interesting content on any format please get in touch.

May I take this opportunity on behalf of the BVWS committee to wish you all a very Merry Christmas and a happy New Year!

Best regards

Greg

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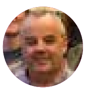
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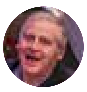
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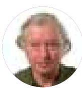
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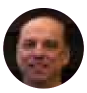
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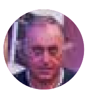
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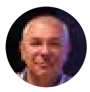
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The Chakophone Junior Two radio

Stef Niewiadomski

Having worked my way through numerous radios of the 1960s, 50s, 40s and 30s, I thought it was time to go backwards in time by another decade and to restore an example from the 1920s. There are still many of these radios about, especially home-made ones from this golden age of amateur radio construction, and they come up for sale at BVWS auctions regularly. I wanted one that was fairly compact for my first attempt but many of the ones you see are rather large.

Before I found a suitable radio at auction, I came across a two valve Chakophone Junior Two of 1927 vintage - made by the Eagle Engineering Company in Warwickshire - in an antiques shop, which is usually not the most cost effective way of acquiring a radio. In view of its compact size, the excellent condition of the 90-year old cabinet and the transfers on the front panel (see Figure 1), and that the two valves were present, I thought it worth the price I paid after a little downward negotiation.

Figure 1: Front view of the radio, showing the excellent condition of the front panel. The lettering is pretty much complete, apart from the worn Pull On and Push Off decals above and below the on-off switch.

The Chakophone brand and the Eagle Engineering company

Briefly, Guy Henry Champ and his partner George Ernest Osbourne Kay formed Champ, Kay and Company in 1919. Their early endeavours were in the repair and overhaul of motorcar lighting and starting sets, recharging batteries, and general electrical engineering. In 1922, as the radio boom started to take off, they progressed into the manufacture of radio parts, and operated a wireless receiving station so that customers could experience the wonder of radio reception. In 1923, Champ and Kay merged their company with the Eagle Engineering Company, which had started life in 1911, located in Saltisford, Warwickshire. The Eagle Engineering Company manufactured vehicle bodies, and so they had the expertise to build wireless sets in wooden cabinets, under the Chakophone (thought to be derived from Champ and Kay's surnames) brand from 1923 onwards. The venture continued until about 1936, when Champ opened a retail shop, selling Murphy radios and TVs, and presumably a condition of his becoming a Murphy agent was that the manufacture and sale of Chakophone-branded radios ceased. A search of the Radiomuseum website (Reference 1) shows 21 radios – a few crystal sets, several TRFs (including my Junior Two) and one superhet - bearing the Chakophone brand, though it's uncertain whether this is a full list. None of the radios listed has a schematic attached.

As for the Eagle Engineering Company, its long and successful history continues today. It eventually became Dennis Eagle - an independent business within Dennis Group plc – manufacturing dustcarts / refuse lorries, which it still does to this day.

BVWS member Andrew Humphriss has researched the origin of the Eagle Engineering Company and the Chakophone brand, and is a collector of their radios. For a fuller history of the company and its products, see Andrew's recent article in Practical Wireless (Reference 2).

5XX

A three-position switch on the front panel of my radio is marked 5XX, 1BBC and 2BBC: see Figure 2 for a close up of the markings around this switch, and the Chakophone branding. 5XX was established in July 1924 by the Marconi company in Chelmsford, broadcasting on 1600m (187.5kHz). About a year later, the Chelmsford transmitter was closed down, and the fledgling BBC adopted the 5XX callsign and started transmissions from Daventry, still on 1600m. By 1927, the 5XX Daventry station was shown in the Radio Times as 187kHz (1604m), which implies that either its frequency had changed, or that the original stated 1600m wavelength was a rounded-off version of its true value. There seems to be no consensus as to which is true.

In January 1929, under the Brussels plan, 5XX was allocated the 192kHz slot, and it moved up in frequency by a further 1kHz just a few months later. Around this time, the BBC dropped the call sign identities for its transmitters, and 5XX became the Long Wave National service, still on 192kHz. Implementation of the Lucerne plan in January 1934 resulted in Long Wave National's frequency moving to 200kHz (marked as 1500m on most radio dials) and during that year the BBC physically relocated the station to Droitwich. It remained as the Light Programme (Radio 2 from 1967) on 200kHz until 1988, when it shifted to its current frequency of 198kHz.

The upshot of the way 5XX's frequency varied over the years is that selecting the 5XX position on my Junior Two would position the listener firmly in the Long Wave, and 5XX or its later incarnations would be found close to its original position on the tuner dial.

The design

I couldn't find an original schematic for my Junior Two, but the design of a two valver at this time was fairly generic. As an example of a two valve radio of the period, I found the schematic of the Kendall-Price Two (see Figure 3) which was sold as a kit in about 1932. I used this to give me clues as I traced the circuit of the radio itself, which is shown in Figure 4.

The radio uses two triodes, specifically a Mullard PM1HL as a grid-leak detector, and a Mullard PM2A in the audio output stage. Both valves have 2V filaments, the PM1HL needing 100mA, and the PM2A 200mA, of DC. Printed labels around the base of both valves state 'There is practically no glow from this filament', presumably to warn users not to suspect a faulty valve if they saw little glow. In fact I could see no glow at all from perfectly good, working valves.

The PM2A is fed with its grid bias voltage from a dry battery mounted inside the cabinet. The valve takes negligible grid current and so the battery can be left permanently connected, but you need to be aware that if a radio using such a battery is out of use for a long period, the battery can degrade and leak into the cabinet – I've seen evidence of this on several vintage radios – which is not good news!

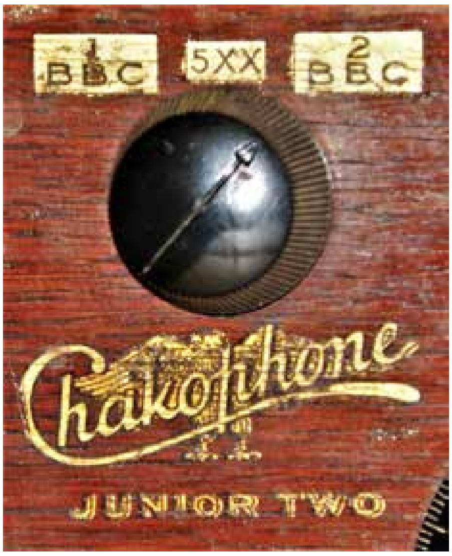

Figure 2: Close-up of the waveband switch and the 'Chakophone' branding on the front panel. Note the eagle behind the Chakophone lettering, presumably referencing the Eagle Engineering Company.

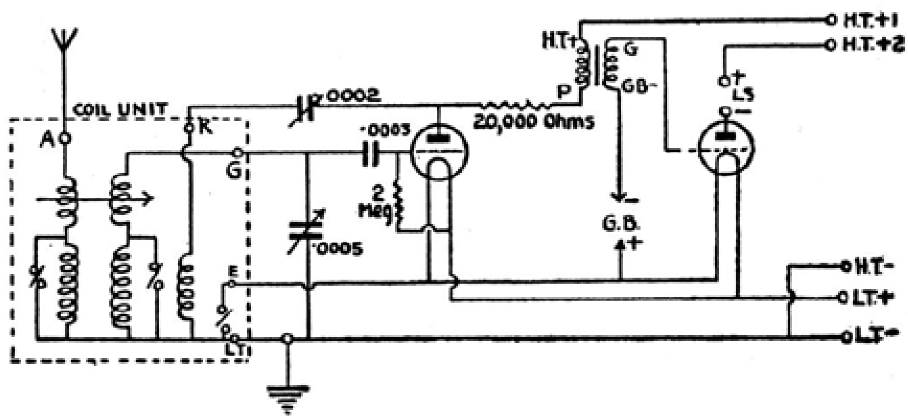

Figure 3: Schematic of the 1932-vintage Kendall-Price Two, which I used for hints to the circuit of my Junior Two.

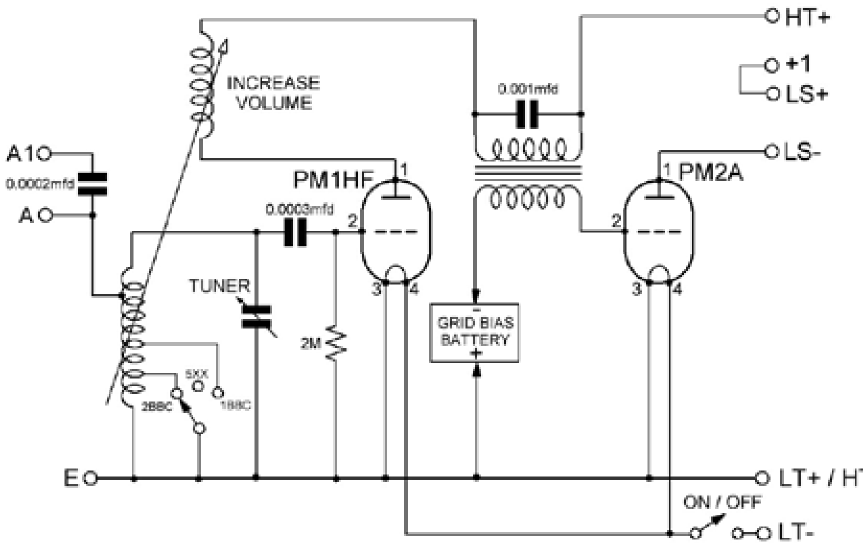

Figure 4: Schematic of my radio, traced from the radio itself. Note that there is no high frequency choke in the anode circuit of the detector valve.

The balloon shape of the PM2A is well known, but what is less well known is that in the 1930s Mullard produced a version with a shape like the octal-based G envelopes then being manufactured. See Figure 5 for these two shapes of the PM2A, the right hand one was kindly supplied to me by Mike Lewis.

An aerial can be connected either directly to the tap on the coil, or via a 0.0002µF (that is 200pF, marked 0.0002mfd on the component itself). The waveband switch selects taps at the earthy end of the coil: see later for the coverage obtained with the switch in its three positions. The Increase Volume knob on the front panel adjusts the angle of the reaction coil (in the anode circuit of the PM1HF valve) with respect to the tuning coil. This varies the coupling between the two coils, and hence the anode to grid feedback, which is how TRF reaction works. If the coupling is set too high, the circuit will oscillate, producing an annoying whistle on AM signals, but which was the recognised way of receiving CW signals. Demodulated audio passes through the coupling transformer to the grid of the PM2A, whose negative bias is set by the tapping on the grid bias battery. In many contemporary designs, an HF choke was included in the anode of the detector valve to prevent RF from reaching the audio valve. In the case of the Junior Two, this choke is not fitted – perhaps because of space and cost factors - and the intention seems to be to filter out RF with the 0.001mfd capacitor wired across the primary of the transformer.

High impedance headphones are connected in the anode circuit of the PM2A: the valve was spec'd to generate a maximum of 150mW, presumably at its maximum anode voltage of 150V. As you will see later, the valve is capable of producing a very reasonable volume into a speaker at a much lower voltage.

Making it work

At first, it wasn't obvious to me how to remove the cabinet to get access to the baseboard onto which most of the components are mounted. I removed the lid, and then rather randomly, I unscrewed the various woodscrews I could see, until I realised that only the four screws in the bottom needed to be removed to allow the cabinet to slide upwards, leaving the front panel, the baseboard and a small ebonite rear panel onto which the power, aerial, earth and speaker terminals are mounted. Figure 6 shows the cabinet removed from the front panel and base board.

I removed the two valves from their anti-vibration bases to give me better access to the wiring, and to allow dust and dirt to be brushed out of the baseboard. The filaments of both valves tested OK for continuity, but the glass envelope of the PM1HL was loose on its base.

All the components seemed to be present and the only obvious thing wrong with the radio was the perished insulation on some of the wiring. In fact, the wiring consisted of three distinct types: there was uninsulated wiring, low down in the chassis and made with stiff copper wire; then there was systoflex (or something similar) coated wire, used where wires crossed the uninsulated layer; and finally there was rubber-coated wiring for the 'top' level, used where flexible connections were needed (for example to the plugs connecting to the grid bias battery) and it was this rubber-coated wiring that was brittle and cracked.

I had some dark grey silicone-covered wire which was a good match for the perished flexible wires in the radio, so I used this to replace the flying leads to the grid bias battery plugs and a connection from the tuning capacitor to the grid coupling capacitor. As I unsoldered the original wires, the smell of burning rubber confirmed my suspicions as to the nature of their crumbling insulation.

Two more leads connected to the moving section of the coil, but their ends were not easily accessible and I didn't want to try to disassemble the coil assembly, and so I left them alone. They were positioned where they were in no danger of shorting to anything else or to each other, and so the perished insulation wasn't too important, except for the sake of appearance.

I could see three flat rectangular components and printed labels on them identified them as Chakophone-branded fixed mica capacitors. Their values were hand written onto the paper labels. A couple of these labels were loose so I carefully glued them back in place. Figure 7 shows these capacitors, along with the Chakophone audio coupling transformer and the PM1HF detector valve.

Most of the terminals of the rear panel (see Figure 8) still retained their knurled nuts, but sadly four were missing. I checked the thread and substituted 4BA brass nuts, so they would have to do until I could find nuts that were closer to the originals.

Supplying the power

In the Mullard data, the PM1HL is spec'd to work with anode voltages of 100V, 125V and 150V, with correspondingly more negative grid bias voltages from -1.5V to -3V, and an anode current between 1.0mA and 1.4mA. The PM2A needs a similar range of anode voltages, with grid voltages between -3V and

Figure 5: The two shapes of the PM2A as manufactured by Mullard. The left hand valve is the original balloon shape and on the right is the later, 1930s envelope style.

-6V, and an anode current between 5mA and 8mA. Typically, these radios were operated with rather lower HT voltages, perhaps 60V for the detector and 90V for the audio valve. I soldered two 1.5kΩ and a single 3.3kΩ resistor in series and connected the combination to about 120V. This would allow about 20mA to flow down the resistor chain and so I could tap off 90V for the PM2A HT (via the headphones) and 60V for the PM1HF HT. The relatively low HT currents of the two valves wouldn't seriously affect the voltages at the tapping points. Figure 9 shows the way I generated these voltages. I supplied the 2V for the filaments from a low voltage variable supply.

Mike Lewis kindly supplied me with a grid bias battery, an Ever Ready 'Winner' brand, which he had already gutted and installed six AA batteries. The batteries were rather tired and so I opened up the cardboard casing and changed them for fresh batteries, which was very easy because Mike's 'old' wiring was in perfect condition. I glued the joints together using Copydex, which should be easy to unpick when a new set of batteries is needed.

Figure 6: The cabinet, removed from the front panel and base board. The brass bracket holds the grid bias battery. The labels advise the user to use only BVA-manufactured valves, and that 'this instrument is licensed under Marconi Patents for the reception of broadcasting in Great Britain, Northern Ireland, the Irish Free State, the Channel Islands and the Isle of Man, but only for private use, and not for any public, commercial or revenue earning purposes' – you have been warned! It also reminds that a Post Office license is necessary and mentions that it contains two valves. Did the cost of the licence depend on how many valves the radio used?

Switch On

I inserted the original valves, connected power leads, aerial, earth and a set of 4kΩ headphones to the rear panel terminals, set the waveband switch to 5XX, and switched on the external power supplies. The radio has a front panel mounted push-pull on/off switch – which switches the LT- lead - with tarnished contacts, and this had to be cleaned before I could get any life out of the valves. The valves warmed up very quickly and I could get a few crackles and hiss from the radio, especially when I touched the PM1HF. I was concerned that the waveband switch would be unreliable as this type of switch, under the tension from a phosphor-bronze strip, simply moves a bronze ball into the three socket contacts without any great wiping action, which means that the contacts tend to become intermittent. I applied some finger pressure to the strip and better contact was made, and as I tuned around, I could hear Radio 4 in the headphones (positively identified by a news bulletin), confirming that this was the long wave position of the switch.

Increasing the volume control (which increases the amount of reaction) and fine tuning accurately to the broadcast brought it in at deafening volume! After a restoration, receiving the first signal is always an exciting event for me – especially so with this old radio. I had to de-tune away from the broadcast to obtain a comfortable listening level. I could also hear the Irish broadcast RTE Radio 1 on the 5XX band.

The radio was still very sensitive to being touched and so I tried a known-good PM1HF. This improved matters greatly: the microphony had gone away and the radio was even more sensitive. Switching to the 1BBC and 2BBC positions in turn brought in many medium wave broadcasts, including the usual suspects - BBC Radio 5 Live, TalkSport, Absolute Radio, Smooth Radio, BBC Radio Wales, BBC Radio Wiltshire (local to my location) and others. As I would expect with a TRF receiver, I could get a whistle by advancing the reaction control too far: the most sensitive and selective position is when the control is set just below the point of oscillation.

The waveband switch was still unreliable and so I removed and cleaned the ball, cleaned the contact sockets and tensioned the spring strip a little more, all of which made the switch behave rather better, but still not entirely reliable.

Figure 7: The audio coupling transformer, and the three mica capacitors - all with Chakophone branding and presumably produced locally at the Warwick location – and the PM1HF detector valve.

Figure 8: Rear view of the chassis, alongside my distinctly non-period loudspeaker. The connections to the Ever Ready Winner grid bias battery and the other power wiring can be seen.

Figure 10: The front panel of the Amplion Convette model M2V mains power supply connected to my radio. The Low Tension Adjustment control adjusts the position of the slider on a 16Ω potentiometer.

The volume in the headphones was so loud that I thought I'd try the PM2A driving a loudspeaker. I had a 5-inch speaker conveniently fitted with an output transformer fastened to its frame, and so I connected the primary of the transformer instead of the headphones, and switched on again. I was very pleased with the volume level from the speaker. I could hear many stations at loudspeaker volume as I tuned around. I later checked the transformer's primary impedance and it measured at 5kΩ, which was close enough to the PM2A's 3.6kΩ anode impedance to give a reasonable match.

Cabinet

The compact oak cabinet (11-inches wide by 7-inches high by 7¼-inches deep) and the fact that it was in very good condition, had attracted me to the radio. There were a few filled woodworm holes, but nothing active, and just a few nibbles taken out of two of the corners. I was keen not to damage any of the transfers on the front panel, so I simply wiped it carefully with a dry cloth to remove any dust. I then wiped down the rest of the cabinet with a damp cloth to remove surface grime and treated it with furniture oil which restored the original shine of the varnished surface. The lid in particular had lost its shine, presumably because of long term exposure to the sun, and the oil improved its appearance greatly.

Frequency coverage

Once the radio was working well, using an RF signal generator I measured its frequency coverage in the three positions the waveband switch:

5XX position: 150kHz (2000m) to 400kHz (749m).

1BBC position: 600kHz (500m) to 1350kHz (222m).

2BBC position: 450kHz (666m) to 1200kHz (250m).

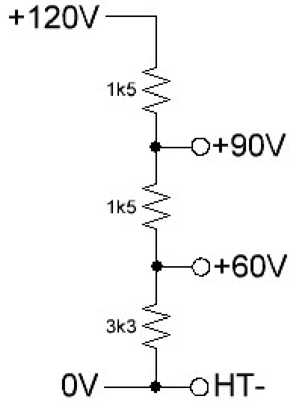

Figure 9: Schematic showing how the HT voltages were generated by a potential divider network from an external 120V supply.

The upper limit of the modern medium wave band is 1611kHz, and so the Junior Two doesn't quite reach up to this limit.

Amplion Convette

For a while I've had an unrestored Amplion Convette model M2V 'battery eliminator' power supply, designed for use with 2V filament radios like my Junior Two. I thought I'd bring it out, check it over and use it to power the radio. The original-looking 8000μF 3V LT smoothing electrolytic was dated January 1952, so I guess this dates when the unit was manufactured.

After removing the external self-tapping screws, I removed the cover and took a look inside. The components and wiring looked OK, apart from the mains lead which had only two cores, so I changed it for a three core version, and connected the steel cabinet to mains earth. I fitted a rubber grommet where the mains lead passed through the cabinet and fitted a 1A fuse into the plug. When I plugged the power supply into the mains, there was a spark which caused the fuse to blow. Looking carefully, I could see that mains live was shorting to earth on the mains voltage adjustment rotary switch. I re-arranged the wiring to eliminate the problem, fitted a new fuse and switched on again. Now all seemed to be well.

I measured the output voltages with no load connected: the HT outputs were all at 98V (this was as expected as no current was being drawn through the series resistors which produce the various HT voltages) and the LT output could be adjusted between 1.6V and 3.5V. I connected an external 6.8Ω resistor to the LT output to emulate the 300mA load of the Junior Two, and adjusted the voltage to as close to 2V as I could get. I connected the Convette to the Junior Two, as shown in Figure 10, and switched on. The radio worked well and was hum-free. I measured the HT voltages being fed to the radio: HT+ was 62V and HT+1 was 76V. These seemed close enough to the ideal voltages needed to power the radio.

Summary

Restoration of this radio proved to be a completely different experience from all the other radios I've worked on. The state of the wooden cabinet and chassis construction methods, and the simplicity of its circuit made the restoration comparatively simple, and I could trace the schematic fairly easily. Although components, including valves from this period, are still commonly available, I can imagine that finding an exact branded match for a missing component could be tricky.

At first I used a combination of external supplies to power my Junior Two, and then I carried out a quick restoration on an Amplion Convette battery eliminator and used it with the radio with good results. I was surprised that the valves warmed up and the radio came to life almost instantaneously, although I suppose it's fairly obvious that this should be the case since they are directly heated and so there is no cathode to warm up. I wonder how disappointed listeners were when indirectly heated valves appeared and they had to wait for maybe 30 seconds for 'new' radios to lumber into life.

Reception of many broadcasts using high impedance headphones was unbearably loud and the PM2A happily drove a modern loudspeaker – via an impedance-translating output transformer – at a very respectable volume level. I'll have to look out for a contemporary speaker to match the radio.

It's a remarkable testimony to the success of AM broadcasting that a radio constructed in 1927 (and others built many years earlier) can still receive broadcasts 90 years later. Despite the efforts of those who wish to close down AM broadcasting, long may this continue.

References

Reference 1: The Radiomuseum website can be found at: http://www.radiomuseum.org/.

Reference 2: 'The Chakophone Story' by Andrew Humphriss 2E0NDZ, published in the January 2017 issue of Practical Wireless.

Reference 3: A very useful history of the development of the BBC AM transmitter network can be found at: http://www.bbceng.info/Technical%20Reviews/dev_am_tx_nw_6a.pdf

Building a Pulse Counting FM tuner

David Smith

A rather forgotten technology can still offer great potential to the home constructor.

This is the story of how a chance find led to some old memories being revived and a new project being built. Two years ago, I went to a Golborne swap meet and on the BVWS stall I found a pile of old Practical Wireless magazines from 1967. I recognised most of them because I was a regular reader at the time. The asking price was a pound, which was too good to resist. In the collection was one from August 1967 whose front cover struck an immediate chord. It had a picture of an FM tuner on it (Figure 1).

It brought back to mind the FM tuner I had built as a teenager from another design in 1969 Practical Wireless (February & March 1969) (Ref 1). After re-reading these old magazines I thought I might attempt another FM tuner, possibly a valve one. Most of the circuits I looked at were impracticable to build because they specified inductors for the RF, IF and discriminator stages that are almost impossible to find nowadays. After much research on the internet I found a design for a valve FM tuner that I liked the look of. Most of the circuitry has its origins over sixty years ago. It is a superheterodyne receiver with excellent sound quality. I have been very pleased with the results and I thought others might be interested and perhaps like to try it for themselves. I needed nothing more than hand tools to build it. There are no obscure or difficult to come by parts and no IF circuits to align. The receiver is slightly more complex to operate than a normal FM radio but you soon get used to that.

The tuner uses a pulse counting discriminator to generate an audio signal from the frequency modulated signal. The usual discriminators for FM reception are well known; the ratio detector and the names Foster-Seeley and Round-Travis will all be familiar. These require careful adjustment using equipment that may not be available to the home constructor. The pulse counting discriminator enjoyed a brief period of popularity with home constructors from the mid-fifties to the mid-sixties – it eventually fell from favour when regular stereo broadcasts first began in 1966 because it turned out that the design is not suitable for effective stereo decoding. If however you are content with a mono output then this design may be for you.

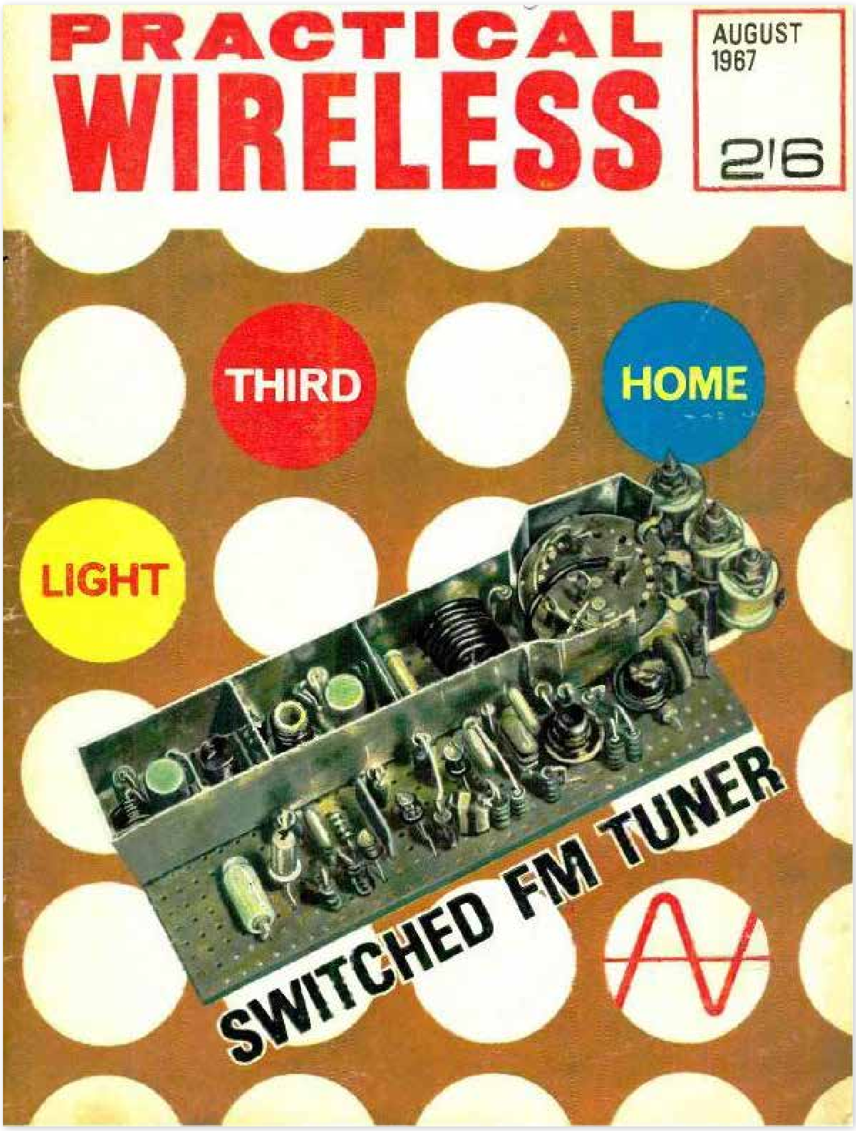

Figure 1: Front cover Practical Wireless August 1967

What is a pulse counting discriminator?

In outline an FM tuner with a pulse counting discriminator is a superheterodyne receiver with a very low IF (approx 150 – 200 kHz) and as a result the IF circuits can be RC coupled. The FM signal is amplified and then limited, i.e. clipped, into an approximation of a square wave as happens with the more usual designs. It is then differentiated by an RC circuit that drives a simple frequency to voltage converter where voltage output is directly proportional to the frequency of the input signal. The result is the original audio signal. There are no IF or discriminator circuits to align and nothing to go out of adjustment. The audio quality is very good indeed; the pulse counting discriminator was actually first developed during the early forties as a broadcast monitor in the United States. The original January 1942 paper by Seeley, Kimball and Barco was reprinted in 1947 in an RCA Review on Frequency Modulation which is available on line (Ref 2). It was very insensitive but for use as a broadcast station monitor that did not matter.

History of the pulse counting discriminator

Before building the pulse counting FM tuner I wanted to understand as fully as I could how it worked and I traced its history back to the following key references. All the magazine references I have quoted can be found at the American radio history website; this is a superb resource and well worth exploring if you have not come across it before.

In the UK the first mention of a pulse counting discriminator is by Thomas Roddam in Wireless World in 1948 (Ref 3); he asked “Why Align Discriminators?” and described the mechanism of the pulse counting discriminator. He provided an example of a working discriminator circuit but not a fully worked out receiver circuit. Nothing much seems to have happened then with this design until 1955 when Wireless World (Ref 4) published a letter from a reader asking what had happened to Thomas Roddam’s circuit and enquiring whether it really worked. In April 1956, M. G. Scroggie, writing in Wireless World (Ref 5), answered that it did indeed work and presented a very clear and thorough analysis of the processes involved, which is well worth reading. The article showed why a low IF frequency of about 150 kHz is essential to the circuit. It also includes an assessment of the distortion levels, which are very low, and an explanation as to why the circuit is not prone to image response problems. In June 1956 Scroggie published a further article in Wireless World (Ref 6) in which he described a complete FM tuner using the pulse counting discriminator circuit.

The design by Scroggie used four EF80 valves, an ECC81 valve and three germanium diodes; it required a power supply of 200 Volts at 28mA. The IF circuit, the limiter circuit and the discriminator circuit, which includes de-emphasis and low pass filtering, are still being used by constructors today. The circuit was switch tuned which was feasible because there were only three FM stations available in the UK at the time: the BBC Home, Light and Third Programmes. The circuit of Scroggie’s limiter, discriminator and de-emphasis design is shown in Figure 2.

The sensitivity of the design is rather low compared to conventional FM superheteterodyne receivers that use a 10.7MHz IF. The RF stages were more or less conventional LC circuits; the local oscillator operated at about 30MHz with the third harmonic used to heterodyne with the incoming 90MHz, or thereabouts, signal. An oscillator with a frequency of about 45MHz could have been constructed, with its second harmonic being used, but the idea was rejected at the time on the grounds of possible interference with BBC Television transmissions in VHF Band I (41 to 68 MHz in Europe). The AF output was of the order of 100mV and does need to be fed into a high impedance such as a valve amplifier.

