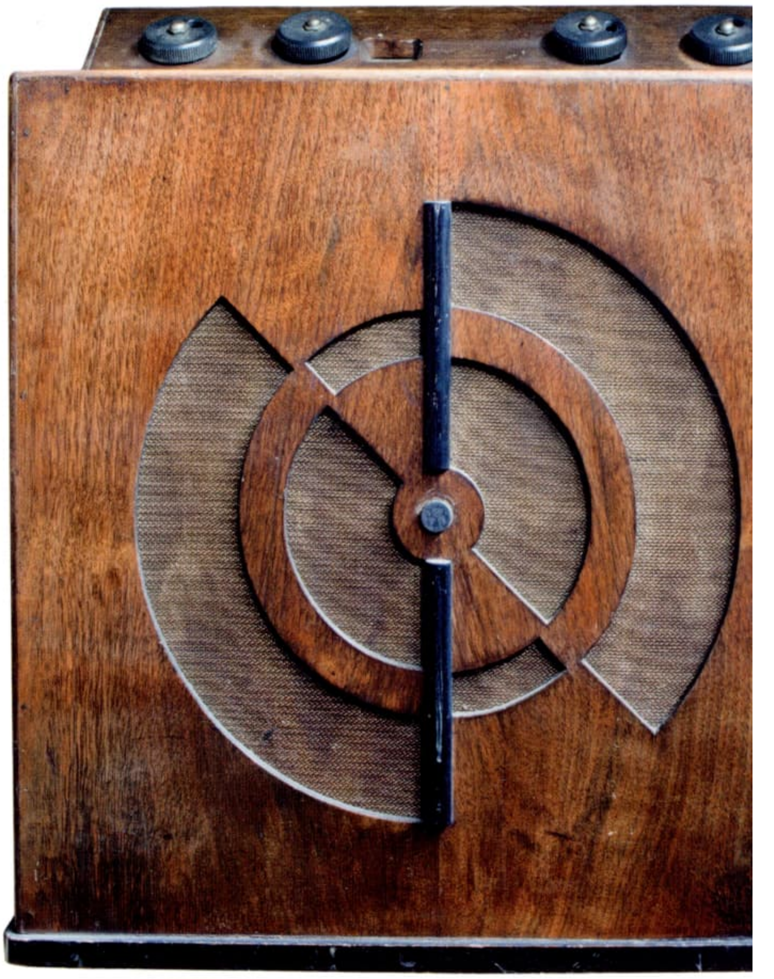
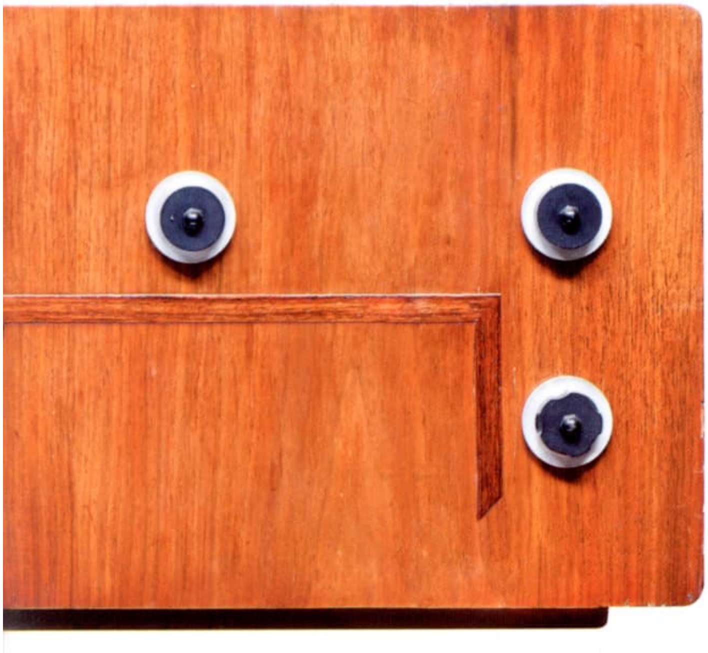
The Bulletin

Vol. 39 no. 4 Winter 2014





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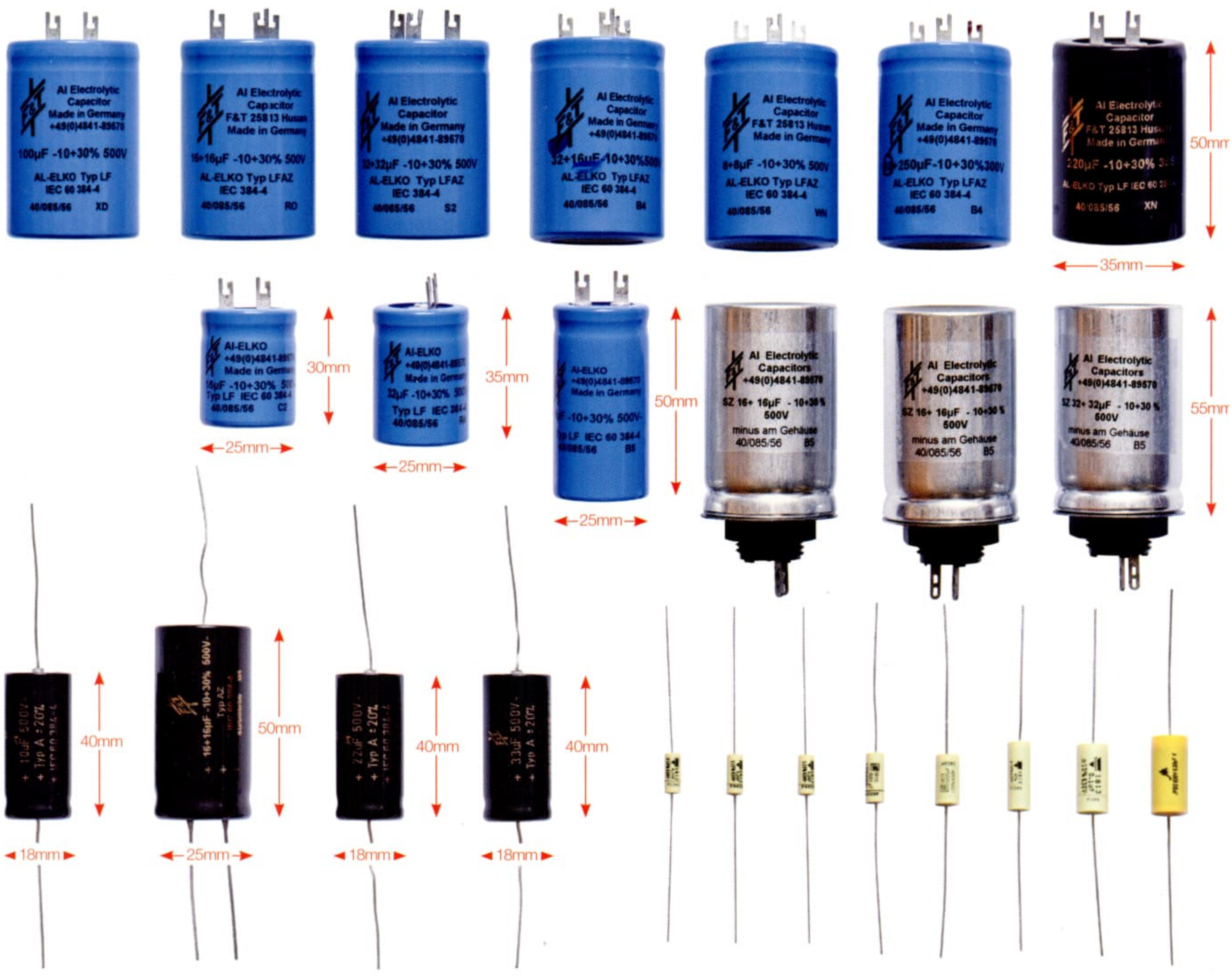

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Bulletin of the British Vintage Wireless Society
Incorporating 405 Alive
Volume 39 No.4 Winter 2014

www.bvws.org.uk

Separations and printing by Hastings Print

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Front and rear cover: Murphy radios from the Daventry Room at The British Vintage Wireless and Television Museum, West Dulwich, London

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Graphic design by Carl Glover and Christine Bone
Edited by Carl Glover. Sub–Edited by Ian Higginbottom
Proof–reading by Mike Barker and Steve Sidaway

Contents

From the Chair

Here we are again! The Winter Bulletin. The months have flown by and we are now in sight of the door marked 2015. We certainly cannot complain about the wonderful summer months we have enjoyed and the prolonged autumn colours all around us.

Having just completed compiling the normal flyers for this Bulletin I note that there have been 35 main articles over the past year. This is an amazing amount for such a small Society. Our membership have certainly given enormous amounts of time to repairs/ restorations and research. From this, they have taken the time and effort to allow us all to share in their experience by writing it up as an article. We would like to pass on our Thanks to all of those who have contributed. Your efforts make the Bulletin outstanding.

Over the past year we have been very frugal with Society expenditure and looked for ways of reducing our overall costs without sacrificing quality. The new way of printing and posting via Hastings Print has certainly made a significant difference and they have been exceptionally helpful to us by suggesting how we can achieve this. The effect of these savings is that we are in a position to produce the annual DVD once again.
This still may not be every year, but it will be given when we have sufficient material and can afford to produce it. Currently Jonathan Evans is working on the compilation of the DVD, but there may not now be enough time to get it manufactured for this Bulletin. So if there is no DVD with your Bulletin, then it will be sent out with the Spring 2015 Bulletin.

For many years there has been a register of Pre-War Televisions. This is maintained by Steve McVoy of the Early Television Foundation. There have been various sales and discoveries that are not reflected in the list as Steve has not been notified, so I have offered to try and update and enhance the listing with as much information as I can obtain.
If you are the owner of a Pre-War Television we would very much like to hear from you so that we can update the list. Your personal details will be kept confidential, but the information will help with our research into early TV.

At the recent Golborne meeting a conversation about events led to the suggestion of holding a combined meeting with the Cinema Museum in South East London. We are currently working on finding a suitable date in 2015 to stage such a meeting so look out for further news in the Bulletin. The Museum is a fascinating place and a joint venture would give all visitors plenty to see and do.

And Finally I would like to thank all our Auction Helpers and events helpers for their dedicated work throughout the year. We could not do it without you!

I'll close by wishing you all a Merry Christmas and very happy and prosperous New Year. Mike…

The Ekco AD38 by Jeremy Day

I was interested to read recently that the Ekco AD38 receiver was the cheapest model available from them for the year of 1937. For £8 8s a walnut, or for another five shillings a black and chromium AD38 could be yours. With the average weekly wage for 1937 being less than £4.00, this purchase would have represented a significant investment for its owner.

The cost effectiveness or otherwise is immaterial. Notwithstanding the fact that an AD38 is only a three valve plus rectifier TRF receiver, it is in my opinion an attractive radio with a good performance, featuring an attractive bakelite case, contrasting loudspeaker fret material and a colourful scale.
This article concerns the restoration of an Ekco AD38, purchased at a Harpenden auction four or five years ago. The set was in poor condition with a deteriorated although still usable scale (a common problem with this model) and it had no back cover. At the time, and due to more important matters going on in my life, I had neither the time nor the inclination to embark on a restoration project, so the radio was stored in the garage.

Two house moves later and around six months ago I happened upon the radio while looking for other Ekco radio spares. On taking it off the shelf I found what was originally a reasonable looking radio had deteriorated even further as a result of being stored in a damp environment for several years. The scale, always fairly vulnerable on this model, was now beyond saving, the chassis had rusted, and the loudspeaker had seen better days. The saving grace was that, although filthy, the cabinet hadn't suffered any permanent damage.

Having brought the radio indoors this was placed adjacent to a radiator in the kitchen and left for several days to dry out. I then took the radio into the workshop and removed the chassis from the cabinet. Although the chassis had seen some considerable repair work over the years it still had a number of original components in place, which I would go on to later refurbish and reuse.
I should state now that my attitude to restoration is that an item should show its true age and I restore what is there to original condition as far as practicable. Any restoration should be done in a sympathetic manner using original materials and components wherever possible.

With any restoration I always start with the cabinet. This has the effect of spurring me on with the rest of the restoration as I can see the beginnings of the finished project. Because the cabinet had suffered water damage the heads of the screws holding the scale in position had completely rusted away. The only option would be to file down the remaining screw stubs, drill out the remains and re-tap the holes. Although this was reasonably straightforward some care had to be used to prevent cracking the base, particularly when using a hammer and a centre punch to define the centre point for the drill. The other issue was being careful not to drill right through the cabinet. With the four holes

drilled out they were re-tapped at 4Ba.

This done the case was washed thoroughly inside and out. Bearing in mind that the speaker fret material is fixed to the case and cannot be easily removed, it is worth taking time with this, being careful not to saturate the speaker fret and paying attention to the intricate mouldings of the case - a toothbrush and a small paintbrush will be found useful for this purpose. Once dry some proprietary bakelite polish was applied and buffed off, which leaves a smooth but slightly dull cabinet. To finish the process I use one or two applications of pure wax polish, selecting a small area at a time, buffing off before the polish has had time to dry, to prevent streaks or swirls appearing. Although all of this sounds a quick process it can take three or four hours to achieve a reasonable finish. At this stage I leave the cabinet, but a final buff a week later will further enhance the polished finish.

Chassis restoration

I started the restoration on the top of the chassis, and to remove the surface rust that had developed, I used some Autoglym. This mildly abrasive cream cleaned the chassis to a reasonable standard without removing any paint.

I used a wire brush of a type suitable for suede shoes and fine wire wool on the SP13C screening can with Duraglit to polish the aluminium top cap.

A thorough clean of the top of the chassis including the valve sockets and IF transformer cans was then undertaken. The tuning capacitor was removed, cleaned with a brush and compressed air and the perished rubber mounting inserts were replaced before remounting on the chassis.

The heater circuit ballast wiring required replacement for safety reasons, given that most of the wiring insulation had dried and disintegrated. I considered the options for which wiring product to use, but settled on silicone rubber covered stranded cable. The available pastel colour range of this cable blends well with the existing braided cabling and withstands the heat from a soldering iron well.

I then turned my attention to the 8μF chassis mounted smoothing capacitor (C18), which had been replaced with a much later component. My aim was to replace this with an original component and a chat and subsequent visit to see Mike Barker produced a TCC manufactured wet electrolytic, similar to that which would have been fitted originally.

After removing the top vent cap, the top of the capacitor (which includes the rubber fluid sealing bung) can be removed by drilling a few small holes. At this point the fluid can be emptied and the internal coiled electrode assembly removed with the aid of some long-nosed pliers.

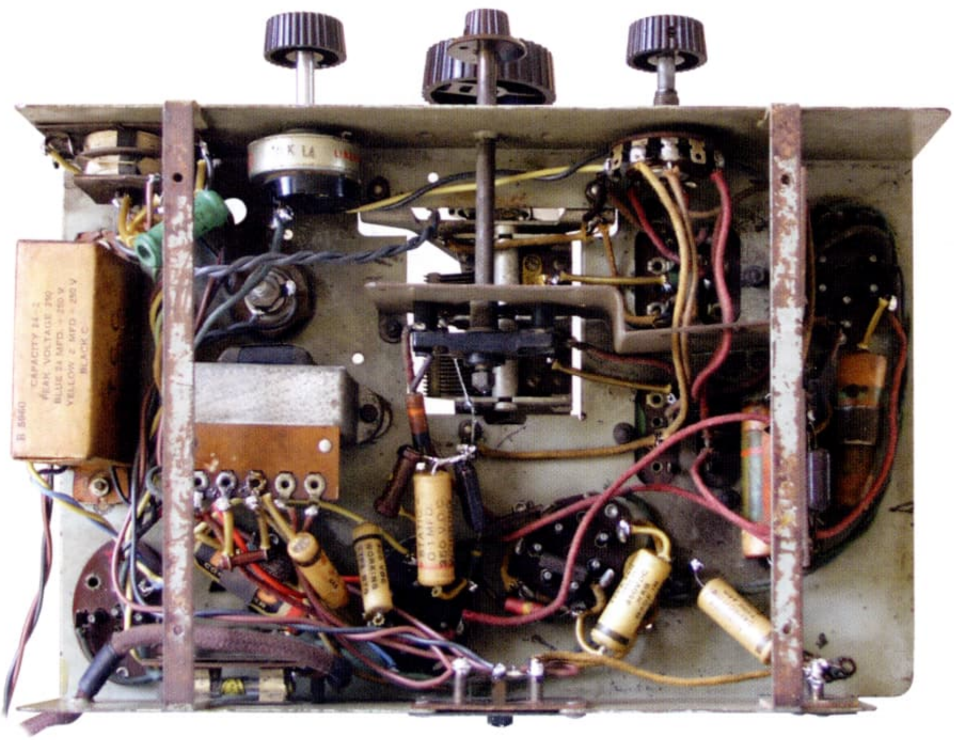
The hole thus formed can then be filed to a uniform shape of the correct size to accept the replacement electrolytic capacitor. At this point I washed, polished and dried the can thoroughly.

For the sake of originality I wished to retain the centre post as the positive connection for the rebuilt capacitor. This is best done by tapping the exposed threaded portion back into the case, I've done this several times and in doing so the rubber seal is preserved sufficiently for it to be reused successfully. A tip would be to put the nut back on before this procedure and tap the nut rather than the end of the aluminium threaded shaft, given that it may distort or burr under the pressure of a hammer.

I first shortened the centre post by an inch, drilled a 4ba clearance hole and fitted a screw, nut and tag through the post, as shown in the photograph. A wire was soldered to the tag. The can forms the negative connection and to this end a small area on the inside of the can was keyed and then tinned with the aid of a large wattage soldering iron to which another wire was soldered. The centre post was then replaced into the body of the capacitor through the open end, thread first. The two paxolin washers, tags and nut were then replaced. A replacement 8μF capacitor was then inserted, tags uppermost, and the two free wire ends from the post and can were soldered accordingly. Some cotton wool was used to fill the remaining cavity and the top cap replaced.

All valves were then tested. For V1 an Ekco VPU1 had been fitted which had low gain on test. This was replaced with a VP13C as per the Ekco service manual. A PEN3520 had been fitted in place of the PEN36C and although both valves are comparable, a good tested PEN36C was fitted. The remaining valves, SP13C and UR1C, tested to manufacturer specification.

The underneath of the chassis revealed that a lot of components had been replaced or removed over the years. The output transformer had been replaced with a much smaller device with a primary resistance a quarter of that specified in the Ekco service manual which may have also had something to do with the fact that components forming



Capacitor build

the fixed tone correction had also been removed; the original smoothing capacitor block had been removed and replaced with a selection of hanging electrolytic capacitors, and an incorrect value and type volume control had been fitted. In addition the two capacitors forming the mains RF bypass circuit had been removed entirely.

The process of re-stuffing the capacitors then commenced. A suitable size and correct 24µF + 2µF capacitor block was obtained from Mike Barker and rebuilt with new components. In general I find the easiest way to remove the contents is to warm these components in an oven at 100°C. After around 10 minutes the wax will soften and one end of the cardboard case can be opened easily with the aid of a knife and the block removed as a whole. The process of inserting new components is fairly straightforward. I make up the capacitor bundle, tie the components together and solder on the correct colour flying leads as stated on the block. This is then inserted with suitable wadding to fill the void.

The tubular capacitors can be rebuilt fairly easily. When warm carefully open one end of the tube and with the aid of pliers the component inside can be removed in one piece leaving a clean tube. To rebuild, a new component is inserted and centralised. Because the new component will invariably be much smaller than the original some stuffing is required to fill the void. I use cotton wool but loft insulation can also be used. Then seal both ends. I use a hot glue gun as this sets quickly and has a translucent waxy appearance. The refurbished components are reintroduced into the chassis and where necessary, systoflex insulation used to give an authentic appearance.

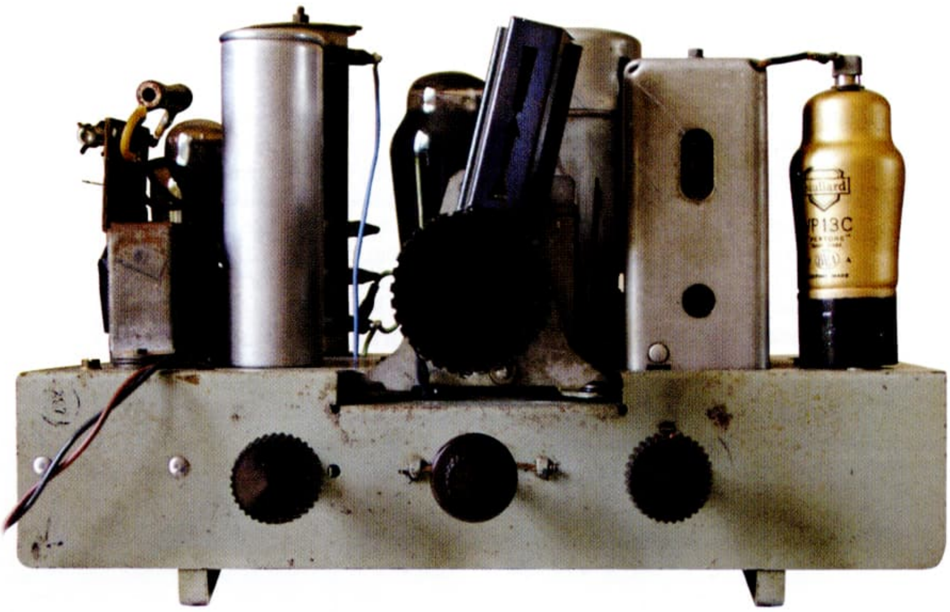
Where components were missing these were replaced and at this point all the resistors were tested for accuracy within 20% of their stated value and any falling outside of this were replaced. The volume control was replaced with one of the correct value and type and the wave change switch was cleaned with DeoxIT. Experience has revealed that the wave change switches used by Ekco at the time were of a fairly poor quality but invariably respond well to treatment.

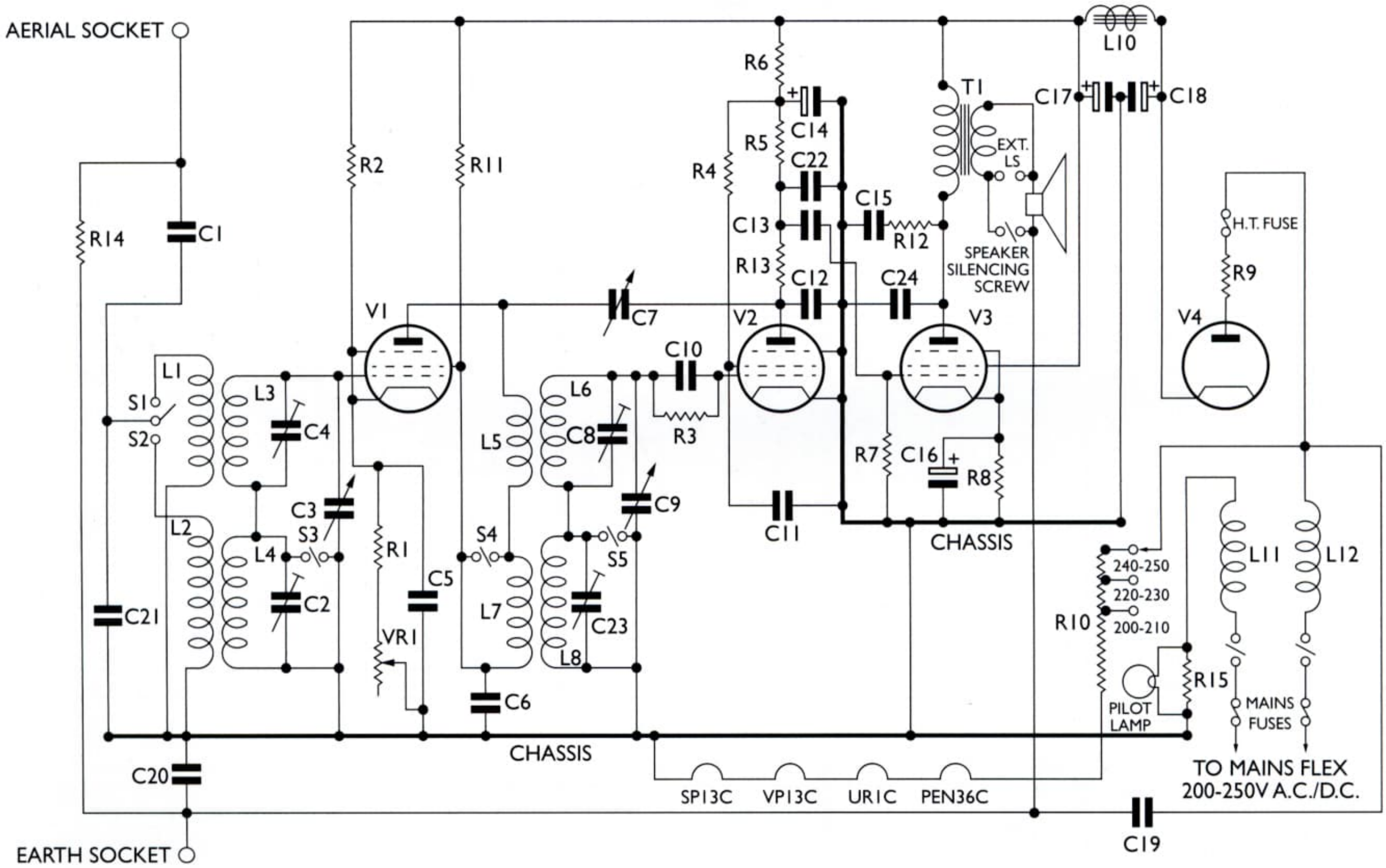
Any existing PVC or perished cotton covered wiring was replaced with silicone rubber covered stranded cable. The mains flex was replaced with new cotton covered

PVC cable similar in appearance to that fitted originally, taking care to connect the mains neutral to the chassis end of the heater chain, and rather than knot or clip to form a strain relief it was fitted with two overlapping rubber sleeves which effectively stops the cable being pulled through.

Around a year ago I was fortunate enough to acquire a poorly restored AD38 with a bad cabinet but with a good scale. This formed the source of several parts, including the scale, output transformer, loudspeaker, and the indicator mask which covers the scale lamp.

At this point and after a thorough check the set was connected to the mains via a Variac and the mains voltage slowly increased. At around 100 volts AC and after what seemed an eternity some tentative checks were made around the HT supply components which confirmed the existence of HT voltage albeit low, which suggested the rectifier was working and that there was nothing seriously amiss. Thus assured I increased the voltage still further and heard a faint hum from the speaker. By adjusting the sensitivity control to point of oscillation





Circuit description

Aerial input via C1 and S1/S2 and coupling coils L1 and L2 to single tuned circuits L3, C3 (M.W.) and L4 C3 (L.W.). Switches S3, S4 and S5 short L4, L7 and L8 respectively for operation on M.W.

V1 (Mullard VP13C or Ekco VPU1) is a variable-mu RF pentode operating as an RF amplifier. The radio gain control is effected by variable resistance VR1 in series with R1 in its cathode circuit, supplemented by an HT feed via R2 to increase the voltage drop across VR1, thus increasing the range of the grid bias volume control.

Tuned secondary RF transformer coupling by primary coils L5 and L7 and secondary coils L6 and L8, which are tuned by C9 between V1 and V2 (Mullard SP13C), an RF pentode operating as a grid leak detector formed by C10 and R3. Reaction control is via C7 connected between the anodes of V1 and V2. RF bypass filtering is from C12, C22 and R13.

Resistance capacitance coupling between V2 and V3 (Mullard PEN36C) is provided by R5, C13 and R7, in the anode circuit of which is the primary of the output transformer T1, the secondary of which is connected, via a speaker silencing switch, to the speaker. Tone correction is provided by R12, C15 and C24.

The output of the rectifier V4 (Mullard UR1C) is smoothed by electrolytic capacitors C18, C17 and L10. On the latter device a 0.5A fuse protects the smoothing capacitors should the rectifier short-circuit internally and R9 in the anode circuit further protects the rectifier from high surge currents. A 1A fuse is fitted in each side of the mains lead.

Capacitors C19, C20 and filter coils L11 and L12 reduce mains-borne H.F. interference.

Valve heaters together with scale lamp shunt R15 and ballast resistor R10 are connected in series across the mains supply. The scale lamp will respond accordingly to the initial surge and dim when HT is established.

and then backing off, and with adjustment of the tuning capacitor familiar voices could be heard on Radio 4 and I was now fairly confident I had a basic working chassis. At this point I usually leave the chassis on the bench for a period of time to use and test for any intermittent faults that may arise.

A characteristic of this set is the very long warm up time. The Ekco owner instruction book states that the user should wait approximately two minutes for the valves to warm up before the set can operate. Part of this delay is no doubt caused by the valve heater chain and the UR1C rectifier for which the Mullard valve guide states a "heating time" of 70 seconds. The volume control also has to be around the halfway point before it will operate satisfactorily at reasonable volume levels; indeed this is confirmed in the owner instruction book.

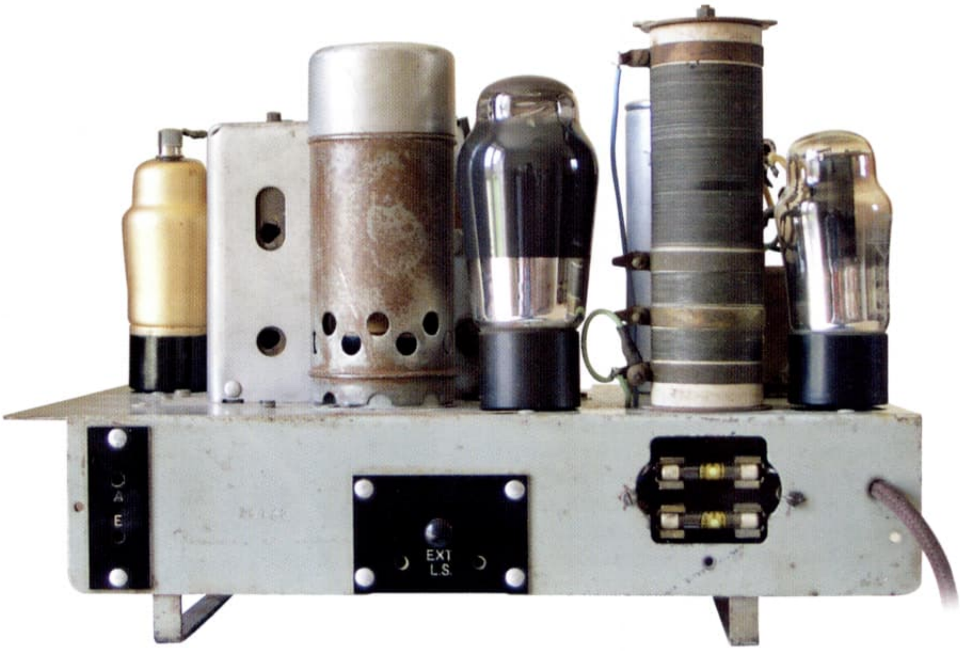
Once I was happy with the restoration I fitted a new scale, replaced the speaker and returned the restored chassis to the cabinet. All knobs were then refitted. Fortuitously around this time a back cover in good condition appeared on eBay which I acquired for £7.20 and replaced the original which had been burned by the heat from the dropper resistor.

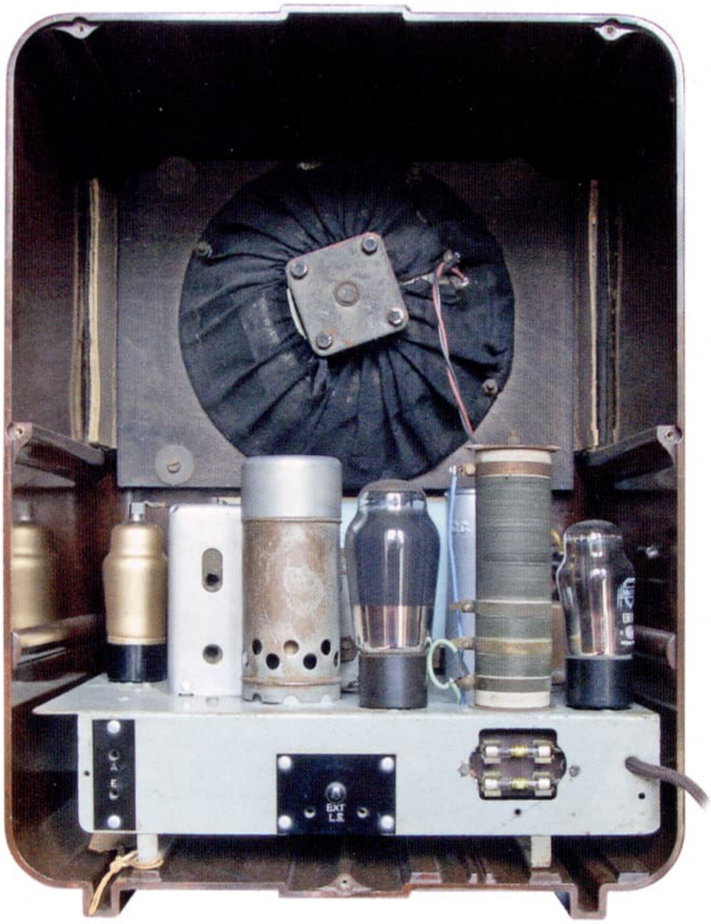
Alignment

Circuit alignment is a fairly straightforward procedure on this set. Given that the slow motion tuning gang drive had seized solid its replacement necessitated the realignment of the pointer which can be done as per the Trader sheet (237 or 653) by loosening the two small screws in the front of the pointer to coincide with the tuning gang at maximum and the pointer at the 560m mark on the scale, subsequently tightening up the screws again. This done switch the radio to MW, tune the radio to 250m with volume at maximum and the reaction control just short of oscillation. Connect a 1200Khz signal to the aerial and earth sockets via a 0.0002μF capacitor and with the aid of a output meter connected to the loudspeaker output, adjust C8 and C4 for maximum output. Similarly, switch the radio to LW, tune the radio to 1090m, connect a 275Khz signal and adjust C23 and C2 for maximum output.

Conclusion

I have coveted the AD38 as a particular personal favourite and have sought a good example for several years now. I am delighted with the outcome of this restoration and this model will complement any radio collection, and especially the battery version of this set (B38) that I have had in my collection for some years now. These sets are now comparatively rare in good condition and do not turn up at auction very frequently. For a TRF set and for all its simplicity this radio works remarkably well and is sensitive on both wavebands.

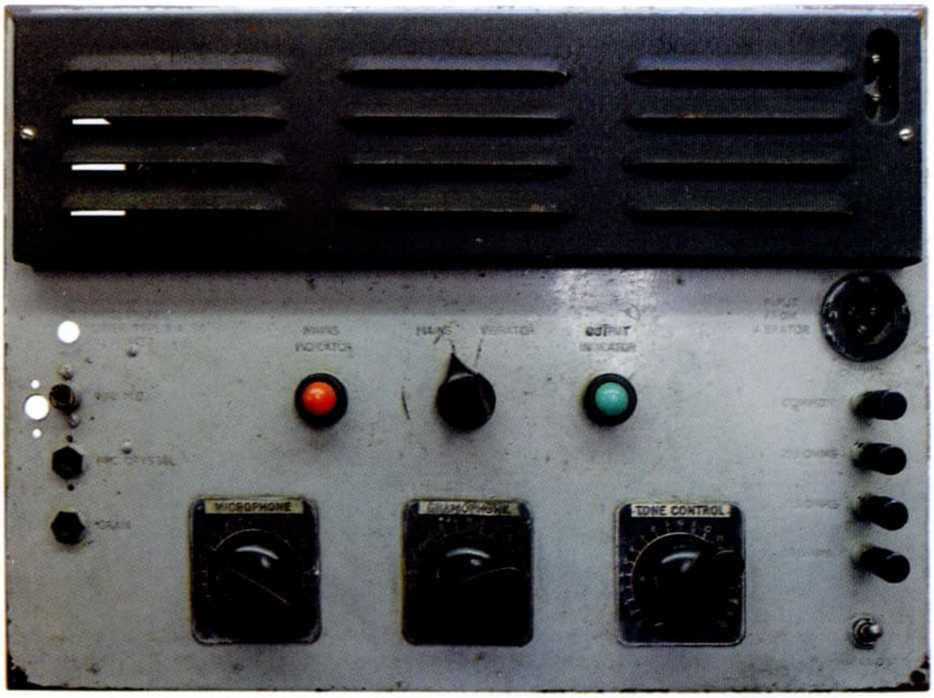




Restoration Heaven – The BSR PA20 amplifier

by Terry Martini-Yates

It is funny how things turn up when you least expect them to. At an estate clearance of a friend, I came across a BSR amplifier in a somewhat sorry state having been found sitting outside exposed to the elements for an indeterminate period. Upon further inspection, it was found to be missing a number of valves, including the inspection panel and cabinet lid. It was also in a pretty bad state paint wise and had clearly been very poorly treated with rust in just about every place you could imagine, along with a couple of extra holes on the front panel, not as intended by the makers, it became evident why it had ended up where it was. On asking what was going to be done with it I was told it was heading for the tip and that if I wanted it, to take it away. I collected up the unit and by sheer stroke of luck, also found the missing cabinet parts lying in one of the outbuildings.



The BSR PA20 on the workbench as found. The DIY holes can be seen on the left and above the input sockets

Close up view of the damaged amplifier front panel

Back at the workshop, I could not resist the urge to check it over in more detail to see how bad it was. It turned out that the amplifier was a model PA20 which appears to have first entered into production during the mid-1940s the dates stamped on a number of original HT smoothing caps suggested that this example of the amplifier was probably produced and sold around early 1950. With my initial curiosity satisfied and out of the way, the amplifier was put into the collection store as a future project as the check over had proven that the equipment would require plenty of time set aside to tackle all the problems.

Although probably most remembered for record decks, Birmingham Sound Reproducers had also produced a long line of audio related products, with the company having been formed in 1932 by Daniel Mclean McDonald. (1) BSR initially produced a range of wireless components and with McDonalds experience in amplifiers, by the late 1930s had seen the firm starting to produce test gear and public address equipment. By the end of the Second World War, BSR had increased the range of equipment and alongside the PA amplifiers and audio oscillators had also produced "Direct to Disc" recorders using acetate discs as the recording medium, the PA20 portable had appeared alongside these post war developments, having being marketed under one or two alternative guises each offering slightly differing specifications.

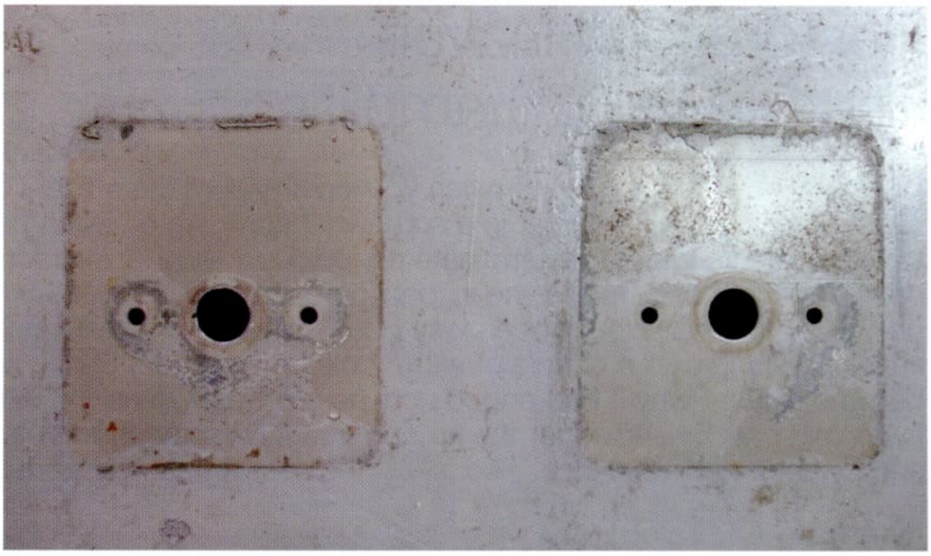
One of the versions marketed as the PA20B was produced with modified inputs for either a ribbon or moving coil mic, gram and fitted with a Belling Lee O-Z multi-pole socket that when connected up, provided HT and LT supplies and a line in for a separate tuner unit. The Model B variant appears to have been on the market around the same time as the version of the amplifier featured here.

