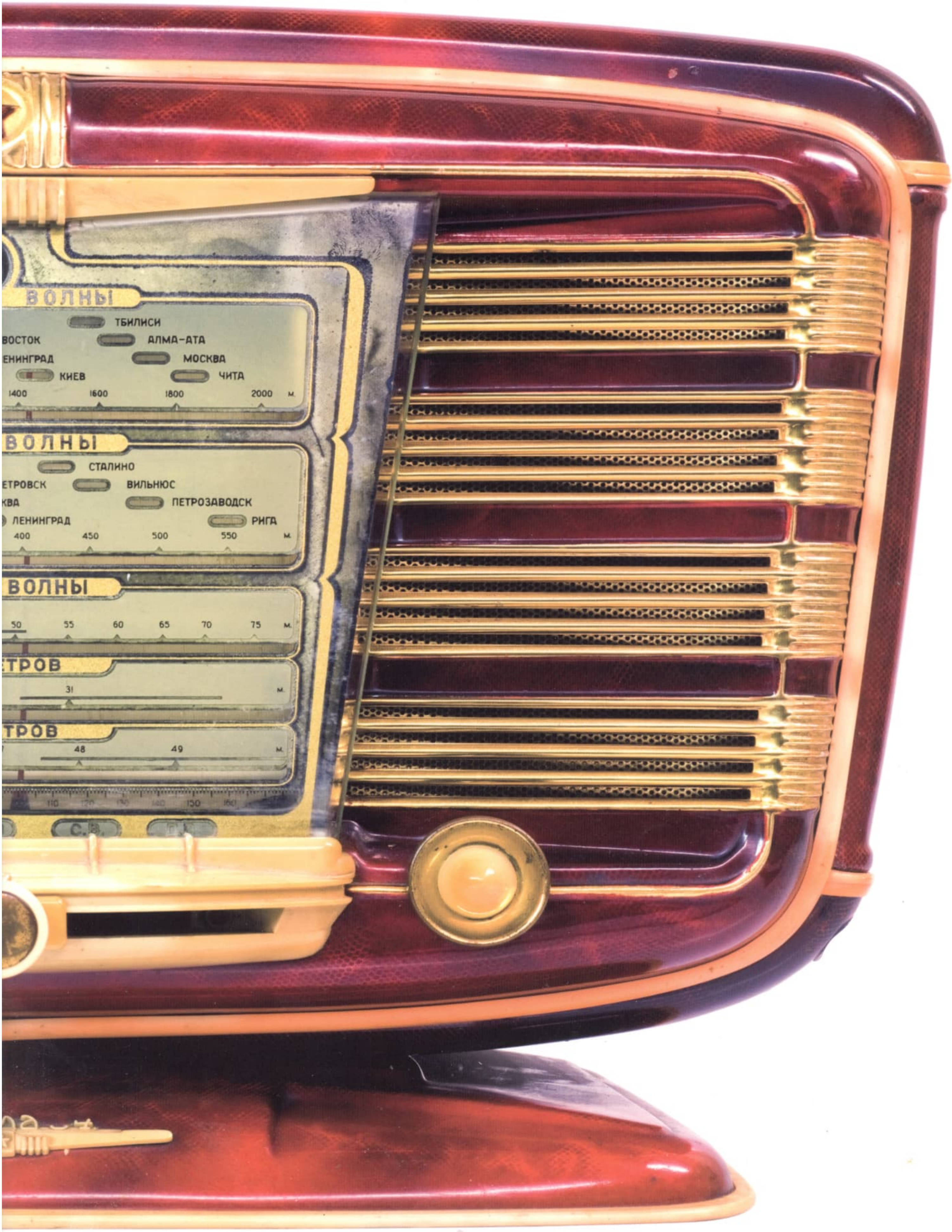
The Bulletin

Vol. 41 no. 2 Summer 2016 www.bvws.org.uk **BVWS 40th Anniversary**



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

BVWS team

Chairman/ Events Co-ordinator:
Mike Barker,
Pound Cottage,
Coate, Devizes,
Wiltshire,
SN10 3LG
Tel: 01380 860787
chairman@bvws.org.uk

Bulletin Editor/Designer
Carl Glover, c/o Aleph,
33 Rangers Square,
London SE10 8HR
Tel: 020 8469 2904
Fax: 020 8694 4817
bulletin_editor@bvws.org.uk

Sub Editor:
Ian Higginbottom

Vice Chair:
Jeremy Day
62 Sherbourne Drive,
Old Sarum, Salisbury
Wiltshire SP4 6GA
vice_chair@bvws.org.uk

Ordinary Committee Members:
Jon Evans
Tel: 0121 5447006

Terry Martini-Yates
18 Sherbrooke Road
Rosyth, Dunfermline
Fife KY11 2YP
Scotland
Tel: 07947 460161
enquiries@ferrographworld.com

Membership Secretary:
Martyn Bennett
Wood Cottage,
58 Church Road,
Fleet, Hampshire,
GU51 4LY
Tel: 01252 613660
membership@bvws.org.uk

Harpenden Organiser:
Vic Williamson,
Tel: 07805 213369

Treasurer:
Greg Hewitt
54 Linnell Road,
Hillmorton, Rugby,
Warks
CV21 4AW
treasurer@bvws.org.uk

BVWS Archivist:
Lorne Clark
16 Kibblewhite Crescent
Twyford, Berks. RG10 9AX
Tel: 0118 9345606
Archivist@bvws.org.uk

Members' Advertisements Committee Secretary
Guy Peskett,
13 Warneford Road,
Oxford, Oxon
OX4 1LT
Tel: 01865 247971
secretary@bvws.org.uk

Webmaster:
Paul Stenning
Box 170
89 Commercial Road
Bournemouth BH2 5RR
webmaster@bvws.org.uk

Bulletin of the British Vintage Wireless Society
Incorporating 405 Alive
Volume 41 No.2 Summer 2016

www.bvws.org.uk

Separations and printing by Hastings Print

Honorary Members:
Ralph Barrett | Dr A.R. Constable | Jeremy Day | Ian Higginbottom | Jonathan Hill | David Read

Front and rear cover: Zvezda 54 'Red Star', 1954 USSR.

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

Contents

From the Chair

The dreaded VAT Man – the resolution.

Since the last Bulletin and my report on the BVWS falling fowl of new VAT legislation on printing services that even those who came up with it could not explain in simple terms, I drafted a letter which would be used with others to present to the local MP in Hastings. This letter laid out the views of, and the consequences that the addition of VAT would have on the BVWS. Together with other representations the local MP took the case to the Financial Secretary to the Treasury where it was resolved that although HMRC were correct in pursuing collection of VAT, it was not appropriate in this case and declared that Hastings Printing Co. were in fact exempt from VAT on the services that we use. The letters made clear that the Legislation had been written and communicated in a way that had caused "genuine confusion".

Therefore I am happy to report that we will no longer be liable for VAT on the Bulletin production and postal services. This is a great relief to the Committee.

The BVWS are now pursuing a re-claim of the VAT paid on the winter 2015 and spring 2016 Bulletins from the printers if at all possible.

The radio equipment collections have hit an all-time high. We are currently drowning in massive amounts of radios and radio related equipment. One collection we are currently dealing with will need at least six transit van loads to clear. Another will be at least three van trips and even this week we have been out for another members' collection. So much so that the BVWS store is crammed full, a second store is currently full of thousands of valves from another collection and we have had to hire two 20 feet shipping containers locally to hold more stock which will take us several weeks to collect. If this was not enough, we have just been notified of another very large collection that the executors want us to auction.

Keep a lookout for special auction dates on the internet Forums and the BVWS website as we will need several events to be able to handle the vast quantity we currently have to offer.
Mike…

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

Roger Grant receiving his Geoffrey Dixon Nuttall award

Gary Tempest receives his Pat Leggatt award at the NVCF

The BVWS Committee at the Harpenden Annual General Meeting

Reworking an unknown US radio from 1935

by Gary Tempest

This is another article that came about from what to do on a dark wet winter's afternoon. Although this is in the summer issue I am actually writing it in the first few days of the New Year and this afternoon is particularly miserable.

The refinished radio, second attempt

It was one of the first radios that I bought, back at the Spring Harpenden meeting in 2000. It came from a stall in the entrance, which is now used for the Bring and Buy, and looked in a poor state but I was much taken by the dial (see pictures). Mostly it was all there and the cabinet wasn't too bad: it had damage but no lifting veneer on the attractive front.

It was obviously an American import set having LW and how it was originally powered was not obvious. If there had been a transformer, it was missing and in its place was a suspect looking mains dropper and a capacitor of the oil filled variety.

My researches back then came up with it being sold as part of the Knight equipment range of Allied Radio. But there is now a marvellous Allied archive internet site (Reference 1) and browsing the catalogues I can't find the model. Also, all their radios feature an "Allied" name tag and this radio had no markings to show that there had ever been one. Apparently Allied didn't actually make anything and their radios were most likely made for them by Belmont or Detrola. This led me to searching the internet Radio Museum and it bears resemblance to a Detrola 5W which has a very similar world globe dial. The valve (or should I say tube) line up is what was in vogue back in 1935 but Detrola were using higher IFs by then compared to my radio which turns out to be around 130 kHz. It seems unlikely that I will ever know the true maker and model.

This article was just going to be about re-refinishing the cabinet from my poor novice attempt back in 2000 to another more pleasing outcome back in 2011. However, why not a review of what I did to the electronics back then and how, with more knowledge and experience, I might go about it today. But, as has happened before, it turned out more interesting as the radio had developed a fault of low gain in the intervening years.

The electronics

My note taking was pretty poor back then but I have since much improved, often things crop up and it's nice to have all the information. From the chassis top side it looks quite workmanlike with a rather odd looking black box which is the mains transformer.

The power supply

The view underneath shows that there was a cut out for a drop through mains transformer which figures as the radio seemingly, in US fashion, never had a back. Exposed droppers wouldn't have been acceptable even with the low safety standards of the time. I cut a plate to cover the hole and my transformer is bolted to that. So what is it? It is made from a transformer kit that could be bought back then from Maplin Electronics that had a bobbin with a wound primary, an open frame and a set of laminations. I have some confusing notes on the rating but believe it was for 50VA which looks right for the volume. At the time I didn't have a coil winder and so the secondaries were wound using a battery powered drill or by hand. Presumably, to minimise the number of turns for HT, the power supply, using the 25Z5 that was present, was configured as a voltage doubler. There is nothing too wrong with that although regulation would have been better if I had gone for a full wave design.

I did use the doubler that is a bridge type where the ripple is at 100Hz rather than the half wave one where it is at 50, see full information on Wikipedia at Reference 2.

A look at the circuit diagram shows that I used an 85V winding for an HT of 118V with 50V dropped across the field coil of the electro-dynamic speaker. The heaters were configured unusually to be powered from a second winding of 25V, with the four 6.3V valves wired in series across it. For dial lights I used two 12V 0.1A lamps, wired in series, for each dial segment.

The setup worked as expected apart from having a lot of transformer buzz which I put down to being short of at least three laminations. But the problem was solved by potting the transformer in a simple plywood box to be later broken away. The fixing method for the finished item was by bolts, used as studs, through the frame. It's possible that the transformer could have run hot but I have run it for hours at a time and it only gets comfortably warm.

Of course if I was doing things today I would wait until I found a suitable through chassis transformer rather than rushing impatiently ahead as I did then.

The refinished radio, first attempt

What else did I do

The chassis was completely stripped, the rust dealt with and then sprayed with silver Hammerite Smooth and I'm impressed at how good it still looks.

All the canned coils were taken apart in order to trace through them and come up with a circuit diagram aided by having the wave-change switch out. The battery drill did other good work as the field coil of the speaker was open circuit. After re-stuffing the electrolytics and the wax paper capacitors the chassis was rebuilt using nuts and bolts as I had no way of riveting even if I could have found the right sizes.

At the time I used a modern plastic shaft tone control with switch that has been replaced with one from Blore Edwards (Reference 3). The 0.1 630V poly' capacitor across the mains transformer primary has also been corrected to an X / Y type.

There is an advantage in having the mains on/off switch on the tone control and that is the volume control, in the sensitive area of the audio pre-amp, can have wiring without screening which must have been a manufacturing cost saving.

A look at the circuit

The aerial input uses transformer coupling on SW and this transformer is always in circuit with the other aerial coils bypassed in the SW switch position. On MW another transformer is used which shares the same former and screening to that of the SW. The secondary sides of both of these are tuned. An additional tuned circuit for LW which is shorted circuited in the MW band switch position, is free mounted on the chassis. On LW it is used with it so alignment must be for the MW band first.

The output of the 6D6 RF amplifier uses a similar transformer and LW coil arrangement to that of the aerial input, coupling to the 6A7 heptode frequency changer. This uses, for the oscillator section, separate switched primary and secondary transformers for each waveband. None of these are screened and are distributed in the chassis corner adjacent to the 6A7.

An IF transformer, with tuned primary and secondary, couples the 6A7 output to the 6D6 IF amplifier. This has an IF transformer which is tuned only on the primary side. I understand that this gives extra gain (ideally 6dB) but with some loss of selectivity. If the secondary side were tuned its dynamic impedance would be reflected across to the primary, the transformer having a nominally 1:1 turns ratio, and be in shunt with that sides impedance. Thus the anode load and stage gain would be halved.

Following on is a 75 double diode triode for detection, AVC and audio pre-amplification. Both diodes are strapped together and some AVC delay is given by the cathode bias. The output amplifier is a 43 with bypassed cathode bias resistor.

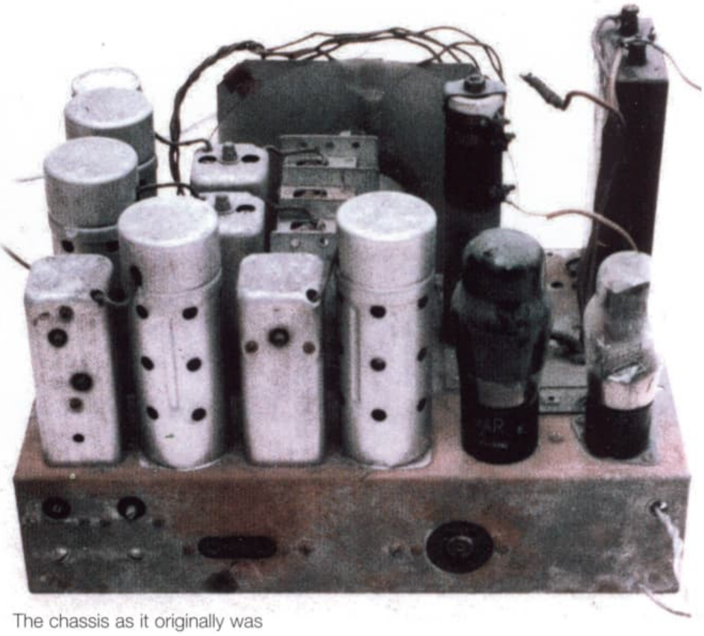
The radio having low gain and an open circuit secondary on IF1

I was surprised by this as the radio had always worked when tried. Eventually after checking voltages I got out an audio signal generator, my RF one not tuning low enough for the IF used. Injection was to G4 of the 6A7 frequency changer, using a spare top cap with an added 1M Ohm grid leak. The oscillator was stopped by a short circuit across the middle tuning gang. Monitoring was by oscilloscope to the detector diode anodes and AVC was inhibited by a short across the lower phono socket as shown on the schematic.

It was easy to peak IF 2 primary and that of IF 1, at the expected frequency, but not so the secondary of IF 1. Then I messed around trying to find at what frequency it would peak before doing what an old serviceman would have done straight away. That was measure the resistance from the top cap of the IF amplifier to the AVC line, finding that the winding was open circuit. But I didn't do a quick repair, which the serviceman would have done, and that was to bypass with a capacitor from the anode of the 6A7 to a grid leak on the 6D6. For me it was off with the IF transformer and see what could be done.

First thing after removing the coil and trimmer panel from the screening can was to unsolder the coils from the panel. I then went on what I thought was a vain hope of unwinding the

The dial



The chassis as it originally was

outer coil connection, of the secondary, to try to find a break near the outside. The first snag was a piece of tape, covered with wax, which had been used to secure the wire. Removing the wax with white spirit was simple enough but no solvent I had, and I have a variety, would remove the tape. There was nothing for it but to use the wire like cutting cheese with the inevitable breaks but slowly I removed all the wire covered by the label and then to my amazement a resistance check showed that I had a continuous coil again. I had lost 3 to 4 Ohms and a couple of mH compared to the primary coil but no matter I could add a small extra capacitor of 22 pF to achieve the same tuning range. The coil was soon back on the chassis but now I had extra gain I also had an oscillating IF strip.

The oscillating IF strip and final IF alignment

The chassis had been prone to this before but only at one end of the LW band but now it was present on all bands. Topside there is plenty of screening but underneath none which isn't really needed as the IF wires are very short. On the oscilloscope, at the detector diodes the level was about 50V at around the IF of 130 kHz. I didn't know the IF of course but reasoned that for an American designer back then, and the US not having LW, they would look at what European radios were using. LW goes down to 150 kHz so the IF should be lower than that and what was Philips using? Beyond the mid 30's they preferred 128 kHz so that should be fine. It was not until around 1938/9 that they adopted higher frequencies in the mid 400 kHz range, which was between the highest LW frequency, of 375 kHz, and the lowest MW frequency of 526.5 and 535 kHz in the US.