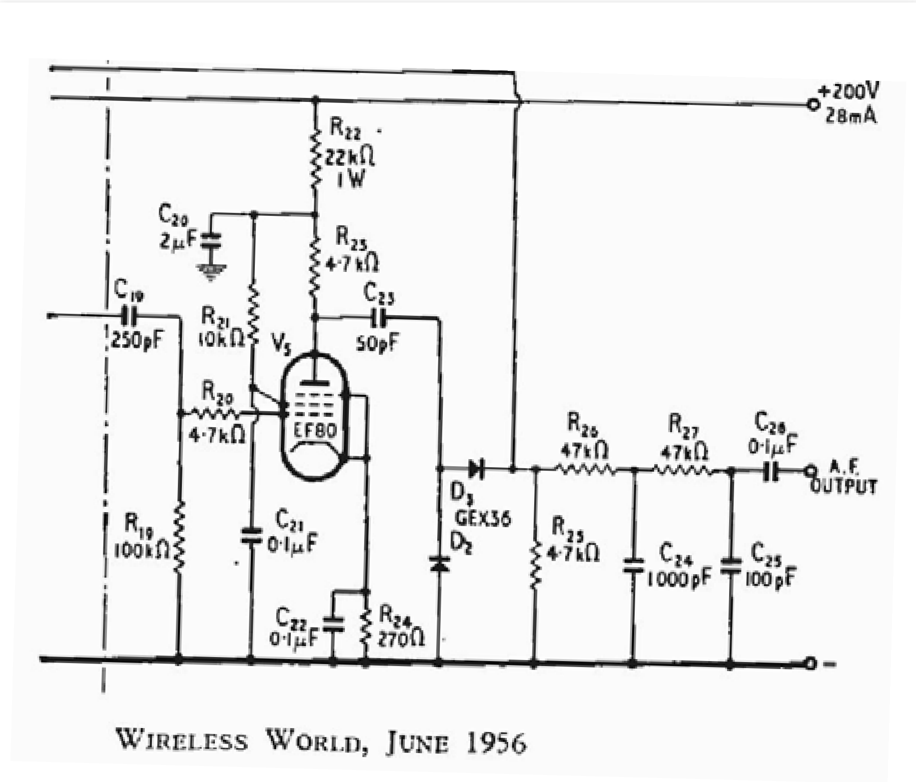

Figure 2: Scroggie’s limiter, discriminator and de-emphasis circuit

In April 1958 Wireless World (Ref 7) published a follow up article by Scroggie in which he reported on readers experiences with the design and provided a crystal controlled option which, as there were still only the three BBC FM stations available at that time, would have been a viable, if rather expensive, option.

After that, Wireless World did publish more constructional articles for FM tuners using pulse counting discriminators but they used transistors instead of valves. The first of these was in July 1964 (Ref 8) and was a constructional project with a crystal controlled, ten transistor circuit.

Two valve based designs were published in Practical Wireless in the 1960’s. The most significant of these was by D. V. Debbage in the February 1967 edition of Practical Wireless (Ref 9). The IF and discriminator stages were much as described by Scroggie in Wireless World (Ref 6) but the RF front end broke new ground by proposing the use of a very simple autodyne converter, where the valve performs as both the oscillator and mixer, to generate the required 150 kHz IF frequency. This design used continuous tuning rather than the switched tuning that had been used up until that time. This bought a slight disadvantage; because of the low IF frequency there are two tuning points for each station received, one on the high side of the carrier frequency and one on the low side. In addition, Debbage’s autodyne converter is open to criticism because there is no RF stage to isolate the local oscillator from the aerial, which could lead to interference being radiated. Apart from that, this design greatly simplified the circuit, which must have made it appealing to many constructors.

However, by the mid-sixties, a problem had started to appear with the pulse counting discriminator, whether implemented with valves or transistors. In the UK, the BBC had started experimental stereo broadcasts in 1962 and by 1966 the first regular stereo radio transmissions had begun from the Wrotham transmitter. Stereo broadcasts around the world use the GE-Zenith FM stereo transmission system that requires a total bandwidth of 53 kHz. With its low IF frequency the pulse counting discriminator did not handle this bandwidth well and stereo decoders did not work properly when fed with a signal from one of these receivers. A number of attempts were made to solve this problem, such as using dual conversion circuits or raising the IF to around 300 kHz. None of these proved very satisfactory. In 1971 D. E. O’N. Waddington, writing in Wireless World (Ref 10), stated that none of the pulse counting discriminators using single conversion circuits is suitable for stereo decoding. This appears to be the definitive statement on the subject and, apart from a transistor design in Radio Constructor by R A Penfold in 1974 (Ref 11), I have not found any more published articles in magazines for FM tuners using a pulse counting discriminator.

A number of commercial Hi-Fi tuners using pulse counting discriminators were made until the early eighties. These were complex and expensive designs; examples were made by Fisher (TFM-1000), Kenwood (KT-917) and Pioneer (F-90). Some of these now go for high prices on internet auction sites. Readers might

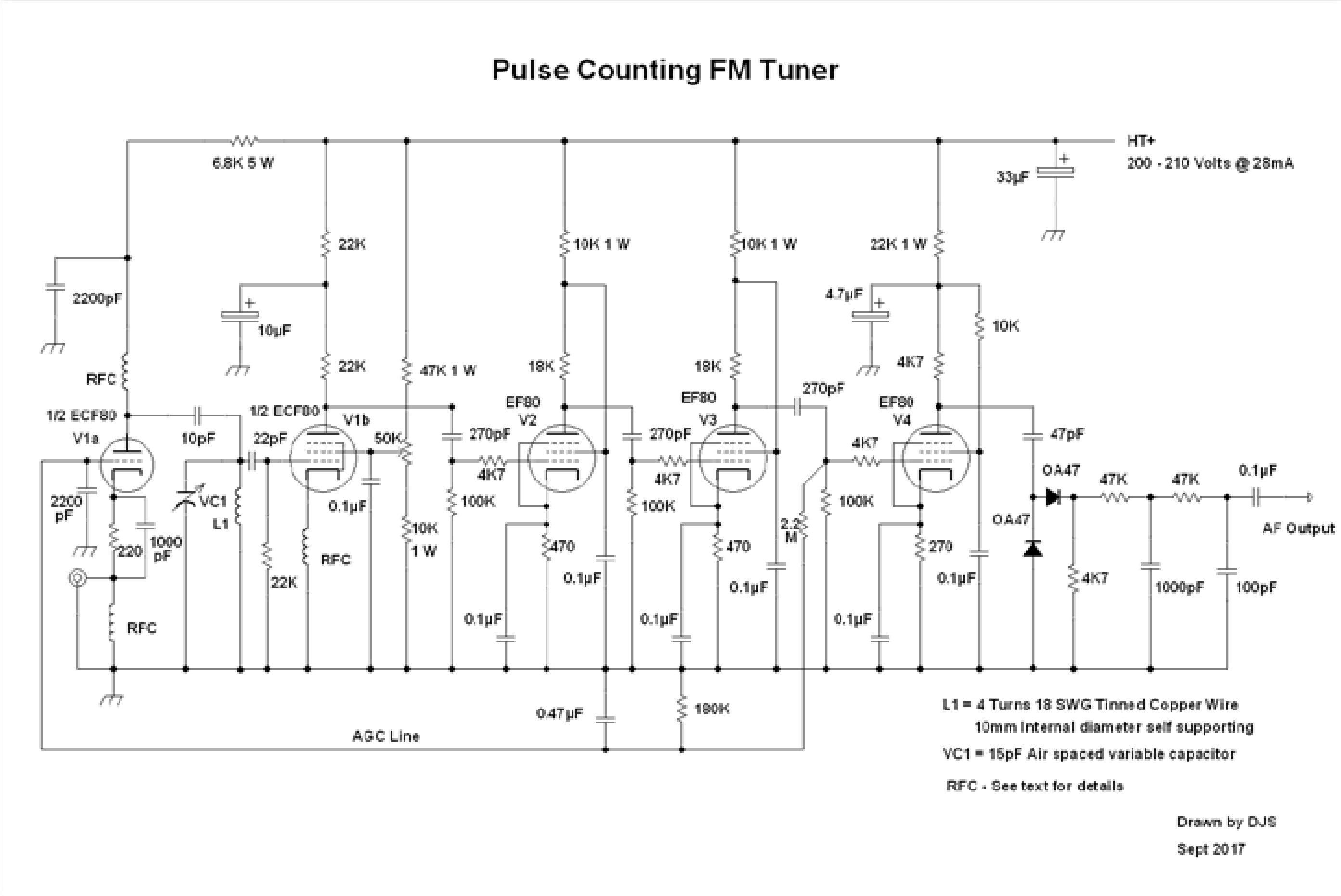

Figure 3: Circuit diagram of the Pulse Counting FM Tuner

also remember the Sinclair Micro FM receiver; this too boasted a pulse counting discriminator.

Recent developments with Pulse Counting receivers

More recently, an Australian constructor, John Hunter, has published on his website (Ref 12), a number of designs for pulse counting FM receivers using valves. The IF, limiter and discriminator stages are based on the Wireless World design by M. G. Scroggie in 1956 (Ref 6). The frequency conversion stages however use an autodyne circuit, preceded by an untuned grounded grid RF stage for isolation from the aerial. The frequency conversion circuitry was designed by John Hunter around an ECF80 valve. The website also provides plenty of excellent advice on construction of VHF circuitry. I studied the designs on the website and selected what I considered the most straightforward one (Design No.4); this uses Scroggie's original IF, limiter and discriminator circuits with the addition of an AGC circuit. Scroggie had reported that there was not much difference between using a double diode valve or two germanium diodes in the discriminator circuitry. John Hunter used a double diode valve and I used germanium diodes to save space and for ease of construction. The final circuit that I built uses one ECF80 valve, three EF80 valves and two germanium diodes. I have redrawn the receiver circuit with germanium diodes (Figure 3).

There is only one tuning coil, L1. It is self-supporting and consists of four turns of 18SWG tinned copper wire with 10mm internal diameter; I wound my coil on the shaft of a 10mm drill bit. See Figure 4.

For the tuning capacitor I used one of about 20pF; it is air spaced and incorporates a high quality slow motion drive. I got it from Birkett's shop in Lincoln. I think some form of slow motion drive is almost essential for ease of tuning.

The three RF chokes around V1 (ECF80) are home made in accordance with the recommendations made on the website. I made mine from 75 cm of 24 SWG enamelled copper wire wound on 6 mm wooden dowel. The long leads in the picture are for ease of handling when they were made – they are cut as short as possible when they are soldered in place. See Figure 5.

I used standard quality components throughout with the exception of the coupling capacitors in the IF and discriminator stages; I opted to use silver mica capacitors in those positions. This may be overkill. One thing I should definitely have done is to use gold plated valve sockets rather than the nickel plated ones I bought; I subsequently found that the gold plated ones are much easier to solder and this makes a real difference when components are densely packed.

I used OA47 germanium diodes in the discriminator. I used these because I had them available. I think any germanium diodes would work although it would obviously be wise to ensure they are both the same type numbers.

I opted to use a separate power supply and a separate valve audio amplifier. The tuner does need to be fed into a high impedance and I have found that a FET source follower circuit works just as well in this respect as a valve amplifier. I constructed one from a design in Practical Wireless April 1970 (Ref 13) which works very well and gives me the flexibility to connect the receiver to a transistor amplifier.

Figure 4: My tuning coil

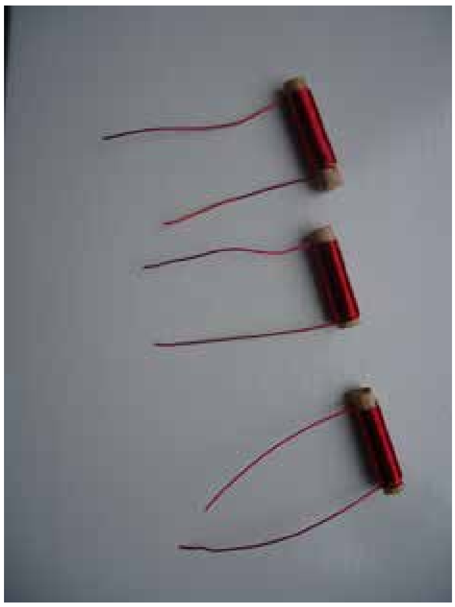

Figure 5: My homemade RF chokes

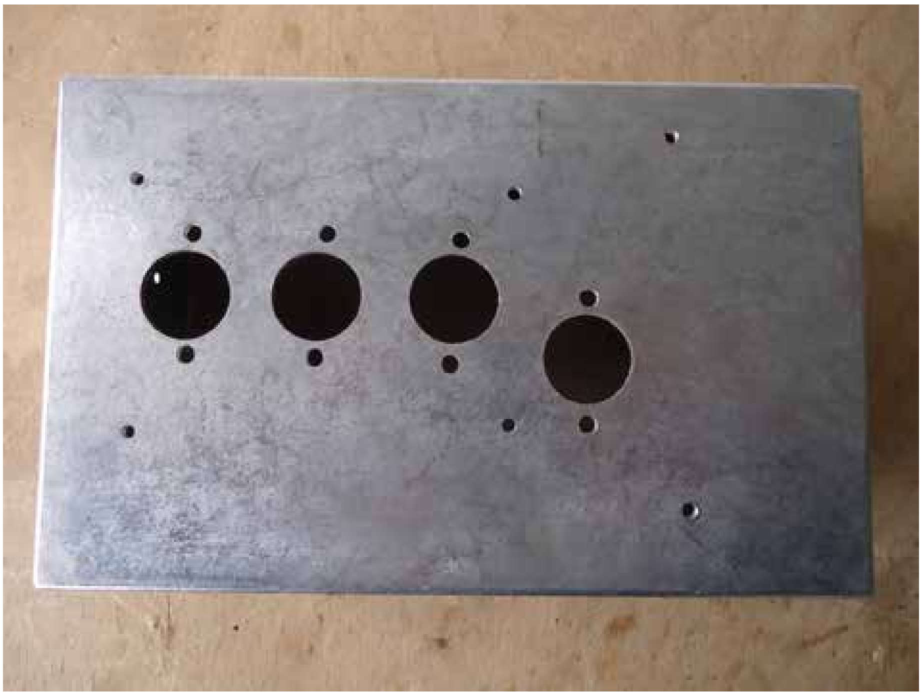

Figure 6: The chassis drilled and punched

Construction of the FM tuner

I knew that construction at VHF frequencies would be critical, requiring a metal chassis, short leads and solid earthing practices. I thought a die-cast box would be ideal and used a Hammond one measuring 188 x 120 x 82mm. I got mine from Maplin but they are widely available. I had no layout diagram to work from for this project so I needed to develop my own. Fitting the tuning capacitor correctly would be critical and would dictate the rest of the layout and, in particular, the components associated with V1 the ECF80 valve. I therefore measured the chassis, prepared the mounting holes and bolted the tuning capacitor to the die-cast box. The tuning capacitor I used is quite bulky, because it has AM sections as well as FM sections, and took up a lot of room leaving less space than I would have liked for the other components. I could have solved the problem by mounting the tuning capacitor on top of the chassis but this looks untidy, would be prone to damage and would gather dust.

I then worked out a layout for the chassis, which turned out to be a time consuming business. I planned to assemble the discriminator and de-emphasis components, including the two germanium diodes on a piece of tag board that could then be bolted in place as a complete section with only two external connections.

Chassis preparation

I drilled the die-cast aluminium chassis to accommodate the remaining controls mounting tags and sockets in accordance with my plan. I did not encounter any particular problems in doing this although cutting the four B9A valve holder holes was hard work. See Figure 6.

I then loosely fitted the various controls, tag strips and sockets on to the chassis to ensure there would be no nasty surprises later on. As a result of doing this I found the socket for the ECF80 valve needed to be re-orientated to keep the tuned circuit wiring as short as possible; the socket hole remained the same but I drilled two new fixing holes which allowed the socket to be rotated by approx 30 degrees. I also re-orientated the tag board for the discriminator and de-emphasis circuitry by rotating it through ninety degrees. With these changes made, I was satisfied that the intended layout was as good as I could make it. See Figure 7.

Most of the pieces of hardware were then mounted onto the chassis; this includes the valve bases, aerial socket, output socket, power sockets and tag strips. One component that I did not mount at this stage was the tuning capacitor; most of the circuitry around V1, the ECF80 valve, could be assembled more easily with this component not in place. I first wired up the heater circuits, using a twisted pair feeder kept as close to the chassis as I could. I soldered 0.1μF Mylar capacitors across each valve heater. The heater circuit was earthed only at V1, the ECF80 valve. The tag board holding the discriminator and de-emphasis circuits was assembled and the completed tag board bolted onto the side of the chassis and connected to the output phono socket using screened cable. See Figure 8.

The valve socket centre spigots were earthed to chassis using solid copper wire. Doing this ensures a solid RF ground plane for the valves.

The receiver was then wired up, working backwards from the output stage to the RF stage. I planned the wiring around the RF valve, V1, very carefully. The wiring itself was carried out slowly, double-checking my work before soldering each connection. Any wiring errors or inadvertent short circuits in this circuitry would be very difficult to identify and correct because of the density of components around V1. The three RF chokes are visible around the valve holder for V1. See Figure 9.

Finally, I was ready to solder in place the few remaining components and bolt the tuning capacitor in place. The tuning coil was the last item I soldered in place; you can see it by the side of the tuning capacitor. See Figure 10.

I was quite pleased with the external appearance of the receiver; Figures 11 & 12 show front and back views of the completed receiver.

Testing the receiver

I had found the RF stage so difficult to build that it was the following day before I could bring myself to test the set. I half expected it not to work at all. I connected an aerial to the set, then the external power supply unit and finally connected the output to my valve amplifier. Much to my relief the tuner worked first time with no minor adjustments or faultfinding necessary. The 88 – 108MHz frequency range was fully covered and no adjustment to the tuning coil was necessary. The slow motion drive made tuning easy and I quickly found that the set was very stable and quiet in operation. There are twin tuning points as the local oscillator tunes from the low side to the high side of the carrier frequency but

Figure 7: The various controls, sockets and tag strips loosely mounted

Figure 8: Discriminator tag strip in place and valve heaters wired up


Figure 9: Nearing completion


Figure 10: The completed receiver


Figure 11: Front view of completed receiver


Figure 12: Rear view of completed receiver

you soon get used to this and, in practice, it is not a problem. There are no hand capacitance effects when tuning the receiver. There is, of course, no inter-station muting with this design. I was very impressed with just how good the sound quality is when tuned in, with no hiss, hum or sibilance on voices. It is also untiring to listen to for longer periods. For maximum sensitivity the oscillation level control needs to be set at the point where the tuner has just gone into oscillation; this requires adjustment as you tune through the band. If you are content with your local radio stations you can find the optimum setting for the oscillation control and more or less leave it alone after that. I have found that my tuner shows virtually no drift in frequency even after hours of use.

Conclusion

Building this tuner was more difficult than I thought it would be. The main difficulty is the density of components around VI, the ECF80 valve. Rigid construction, using short leads, bypassing the valve heaters and attention to earthing have all undoubtedly played their part in making the construction of this FM receiver a success. The sound quality is indeed excellent and the result has justified the effort that went into planning and construction of the tuner.

I hope that I have aroused some interest in a piece of vintage technology that has rather been lost sight of but can deliver high quality sound to the home constructor without requiring access to expensive equipment to set it up.

References

All of the Wireless World, Practical Wireless and Radio Constructor magazine references can be found at www.americanradiohistory.com

Follow the Path: Home > Bookshelf & International > United Kingdom and select from the drop down boxes

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2. Generation and Detection of Frequency-Modulated Waves by S. W. Seeley, C. N. Kimball and A. A. Barco. http://www.njarc.org/books/Frequency%20Modulation%20-%20RCA%20Review%20-%201948/Rca1948FrequencyModulationVol1_text.pdf

3. Why Align Discriminators? by Thomas Roddam Wireless World July 1948

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A tale of three DACs

Scott Elliot

I have three Bush DAC 90A's in my small collection of vintage radios; each came into my possession through very different routes and as with all my radios, how I wish they could tell their life stories prior to ending up with me.

DAC number 1

DAC No.1 however is the exception – I do know its history – because it was purchased new by my wife's Uncle and remained in their family. I hold this radio especially dear, not only for the family connection, but because it's the radio that got me into vintage radio restoration in the first place…

About ten years ago, my wife presented me with what appeared to be a cardboard box full of junk. It turned out to be the result of a failed attempt by someone at repairing an old radio, which had been abandoned and left in a state of partial disassembly. In an attempt to save it from eternal landfill, some bright spark suggested, "maybe Scott can do something with it"!

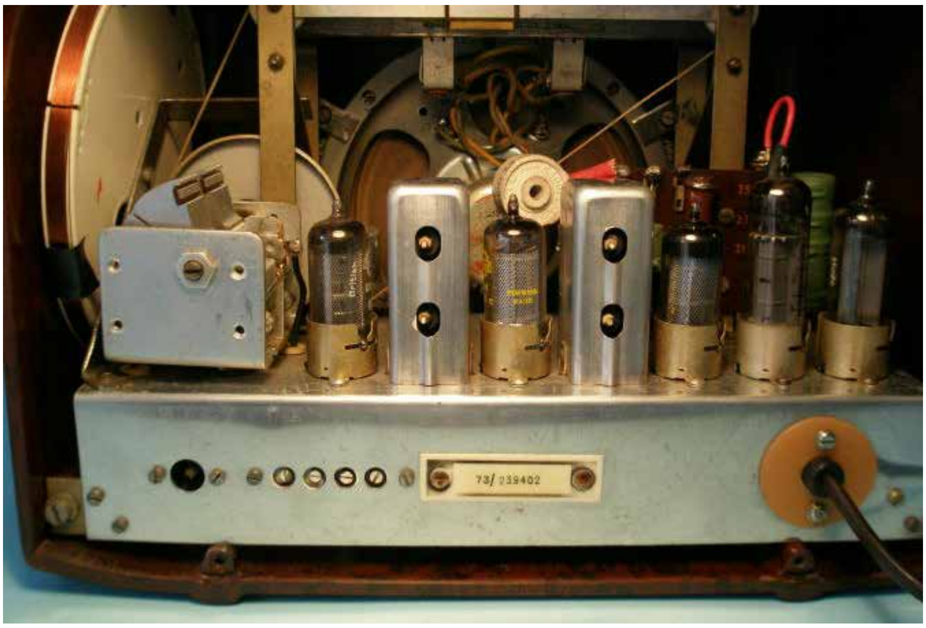
The chassis had been removed from the case, so I noticed straight away that it was a valve set, and a sudden pang of nostalgia swept over me. A quick mental calculation told me that it must be at least thirty-five years since I had clapped eyes on a valve. During the valve era I worked mainly on HF and VHF communications equipment including 10 kilowatt transmitters. I had never worked on commercial radio receivers or television professionally; so the little glass valves I beheld were in one sense familiar – yet strangely unfamiliar at the same time.

I took some time pondering what to do about the "wreck". It had a dark brown mottled Bakelite case, which was actually quite attractive in spite of a large split on the underside. The chassis and other mechanical parts had some corrosion and rust in places which all led me to believe that it had spent at least some of its life in a damp place and had been dropped from a great height! I began thinking that the reason for its demise

The DAC trio

was probably because it had faulty valves and I knew for sure it would be impossible to obtain any of those nowadays. I was slowly coming to the conclusion that an attempt to "do something with it" was a bit futile. The writing on the back cover said "Bush Radio AC-DC Mains Receiver Type DAC90A."

It was more out of curiosity than anything else that made me search "DAC90A" on the Internet – and WOW! I was utterly amazed at the amount of information that instantly filled the screen. I quickly realised that vintage radio collecting and restoration is a big subject and very much alive. Even valves and circuit diagrams seemed to be readily available, which I thought was quite incredible; I got a strange feeling that a new hobby was lurking just around the corner!



DAC number 1 - Restored chassis

I thought the best way to tackle the project would be to initially do the minimum work necessary to see if it could be brought back to life, and if it could, then a cosmetic makeover may be justified later. I didn't want to spend hours removing rust etc. if it turned out to be a lost cause. I purchased the Bush service data and the appropriate Trader Sheet via the Internet and was ready to make a start. There was a waxy capacitor that had been removed from the set, lying in the box. This turned out to be the mains filter, so I decided to leave it out for the time being. The reservoir and smoothing capacitors seemed in good order with no obvious bulging out at the ends, and a quick test with a digital multi-meter between each terminal in turn and the chassis showed an initial low resistance, which quickly went very high. I was therefore happy that the capacitors were probably functional and that no short circuits existed between the HT line and chassis. The wiring to the mains input voltage adjustor was devoid of any insulation and of course the brass adjustor retaining nut itself is a bit of a high voltage hazard, so I temporarily covered both with insulating tape. The two-pin mains plug, which is integral to the chassis, was also rather precarious in as much as its supporting paxolin mount was cracked. However, when the mains lead socket was plugged in, a certain amount of rigidity was restored, so that problem too, was added to the "do it later" list. The next thing was the mains polarity. I had noticed from the circuit diagram that one side of the mains supply went to chassis via a 75-ohm scale lamp shunt resistor (and the lamps). With the mains plug and socket not being polarised, I wanted to make sure that it was the neutral not the live that went to the chassis. Whilst doing this, I also checked that there was continuity from the mains 13-amp plug pins, through the on-off switch (part of the volume control), to the mains dropper and the chassis. I considered that what I had done so far was the minimum of checks I could get away with prior to switching the set on. The loudspeaker, which was still fitted within the Bakelite case, was connected up to the twisted pair of wires coming from the audio output transformer.

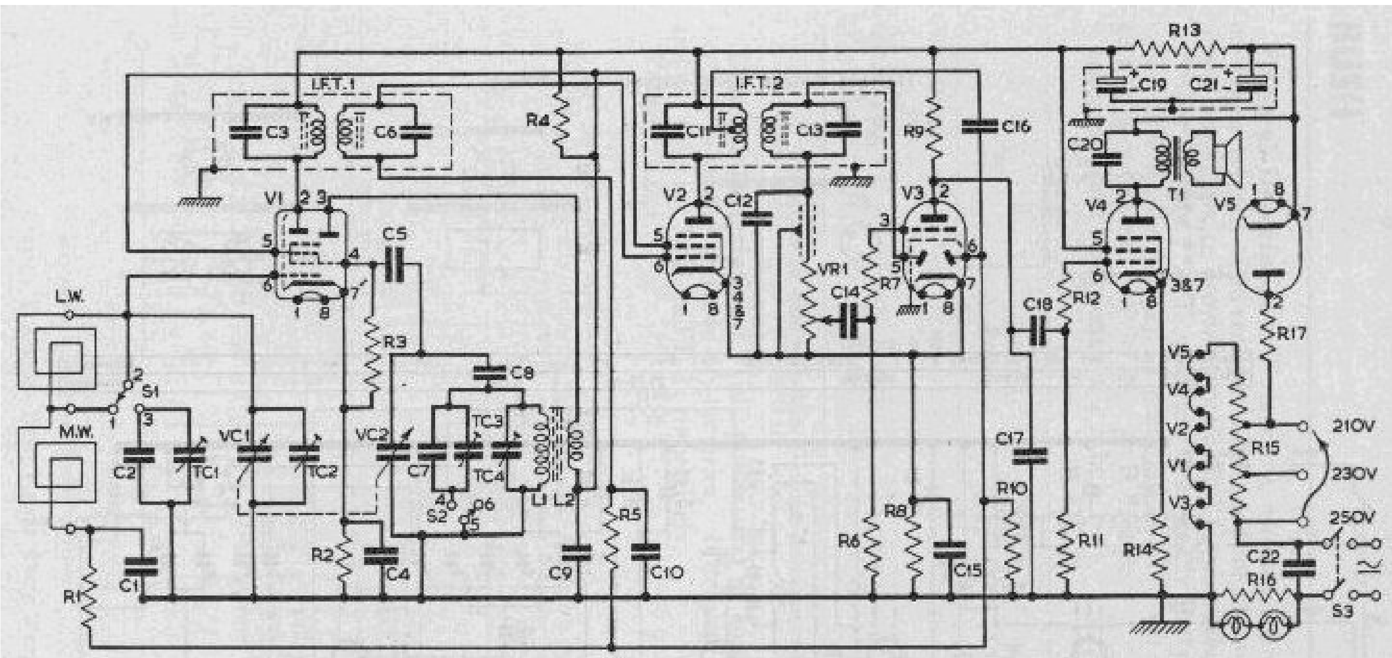
The multi-meter was connected between the smoothing capacitor positive terminal and chassis and the set switched on. The dial lights lit up quite brightly but then quickly faded away – as did my hopes of being lucky enough to have a working set. But just as I was wondering what to do next, the meter started to count up, 50, 60, 70, 90 volts, and the dial lights were starting to get brighter again. A faint hum was emanating from the loudspeaker. I had forgotten how long it takes a mains valve set to warm up! I adjusted the volume control which produced lots of crackling from the ‘speaker, but as the tuning control was rotated, lots of stations were being received across the medium wave band. I switched to long wave and was able to tune in four stations, one of which was French and another Irish, so I came to the conclusion that the sensitivity of the set was probably ok.

After the set had been on for about twenty minutes there was a horrible sound of arcing or sparking coming from somewhere, but then cleared after a few seconds, and the set continued to work fine. There were no telltale signs of smoke or smell, and after switching the set off to do a visual inspection, nothing untoward could be found. I ran the set again and after about half an hour the same arcing sound was heard – again just for a few seconds or so with no apparent detriment to the receivers performance afterwards. It occurred to me that if indeed there was some arcing going on, then maybe if I darkened the room I might be able to see where it was coming from. I didn’t have a workshop at this time and was carrying out the work on my dining room table. I simply drew the curtains, watched and waited… and waited… and waited… and eventually it happened. V3 the double diode triode lit up in spectacular form, attempting to produce most of the colours of the rainbow! After such a display, it was hard to believe that it could continue working normally again – but that’s exactly what it did.

DAC number 1

I promptly ordered a “new old stock” Mullard UBC41 from the Internet. Whilst awaiting the arrival of the replacement valve I continued working on the radio, the faulty valve not being bad enough often enough to be a major problem for now. However, a different problem soon reared its head. The set suddenly refused to receive any stations at all on either wave band, yet there was still the faint hum from the ‘speaker and much crackling when the volume control was adjusted. As mentioned earlier, some corrosion was apparent on the chassis, and this was concentrated around V1, V2, and V3 valve bases, so with the set switched on and still tuned to where it was last receiving a station, I gently waggled the valves in turn, and as V2, the IF amplifier was moved, the set came to life again. I could replicate the fault by rocking V2 slightly so concluded that it was probably a valve base problem.

On trying to extricate V2 from its base I had a bit of bad luck. The valve was in so tightly that I couldn’t get it out. I eventually must have produced enough force in the right direction, because not only did the valve shoot out of the base but it shot out of my hand also! Gravity got the upper hand just in time to prevent the valve from hitting the ceiling, but on its return path my attempt to catch it merely deflected it away from a relatively soft carpet landing to the hard tiled floor of the kitchen. The result was entirely predictable, so it was amid much cursing and self-chastisement that another email was sent, ordering a NOS Mullard UF41!



DAC 90A circuit diagram

With V2 valve base now exposed it could be seen that some of its contacts were white with corrosion. The two halves of the contacts looked too widely spaced and I suspected they had lost their springiness and causing intermittent contact with the valve pins. This was confirmed as I tried to push the two halves closer together with the aid of two sharp meter probes. The contacts simply broke in two. I did notice however that most of the valve bases had some contacts that were not connected, and as luck would have it those were in good condition and easy to remove. So I harvested enough of the "spare" contacts to replace the worst ones in V1, V2, and V3 bases. The springiness and tightness of all the contacts were then tested using a pin from the smashed UF41, and squirts of switch cleaner were administered at the same time. Cleaning all the valve pins using very fine wet and dry paper completed this task.