The styling of all these amplifiers was quite distinctive, with an eye catching, louvered removable grill finished in black wrinkle paint. Its purpose was designed to provide ventilation, access to the valves and to the mains voltage selector without having to resort to opening the whole thing up. The amplifier equipment range appear to have been discontinued at some time in the early 1950s with BSR then concentrating on the manufacture of record decks (and for a period, tape decks) in which the company successfully marketed all over the world, right up to the demise of BSR in the early 1980s.

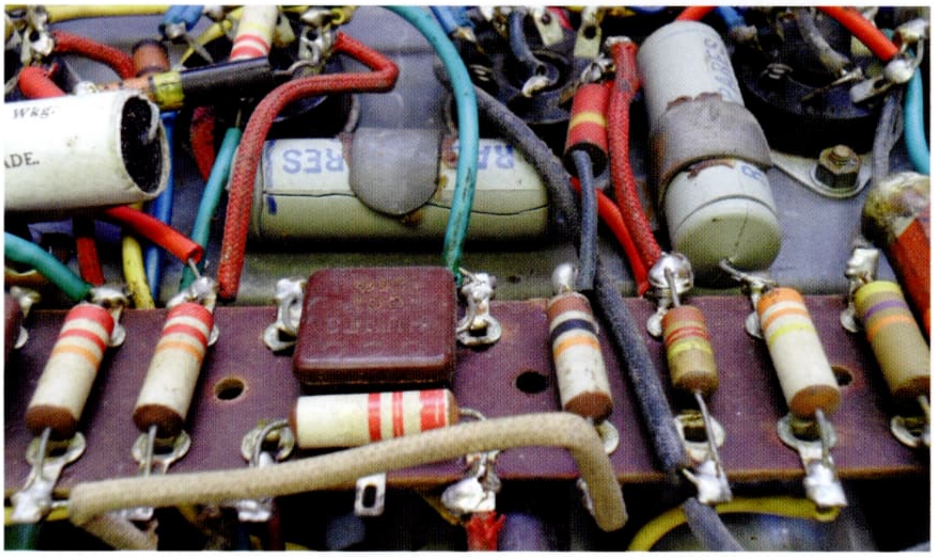
With the amplifier in question back on the bench, (some 18 months or so later) a full assessment could now take place to see if it was actually worth the effort of saving such a wreck. The cabinet as found was so poor that it was decided a complete strip and re-spray was the only option.

The outside of the case, lid and inspection cover were finished in black wrinkle paint typical of the type found on communications equipment and test gear. The finish was considered pretty hard wearing and presumably the reason why BSR had used this as well. Unfortunately on the example here, it had not stood the test of time and had completely delaminated in some places, with rust taking over in others. The inside of the lid, case and inspection cover were finished in black cellulose gloss paint and some of this was missing or was ready to fall off. As was to be discovered later, the metalwork was actually riddled with light rust throughout and this had crept underneath the remaining paintwork, and was showing through as areas of blistering in a number of places. The latches and carry handle

The very poor paint job carried out to the front panel



A vital clue to the original makers paint finish was discovered under the input–control dials



The poor condition of the RS capacitors can been seen in this picture. Right: The sad state of the painted cabinet finishes that necessitated the action that was taken

were less of an issue and mainly covered in years of grime and light rust; these were set aside to be dealt with separately.

The front panel of the amplifier had suffered at the hands of a DIY drill, and two additional holes had been very haphazardly made alongside the microphone socket and straight though part of the engraved BSR legend above. The paintwork had also at some point been attacked with a very poor paint job which had in the process, covered just about everything in sight in a poorly matching, glossy grey paint. It has been assumed that this had been done in an attempt to disguise all the digs, scrapes and dents that the front pressed steel panel and paint work had received in a former life.

There were a couple of additional screw holes also noticed, suggesting that at some point in its history the amplifier had had something extra mounted on the rear of the chassis. Whatever this was though, it had long gone. Further tell-tale signs of alterations were the discovery of a couple of extra connections made but then cut, across the spare contacts of the Mains/ Battery change over switch wafer. The purpose of these will never been known or what they may have been connected to.

The full extent of the missing valves became apparent, with both 6L6 output valves the 5Z4 rectifier and one of the two 6J5 amplifier triodes missing; all in all then a pretty major restoration.

Having a circuit diagram handy made the trouble shooting easy although BSR had also helpfully stamped the valve type numbers alongside each of the valve holders as an aid to identification. The amplifier design is pretty straight forward with input No 1 optimised for a low impedance, balanced line, moving coil microphone rated at 15Ω. A 2nd input to suit a high impedance microphone such as crystal type is also provided. Only one microphone input can be used at any one time. The low impedance input is shorted out once anything else is connected into the high impedance jack socket; Input 3 is suitable to deal with a gramophone pickup or a line level source.

Signals from the mic stages appear at the grid of V1, 6J7G (2) this is passed to V2, also a 6J7G. As the signals from the first stage are couple into the grid of this valve, this allows simple mixing and fading of the two inputs together as required. These signals are passed to V3, 6J5G which acts as a voltage amplifier. V4, 6J5G provides phase splitting and push pull output is provided by a pair of 6L6Gs. Negative feedback is picked off from the 15Ω tapping on the secondary of the output transformer this being fed back to the voltage amplifier stage. A simple but effective tone control is also fitted which lifts or cuts the treble to both input channels.

The output transformer is wired with 2.5Ω, 7.5Ω and 15Ω taps which are taken to the binding posts on the front panel. A simple peak volume indicator in the form of a 6.3V dial lamp is fitted across the 2.5Ω tap. Rectification is provided by a full wave rectifier, 5Z4G. The mains transformer is fitted with taps covering 200-250V AC. Operation from battery simply requires the user to plug in a suitable BSR vibrator pack into the 3 pin Bulgin input socket provided, and change over the supply switch. As would be expected in this type of amplifier, the HT smoothing is generous and features two smoothing chokes and combination of electrolytic capacitors. The amplifier is quite portable weighing in at around 25lb and with the lid fitted measures 12½ (H) x 16½ (W) x 8½ (D).

Checks of the components suggested that at some point, a number of the original wax paper capacitors had already been replaced with RS equivalents that probably dated from the 1960s themselves. In addition, the output transformer had also been replaced with a Farnell service replacement from their "Elstone" branded transformer range. The type fitted is a multi-ratio replacement, MR/15. I decided that before anything else was done that both the mains and audio output transformers were checked to ensure that they were serviceable and would determine the next steps; fortunately, all appeared to be ok.

All the HT smoothers were reformed and because of the poor condition of the remaining original paper capacitors and the later RS branded ones, these were all replaced. All the missing valves were replaced from stock. Further checks to the chassis showed that the wiring from the low impedance mic socket and matching transformer had badly perished, the only other problem found was a detached wire from one of the mains transformer tags; this was re-soldered. The rest of the chassis wiring was ok and was left alone.

A suitable test speaker was connected up. With the amplifier plugged into the mains and power applied it was not long before a faint hum appeared followed by hiss when the gram and mic volume controls were increased. With a connection made to the gram socket from an audio source, good quality sound appeared initially in the test speaker. This at least confirmed that the repair work to the electronics had met with some success and it was time to move onto dealing with the cabinet and front panel. I generally keep a check on the HT cans for signs of stress; it was as well that I did. Even after careful reforming, the two cans smoothing the pre-amp stages were decidedly very hot after a fairly short running period. Fortunately, no fireworks ensued. Both cans were replaced with a pair of modern equivalents which are unfortunately half the height of the TCC types they replaced so look a little out of place.

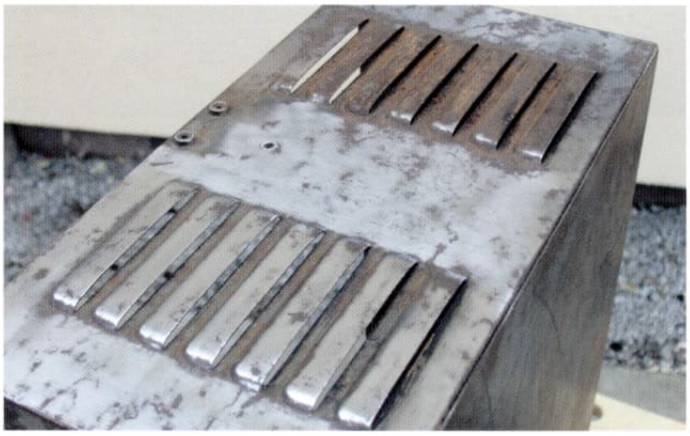
A further running period revealed that the mic stage was quite low on gain. I had initially assumed it was to do with the mismatch of the ribbon mic I had used for the tests. After a short while a burbling noise had also appeared on the gram input which came and went, causing much irritation. Both faults were traced to the 6J7G valves with the second stage also suffering with microphony. It has been assumed that both of these must have had a pretty hard life and the sudden wake up call was enough to do it. As I had a few near direct equivalent Mullard EF37A types to hand a couple of these were pressed into service. These completely cured the problems in the both the gram and mic stages which both saw a dramatic increase in gain following the replacement valves.

With the electronics sorted out, it was now the turn of the cabinet and front panel. This was the most time consuming aspect of the restoration. The cabinet was completely

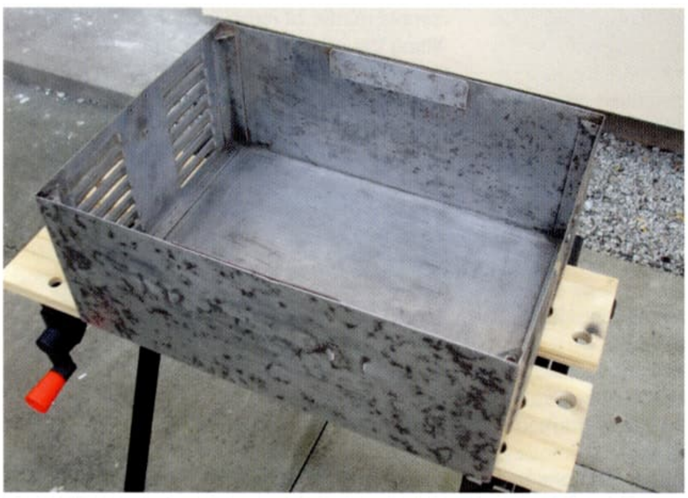
The poor condition of the paintwork on the inside surfaces of the lid

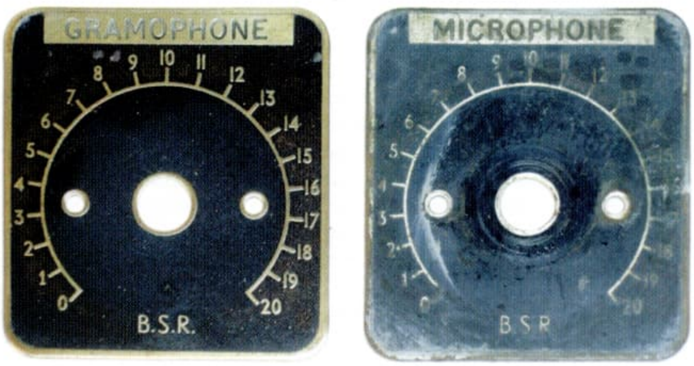
The inside of the lid once stripped revealing all the rust

The insides of the cabinet showing the general condition of the paintwork



The laborious task of removing all the rust and general preparation of the cabinet

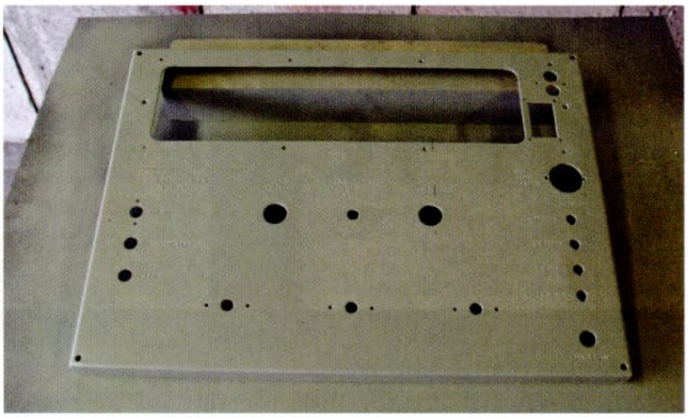




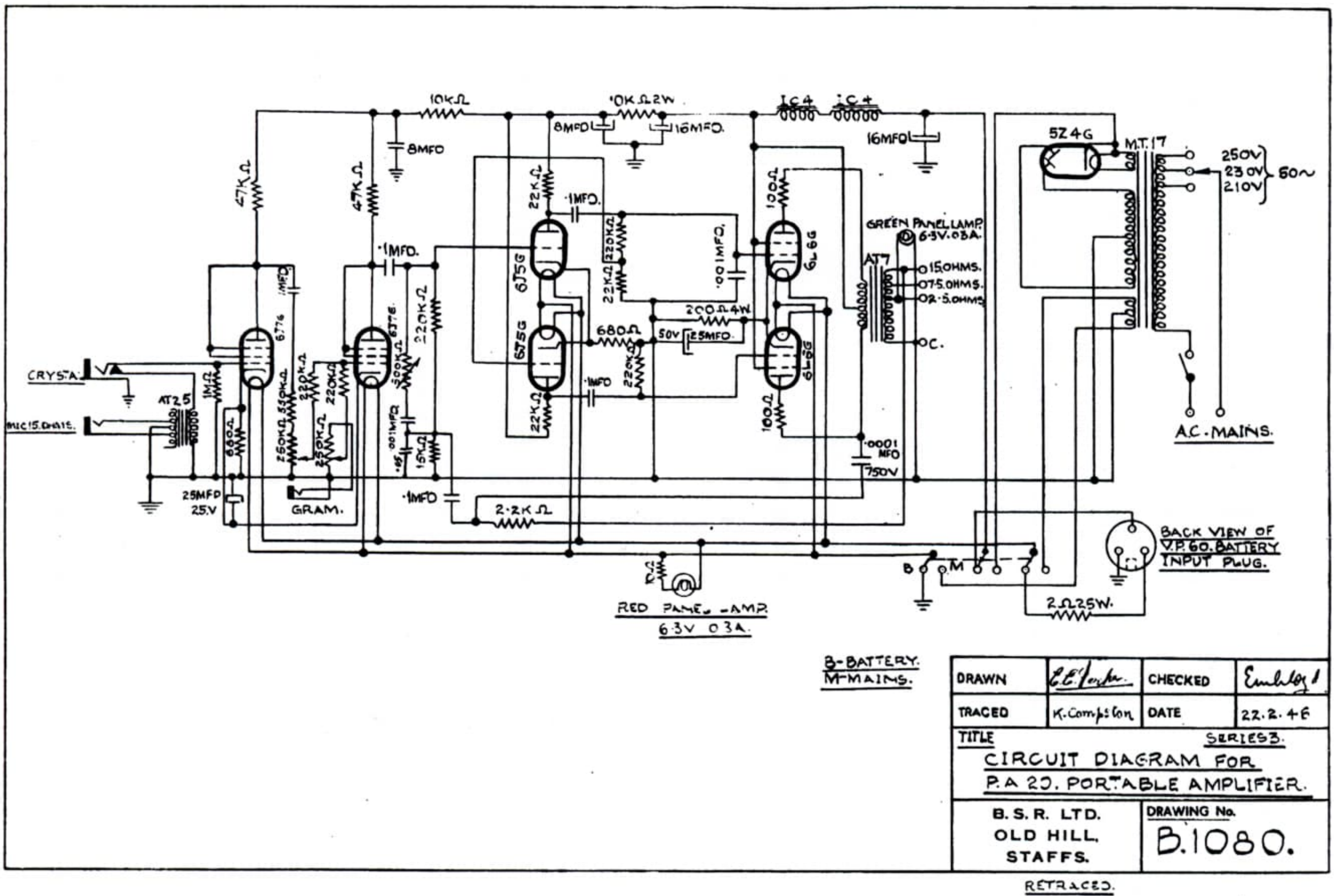
Left: The surface discolouration left by the rust can be clearly seen

Above: On the left is one of three control bezels after cleaning, the one on the right shows just how bad these all were to start with

Getting started with the zinc primer on the front panel



The front panel fully restored and ready for refitting



stripped inside and out. Initially I had considered having this carried out via a soda blasting specialist (3). In the event the quote was to prove quite costly, so I settled for chemical stripper on the remaining wrinkle finishes and gentle heat from a hot air gun on the rest of any remaining cellulose paintwork which can be surprisingly difficult to remove as modern chemical strippers are simply not effective against this type of older finish.

With this completed it revealed that there were large areas of surface rust and pitting underneath the removed paintwork. There was not one side of the metalwork that had escaped this confirming a long period of poor storage.

Over a couple of weekends, I tackled all the rusted areas to both the cabinet and lid with a couple of different wire wheel drill attachments; these made fairly light work of the rust , bringing the various areas back to something reasonable that would take a new paint finish. To finish off everything was progressively sanded in readiness for the primer coat.

Something that had been noticed with the paintwork on the cabinet was the lack of a primer coat having been used on the areas where the cellulose painted finish was applied. This perhaps explains the reason for the early demise of the original cellulose paintwork finishes on certain areas of the front panel and insides of the cabinet. It suggests a degree of corner cutting by the manufacturer, perhaps due to the availability of certain materials during the period this was made.

With the front panel next to be tackled, BSR had actually made the job of separating the main amplifier (which had been formed into a "U" shaped chassis) easy to remove as this was fixed by eight nuts and bolts to the rear of the front panel, with the removal of the volume pots, switches, jack sockets etc. from the amplifier front panel it was a simple matter of removing the fixings and lifting the whole thing clear. In order to carry out repairs to disguise the drill hole damage and extra screw holes, I turned to Isopon P40; a product normally associated with car bodywork repairs. This is a quick setting, easy to use, two part fiberglass product that is ideal for this type of chassis repair. Progressive sanding with various grades of wet and dry gave a smooth, ready to paint finish. The final touch was to etch the small area of new fiberglass with a fine tipped scriber, to restore parts of the missing engraved lettering. Both the "A" and "S" had been pretty much obliterated by the original damage. The results have been very worthwhile with the original damage hardly noticeable now the front panel has been repainted.

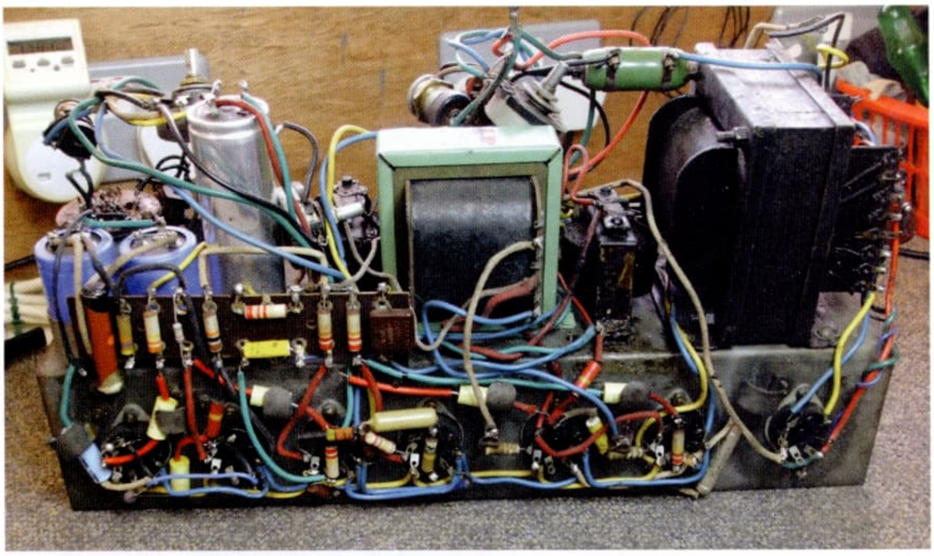
With the repairs to the holes completed everything was thoroughly prepared, and degreased. The metal work was spray primed with a zinc rich primer. I was able to ascertain with the aid of a colour swatch card that BSR had used French Grey from the BS381C standard range of industrial colours. Suitable cellulose based, semi-gloss was sprayed painted onto the front panel. The engraving was tackled once the paint was sufficiently cured; a black "Lacquer-Stik" was used to "infill" all the lettering. (The suppliers used for the special paints and materials used in this project are listed at the end)

The paint finish to the cabinet, lid and inspection cover was obtained by the use of a current production wrinkle paint finish on the outside of each item. The trick with applying this paint is to apply three coats each in a different direction to the previous coat i.e.: horizontal then diagonal and then vertical. A period of ten minutes is left in between each coat before applying the next one. When this material first goes on it is very glossy in appearance. The clever bit is in the curing process, either by placing the prepared item in a curing oven at a minimum temperature of 93°C or as I have done, with the use of a hairdryer.

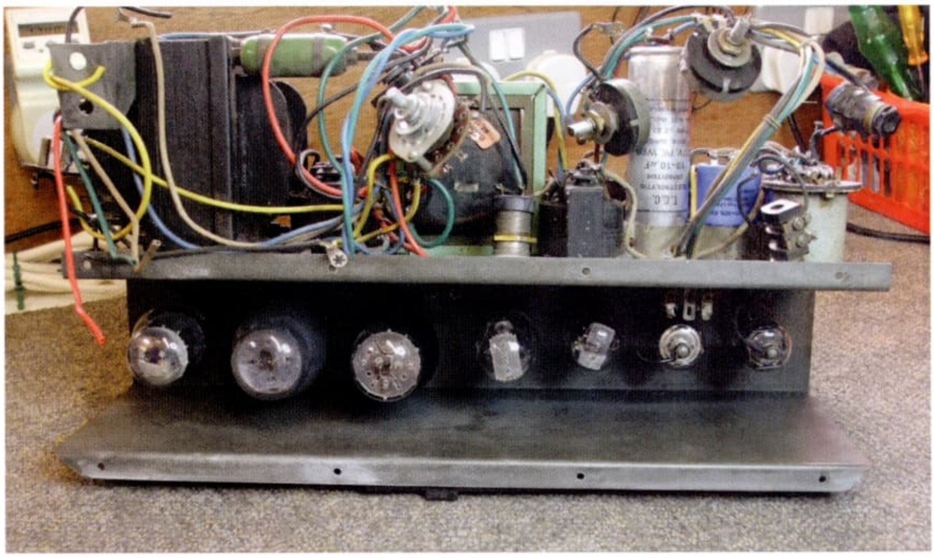
The idea is quite straightforward and simply requires that you warm the paint up by running the hair dryer up and down the work piece after the final coat is applied. In a short space of time the paint starts to wrinkle. (It took around 6 minutes on the lid of the BSR cabinet before the process started) The beauty of this method is that you can control the amount of wrinkling. The resultant finish is very close to the original. The inside of each of the cabinet sections was spray finished with BS 642 black gloss cellulose paint to finish off the job. To quote a saying from an uncle of mine "It's all in the prep" was never truer, and I cannot emphasize enough about giving sufficient time and patience to any project where a painted finish is concerned.

All of the sockets, binding posts, latches and catches were carefully cleaned to remove all the grey paint this came off remarkably easy once the items had been soaked in hot soapy water and then cleaned up with the aid of an old tooth brush. The volume control escutcheons were carefully cleaned up with "T Cut". The large pointer knobs were in a filthy but otherwise surprisingly good condition and were also cleaned up; to finish off, the BSR engravings in each of the knobs were in-filled with white "Lacquer-Stik".

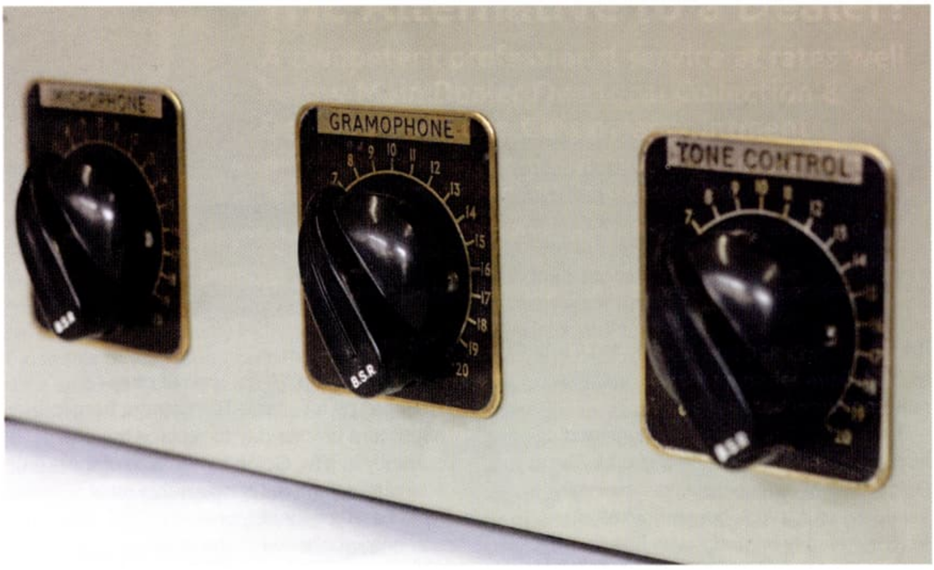
In conclusion, the results are very pleasing and the amplifier gives a good account of itself. Being portable the amplifier probably saw more than its fair share of abuse and perhaps the reason that bought about its early demise. A couple of criticisms I have is that the equipment does run rather hot in use, not helped by the orientation of the valves. BSR have for reasons only known to them, never fitted any rubber feet, so the paintwork to the underside had suffered very badly as a result. The one and only modification made



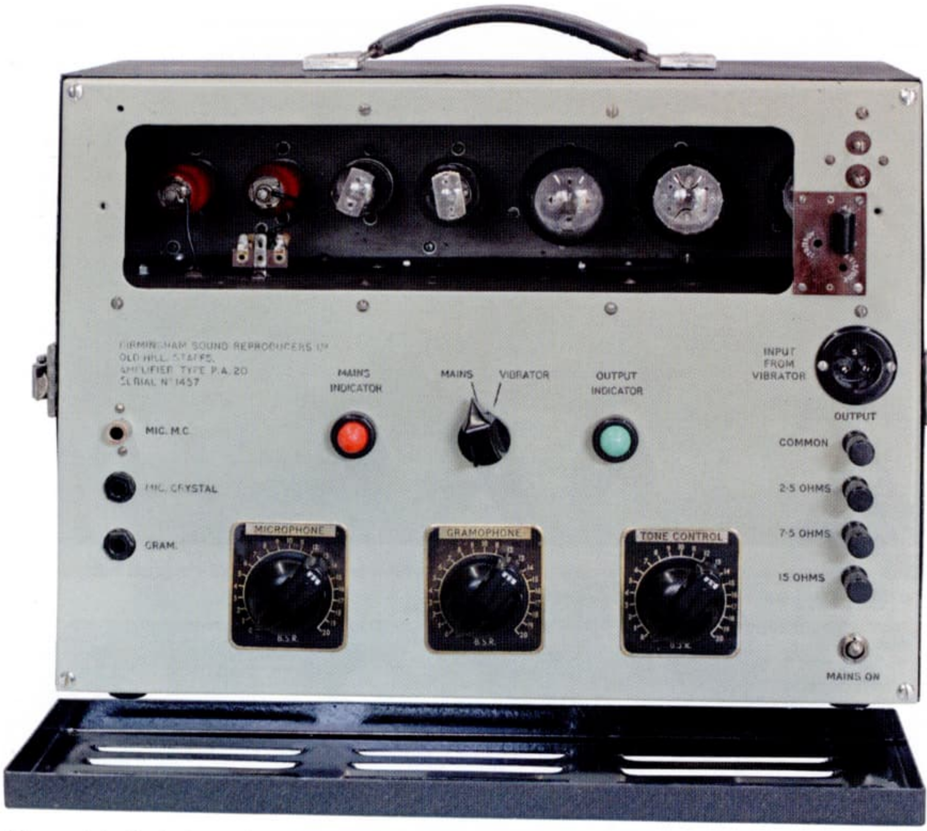
A rear view of the restored chassis. The original capacitor clips have been left in situ but is a good indicator of the difference in size with modern replacements



A front view of the amplifier chassis showing the compact shape and size and orientation of the valves, the explanation for the amount of heat transferred to the top of the amplifier cabinet



What a difference the cleaning made. The control knob after a wash and in-filling with white "lacquer stik"



All is revealed with the louvered panel removed, the valve line up can now be seen


The restored BSR PA20 amplifier featuring a period Reslo microphone

to the amplifier was to fit some suitable feet to avoid this happening again.

The choice of power input plugs and sockets may at first glance see odd. The Bulgin socket for example was generally accepted as a mains power socket from quite early on and it was fitted as standard in this position on a lot of equipment. On this amplifier, it's actually there to take the vibrator supply.

There is no mains earth wiring either which surprised me. This was presumably left to the user to make suitable arrangements with whatever was to hand locally. The mains supply connector is a standard 2pin 5A flat type of plug.

Hopefully a suitable BSR output transformer might turn up one day to replace the one currently in situ. Going by the size of the mains transformer, I suspect this must have been reasonably well specified. We can only wonder what the original cause of its demise was. The Elstone transformer currently fitted is slightly under-rated but is otherwise very well matched. The amplifier has not been fully tested against the manufacturer's specifications; however I have no reason to doubt its capabilities in being able to fill a small auditorium and to be able to deliver the claimed 20W.

References:

(1) The history of the BSR Company is covered in a well-researched softcover A4 sized publication entitled "Just for the record", the story of BSR and its employees, by Alan R. Cox originally published by Black Country Society in 1998 ISBN-13: 978-0904015461

Copies of this book turn up from time to time on various internet sites such as EBay and Amazon.

(2) Although originally designed as a detector, the 6J7G has a linear characteristic and excellent internal shielding. This made it a very good choice for audio work. The EF37A is electrically very similar.

(3) Soda blasting is a process in which sodium bicarbonate is applied against a surface using compressed air. It is a gentle, non-destructive method for many applications in cleaning, paint stripping, car restoration, chassis stripping paint and rust removal. The list goes on.

Resources:

The wrinkle paint used for this project is manufactured by US paint company VHT and obtainable in the UK from: Frost auto restoration techniques Tel: 01706 658 619 www.frost.co.uk

They stock a limited range of colours (Black & Red). The range is also made in grey and green and you will find these stocked by a number of automotive sellers on EBay. VHT only seem to supply the wrinkle paint in spray can form. If like me you prefer a paint gun over a rattle can this proved a little frustrating. The BSR amplifier project used approximately, one and a half cans. If you have not had experience of using this type of paint before, I would advise that you waste a little on a practice piece before anything else as it can be very unforgiving. Once applied it cannot be over-coated so mistakes may mean a complete re-strip.

There are a number of specialist paint suppliers who can supply the complete range of BS381C designated paint colours (such as the vintage finishes used on the BSR), as a cellulose based paint or in acrylic and even synthetic formulas as matt, semi-gloss or gloss. Over the years some of these traditional finishes have been increasingly difficult to source due to changes in EU legislation.

If you are planning on any degree of paint restoration work it would be well worth your while investing in a BS colour matched swatch for the appropriate paint standard. This along with more recent standards can be obtained fairly cheaply from: www.technicalpaintservices.co.uk

The BS 381C range was extensively used in industry and military with many of the vintage radio, television and hi-fi manufacturers selecting paint colours from this standard range.

The following paint companies can supply custom made aerosol paint cans or in standard sized tins for spray guns for any paint range including BS 381C . The "rattle can" types are ideal for small jobs, touch ups etc. The postal costs can be expensive on a small order, due to the legislation surrounding the shipping of this type of item.

CJ Aerosols Tel: 01980 467 990 www.cjaerosols.com

Autopaint-pro.co.uk Tel: 01843 604995. sales@autopaint-pro.co.uk

The Lacquer-Stik referred to in the text is manufactured by Markal these days in a number of useful colours. The company lists UK suppliers on its website. http://www.markal.com/
The Lacquer sticks have also been obtainable from Antique Radio Supply
www.tubesandmore.com

All Images: Terry Martini-Yates with additional post restoration photography by Peter Martini-Yates

RCA's second transistor radio, the 8BT10K

by Henry Irwin

In 1955 the Radio Corporation of America launched a pair of transistor radios, a small personal set and a larger 7BT10K. Shortly afterwards this radio underwent a redesign of its RF stages to become the 8BT10K. The mechanical design and external styling however remained the same. This early change was necessary because RCA's first sets actually used Texas Instruments semiconductors in the mixer and I.F. stages whereas the second iteration of the RCA radio came with a full complement of its own in-house devices.

I purchased this radio on eBay from the USA several years ago. My interest was in these early sets which still used point to point wiring on a chassis but I also found the styling of the case very appealing. It carries on a number of styling elements that were evident in RCA tube radios from the late 40's through the early 50's. The large slide rule tuning strip with satin alloy surround extending down to the slotted alloy grill and flanked by knobs is set into a case of stitched hide. With its good proportions the overall effect is one of quality and sophistication. It makes an interesting contrast with the flashy Emerson 868 or the staid Pye 123 which were both contemporary sets. The impression is spoiled a bit however by the ribbed alloy trim above the tuning scale which is very thin and is prone to bending.

The internal metal chassis is well made and sparsely populated on one side by a complement of 7 black socketed transistors and 3 IF transformers that are surprisingly small for the period. Also mounted on it are the tuning capacitor with a drum and cord arrangement for the pointer and a calibrated tuning scale which is fixed along the chassis top. Finally, a long and very thin ferrite rod is attached just below this.

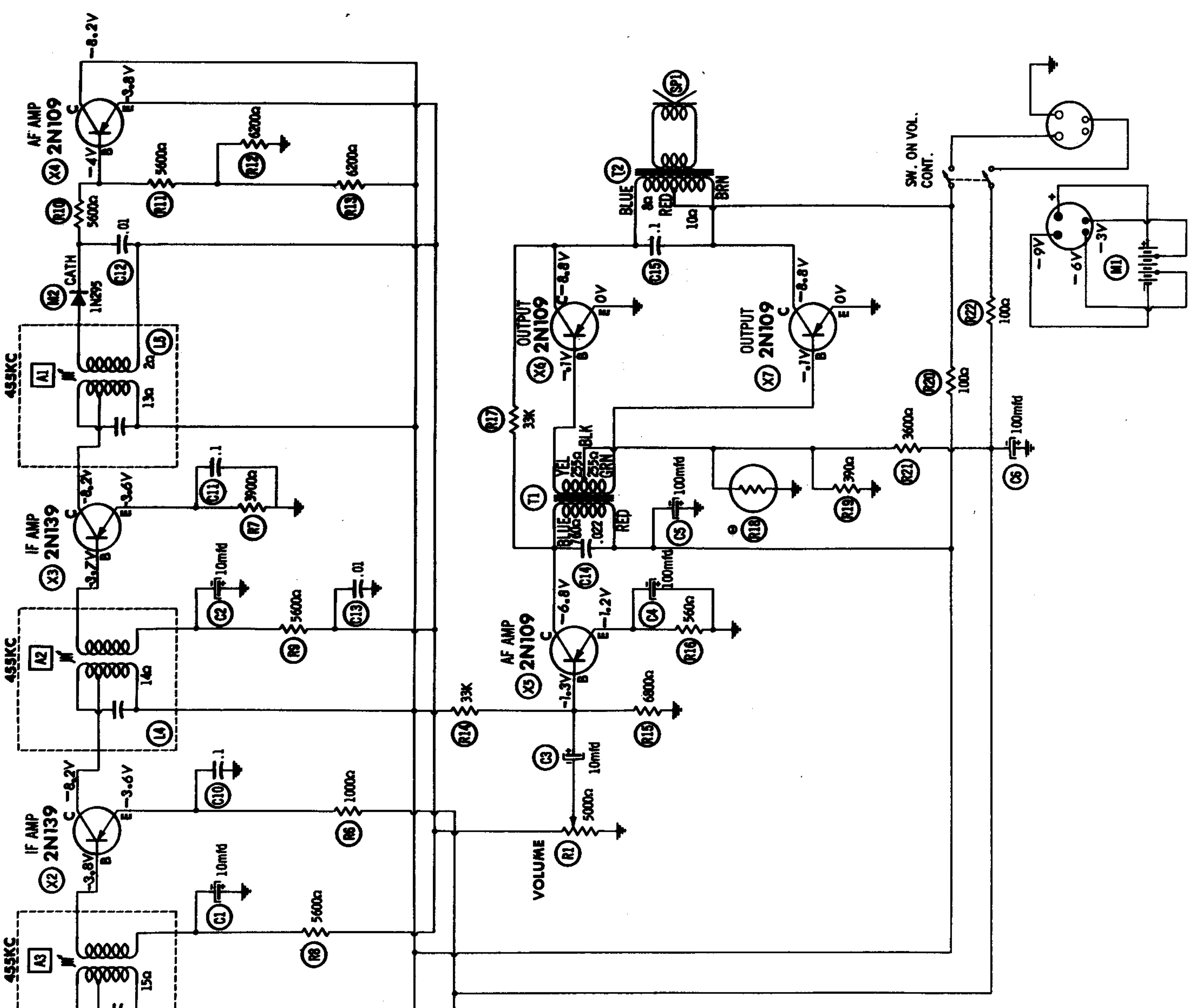
The reverse side of the chassis is in contrast much busier with components wired point to point between sockets and a few tag strips. The densest part of the circuit is around the IF output and audio stages where the wiring is stacked in layers. This looks much more like the under chassis of a late 1950's valve portable.

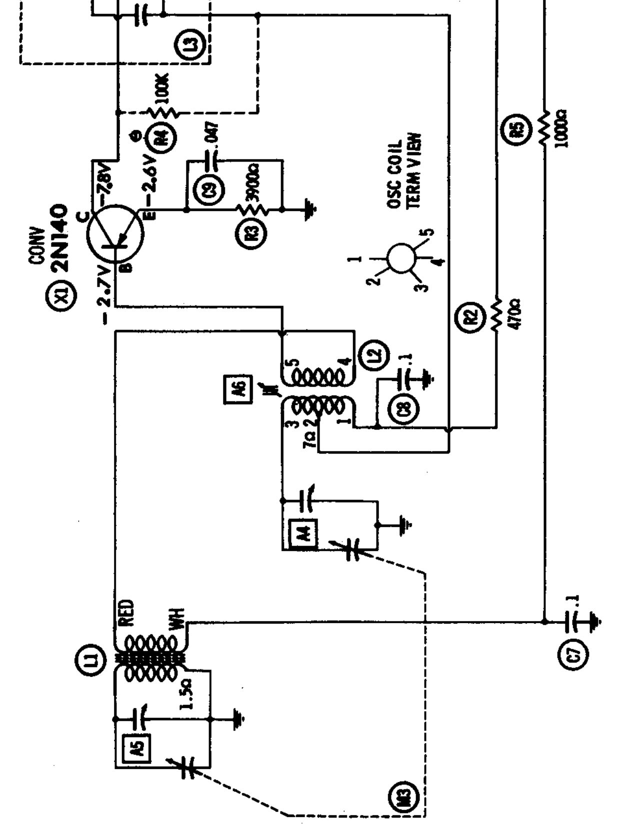
An original RCA VS301 period battery, a large oblong affair designed to sit below the chassis, came along with the radio. Although marked "9 volts" this package had a small paxolin socket on its top designed for a 4 pin power plug, very similar to battery valve portable practise at the time. It was a bit frayed around the edges but otherwise intact. When I examined it closely someone had penned in +,-3v,-6v and -9v around the socket, so this was obviously a tapped battery. God knows why RCA had decided to use this or why it had both 3v and 6v taps but it was clear that it would be better not to proceed further without a circuit diagram!