Normally the cause of oscillation is not too difficult to find just needing a 0.25 uF capacitor and a little probing around along with checking wire positions and lengths. But this one was different: it really wanted to be a transmitter rather than a receiver. It turned out to be a daft wiring error when I put back the sorted first IF transformer. I had wired the secondary AVC connection to the top PHONO socket rather than the bottom as viewed on the circuit diagram. It seemed physically right there with the correct wire length and "its only four wires I'll remember where they go" and of course I had a circuit diagram but it still fooled me for a while. Not really an excuse but I had a lot of other things on my mind at the time which does show that on such occasions extra care is needed and a crude sketch can save a lot of time and bother.

The IFs were realigned at 130 kHz and peaked nicely with the trimmers near to being closed which is more stable than if they are very far open. Making a quick check of the IF bandwidth, with the wobbulator, showed that they had achieved a very narrow result, of only about 4.5 kHz at half height, with just three tuned windings, see "Performance and Conclusions".

The MW, LW and SW bands and tracking

On the first alignment I had used 130 kHz for the IF and found the tracking good so that was a reason for using it again. It was time to hook up the signal generator, with a frequency counter and a 'scope (10 M probe) on the AVC line and tune to points on the dial, for the respective wavebands, and see how it looked now.

MW

At 500, 400, 300 and 200 metre points on the dial the frequency was correct to mostly better than 0.5% and only 1% out at 500 metres.

LW

Then just for interest I spent a little time seeing how good I could get this waveband. Over most of it I could achieve better than 2% but in the end I set the tracking trimmer to put R4 spot on but it was still within 3% anywhere in the band.

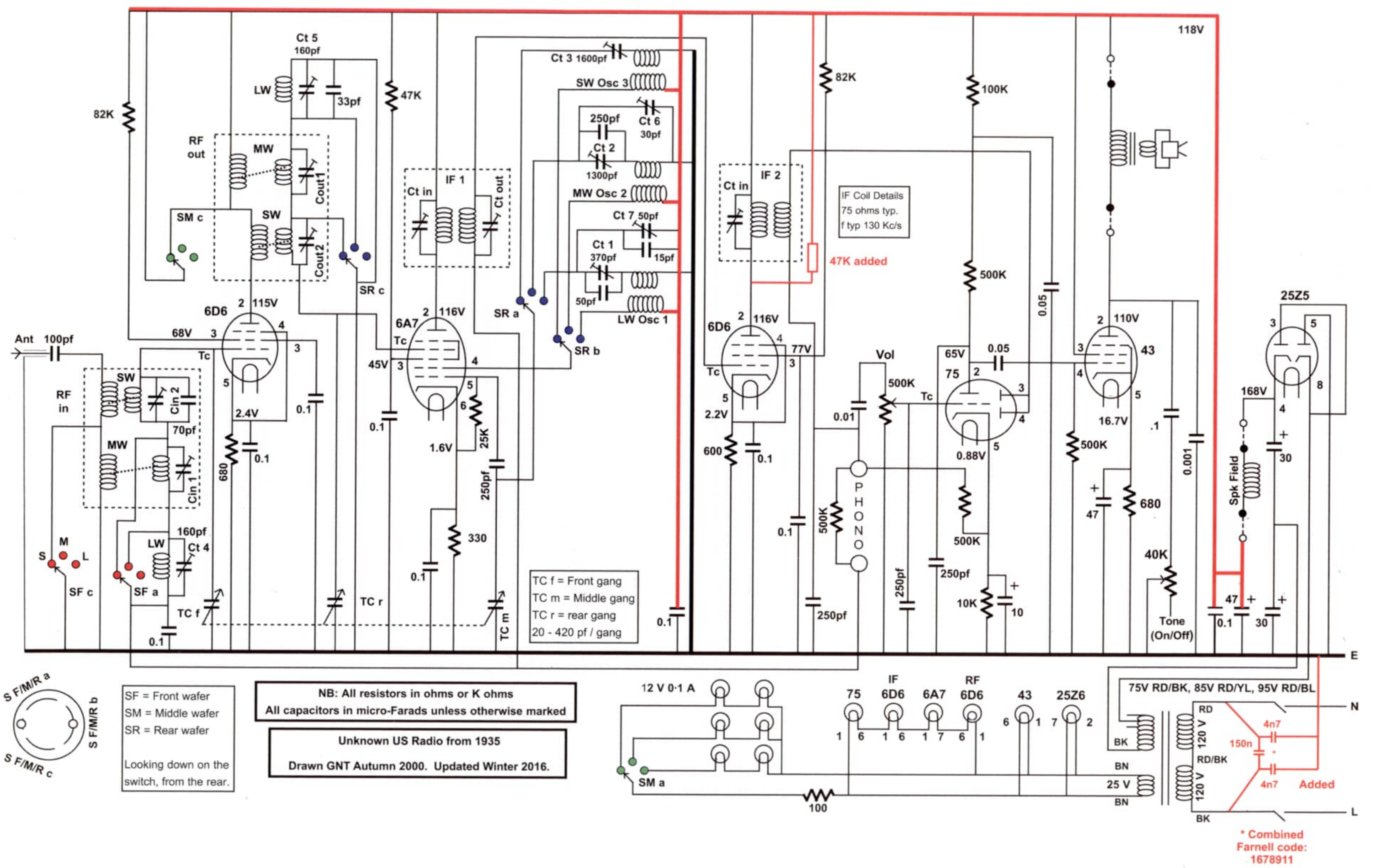
The chassis was unstable, with the signal generator input, at around 1100 m with audible motor-boating. Let's say that at this input the frequency is close to twice the IF so the oscillator would be at 390 kHz and producing IF as expected. But if some of the oscillator frequency reaches the antenna or the input circuits, and with LW being an add on feature the antenna tuned circuit is unscreened, it could mix with the 260 kHz input and produce a frequency at, or close, to the IF and account for the audible beat. Of course with later high IF frequencies this would be unlikely to happen as the oscillator would be at around 700 kHz and more easily rejected.

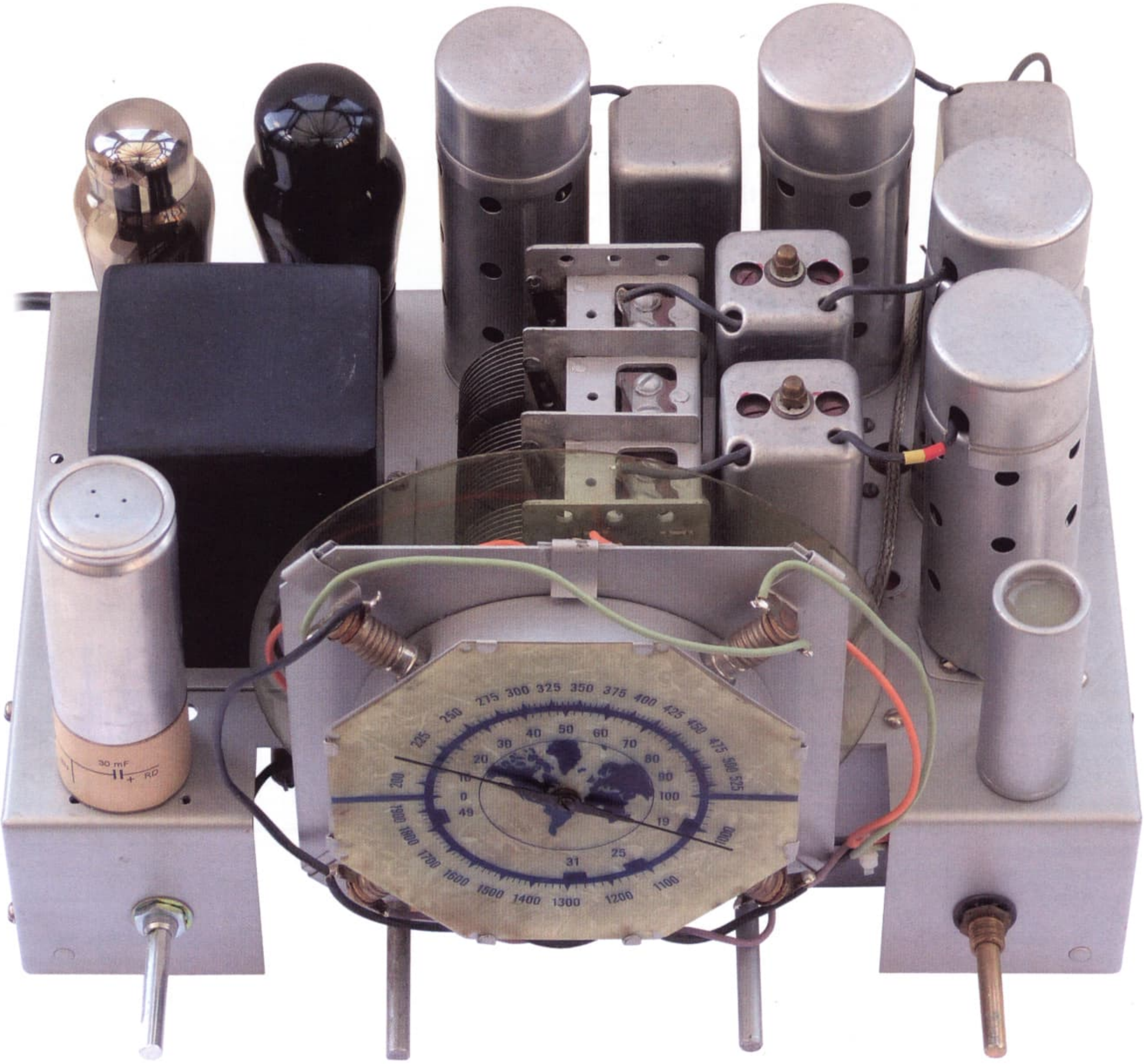
The antenna input is typical of many early US radios and is just a wire that hangs out the back often along with an earth wire. This is unscreened and passes from the front of the chassis to the rear. Screening it did improve things with the chassis stable with no signal from the generator or antenna but it is still there, at reduced level, with either of them. Just for interest I tried making a bottom screen from cardboard covered with tin foil but it made no difference.

SW

At the low frequency end of the band the dial was accurate but as the radio was tuned to higher frequencies the error just became greater. At 31 metres it was 4% low rising to 12% low at 19 metres. Instead of being 16 mHz the input was 14 mHz.

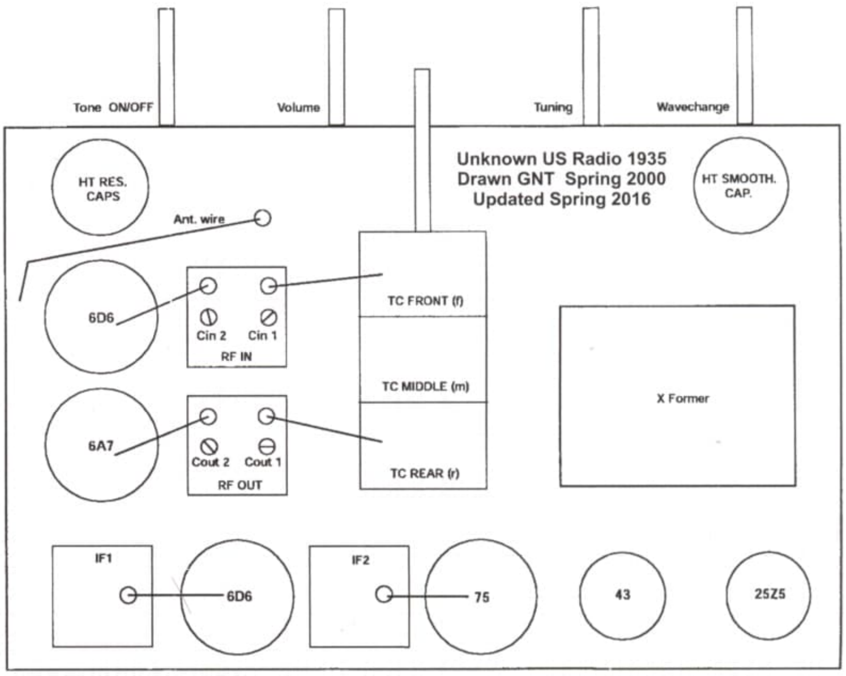
It must have been one of those days when I was feeling really keen as I took off the SW oscillator coil ("Osc 3") and removed one turn from about 10 of enamelled copper wire wound with one wire spacing. This to me was a 10% reduction and being as L is proportional to the square of the turns then a reduction of that by 20%. But as frequency is inversely


Ant 100pf
RF in
SW
MW
Cin 2
Cin 1
70pf
SF c
S M L
SF a
LW
160pf
Ct 4
TC f
0.1
RF out
SM c
Cout1
Cout2
Ct 5 160pf
33pf
82K
6D6
2 115V
68V 3
Tc
5
2.4V
680
0.1
4
SR c
TC r
47K
6A7
2 116V
45V 3
1.6V
25K
250pf
330
TC m
IF 1
Ct in
Ct out
SR a
SR b
Ct 3 1600pf
SW Osc 3
250pf
Ct 6 30pf
Ct 2
1300pf
MW Osc 2
Ct 7 50pf
Ct 1 370pf
15pf
50pf
LW Osc 1
TC f = Front gang
TC m = Middle gang
TC r = rear gang
20 - 420 pf / gang
6D6
2 116V
77V
2.2V
600
IF 2
82K
47K added
IF Coil Details
75 ohms typ.
f typ 130 Kc/s
Vol
500K
0.01
PHONO
75
65V
0.05
0.88V
10K
10
100K
500K
43
2 110V
16.7V
680
47
40K
Tone (On/Off)
.1
0.001
118V
25Z5
168V
Spk Field
30
E
N
L
S F/M/R a
S F/M/R b
S F/M/R c
SF = Front wafer
SM = Middle wafer
SR = Rear wafer
Looking down on the switch, from the rear.
NB: All resistors in ohms or K ohms
All capacitors in micro-Farads unless otherwise marked
Unknown US Radio from 1935
Drawn GNT Autumn 2000. Updated Winter 2016.
12 V 0·1 A
SM a
100
IF
RF
75 6D6 6A7 6D6 43 25Z6
75V RD/BK, 85V RD/YL, 95V RD/BL
BK
BN
25 V
RD
120 V
RD/BK
150n
4n7
Added
* Combined Farnell code: 1678911



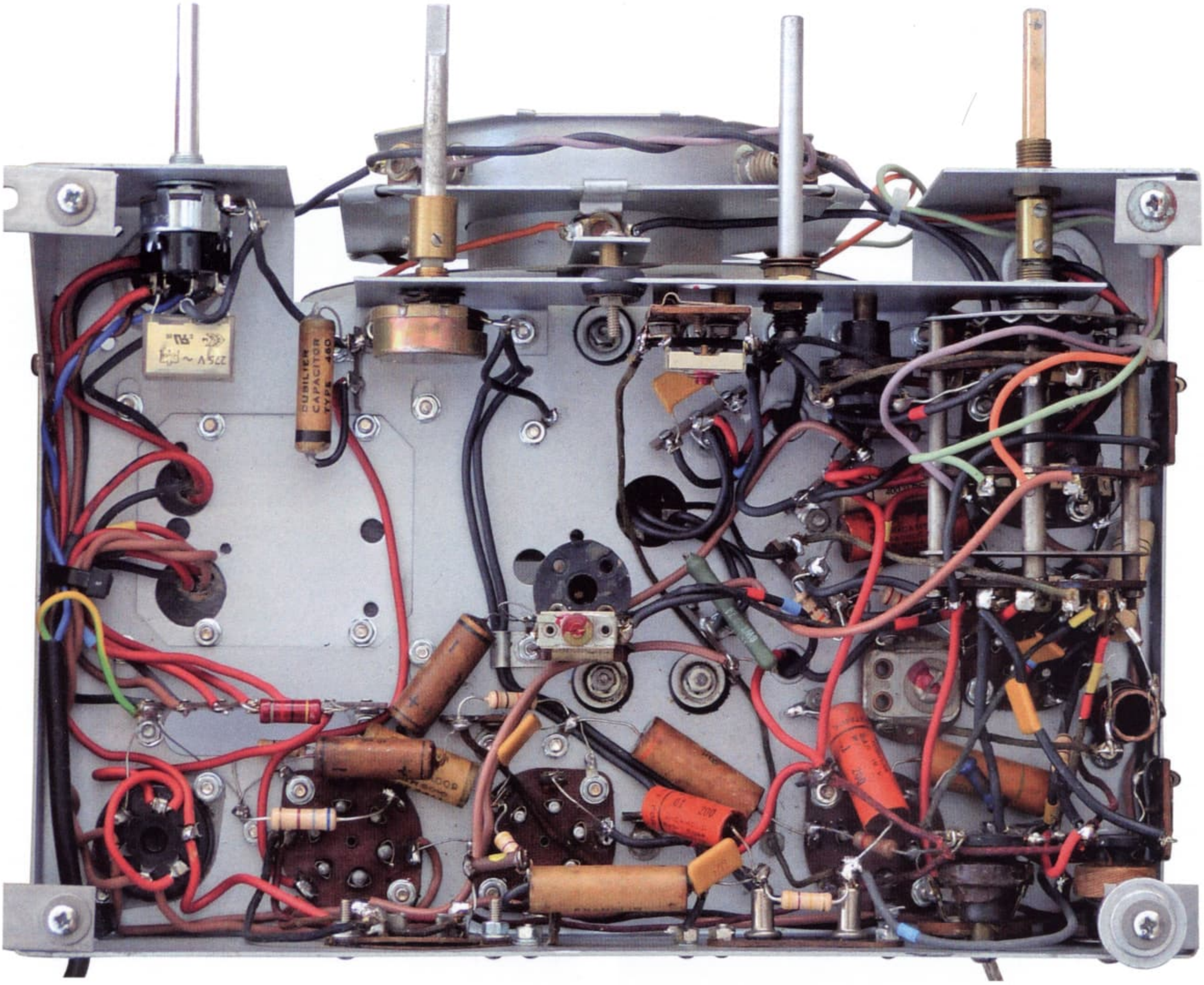
proportional to the square root of L then it is back to 10% and the frequency should have risen to about 15.4 mHz. It didn't and I only gained about 200 kHz: perhaps the frequency didn't rise as I thought because of being held down by stray capacitance? I wasn't keen enough to remove the coil again and take off another turn but vainly tried another 6A7 with as expected no effect.

