# The Bulletin

Vol. 38 no. 3 Autumn 2013

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

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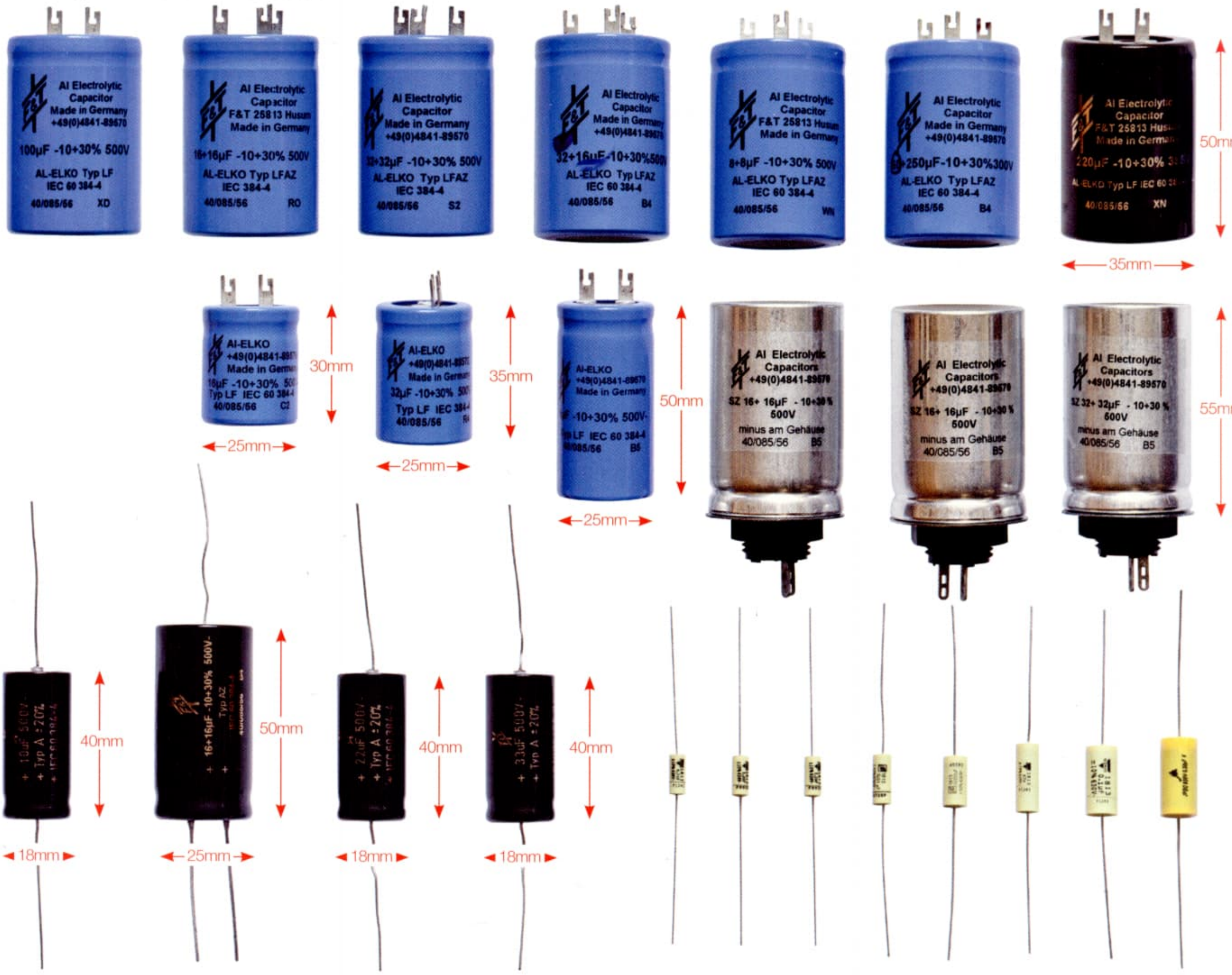


For non UK addresses, please contact Mike Barker for prices, (see below). All orders should be sent (with payment made out to BVWS) to: Mike Barker, Pound Cottage, Coate, Devizes, Wiltshire, SN10 3LG. Cheques payable to British Vintage Wireless Society. Please allow 14 days for processing, but usually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

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Front and rear cover: Various horn loudspeakers from the the British Vintage Wireless and Television Museum, West Dulwich, London.

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# From the Chair

The best laugh I have had for some time was given to me courtesy of the new BBC advert promoting Digital radio. A puppet, known as "D-Love" fires a cannon in his conquest to convert us, shooting a digital radio into someone's garden where it hits the ground with tremendous force and half buries itself. If only the advert had gone on to show the gardener firming it in and then watering it...

Whilst having a grumble about Digital Broadcasting, We are about to be dealt another blow by the 4G mobile telephone network which is already responsible for forcing many re-tunes of TV's and digi-boxes across the land. Now it seems that what grotty signal we do get may well be made worse by interference which requires the fitting of aerial filters.

Thankfully the problems with Radio 4 Long wave seem to have been fixed and the symptoms of 'over-load' on speech have gone making it very pleasant on 1930's Murphy's. If only they could now do the same on Classic FM! Here in Devizes, we have been getting very strange things happening around the 100MHz area. On several occasions Classic FM has faded away only to be replaced by a foreign station. One morning I was listening to the traffic reports from Milan. Another morning several times I heard a French station. Checking around, I find that I am not the only one who has experienced it, so you cannot blame my trusty work-horse Hacker Mayflower for that.

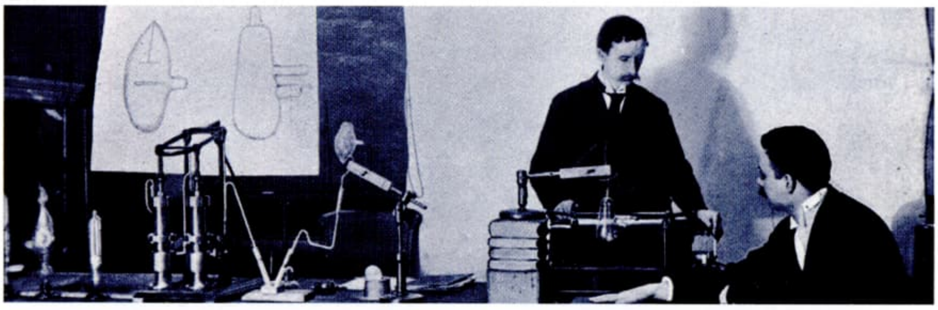
You will see that some of the postage costs for sending out books etc. have been increased. This is regrettable, but necessary due to the excessively complicated way the Royal Mail now calculates postage. Even the staff in our local Post Office are confused and have made up dummy boxes to work out what is a small, medium and large parcel. It would also seem that prices change depending on where you send it from. We sent out two of the same books, packaged in the same way, but just by sheer convenience, from different Post Offices. One was nearly 60p more than the other.

Postage is one of the largest outgoings for the Society at about £12,000 per year. As times are hard and this year has seen a drop in membership renewals, we have to look at making savings. We are actively seeking to make savings in this area and looking hard at what we do, and what we can afford. Whatever we decide will be reported in the next Bulletin. However, the Bulletin and its quality are assured together with something at Christmas.

An option for late renewals would be to charge a smaller amount, but not send out the previous publications of that year, and offer an earlier renewal of the next year at the same time. Perhaps set at the Autumn Bulletin and later.

Have you noticed that the BVWS has started trading on Ebay. The ID is "BVWS_Retail". The intention is to offer an electronic way of purchasing books and capacitors directly and being able to pay with PayPal. The item prices quoted will be "public" prices and members will be refunded the member saving (via PayPal) after the transaction has completed. This will be made clear in the Ebay listing. We hope this will encourage some new members as well. We are also continuing with electronic sales from the BVWS website, but this will come later when we have a secure method of doing things.

Mike...



## A A Campbell-Swinton talk at Harpenden 29th September 2013

Paul Marshall will give a talk about A A Campbell-Swinton in the small hall at about 12 noon. Campbell-Swinton proposed a television system based on cathode ray tubes in 1908. In 1911 he lectured on the subject in more detail. He died in 1930, before the advent of practical TV systems based on cathode ray tubes. Paul has done extensive research on Campbell-Swinton and has uncovered much new material.

# The R1155: Modifications gone mad

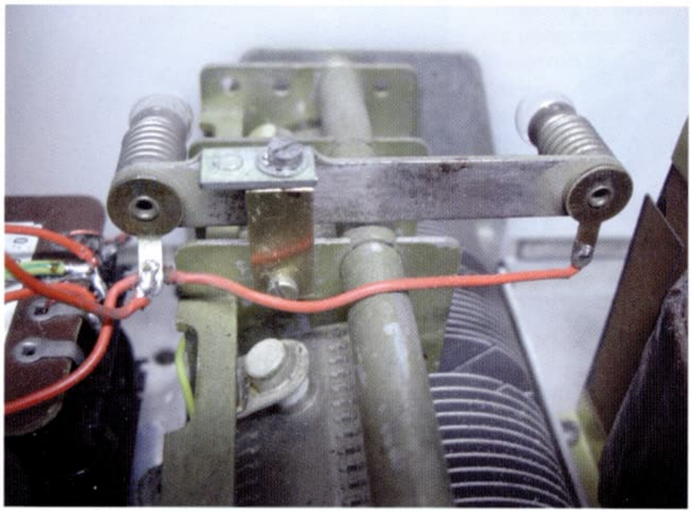
by Roger Grant

The radio I listen to in my workshop is usually my latest restoration project replacing the previous one. To qualify, it has to be an interesting set that looks and sounds good. The current set is the R1155 of my bulletin article Winter 2010. This really looks the part and sounds reasonably good but it lacks the mellow tone of a large speaker in a large 1930's wooden cabinet and the warm glow of an illuminated tuning dial that makes a set come alive. The R1155 does have the added feature of being a very sensitive communications receiver with three shortwave bands when connected to a long outside garden aerial. Whenever I find myself with the odd half hour or so to kill I like to sweep these bands, listening in to the rest of the world. Many countries broadcast in English and its nice to hear alternate versions of world events and some of the music played can be quite interesting. If I were to replace it with a domestic set, I would miss it's sensitivity with it's two IF stages and an RF amp stage, It's also quite a robust set just right for the workshop with no worries about it getting dirty or damaged. Quite a dilemma.

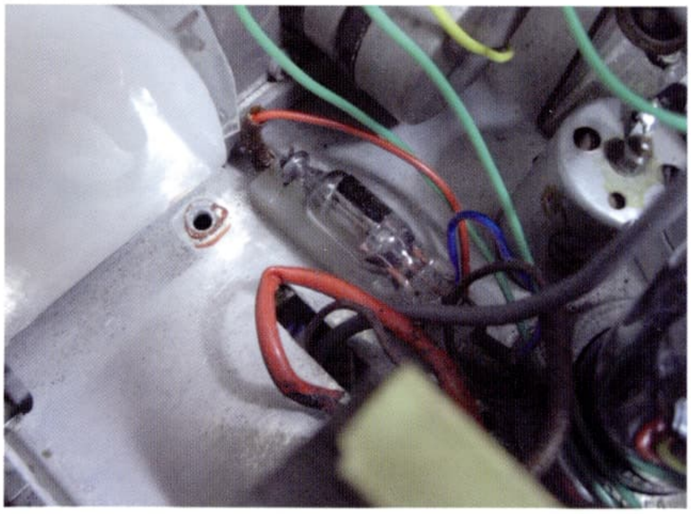

The answer is to further domesticate the R1155. I do have two of these sets, the second set mentioned in my article had more of its original direction finding components removed including the master switch and was already a lot closer to a domestic set, but still retained its communications capability. This set had a couple of outings to Harpenden with only passing interest so was going spare. As it had already been extensively modified, it would do nicely for this continued 'no holds barred' project, and I could keep the set in the original article as unchanged.

Adding an external speaker in an appropriate cabinet would be the first step to produce the required mellow tone. Most domestic extension speakers are a bit too small and I was reluctant to use a domestic speaker on a military set, so I looked for something a bit bigger, with around a 10" speaker and more fitting the period and purpose. I found the answer in the film 'Angels One - Five'. In the Ops room in this film there are three large speakers in cabinets featured in the chit-chat to the Spitfires and Hurricanes fighting the battle of Britain. They even have an RAF logo speaker fret, one of these would be ideal. I would think that obtaining one of these would be almost impossible but manufacture reasonably easily, just a wooden box and it would be nice to have one with this interesting speaker fret, so making a copy became irresistible.

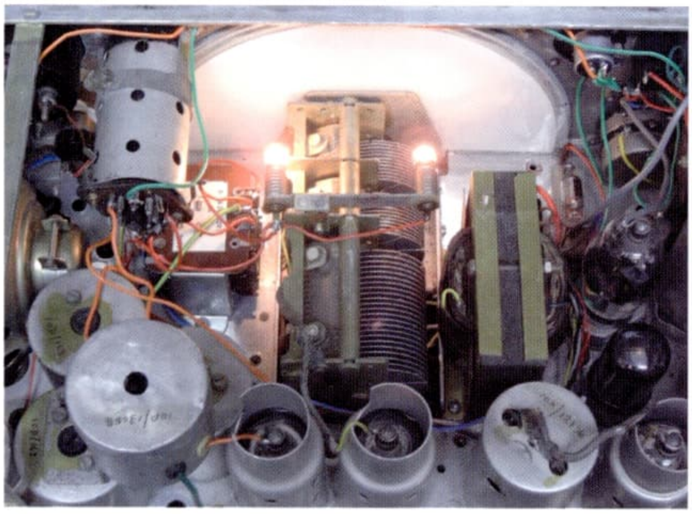
I started by pausing the film and taking a photograph. In the film the shot was at an angle, this made the speaker fret an ellipse, so needed manipulating, I cropped the photograph down to the speaker fret only and rotated it so that the ellipse was vertical. This was done in the Microsoft Photo Editor, a relatively simple photograph manipulator. Next, I imported the modified photo into my preferred drawing software Microsoft Visio. I then stretched the photo horizontally making the speaker fret round again, then used the drawing tools to draw over the top of the photo. When finished I deleted the photo just leaving the artwork for the speaker fret. This is the same process I use when making reproduction batteries or re-drawing circuit diagrams. With a Visio drawing it is easy to change sizes to suit the speaker and



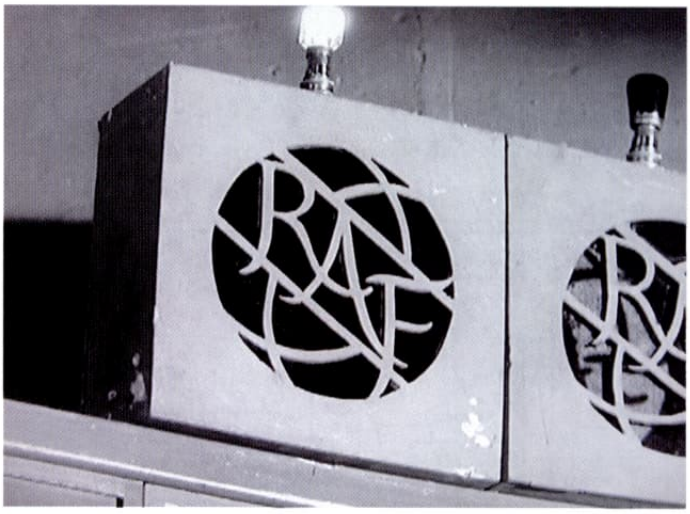
The dial lamp mounting pillar and arm



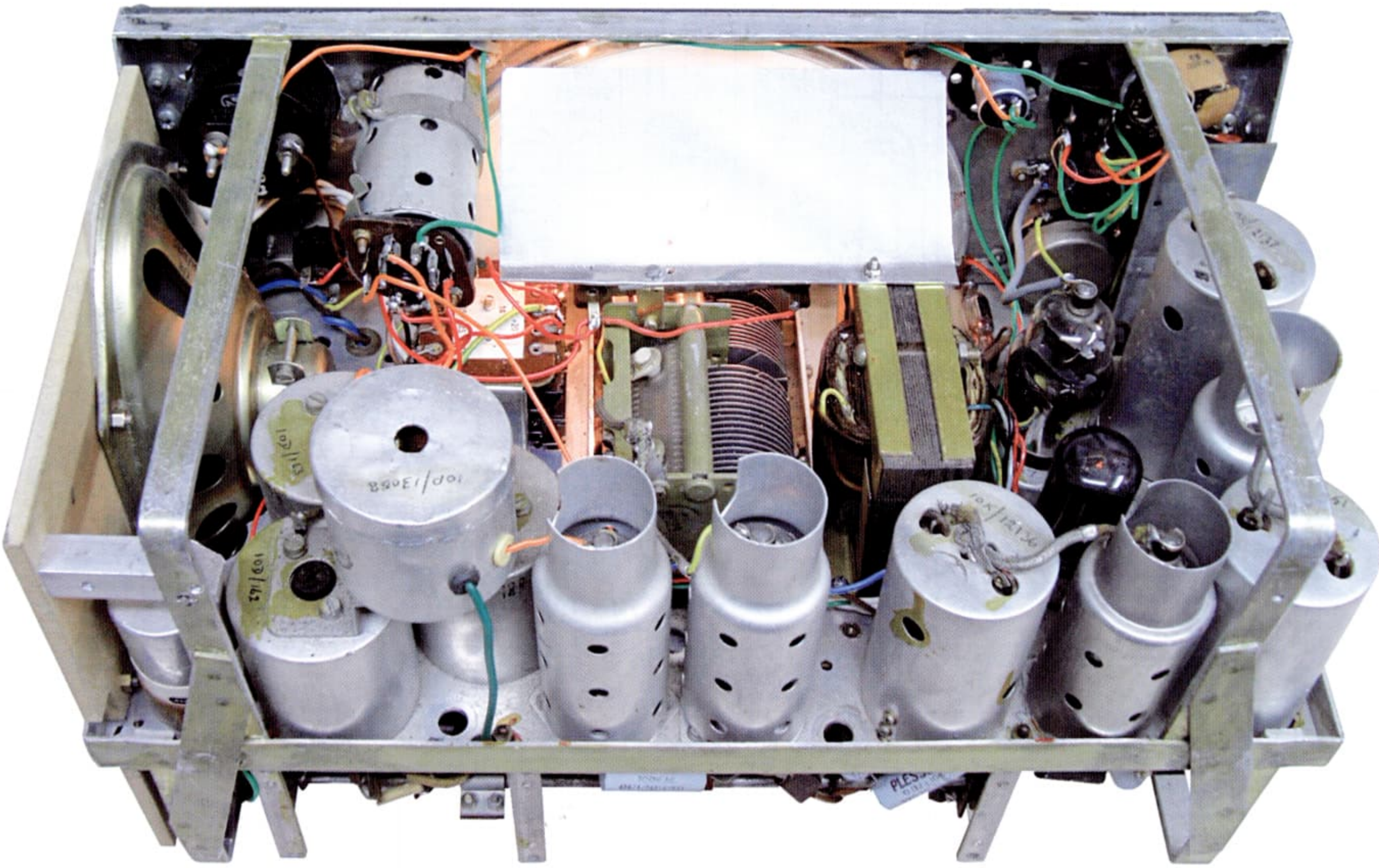
The new V7 EA50



Dial lamps "On"



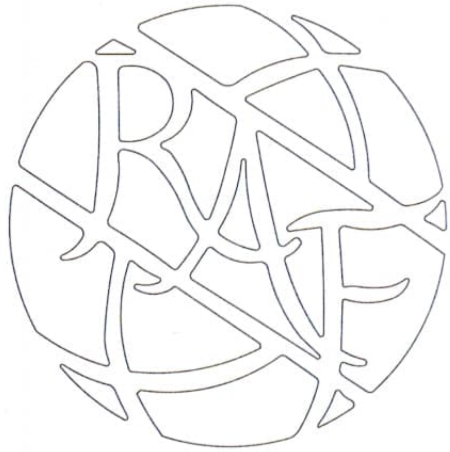
Speaker from the film 'Angels One-Five'



Completed chassis with components in place

Film image rotated vertically

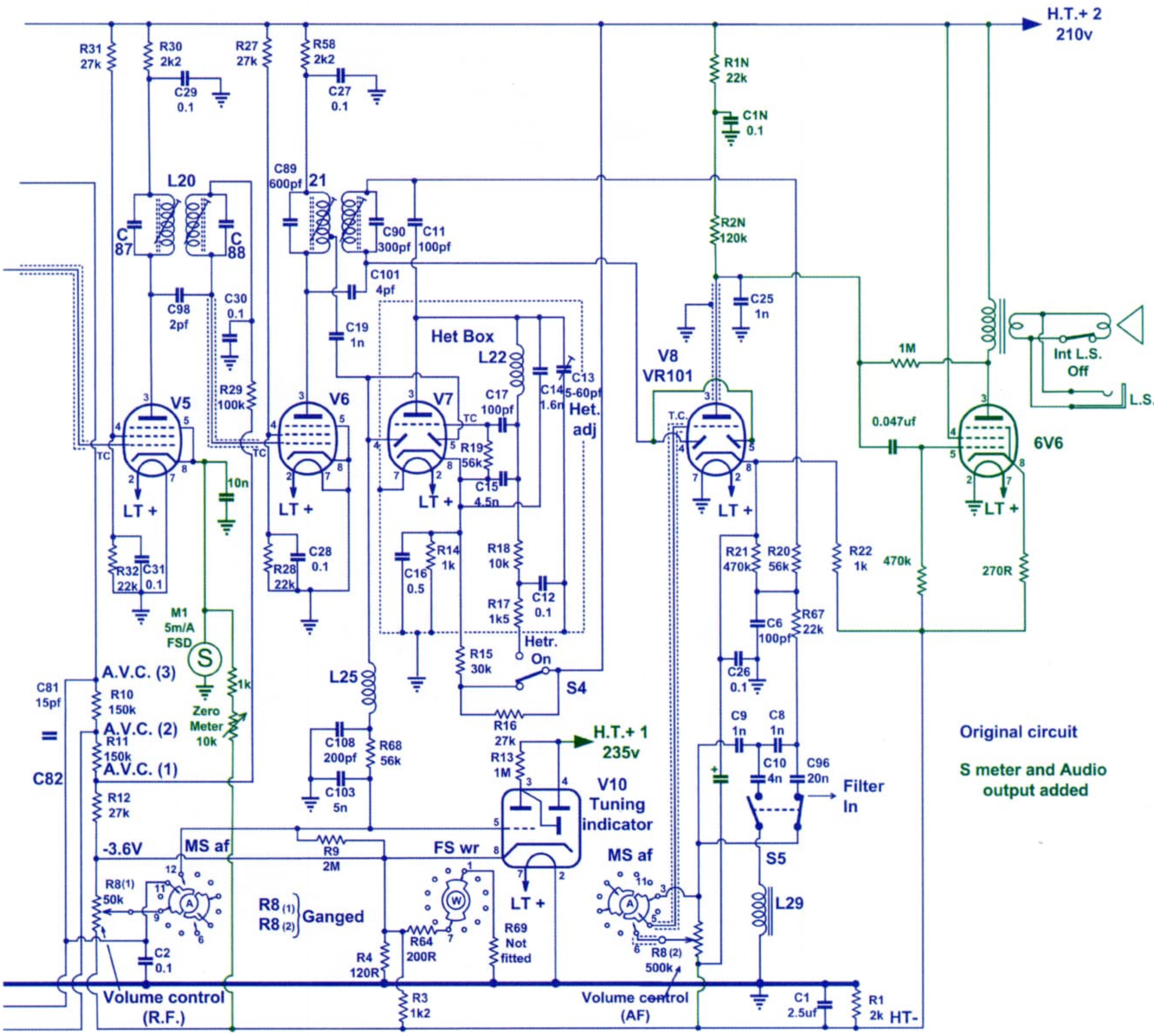
Tracing the outline of the 'RAF' speaker grille



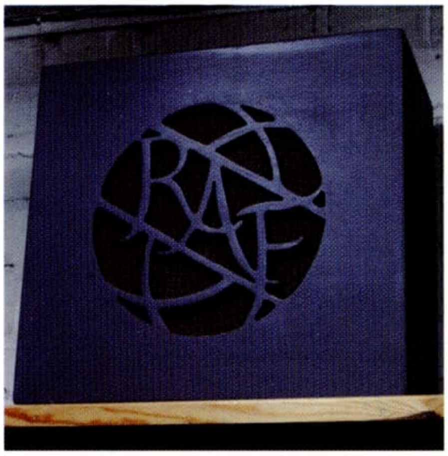
The finished outline

the box you are going to make to print onto a paper template. For my box I had a selection of 10" speakers ready to go. I purchased a 2' x 6' sheet of 9mm plywood from my local DIY shop and borrowed a joggle saw from a friend (some call it a scroll saw. I later purchased one myself, £60 available from several of the large DIY outlets), I then cut out the fret and made up the box. I did cheat a little by fitting a bass tube to the back of the box, nothing wrong with a little modern technology, improving the bass response and the first step to my final goal. Despite having fitted a 'top cut' control comprising of a .01 capacitor in series with a 500k pot across the primary of the output transformer, part of the original modification, the tone still lacked a little something so further tone modification was required. I didn't want to fit a conventional bass and treble control circuit, just a simple filter.

The set has an existing selectable filter




The original R1155 circuit



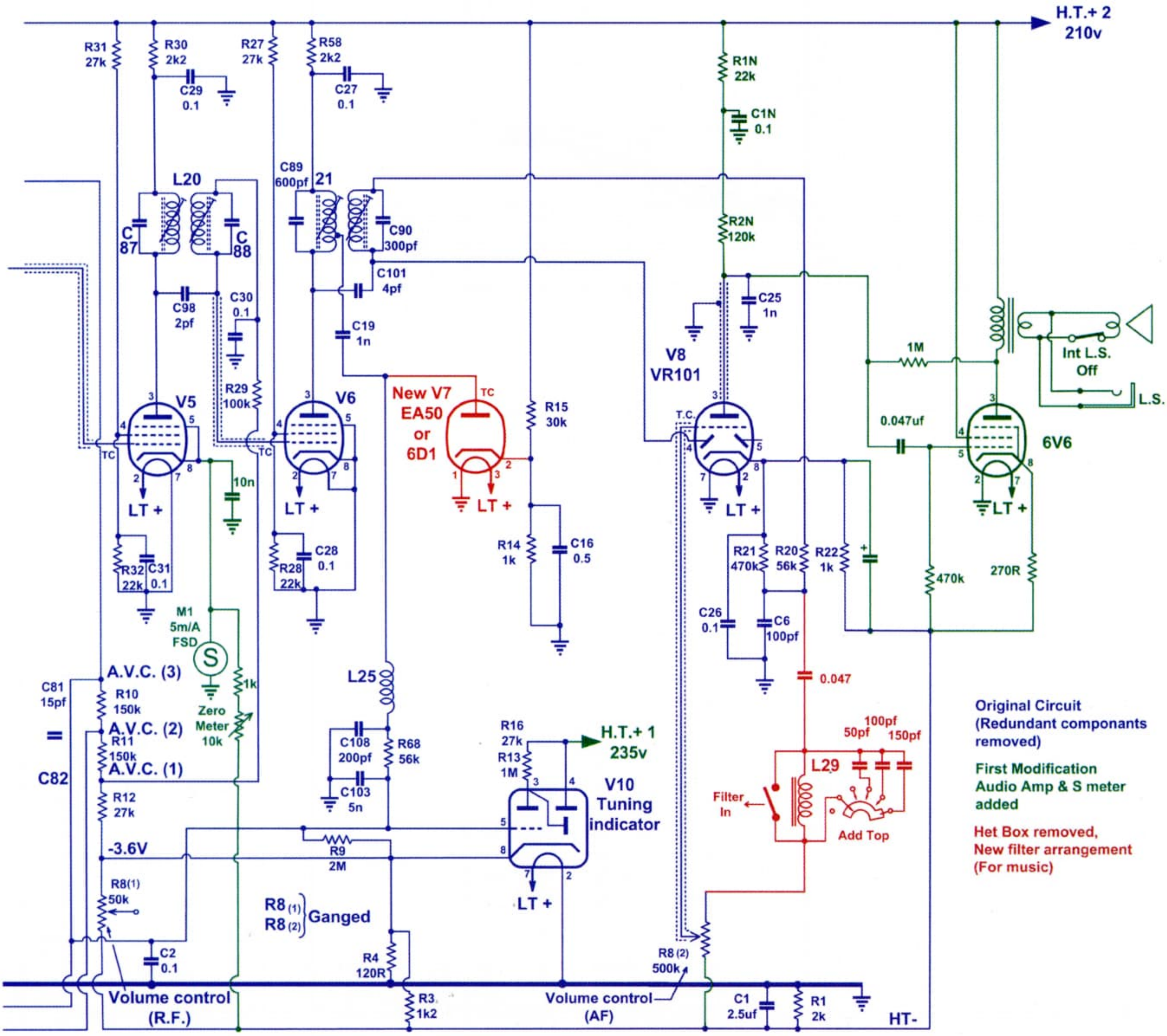
The completed RAF cabinet

network of resistors, capacitors and a choke L29 in the output of the detector feeding the grid of the audio triode. This is designed to enhance the clarity of speech and Morse. Switching in this original filter kills any bass and makes the audio response very peaky and tinny, not much use if you're going to use the set for listening to music, so this part of the circuit is unnecessary and needs some redesign. I started by connecting the detector output directly to the grid of the audio triode via a .047 capacitor, completely by-passing any filter circuitry and getting back to basics.

With the original filter in, the choke L29 dumps any bass response to ground,

> Now I'm doing serious modifications, I may as well go the whole hog and illuminate the large and colourful tuning scale, after all, it would be a shame to waste it.

exactly the opposite to what I wish to achieve. The frequency response of the choke appeared to be about right so wiring this choke in series with the audio signal will produce the opposite effect, passing only the bass frequencies, or at least that's the theory. This worked very well and all I need to do now is re-instate the very top audio frequencies. This was achieved by bypassing the choke with a small capacitor, about 100pf, this turned out to be a good guess and about right. This now created the flat top plateau audio response required, emphasising the bass and treble for a really good tone. This very basic new filter circuit was switched in from the direct coupling using the original filter switch on the front panel. I completely removed the 'Top cut' tone control on the front panel connected across the output transformer primary. This left a hole so I filled it with a four way switch, this switched in one of three treble bypass capacitors across the choke L29 controlling the treble response, replacing the top cut control. The three capacitor values are:- position 1. O/C, 2. 50pf 3. 100pf and 4. 150pf. I didn't get around to working out L29's inductance but its DC resistance was measured at 2k. All other redundant components were removed. This circuit with the purpose built external speaker really made this




Modified R1155 circuit

A second speaker constructed for my other R1155

set sound as good as the best of the rest and I had my 30's mellow tone.

Now I'm doing serious modifications, I may as well go the whole hog and illuminate the large and colourful tuning scale, after all, it would be a shame to waste it.

The original tuning scale is printed onto an aluminium plate. I had fitted a new tuning scale printed onto paper over the original as it had faded and discoloured. I removed the original plate and made a new one out of a piece of translucent Perspex I had to hand, alternatively I could have used a piece of ordinary Perspex with the back lightly sprayed with white primer. That had worked well on the tuning scale of an AD65 restoration some years ago. I printed a new tuning scale onto an acetate and attached this to the Perspex plate, this new tuning scale now capable of being illuminated from behind. Next, I fitted a brass pillar to the tuning condenser gang dividing plate and on this mounted an arm about three inches long with two dial lamp holders one on each end. I found the lamp holder arm in a junk box, this was salvaged from a non restorable wrecked set, ideal for the job, although to manufacture one wouldn't be too difficult.

The mains transformer was already stretched to its limit current wise, so I needed to fit a small 6.3v heater transformer to supply the dial lamps, the one chosen was a CRT boost type and has an added +20% winding originally intended to boost a tired tube in a TV set. I also used this extra winding to squeeze the last ounces of life out of a tired tuning indicator.

The next problem was the Het tone box, this cast a shadow across the first left hand quarter of the tuning scale, and so did the mains transformer on the right hand quarter, so some re-arrangement was necessary. Not having heard any CW Morse on short wave for a long time I decided the Het box could go, so out it went. This created a space further back out of the throw of the dial lamps and made space for a much smaller dial lamp heater transformer where the main mains transformer used to be. The two dial lamps now illuminate the tuning scale very nicely, but also show through the ventilation grille in the top of the case. This was an earlier modification, a previous owner had drilled random holes in the top of the case, probably as these sets run quite warm, this looked awful and I had tidied it up by fitting a grille.