Circuit

I ordered a Sams Photofact document for the radio and when I finally had a chance to examine the circuit I was glad I had waited. This is a seven transistor circuit but with many surprises.

Firstly the battery is tapped at -3v and this is used to supply bias to the base of the mixer transistor. It is also used to provide emitter bias for the 1st IF amplifier as well as providing bias for the push pull output transistors. All this is unusual but so also is the fact that the 3v bias to the output transistors is temperature regulated by a thermistor, R18, since they have no heatsinks or emitter resistors. Second, the self oscillating mixer uses positive feedback from its collector to its base rather than from collector to emitter. This means that the oscillator is essentially operated in grounded emitter rather than the more usual European arrangement of a grounded base oscillator. You can see from the diagram that the coupling winding (L1) from the ferrite antenna and the feedback winding (L2) from the oscillator coil are both in series with the base circuit. This is actually common in many early American and Japanese transistor radios. Thirdly, the IF amplifier stages do not appear to have neutralizing feedback capacitors to maintain stability. Early germanium alloy RF transistors had relatively high collector to base capacitance and to prevent instability they could either be neutralized by compensating capacitors or operated in common base mode. I can only assume that the RCA transistors had lower than average internal capacitance (10pf is quoted by RCA) and that they relied on a degree of deliberate mismatch in the IF transformers to maintain stability. Lastly, the fourth stage is arranged as a DC amplifier and emitter follower. It uses the volume control as its emitter load thus providing a little audio gain but also amplified AGC to both IF stages.





Faults

Now that I knew from the circuit which were the correct pins for the 3v and 9v lines and what they were supplying, I placed the original battery to one side for later assessment and I was able to apply power with confidence by modifying a holder for 6 AA cells. A PP3 type connector was clipped on to the holder terminals for the + and – 9v while a flexible wire was soldered carefully to one of the internal spring connectors at the -3v point and the other end of the three wires soldered to the appropriate pins on the power plug. With this in place I switched on and was greeted by silence, not even much of a discernable hiss from the speaker. On tuning across the band things seemed pretty dead until I came to my strongest local station which sounded forth with raucous distortion. Not just moderate distortion but the kind that rock music fans would recognise from a Fuzz Box on an electric guitar!

Remedies

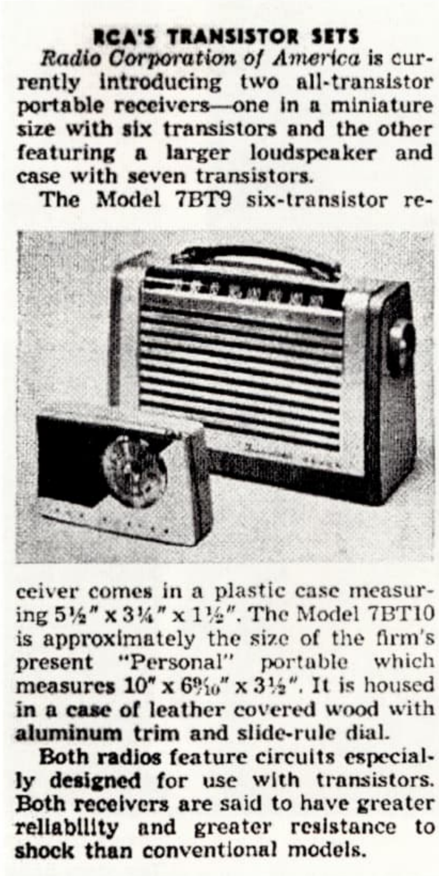
So, time to remove the chassis. First the side knobs have to come off. These are reputedly very fragile but I had no difficulty since it is easy to insert a screwdriver from the back and separate the jaws of the little clamps as the knobs are eased off the shafts. The chassis itself is held by four screws that self tap into brackets which are riveted to the thick fibreboard backing of the hide case. The original RCA promotional "blurb" says that the 7BT10K is "housed in a case of leather covered wood". However in my 8BT10K the wood appears to have become fibreboard, the only wood being two reinforcement blocks at the bottom. I have said before that leather covered card cases are not the most durable but this is really thick top quality hide with innate stiffness and in this instance it has survived well with only slight warping. The speaker is a large 6x4 inch but connected with miserly length wires so I left it in the case and attached a small monitor speaker to the removed chassis so that I was ready to commence fault finding.

I have to admit I am always nervous with DC amplifier stages such as those around Tr 4. With DC coupling a fault around the diode detector or VR 1 in the emitter could easily upset the biasing and thus affect any audio passing through. I shouldn't have jumped to conclusions though since meter readings around this stage showed voltages to be in order. I further suspected the coupling capacitor from the volume control to Tr. 5 or the thermistor in the bias chain to the output pair Tr. 6 & 7 or even the output transistors themselves but the problem proved to be elsewhere. Systematic checking of the voltages showed the 3v bias line was actually sitting at about 1.5v and the culprit was a leaky C6, a 100mf bypass capacitor, the disconnection of which removed most of the distortion. I was surprised that the voltage reduction in this shared bias line hadn't also stopped the self oscillating mixer completely as well as messing up the output stage!

C6 is one of three similar large electrolytic capacitors, the other two, C4 & C5, bypass the main 9v supply and the emitter of the audio driver Tr 5. They are aluminium axial types sheathed in a tough orange cardboard cover. Although the other two did not appear leaky the failure of one after 57 years seemed to indicate the need for complete replacement. I decided to try and conceal new capacitors inside the big cardboard covers even though there was no sensible reason for it as this part of the chassis is not on view when the back is open! While I was about it I decided to replace the coupling capacitor C3 from the volume control to TR 5 as well. It wasn't leaky but any reduction of capacity in this 10mf component, in addition to C4, could affect the bass response of the stage. C3 is a smaller capacitor in a black plastic sheath so replacing it with a modern axial doesn't look out of place.

Action

Wiring around this part of the circuit is a bit of a rat's nest so it required careful probing with a pair of fine nosed snips and pushing some components to one side to remove these capacitors while leaving little stubs of wire to solder back on to. The way I approached re filling of the three largest electrolytics was to remove carefully the cardboard sheaths by slitting along their length with a sharp scalpel blade,



RCA'S TRANSISTOR SETS

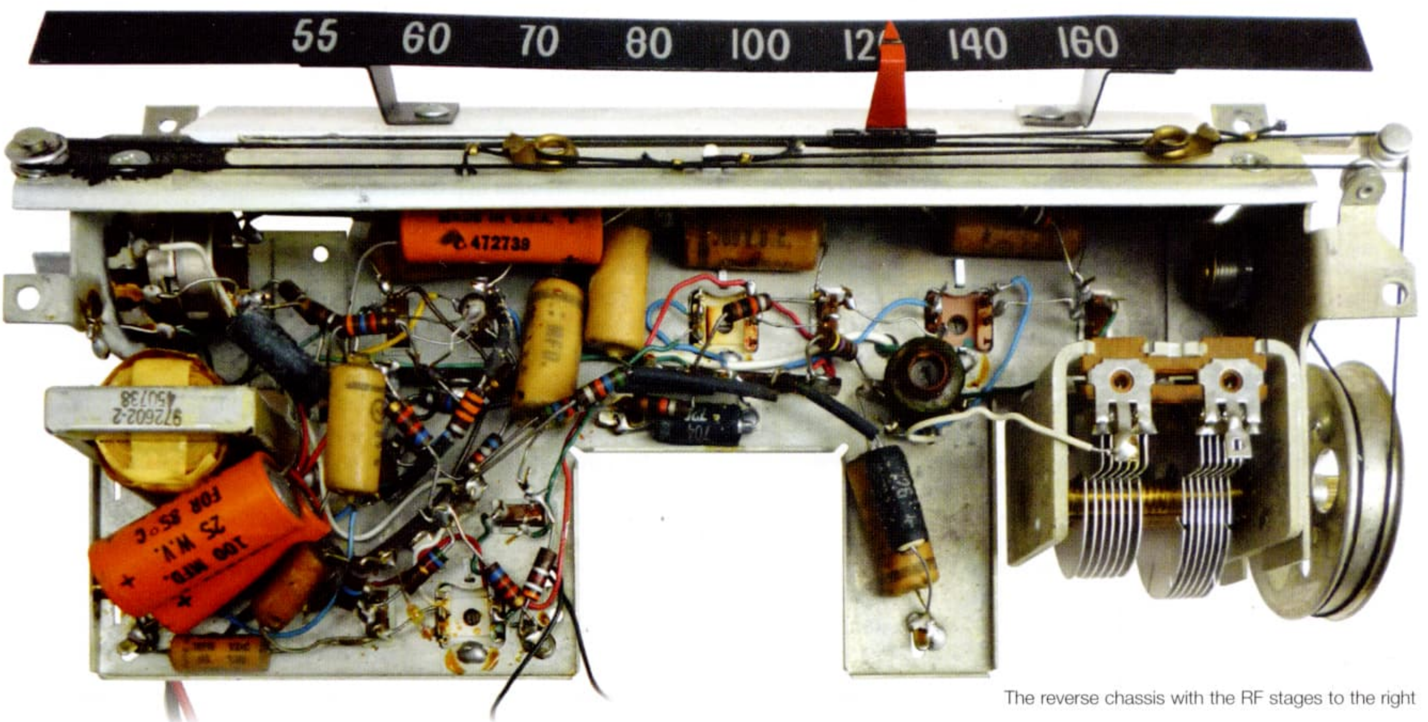
Radio Corporation of America is currently introducing two all-transistor portable receivers—one in a miniature size with six transistors and the other featuring a larger loudspeaker and case with seven transistors.

The Model 7BT9 six-transistor receiver comes in a plastic case measuring 5½" x 3¼" x 1½". The Model 7BT10 is approximately the size of the firm's present "Personal" portable which measures 10" x 6⁹⁄₁₀" x 3½". It is housed in a case of leather covered wood with aluminum trim and slide-rule dial.

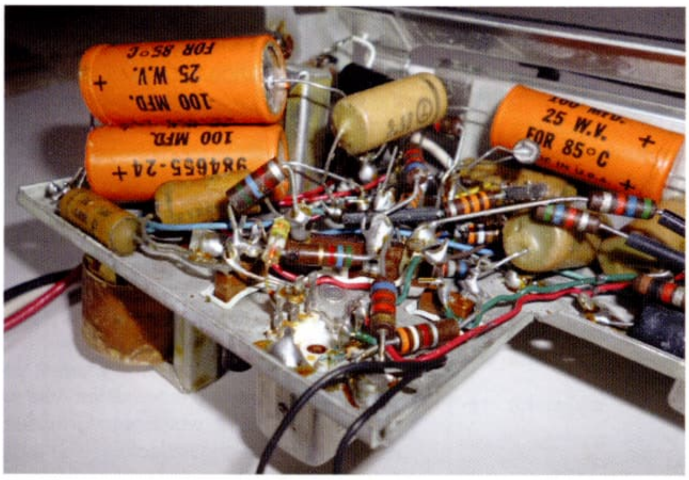
Both radios feature circuits especially designed for use with transistors. Both receivers are said to have greater reliability and greater resistance to shock than conventional models.

News of the release of RCA's 1st transistor portables

prising apart gently with a screwdriver and pushing out the internal aluminium cylinder. Previously I have cut off with a hacksaw the + end connector and rubber grommet from the original capacitor for reuse but this is protracted and messy. This time I discovered some foil backed stiff card, the kind that comes with aluminium foil dishes and after measuring the end diameters of the capacitors I was able to carefully cut out small discs. The chosen replacement then had one of the foil disks inserted over the – lead of the new component which was glued tight against it. When secure this assembly was pushed down the cardboard sheath until the disc contacted the inside of the lip at the far end where it was glued around the edge. Allowing this to dry, a slightly smaller disc was then pierced and slid over the wire to the + end where it was glued to the recessed external lip. A bit of orange model paint, which was fortuitously very close to the original colour, was carefully painted around the + end to simulate the original seal and things were ready for reassembly. Because of the "rat's nest" the capacitors had to be reinserted in the reverse of the sequence they were removed in. Re-soldering was more difficult than initially just snipping them out. The + ends were originally soldered to lugs stamped out from the plated steel chassis and this required an iron more powerful than the 18 Watts I normally use for transistor work so out came my seldom used 30 Watt iron. While putting these components back in I was struck by how little insulation had been used on the wiring in such a confined area and noted that in one or two places multiple soldered joints were almost touching. One precaution I also took was to remove Tr 4 from its socket while soldering since two of the capacitors were connected to its pins. This procedure thankfully sorted out the distortion and the one remaining thing was to correct the position of the tuning pointer which wouldn't travel all the way along the scale. This was because the tuning capacitor was not fully meshed while the pointer was at the low frequency end. Solution, firmly grasp the chassis and forcibly turn the spindle to mesh the capacitor while the cord slipped over the spindle. Crude but effective! Someone had obviously been heavy handed in the past.



The reverse chassis with the RF stages to the right

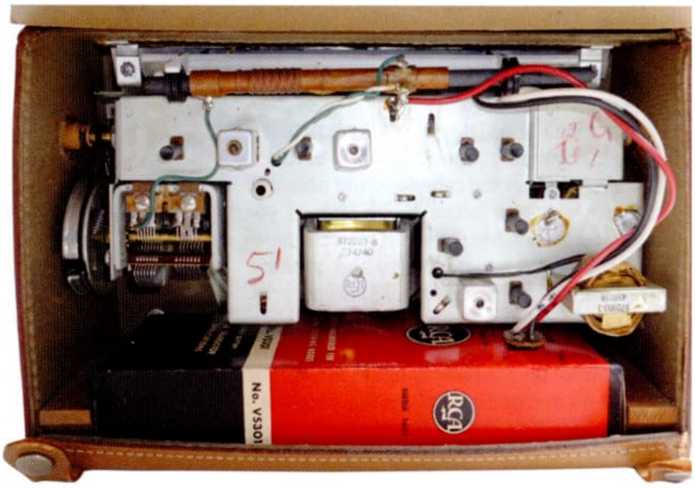


Close-up view of rats nest around detector and audio stages

Foil covered end disc glued to replacement capacitor

A 2N410 RF transistor in the mixer position

Paxolin socket above original D size cells



Exposed chassis with socketed transistors and VS301 tapped battery beneath

Battery

With everything else attended to it seemed a shame that the original VS301 battery could not return to its allotted spot beneath the chassis. The obvious thing, as per previous articles in The Bulletin, was to scan the faces and rebuild a facsimile from thick card. I toyed with the idea of carefully slicing it open, removing any gunge and reusing the original as a shell. Apart from a few frayed edges it was in surprising shape but how easy it would be to remove the innards was an unknown quantity.

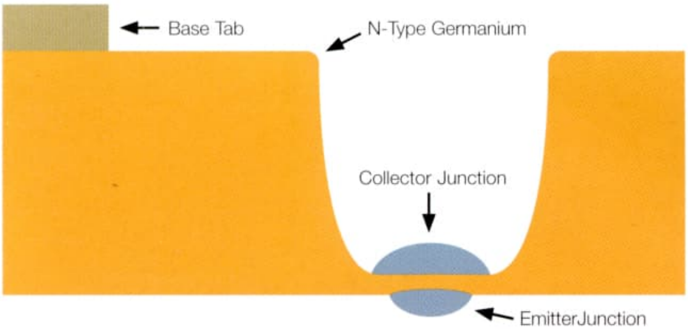
At this point Sod's Law came into play and my ancient Xerox scanner gave up the ghost so I went along to my local copy shop with the original and had a word with the bemused owner. I explained that the American purchaser of the radio that it came from had probably heard Elvis Presley on it for the first time and that got him interested! The result was several printouts of all the scanned sides assembled together. They were at slightly different scales to allow trial glueing over stiff card replicas of the battery. When I gutted the original carcass to retrieve the paxolin socket for reuse I discovered, not a layer type battery with gunge, but a row of six D size cylinder cells sheathed in thick cardboard and remarkably little sign of deterioration.

The next major decision was how to support the four pin socket inside the new case since this would have to take the force of the plug being inserted and removed. A block of soft wood was used, 66 wide x 33mm high to comply with the inside dimensions and with a slot cut in it to accommodate the pins of the socket and the new emerging wires. Two tiny holes were drilled in the paxolin and small flat head pins inserted to secure it to the wood. 1.5mm thick card was marked out with a drafting pencil and the fold lines scribed about 0.5 mm deep prior to folding. A cell holder was wired up, as before, with long wires to the socket pins to allow it to be removed from the end remote from the socket. The card was folded around the wood block and glued to provide reinforcement. When set, a suitably cut specimen of the print out was stuck to the surfaces beginning with the top, followed by both sides and bottom. At the end where batteries would be inserted the card was cut off and glued to a piece of expanded polystyrene that was a push fit in the box end to act as a cover.

The story behind RCA's transistor development

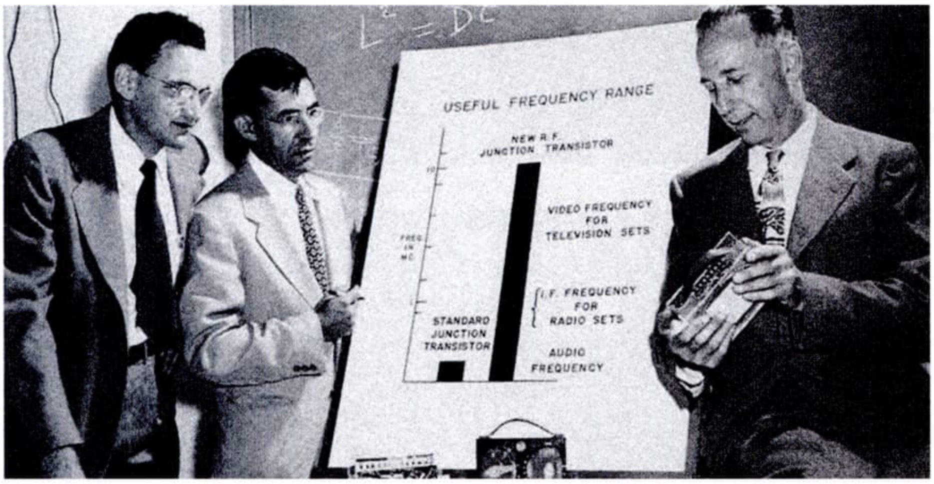
Most American manufacturers introduced their first transistor radios sometime during 1955 using either Texas, Raytheon, Sylvania or General Electric transistors. Why then, you might ask, did RCA have to take the stage right at the end of the year using RF semiconductors from another company? RCA were a big player in the radio and TV field and were in from the beginning in researching the production of point contact transistors and also in the early fabrication of alloy junction devices so there is an interesting story behind why they were not ready with their own complete range of transistors for the introduction of their first transistor radios. In 1952 RCA did pioneering work along with General Electric in developing a method of realizing a germanium junction transistor using indium pellets alloyed on to both sides of an N type base wafer but it was GE who were in first with a patent. The race was then on to raise the high frequency performance of these so that they would be useable in the RF stages of a radio. The parameters that governed this were the base thickness, the resistance of the base connection and collector to base capacitance. Control of base thickness at the time was a bit of a black art, akin to Alchemy, with many variables not yet fully understood. It depended on the length of time the indium pellets were alloyed into the germanium wafer, critical control of alloying temperature in a special furnace with a hydrogen reducing atmosphere and even the orientation of the crystal planes in the germanium.

In about 1953 RCA tried a bit of lateral thinking. Two of their engineers devised a method whereby a relatively thick wafer of N type germanium had a "well" etched into it leaving a very thin section at its bottom. This appeared easier to manage than prolonged control of the alloying temperature and required that the two junction pellets only needed to be lightly alloyed for a comparatively short time. The resultant SX160 "Well transistor" met expectations for reproduceable high frequency performance and during 1953 the company displayed a number of experimental radios using these devices. Two RCA promotional photographs from the period illustrate this confidence.

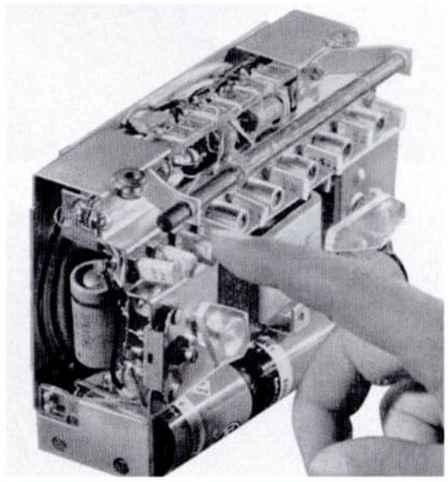


RCA's 1st experimental RF junction design used an etched pit in the germanium to reduce the width of the base region

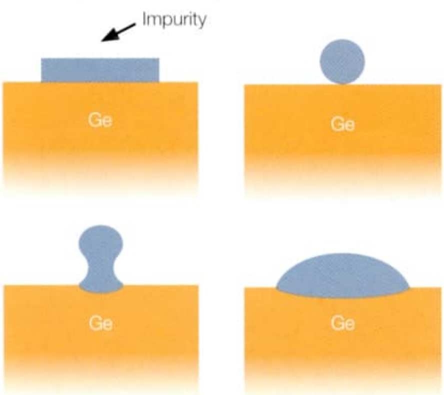
1950's tube predecessor shows where the 8BT10K's styling cues came from



Loy Barton with members of RCA's transistor division showing one of the 1953 experimental receivers



1953 experimental prototype transistor radio interior



Uncontrolled wetting of the germanium surface by the melting indium pellet posed a problem for RCA

The optimism however proved to be premature and as development continued through 1954 it became obvious that, although clever, the etched "well" approach posed other cost and manufacturing problems so RCA abandoned it and returned to refining the more conventional techniques being pursued by their competitors.

An engineer who joined during this period described the problems RCA were having with uncontrolled "wetting" as the indium pellet began to melt on the crystal. The sequence can be seen in the illustration. He identified the cause as being the unusual "perfection of the RCA crystals" with the number of defects in the lattice being at a very low level. Ironically it was the higher level of dislocations in the crystal lattice of their competitors that hindered the uncontrolled spread of the melting indium!

Throughout 1955 RCA engineers applied themselves to this problem. Being unwilling to reduce the quality of the germanium crystal they instead developed a two stage process.

1: Wetting or "soldering" of the indium to the germanium was carried out separately in a hydrogen atmosphere at 350°C.

2: Alloying of the indium into the germanium was then done at 550°C. in an oxidizing atmosphere. This prevented further lateral spreading of the indium on the germanium surface.

By this technique and by using a specific crystallographic alignment in the germanium RCA were able to produce accurately controlled junctions and in March 1956 they announced production of their first commercial RF transistors, the 2N140 and 2N139. This explains why, not wanting to be left behind by other manufacturers, they released the 7BT10K in 1955 with Texas Instruments NPN RF transistors and then several months later, redesigned the circuit when the 2N140 and 2N139 became available. It is interesting to note that the Texas devices were grown junction types (different in construction to the RCA alloy transistors) and needed reversed polarity supply lines.

Summary

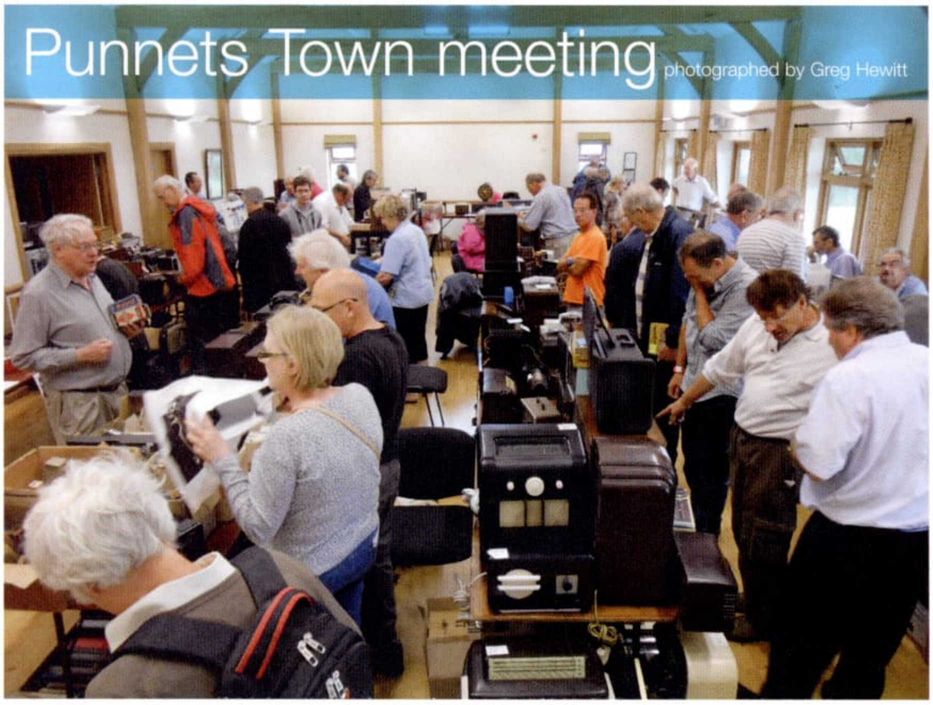
The 8BT10K displays average selectivity and quite good sensitivity. This could probably have been improved further by the use of a larger diameter ferrite antenna. It's an interesting set in the way it reflects the transition in design practice from valve to transistor. I am still intrigued however as to why it was necessary to employ the use of separate bias rails with a tapped battery. On the audio side bass reproduction is not as strong as expected, given the size of the case and speaker, which is slightly disappointing. There is also an odd "constriction" to the sound in the upper registers. This could be due to that stylish metallic grille. The actual ratio of openings to obscuring metal is quite small and this can cause a resonance between the speaker cone and the grille. Hacker got away with a similar grille years later without apparent ill effect but that had much larger openings. Anyway, while this isn't disastrous, whatever the reason, it is hardly the "Golden Throat" sound that RCA advertised for some of it's radios at this time! This is a shame because it is a stylish radio with good RF performance and I really like that three dimensional tuning strip with its curved Perspex and its Cold War Civil Defence markings.

References:

RCA transistor history; Mark Burgess. Google.com
Transistormuseum.com. Oral Histories

Punnets Town meeting

photographed by Greg Hewitt



Two Ekco 313's plus Ekcone loudspeaker

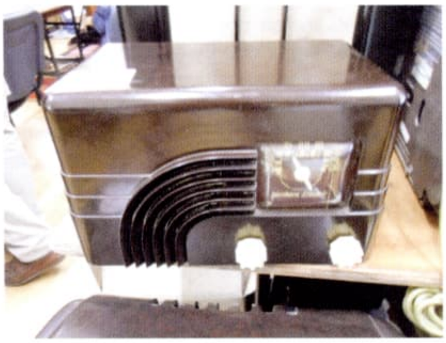
BTH 'E' Loudspeaker

Crosley Loudspeaker

BTH C2 Horn

Cigarette case PoW crystal set

A beautiful example of an 'R' valve



A Northern Electric 'Waterfall'

An American Detrola split-grille radio

R1155: modification one step beyond

By Roger Grant

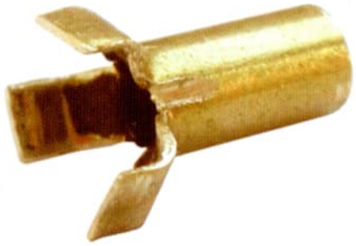
Just when you think there couldn't be anything else that you could do to an R1155, necessity, the mother of all invention, finds an excuse for another mod!

Are you sitting comfortably?...
It's mid December, I wandered out to my workshop to continue with my latest projects. I powered up the bench, (it's a bit chilly, around 10 degrees) fired up the portable gas fire, and the workshop radio. The R1155 that comes on with the bench, was just warming up and making a rasping noise, as usual it's off tune, a slight tweak and it's loud and clear.
After fifteen minutes or so the radio had drifted off tune as the room and internal temperature of the set increased. I was struggling with a difficult drive cord re-string at this time, one of those jobs that requires three hands, so it will have to wait. Several more minutes passed and the mis-tune had got worse and was now quite irritating. I stopped the job and re-tuned the set, all is well again for another twenty minutes or so and then the set required retuning again, this set can sometimes take a hour to fully settle down and stay in tune. This annoying little problem obviously gets much worse with relatively large temperature variations in the winter months, when the weather forces a lot more indoor activities and a lot more background listening, and it's about time I looked into this problem.
Other sets I've used as my workshop set have needed the odd slight tweak, but this ones bad enough to require fixing or modification. I like this iconic radio and set up, it looks and sounds good and I don't want to change it, so I was determined to improve the situation before I start on anything new.

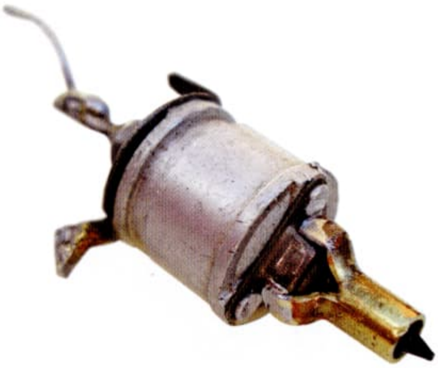
The first step was to change the local oscillator valve, a VR99 or 6K8 in real money, (the VR99 is a 6K8 beefed up to tolerate heavy shock and vibration as in aircraft or other military applications). This didn't make any difference and was changed again just to make sure I didn't have two dodgy valves.
HT variation was considered next, this set uses a centre tapped HT secondary winding on the mains transformer and two BY100 silicon rectifiers for full wave rectification, a power supply mod by a previous owner. Monitoring the voltage from cold switch on to fully warmed up showed a swing of around eight to ten volts, around 210v cold, reducing to around 200v when fully warm.
The possibility of HT stability causing my problem was eliminated by fitting a 2K heavy duty wire wound pot in series with the HT rail and swinging the voltage from 210v all the way down to 95v, this obviously reduced the volume level but made no difference at all to the tuning.

Looking at the circuit diagram of the local oscillator identifying all of the components in circuit on the MW band, I gave all of the components a short puff of aerosol freezer one by one. I found that they were all sensitive to temperature related drift, the amount of temperature reduction on any one component required to cause my problem, was far in excess of that experienced. During this test it was noted that the most sensitive component was the oscillator coil itself, and the least sensitive was the tracker trimmer C70, the base part being the chassis. Stray capacity around any of the oscillator components had the most effect, moving a finger within half an inch or so of any of these components could bring the set back in tune.

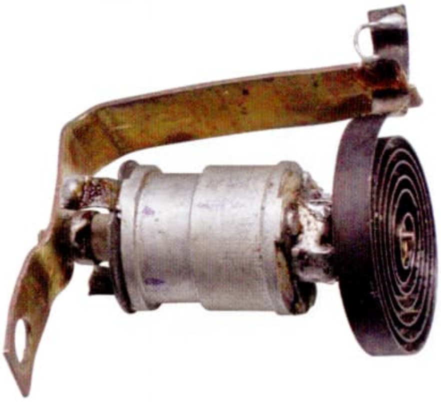
So how much temperature change am I actually getting? And I need to quantify the range of the drift.
The set was left outside in the cold for several hours and acquired a temperature of 10 degrees C. A thermometer probe was inserted into the coil box and the set covered up and run continuously for several hours, after a hour or so the internal temperature reached 40 degrees C where it remained reasonably constant, the metalwork of the chassis, front panel and cabinet managing to dissipate anything more than this. Using my preferred background listening station on 1548 kc/s, the tuning drift was observed as 10 kc/s or so at the high frequency end of the



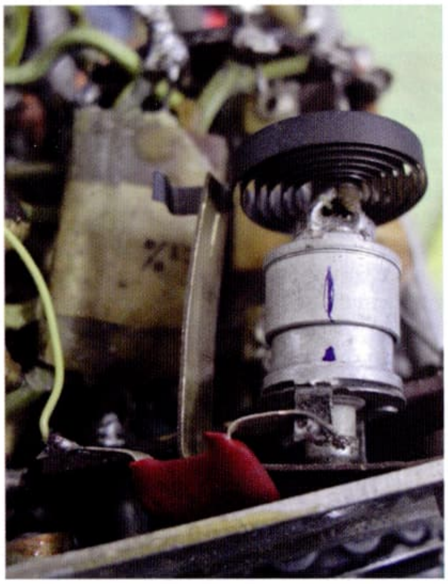
The brass tube interface



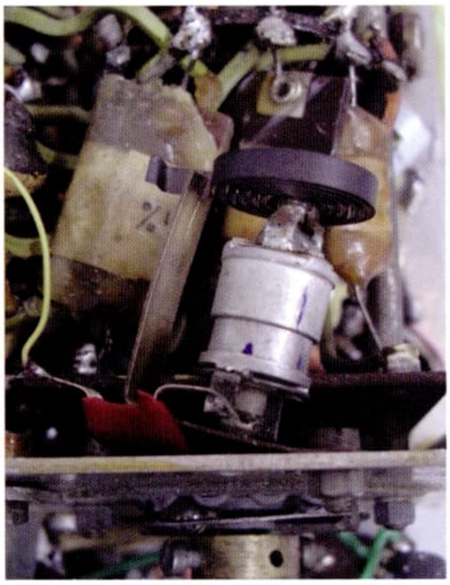
The modified beehive



The finished assembly



The experimental set up low temp



The experimental set up high temp

The finished mod installed

MW band (from 1545 kc/s cold drifting to around 1555 kc/s when fully warmed up). This set has had its MW band moved up 100 kc/s from 700 - 1500 kc/s to 800 - 1600 kc/s to include my preferred background listening station and to accommodate the present MW band up to 1600 kc/s, and this has increased the level of drift as it's much worse at this high frequency end of the band.

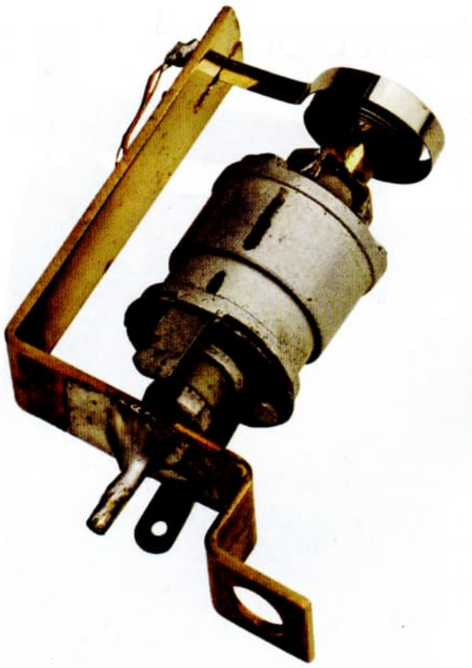
Having eliminated all of the capacitors by substitution one by one (There are only three of them), I had now run out of ideas as to where to look next. All sets drift a bit but this one is particularly bad. After much brain strain looking for the next step I wondered whether this is a fault with this particular set or are they all like it? Remembering I do have my more original R1155 a much less modified set in my collection, this other set was dragged out and run up, and the drift characteristics were exactly the same. It appears that it's a design limitation not a fault.

Thoughts of designing some sort of Automatic Frequency Control passed through my mind. This would require a discriminator for detecting the error and an oscillator control circuit, adding a least two valves, and require a specially wound IF transformer for the discriminator and an extra control winding on the local oscillator coil. This could be a very interesting major project but likely to take a lot of time and not the relatively quick fix I'm looking for. As my problem appears to be purely temperature related perhaps a much simpler device might suffice, something like a varicap diode as only a few pf's were needed, this coupled to a thermistor via a scaling amplifier. This would require a low voltage regulated power supply, now even this simple idea is getting a bit complicated, besides, using silicon devices wouldn't be cricket as they say.

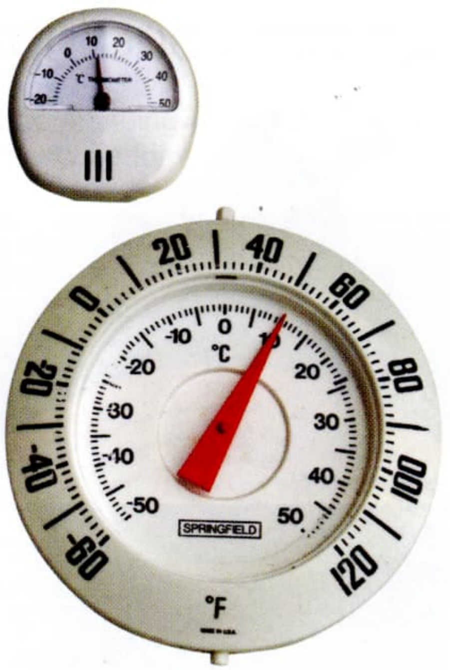
Perhaps I could exploit the stray capacity effect, a bi-metal strip moving closer to one of the C's compensating for the drift the same as when approached by my finger. I needed to know more about the properties of bi-metal strips so my first port of call was Google on the internet, and very useful it was too. A bi-metal strip is as it says, two strips of dissimilar metals such as Iron and Copper, with a different rate of thermal expansion, joined together in parallel. As the temperature rises the different rate of expansion causes the strip to warp proportional to the difference in temperature, exactly what I'm looking for. Reading on, I discovered this idea was employed by John Harrison of marine chronometer fame, and used on his third chronometer in the mid eighteenth century while solving the problem of an accurate clock for longitudinal navigation.

My next port of call was my junk box looking for anything that may contain any kind of thermo dynamics, a bi-metal strip, a thermostat or temperature sensitive bellows, an old central heating thermostat perhaps. After a few bench experiments I couldn't find anything suitable, all too big or not enough movement over the required temperature range. I then happened on an old greenhouse thermometer, a very cheap device acquired with a lot of junk from a shed clearance, this only had three components, the plastic face plate with a printed scale and a plastic pointer attached to a bi-metal spring. The pointer wasn't particularly light so the spring must provide a reasonable amount of torque to move and support the weight of this pointer. The scale indicated a change of around 90 degrees of angle between the 30 degrees (10 and 40 degrees C) of temperature, this may drive a single vane low pf capacitor to solve my problem.