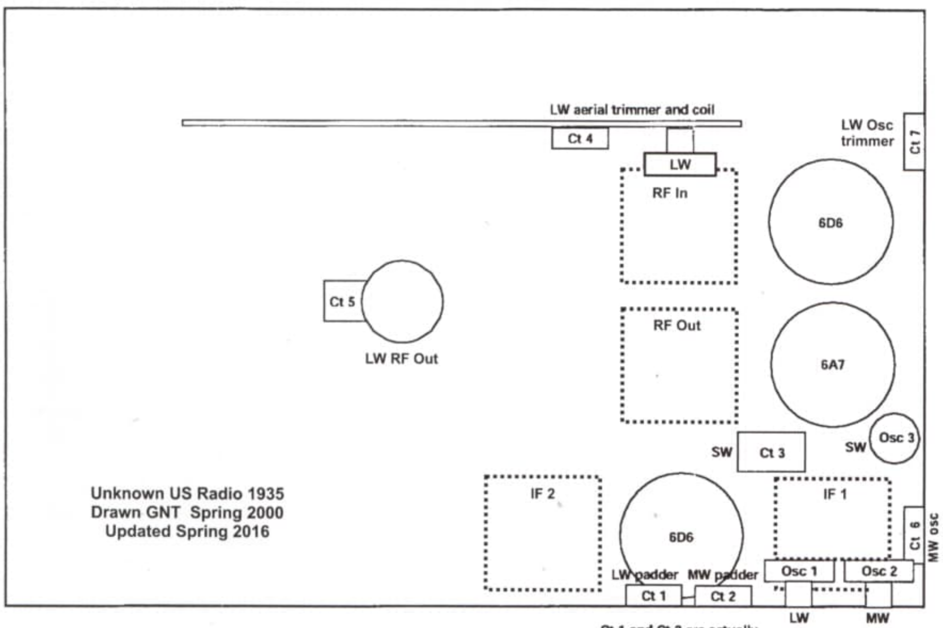
Just in case anyone didn't really believe the engineer's quick approximation it can be checked with an online tuned circuit calculator. Using 50 pF and 2.5 microH the resonant frequency was 14.2 mHz. Reducing L by 20% to 2 microH gave 15.9 mHz; about 12%.



The cabinet

So now to what the article was going to be about which was refinishing the cabinet, for the second time. As can be seen from the pictures the first attempt ended up far too dark. My plan back then was to clean, flat down and apply some Mohawk Classic aerosol walnut toner before clear lacquer. The Classic range, is semi transparent, and builds its colour as layers are applied. But then and never





Ct 1 and Ct 2 are actually under Osc 1 and Osc 2

in the future did I acquire the knack of applying this toner such that it was light and uniform over a large area. It was most likely never intended to do this with the large droplet size compared to a spray gun. The result was peppery and then just got darker as I attempted to fill in the gaps.

For the second attempt, in 2011, all the old finish was removed with Nitromors lacquer and varnish stripper (for Furniture). Usually I go for cellulose thinners (with a little anti-chill if I have any) and medium wire wool but modern lacquers go very hard even after just 10 years and something stronger was needed.

Next it was the laborious filling with tinted grain filler leaving it to set up for longer than usual. It was harder to flat down and remove the excess but I think the overall fill was better. This step was almost certainly done more than once.

Most of the wounds were to the sides and were filled with car body filler which really hangs in there particularly if near an edge. They would need touching up with artists oil paints before final spraying. The front and sides were probably given a rub over with thinned walnut stain.

There was damage to the box wood front corners, and after filling and sanding smooth, I sprayed them with Mohawk Light Walnut tone toner; this is the type that is obliterating. For me it was a bad colour as it came out too yellow and looked almost painted. It was adjusted with artist's oil paint and lacquer using a raw umber that was dragged along it with a rag to make tiny grain lines. I'm happy with the result.

The grill bars were sprayed with a dark mahogany toner, again of the obliterating type, but this came out too chocolate and I didn't like it. So it was taken off and done in the same way as the cabinet corners as was the top. The top had been a cheap wood that had been sprayed with a solid colour so this was in keeping with the original.

Finally the whole radio was lacquered with Mohawk 75-80 sheen lacquer and after a couple of weeks rubbed out in the normal way.

Performance and conclusions

It was probably quite a cheap radio when manufactured but it is well made. The coil and tube screens are attractive and it was lucky that all the top hats for these were present.

The dial and tuning gang drive doesn't work that well. It is achieved by a small pinch wheel having a friction grip to a large plastic disc, giving a reduction ratio of about 15:1. It doesn't slip but has a dead feel when changing direction that feels like a delay. For SW, if there was anything worth listening to, it would make tuning very difficult. Even on the longer wavebands, with the good selectivity, it makes getting the tuning spot on not that easy. Perhaps it was better when new.

The waveband switch deserves comment being not the usual 'finger and thumb' contacts but just single fingers on the rotating segments on one side of the wafers. These have a visible high lift and the switch is quite and reliable in operation.

The performance is about what I expected, lots of gain and very selective although unpleasant to listen to and awful on modern 'pop' stations that use high levels of modulation. It had the worst case of sideband cutting that I have come across. An attempt was made to offset the windings of the first IF transformer to achieve a wider IF bandwidth. However, to me it was better, and safer for the future, to return it to peak tuning and lower the Q of the single winding of the second IF transformer. This was physically easy to do with a shunt 47K ohm resistor. This increased the bandwidth from 4.5 kHz to about 7.5 kHz, at half height, which improved the music quality from my MW transmitter and made listening to Absolute Radio reasonable, assuming anyone likes that kind of music. The best 'real' station with least interference was R4 on LW. Comparing the AVC line voltage of this station, with an oscilloscope and X10 probe, with and without the resistor, indicated a loss of gain of less than 5 dB. Doing the same on MW, for the station received from the transmitter gave a similar loss; of course the audio increased slightly as the clipping had been reduced.

Final thoughts are that it is a radio that is good to look at but maybe not the best to use or choose to listen to.

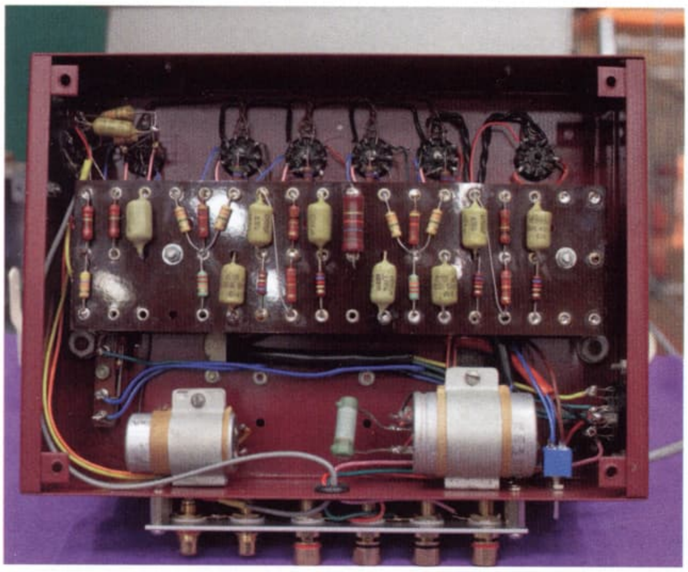
The first IF transformer

References

www.alliedcatalogs.com/catalogs_main.html
wikipedia.org/wiki/Voltage_doubler
www.blore-ed.com/

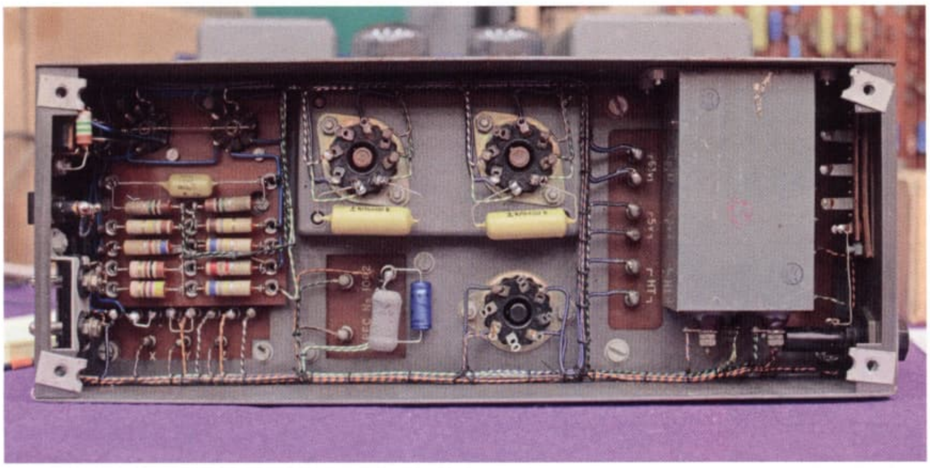
Audiojumble, Sunday 21st February photographed by Carl Glover

1960's Scott 4 x ECL86 stereo amplifier (note the dud valve)



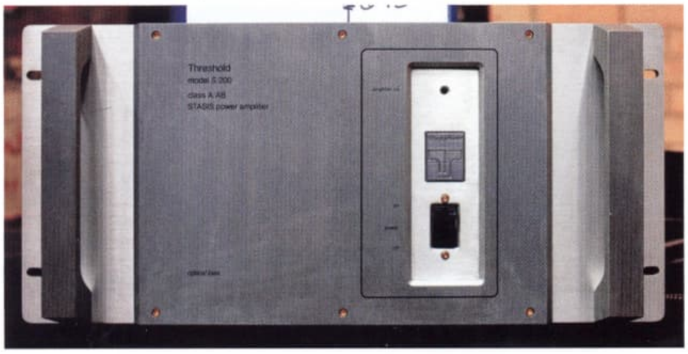
Modified Rogers stereo valve amplifier

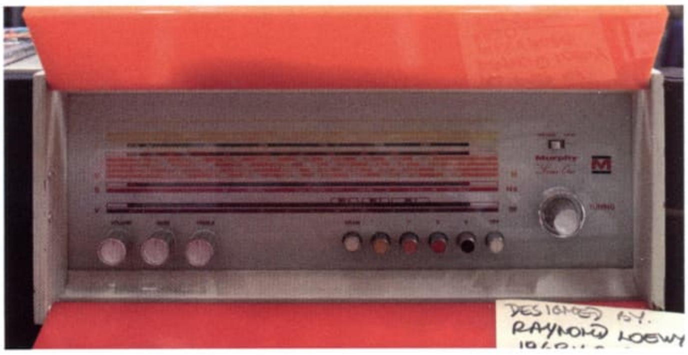
The famous Osram '912' amplifier



Underside of Quad II amplifier

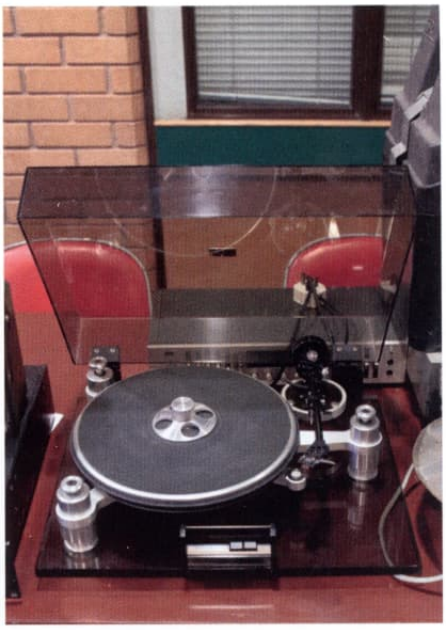
Champion 'Venus' radio



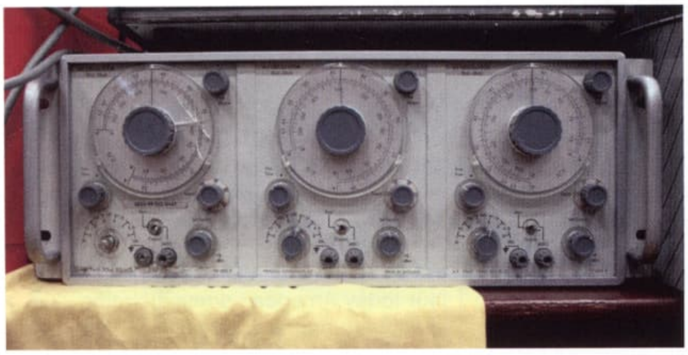


Murphy 'Scene One' 1960's stereo radio

A quad of Quads



Leak TL50 KT88 Amplifier



Roy Hollyer manning the Brimar valve stall

The Pilot H594 - A very different receiver

by Peter Lankshear

Recently a young woman visitor to my home observed some of my collection and remarked that I obviously knew something about old radios. I admitted to having a little experience in that field. "Good" she said, I have been looking for someone like you to help me," and explained her problem.

This rare and unusual radio is the mantel version of the Pilot H594. It would make a striking centre piece for any display.

An unusual radio

She had a friend who had been in need of some finance and who owned a consol radio that worked - sort of. Partly because she wanted to help her friend, and at the same time thinking that the radio would look good in her lounge, the young lady had purchased the radio. The cabinet was showing the ravages of a long life but she was confident she could, as a winter's project, restore its finish and hoped there was someone around who could get the receiver working properly. Cautiously I agreed to have a look at the chassis but made no promises regarding its revival. Thinking it would probably be just a servicing job, with an unexciting routine component replacement, and on the understanding that it would not be a full restoration, I visited her home to look at the set.

I was confronted with a massive and handsome cabinet featuring a large drum dial and its associated ornamentation that at first put me in mind, inappropriately perhaps, of a jukebox. I suspect that the cabinet is a one off New Zealand production but the top of the escutcheon proudly claimed that the chassis was made by Pilot. The Pilot Company of New York, was one of the smaller American companies but with a long history and who made some well engineered products. At the least it had an impeccable ancestry.

At the top of the dial area was a large celluloid drum with calibrations for three bands but without any form of cursor or pointer and immediately below it was a row of a dozen piano type keys, indicating that it had motorised tuning. Visions of a quick and simple repair job quickly evaporated. In my experience motor tuning, given that it would be at least 75 years old, would likely mean trouble. Switching the set on confirmed my worst fears. A finger on the grid cap of the first audio stage showed that the set was at least alive but pressing a motor tuning key brought little response.

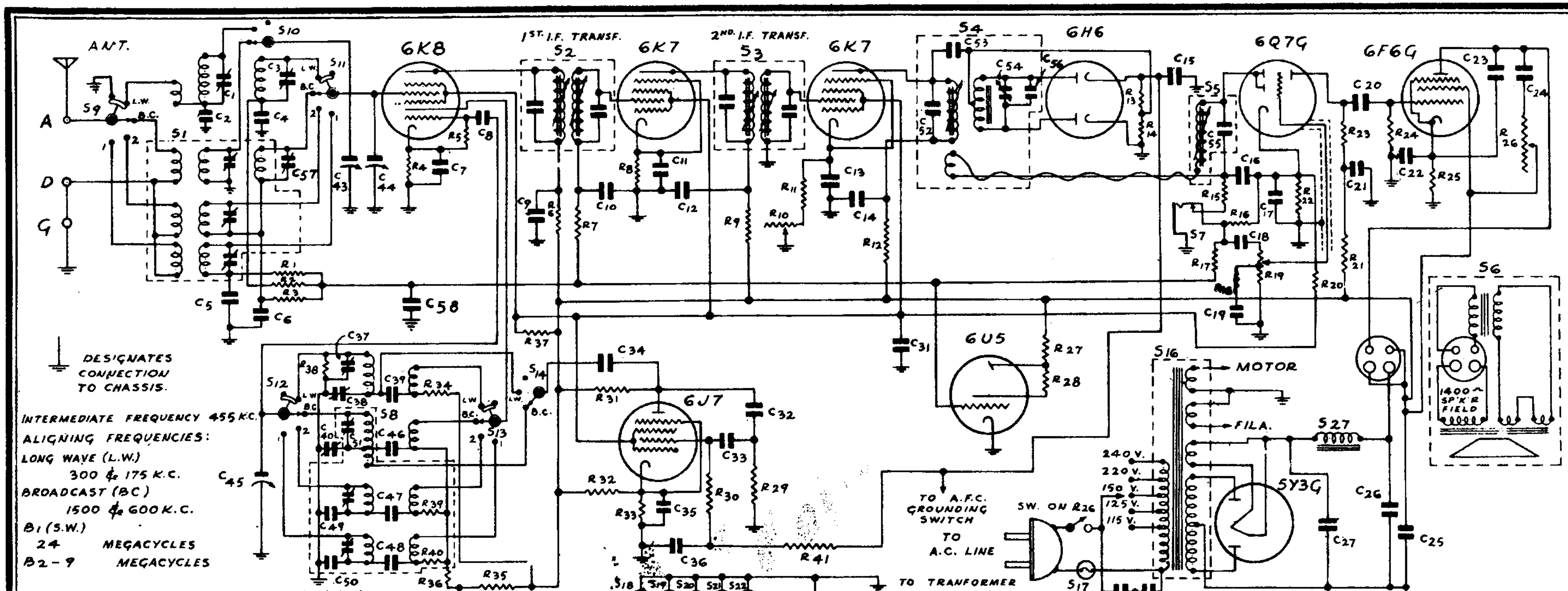
Normally with no high voltages accessible above chassis, American sets fitted with a power transformer rarely had a back panel. This was the case with the Pilot. An open back improves ventilation and makes life easier for servicing but can encourage mice to take up residence. Fortunately there was no evidence of rodent activities but some of the metal work showed signs of damp storage. However, any corrosion proved to be a problem cosmetically rather than operationally. It was pleasing to see that the speaker was a husky twelve inch model complete with a suitably large output transformer to do it justice. The eight valves were a mix of glass and metal and there was the inevitable worn out tuning eye. Interestingly, tucked inside the cabinet were three blueprinted pages from Rider's Manual, Edition 9. Riders Manuals are an unequalled reference source for American receiver circuits and were produced more or less annually. (I have a set of the first 13 manuals and they occupy about four and a half feet of shelf space!). It was encouraging that previously someone had the right information when they had worked on the set. Rider 9, like its companions, is about 4 inches thick and contains data for many hundreds of American receiver models, mostly for those made in 1938. Radio was then an enormous industry but today American domestic radio manufacturing is practically extinct.