When the two new valves arrived they were quickly fitted and the set soak tested. All seemed to be well, so I saw no reason not to continue with the restoration. In the meantime, I had read that the old wax capacitors are notoriously bad for going electrically leaky and is particularly bad news if it's the one that couples the audio to the grid of the output valve as this could make the grid positive causing the valve to burn out. In spite of my set sounding fine (at least to my ears) I thought it wise to check the capacitor anyway. I snipped the capacitor lead that went to the grid and connected the meter between the free lead and chassis. Then, with the set switched on, the meter was seen to be reading voltage and therefore the capacitor was obviously leaking. I tested the tone corrector capacitor in a similar way and found it to be leaky as well. Both were replaced with modern equivalents, and in view of these findings, the mains filter capacitor was hastily discarded and replaced with a modern "mains rated" one. Out of interest, I later checked the old mains filter capacitor with the meter and found it read zero ohms! So maybe the mains filter was the original fault, which would be causing the set to constantly blow fuses.

I considered that the three capacitors replaced were probably the most critical ones, but could any of the others be leaky too? I thought if I determined the total current taken by the set and compared this with the maker's data, it would give a good assessment. I did a couple of quick calculations to check what the total current consumption of the set was. By measuring the exact value of V4 cathode resistor and then measuring the voltage across it, the current taken by V4 was calculated using ohms law. The current through the HT smoothing resistor was then calculated by the same method. The results were that, according to the maker's service data, the current taken by V4 was correct and the current through the HT smoother was 3mA less than the sum of the stated currents taken by the other valves. Rightly or wrongly, I decided that if there was any more leakage going on, it wasn't enough to worry about, so didn't replace any more capacitors.

The wiring was tackled next by replacing any that had lost its insulation. This was mainly in the area around the mains adjuster and dropper, no doubt caused by the heat from the latter. The two-pin mains input plug, as mentioned earlier, also needed attention. I couldn't see any safe way to repair it so decided to eliminate it altogether by hard wiring the mains lead through the chassis to the on / off switch. This was achieved by replacing the two-pin plug with a circular piece of glass fibreboard after drilling and fitting it with a plastic cable clamp. On connecting the mains cable, I used heat resist sleeving on the wires between the cable clamp and the on / off switch. I also made sure that it was the neutral lead that went (via one pole of the on/off switch) to the chassis. Some time was spent removing the corrosion and rust from the various parts of the chassis using Brasso, cloths, cotton buds and elbow grease.

The moving parts associated with the tuning mechanism were lightly oiled where appropriate and the slider with the dial pointer attached was given a smear of grease, care being taken not to get any oil or grease on the dial cord itself. The wave change switch contacts and the volume control were treated to a dose of switch cleaner plus a spot of oil on their spindles. The volume control could now be operated without any crackling being heard from the loudspeaker.

The large tuning coil cum frame aerial had lost a couple of turns of its wire over the edge of its plastic former. An attempt at sliding them back into place proved unsuccessful, so the end of the wire had to be unsoldered from its tag in order to create some slack. The wire was then rewound onto the plastic former and re-terminated. Some tape was used to prevent this from happening again in the future.

The split in the case although quite severe was easily filled and strengthened from the inside by using lots of Araldite. It is still noticeable from the outside, but only if the radio is turned upside down! The wave-change knob looked like it had been nibbled by a hungry parrot, but I suspect the real cause of its demise was by someone, having pulled the volume and tuning knobs off, thought that the same could be done with the wave-change knob. I can only imagine the ensuing combination of frustration, a small screwdriver and brute-force, which ensured the poor knob would never be the same again! It is of course retained on the spindle by a grub screw accessible from the inside of the case. I attempted a repair on the knob by building up the missing bits – again using Araldite. I added black and brown paint to the Araldite as I mixed it to try and camouflage the repair, but can only claim mediocre success. The rest of the restoration was really just down to cleaning and polishing. The dial and its fixing components were removed for cleaning but the inside of the dial itself was only lightly dusted with a soft dry cloth for fear of damaging it. Bakelite polishing paste No.5 worked its magic on the case – inside and out.

The chassis was finally re-fitted inside the case and after a few calculations to convert Mhz to Metres it was found that stations seemed to be more or less where they should be on the dial; I didn't have the necessary equipment to do re-alignments anyway. But – the annual National Vintage Communications Fair was on my radar…

DAC number 2

DAC No.2 was purchased from a dealer at the following NVCF for £35. I was attracted to this one mainly because of the distinctive pattern and colour of the Bakelite, which was darker with a deeper lustre than DAC No.1. I noticed that its knobs and dial were also different from No.1; a bit of research showed that the DAC 90A had three different types of knob over its production lifetime and quite a few different colours of dial as well. Going by

DAC number 2

DAC number 3

DAC number 3 - Case interior

DAC number 3 - chassis as found

the knobs I concluded that DAC No.1 was from the 'youngest batch' and No.2 from the oldest, which was released in February 1950. Their serial numbers also seemed to confirm this.

In spite of being older, DAC No.2 was in very good condition with very little needing doing to it internally or externally. I replaced the mains filter capacitor as a precaution and performed the usual 'cold' checks before switching the set on. As with No.1, the output coupling and tone corrector capacitors were found to be leaky, so were replaced. A soak test revealed an intermittent fault, which turned out to be the 'lower' section of the dropper resistor going open circuit. The faulty section was replaced with a suitable fixed resistor, the former being isolated so that it couldn't shunt anything when it decided to start working again! The set did however have a bit of a low frequency 'growl' in the background, which became noticeable when listening at low volume levels. I borrowed V4 (UL41, audio output) valve from DAC No.1, which silenced the hum. I suspect the UL41 was suffering from a bit of heater to cathode leakage. Around this time, I discovered (via the Internet) that according to Mullard, UL41 pin 4 is connected internally and should be kept floating, but Bush use pin 4 as a 'spare' wiring terminal on DAC90A's. I modified both sets so that pin 4 was floating and the result was that even with its original UL41 fitted, DAC No.2 was still hum free! I can only conclude that provided pin 4 is kept unconnected (as its supposed to be) then some degree of heater/ cathode leakage can be tolerated. I purchased a UL41 anyway and kept it as a spare.

DAC number 3

DAC No.3 was somewhat more reluctant to cross my path. I became aware that a cream coloured case version of the DAC 90A had been manufactured, so from then on I had been on the lookout for one to complete the trio. The problem was, any that I did come across always had, at best a brown scorch mark on the case and at worst a hole burnt right through it! I saw one in good condition at a NVCF, but with a price tag of £90 it was more than I was prepared to pay. So the search continued.

One day whilst on holiday in Oxfordshire I visited Henley-on-Thames. On such occasions, I always like to rummage through all the antique/junk shops that I can find, and here I thought I'd found a good one. It was huge – and definitely more 'junk' than 'antique'! Just how I like them. However, size isn't everything and my search for any old radios within it was starting to look unfruitful. After some considerable time, I reluctantly concluded that there were no radios here and started moving towards the exit door. As I approached the door, in the corner of my eye I noticed a recess, which was actually the 'cubby hole' under a flight of stairs, and in that confined space I spotted a cardboard box with the picture of a radio on it. Halt! About turn! The radio in the box turned out to be quite modern, but it had done its job by luring me further into the dark recess.

DAC trio chassis

In the dim light under the stairs I could just make out the outline of what looked very much like an old radio. I picked it up and took it into the light. I had struck gold! It was a cream DAC 90A. Not only that, there were no cracks or burn marks anywhere to be seen. As an added bonus, its dial and knobs were different from my other two, the latter dating it to the 'middle' part of the 90A's production period; just what I wanted. The only downside was, like the one at the NVCF it too had a price tag of £90! One word sprung to mind – barter!

On taking the radio to the proprietor to discuss the price, he said, "make me an offer I can't refuse". I said "£40". He said, "50?" I said, "Done!" (And hoped I hadn't been). The radio was complete with its original mains lead connected and as it also had a 13-amp plug on the other end, the proprietor offered to plug it in to "see if it still works"! I quickly declined with as much composure as I could muster!

Back home, the radio was examined and found to be near perfect. Even the inside of the case didn't have any scorch marks near the dropper resistor, the heat from which seems to cause so many problems with cream cases. It also holds the record for having the most undisturbed dust I have ever seen in a radio! The usual three capacitors were replaced and I isolated V4 pin4, but nothing else electrical needed to be done. There was no rust or corrosion anywhere and it's hard to believe that the radio had ever been used; it really does look brand new. In fact, you could almost say that it's the restoration that never was!

Conclusion

Where would we be without a bit of good luck occasionally?

Audiojumble, September 2017

Photos by Carl Glover

Quad 33 control unit + Quad FM3 Tuner

BBC Marconi AXBT Microphone

AVO VCM MK3 Valve Tester

Restoration heaven – the Ferrograph series 420 stereo tape recorder

By Terry Martini-Yates

Ferrograph were once the reel to reel recorder marque that the serious home recordist aspired to own, and which were as the saying goes, built like a battleship. With good reason of course as for many years, the firm supplied industry, the military, they were used by broadcasters such as the BBC, sold around the world and could be found in the well-heeled recording enthusiast's home.

Originally a subsidiary of Wright and Weaire, and formed in 1948, The Ferrograph Co were the first British firm to have completely designed and produced a magnetic tape recorder from scratch for the UK market in 1949. By the early 1960s, the signs of a change in the fortunes of the firm due to the competition that was emerging from Japan and the Continent (in particular Germany, Holland and Switzerland) was just starting to make its presence felt, along with a significant number of home grown UK manufacturers both big and small all vying for a piece of the action. Clearly the firm had to come up with new models in an effort to keep its share of the market. The Ferrograph Series 420 was one of those new designs; a serious attempt to woo the hi-fi market with a half-track stereo machine that had inherited all of the honest to goodness engineering, but subtly redesigned under the hood, to take advantage of advances in the industry, without compromising on quality. The 420 is the subject of this restoration heaven article.

Fig 1 This image gives an indication of the general state of the machine when first found.

A potted history of the Series 420

The 420 came to market in late 1961, and sported a number of features not previously found on any of the earlier Ferrograph machines. (The 420 is often incorrectly described as the stereo series 4; this was an honour that was actually bestowed on the model 808, its short lived predecessor) The Series 420 pedigree can be traced back even further to the early 1950s when the firm first marketed staggered head, dual channel machines to industry, the slightly later Series 77, 88 and finally 808 stacked head, stereo tape recorders for the semi-professional market, and a bolt on stereo unit for existing users with mono recorders and marketed as the "Stereo Ad". None of these models were common place even then and are a rare find today due to the expense of the equipment, along with the public's lack of enthusiasm in general with stereo from tape. Even the high quality EMI Stereosonic tape recordings of the mid 1950's failed to make any significant impact. By the early 1960's though, fortunes had changed and stereo from tape was becoming the next must have; the rest as they say is history.

Some of the existing Ferrograph design such as the twin amplifier chassis (required to house both sets of record and replay channels) was common across the Series 420's predecessors. What differed with the 420 was the exclusive use of double triode valves throughout (ECC82s and ECC83s) a radical departure from the electrically noisier EF86 pentodes that had seen extensive use by Ferrograph in their designs up until this machine first appeared, (and even beyond) with the re-design also simplifying some of the chassis layout. Other notable points saw DC supplied valve heaters in the pre-amplifier stages (a useful hum reduction measure) and a push pull bias erase oscillator. A cathode follower output was catered for along with all connections fitted on the rear of the machine; the list goes on. The 420 however is not in itself a particularly rare machine given the number still around and like a lot of Ferrograph equipment, has gained quite a following; with a reputation that has almost been handed down. Fuelled by the resurgence in recent years in an interest in analogue recording in general, certain Ferrograph models such as the 422 and its later sibling the Series 632, having certain kudos, can command fairly large sums on internet auctions sites such as EBay.

A brief look at the spec

The Ferrograph Series 420 is a twin speed (3.75 and 7.5ips) three head (Erase, Record and Replay), half-track stereo recorder; the model under discussion is designated 422. A second version appeared as the 424 with a ¼ track replay head that could be moved up and down on its vertical plane to allow the user to correctly align a ½ track recording as desired; this was an additional selling point that gave the user further scope particularly as ¼ track stereo tape records had started to appear on the market (having first gained popularity in the US and to whom this feature was aimed at). The lever is fitted to all the 420 models and has a fixed plate in place at the rear of the head that can be removed if the user decided to upgrade the ½ track replay head to ¼ track replay in the future. Full ¼ track models offering recording facilities with this track width also appeared in due course confusingly also numbered 424.

Home models were designated with a "U". Models were also exported overseas through Ferrograph's overseas network of dealers. The story goes that the company consulted with several hundred of its existing users over a new design which culminated in the eventual release of the Series 420 initially, with NAB (1) correction only.

The cost of the Ferrograph 420 when new (taken from a February 1962 advert) was quoted as 110 guineas (about £2,230 in 2017 money).

A third setting was fitted on the equalisation control for CCIR (2) correction for tapes recorded with this characteristic, and was introduced as a modification on the machine during a very early production run of the recorders. NAB was an unusual move for

Ferrograph as this would have been to special order as a rule, as it was more usual to issue machines with CCIR correction as a European standard, rather than the other way about.

The American HI-FI market are the most likely influences here, as Ferrograph had already a degree of success with the marketing of earlier models in the US. (3) The frequency response of the recorder was 40 Hz to 10 KHz at 3.375 ips and 40Hz to 15 kHz at 7.5ips. Wow and flutter at 7.5ips was less than 0.16%. The series 4 Wearite tape deck was employed as standard. The performance at the lower speed despite the specification, could be described as just adequate and nothing particularly special. At 7.5ips, the machine easily out performed many of its close rivals of the period, and it is not difficult to see why Ferrograph were so highly regarded in terms of audio quality and performance. In fact recordings made at this higher speed "sparkle".

Fig 2 A rare glimpse of the very early version of the Series 420 can be seen in this Ferrograph leaflet before the equalisation switch was modified. The machine is also fitted with a different style of control knobs. It is unknown if any of these machines actually left the Simonside factory.

Fig 3 Ferrograph's more familiar version of the 420 atop the special table that had been designed and produced for Ferrograph by Will Beck Ltd, contract furniture maker. The quoted price for this was £7-10-6d (£154.00 in 2017)

The firm also incorporated the new type of Sifam recording level meter that had been designed for them and that had appeared a little earlier on the Mark 2 series 4 mono recorders. The new design of meter retained the famous reverse movement and incorporated a new design of window which was bevelled and designed to be mounted inset, allowing for a general tidy up of the front panel. As noted previously, all connections were made on standard ¼ jack sockets located in a recess to the rear left of the machine, (looking at it from the front) one of the first of the firm's models to do so as standard. The 420 was also the first Ferrograph recorder to introduce semiconductor diodes in place of the traditionally fitted EZ80 rectifier valve. In fact the power supply has two sets of rectifiers fitted, one for the HT and the other to supply DC to the pre-amplifier valve heaters.

By a very strange quirk of fate

The machine came into the collection as a donation quite by chance. An initial enquiry via my website from a London based musician led to not one, but two Ferrograph tape recorders (the other being a series 5 mono recorder) being offered. The problem was that neither was in good shape and they were being offered to me for spares only as they were in such poor condition. A couple of emailed photos confirmed the state of things and if I didn't want to take them in, it was off to the tip with them. As it was to transpire, they had once belonged to a friend of the enquirer who was also a fellow musician and who had been based in Sheffield, and had recently passed away. Both machines needed to be cleared quickly, so an arrangement was made to collect both of them from Fulham in London at a later date (where they had ended up for safe keeping).

No Ferrographs were harmed while writing this article!

Now for the avid Ferrograph collector such as myself, breaking up any machine for spares is a last resort, once both machines had been collected, the 420 stood out as the worst of the two, lacking a lid, missing cosmetic parts, and had clearly suffered during a period of prolonged poor storage, acquired thick layers of dust and dirt and one or two species of indigenous spider, both of which had once lived in the deep recesses of the machine and even inside the replay head assembly. When potential scrap machines turn up this way though they can come in handy for spares, and when a machine has to be reluctantly broken up because it is really beyond any form of repair, any useable parts will get saved for reuse. The spares collection didn't gain anything this time and actually came to the rescue of the 420, as we will see later. The machine in question was actually eminently suited for restoration!

With the resurgence in analogue recording in general, the Ferrograph and other vintage high end equipment is often sought out by musicians seeking the valve sound as part of the digital recording chain to impart an analogue quality on the work being recorded onto a PC. This can also involve using machines such as the Ferrograph simply as a straight through amplifier to get this effect. Whether or not this had been the intention of the previous owner, by the time the machines had been rescued from their fate, it looked as if they had lain in storage for a very long while.

At the other end of the scale are the thankfully, very small number of people involved in deliberately breaking up these venerable machines for their valves, transformers and other high value parts. Incorrectly pedalling the transformers as made "by Partridge" when it is an actual fact that the firm produced most things in house, including all their own high quality wound components such as the various types of transformers found in these recorders. Wright and Weaire In fact built their reputation on coil winding (although I don't doubt that the firm would have been chuffed to bits to learn of the comparisons made!). Unfortunately this is one of several unsavoury practices these machines can suffer from. In some cases the deck and cabinet are completely thrown out

4 A wider view of the general state of the tape path area of the deck and the recently deceased livestock whose home had occupied most of the replay head.

Fig 5 The general view of the front amplifier chassis showing the layout of the valves associated with the recording amplifiers and meter circuit. Note the sticky pool of electrolyte on top of the capacitor towards the lower left of the picture.

Fig 6 This view of the magnetic heads with their mu-metal shields removed shows just how much further tape oxide and general dirt was found.

Fig 7 Yuk! What a mess. The screen printing will have to be cleaned very carefully to avoid removing what remains of it.

Fig 8 Treacle anyone? This is how the bearing races were found once the capstan had been completely disassembled.

Fig 9 This view of the control knob area fitted on a later series of deck shows quite clearly the wear and tear generally inflicted upon it and the things to look for.

and the amplifier and chassis are modified and fitted into a new case; these are being sold for large sums of money as guitar amplifiers and often appear on eBay in a disguised form.

I am not interested in resorting to any of these practices and so the process of getting the 420 back into service presented another opportunity to save what really is a superb bit of British engineering (not that I really needed yet another Ferrograph).

It was time to attend to what missing or had been got at on the 420 and focusing on getting the machine back up and running. A lot of people shy away from this type of restoration work due to the perception that a tape recorder such as the Ferrograph is far too complex to repair. Granted there is more to consider here but it should not really present any more trouble than fixing say a good quality stereo valve amplifier and if you have worked on record player auto-changers, then the tape deck is really not

Fig 10 This shows one part of the assembly that needs to be cleaned and re-greased. Wear on this roller guide and the deck function cam can impede smooth operation of the deck

that much more complicated to understand and work on. Confidence and sufficient time is all that is required and most of the faults encountered are generally minor in nature.

In addition to the usual workshop test equipment, having access to a reproduce alignment tape to set the machine up is also an essential, especially if any preset adjustments have been fiddled with or the heads have been wrongly adjusted; how this is achieved is discussed later on in the article. (It is not just vintage radio that suffers in the hands of the inexperienced when it comes to “pot twiddling”).

Ferrograph produced a hard bound manual for all of its principal models and these are fairly easy to come by, often turning up for a couple of pounds at swap meets and are a worthwhile investment. These sorts of things often part company with the original machine as does the mains lead! There are many similarities across the mono series of the valve based models produced in the years the Ferrograph was popular, the Series 420 amplifier circuitry is very different however and the exact manual will be required before any work is started.

Fifty shades of battleship grey

It was time to get the workshop vacuum out and clear out the years of thick dust, cobwebs, spider remains and old bits of recording tape to see what we would be up against. With this done it was evident that the machine had probably not seen that much use. Part of the give-away is the raised control knob escution, and the surrounding area of deck plate. When the deck has seen extensive use, there are often tell tail signs such as paint loss, along with scratches and gouges in the metalwork. Other tell-tale areas are the general wear and tear that can manifest itself on the guide posts, tape bobbins, general deck mechanics, and on the magnetic heads. Often the toil of the tape editing razor blade will have left multiple marks and score lines in the paint work, perhaps indicating a pretty hard life in a small studio.

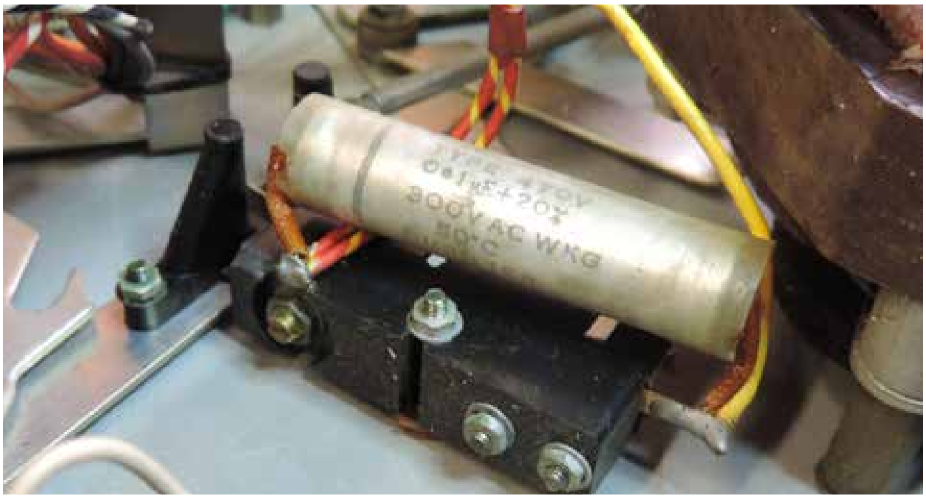


Fig 11 The main stop switch fitted underside of the deck. The capacitor seen here (C2) should always be renewed with a class X2 rated equivalent before a problem arises.

With experience, you can often tell how much mileage a machine has done by a keen eye. On some later Ferrograph machines such as the one here, the amplifier panel legends are screen printed in silver and this starts to rub off over time and with use, and is another good indication of its former life; This though was also in fairly good condition. Overall, none of the areas examined showed any particularly heavy use and the conclusion was that the machine probably saw less than average use over the years before it ended up as it was found.

Cosmetically, the 422 was missing the equalisation knob and front lid catches. The cabinet lid was missing. The spool that was with the machine was very dirty and damaged (this was removed for cleaning and a repair later). There were small sections of leather cloth that had lifted from the cabinet and the remains of masking tape clumsily stuck down in one or two places; there was a tiny screw lodged in one side of the cabinet rear that defied any explanation for being there. The head pads were missing on the replay head and in poor condition on the two others. The Wearite deck was also filthy dirty and the head box cover was missing. A very thick layer of dirt and grime covered the whole deck but it was otherwise intact.

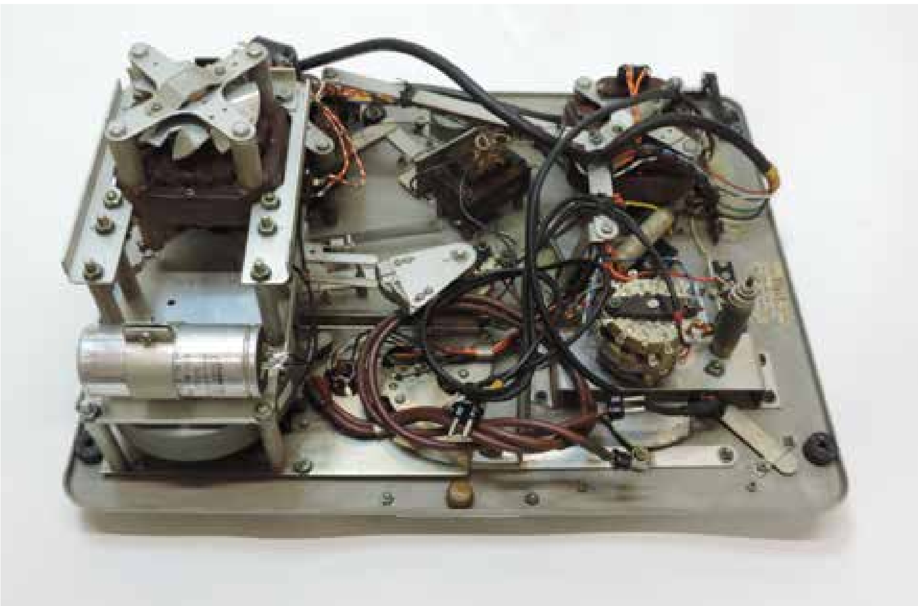


Fig 12 The underside of the series four Wearite tape deck showing the general layout of the motors, capstan and other key components. The deck contains very few parts that will give the restorer rise to any problems.

The strip down begins

The next order of business was to separate all the electronics, power supply and deck from the cabinet so that this could be properly cleaned. The amplifier was the first to be removed. This is secured by four screws at the front (two either side of the amplifier panel) and three captive screws/nuts at the rear of the amplifier chassis. Any cables were carefully unplugged from their respective interconnecting plugs and sockets and the complete “L” shaped chassis was lifted clear from the cabinet. Next was the power supply unit that sits secured by four nuts to the bottom of the cabinet, finally the hinged Wearite deck was unbolted from the rear of the cabinet and lifted clear.

The amplifier was checked over and everything appeared totally untouched and original. Ferrograph had been using Philips C296 series (mustard types) capacitors for a while before this machine had appeared (having previously used TCC Visconols up to around the early series 4) and no issues were expected with these. Valves were all present and correct. It was noticed that C14, one of the two large 0.5uf capacitors fitted on the record amplifier chassis had leaked electrolyte, and this was sitting in a sticky pool on top of one of the cans.

Tackling a rather filthy cabinet

Not the worst ever seen but the leather cloth covering on this was almost a yellow pallor because of the nicotine coating. One can almost envisage a smoke filled recording studio (or bedroom) where the machine perhaps once lived and entertained its former master.

Any remaining cabinet fittings were removed and cleaned separately; the missing front

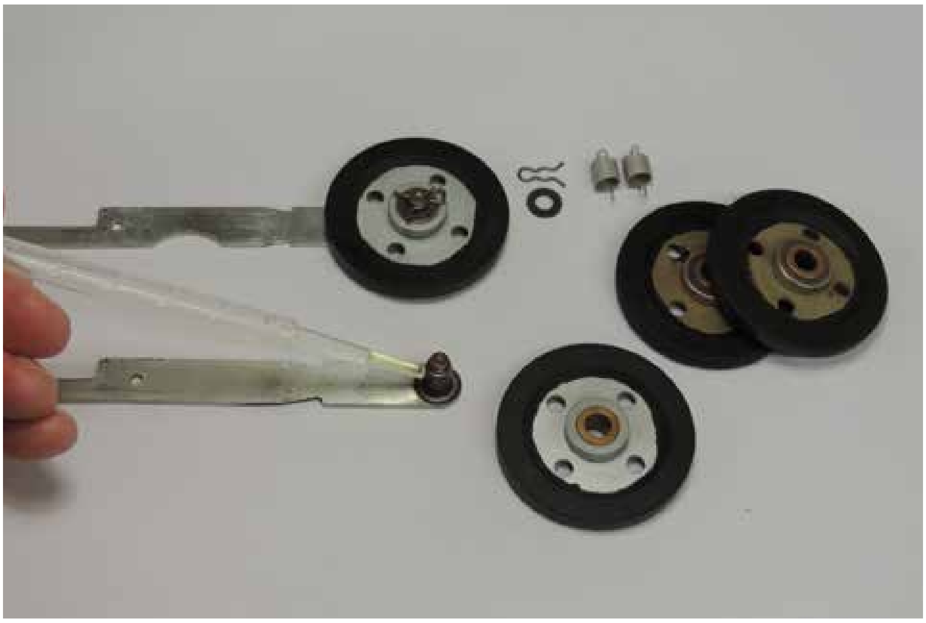


Fig 13 The two idler carriers ready for reassembly with new idler wheels also receiving a single drop of oil prior to reassembly.

Fig 15 The restored capstan drive sub unit prior to re-assembly onto the main deck showing the relative positions of the idlers, capstan and motor.

catches were replaced with a couple from the spares box. With all said and done, the cabinet responded very well to a wash with a weak mixture of flash and warm water. Most if not all of the dirt disappeared leaving the typical green /grey mottled finish unique to Ferrograph. Any minor repairs to the leathercloth were dealt with and I managed to get most of the paint off as part of the cleaning regime.

It is not generally known, but Ferrograph latterly stamped the cabinet and the lid of the various models with a matching serial number. The reason for this was that the cabinets invariably differed very slightly in shade and pattern due to natural changes encountered during the production of the rolls of leathercloth used on the cabinets; The idea being that it minimised the cabinet lid being mixed up with one another either at the factory or in the showroom.

As it transpired the lid that came with the other machine was in fact the correct lid for the 420 and could be confirmed by the special numbering; in this case “98” stamped on both the lid and the cabinet.

The Wearite tape deck

Synonymous with Ferrograph (and adopted by a number of other manufacturers during the years it was popular) the Wearite deck that forms the integral part of this tape recorder probably needs no introduction. Service of these is by and large straight forward and like most other things, have one or two “must dos” as part of any overhaul. The series 4 deck is (of which a very large number were made) a very reliable workhorse and incredibly long lived. These decks will go on and on with just a little bit of TLC. First off the capacitor C2 (fitted across the stop switch) should be changed automatically for a suitable class X2 rated equivalent. The reason for this is that they can break down quite spectacularly, due to the stress of mains AC and a constant duty across the switch to supress noise when the machine is stopped. One or two weird faults can appear such as a constant running deck due to the capacitor having gone dead short. Another is interference in the form of crackling noises being superimposed over the normal operating levels of the amplifier due to the capacitor breaking down internally (Most noticeable when the deck is stationery).

Fig 14 The bottom bearing of the capstan drive motor, this along with the take-up and rewind motors were disassembled, cleaned and re-lubricated

The tape path areas of the deck was thoroughly brushed out with a small artists paint brush and the resulting detritus vacuumed up, the magnetic heads were in very good condition other than a clean-up with Isopropyl alcohol and cotton buds to remove any tape oxide that had been shed on the faces of the heads themselves. All the tape guides received similar treatment. The head pad arms were removed and carefully cleaned of any of glue residue and remnants of old felt (acetone is useful here).

Ferrograph used high quality wool felt for the head pads, (a practice that persisted long after other concerns had started to move away from felt due to the promotion of head wear) the closest equivalent these days being the type of wool felt found in pianos. This can still be obtained from specialist suppliers and three new pads were made from a 5mm thick felt sheet kept for this purpose. A scalpel or craft knife is required to carefully cut the felt to size. In this case 6mm (W) 8mm (L) to match the existing profile. These were then glued in place on the head pad arms with an epoxy adhesive, and then left to cure.

Other areas of attention are the capstan drive idlers; there are two of these fitted to the model of the deck on this machine (one for each of the speeds) both idler carriers are held under tension by a spring between each carrier and the actuator bracket. With the removal of both of these, each idler can be gently slipped out of the speed change assembly for cleaning and further disassembly and any lubrication (Once cleaned, a tiny drop of sewing machine oil on the idler carrier post is all that is normally required before reassembly). Any rubber parts should be carefully cleaned with Isopropyl alcohol.

With the idler wheels re-installed, the next task is to check the run up and spin down of the capstan flywheel. If all is well, the run up will be a near instantaneous start and the spin down will take several seconds due to the inertia that the heavy die cast capstan flywheel is under before it comes to a halt.