This was remedied by fitting a piece of thin aluminium sheet attached to the dial lamp arm pillar and the end of the mains transformer clamp, folded at an angle of about 45 degrees. This shielded the light from the ventilation grille and reflected this lost light through the tuning scale. Removing the Het box caused another small problem, I now need to replace the AGC diode in the Het oscillator valve, now missing.

There's a spare diode in the same valve as the detector so I tried to use this, only to find that the cathode bias shut off the AGC, so I needed to fit an extra diode. Not wanting to use a silicon diode, I fitted an EA50 miniature valve diode, I had hanging around looking for a home. The heater was supplied from the original Het tone triode now removed. With this final problem now solved the set is back in service and in a designated permanent home. With much deviation from the original, the set now has all of the best features of any vintage radio.

As I like to listen to 40's, 50's, and 60's popular music, from Big Bands to Rock 'n' Roll, a good tone, not necessarily an accurate reproduction, is essential and the warm glow of the illuminated tuning dial makes all the difference.

# Table Top Sale at the British Vintage Wireless and Television Museum

Photographed by Carl Glover









# The Shape of things to come in 1961 by Stef Niewiadomski

*Wireless and Electrical Trader* magazine is best known as the source of the pull-out Trader service sheets that we use today for circuit diagrams and alignment information for the radios we collect and restore. Originals of these service sheets are still commonly available but as far as I can tell copies of the magazine itself haven't fared so well in terms of survival into the 21st century. This is a shame as it offers a useful history of the state of retailing of radios, TVs, and electrical appliances more generally, in the UK. Perhaps it was regarded at the time as a throwaway item, after removal of the service sheet, and few were saved for posterity. An annual Year Book was also published, and occasionally these can be found on Amazon and eBay.


Fig 1: Cover of the 23rd December 1961 issue of *Wireless and Electrical Trader*

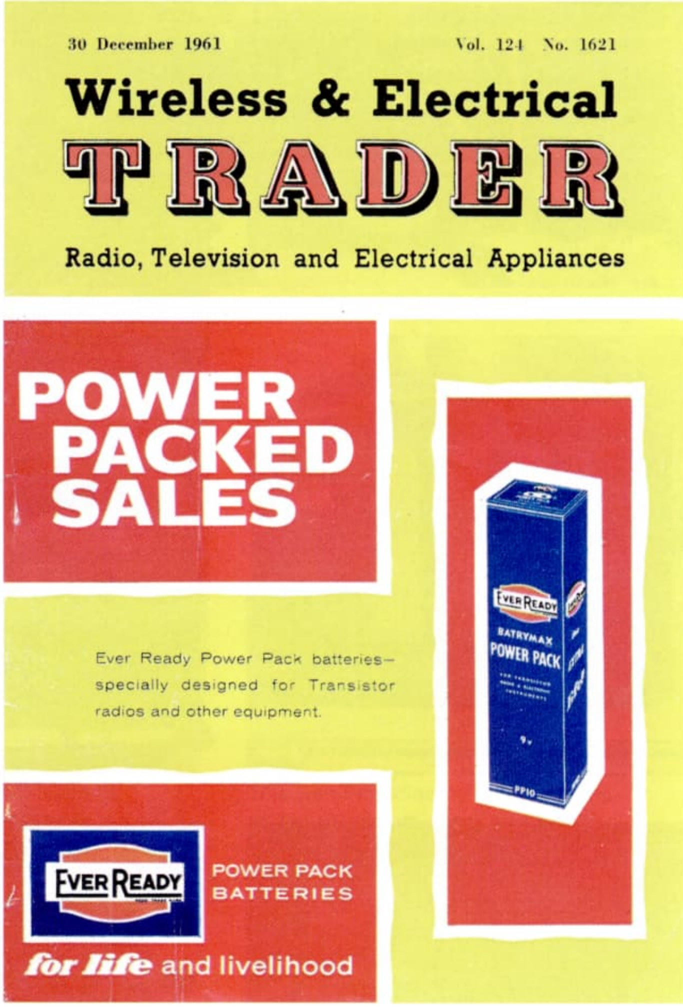



Fig 2: Cover of the 30th December 1961 issue of *Wireless and Electrical Trader*

I recently came across two editions of the magazine, specifically those for the 23th and 30th December 1961 – the magazine was published weekly – and a couple of items caught my eye that I thought pointed to the direction that electrical retailing was heading at the time.

Figure 3 shows an interesting announcement in the 23th December issue. Tesco (which had started retailing in 1919) were selling electrical appliances 'at cut prices' at the Auto Magic Shopping Park in Leicester. Perhaps the average trader reading this didn't allow his Christmas lunch to be spoiled: the quote from the dealer in Leicester town centre who wasn't too concerned probably summed up quite well what the vast majority would think. This was of course the tip of the iceberg: Leicester wasn't unique and other towns throughout the UK were beginning to see this revolution in retailing.

Car ownership was just beginning to take off, and more and more prospective buyers could now reach out-of-town shopping parks. Who could have anticipated that today we would be just as likely to pick up a TV or a computer from Tesco (or Sainsbury, or Asda, etc) as we are to buy our food? Of course the likes of Tesco eventually affected all small traders, and not just those selling radios, and other electrical appliances.

**Resale Price Maintenance**

The nub of the problem that Tesco was trying to tackle was neatly explained in the following week's magazine: see Figure 4 for a section from the editorial of that issue. As you can see the editor had the firm belief that Resale Price Maintenance (RPM) was a good thing and should be protected at all costs against attack by the 'discount houses'. RPM was the legal mechanism by which common selling prices were maintained, supposedly to protect small traders from the effects of price erosion. *The Trader's* editor was simply reflecting the view of BREMA, the trade organisation. When in 1964 the Resale Prices Act was passed, which then considered all resale price agreements to be against the public interest unless proven otherwise, BREMA believed the act was a threat to its members and briefed solicitors to prepare a case for exemption. The Act was strengthened in 1976, and books were one of the last items to have price maintenance removed, in 1997.

To us today the thought of controlled prices being open and legal seems strange (though we suspect this still goes on in some sectors), but the rationale was to try to protect small traders who gave additional services, for example maintenance and

## TESCO DISCOUNT STORE SELLS ELECTRICAL APPLIANCES

OPENING day for Tesco's Supermarket discount store-cum-multistorey car park at Lee Circle, Leicester, was December 12. The store occupies the ground floor of the Auto Magic Shopping Park, in which customers park their cars on the upper floors and descend by lift to do their shopping.

Tesco announced that electrical appliances as well as household goods and food would be sold at cut prices. A *Trader* representative who visited the premises on the following day found that a restricted range of small appliances was shown, all bearing price tickets showing substantial reductions on normal retail prices.

Typical reductions were: Ducal fan heaters £4 15s 6d normally £5 11s 6d, Belling electric fires £12 4s 4d normally £13 4s 4d, Hoover Junior cleaners £22 12s normally £25 12s 11d, Kenwood food mixers £27 8s normally £29 8s, and G.E.C. electric fires 19s 6d normally £2 3s 9d.

One dealer in the town centre who was interviewed stated that he was not unduly worried about the effect of the new store on his business because of the limited range of goods offered.

Fig 3: Announcement that Tesco were selling electrical appliances 'at cut prices' at the Auto Magic Shopping Park in Leicester

**Resale Price Maintenance.** The attack on price maintenance is intensifying and 1962 will be a crucial year. The discount houses are making a strong bid to destroy maintained prices—which we submit are essential in the case of radio, TV and electrical products of a "technical" nature on which after-sales service must be provided. Manufacturers *must* make firm and immediate use of their powers to uphold their published prices if the slide to chaotic marketing conditions is to be checked. Otherwise, overnight, damage may be done to the industry which may take years to repair.

Fig 4: The Trader's editorial on the subject of Resale Price Maintenance.

DO you want to sell your business? A prominent multiple retail group with extensive interests in radio and television is anxious to acquire established business in any part of the United Kingdom. Principals only are invited to write in strict confidence to Box 639, Wireless Trader. [S23

IF you are thinking of retiring or of disposing of your Radio, Television and Electrical Business for any other reason, you are invited to send particulars in strictest confidence to Currys, Ltd. (Ref. J.W.C.), at 77 Uxbridge Road, Ealing, London, W.5, who are interested in purchasing businesses of this kind in main shopping centres. [P5

Fig 5: Classified Ads of retail groups looking to acquire High Street radio businesses

Fig 6: Hoover's 'old age pensioners' employment arrangements in High Wycombe, from the 30th December issue

## LIGHT WORK AT HOOVER'S FOR PENSIONERS

For some time Hoover Ltd. have been providing light work for old age pensioners at their High Wycombe, Bucks, factory. The pensioners are employed on packing vacuum cleaner Disposall bags.

A group of older people in this Buckinghamshire country town has operated since July, 1955, a workshop where people from the surrounding districts are able to busy themselves with some occupation and to meet others in pleasant surroundings. The workshop was initially started in the local church hall and was opened two days a week.

Since this time the workshop has flourished and a large number of old people attend regularly. Payment received for the work done is passed on to the pensioners on an hourly basis after about 10 per cent has been deducted to meet the cost of heating, cleaning, stationary, and the provision of refreshments. The pensioners, who work from 9 a.m. to 3.30 p.m. are not bound by any contract to attend regularly, but for the record a book of attendance is kept.

repair of the radios and TVs they sold, from bigger stores who had no intention of providing these services. More generally, another aim of RPM was to protect the whole of British industry from cheap imports. Of course the price you pay is that consumers have to pay higher prices, and local industry tends to become lazy and uncompetitive - since it has guaranteed prices in its own country - and tends to discourage it from being competitive abroad.

### Acquiring high street businesses

Lurking at the back of the 30th December issue in the Classified Ads section was a small advert by Currys, see Figure 5. The company was formed in 1884 by Henry Curry as a bicycle building business and it started selling radios in the 1920s. In 1961 they were looking to acquire High Street businesses (they already had 330 branches at this time), as was an unidentified 'prominent multiple retail group'. Currys were bolstering their board of directors, including the appointment of some of the descendants of Henry Curry, presumably in anticipation of the expansion in business.

In view of the impending assault by discount sellers such as Tesco, maybe 1962 was a good year for the independent trader to get out of electrical retailing? Of course Currys did grow in the High Street partly by this mechanism for many years, but itself was acquired by Dixons in 1984, and was eventually seriously affected by that trading revolution of the 21st century – the internet, and had to close many high street stores.

Maybe any BVWS members who were in the trade at the time could comment on how much they anticipated the trade would change over subsequent years and whether they thought it was for the better or worse.

### Hoover's and Pensioners

Though slightly off-subject I couldn't resist including an announcement about Hoover's practice in their factory in High Wycombe, in the 30th December issue (see Figure 6). By today's standards this sounds rather condescending towards old age pensioners who needed to 'busy themselves'. But the arrangement seems to combine useful paid work with a social club. I'm not sure what the tax man would think of this informal cash-in-hand arrangement today. No doubt they would want to spoil the fun!

### References

You can see a picture of the Auto Magic Shopping Park in Leicester at: https://en-gb.facebook.com/Leicestermemories/posts/617611658266315.

# Super Wasp Mk2, A nostalgic fun project

Peter Lankshear

Recently I was reorganising my storage area and came across a project that I felt might, as a novelty, be of interest to Bulletin readers as one example of what can be done playing with early technology.

**Not every project has to be serious!**

During the early 1920's experimenters were discovering that sometimes spectacular results were achievable with the reception of low powered transmitters operating on frequencies above 2 mHz. However the only valves available were triodes, useless for shortwave R.F. amplification and consequently aerials were coupled directly into a regenerative detector. The most cost-effective valve circuit, of all time, was the now century old regenerative grid leak detector. A triode valve and a handful of components was sufficient to make an effective receiver and with one or two simple audio stages it was capable of serious work. Top of the range examples, for build quality, are the SE1420 and IP501 /A as described in the writer's article in the Autumn 2010 Bulletin.

Some remarkable shortwave results were achieved with similar low 'tech' equipment. In 1924 from England, G2SZ Cecil Goyder worked Frank Bell's New Zealand station Z4AA , a distance of almost 12,000 miles.

A major advance in technology came with introduction late in 1927 of the screen grid tetrode which was able to provide some R.F. gain without neutralisation. A landmark all wave battery powered receiver, Pilot's Super Wasp using a UX222 screen grid R.F. stage appeared in 1929, to be followed shortly afterwards by the mains powered AC Super Wasp.

At this stage, for some background, I recommend reading Gary Tempest's description of his superb restoration of his AC Super Wasp, featured in the Winter 2007 Bulletin.

**75 years on from the Super Wasp**

The project to be described is a regenerative TRF, directly descended from the AC Super Wasp and complete with plug-in coils but with ganged tuning, Noval based valves and built in speaker. Of course it was a fun project – no one in their right mind today would take a TRF too seriously. It was a real retro design intended to see just what could be done with 1930 technology.

This story starts in 1947 when I decided that I wanted to build a shortwave receiver that was a bit more ambitious than the usual small domestic set. What better than to build something of the nature of the ham receivers in the RSGB (Radio Society of Great Britain) and ARRL (American Radio Relay League) handbooks. Even at that time regenerative receivers were still being described. In fact there was still one in the 1968 RSGB Handbook! By the way both organisations are still in existence and have Internet sites. I settled on what the 1936 ARRL handbook, and QST magazine (the name is derived from the Q signal meaning "calling all stations") called "The Old Reliable" TRF. I didn't realise until recently that at that time the editor of


Construction of the coils for the SW2

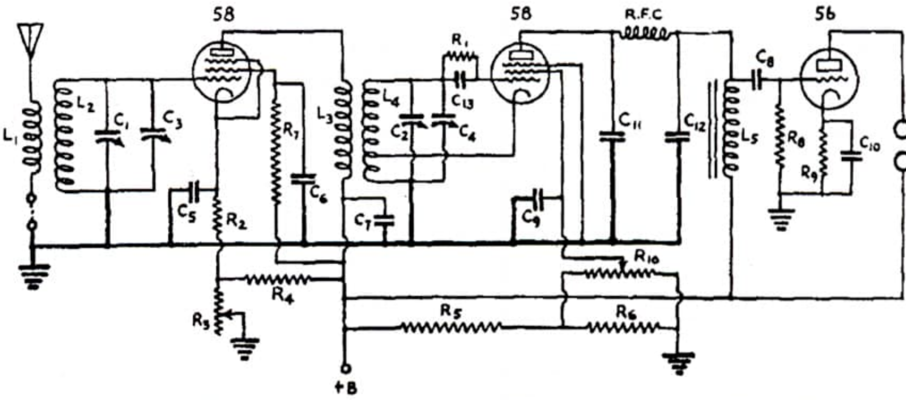
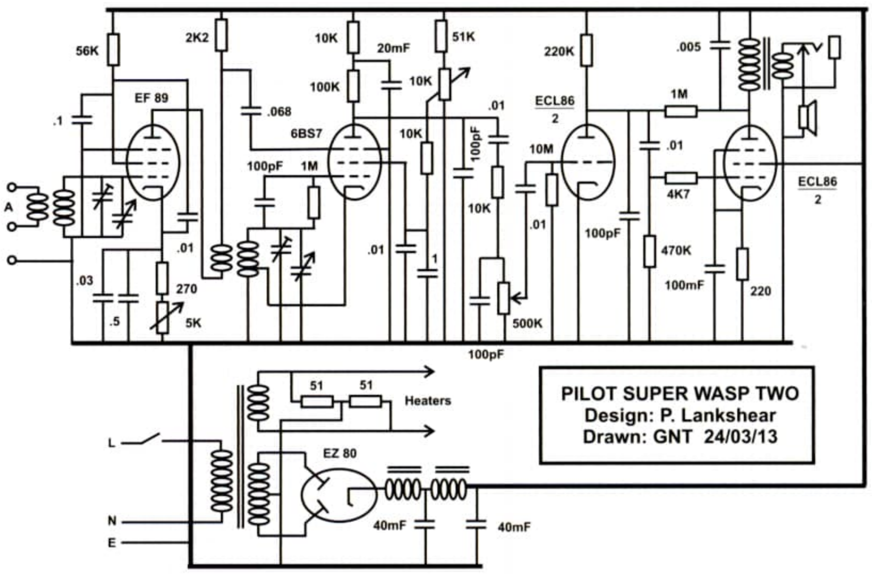


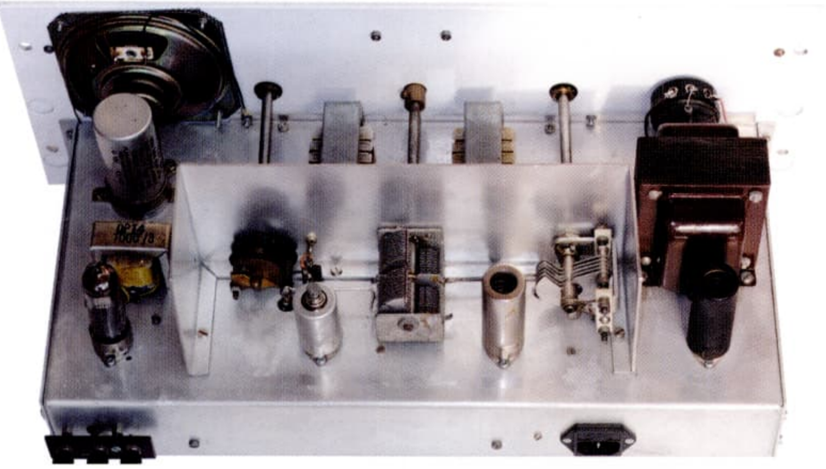

**FIG. 713-A — CIRCUIT DIAGRAM OF THE "OLD RELIABLE" RECEIVER**

Copied from the 1936 ARRL Handbook. The detector valve could also be a type 57.

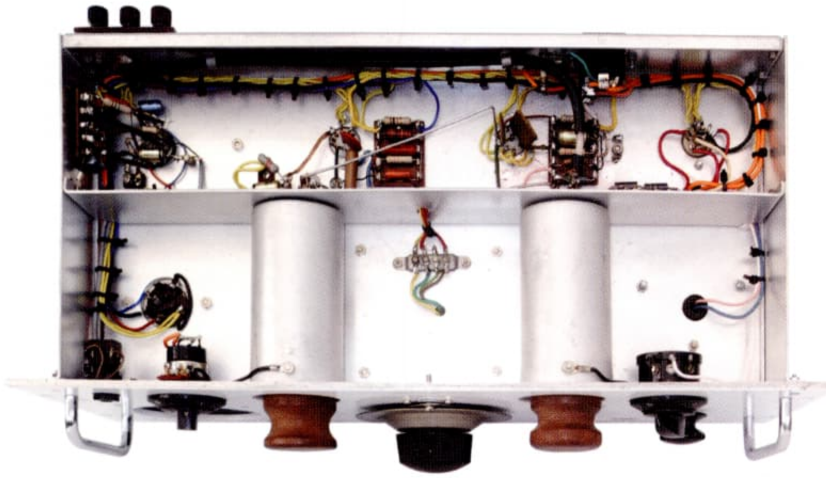



Super Wasp Mk2 Circuit

The Super Wasp Mk2 was built 75 years after the original



Note that, unusually, the Noval based detector valve has a grid cap



Modern components permit uncrowded wiring.

QST was Robert S. Kruse who had developed the Super Wasp for Pilot. His Old Reliable was not surprisingly based closely on the AC Wasp concept but using the improved 1932 series of 2.5 volt heater valves types 56,57 and 58.

I made a few minor modifications such as adding a loudspeaker stage, and it worked! And well. I had a lot of fun with it but eventually it was relegated to the odds and ends department and cannibalised. However, I never quite forgot it.

In 2006, in a bout of nostalgia I decided to make a second Old Reliable with modern valves just to see what it could do. A look around my bits and pieces collection produced more than sufficient to proceed. I found a case that had been used for some test equipment and which fitted a standard 19 inch rack panel. One thing that I had learnt was the importance of rigidity so I used a 5.0mm thick aluminium panel with 2.0mm thick aluminium for the chassis. The QST Old Reliable receiver had plug-in coils but as my cabinet has no lid I decided on front panel access for them. You can see the coil construction in the photo. Old UX and UY valve bases are a perfect size to take 1 ¼" coil former and in turn slide nicely into a piece of 1 1/2" polyethylene pipe. This might introduce losses in the coils but baking a piece for a few minutes in a microwave oven produced little heat, confirming its suitability. A woodworking friend turned up some functional 'pulls' for the ends. I had some suitable coil cans to serve as shields and it all came together nicely.

An EF89 pentode with plenty of gain (3.5 ma/v, more than twice that of the 58 used in my first project) seemed to be a good valve for the RF stage and a triode/pentode ECL86 would more than suffice for the two audio stages. With the gain now available, it was not necessary to have interstage audio transformers.

**Detector Problems**

At first it seemed obvious to go for a high gain detector and I selected an EF85 (6.0ma/v) as the regenerative grid leak detector.

The set certainly worked but regeneration was fierce and capricious and the whole thing was microphonic. Whereas my original receiver had been remarkably docile, this new incarnation was just about unusable. It was clear that the problem was the detector. I thought about it for a while and realised there would be no benefit in a high mutual conductance detector valve. My reasoning was that a regenerative detector has three functions. First it is a diode detector. The second is to supply positive feedback to raise the coil Q to the point of oscillation, and the third is to provide audio gain. Practically any valve will act as a diode and supply sufficient positive feedback for regeneration. Audio gain was no big deal as there was plenty in the 2 audio stages already. My first "Old Reliable" detector was docile and effective using a type 57 pentode. The 57, providing an audio gain in excess of 100 with low microphony, is the ancestor of a remarkably useful and versatile family of valves. There were numerous 6.3 volt versions with identical characteristics. Best known to readers in Britain will be the ubiquitous metal 6J7. Brimar had made two compact Noval based versions, 6BR7 and the 6BS7. Unusually for a Noval based valve the 6BS7 has a grid cap. Just why Brimar produced it I don't know. It could have been intended for microphone head amplifiers but it seemed ideal for my purpose. I imagine an EF86 would have also served well but I had a couple of new 6BS7 so I rewired the socket to use one. Success! Regeneration is now very smooth and stable with plenty of gain and the set deathly quiet with no aerial connected.

How well does the set go? Of course I couldn't compare it alongside the Old Reliable but it is considerably more sensitive and stable than the Super Wasp. Without an aerial, and screened in its metal case it is completely deaf, but a 10 inch aerial provides full output on the local Medium Wave stations. On shortwave, using a 50 foot long wire aerial, I find the 10 mHz WWV transmission, from the US National Institute of Standards and Technology in Colorado, provides a good test signal source, down here in NZ, as the modulation is constant. In receiving WWV, apart from the lack of AGC the Wasp Mk2's performance is comparable to an Eddystone 640, an entry level communications superhet with a single R.F.Stage. Of course the Eddystone 940 described in the Spring 2013 Bulletin, beats it – but so it should.

Not bad for a set with a basic design over 80 yrs old. In conversations with some of the Old Time hams I learnt that they considered that for CW (Morse) DX the regenerative TRF was often better than the early superhets and it was the mainstay of many prewar ham stations. However, ease of tuning and knife edged selectivity favoured the superhet when they matured and became affordable.

Acknowledgement: Thanks to Gary Tempest for drafting the circuit diagram.

References:

Winter 2007 BVWS Bulletin: *Restoring an AC Super Wasp* by Gary Tempest.
Autumn 2010 BVWS Bulletin *The SE1420, IP501 and 501A Marine Receivers.* by Peter Lankshear.
1936 The ARRL Radio Amateurs Handbook.

# National Panasonic component television receiver TR565G

by John R. Sully.

The previous articles about the Dinosaur/Celestion Telefi and Motion Electronics Television Sound Monitor had constituted all that I intended to write for the Bulletin concerning improvements in audio sound quality available from broadcast television signals. However, the articles have initiated some interest and comment, including the postscript by Tony Clayden featured in the Summer 2013 Bulletin. So to further complete the story, this short piece briefly describes the Japanese made National Panasonic equipment that succeeded the British designed and manufactured Telefi and Television Sound Monitor devices.


Fig 1: National Panasonic TR565G

In fact, in the last article I mentioned two devices that appeared to have become available in the early 1980s, the Arcam Delta 150, and the National Panasonic TR565EU. I have never seen an Arcam 150 in real life, and the National Panasonic TR565(x) was the designation used for a device sold across many regional markets. The suffix (x) determined which countries the device was intended for. TR565EU appears to be the generic device for the European market, but there was a version specifically for the U.K. market designated TR565G. A picture of the device can be seen in Fig 1. As is instantly obvious, it has a small (5" diagonal) cathode ray tube screen, but it is not simply a small television.

The TR565G was introduced to the U.K. market in 1978, only a couple of years after the Telefi and Television Sound Monitor. However the custom dimensioned cabinets of the aforementioned devices have given way to a standardised folded steel black box, which is designed to match the hi-fi separate systems which were becoming the trend at the time. Many Japanese manufacturers marketed hi-fi systems in the late 1970s/early 1980s in matching units of about 16 ½" width. Earlier systems retained the brushed aluminium front panels popular in the mid 1970s, but these gave way to the newer trend of black panels. (Subsequent to this the standard of about 16 ½" width of separates changed to approximately 13 ½" width as a result of ongoing component miniaturisation, and then became known as 'midi systems'). So the TR565G would have matched nicely, particularly if the owner had bought other National Panasonic gear, as many of these systems were supplied in sets to complement each other by retailers such as Currys and Comet. Although I have been able to find some advertising relating to National Panasonic audio systems, there seems to have been a far greater prevalence of Technics advertising. Today surviving Technics hi-fi components are far more commonplace than National Panasonic branded survivors, suggesting that Technics was the main brand name used by the National Panasonic group for audio components in the late 1970s. The TR565G looks as though it would have matched existing Technics products. The U.K. version has a Rosewood wood-effect covering applied to the top main steel body of the device, perhaps to enable the unit to blend in with the home and/or other older hi-fi equipment. Versions intended for other markets in Europe appear not to have the wood-effect added, but are supplied sprayed entirely black.

I mentioned earlier that the TR565G is not a television, which readers may find a surprising statement bearing in mind the obvious inclusion of a screen. However, by definition I would say that to be described as a television receiver it must have an audio output via loudspeaker or similar. The TR565G does not have any loudspeaker or sound monitoring equipment; it only provides an audio component signal via the phono socket to the rear of the cabinet. One might well wonder why National Panasonic has gone to the trouble and expense of providing a screen. I don't have the instructions with my example, so I cannot be definitively sure. Perhaps purely to monitor the signal? To confirm that the right channel is being listened to? Maybe to help with fine tuning the signal? Possibly to monitor signal performance/degradation via the picture quality? None of the aforementioned seem convincing to me, certainly not enough to justify the cost of picture equipment inclusion, but I cannot think of any other reasons. The picture display can be turned off by a pushbutton on the front panel.

Arguably the TR565G is not as user-friendly as the Motion Electronics Television Sound Monitor, because the latter used push-button tuning, whereas the TR565G requires manual tuning with a rotary tuning knob each time a programme on a different channel is to be listened to. Like the Television Sound

Monitor, the aerial input lead will also need splitting or alternatively the provision of a separate aerial source. It should be remembered that the National Panasonic unit cost twice as much as the Motion Electronics Television Sound Monitor. This U.K. version incorporates a UHF tuner alone, not surprising as anyone interested in high quality television sound would be unlikely to still be utilising the 405 VHF television service by then. I note that in some of the European versions of the TR565 a VHF tuner is incorporated as well as a UHF tuner.

In use the sound quality is very good indeed, subjectively I would say better than the Telefi and Television Sound Monitor. However I have not conducted side-by-side tests, and once at this level of quality direct comparison is the only way to really determine performance. As previously mentioned, the audio (mono) component for connection to a hi-fi system is provided by a phono socket on the rear panel. The rear panel (Fig 2) also accommodates either dipole or coax aerial input socket, together with a slider switch to move between 300Ω and 75Ω. There are also two occasional controls for vertical and horizontal hold adjustment. The front panel has the main channel tuning knob, together with brightness and contrast controls for the crt monitor. The TR565G is assembled upon a single printed circuit board accommodating 24 semiconductor devices with individual component identification (Fig 3). The crt, UHF tuner and mains transformer are individually mounted within the case. It looks as though the internal components could have been confined to an even smaller footprint, but matching the case width of approx. 16 ½" to other hi-fi components results in some unused space.

The TR565G cost £110.95 in 1978, a price which seems surprisingly low for such a specialist item able to also fully display a television picture. By way of comparison, a Technics (same manufacturing group) moderate quality amplifier (model SU2300) cost £63 at the time, and complete popular sound system (pre-selected) combinations seem to be mostly in the range £250 - £450 judging by contemporary Comet advertising.

Tony Clayden concluded his article by saying that he has donated his Television Sound Monitor to the British Vintage Wireless & Television Museum. So that the BVWTM has examples of both the main British designs I will therefore donate a Telefi to the Museum collection.