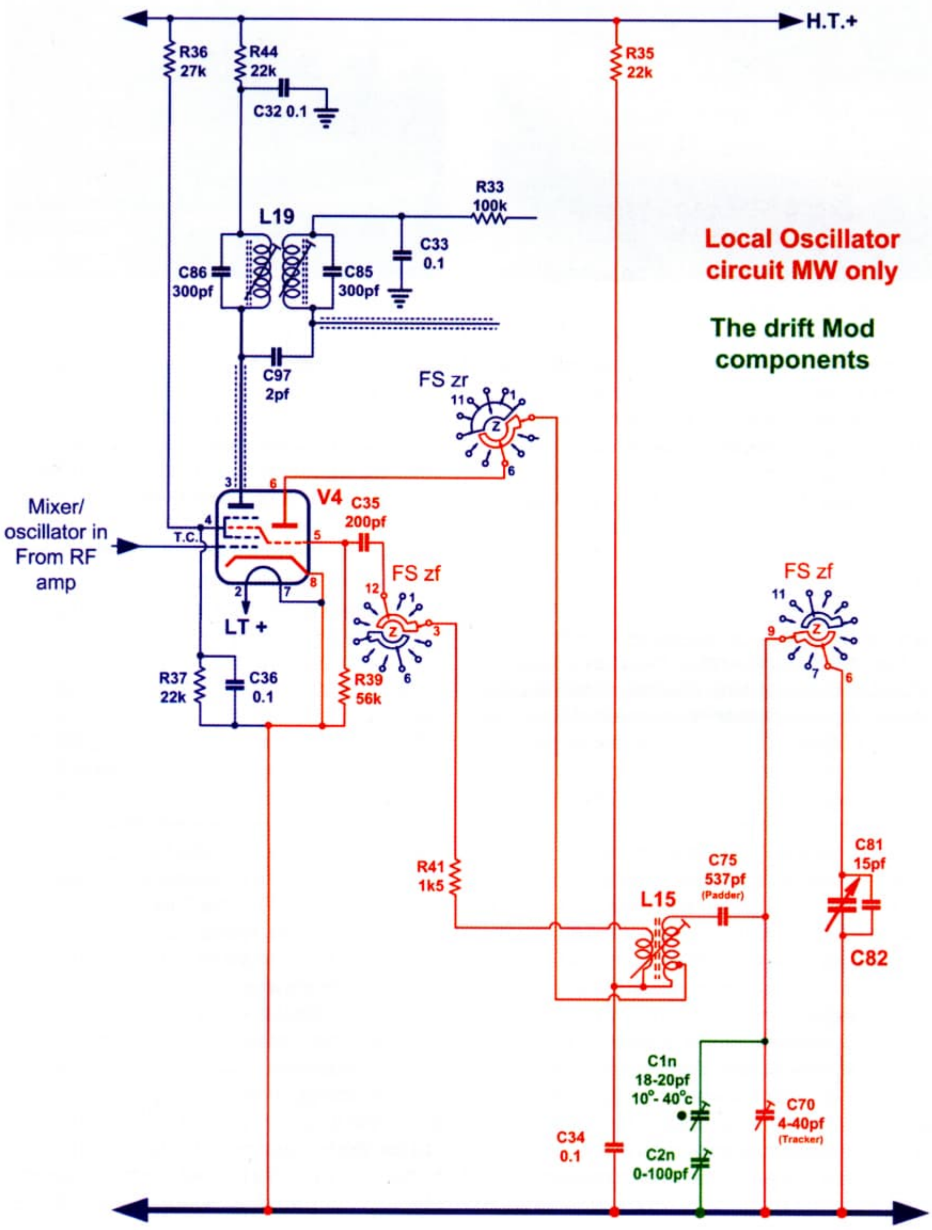
On test there wasn't enough torque to rotate a trimmer or low pf tuning capacitor but it might drive a beehive trimmer. A beehive trimmer has a capacity range of 3-30pf in just under three revolutions, 9pf per rev and around 2pf for the 90 degrees of rotation of my bi-metal spring, just about right or a good place to start anyway. (Guessed by the



The tidier version



The donor thermometers



The circuit diagram of the local oscillator

amount of drift correction on the tuning capacitor over its total capacitance)

The spring consists of around ten turns with an outside diameter of around 20mm, the centre around 4mm. For a mechanical interface I found a piece of 4mm brass tubing left over from another project, I cut off a length of tube about half an inch long then cut three slots equally spaced down around half its length, the three prongs formed were flattened with a pair of pliers and bent to shape to fit over the pressed brass hexagonal nut of the beehive trimmer, the trimmer spiral thread passing through the centre of the tube and the interface prongs soldered to the pressed brass nut. The friction springs inside the nut were opened out to reduce the friction to a minimum without any backlash.

A basic support frame to anchor the outer end of the spring and house the beehive trimmer base was made out of a piece of 22 gauge brass plate about half an inch wide and bent to shape. This assembly was installed in the coil box close to the other components and wired across the MW tracker trimmer C70. The beehive trimmer was set to mid travel around 15pf, the push fit of the spring over the brass interface tube had enough friction to hold it firmly in place but still allow adjustment. The tracker trimmer was wound out to compensate for the 15pf of the beehive trimmer, the position of the beehive trimmer was marked and noted at the current ambient temperature of 15 degrees C.

The set was covered up and powered up, a slight adjustment was made to the tracker trimmer to align and calibrate the tuning scale to where it was before the beehive was fitted and then the set left to warm up. Shortly the set drifted off tune far worse than before, inspection showed the beehive trimmer was going the wrong way so the spring was refitted the other way up, the set left to cool down over night and the experiment started again the next day.

This all went very well, the set ran covered up for over an hour and stayed in tune, it had started at 12 degrees C and was now up to 28 degrees, Eureka! this is looking good but needs pushing to extremes as I don't believe I've just scored this hole in one.

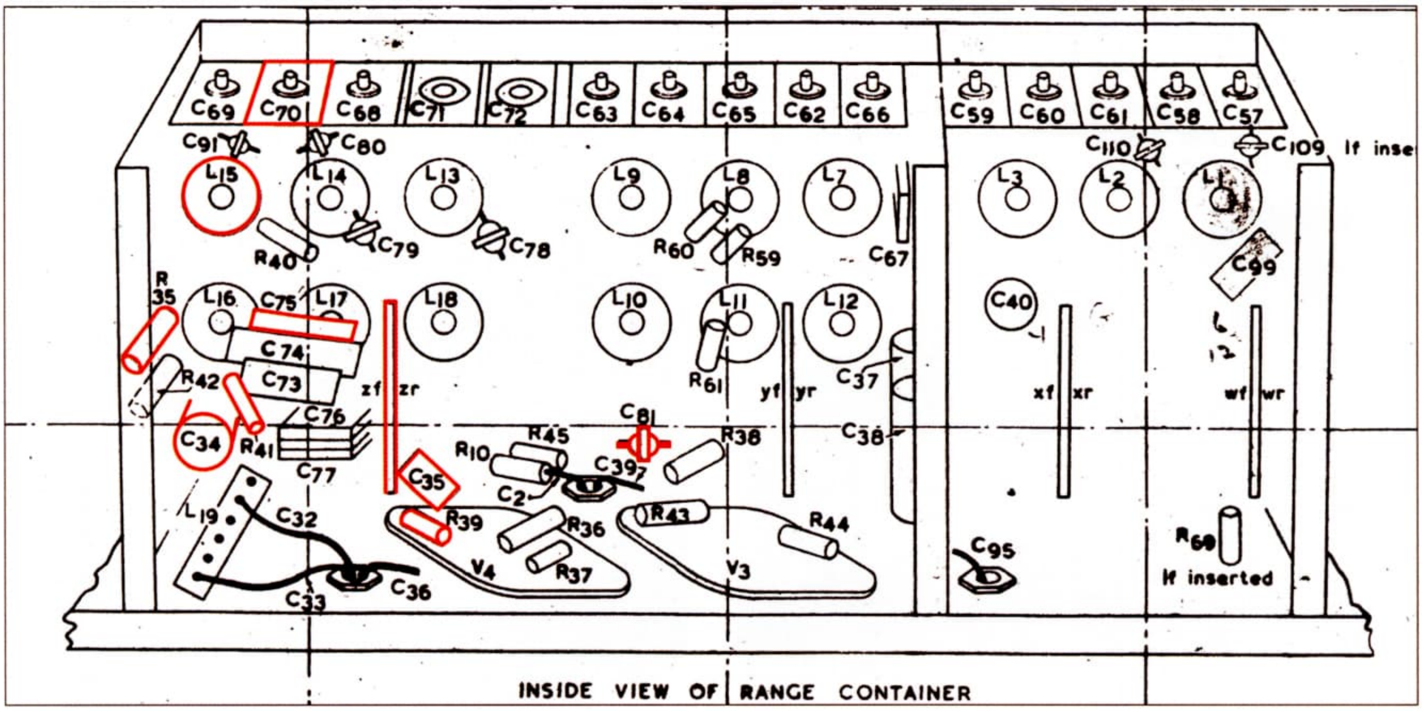
As the temperature rose through 33 degrees the set had drifted slightly off tune and a bit more at 40 degrees. On inspection I found that the beehive had over compensated and the 2pf difference over this temperature range was too much. Manually moving the beehive back a few degrees with a wooden stick bought it back in tune so only around 1.7pf of difference was required.

If I only adjust the beehive itself then I only adjust its capacity and not the difference in change.

If I reduce the whole capacity of the beehive then I also reduce the difference, I did this by placing a capacitor in series with the beehive, this calculated to be around 80pf.

I had a 79pf silver mica capacitor to hand, this fitted and the whole experiment

R1155 MW local oscillator component location in the coil box



The component location in the coil box

started again, this seemed to do the trick. Now the mod is fully working I needed to make a better job of fitting this assembly. I rearranged the capacitors between the wave change switch wafer FS zf/zr and switch end tag strip, this affording a space for this mod assembly inside the coil box close to the other local oscillator components, especially the coil. I applied a small amount of light grease on the beehive spiral to avoid any stiction. I then soldered a piece of super flexible wire from the ground point to the brass interface tube, as the moving connection between the moving vanes of the beehive and the spiral would be bound to get noisy eventually. The set now put back in its case and back in its place on the shelf, ready for the test of time. I only applied this mod to the medium wave band for my regular listening station as I would only use this for long period listening and the capacity calculations would be different for the other bands.

When surfing the airwaves drift is not so much of a problem as I wouldn't be on the same station for any long periods and long distance listening requires a lot of attention and tweaking anyway, so the main purpose of this mod is just for uninterrupted long period background listening whilst working in the workshop. The set behaved admirably over the next few days and Christmas was now only a few days away.

The proof of the pudding was the next time the set was used early in the new year nearly two weeks later and it came on in tune much to my delight. Whether my efforts are considered innovative engineering or an elaborate bodge-up, it works very well.

Cobbling things together with junk is all very well but I wondered if these cheap thermometers are still available just in case I feel the need to repeat it. I tried several hardware shops and garden centres, most stocked the liquid in a tube variety of thermometer. I eventually found one, a bit smaller than the one I used but with a very similar bi-metal spring, and all for the princely sum of £1.49.

A photograph shows this later much tidier version of this device made with the smaller spring from this purchase. This new tidier version was fitted to the set and the same test run and it was found to be just the same except that it's a bit smaller taking up less space and the spring appears to be a bit stiffer than the original, giving a bit more torque. This new device was modded slightly from the original, the spring was soldered to the beehive brass tube and frame serving a better ground connection and disposing of the flexible wire. Now that I have a source of cheap bimetal springs I don't have to worry about damaging one and I can play around to my hearts content. Monitoring continued and on a particularly cold day it was found that there was still a very slight level of drift over the extremes, something a bit less than half the R1155's pointers width. This was remedied by replacing the beehive 79pf series capacitor with a 0-100pf trimmer, this allowed the exact difference in capacity to be set spot on. The set-up procedure I used for this trimmer was to note the pointer difference from cold to hot. When the set was hot set the pointer to half the difference and retune using the trimmer, this worked very well and was spot on after only two hot - cold cycles and completely eliminated any drift. The set now comes on in tune and stays that way all day, even on the coldest of days.

The final phase was a good long test over several months, I wanted to see how it coped with the warmer summer months, but of course the temperature difference being much less and likewise the drift, so the worst case in the winter months already fully tested. Over time the newer version suffered a little with occasional stiction and the tuning corrected by a nudge of the shelf the set was sitting on, a bit like tapping a barometer, I removed this newer version and found that soldering the spring had caused a side twisting bias on the spiral bearing increasing the friction, causing the occasional stiction. While the original mod had been out of the set I removed the earthing wire and soldered both ends of the bimetal spring to the frame and brass tube, making sure this time there was no lateral stress on the spiral to increase any friction. This was re-installed in the set and is still there working very well.

I very much enjoyed sorting out this little problem with this relatively quick fix and the only disappointment was finishing it. For a set that's already modified way beyond its original design, this little mod was great fun and ideal for anyone who likes tinkering with old radios.

Decca Prestomatic PT/AC by John Sully

This receiver appeared in early 1938, and is a four valve plus rectifier 3 band AC superhet with pushbutton tuning for 8 preset stations. This receiver is set apart from the rest of the market in 1938 by its striking and unusual cabinet. It would be impossible to ever find a PT/AC with water stains from a plant pot, as the top of the cabinet has no flat surface at all.

Fig 1: Prestomatic baffle cabinet

Fig 2: Murphy A104 baffle cabinet

The cabinet shape is significant, in that toward the top a baffle panel is constituted. The brand "Murphy" would probably spring to mind of many readers if the term "baffle board receiver" is mentioned, but the Prestomatic PT/AC seems to suggest that Decca got there first, and by a margin of about a decade. When the side profile is viewed it can be clearly seen that the cabinet shape slims at the speaker area, becoming more like a baffle panel than a boxy cabinet. In fact, the baffle principle is even more pronounced than is at first apparent. This is because the mounting board carrying the loudspeaker is recessed 5cm into the cabinet, with the cloth immediately in front of the speaker. The four slats are also about 5cm deep, and thereby fill the gap between the speaker mounting panel and the front of the cabinet. (Walnut sound diffusion slats were seen again after WWII when they re-appeared on the high quality Beau Decca and Decola radiograms). At the rear of the cabinet there is sufficient room only for the speaker metal framework, about 6cm. As the cabinet increases in depth, space becomes available to accommodate the magnet and speech coils etc. So, the top of the cabinet does indeed create a baffle panel. Perhaps Decca were not confident of the public's reaction to the idea so have disguised the extent of the baffle by the slats in front of the speaker. Could it be that perhaps when Murphy were designing their first baffle receiver, the A104 (fig 2), the pre-war Decca Prestomatic PT/AC provided ideas and inspiration, even if subconsciously? If one wanted to be really mischievous, one might also remember that the Murphy model A104 was the subject of complaint by another manufacturer, Ferranti, for stealing ideas. Ferranti believed that they had developed the concept of the SW logging scale utilising an extended scale projected onto a small window, and which was first seen in their Nova range of receivers in about 1936.

Therefore perhaps Decca can lay claim to pioneering the practice of incorporation of baffle principles to reduce "boxiness" and improve sound clarity in their Prestomatic PT/AC receiver. The PT/AC seems to have aroused some interest amongst the technical and listening press at the time, having been reviewed by several publications. The reviewer in The Gramophone magazine seemed impressed, the following excerpt is taken from a review that appeared in the April 1938 issue: "It may be that much of the cleanliness of the tone generally is due to the wedge-shape design of the cabinet. Reference to the illustration shows that the speaker is located high up where the depth from front to back is least; thus the chances of cavity or wood resonances developing are considerably lessened". The Wireless Retailer and Broadcaster reviewed the PT/AC in February 1938 (along with providing servicing information), but the reviewer does not seem to remark on the baffle principles incorporated into the design, or acknowledge any resultant improvements in sound quality: "Representative balanced tone with adequate volume for an ordinary room. With minimum tone-control there is reasonably upper register with good attack, and the tone is quite full. Middle and lower registers radiate well". The Wireless World magazine reviewed the PT/AC in April 1938 and was rather more enthusiastic, noting the new cabinet concept as follows: "The cabinet is of unconventional design, and its tapering depth from front to back effectively suppresses all trace of box resonance. The wooden slats bridging the loudspeaker opening slant downwards and prevent useless radiation of high frequencies upwards without affecting the forward response. There is no fault to find with the general reproduction on all types of transmission, and the lack of the customary table-model bass is not necessarily a disadvantage"

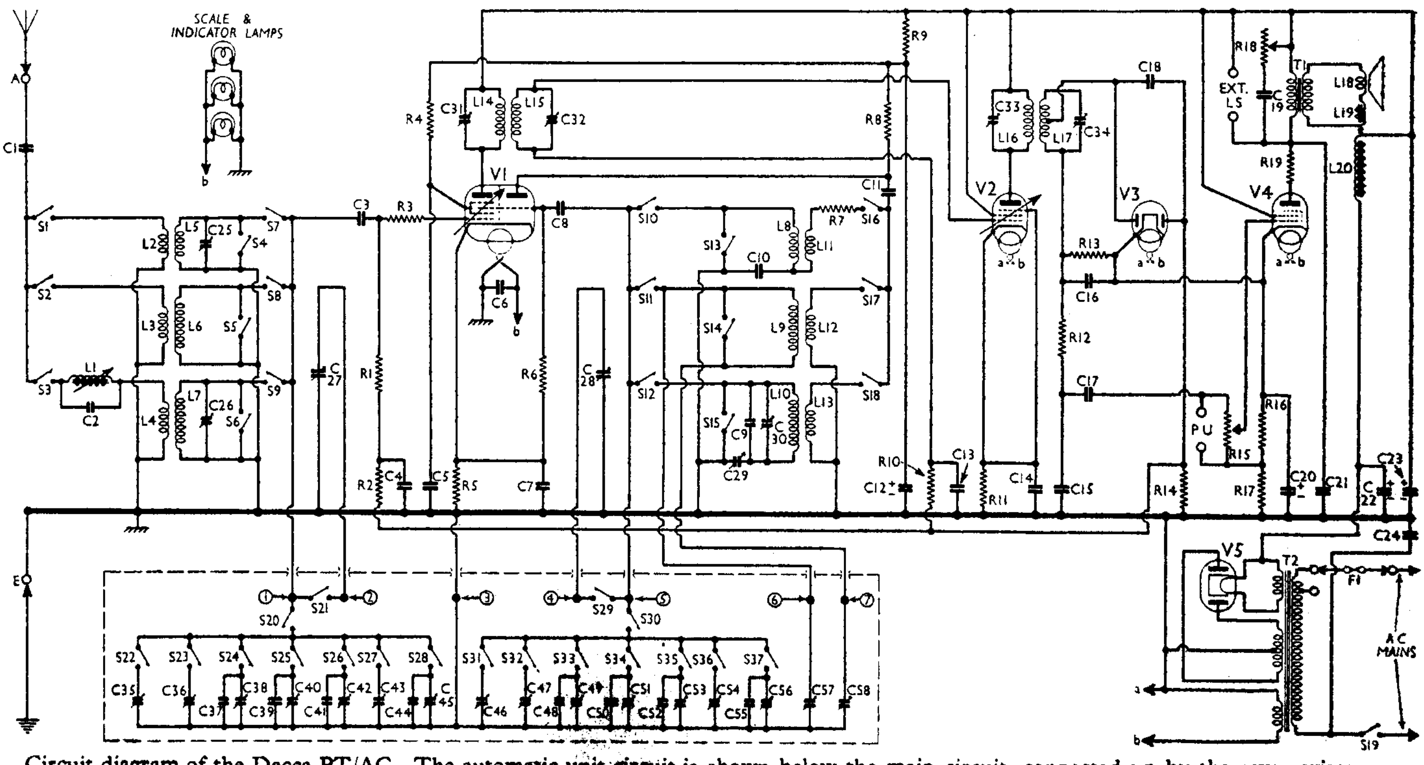
It would have been interesting to assess the effect of the baffle myself, but I do not have any acoustic testing equipment available to me, so all I could really do is an unscientific comparison. Before the war Decca was placed towards the middling/ lower end of the market, so a comparison with something like an H.M.V. or Philips set would not be really fair. Cossor were perhaps similarly positioned to Decca in the market in 1938, so I selected a model with a traditional upright "boxy" cabinet and 8" loudspeaker as a quick comparison test. This test was only to check whether the baffle principles made any difference to sound quality, not to determine technical performance/quality of either receiver. The test was performed by positioning the Decca cabinet alongside the Cossor cabinet, and moving the loudspeaker between the two cabinets part-way through a record as broadcast. This allowed some degree of comparison during the same record. (Obviously the loudspeaker from the Cossor was removed during the testing). The test was performed using my PT/U example of the receiver, because this has a permanent magnet speaker making quick movement of the speaker slightly easier. The tone control was set to the mid position.

By listening to the same record first in one receiver, then moving the same loudspeaker to the PT/U baffle cabinet I tried to determine whether any difference in "boxiness" could be perceived. I have to report that sound reproduction did not sound significantly different to me. My wife was also present during the tests, but without knowing which cabinet the sound was emanating from. She too reports that she could not really discern much difference, and also did not always pick the same cabinet as sounding the best. However I don't think anything can be read into this experiment because the only true test is side-by-side comparison, which was not possible to set up. It did seem to me that the tone of the chassis tended to the have more of a treble emphasis than some other late 1930s receivers due to circuit design, which would also contribute to less of a "boxy" sound during a demonstration in a retailer's showroom.

The Prestomatic PT/AC then is perhaps most notable because of its early adoption of baffle board sound reproduction principles. It was also available in radiogram form, designated model PG/AC. The radiogram model included the A.C.chassis with minor changes to switching. A larger 10" speaker was incorporated, as well as a piezo electric pick-up, an innovation which reduced record wear and normally only found on higher quality radiograms. A universal version was also available designated PT/U.

There are no real surprises in the circuit, which is shown in fig 3. Decca were not constrained by exclusivity agreements with any valve manufacturer and hence no brand loyalty is evident in the choice of valves utilised. In brief summary, H.T. is supplied by rectifier Brimar R2 (or could be Mullard IW4/350). H.T. smoothing via the speaker field and dry card-boxed electrolytic condensers. The signal from the aerial via either manual control or one of the pre-set tuners is presented to a Mazda AC/TH1 triode hexode operating as a frequency changer. A Mazda AC/VP2 variable-mu R.F. pentode is the IF amplifier, with an IF frequency of 465kHz. Second detector is one diode of a Mullard 2D4A, the other diode within the 2D4A envelope provides the rectified output for AVC operation. The output valve is a Mazda AC5/PEN tetrode, which provides an output of about 4.8W. The loudspeaker is an 8" Rola energised field loudspeaker of good quality. The universal version featured a functionally similar valve line-up of 1D5, TH2320, VP13C, 2D13C PEN3820 plus barretter driven into an 8" Rola permanent magnet loudspeaker. Pictures of the two chassis can be seen in fig 4, somewhat surprisingly one I.F.T. can moves position on the chassis as a result of the inclusion of either the mains transformer or barretter. The chassis is very compact leaving plenty of unused space within the cabinet. A tone control is included, and is provided at the top of the cabinet on the right hand side. The knob for this control is partially recessed into the cabinet.

1938 was the year of pushbuttons, so it would be expected that a mid-priced radio would incorporate pushbutton station selection. The Decca Prestomatic PT/AC incorporated a bank of eight pushbuttons, including one button which switched the receiver to manual operation. The remaining seven pushbuttons provided for a choice of eight stations. The wavechange switch had to be set to the appropriate waveband, and this also explains how seven pushbuttons can select eight stations – one of the buttons is arranged such that it tunes a pre-determined station when MW is selected and Droitwich when the receiver is set to LW. Decca



Circuit diagram of the Decca PT/AC. The automatic unit circuit is shown below the main circuit, connected up by the seven wires which are numbered to correspond with the same wires in the illustrations of the under-chassis and auto-unit.

Fig 3: PT-AC circuit diagram

Fig 4: AC and Universal versions internal view

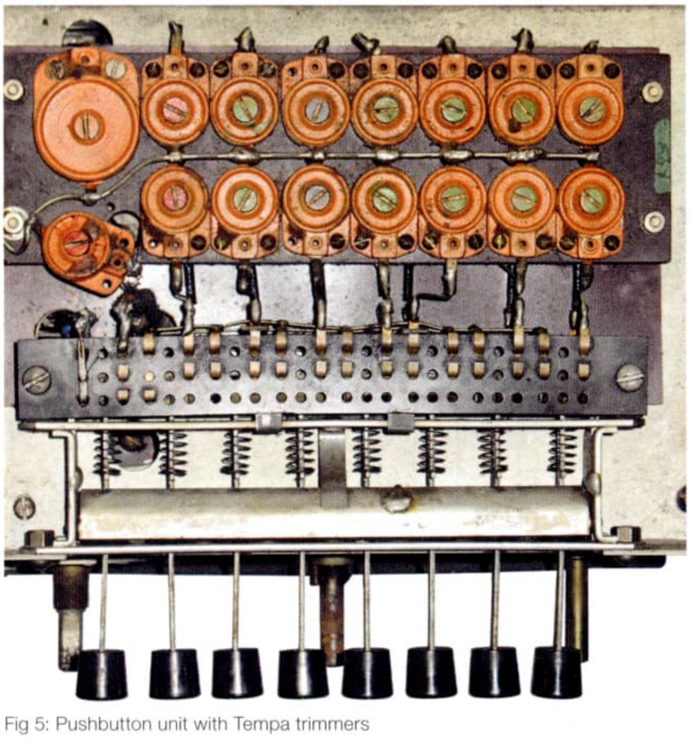


Fig 5: Pushbutton unit with Tempa trimmers

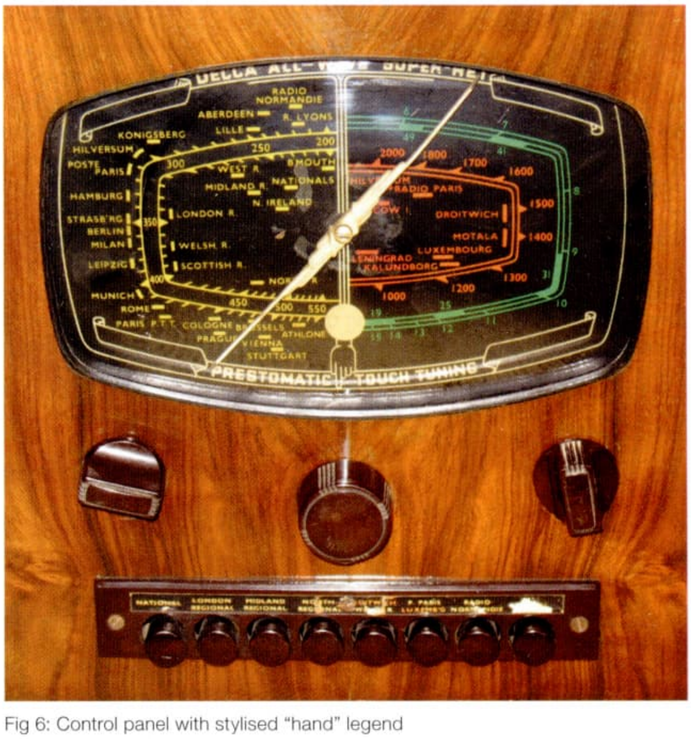


Fig 6: Control panel with stylised "hand" legend

recognised that the situation could occur where the MW station and Droitwich did not perfectly coincide at the same pushbutton, so it was possible to marginally correct this problem by use of a LW padding condenser accessible at the rear of the chassis. Decca utilised the pre-set tuning method, whereby each pushbutton has an aerial and oscillator Tempa trimmer associated. Each pair of Tempa trimmers cover a band of anything from 35-55m, within fixed ranges as follows: 215m-270m, 270m-320m, 315m-360m, 350m-390m, 385m-420m, 420m-465m, 515m-550m. If the owner wanted to receive a station outside the range of those available on the receiver when supplied, it would have been necessary to substitute a different set of trimmers, the cost of the replacements to the dealer being 3s. The receivers were all supplied pre-tuned to a pre-determined set of stations dependent upon area of use. The receiver could be supplied intended for three regions – Southern England And Midland Model, Northern Counties And Scotland Model, South Western England Model. The pushbuttons were labelled with a heavy glossy paper strip, which is positioned very close to the pushbutton itself. Over time some of the labels have worn away as they come into contact with stray pushbutton-operating fingers. A removable access panel is provided on the underside of the cabinet to provide access to the Tempa trimmers for adjustment and different station selection (fig 5).

The pushbutton assembly is a self-contained unit, which is fixed to the underside of the chassis by four self-tapping screws. If the pushbutton assembly is to be removed seven soldered connections need to be disconnected from it. Unfortunately there is no access to any of the components underneath the chassis unless the pushbutton unit is removed. One imagines this may have become rather tiresome for service engineers, particularly as the aerial, earth, loudspeaker and pick-up leads also have to be disconnected in order to remove the chassis from the cabinet, themselves a total of eight soldered connections. The pushbutton unit

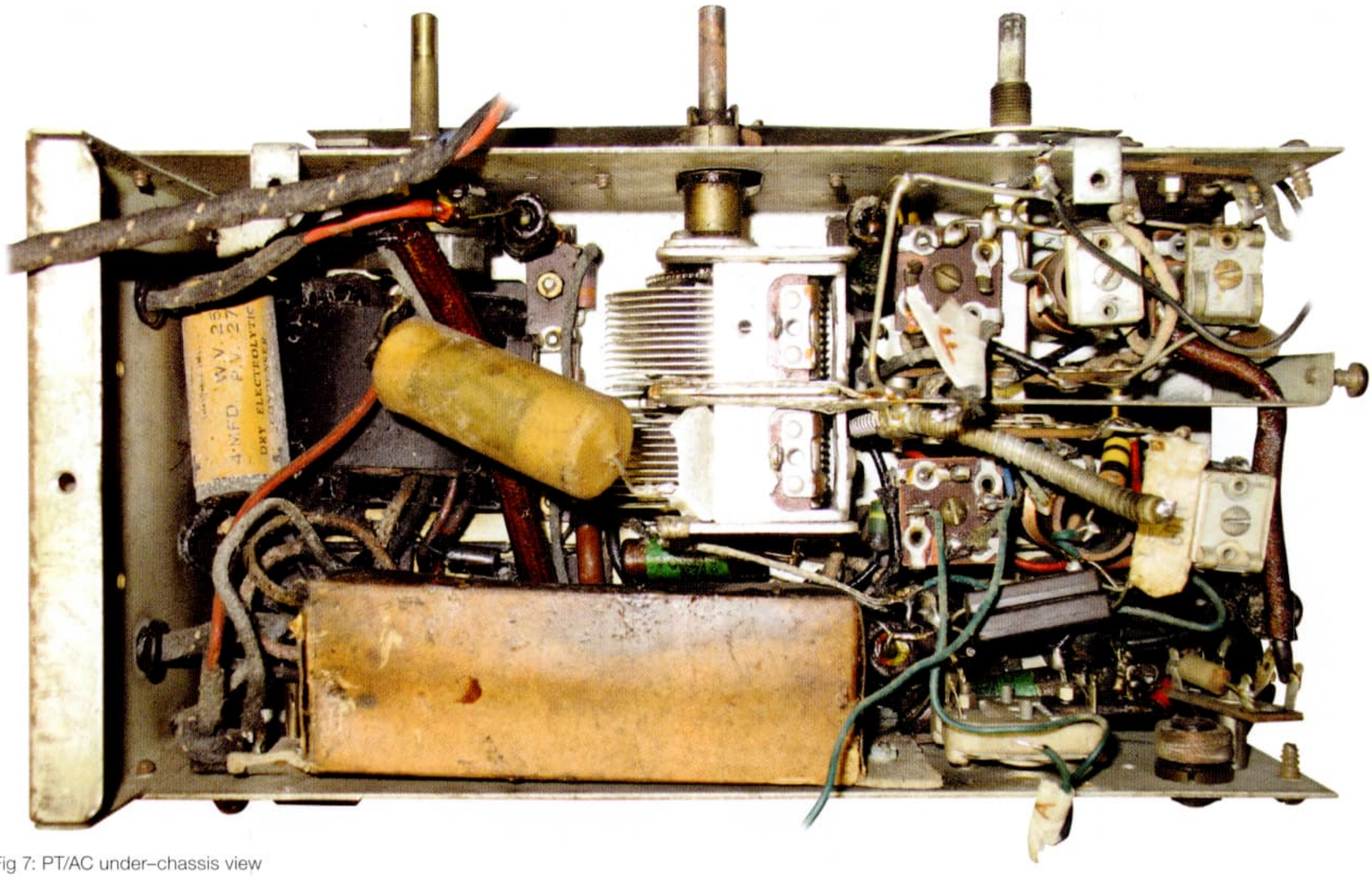


Fig 7: PT/AC under-chassis view

consists of the switch bank itself, plus 14 Tempa pre-sets, seven for aerial trimming, seven for oscillator trimming, plus a small number of common components. A Tempa condenser takes its name from one of its constituents, and consists of a disc of Tempa (similar to Steatite/soapstone, a metamorphic rock type) to which a layer of silver has been applied in a semi-circle. This disc is rotated relative to a similar circle of silver which is plated to a ceramic base. A variance in capacity results from these silver semi-circles overlapping to a greater or lesser extent. Top of chassis is very clean looking, with all five valves in a row nearest the rear of the cabinet. So if an engineer could be sure that just a valve needed replacement this set would be quick and easy to work on. However, if any voltage/current measurements or component replacement is required, then it wouldn't have been a quick job.

The cabinet is veneered with straight-grained walnut, and is well done and of good quality. The tuning scale is an interesting shape, and protected by a domed glass cover. This looks rather classier than the clear plastic tuning scale protection usually seen provided by the likes of Ever Ready and Truphonic etc. A three colour tuning scale is provided, printed onto acetate sheet which has lasted very well. Decca were clearly very pleased with themselves, having reached the "big league" of manufacturers who offered receivers with pushbutton tuning. In case the user was in any doubt, a stylised hand is pictured in the tuning scale adjacent to the word "Prestomatic"! (see fig 6).

The tuning scale is lit by two dial lamps. A third lamp is used to indicate the waveband currently selected. This indicator is a linkage fixed to the wavechange switch, which draws appropriate legends back and forth in front of the illuminating lamp through a small window in the scale. The gramophone pick-up, aerial, earth and external loudspeaker connections are brought out to paxolin strips right at the back of the cabinet, avoiding the need to plug in connections direct to the chassis. Power consumption seems quite high for a five valve receiver at 70w quoted. A fuse is incorporated in the voltage selector of the receiver.

So a receiver in an interesting shaped cabinet, good acoustic properties, quality veneers, pushbutton tuning and a reasonable selection of user enhancements is incorporated within the Decca Prestomatic PT/AC. This receiver does not seem to be very common these days though. It could be that the cabinet shape did not appeal to buyers, but there may have been a greater problem. This receiver went on sale at 14gns, more than a motor-tuned Ekco PB189 7 valve receiver in conventional box cabinet. In May 1938 the price of the Prestomatic PT/AC was reduced by 2gns, a substantial drop in price which will have seriously reduced profits on the model, but which perhaps acknowledges that it was initially too expensive.

Unfortunately for Decca, within weeks of the receiver going on sale, Radio Normandie changed the frequency that it broadcast from. The new frequency of 212.6m was not within the assigned Tempa trimmer range, so new Tempa trimmers for oscillator and aerial had to be fitted to all receivers already sold so that the pushbutton station legends would remain correct.

Less than a decade later Murphy built a successful table receiver designated A104, and subsequent range of radios and consoles with the aim of improving sound quality reproduction. The A104 was a five valve model with tetrode output. It was particularly notable due to the shape of the cabinet, which was in the form of a baffle board. The baffle board was claimed by Murphy to reduce the "boxiness" sound quality which tended to be a feature of large table radios housed within substantial wooden cabinets. In order to reduce the "boxiness", Murphy dispensed with the cabinet, and instead mounted the chassis behind a curved wood panel, within a perforated metal cover. Most readers will be familiar with the cabinet shape as the model sold well and many still survive today. It was certainly considered innovative at the time, and indeed was selected for the *Britain Can Make It* Exhibition held at Wembley in 1946, which was staged as a showcase to demonstrate the latest innovations developed by a range of British manufacturing industries. A Murphy advertisement from the time led with "... truly functional ...a large baffle to which is attached the chassis and speaker" the advert rather disjointedly continuing "No! no box. Instead, a radio set designed as a radio set. Advantages? None of that boom-boom resonance". Baffle board principles continued to feature in the Murphy range for many years, certainly well into the 1950s by which time the demand for large table radios was declining anyway. So the 1938 Decca Prestomatic PT/AC, with cabinet and baffle principles ahead of its time, seems to have been re-interpreted by Murphy after the war. The Decca Prestomatic PT/AC was just too soon.

How do they work? 6. Frequency measurement & wavemeters

by J Patrick Wilson

This final part of the series is on measurement of frequency and wavelength which express different properties of the same wave. The frequency in cycles per second (Hz) is inversely related to wavelength by the speed of the wave - approximately 3×10^8 m/s for light and radio waves in space, and 330 m/s for sound waves in air, $f = c/\lambda$, where f is frequency, c is speed and λ is wavelength.

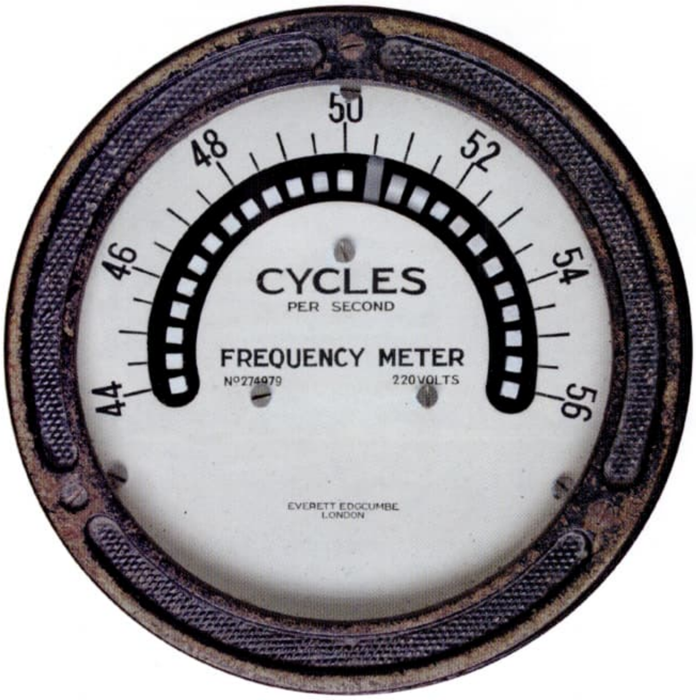


Fig 1a: Everett Edgcumbe unpolarised reed meter

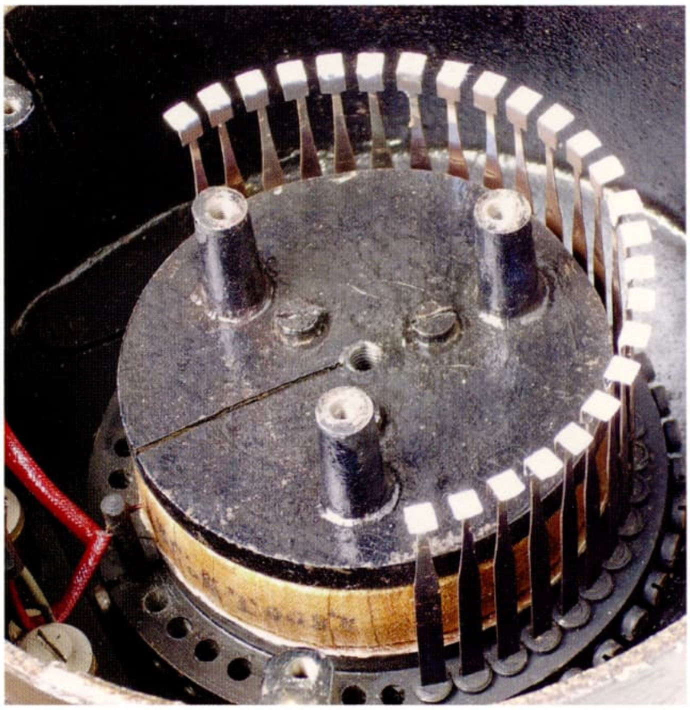


Fig 1b: Everett Edgcumbe unpolarised reed meter

Most instruments are based on resonance, the natural frequency of vibration of a mass bouncing on a spring or, in electrical systems, inductance interacting with capacitance. These are thus strictly speaking, frequency meters, the name wavemeter being applied because radio stations used to be specified by wavelength. The unit of time on which frequency is based originates from the duration of a day but is now defined more precisely in terms of an atomic resonance frequency.