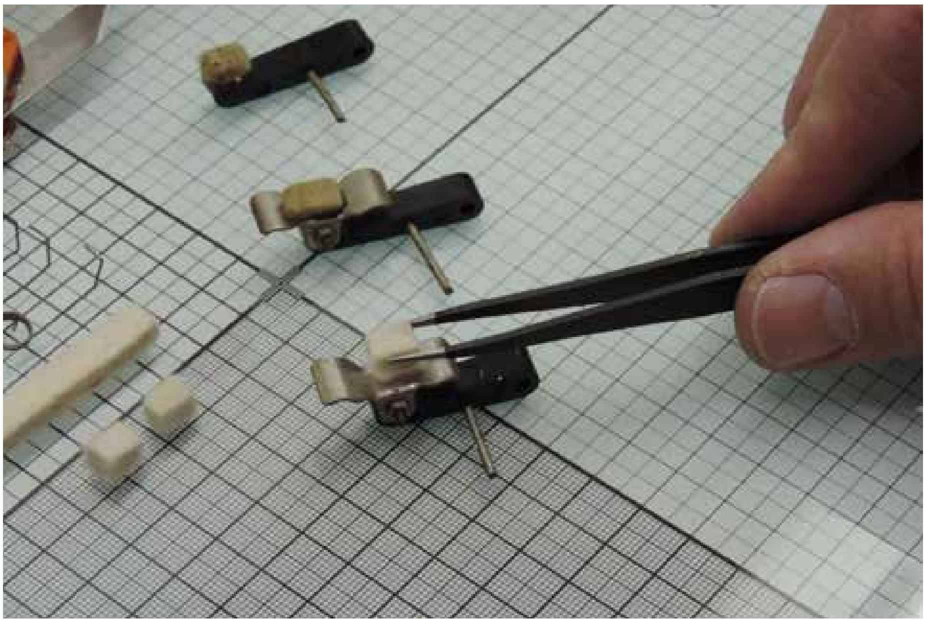


Fig 16 The head pad arms receiving new wool felt, with the two remaining original ones at the rear shown for comparison.

The test is best done on the highest speed. If it is not possible to power up the machine, as was the case here, the power was simply applied direct to the capstan motor from a separate mains supply whilst the deck run lever was engaged into the play mode manually.

It is very common on these decks that over the years, the capstan bearing grease will have become tired and it will have lost its properties. The capstan will labour and take its time getting up to speed and then take next to no time at all in stopping when disengaged. This will affect the running reliability and play havoc with the general performance of the machine; Ambient temperature also plays a part, and a secondary symptom will be gradual improvements as the grease slowly starts to warm up due to friction.

Whilst everything else was being serviced, it was decided this was the next area to be tackled. The job is a bit of a pig to undertake and from start to finish, it will take about two hours. The first thing to do is to slacken off the die-cast stabilising bracket that the top of the capstan snugly fits inside, and then turn the deck over. De-solder and remove the motor run capacitor from its bracket and unplug the miniature two pin power socket fitted to the motor. Carefully removing all five bolts, nuts and any bolt sleeving posts will then allow the removal of the complete capstan assembly. Some of these are recessed and difficult to get at from the underside of the deck and a bit of jiggery pokery is required.

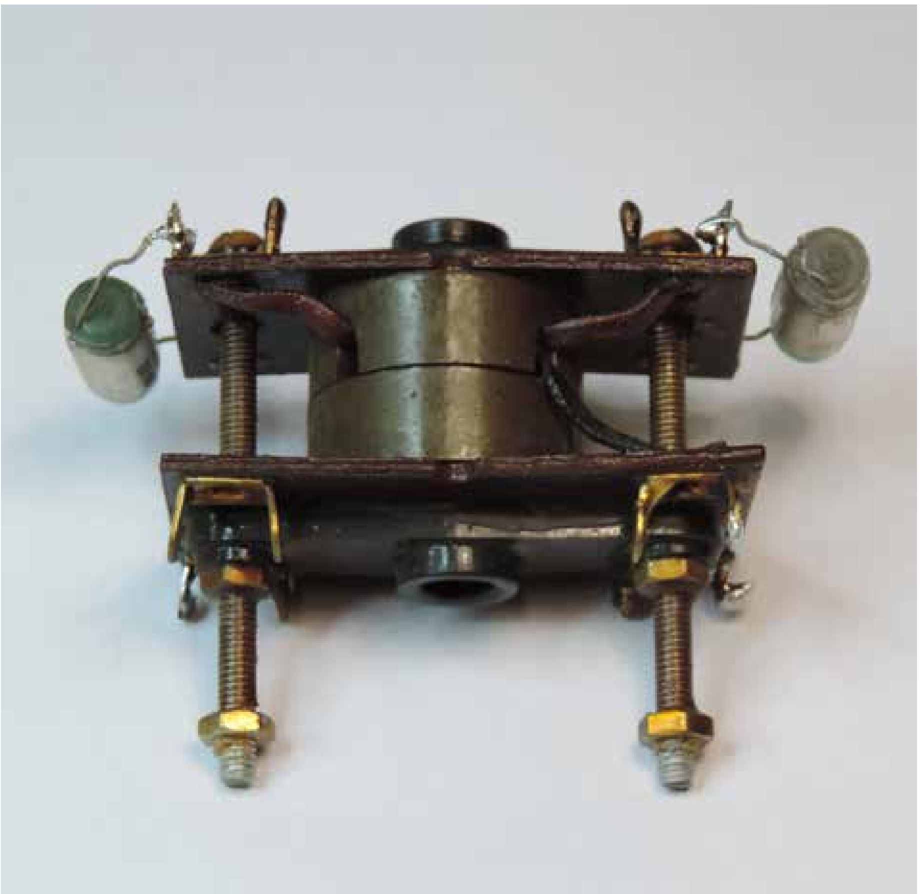


Fig 17 The defective bias/erase oscillator coil referred to in the text. It is very unusual for this component to fail in these machines; in fact almost unheard of.

The capstan flywheel can then be completely removed by carefully loosening a special slotted nut fitted on top. Under this will be the first ball bearing race which is held under slight tension by a small spring (careful that this does not fly off). Once the capstan is lifted clear, all that will remain is the shaft that the capstan slides onto and the lower ball bearing race.

This can be completely removed and disassembled by removing the nut underneath the capstan motor sub chassis. The removed parts can be then cleaned in degreaser to remove any grease and ancient crud (Swarfega “Jizer” de-greaser works really well) and just prior to reassembly, No: 2 lithium based grease should be applied to the bearings.

Following reassembly, a marked improvement should be noted in the capstan response time. In the case of our machine, the overhaul made a notable difference and well made up for the time spent stripping down the assembly.

One further issue that came to light was with the original idler wheels, whilst cleaned up, were noisy when running, gradually getting quieter the longer they were in operation. No amount of adjustment, cleaning or lubricating made any difference and age related noise was concluded with the rubber surfaces. Two new idlers from stock completely cured the problem.

Whilst the capstan was still on the bench, a careful check on the rubber surface was carried out. There are occasions when examples have been seen where the rubber coated surface has started to crack and perish and the only option would be to renew the whole capstan. A problem of this type these days can write an otherwise good machine off as it would be impossible to find anyone these days that could refurbish this rubber surface at a reasonable cost. This was a design fault that never really got resolved until the series 5 deck appeared and the capstan rubber surface was modified and applied to a removable brass sleeve. This could be detached from the main capstan with out to much trouble, I digress though. Luckily the capstan rubber surface on the 420 was in very good condition so this issue never arose.

Checks were made on the motor bearings and these were cleaned and re-lubricated only where required. Similarly, the main selector cam, associated roller and any sliding deck parts were checked and cleaned and a tiny amount of No: 2 grease re-applied. The end results provided a smooth and responsive deck that proved to work very well.

The recording, replay amplifiers and power supply

It was now the turn of the power supply chassis and amplifiers in turn. The power supply sits on a small chassis shared with the bias/erase circuitry in the bottom of the cabinet and the first thing was to check it over, reform the HT cans and deal with a couple of known issues with this model. Firstly the DC heater supply smoothing capacitor, C48 was changed, this is not only prone to fail, but suffers the fate of being slowly cooked

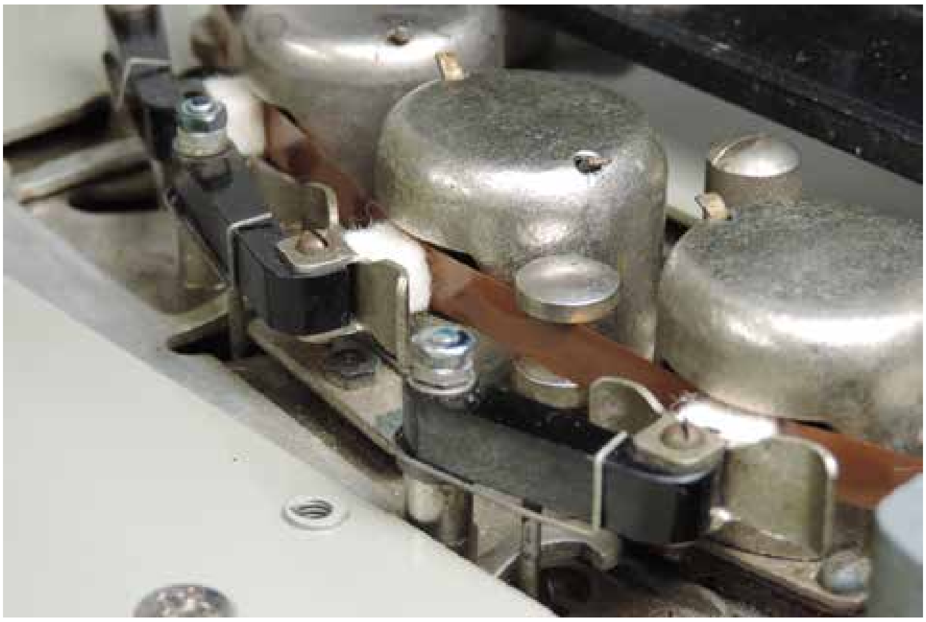


Fig 18 Good as new; the head pad arms along with the new head pads back in situ.

Fig 19 Demagnetising the record and replay heads along with the tape guides is an essential part of the maintenance regime.

due to the heat from a closely mounted wire wound resistor. The body of this capacitor is quite often left with a distinct burn mark.

The other fault to look out for is dry joints on any of the wire wound resistors. The culprit this time was R82 a 5 Ohm 6 Watt rated component that forms part of the circuit suppling the DC heater supply. With this done the chassis was placed back into the cabinet.

The amplifier chassis was next to receive a closer inspection and overhaul. Ferrograph have laid out the amplifiers in a straight forward manner with both upper and lower (left and right) recording channels and the meter amplifier on the front section of the chassis. The replay channels are located on the left side section of the chassis.

The triple HT cans located on the front chassis were checked over, reformed and then re-tested. These are known to give issues, and often one of the sections will decide to leak heavily or lose capacity and replacements of this size are near impossible to find. Restuffing might be possible with three miniature sized equivalent components but trying to squeeze them into the space available may present a challenge. Luckily this time both cans proved serviceable and reformed well.

The last of the initial jobs was to tackle the two de-couplers C14 & C26 one of which had leaked. These form part of the recording amplifier valve output V3 (a&b) and must be

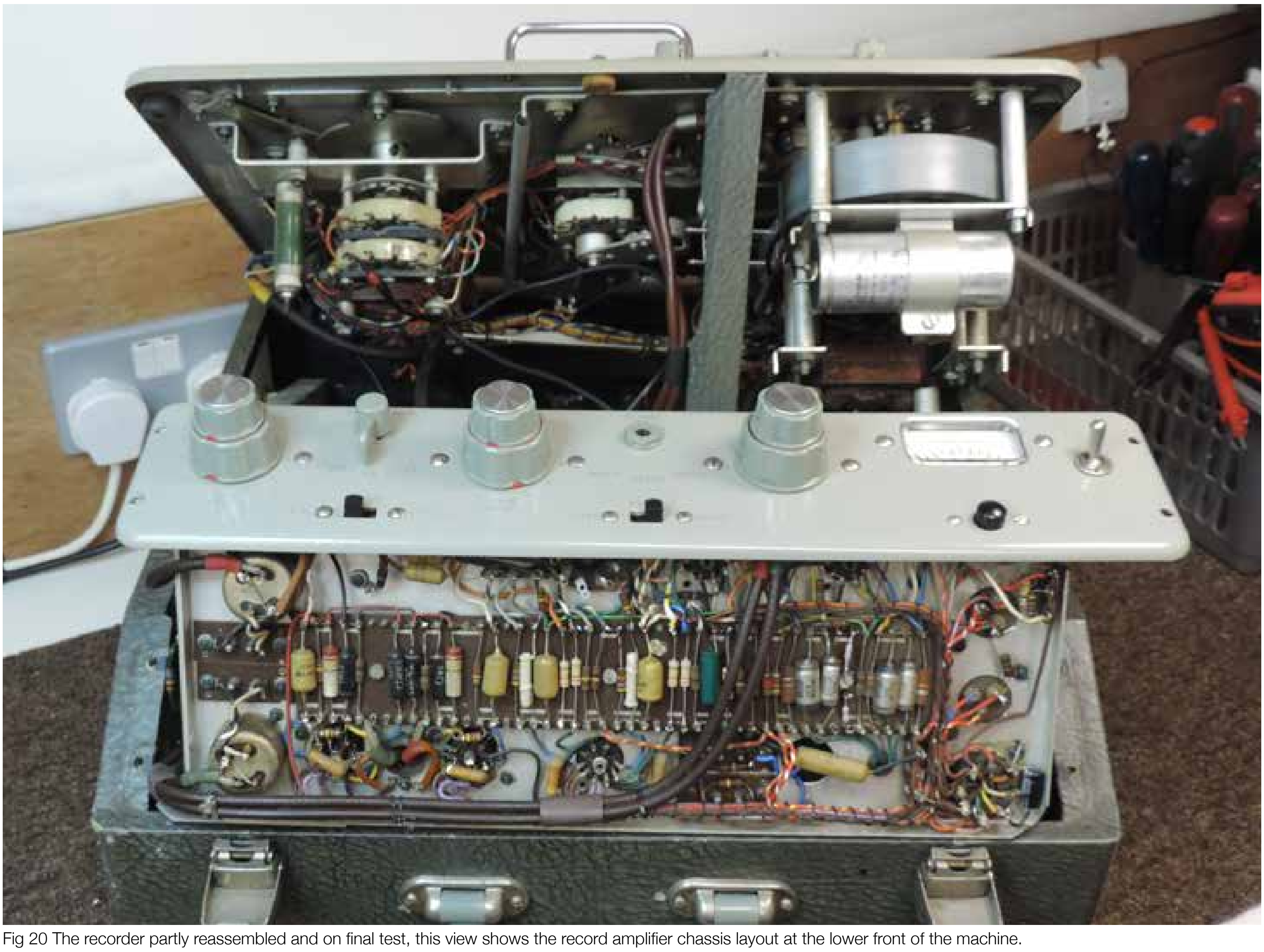


Fig 20 The recorder partly reassembled and on final test, this view shows the record amplifier chassis layout at the lower front of the machine.

Fig 21 A small number of components were renewed in the Ferrograph mostly resistors associated with the amplifiers. The scorched capacitor (C48) can be seen at the back of the picture.

electrically sound otherwise heavy leakage could damage the recording head windings. For this reason alone they should as a matter of course, be checked and replaced, in this instance, and due to their size it was decided to restuff both with a suitable modern equivalent of the same voltage rating and value of 0.5uf.

With all these initial checks and repairs carried out it was time to apply power, after partial reassembly into the cabinet. Whilst all the voltages appeared as expected on the heaters, the HT was somewhat down at 223V instead of the expected 250V (or thereabouts) as quoted in the manual. This was traced to the BY100 bridge rectifier array situated on the underside of the PSU and changing all four cleared the problem.

A much healthier 249V appeared when the power was reapplied, this was good enough for me. No exact reason could be found for this as each of the old rectifier diodes were checked in turn and they all appeared to read about right.

With the recorder connected up into the workshop amplifier system, it was not long before a healthy background hiss had appeared from each channel. Before anything else was done the machine was switched off and a demagnetisation was carried out to the tape guides and record and replay head. This is another routine (but essential) part of the work that should be carried out. With this done and the machine switched back on, a stereo tape was laced up and replayed.

First results weren't bad but what was clear from the playback was that the replay head azimuth was misaligned and that the replay equalisation was wrong. The azimuth adjustment is straight forward enough to deal with and a reproduce alignment tape carrying a 10 kHz tone is replayed with an oscilloscope or valve voltmeter hooked onto the output at a suitable level. The replay azimuth head adjustment screw is turned until the peak of the replayed tone is found.

This then sets the replay head to a known reference standard. It is not advisable to attempt this without a suitable tape to hand. If the settings are still factory sealed, then they are best left alone.

The record head was found to be incorrectly aligned and sorting this out was straight forward, this involved changing over the test tape with a reel of standard recording tape, and then running the machine at 7.5ips in record mode. As the 420 is a three head machine it is a simple matter of injecting a 10 kHz tone into input 2, from an audio frequency generator, monitoring the tone directly off tape and peaking the record head azimuth, a small adjustment corrected the alignment of this head. This ensures recording interchangeability with other machines.

The Ferrograph 420 is unusual in that it was probably one of the few semi-professional machines in its class at the time that it was on sale that offered user switchable NAB or CCIR replay at 7.5 ips as standard, and setting this up at 7.5ips is straight forward enough. It was evident already that on the NAB position, the replay was too bright for what should have been a flat replay response.

This was resolved by setting the machine to the correct standard. The NAB setting was selected and a suitable alignment tape with a characteristic of 3180/50µs (NAB) was replayed. These tapes have various frequency bands and the 1 kHz portion was replayed at a high enough level so that the oscilloscope and valve voltmeter displayed a useable reading. In the case of the 420, it is a simple matter of carrying out the same test on both channels and adjusting the appropriate pre-set pots R54 (upper) and R56 (lower) to get the same reading at 10 kHz. All the frequencies on the tape should then be ± 3db of the original 1 kHz figure. This set up is good for both characteristics so switching the equalisation switch to 7.5 X (the CCIR characteristic) is already compensated for and setting up separately is not required. It is only necessary to set the machine up on the one standard and this certainly saved some time.

Now it was time to carry out a test recording, and after loading a suitable reel of tape, a test was made; the first thing that was checked before recording any new material was the full erasure of any old recordings and minimal background noise. To start with the erasure was quite poor and checks at various points, showed both the bias and erase voltages to be low. This can sometimes be due to a low emission ECC82 valve as it does work quite hard in this circuit.

There was also a noticeable rustling noise in the background of the recording that was clearly being generated from with-in the circuitry and was more noticeable on the lower channel for some reason. This was traced and turned out to be HT feed resistor R79; once replaced this provided a complete cure. The first fault (with the incorrect voltages) persisted and after a couple of further tests around the bias and erase oscillator stages along with a change of valve (ECC82) the finger was pointed at the oscillator coil which was simply not oscillating correctly at the right frequency and there is no adjustment. Very luckily I remembered that I had a box of Ferrograph oscillator coils and was able to swap this out; in doing so, provided a complete cure to the problem. This is only the second time I have come across this sort of problem in all the years repairing these machines. Perhaps a rogue coil had somehow made its way out of the factory.

A handful of carbon resistors were changed in both channels including the 1Meg feeding the meter circuit from the record amplifier. Other symptoms from past experience are intermittent rustling noises on one of the replay channels due to an electrically noisy anode feed resistor or problems around the meter circuitry leading to incorrect metering levels.

The circuit in more detail

The circuit diagram that accompanies this article was the last revision issued by Ferrograph and should cover most of the models issued save for minor modifications that appeared early on in the series. Copies of all versions are available to BVWS members (see the bibliography).

Power supply

The pre-amplifier valves in both record and replay sections have their heaters fed with DC, the advantages of this arrangement is that it reduces hum. The remaining stages are supplied in the conventional way. DC is supplied by MR2 & MR3 in a full wave circuit arrangement. Smoothing is by R82 &C50 the resulting 12.6V is applied to the respective heaters. The hold in solenoid, in series with R77 is also connected across the same supply with the junction of the two connected to chassis. The function of R77 is to prevent a short circuit of the DC supply when the deck is stopped or the auto stop is engaged. Valves

Fig 22 The restored Ferrograph Series 420, ready to give many years of further service.

V3, V5 and V7 have their heaters wired in series across one half of the 19-0-19v AC secondary, while V9 plus resistor R84 and the two meter lamps and series resistor R90 are across the other half. HT is supplied by MR4, 5 6 & 7 in a conventional bridge arrangement. Smoothing is via R83, C49 and C51. The HT supply for the bias/erase oscillator and meter valve is tapped off at the junction of R83 and C51.

Record channels

As each of these is identical to one another the description will cover both of these; the upper channel is the one described here. As mentioned earlier, both channels are positioned at the front of the chassis underneath the control panel. Input 1 is connected directly to the grid of one half of the triode section of V1 and has an input impedance of 1 meg. The first half of V1a is resistance capacity coupled to the second section of V1b and the input gain control R10. R11 prevents the grid of V1b being at chassis potential when R10 is at its minimum position. R14 performs a similar role with respect to input 2 gain control R13, which is also connected to the grid of V1b.

R8 & C10 are connected to the anode of V2a and to the cathode of V1b providing a degree of bass boost. The anode load of V2a is fed from R15 & R16. This is done to feed a certain amount of the signal via C9 into the grid of the replay amplifier output valve for the tape "before/after" monitoring switch.

HT to V2a and V2b (upper and lower tracks respectively) is decoupled via R12 & C8. The signal that appears at the anode of V2a is passed to the recording output valve V3a and onto the meter circuity and associated valve V5. Treble boost is added during recording and provided by L2 and C15 across the cathode resistor network of V3a. This is switched to the appropriate value depending on the tape speed selected. The signal appears at the recording head Via C14 and Sk 4, passed to the main selector switch and then onto the record head.

Replay channels

With one very small difference (noted below) these are also identical so only the upper (left channel) will be described here.

The signals from the replay head are fed to input transformer TR1. The secondary of this is connected to the grid of the first section of V6. This section is resistance capacity coupled via R50, C32 & R53 to the other and between the two, forms the replay equalisation network. Negative feedback is applied via C33, R54, and R92 & R52 to the cathode resistor of V6. SW6 switches the equalisation to suit either speed. At 3.75ips, C31 is introduced across R49 to increase treble boost at this lower speed.

I mentioned that there is one minor difference between the two channels, and that is an extra capacitor (C55) is added. The reason for this is to compensate for the additional capacitance of the longer screened leads due to the different locations of the amplifiers.

The equalised signal passes through C34, and SW7 (before/after switch) and if set in the "after" (or tape position) is passed to the replay gain control R56. From there the signals are applied to the grid of V7a cathode follower output. The signal is taken from R59 and via C35 to the output socket fitted on the rear of the recorder. The channel can be balanced via R57 to compensate for slight gain differences in each channel so that both channels are at the exact same gain when set on at particular level by the operator.

Metering circuit

This arrangement is similar to that seen on all the Ferrograph models of the period. In essence the circuitry is a valve voltmeter and the meter type used was a reverse type 1ma FSD especially produced for Ferrograph by Sifam. With HT applied to the circuit, the meter immediately travels from right to left, with zeroing provided by R29 on the front panel. The meter circuit can be switched back and forth between channels for signal comparison. The signal arrives via R25 & C24 at the grid of one half of V5, this is connected as a cathode follower in order to provide a low impedance source for charging C18. R24 is included along with R26 to allow the meter sensitivity to be correctly set.

From the cathode of V5a the signal is rectified by MR1 and charges up the reservoir capacitor C18. The appearance of a signal at the input of V5, causes a negative voltage to appear at V5B grid, reducing the anode current and deflecting the meter movement. The number “8” additionally highlighted with a red line corresponds to the peak recording level and each machine was set up at the factory using close tolerance (selected on test) components. The meter circuit only comes into operation when its HT supply is switched at the same time as the Bias/Erase oscillator into the recording position on the tape deck.

Erase and bias Oscillator

The required voltages are generated by V9 and the valve, oscillator coil (L4) and associated circuitry are fitted on the power supply chassis located in the bottom of the cabinet. The circuit is that of a conventional push pull oscillator. The primary winding of L4 is tuned by C54, C46 & C53 in series. One side of the secondary is connected to chassis while the other side goes via the erase link socket fitted on the rear of the power supply chassis and track selection switch on the front control panel. This also connected to R86. The function of this pot is to balance/compensate the reduced bias voltages required when the selector switch is only set to mono (or single channel only operation).

The final take

With all repairs completed and the recorder back together. The results have been excellent with the Ferrograph 420 performing extremely well. The fact that the machine was in such poor condition and in danger of being carted off to the local tip It just shows that with some time and TLC restoration is well worth the effort. In fact as I am writing up this article, I have listened to several hours of high quality recordings made on this machine, along with several other tapes from my recording library, reminding me (if any reminder was needed), of just how good these machines were and the reason why they are highly prized by the audio collecting fraternity.

As for Ferrograph, they continued to prosper throughout the 60’s and beyond. The heyday of the Wearite deck though was beginning to wane and the final Series 420’s sported a Series 5 deck, which itself, had been updated with new features. By 1968 though, the Wearite deck itself was obsolete and production ceased.

With perhaps the odd exception, most of the latter valve era Ferrograph’s were considered by some to be embellishments of previous offerings, with teak ends and one or two cosmetic niceties, which did not go down well with the diehard recording enthusiasts of the period. The 420 therefore was probably one of the last notable major valve based developments to come off the Simonside production lines during this period of the firm’s history.

Bibliography and references

(1) NAB (National Association of Broadcasters)

(2) CCIR (Comité consultatif international pour la radio)

Standard equalization curves were developed during the 1950’s and 1960’s. During the early 1950’s NAB adopted the standard originally developed by Ampex. This remained the standard in the US primarily for professional use and appeared on numerous semi-professional tape recorders

The CCIR standards also appeared during the early 1950s. The CCIR curve became the standard in Europe for professional use. Latterly CCIR became IEC2.

Both standards changed over the years to adapt to the developments in magnetic tape. To confuse things further in the early days, manufacturers such as Ferrograph also had their own replay standards

There is a significant amount of information and resource on the theory of magnetic recording and the various equalisation standards that have been adopted over the years which can be readily found on the internet.

(3) Ferrograph had a large number of overseas agents, during the 1950s & 1960s and their products were marketed and sold in the US by The Ercona Corporation.

(4) The circuit diagrams covering all the revisions of the Ferrograph 420 are available to BVWS members free of charge by contacting the author at ferrographworld@gmail.com