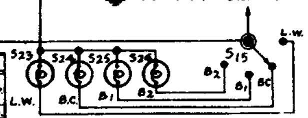
Easy to date

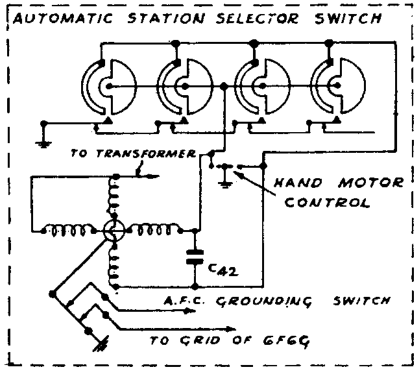
Even without the Riders material, it would have been easy to date the Pilot. Despite the first half of the 1930's being over shadowed by the Great Depression, advances in radio technology during the decade were impressive. Initially, RCA held a virtual monopoly on the U.S. domestic market for the Superheterodyne but in 1930, antitrust laws forced them to share patents with other makers. By 1932 there were few new American TRF models, but literally hundreds of superhets and Europe was soon to follow. Developments were so rapid that by the mid '30's, the format of the modern receiver had been established. Thereafter, there were largely only additional

MODELS H594, H597
Schematic, Tuner
Parts

PILOT RADIO CO.







CONDENSERS FOR MODEL H-597		
C7, C11, C13, C35, C36	22055-M	.1 MFD. 200V. PAPER
C6, C10, C8	22055-T	.01 MFD. 200 V. PAPER
C9, C12, C14, C18, C20, C34, C39, C46	22055-A	.01 MFD. 600 V. PAPER
C21, C31	22055-AB	.1 MFD. 600 V. PAPER
C23	22055-R	.005 MFD. 1000 V. PAPER
C15	22055-F	.25 MFD. 200 V. PAPER
C28, C29	78503	.01-.01 MFD. 1000V. PAPER
C17, C22	22481	10 MFD. 25V. ELECTROLYTIC
C26, C27	71045-9-B	8-8 MFD. 475 V. ELECTRO.
C16	27701-O	.00025 MFD. MICA 10%
C8, C33	83380	.0001 MFD. PER MICA 10%
C5	28022-W	.001 MFD. MICA 5%
C24	22055-V	.03 MFD. 1000 V. PAPER
C32	83381	.00005 MFD. MICA 5%
C25, C41	85018	(8-4-4) MFD. 475 V. ELECTRO.
C1, C3	72283-B	30 MMFD. TRIMMER ASS'Y.
C2, C4	27744-W	.00287 MFD. MICA
C43 C44 C45	83359	3 GANG CONDENSER
C37	83416	75 MMFD. DUAL PADDER L.W.
C38	83416	145 MMFD. DUAL PADDER L.W.
C40	83394-A	260 MMFD. MEDIUM WAVE PADDER
C42	85040	60 MFD. 30 V. A.C. ELECT.
C49, C50	27704-W	.002 MFD. MICA.
C47	27734-W	.006 MFD. MICA.
C48	27794-W	.005 MFD. MICA
C51	83415	AIR TRIMMER
C52 C56, C55	92000-A	125 MMFD. SILVER CAP.
C53	28016-W	.0001 MFD. MICA
C54	79838	30 MMFD. TRIMMER COND.
C57	79455-B	WAVE TRAP COND. 20 MMFD.
C18	22055-T	.001 MFD. 200V. PAPER
CONDENSERS FOR MODEL H-594 SAME AS FOR MODEL H-597 EXCEPT FOLLOWING		
C1, C3	72283-B	NOT USED
C2, C4	27744-W	NOT USED
C37 C38	83416	NOT USED

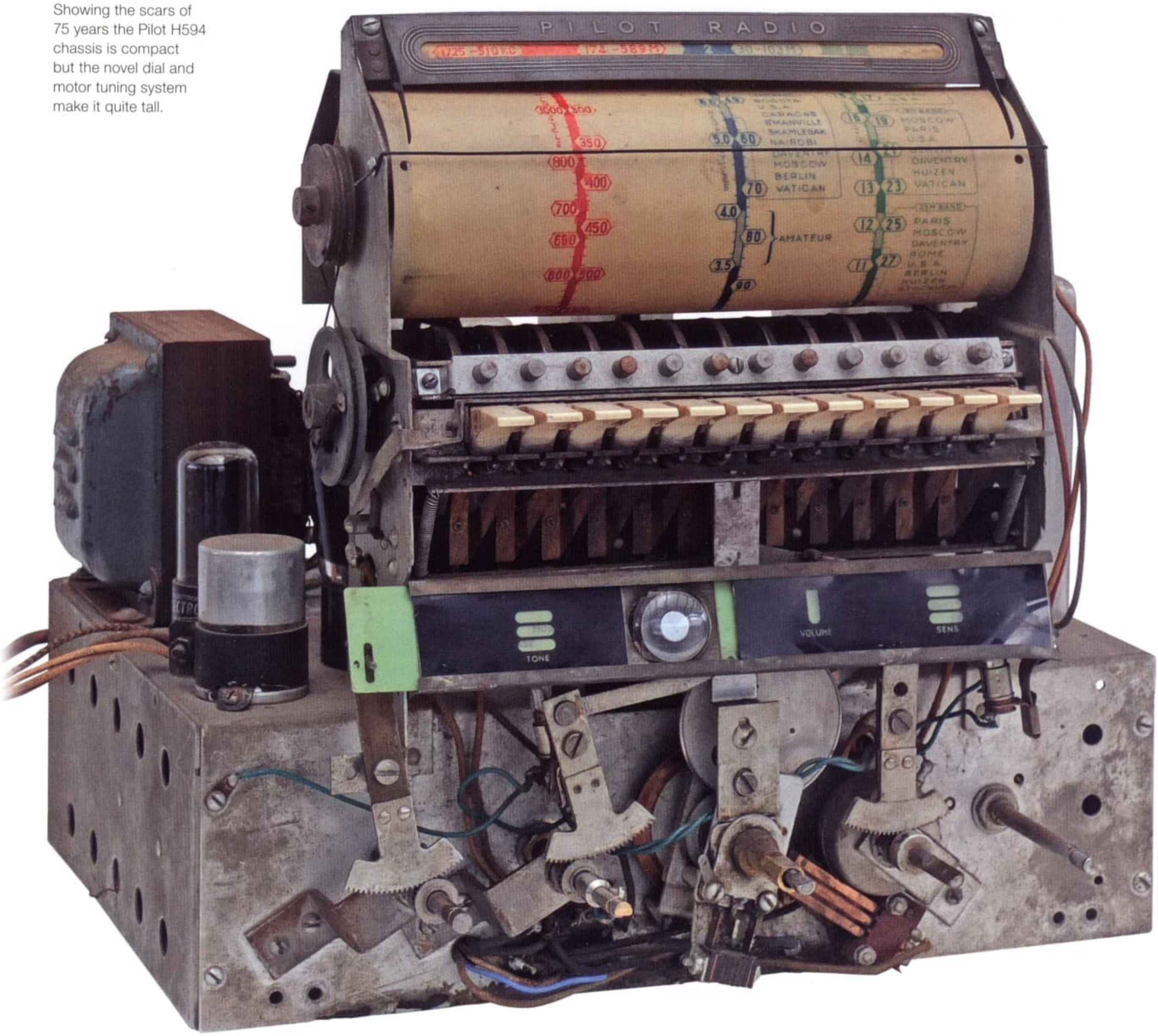
RESISTORS FOR MODEL H-597		
R1, R2, R3, R7, R21	13031	100,000 OHMS 1/4 WATT CARB.
R6, R9, R12	13028	1,000 OHMS 1/4 WATT CARB.
R8, R11	13215	390 OHMS 1/4 WATT CARB.
R41	13223	3.3 MEGOHMS 1/4 WATT CARB.
R4	13203	200 OHMS 1/4 WATT CARB.
R5	13228	47,000 OHMS 1/4 WATT CARB. 5%
R10	79178-B	15,000 OHMS WIRE WOUND SENS. CONT
R13, R14, R30	13231	470,000 OHMS 1/4 WATT CARB. 5%
R15,	13225	47,000 OHMS 1/4 WATT CARB.
R16.	13224	330,000 OHMS 1/4 WATT CARB.
R17, R28	13001	1 MEGOHM 1/4 WATT CARB.
R19	83364	1 MEGOHM VOL. CONTROL
R20,	13229	30,000 OHMS 1 WATT CARB. 5%
R22	13220	470 OHMS 1/4 WATT CARBON.
R23	13221	220,000 OHMS 1/4 WATT CARB.
R25	13226	430 OHMS. 1 WATT CARB. 5%
R26	83366	100,000 OHMS TONE CONT. & SW
R27	13199	22,000 OHMS 1/4 WATT CARB.
R29, R33	13227	620 OHMS 1/4 WATT CARB. 5%
R31 R34	13232	15,000 OHMS 1/2 WATT CARB. 5%
R35	13092	30,000 OHMS 1 WATT CARB. 10%
R36, R39, R40	13030	10,000 OHMS 1/4 WATT CARBON
R37	13129	15,000 OHMS 1 WATT CARB. 10%
R38	13230	33,000 OHMS 1/4 WATT CARB. 10%
R24	13217	470,000 OHMS 1/4 WATT CARB.
R-32	13236	30,000 OHMS 2 WATT CARB. 5%
RESISTORS FOR MODEL H-594 SAME AS FOR MODEL H-597 EXCEPT FOLLOWING.		
R34	13232	NOT USED
R38	13230	NOT USED
R2	13031	NOT USED

MISCELLANEOUS FOR MODEL H-597		
S1	73171	ANTENNA COILS & CAN ASS'Y.
S2, S3	73166	1ST. & 2ND. I.F. TRANSFORMER ASS'Y.
S4	73167	DISCRIMINATOR. TRANSFO. ASS'Y.
S5	73168	AUDIO DET. A.V.C. COUP. COIL ASS'Y
S6	40849	8" A.C. SPEAKER 1400~ FIELD
S6	40784	12" A.C. SPEAKER 1400~ FIELD
S7	70950	PHONO JACK
S8	73170	OSCILLATOR COILS & CAN ASS'Y.
S9, S10, S11, S12, S13, S14, S15	83361	BAND SWITCH FOR H-597
S16	79819	PW'R. TRANSF. UNIVE. 50-60 CY.
	83420	" . TRANSFORMER 60 CY.
	83421	" " 25 CY.
S17	70053-K	1 1/4 AMP. FUSE
S18 TO S26	78889	DIAL LIGHTS (6.5V. 25 AMP.)
S27	79029-B	FILTER CHOKE 170 Ω
MISCELLANEOUS FOR MODEL H-594 SAME AS FOR MODEL H-597 EXCEPT FOLLOWING.		
S9, S10, S11, S12, S13, S14, S15	83360	BAND SWITCH FOR H-594
S23	78889	NOT USED

CLASSIFICATION	
H-590-SERIES	THIS PRINT SUPERSEDES ALL OTHERS PRIOR TO [redacted]
	DO NOT SCALE THIS PRINT

PILOT RADIO CORPORATION
LONG ISLAND CITY N. Y. U. S. A.
SCHEMATIC CIRCUIT DIAGRAM FOR MODEL H-594 & MODEL H-597
MATERIAL
SCALE
DRAWN BY B.R.
CHECKED BY
APPROVED BY
DATE 6-14-38
DRG. No. 25188-3

Showing the scars of 75 years the Pilot H594 chassis is compact but the novel dial and motor tuning system make it quite tall.



features added to the domestic radio.

Many of these were styling changes and some just gimmicks but it was a competitive market even though the technology was fully developed with little left for significant improvement.

What rightly did become fashionable were better dials, developing over the decade, progressing from peep holes to big circular styles with one or more rotating pointers and then for some makers, long horizontal dials with vertical cursors and tuning shaft flywheels. Around 1937, push button tuning became fashionable but by 1938 some up market receivers were fitted with motorised tuning. The Pilot H597 is an example. However the fashion for motor tuning was short lived. By the end of 1940, wartime restrictions meant no more fripperies and further development of motor tuning for domestic receivers was discontinued.

In reality, motor tuning was of limited benefit. It was complicated, ponderous, and often no faster than a flywheel spin drive. It is likely that even had the war had not intervened, motor drives would have soon disappeared anyway. There were other problems, not the least being that electro-mechanical systems are prone to wear and can get out of adjustment. Motor tuning was not practical for the shortwave bands either, and its inherent lack of accuracy required the receiver to be fitted with automatic frequency control (AFC), entailing a double diode discriminator and separate variable reactance valve for oscillator correction, a further complication and an addition to the cost. Motor tuning was usually reserved for prestige models and its demise was no doubt unlamented by those who had to service receivers fitted with it.

I discussed the Pilot with Gary Tempest who was much more enthusiastic about the project than I. He pointed out that it was a rare model, rarely seen outside of America and certain to be of interest to BVWS members. Gary went so far as to hunt out some material on the Internet, including the same material that Rider provided, plus a picture, reproduced with this article, of a handsome mantel version in a most unusual cabinet, quite unlike the conventional console that the young lady was dealing with.

Back in the workshop

With the chassis and speaker on the bench I studied them and the data in detail, and found Pilot made three different versions of the H594. There was the standard 110 volt U.S. model with Medium wave (Broadcast) and two Short wave bands. Export models, of which this chassis is an example, were similar but with a power transformer with a multi-tapped primary to suit various mains supply voltages, and the third was a European model with a fourth band for Long wave reception. There is no

R.F. amplifier stage, but with the first valve a 6K8 triode/hexode converter. Its oscillator section is coupled to a 6J7 pentode operating as a variable reactance frequency corrector (AFC).

Following the frequency converter are two type 6K7 I.F. stages, the second with a variable resistor manual sensitivity control. The 2nd I.F. valve feeds a transformer with a centre tapped winding connected to a 6H6 double diode discriminator controlling AFC. This transformer, has a third winding, a link coupling to a conventional combined diode/triode detector, AVC generator and audio amplifier type 6Q7. It is in turn coupled to a 6F6G output pentode. There is a 6U5 tuning eye and the ubiquitous 5Y3G rectifier. With the exception of the AFC, electrically, the set is conventional, but mechanically it is, for an American receiver, somewhat complicated and inaccessible. On the shafts for the tone, volume and sensitivity controls are toothed quadrants coupled to sliding labels; illuminated from the rear, that indicate their settings. For example, the tone control label reads Base(sic) Music and Voice. However these features were out of adjustment or not operating.

In most radios of the time, a calibrated dial was behind a pointer or cursor which followed the rotation of the tuning capacitor. The Pilot is quite different. The dial is a cylindrical translucent illuminated drum printed with the tuning calibrations, and is geared to rotate as the tuning capacitor is varied. Instead of a cursor there were the easily renewed remnants of a cord stretched across the face of the drum. To set this display off, there is an array of eight lamps!

Pilot receivers were superior in construction and performance, and it was pleasing to note that rather than being distributed around the band changing switch as is common, the aerial and oscillator coils are enclosed in shielding cans. Unfortunately, the power transformer is not original. There can be a problem with exported American sets in countries with mains supplies of 50 Hz. American sets were normally designed for 60 Hz mains. This 20% difference can result in transformers running hot with some burning out from overheating. Unfortunately, in this case, the original transformer was vertically mounted whereas the replacement unit was intended for horizontal mounting. The outcome was that there were exposed terminals above chassis. A crude and flimsy cover had been made from what looked like a piece of plastic from a shirt package. My first job was to make a more robust cover from a sheet of clear polycarbonate plastic. This material has the great merit that it can be worked like sheet metal and is a good insulator.