Frequency meters

The reed frequency meter uses a set of prongs, each tuned to a slightly different frequency by a combination of springiness and effective mass to indicate the frequency of the mains by the reed which is vibrating most strongly. The vibration is excited by an electromagnet acting equally on all the reeds. There are two versions of this instrument depending on whether the reeds are polarised by a permanent magnet. In the unpolarised version the reeds vibrate at twice their indicated frequency because the force is attractive twice during each cycle and will be proportional to the square of the current. If the tines are magnetised sufficiently to exceed the negative half cycle they will be attracted only once per cycle and will be more sensitive.

Everett Edgcumbe unpolarised reed meter

Fig.1 (20cm diam, 10cm depth, circular display 44-56 x 0.5Hz, coil 1.1kΩ, 10kΩ resistor, 16.5mA @ 220V, Everett Edgcumbe, London, No.274979, stamped behind dial 24 Feb 1928) shows the response peaking at 50.5Hz when connected to the mains power supply. As the 51Hz reed also vibrates slightly it indicates that the frequency must be somewhat higher than 50.5Hz. Fig.1b shows the coil wound round a central core with parallel disc pole pieces attracting the lower parts of the reeds.

AEG polarised reed meter

Fig.2 (13cm diam, 8cm depth, linear display 45-55 x 0.5Hz, coil 3.8kΩ, 39kΩ overall, 5.5mA @ 220V, AEG No.2178034) shows the polarised version which is sometimes called a Frahm frequency meter. In this case the mains frequency appears to be just below the peak response at 50Hz. Fig.2b shows the coil wrapped round a long bank of 'H' stampings which acts on all tines together. But in this case the presence of four permanent magnets spaced along the array polarises them so that they are alternately attracted and repelled by the AC field.

Stroboscope

Stroboscopes can take various forms and work on the principle that if the view of a moving object with a regular pattern is interrupted at the same rate that the pattern repeats itself it will appear stationary or, if the rates are slightly different, to be moving slowly. Thus if the strobe rate is known the rate of say, the rotation of a shaft, can be measured. With the tuning fork stroboscope shown in Fig.3 a standard interruption frequency of 125Hz is generated by two plates attached to the tines with slots in each which are only aligned at the mid position. It should be noted that stationary views will also occur at 2, 3, 4, 5, etc, times the strobe rate. A common device for checking the speed of a gramophone turntable consists of a disc with three rings of 77, 133 & 180 black and white sectors which appears stationary when rotating at 78, 45 or 33$^1/_3$ rpm when viewed by a mains lamp flickering at 100Hz. A number of Xenon lamp stroboscopes have been produced for various purposes including special lighting effects at rock concerts. As a research student I remember spending an evening at a Royal Society Conversazione demonstrating an optical illusion under strobe lighting. As most strobes depend upon a relaxation oscillator their calibration may not be particularly stable but the capacitor discharge gives very short light pulses. An example by Harris (Fig.4) has three ranges covering 1 to 250 flashes per second at ±2% accuracy and 12µs duration but the intensity decreases at higher rates.

Lissajous' figures
With an oscilloscope set to X-Y display and one set of terminals connected to one frequency and the other to another, the spot will move around within a rectangle whose side lengths represent the amplitudes of the signals. When equal in frequency (Fig.5a) the pattern traced will follow the sequence: forward diagonal (in phase), forward ellipse, vertical ellipse (or circle with equal amplitudes), backward ellipse, backward diagonal (out of phase), etc, as the phase is varied, and can be seen in slow motion if the frequencies are slightly different. With harmonically related signals more complex patterns arise in which the number of loops in each direction indicates the ratio of frequencies. Fig.5b shows an example for ratios 3:4. Thus with one frequency known it is possible to measure the other.

Pointer frequency meter
One method of obtaining a simple pointer indication of frequency is similar in principle to that of an Ayrton & Perry ohmmeter which measures the ratio between two currents. If one current is made frequency dependent by passing through an inductance whilst the other remains constant by passing through a resistance the pointer will indicate frequency directly. Fig.6 shows an Admiralty unit designed to operate from 505-595Hz based on the moving iron principle with two sets of coils at right angles as in the ohmmeter.

The frequency dependency could be increased by using a capacitor in place of the resistor to cause one current to decrease whilst the other increases.

Venner TSA 3436/2 digital frequency meter
The general intention of this series has been to stop short of digital technology but the excuse in this case is that the readout is by analogue taut suspension moving coil meters even though the display is digital! These are easier to read than dekatrons, the only digital readout available before nixi tubes, LED and LCD displays. The moving coils carry small photographic sectors with numbers 0-9 through which light is projected on to the windows, and the current to the moving coil is set electronically to integer values in the range 0-9. To correct drift there are presets at the back to centre the 0s and 9s.

Fig.7 shows the Venner Frequency & Time Measuring Equipment Type TSA 3436/2 which was one of the earliest on the market in 1965 (37x37x10 excl. handle feet etc, 6-digit readout of Frequency x0.1, x1 & x10, max 1.2MHz; Period of 1, 10 or 100 cycles in units of 1, 10, 100μs, 1, 10, 100ms; Counter to 999999; Timer 1μs to 100,000s in units of 1μs to 100ms; oven controlled 1MHz crystal ±1ppm ±1 count; Venner Electronics Ltd, Surrey, England, No.N2417). I had to argue with my head of department for this instrument in 1966 as he claimed that I could use Lissajous' figures, but was soon joined by many others in the department when cheap mains-reference nixi-tube models became available. Unfortunately with its many early germanium transistors it no longer works. Although digital, its crystal time reference is of course set by the mechanical resonance of its piezo-electric crystal.

Frequency analysis
In nature pure sine waves are not common as most sounds contain many different components, sometimes harmonically related others not, and we frequently need to know the relative amplitude and frequencies of these (and sometimes their phases). In fact looking back this has been a recurring theme throughout my working life. My first job, whilst waiting to go to university, was with English Electric where I had to design, and with the aid of a Marconi bridge, select capacitors and wind inductors, build and calibrate a filter to analyse the vibration frequencies of railway rolling stock. My recollection is three ranges: LP to 3Hz; BP 3-7Hz; HP above 7Hz, using constant-k sections and m-derived terminations. I was surprised how closely the performance matched the equations given in Terman. I later spent my summer vacation of 1955 working for Hasler in Bern where I had to balance the frequency responses and levels of the audio channels of the newly installed carrier system telephony in the Swiss PTT. This was divided into 4kHz channels, each covering the 300-3.4kHz audio range, using carrier suppressed single-sideband modulation.

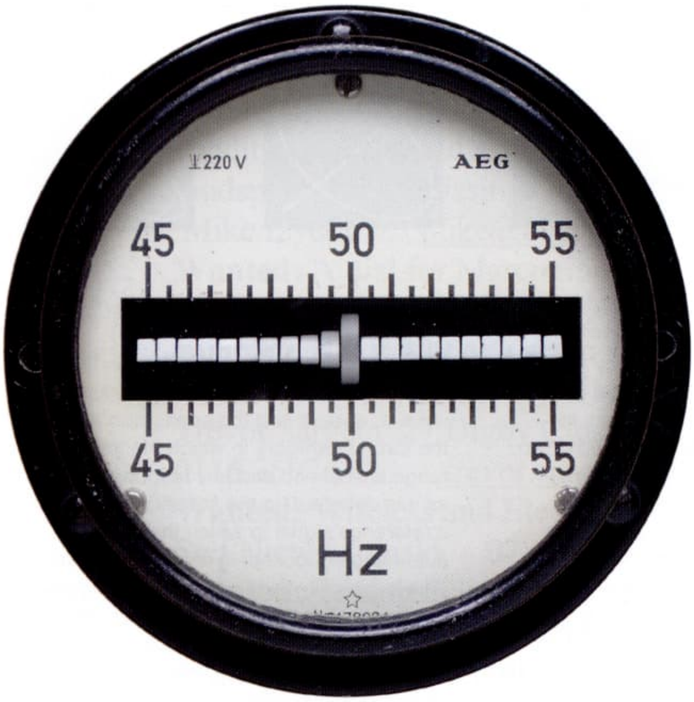


Fig 2a: AEG polarised reed meter

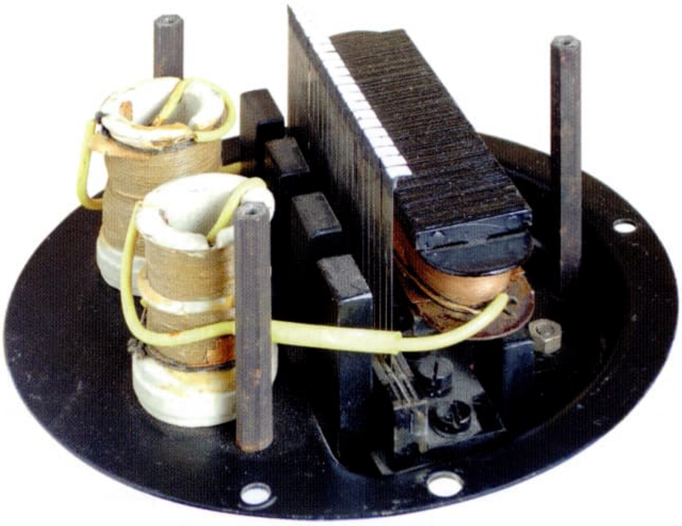


Fig 2b: AEG polarised reed meter

Fig 3: 125Hz tuning fork stroboscope

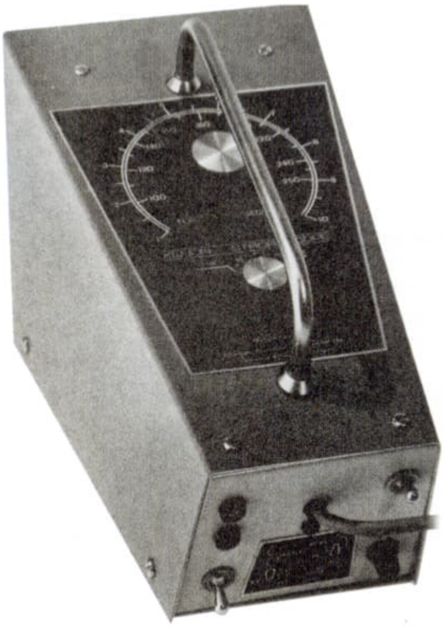


Fig. 4: Xenon stroboscope by Harris (1-250Hz)

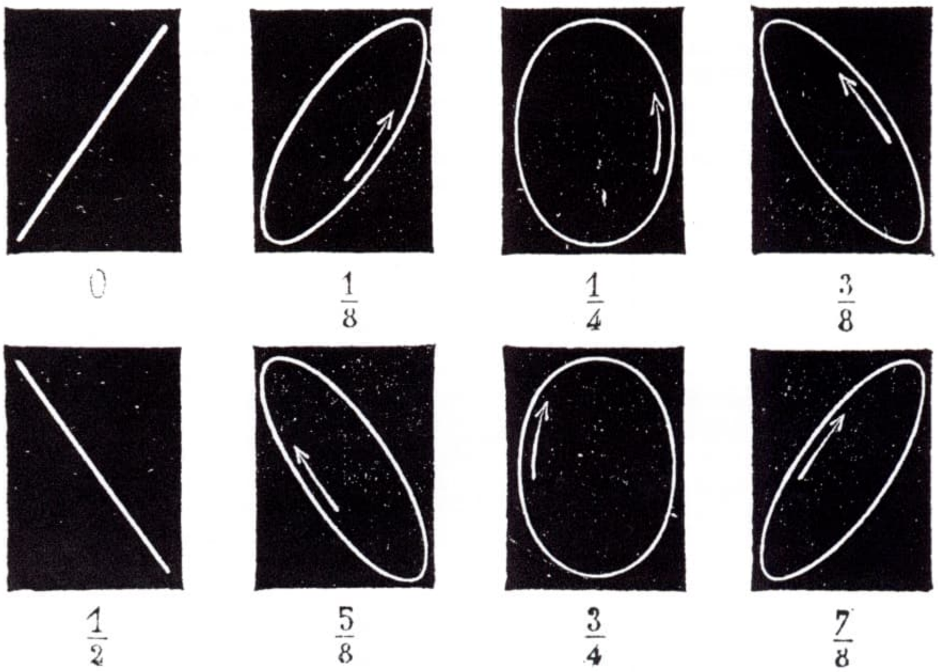


Fig. 5a: Lissajous' figures for equal frequencies at various phases

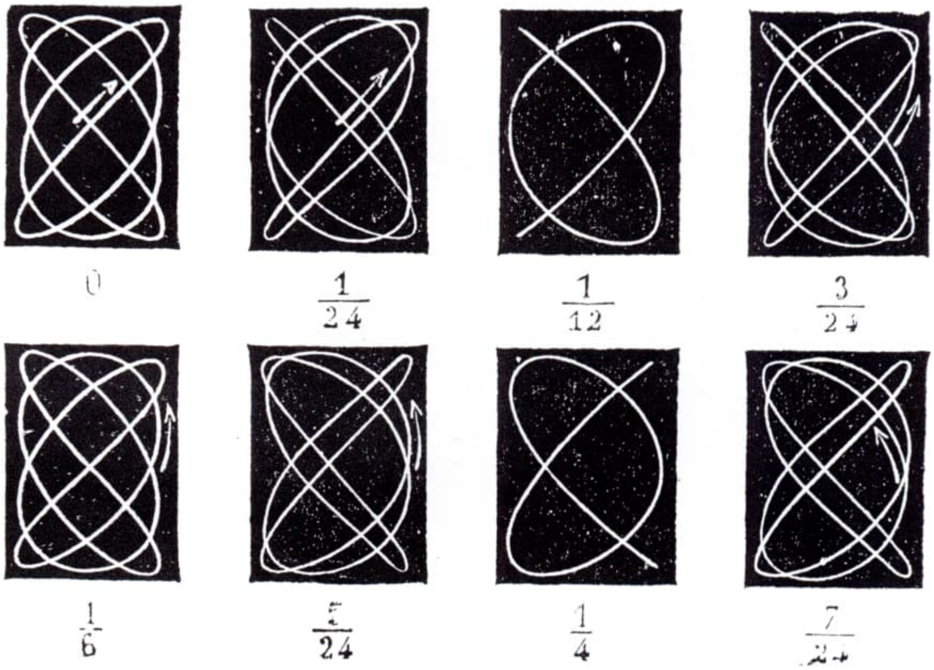


Fig. 5b: Lissajous' figures for frequencies in ratio 4:3

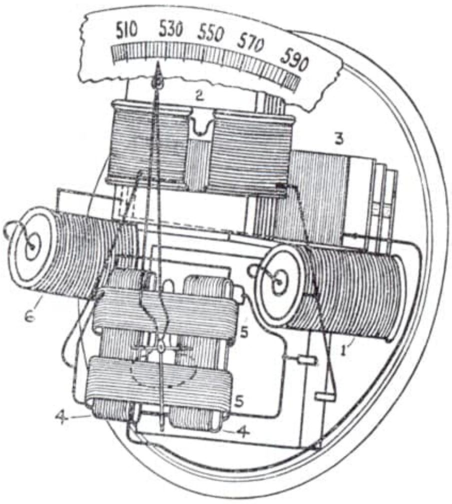


Fig. 6: Admiralty direct reading frequency meter

The responses were expressed in Nepers, based on natural logarithms, rather than dB as used in Britain and the USA.

Most of my research at Keele University has been concerned with the inner ear's performance and how it works as a spectral analyser, measuring it by psycho-acoustics, single nerve fibre responses, mechanical vibrations within the inner ear using a capacitive probe, and acoustic measurements of sound re-emitted from the inner ear, a phenomenon discovered in 1978 by one of our own members, David Kemp.

Wave or frequency analysers

These devices come in several different forms and in a series like this there is only space to outline the basic principles rather than go into circuit details. These are (1) filter banks where the frequency range is divided up into a series of bands, (2) tuneable filters in which the bandwidth at any centre frequency may be approximately proportional to that frequency, (3) heterodyne filters in which the signal is frequency shifted down to a low frequency narrow-band filter - essentially an audio frequency version of a superhet receiver, (4) the sonagraph which is a development of the heterodyne filter to give a full visual analysis of speech or other signals, (5) lock-in amplifiers in which bandwidths as narrow as 0.003Hz are available, and (6) digital methods based on fast Fourier transforms (FFT) which have largely superseded other methods because they are so versatile and can be run by computer. These have the advantage of preserving phase information and the even greater advantage of allowing acoustic measurement in non anechoic conditions if the required impulse response is over before the first echo arrives.

Some filters can be used only as a search tool whereas others can be used in two modes. Filter banks, tuneable filters, most wave analysers and the sonagraph fall into the former category in which the frequency range is scanned and any response noted as it is detected. In the second mode a reference signal to which the filter is automatically locked, is fed into the system. This is typically used when measuring the frequency response of a system at very low sound levels or in the presence of interfering signals. Tracking heterodyne filters and lock-in amplifiers fall into this category.

Filter banks

Electrical filters are based on the fact that the reactance of an inductor increases with frequency (+6dB/octave) whilst that of a capacitor decreases (-6dB/oct) and these components can be placed either in series with or across the signal path. Thus as more sections are added each reactive

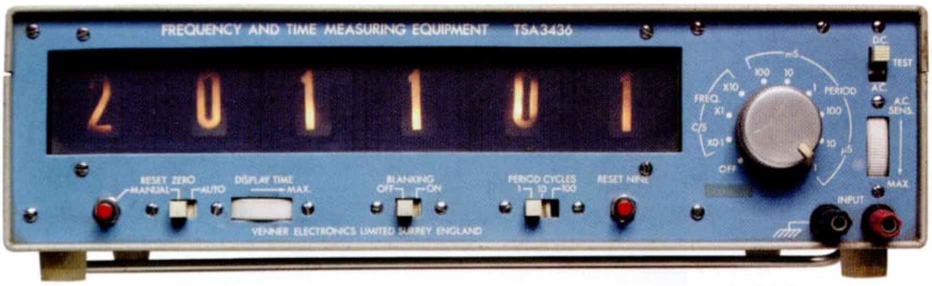


Fig. 7a: Venner crystal-controlled frequency/timer/counter (DC to 1.2MHz)

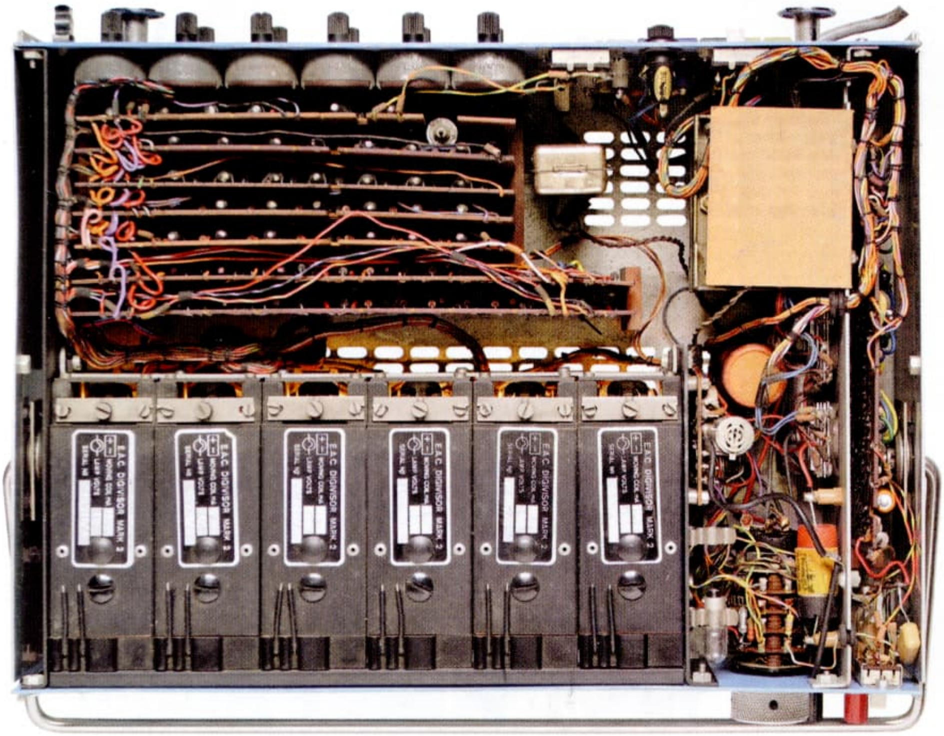


Fig. 7b: Venner crystal-controlled frequency/timer/counter (DC to 1.2MHz)

element should increase the cut-off slope by 6dB/oct. A filter works correctly only at its characteristic impedance and special (eg, m-derived) sections should be used to match between the reactive filter and its resistive source and load impedances.

For most AF applications a logarithmic frequency scale is more useful than a linear one. This is based on the musical scale in which an octave represents a doubling of frequency and this also approximates the way in which the ear analyses sound. Thus filter banks are most commonly either octave or one third octave and mostly cover the audio range of 20Hz to 20kHz. For acoustic measuring equipment the Danish firm of Bruel & Kjaer (B&K) is outstanding and I used to have an extensive range of their instruments. Fig.8 is based on the individual filters from their 1615 Band Pass Filter Set connected by a patchboard and buffers so that any combination of 1/3 octave filter elements can be passed via four input and output channels instead of being restricted to a single channel of 1/3 or 1 octave. Fig.8b shows the 25Hz (top) and 31Hz filters separated by the 6.3 to 16kHz filters and Fig.8c, the intermediate values mostly grouped in pairs per board. A typical response curve with flat top and steep skirts is shown in Fig.8d.

Filter bandwidth can be expressed in several ways, most commonly the width at say -3dB, -6dB, -20dB, etc, with respect to response at the centre frequency. Another useful measure is the 'effective bandwidth' or 'equivalent rectangular bandwidth' which is the width of a perfect rectangular filter whose height equals the peak response and passes the same total power when fed with a white noise signal (containing equal power within each Hz).

Tuneable filter

The B&K Audio Frequency Analyser Type 2107 is shown in Fig.9 with bandwidths of 6, 8.5, 12, 16, 21 or 29% of the tuned frequency. Tuning can be performed either manually in six ranges with the large circular dial or motor driven via bowden cable from a Type 2305 Level Recorder. The filtering is provided by two cascaded tuneable Wien bridge feedback amplifiers. This instrument also provides A, B, C & linear weighted networks with a meter responding to peak, average or rms waveforms.

Heterodyne filters

The traditional wave analyser such as the Marconi works on the heterodyne principle which permits very narrow bandwidth responses to be obtained with very steep sides allowing many of the higher harmonics of a signal to be resolved and measured and thus is frequently used for distortion measurements in electronic and electroacoustic devices.

The circuit of a wave analyser is similar to a superhet receiver with a bandwidth which can be set at say 1, 3 or 10Hz and whose response drops off quickly to a noise floor of about -70dB.

Frequency response measuring system

Before describing the next type of heterodyne filter it is necessary to describe the system in which it operates. This consists of a pen recorder which mechanically drives an associated oscillator keeping its frequency in step with the recording paper markings. Fig.10 shows the B&K 2305 Level Recorder which can feed the paper at various speeds and, when expanded frequency scales are required, different mechanical drive speeds. The servo controlled pen follows a linear track across the paper and can be set to various writing speeds. An interchangeable box in the centre of the top panel allows different potentiometers to be inserted for either a linear response or a logarithmic one covering ranges of 10, 25, 50, or 75dB. The detector can be set for average, positive or negative peak, or rms response.

The associated B&K 1024 Sine-Random Generator is shown in Fig.11. It can be set either manually or driven by flexible shaft from the recorder and has three types of output (1) white noise covering the frequency range 20Hz-20kHz with uniform spectral density (power per unit bandwidth) and gaussian amplitude distribution, which can be fed direct to the output amplifier, or (2) fed through a narrow band filter centred on 3kHz which can be set to a bandwidth of 10, 30, 100 or 300Hz and then passed through a heterodyne system to adjust its centre frequency anywhere in the 20Hz to 20kHz range, or (3) a 3kHz sine wave oscillator to be passed through the same heterodyne system producing a sine wave output from 20Hz to 20kHz. An example of a frequency response curve plotted on this system for an Amplion Dragon horn loudspeaker (Fig.12) is shown in Fig.13. On speech and music this loudspeaker has strong 'colouration' and sounds very 'vintage' as this response would indicate. If a slow pen speed is used the response of a loudspeaker can be made to appear smoother than it really is.

The B&K 1024 generator mixes the 3kHz sine or narrow-band signal with a fixed 123kHz oscillator and passes the lower sideband through a variable-mu amplifier to a second mixer with a variable oscillator of 100-120kHz, again taking the lower sideband by using a 20kHz LP filter to place the final output in the required AF range. The tuning capacitor for the variable 100-120kHz signal is shaped so that the output frequency from 20Hz to 20kHz follows a logarithmic law to match the prescaled paper of the 2305 recorder.

The variable-mu amplifier is normally set at fixed gain but in compression mode it can be controlled by a reference signal. Fig. 14 shows a Marconi-Reiss, marble cased, transverse current, carbon microphone and Fig.15 shows its

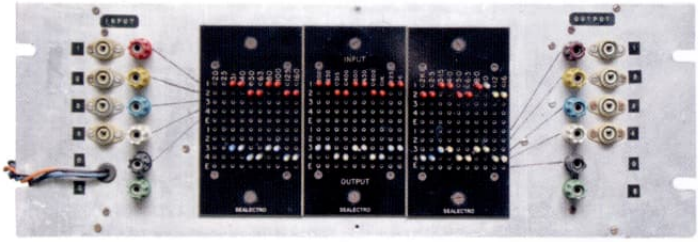


Fig. 8a: Patchboard version of B&K 1/3oct filter bank (25Hz-16kHz centre frequencies)

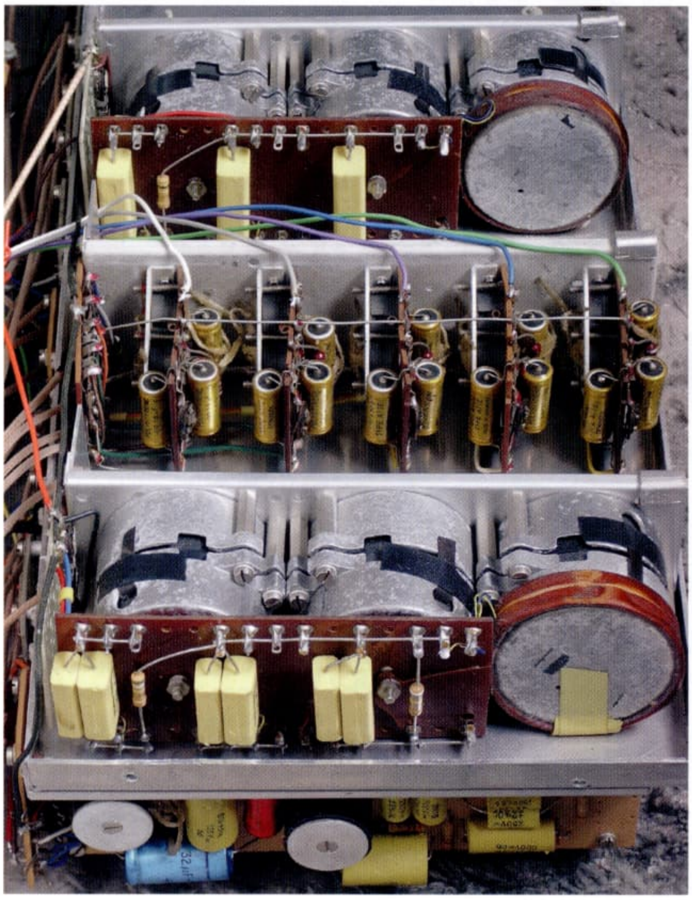


Fig. 8b: B&K filters: 25 & 21 Hz top and bottom, and 6.3 to 16 kHz (centre)

frequency response at various angles using this compression mode. A B&K 4133 half-inch condenser microphone with a flat free-field response was placed alongside the test microphone and fed to the compression input. This thus adjusts the electrical signal fed to the loudspeaker to compensate for its response and keep the sound level at the test point absolutely flat. This curve shows an excellent response, superior to many moving coil microphones, up to 1.5kHz followed by a broad smooth peak to 8kHz which would improve clarity and compensate for the falling high frequency response on an AM radio. To the ear it sounds clear and uncoloured with an unobtrusive noise level considerably lower than a telephone type carbon microphone.

The B&K 2020 Slave Filter

The slave filter (Fig.16) is driven electrically (Fig.17) from the 120 & 100-120kHz signals from the generator. The AF input signal to the filter is mixed with the 100-120kHz signal and passed to a phase-splitter whose two outputs are mixed down to DC using two versions of the 120kHz signal in quadrature. These signals then pass though a pair of LP filters set to 1.58, 5, 15.8 or 50Hz, chopped by the same quadrature 120kHz signals and summed. This sum is then mixed with the 100-120kHz signal to bring it back to the original AF range with a bandwidth of from 3.16Hz (±1.58Hz) to 100Hz. It can be used, with the generator output as signal source, to measure frequency response curves in noisy environments, or as a scanner to search for the frequency content of an unknown signal. Examples of the latter would be to plot the spectrum of a musical instrument, distortion measurements of an electroacoustic device, or measure white or pink noise.

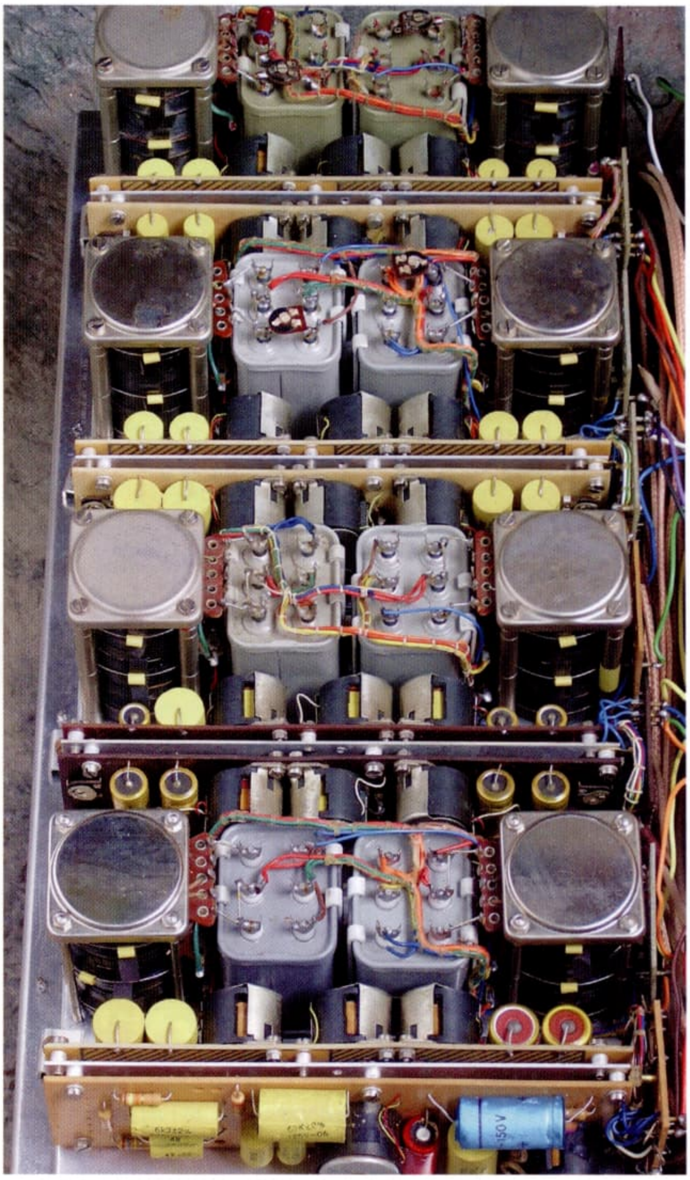


Fig. 8c: B&K filters 40 Hz to 5 kHz

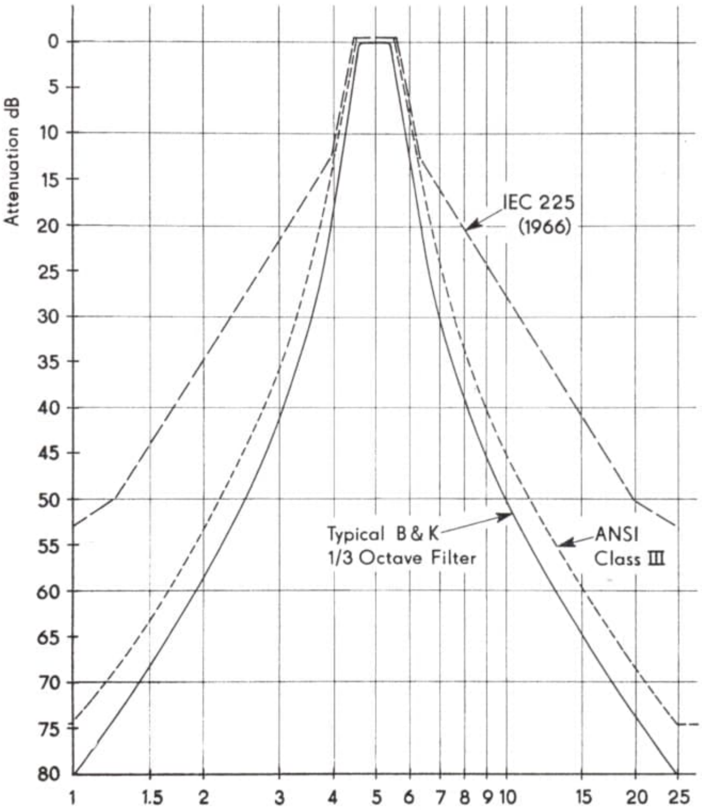


Fig. 8d: Typical 1/3 octave filter characteristic (5 kHz)

The Sonagraph

The above filters are not of much use for signals that are continually changing as for example the spectrum of speech. A device for doing this is known as a sonagraph and the displays it produces are sonagrams. This is a task which of course has now been entirely taken over by computer methods. Unfortunately I cannot find an illustration of the Kay Sonagraph which I used occasionally, but it can be described as follows. It consists of a rotating turntable supporting a sheet of magnetic recording tape. Resting on this is a magnetic record/replay and erase head. The disc revolves in 2.4s during which time it is recording say a speech signal. The moment the record and erase heads are switched off it is left with the previous 2.4s of speech which, with the head now set to replay, is then played back repeatedly.

On top of the disc is a vertical drum about 10cm in diameter and 15cm high around which is wrapped a sheet of electrosensitive paper held in place by two spring bands (outside the range of the stylus) and set so that the overlap trails and corresponds with where the tape recording starts and finishes. To the side of the drum and parallel with it is a finely threaded rotating screw thread driven from above via an arm supported outside the rotating table. This slowly drives a springy electrical stylus which is held in contact with the paper and blackens it when activated. The drive to the screw also adjusts the frequency of an HF oscillator from say 100kHz at the bottom of the recording to 112kHz at the top. Thus when heterodyned with a fixed 100kHz oscillator as in the heterodyne filters above, the paper will cover the range 0-12kHz, linearly in this case. Each revolution represents an increase of about 30Hz in input frequency and it covers the 12kHz range in 400 passes taking about 16 minutes.

Fig.18 shows a sonagram of a signal which I used quite extensively, white noise added to a delayed version of itself. During the 2.4s recording time the delay was increased from zero (in phase) to 5ms. Any vertical slice contains a series of evenly spaced spectral peaks (maximum blackening) separated by troughs (white) in which the spacing in Hz corresponds to the reciprocal of the time delay in seconds. Thus at 1ms there is a 1kHz spacing. The slight irregular vertical banding is due to wear on the magnetic tape which has a rather hard life.

There are in fact different filter bandwidths available on the sonagraph so that in plotting speech at a bandwidth of 30Hz all the harmonics of the glottal pulse rate are resolved into near horizontal bands whilst at 200Hz each glottal pulse is resolved in time as a vertical band. Both displays show the rise and fall of formant bands caused by vocal cavity resonances which convey most of the information in speech.