All images by

Terry & Peter Martini-Yates

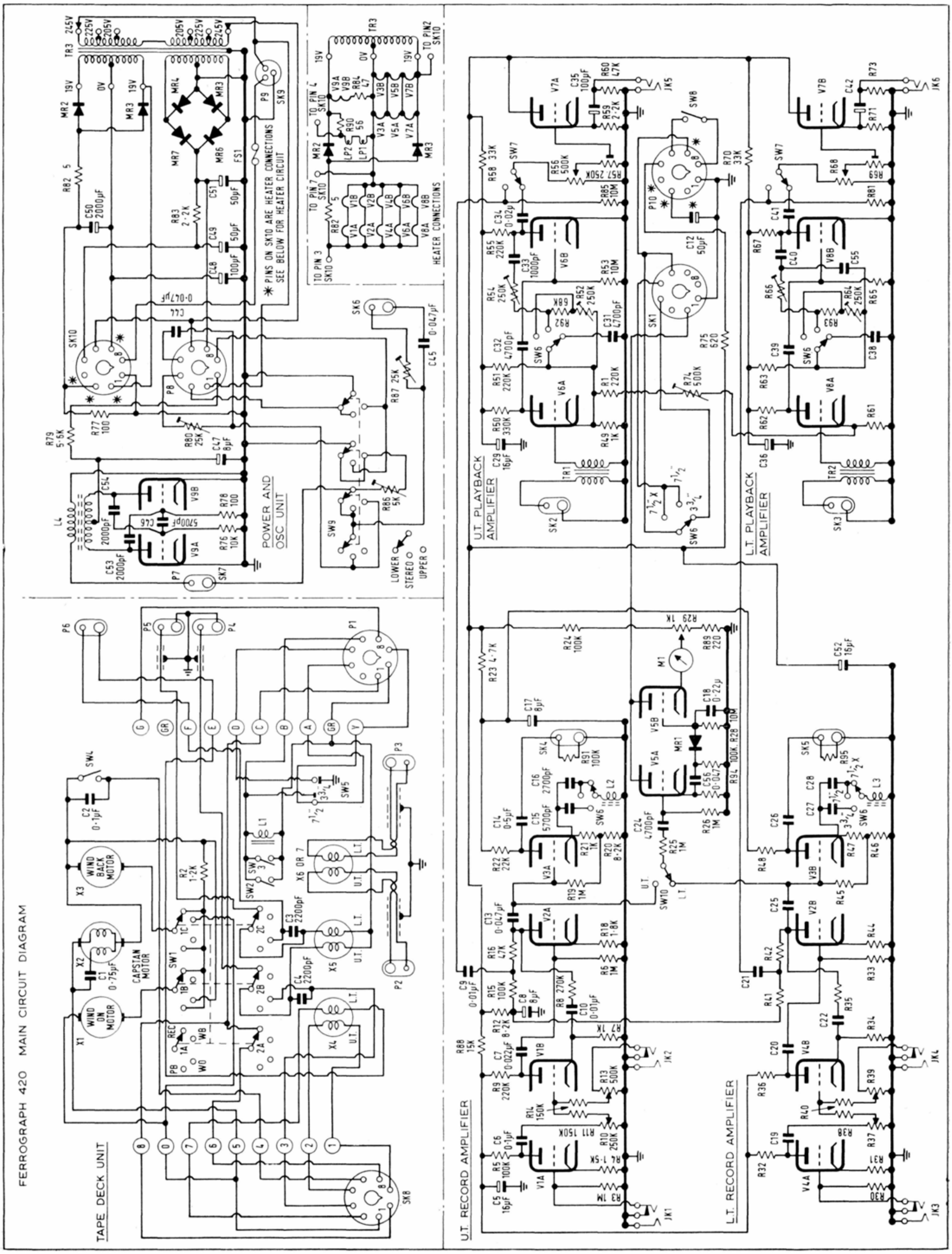
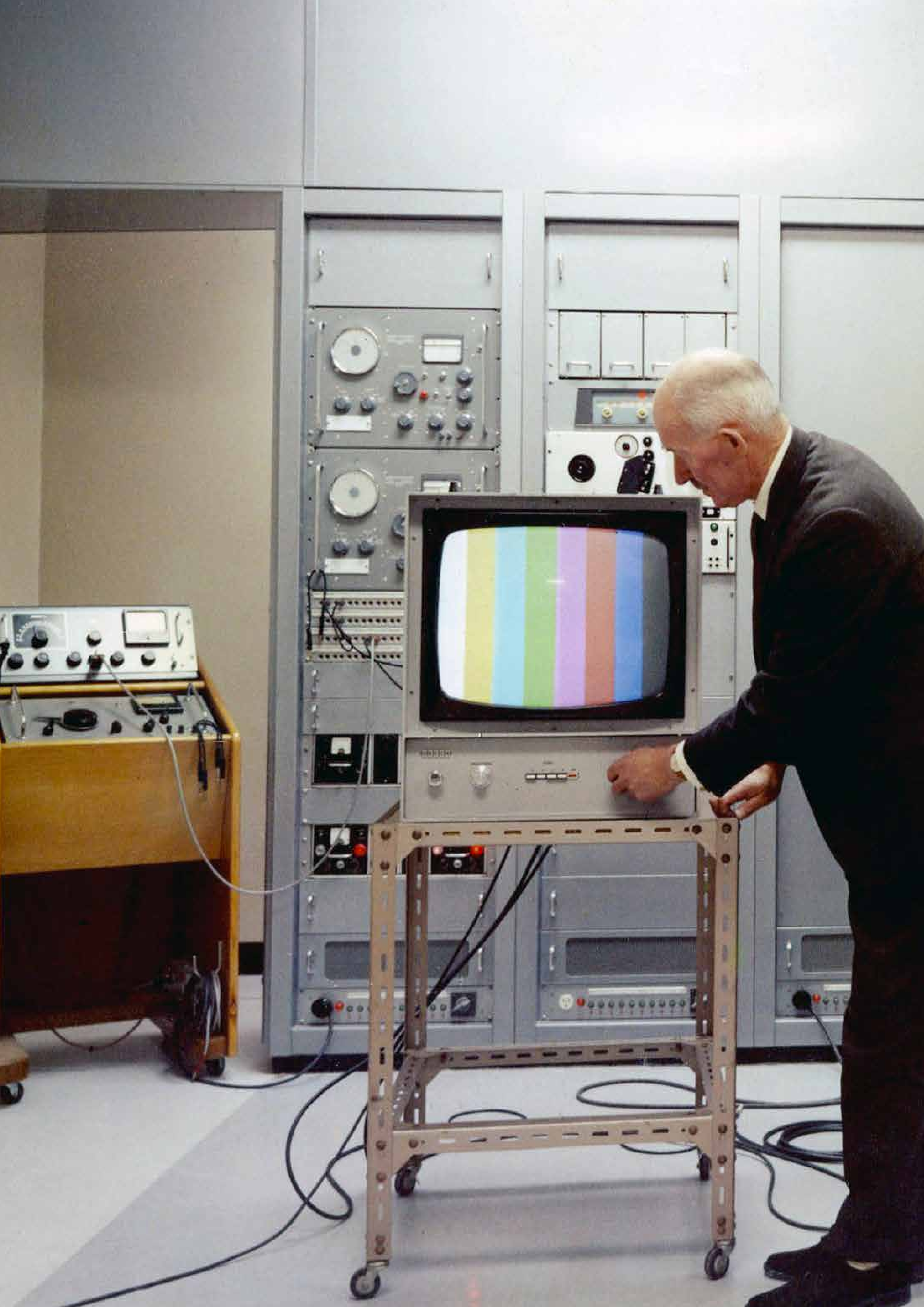
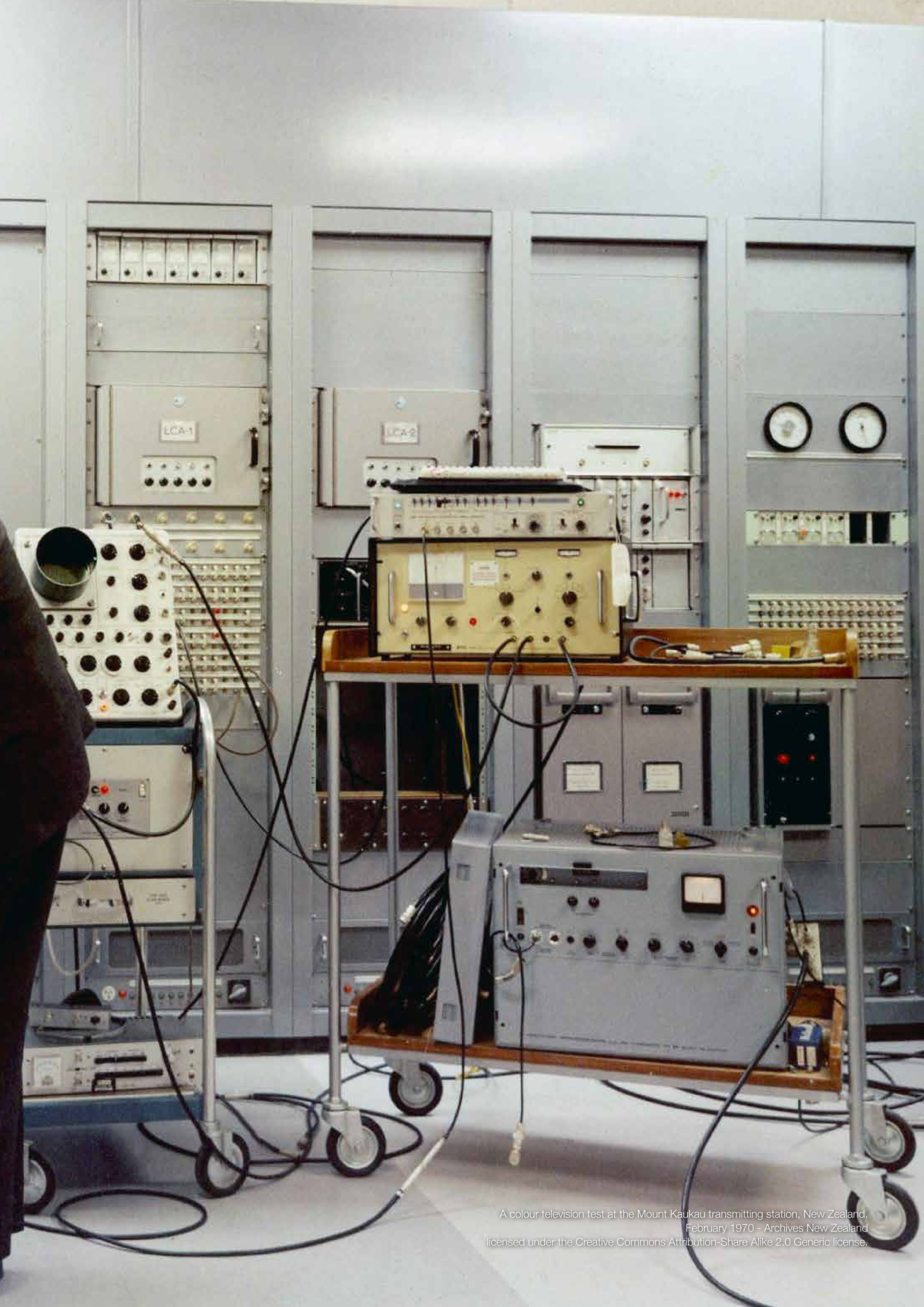


Fig 23 The circuit diagram of the Ferrograph Series 420 magnetic tape recorder.





A colour television test at the Mount Kaukau transmitting station, New Zealand.
February 1970 - Archives New Zealand

Pre-amplifiers for single valve record players

Alex Caisey

Although I have for many years been a restorer/collector of vintage radios, I have recently been playing - as my Wife calls it - mostly with portable record players of the suitcase type, primarily those with valve amps.

One of the problems I frequently come up against and which is difficult to solve, involves single valve players that had previous been fitted with high output cartridges, typically the BSR TC8H. The only remaining source of anything suitable, are the ever diminishing supplies of the BSR SC12H, which seem to command high prices in any event. Something was therefore needed to enable the use of those “Red” Chinese medium output types which are generally very good and cheap to buy. The answer seemed to be the use of a “solid state” pre-amplifier.

My criteria for the pre-amp was (1) It was to be constructed using cheap, easily obtainable components (2) It was to be easy to make for anyone with basic knowledge/soldering skills.

My abilities on the technical side of things are ok when I have a service sheet in my hand but are sadly lacking when it comes to innovation and so a solid state kit which just needed putting together seemed to be the answer. I wanted something that would be a universal fit as far as possible, that could be inserted easily with minimal interference with the original circuit and which could just as easily be removed and the circuit restored to its original design if desired.

I decided to try a kit from Maplins based around a op-amp, the LM358. This was duly purchased and constructed and although it worked, the sound was distorted and thin and with little amplification, due, I was subsequently advised, to the input being overloaded and of low impedance, whereas a ceramic cartridge of course, needs one of high impedance.

Time to seek advice from those more talented in such matters, so off to the UK Vintage Repair and Restoration Discussion Forum.

There was already a thread dealing with the issue, (Dansette Major De Luxe volume problem) which had led me to the LM358, so I decided to do a follow up of this thread as the original had come to no firm conclusion. Going on to the Forum with my request generated much more debate and varying opinion than I had anticipated and in the end the thread on the subject resulted in over 114 posts!

As the results from the Maplins kit, in the application I wanted to use it in, were so poor, I sought Forum advice and adapted it as shown in Figs. 1 and 2. After sorting power supply issues, the revised circuit as shown by Fig 3, was built on a scrap piece of Veroboard as in Fig 4.

Spurred on, I constructed a tidier version on a 9 x 25 hole Veroboard viz Fig 5.

Eventually, on the construction of the Mk 7 version of the pre-amp, it was done and I am pleased to say it lived up to expectations with good sound and minimal hum.

This amp though, was designed to run off the 6.3v heater winding on a transformer fed amp using, usually, a EL84 output valve. As it is much more common to encounter an AC/DC amp using the UL84 valve, it was back to the Forum requesting a suitably revised version. I built the revised amp running it off the HT using a Zener diode and this worked just as well as the AC only version. The circuit is shown in Fig 6 (for EL84 read UL84) and the constructed amp in Fig 7 with a component list overlay.

Tidier circuit drawings and component position details for both versions, as provided by a Forum member, are shown in Figs 8 & 9

If you are interested in building either version please read through the thread “Dansette Major De Luxe volume problem - 2” (search for Dansette and go down the list) on the Forum where you can see the whole saga. I would suggest though that you go to the end first and work backwards, as the “meaty” bit is towards the end. As mains voltages are involved, the disclaimer from liability

Figure 1

Figure 2

Figure 4

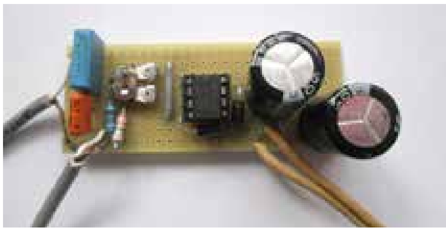


Figure 5

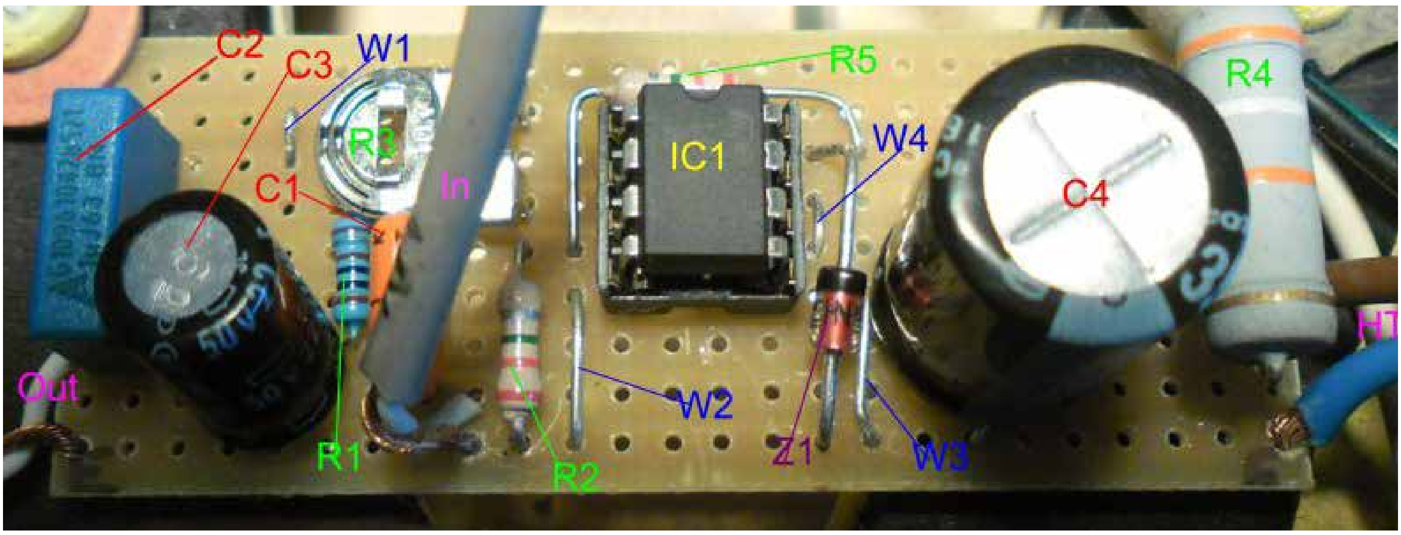


Figure 7

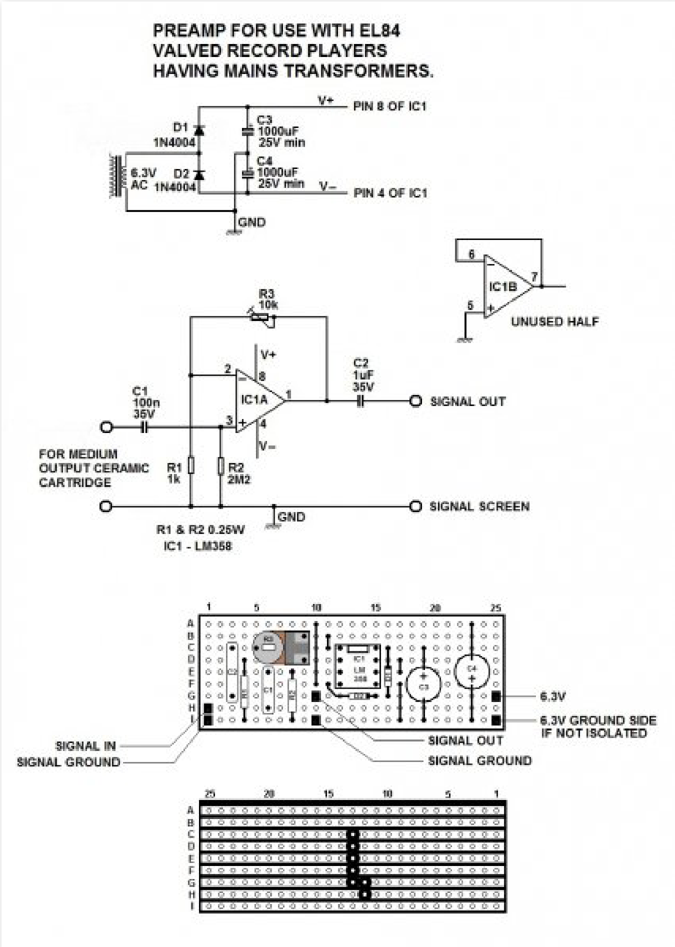


Figure 8

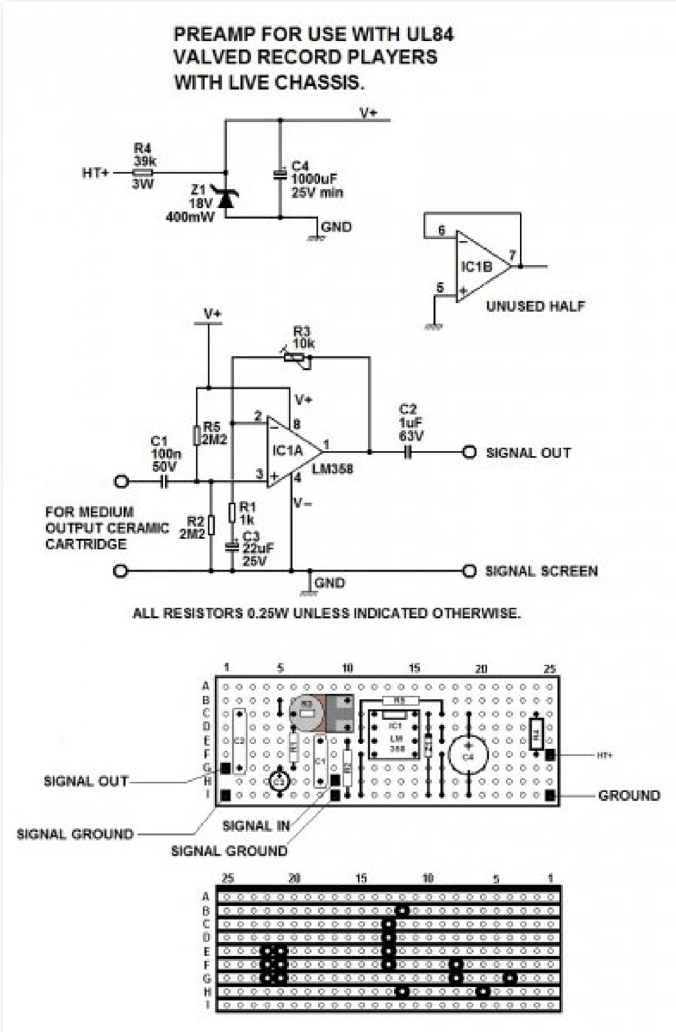


Figure 9

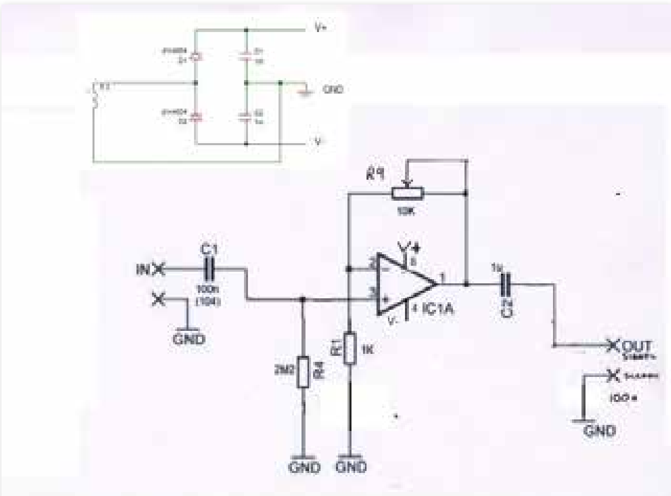


Figure 3

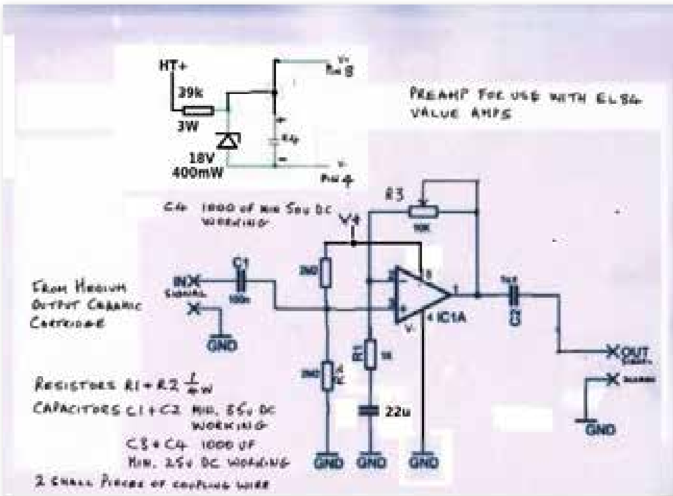


Figure 6

attached to the UK Vintage Repair and Restoration Discussion Forum threads apply in full to this article so please make sure you read them before starting construction.

Finally my fulsome acknowledgements go to Herald 1360, Hartley118, Top Cat and all the other contributors to the thread for their invaluable help and assistance.

Murphy Day, September 2017

Photos by Greg Hewitt

1950s Illuminated Shop Sign

Murphy AD94

Murphy 'Coloured' Acoustic Deluxe TV's from 1967

British Relay Wireless (BRW) version of Murphy U198M


Murphy TB605 Export Transistor Radio

Murphy U502 VHF Only

Murphy TA160R Export Radiogram


Murphy A96

V1913 'Gloss Black'


V1913 'Revolution Red'


V1913 'Smooth Blue'

CV2215 'Quiet White'


CV1912 19" Colour TV of December 1967

Restoration of a Zenith 7-A-28A from 1936

Gary Tempest

I had said I would never do a rusty chassis radio again. But having always wanted a black dial Zenith, and this one had a tuned RF stage which should make it a good performer, it was too tempting to pass on. To wait for one in better condition was not on as I may never see another in my remaining years. "Commander" E.F. McDonald, the founding President, was on to something with the colourful dial and the lightening bolt pointer and it still appeals to many today including me.

The title Commander was self appointed to go with his luxury 'yacht' the Mizpah which was a really grand ocean going vessel. A picture can be seen in the book "Zenith, History and Products" by Cones and Bryant, which is worth having just for the assembly line images alone.

A little about the radio

The US model is the 7S28 and the A's denote it as the export version. The 28 is down as "Uncommon" in the book's photographs of products, so the A must be even rarer.

It has LW and a dial in metres rather than Kc/s and of course a multi-voltage mains transformer. Upon starting on the chassis I was a little sceptical that it could cover input from 110 to 250V from 25 to 133 c/s although the transformer was large: would it run hot on our, getting close, to 250 V input?

A good place to start is to look at the dial. The outer ring is a simple clock minute scale for the vernier pointer.

The fully anti-clockwise waveband switch position is "C" which is LW, 850 to 2000m.

The second switch position is "A" which is MW, 175 to 525m. In the US version this is the Broadcast Band 550 to 1700 kHz.

The third switch position is "B", the lower part of what used to be called Band 4, 50 to 145m (2 to 6 mHz). In the US version this is the same from 2.1 to 6 mHz.

The last switch position is "D", the upper part of Band 4, 14 to 43m (7 to 21 mHz). In the US version this is the same from 7 to 23 mHz.

It is a 7 tube chassis that is very conventional and seemingly almost simple after working on the Philips D57. But there is no circuit for the export version and this made it far from easy.

The speaker

This was the first item of the electronics that I started with. As with many US made radios it was conveniently connected to chassis with a plug and socket, albeit the plug being broken. Apart from an open circuit field coil it also had a bolted on output transformer having a primary with the same problem.

After so many decades it was full of dust which was carefully removed from the excellent cone with a small brush and an 'air' canister.

Then it was strip the output transformer and field and rewind them. Whilst the field and magnet were off, the speaker frame was de-rusted and then spray painted after filling all the frame openings to the cone, with soft tissue.

For re-assembly what was needed was a way of putting back the field magnet without buckling the edge of the voice coil. The solution (see picture) was to use pieces of 5 mm studding covered with heat shrink tubing for a snug fit in the holes of the magnet. Of course M5 was not the thread in the speaker but a few turns went in before binding and allowed enough torque to lightly tighten down nuts. A few dummy runs at inserting the magnet were made without the field coil as with it not much can be seen. Finally, it was carefully lowered into place with it for a successful result.

The screws for the voice coil suspension 'spider' were slackened and four pieces of thin card inserted between the voice coil and magnet before retightening the screws; it took me two attempts to get it near perfect, which could be due to distortion of the cone. Somewhere, I read a recommendation that if possible rotate the speaker through 180 degrees so that gravity will have a correcting positive effect rather than more negative but like most I didn't do this. Then after replacing the output transformer the two were tested together on a baffle and a 'lash up' of the output amplifier and sounded normal for this era of speaker.

The socket for the plug turned out to be UX6 and a base from a junk tube, with the two heater pins removed, made a new plug.

The cabinet

This is a little more complex than most rectangular boxes and it wasn't in too bad a shape, having a worn and patchy finish, some loose veneer with a missing small piece, a few dents and some tiny cracks. I decided the best thing to do was to strip and start over. Fortunately, the lacquer was able to be removed with cellulose thinners and medium wire wool, all done outside of course with me standing 'up breeze'.

Then it was time for a light sand down and to consider the best way forward.

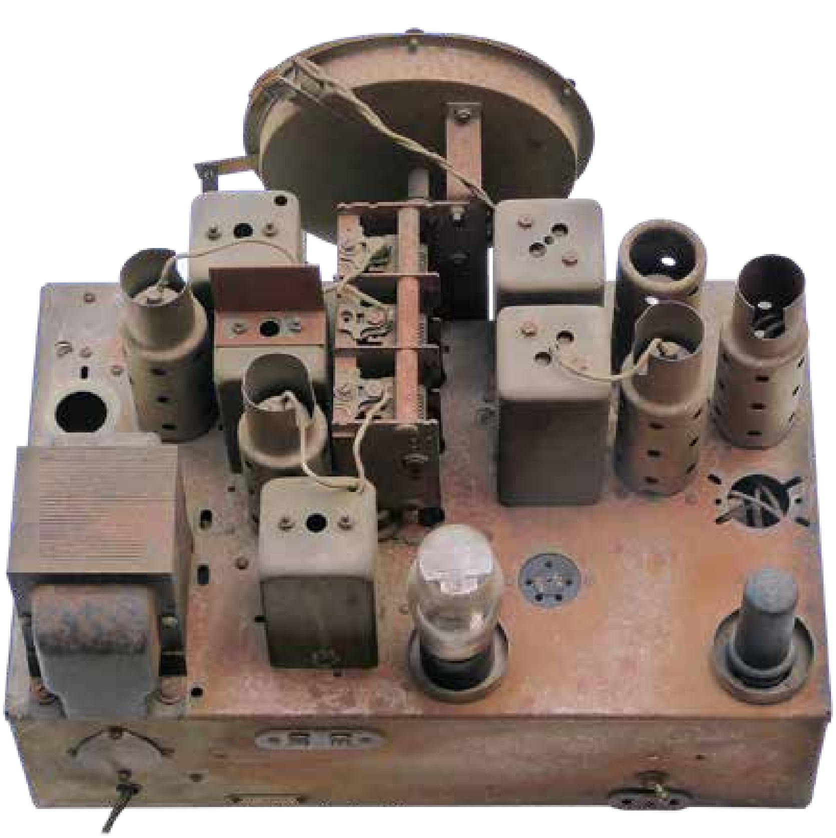
I had some pieces of veneer and cut one in for the missing piece. For the loose veneer which was on one of the top side panels, it and the wood beneath, were cleaned by inserting 240 grit aluminium oxide paper. The gap was carefully blown out using an air duster. The next step was to apply PVA glue, which many say works well with the old hide glue and I'm sure I have previously done it with success. So once the glue was applied the surface was covered with cling film and a wooden block and left clamped over night. That should have been it but it wasn't perfect this time. A small area hadn't glued down which was worrying but there was nothing for it but to repeat the procedure and try again. The use of PVA is recommended as it will soften with a hot iron making it reversible; always an important consideration with any restoration work. I was hoping that I wouldn't need to take advantage of this as it would almost certainly mean removing and replacing the veneer from both top side panels, to ensure matching.

The veneer is mahogany; not a favourite as it has a very open grain and needs a lot of grain filling. Now a nice part was to apply some mixed and thinned stain (with White Spirit) which shows some colour and contrast to the wood and is inspiring for the work ahead.

Then the cabinet was left in a warm cupboard for almost a year to see if the glued down veneer was stable: no point in applying lacquer if not. A written about way to check for this is to wet the area with White Spirit and look against the light: any hills and valleys that show up indicate a lack of flatness.

After its rest the cabinet, looked fine and passed the above test. It was ready for touch up of filled wounds and then lacquer. Alas, once finished, in the glued down veneer area, with the shine from the lacquer, I could see one hill towards an edge, against the light. Pressing showed that this wasn't actually fixed. This was a disappointment but really it's so tiny that no one, including me, would notice in normal lighting.

It was a conscious decision not to go for a high gloss piano shine but rather a satin finish. Probably lots of lower cost radios were done like this and it would suit the escutcheon better. I was strongly advised not to polish and refinish this in anyway as it was so original. Many restorers do, burnishing them back to gleaming metal before lacquering. Of course it never was gleaming metal being dulled by a chemical fuming process. So mine was only cleaned and then given a little Museum wax. It has some slight rub and wear marks from all those years ago but I really like those.



Chassis before...

... and after

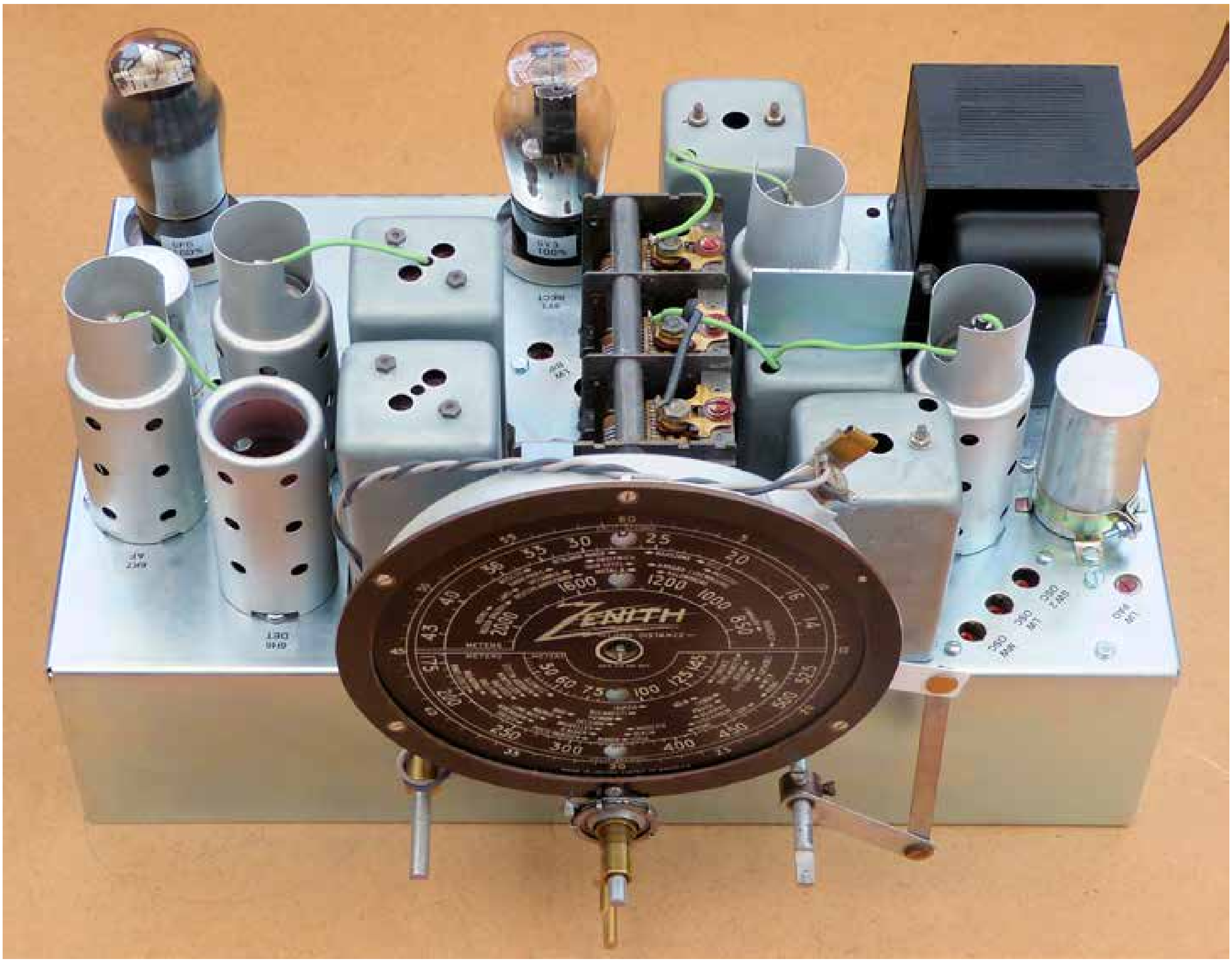
And back on the electronics

What I wanted to do was to get the chassis stripped down topside so that I could get the surface rust dealt with during the warm weather. But this wasn't to be, or at least not quickly.