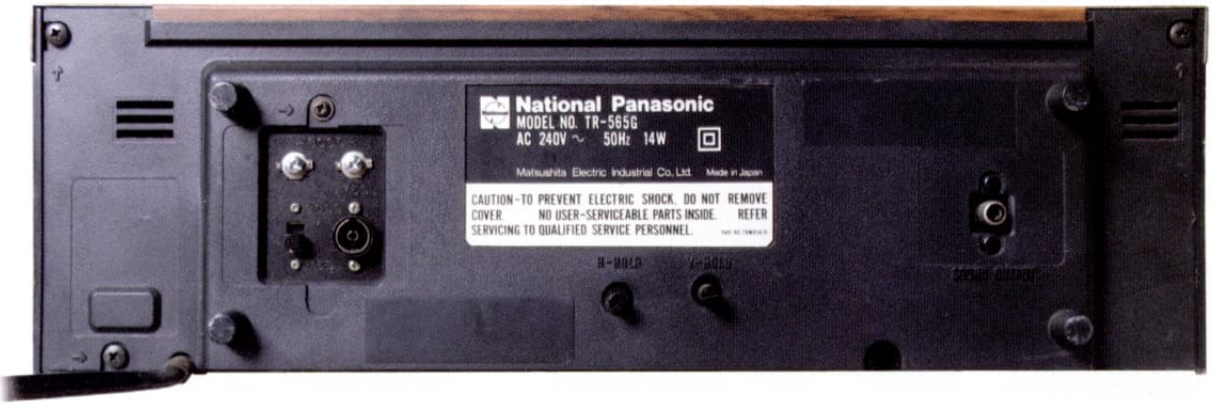
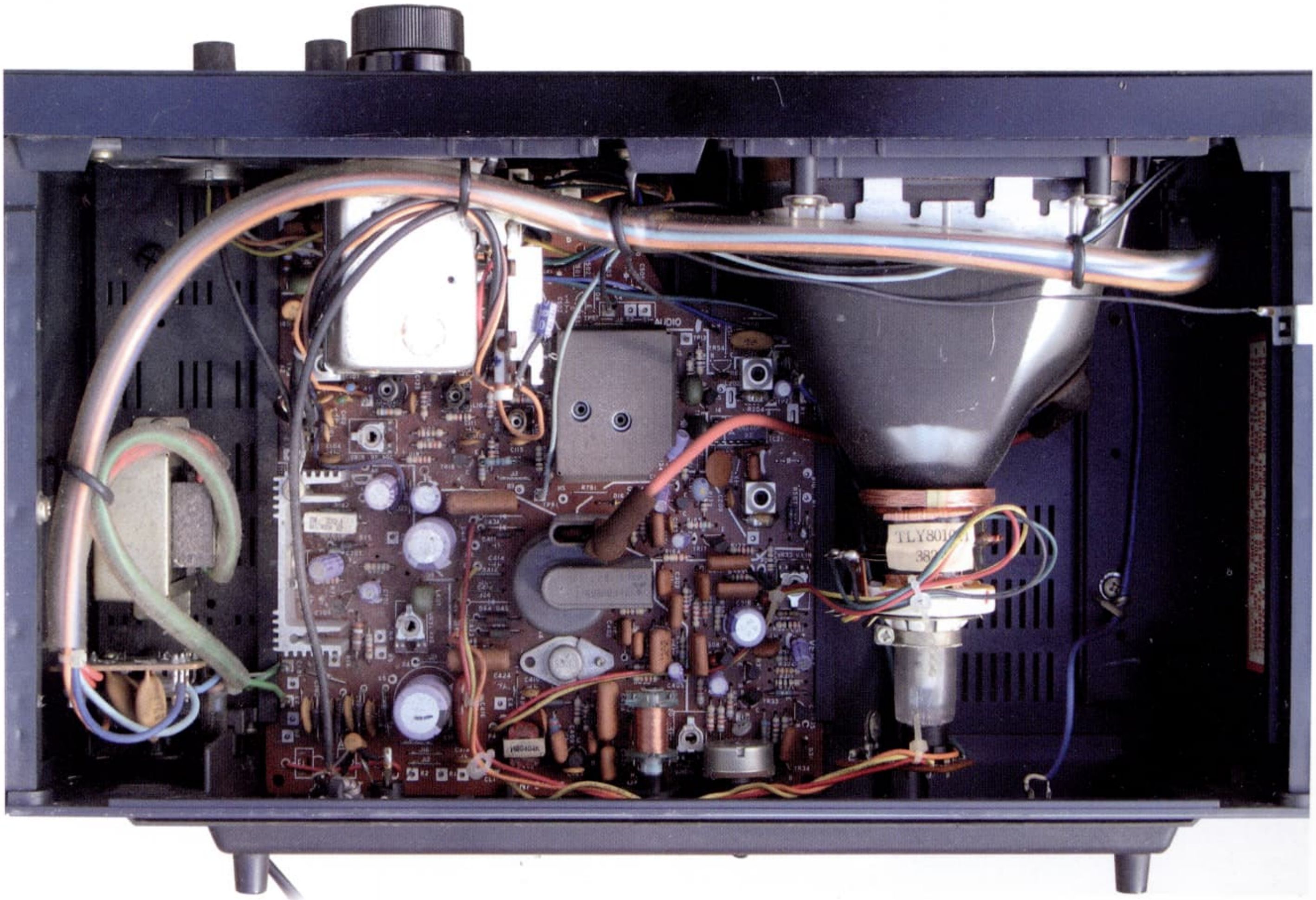
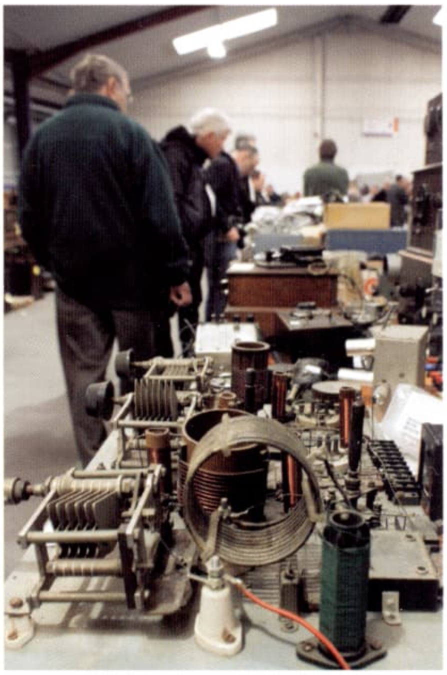


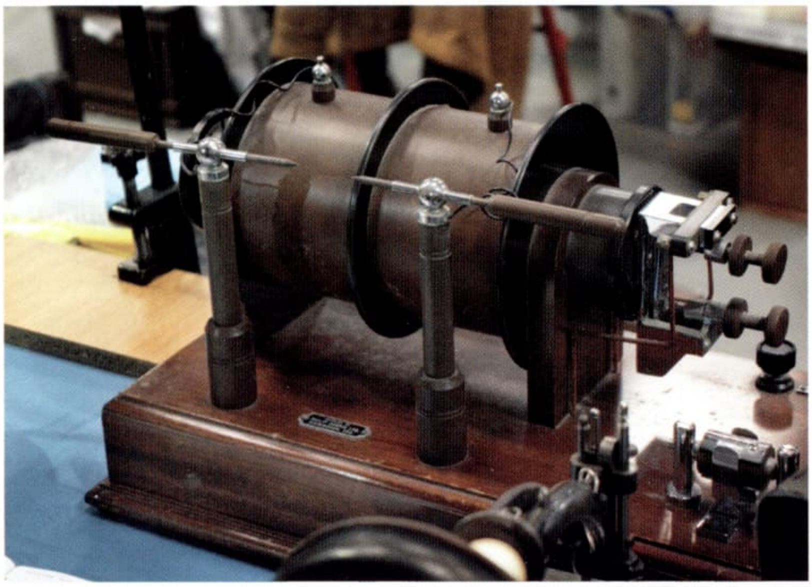

Fig 2 (left): TR565G Rear panel

Fig 3 (below): TR565G Internal view



# NVCF, May 2013 Photographs by Richard Hetherington












BBC

# The Pye P131MBQ 'Jewel Case' mains/battery attaché radio

by Stef Niewiadomski

It isn't often that you come across a mid-1950s radio in almost factory-fresh condition. I couldn't resist this Pye P131MBQ at the BVWS auction at Royal Wootton Bassett in December 2012. As you can see from the general view in Figure 1 the front panel and case are in very good condition and only the carrying handle shows sign of wear. Bearing in mind that by definition portable radios get carried around, with the accompanying risk of knocks, drops and accidental damage, this example must have been very carefully handled and perhaps spent most of its life static on a sideboard, running from the mains.

Another factor in the survivability of valve portables is what happened when the necessary batteries were no longer available. If the radio could also be powered from the mains, as is the case for the P131MBQ, then there was at least the option of using it in the home as a 'static' radio, maybe in the bedroom or kitchen. Radios that were purely battery powered ran the risk of being thrown away, or at best being relegated to the loft or shed.

This model was introduced in May 1955 at the price £13 5s 4d, purchase tax and batteries extra. The medium and long waves are covered, with an IF of 470kHz. Judging by the number of these radios that come up for sale today – I can see three on eBay now - they must have sold very well at the time and have been reliable and well valued over the years. The front panel (see Figure 2) consists of two shiny chrome-plated strips separated by a gold-coloured band containing the speaker grille and tuning dial. The four clear plastic control knobs (with gold inserts) – Mains/Off/Battery, Volume, Tuning, MW/LW – run across the lower chromed strip. I've seen examples of the radio where one or more of the gold inserts to the knobs is missing, so maybe they are not fixed in as well as they should be. I think the panel is very well designed and attractive, and this combination of silver and gold is the origin of the "Jewel Case" name.

As with many portables of the day the case of the radio is covered in 'Rexine', an ICI product. According to ICI's adverts to the trade: "Rexine is handsome as well as durable. It will not easily scratch or tear and it can be washed clean with soap and water. Models styled in 'Rexine' gain in sales appeal. Good looks count for a lot with the customer". The P131MBQ was offered in three colour schemes, specifically white squares on green with a dark red band; grey lizard with a blue band; and a white pattern on lilac with a band of white polka-dots on grey. The case of my radio is the latter scheme, as can be seen in Figure 3.

Fig 1: General view of my P131MBQ with the lid open.

## Evolution from suitcase radios

Attaché radios were an evolution from pre-war portables, which in general were rather like suitcases in style, weight and size. Even some of the immediately post-war and early 1950s portables which are considered to be attaché in style and size were rather heavy as they made use of metal (mostly steel) cases, chassis and front panels, and accommodated large and heavy batteries. The introduction of low filament current (first 50mA and then 25mA) valves allowed batteries to get smaller and lighter. Cases became lighter as wooden construction largely replaced metal, and plastic started to be used for front panels. It was not until the late-1950s/early-1960s that transistor portables arrived where a 100% plastic case became the norm, and even then some early transistor portables used wooden cabinets (see for example the Decca TP22 of 1959, as described in The BVWS Bulletin for summer 2013).

In any 'case' radio, attaché or otherwise, the lid was a very handy place for the frame aerial, allowing it to be deployed with its plane vertical, when the lid is open. Once the frame aerial had evolved into a ferrite rod for the vast majority of portable radios, there was much less need for a lid, and hence the rectangular and lid-less shape of most transistor radios.

## Successor

The P131MBQ was the successor to the P31MBQ, introduced in September 1951, and using the DK91, DF91, DAF91 and DL94 'standard' line-up of 50mA filament valves. The letters 'M' and 'B' stand for 'mains' and 'battery': the 'Q' is more difficult to attribute, but I think it celebrates the 'Baby Q' range of radios, which had been Pye's brand for its portables from the late 1930's until about 1950.

The new valves (the 96-series of valves was introduced in 1953) used in the P131MBQ gave a distinct advantage over


Fig 2: Front panel of the radio. The lid-operated On/Off switch (which only operates in battery mode) can be seen at the left hand side of the gold band. The chromed screw by the lid is used to lift the chassis out of the cabinet, assuming its captive washer is still intact.

Fig 3: The colour scheme on the case of my radio, a white pattern on lilac with a middle band of white polka-dots on grey. The rather narrow slot for the mains plug can be seen.


the 'old' valve technology in terms of battery life and size, and it was well worth the effort for Pye to design a new radio, and of course pretty much commercial suicide not to.

**Contemporaries and evolution**

This style of radio was very popular at the time and several manufacturers offered similar products. The 96-series valve line-up was identical (apart from some manufacturers using equivalents, such as the Mazda 1C3 for the DK96, etc) and some offered ferrite rod aerials, while others persisted with lid-mounted loops. Manufacturers tended to offer a battery-only radio, and a mains/battery version, this sometimes being an AC-only model using a mains transformer, or sometimes a transformer-less arrangement and therefore able to operate from AC or DC mains.

One example of a very similar radio to the P131MBQ was Vidor's CN430 Lady Anne AC/AD (all-dry, see later for the significance of this) medium/long wave attaché portable, released in January 1955 and priced at £14 14s 2d. This used the same valve line-up, and a transformer and full-wave metal rectifier in its AC-only power supply.

Just a few months after the P131MBQ, Pye released the P114BQ (still described as a "Jewel Case") and as the lack of an 'M' in the model number indicates this was purely a battery-powered set. Again it used the 96-series of valves: the simpler power supply circuit and the fact that it used printed circuit board construction meant it could sell at the lower price of £9 9s 6d. The move to a PCB for this radio, even though it was still valve-based, was

Fig 4: Advert for the M131MBQ, also showing Pye's contemporary radio the P114BQ, a battery-only radio. Also shown is the P94MBQ/LW upright radio, sometimes referred to as the 'Intercontinental' because of its RF stage and short wave coverage. Note some of the aspirational activities that an owner might enjoy, including air travel! Reproduced by kind permission of Mark Johnson, author of *Attaché Radios*.

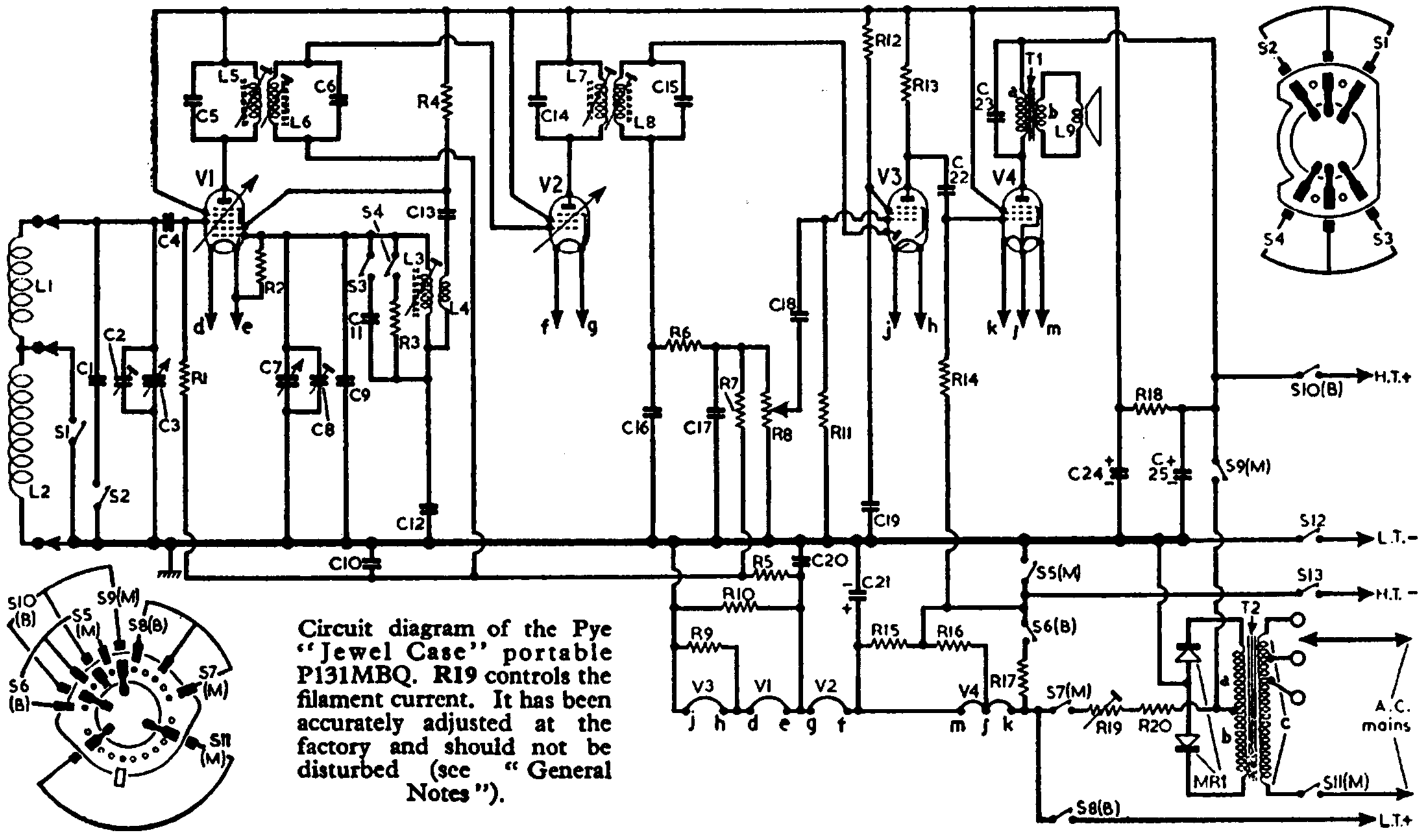


Fig 5: Circuit diagram of the P131MBQ, taken from the Trader service sheet.

| ever ready ferranti mullard | brimar emitron ferranti | mazda | gec marconi osram | valve function / ratings | |
|---|---|---|---|---|---|
| DK91 | 1R5 | 1C1 | X17 | Heptode frequency changer 1.4V / 50mA | Valves within each line are interchangeable |
| DAF91 | 1S5 | 1FD9 | ZD17 | Diode A.F. Pentode 1.4V / 50mA | |
| DF91 | 1T4 | 1F3 | W17 | Variable-mu R.F. Pentode 1.4V / 50mA | |
| DK92 | 1AC6 | 1C2 | X18 / X20 | Heptode frequency changer 1.4V / 50mA | Principal manufacturers of each type are shown at the head of each column. Some types were produced under further additional brand names. |
| DL92 | 3S4 | 1P10 | N17 | Output Pentode 1.4V / 100mA or 2.8V / 50mA | |
| DL94 | 3V4 | 1P11 | N19 | Output Pentode 1.4V / 100mA or 2.8V / 50mA | |
| DL95 | 3Q4 | – | N18 | Output Pentode 1.4V / 100mA or 2.8V / 50mA | |
| DK96 | - | 1C3 | X25 | Heptode frequency changer 1.4V / 25mA | |
| DL96 | 3C4 | 1P1 | N25 | Output Pentode 1.4V / 50mA or 2.8V / 25mA | |
| DAF96 | - | 1FD1 | ZD25 | Diode A.F. Pentode 1.4V / 25mA | |
| DF96 | - | 1F1 | W25 | R.F. Pentode 1.4V / 25mA | Dashes indicate types that were not found, but may exist |
| EZ41 | - | - | - | Full wave Rectifier 6.3V / 400mA | |
| UY41 | - | - | U142 | Half wave Rectifier 31V / 100mA | |

Fig 6: Table of D-series valves and their equivalents. Reproduced from *Attaché Radios* by permission of Mark Johnson.

good practice for the Pye engineers to master this new construction technology.

Figure 4 shows an advert for the M131MBQ, from the May 1956 issue of Wireless and Electrical Trader, and also showing the P114BQ. This advert is aimed at radio dealers, encouraging them to stock Pye's range. Also shown is the P94MBQ/LW five-band upright radio, a complex and interesting design in itself. It used a DF91 as RF amplifier; then a DK92 frequency changer; DF91 IF amplifier; DAF96 detector and audio amplifier; DL94 audio output; EZ41 mains rectifier; and a DM70 'magic eye'.

In 1959 the last of a long line of Pye's valve portables was released in the form of the P152BQ Caribbean, again using the 96-series of valves, but by now showing the PCB construction and ferrite rod aerial influence of a transistor set. Although the Pam 710 was produced in 1956 by a wholly owned subsidiary of Pye, Pye's first 'official' transistor portable appeared in January 1957 in the form of the P123BQ upright, a six-transistor design with an IF of 315kHz, chosen to 'help' the early frequency changer transistor reach the high frequency end of the medium wave.

Pye owned Newmarket Transistors Ltd, who made the transistors used in the P123BQ, and I think we should assume that the transistor and the radio designers worked very closely to get the radio into mass production. The Wireless and Electrical Trader service sheet for the P123BQ insisted on describing it as an "all-dry portable" – old habits die hard. See the Autumn 2008 edition of The Bulletin for Henry Irwin's interesting description of how Pye's transistor portables evolved from the Pam 710.

### Power supply

The circuit diagram of the P131MBQ, taken from the Wireless and Electrical Trader supplement, is shown in Figure 5. The design is a four-valve, plus metal rectifier (a Westinghouse 16RE2181), AC/AD - strange how even in the mid-1950s "all dry" referred back to a time when the LT batteries were 'wet' – covering the medium and long waves via a lid-mounted loop aerial. The radio was designed to accommodate separate 90V HT and 7½V LT batteries. Using separate batteries had a couple of advantages: firstly the batteries could be changed independently as each 'wore out', rather than having to throw away a combined battery with say a half-discharged HT section when the LT section was exhausted; and secondly, as far as I can determine only Vidor made a combined 90V + 7½V battery, and hence if Pye had designed this into their sets they would have been giving the battery business to just one of their rivals, rather than spreading the business across the likes of Ever Ready, Vidor, Exide, GEC and Oldham.

The valves in the set are the standard line-up of 1.4V 25mA filament DK96 frequency changer, DF96 IF amplifier, DAF96 detector and AF pre-amp, and DL96 audio output. The circuit of portable radios at this time was very standardised, based on effectively this single set of valves, and their Brimar, Mazda and Osram equivalents. See Figure 6 for a table of these equivalents.

Generally speaking portable radio designs which could also be powered from the mains had their valve filaments connected in series. This meant that less voltage had to be dropped from the HT supply, via R20 and R19 in this case, and hence there was less wasted power, and heat dissipated inside the case. The P131MBQ power supply was isolated from the mains, via transformer T2, whereas many portables, such as the Vidor CN431 Marquisa had a transformer-less design. Of course this means that the P131MBQ can only be operated from AC mains, whereas transformer-less designs can also work from DC mains.

**Filament voltages**

When you add up the valves' filament voltages you get 7.0V, and not the 7.5V you would nominally expect from the LT battery when used in portable mode. The LT battery would certainly have some series resistance and I presume that its voltage was expected to drop to closer to 7.0V when under load. When I measured the filament supply voltage of my P131MBQ when operating from the mains I found it was 7.4V, which means that in theory at least the valves are slightly over-run in this mode. However the filament current was 24mA (see below for how this was calculated), so the current looks slightly lower than the nominal value of 25mA spec'd for these valves.

The way that MR1 is connected is a little unusual: the rectifiers are in the negative (chassis) circuit and the centre tap of the mains transformer is the positive side of the supply. The Westinghouse 16RE2181 was a contact cooled rectifier rated at 120V-0-120V RMS at 40mA maximum current. The case of the rectifier is the common negative connection and so could be directly connected to the chassis of the radio. I managed to capture a photo (see Figure 7) of MR1, lurking behind the mains transformer. At about the same time the designers over at Vidor chose the more conventional connection of the metal rectifiers in the CN430 power supply, so there doesn't seem to have been any compelling reason to adopt one approach or the other.

**Dick and Smithy**

The series connection of the valve filaments has an interesting consequence: as you move 'down' the chain (in the order of V4, V2, V1 then V3) then the anode and screen currents of successive valves also have to pass through - or around, via resistors - the filaments of valves further down the chain. This was elegantly illustrated and explained by 'Dick and Smithy' in The Radio

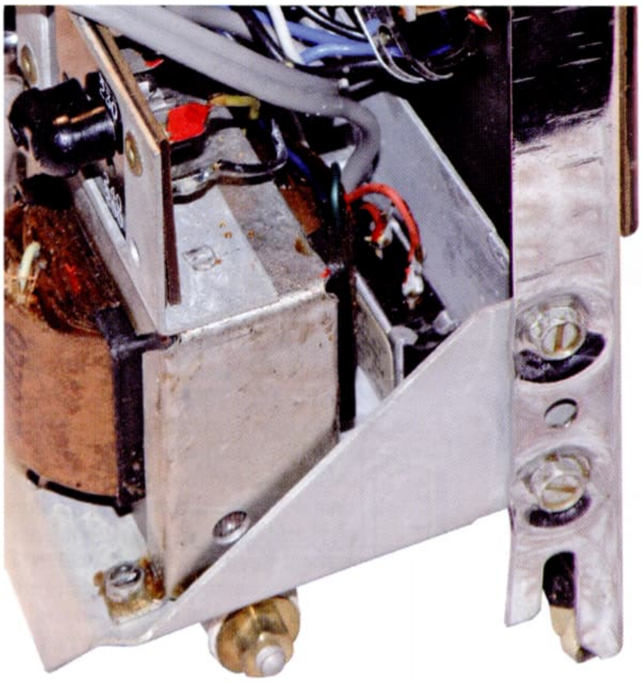


Fig 7: The Westinghouse 16RE2181 contact cooled rectifier lurking behind the mains transformer.

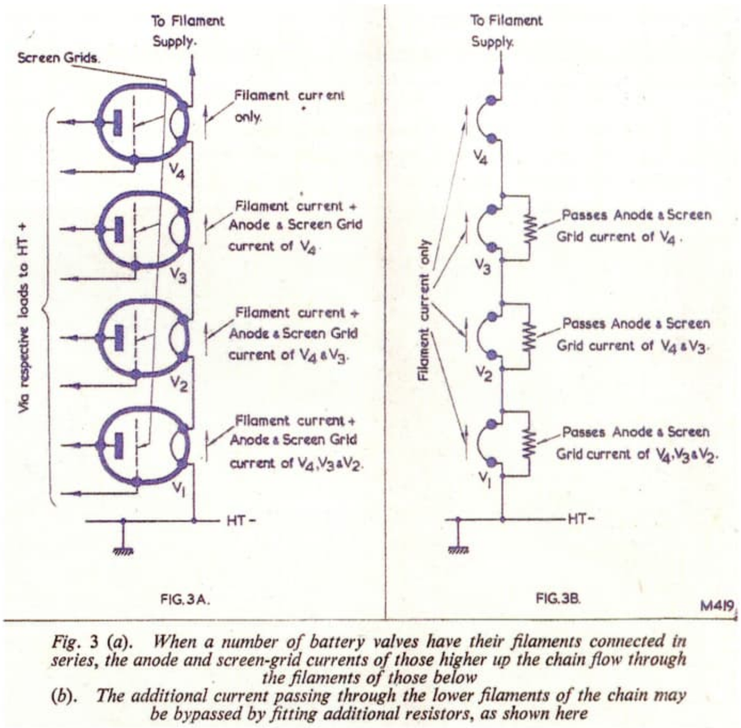



Fig 8: Dick and Smithy's diagrams from The Radio Constructor's 'In the Workshop' column for May 1957, explaining how the anode and screen currents of successive valves have to pass through - or around, via resistors - the filaments of the valves further down the chain.

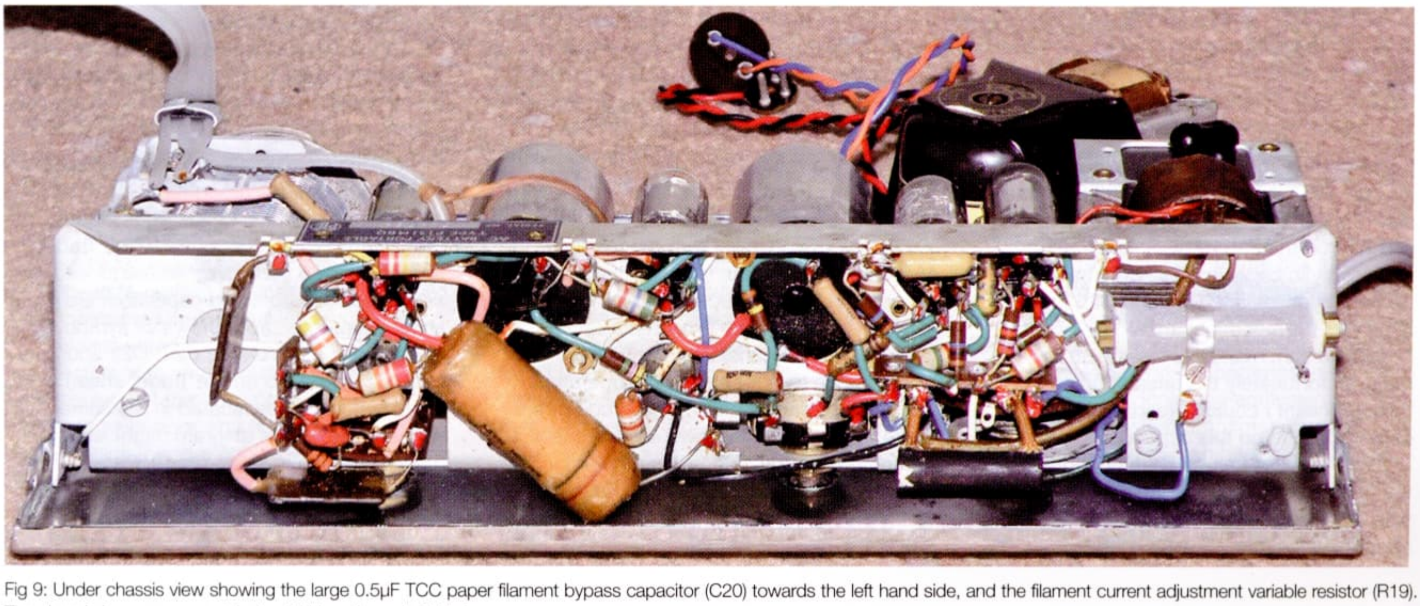


Fig 9: Under chassis view showing the large 0.5μF TCC paper filament bypass capacitor (C20) towards the left hand side, and the filament current adjustment variable resistor (R19). The chassis is very compact, being 11" long by only 2½" deep.

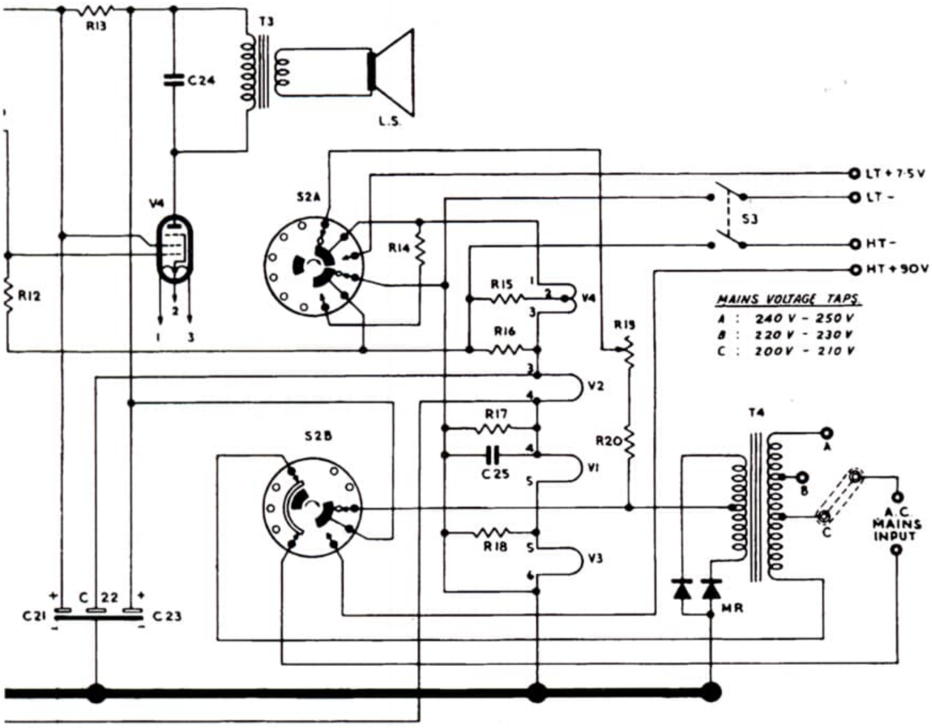
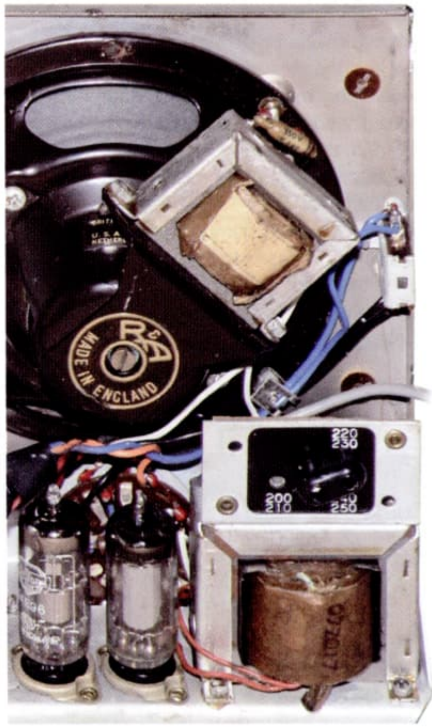
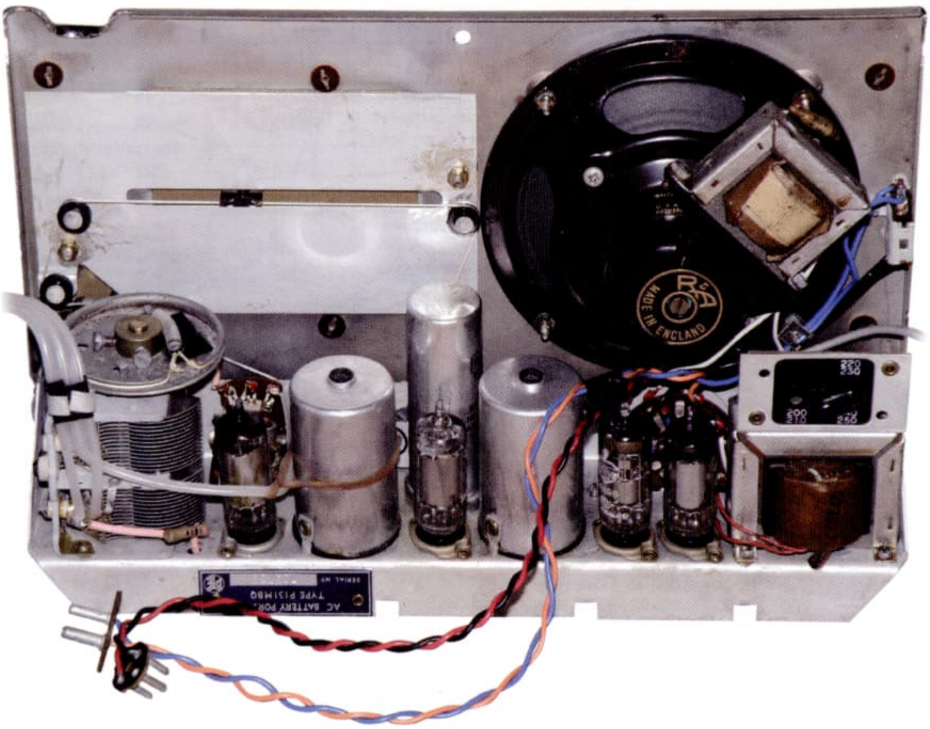



Fig 10: Part of the circuit of the radio taken from Pye's own service sheet. It's interesting to see how it is different in style from the Trader sheet, particularly in how the switching is represented.

Fig 11 (below): The power supply, audio amplifier and speaker end of the chassis. The lid-operated on/off switch S12/S13, which is effective only in battery mode, can be seen to the right of the output transformer. The mains adjustor plug mounted on the transformer allows use over the 200-250V range, just like a 'grown-up' radio.