The Vocoder

It is possible to restrict the bandwidth of a speech signal to the telephone range of 0.3-3.4kHz without serious loss of intelligibility but, below this, intelligibility suffers even though there is still much information redundancy. In the Vocoder, a device developed during the war, the speech signal is split up into say 12 frequency bands and instead of transmitting these signals, they are rectified and low pass filtered and each of these control signals, now of narrow bandwidth, transmitted by multiplexing. At the receiving end the signal is resynthesised using a pulse train representing the glottal

Fig. 9: B&K Audio Frequency Analyser Type 2107 tuneable filter (20Hz to 20kHz)

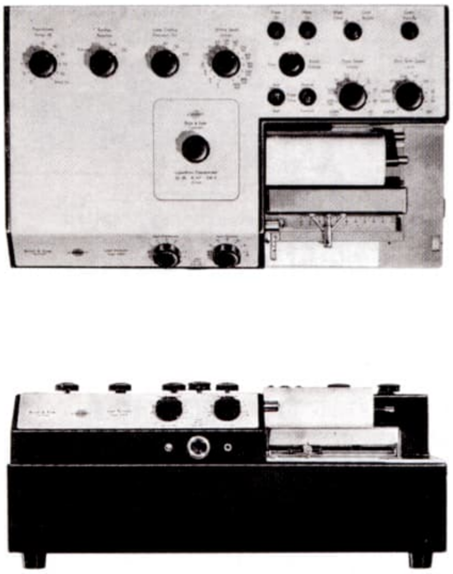


Fig. 10: B&K 2305 Level Recorder

Fig. 11: B&K 1024 Sine Random Generator (20Hz to 20kHz)

Fig. 12: Amplion Dragon horn loudspeaker

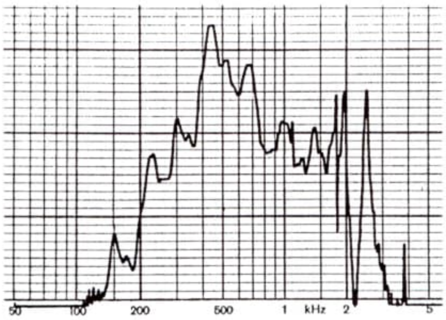


Fig. 13: Frequency response of Amplion Dragon

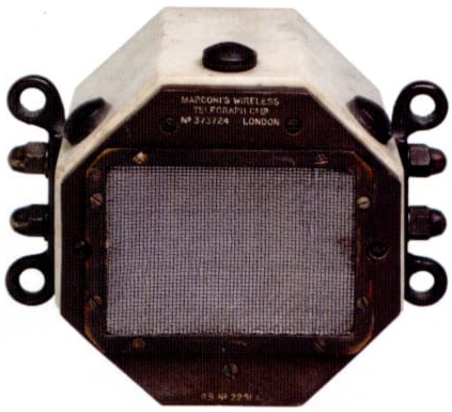


Fig. 14: Marconi-Reiss transverse current carbon microphone

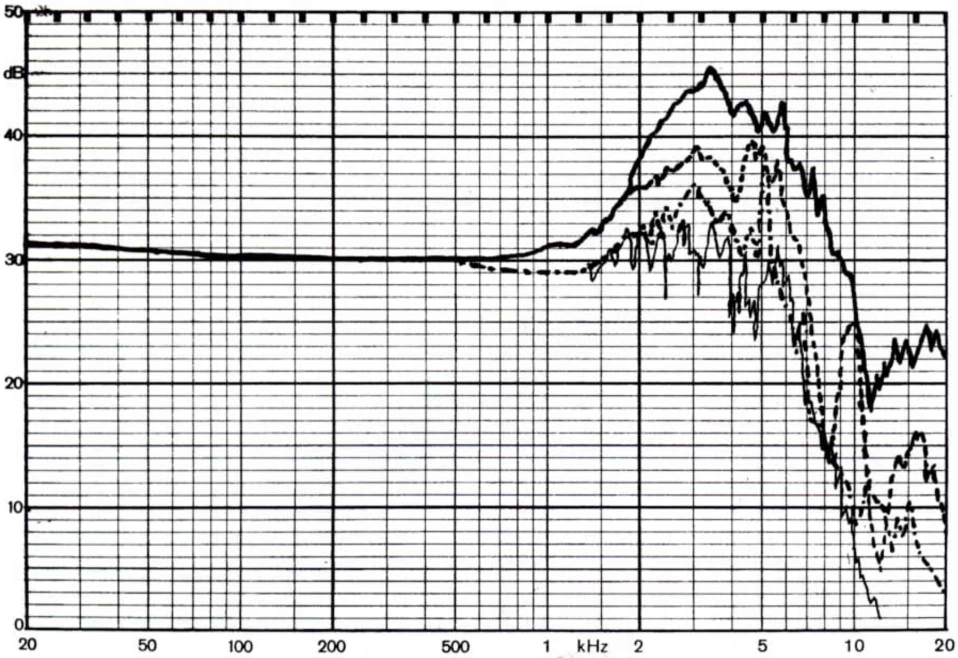


Fig. 15: Response of Marconi-Reiss microphone at (top) 0°, 45°, 90° & 180°

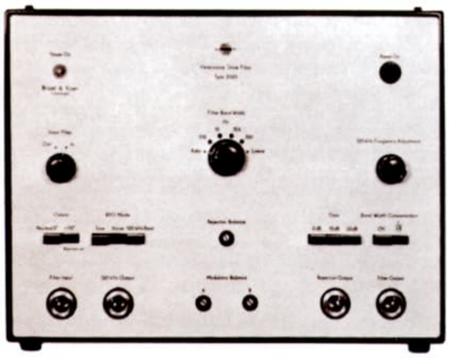


Fig. 16: B&K 2020 Slave Filter (20Hz to 20kHz)

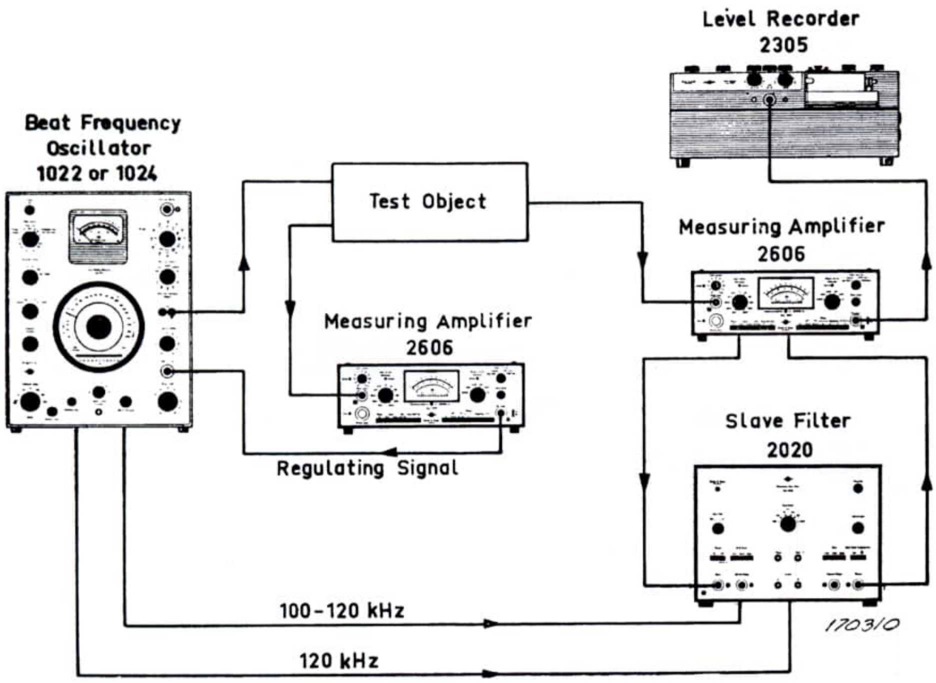


Fig. 17: Instrument layout for plotting frequency responses using slave filter & compressor

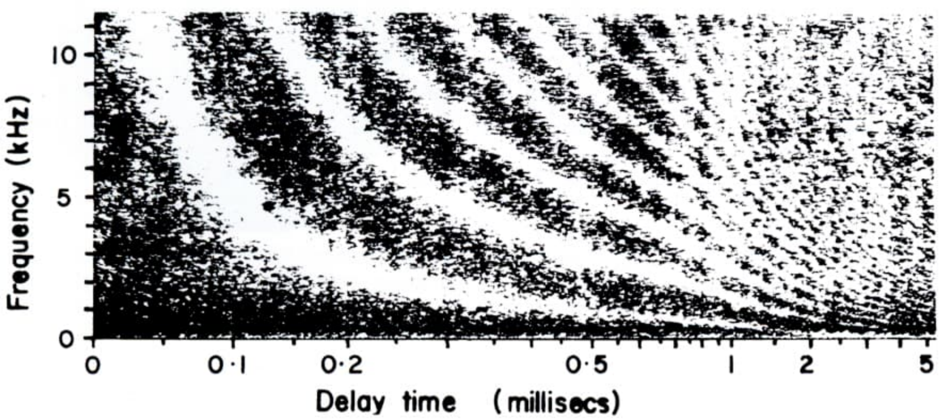


Fig.18: Sonagram of white noise plus echo for delays from zero to 5ms

pulse, usually controlled in frequency by one of the channels, and passed through a bank of filters corresponding with the input ones and combined via variable-gain amplifiers each controlled by its component signal. A number of systems of this type have been developed and the resulting speech is intelligible but unnatural.

The ear as a filterbank or frequency analyser

Psychophysical studies of auditory perception show that the ear acts like a large number of overlapping filters which, if non-overlapping, would cover the frequency range with about 30 separate filters. Their effective bandwidths increase progressively from about 40Hz at 100Hz, to 120 Hz at 1kHz, and 1kHz at 10kHz. The smallest difference in frequency that can be detected as a change in pitch, however, is far lower and depends on the steepness of the skirts of these filters. We can discriminate differences of about 0.5Hz at 100Hz (ie, 0.5%), 1.5Hz at 1kHz (0.15%), rising to 80Hz at 8kHz (1%).

Frequencies are separated out along the basilar membrane dividing two parallel fluid-filled channels coiled into a spiral, the cochlea. It was suggested in the 19th century that the fibres across this membrane act like the strings of a piano, each responding to its resonant frequency, and sending their signals, picked-up by hair cells, to the brain via a multicored cable, the auditory nerve. Although useful as a didactic idea, unlike a piano string there is no tension but there is a decreasing stiffness along the membrane and an increasing mass loading. Fluid coupling between adjacent resonators and damping also greatly modify the response and early direct measurements of mechanical vibration indicated that it was nowhere near as sharply tuned as psychophysics implied. All the qualitative amplitude and phase characteristics of this response were modelled (Fig.19) using the frequency meter shown in Fig.2 by weaving a thin rubber thread between the reeds and back to provide coupling and damping.

In 1947 the future cosmologist, Thomas Gold, suggested a mechanism to sharpen up this mechanical response by positive feedback like reaction in a radio receiver, an idea thought ingenious but highly improbable in a biological system. Meanwhile recordings from single nerve fibres revealed filter characteristics within the cochlea in line with psychophysics. Fig.20 (in collaboration with EF Evans) shows such a semi-automatic threshold recording through which a smooth curve can be drawn and from which its effective bandwidth can be calculated and sensitivity to white noise derived. The white noise threshold plotted immediately afterwards corresponded to this calculation and indicated that the filter acts linearly and much more sharply than mechanical recordings. As electrical tuning had been found in hair cells in fish a search for a second, possibly electrical, filter had started, but newer recordings of mechanical vibration were also starting to show much sharper responses suggesting that perhaps there was some electromechanical feedback system increasing sensitivity and sharpening tuning.

In 1978 Kemp showed that if a sensitive miniature microphone and loudspeaker were sealed into the ear canal, a very low intensity pulse appeared to give a delayed 'echo' from within the inner ear not much lower in intensity than the original signal and, perhaps even more significantly, sometimes a continuous tone could be picked up suggestive of a reaction control set too high. These results have been confirmed by many other laboratories and form the basis of a hearing test as they occur only when the cochlea is unimpaired.

In an attempt to reveal the details of this mechanism, mechanical and single nerve fibre responses have been measured in several species with different features in their structures or performance. Frogs have hearing organs having no obvious structure for mechanical filtering yet produce evoked and spontaneous acoustical emissions. Some groups of bat have a small frequency range around their call frequency showing tuning about twenty times sharper than most mammals which is adapted to detect the small frequency changes produced by the Doppler effect with moving objects. Both these studies required a sensitive frequency analyser for which the lock-in amplifier was ideal.

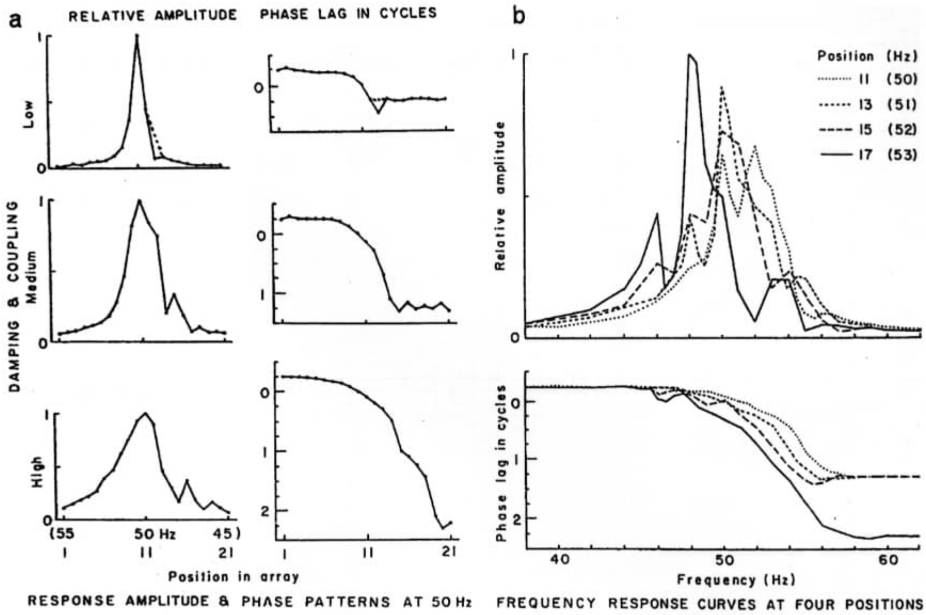


Fig. 19: Amplitude & phase responses across reed array (left) and against frequency (right) for damped & coupled reeds of AEG frequency meter modelling inner ear vibration

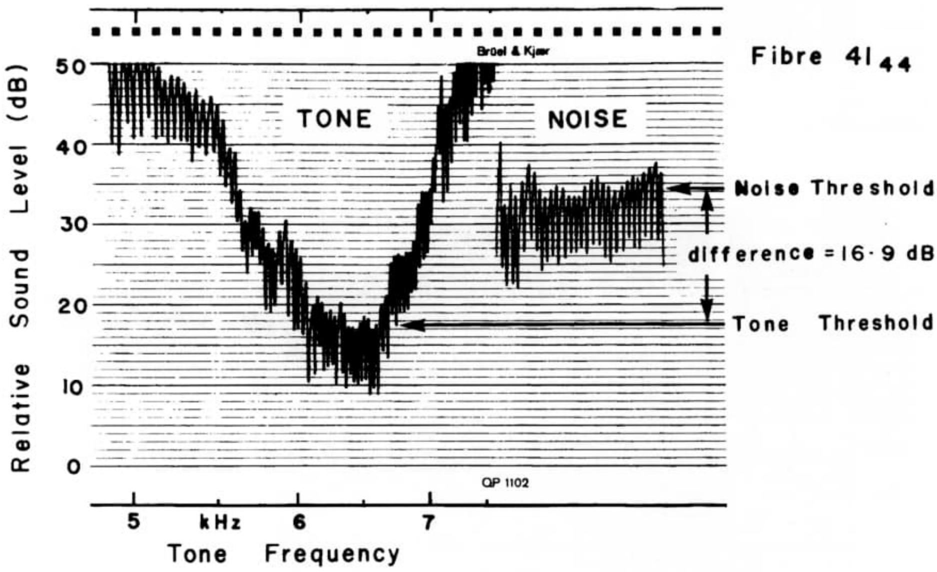


Fig. 20: Tuning curve for auditory nerve fibre and white noise threshold

Lock-in amplifier

The principle of a lock-in amplifier is that the signal is amplified by a broadband high gain amplifier, adjustable in say 10dB steps, whose output is chopped by a reference signal and passed through a low-pass RC filter. The resulting DC signal is proportional to the input signal times the cosine of the relative phase between the two signals. The reference signal, which is normally that fed to the system under test, is amplified and clipped to produce a square wave and passed through a selection of 90°, 180° and variable phase networks to either adjust the DC response to maximum or to provide quadrature readings to calculate the vector sum. The RC time constant sets the bandwidth and the time it takes to obtain a stable reading. The output is read on a centre zero meter calibrated in both volts and plus and minus 0-10dB.

In use this system proved cumbersome particularly when using long time constants for narrow bandwidth measurements so a second instrument was purchased. The two instruments were linked together (Fig.21) so that only the lower input and reference sockets were used and the lower time constant and gain controls fitted with new switches to control both instruments together. The phase controls were left untouched with the upper one set permanently to +90° and the lower to 0°. The output sockets were fed to an X-Y oscilloscope giving a display where distance from the origin gives amplitude and its position around a circle, its phase. This was the configuration in which it was normally used when making measurements of very low sound levels or very low vibration amplitudes using a capacitive probe (Fig.22). Figs.21a & 22 also show the low distortion Brookdeal 9471 voltage controlled oscillator used as source and reference, whose frequency could be set to four digits by the box in the foreground and shows the capacitive probe array in the centre. The amplifiers were also modified to extend their original bandwidth from 50kHz to 100kHz for the bat measurements.

It is, however, possible to use it in the search mode to look for very low signals close in frequency to the reference when the trace follows a circular path at a rate of rotation equal to the difference frequency. Obviously as the difference frequency increases the radius of the circle will decrease as it moves outside the passband of the filter. The bandwidth is set by the time constant and ranges from 250Hz at the 10ms to 0.008Hz at the 30s settings on the Brookdeal 401. One potential pitfall of a lock-in amplifier is that because a square wave version of the reference signal is used it also responds to odd multiples of the reference (i.e, at 3f at 1/3 amplitude, 5f at 1/5 amplitude, etc.). Using this system in conjunction with a sensitive condenser microphone it has been possible to measure sounds down to a noise level of -50dB SPL, and with a specially designed capacitive probe, vibration amplitudes down to a

Fig. 21a: Quadrature pair of linked Brookdeal 401 lock-in amplifiers & Brookdeal 9471 voltage controlled oscillator

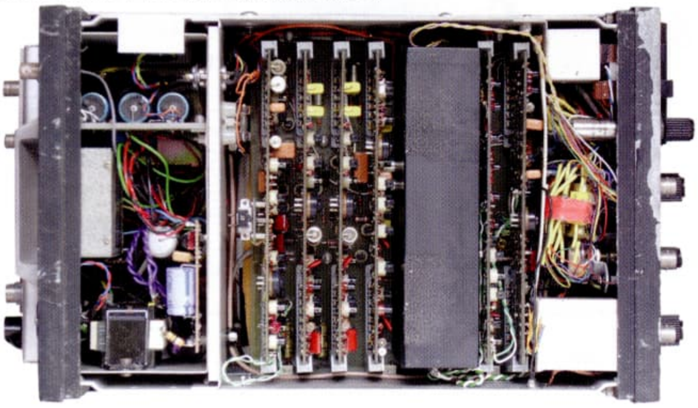


Fig. 21b: Inside lower Brookdeal 401 locking amplifier

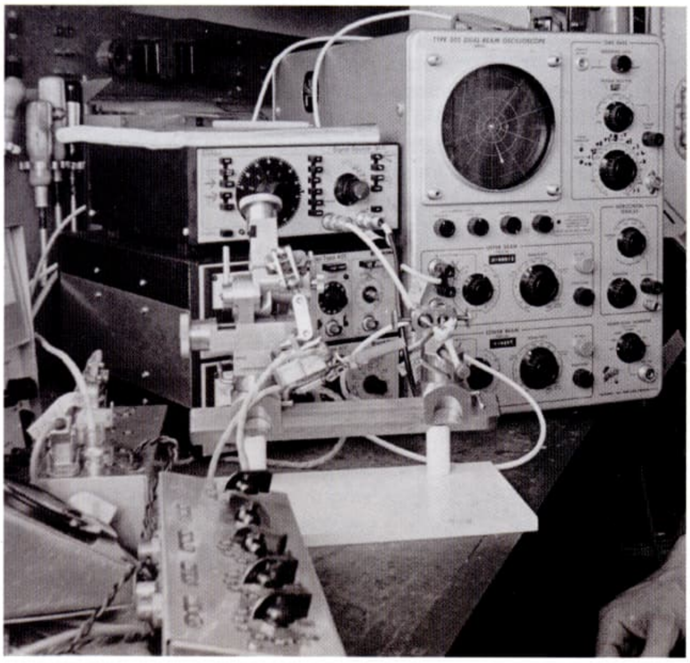


Fig. 22: Capacitive vibration probe system in front of lock-ins and polar response on Tektronix 502 oscilloscope

noise level of 0.02nm. Fig.23 shows the vibration response of the basilar membrane within the cochlea measured up to 20kHz using the slave filter set at 3.16Hz (continuous curve) and the lock-in amplifier for higher frequencies (spot measurements). Fig.24 shows the polar (Nyquist) plots photographed on a storage scope for acoustic re-emission from a human ear at two sound levels as frequency is increased from below 5kHz up to 10kHz and back. The crosses (+) indicate the origins and the 'scribble' around 5887Hz signifies a spontaneous emission at this frequency. As sound level is increased the loops decrease because the energy source generating the re-emitted sound is limited and represents a negligible proportion at higher levels. This is seen clearly in Fig.25 (left) for a frog at five different sound levels. On the right (all at 32dB SPL) is seen the influence of body temperature which lowers tuning frequencies as temperature is reduced. Fig.26 shows a sonagram analysis from a human subject with a set of very strong spontaneous frequencies changing in amplitude over time.

Wavemeters

Unlike most of the instruments discussed so far, which have worked in the audio range, wavemeters are designed for the RF range to check transmitters and receivers. The first measurements of the wavelength of radio waves were direct, measuring the distance between nodes in standing wave patterns, and were performed independently in 1888 by Heinrich Hertz across free space and by Oliver Lodge along wires. This technique is convenient for microwave measurement. For the broadcast bands, however, wavemeters usually work on the principle of the tuned circuit with an indicator, frequently a torch bulb, in series with an inductor and capacitor so that when placed in the magnetic field surrounding a transmitter aerial lead it will glow brightest when the instrument is tuned to the transmitter frequency. Alternatively a high impedance detector or neon discharge tube can be placed across the tuned circuit.

To calibrate a receiver a buzzer can be incorporated to shock-excite the wavemeter to act as a radiator and check at various dial settings. Some wavemeters use a set of fixed coils for multiple ranges, and vary the frequency with a tuning capacitor. Others use a set of fixed capacitors in conjunction with a variometer in which two coils in series or parallel can be rotated in relation to each other to increase or decrease the inductance.

Fleming's Cymometer

Fleming's Cymometer (Fig.27, seen at UCL) is one of the earliest wavemeters and probably one the most ingenious mechanically as inductance and capacitance are varied simultaneously. A knob at the right end of the box rotates a metal rod carrying a grooved ebonite former wound with a coil of thick copper wire. The other end of this rod is threaded at the same pitch as the coil and passes through a threaded hole below the black knob, to a bearing at the left of the box. This assembly is thus pulled along the thread carrying with it (a) the pointer on the scales above, (b) four metal tubes, three of which are visible, which slide over fixed thin ebonite tubes with metal tubes within, constituting variable coaxial capacitors and (c) a thin metal rod carrying a spring assembly embracing the coil and holding a contact firmly against one of the turns. As the contact is carried at the same pitch as the coil rotates it will always maintain optimum contact without bridging between turns (the base end connects to a ring contacting a fixed spring). Thus as the assembly moves to the left both the inductance and the capacitance increase.

The pointer moves over five scales simultaneously, the top calibrated in 'Oscillation Constant' $\sqrt{LC}$, the second in 'Wavelength in Feet', the third 'Wavelength in Metres' (560-30m), the fourth in 'Number of Oscillations Per One Millionth Second' (0.55-8MHz), and the fifth is a section of wooden metre scale. The wavelength scales appear linear which is surprising because the relationship between inductance and length of coil, or number of turns, is only linear for very long coils. Missing from this instrument is the neon discharge tube to indicate resonance.

Townsend Wavemeter

This (Fig.28, 13.5x13x16, 300-600m (600-1200m) with the link/pointer to the right, 1000-2000m (2000-4000m) to the left) is

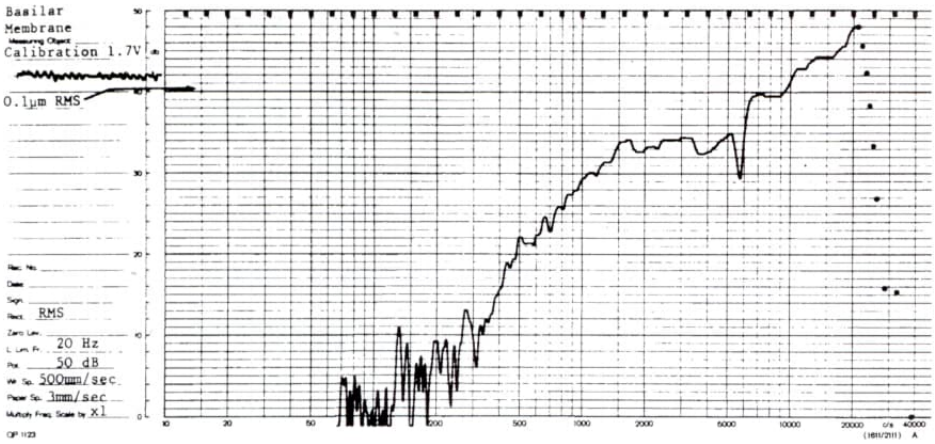


Fig. 23: Uncorrected vibration response of inner ear to sound: continuous curve via slave filter; dots above 20kHz via lock-in

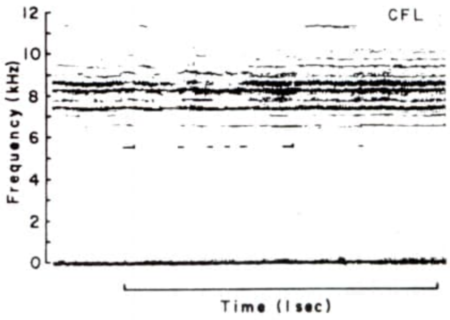


Fig. 26: Sonagram of multicomponent spontaneous emission from human subject showing changes with time

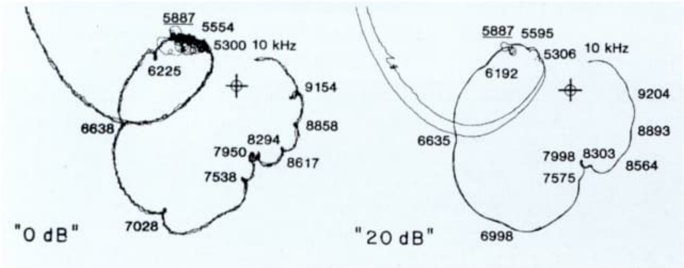
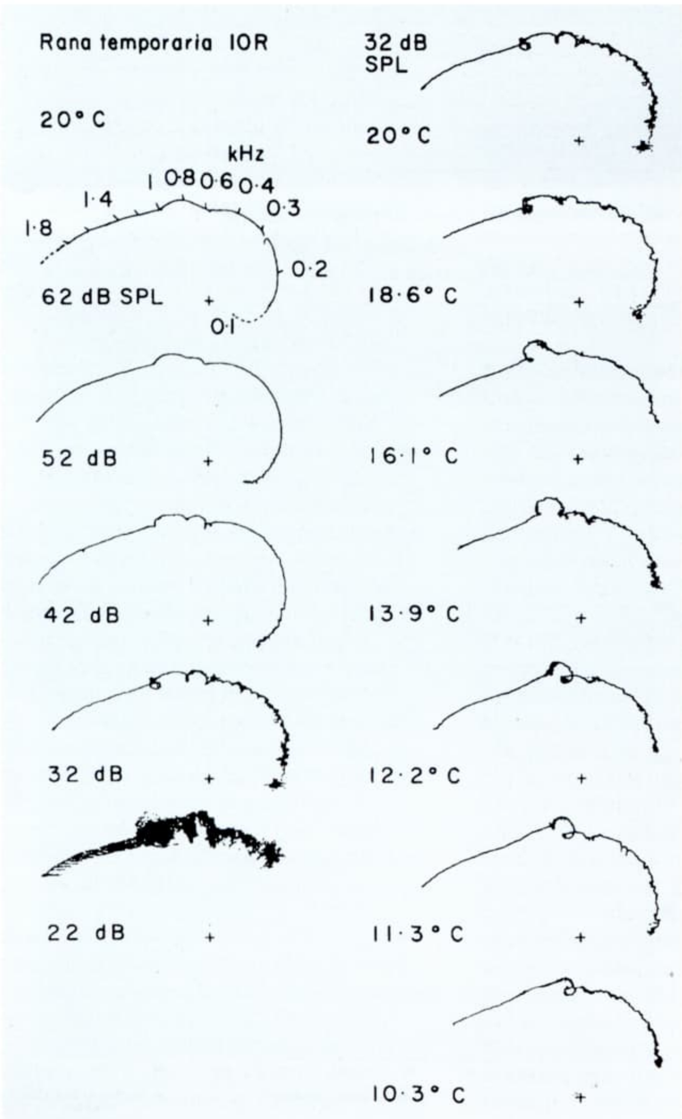


Fig. 24: Polar plots of sound reflections from inner ear interacting with input sound at two levels: cusps indicate frequencies of strong emission; the 'scribble' at 5887Hz indicates a spontaneous emission



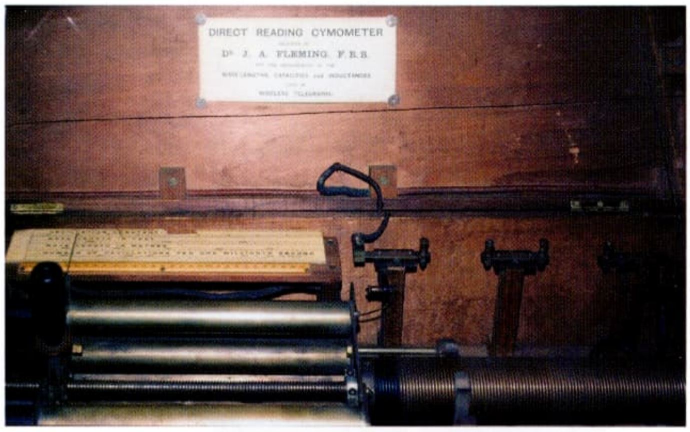


Fig. 27: Fleming Cymometer: as coil rotates, the outer sleeves of coaxial capacitors slide, carrying coil contact and scale pointer

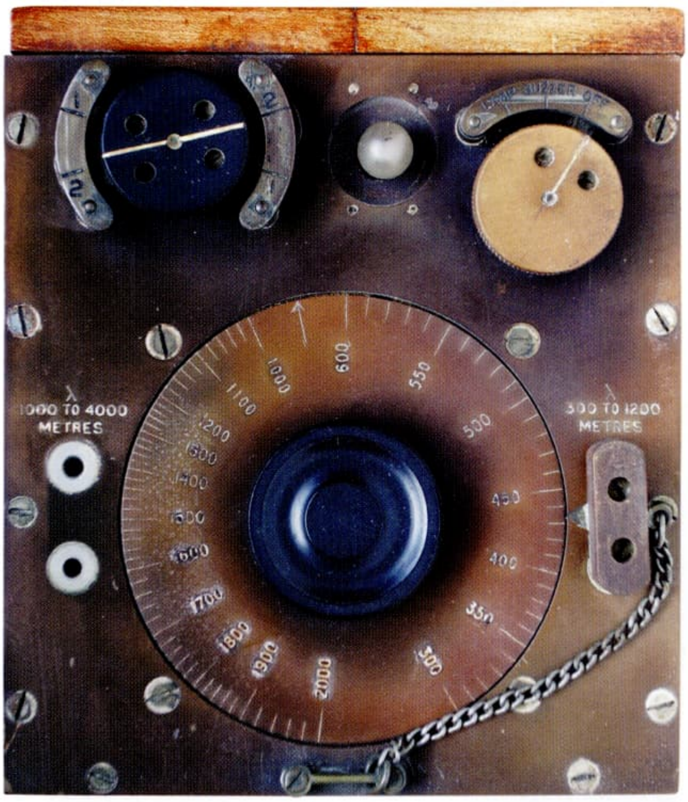


Fig. 25 (left): Plots from frog ear at different sound levels (left) showing limiting and for different temperatures (right) showing shift in tuning frequencies

Fig. 28a (above): Townsend variometer tuned wavemeter (300-4000m)

Fig. 28b: Townsend variometer tuned wavemeter

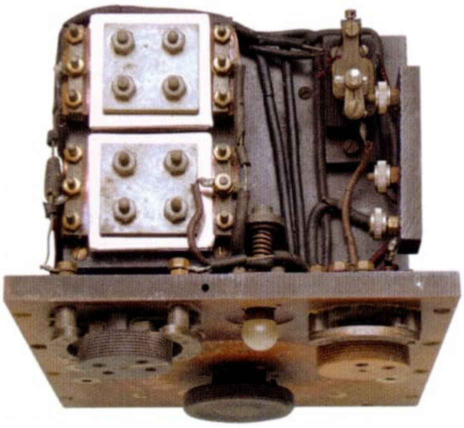


Fig. 28c: Townsend variometer tuned wavemeter

Fig. 29a: Jewell No.90 capacitor tuned wavemeter (480-2000kc/s, 625-150m)

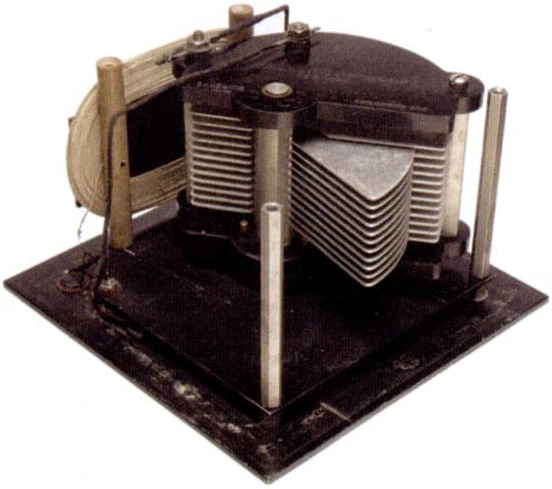


Fig. 29b: inside the Jewell No.90 capacitor tuned wavemeter

JEWELL WAVEMETER Pattern No. 90

To Tune a Transmitting Set

Bring the wavemeter near the tuning inductance of the transmitting set and rotate the handle until the light flashes. Adjust the handle carefully until the lamp glows with maximum brilliancy, which indicates the condition of resonance, and the wave length in meters or frequency in kilocycles will be indicated on the scale. Care should be taken that the wavemeter is not too close to the transmitter, as considerable energy may be transferred to the wavemeter, which will burn [illegible] lamp. Best results both as to accuracy and safety to the lamp will be obtained when it merely glows to a bright red at its brightest point. Should the lamp burn out, it may be replaced with an ordinary flash light lamp.

For more accurate results or for making [illegible] measurements, a current squared thermo galvanometer, such as the Jewell Pattern No. [illegible], may be connected to the right hand pair of [illegible] posts, as shown in the dotted lines at the right of [illegible] diagram. The lamp should be removed and the leads to the galvanometer be made as short as possible and preferably [illegible] together. Measurements are made in a similar way, resonance being indicated by the maximum deflection of the galvanometer [illegible].

If a very small amount of energy is being transmitted, a crystal detector and phones may be connected to the left hand binding posts and resonance will be indicated by the point of maximum response.

To Tune a Receiving Set

Connect a dry cell and a small buzzer to the left hand binding posts as shown in the dotted lines at the left of the diagram. The lamp should be left in place, or if it happens to be burned out, connect the two right hand binding posts together, which will short circuit the lamp socket. Place the wavemeter a few feet from the receiving set and set the buzzer in operation.

If it is desired to check a point on the receiving set, rotate the wavemeter handle until the maximum response of the buzzer is heard in the receivers; the receiving set is then tuned to the wave length indicated on the dial of the wavemeter. If it is desired to calibrate a receiver, set the wavemeter dial at the desired wave length and tune the receiver until the maximum response is heard in the head phones and at this point the receiver will be in tune for that frequency. A number of other points may be taken and a complete calibration curve of the receiver obtained.

DRY CELL

To Open the Wavemeter

If it is desired to open the wavemeter, remove the four screws from the bottom of the box whereupon the entire wavemeter assembly may be removed from the case without disturbing its calibration.

General

This wavemeter may be used as a parallel wave trap by connecting the antenna circuit of a receiving set in series with the left hand binding posts. While not specifically designed for this purpose, it will frequently be of material help in eliminating unwanted stations. In this case the dial should indicate the wave length of the station which it is desired to eliminate.

Range 150 to 625 Meters

Jewell Electrical Instrument Co.
Chicago, U.S.A.

Fig. 29c: Jewell No.90 capacitor tuned wavemeter instructions

Fig. 30a: Sullivan 1-valve capacitor tuned heterodyne wavemeter with buzzer modulator

Fig. 30b: Sullivan calibration chart for coil C

Fig. 31a: AVO All Wave Oscillator (95kHz-80MHz)

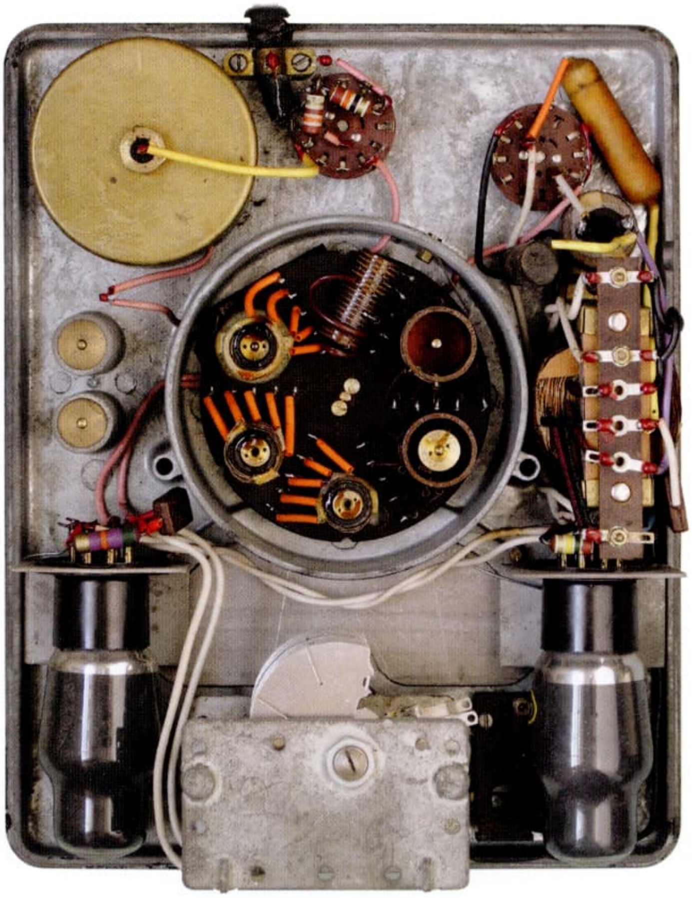


Fig. 31a: Inside the AVO All Wave Oscillator (95kHz-80MHz)

another early wavemeter manufactured anonymously by Muirhead and popular during WW1. Fig.28b shows the variometer tuning which has a pair of coils wound on a fixed rectangular mahogany former and two more on a smaller former which can be rotated within the fixed one to vary the coupling. The coils can be set by the left knob to be in series or parallel giving in series, four times the inductance, and twice the wavelength. A capacitor (Fig.28c) is connected in series with the variometer and a torch bulb forming a tuned circuit. When the pointer/link is inserted on the left a second capacitor is connected in parallel with the first for the longer wavelength ranges. The right knob switches in current from an internal battery to (left) the indicator 'Lamp' to increase its sensitivity, (centre) a 'Buzzer' to shock-excite the tuned circuit for calibrating nearby receivers and (right) 'Off' when the instrument acts as a simple absorption wavemeter when, magnetically coupled to the aerial lead, it absorbs sufficient energy to glow at resonance. Its calibration corresponded with the AVO oscillator (above) over most of its scale but became 2% low at maximum wavelength.

Jewell Wavemeter
This wavemeter (Fig.29, 16x16x12, 14cm individually-calibrated semi-circular scales behind a fixed pointer 480-2000kc/s and 625-150m, Jewell Wavemeter Pattern No. 90, ser. No.436307, Jewell Electrical Instrument Co, Chicago, USA) is tuned by a variable capacitor in series with an indicator lamp and a flat oval coil. There are terminals to allow a more sensitive detector to be used or for a buzzer to be connected when used to calibrate a receiver. The instructions also indicate that it can be used as an aerial trap. Its calibration corresponded with the AVO oscillator within 2%.

Sullivan Wavemeter
Unlike the previous instruments this wavemeter is based on a valve oscillator (Fig.30, 18x22x15 excl. valve, knob and interchangeable coil at rear, variable capacitor 110-1150pF, search coil, 'A' 50-100m & 'C' 187-517m tuning coils and calibration charts, HW Sullivan Ltd, London, Type 740/741, No.579, calibrated 18.12.25 with R5 valve No.22993, 6V LT, 60V HT, brass plaque 'Reginald C Patrick on his 21st Birthday Nov.2.1925 from Auntie Tit'). It has an electromechanical buzzer which is used to modulate the RF rather than directly activate the tuned circuit as in the previous examples. Thus in addition to checking transmitter and receiver frequencies it can be used for CW reception in conjunction with a normal receiver. Direct access to its calibrated capacitor allows this to be used in other applications and for measuring unknown capacitors in the 0-1nF range. The wavemeter did not oscillate with the unmarked valve shown but with the 'C' coil connected as a wavetrap it was accurate over the lower 2/3rds of the calibration chart and 3% low at maximum.