Two valves were a bit below par and inevitably the tuning eye had lost its glow. Fortunately I had replacements, but I was not surprised to find they had no effect at all on receiver performance. It was time to look under the chassis.

Previous servicing.

It was apparent that the set had, in the not too distant past, been serviced, with all the paper capacitors and several resistors replaced with modern types. This was fine, but many leads had not been trimmed to length. This is not a good practice as it may encourage instability and does not help reliability. I then spent some time tidying the wiring. In the process some rather ancient electrolytic capacitors were discovered and replaced. I found too that the motor phasing capacitor, which should have been a 60mfd AC electrolytic, had been replaced by a standard polarised type. Fortunately my local electronics supplier stocks bi-polar electrolytic capacitors and a paralleled pair of 33 mfd units were just fine.

Although a check of voltage points around the chassis showed nothing seriously wrong, the set was completely silent from grid of the 6Q7 audio stage forward to the aerial. It was moreover dead at the volume control. This narrowed the search and the culprit was soon found. The phono socket's breakable contacts were out of adjustment. When corrected there was some life, but the alignment was hopeless with the motor AFC tuning especially so. Unfortunately this was the victim of a common problem. Tinkerers attack trimmers in the vain hope that this will somehow cure a faulty receiver, but of course it never does, and consequently, when it is properly repaired, extra work is needed. Fortunately the data from Rider, which warns of tinkering, includes alignment instructions which enabled me to restore the chassis operation to something like it should be.

No operating instructions.

There remained a problem. Nowhere could I find any instructions on setting up or even operating the motor tuning. No doubt there was a booklet originally supplied with the set, but this had long vanished. There was nothing for it but to settle down with a cup or two of coffee and find out just what controlled which. Predictably once the puzzles were solved, operation proved quite straight forward and effective.

There are two concentric tuning controls. The inner control is connected to a very low ratio friction drive, being affectively a vernier for shortwave and fine tuning. There is no conventional main manual tuning. Instead, the outer knob controls a switch governing the motor direction. Turn the knob clockwise and the motor rotates the tuning capacitor clockwise, and vice versa. The tuning is quite rapid but the low ratio manual drive demands use of the motor for significant manual tuning. Whilst tuning the set with the vernier is possible, it takes a lot of patience to cover more than a few degrees.

Associated with each key is a metal disc backed by fibre with a notch in its perimeter. The discs are a friction fit on a shaft running the width of the dial assembly. Associated with each disc is a set of contacts. When a key is pressed, the motor operates in the required direction, rotating the discs until its notch encounters a stop on the key. Precisely how the motor knows which direction to rotate is not clear. There are other contacts on the discs but the entire assembly is largely hidden and practically inaccessible. As the system is working well I decided to leave it alone.

Setting the position of each disc is very simple. Each key has a metal button above it. The required key is pressed until the motor stops. If the button is then firmly pressed whilst the tuning is rotated by motor the desired transmission will be selected and set. The disc, being a tight friction fit on the shaft will have remained locked in the new position until the button is released.

The system is very effective and flexible. Unlike most other motor driven systems, is not restricted to a consecutive sequence of tuning positions. The order of key locations can be random and even more than one key can be used for tuning a given programme. In my opinion, the Pilot motor tuning is the most versatile of several methods that emerged in the late 1930's.

Setting tuning keys

1. Select a suitable key and press it down. The system will rotate to the position determined by the key 's control disk.
2. Release the key to the resting position.
3. Firmly press the metal button above the key. This will lock the control disk in position.
4. Still holding the button down, use the motor to tune in the new transmission.
5. Fine tune with the small centre tuning knob and then release the button.

Restoring a Masteradio D120 Sandown midget radio

by Stef Niewiadomski

I came across this radio at Harpenden in 2015, and was attracted by its small size, and dusty and dirty appearance, indicating that it hadn't been 'got at' too much. The Masteradio maker identity was obvious from the slide-rule dial, as was the medium and long wave coverage, but I could see no model number or name on the chassis. The Bakelite cabinet had a crack in its top, but no pieces were missing, and only one knob was present. Turning the radio around, there was no back, and lots of dust and cobwebs re-enforced my first impression about originality.

Figure 1: Rear view of the Masteradio radio, with its original mains line cord. The red DK32 in the centre of the view is a cuckoo in the nest.

Figure 2: Front of the D120 radio, as found, with only a single knob left.

A long line cord was fitted, with no mains plug, and a throw-out aerial was present. Five octal valves were fitted, but rather worryingly, a red coloured Ever Ready DK32, which was clearly not the original valve, sat in the middle of the chassis. The four other valves looked like they were probably the correct ones. Money changed hands, and the radio was mine. Figure 1 shows the rear view of the radio in the condition I bought it.

Masteradio the company

Founded in London by Harold Burns and George Benning in 1938, the company had a fairly enigmatic beginning, being involved during the war years in the manufacture of sensitive military equipment, details of which are very scarce. The risk of bombing caused the company to relocate to Watford at the outbreak of war. Eventually the company had service depots in Birmingham, Glasgow and Edinburgh, and a factory and service depot in Glamorgan. The company also produced car radios, vibrator packs, TVs and radiograms until its amalgamation into Radio & Allied Industries (then GEC) in 1960. The Masteradio brand name was used for several years on transistorised radios and radiograms, and eventually its identity disappeared altogether.

Released in July 1946, Masteradio's first domestic radio was the AC/DC superhet D110, housed in an American-influenced midget cabinet and using a very American 12K8GT, 12K7GT, 12Q7GT, 35L6GT and 35Z4GT 150mA series heaters valve line up. I presume that the company had good reason to believe that these valves would be easier to get hold of than any other: perhaps there were already large stocks in the UK, brought over during the war, which they could secure. UK manufacturers became very frustrated after the war, as because of component shortages, they were unable to build enough sets to meet local and export demand. In some cases, as they launched new models, they had to openly warn their distributors not to order too many because this would only lead to frustration. The D110 covered the medium, long and short wave bands, and a walnut-cased version was available for about £1 extra, as the D110W. An export version, the D110T (in a white cabinet), covering medium and short waves only, and capable of being switched for 100V mains operation, was also produced.

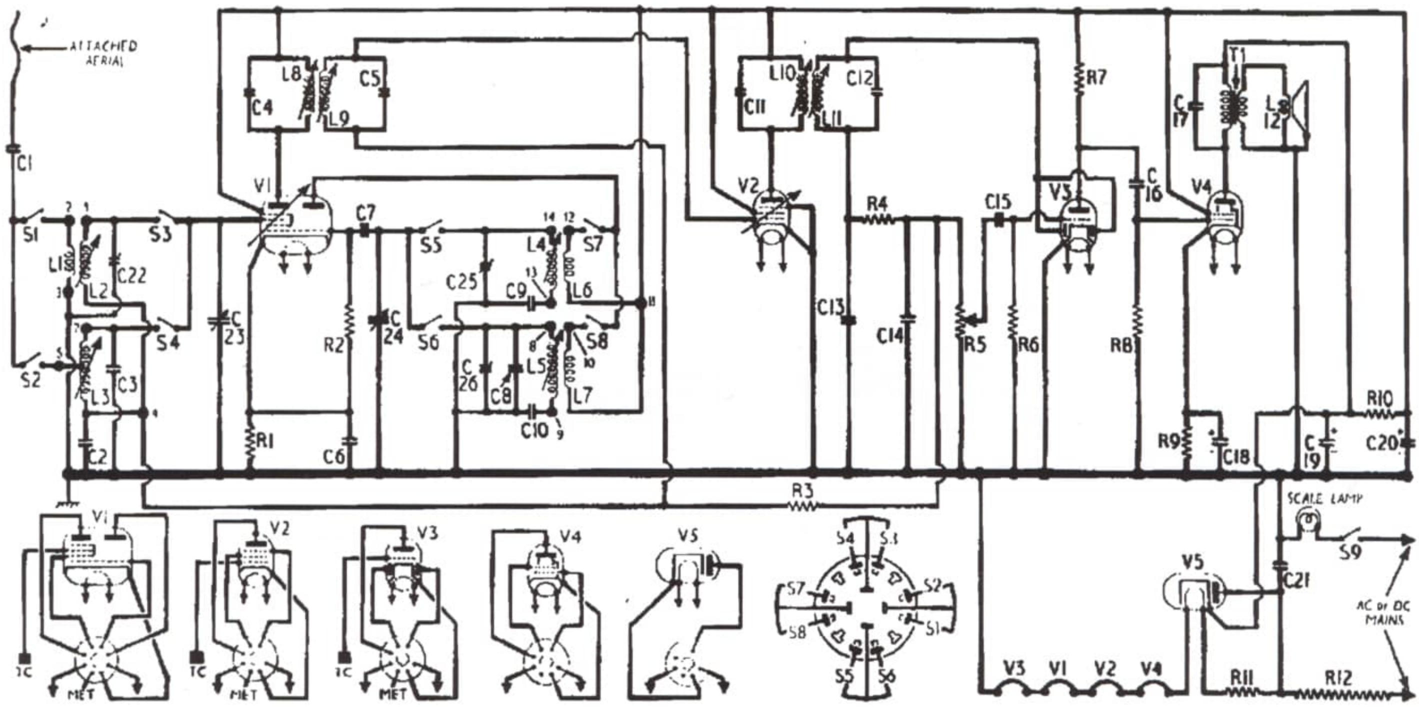


Figure 3: Schematic of the Masteradio D120, from its Trader service sheet.

The D120 Sandown

Although several of the Masteradio radios look very similar, I identified mine as a D120 Sandown by its coverage of long and medium waves, and the line cord showing that it was intended to be powered by the UK mains. This model was introduced in November 1949, at about half the price of the 1946 D110. The cabinet is 10¼-inch wide by 6½-inch high by 5½-inch deep, so it definitely qualifies as a midget, and the dial peeps out via a 5¼-inch by 1¼-inch horizontal cut-out. The cabinet style is very evocative of some late 1930s / early 1940s American radios, by which it seems to have been inspired. Figure 2 shows a front view of the radio, as found.

The chassis was very similar to the D110 range, and used the same octal valve line-up. Legend has it that the Sandown name was added to the D120 model number after a pleasant family holiday on the Isle of Wight. Whatever the reason, the habit seems to have stuck, and during the 1950s we get the Chepstow, Ripon, Harlow, Elstree, and many other UK place names.

The D120 Sandown Star (released in July 1951) included a frame aerial, and a bigger speaker, and used the B7G 12BE6, 12BA6, 12AT6 valves, followed by the 'good old' octal 35L6GT and 35Z4GT. This again follows US practice, where B7G valves were used as they became available, but the last stages where octal valves were displaced tended to be the audio amplifier and mains rectifier. A thermistor had been incorporated into the heater chain to protect the valves and the dial lamp during the switch on current surge. The model was identifiable externally from the plain old Sandown model by the imprint of a six pointed white star on the back cover, and of course by the different valve complement once the back panel was removed. Then there was the D120A, where the 35Z4GT was replaced by a B7G 35W4; and an export version, the D120T Star, covering medium and short waves. And that seems to have been the end of the impressive range of radios produced in this midget cabinet and essentially with the same chassis.

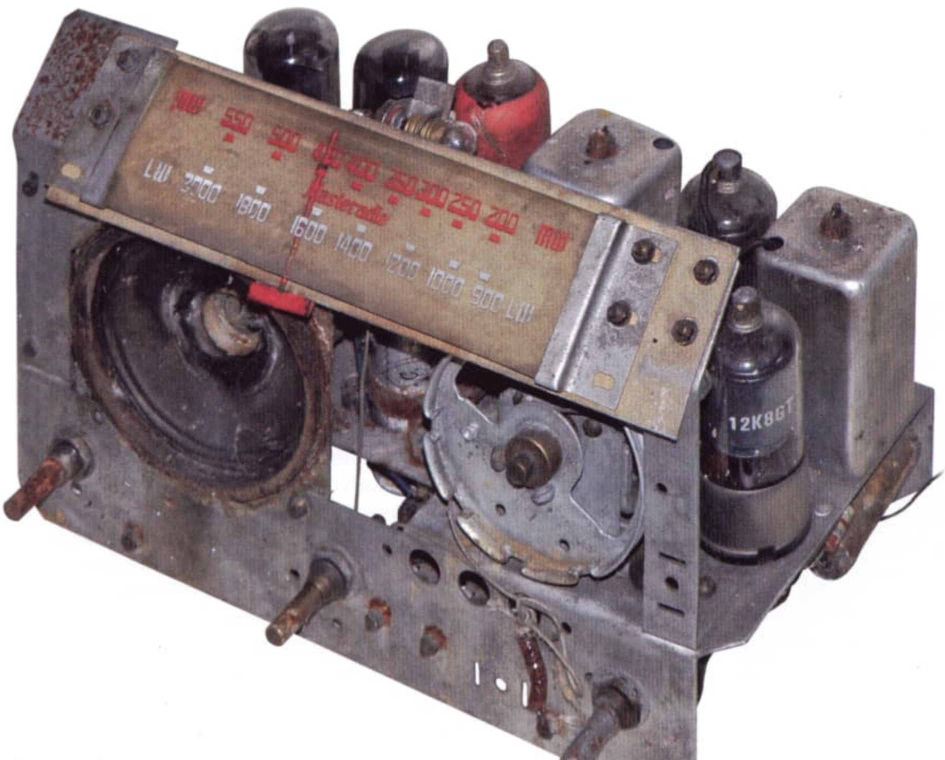


Figure 4: Front view of the unrestored radio's chassis. The glass dial was still intact and I carefully removed it to keep it that way.

The design

Figure 3 shows the schematic of my D120, as taken from the Wireless and Electrical Trader service sheet number 943, published in February 1950. The radio is a conventional superhet using a 12K8GT triode-hexode in the frequency changer stage; a 12K7GT variable-μ pentode as the IF amplifier at 465kHz; a 12Q7GT double-diode triode in the detector / AF amplifier stages; a 35L6GT as the audio output stage; and a 35Z4GT as the half-wave mains rectifier. My radio was fitted with three valves of Brimar origin (who were manufacturing these American-coded valves in the UK) and one from Sylvania, plus the imposter Mullard DK32.

The valves' heaters are all rated at 150mA and are connected in series with R11 (200Ω) to give the correct current down the heater chain when everything has warmed up. A 400Ω mains line cord (shown as R12 on the schematic) drops the UK mains voltage to feed the anode of the rectifier and R11. A scale lamp is connected in the neutral 'return' line, and so all the HT and heater current (say about

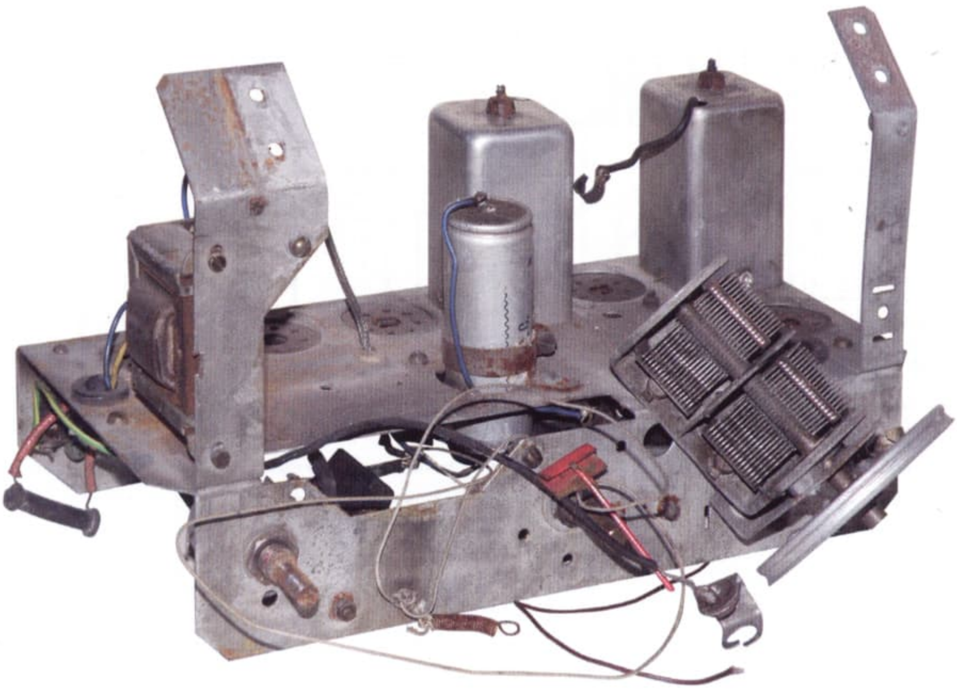


Figure 5: The chassis after most of the components had been removed, or fallen off.