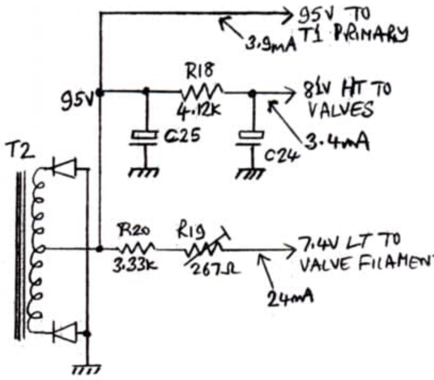



Fig 12 (left): Rear view of the chassis removed from the case. Note the upside down identity label (which I've seen on other Pye sets of this type) showing a chassis number of 705736.

Fig 13 (above): The power supply components, showing the measured voltages and calculated HT and LT currents. The resistors are shown with their measured values.

Constructor's 'In the Workshop' column for May 1957, as shown in Figure 8. These resistors can be seen as R15/R16, R9 and R10 on the P131MBQ's schematic.

Electrolytic capacitors C21 (100µF for filament bypass), and C24 and C25 (both 32µF for HT smoothing) are all contained in a single can, marked 'Plessey' on my radio. Unfortunately the orientation of the can meant I couldn't read the date of manufacture on this capacitor. The underside of this can be seen at about the middle of the chassis in Figure 9, with the HT smoothing resistor R18 (orange, white, red - 3.9kΩ) soldered between the tags of C24 and C25.

Medium / long wave switching of the local oscillator is effected by simply connecting C11 (470pF) in parallel with the medium wave trimmer and the tuning capacitor, all across L3. No inductor is switched in the oscillator circuit. The aerial circuit switches in additional inductance and capacitance (C1) for long wave operation.

Figure 10 shows part of the circuit of the radio taken from Pye's own service sheet. It's interesting to see how it's different in style from the Trader sheet. The Trader definitely had a 'house style' and converted the many radio manufacturers' circuits into this unique style. Pye's own circuit diagram shows connections brought back to the switch wafers, which I think adds clutter to the diagram when compared to the Trader approach. Also the valves' filaments and associated resistors and capacitors are shown separated from the valve symbols themselves. Electrolytics C21, C22 and C23 (C24 and C25 on the Trader sheet) are clearly shown to be located in the same can, whereas the Trader diagram might leave the serviceman in some doubt. Perversely, neither service sheet shows component values on the diagram, and in both cases the serviceman has to refer back to tables.

**Loudspeaker and handle**

The radio uses a 5" diameter speaker marked R&A 'Made in England', as seen in the rear view of the chassis in Figure 11. The R&A logo stands for "Reproducers and Amplifiers", of Wolverhampton. The lid-operated on/off switch S12/S13 can be seen to the right of the output transformer. The mains adjustor plug mounted on the transformer allows use over the 200-250V range.

The carrying handle of my P131MBQ needs replacing and having seen a couple of sellers of new handles at the May 2013 NVCF I think this will be the last part of the restoration, if I can get a good colour match to the original.

**Switch on**

Before switching on under mains power I removed the chassis from the case. This was a bit of a struggle as the fibre captive washer on the chassis fixing screw was captive no longer and had fallen into the case. This seems like a weakness in the design as the washer has to take the full weight of the front panel when being lifted and being made of chromed steel, this is quite heavy. I used a screwdriver very carefully to lift the chassis upwards, making sure I didn't scratch the front panel. I made this screw captive again by repairing the split washer with a small blob of Araldite.

Figure 12 is a rear view of the whole chassis, with its neat layout, removed from the case. Note the upside down identity label - which I've seen on other sets of this type, so it's not a manufacturing error on this example - showing a chassis number of 705736. I presume this was so that anyone lifting the front panel to change the batteries could see the number the right-way round, maybe to take a note of it in some records? Are there any other theories for why this was done?

I made a careful check of the wiring of the chassis, which looked intact. A former owner had clearly lost the mains lead and so had drilled a hole between the pins of the mains socket and inserted a permanent mains lead, but no harm done as this was all but invisible. At least this action had extended the usefulness of the radio and prevented it from being discarded when the original lead had been lost.

I wanted to re-instate the original plug and socket arrangement so I cut out the old mains wiring. The mains socket at the back of the case is the standard 2-prong arrangement but the slot cut into the case proved narrower than most matching plugs I could lay my hands on. With the help of Mike Barker I managed to find a plug sufficiently narrow to pass through the slot and into the socket. I can understand how difficult it must have been to replace the mains lead supplied with the radio if the original lead was lost.

I also insulated the HT and LT battery connectors with small plastic bags and insulating tape: they probably wouldn't have done any damage but I didn't think it was a good idea to let these 'float' around inside the radio, especially with mains voltages around.

I perched the chassis to the right hand side of the cabinet (having ensured that the internal mains connection was long enough to allow the chassis to be comfortably removed). A couple of the valves looked slightly 'wonky' in their sockets and so I straightened them up, noting that all the valves seemed a little loose in their sockets. Maybe Pye could have chosen some more tightly fitting sockets for a radio that was intended to be carried around?

Switching to LW and Mains and tuning to around 1500m brought in Radio 4 loud and clear, and the medium wave produced lots of stations as well. The power taken from the mains was about 5W, compared to the 9.2W specified in the Pye service sheet.

The paper coupling and decoupling capacitors, and the electrolytics, seemed to be in good condition and after running the chassis for a couple of hours out of its case, I was satisfied that the components would be good for a few more years of operation.

**Measurements**

I was interested in the actual supply voltages and currents in my radio so I made some measurements before reassembling the chassis into the case. First of all I measured the actual values of R18 (nominally 3.9kΩ, and actual value of 4.12kΩ), R20 (nominally 3.2kΩ, and actual value of 3.33kΩ), and R19 (variable at up to 750Ω, and actual value of 267Ω). The transformer centre tap end of R18 was measured at 95V and its other side was at 81V, so it was dropping 14V across its actual value of 4.12kΩ, giving a current of 3.4mA flowing into the valves' anode and screen circuits - I'm assuming here very little leakage current through C24 and C25. The anode of V4 is fed separately from the 95V HT via the primary of the output transformer, T1. The service sheet gives this current as 3.9mA, giving a total HT current of 7.3mA.

Figure 13 shows these components and the measured voltages. The junction of R20 and R19 was at 13.8V, hence R20 was passing 24.4mA, calculated from its actual value. Doing the sums for R19 gave a current of 24mA, which was close enough to that through R20 (which passes exactly the same current as R19) that I was satisfied I'd done the sums correctly. So the HT current was 7.3mA, compared to the service sheet value of 8.1mA, and the LT current was 24mA ± some small amount.

If you add up the LT and HT power actually supplied to the valves you get about 0.8W. Therefore when operated from the mains only about 16% of the power consumed by the radio (about 5W) actually does useful work.

I presume R19 was set in the factory to get the filament current as close to 25mA as possible, and an ageing effect has caused R19 and R20 to get slightly higher in value over the years. As a valve gets older its filament resistance tends to remain pretty constant, which of course is good news for all portable radios using series dropper resistor chains (or indeed any radio type that uses heater dropper resistors), even if the valve's emission reduces because its cathode effect starts to 'wear out'.

So I finally reassembled the radio and switched on again: tuning around gave good results on both bands. I made one final check to see the effect of closing the lid whilst the radio was switched on – no effect, apart from a muffling of the sound caused by the closed lid. I thought at first that the switch operated by the lid wasn't working, but after checking the Trader schematic I could see that this switch (two poles, S12 and S13, shown as a ganged switch S3 on Pye's own service sheet) disconnect the LT- and HT- supplies, and hence when operating from the mains they have no effect. They are clearly intended to prevent you from running down the batteries if you close the lid and walk away. I suppose that when the radio is being powered from the mains this doesn't matter. The fairly low consumption from the mains is unlikely to cook the radio, even with the lid down.

**Conclusions**

My Pye P131MBQ "Jewel Case" attaché radio didn't take much effort to get working, as expected from its excellent external condition. I realise that this isn't a very rare radio, but it is a good looking example of this style of radio, which no doubt has added to its survivability. This one has been looked after very well over the years and its internal and external condition, apart from some wear on the carrying handle, reflects this.

It survived the demise of suitable batteries and the loss of the original mains lead, which some subsequent owner replaced by bypassing the hard-to-get plug arrangement, thereby extending the usefulness of the radio. The "Jewel Case" name was also used for the P114BQ battery-only radio, Pye's contemporary of the P131MBQ. Both sets used the 96-series of valves, the last fling of portable radio valve technology, which was very soon overtaken by the transistor revolution.

The "Jewel Case" facia effect was also used in at least one of Pye's early transistor sets, specifically the model Q4, introduced in 1960, though I don't think that this expression was used in Pye's marketing material at the time.

**Useful references**

'Attaché Radios' by Mark Johnson, published in 2005 by the British Vintage Wireless Society is an excellent book on the history of this style of portable radio. The book is a vast collection of colour pictures of these radios and advertising material, and many useful facts and figures. One interesting fact is that the range of miniature-B7G valves used in attaché radios, and probably the vast majority of other portables, consisted of only eleven DK/DF/DAF/DL types (plus equivalents of course). To me this shows great restraint by the valve manufacturers not to produce numerous variants of the same basic valves. The book also contains very useful data on the batteries used in these radios, including equivalents between the main battery manufacturers.

My thanks go to members of the UK Vintage Radio Repair and Restoration forum for providing data on the Westinghouse 16RE2181 metal rectifier.

# A Sequel to the project of a lifetime

by Keith Fishenden

**Continued development**

At the end of the Spring Bulletin article I said that I had ideas for improving RF performance, so that I could pull in long-distance stations above the noise threshold. I had in mind additional RF amplification, and an ATU (Aerial Tuning Unit). The amplifiers I considered were one using a 6J4WA valve, the other a 717A. The 6J4 came from RCA (Victor Division). (I think). The 717A came from Western Electric. There is not much documentation for the 717A valve; some quote UHF operation and others quote VHF.

The 717A valve is a known proven type used to enhance communication receivers in the late 1940's, which I could use as a fallback. The 6J4WA (WA is a special quality version), was designed for use as a grounded grid amplifier for frequencies up to 500Mc/s. 'Pundits' say that the 717A would give satisfactory operation up to about 30Mc/s, as advised by Rod Burman who used to trade in valves on the Isle of Wight. When Rod retired he sold his stock to a German valve trader who continues in that business. Some documentation quoted radar frequencies for the 717A, perhaps that was a fancy. Assuming that this means a flat performance up to a breakpoint at around 30Mc/s then tailing off, then this should be good enough. Perhaps this performance quote was based on the limitations of the chassis layout.

The grounded grid type of amplifier was used as a first stage RF amplifier in UHF and FM applications, as this configuration could be realised with very few components, mostly blocking RFC's, and uncomplicated to implement. I believe RCA designed the 6J4 for use in Airborne Radar, and released the specification on the 1st April 1944 (1st April!). So I thought that I would give this valve a try. The RCA specifications are shown below. The second circuit down on the information sheet was the layout to go for as the cathode bias was in the right place for a practical application in my layout. The input and output of the circuits are in series, and therefore has large amounts of negative feedback, which reduces distortion and gain. This was looking good, as I had decided to make this amplifier untuned, to make it look like a more powerful aerial.

A few formulae to help in the design are:

The DC anode current for a grounded grid $I_A = \frac{V_{IN}(\mu+1)}{RA(\mu+1)R1+RL}$

The input impedance (ignoring capacitances) $R_{IN} = \frac{R_A+R_L}{(\mu+1)}$

Note: I just use R for resistance as it's too complicated with all the reactive elements included:

Voltage Gain $V_{OUT} = \frac{R_L(\mu+1)}{R_A+R_L}$

Where $I_A$ is anode current, RA is the valve anode resistance, $R_1$ is the cathode bias resistor, and RL is the load resistance that the circuit is looking into. The resulting circuit design with the 6J4 in place is shown on the page opposite.

**6J4**

**U-H-F AMPLIFIER TRIODE**

(continued from preceding page)

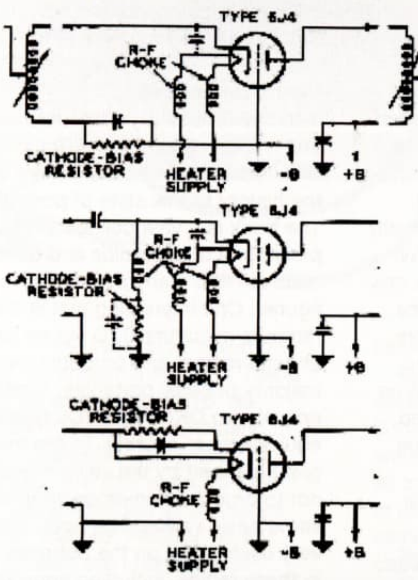
NOTE:

For grounded-grid operation, all three grid terminals should be grounded to minimize the effects of grid-lead inductance on u-h-f performance.

In arranging the circuit for the 6J4 used as a grounded-grid r-f amplifier or mixer, it is preferable to have the heater operate at the same r-f potential as the cathode, so that the cathode-heater capacitance will not be added across the input-circuit capacitance. Placing r-f chokes in series with the heater leads is suggested as a suitable method of operating heater and cathode at the same r-f potential.

TYPICAL GROUNDED-GRID CIRCUITS

Having Heater at R-F Cathode Potential




92CM-6550

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligations.

APRIL 1, 1944 RCA VICTOR DIVISION TENTATIVE DATA

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

**6J4**

**U-H-F AMPLIFIER TRIODE**

GROUNDED-GRID, MINIATURE TYPE

For use at frequencies up to 500 Mc. approx.

| | | |
|---|---|---|
| Heater | Coated Unipotential Cathode | |
| Voltage | 6.3 | a-c or d-c volts |
| Current | 0.4 | amp. |
| Direct Interelectrode Capacitances (Approx.):° | | |
| Plate to Cathode & Heater | 0.24 max. | μμf |
| Grid to Cathode & Heater | 5.5 | μμf |
| Grid to Plate | 4 | μμf |
| Heater to Cathode | 2.8 | μμf |
| Maximum Overall Length | | 2-1/8" |
| Maximum Seated Height | | 1-7/8" |
| Length from Base Seat to Bulb Top (excluding tip) | | 1-1/2" ± 3/32" |
| Maximum Diameter | | 3/4" |
| Bulb | | T-5-1/2" |
| Base* | | Miniature Button 7-Pin |

Pin 1 - Grid
Pin 2 - Cathode
Pin 3 - Heater
Pin 4 - Heater
Pin 5 - Grid
Pin 6 - Grid
Pin 7 - Plate

BOTTOM VIEW (7BQ)

| | |
|---|---|
| RCA Socket | Stock No. 9914 |
| Mounting Position | Any |

*Maximum Ratings Are Design-Center Values*

GROUNDED-GRID AMPLIFIER

| | |
|---|---|
| Plate Voltage | 150 max. volts |
| Plate Dissipation | 2.25 max. watts |
| Plate Current | 20 max. ma. |
| D-C Heater-Cathode Potential | 90 max. volts |

*Typical Operation and Characteristics - Class A, Amplifier:*

| | | | |
|---|---|---|---|
| Plate Voltage | 100 | 150 | volts |
| Cathode-Bias Resistor* (Suitably by-passed) | 100 | 100 | ohms |
| Amplification Factor | 55 | 55 | |
| Plate Resistance | 5000 | 4500 | ohms |
| Transconductance | 11000 | 12000 | μmhos |
| Plate Current | 10 | 15 | ma. |

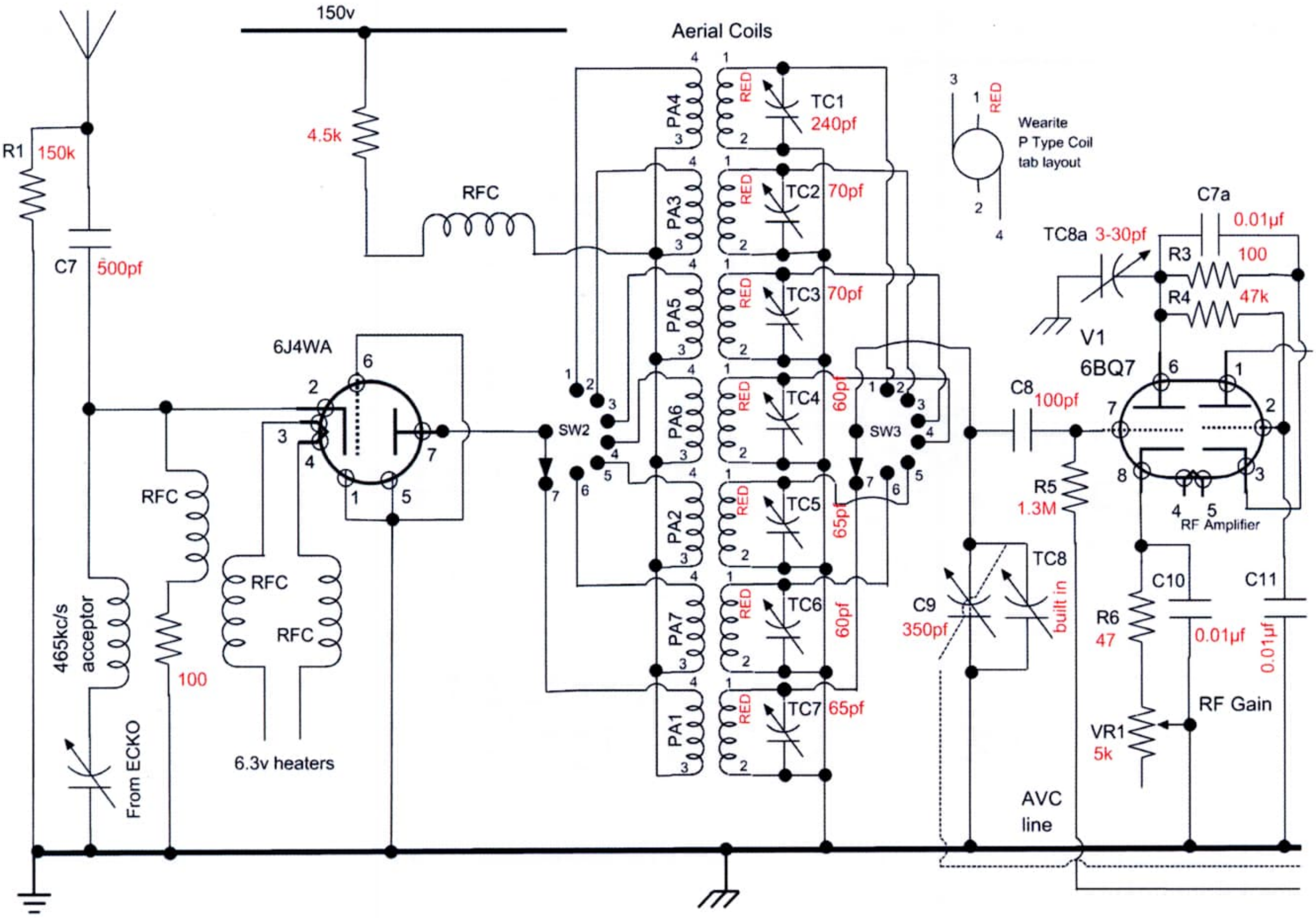
° With close-fitting shield connected to grid.

* The 6J4 should always be used with a cathode-bias resistor suitably by-passed. The d-c resistance in the grid circuit under maximum rated conditions should be limited to 0.25 megohm.

* The center hole in sockets designed for this base provides for the possibility that this tube type may be manufactured with the exhaust tube tip at the base end. For this reason, it is recommended that in equipment employing this tube type, no material be permitted to obstruct the socket hole.

APRIL 1, 1944 RCA VICTOR DIVISION TENTATIVE DATA

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY



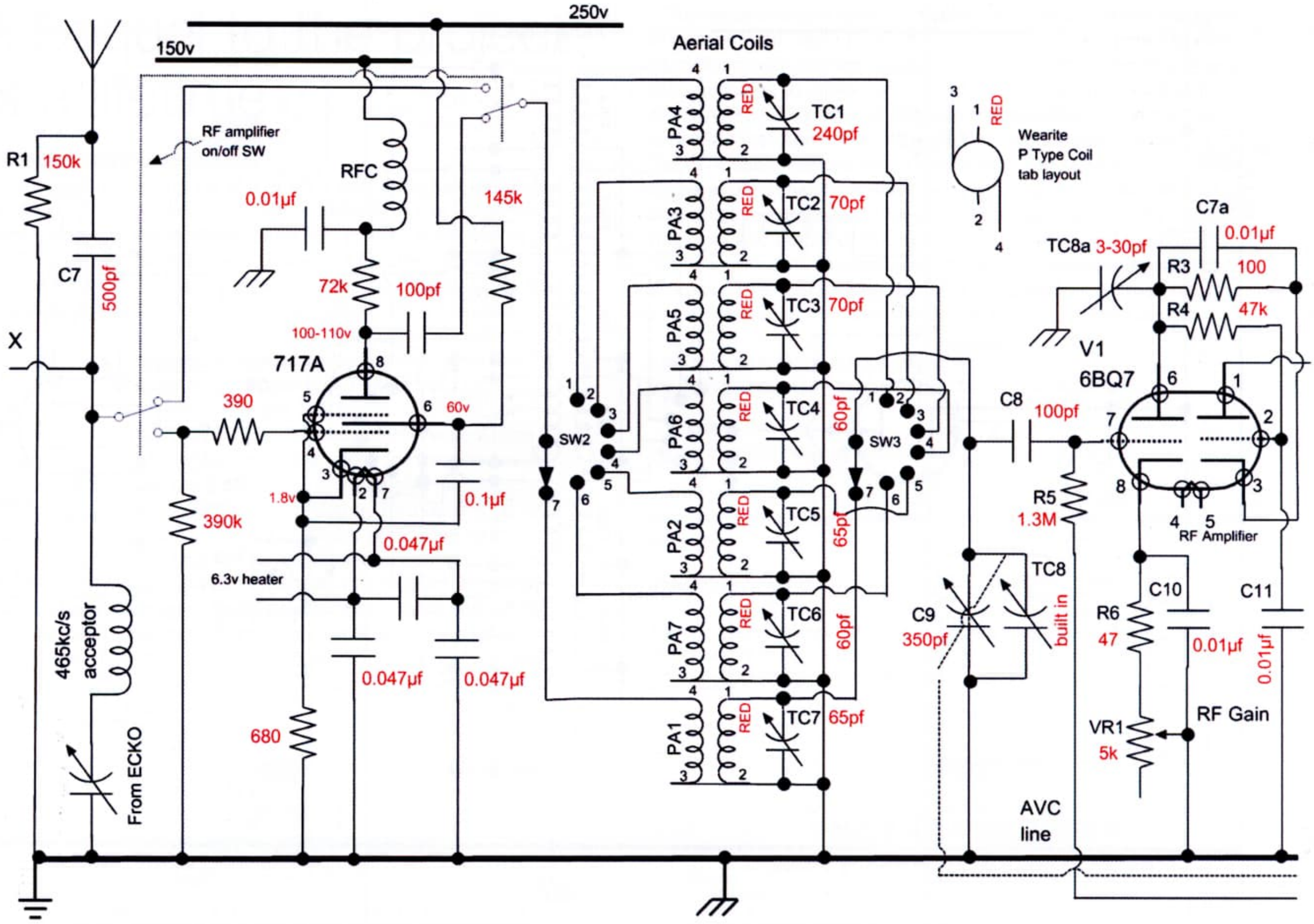

RF Amplifier circuit

It was clear when I got this circuit running that there were problems, even though the valve was screened. Although there was ample gain, it was unstable, highlighted by whistling on every station tuned in, on all bands. I tried all sorts of remedies but I could not stop the unstable operation. All the circuit design parameters had been met. I had high hopes for this circuit due to its simplicity. We have all heard of the acronym KISS (Keep It Simple Stupid), well I gave up. Clearly my circuit layout was not good enough. Perhaps this is why you find similar circuits in commercial sets built into shielding boxes, with feed-through capacitors between stages.

So I had to move onto plan 'B'. Out came all the components and wiring for the 6J4 to make way for a 717A circuit. I had high hopes that this circuit would make the 30Mc/s quoted. The maximum frequency for the P4 Wearite coils is quoted as 25Mc/s (the 12m band). As the 717A is a high performance RF pentode, recommended as an upgrade for the AR88D, and unlikely to go steaming off into multi-megacycles on its own if laid out right, I reckoned I was more likely to achieve my aims this time. The final circuit design arrived at is on the next page

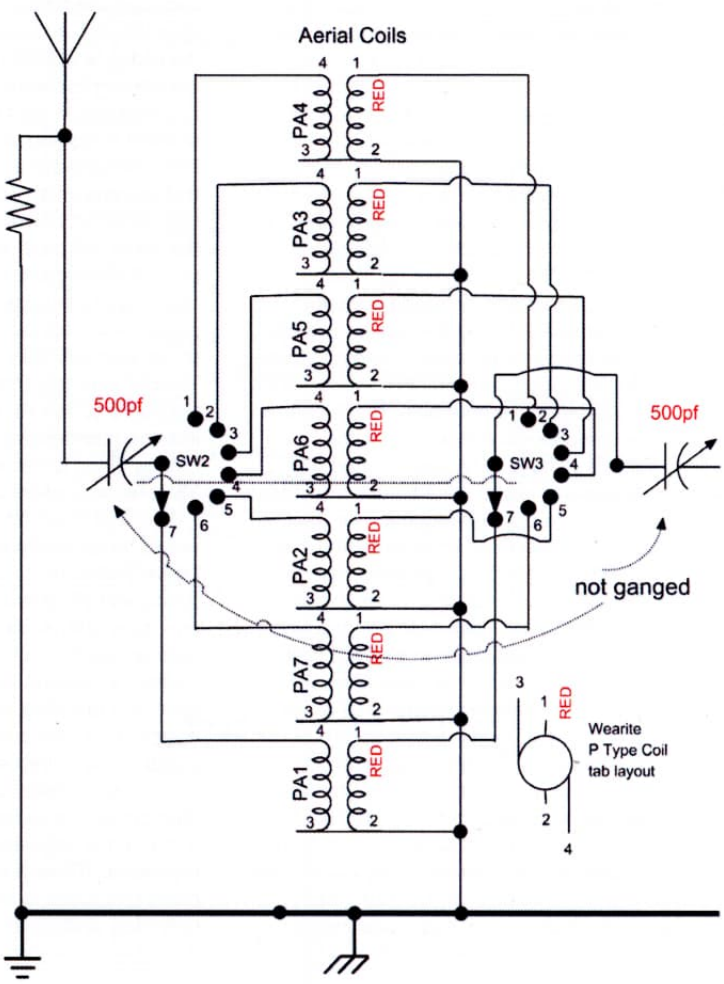
To get the biasing right, I had to work from first principles using the manufactures characteristic curves, and projected load lines across the graph characteristics. What I determined as the right operating parameters was an anode voltage of 100-110v with 60v on the screen grid, and a bias resistor of 680R. A recommended practice is to decouple the heater wiring right at the base. I just picked on 0.047µf as I had a few in the scrap box. I did not include a cathode decoupling capacitor as I preferred maximum RF feedback in the circuit for maximum stability. It worked well (thank goodness). I also designed in a bypass switch so that the amplifier could be connected or disconnected between the aerial input and the aerial coil band selection switch. It was difficult to measure the increase in gain because of the uncertain calibration of my signal generator, but I reckon it's around 5 times, and definitely changed with frequency. The big plus was that it was stable at all frequencies. The RF gain control designed into the now second stage also worked well, cutting down unnecessary gain on powerful MW stations, where overload was showing.

The final stage (the icing on the cake) would be the design of an aerial tuning unit. I gave this some careful thought. An aerial tuning unit (ATU) is a useful accessory for any radio listener as it matches the aerial resonant length to the received frequency, thereby increasing selectivity and apparent gain, and reducing spurious signals. The ATU does not provide active gain, but provides a better match between aerial and receiver, which usually gives an increase in signal strength on the tuning indicator and/or signal meter of the receiver, due to the ATU's filter resonance. There are many designs, and types of circuits to choose from. This is not a new idea, and it's all been done in the past. So my approach was to research through as much information as I could find, and look at the pro's and con's of the ideas and circuit designs out there to copy. I decided not to get into electronic enhanced varieties for phase matching and all that; that becomes important if you are going to transmit through the same aerial. KISS it again and stay with passive components. Having studied the subject of filter design, the ATU would be under the theoretical heading of a two port network. This would mean that the network between the ports could be an 'L', 'T', 'π' or 'lattice', that had to have independent variable input and output impedance matching. I decided that a 'T' type circuit, would be more effective than the Pi type at my listening post, because this design acts as a 'high pass' filter, and is therefore very useful for filtering out interference to short wave reception caused by high power medium wave transmitters that can cause overload on short wave bands. Calculations for lattice cross over filters are complicated, especially when it comes to inductors that would have to be coupled across the branches. And then it hit me! I still had spare Wearite aerial coils that I could use. The inductive coupling between the primary and secondary's would sharpen the pass-band at the tuned resonance. As the Wearite coils have the right inductance to work with 500pf variable capacitance, just like the standard arrangement for RF and HF amplifier stages; I needed to look no further. I bought a shielded box from Maplin, a few screw grip terminals from Mike Lewis at a BVWS meeting at Harpenden and dug out




RF Amplifiers circuit

Below: Aerial Tuner Unit circuit



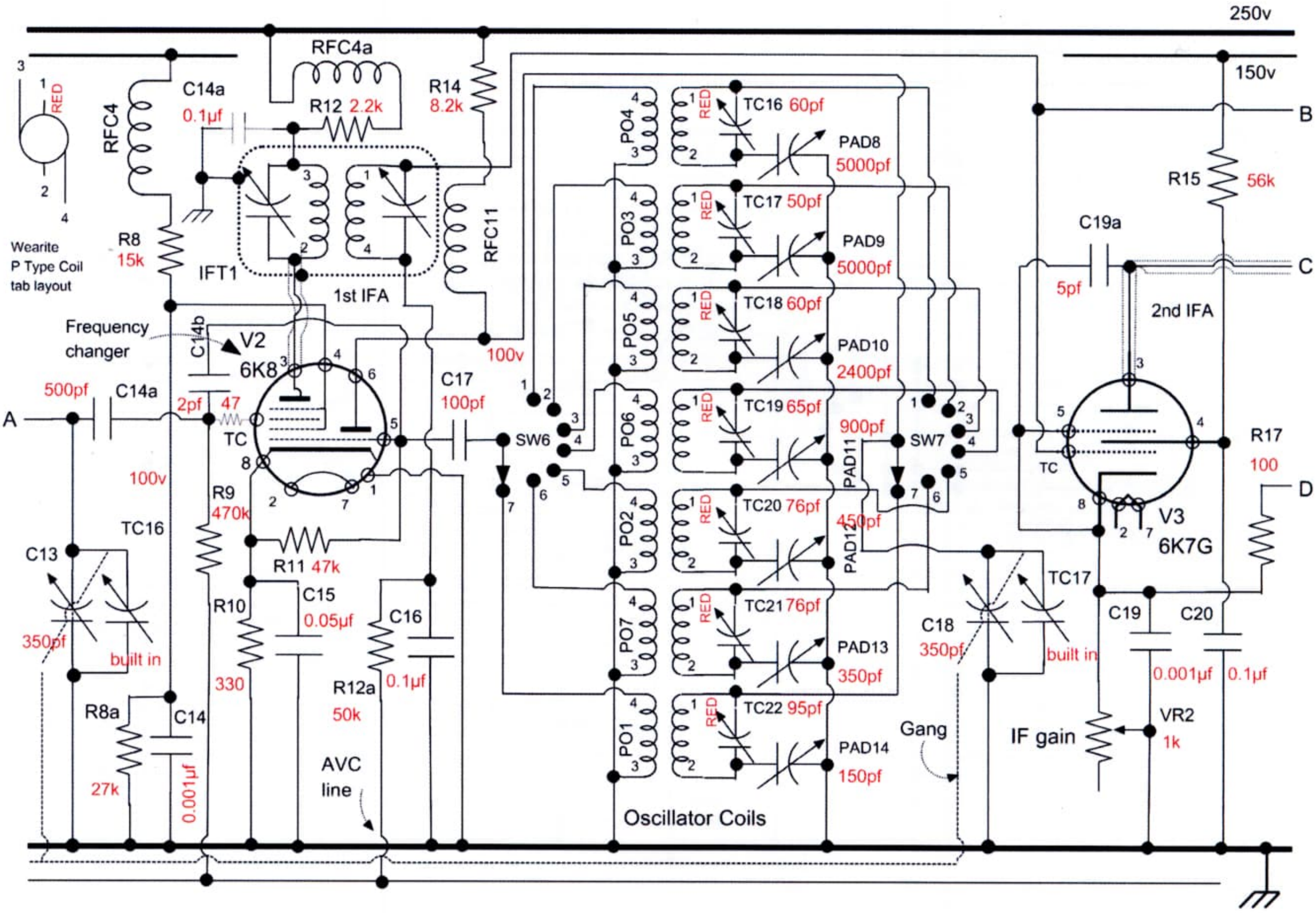

a two gang Yaxley switch from my switch box; job done. The circuit design for the ATU arrived at is shown on the right. This circuit works very well; after all, the frequency ranges of the coils in the tuned circuits match the wavebands designed into the set using the same type of coils. It also worked extremely well with the 717A RF amplifier.