It became apparent that I had to try to understand the waveband switching and the coils. So I started on a layout diagram concentrating at first on these items. This didn't last long as I found differences to the US circuit and so I just went with it and drew a complete diagram.

For the switches and coils, it was a case of examine, draw, remove, scratch head and try to fathom out what was what and then make corrections.

I started with the easiest wafer of the switch: that for the antenna coils, as it was at the back with the most visibility. The switch is unlike that used on the US model and easy enough to understand unlike the coil. This is a type that I don't remember coming across before, in that it has the antenna coupling into what is effectively a long tapped winding although there are definite sections with connections disappearing below windings or inside the former. The LW had been added by a large coil at the bottom and it and the MW were easy to follow but the SW bands were more difficult. The US coils for this had just been left, as a little extra inductance, added into those for LW and MW. All these were shorted out on the short wave bands, with



new coils for these added at the top of the stack. Just a few turns and micro henries are needed with the 450pF tuning capacitor used.

How much simpler it is when separate series transformers are used with the primaries and secondarys being opened and shorted as each waveband is selected.

The middle "Detector" coil was going to be difficult as the switch wafer for it was directly above it. The only way was to strip the waveband switch in situ, so that I could move the wafer around to see how it worked and what was going on. This wasn't easy as the long screws for the switch had been cropped off with a cutter. It was now obvious that these were very crudely made radios (AK wouldn't have approved). With the aid of a special screwdriver, ground out of an old hacksaw blade, I was able to hold the heads and unscrew the nuts.

Then I got to grips with the wafer connections and ended up just cutting away many but being sure to put on heat shrink markers, so I knew what connected to what.

Then with the coil removed it was sit and work out what was going on and translate this onto my circuit diagram.

Eventually it was time to tackle the oscillator switch wafer and coil and this certainly was the most complex. But taking time I eventually got a handle on it and completed the diagram. For those who take an interest in circuit details it can be seen that, excepting the band pass wafer, the rear contacts on the wafers are unnecessary; they are a legacy from the US model; the circuit diagram for which is on-line. The band pass wafer (drawn lowest on the diagram) makes use of a rear wiper to connect the HT feed through to the RF choke as successive parts of it get shorted out.

It was very fortunate that all coils and the substantial mains transformer tested well.

As usual once the circuit diagram was finished I asked Peter Lankshear, what he thought and my analysis of it. With his long gained knowledge of the "Golden Era" of radio he added to my understanding. So, with a little editing, this is what he had to say:

"The Zenith coils appear to be designed by someone very familiar with the subject. I also can't fathom out what C4 really does. Let's hope you never need to replace a faulty coil – there's a lot of integration here.

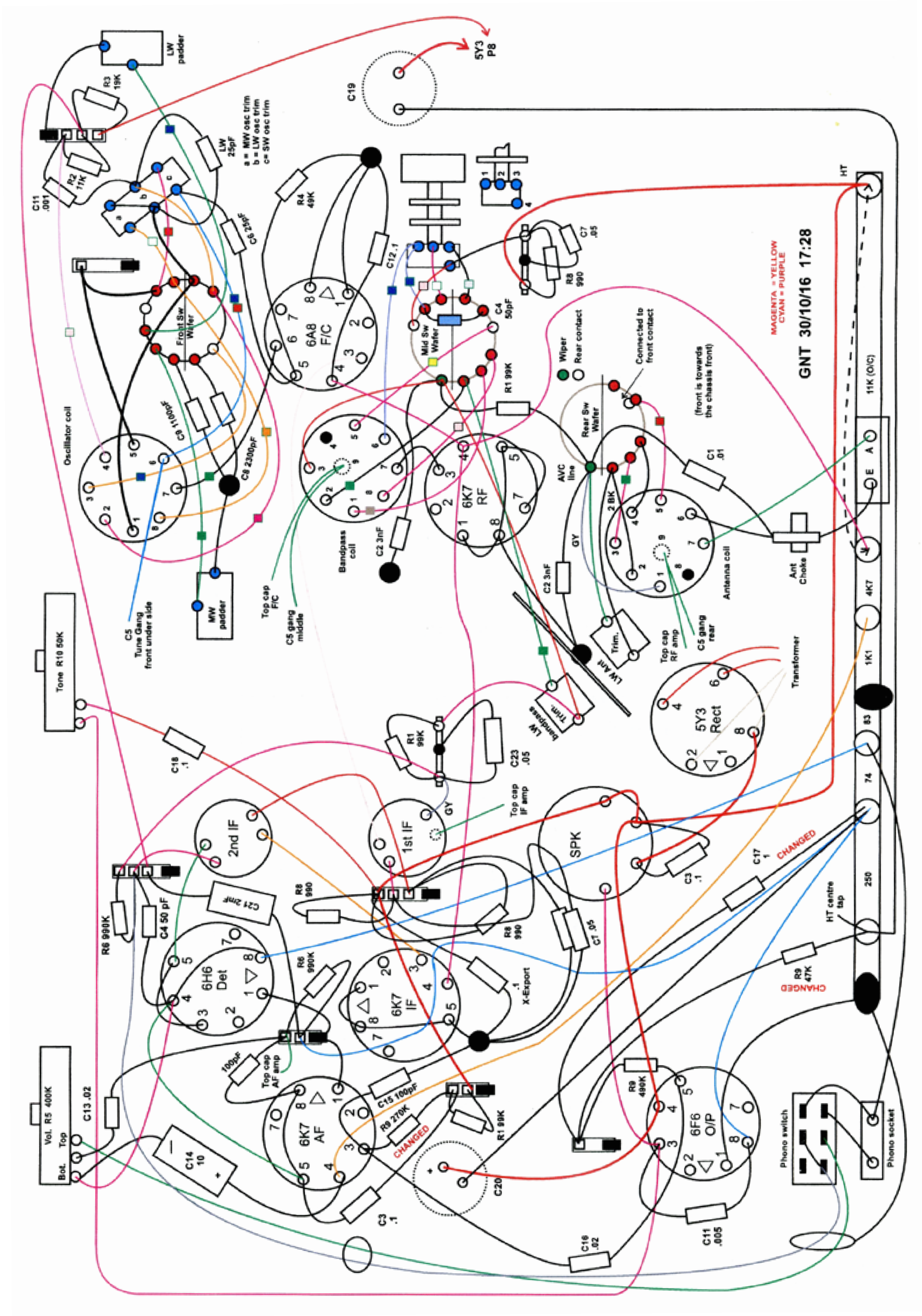
I have spent a lot of time studying the biasing and audio system including drawing up potential "ladders" etc. and have come to the conclusion that its complication was not to improve performance. More likely to discourage and confuse uninformed tinkering. Precisely the same results could be achieved with conventional circuitry with fewer components. I agree that a set of this potential performance should have had delayed AGC.

For the first AF stage, the correct valve would be a 6J7, the sharp cut-off companion to the variable mu 6K7. Feeding the screen of the first AF stage from a low impedance source, such as the Candohm divider, was not good practice as it needs a large bypass cap (C14) and the 25 volt 'electros' of that era were notorious for their unreliability. Better the normal method which is to use a high value screen dropping resistor and a paper cap for bypassing. Also this method helps iron out the inevitable variations between valves.

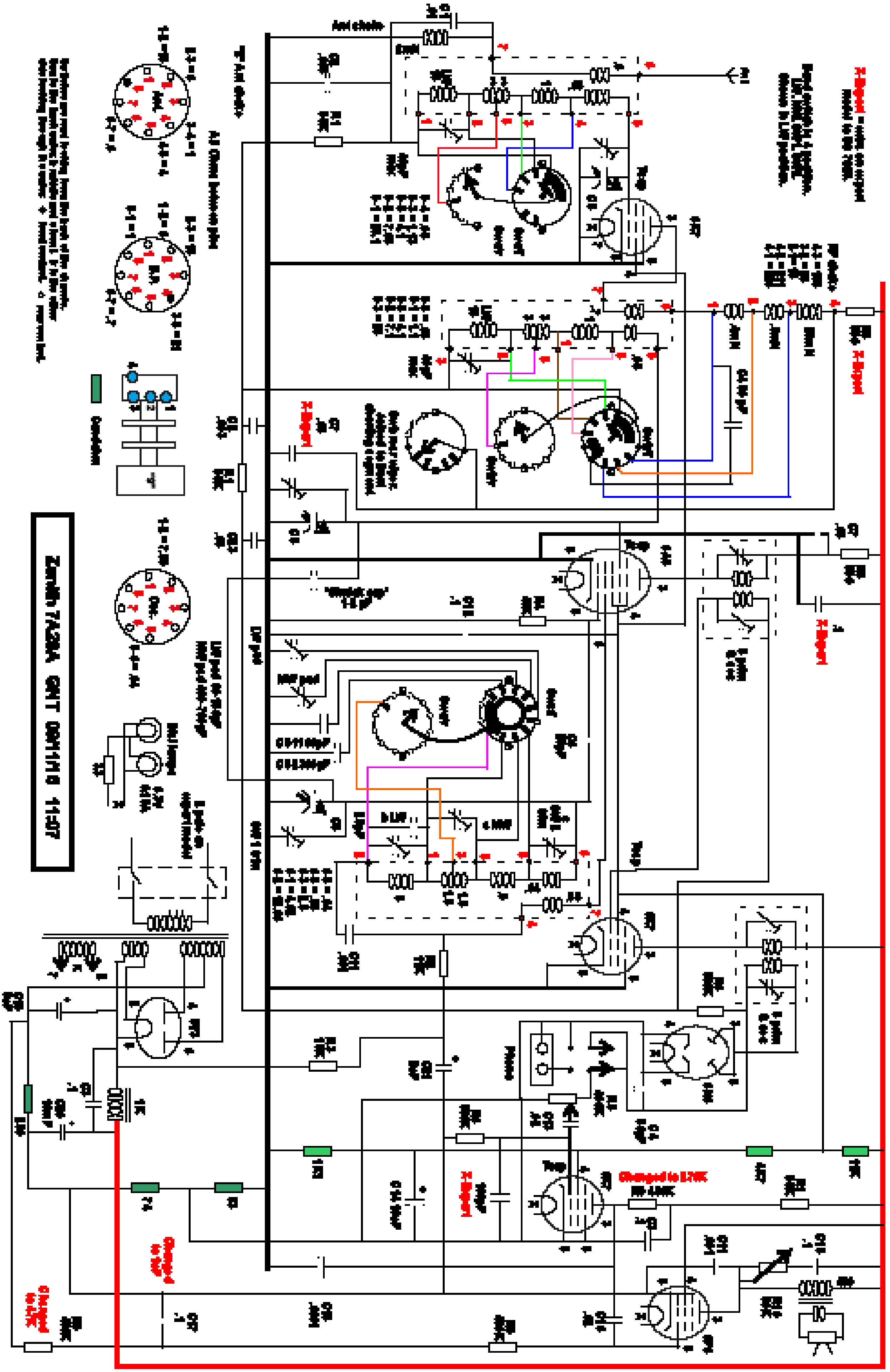
There are no fewer than three half M Ohm resistors (R9) in the audio system. The anode load for the first audio stage should be no more than half the value of the 6F6 grid resistor. Worse is the total value of the resistance in the grid circuit of the 6F6 of 1 M Ohm. RCA were quite clear on this. A self biased power valve should have a maximum of half a M Ohm in the grid to earth path. Fixed bias was ideally limited to 50K for output valves. The 490 M resistor between the Candohm and the C17 bypass capacitor should not be greater than 100K and preferably 50K which is in line with many other receivers. The danger of very high value grid resistors in power valves is grid current from traces of gas can cause a type of run-way grid current which among other evils can shorten output valve life.

The Candohm system was a good idea that didn't quite come off. They were very prone to develop open circuits in one or more sections and yours is no exception. In my experience it is rare to find an intact one.

The carbon resistors in your set are interesting. There are only 7 different values and they are



LW padder
R3 19K
R2 11K
C11 .001
LW 25pF
a = MW osc trim
b = LW osc trim
c = SW osc trim
C6 25pF
C19
5Y3 P8
R4 49K
C12 .1
6A8 F/C
Front Sw Wafer
Mid Sw Wafer
C4 50pF
C7 .05
R8 990
R1 99K
Wiper
Rear contact
Connected to front contact
(front is towards the chassis front)
Rear Sw Wafer
MAGENTA = YELLOW
CYAN = PURPLE
GNT 30/10/16 17:28
HT
11K (O/C)
Oscillator coil
C9 1100pF
C8 2300pF
C5 Tune Gang front under side
MW padder
Top cap F/C
C5 gang middle
Bandpass coil
C2 3nF
6K7 RF
AVC line
C1 .01
Antenna coil
Ant Choke
Top cap RF amp
C5 gang rear
LW Ant
Trim.
LW bandpass Trim.
4K7
1K1
83
74
250
HT centre tap
Tone R10 50K
C18 .1
R1 99K
C23 .05
Top cap IF amp
Transformer
5Y3 Rect
2nd IF
1st IF
SPK
C17 .1
CHANGED
C3 .1
R6 990K
C4 50 pF
C21 2mF
R8 990
6H6 Det
6K7 IF
X-Export
C7 .05
R9 47K
CHANGED
Vol. R5 400K
Top
Bot.
C13 .02
C14 10
100pF
Top cap AF amp
6K7 AF
C15 100pF
R9 270K
CHANGED
R1 99K
C20
C3 .1
R9 490K
6F6 O/P
C11 .005
C16 .02
Phono switch
Phono socket


Zenith 7A39A GNT 09/11/16 11:07

odd – (not the preferred valued series which came later.) There are no reds, greens or blues in the codes. The same situation applies to Philco sets of the same period. The reason was that the factories used vapour (sodium?) lamps which do not generate these colours, for lighting."

So, from this, I have reduced the 6K7 anode resistor to 270K and changed the lower R9 bias resistor, for the 6F6 output valve, to 47K and increased the decoupling hum filtering capacitor, C17, to 1uF.

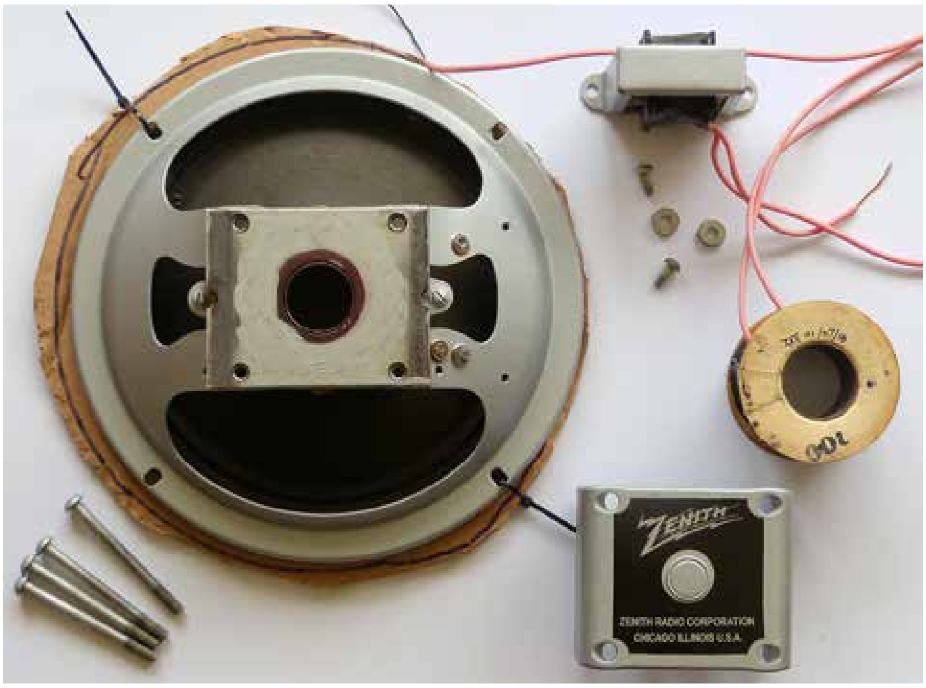
The restoration

Having removed so much, the easiest and healthiest thing to do, rather than sanding down the chassis and spray painting, was to drill out the rivets holding the remaining items and take it and a couple of brackets for re-plating. After discussion the best option was zinc which was what it had been plated with originally.

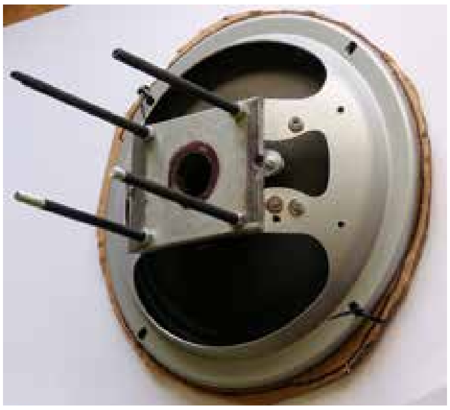
This was very quick but during it I started the labour of love cleaning all the coil and tube cans and worst of all the tuning gang. The RF and IF containers were unusually made from zinc which cleaned wonderfully with a quick wipe over with phosphoric acid. After removing the micas from the gang trimmers, it and the tube cans went through the dishwasher. They came out looking very clean but the cans needed some dents and distortion pushed out and the tuning gang required de-rusting with phosphoric acid. Once this was done the cans were sprayed with spray shellac, followed by matt lacquer as I don't like too much shine but the only way for the gang, was to apply it by brush which turned out looking acceptable to me. The gang sections were measured for capacity and leakage during rotation after new 'lube'. All were good but I did change the mica insulation in two of the trimmers. The gang was remounted on new rubber bushes.

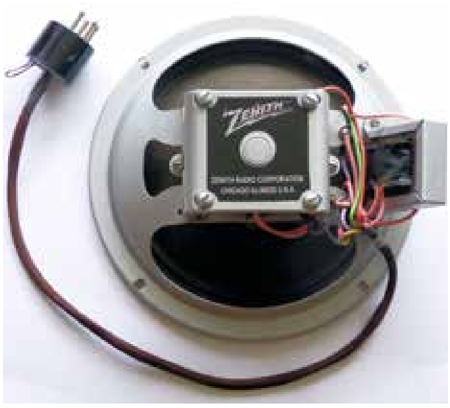
Then it was a rebuild of the chassis with replacement passive components, the new poly capacitors are housed in styrene tube and covered with PC generated labels, on new mainly vertical tag strips, as used originally, but with more tags. These had been so minimal that up to 8 components and wires could be on one tag and even the band switch had as many as 6. It was far easier to use new valve bases than trying to clean up the old ones.

The under-chassis LW and MW padder trimmers were in good condition, after cleaning, being of ceramic and brass construction. This wasn't so for the RF trimmers where the screws had corroded in the Paxolin threads of the panels. To me



Speaker items ready for reassembly


Speaker with assembly studs


Speaker back together

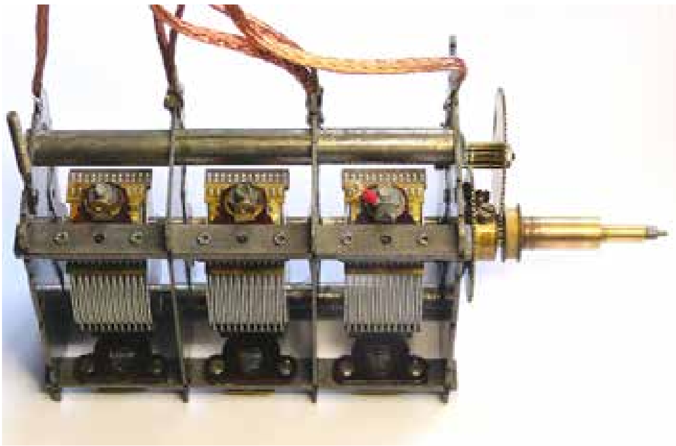
they weren't fit to continue but fortunately my stores had some old style replacements, of the same construction as the padders, with some actually NOS. However, it did mean making up new panels and mountings.

The Candohm wire wound resistor string, with one section open circuit, was remade with metal clad 10W resistors on an aluminium T section strip. Of course they didn't all need to be this wattage but I wanted to keep the layout roughly the same and the resistors fit in the same space and come with their own tag strip connections. It is a very neat replacement idea.

The dials

The outer one, with coloured rings on the rear for each waveband, was in good condition but a little distorted. There weren't enough of the original securing press studs, made like an expanding rivet, but even with a full complement they wouldn't have held it flat to the housing. Cutting an annular ring from SRBP (Synthetic Resin Bonded Paper) holds it perfectly flat using 6 BA screws and nuts. The screw at 2' O clock is from behind, with a countersunk head, going into a tapped hole in the ring. It needed this as the operating arm, for the inner dial, fouls a nut and shake-proof washer at the rear. I surmise that Zenith put the popper in from the rear also.


Antenna, bandpass and oscillator coils


Tuning gang

Chassis originally

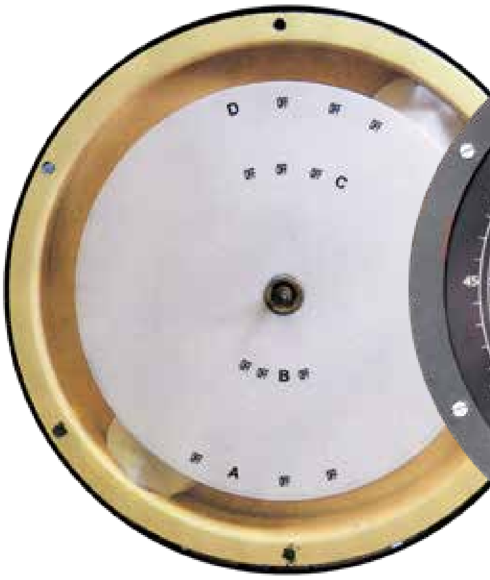
After rebuilding

Unfortunately the inner dial, that identifies which waveband is in use, was badly warped and the letters worn.

Firstly I needed a new disc and some were cut from 0.5mm translucent white plastic sheet from a model shop. The disc rotates on a bush secured to it by peening over the end of the hollow shaft but it is not re-useable. So, not having a lathe, I asked my friend, and member, David Taylor if he could make a bush and peen it to the disc. Kindly he did several and success was achieved by making the hole in the dial slightly larger than the part of the bush that passes through it. Failure to do this distorts the disc as the shaft expands as it is peened, using the ball end of a small hammer, with pressure from a vice.

It should have been easy to create a decal, to put new letters on the dial, but not so as a scan of the original didn't give accurate registration to the holes in the outer dial. Also, because of the cranked arm used for rotation, it did not follow the same angles as the switch indents. But eventually with paper print outs stuck to a replacement disc and a lot of hand tweaking a satisfactory result was achieved.

As usual, I used Papilio decal material (USA), which is the strongest and has the best adhesion of any that I have tried. After pull off tests on scrap material I found it slightly better to prime the disc with Zinsser Spray Shellac after having randomly flatted the plastic with 600 grit carbide paper. With or without the shellac, in flex tests, through both right angles, there was no sign of the decal material coming away. The front side decal added a slight curl to the disc and so I added a plain decal to the rear which made it perfectly flat again. Finally the decals, deliberately cut a couple of mm smaller in diameter, were sprayed with a sealing coat of matt lacquer.



New inner dial

Dial and support ring

Dial at night

The first switch on

With all the checking I had done I wasn't expecting any surprises when I first applied power, firstly without the rectifier just to check heaters and the HT winding. Then with this present, the HT came up to exactly the correct value and the voltage across the output transformer was correct from knowing its DC resistance and the expected 6F6 tube current.

With those instant checks out of the way I could make a more leisurely tour of the tube voltages, mostly bias and screen voltages and all were satisfactory.

No stations were present but this was to be expected and soon rectified by tuning the IFs, with a signal generator, followed by a quick look with a Wobbulator. Bandwidth was normal at about 6 kHz.

Now the radio picked up stations on all bands which was gratifying and just left me to do a proper alignment.

Conclusions

This is one of the most difficult radios to re-wire that I have completed. It was particularly so around the wave band switch and coils. I made it easier by deciding which wires to add to the switch and which to the coils before putting the switch into the chassis. Making the wires the same length as the originals and preparing the free ends of the wire also helped.

Even getting the chassis into the cabinet is tricky as there is little to get a firm grip on and its heavy, so whatever is held has to be substantial. After a dummy run and later, with the chassis mount rubbers in place, I cut a piece of thin ply to act as a slide before pulling this clear once the chassis was nearly home.

The performance of the radio is very good. It possibly has slightly more sensitivity than my other tuned RF stage radios and it is selective but doesn't have switchable bandwidth. For audio performance it is easily beaten by the Philips D57, of recent articles, and by top EMI sets. Both of these have permanent magnet speakers and more trouble is taken with detection and AVC. The Philips has, for the time, a sophisticated audio amplifier, with bass boost that employs 'tailored' negative feedback from the output transformer secondary. But perhaps the comparison is unfair, as all of these radios were two to three years later than the Zenith and improvements were being made very rapidly, rather like the early days of the computer industry.

Finished!

I posted before and after pictures of the radio on the US Antique Radio Forum (ARF) and got some amusing and pleasing comments from my American friends. Here are a few of the best:

"Looks like a WOW to me..." (35Z5).

"WOW, I mean WOW, HOLY COW that is really something!!!" (Lou deGonzague).

"Stunning to say the least, a true work of art." (Apollo18).

"You did good job on both the chassis and the cabinet. You should be proud to show this radio anywhere. I also like the escutcheon the way you left it, it looks more natural. (Dan in Calgary).

"… my personal favorite high-end Zenith tombstone. I like it even more than the "Walton". Just classic '30's styling. You did an excellent job restoring it. Beautiful and agreed that refraining from polishing the dial bezel was a very wise choice. It looks great that way." (decojoe67).

50 years of UK colour television, celebrated with a restoration of a BRC/Thorn 2000

Stephen Niechcial

The early days of U.K colour TV - experimental colour transmissions on the British 405 line system using the American NTSC colour encoding system - had gone out in the London area from the mid 1950s.

A prolonged period of industry and government wrangling over technical standards followed before the UK finally settled on the adoption of colour TV on 625 UHF only, using the PAL encoding system in the mid - 60s. December 1967 marked the official launch of the colour TV service in the UK - one of the first in Europe. It went out on the then only channel transmitted on UHF - BBC2. Duplication of BBC1 and ITV services in colour on UHF began in late 1969. However, it would be another seven years before national coverage equal to 405 transmissions was achieved. So paying out about £320 (roughly £5,300 in today's money) for a typical 25" set got you just a very limited number of colour programmes on one channel. Interestingly the summer 1967 test broadcasting of tennis from Wimbledon in colour prior to the launch was a re-run of history. Outside broadcasting from Wimbledon had been one of the first programmes from BBC television when it first started in 1936.

The fact that BBC1 and ITV were still only available on 405/VHF meant that all first generation UK colour sets followed contemporary black and white (monochrome) practice and were 'dual standard', designed to operate on 405 and 625 systems. This presented extra complexity on colour sets. A vhf tuner was of course needed, with IF and time base switching as with monochrome sets. But on top of that, the complex high power 'convergence' adjustment circuits and controls used to accurately shape and overlay the red, green and blue rasters on the tube face were highly frequency specific. This meant they were more or less duplicated on each system. The manufacturers made a great point of stressing accurate time consuming optimisation of convergence when installing the set. In practice, an hour of twiddling ten or more highly interactive controls for each standard seldom improved things, and often made them worse. Colour fringing errors were always more noticeable on monochrome pictures. Additionally, the first generation of colour tubes were nothing like as bright as contemporary monochrome ones, and had to be watched in subdued lighting. The net result was that the monochrome pictures on a colour set were four times more expensive, but not nearly as good as on a monochrome set! (Figs 1 and 2) Manufacturers reckoned that single standard sets when they appeared would be about 20% cheaper, allowing for inflation, which indeed they were.

Customers buying these sets were clearly paying a huge luxury premium to be the first. As a result there was no skimping on the peripherals of cabinet quality and sound quality, both of which hit a peak that hadn't been seen for a few years. Most sets were 25 inch console models with a few 19 inch table models. Apart from the sheer cost of the sets and the small amount of colour programming, manufacturers faced a risky launch environment because of government regulation. The government of the day controlled consumer spending by controlling consumer credit. In practice this meant varying the deposit size you had to have as a percentage of a hire purchase loan. In 1967 this was quite a chunk, and tended to depress sales. Because of all these issues of cost, reliability and lack of credit, a large percentage of viewers in the first wave rented their sets, rather than buying them. The only sets exclusively built for rental in 1967 were made by the Baird firm. Another major rental company, Rediffusion held off set manufacture until the Single Standard era but sourced badge engineered sets from the rank organisation (CTV25 Chassis). By 1967, Baird had become a manufacturing subsidiary of Radio Rentals - one of the biggest TV rental companies in the UK. Baird sets were specifically designed and manufactured for distribution by Radio Rentals. All other rental sets were 'badged' models from the half dozen or so major UK manufacturers. Colour TV was slow to catch on. By early 1969 there were only 100,000 colour TV licences compared with ten million monochrome ones.

In the early 1970s the government suddenly took the brakes off hire-purchase deposits just as cheaper single standard sets appeared. The result was a sudden sales and rental boom which most manufactures were unable to keep up with. A flood of imports followed, often sets of superior performance and reliability. Simultaneously Japanese firms such as Sony found ingenious ways around the PAL signal patents which had been intended to keep them out of the European market. They also focussed on the small screen market which had been completely ignored by UK manufacturers. In retrospect these developments put together marked the beginning of the end of the indigenous UK TV manufacturing industry.

The first sets

With the exception of the Thorn 2000, all first generation of UK colour sets followed their monochrome counterparts in being hybrid designs. Transistors were used in the signal circuits with valves in the high power/ high voltage stages such as timebases and usually video/colour outputs. The additional demodulation circuits of the PAL decoder were also transistorised by most manufacturers. The power requirements of these output stages were considerably higher than for monochrome sets, resulting in a new set of valve designs specifically for the purpose. Higher powers and voltages brought a new set of reliability challenges. Particularly notorious was the EHT 'smokestack'. The majority of manufacturers went for this - a 25Kv transformer overwind and valve rectifier. A valve shunt stabiliser was also incorporated to keep the EHT current, and hence EHT voltage, stable regardless of picture content changes. Not only was this set-up a major point of failure (hence the name 'smokestack'), it could also emit harmful levels of X-rays if the valves heaters failed for any reason. The whole caboodle was placed in a large metal screening tower, sometimes with an interlock to cut HT to the

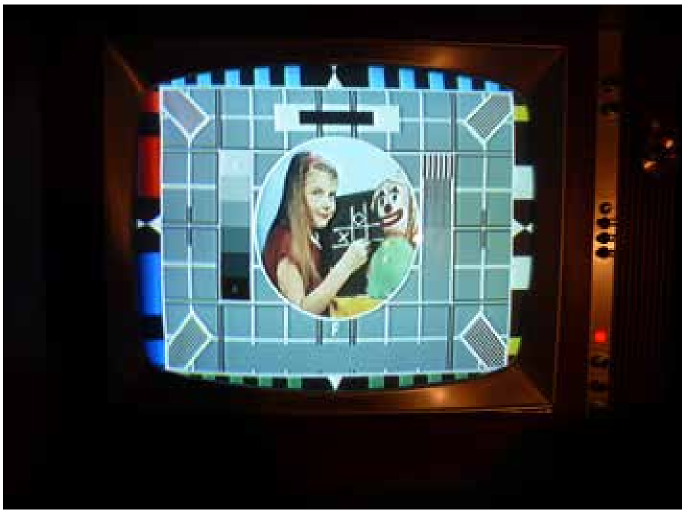


Fig 1: A colour Test Card on a 1967 GEC hybrid . Note the colour patterning in the middle of the frequency bars on the right. This is due to the 4.43 colour sub-carrier falling within the luminance pass-band and is a limitation of the PAL and NTSC systems. The red light on the right comes on to indicate you are receiving a colour picture!