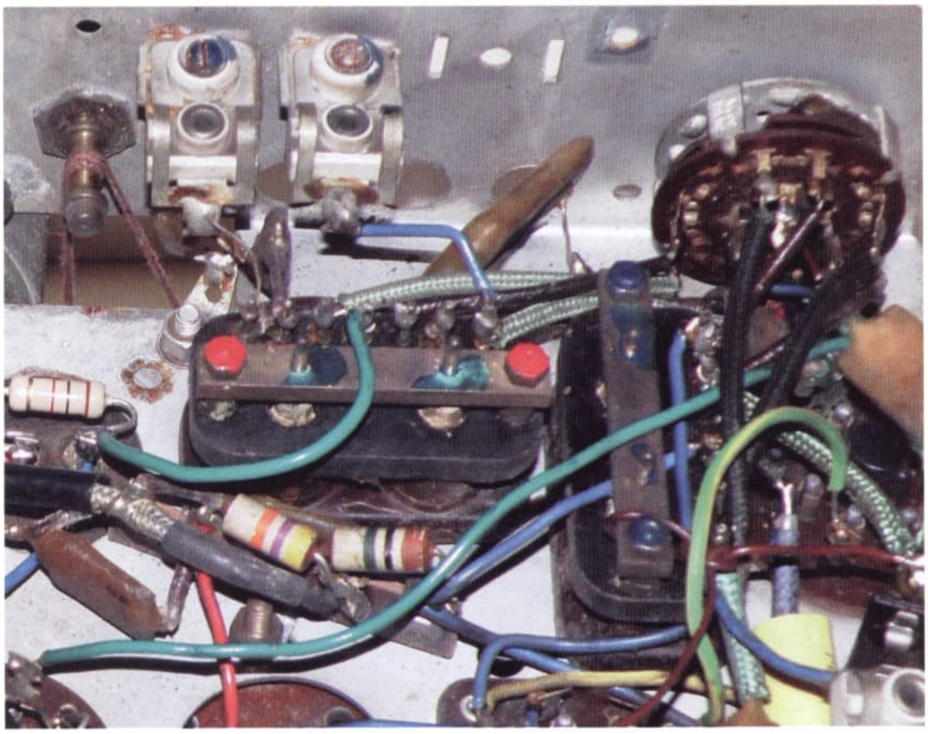


Figure 6: The neat construction of the coil assemblies, and the wavechange switch.

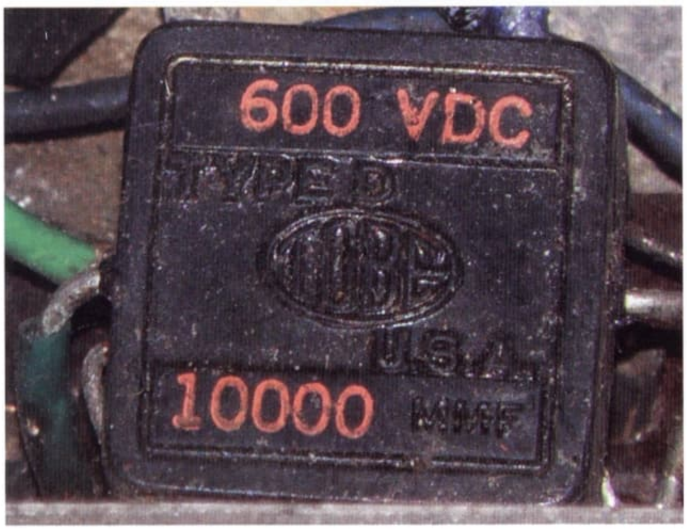


Figure 7: One of the US-manufactured Tobe type D capacitors used for coupling and decoupling purposes on the chassis.

200mA in total) flows through this lamp. A 6.5V 300mA lamp is specified so that it survives the switch on / warm up surge current, and then settles down to passing this 200mA while the radio is operating. This over-specification of the current rating is the method used to guarantee the lifetime of the lamp: if the lamp blows, the radio is dead until it is replaced, so steps need to be taken to prolong its life. I'm not sure why the designers at Masteradio didn't use the 35Z5GT valve, which was designed with a tapped heater, across which the dial lamp is connected, and which was standard US practice. Maybe the 35Z5GT was more expensive, and so was excluded on economic, rather than technical, grounds.

Disassembly

The attractive glass dial was intact and I wanted to keep it that way, so after removing the last remaining knob, I slid the chassis out of the cabinet - there being no fixing screws present. I dismantled the metalwork supporting the dial and bezel assembly, and put it away somewhere safe. The large clear spherical MES dial lamp was present in its holder, and its filament was intact.

The chassis is very neat with the 3-inch speaker bolted to the chassis and its left hand upright, as shown in Figure 4. I unsoldered the speaker from the output transformer, removed it from the chassis, and tested its coil which measured 3.2Ω, so it was intact. The centre of the cone moved in and out freely, so I was confident that it would work in the restored radio. There was some rust on the frame and magnet assembly of the speaker, so I treated this and then put the speaker away so there was no risk of my damaging the cone whilst tackling the chassis. The output transformer also tested good, at about 147Ω for its primary winding, and 0.6Ω for its secondary.

I removed all the valves, being careful to record their positions and checked their heaters for continuity. The 12K8GT, 12K7GT and 35L6GT checked out OK, but the heater on the 35Z4GT was open circuit. From the Trader sheet, the missing valve was a 12Q7GT, so I took steps to source one while I got on with cleaning the chassis. The DK32 was obviously a 'cuckoo in the nest', but its filament had good continuity, so I put it away for the next time I was restoring an immediate post-war portable.

The tuning capacitor had detached itself from the chassis and was dangling by a couple of wires. The sections of the tuning capacitor were dusty, but still in good condition, with no short circuits as they were rotated. Figure 5 shows the state of the chassis after I'd removed the valves and dial assembly: there was a little rust on the steel chassis which I wire-brushed off.

The under-chassis coils are rather interesting and neat: Figure 6 shows their construction. The aerial coils L1-L3 are in the assembly running top to bottom, close to the wavechange switch; and the oscillator coils, L4-L7, are in the assembly running right to left. Hopefully you can see the adjusters sticking up out of the frames. Trimmers C25 and C26 can also be seen adjacent to L4-L7.

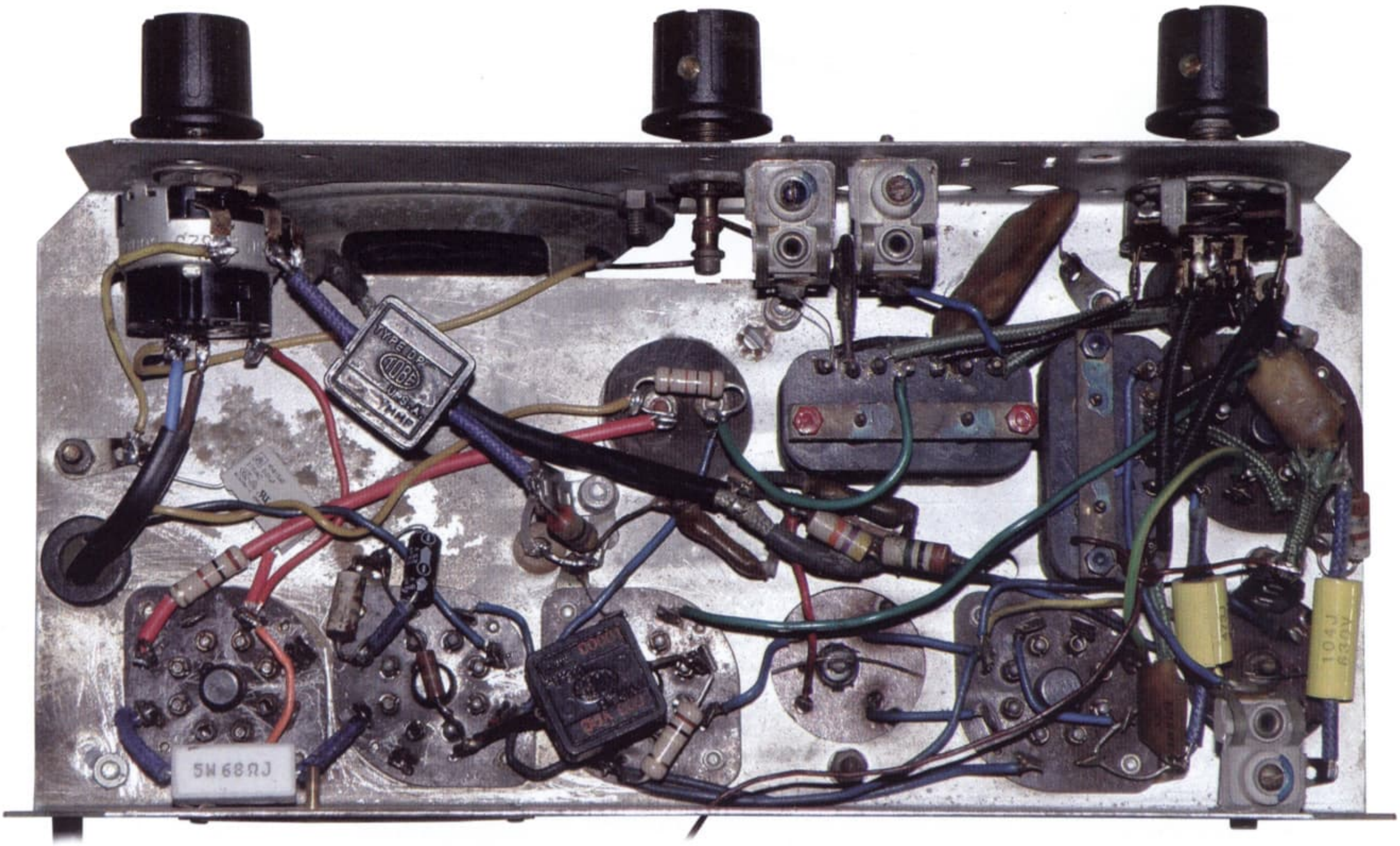


Figure 8: Bottom view of the restored chassis. There seem to be relatively few components, compared to what you see in many radios.

Restoring the chassis

I decided to renovate the radio as operating from 115V mains voltage, so the first thing was to discard the line cord. I removed the 40µF + 40µF 150V HT smoothing capacitor can (C19 and C20), which was marked TCC and dated April 1956, for testing. The Trader service sheet specifies a 30µF + 30µF capacitor, and so I suspect that this had been changed at some point in the radio's life. The capacitor measured OK for capacitance, and its leakage was low on my capacitor reformer, but it had a nasty bulge at the HT end, so I discarded it. I had a 50µF + 50µF 275V vintage (dated Dec 1956) electrolytic which fitted neatly into the original space, just needing a new hole for one of its fixing screws.

Turning the chassis over, there was discolouring around V5's (the 35Z4GT) socket, and the resistors and wiring in the area looked suspect, as did some of the soldered joints. Some connections made use of unused pins on the socket, which I always find confusing and avoid whenever I can, and can lead to some minor disasters. Take the case in hand: let's say pin 3 on the 35Z4GT's socket has been used to anchor a couple of components' legs. We want to replace the 35Z4GT, but we only have a 35Z5GT to hand, which should be a drop in replacement. However on the 35Z5GT, pin 3 is used as a tap on the heater (as mentioned above) and so when we plug it in and switch on, we are very likely to blow the heater of our precious new valve!

After unscrewing the two front-to-back chassis stretcher bars to give better access, I stripped out all the wiring and components around V5, and cleaned up the socket and chassis. I debated whether to fit a new socket, but in the end decided to try the old one and see how it performed.

There were only two waxed paper capacitors used on the chassis: C6, a 0.1µF decoupling V1's cathode resistor, and C2, a 0.05µF decoupling the AGC line. Both were changed for modern polyester equivalents. Apart from the normal low-value silver mica capacitors in the RF section, the remaining coupling / decoupling capacitors were chunky US-manufactured rectangular black blocks, marked 'Tobe Type D, 10000mmF 600VDC', see Figure 7. 'mmF' is the old way of writing µµF, that is pF, and so these capacitors had a nominal value of 10,000pF, that is, 0.01µF or 10nF. I removed one of these capacitors and checked its capacitance (it measured at 15.2nF), and for leakage. Its leakage at 300V was very low and so I soldered it back into place, and left the others alone. These were clearly good quality capacitors, sourced from the US, and had lasted very well over the years. C18, V4's cathode resistor 25µF bypass electrolytic, was changed for a modern 22µF component.

Most of the resistors measured close enough to their nominal values to be left alone, but R7 (V3's anode load resistor) was rather high in value and was changed for a new 100kΩ component. Initially R6 (nominally 4.7MΩ) seemed to have gone short circuit, but careful examination of its screened link through the chassis to the top cap of V3 showed that the screened cable had perished and the grounded outer was now shorted to the inner conductor. I replaced the lead with a new piece of screened cable, and R6 then measured 5.03MΩ, which was good enough. The HT smoothing resistor, R10, was discoloured, and was changed for a new 1kΩ component.

The valves' heater voltages added up to about 108V, and when added to about half the dial lamp's voltage (I'm assuming that when the radio is fully warmed up, the lamp drops about half its rated voltage of 6.5V since it's run at reduced current), gives about 110V. To compensate for the extra volts, I could have swapped the 35L6GT for a 50L6GT, but I wanted to keep the original line-up. So I added a 68Ω 3W resistor in the connection between V5's and V4's heaters to drop the extra few volts to add up to about the 117V mains voltage I intended to run the radio at.

The maximum reservoir capacitor value is specified at 40µF for the 35Z4GT, and because I had used a 50µF capacitor, I added a 100Ω resistor between the rectifier's cathode and the reservoir capacitor to limit the charging current through the valve. A new class X2 0.01µF 275V AC metallised polyester capacitor was fitted across the mains, after the on / off switch.

I refitted the tuning capacitor using a couple of spacers to raise it slightly above the chassis. I suspect that originally it was mounted using rubber grommets, but these had perished and totally disappeared over the years. The throw out aerial was connected to somewhere on the wavechange switch, rather than to one end of C1, and I put it back to the correct position. At about 6 feet, the aerial looked rather short (typical throw-out aerials on American midgets were 20 feet or so) and so I cut it short and added a 4mm socket into which I could plug my workshop's longwire, or

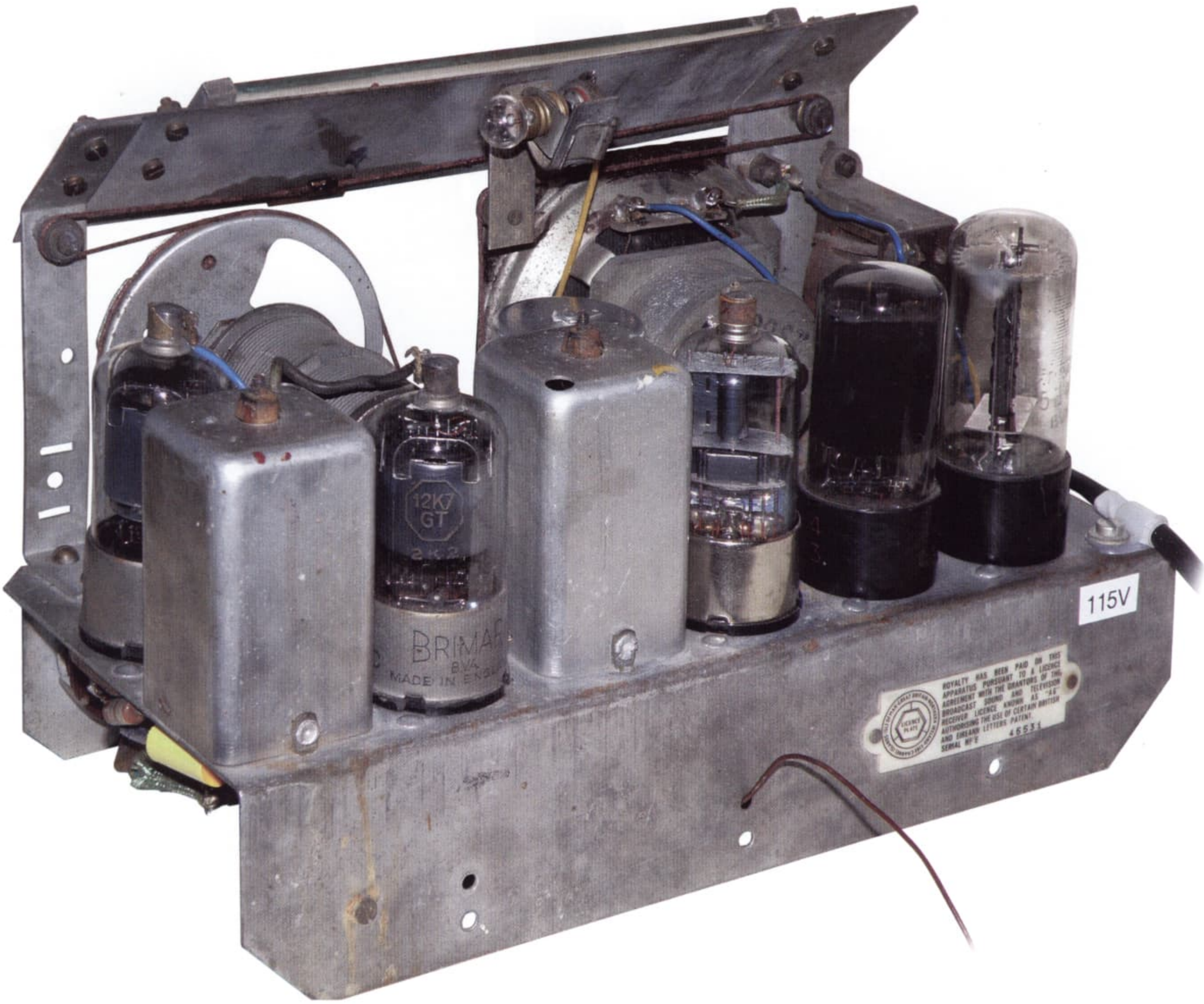


Figure 9: Rear top of the restored chassis.

various lengths of wire to experiment.