I have two aerials at my house. One is an end fed wire, about 60 feet long pointing across the garden in a roughly south direction, running from about 40 feet high to 15 feet high at the far end. The other is a vertical 'Moonraker' type, known in the trade as a 7/8 end fed vertical with 50Ω impedance matching, with a 50Ω coaxial cable running into the house. This ATU works very well with both aerials at any frequencies above the long wave band, where it does not do much at all. On both aerials where signals are weak, due to either long distance from the transmitter or near anti-resonance aerial length for the frequency, the ATU improved reception significantly.

In operation the inductance selector switch is rotated until the band match shows best signal, then the input and output capacitors are rotated for strongest signal (which is quite sharp), i.e. matching the aerial impedance at the ATU input and the set impedance at the input sockets from The ATU output. The ATU worked very well with other sets in my small collection. As politicians say, 'I commend this to the house', the results are well worth the effort in making it. Try it, you will not be disappointed.

**The Oscillator and Frequency Changer.**

During my investigations regarding frequency changer circuits, I came across a very interesting article published in America I think by C R Hammond. That's all I can find out about the source. The article is about the comparison of the valves specifically designed for use as frequency changers. The types tested and compared were 1A7G, 1R5, 6A8, 6K8, 6J8G 6SA7 and the 6L7. It turns out that the best valve was the 6SA7 (with provisos), with the 6K8 as runner up (thank you Gerry), with Conversion Conductance of 450 and 350, and gain 65 and 47 respectively. The oscillator transconductance of a 6SA7 and 6K8 is higher than the other valves, which is of advantage at high frequencies, where they oscillate easily.




Frequency Changer and 1st IF Amplifier

However both valves have a space charge coupling which is experienced at high frequencies. In the 6K8 the oscillator voltage on the triode grid causes a change in the electron field in the region of the pentode section signal grid. The electron density changes at the oscillator frequency and as a result a displacement current flows into the signal grid. The impedance of the signal grid circuit is high and as a result the displacement current produces an ac voltage across the signal grid circuit. This voltage (smaller than the bias), reduces the gain of the valve. Under large signal conditions the voltage across the signal grid circuit causes rectification and a large loss in gain (and can cause the oscillator to stop, which is what I had on the top short wave range). This coupling can be neutralised by adding a small capacitor (2pf/3pf) between the oscillator and signal grids, thereby increasing the gain and image rejection. Figure 17 above shows the space charge capacitor in place between pin 5 and the TC of valve V2. A 47R resistor is placed in series with the TC which helps to prevent spurious breakthrough oscillations, and makes oscillation more stable. Back in the old days 'they' used to call this small capacitor a 'gimmick', by wrapping two pieces of wire together to give the desired effect. So if you see this in an old radio, it's not a bodge, but a tweak. So don't fiddle with it!

The 6SA7 converter is tricky because the cathode returns through the oscillator coil, so the types of circuit possible are limited. However, the stability is obtained from the cathode current. AVC voltage variations on the signal grid do not change the cathode current appreciably, so that the oscillator frequency is almost independent of the AVC. Screen voltage variation produces a frequency shift in the opposite direction and the two effects practically cancel.

The 6K8 has been used by amateurs and commercial manufactures because stability is good, with simple design problems. The standard tuned grid Hartley oscillator gives very little trouble and is easy to build. The frequency is not independent of screen and AVC voltages, but in the design used here the frequency shift caused by one is offset by the other, so good stability is obtained, which has been confirmed in use. A stabilised 150v line is used for screen grid supply in this design, to minimise oscillator frequency drift. It works well.

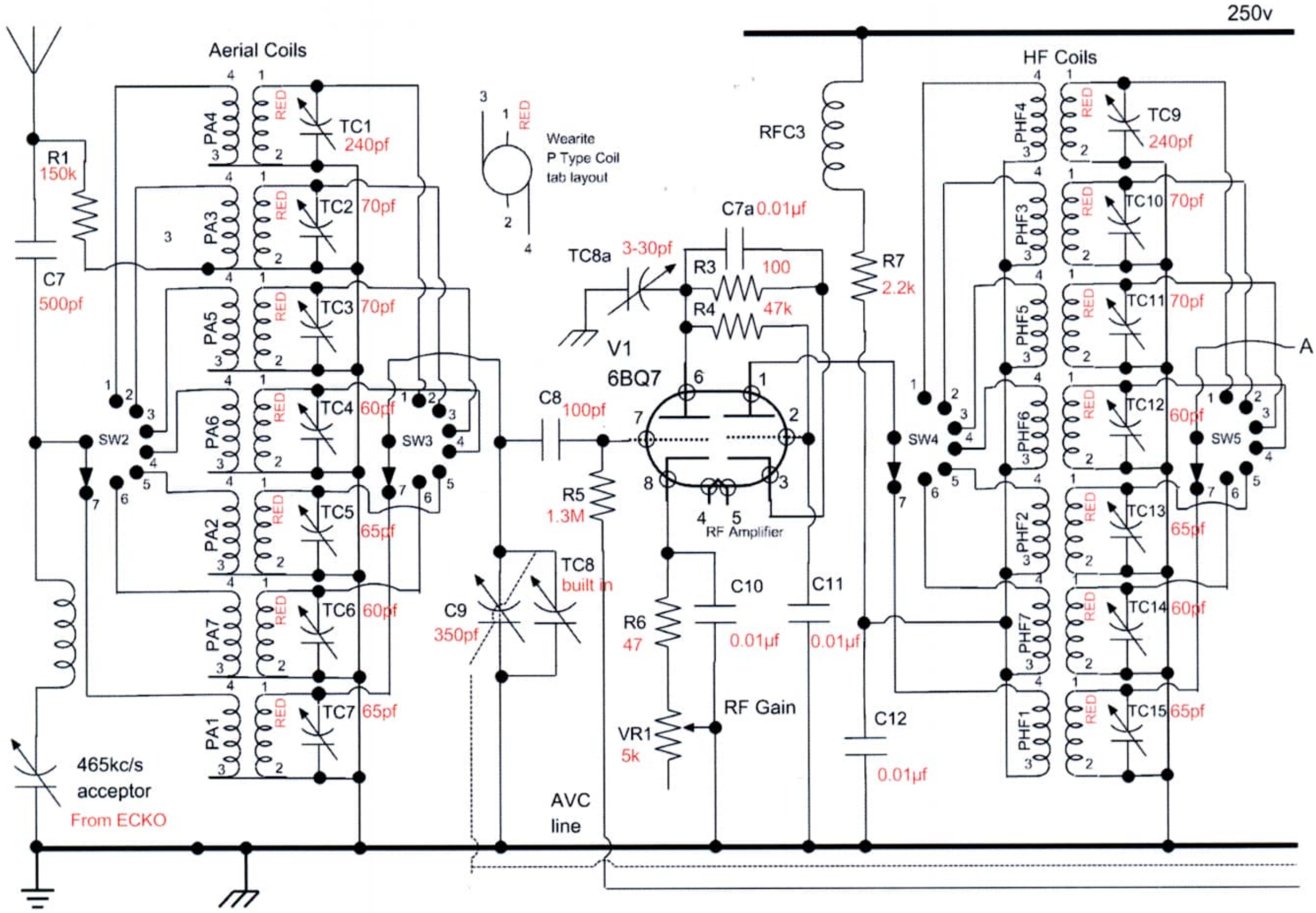
The 6SA7 makes the best mixer because it has the highest gain and has improved internal shielding of the signal and oscillator grids by the way it was made.

Within the valve, there is a current developed at oscillator frequency which is modulated by the incoming signal to produce an intermediate frequency. The ability of the valve to develop a current at an intermediate frequency is given by the 'conversion conductance', which by definition is the ratio of an incremental change in intermediate frequency current to the incremental change in RF signal voltage that produces the current. This conductance in micromhos is published for all converters, and its use to calculate stage gain is analogous to the use of mutual conductance with RF amplifiers. The gain equation for a single tuned load is:

$$\text{Gain} = \frac{G_C R_P R_L}{R_P + R_L}$$

Where $G_C$ is the conversion conductance, RP is the anode resistance, and RL is the tuned load resistance. Published values of anode resistance and conversion conductance can therefore be used to calculate conversion gain. The table below gives a comparison for the gain for a few valves used as converters. The gain figures were calculated for a tuned load impedance of 200k, which is equivalent to the oscillator coils which are commonly used such as the Wearite PO series used in this design.

| Type | Conversion Conductance | Anode resistance | Calculated Gain |
|---|---|---|---|
| 6A8 | 550 | 360k | 60 |
| 6J8G | 290 | 4M | 54 |
| 6K8 | 350 | 600k | 47 |
| 6SA7 | 450 | 800k | 65 |
| 6L7 | 375 | 1M | 58 |
| 1A7G | 250 | 600k | 33 |
| 1R5 | 250 | 750k | 35 |




RF Amplifier circuit. If instability of PA7 or PHF7 occurs, insert resistance of 50 – 500Ω in series with reaction winding

To check the performance of the 6K8 converter, we look to see if the oscillator amplitude is high enough. To do this, the dc grid current in the grid leak is measured. It should be 0.15 milliamperes, as stated by the manufactures (you don't see this quoted very often). This current increases directly with oscillator voltage. In practice this voltage cannot be held to this value over the band, especially if a wide tuning range is required as in a broadcast set such as this one. By rule of thumb, a 2 to 1 variation in a set having a wide tuning range is not bad. If the rated grid current is obtained in the middle of the band the variation over the band is not excessive. The grid current is important because it determines the point of optimum gain. For this reason I removed the AVC control from the converter in this set, and let it run flat out all the time. The gain of the set being controlled in the RF and IF stages. Reducing the set gain after the converter, improved the signal to noise ratio, and it sounded better.

Where the oscillator and HF tuning gangs are adjacent to each other, as in this set, the neutralising capacitor can be connected between the stators of these two sections of the gang. This is why on some sets, commercial practice is to solder two small pieces of wire to the stator lugs and then twist the ends together.

Neutralisation is done at the high frequency end of the highest frequency band. I used a low loss Philips type trim capacitor (looks like a little bee hive or rubbish bin), and trimmed for maximum sensitivity. You can see this on page 26, marked as TC8a, connected to pin 6 of the 6BQ7 RF amplifier.

In the figure on page 27 there is a 5pf feedback capacitor between pins 3 and 5, on valve V3, that reduced any very high frequency signals coming through the 1st IF. There was a big improvement in noise reduction. There is also a bit more decoupling on the primary of the 1st IF. Some additional signal screening is included on the anode pin 3 of V2 and pin 3 anode of V3. The R9 AVC connection has been removed to enable the converter section of V2 to run flat out.

**A little story before the conclusion**

Recently as I sat enjoying my labours, seeing what short wave stations I could pick up, I came across a test transmission. There was some nice music being played with the occasional announcement that this was a test transmission. Then on one station announcement information was given to contact the email address 'transmissiontest@gmail.com' which I did, saying that the signal was about strength 5/6 on the S meter on about 4Mc/s, which actually was in a very quiet area of the band. I had an almost immediate answer back saying that the transmission was on 3.955Mc/s (pat on the back for dial calibration), testing an aerial orientation of 114° for new DRM and AM services for Europe, with an official QSL attachment confirming contact. Wow I thought! So I sent back a question asking what this was all about and where was the transmission aerial? Nothing, no further contact, I felt a bit miffed with that.


Copy of original contact and reply:

*Hi Keith,*
*Thank you for your reception report*
*We are testing a new antenna on 114 degrees in preparation of 3955 DRM & AM services transfering to us on Friday.*
*You will hear testing on both DRM & AM over the next few hours and through tomorrow.*
*Best Regards UK*

On Wed, Feb 13, 2013 at 12:24 PM, Keith Fishenden wrote:

*Hello,*
*Test transmission received on shortwave around the 4Mc/s mark (roughly), not calibrated, about 12.12hrs. Strong signal, 5 or 6 on the S meter. Location Hemel Hempstead UK. Anything else you would like to know?*
*Regards*
*Keith Fishenden*

I did some investigation and found out that the transmission site was Woofferton, Shropshire. It has an aerial array orientated to 114°. The new service was setting up on a BBC World Service array for beaming across Europe as far as Greece. You can see the broadcast schedule and coverage on the DRM web site. No wonder it was a strong signal! If you look up DRM it is an up and coming 'Digital Radio Mondiale' service as a universal, openly standardized digital broadcasting system for all broadcasting frequencies, including LW, MW, SW as well as band 1, 11(FM band) and 111. What about the AM bit quoted? Look it up on Wikipedia, its all explained there. Digital, ouch. It maybe a way at least of keeping existing low use or potentially redundant terrestrial transmitters going. Being long distance, and not line of sight reception, there might be a future in it as the expensive hardware already exists.

To end with, just think that you might be able to hook up your PC, iPad, or smartphone to the output of your valve radio detector and get AM radio in the future.

**Conclusions.**

I should have designed in a switched method of grounding the aerial and HF coils that were not used when one of the frequency ranges was selected. This would have been easy enough by including a guard ring on the rotating section of the Yaxley waveband selection switch to ground out the unused connections. The unused coils would have included some screening between the used coils. This might have made a difference in the improvement of image rejection.

Had I known more about the characteristics of converters and oscillators, I would have designed the switching arrangements differently for the oscillator. The selector switch on the oscillator would have been better placed in the ground end of the coils. This puts the inductance and capacitance of the switch and the connecting leads inside the closed tank circuit. Since the tank currents flow through this inductance/ capacitance it contributes to feedback and gives oscillation with a minimum of cathode to ground voltage. In other words the trimming of the oscillator frequency incorporates the 'strays' into the tuned circuit, and that would reduce imaging. Now why have we not seen this exploited in commercial radios, complexity is not increased?

I found three nice Octal valve screening cans in an old HMV radio set that had been nickel plated in manufacture. These were very useful as the can bases could be screwed to the chassis around the outside of the valve bases without disturbing anything. I used these on the two IF amplifiers and the first AF valve on the main amplifier. This meant that I could wind up the IF gain even more before instability would begin to show, so I could tease a bit more out of the weak stations.

The variable manual AVC circuit that is designed into the set does not do much on strong LW and MW signals. Using the Manual RF and IF gain controls is better at getting what you want. However, the manual AVC is very effective on the two top shortwave bands, where I was able to get entertainment value from some stations directly from the USA, for instance WYFR Florida. I notice that there are quite a lot of stations being transmitted by China these days. There was one mystery station calling itself Shamulear (sounded something like that), that seemed to be coming from Afghanistan.

It is my opinion that there is more noise generated by the frequency changer than in any other stage of the set. The conversion valve and process is inherently noisy and is known to be approximately 4 times greater than an RF amplifier. It is for his reason that the ultimate signal-to –noise ratio is improved by preceding frequency converters with RF stages. There seem to be many complaints these days from the Amateur Radio enthusiasts about a lot of RF noise present on the HF bands. They seem to be pointing at the use of the National Grid power lines as transmission media for the generation of radio interference, some people seem suicidal about it! Citing this problem as a reason to give up long distance (DX) reception. My experience has been a lot of interference on Long Wave and very quiet on Short Wave. There are not as many Short Wave stations as there used to be.

Would I do it again? Definitely yes. Like winemaking or photography, you have something at the end for your efforts.

The Automatic Volume Expansion and Noise limiter work. The noise limiter lifts the floor of the threshold where weak noise is cut off, such as tuning between stations and weak station signals. It does not have that horrible clipping at the loud end where the audio becomes distorted (by cutting the tops of the signal). But to listen for very weak signals, the noise limit needs to be turned off, otherwise you might miss something. The AVE does not have as much effect as I would have expected, but you can tell the difference, to my ears the audio output sounds better, but I suspect that the bass end of the amplified range adds to the over boost of the bass at the tone controls. The circuit does add useful audio gain without adding to distortion. Well, I can't detect increased distortion with my 68 year old ears. (A harmonic analyser would be useful, but I don't have one of those).

The tone control circuit I designed into the set is not particularly effective on treble, but gives massive bass boost (far too much), and could be exacerbated by the AVE in front of it. I need to do something about it.

I have noticed on Radio 4 on long wave, a rather irritating accentuating of voice sibilants. At the moment I am not sure if the original transmission is like this or that the selectivity of the RF and IF stages are producing this.

The performance of the ATU exceeded my expectations, as aerial signal sensitivity improved more than expected. I would recommend any radio enthusiast to try one as it will help overcome shortcomings in most aerial installations.

If I had used thick single strand copper wire as ground/chassis bridges to connect components to, as per build practice you see in some commercial sets, the layout would have been greatly improved (much more flexible technique than using tag boards, which I did not use either). As it is, there are difficult to get at component clusters in my build.

Would I do it again? Definitely yes. Like winemaking or photography, you have something at the end for your efforts. I hope to have helped to spur on other enthusiasts to have a go with their ideas.

## Frank Hawkins 1920 - 2013

It is with much sadness that I report the passing of Frank Hawkins.

Frank had been a member of the Society from the late 1970's and it was he who introduced me to the BVWS. For some years we attended all the meetings together and always had a stall at Portishead. We set up the Wootton Bassett meeting together after being barred from the Cricklade event (see BVWS History book, 1993). At one time Frank had an excellent collection of Philips radios and even visited the factory in Einhoven.

Frank spent his working life from the age of 14 in the radio and electrical trade with only a break of 6 years in the RAF. Later working for J&M Stone in Wimbledon and then in1949 taking on the Swindon branch as Manager. Frank progressed to managing 13 shops at one point. He left Stones when both the ownership and name changed and became "Civic". He moved on to the Swindon Co-op electrical store as manager. He became their 'trouble shooter' and worked on bringing many Co-op stores from near closure to profit and eventually retired at the age of 62 to spend more time doing his hobbies and charity work.

Apart from his radio and electrical interests, Frank was very well known for his charity work and spent much of his spare time over more than 40 years fund raising for various charities and setting up organisations and projects for the benefit of those with learning difficulties and severe disabilities. He was recognised for his work by an invite to Buckingham Palace. Frank was always a jolly character and a Gentleman. Mike Barker

# AVO valve data manual errors (1968 edition) by Philip Taylor

Many years ago, the then editor of the Bulletin made available copies of information regarding AVO valve tester and valve characteristic meter roller switch and valve data errors. These errors have been compiled over a number of years and applied to the 1968 edition of the AVO valve tester manual. This edition was chosen as it was the last to include information for the older two panel tester or AVT. Valve data errors can be used for the VCM163 as well but roller switch errors will need attention due to the different numbering sequences used with the VCM163.

At the time some BVWS members came forward with more undiscovered errors and this information has been added. As the Bulletin is now a much larger publication, this new error listing is now published as editorial rather than as an optional supplement.

It should be noted that some new valve data has been obtained by testing unused valves. This means anode current and mutual conductance figures can be higher, even allowing for the usual plus and minus 20% tolerance allowed.

In a later article, general tube testing lore, observations, anecdotes, and experiences of real world valve testing will be detailed, with perhaps a little pontification and bubble–bursting too.

**Roller switch errors**

| Valve Type | Roller Switch Setting | TC | Base | Type |
|---|---|---|---|---|
| 1LA4 | 365 004 020 | | | |
| 1LE3 | 360 0*4 020 | | | |
| 1U6 | 266 451 300 | | | |
| 2D4A | 892 310 000 | | | |
| 2D13 | 023 180 000 | D2 | 5SC | DD |
| 2D13A | 923 180 000 | | 5SC | DD |
| 6A6 | 247 146 300 | | | |
| 6CY7 | 7*4 236 411 | | | |
| 6DZ7 | 426 547 310 | | | |
| 6EM7 | 471 461 230 | | | |
| 6ER5 | 142 361 *00 | | | |
| 6N6 | 027 610 310 | | | |
| 6SF7 | 041 586 230 | | | |
| 13DE7 | 644 237 411 | | | |
| 15A2 | 545 231 600 | | | |
| 15D1 | 545 231 600 | | | |
| 15D2 | 545 231 600 | | | |
| 61SPT | 021 540 310 | A1 | | |
| 1876 | 023 000 080 | | | |
| 7025 | 741 226 413 | | | |
| 18016 | 005 231 600 | G1 | | |
| ACH1 | 123 564 700 | | | |
| AC/TH1 | 645 231 700 | | | |
| APP4G | 005 231 600 | | | |
| AZ41 | 090 008 230 | | | |
| B30 | 446 231 700 | | | |
| DCH11 | 642 372 450 | | | |
| DK96 | 265 460 300 | | | |
| EC54 | 244 664 413 | | | |
| EC97 | 142 361 100 | | | |
| ECF804 | 645 237 114 | | | |
| ECH21 & 22 | 276 454 131 | | | |
| ECH84 | 441 237 564 | | | |
| H42 MOV | 000 231 600 | G1 | | |
| HP1118 Euro 6 | 123 510 600 | G1 | | |
| HP2118 B7 | 041 231 500 | A | | |
| MH1118 Euro 7 | 123 545 600 | G1 | | |
| P2460 | 652 310 000 | G1 | | |
| PL504 | 441 235 510 | A1 | | |
| PM24 4 Pin | 642 300 000 | G2 | | |
| PP4118 Euro 7 | 123 540 600 | | | |
| SD4 | 045 231 800 | A | | |
| VP133 | 216 510 030 | G1 | | |
| W148 | 265 114 130 | | | |
| X30 | 645 231 600 | G1 | | |
| X42 | 545 231 600 | G1 | | |
| X145 | 276 454 130 | | | |

Note that the TC (top cap) connections can equally be a side terminal on British 4 and 5 pin bases.

**Valve data errors**

| Valve Type | Roller Switch | TC | Vf | Grid Neg | Anode | Screen | Ia mA | mA/V | Base | Type |
|---|---|---|---|---|---|---|---|---|---|---|
| 4THA | 645 231 700 | G1 | 4 | 3 | 75 | | 6.2 | 3.5 | B7 | TH |
| | | | | 2 | 250 | 100 | 6 | 4 | | |
| 6AE6 | 026 740 310 | | 6 | 1.5 | 250 | | 4.5 | 0.9 | AO8 | TT |
| 6C9 | 276 454 130 | | 6 | 2.5 | 100 | | 8 | 3 | B8A | TH |
| | | | | 2.5 | 250 | 100 | 5 | 2.5 | | |
| 6D6 | 265 113 000 | | 6 | 3 | 250 | 100 | 9 | 1.2 | UX6 | P |
| 6DN7 | 471 461 230 | | 6 | 8 | 250 | | 8 | 2.5 | B9A | TT |
| | | | | 9.5 | 250 | | 41 | 7.7 | | |
| 6DQ5 | 421 541 350 | A | 6 | 17.5 | 150 | 100 | 110 | 10.5 | A08 | P |
| 6DZ4 | 642 314 600 | | 6 | 4 | 75 | | 15 | 6.7 | B7G | T |
| 6GX6 | 412 365 100 | | 6 | 1.5 | 150 | 100 | 3.7 | 3.7 | B7G | P |
| 6JH8 | 115 234 166 | | 6 | 4 | 250 | 250 | 14 | 4.4 | B9A | P |
| 6KN9 (see 6R–HH8) | | | | | | | | | | |
| 6N6 | 027 610 310 | | 6 | 0 | 300 | | 18 | 1 | A08 | TT |
| | | | | 0 | 300 | | 4 | 0.8 | | |
| 6N7 | 027 446 310 | | 6 | 5 | 250 | | 5 | 1.6 | A08 | TT |
| 6R–HH8 | 641 237 410 | | 6 | 1 | 100 | | 16 | 16 | B9A | TT |
| 6U8A | 645 237 114 | | 6 | 1 | 150 | | 18 | 8.5 | B9A | TP |
| | | | | 1 | 250 | 100 | 10 | 5.2 | | |
| 12AH8 | 541 227 463 | | 6 | 1 | 100 | | 14.7 | 3 | B9A | TH |
| | | | | 3 | 250 | 100 | 4 | 2.2 | | |
| 13DE7 | 644 237 411 | | 13 | 17.5 | 150 | | 32 | 6.5 | B9A | TT |
| | | | | 11 | 250 | | 5.5 | 2 | | |
| 15A2 | 545 231 600 | | 4 | 6 | 250 | 100 | 3.5 | 1.1 | B7 | H |
| 15D1 | 545 231 600 | | 13 | 6 | 250 | 100 | 3.5 | 1.1 | B7 | H |
| 15D2 (see 15D2) | | | | | | | | | | |
| 19AQ5 | 412 365 400 | | 19 | 12.5 | 250 | 250 | 47 | 4.1 | B7G | P |
| 20A1 | 645 231 700 | | 4 | 0.5 | 100 | | 6 | 1.5 | B7 | TH |
| | | | | 1.5 | 250 | 100 | 2.2 | 2.2 | | |
| 30FL1 | 641 237 541 | | 9 | 7.7 | 200 | | 10 | 3.6 | B9A | TP |
| | | | | 2.7 | 200 | 200 | 10 | 4.4 | | |
| 30PL13 | 414 237 516 | | 16 | 2.2 | 100 | | 10 | 4.4 | B9A | TP |
| | | | | 11 | 200 | 45 | 7.5 | | | |
| 40 | 364 200 000 | | 5 | 3 | 200 | | 0.2 | 0.2 | UX4 | T |
| 41MDG | 652 310 000 | G1 | 4 | 0 | 20 | 20 | 4 | 1.2 | B5 | DG |
| 41MPG | 545 231 600 | | 4 | 3 | 250 | 100 | 2.5 | 2.5 | B7 | H |
| 48 | 265 413 000 | | 30 | 20 | 100 | 100 | 52 | 3.8 | UX6 | P |
| 220B | 446 230 700 | | 2 | 0 | 150 | | 2.5 | 1.5 | B7 | TT |
| 350B | 026 540 310 | | 6 | 20 | 400 | 250 | 53 | 6.2 | A08 | P |
| 506K | 892 300 000 | | 4 | | | | 30 | | B4 | RR |
| 4673 | 023 110 560 | | 4 | 2.5 | 250 | 200 | 8 | 5 | SC8 | P |
| 7027 | 526 544 310 | | 6 | 14 | 250 | 250 | 72 | 6 | A08 | P |
| 7591 | 026 514 350 | | 6 | 10 | 300 | 300 | 6 | 10.2 | A08 | P |
| 7699 | 414 226 573 | | 6 | 3.5 | 250 | 150 | 45 | 10 | B9A | PP |
| 18013 | 061 231 500 | G1 | 4 | 2.2 | 200 | 200 | 8 | 5 | B7 | P |
| 18014 | 005 231 600 | G1 | 4 | 5 | 200 | 200 | 35 | 8 | B7 | P |
| 18015 | 061 231 500 | G1 | 21 | 2 | 150 | 125 | 8 | 8.3 | B7 | P |
| 18016 | 005 231 600 | G1 | 21 | 5.5 | 150 | 125 | 48 | 9 | B7 | P |
| AC/2HL | 642 310 000 | | 4 | 1.2 | 200 | | 7 | 6.5 | B5 | T |
| ACH1 | 123 564 700 | G1 | 4 | 2 | 150 | | 5 | 2 | C7 | TH |
| | | | | 2 | 250 | 75 | 2.5 | 3 | | |
| ACP | 642 300 000 | | 4 | 21 | 200 | | 27 | 2.7 | B4 | T |
| Clarion | | | | | | | | | | |
| AC/P | 642 310 000 | | 4 | 13.5 | 200 | | 17 | 2.7 | B5 | T |
| Mazda | | | | | | | | | | |
| AC/P1 | 642 310 000 | | 4 | 28 | 200 | | 24 | 2.3 | B5 | T |
| AC/TP | 571 231 640 | G1 | 4 | 1 | 100 | | 2 | 2 | B9 | TP |
| | | | | 5 | 250 | 200 | 5.5 | 1.6 | | |