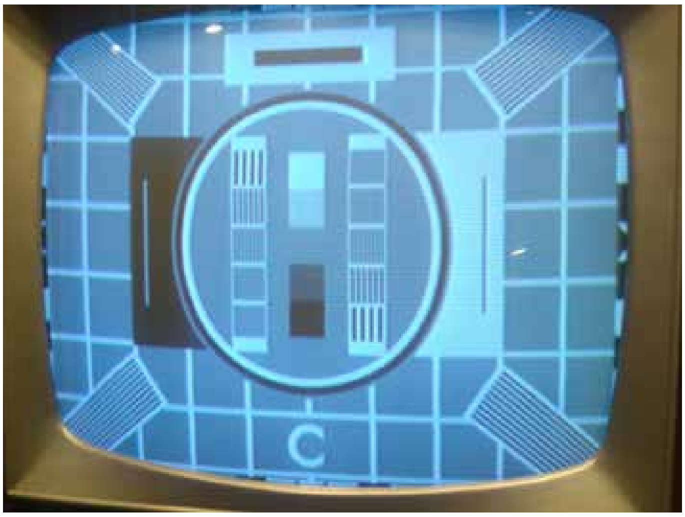


Fig 2: A 405 Test Card on the same set. On 405 a 'colour killer' switches in to prevent coloured noise. The lack of a colour sub-carrier means no interference this time on the frequency gratings. Black and white is what you would probably be watching 75% of the time on these first sets!

line stage when the screening was removed. Several manufacturers (including Thorn) went for a much more reliable 8Kv transformer with solid state EHT multiplier and usually no further stabilisation. All sets had some kind of protective 'beam limiting' device designed to reduce picture brightness, and hence EHT load, if for any reason this exceeded a pre-set level (around 1 mA). Two other variations from standard monochrome practice of the time were AFC on UHF, and DC restoration/ black level clamping; correct colour rendition required precise tuning of the 4,43 Mhz colour sub-carrier and accurate black levels. These sets came out a couple of years before any integrated circuits for TV use. They were built entirely of discrete components and so in servicing terms represented the most complex domestic electronic device produced to date. They also produced a step change in service engineering skills required (Fig 3). Reliability overall was not great. Which Magazine tested and reviewed eight sets and reported that six of them broke down at least once. To add insult to injury, the standard one year warranty did not cover labour charges.

A ground breaking design

Whilst most manufacturers followed set design principles described above, the launch of BRC/Thorn 2000 stood out as a revolutionary device. It holds the claim to be the first fully transistorised commercially produced large screen colour TV in the world. In breaking with conventional hybrid practice, Thorn were taking considerable risks. Some of the transistors involved, such as the Texas R1039 used in the line output stage, were 'cutting edge' devices on the very edge of being able to meet the set's power/voltage demands. The power/voltage limitations of transistors available accounts for the fact that two transistors were needed in various power stages instead of the usual one of later generations These high power output stages in turn needed high current voltage stabilised regulators to supply them . Also, the demands on power transistors meant that the EHT supply could not be derived in the conventional way from the Line Output Transformer. Instead it had to be supplied from a separate EHT generator stage. The cost of those transistors and extra circuits, plus an expensive, high current, double wound mains transformer (not needed in hybrid sets) made it more expensive to produce. I have heard it claimed that the 2000 has the highest component count of any domestic electronic device produced before or since. In a competitive market, BRC/ Thorn were forced to market the set at a considerable loss. For all this, the performance and reliability of the 2000 matched (but did not exceed) its hybrid rivals. Whether Thorn gained valuable experience and so a longer term commercial advantage in going transistor from the start is a moot point. Some of the first single standard colour sets were just chopped down versions of earlier hybrid dual standard ones with the 405 bits removed. However, by the early 1970s, most UK manufacturers had gone over to all solid-state designs.

Fig 3: Inside the GEC. A total of 10 valves. The slanting vertical bar on the top left operates a system switch running along the front length of the chassis. The line output is on the right- but no tall 'smokestack' as the set uses an EHT tripler. The chassis hinges upwards to give access to the 'print' side. The convergence panel at the top hinges up and forward for adjustment while viewing the screen.

Apart from being all transistor, the 2000 was also revolutionary in servicing terms. Most hybrid designs were build as a number of circuit boards hard wired together on a metal chassis. By contrast, almost all of the 2000 circuitry was on ten completely removable circuit boards. These plugged into a rectangular framework by means of edge connectors and flying leads. The whole framework itself could be slid out from the cabinet giving excellent access to both sides of the board for service. Instead of two men having to lug a huge console back to the workshop for trickier repairs, a good board could simply be substituted, and the faulty one taken back for repair (see Photo 4).

Starting work

My 2000 is one of the mid range ones - 25 inch, but without the doors of the console version. It is badged as an Ultra and originally

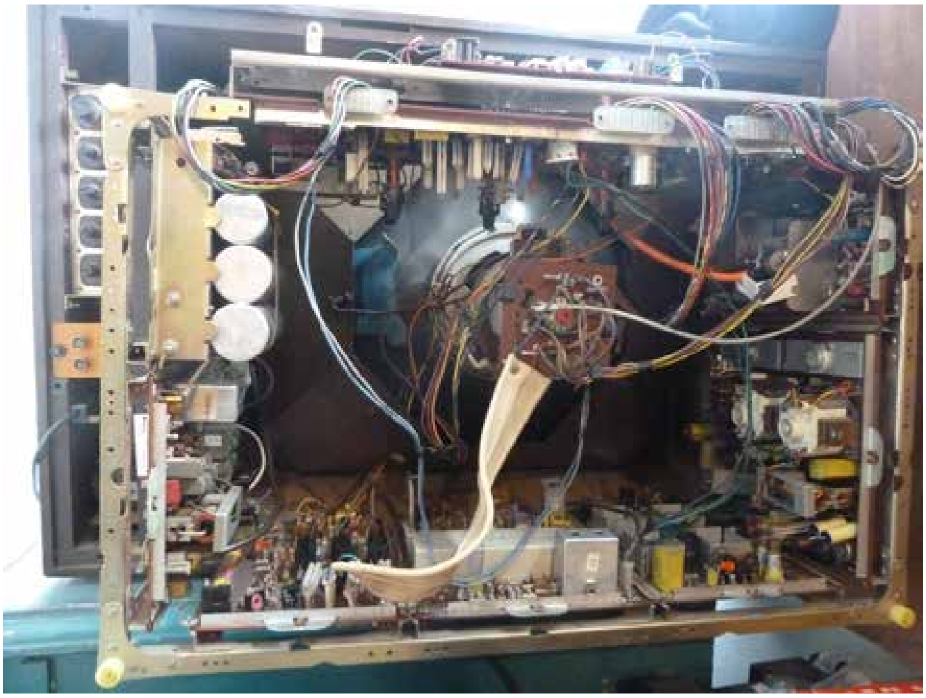


Fig 4: The 2000 showing chassis pulled back for service. The two line output transformers and the EHT transformer are visible on the right. The large mains transformer is concealed in the front of the cabinet on the other side. The largish grey block bottom centre is the PAL delay line. The convergence adjustment panel, inverted at the top, slides out and can be mounted on the top of the cabinet for adjustment from the front.

Fig 5: The main power regulator board

slotted into a separate castering stand, which unfortunately did not come with it. I got it from a fellow enthusiast who had kept it stored and unused for several years. On arrival, a look around the inside showed a complete set with little sign of bodging other than the two aerial sockets cut off and missing. It was a case of 'dead set' - just a brief loud hum from the auto degaussing when switched on, and tube heaters glowing showing the mains fuse was intact. Before committing to a full restoration, I was keen to get a picture up to judge the general condition of the set.

For the 24Kv EHT to be present the line timebase has to be working, as pulses from this drive the EHT generator. The main voltage regulators delivering power to the line and field stages sit on top of the set with their associated power transistors so that most heat goes straight up and out through the vents on the top of the cardboard back. Unfortunately the board still tends to get fried by the wire wound resistors mounted on it and the regulator power transistors nearby (Fig 5). As soon as I touched the board with a meter probe the set burst momentarily into life. Removing the board from the heat sink showed a whole host of overheated joints, frazzled looking circuit tracks, and the hardened insulation on the leads to the power transistors fell off as soon as I disturbed them. A good all round rebuild was necessary, including replacing some of the high wattage resistors whose lead out wires were too oxidised to solder well.

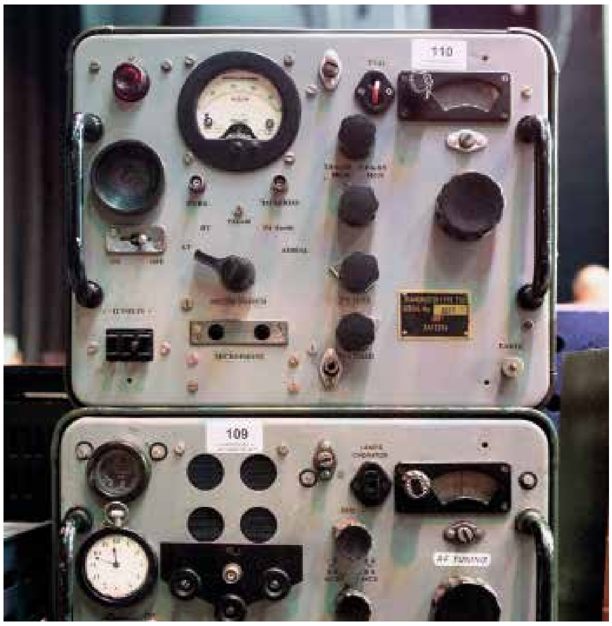
On switching on again I was rewarded with the crackle of the EHT coming up and a small green tinted raster of UHF noise. Hooking up a UHF aerial direct to the tuner (no isolation necessary because of the mains transformer), and twiddling a tuner button brought in a small picture in the middle of the screen. Checking on the regulator board again showed that both frame and line feeds were both down about 30% with the adjustment presets set at maximum (there are separate presets for 625 and 405 voltages labelled 'width'). Both regulators are fed direct from a dedicated mains transformer secondary and bridge rectifier circuit on the Power Board. The fault was easy to see when I removed it. One of the four diodes in the bridge rectifier had exploded, blowing itself in half. For good measure I replaced all four diodes and turned both voltage regulator pre-sets down to minimum. On switching on and advancing the 625 voltage/width control the width filled out nicely until the correct voltage setting point (about 53 V) and then started to jitter in and out; a dead spot on the control. It didn't respond to a good cleaning, so out came all three pre-sets, and new ones went in. These miniature pre-sets are a weakness of most TV sets of the 1960s. Unfortunately replacements are quite hard to come by. A solution avoiding replacement, is to swap the connections to the two ends of the control so moving the correct adjustment spot away from the 'dead' area of track. However this is awkward on printed circuits, and of course doesn't work if the correct adjustment falls in the centre of the track.

Checking for the cause of my green picture I found no A1 anode voltage on the blue tube gun. This is not an uncommon fault on any primary colour - caused either by a faulty de-coupling capacitor or leakage to earth inside the relevant Red, Green or Blue A1 gun on/off switch provided for service purposes. These components are on the convergence board. It turned out in this case to be the switch. Not having replacements I removed and bridged all three switches to save any intermittent problems later. Slight adjustment of the A1 and focus controls gave me a nice grey raster of noise with the greyscale tracking with the brightness control. A slight adjustment of focus made the snow pin sharp over the whole screen. Good news then - the tube was decent. The one fitted was probably a replacement - an A63-200X instead of the original A63-11X. About the only difference between them is the screen phosphors which were considerably improved and give a brighter picture on the later tube. By twiddling a button tuned into my digibox signal I was rewarded with a somewhat poorly converged 7/8ths colour picture - the left hand edge was in black and white only!

I hadn't tried a 405 picture at this point, but I had done enough to know that I had a set viable for restoration. The difficult to source components of tube and transformers and tuner were OK. The next part of my article will cover the detailed restoration.

Harpenden, September 2017

Photos by Carl Glover



Ekco R52

The Theremin

Evan Murfett

A short while before my father's death in 2014, he gave me a RCA Radiola 16 from 1927 (the year of his birth) which he had restored. This sparked some interest and subsequent research into RCA from the late 20's during which I became aware of, and fascinated by the 1929 RCA Model AR-1264 Theremin.

The instrument was invented by a young Russian physicist named Lev Termen (known in the West as Léon Theremin) in 1920 as a result of Soviet government-sponsored research into proximity sensors. Theremin found his way to the United States, where he patented his invention in 1928 and subsequently granted commercial production rights to RCA.

In 1929 RCA commenced production of the AR 1264 Theremin. RCA contracted the RF chassis production to GE and Westinghouse. GE produced approximately 300 RF Chassis with serial numbers from 100000 to 100300 whilst Westinghouse produced approximately 200 RF chassis with serial numbers from 200000 to 200200. The A/C mains power supply is identical to that in the RCA Radiola 60, the first A/C mains supply super-heterodyne produced by RCA. The tapered legged, lectern-like cabinets standing 1.2m tall were produced by Jamestown Mantel Company in furniture grade mahogany. As the AR 1264 Theremin does not have its own integral speaker, sockets are provided for the connection of an external speaker. RCA recommended the model 106 electrodynamic moving coil speaker.

RCA released the AR 1264 Theremin in 1929 shortly after the Stock Market crash which almost certainly contributed to its lack of commercial success. Theremins were luxury items, priced at $175.00, not including valves and RCA's recommended Model 106 Loudspeaker, which brought the total cost of buying a complete outfit up to about $232.00. Approximately 500 AR 1264 Theremins were produced between 1929 and 1932, to put this in perspective, RCA were at that time producing 9,000 radios per day. The Theremin was also advertised as being easy to play, but nothing could be further from the truth! Unlike almost all other instruments, the space or rest between each note also needs to be actively played. When properly adjusted and voiced, the RCA Theremin has a pitch range of 3.5 to 4 octaves, and a timbre that is somewhat like a cello at the low end and somewhere between violin and voice at the high end.

The Theremin comprises two metal antennas which act as plates of a variable capacitor. In the case of the RCA Model AR-1264 Theremin, the pitch control antenna is a vertical rod and the volume control antenna is a horizontal loop. The Theremin uses the heterodyne principle to generate an audio signal. The instrument's pitch circuitry includes two RF oscillators set below 500 kHz to minimize radio interference. One oscillator operates at a fixed frequency. The frequency of the other oscillator is controlled by the performer's distance from the pitch control antenna. The performer's hand acts as the grounded plate of a variable capacitor in an L-C circuit. The fixed and variable frequencies 'beat' against each other to produce the audio frequency. To control volume, the performer's other hand acts as the grounded plate of another variable capacitor.

RCA AR 1264 Theremin S/N 200052, Cabinet viewed from performer's side

The bottom edge of each hinged door carries a bracket to operate a safety interlock, intended to cut power when either of the doors are opened.

Valves as seen from left to right through the open doors are as follows:

UY-227 – variable pitch oscillator

UY-224A – detector modulator (mixer)

UY-227 – fixed pitch oscillator

UY-227 – audio pre-amplifier

UX-120 – volume control

UX-171A – volume control oscillator

UX-171A – power audio amplifier

The power supply carries a single UX-280 full wave rectifier valve.

Clara Rockmore was a Lithuanian born virtuoso performer of the Theremin who developed a close friendship and collaboration with Leon Theremin during the 1930s, touring the US

RF chassis (above) and power chassis (below) with 240 to 110V transformer on left.

extensively with Paul Robeson. Other notable RCA Theremin owners and performers were Charlie Chaplin and Harpo Marx.

Percy Grainger, the celebrated Australian-born composer, arranger and pianist, collaborated with Leon Theremin from 1936-37, composing three pieces for the Theremin before Theremin 'disappeared' back to the Soviet Union supposedly at the hands of the KGB.

In the mid 1940s, Hollywood composers discovered the Theremin and began to arrange scores that included its haunting sounds. The Theremin was again popularised in the 1950s by Bob Moog who went on to invent the Moog Synthesiser. By the 1960s, Theremin sounds began to be heard in experimental and rock music.

In January 2016 I had the pleasure of being personally shown RCA AR 1264 Theremin S/N 200052. This instrument was donated to Museum Victoria by Mrs Jeffery of Bentleigh East in 1977 along with other items of an electrical and technical nature, perhaps after the death of her husband. The theremin was on long term loan to the Percy Grainger Museum located in the grounds of the University of Melbourne. It is now stored at Scienceworks as part of the History and Technology Collection. Although not currently on public display, I hope that raising the awareness of this unique instrument will earn it a place in the public collection.

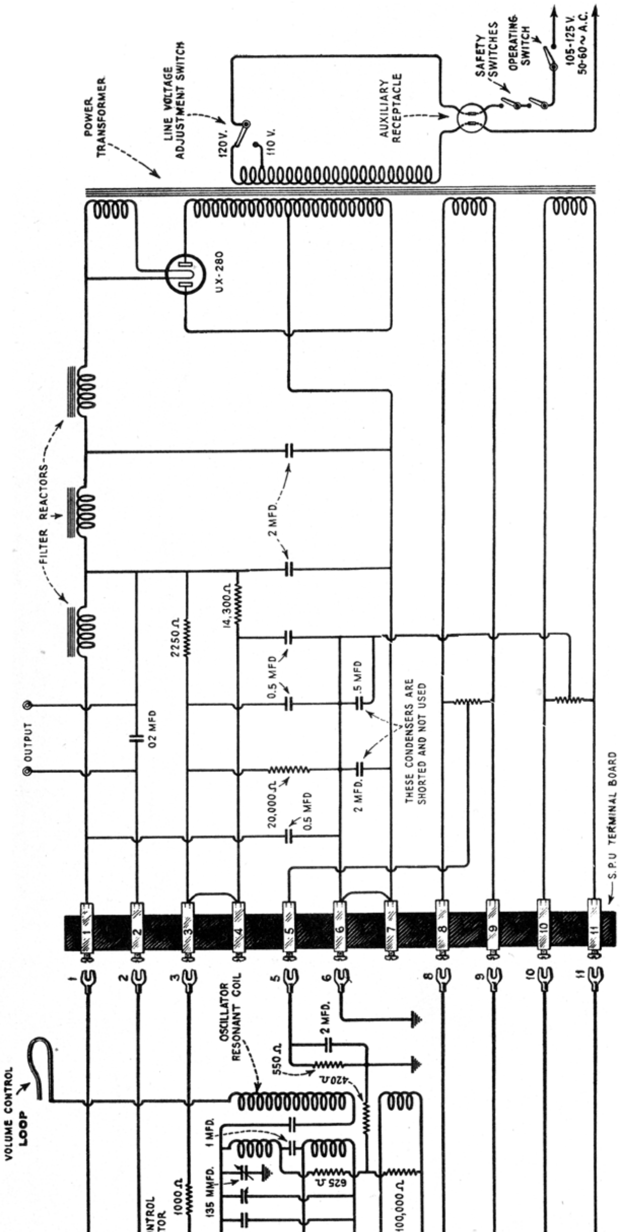
Of the approximately 500 RCA AR 1264 Theremins produced, only 113 are known to remain, making them rare, collectable and valuable. S/N 200052 is the only recorded example in the Southern Hemisphere and one of only two outside North America and Europe. Several Theremin enthusiasts have created faithful reproductions of these instruments, using the power supply chassis from a RCA Radiola 60, and the RF chassis from a Radiola 60 or 66.

I have recently acquired a Radiola 60. So begins another journey.

The generous assistance of Nick Crotty, Scienceworks - Museum Victoria is gratefully acknowledged.

Photographs by David Thompson provided by Museum Victoria.

RCA AR 1264 Theremin schematic and additional information: www.rcatheremin.com.



Above: RCA AR 1264 Theremin Schematic

Golborne, November 2017

Photos by Greg Hewitt

Murphy Colour Television, but you can't buy one!

Mike Barker

As long ago as 1946 the BBC were looking into the prospects of a colour television service for the UK.

A small group of engineers were tasked with investigating the requirements of such a service and examining the various different ways that had already been demonstrated, both mechanically and electronically. A great interest was shown in the developments being made in the USA by CBS and RCA. The clear leader with a system of colour which was also compatible with their existing black & white receivers was RCA with its Luminance-Chrominance system.

Since 1938, RCA had also been developing a German patented invention which was later known as the shadow mask in the construction of a colour cathode ray tube. The RCA version was an improvement and used three electron guns.

Between 1950 and 1953 RCA had produced and demonstrated several experimental colour television sets, all using their metal cone shadow mask cathode ray tubes. These showed the greatest improvement in picture quality of any other system. The National Television System Committee (NTSC) recognised the improved potential of the RCA system and gave its support. The system subsequently became known as NTSC.

Back in the UK, The NTSC system was seen as the logical choice for a UK colour service.

It required only a relatively small amount of change to be usable on 405 lines and 50 Hz mains.

It would be compatible with the 405 line black & white receivers in use as the extra colour information in the signal would not be resolved by the televisions of the time and therefore no interference would be visible on screen.

The BBC along with several BREMA member manufacturers of domestic televisions and radios then embarked on the development of experimental colour studio equipment, cameras and receivers.

The mains players in the studio equipment and cameras were Marconi and Pye. The receivers and monitors were made by at least eight different manufacturers including Marconi, Murphy, Pye and Ekco. In April 1956 the BBC transmitted a programme of colour films (mainly American), colour slides and live studio action from Alexandra Palace for a demonstration by BREMA to the CCIR (International Radio Consultative Committee). One such receiver was made by Murphy.

The Murphy colour receiver started life some five years prior to the 1956 demonstration, just as soon as Murphy radio could acquire an RCA shadow mask tube. A very small area of the development section was set aside for engineers to gain the knowledge and experience of working with the American system and using newly developed American components.

There were no available colour signals being transmitted in the UK so Murphy made an in house 405 line colour bar generator. Later

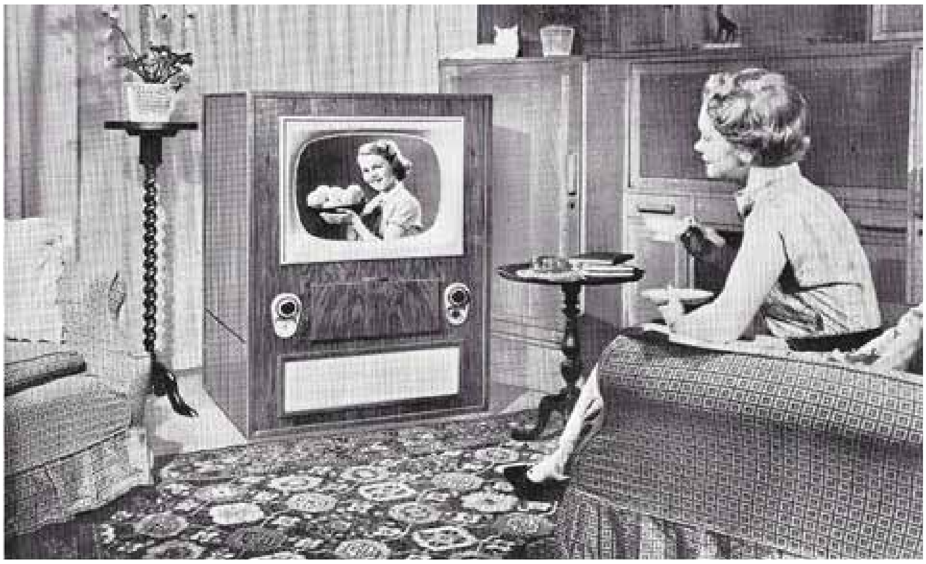


Figure 1 Murphy experimental colour TV in domestic setting

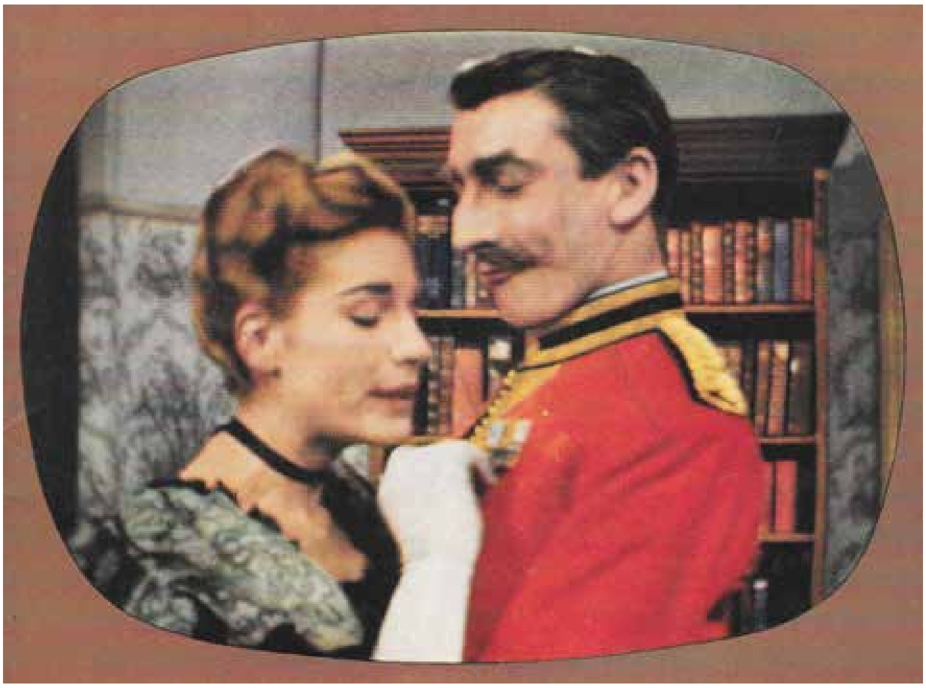


Figure 2 Actual off screen picture of BBC experimental broadcast

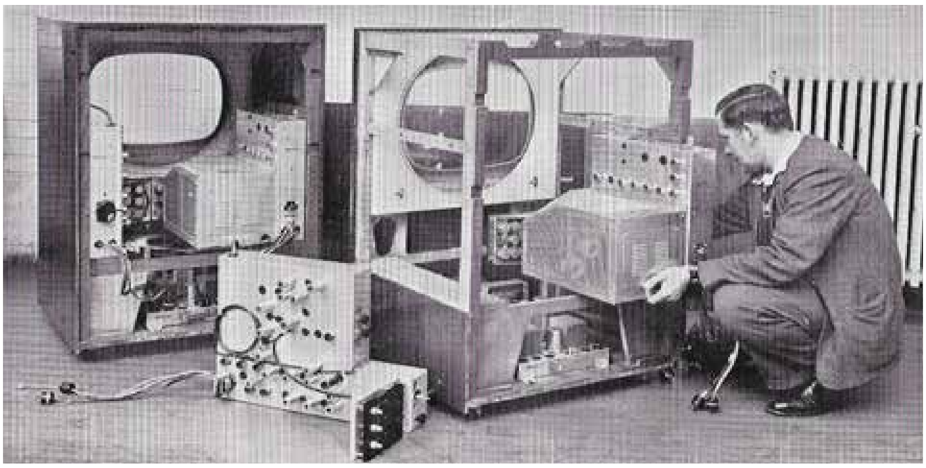


Figure 3 Internal units of the colour receiver

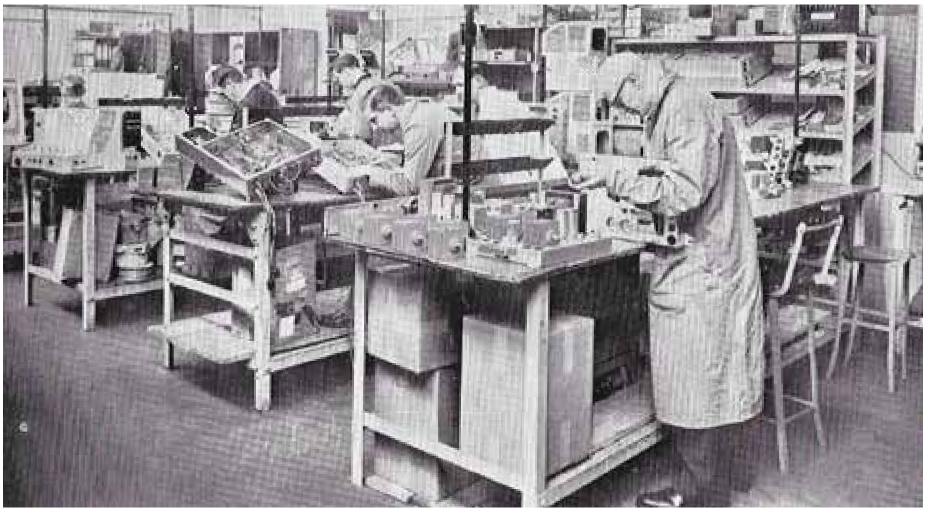


Figure 4 Chassis being hand built.

Figure 5 Factory visitors seeing colour TV for the first time. Note the metal cone tube

Figure 6 Colour from the inside

Figure 7 View of BBC experimental colour television studio control room at Alexandra Palace

they constructed another test generator using an optical colour slide scanner. Some years ago, I was able to obtain a quantity of glass slides from the Rank Bush Murphy factory and some of these are shown.

Murphy built 15 complete receivers. Twelve were supplied to the BBC, two were sent to the Ediswan Co. who was interested in the manufacture of colour tubes and one receiver went to the GPO. A further order for twelve more was received from the BBC shortly after. It was estimated that each receiver cost six times that of a 21" monochrome receiver to make. The RCA 21" colour tube alone cost more than a standard 17" receiver at the time. Murphy estimated that their colour receiver would have an expected retail price of between £300 and £350 (£6,700 to £7,800 in 2017), but it was never for sale. In total the complete receiver as shown in the block diagram (Figure 8) used 40 valves and the RCA metal cone 21" tube. The metal cone operating at a potential of 25Kv was protected by a Polythene cover and all of the high voltage circuits were encased in a fully screened metal enclosure.