The resistance of the volume control seemed to be OK, but I changed it for a 500kΩ control fitted with a two-pole on / off switch (rather than the single pole on the original switch), which made the radio a little safer to use. Figure 8 shows an under chassis view of the restored radio, and the rear top of the chassis can be seen in Figure 9.

Switch on

I fitted a new two-core mains lead and a US-style plug (obtained from Maplin), so there was no chance of my accidentally plugging it into a UK mains outlet. For the initial switch on, I hadn't refitted the dial lamp, so the neutral side of the on/off switch was connected directly to the chassis. I connected a DMM set to its 600V AC range between the radio's chassis and mains earth, so I could check that the mains lead was connected the right way round.

I plugged the radio into a 240V-to-120V autotransformer, connected an aerial, and switched on. My DMM showed a few volts between mains earth and chassis, indicating that the live and neutral were the right way round. After a while the valves glowed, showing continuity along the heater chain, and eventually the radio came to life with Radio 4 on the long wave. The medium wave gave no stations at all, until the wavechange switch was sprayed and operated a few times, after which I could hear a few stations. The volume control worked the wrong way round, so I unplugged the radio from the mains and swapped over its connections.

The HT voltage across C19 measured at about 96V – a little lower than expected – which maybe indicates a low-ish emission on the 35Z4GT I used. I may try another one to see if this comes up by a few volts. I also measured the heater current, using a low resistance AC ammeter in series with the heater chain, and read a value of 153mA RMS, which was satisfyingly close the nominal value of 150mA.

I let the radio soak test for a few hours, after which medium wave reception seemed to get better. I wonder if this was due to the coils, and maybe other components, drying out after years of non-use and returning to their original condition. The performance of the radio was acceptable, and I didn't attempt a re-alignment at this stage. I think I'll leave it to settle down a little before I start fiddling with its alignment.

Dial cord

The original dial cord had collapsed from the pulleys and tuning capacitor drum, but the tensioning spring was still present and the cord itself was intact. I had hopes that it would be a simple task to re-thread the cord once the chassis was re-assembled, without untying it from the spring or having to use a new length of cord. However this didn't turn out as planned: try as I could, I couldn't make the cord fit, and in the end I came to the conclusion that I had refitted the tuning capacitor at a different height above the chassis than where it was originally, and this meant that the cord was too short. So I cut the old cord and tried to thread a new one. The service sheet shows how the cord is fitted (which doesn't look too difficult), but I fell at the first hurdle of trying to get the tensioning spring to stay on the drum, so I resorted to Alraditing its fixed end to the fixing point on the drum. I still couldn't make the cord stay on the drive shaft, the pulleys and the drum all at the same time, and it kept on slipping off.

After a frustrating hour or so, with a small hook fabricated from a paper clip holding the spring extended, and

Figure 10: The restored radio.

some blobs of BluTack holding the cord in a few strategic places, I eventually achieved the desired result. I presume that in the factory this was a two-man (or woman) job, or maybe there was a knack to the task that eluded me.

Cabinet

I gave the cabinet a good wash in hot soapy water and polished it with Bakelite polishing paste. A couple more minor cracks were revealed, but I left these as they weren't too obvious, and weren't affecting the structural integrity of the cabinet.

Before remounting the dial, I cleaned the glass very carefully, ensuring that the dial markings weren't erased, as can easily be done. The bezel, to which the glass is fitted using a couple of small brackets, was a sort of sandy colour: I'm not sure if this was original or some sort of corrosion. It didn't look too bad and so was left in this condition. I refitted the dial lamp and tested its operation: when first switched on from cold, the lamp glows brightly, and after a couple of seconds it dulls considerably in brightness. Then after about another minute - I presume when all the valves have fully warmed up - it has brightened up a little and stays at that brightness.

Finally the radio was re-inserted into the cabinet and a set of matching knobs fitted. I had some felt washers, and these were fitted behind the knobs to prevent scratching the cabinet's surface. I covered the exposed fixing screw heads with insulation tape, and the filled the knobs' grub screws with a little wax to isolate the user from the chassis. The radio needs a new back panel making, to make it fully safe from touching the chassis if the live side of the UK mains gets connected to the chassis by accident.

The finished radio is shown in Figure 10. I think it shows considerable improvement on its original state and well worth the effort expended.

Conclusions

The D120 Sandown was one model of a series of table-top midget radios, based on American valves and using an American-inspired Bakelite cabinet, produced by Masteradio between 1946 and the early 1950s. At first sight the radio seemed to be in poor condition, but the chassis just needed some de-rusting, two new valves fitted, and a few resistors and capacitors changing to bring it back to life. Because the valves used had been designed for use on the American mains voltage, it wasn't too difficult to adapt the radio to 115V mains operation. The cabinet responded to some elbow grease and came up well.

The HRO-MX Communications Receiver

by Steve Richards

Based on an innovative 1930s design, it saw wartime service and is still going strong after 74 years

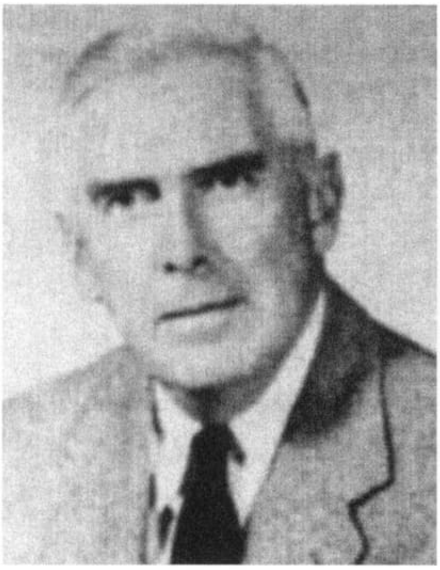


Fig 1. James Millen

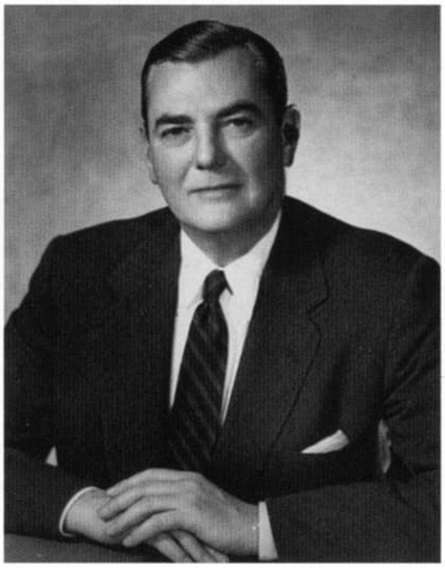


Fig 2. Herb Hoover Jr.

Fig 3. James Lamb

Introduction

I found the HRO under a table a few years back at the Vintage Communications Fair. Crawling on hands and knees, I opened the lid to check there was nothing missing, particularly mechanical components. It looked to be complete and had five of its plug-in coil packs so I asked the price. Being somewhat lower than I had expected, I paid the asking price and walked away with my new acquisition. I used to have one of these receivers when I first got interested in radio as a teenager, but regrettably sold it to raise money to buy a hi-fi amplifier. So the opportunity to obtain and restore one was just too good to miss.

The receiver, manufactured by National Company in Malden Massachusetts, is not uncommon in the UK as the British bought around 10,000 of them to support the war effort. They saw service principally by Y service listening stations providing Enigma intercept for decode by Bletchley Park but were also used by the Royal Navy and Special Operations Executive (SOE). After the war they came onto the surplus market and were eagerly snapped up by radio amateurs and shortwave listeners who had never before had the opportunity of owning a set of this calibre.

History

Before describing its restoration, it's worth telling the story of the HRO receiver as best I can piece it together from information on the web by various enthusiasts, radio historians and museums.

In 1932, the United States Bureau of Air Commerce, the forerunner of the Federal Aviation Authority, awarded a contract to the General Electric Company for provision of air ground stations for communicating with civil aircraft. General Electric (GE) supplied a transmitter of their own design but approached James Millen (Fig 1), the chief engineer at National Company, to design and build the receiver. Clearly both Millen and National Company, who had been manufacturing domestic radio receivers since the early 1920's, had something of a reputation. The resulting receiver was a single conversion superhet with a single stage of RF amplification and covered 1.5 to 20MHz. The set included a BFO allowing reception of both AM and CW signals. To avoid complex band switching, sets of plug-in coils were used to configure the receiver for a particular frequency band. There were three coils per set, RF pre-selector, tuned RF amplifier and local oscillator, and these plugged independently into sockets in the front panel of the receiver. The receiver was designated the AGS (or Aeronautical Ground Station) receiver. A working example of an AGS can be found on youtube at reference a.

Millen, being a radio amateur himself, realised that there was a potential amateur radio market for a receiver like the AGS, but with a price tag of $165, AGS was well beyond the means of most amateur radio enthusiasts. Not wishing to miss an opportunity, National produced a cut-down version known as the FB7. This had a single set of coils covering just the 80m amateur band comprising the RF amplifier and local oscillator coil but no RF pre-selector. This sold for around $55.

Although the AGS receiver met the terms of the contract, in use, the airlines were not entirely satisfied with its performance and wanted a number of improvements. As a result, they appointed Herb Hoover Junior (Fig 2) to specify a replacement. Herb Hoover was the son of President Herbert Hoover, was employed by Western Airlines, later to become TWA, taught part time at Cal Tech and like James Millen was an amateur radio enthusiast. In response to the airlines' requirements, he set up a laboratory in the garage of his house in Pasadena, employed Howard Morgan from Western Electric and collaborated with James Millen, Dana Bacon, another radio amateur, and Millen's team at National Company in Massachusetts to design the new receiver.

National's new receiver was to draw heavily on the experience gained from producing AGS. Its design was also influenced in no small measure by the work of James Lamb (Fig 3). Lamb was technical editor of the amateur radio magazine QST and in 1932 wrote a series of articles on receiver design. The first of these was highly technical, investigating deficiencies in existing circuits and postulating solutions. The later articles presented experimental work on a "single signal superhet". Lamb's prototype receiver from 1932 still exists and is in the possession of the Amateur Radio Relay League (ARRL) at their headquarters in Newington. A photograph can be found at reference b. Although Hoover and Morgan were responsible for its electronic design and Millen and Bacon its mechanical design and production, Lamb's work effectively set out an architecture on which the National receiver was based.

National intended that the new receiver would be available in 1934. Indeed, it was advertised in QST magazine in December 1934. However, niggling problems resulted in last minute design changes which led to production delays. To save face, National put its production workers on overtime and finally released the receiver to market in March 1935. Not having a job number to record their overtime against, the workers started entering HOR, "HELL OF A RUSH", on their job cards and the receiver became known as the HOR, at least at the Malden factory. Not wishing their new product to be known as a HOR, National's marketing department reversed the letters and the receiver became the HRO. Or at least that's the story.

The HRO design comprises an RF pre-selector followed by two stages of RF amplification. Signal applied to the first mixer is converted to 456kHz by a local oscillator tracking HF of the wanted signal. The pre-selector, the two tuned RF stages and the local oscillator are tuned by a four gang variable capacitor. Using two tuned RF stages is effective in suppressing second channel interference up to about 15MHz, although it is still a problem at higher frequencies. Like its AGS predecessor, plug in coils are used to select the band. However, the four coils, needed for RF pre-selector, first RF amplifier, second RF amplifier and local oscillator, are now attached to a plate providing a single pluggable coil pack (Fig 4). In its original form the HRO was supplied with four coil packs covering 14.0 to 30MHz (pack A), 7.0 to 14.4MHz (pack B), 3.5 to 7.0MHz (pack C) and 1.7 to 4.0MHz (pack D). A feature of the coil packs is a small machine screw on each of the coils which when inserted in its left hand position adds extra capacitance that converts the coil pack from its general coverage range, stated above, to bandspread covering the 10m (pack A), 20m (pack B), 40m (pack C) and 80m (pack D) amateur bands respectively. There are nine valves in total – the two RF amplifiers (6D6), mixer (6C6), local oscillator (6C6), two IF amplifiers (6D6), detector / audio pre-amplifier (6B7), BFO (6C6) and an audio power amplifier (42). The receiver employs a crystal filter in the secondary of the inter-stage coupling transformer between the mixer and first IF amplifier which may be switched in or out of circuit. In circuit, the IF bandwidth is reduced to around 80Hz. When out of circuit, a variable capacitor between the primary and secondary transformer windings controls coupling effectively varying the selectivity of the set. The RF gain controls the bias on the screens grids of both the RF and IF amplifier stages. Similarly, when selected, AGC controls bias on their control grids.

Mechanically, the set is a masterpiece. The chassis and case are of steel construction which is firstly copper plated and then painted. The coil packs mate positively with spring contacts. A crank, attached to the spindle of the variable capacitor that controls the BFO frequency, engages a toggle switch at one end of its travel to switch the BFO on or off. But perhaps the most notable feature is the four gang tuning capacitor and vernier tuning dial. The four gangs of the capacitor are driven by a worm drive that sits in the centre. This is spring loaded to eliminate backlash and indeed when tuning a signal it appears at precisely the same dial reading whether tuning from above or below the frequency. The main tuning control is geared ten to one. Thus ten rotations of the tuning knob are needed to tune from one end of a band to the other. A plate behind the dial is driven by gears, this presents a number, which appears in a window adjacent to a pointer at the top of the dial. Every fifth of a turn of the tuning knob this number is incremented by ten that is between 0 at the low frequency end and 500 at the high frequency end of the band. The dial is marked with ten divisions between numbers. The result of all this is a dial with an effective length of twelve and a half feet divided into 500 discrete intervals. A logging graph for general coverage and another for bandspread are attached to the front of each coil pack which translate the dial reading to a frequency. The vernier

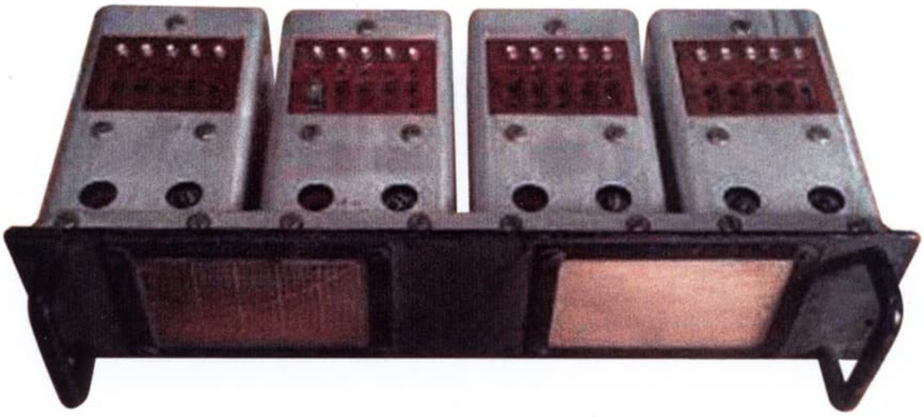


Fig 4. Coil pack

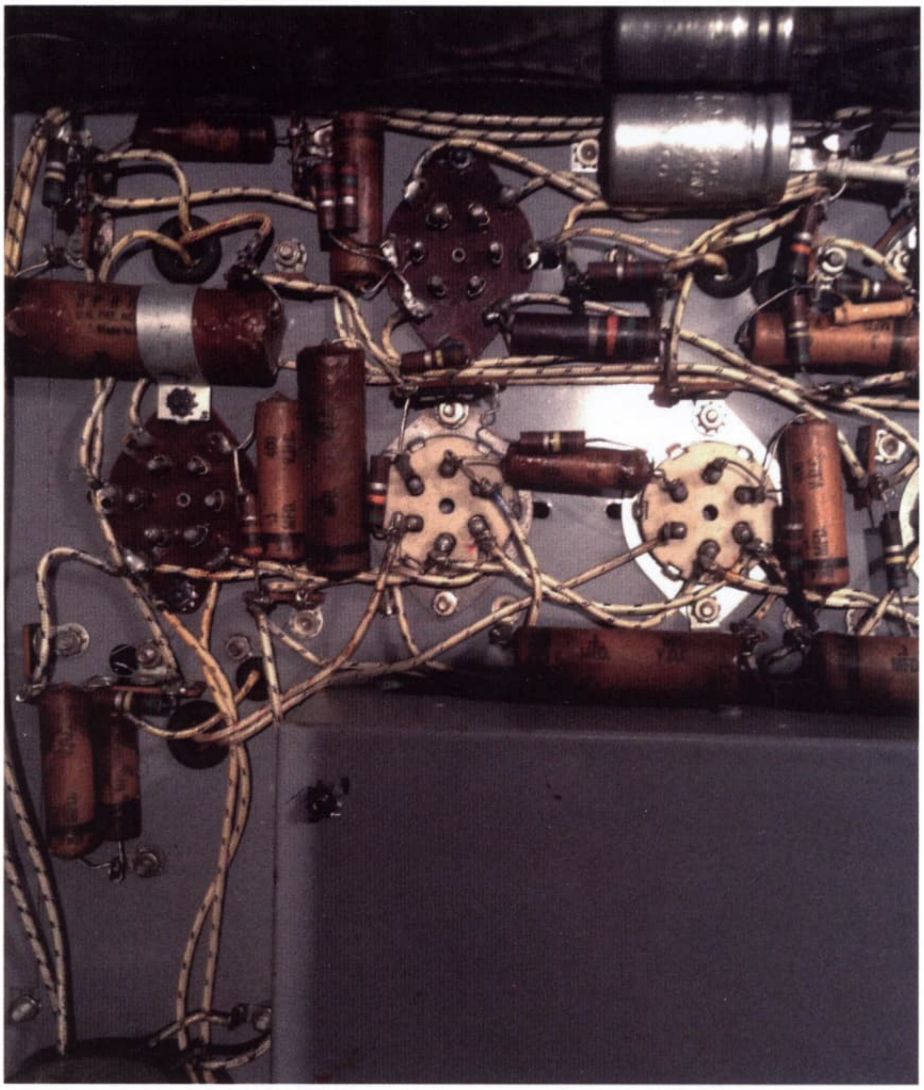


Fig 5. Underside of chassis (showing wax/paper capacitors

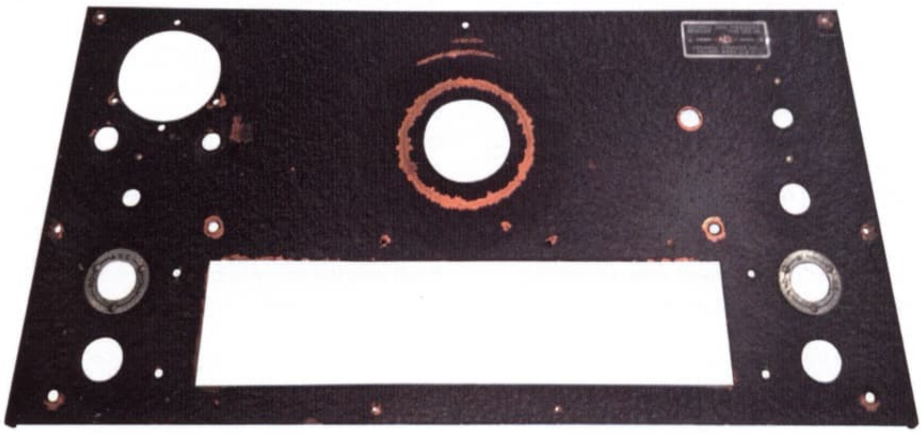


Fig 6. Damaged paintwork (front panel)

Fig 7. Case stripped for re-painting

Fig 8. Re-painted case

tuning dial, worm drive and variable capacitor assembly were designed by William Graydon Smith and were later patented in November 1936 (US patent No. 2060537) described as an "Indicating Device" (reference c). Seen through modern eyes, the set suffers a degree of frequency drift on higher frequencies. However, for its time it is remarkably stable, a characteristic that owes as much to the mechanical construction as to the electronic design of the receiver.