## Valve data errors continued

| Valve Type | Roller Switch | TC | Vf | Grid Neg | Anode | Screen | Ia mA | mA/V | Base | Type |
|---|---|---|---|---|---|---|---|---|---|---|
| AC/VP2 | 061 231 500 | G1 | 4 | 2.8 | 250 | 200 | 7.4 | 2 | B7 | P |
| B443 | 642 350 000 | | 4 | 17 | 200 | 150 | 23 | 1.2 | B5 | P |
| B2049 | 123 545 600 | G1 | 20 | 2 | 200 | 75 | 3 | 2 | C7 | HX |
| BL63 | 027 146 310 | G1 | 6 | 8 | 200 | | 14 | 4.2 | A08 | TT |
| DC3/HL | 642 310 000 | | 25 | 3 | 200 | | 6 | 3 | B5 | T |
| DCH11 | 642 372 450 | | 1.2 | 1 | 90 | | 2 | 1.5 | F8 | TH |
| | | | | 1 | 150 | 60 | 2.1 | 1.4 | | |
| DCH25 | 276 454 030 | | 1.2 | 0 | 60 | | 2 | 1.3 | B8G | TH |
| | | | | 0 | 90 | 60 | 1 | 0.75 | | |
| DF25 | 265 114 130 | | 1.2 | 0.5 | 90 | 60 | 1 | 0.6 | B8G | P |
| DK1 | 023 064 560 | | 1.4 | 0 | 90 | 40 | 1.8 | 0.5 | 8SC | H |
| DK32 | 036 546 200 | | 1.4 | 0 | 90 | 40 | 1.8 | 0.5 | A08 | H |
| DK92 | 266 464 300 | | 1.4 | 4 | 75 | | 4 | 1.2 | B7G | H |
| DT41 | 809 321 600 | | 4 | 1 | 100 | | 4.5 | 3 | B7 | DDT |
| E180F | 141 23* 615 | | 6 | 1.5 | 200 | 150 | 13 | 16.5 | B9A | P |
| E442 | 542 310 000 | A1 | 4 | 1.5 | 200 | 100 | 1.5 | 0.9 | B5 | P |
| ECL82 | 414 237 516 | | 6 | 1 | 200 | | 3.7 | 2.4 | B9A | TP |
| | | | | 22 | 250 | 250 | 28 | 5 | | |
| EDD11 | 742 301 460 | | 6 | 6 | 200 | | 3.5 | 1.5 | F8 | TT |
| EF80 | 141 230 651 | | 6 | 2 | 200 | 150 | 8 | 7.2 | B9A | P |
| EFM1 | 023 114 560 | | 6 | 2 | 250 | 100 | 1.3 | 1.7 | 8SC | P |
| **Pentode section** | | | | | | | | | | |
| EK3 osc | 023 154 000 | G1 | 6 | 1 | 100 | | 10 | 3.5 | 8SC | 0 |
| mix | 023 154 570 | G1 | 6 | 2.5 | 250 | 100 | 5.5 | 2.5 | | |
| EL6 | 023 104 560 | | 6 | 7 | 250 | 250 | 72 | 14.5 | 8SC | P |
| FC4 | 645 231 700 | G1 | 4 | 1.5 | 90 | 90 | 4 | 1 | B7 | 0 |
| | | | | 4 | 250 | 90 | 3 | 1.5 | | |
| H42 MOV | 000 231 600 | G1 | 4 | 2 | 250 | | 1 | 1.5 | B7 | T |
| HL13 | 023 100 060 | G1 | 13 | 2.7 | 200 | | 5 | 3.3 | 8SC | T |
| HL41 | 216 040 030 | | 4 | 3.1 | 200 | | 5 | 3.4 | M08 | T |
| HL42DD | 216 090 830 | G1 | 4 | 3.5 | 200 | | 9 | 2.9 | M08 | DDT |
| K50M | 041 231 500 | A | 2 | 1 | 150 | 125 | 3 | 1.5 | B7 | P |
| K435/10 | 642 300 000 | | 4 | 40 | 250 | | 50 | 3.5 | B4 | T |
| KT44 | 041 231 500 | A | 4 | 11 | 250 | 250 | 85 | 6.3 | B7 | P |
| KT45 | 041 231 500 | A | 4 | 11 | 250 | 250 | 85 | 6.3 | B7 | P |
| KT77 | 026 540 310 | | 6 | 12 | 250 | 250 | 100 | 11.5 | A09 | P |
| L21 MOV | 642 300 000 | | 2 | 2.5 | 150 | | 2 | 0.9 | B4 | T |
| LS5 | 642 300 000 | | 5 | 28 | 300 | | 20 | 1.25 | B4 | T |
| LS5A | 642 300 000 | | 5 | 40 | 200 | | 28 | 0.9 | B4 | T |
| LS5B | 642 300 000 | | 5 | 10.5 | 400 | | 7 | 1.25 | B4 | T |
| LS6A | 642 300 000 | | 6 | 40 | 200 | | 30 | 2.3 | B4 | T |
| Oxide fil. version | | | | | | | | | | |
| MHL4 | 642 310 000 | | 4 | 6 | 200 | | 7 | 2.5 | B5 | T |
| MX40 | 645 231 700 | G1 | 4 | 1 | 150 | 75 | 2.5 | 0.15 | B7 | H |
| | | | | 3 | 250 | 75 | 4.5 | 2 | | |
| N30 | 045 231 600 | | 13 | 12 | 250 | 250 | 40 | 3.9 | B7 | P |
| N41 | 045 231 600 | | 4 | 3.5 | 250 | 250 | 32 | 10 | B7 | P |
| P2 MOV | 642 300 000 | | 2 | 10.5 | 150 | | 19 | 3.5 | B4 | T |
| P440N | 642 310 000 | G2 | 4 | 15 | 250 | 250 | 20 | 2.5 | B5 | P |
| P625 | 642 300 000 | | 6 | 20 | 200 | | 19 | 2.5 | B4 | T |
| P625A | 642 300 000 | | 6 | 39 | 200 | | 25 | 2.3 | B4 | T |
| P625 and P625 both Marconi–Osram | | | | | | | | | | |
| P2460 | 652 310 000 | G1 | 24 | 19 | 200 | 100 | 40 | 8 | B5 | P |
| PCC84 | 147 234 116 | | 7 | 1.5 | 90 | | 14 | 6 | B9A | TT |
| PM24A | 642 350 000 | | 4 | 22 | 300 | 200 | 20 | 2 | B5 | P |
| PM256A | 642 300 000 | | 6 | 33 | 200 | | 32 | 2.6 | B4 | T |
| PP5/400 | 642 300 000 | | 4 | 32 | 400 | | 62 | 6 | B4 | T |
| PT25H | 642 350 000 | | 4 | 11 | 400 | 300 | 62 | 6.5 | B5 | P |
| PX4 | 642 300 000 | | 4 | 34 | 250 | | 48 | 6 | B4 | T |
| Data for the MOV PX4 suits all valves made 1931 to the 1950s | | | | | | | | | | |
| QP25 | 207 544 630 | | 2 | 2 | 150 | 125 | 10 | 3 | M08 | PP |
| QP230 | 446 235 700 | | 2 | 0 | 100 | 100 | 4.6 | 3 | B7 | PP |
| S4VB | 542 310 000 | | 4 | 1 | 200 | 75 | 6 | 3.5 | B5 | P |
| S215 | 542 300 000 | A | 2 | 1 | 150 | 90 | 3 | 0.9 | B4 | P |
| SD4 | 045 231 800 | A | 4 | 0 | 200 | 100 | 10 | 3 | B7 | DT |
| SD4 | 045 231 800 | A | 4 | 3 | 200 | 100 | 6 | 2 | B7 | DT |
| TH2 | 645 230 700 | G1 | 2 | 1.5 | 150 | | 4 | 1.2 | B7 | TH |
| | | | | 1.5 | 150 | 75 | 0.95 | 0.6 | | |
| TH4B | 645 231 700 | G1 | 4 | 3 | 100 | | 9 | 3.8 | B7 | TH |
| | | | | 2.5 | 250 | 100 | 3.25 | 2.5 | | |
| UABC80 | *81 239 146 | | 28 | 2.3 | 200 | | 0.8 | 1.4 | B9A | DDDT |
| VEL11 | 452 371 560 | G1 | 90 | 0 | 100 | 40 | 2.4 | 1.6 | F8 | PP |
| VP41 | 216 510 030 | G1 | 4 | 2.7 | 250 | 200 | 7.7 | 2 | M08 | P |
| VP133 | 216 510 030 | G1 | 13 | 2.7 | 150 | 150 | 8 | 2.1 | M08 | P |
| VT52 | 264 300 000 | | 7 | 42 | 250 | | 29 | 2 | UX4 | T |
| This is an American VT number and the VT52 is sometimes called 45 Special | | | | | | | | | | |
| X24 | 645 231 700 | G1 | 2 | 1.5 | 100 | | 2.1 | 2 | B7 | TH |
| | | | | 1.5 | 150 | 60 | 0.7 | 0.3 | | |
| X30 | 645 231 600 | G1 | 13 | 3 | 150 | 75 | 7 | 2 | B7 | H |
| X78 | 542 376 400 | | 6 | 2 | 100 | | 5 | 2.2 | B7G | TH |
| | | | | 2 | 250 | 75 | 4.5 | 2.2 | | |
| X79 | 541 237 46* | | 6 | 2 | 100 | | 5 | 2.2 | B9A | TH |
| | | | | 2 | 250 | 75 | 4.5 | 2.2 | | |
| X101 | 276 454 130 | | 19 | 2 | 100 | | 6 | 2.5 | B8B | TH |
| | | | | 2 | 250 | 100 | 6 | 3.5 | | |

## Tuning Indicators & Magic Eyes Roller switch & Data errors

| Valve | Roller Switch | Vf | Neg. grid | Anode | Target | Ra M | Base |
|---|---|---|---|---|---|---|---|
| 1M1 | 400 230 060 | 1.4 | 10 | 90 | | | BD8 |
| 1M3: see 1M1 | | | | | | | |
| 1N3: see 1M1 | | | | | | | |
| 6E5C | 026 045 310 | 6 | 5 | 250 | 250 | 1 | A08 |
| 6EG5 | 264 513 000 | 6 | | 250 | 250 | 100k | UX6 |
| 6G-E12 | 461 465 230 | 6 | 3 | 250 | 250 | 1 | A08 |
| 6M2 | 026 456 310 | 6 | other data as EM34 | | | | A08 |
| 6M-E5 | 462 350 100 | 6 | 6 | 150 | 150 | 1 | B7G |
| 6M-E10 | 462 350 100 | 6 | 6 | 150 | 125 | 1 | B7G |
| 6U5G | 026 540 310 | 6 | 22 | 250 | 250 | 1 | B7G |
| 10M2 | 206 546 130 | 12.6 | 3/20 | 200 | 200 | 1 | A08 |
| AM2 | 023 154 560 | 4 | 6 | 250 | 250 | 1 | 8SC |
| DM21 | 206 540 030 | 1.4 | 3 | 90 | 90 | 1 | A08 |
| DM70: see 1M1 | | | | | | | |
| DM71: see 1M1 | | | | | | | |
| EAM86 | 681 236 541 | 6 | 3 | 250 | 250 | 1 | B9A |
| EFM1 | 023 161 410 | 6 | | 250 | | | 8SC |
| EFM11 | 402 361 100 | 6 | | 250 | | | 8SC |
| EM35 | 026 456 310 | 6 | other data as EM34. European. | | | | A08 |
| EM83 | 441 231 566 | 6 | 8 | 250 | 250 | 1 | B9A |
| EM85 | 401 235 606 | 6 | 18 | 250 | 250 | 1 | B9A |
| EM800 | 401 235 606 | 6 | 10 | 250 | 250 | 1 | B9A |
| EMM801 | 151 236 464 | 6 | 10 | 250 | 250 | 1 | B9A |
| TV4 | 023 104 560 | 4 | 5 | 250 | 250 | 1 | 8SC |
| Y25: see 1M1 | | | | | | | |

### Notes

Not all 6E5 tuning indicators were created equal. The Russian 6E5C is an octal-based type with a non-standard pin-out. The 6E5M is an end-view miniature valve with a B7G base and is the same electrically as the 6M-E5. The 6E5GT was made in Italy by Fivre and sold by Brimar. It has a short GT format and an octal base. The 6EG5 is a Swedish valve with a partial annular target display. Rumour has it that the 6EG5 is an equivalent for the US 6T5 but the two valves are different.

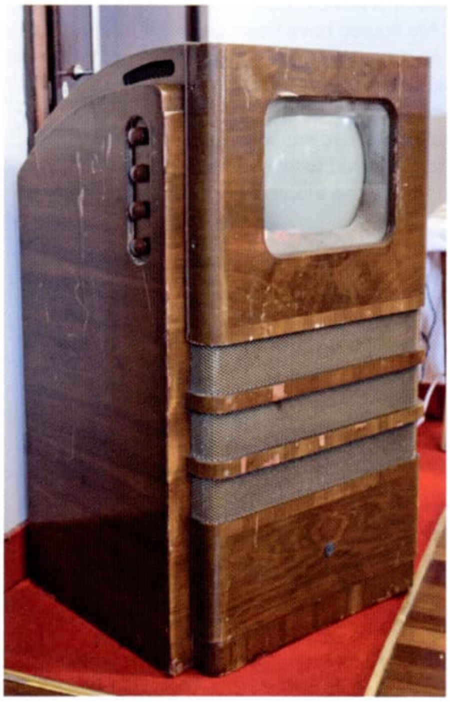
The 6M2 and 10M2 were both made in Germany and branded by Mazda for sale in the UK. Both valves are Maltese Cross display. The 6M2 is an EM35 electrically similar to the EM34 with a standard pin-out. The 10M2 is a UM35 similar to the UM4 and has an octal base with a European pin-out.

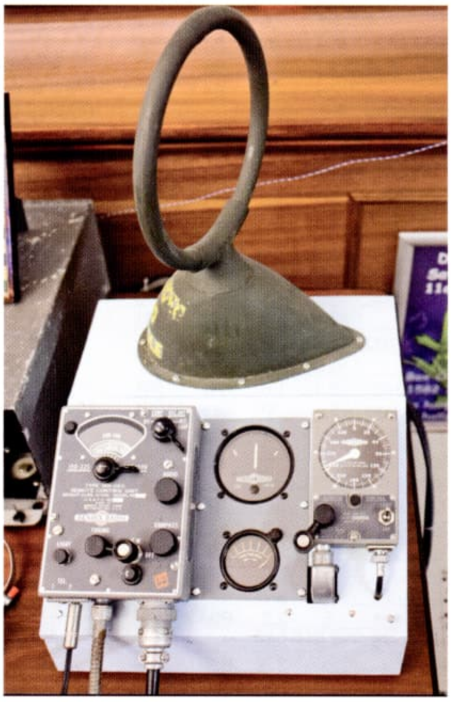
Avo got the data for the DM70 and its equivalents very wrong. The data shown is correct and was obtained by testing a DM70 and referring to Mullard data.
The DM70 is a wire-ended valve with leads not used cropped off. The DM71 has all its leads cropped and needs a socket. The DM160 is not a tuning indicator but a voltage indicator used in early computers.

It will be noticed that the same value anode resistor has been used for all tuning indicators. This is purely for convenience and in practice makes little difference to magic eye operation. No figures have been given for triode amplifier anode current as it usually has a very small value. When testing tuning indicators it is the brightness of the target display that is being checked, and whether varying control grid voltage makes the eye section move. It's likely that the target will be rendered useless by having dark stains or being dim long before the triode section loses emission.

# Harpenden, June 2013 Photographs by Carl Glover

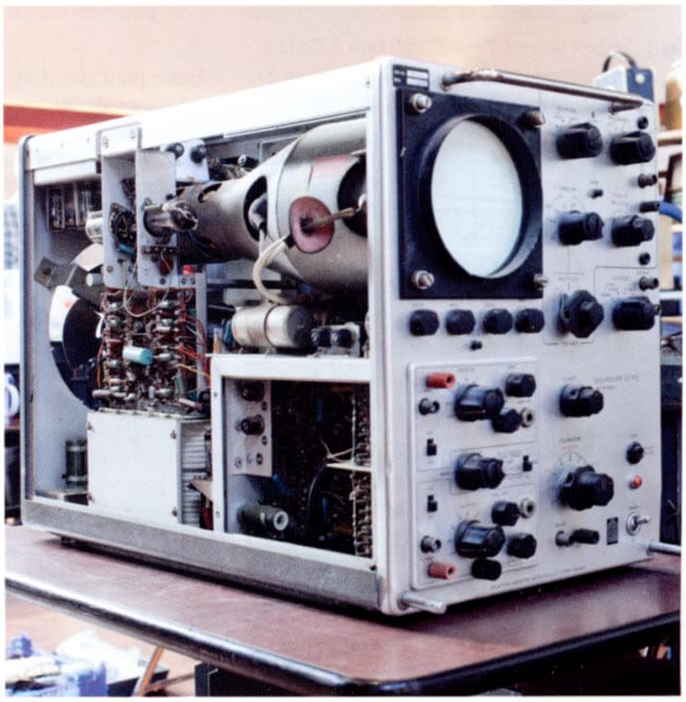





Olympia


BROWNIE WIRELESS




SKYRIDER

# How do they work? 1: Ammeters

by J Patrick Wilson

This is intended to be the first of a short series on ammeters, voltmeters, ohmmeters, multimeters & wattmeters covering their development throughout the electromechanical era. Their prehistory started in the science lab and with the requirements of telegraphy, but it was during the rise of the electrical power industry in the critical period 1880-1895 that most innovations were introduced. Then with the introduction of electronics, more sensitive meters were required to minimise disturbance to the circuit being measured.


Fig 1: Tangent Galvanometer (Philip Harris & Co Ltd)

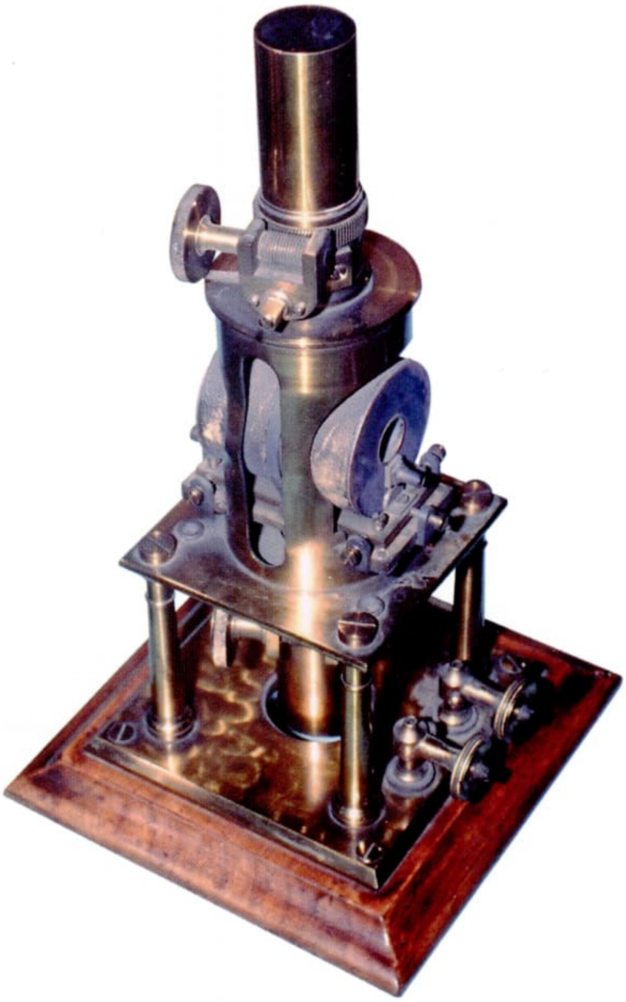


Fig 2: William Thomson's Marine Galvanometer (Glasgow University)

Many of the early instruments were beautifully made by craftsmen not merely, I like to think, to assist sales. Later, competition and cost shifted the emphasis from beauty to the need to look modern and up-to-date. It is, however, the ingenuity of their mechanisms that intrigues me most, driven both by technical requirements and the need to circumvent patent infringement. An instrument should if possible look clean and original but, more importantly, work in the way intended although not necessarily to the original specification.

**General principles**

The general principle of a measuring instrument is to balance one force, that to be measured, against another force, the reference quantity. In common parlance two examples seem to be misnamed: a 'pair of scales' should really be called a 'balance' as it does not usually have a 'scale' whereas a 'spring balance' does use a scale. The latter device introduces the basic principle of most electrical meters in which an electromagnetic force is balanced against a restoring force, most commonly that of a spring, a magnetic field, or gravity, in which ideally that force is proportional to the distance moved, and indicated on a scale calibrated in the units to be measured.

'Weight' is the downward force exerted by gravity on a 'mass' whilst 'mass' is the quantity of material present and has the quality of opposing acceleration. In SI units force (F) is measured in Newtons (N) and mass (m) in kilograms (kg).

The principle of the 'balance' is used in electrical 'bridge' measurements where an unknown resistance, inductance or capacitance is directly compared with a set of standard resistors, inductors or capacitors until a balance, or null, is obtained without the need for a 'scale'. There are of course many types of bridge, which are used when the highest accuracy and precision are required, but these are not the topic of this series.

**Resonance and response Time**

Because a meter movement plus pointer acts like a mass bouncing on a spring it has a natural frequency of oscillation (usually expressed inversely as period). To obtain a rapid response the mass (or moment of

Fig 3: Astatic Bridge Galvanometer (Siemens & Halske)

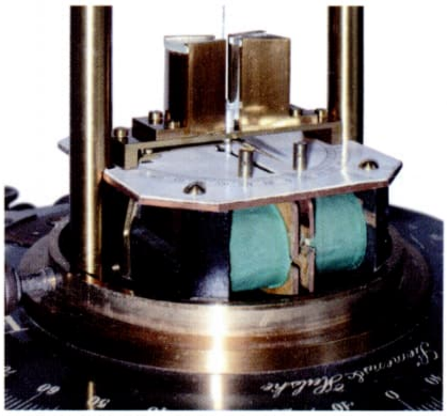



Fig 4a: Astatic Tangent Galvanometer (Nalder Bros)

Fig 4b

Fig 4c

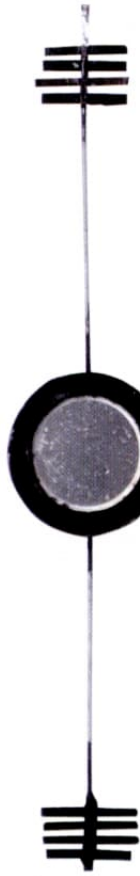


Fig 4d

inertia when it is a rotary motion) should be as small as possible which is why meter pointers are frequently made from thin aluminium tubing. If, however, the size of the moving magnet or coil is reduced this will tend to reduce the sensitivity of the instrument. Stiffness can also be increased to speed up the response but this again reduces sensitivity. The equation used to calculate the frequency of a tuned circuit ($f_o=1/2\pi(LC)^{1/2}$) can be used by substituting *mass* or *moment of inertia* divided by *stiffness* (m/S) for (LC). The response times of galvanometers and pendulums are sometimes given for a swing in one direction rather than the full period $T=1/f_o$ .

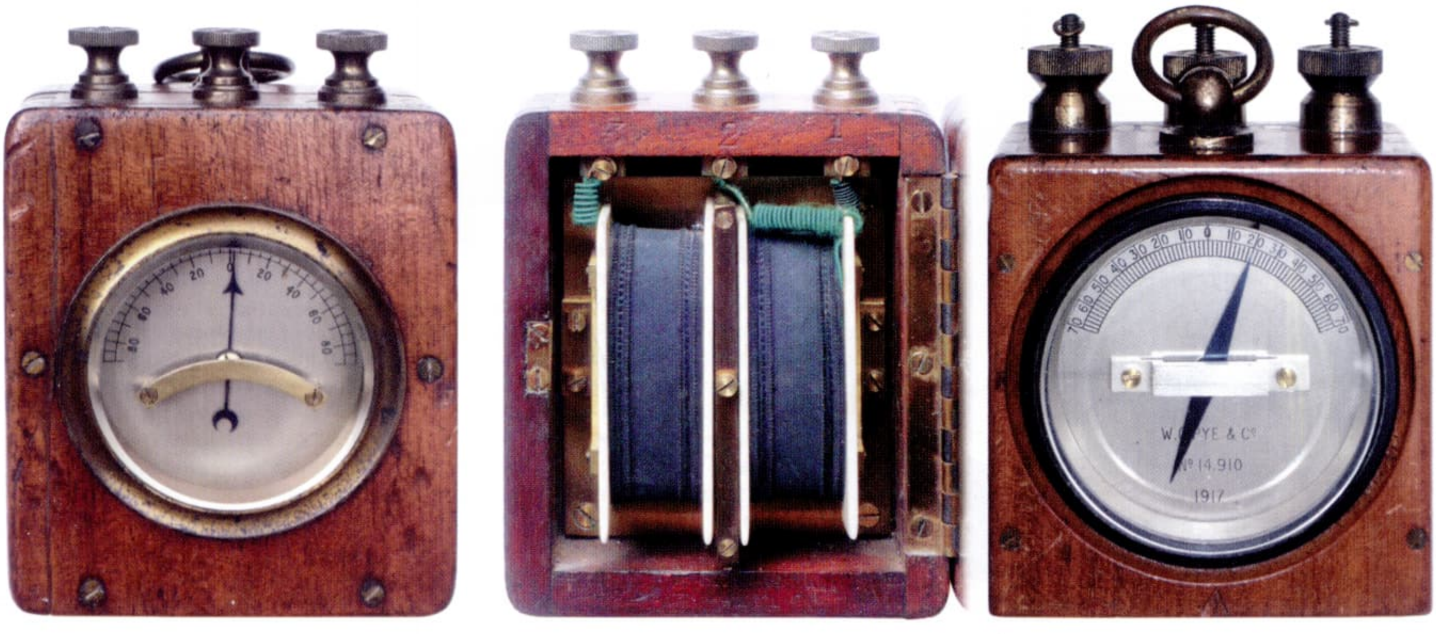
**Damping**

In obtain a rapid response it is also necessary to have *damping*. Without any, the oscillation would continue indefinitely, whilst with excessive damping the pointer would move sluggishly taking a long time to creep towards its final position. In practice it is desirable to allow some overshoot, keeping slightly below optimal or critical damping to reduce the influence of friction in the bearings. Some instruments use a thin aluminium paddle in a nearly sealed air cell, a dashpot, whilst others use a disk suspended in an oil bath. Eddy current damping is also common, particularly in moving coil instruments, where currents induced within conductors moving in a strong magnetic field incur resistive losses.

**Scales**

Scales may be linear, square-law, tangent, square-root or arbitrary. Although a linear scale is easiest to calibrate and to read, the important feature is that the scale should be 'open', allowing precise reading, in the region where it is intended to be used most, e.g., around 220-250V for monitoring a mains supply. In general the longer the scale, the better. *Precision* refers to fineness of change that can be detected and read whilst *accuracy* refers to how closely that reading approximates to the true value.

Fig 5: Linesman's Galvos (a&b) unnamed, (c) WG Pye & Co 1917



In better class instruments the scale may be backed by a mirror behind an annular cut-out. When the reflection of the pointer is hidden, the eye is in the right position to avoid parallax error due to the differing planes of scale and pointer.

The term 'direct-reading' implies that the pointer indicates directly the quantity to be measured on a scale calibrated by the manufacturer against a standard reference instrument. Multirange instruments may use a single scale with various *range factors*.

**Levelling of movement**

It is desirable that an instrument should be able to operate in any position. However, some instruments such as galvanometers and gravity controlled instruments require levelling to perform correctly, and magnetically controlled meters may also require rotating in the earth's field.

Even spring controlled instruments, however, may give different readings in different positions and incorporate adjustable weights to obtain dynamic balance. With the rotation axis and pointer horizontal it is obvious if the pointer is light or heavy. Similarly if the pointer shows an error when vertical, lateral balancing is required, although this may also be caused by a bent pointer.

**Tangent galvanometers**

Current indication started with Oersted's observation in 1820 that a compass tended to set at right angles to a wire when connected across a battery. Soon after this discovery Schweigger showed that this effect could be magnified by wrapping the wire around the compass as a vertical coil. This forms the basis of the tangent galvanometer.

In a *tangent* galvanometer the compass needle will settle along the *resultant* of a fixed field, due to the earth's magnetism, and the field produced by a current in a vertical coil set at right angles to the earth's field. The resultant angle is independent of the strength of the compass needle, but because the earth's field is weak, it will be greatly influenced by any magnetic material in the neighbourhood. Instruments based on this principle are restricted to DC.

Fig. 1 shows an educational example by Philip Harris & Co Ltd which incorporates three windings of 2, 50 & 500 turns for differing sensitivities and current capacities. The needle, with pointer attached at right angles, aligns itself with the earth's magnetic N and S. The upper part of the instrument then has to be rotated until the coil is parallel with the needle, and the pointer along the axis of the coil. Next the compass case and scale is rotated until the zero degree markings lie below the ends of the pointer. Current then deflects the needle either left or right depending on its direction. The *tangent* of the angle of deflection is proportional to the current flowing, and also to the number of turns in the coil. Thus it is possible to compare currents over a wide range.

The needle swings quite slowly because the balancing 'spring' is 'soft' as the earth's field is fairly weak. The stiffness can be increased either by adding an external magnet above or below the needle to augment the earth's field or by introducing a real spring to apply an additional restoring force.

**Marine galvanometer**

An early use was identified by William Thomson (later Lord Kelvin) in his marine galvanometer (Fig. 2) used to read telegraph cable code and to test the cable and equipment during the laying of the first Atlantic submarine cable in 1858. To give rapid response the stiffness was increased by suspending the needle at the centre of a taut torsion wire, running the height of the vertical brass tubes, and this keeps the system stable during motion of the ship. To compensate for the reduced sensitivity a coil of many turns, inside the horizontal leather covered tube, was used together with a very long and very light pointer. The latter was a light beam reflected by a small mirror attached to the needle at the centre of the wire. Kelvin later claimed the inspiration for this came from observing the reflection of the sun from his dangling monocle. Kelvin used a close fitting glass case to increase air damping allowing about ±10° rotation of the mirror. The coil is in two halves for access, and the ends of the vertical tube can be rotated by the knurled knobs to twist the wire and zero the reflection.

For laboratory use, where maximum sensitivity is required and speed may be less important, the effects of the earth's field can be reduced by placing an opposing external magnet above or below the instrument.

**Astatic galvanometer**

(in Siemens & Halske bridge No.1935U)

A different approach to increased sensitivity is the *astatic* galvanometer in which an oppositely magnetised needle is attached to the first one, but outside the coil, where it cancels the effects of the earth's field and,

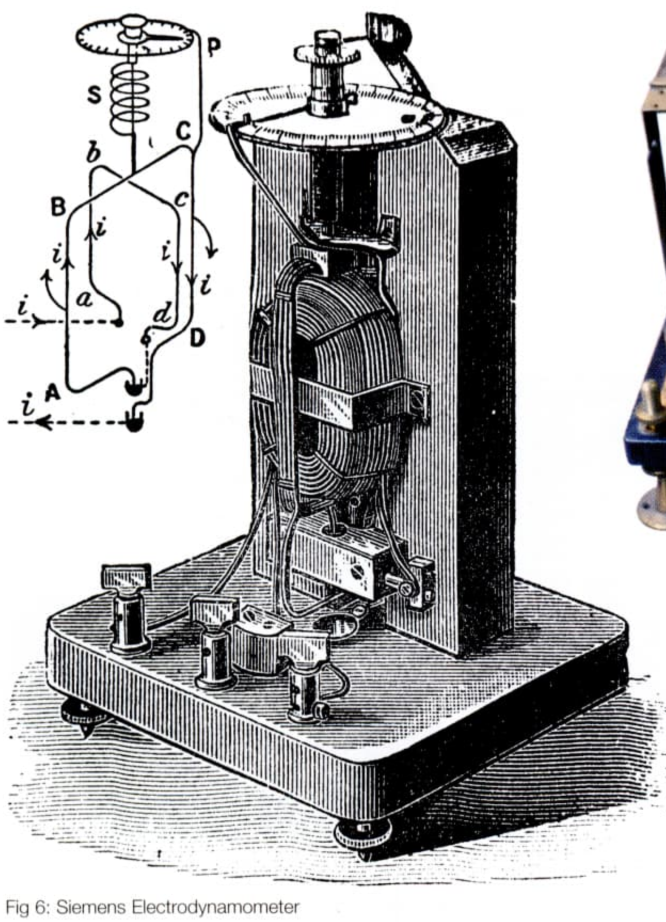
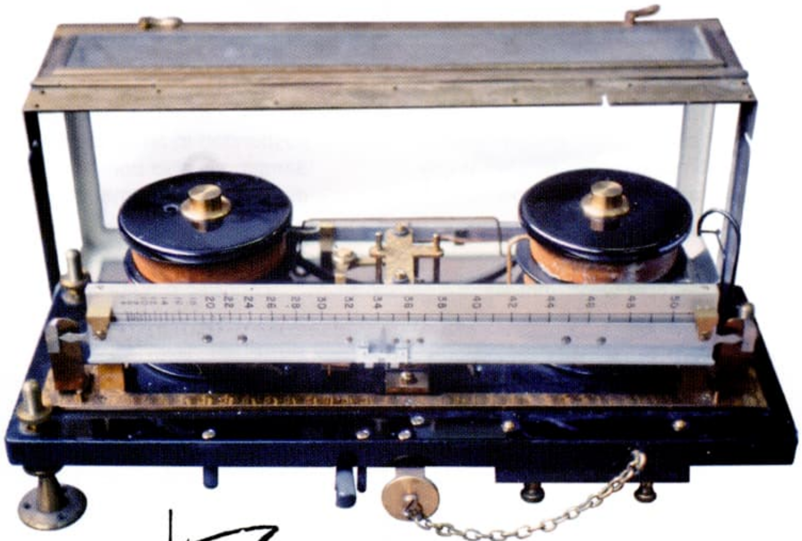



Fig 6: Siemens Electrodynamometer



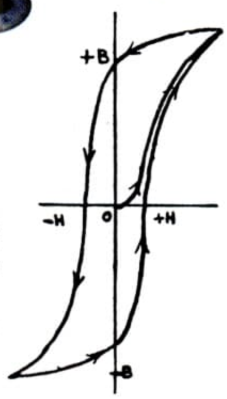



Fig 7 (above): Kelvin Current Balance (Glasgow University)
Fig 8 (left): B-H magnetisation curve

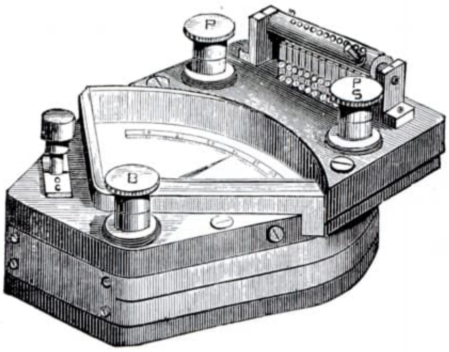


Fig 9a: Ayrton & Perry's first Am-meter

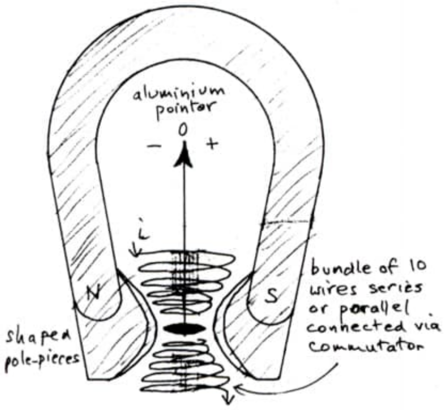



Fig 9b

Fig 9c


Fig 9d

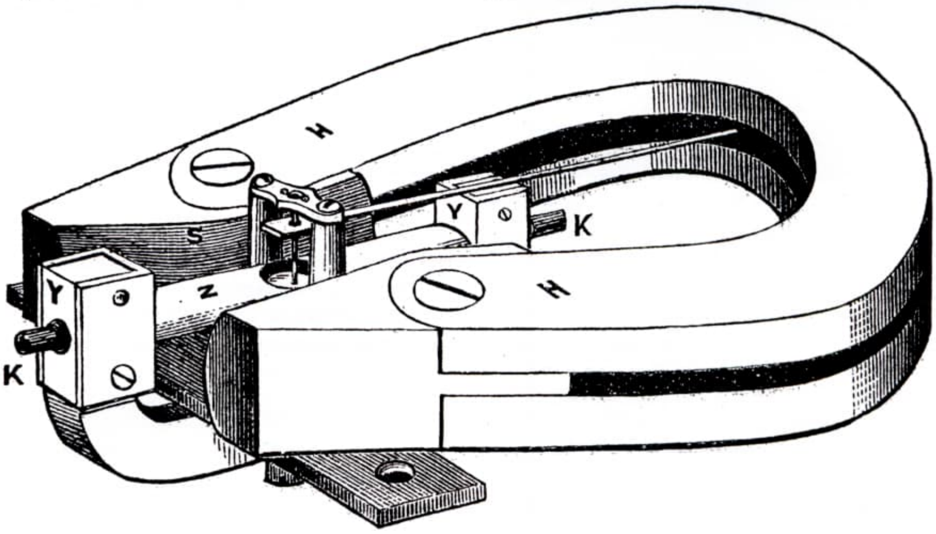



Fig 9e

because the coil's field is opposite here, augments its effect. This is the method used in the Siemens & Halske self-contained Wheatstone bridge shown in Fig. 3 where the second needle is also the pointer. Aluminium paddles inside the brass sectors above the pointer are attached to give air damping although this is quite inadequate.