A lot of the construction was of recognisable

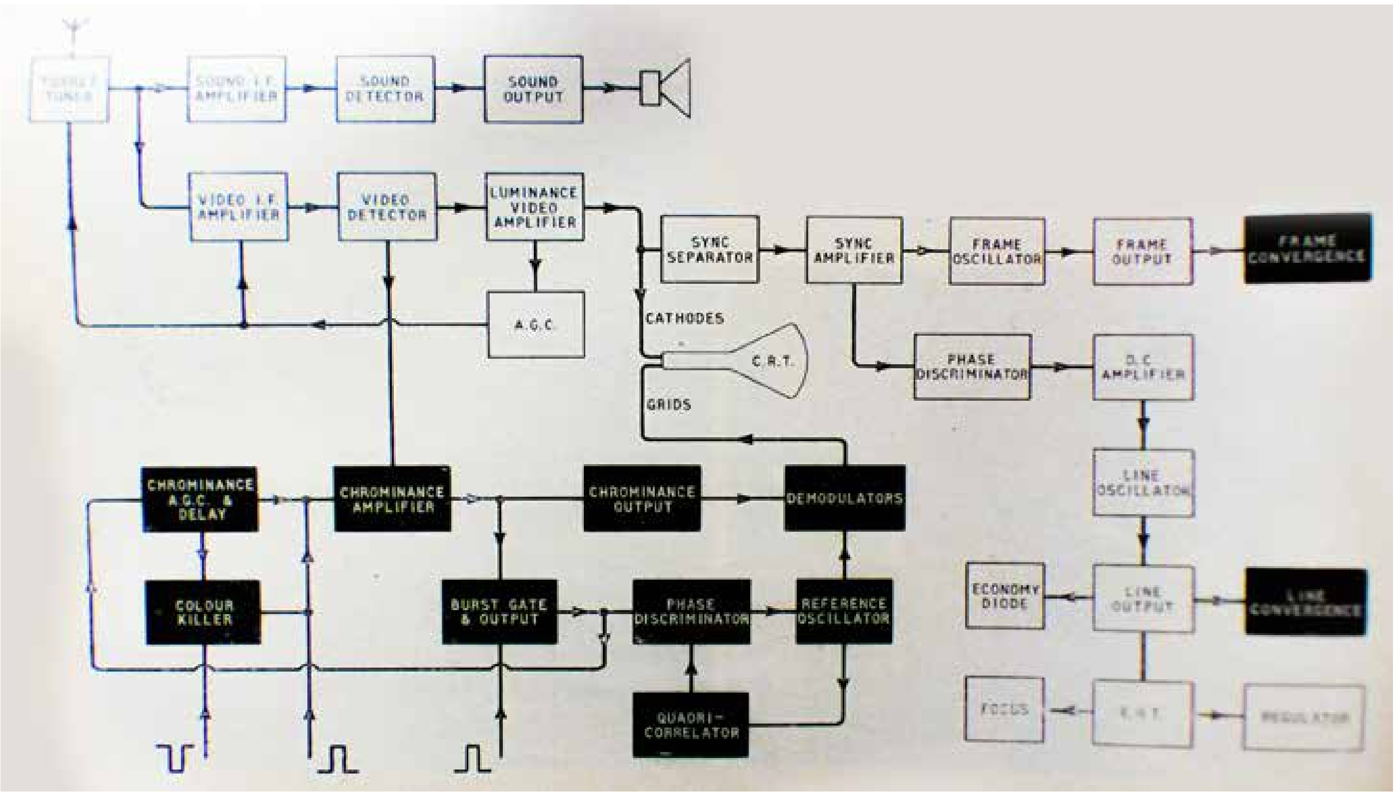


Figure 8 Block diagram of experimental colour receiver

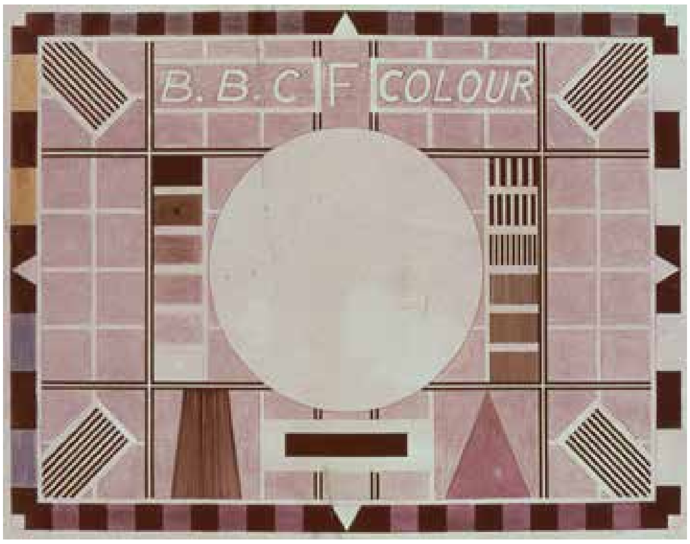


Figure 9 Off Hand drawn Test Card F - Early prototype

Figure 10 Test Card F - Bathing Belle

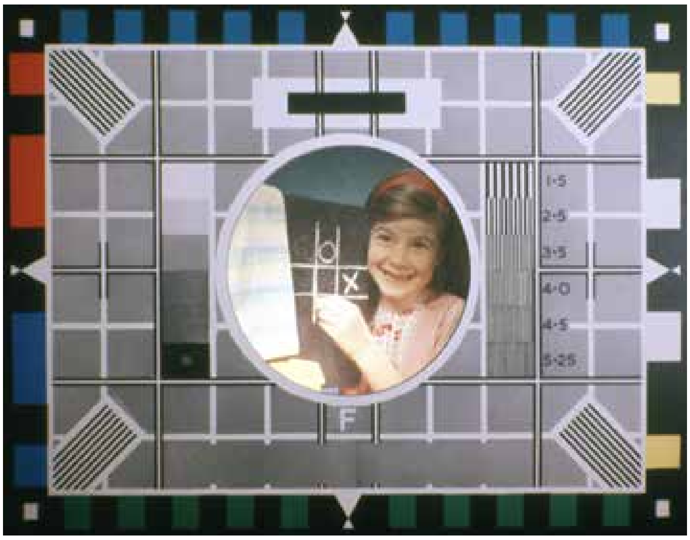


Figure 11 Test Card F - Very young Gillian Hersee

Figure 12 Off screen photo, girl in red coat

Figure 13 Off screen photo, lady in floral hat

Figure 14 - Off screen photo, lady in kitchen pealing fruit

Murphy design and manufacture.

Murphy continued to supply quantities of colour receivers and studio floor monitors to the BBC for transmission testing at Alexandra Palace and out in the field.

In the early 1960's a second generation colour receiver was supplied by rank Bush Murphy to the BBC this was known as the CVB100, again using a round 21" tube which by now was all glass and marketed in the UK by Mullard as the AX53-14.

This was an re-designed version of the original, still for NTSC but the surviving examples seem to be modified for PAL 625 lines. Once again these were only meant for experimental work and were never offered for sale.

It was not until autumn of 1967 that Murphy announced their first colour televisions for the public to buy. These were the 25" CV2510 console at 315 Gns. The 19" CV1912 at 295 Gns. And the 25" CV2511 at 295 Gns.

All three use the Rank CTV25 chassis.

If anyone has ever seen, worked upon or know of the existence of a Murphy 1956 experimental television I would be very happy to hear from you.

Acknowledgements

My thanks go to Mikey Bennet for scanning the slides.

Dear Editor,

Regarding your plea in BVWS Bulletin vol 42 Autumn 2017 for articles. A suggestion; for the times when the supply of publishable material gets a bit thin, or maybe even as a regular feature, why not have a section named "From our archives" or similar? There is so much content from years or even decades ago that could surely be worthy of republication? I'd be surprised if it hasn't already been considered, but maybe ruled out for some reason. I expect there will be vanishingly few members who will recall the older articles from first time around!

Regards,

Ian Liston-Smith

Dear Editor

I quite understand the mild objection and questioning of some members regarding the word 'Wireless' in our title, although as you so rightly say a great identity has been established under this name over the last 40 years. However, speaking as someone who grew up in the 50's and 60's this term was to me and others excruciatingly old-fashioned even then. How both my brother and I would cringe inwardly when dad asked what was 'on the wireless'. 'It's the radio' we would mumble (to ourselves, thinking 'oh dear dad, it's not the 1930's now etc!

It is nonetheless a respectable title, and to try and change it in my opinion would be something of an ongoing process as we all get older, and vintage technology to some will come to be viewed as starting in the 1990's or later. Perhaps a useful compromise would be to add a short qualification to the title to illustrate the considerable breadth of interests of our membership? Generally I feel that it is what clubs and societies actually do - and many are anyway drawn in by word of mouth - rather than too much credence being given to what is thought to be a forward-looking and 'wizzy'name.

Regards,

Jeremy Flutter

Dear Editor

Many thanks to Scott Elliot for his article on the Bush TR102. It inspired me to dig out my own example and do further work on it! Soon after purchase, I'd given all three AF117's the snips, and that seemed to restore good, sensitive working. I now observed that, sure enough, the gang on mine was being pulled drunkenly out of true by the drive cords, just as Scott describes. The original brown grommets, particularly the bottom one, seem to shrink/perish/harden over fifty-five years, to judge by other sets seen on the web. More worryingly, the years spent with the gang's shaft at a slightly upward angle had bent the mounting of the drum shaft upwards to match. This meant that when the gang's shaft was belatedly restored to the horizontal by grommet replacement, one of its two cogs no longer meshed with the off-kilter drum spindle gear, and the 'contra-rotator' spring kept going slack and falling off. This had to be fixed by screwdriver bending (!) of the metal plate to which the drum shaft was riveted, all done whilst manually (and painfully!) holding the double cog against the tension of its spring.

I'm afraid I think Scott is a bit unfair when he writes that the TR102 is 'very unsteady on all but a hard flat surface', without mentioning that the most cherished Ogle design, the evergreen MB60/TR82/VTR103, is almost equally likely to cockle over at the slightest knock. Don't believe me? Try placing the TR102 (with correct PP9 fitted and handle in least favourable position for stability) on a tiltable flat surface-a gram lid is ideal. Interpose a carpet tile if you like, to roughen the surface, then lift the lid cautiously, noting the angle at which the set starts to tip. Next, repeat this test with a 60 or 82 or103, (same remarks for handle). You'll find there's very little difference! I would say the 102 may *look* unstable, but it isn't, really, compared to its stablemates (or maybe, even, its lankier peers, e.g., the Ultra TR70, Fidelity Fairlane etc).

To finish, some component faults I encountered on my set:

Overload-type distortion on music on batteries, OK on bench PSU: C29 o/c.

Poor bass: C22/26 o/c. (All references: WET 1651)

In my set, (though not in Scott's, I see) all three were the pretty red/black/yellow Plessey electrolytics and were shunted with modern ones placed on the blind side of chassis to keep up appearances,

Cordially,

John Ounsted

Dear Editor

Reading the editorial in the Autumn 2017 Bulletin, I have this to say about the name of the Society.

My trusty Concise Oxford English Dictionary contains a usage note for the word "wireless", which reads:

"The term wireless is now old-fashioned, especially with reference to broadcasting, and has been superseded by radio."

Delving deeper, I find in the Shorter Oxford English Dictionary that our word "wireless" has been in use since 1894, and not surprisingly means: "without a wire or wires; specifically in Electricity, dispensing with the use of a conducting wire." The entry continues with a 'b' section: "Short for wireless telegraphy, telephony, message, apparatus, receiver 1904". Finally, we are treated to a definition of Wireless telegraphy as follows: "A system of telegraphy in which no conducting wire is used between the transmitting and receiving stations, the signals or messages being transmitted through space by means of electric waves."

So, the term wireless is historic, we know that, surely even these younger members, of which you speak, must know that! Now a humorous quote from a wonderful book that's no doubt well known to many members; The Setmakers: A history of the radio and television industry: "An overworked joke in the 1920s was that the word 'wireless' was used to describe a device which, with its external batteries, separate loudspeaker, earth connection and aerial, festooned the living room and garden alike with wire".

The words used in the Bulletin editorial, "no longer appropriate" and "misleading", with regard to the word "wireless" are unfounded once the difference between the hardware and the communication medium are appreciated. The modern term for the hardware is "radio" and the communications medium is "space". The "electric waves" mentioned in the Shorter Oxford English Dictionary are in fact the electromagnetic waves which carry the information from point to point (i.e. the broadcast). If you want to be bang up to date you can call them radio waves!

Readers of Wireless World will know that the magazine was faced with a similar dilemma in the 1980s and opted for a change of title to Electronics & Wireless World. Not satisfied with that they later changed to Electronics World + Wireless World. It seems the legacy title had to persist regardless of the anachronism, and why not?

Does the Society need to change its name? No, not at all. If it must appeal to younger members who think "wireless" is a confusing term in the title, then the expression 'the tail wagging the dog' comes to mind. They must accept that it is wholly appropriate for a society, which deals with vintage electronic equipment of all kinds, to use the quaint old term for the hardware in its title.

I agree with that daft adage: if it ain't broke, don't fix it! My English teacher would probably have wanted that corrected to "if it isn't broken, don't try to fix it". Of course, logically, there is nothing to fix if something isn't broken, but I think we all get the general idea. Basically, forget about the whole thing and go and get on with something useful, instead of bickering about the title of the Society.

However, I fear that this argument isn't going to go away, so if you really must change the title and you would like to hear my twopenn'orth, I would agree with you that 'technology' should be ruled out as too general and that the only word that is fit for purpose is 'electronics'. Since the precedent has already been set we might end up with The British Vintage Electronics & Wireless Society.

Long live the British Vintage Wireless Society!!

Regards,

Philip Hughes

Dear Editor,

Just a quick line it could be an idea for members to photograph their favourite item in their domestic setting and a few words about how they found it ect… Our vintage car club does this.

Also I agree that the word wireless has a totally different meaning to a younger person than it does to me.

Also vintage audio seems to have a lot of fans when you see what Dansette record players are going for on eBay. So something like vintage radio/tv and audio society may be somewhere near?

As the chairman says we are put off giving articles as those in the bulletin are of such a high standard and I do somersaults when I find a radio get it going by a little bit of fault finding change a few items and give it a clean. So the photo idea might give a platform for us mere mortals I have a really good looking radio gram in our lounge and the wife likes it !! can life get any better.

Regards,

John Kell

Dear Editor,

I just want to say that I'm happy to stick with "Vintage Wireless Society". I'm in my 40s, so still remember my Grandfather talking about the Wireless, rather than Radio, but do understand that the term Wireless today means something else. Maybe we will have to re-brand once people start getting nostalgic over Netgear routers.

Regards,

Stuart Rose

Accounts 2016

British Vintage Wireless Society
Statement of accounts year to 31st December 2016

	Year ended 31st December 2016		Year ended 31st December 2015	
Receipts				
Subscriptions (net)		30375		42894
BVWATM friends group subscriptions (net)		1400		890
Sale of publications		178		369
Adbertising		400		203
Insurance		367		250
Capacitor sales		4536		4505
Deoxit sales		743		680
Meetings		1653		1863
Estate sales receipts		75886		42573
Valveman DVD sales		94		122
Donations		344		0
Bank interest		34		6
Miscelloneous		813		0
Postage		6		0
NVCF profit/(loss)		1130		2658
Total receipts		117879		97013
Payments				
General expenses	4135		2206	
Friends Group Donations	1400		890	
Stationery	764		584	
Storage facilities	2730		2520	
Postage (net)	861		733	
Meetings	10435		7622	
Bulletin costs including postage	33676		20278	
Estate sales payments	55804		38305	
Capacitor costs	90		3085	
Deoxit purchases	549		1099	
Valveman DVD sale proceeds transferred to BVWATM	210		0	
Donations	713		347	
Accounts	740		0	
Public Liability	550		500	
Auction Laptop	800		0	
Other publication costs	22		111	
Total payments		113484		78283
Surplus for the period		4395		18730
Total assets at beginning of period		37182		18452
Total assets at end of period		41577		37182
Assets				
HSBC current account		26287		23045
HSBC deposit account		4235		4232
NVCF assets (held for the benefit of the B.V.W & T.V museum)		11055		9905
Total assets		41577		37182

At 31st December 2016 £9357.82 was owed by the BVWS to the beneficiaries of estate sales
Bulltin costs included the winter 2015 edition at £9498.00 and membership handbook at 925.00
The accounts of the Society reflect the receipts and payments on a cash bash and do not reflect any prepaid or accrued income and expenditure. As an unincorporated club, all surplus is passed to members by way of bulletins, sappliments and events. At the same time a prudent asset balance is maintained in order to provide for the unexpected.

Treasurer

AUDITORS REPORT TO THE MEMBERS OF THE
BRITISH VINTAGE WIRELESS SOCIETY

We have examined the above Accounts and the attached Accounts of the National Vintage Communications fair for the year ended 31st Decemebr 2016 together with the accounting records and supporting documents and vouchers and confirm the same to be in accordance therewith.

Anstey House
43 Stennels Close
Coventry CV6 3JG

MAAT
Hodgekins Accountancy

BVWS Spares Dept

DeoxIT D5 contact cleaner / lubricant £16.50
aerosol can. Not cheap – just the BEST.
Available at all BVWS events or by post for an additional £4.00

New manufacture high quality metallised polyester film capacitors to replace all old paper types in
vintage equipment. Ideally sized for re-stuffing

All capacitors are 630 Volt working
All prices are for packs of 50 components and include postage and packing

Available in mix-and-match packs of 50 within price band by post.
Available in smaller quantities at all BVWS events.

0.001µF	**Price band A**	**0.022µF**	**Price band B**	
0.002µF	**Price band A**	**0.22µF**	**Price band B**	
0.003µF	**Price band A**	**0.047µF**	**Price band B**	**BACK IN STOCK**
0.0047µF	**Price band A**	**0.1µF**	**Price band B**	
0.01µF	**Price band A**			

Price band A is £25.50 (inc postage)
Price band B is £29.00 (inc postage)

Electrolytic smoothing capacitors, standard 'old-fashioned' size, 500 Volt DC working

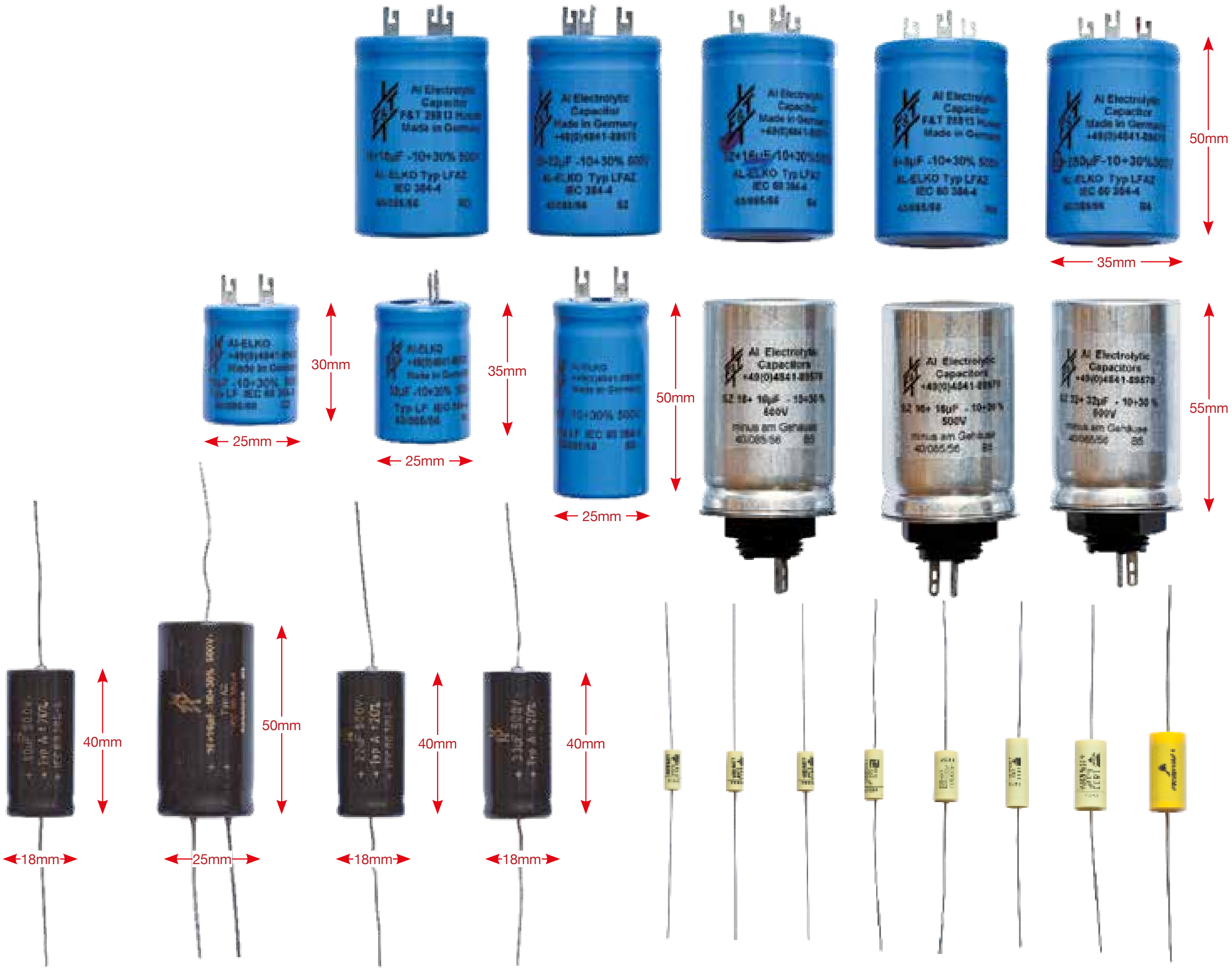
16/16µF £7.00 each
50/50µF £9.00 each
60/250µF for TV22 £9.00
8/8µF screw–type, 16/16µF screw–type,
32/32µF screw–type £9.00 each
16/16 µF tubular axial £6.50
10µF tubular axial £4.00
22µF tubular axial £4.00
33 µF tubular axial £4.00
47 µF tubular axial £4.50
70 µF tubular axial £4.50

NEW smaller 25mm can types for re-stuffing original single electrolytic capacitors

32µF, 47µF, 500Volt DC working £5.00 each

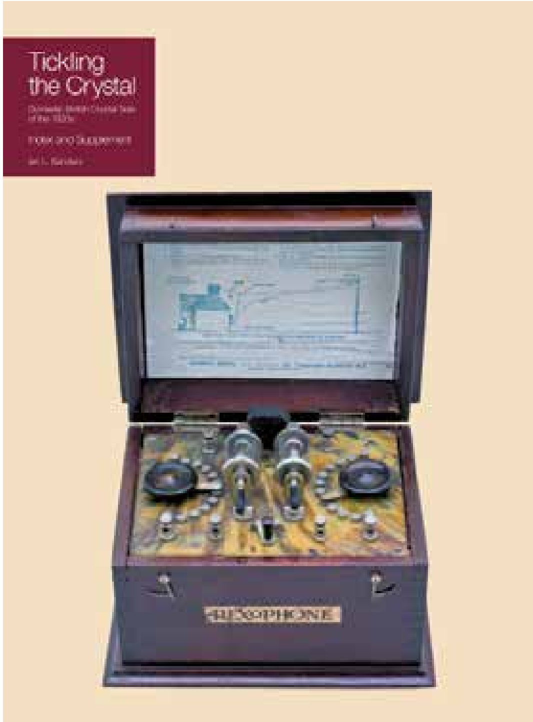
Postage and packing 1 – 4 caps £3.00 5 – 8 caps £4.50

All prices quoted are for BVWS members



For non UK addresses, please contact Mike Barker for prices, (see below). All orders should be sent (with payment made out to BVWS) to: Mike Barker, Pound Cottage, Coate, Devizes, Wiltshire, SN10 3LG. Cheques payable to British Vintage Wireless Society. Please allow 14 days for processing, but usually quicker! The above capacitors are supplied as a BVWS member benefit. Anyone found to be reselling these items for profit will be expelled from the Society

BVWS Books



Tickling the Crystal

index and supplement
80 pages of GPO No. era British crystal sets. including comprehensive index listing sets in all five volumes of Tickling the Crystal
£11.95, £9.95 to BVWS members.
(+ £2.50 p&p UK) £3.50 EEC (rest of world £5.50)

Shareholders of the British Broadcasting Company

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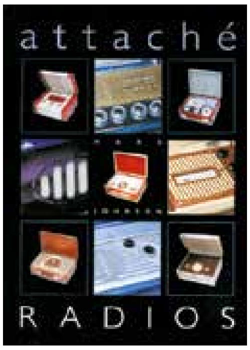
68 pages. For the first time, a comprehensive listing of all of the companies, large and small, comprising the British Broadcasting Company - the forerunner to the British Broadcasting Corporation. Illustrated.
£10.95 (+ £2.50 p&p UK)
£3.50 EU (rest of world £5.50)



Attaché Radios

by Mark Johnson

An 80 page colour paperback guide to the Attaché portable
• Detailed specifications
• 140 radios in full colour
• Over 200 additional photos of sales literature, trade ads etc.
£12.00 (+ £2.50 p&p UK)
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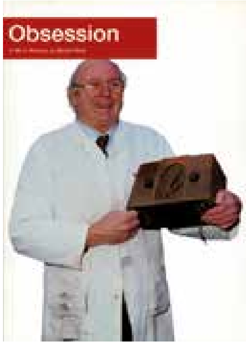

Obsession

by Gerry Wells

Growing up in the 1930s, young Gerry Wells preferred wireless to toys. He had a postwar career as a radio and TV engineer designing and managing amplifiers, PA's and TVs. He founded the British Vintage Wireless and Television Museum from the home where he was born. This is the story of one man's dedication to wireless
£6.00 196 pages paperback (+ £2.50 p&p UK)
£3.50 EU (rest of world £5.50)

Tickling the Crystal
256 pages. Over 200 full-page photographs.
£14.95 for BVWS members plus £7 p&p for UK, £13 EU
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Tickling the Crystal 2
Limited, Only 750 copies printed. 208 pages. Over 125 full-page photographs. £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EU
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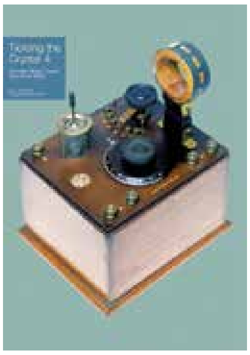
Tickling the Crystal 3
Limited, 500 copies printed. 240 pages of GPO No. era British crystal sets. Over 75 full-page photographs.
£29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EU (rest of world £19)



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More Domestic British Crystal Sets of the 1920s.
280 pages of GPO No. era British crystal sets. Over 115 full-page photographs. £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EU
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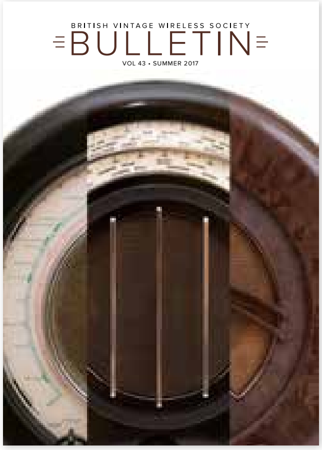
BVWS Books

Slipcase to house the first three volumes of Tickling the Crystal £9.95 Buy all three and get slipcase free! (postage £12 UK, £35 EEC, £55 US) BVWS members buy two and save £12 (postage £9 UK, £24 EEC £28 US)
Cheques payable to British Vintage Wireless Society
Mike Barker, Pound Cottage, Coate, Devizes, Wiltshire, SN10 3LG



The Bulletin back issues

All Bulletins and supplements are priced at £4.00 each + postage.

Postage: for individual Bulletins add £1.50, for all extra bulletins add £1 each. Cheques to be made payable to 'British Vintage Wireless Society'.

Mike Barker, Pound Cottage, Coate, Devizes, Wiltshire, SN10 3LG

The British Vintage Wireless and Television Museum

RE-OPENING EARLY 2018

Other times by prior arrangement
23 Rosendale Road, West Dulwich, London SE21 8DS
020 8670 3667 Registered Charity No. 1111516
Please make appointments beforehand

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Thousands of new old stock vintage styluses & cartridges to fit a huge range of record players & radiograms from 1930 to 1970.

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Styluses from £4.99 each post free to UK.
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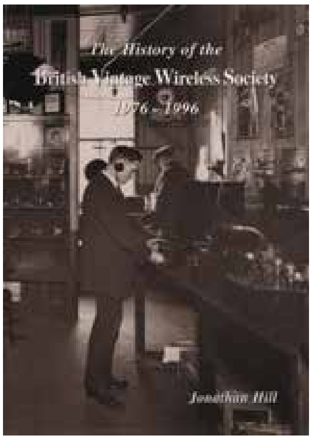

The History of the British Vintage Wireless Society 1976 - 1996

by Jonathan Hill

A personal account of the BVWS and of Radio Collecting. Find records of the year-by-year achievements of the BVWS from it's foundation in 1976 to it's 20th anniversary exhibition in 1996. It also contains a fascinating personal account of the history of radio collecting in Britain with descriptions of markets, auctions, exhibitions and many other events.
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Valveman

The story of one man's lifetime of obsession.

Gerald Wells was Valveman. His life's work was an attempt to amass one of the world's largest collection of valves, vintage radios and other early apparatus from the pioneering days of wireless communication.
This documentary film innovatively blends, using a variety of motion design and filmed reenactments, the last hundred years since radio began through to the early days of television.

£12.00 (including p&p) £14.00 in EEC. Rest of world £15.00

Mike Barker, Pound Cottage, Coate, Devizes, Wiltshire, SN10 3LG

£9.99 from The British Vintage Wireless and Television Museum, 23 Rosendale Road, West Dulwich, London SE21 8DS and all BVWS meetings

www.valveman.co.uk
www.bvws.org.uk
www.bvwm.org.uk

Sunday 18th February 2018
10.30AM - 4.30PM

AUDIOJUMBLE 2018

Sale of Vintage and Modern Hi-Fi Equipment at The Angel Leisure Centre, Tonbridge, Kent

10.30am Standard Entry £6-00 9:30am Early Entry £12-00 Stalls £30
Bookings/Enquiries 07873 862031
info@audiojumble.co.uk

11th February 2018

Royal Wootton Bassett Special Auction

Royal Wootton Bassett: The Memorial Hall, Station Rd. Wootton Bassett. Nr. Swindon (J16/M4). Doors open for viewing 9:00am, auction start 10:30am.
Contact Mike Barker, 01380 860787

1/8 page advertisements cost £22.50 - 1/4 page advertisements cost £45 - 1/2 page advertisements cost £90 - full page advertisements cost £180.
Contact editor_bulletin@bvws.org.uk for more infomration.

Events Diary

2018 Meetings

11th February Royal Wootton Bassett - Special Auction
18th February Audiojumble
11th March Harpenden
8th April Golborne
13th May NVCF
2nd June BVW&TV Museum Garden Party
8th July Royal Wootton Bassett
5th August Punnetts Town
9th September Murphy Day
23rd September Harpenden
7th October Audiojumble
11th November Golborne
9th December 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.
Martyn Bennett, 58 Church Road, Fleet, Hampshire GU51 4LY
telephone: 01252-613660 e-mail: martyb@globalnet.co.uk

The British Vintage Wireless and Television Museum:
23 Rosendale Road, West Dulwich, London SE21 8DS
020 8670 3667
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, 07873 862031 info@audiojumble.co.uk
NVCF: National Vintage Communications Fair
For more information visit: 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 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:
www.bvws.org.uk/events/locations.htm

11th March 2018
Harpenden Auction, Swapmeet & AGM

Harpenden Public Halls,
Southdown Rd, Harpenden AL5 1PD
Contact Vic Williamson 07805 213369

CONTRIBUTE TO THE BULLETIN

WE NEED YOUR ARTICLES!

Do you have a restoration you'd like to share?
Do you want to share any stories from working in the trade, i.e. manufacture, broadcast, retail or service?
Are their memories you'd like to share?
Do you want to talk about your current projects or collections?
Or anything Radio, Television or Audio related!

Even if it's just a letter send it our way!

Articles can be as long or as short as you like, about anything you want as long as it is relevant to the magazine. If you have an idea that you're not sure about, email **bulletin_editor@bvws.org.uk** and we'll be happy to listen.