AVO All Wave Oscillator
This general purpose RF oscillator, which can be AF modulated either internally or externally, can also be used as a wavemeter. (Fig. 31, 21x26x13 incl. knobs, individually calibrated scales ~15cm (1H) 80-30MC using second harmonic of (1) 40-14MC (MHz), (2) 15-5MC, (3) 6000-1800KC, (4) 2200-700KC, (5) 800-250KC, (6) 300-95KC, Automatic Coil Winder & Electrical Equipment Co Ltd, Winder House, London SW1, No.8659-646). Fig.31b shows the 2-valve construction in which the coils for the six ranges are mounted on a rotating turret at the centre with the tuning capacitor below. Unfortunately, as the Venner crystal-controlled frequency meter is no longer functional, it could not be tested comprehensively but spot checks against known radio stations were all within 1%. Although its calibration goes up only to 40/80MHz there are higher harmonics present allowing comparison with FM stations.

Book review

Decoradio

the most beautiful radios ever made

by Peter Sheridan. Published by Schiffer Publishing Ltd. isbn 978-0-7643-4605-7
reviewed by Carl Glover

Clocking in with 352 full-colour pages, this is a serious contender for the best coffee-table book on radio ever printed.

Not just aimed at the wireless enthusiast, *Decoradio* succeeds at attracting art-deco followers, people with an interest in beautiful objects and the early history of industrial design. *Decoradio* as it happens, is jam–packed with beautiful objects.

Within *Decoradio's* pages are 380 different radios, with a significant minority never seen in print before - an unknown, stamped–brass set from Belgium, along with the catalin Namco set from the USA are notable examples.

The photographs in the book were all taken by Peter himself, and are for most of us the closest we will ever get to seeing such objects. The detail and colours are faithful to the original radios as far as conventional 21st Century printing can go.

There are 84 pages leading up to the gallery section of the book dealing with a wide range of useful chapters covering aspects such as industrial designers, branding, knobs and escutcheons, collectors and collecting, and the early days of wireless.

Most of the sets featured in the book are from Peter's own collection with the remainder coming from fellow enthusiasts and dealers from around the globe. He has kept the scope of the book broad in the aspect of global content, with the USA being the largest nation represented due to the sheer variety of sets manufactured during the golden age of valve wireless. There are 14 UK radios, 19 Australian, 13 French, 7 German, 3 Canadian, and sets from many other nations include some unique items from Mexico and France which have never been seen before.

Occasionally, when non–collectors have discovered my interest in vintage wireless, I am greeted with dismay. This book will be a useful weapon in demolishing their preconceptions regarding the subject, mainly due to it's broad crossover appeal. The subtitle says it all: *the most beautiful radios ever made*. I Recommend this book.

Available to order from the usual booksellers and online. Prices from £64.38 to £34.79.

Pictures from Royal Wootton Bassett

by Greg Hewitt

An Emstonette three-valve 'short' superhet radio – A wallflower waiting to bloom

by Stef Niewiadomski

On the wall outside the Harpenden Hall in June 2014 was a faded, beaten-up, plastic-cased radio that no-one else was interested in. I could see from the presence of a mains dropper resistor that it was a transformerless AC/DC radio, and the case style was of the 1950s. I thought it was worth taking home and salvaging at least the UL41 and its output transformer. I read the name of the radio on the front panel as 'Emitonette', written in an italic script, and thought it was some offering from EMI.

1: My Emstonette three-valve superhet in 'as found' condition, looking rather unloved

Champion

CHAMPION ELECTRIC CORPORATION, LTD., Champion Works, Newhaven, Sussex.

Distribution policy:—Selected wholesalers.

851, Mini-ette.—2 v (plus) AC/DC 2-band table. UCH81, UCL83, UY85. 470 kc/s. ML. 200–250 V, 40–60 c/s. £8 6s 9d., plus tax £3 4s 3d. Aug., '56.

851/3.—3 v (plus) AC/DC 2-band table. UCH81, UBF89, UCL83, UY85. 470 kc/s. SS (16–40m, 40–100m). 100–250 V, 40–60 c/s. £11 7s 6d., plus tax £4 7s 6d. Jan., '57.

854.—5 v FM tuner and pre-amplifier. EF86, ECC85, EF89 (two), EB91. 10·7 Mc/s. VHF. PU. Microphone and tape recorder inputs. Output to amplifier; no speaker. £25 0s 4d., plus tax £9 12s 8d.

860, New Minuet.—2 v (plus AC/DC single-band TRF table. UF89, UCL83, UY85. M. 200–250 V, 40–60 c/s. £7, plus tax £2 14s. Aug., '56.

862, New Picnic.—4 v 2-band AD portable employing printed circuit and metal shatter-proof cabinet. Int. aerial, DK96, DF96, DAF96, DL96. 465 kc/s. ML. HT (90 V) Ever Ready B126; LT (1·5 V) Ever Ready AD35. £9 17s., plus tax £3 13s. Aug., '57. (Service Sheet 1319.)

863, Fantasia.—3 v (plus) AC 3-band 4-speed TARG with optional legs. Int. aerial. ECH81, EBF80, PCL83, EZ80. 470 kc/s. SML. 200–250 V. £29 11s 4d., plus tax £11 7s 8d. Legs £3 3s. extra. Aug., '57.

864, Trav-ler De-Luxe.—4 v AD 2-band portable employing printed circuit. Int. aerial. DK96, DF96, DAF96, DL96. 470 kc/s. ML. HT (90 V) Ever Ready B126; LT (1·5 V) Ever Ready AD35. £9 13s., plus tax £3 14s 6d. March, '57. (Service Sheet 1319.)

866, Calypso.—3 v (plus) AC 2-band transportable TARG. Int. aerial. UCH81, UBF89, UCL82, UY85. 470 kc/s. M.L. 200–250 V. £23 10s., plus tax £9 1s. Oct., '57.

2 (left): The Emstonette name tag on the front panel, which I had misread when I first saw the radio.

3 (above): Champion's table, portable radio, and radiogram line-up for 1958, taken from the Wireless and Electrical Trader Yearbook for that year.

After a few days I finally got round to taking a closer look at the radio. Another look at the front panel revealed that I had mis-read its identity, and it was in fact an 'Emstonette' (see Figure 1 for the 'as found' condition of the radio, and Figure 2 for its name tag), which was a name unfamiliar to me. The underneath of the cabinet showed its original rich burgundy colour, but this was hardly detectable from the top and sides, which were a faded and dull brown colour. Looking into the back of the cabinet I could see only three B9A valves, including a UY85 rectifier and a UCH81 frequency changer, and only one IF transformer, which seemed strange. The third valve's markings had been rubbed off, but it looked to me like the set was a two-valve superhet - which is quite a rare and strange line-up - plus rectifier.

Connection with Champion

From the size and style of the cabinet, I suspected that my radio was manufactured by Champion. A look through various Champion radio service sheets revealed the model 750 (released in December 1951), which is a four valve plus rectifier (all octals) set, whose case looks very much like my radio. A little later in Champion's history there's the model 851 'Mini-Ette' (of 1957 vintage), a three-valve (including rectifier), two-band radio using an all-B9A line-up of UCH81, UCL83 and UY85. This line-up looked identical to my radio and so I concluded that my valve with no markings was a UCL83. The picture of a UCL83 at The National Valve Museum (Reference 1) certainly looks like my valve. So the circuit design of my Emstonette was that of the Champion model 851. I recently noticed what looks like my Emstonette model in the Champion cabinet in the photograph of the radio room of Seaford Museum in the spring 2012 edition of The Bulletin. If you can get to the museum you can take a look at one of these radios 'in the flesh'.

A search on Google for the Champion 851 Mini-Ette sent me to a picture of the radio, and the chassis and case are completely different from my radio. Therefore my conclusion is that at some time around 1957, Champion put together a radio using their model 750 case and bare chassis (with octal-sized holes, and which was out of production by this time), built the B9A-based model 851 circuit onto this chassis, and branded it as an 'Emstonette'.

The Champion Electric Corporation

Champion was a small company based

MODEL 851 ("MINI-ETTE")

General Description: Three-valve (including rectifier), two-waveband superheterodyne receiver in small transportable plastic cabinet with "throw-out" aerial.

Power Supply: A.C./D.C. mains, 200–250 volts.

Wavebands: M.W. 200–550 m.; L.W. 900–2000 m.

Valves: (V1) UCH81 (frequency changer); (V2) UCL83 (*triode* leaky grid detector with regenerative feedback; *pentode* audio output); (V3) UY85 (rectifier).

Intermediate Frequency: 470 kc/s.

Figure 4: Brief specification for the Champion model 851 Mini-ette, as published in the Radio and TV Servicing Sheet for the radio.

in Newhaven, in Sussex, that made budget equipment in the 1950s and 1960s. Their compact radios seem to have been sold as second sets, perhaps for use in the kitchen or bedroom, rather than as the house's main radio.

Figure 3 shows Champion's table and portable radio line-up for 1958, taken from the Wireless and Electrical Trader Yearbook for that year. As indicated by my Emstonette-branded radio, they were also willing to make radios, and badge them appropriately, for specific outlets, and I believe they even made sets for the Defiant brand for sale through the Co-Op. Figure 4 shows the brief spec for the model 851, as published in the Radio and TV Servicing Sheet for the radio.

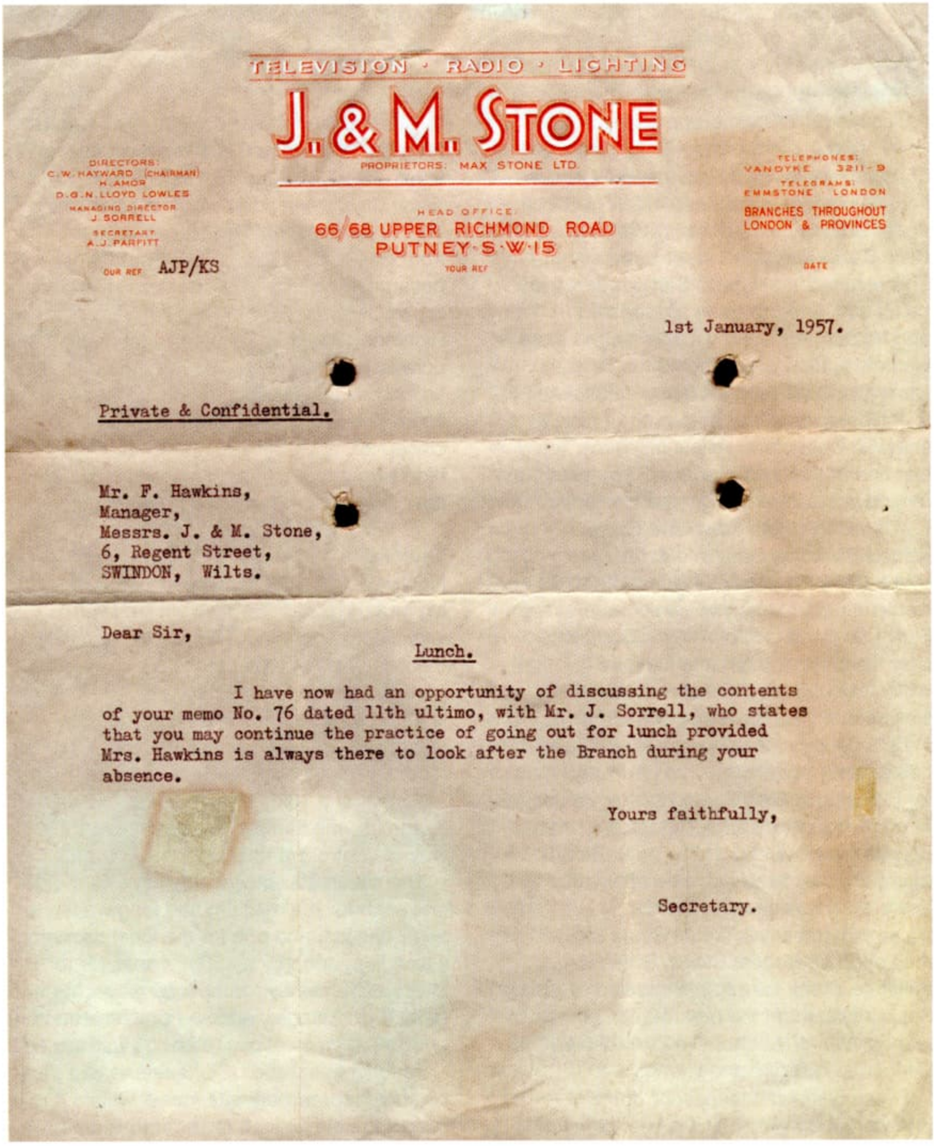
If you look at the valve line-up for the model 851/3 (released in January 1957), you can see that the 'missing' valve – the IF amplifier of course – has been added, but strangely this set is shown covering two short wave bands, with no coverage of the medium or long wave bands. I believe this is a mis-print and the radio did also cover the medium wave. Perhaps this was Champion's attempt to sell into the export market? There was also the model 860 'New Minuet' three-valve (including rectifier) medium wave only 'straight' (that is, TRF) receiver. For the first stage of a TRF, a heptode isn't needed and so a UF89 pentode was substituted, followed by the UCL83 and a UY85 rectifier.

At the higher end of the market, the company was also producing radiograms (the 863 Fantasia and the 866 Calypso), as well as a couple of portables. Finally, the five valve model 854 was an FM tuner and pre-amplifier, designed for feeding into an external amplifier and speakers.

Emstonette and J & M Stone

The 'Emstonette' connection comes from J & M Stone Ltd, registered at 66 Upper Richmond Road, London, SW15, which was a TV and radio retailer with multiple outlets, established in about 1929: by 1950, they had 64 shops around the UK. The 'J' was the Managing Director, John Stone, and the 'M' was from the name of the other director, Max (John's brother, I believe). They used the 'Emston' and 'Emstonette' brands, with the 'Em' seemingly coming from Max, and the 'Ston' from Stone. My radio was therefore built by Champion, and branded with the Emstonette name for sale in J & M Stone Ltd's shops.

5 (above): The exterior of the J & M Stone's shop in Swindon in the 1950s, with the staff standing outside. Frank Hawkins is second from the left.



TELEVISION · RADIO · LIGHTING

J. & M. STONE

PROPRIETORS: MAX STONE LTD.

DIRECTORS:
C.W. HAYWARD (CHAIRMAN)
H. AMOR
D.G.N. LLOYD LOWLES
MANAGING DIRECTOR
J. SORRELL
SECRETARY
A.J. PARFITT

HEAD OFFICE:
66/68 UPPER RICHMOND ROAD
PUTNEY · S · W · 15

TELEPHONES:
VANDYKE 3211-9
TELEGRAMS:
EMMSTONE LONDON
BRANCHES THROUGHOUT
LONDON & PROVINCES

OUR REF AJP/KS

YOUR REF

DATE 1st January, 1957.

Private & Confidential.

Mr. F. Hawkins,
Manager,
Messrs. J. & M. Stone,
6, Regent Street,
SWINDON, Wilts.

Dear Sir,

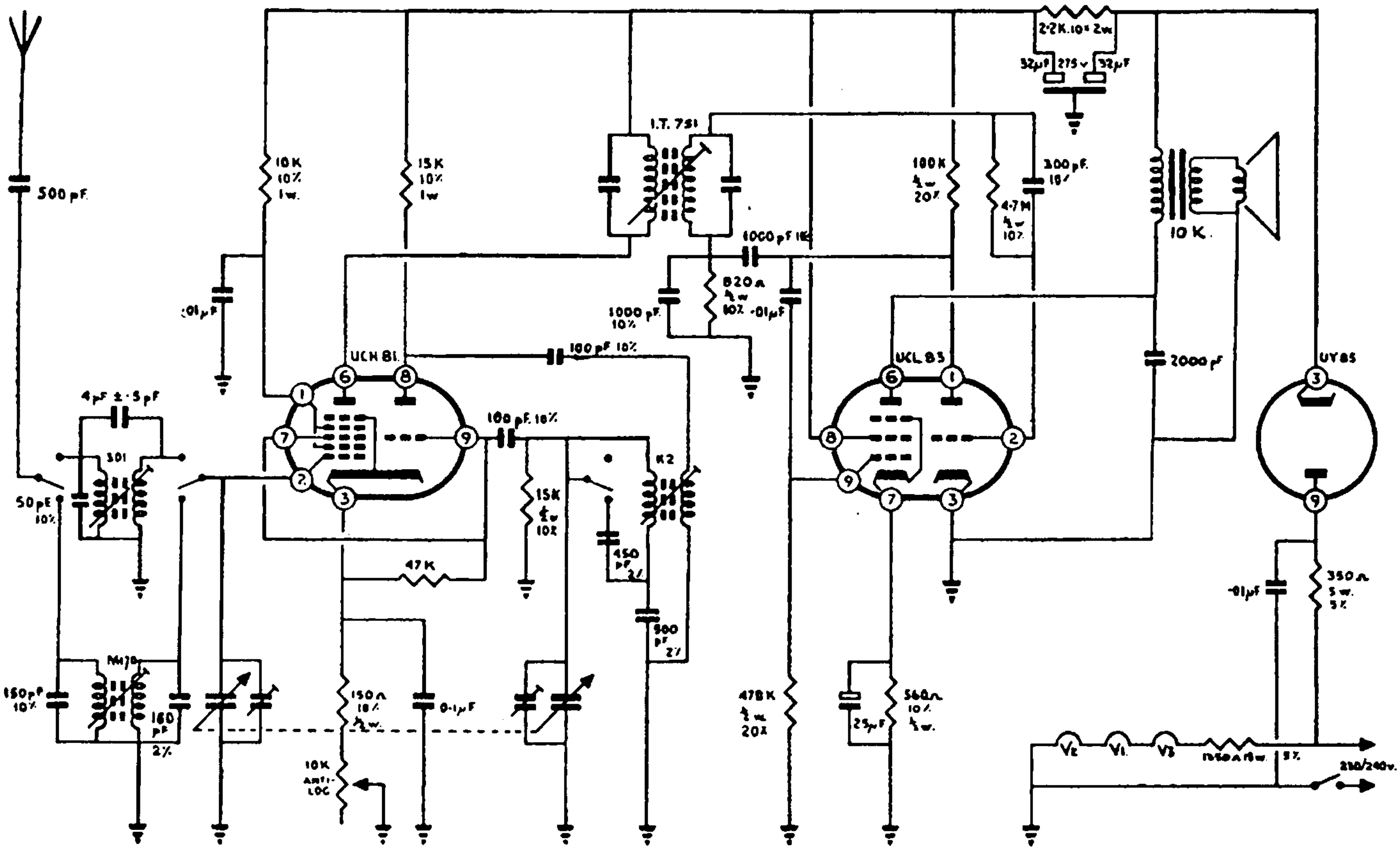
Lunch.

I have now had an opportunity of discussing the contents of your memo No. 76 dated 11th ultimo, with Mr. J. Sorrell, who states that you may continue the practice of going out for lunch provided Mrs. Hawkins is always there to look after the Branch during your absence.

Yours faithfully,

Secretary.

6 right): A slightly amusing letter, from HQ in Upper Richmond Road, London, giving Frank permission to eat his lunch off the premises.



Circuit Diagram—Champion " Mini-ette " Model 851

(Note that " earth symbol " denotes chassis connection not true earth.)

7: Schematic of the Champion model 851 'Mini-ette', which seems to be very close to the design of my radio.

The history of the company becomes more complex in the late 1950s, with the consolidation of many radio and TV shops in England, including those of J & M Stone, under Broadmead Ltd, which also owned Civic Radio Services Ltd, of Birmingham. This resulted in all J & M Stone branches being converted to trade as 'Civic' in about 1960. Apparently it was a Civic store window behind which the 1960s TV star Harry Worth was shown doing a simulated levitation splits at the beginning of his TV show, using a clever reflection effect. You can find this clip on YouTube if you want to remind yourself of this genteel comedian.

A little later, Firth Cleveland Group gained control of Broadmead Ltd, and eventually GKN (formerly Guest, Keen & Nettlefolds Ltd) acquired some parts of the Firth-Cleveland group in 1972. Sometime later the company ran into financial difficulties and the TV and radio division was sold off, broken up or closed down.

By a happy coincidence Mike Barker has recently acquired – with permission for inclusion in BVWS publications - a set of correspondence and photographs from Brenda Hawkins, the widow of ex-BVWS member Frank Hawkins, who sadly died last year. These show some history of his employment with J & M Stone Ltd, at their shop on Regent Street, Swindon in Wiltshire. Frank rose to the position of Area Superintendent in the organisation and was responsible for 13 shops in Oxfordshire, Berkshire, Wiltshire and Hampshire.

Figure 5 shows the exterior of the Swindon shop in the 1950s, with some of the staff standing outside: Frank is second from the left. Figure 6 is a slightly amusing letter, dated 1st January 1957 (yes, in those days we used to work on New Year's Day, in perhaps a rather delicate state from celebrations on the night before. It became an official bank holiday in England on 1st January 1974) from 'HQ' in Upper Richmond Road, London, giving Frank permission to eat his lunch off the premises, as long as he left Mrs Hawkins in the shop. This was a time when many shops closed for lunch, and the company clearly didn't want this to be the state of affairs in their shops, or at least not in Swindon.

The circuit

Figure 7 shows the schematic of the Champion model 851, which seems to be very close to my radio. A UCH81 forms the self-oscillating frequency changer, generating an IF of 470kHz; then a UCL83 is the leaky-grid detector and audio output stage; finally a UY85 is the mains half-wave rectifier. The cathode current of the UCH81 is adjusted by a 10kΩ potentiometer, which acts as the volume control, there being no other way of controlling the audio level of the radio.

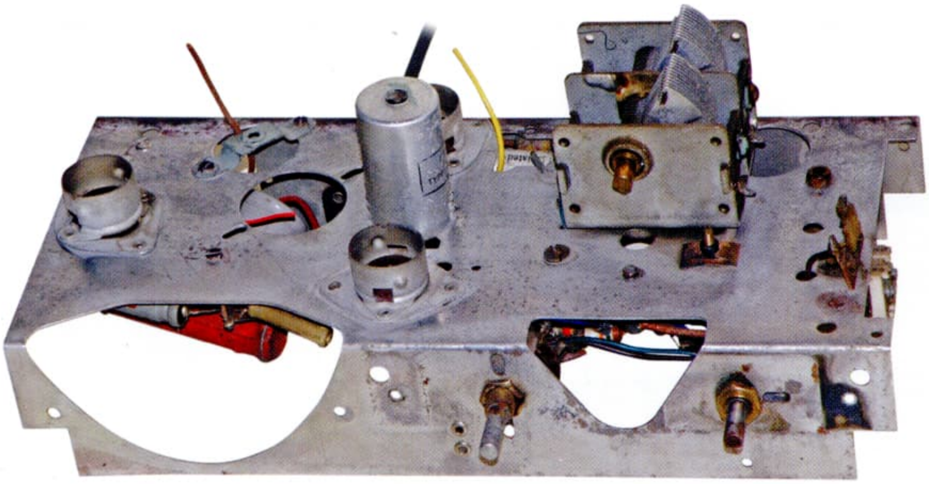
The schematic shows only three RF coils: one each for the medium and long wave aerial circuits, and one for the local oscillator, which is padded by a 450pF capacitor to lower its frequency for the long wave. My radio has four coils, and so I presume that as built, an extra local oscillator coil was added.

The symbol of the UCL83 seems to be shown the wrong way round, which makes the circuit look more complicated than it really is. It would have been better to show the triode leaky-grid detector section first, and then the pentode output stage, which is the way the signal flows through the two sections of the valve.

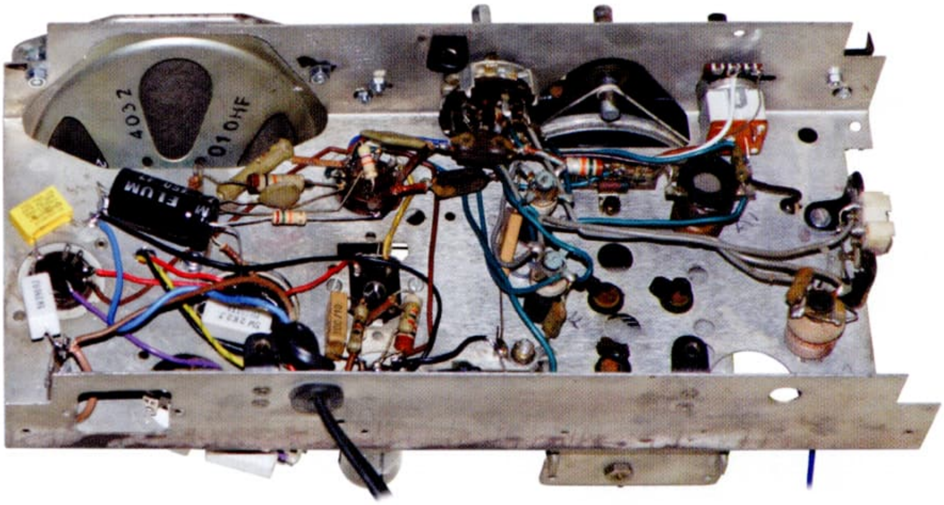
The cabinet

I removed the chassis from the cabinet by unscrewing the three fixing screws underneath: the radio had no knobs and so it then slid out of its case. Before attempting to renovate the cabinet I decided to break it down into its three constituent parts to make it easier to clean and polish. It came apart into the main outer case, originally a rich burgundy colour from looking inside; the front panel - made from ivory-coloured plastic; and a rectangular bezel, which highlights the dial, and which was the same colour as the main case. Metal spring clips hold these parts together and as expected, some came off fairly easily, and others came off along with the plastic lugs they were attached to. I wasn't too concerned with this, or surprised, as this kind of attachment is only intended as a one-time method, and generally speaking some other method has to be found to re-assemble the parts.

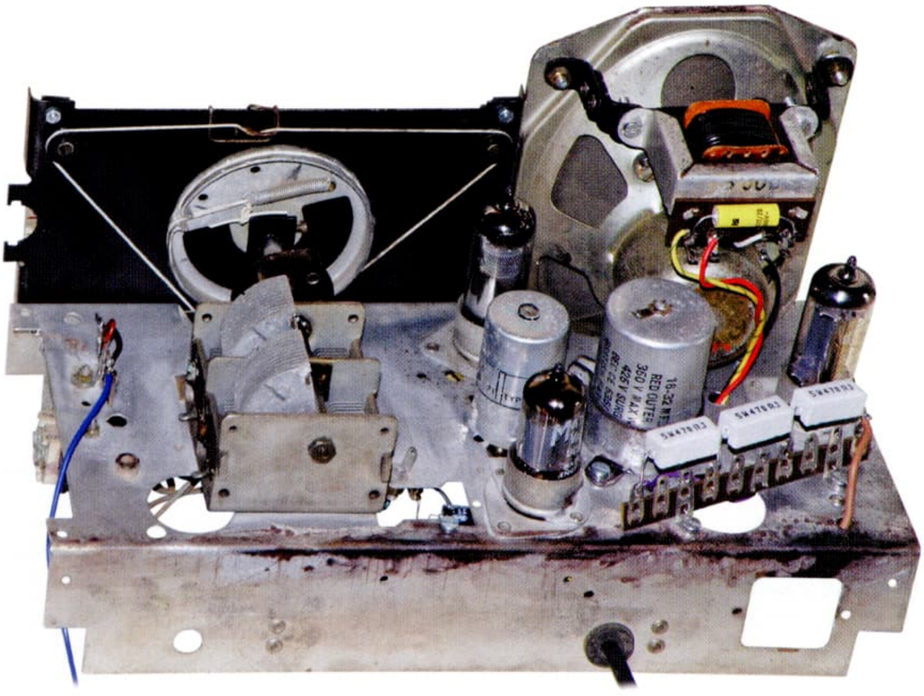
The separate parts were first thoroughly washed in hot soapy water, and then I started work on polishing the main case. Most of its surface was dull and faded, and the side that had been exposed to most internally-generated heat was a dull brown colour, was showing signs of bubbling, and had a couple of small cracks. I didn't have high hopes for what the finished case would



8: The stripped down chassis of the radio



9: Under chassis view of the radio after restoration



10: Top chassis view of the radio after restoration

look like, so I was pleasantly surprised as I applied lots of Greygates Paste Polishing No 5 and elbow grease, and the original smooth finish and burgundy colour started to reveal itself. After several passes over the whole area, mainly to remove an ingrained layer of dirt, I started to concentrate on smaller areas. I found that circular polishing movements with the paste over small areas, followed by buffing with a clean cloth, gave the best results.

I couldn't remove all the bubbling, but it was much less visible once the colour and shine was back in the surface. In the end the case was certainly not back to its original ex-factory state, but definitely much better than I found it, and acceptable for an almost 60-year old radio that has had some abuse over the years. The bezel had the same treatment as the main part of the cabinet and came up into good condition. The ivory plastic front panel simply needed a good wash in soapy water to get rid of the years of accumulated dirt.

I reassembled the cabinet using quick-setting bath silicone sealant to hold the three pieces together. This allows for a later restorer to take it apart sometime in the future.

Repairing the chassis

I first checked the mains cable connection to make sure that the mains neutral lead was connected to the chassis metalwork via the on-off switch. As was common practice with most radios of the period, the on-off switch (on the volume control) only switches the neutral supply to the radio. This means that when the radio is turned on, as long as the mains plug has been wired the right way round, the chassis is connected to mains neutral, and is relatively safe to touch. However, when the radio is turned off, the chassis becomes connected to the live side of the mains, through the heater chain. The message to take away from this is always to turn the radio off and unplug it at the mains, before attempting any modifications or repairs to the chassis.

The chassis was generally dirty and had some areas of rust. A good clean and treatment of the rust with Kurust brought it to a reasonable condition. The backing plate to the dial, which holds the cord wheel and spring, and the wheels over which the dial cord runs, was removed, cleaned of its rust and re-painted in black. When I re-assembled the dial back onto the chassis, the cord kept on slipping off the wheel at one end of its travel, because of some wear and sloppiness in the dial mechanism. No amount of adjustment would stop this from happening, and so in the end I built up the sides of the cord wheel with Araldite, let it set, and then filed it back to the correct groove width using a needle file. This cured the problem, hopefully once and for all.

Figure 8 shows the chassis stripped back to the state where I was ready to start adding components again. You can see that the chassis was originally designed to accommodate octal valves, and circular plates onto which the B9A valve holders are mounted, have been riveted over these holes. You can also see numerous other holes which are unused, showing something of the previous radio for which the chassis was originally designed.

The dial (which had 'Cellgrave' printed out-of-sight along its edge) was in generally good condition, but with some lifting of the gold markings, which I though was acceptable and I didn't attempt to rectify this.

The 6-inch by 4-inch speaker had a large

11: My Emstonette three-valve superhet in restored condition, certainly not back to its original ex-factory state, but definitely much better than I found it. The interesting detailing on the right hand side is evocative of a pre-war Deco style

tear in its cone and so I changed it for one in better condition. The fixing holes spacings were the same as the original, but I had to 'fettle' the chassis a little to fit it. I took the opportunity to de-rust the output transformer's fixing brackets and turn the transformer round, as for some strange reason it had been fitted with its tags pointing upwards and touching the inside of the cabinet. The original 2000pF tone correction capacitor from the anode of the output valve to ground had seen better days, and so I changed it for a 2200pF high voltage component.

Power supply

As with most AC/DC radios, the power supply components are under most electrical and heat stress and generally need attention. At some stage the two 32µF HT smoothing capacitors had been separated into two cases, one metal-cased tubular component correctly mounted through the chassis, and the other an RS component dangling in the below-deck wiring. These were both removed and replaced with a 16µF+32 µF can electrolytic and clamp of the correct mid-1950s vintage mounted above chassis into an original pair of holes that fitted perfectly.

I removed all connections to the socket of the UY85, as all the soldered joints looked suspect, as expected for an area that was subject to heat being conducted down the wires of hot components. After cleaning the pins of the socket, reconstruction could begin.

The original green 350Ω 5W wirewound HT dropper resistor showed signs of overheating, and was replaced by a modern 330Ω 5W ceramic-cased component. The 2k2 HT smoothing resistor was an 80mm-long dog bone component which looked much too big for the space it was trying to fit into. I replaced it with a modern 5W ceramic-cased component, which was in fact over-rated for the power it needs to dissipate, but it looked good. The 0.01µF mains filter capacitor was replaced with a modern 275V AC class-X capacitor. This made the under-chassis look much tidier (see Figure 9), and hopefully fit for a few more years of service.

Above the chassis, the series heater chain resistor needs to pass 100mA while dropping the mains voltage down to 95V for the valve heaters (19V for the UCH81; 38V for the UCL83; and 38V for the UY85). The original 1350Ω component showed signs of repair, but was in fact open circuit and so it was replaced by three 470Ω 5W resistors connected in series, and mounted on a tag strip. Doing the sums, these three resistors have to dissipate 14W between them, and so need to be placed close to the back of the radio to help air circulation around them. Figure 10 shows the top chassis view of the radio after restoration. You can see how the three 470Ω resistors were accommodated in the radio - not very true to the original arrangement, but they do the job.

In the rest of the radio all the resistors were checked and were verified as being close enough to their nominal values. The audio amplifier's 25µF cathode bypass electrolytic was replaced with a modern component. I replaced the 500pF aerial coupling capacitor with a 500V 470pF component, as this gives protection from a possibly live chassis. The other capacitors were of various types, but looked OK and were left alone.

Throw-out aerial

The radio was intended to be used with a 'throw-out' aerial, which means a length of wire provided with the radio, and permanently attached to the 500pF capacitor in the aerial circuit. The original aerial wasn't present and I wasn't sure how long this wire should be. I thought a couple of metres should do the trick. I replaced the original capacitor, and its tag strip, after I broke the original during my restoration of the chassis.

Switch on

I wanted to test the chassis before putting it back into the cabinet, so I added some temporary knobs, and about 2m of aerial lead. After a careful check that the components I had changed were correct, and all the soldered joints were good, I switched the radio on. I checked that the chassis was connected to mains neutral by measuring the AC voltage between the chassis and mains earth, and this came out at just a few volts, so I was confident that the mains was connected the right way round.

The valves lit and so I knew that

continuity of all the heaters was good. I measured the voltage across the heater chain and it came out at 97V, which was very close to the nominal value of 95V, and so I was confident that the replacement heater dropper arrangement was working well. The smoothed HT voltage measured at about 240V and the radio's total power consumption was 31W, which seemed about right.

After a while the radio came to life, if that's what you call a loud hum, which was unaffected by the volume control, that changed to a buzz after a few minutes. I thought that maybe the lower value of smoothing capacitor was causing excessive ripple on the HT line, so I added a 16µF electrolytic across the 16µF section in the can. This didn't make much difference, but I left it there as it wasn't going to do any harm. I was wondering whether the volume control was in fact open circuit, so I measured it, and indeed it was only in circuit for about half its travel. So I changed it for a 22kΩ linear pot, which was the only one I had with an integral on/off switch. Switching on again, things were better: there was still some hum, but the buzz had gone away, and I could now receive BBC 5Live on 693kHz, and a few other medium wave stations. When I connected a long wire aerial, more stations could be heard. Initially the long wave was completely dead, but a spray of the wave change switch brought it to life.

New valves

At this stage I thought a new set of valves would be a good idea, thinking that the extra gain of the new ones would help reduce the level of hum, and there may have been cathode-heater leakage in the original valves. When the new valves arrived I changed them one-by-one, starting with the UCH81, and noted an immediate improvement in volume level and reduction in hum. After changing all three valves, sensitivity and volume level were acceptable, though there was still some hum audible between stations. I wondered whether this was a feature of such a simple radio, but I still thought it worthwhile to try to reduce it. The first step I took was to eliminate the on/off switch from the circuit, and take the neutral lead directly to the chassis, close to the UY85 rectifier. I was hoping that this lead caused some radiation of hum into the audio sections, and indeed I think the hum level did get a little lower, though of course this is a subjective judgement.

The more significant thing I tried, which did make a big difference, was to change the way the heater chain's 100mA of AC current returned to chassis and thereby to mains neutral. The original arrangement was that it shared a connection with the 1000pF capacitor and 820Ω resistor at the 'lower' end of the IF transformer, which didn't seem like a good idea to me. The heater current then had to flow through the rather thin chassis back to the neutral connection. I changed this so that the heater current had its own lead back to the mains neutral connection to chassis close to the rectifier valve, and this definitely produced a significant reduction in the hum level.

Operation of the volume control was still quite crude, and tricky to adjust until you get used to it. It was only acting as an effective volume control over a relatively short part of its travel, and so careful adjustment was needed to get the desired volume. Effectively it is adjusting the conversion gain of the frequency changer stage. Checking some more conventional UCH81-based radios, I could see that typically this cathode is returned directly to the chassis, or sometimes via a low value resistor of about 150Ω, and so working the stage with cathode resistor values of greater than this was relatively unknown territory. I presume the designers at Champion had consulted the valve's manufacturers for their view on this arrangement, or maybe they just went ahead anyway.

For the final assembly of the radio, I replaced the throw out aerial with an aerial socket mounted on the back panel, so I could easily adjust the length of wire connected. Figure 11 shows my Emstonette three-valve superhet in restored condition, now fitted with new knobs to match the ivory front panel. I think the interesting detailing on the right hand side is neat, and evocative of pre-war Deco style.

Conclusions

Occasionally you find something interesting when you're not really looking for anything in particular, a process known as 'serendipity', and very satisfying when it happens. This Emstonette three-valve 'short' superhet barely escaped being scrapped, which would have been a great shame bearing in mind its interesting circuit design and the use of a Champion chassis and case. The radio needed some repair, especially in the area of the power supply, and a new set of valves, to get it working to a reasonable state again.

With a 2m length of aerial, the radio's performance on local stations was very acceptable. More distant broadcasts could be heard when the length of the aerial was increased. For typical usage of the radio when it was new, perhaps in a kitchen or bedroom, I expect that the throw-out aerial provided was good enough.

We tend to have a preference for collecting and restoring 'quality' radios, but even the cheap and nasty ones, such as this Emstonette, have a place in the history of British domestic radios, both from the point of view of manufacturers and retailers, and also the purchasers who were looking for a bargain. The radio's minimalist circuit design makes it interesting, and even rare, these days. Its Bakelite case was dull, dirty, faded, cracked and bubbly, but lots of elbow grease and polishing paste brought it to a surprisingly reasonable state, with most of its original burgundy colour restored. My thanks go to the original owner, who I hope is reading this, and appreciates that the radio has been saved and has formed the basis of an article.

This restoration has stimulated in me an interest in Champion radios. I've just acquired one of their early-1950s TRFs, and hopefully its restoration will form the basis of a future article in The Bulletin.