The full astatic galvanometer utilises a second coil connected in series, but wound oppositely, which embraces the second needle (Fig. 4). In this galvanometer, by Nalder Bros & Co, London, bar magnets above and below can be rotated to control sensitivity, speed and zero position. The needles (Fig. 4d) each consist of four parallel pieces of magnetised watch hair spring.

**Linesman's galvanometer**

The other variant of the tangent galvanometer in widespread use over a long period was the linesman's galvo (Fig. 5). The earlier one is anonymous and has a full ±90° deflection whilst the WG Pye version of 1917 is restricted to ±70°. They have astatic movements with opposed central and front mounted needles, the latter acting as pointer. The controlling 'spring' is provided by gravity with the lower parts of the needles slightly heavier. The vertical coils of both instruments have bone former ends in the tradition of the philosophic instrument maker. The 'Q' (Quantity) terminals have a resistance of about 0.2Ω and are for current whilst the 'I' (Intensity) terminals are for voltage and are about 100Ω. Although relative comparisons can be made using tangents, the scale readings have no absolute reference.

**Practical instruments**

Most of the instruments so far discussed require levelling and separation from external magnetic effects, which in a power station may greatly exceed that of the earth's field. A practical instrument should, as far as possible, overcome these restrictions and should be robust. William Thomson (Lord Kelvin) devised many ingenious new instruments, although not always convenient in use. Ayrton, and his former students, Perry and Mather, also introduced many instruments which on the whole, were more practical. Other inventors of note include the Siemens brothers, the Varleys, Crompton, Evershed, Weston and many whose names attach to a specific instrument. Over the years most of these have been improved and many discontinued.

**Electrodynamometers**

The dynamometer principle harks back to Ampère who, a few weeks after Oested's observation in 1820, noticed that two parallel wires close to each other were attracted or repelled depending on whether the currents were passing in the same or opposite directions. Thus dynamometer instruments do not need magnetic material to operate.

**Siemens dynamometer ammeter**

The first direct-reading ammeter was introduced by Siemens & Halske in 1877 based on this *electrodynamic* principle (Fig. 6) although this principle had been used by Weber to make an absolute measurement of current in 1845 and refined versions for this purpose have continued up to recent times. The outer, moving, coil is set at right angles to the inner coil and is suspended by a torsion wire which provides the '*spring*' control. The electrical connections to it are made by mercury cups below ensuring good conduction with minimal friction.

The upper end of the torsion wire is attached to a rotating head with a pointer and scale. The moving coil has another pointer which should be at zero when the coils are at right angles with no current flowing.

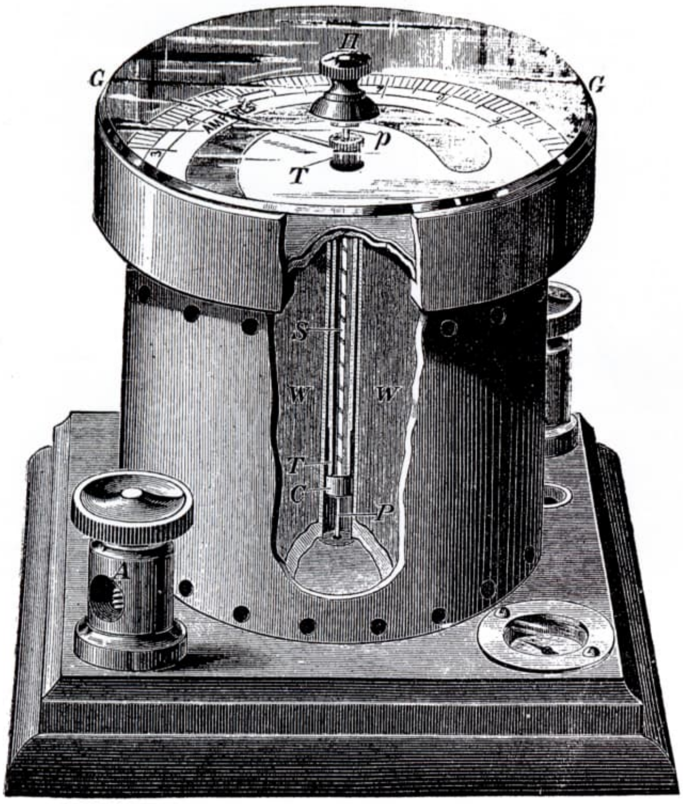



Fig 10a: Ayrton & Perry's Magnifying Spring Ammeter


Fig 10b

Current rotates this coil and pointer to a stop. The torsion head is then rotated to bring it back to the null position and the current read-off from the new position of the head.

As the current flows through both coils, the effects *multiply* and it is a *square-law* device, agnostic to the polarity, and thus suitable for both AC & DC. The scale therefore follows a square-root law which can be calculated to give accurate subdivision with 'open' readings at higher values. The overall sensitivity is set by the length and stiffness of the torsion wire. Although this was a widely used instrument it stretches the concept of direct-reading and was not ideal for use in the field.

**Kelvin current balance**

Another early *electrodynamic* instrument was William Thomson's current balance of 1887 (Fig. 7). Although this was produced commercially it was more practicable in the lab for calibrating other instruments. The magnetic forces between two moving coils, at the ends of a balance beam, and fixed coils above and below them are balanced by a weight moved along the calibrated beam. The moving coils are energised in the same sense (e.g. both N poles upwards) so that the effects of the earth's field are cancelled, whilst the four static coils are wired to give an upward force at one end and downward at the other. Several different models were produced for measurements from 10mA to 2,500A AC or DC.

**Moving iron meters**

Moving iron meters operate in a variety of ways, the simplest relying on a single piece of iron being pulled into a solenoid. By placing two or more pieces in close proximity within the solenoid the forces between them become lateral, across the axis of the solenoid. All pieces are magnetised in the same direction so, when placed in parallel, like poles are adjacent and repel. When placed end to end, opposite poles

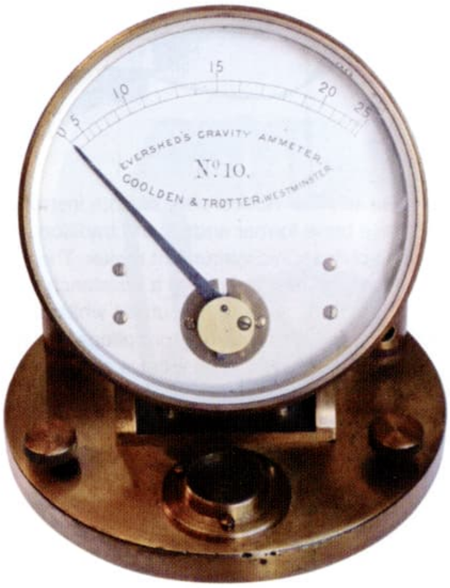



Fig 11a and b: Evershed's Gravity Ammeter (attraction)

adjoin and they attract. For both types, both pieces of iron become magnetised in proportion to the current flowing so the effects multiply making them square-law devices equally suitable for AC or DC.

Unfortunately the situation is more complex as the degree of magnetisation depends on the B-H curve (Fig. 8) in which the magnetisation B increases as the magnetic field H is increased but reaches a *saturation* point. When reduced back to zero, *permanent* magnetisation remains, which only returns to zero for a negative field. By continuing the process to negative saturation then returning to positive saturation a complete B-H curve is plotted. The slope of the curve represents the *permeability*. These curves exhibit non-linearity, saturation and *hysteresis* (magnetic backlash), which depend on the constitution and heat treatment of the magnetic material, and influence in turn how closely the AC and DC responses correspond. Nevertheless use of suitable materials and design within these restrictions has resulted in a very useful class of instrument.

**Ayrton & Perry's first am-meter**

(Bench use, 8.3cm scale linearly marked in degrees, 45-0-45, Paterson & Cooper, London No.263).

Ayrton & Perry described the concept of 'direct-reading' in 1881 illustrating it with a meter in which the scale readings were directly proportional to the current in Webers (Fig. 9a). This derives from the Deprez 'fishbone' galvanometer of 1880. Although the needle is soft iron it becomes magnetised by the strong permanent magnet and is thus more akin to a *tangent* galvanometer in which the earth's field is swamped by the much stronger field of the magnet. They claimed that linearity resulted from the special shape and proportions of their needle and pole pieces (Fig. 9b).

The deflecting coil was wound with


Fig 12a: Ediswan Gravity Ammeter (repulsion)

Fig 12b

Fig 12c


Fig 13a: Rumney & Rumney Ammeter (repulsion)

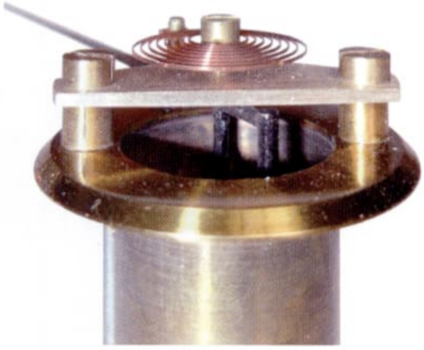


Fig 13b

ten-strand insulated wire (Fig. 9c) which could be connected in series or parallel by a commutator (Fig. 9d). This gives two ranges with sensitivities differing by a factor of ten, whose initial purpose was to allow calibration at a lower current than it was designed to measure. To do this a standard 1Ω resistance was incorporated and from the readings with and without this, and the known battery voltage, it was possible to calculate the sensitivity constant in Webers per degree.

By 1882 the unit of current became the *Ampere* instead of *Weber* and Ayrton & Perry had coined the names *ammeter* and *voltmeter* and had recognised the utility of the lower range for measuring lamp currents. They also introduced voltmeters and single range instruments of various sensitivities working on the same principle and others using spring control.

By 1884 they had devised a magnetic return path (Fig. 9e, Y-Y) to increase sensitivity and soft-iron cores (K-K) to allow adjustment to true direct reading. They claimed these cores also fully linearised the scale which was now inscribed in *amps* or *volts*. This would allow manufacturers to print scales and avoid individual calibration, a hope that was not fully realised for another 60 years.

Thus their 'Am-meter' made by Paterson & Cooper (Fig. 9c&d) must date from 1881-2. The strong field, acting as a stiff controlling spring, together with the use of a small needle and very light aluminium pointer (not a common metal in those days) results in a high resonance frequency of 11Hz or period of <0.1s. This speed was wasted because inherent damping is low and the pointer vibrates for about 4s. The instrument comes with a magnetic keeper which, contrary to a moving coil meter, increases sensitivity and reduces speed when in place. Even with its silver commutator contacts the resistance is variable at less than 0.1Ω in parallel and 0.4Ω in series giving voltage drop and power values of about 1.8V and 8W at fsd (full scale deflection).

Initially the instrument over-read by 27% up to half scale, implying a loss of magnetism. After remagnetising it now reads +1% up to half scale and -8% at fsd. Although this does not quite match Ayrton & Perry's claim it is two to three times better than the theoretical tangent relationship.

**Ayrton & Perry's Magnifying Spring ammeter**

(Bench use, 20cm 270° horizontal mirror-backed circular linear scale 15-75A, The Acme Electric Works, Ferdinand St, London No.S190).

This was patented in 1883 and operates on the *simple attracted iron* principle but in which the motion is greatly magnified by the unwinding of a helical spring (Fig. 10). A thin soft iron tube is suspended by an internal flat helical spring from a zeroing knob at the centre of the dial

Fig 14a: NCS Gravity Ammeter (repulsion)


Fig 14b

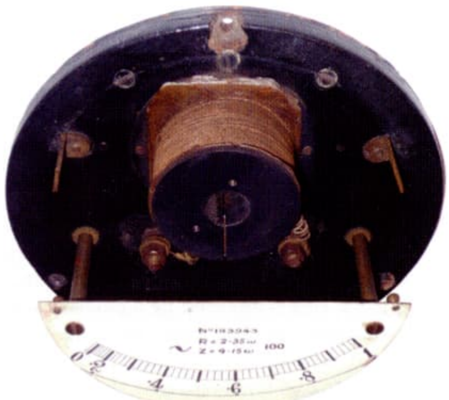


Fig 14c

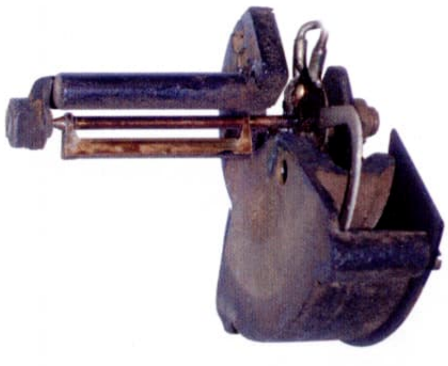



Fig 15: NCS Spring-controlled ammeter (repulsion)

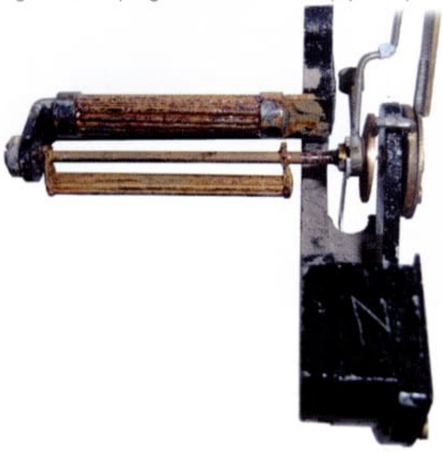


Fig 15b


Fig 16: Current Transformers (a) Smith Hobson Ltd.

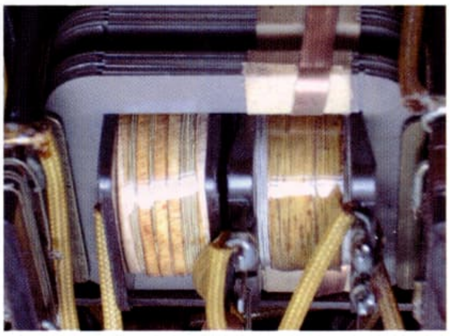


Fig 16b: AVO-7

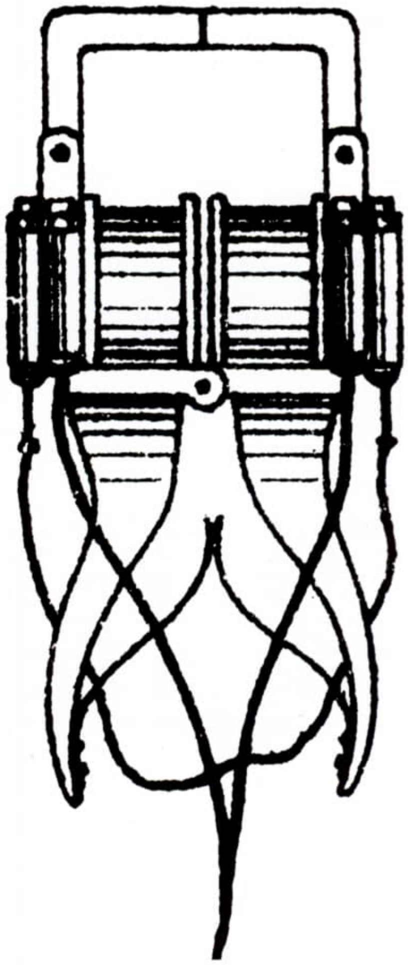


Fig 16c: clamp type

glass. The upper end of the tube carries a thin aluminium pointer which approaches the scale imperceptibly as it rotates. The lower end of the tube is supported by a pin sliding and rotating inside a bearing.

The attractive force is produced by a vertical solenoid of heavy gauge copper which pulls the tube downwards towards its centre. As the helical spring is stretched it unwinds, rotating the tube together with the pointer. The direction of the current is indicated by a small compass inscribed BLUE INWARDS WHEN A POSITIVE.

The instrument under-reads (-5.5±1.5% on DC and -30% on AC). Although the scale is individually marked, it appears to have been linearly interpolated between the calibrated positions at the extremes. The movement is underdamped with a period of 0.3s. The coil has a resistance of 5mΩ giving a maximum voltage drop of 0.37V and consumption of 28W at fsd.

**Evershed's gravity ammeter**
(Bench use, 9cm angled non-linear scale 0-25A Goolden & Trotter, Westminster No.10).

This probably dates between 1886 when Evershed joined the company and 1888 when it changed to WT Goolden & Co. In this design (Fig. 11) three pieces of soft iron (painted black) are situated inside a solenoid where they are each magnetised in the same direction by the current. Thus it is a *compound attraction* instrument as the forces are between the iron pieces where unlike poles adjoin. The two outer ones are fixed and shaped so that as the moving element is pulled backwards, the force tends to increase as the gaps decrease but to decrease as they come more in to line. This results in an open scale between 10 and 20A. The pointer and attracted rod are off balance so that *gravity* provides the restoring force and brings the pointer to zero when the instrument is level. Unusually for a gravity controlled movement it is tilted back at 30° for ease of reading as a bench instrument - a consideration almost unique among instruments I have come across. It is provided with levelling feet and a spirit level.

On DC its accuracy is +1±3% partly owing to hysteresis (the present reading depending on previous readings) whilst on AC it is -2±1%. The response is underdamped with a period of 0.3s. It has a resistance of 68mΩ giving 1.7V and 42W at fsd.

**Ediswan gravity ammeter**
(Vertical bench use, 10cm non-linear scale 0-20A, Ediswan).

This meter (Fig. 12), which appears to date from about 1890-1900, works on the *repulsion* principle. The moving part consists of iron laminations (black) carried on a brass arbor with steel pivots in jewelled bearings and solid aluminium pointer. This is repulsed by a parallel bundle of iron wires packed inside the brass tube behind. The solenoid consists of about ten turns of 4.5mm diameter stranded copper wire. The instrument under-reads (on DC -10% at 4A and -3±2% between 7 & 20A and on AC -20% at 4A and -5±3% between 7 & 20A). It has an underdamped period of 0.4s, and a resistance of 36mΩ giving 0.74V and 14W at fsd.

**Rumney & Rumney amperes**
(Wall mounting 14cm near-linear scale 0-10A, No.3665)

Like the previous meter this works on the *repulsion* principle but with *spring* control (Fig. 13). The fixed iron rod is soldered to the outside of the brass tube (Fig. 13b left side). This repulses a parallel rod causing the pointer to rotate, both rods extending the length of the solenoid of about 30 turns of 14SWG wire. As in most meters of this kind, the arbor is displaced from the axis of the solenoid to allow the necessary movement and scale law. On DC it under-reads slightly, -2±2%, but clearly is not intended for AC use at -11±2%. It has a period of 0.75s but with no damping takes about 30s to settle. Solenoid resistance is 12mΩ giving a voltage drop of 0.12V and power of 1.2W at fsd.

**NCS gravity ammeter**
(Wall mounting, 10cm non-linear scale 0-1A, indicated for 100~, R = 2.35Ω, Z = 4.15Ω, No.183943).

Like the previous meters it works on the *repulsion* principle but with gravity control. It uses solid iron parts and incorporates air damping by an aluminium piston moving within an annular dashpot, but is slightly underdamped (Fig. 14). Although indicated for 100Hz it over-reads only

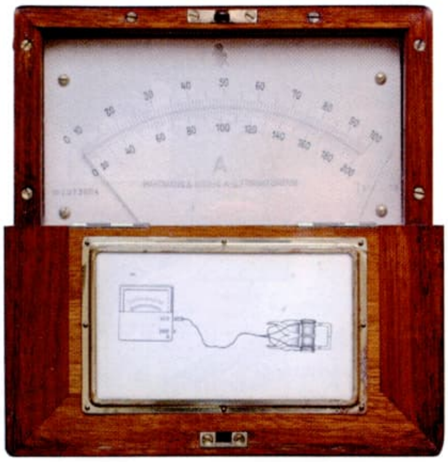


Fig 17a: Hartmann & Braun ammeter (repulsion)

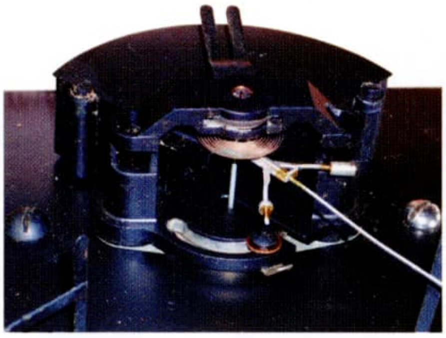


Fig 17b

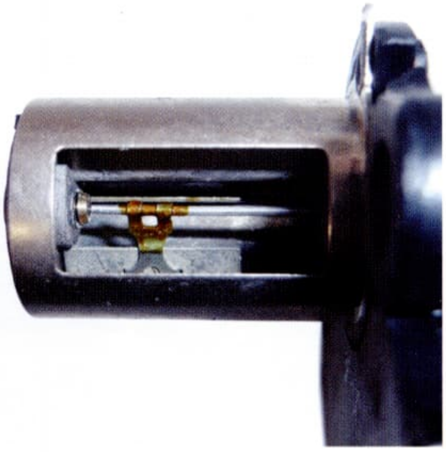


Fig 17c

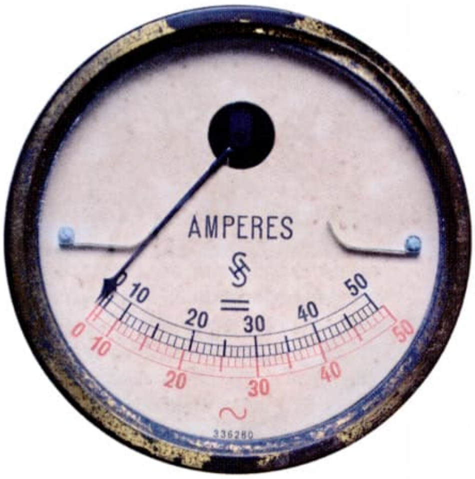



Fig 18a: Siemens & Halske ammeter (simple attraction)

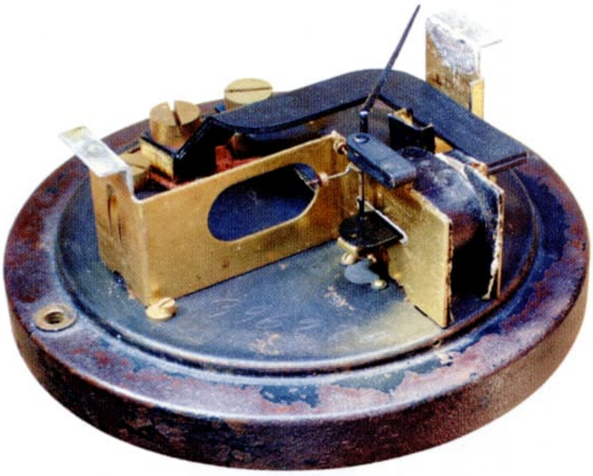


Fig 18b

slightly by +2±2% at 50Hz and +1±2% on DC with a resistance of 2.35Ω, voltage drop of 2.4V and power of 2.4W at fsd.

**NCS spring-controlled ammeter**
(Vertical bench use, non-linear scale for use with current transformer No.1077, 0-500A at 50~ using current transformer No. 1077, or 0-5A direct, No.131064).

This again works on the *repulsion* principle using bundles of iron wire with dashpot damping and balancing force provided by a hairspring with zero set lever in the base (Fig. 15). It over-reads by +3±1% on both AC and DC with direct connection. The response period is 1s under-damped, and resistance 60mΩ, giving 0.3V and 1.5W at fsd. Presumably with its lower serial number it is slightly earlier than the previous instrument. With no information on NCS I would guess at 1900 to 1920.

**Current transformers**
For high current and multiple ranges on an AC ammeter it is necessary to employ a current transformer. This is because the solenoid of a moving iron instrument has an impedance containing a significant inductive component which it would be necessary to match pro-rata in each shunt. Matters are worse for moving coil meters, where rectifiers are used to measure AC, as the series resistance is highly dependent upon the current.

The current transformer 'kills two birds with one stone'. It not only circumvents the above problems but reduces the fsd voltage drop in proportion to the current range. We are familiar with the impedance converting properties between an output valve and a low impedance loudspeaker, $Z_{in} / Z_{out} = n^2$, where **n** is the turns ratio. The voltage is reduced by a factor **n** whilst the current is increased by the same factor n. In an ideal transformer with infinite self inductance and zero leakage inductance its impedance would be zero with its secondary short-circuited, and infinity with its secondary open-circuited. Ideally no power is dissipated in the transformer, and that consumed by the meter remains the same on all ranges.

In fact, as seen in the first Ayrton & Perry Ammeter above and the Weston Ampèremeter below it is possible to provide multiple ranges by using multifilar windings. It is not, however, possible simply to use separate windings as in a transformer because, with an 'open' magnetic circuit, and in the words of *Animal Farm*, 'some turns are more equal than others'. At the other extreme in the case of Sullivan's Inductive Voltage Divider (BVWS Bulletin **35** (4) p.28), by using multifilar windings and efficient toroidal cores, ratios could be specified to 2 parts in $10^8$.

Fig.16 illustrates three types: (a) is a four range example by Smith Hobson Ltd (No. 67846) for use with a 5A 50~ AC meter and should work satisfactorily with the NCS meter above. This then gives ranges of 10, 20 or 50A via the terminals or, by passing the current conductor through the hole in the centre, 500A. Presumably, the transformer core encircling the hole will be standard transformer alloy either as a stack of flat stampings with holes in the centre or as a long rolled-up strip, the copper turns being wound round this as a toroidal transformer. The large size is needed to achieve a high inductance with few turns and it is rated at 7.5VA.

Fig. 16(b) illustrates an instrument transformer from an AVO 7 multimeter giving current ranges of 0.01, 0.1, 1.0 and 10A. In this case the high inductance is obtained by using a high permeability core material such as mu-metal. This also allows it to be used over a large range of frequencies, in this case 15Hz to 15kHz.

Fig. 16(c) illustrates the clamp type transformer in which the core is in two halves held together by a spring which can be opened by the handles to clamp it round a live conductor without disturbing the circuit. The meter can be attached by leads as here (for the following instrument) or it can be an integral item.

**Hartmann & Braun**
(Vertical or horizontal bench use 14cm scale separately calibrated 0-100A, 0-200A, 50Hz Hartmann & Braun A-G, Frankfurt a/M No.1072004)

This meter (Fig. 17) is again a *repulsion* type with dashpot damping for use with a current clamp transformer. In this case the two ranges are obtained using different sets of terminals. As its transformer is missing it is not possible to test it meaningfully. It is spring controlled and dashpot damped. One of the rectangular repulsion plates is attached radially to the rotating arbor whilst the



Fig 19a: Weston Ampéremeter (repulsion)

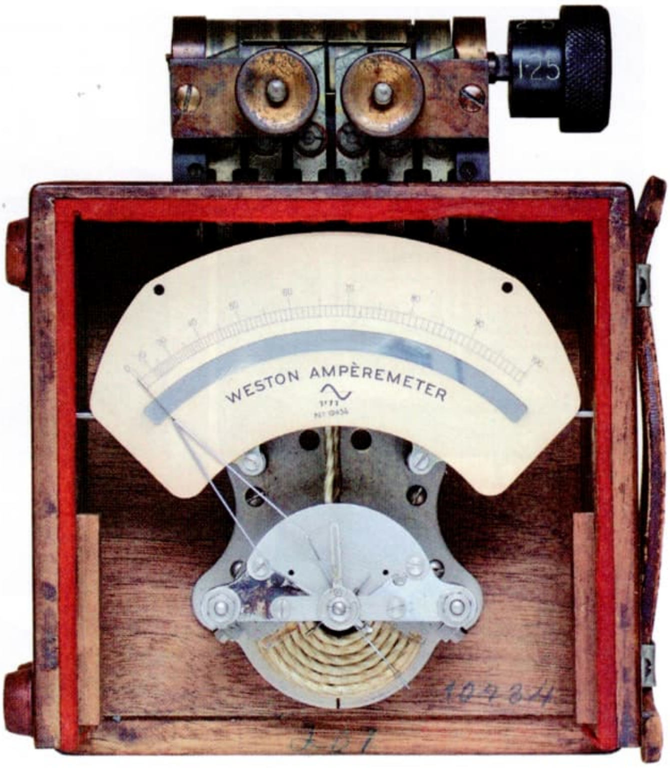




Fig 19b

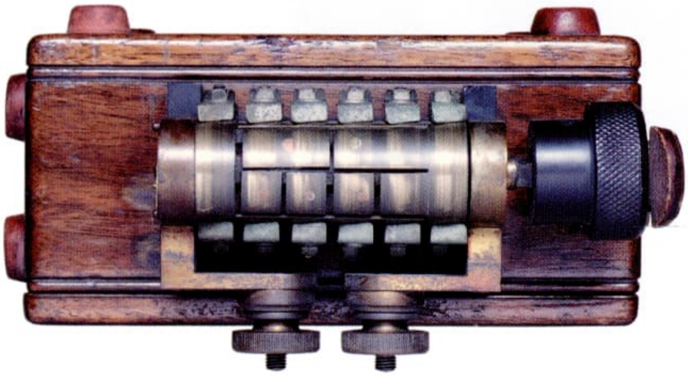


Fig 19c

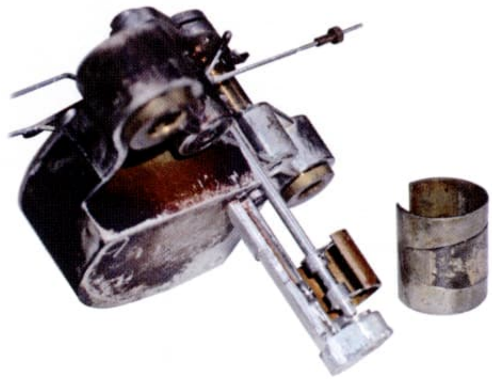


Fig 19d

other (seen edge-on in Fig. 17c) is attached radially inside a plated brass canister which can be rotated (after loosening a screw in an annular slot seen in Fig. 17b) to adjust sensitivity. Period 2s, near critical damping.

**Siemens & Halske**

(Wall mounting, 8cm scale separately calibrated 0-50A black DC and red AC, SH No.33680)

This is a *gravity* controlled *simple attraction* type with a shaped vane pulled into a narrow slot in a solenoid of four turns of triple thickness copper strip (Fig. 18). The shaping of the vane results in an almost linear scale between 10 and 50A. The period is about 0.6s with no damping provided. It has a resistance of 0.5mΩ, and voltage drop of 25mV and fsd power of 1.25W.

**Weston Ampéremeter**

(Horizontal bench use, 13cm scale nonlinear 0 - 100, ranges 1.25, 2.5 & 5A. Weston Electrical Instrument Co, Newark, NJ, USA. Model 155, No.10434)

This is a three-range *repulsion* spring-controlled ammeter based on a number of Weston patents from 1888 to 1901 with cylindrical elements centred on the axis of the solenoid (Fig. 19). The moving half-cylindrical shell (Fig. 19d) rotates towards the camera from the tip end of the encircling tongue-shaped ferrous piece set into a brass cylindrical shell fixed to the aluminium support. Magnetisation occurs along the axis so that, say, N poles are towards the pointer. It is spring-controlled and dash-pot damped and indicated for AC.

The solenoid is wound with four-strand insulated wire which can be interconnected by the commutator switch in series (1.25A), series-parallel (2.5A) or fully parallel (5A). It over-reads by +2+1% on AC and DC. Period 1s critically damped by dashpot; resistance 0.8, 0.3 & 0.1Ω respectively; 0.5-1V & 1.25W at fsd.

**Moving coil ammeters**

A *moving coil* meter works on the same principle as a *moving magnet* instrument but with fixed and moving parts interchanged. The new geometry, however, results in a much greater efficiency as revealed by the power at fsd.

A rectangular coil is situated in an annular gap between a central soft iron cylinder and the shaped pole pieces of a permanent magnet (Fig. 20a). This very small gap in the magnetic circuit gives a very high flux density. The coil is mounted between jewelled bearings with hair springs to lead the current in and out and to provide the restoring force. Because the field in the annular gap is uniform and the spring torque is proportional to the deflection, the scale is linear, but limited to DC unless a rectifier is added.

Although the form of instrument with which we are familiar derives from a design patented by Edward Weston in 1888, its origins are much earlier. In 1856 CF Varley patented a very similar design, in 1867 Thomson patented his siphon recorder, part of which is a moving coil galvanometer. Its form as a galvanometer is due to d'Arsonval and Deprez in 1881-4 with improvements by Ayrton and others. The Weston meter was slow to be adopted because of expense, but ultimately became supreme. In 1903 Robert Paul introduced the *Unipivot* version which reduced friction.

For an ammeter it is desirable to fill the available coil space with few turns of thick wire to produce a low *voltage drop* at fsd whilst for a voltmeter the highest number of the thinnest wire turns should be used for a *low current* at fsd. For a given amount of copper the power at fsd should be the same.

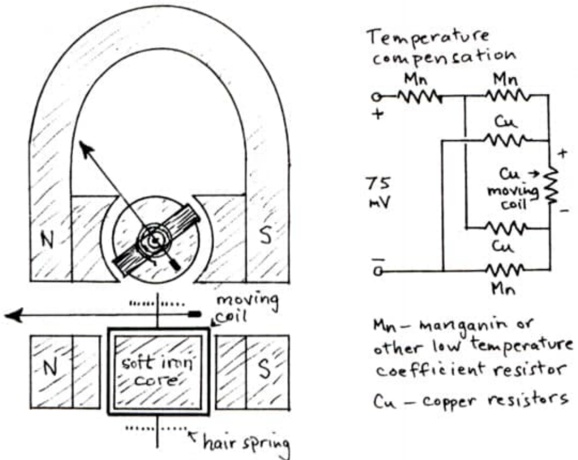



Fig 20a: Elliott Moving Coil Ammeter (Weston)

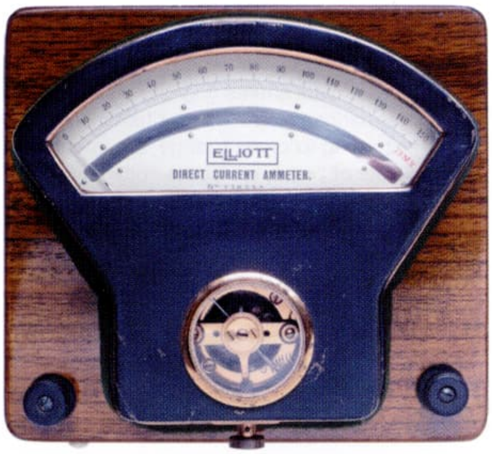



Fig 20b

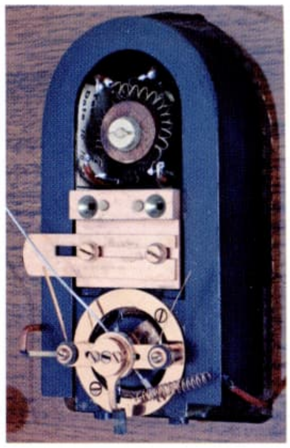


Fig 20c

**Elliott Direct Current Ammeter**
(Bench use, 13cm linear scale marked 0-150, 75mV for use with external shunts 3, 15, 150, 750, 1500A (missing). Elliott Portable Standard Ammeter No.130932, certified 0.5% accurate 9.Nov.1921).

Elliott Bros were agents for The Weston Electrical Instrument Co, who manufactured this spring-controlled *moving coil* instrument (with Weston serial number prefixed by '1'). An interesting inclusion is a temperature compensation network using, presumably, copper and manganin resistors (Fig. 20, inside magnet). For current measurements with a shunt, a constant *voltage* sensitivity is required. The copper cross-coupling resistors reduce the sensitivity by a factor of about five, but less at higher temperatures, counteracting the reduction of reading due the increase in coil resistance. The resulting temperature coefficient was measured at 0.3%/10°C compared with 3.9%/10°C uncorrected.

As found the sensitivity was too high (69.8mV instead of 75mV fsd) but could be adjusted by sliding the copper plated magnetic shunt further across the magnet (Fig. 20c). Period 1s critically damped, impedance 1.6Ω, 44mA and 3.5mW at fsd with network (17.6mA, 13.4mV & 0.24mW direct).

**DC Shunts**
As indicated above, the range of an ammeter can be extended by the use of shunts. A low resistance is used to short-circuit the movement taking say 99% of the current and allowing 1% through the meter giving, in this example, a range multiplication of 100. This does, however, introduce certain problems. The most obvious perhaps is that switch contact resistance variability may not be negligible compared to the shunt. This can be avoided by using the principle of *4-terminal* connection, separate connections for the current and to the meter, although in a multirange instrument with a common terminal, it can be achieved with three switch contacts.

An alternative first described by Ayrton for use with galvanometers and adopted in the AVO, is the universal shunt. In this, the shunts are connected in series, with the meter movement permanently connected to the two ends, the neutral terminal to the high current end, and the live terminal to one of the junctions via a selector switch. Thus the shunt becomes the sum of the resistors to that point whilst the shunted resistance is the sum of the remainder plus movement resistance. Each shunt has to be able to carry the current up to that point. One disadvantage of using a universal shunt is that more voltage than necessary is dropped across the instrument.

Unfortunately the best practicable conductor, copper, increases in resistance by 3.93% for a 10°C temperature rise. Thus if the shunt resistance remains constant, the readings will be about 4% high at 10°C and 4% low at 30°C ambient temperatures. The answer might appear to be to make the shunt out of copper but with its high conductivity this would physically be very large. Furthermore, the greater problem is that considerable power will be dissipated in the shunt which will rise well above ambient temperature. Thus for the higher currents, which also require special terminals and switch contacts, it is normal to use external shunts made from a suitable alloy.

The earliest resistance materials were alloys of expensive metals such as platinum, iridium and silver or the much cheaper *German silver* (55-60% copper, 20-25% nickel, 20% zinc). Their temperature dependence was still rather large, although less than for copper. This led Edward Weston to develop *constantan* (60% copper, 40% nickel; *eureka* is similar 57% copper 43% nickel) which although excellent, suffered from high thermoelectric contact potentials. So in 1892 Weston went on to develop *manganin* (84% copper, 12% manganese, 4% nickel) which has a temperature coefficient of about 0.02%/10°C (20ppm/°C ) and remained the standard resistance material for a century.

**Everett Edgcumbe sub-standard ammeter**
(Horizontal bench use 14cm scale marked 0-15 & 0-150A, ranges and shunts 1.5, 3.0, 7.5, 15, 30, 60, 300 & 450A all at 0.2V, calibration certificate 19.3.54. No.522352)

This is another high quality *moving coil*


Fig 21a: Sub-Standard Ammeter (Everett Edgcumbe))

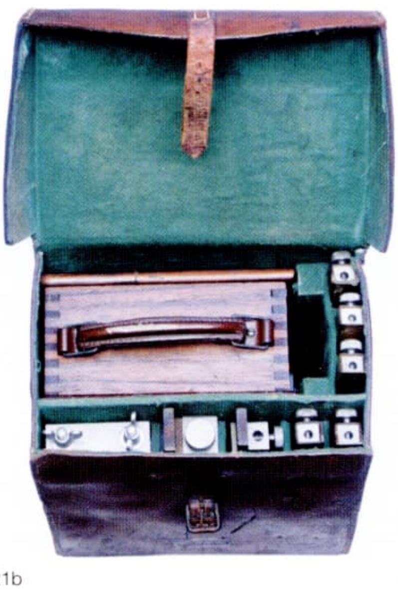


Fig 21b

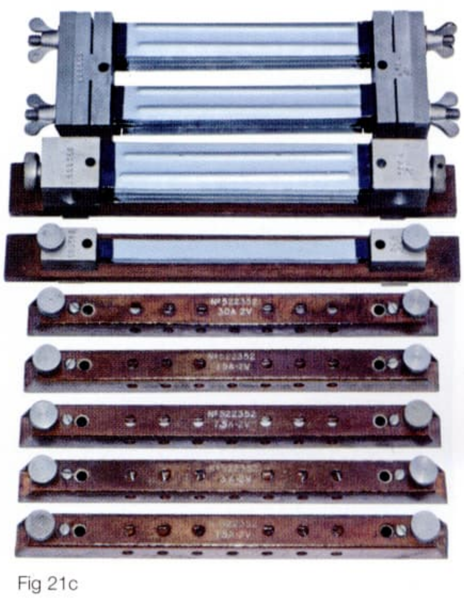


Fig 21c

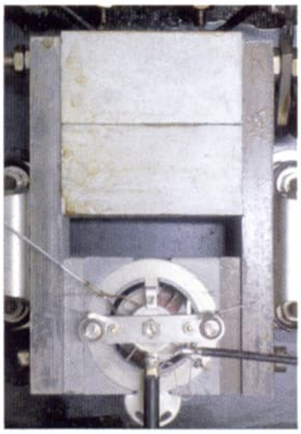
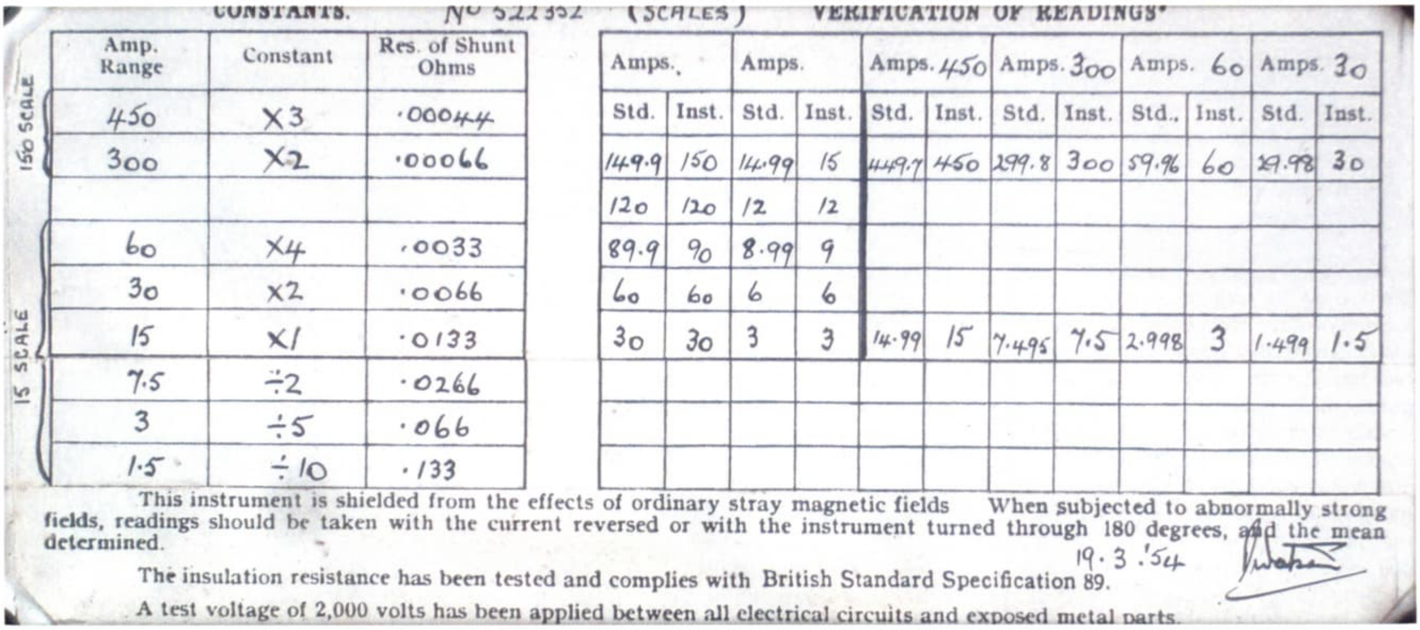


Fig 21d

instrument graded as Sub-Standard (the grades below being Precision and Industrial, the AVO normally being Industrial grade). It is supplied with eight four-terminal shunts (Fig. 21) which appear not to be manganin. The current terminals, which differ according to current range, are integral with solid blocks of brass, whilst the voltage leads to the meter are via plugs inserted in holes in these blocks.

The certificate on the base (Fig. 21e) shows on the left of the right-hand grid, the current flowing when the instrument indicates 30, 60, 90, 120 & 150 (3, 6, 9, 12 & 15) showing its linearity, whilst the right hand columns show the actual currents at fsd with each shunt. These indicate that the meter over-read by 1 part in 1500 (0.07%). A recent check indicates that it now under-reads by about 0.2%. Surprisingly the influence of temperature is not specified. Tests indicate that the 1.5A shunt has a coefficient of about +0.12%/10°C and the meter (~10Ω movement plus 40Ω series resistor which may have a slight negative coefficient) about +0.57%/10°C giving a net ambient dependence of 0.45%/10°C (i.e. under-reads with temperature rise and is inferior to the Elliott/Weston above). The meter movement takes about 4mA, consuming 0.16mW at fsd. With its shunts, however, it ranges from 0.3W at 1.5A to 90W at 450A fsd.

Whilst it would be logical to discuss milli-ammeters and micro-ammeters here, these will be included later when describing instruments more suitable for the radio and electronics field. Any corrections or further information on dating would be most welcome.



CONSTANTS. No 522352 (SCALES) VERIFICATION OF READINGS*

| Scale | Amp. Range | Constant | Res. of Shunt Ohms |
|---|---|---|---|
| 150 SCALE | 450 | X3 | ·00044 |
| 150 SCALE | 300 | X2 | ·00066 |
| | | | |
| 15 SCALE | 60 | X4 | ·0033 |
| 15 SCALE | 30 | X2 | ·0066 |
| 15 SCALE | 15 | X1 | ·0133 |
| 15 SCALE | 7.5 | ÷2 | ·0266 |
| 15 SCALE | 3 | ÷5 | ·066 |
| 15 SCALE | 1.5 | ÷10 | ·133 |

| Amps. | | Amps. | | Amps. 450 | | Amps. 300 | | Amps. 60 | | Amps. 30 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Std. | Inst. | Std. | Inst. | Std. | Inst. | Std. | Inst. | Std. | Inst. | Std. | Inst. |
| 149.9 | 150 | 14.99 | 15 | 449.7 | 450 | 299.8 | 300 | 59.96 | 60 | 29.98 | 30 |
| 120 | 120 | 12 | 12 | | | | | | | | |
| 89.9 | 90 | 8.99 | 9 | | | | | | | | |
| 60 | 60 | 6 | 6 | | | | | | | | |
| 30 | 30 | 3 | 3 | 14.99 | 15 | 7.495 | 7.5 | 2.998 | 3 | 1.499 | 1.5 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

This instrument is shielded from the effects of ordinary stray magnetic fields When subjected to abnormally strong fields, readings should be taken with the current reversed or with the instrument turned through 180 degrees, and the mean determined.

19.3.'54

The insulation resistance has been tested and complies with British Standard Specification 89.

A test voltage of 2,000 volts has been applied between all electrical circuits and exposed metal parts.

Fig 21e

# Letters

**Dear Editor**

Re the article on the BEREC 'Pioneer' radio in the Summer 2013 edition of The Bulletin - The BEREC trademark was applied to all EVER READY products- Torches, Radios , Batteries, etc. - destined for export markets. This was because outside of the UK, the name was owned by the US company 'EVEREADY', and therefore the BEREC brand name (British Ever Ready Electrical Company) was coined to overcome the problem.

Many of the radios, made at their Wolverhampton works, were identical apart from the brand- and model - names, although the colours might vary and, of course, some were specially designed for export only.

I do not know if any of the radio manufacture was outsourced to Plessey, but it is possible. There were occasions when the 'Ever Ready Man' would supply our shop with BEREC-branded batteries, (particularly U11s, U2s , PP9s and 3s etc.), if they were low on stocks of the regular kind, although this was frowned upon by the management of the ER company. In the very early 60s, I had a friend who worked in their Research Department at St Ann's Road, Tottenham, and he arranged for me to visit a couple of ER factories in N. London, one making torch bulbs, the other batteries. At the latter, they had a line making the cardboard sleeves for torch batteries, (this was before the general adoption of steel-cased 'leak proof' cells), and in addition to the ER and BEREC brands, I saw EXIDE, SIEMENS, GEC and one or two continental brand-names being printed, all under contract! The only major UK name missing was VIDOR, who made their own batteries at a factory in Dundee, Scotland.

In their heyday, ER occupied a large, multi-storey office block in Whetstone, N. London, (now the HQ of the London Borough of Barnet), and had quite a number of large factories throughout the UK. After a few changes of ownership, the company is now known as ENERGISER, (although the ER brand name is still applied to some products), and is a subsidiary of a French conglomerate. Today, it is purely a marketing organisation; all manufacturing is undertaken overseas, much of it in the Far East.

Yours sincerely,
Tony Clayden
Barnet, Herts.

## BRITISH VINTAGE WIRELESS SOCIETY

### STATEMENT OF ACCOUNTS - YEAR TO 31st DECEMBER 2012

| | | year ended 31st December 2012 | | year ended 31st December 2011 |
|---|---|---|---|---|
| **Receipts** | | £ | | £ |
| Subscriptions | | 35,437 | | 19,228 |
| BVWATM Friends Group subscriptions (net) | | (130) | | (85) |
| Sale of publications | | 1,502 | | 1,727 |
| Capacitor sales | | 5,415 | | 4,298 |
| Deoxit sales | | 498 | | 705 |
| Meetings | | 2,318 | | 6,057 |
| Estate sales receipts | | 34,738 | | 39,344 |
| Valveman DVD sales | | 130 | | 109 |
| Donations | | 316 | | 273 |
| Bank interest | | 12 | | 17 |
| Corporation Tax refund | | 146 | | - |
| NVCF Profit/(Loss) | | 72 | | (63) |
| **Total receipts** | | 80,454 | | 71,610 |
| **Payments** | | | | |
| General expenses | 11,270 | | 11,518 | |
| Stationery | 2,343 | | 2,538 | |
| Storage Facilities | 2,400 | | 2,400 | |
| Postage | 10,883 | | 8,936 | |
| Meetings | 2,140 | | 5,324 | |
| Bulletin costs | 19,005 | | 13,061 | |
| Estate sales payments | 39,983 | | 29,983 | |
| Capacitor costs | 5,042 | | 9,468 | |
| Deoxit purchases | 979 | | 490 | |
| Donation to BVWATM | - | | 273 | |
| Valveman DVD sale proceeds transferred to BVWATM | - | | 220 | |
| Other publication costs | 488 | | 997 | |
| **Total payments** | | 94,533 | | 85,208 |
| **Surplus for the period** | | (14,079) | | (13,598) |
| **Total assets at beginning of period** | | 39,889 | | 53,487 |
| **Total assets at end of period** | | 25,810 | | 39,889 |
| **Assets** | | | | |
| HSBC current account | | 7,614 | | 9,777 |
| HSBC deposit account | | 10,217 | | 22,205 |
| NVCF assets (held for the benefit of the B.V.W.& T.V. Museum) | | 7,979 | | 7,907 |
| **Total assets** | | 25,810 | | 39,889 |

At 31st December 2012 £661 (2011 - £597) was owed by the BVWS to the authors of various publications that the BVWS sell on behalf of these authors and £898 was owed to the beneficiaries of estate sales. (At 31st December 2011 £7,374 was also owed for Bulletin costs). These liabilities are not recognised in the accounts.

The accounts of the Society reflect the receipts and payments on a cash basis and do not reflect any prepaid or accrued income and expenditure. As an unincorporated club, all surplus is passed to members by way of bulletins, supplements and events. At the same time a prudent asset balance is maintained in order to provide for the unexpected.

...........................................
**Treasurer**

**AUDITORS REPORT TO THE MEMBERS OF THE BRITISH VINTAGE WIRELESS SOCIETY**

We have examined the above Accounts and the attached Accounts of the National Vintage Communications Fair for the year ended 31st December 2012 together with the accounting records and supporting documents and vouchers and confirm the same to be in accordance therewith.

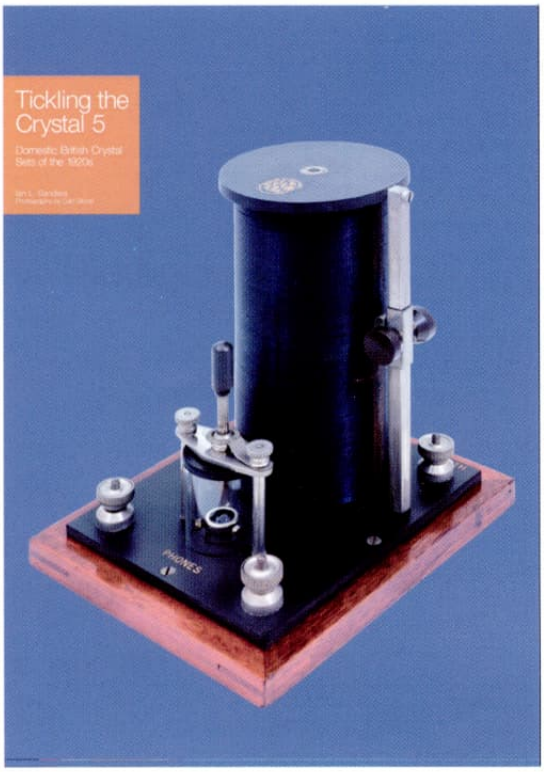
Christchurch House
Upper George Street
Luton Beds
LU1 2RS

Keens Shay Keens Limited

**KEENS SHAY KEENS LIMITED**
**Chartered Accountants**

12th March 2013

# BVWS Books

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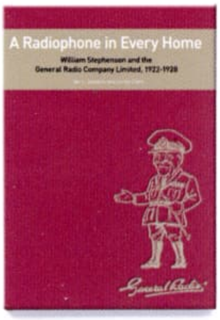
BVWS Books

# Out Now!

## A Radiophone in Every Home - William Stephenson and the General Radio Company Limited, 1922-1928

by Ian L. Sanders and Lorne Clark, with foreword by Jonathan Hill. Published by Loddon Valley Press. ISBN 978-0-570773-0-0.





Between 1922 and 1927, during the life of the British Broadcasting Company (forerunner of today's British Broadcasting Corporation), literally hundreds of wireless manufacturing firms sprang up to take advantage of the new craze for 'listening-in'. In the fiercely competitive market of those pioneering days, many of these businesses were to disappear within just a few years. While much has been written on the history of the larger companies during this period of attrition, names such as Marconi, British Thomson-Houston, Burndept and General Electric – very little has been published about the smaller to mid-sized enterprises.

In their superbly illustrated new book, Ian Sanders and Lorne Clark tell the fascinating story of one of these smaller firms, the General Radio Company Ltd., and its enigmatic Canadian founder, William Samuel Stephenson, WWI air ace and WWII secret agent, thought to be the model for Ian Fleming's James Bond character.

As well as producing an extensive range of radio receivers, the company also worked on the development of mechanical television.

This high quality publication is available for immediate despatch, price £19.95 (£17.95 for BVWS members) plus £4.95 P&P for UK, £7.50 P&P for EEC. BVWS members should quote their membership number in order to secure the discounted price. Payment via PayPal accepted.
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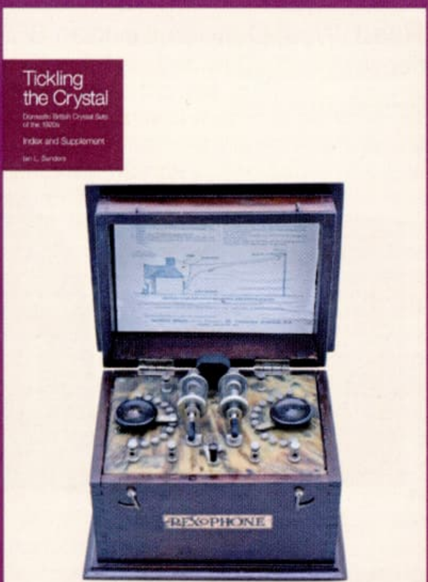
# **Out Now!** Tickling the Crystal index and supplement

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# 1st December
# **Royal Wootton Bassett Swapmeet**

The Memorial Hall, Station Rd. Wootton Bassett.
Nr. Swindon (J16/M4). Doors open 10:00.
Contact Mike Barker: 01380 860787

Eighth page advertisements cost £22.50, quarter page advertisements cost £45, half page: £90 and full page: £180. Cheques made payable to 'BVWS' please




## The Bulletin back issues

All Bulletins and supplements are priced at £2.50 each + postage.

Postage: for individual Bulletins add £1.50, for all extra bulletins add £1 each.
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## The British Vintage Wireless and Television Museum

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Please make appointments beforehand

## Marconi on the Isle of Wight

In November 1897, a twenty-three year old Italian inventor visited the Royal Needles Hotel that overlooked Alum Bay on the west coast of the Isle of Wight. The young Guglielmo Marconi's proposal to rent rooms to perform his 'experiments' over the deserted winter months was warmly welcomed by the hotels proprietors. Marconi used some of the working capital of his newly formed Wireless Telegraph & Signal Company to convert the hotel's billiard room and install his equipment and spark transmitter. Several small ships were hired and fitted with wireless aerials and receivers while moored at the pier below. A huge mast, 168 feet high, had to be hauled up the cliff face of Alum Bay and raised in the hotel grounds, a feat that required the help of most of the able bodied men in Totland. On Monday 6th December 1897 Marconi started his wireless experiments from the Royal Needles Hotel, including a month of private demonstrations for Queen Victoria and the Royal family using wireless stations he installed at Osborne House and on board the Royal Yacht. For the next two and a half years the world's first permanent wireless station would be operated from the Isle of Wight.

By 1900 Marconi realised he need more space, greater privacy and longer ranges to his new stations being built in Cornwall. He moved his equipment and aerial mast from Alum Bay across the Island to a new station built in Knowles farm in Niton. While there Marconi developed the vital science of tuning, enabling multiple wireless signals to be separated without interference. In January 1901 transmissions from Niton reached Marconi's new station at Lizard Point in Cornwall. This was 196 miles away, a world record for 'radio' waves, convincing Marconi that his system was now ready to attempt to transmit across the Atlantic ocean, over 2,100 miles.

The success of Marconi's famous "S" across the Atlantic in December 1901 gave a huge impetus to the growth of wireless (or radio as it soon become known) equipment. As the orders for ships wireless equipment started to increase, Niton soon became an active Marconi shore station (one of 40) handling passing ship wireless traffic in the Solent. Marconi's Niton station was taken over by the Post Office on 29th September 1909 and four years later, as part of a major reorganisation, land at Niton Undercliffe, about four miles from Ventnor, was leased from Lloyds at an annual rent of £5. On the new site a Lloyds signal and wireless telegraphy station using Marconi equipment was built, along with various houses which belonged to the Coastguard, and the station building that was later to become Niton Radio. There was also a Marconi station located on Culver Cliff.

The science and art of wireless communication was born on the Isle of Wight.

The story of a young Italian engineer, whose small experiments on a small Island grew to produce our modern world of instant global communication, radio broadcasting, mobile phones, television, satellite communication and even the internet is simply amazing. Marconi on the Isle of Wight changed the world forever.

The full story of Marconi on the Isle of Wight, 250 pages, 140 photographs is available directly from the publishers:- please see www.authorsonline.co.uk. Or specifically www.authorsonline.co.uk/book/1339/Marconi+on+the+Isle+of+Wight/

For further information please contact the author at timwander@compuserve.com or as always see 2mtwrittle.com

# News and Meetings

**GPO registration Numbers**

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

Martyn Bennett, 58 Church Road, Fleet, Hampshire GU13 8LB telephone: 01252-613660 e-mail: martyb@globalnet.co.uk

**2013 Meetings**

**September 15th** Murphy Day
**September 29th** Harpenden
**6th October** Audiojumble
**3rd November** BVWS Northern meeting - Golborne
**1st December** Wootton Bassett

**2014 Meetings**

**March 2nd** Harpenden
**May 31st** Garden Party at The Vintage Wireless and Television Museum, West Dulwich
**June 1st** Harpenden
**July 6th** Wootton Bassett
**September 28th** Harpenden
**2nd December** 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 10:00, tickets for sale from 09:30, Auction at 13:30. Contact Vic Williamson, 01582 593102
**Audiojumble:** The Angel Leisure Centre, Tonbridge, Kent. Enquiries, 01892 540022
**NVCF: National Vintage Communications Fair** See advert in Bulletin. www.nvcf.co.uk
**Wootton Bassett:** The Memorial Hall, Station Rd. Wootton Bassett. Nr. Swindon (J16/M4). Doors open 10:30. Contact Mike Barker, 01380 860787
**Golborne:** Golborne: Golborne Parkside Sports & Community Club. Rivington Avenue, Golborne, Warrington. WA3 3HG contact Mark Ryding 01942-727428
**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

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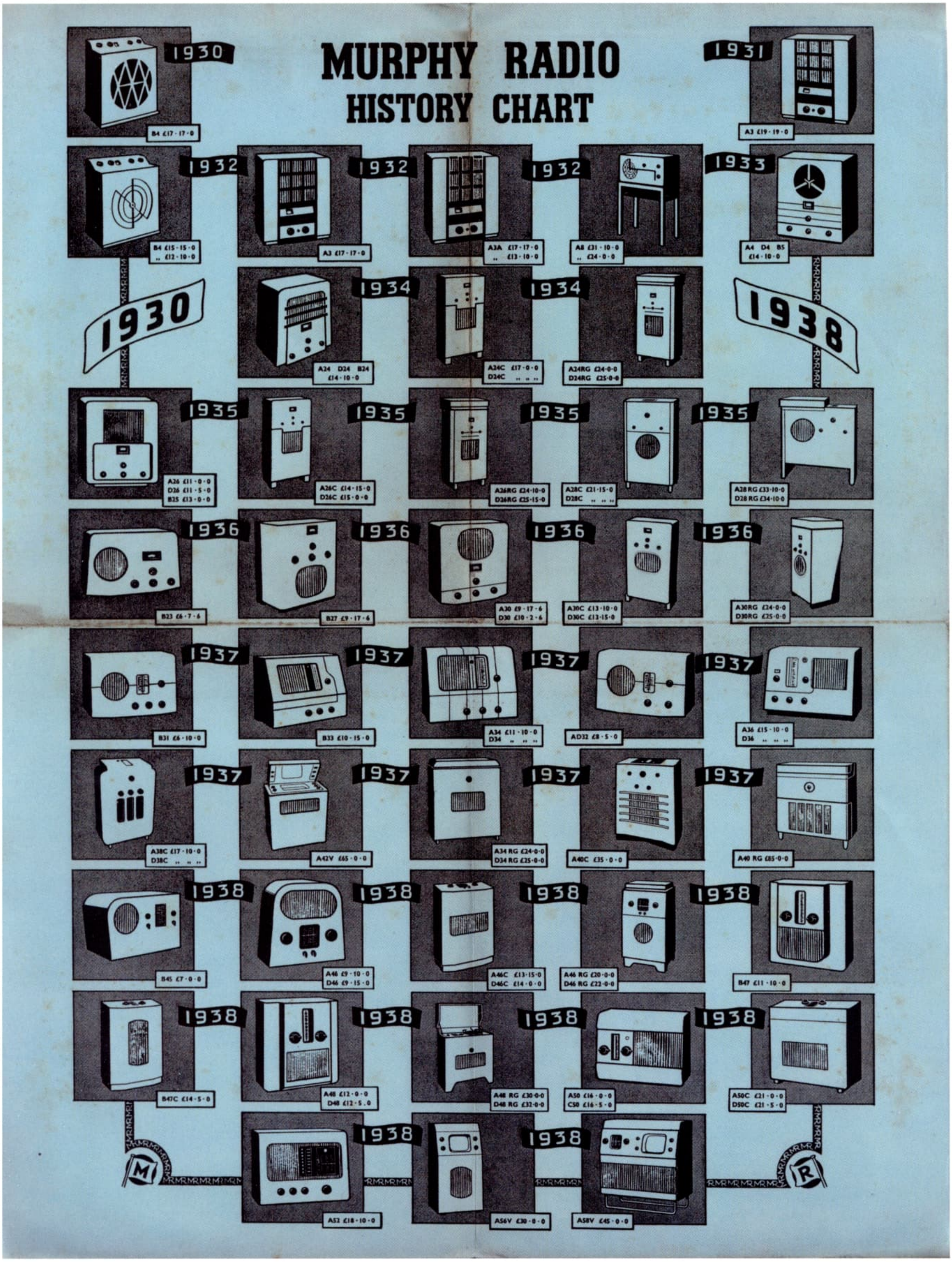
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