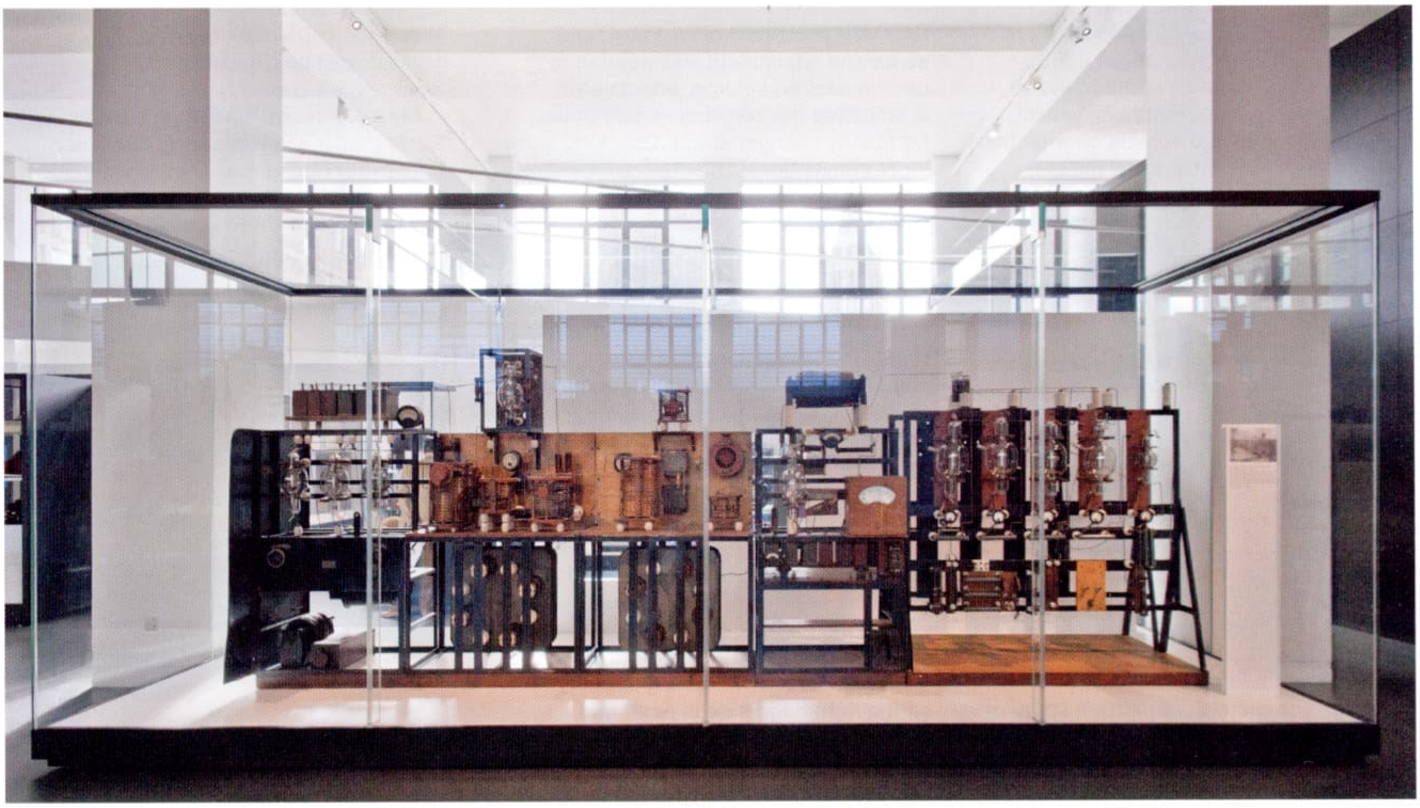
Useful references

Reference 1: The National Valve Museum can be found at: http://www.r-type.org/search.php

My thanks to members of the UK Vintage Radio Repair and Restoration forum at: http://www.vintage-radio.net/forum/index.php, particularly 'Dazzlevision' for the history of E & M Stone Ltd and Champion.

New Information Age gallery opens in The Science Museum

photographs by Carl Glover



2LO goes on public display at last!

More than 200 years of innovation in communication and information technologies are celebrated in Information Age: Six Networks That Changed Our World, the Science Museum's biggest and most ambitious gallery to date.

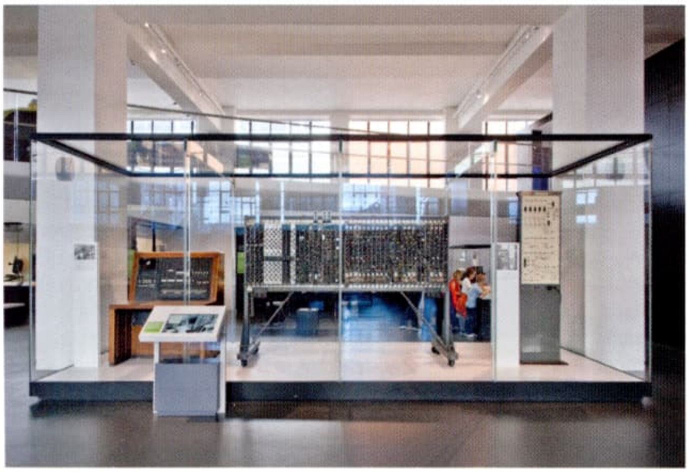
Information Age is divided into six zones, each representing a different information and communication technology network: The Cable, The Telephone Exchange, Broadcast, The Constellation, The Cell and The Web.

The gallery explores the important events which shaped the development of these networks, from the dramatic stories behind the growth of the worldwide telegraph network in the 19th century, to the influence of mobile phones on our lives today.

The gallery opened to the public on October 25th. The photographs were taken a week before at a preview event for contributors and consultants involved in the setting-up and planning over the last few years.

the aerial induction coil from Rugby radio station makes an impressive centrepiece

A case showing Sargrove's innovative wireless sets



Russia's BESM-6 and the American CDC 6600 computers from the 1960s

Spies in Space display

The Gallery curators talking about the exhibits

Telephony is tastefully covered in Information Age

A first generation British receiver with Screened-Grid valve - the 1928 Solodyne (a conservation/restoration project of 2014)

by Robert Lozier

The principle of interposing a fourth electrode between the grid and plate of the basic triode to isolate the grid and plate circuits had been known for several years. Engineers in several countries were working to bring practical tube designs and circuit applications to market. Marconi-Osram in the U.K. claims to be the first-to-market with a Marconi receiver being exhibited in early September 1927 at Radiolympia with their Type S625 screened-grid valve; beating the RCA's official announcement of the UX-222 in October 1927. (The Philips A442 is identified as having been introduced in 1927, but the month is unknown to me.)

1 (left): Before restoration. The hard rubber front panel was originally glossy black.

2 (above): Double-ended construction worked well but was expensive to make.

My Solodyne receiver design is attributed to John Scott-Taggart with special RF coils made by Lewcos and components sold by Peto-Scott Co. Ltd.

The Scott-Taggart Solodyne circuit apparently begins in 1926 using triodes in the RF amplifiers. In late 1927 the design undergoes significant change to make use of the new double-ended screened-grid valve. Analysis of the updated design appears in Modern Wireless for December 1927. Amateur builders are urged not to attempt simply rewiring their old set stressing the critical importance of component placement.

The first of a number of construction articles appear in Modern Wireless for January 1928. By this time, the M-O-V S625 (6 Volt) thoriated tungsten filament valve has competition from Cossor in their SG210 (2 Volt) valve with oxide coated filament. My 1928 Solodyne has the Cossor brand 2 Volt valves. (Figure 2)

While RF performance was considered exceptional, the construction of a double-ended envelope was expensive and certain valve characteristics could not be tightly controlled because of this construction method. By mid-year, the more familiar construction of the Mullard PM12 and US Type 22 replaced this valve in almost all designs.

Apparently the Solodyne in my collection is an early-on construction because the first tuned stage is not ganged with the second and third tuned circuits. A follow-on article suggest that most users of the radio will not find the increased gain from being able to better tune the first stage of any real value. By the time the design appears in the Australian magazine, Wireless Weekly (1922-43); you see a single dial – three gang layout.

The Queensland Radio News, 1/7/29 P47 advertises the Crammon All-Metal Screen-Grid Solodyne by Crammond Radio Manufacturing Co. PTY., Brisbane. The version reviewed does have two dials for tuning and comments: "we have affirmed our belief that the Screen-grid Solodyne is the best receiver for country listeners that is marketed today."

All these designs feature a tunable notch filter in the antenna input circuit that is set to the frequency of your local station. This prevents overloading the RF amplifiers.

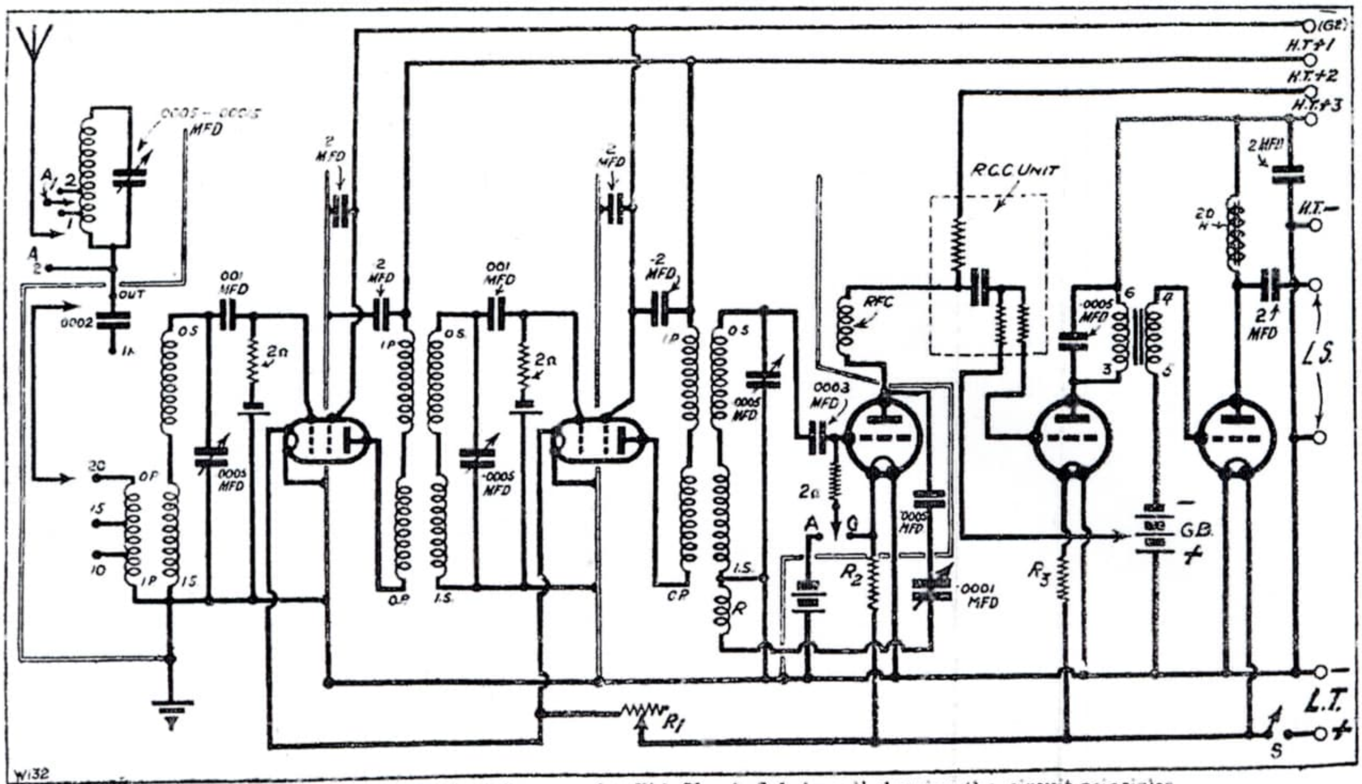
The first plug-in coil is for tuning the antenna. The other two plug-in coils are of the Astatic type with the primary and secondary windings being split into two equal sections where the sections are wound in the opposite direction. The articles go to great lengths to explain the trade-offs in RF amplifier design that were seldom seen in American construction articles of the day.

The detector is a little unusual in that you have the option of choosing grid-leak or anode bend detection via a two position plug board on the chassis. In most cases the anode bend detection is preferable because of less loading of the RF input signal and less audio distortion. With two stages of audio amplification the loss of audio gain was of little consequence.

The circuit has a reaction (regeneration) control but was described as unnecessary for any but the most extreme DX activity.

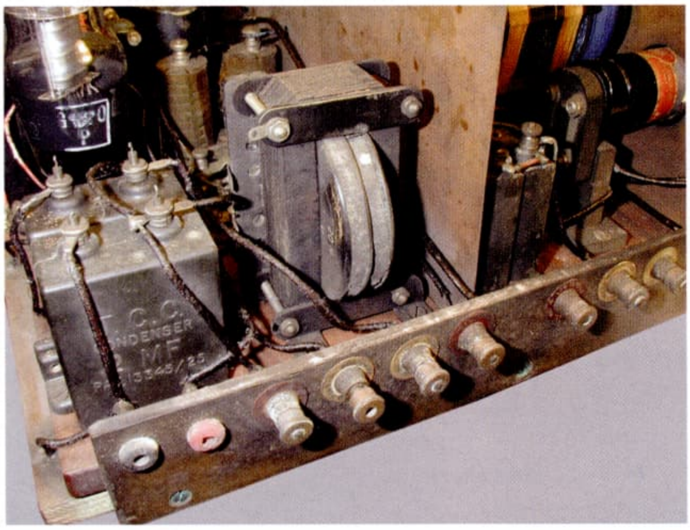
The detected audio is coupled to the first audio valve via a modular R-C network. The output of this valve is transformer coupled to the audio output valve. The output of this valve is coupled to the loudspeaker via capacitive coupling to keep the DC plate current out of the loudspeaker.

Conservation and restoration:
As found at the March 2014 Antique Radio Charlotte (NC, USA) conference,



A slightly simplified theoretical diagram of "This Year's Solodyne," showing the circuit principles.

3: Published schematic. In my set, R2 & R3 are chassis mounted rheostats.



4: Very difficult to remove oxidation and corrosion

5: All metal hardware was processed in my trusty ultrasonic cleaner

the radio was suffering mildew, soil, heavy metal & hard rubber oxidation, a broken cabinet hinge, two missing cabinet feet and a missing piece of cabinet molding. While the period correct Cossor SG210 screened-grid valves were present, the detector and audio valves were circa 1940 ex-General Post Office type VT-68 valves. Numerous solder joints had been very poorly done and were loose or broken.

In general I find British sets of the 20s and 30s to have an especially difficult to remove metal oxidation. No doubt caused by the heavy industrial pollution of much of the country and relatively high average levels of humidity.

Apparently this receiver made its way to the USA during a flurry of buying and trading by a very few, very well off collectors during the mid 1970s Before the advent of the Web, locating documentation for foreign equipment was very difficult if you did not know the right people. Without background information this receiver languished in a somewhat damp basement in Cincinnati, Ohio for a few decades.

All non-metallic components were removed and cleaned using a cream type waterless hand cleaner. All metal parts were cleaned in my ultrasonic cleaner. On reassembly, all metal parts were given a light coat of clear lacquer to delay further oxidation.

The Lewcos coils were grubby with soil. The windings were obviously fixed with a light coating of shellac. I begin by washing them down with mineral spirits and blowing the excess spirits off with moderate compressed air. Then I wash down with alcohol using a very soft camel hair brush. After drying, I give the coils a light brush with shellac.

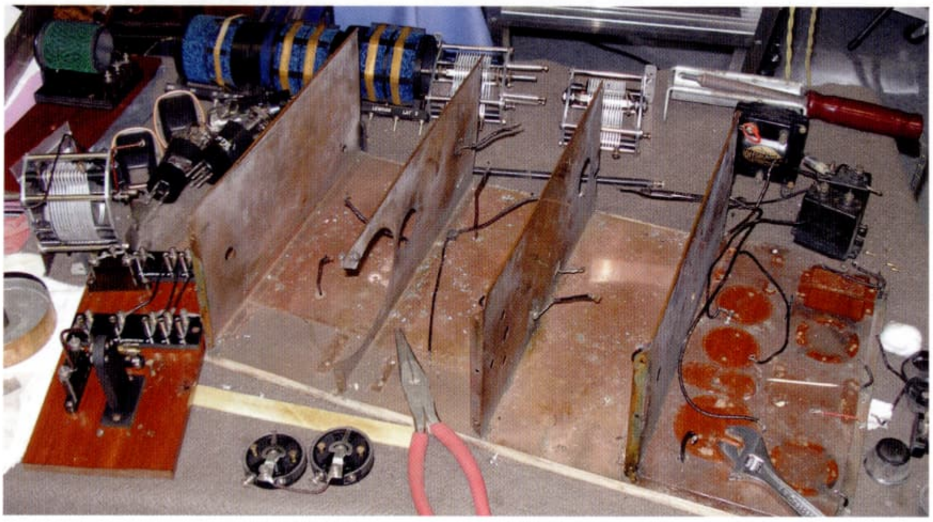
It was interesting to note that each of the mahogany sub–panels had many, many excess screw holes very close to the actual holes used to mount the components. It was hard to imagine that the constructor could have made that many errors in layout because it did not seem as if the sub-panels had been used for an entirely different circuit.

The chassis was stripped almost enough to clean copper shielding. Note the cleaned sub-panel and the final sub-panel yet to be cleaned (see Figure 7)

Each of the screen grid valves requires a 1.5 Volt bias cell that had been replaced a by more modern style 'C' (R14) size flashlight (torch) cell.

The original bias cells used were Siemens brand in a rectangular box form. I was happy to see that the owner had found it convenient to place one of his new 'C' cells inside of one of these old box sleeves. This, plus photos in the construction article and others found on-line gave me all the

6: Many extra screw holes were a puzzle to me



7: Every single part had to come off in order to clean the copper shieding.

8: Part of one original cell case remained in the set

9: With research and effort I made museum grade replicas

information I needed to make museum grade replicas of these cells. (See note at end.)

My general observation was that the builder of this set was no craftsman but I give him credit for having taken-on what I consider to have been a rather difficult construction project.

Cleaning heavily oxidized hard rubber panels is always difficult. I have no way of determining how deep the oxidation penetrates into the panel. It was not until I began to clean the panel that I even saw the shallow engraved Peto-Scott logo. After going as far as I dared to go, I applied a wipe of black dye as is used in colouring urethane plastic resins.

The mahogany cabinet was missing its front two feet and a section of the base molding was broken out. I did not have any router bits that would create the profile for these feet. I figured out how to mount one of the original feet and two mahogany blanks in my little milling machine and used many, many passes with a ball end cutter to match the curves. It was slow but worked well.

I routed out a square path in the broken molding to take a replacement insert. Once glued in place, I needed a small shoulder plane to match the molding. I did not have such a plane but was delighted to find on the Web how to make a shoulder plane using a Marples chisel that I did have.

A roundabout solution but it worked!

Two knobs were obviously wrong; the filament power switch and one of the two tuning knobs. I made a silicone rubber mold of the correct tuning knob and cast a urethane plastic replica. I was able to find a power switch knob in my junk boxes that seems to be close to the correct size and shape shown in one of the construction articles.

The reaction control knob caught my attention; it appears to have been made incorrectly. The pointer arrow molded in the knob is in-line with the grub screw hole! Ugly!

One of the hinges for the lid was broken and the others had considerable corrosion. I was able to silver solder the hinge back together and then nickel plate all the hinges and screws.

Most of the rear terminal posts were soldered in place. With the heavy oxidation of these parts, it was very, very difficult to remove them without damaging the little circular celluloid I.D. tags under most of the posts.

The mahogany cabinet (serial # 7) is French polished with shellac. The heavy gouges in the top lid and bottom-front molding are so deep that I elected to not refinish the top. Only a light additional French polish was applied. The inside of the top lid has a faux inlay decal.

Considering the original condition of the chassis, I am pleased with the appearance and accuracy of the conservation and restoration.

Time to photograph the finished chassis.

To my American eyes, the external view of this wireless set is painfully bland but hides a marvelous assemblage of components unlike many seen in USA sets of the day.

So... does this set work today?

The answer is no. The audio transformer and plate load choke for the audio output have continuity but the 2 Meg. Ohm resistors are out of range and the paper dielectric capacitors are somewhat leaky. The R-C coupling unit has not been tested but probably is not to specification at 80+ years. The detector plate choke is open circuit. I am not going to replace these original components merely to have fun tuning-in for a little while. As it stands today, it remains a very accurate historical artifact.

I have testimonials as to how this radio was regarded at the time of its useful life. That is good enough for me.

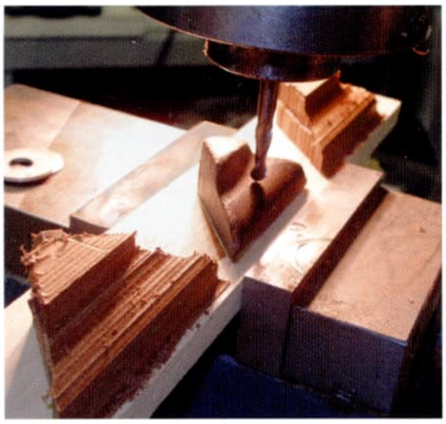
Note: I have built web pages documenting various batteries used in vintage wireless equipment. An index of the batteries available is to be found at: homestead.com/Battery-Art-index.html All information is free for personal use. You may sell replica batteries incorporating these images, but you cannot sell the images without express permission.

My thanks to Dan Bedford in Brisbane, Australia for tracking down the Wireless Weekly & Queensland Radio News articles.

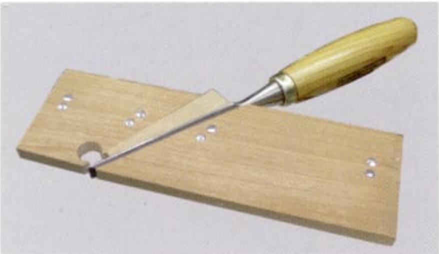
Thanks also to Phil Taylor in Billingshurst, England for supplying me with period correct Cossor brand triodes to replace the VT-68s.

The January 1928 article from Modern Wireless was obtained via the document services of the New York Public Library.

Robert Lozier – Monroe, NC 28112



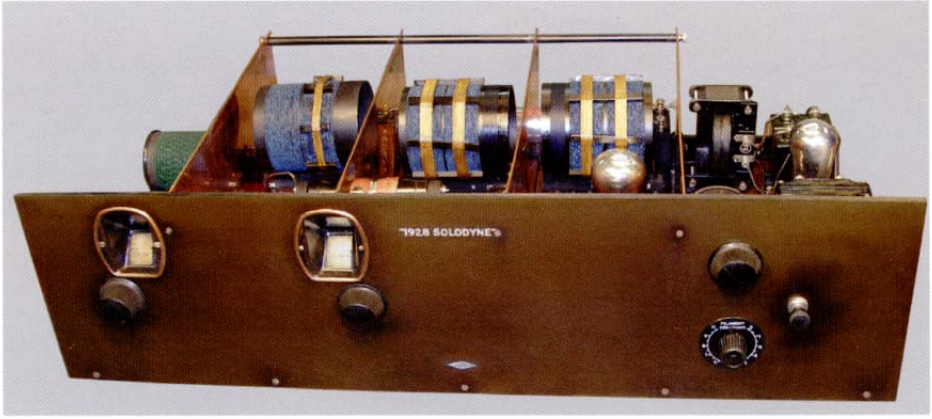
10: Milling two replacement mahogany feet



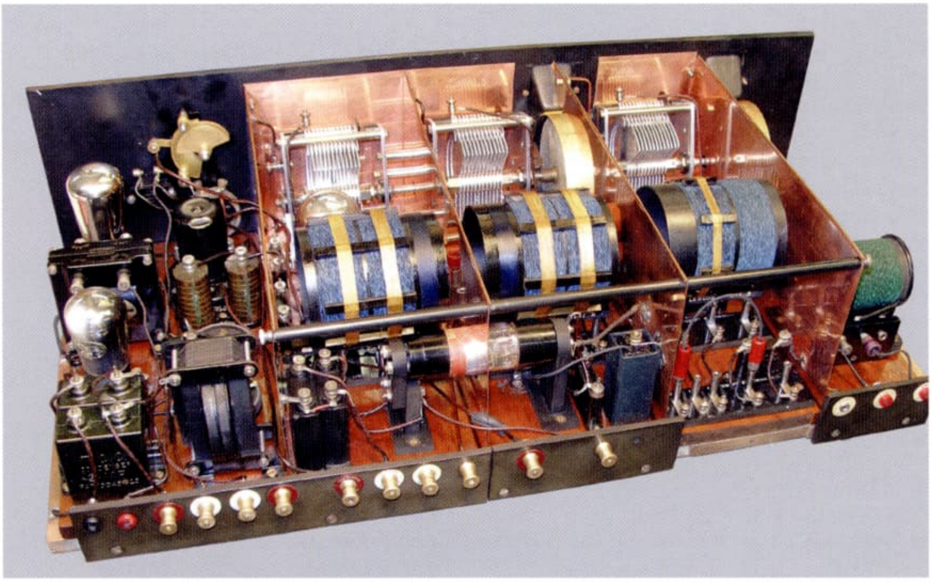
11: Shop built shoulder plane made from plans found on the internet

12: Ready to pour silicone rubber. Replica cast from urethane resin

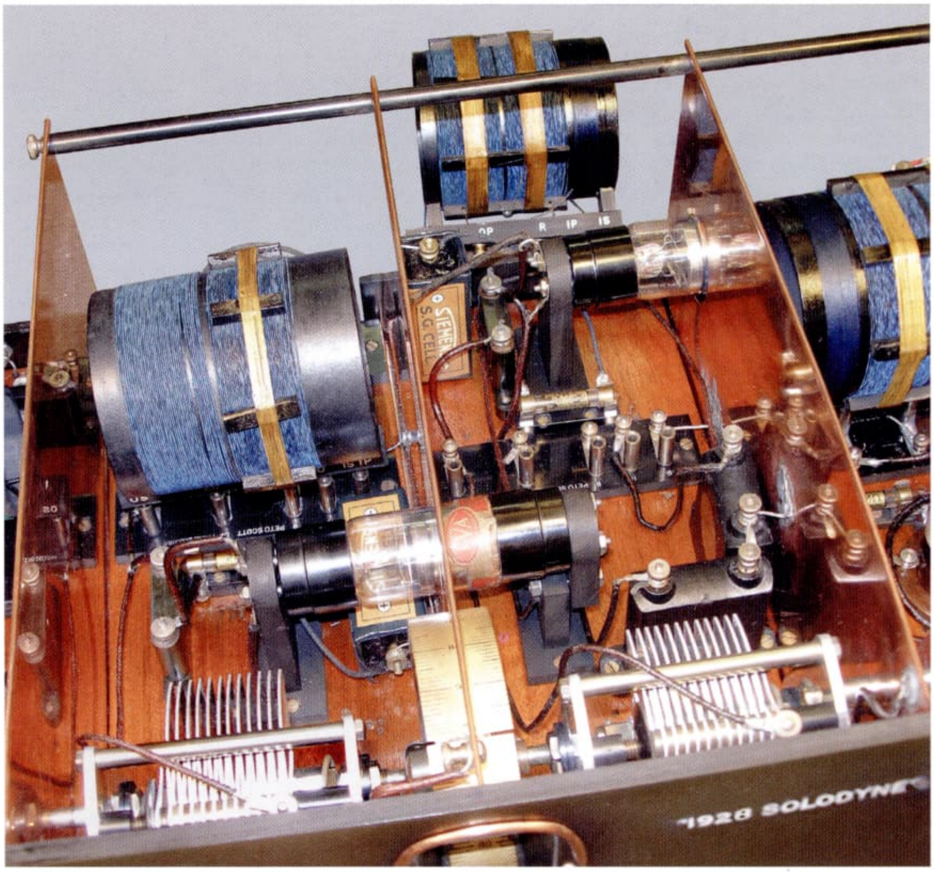
13: Broken hinge silver soldered and all hinge hardware replated



14: After restoration. Panel is just too oxidized to return to glossy black



15: Rear chassis view showing wonderful assemblage of parts



Horizontal mounting for screened grid valves & placement of bias cells

Letters

Dear Editor,
Just to let you know that my latest BVWS bulletin has arrived safely and packaged as last time, but I am pleased to say that this time it has arrived in perfect condition. Since you decided to publish my email expressing concern at what happened last time [Damaged Bulletin in polythene envelope - see Summer issue - Editor], I would be most grateful if you could also go ahead and publish the contents of this e-mail in the next bulletin with my thanks to Mike for the replacement sent for the one which was damaged.

Regards
Derek Burgess

Dear Editor,
Reading the article "A Tranny from Down Under" Richard commented about not being sure of the function of C8 and C11 capacitors in the IF amplifiers. I believe these are neutralising capacitors, they were common in transistor radios due to the Base/Collector capacitance.

You will probably get a much more detailed explanation from other members.

Regards
Frank Greenough

Dear Editor,
On the subject of posting the Bulletin, as discussed by Derek Burgess in the Summer issue, my copy was badly bent in the post. It seems a pity that such a beautifully produced document should be allowed to be damaged by inadequate packaging. I understand that the idea is presumably to minimise postage costs, but I for one would be prepared to pay more to ensure that it arrives in pristine condition. Please give this some consideration, perhaps with an option for those like me to pay the extra for better packing?

Best regards, and many thanks for the excellent quality of production.
Keith Barnes

Dear Editor,
Volume 39, No. 3, page 57
Although I have no dreams of fame and glory I must admit to being somewhat disappointed that there was no By-line giving my name under the item I sent on the Kirkwall museum.

perhaps you could correct this on a future issue?

Phil Rosen

Dear Editor,
As a way to raise the profile of the BVWS and our general interest in vintage radio and TV equipment, may I suggest members consider contacting their local newspapers?

I recently sent a couple of photos to the editor of Fakenham Sun with the caption: "Are these the oldest working TVs in the town?" with a brief note reading: "These are two of my recently restored TVs from the very early 1950s. If you'd like a to see and hear more of my rescued items of vintage 'home entertainment' technology for short piece in the Fakenham Sun, please contact me."

Within a couple of days the editor did contact me and arranged a visit where I demonstrated a selection of my restored radios and TVs in my workshop. The resulting article had a photograph, briefly described how I started, parts availability, the interference caused by modern electronics and how my 405-line sets can display any modern TV signal.

The piece ended with: "For readers interested in all aspects of vintage radio, television and broadcasting, visit the British Vintage Wireless Society website at www.bvws.org.uk"

If you decide to do this, your address won't be published and there's no need to have your photo included, just in case you're worried about security or unwanted public contact.

If possible, I'd strongly recommend you ask to see a copy of the article before it's published; it'll probably be written-up by someone completely non-technical and likely to contain a number of misinterpretations of what you said. Many papers won't give you that opportunity - but the Fakenham Sun did!

For the editor, such an article ticks a number of boxes; local resident, unusual pastime and nostalgia. It also makes a nice change from articles showing angry, frowning locals pointing at dog mess or potholes!

Regards,
Ian Liston-Smith

Dear Editor,
Do readers have a best estimate for the total number of distinct valve types ever produced? It's up to you if you want to consider say the 12AT7 and the ECC81 as the same type, and if you want to count or not count all the equivalents of say the EF91, as long as you state your assumptions in your estimate.

Best regards,
Stef Niewiadomski

Dear Editor,
re: GOSH! a Bush DAC10
I asked my husband to bid on the radio as both my sister and I were treated at Great Ormond Street Childern's Hospital in the 1960's and having recently lost our father who remembered the hospital in his will I thought it would be nice to add a further donation and add a lovely Bush radio to my husband's collection. He also has a connection in that as a Post Office Engineer he covered 'Red Court' the nurses home so called because of the distinctive red nurses uniforms in the 1960's.

The set was dismantled and the tuning scale backing repainted. He fitted a new mains filter cap and replaced the wax caps of which C23 proved to be the most leaky. The main smoother cap was also changed and one resistor was high in value. A further light polish with paste polishing No 5, silver polish to the plaque and a Bush badge finished it off nicely.

It sounds great with a lovely mellow tone. Its tuned to 747khz Dutch Radio 5 Nostalgia which gives a good strong signal here in East Kent.

Regards
Ruth & Steve Gadsden

THE IMITATION GAME

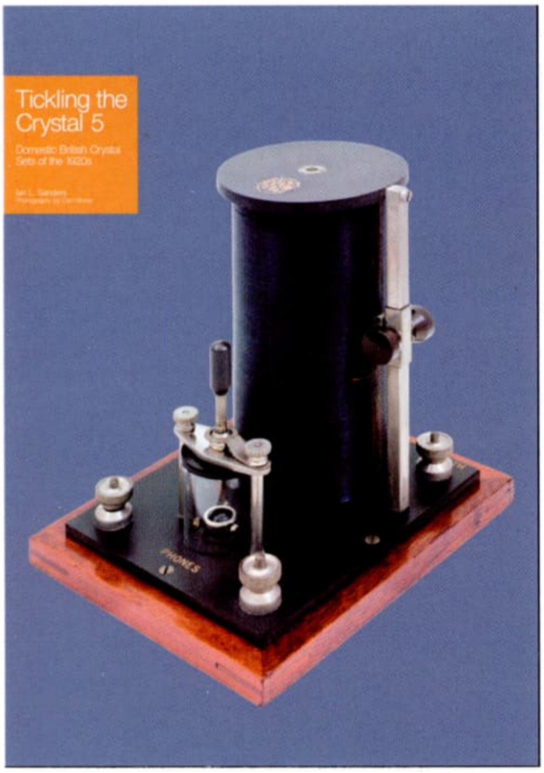
IN THEATRES NOVEMBER 20TH

The Producers of THE IMITATION GAME wish to thank all the individual radio and machine collectors for their help in the making of the film.

Special thanks to: RAF Henlow
The Old Radios Team
Bletchley Park
and The National Museum of Computing

BLACK BEAR PICTURES

BVWS Books



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Photography by Carl Glover

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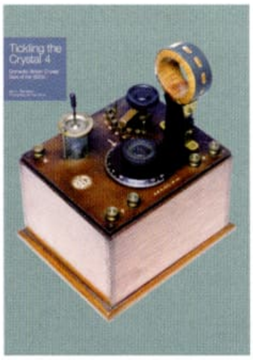

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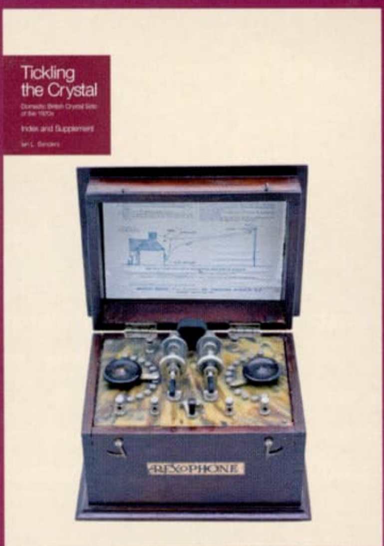
Out Now! Tickling the Crystal index and supplement



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7th December
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Contact Mike Barker: 01380 860787

News and Meetings

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

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telephone: 01252-613660 e-mail: martyb@globalnet.co.uk

2015 Meetings

February 8th AudioJumble
March 1st Harpenden
April 12th Golborne
May 10th NVCF
June 6th Garden Party at The Vintage Wireless and Television Museum, West Dulwich
July 5th Royal Wootton Bassett
August 2nd Punnetts Town
September 13th Murphy Day
September 27th Harpenden
October 4th AudioJumble
November 1st Golborne (changed from 8th due to Remembrance Day)
December 6th Royal Wootton Bassett

The British Vintage Wireless and Television Museum:
For location and phone see advert in Bulletin.
Harpenden: Harpenden Public Halls, Southdown Rd. Harpenden.
Doors open at 9:30, tickets for sale from 09:00, Auction at 13:00.
Contact Vic Williamson, 01582 593102
Audiojumble: The Angel Leisure Centre, Tonbridge, Kent.
Enquiries, 01435 830736
NVCF: National Vintage Communications Fair
See advert in Bulletin. www.nvcf.co.uk
Royal Wootton Bassett: The Memorial Hall, Station Rd.
Royal Wootton Bassett. Nr. Swindon (J16/M4). Doors open 10:00.
Contact Mike Barker, 01380 860787
Golborne: Golborne: Golborne Parkside Sports & Community Club.
Rivington Avenue, Golborne, Warrington. WA3 3HG
contact Mark Ryding 07861 234364
Punnetts Town: Punnetts Town Village Hall, Heathfield, East Sussex
TN21 9DS (opposite school)
Contact John Howes 01435 830736
Mill Green Museum: Bush Hall Lane, Mill Green, Hatfield, AL95PD
For more details with maps to locations see the BVWS Website:
www.bvws.org.uk/events/locations.htm

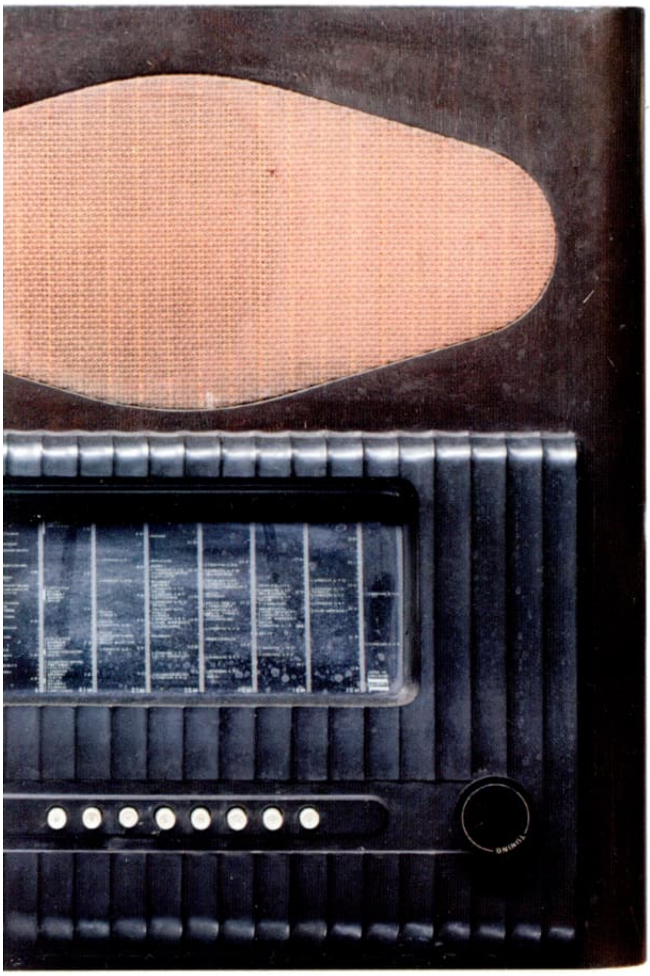
We want your articles!
Share your interests with your fellow BVWS and 405 Alive members.
We accept: Type, handwriting, fax, email, floppy disc, CD

Send your articles to: Carl Glover, 33 Rangers Square, London SE10 8HR
Tel/Fax: 020 8469 2904
bulletin_editor@bvws.org.uk

Sunday 10th May 2015
National Vintage Communications Fair
Warwickshire Exhibition Centre CV31 1XN

Free car parking! **Up to 250 Stallholders**

Normal Entry: 10.30am to 4pm **£10** (under-14s FREE). Early Entry: from 9.00am **£25**
No advance ticketing, all tickets on the door.
Event details plus downloadable stall booking form available at: www.nvcf.org.uk
Any enquiries: info@nvcf.org.uk or post: NVCF 13 Warneford Road Oxford OX4 1LT UK (enclose an SAE)




murphy
METRES 1000 1200 1400 1600 1800 2000
LONG
METRES 200 250 300 350 400 450 500 550
MEDIUM
MC/S 100 98 96 94 92 90 88
V.H.F.-F.M.
OFF ON VOL
TUNING
L M VHF