The second world war involved mechanised and highly mobile ground, air and naval forces whose command and control relied on HF radio networks. The imperative of receiving, decoding and interpreting this radio traffic to discover the enemy's movements or planned movements was not lost on the British who on entering the war had an urgent requirement for a high performance HF receiver to intercept this radio traffic at scale. This had to be robust, reliable, easy to operate and maintain and would have to be supplied in quantity. How the HRO was chosen for the role I do not know. I imagine an evaluation of potential candidates would have been undertaken but I can find no record. If anyone can shed light on this I would be most interested. Anyway, chosen it was, and so National, with the endorsement of the US government, stepped up production to meet demand. I expect that my HRO, like many others, entered the country as part of a consignment on an Atlantic convey.

During the war several design changes were made. Some, like replacement of the graduated S meter with a standard 1mA meter scale were to accommodate availability of components. Others introduced circuit changes such as introduction of metal octal series valves on the HRO-5T model. Such was the success of the set that National continued to manufacture versions after the war. The HRO-7 introduced in 1947 restyled the case and introduced a miniature valve in the local oscillator. The HRO-50, 1951 to 1952, used miniature valves throughout, had a slide rule dial providing direct frequency read-out in addition to the vernier dial and had a built in power supply. The HRO-60, 1953 to 1964, extended the frequency range to cover 50kHz to 30MHz plus 50 to 54MHz. It also incorporated an additional mixer to become a double superhet on frequencies above 7MHz. National manufactured two additional models during the 1960s and 70s bearing the HRO name (the HRO-500 and HRO-600). But these are semiconductor technology and, unlike the earlier models, owe little or nothing to the original HRO design.

The HRO design was also copied. During the war, Germany manufactured the Siemens R4 and Korting KST and Japan the type 41D. East Germany manufactured the AQST during the 1950s and Kingsley's AR7 was manufactured in Melbourne both during and after WWII. All of these sets have more than a passing resemblance to the HRO.

Restoration

Returning to my receiver, the first thing I was keen to know was its date of manufacture. From the name plate in the top right hand corner of the front panel and the glass envelope valves (as opposed to metal octal valves used on later versions) I knew it was an HRO-MX. Its serial number, E487, is both punched into and printed on the chassis adjacent to the aerial termination posts. The serial number is useful because there is some dating information on the web based on serial numbers. Other features that helped me were the S meter legend marked in S units rather than just a standard 1mA meter used on later versions, the S-meter switch which is a conventional toggle rather than a push/pull switch, the square IF transformer covers and the crystal of the crystal filter being out of sight inside the first IF screening cover. With this information I was able to date this set to the beginning of 1942 (74 years old!). On inspection, the set looked clean but had clearly suffered damage to the case. Unfortunately, the paint was scrapped on the front panel down to the copper layer. On the side, the damage was through to the steel plate but as yet there was no rust. Given this level of damage, I decided I would have to re-paint the case but before doing so wanted to get power on the set to assess the amount of electronic restoration needed.

Unfortunately, the receiver did not have its external power supply unit so I would have to build one. The HRO power supply, affectionately known as the dog house by HRO aficionados because of its shape, supplies 250V dc at 70mA and 6.3V ac at 3.5A. From previous experience I knew the HRO's local oscillator has a tendency to drift a little on frequencies above 15MHz so I decided to build a regulated power supply. But I'll keep the design and construction of this for a separate article.

With my power supply completed and tested and having done a few ohm meter checks on the HRO to ensure there were no direct shorts, I applied heater voltage. All valves appeared to be alight. Then, with an aerial connected, I applied ht with my AVO 8 on its 100 mA range in series with the supply so I could switch off quickly if the current looked excessive. The set drew rather more than 70mA and when I tuned it was "scratchy" but produced no signals. I tried switching the BFO on but there was no change in background noise suggesting the BFO might be faulty.

Amongst the five coil packs that came with the receiver was a 180kHz to 430kHz (G), 900kHz to 2.5MHz (E), 1.7MHz to 4.0MHz (JD), 7.0MHz -14.4MHz (JB) and 14.0MHz to 30.0MHz (JA). The J prefix on the higher frequency coil packs indicates that they have no bandspread capability. Another war time expedience which avoided alignment time in the factory for a feature that was not going to be used. I tried the other coil packs in case the lack of signals was down to a faulty coil pack but to no avail.

Before going any further I decided I would disassemble and clean off the thin layer of dust on the chassis, remove and clean the variable capacitor, replace all the wax/paper construction capacitors (Fig 5), which were probably leaky and accounted for the higher than expected ht current, before re-assembling, fixing any faults and re-aligning the set.

I removed and set aside the knobs and valves, then removed the front panel and case. The full extent of the damaged paintwork was now apparent (Fig 6). The paint has a wrinkle black finish and I was wondering how to deal with this when Terry Martini-Yates published his article in the Winter 2014 Bulletin about restoration of a BSR amplifier in which he described the process of re-painting with VHT paint. I bought a spray can of black VHT from Amazon and experimented on a piece of gash steel following Terry's instructions. The result was outstanding. With confidence that I could achieve a good result, I set about stripping the old paint. I found that soaking in methylated spirits and scrubbing with 80 grade paper was effective. The few stubborn final patches succumbed to nitromores leaving the copper plating exposed, clean and ready to accept new paint (Fig 7). Painting the case, which comprised a right and left side, rear panel and hinged top panel was straightforward. I used pvc tape to mask the hinges to avoid sticking them together with paint. The front panel wasn't so easy. There are a number of dome head rivets that hold the model number plate, AVC and B+ switch legends and a couple which provide a pointer to the numbering on control knobs. I didn't want to remove any of these because I thought it unlikely I could find matching replacement rivets. Instead, I applied pvc tape to mask these items, carefully cut round with a modelling knife before applying paint. The re-painted case and front panel were every bit as impressive as my practice piece (Fig 8).

Next, I cut the connecting wires to the variable capacitor assembly and removed it from the chassis. Having washed it in very hot soapy water to remove the dust I rinsed it in clean hot water then stood in the airing cupboard to dry out. Once dry, I used ordinary 80gm printer paper and a little switch cleaner to clean between the spring

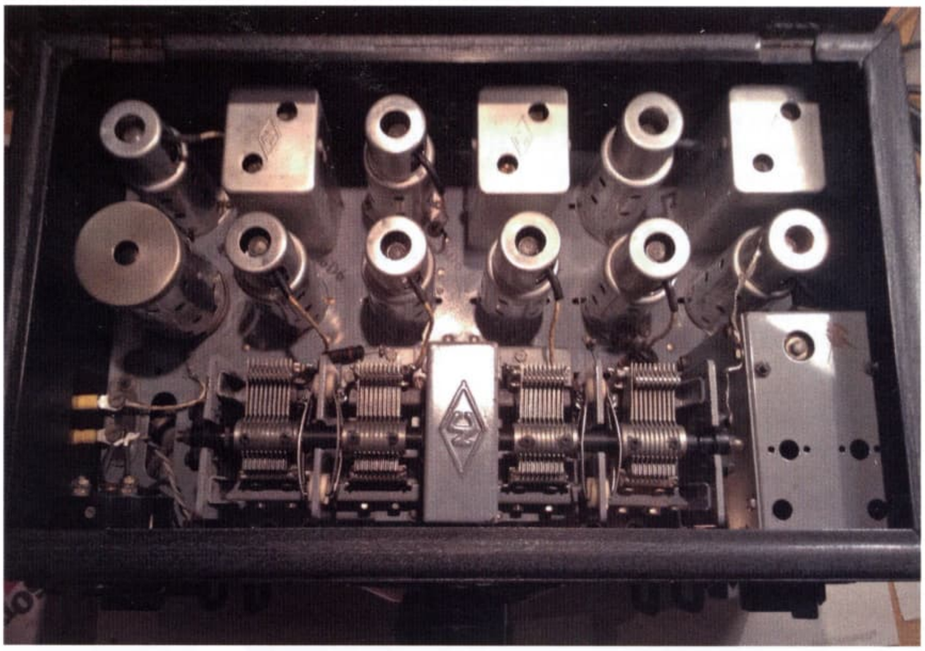


Fig 9 Restored receiver (internal view)

Fig 10. Restored receiver (front view)

loaded contacts and the slip rings on which they run to earth the moving vanes of each of the four capacitors. I removed the cover from the central gearbox and used paraffin to soften and remove the old and hardened grease before sparingly re-greasing. With its overhaul complete, I returned the capacitor assembly to its place on the chassis and reconnected it using new 22 swg wire.

I then replaced the front panel and case. Before replacing the knobs I carefully cleaned them with Brasso. The same treatment returned the S meter to its original condition. Before replacing the vernier tuning dial, I removed and cleaned the rear plate which was sticky with grease and dust. I toyed with the idea of scraping out and renewing the paint on the graticule lines but decided the best treatment was to leave as original. (Fig 9 and 10 show the re-assembled receiver).

Finally, I replaced all decoupling capacitors and inter-stage coupling capacitors with new BVWS 630V polyester capacitors. To make these similar in size and appearance to the originals, I glued them inside plastic tube around which I fixed brown paper printed with the value (e.g. 0.1 MFD). Having plugged the valves back into their respective sockets, I was ready to switch on again. This time ht current measured just under 65mA. With an aerial attached and the 7.0MHz -14.4MHz coil pack installed, I could tune broadcast stations on 41m. The scratchiness when tuning had gone but the BFO still didn't work and I was not convinced the receiver was as sensitive as it should have been.

A few dc voltage measurements around the BFO revealed the cause of its problems. Just 11V on the valve anode. On investigation I discovered the load resistor measured well over 1Mohm instead of 250kohm. On replacing this, the BFO started working.

Finally, using a signal generator and frequency counter, I re-aligned the IF stages which improved sensitivity markedly.

Conclusion

Bringing back to life HRO-MX number E487 has been both enjoyable and challenging. Although I now have a working set I intend doing some further work to sharpen its performance if I can. In particular, I'm concerned about some resistor values that are very wide of the mark which I think may be affecting the AGC. Also, proper alignment and tracking of RF stages and local oscillator for each of the coil packs wouldn't come amiss.

Researching its conception, design and evolution, provided an insight into the motivation and skill of those involved. I think it fair to say that the HRO has a special place in history on two counts. Firstly, when it was designed, in 1934, it was ahead of its time. It demonstrated technology and set a performance standard for other manufacturers to follow. Secondly, it played a significant role in war time because of Britain's large scale adoption.

Acknowledgement
Finally, my thanks to Lin who has lived with the restoration work for many months, took photographs at various stages (that appear in this article), and who must by now be fed up of me talking about the HRO.

References and resources

• AGS Receiver
www.youtube.com/watch?v=5lr7qSDez24

• QST January 2010: The National HRO Receiver: A Historical Reconstruction http://n4trb.com/AmateurRadio/National/Lamb/JamesLamb.htm

• US Patent 2060537: Indicating Device

• The James Millen Society
www.isquare.com/millen/millen-page.htm

• Vintage Military and Amateur Radio Society: HRO User Manual and Circuit
www.vmarsmanuals.co.uk/new/hro.htm

• Crypto Museum: National HRO
/www.cryptomuseum.com/df/hro/

• Western Historic Radio Museum
www.i1wqrlinkradio.com/antype/ch104/chiave34.htm

• National Dial Tips
www.prismnet.com/~nielw/PW_NPW_Dial/hro_dial.htm

• National R106 Radio Manual
http://vacuumtubes.biz/documents/National%20R-106%20Radio%20Manual.pdf

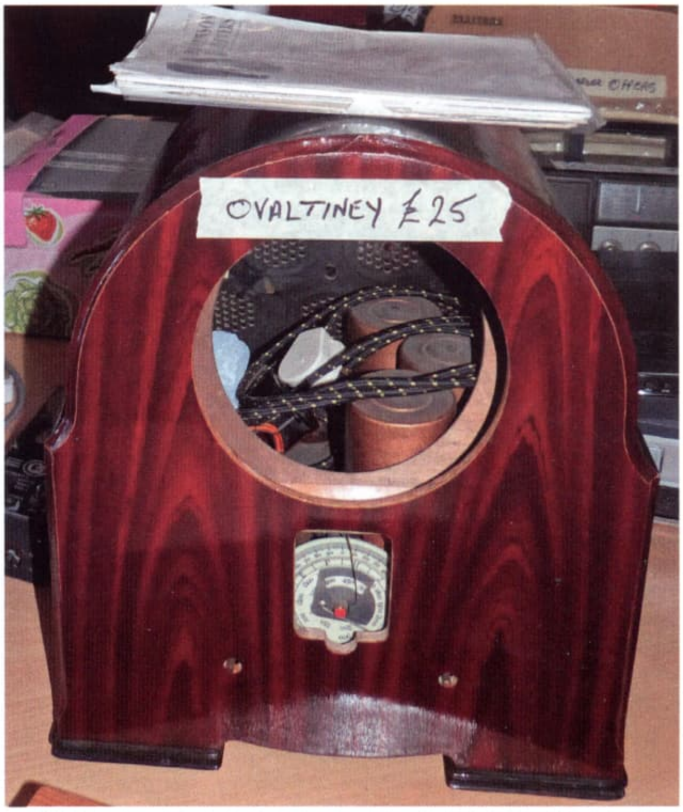
• LA6NCA WW2 Page: KØRTING KST
www.la6nca.net/tysk/kst/index.htm

• Kingsley AR7 Receiver
www.tuberadio.com/robinson/museum/AR7/

• Siemens R-IV Receiver
www.cryptomuseum.com/df/siemens/r4/index.htm

• Military Wireless in the Midlands Museum: Japanese Type 41D receiver
www.qsl.net/g4bxd/japanese.htm

Golborne April 10th photographed by Mike Barker



Submarine Telegraphy - Part One by J Patrick Wilson

Fig. 1: Model of von Sömmering's electrolytic telegraph (Deutches Museum Munich)

Fig. 2: Cooke & Wheatstone's five-needle telegraph of 1837 (Science Museum London)

Fig. 3a: General Post Office single needle telegraph receiver

The Invention of telegraphy

The history of telegraphy is complicated with different systems designed for different applications, and includes many ingenious ideas which never became established in practical systems. As early as 1730 Stephen Gray introduced the concept of conduction, via wet cotton or hemp fibres suspended and insulated by dry silk threads, and demonstrated electrostatic attraction over a distance of several hundred feet. In 1747 Sir William Watson shocked an assistant two miles away with a Leyden jar via a metallic wire and earth return. In 1795 Don Francisco Salva extended this to the 26 miles between Madrid and Aranjuez with 22 wires insulated with paper and pitch giving electrostatic attraction of a row of pith balls.

The first galvanic (i.e., electrochemical battery) system was that of von Sömmering of Munich who, in 1809, used 27 wires 1000ft long ending in water and producing bubbles by electrolysis at the corresponding lettered wire (Fig. 1). In 1810 Sömmering and Baron von Schilling of St Petersburg experimented with rubber and varnish insulation; Schilling detonated mines via wires under the Neva in 1812, and under the Seine in 1815.

In 1816 we come to Sir Francis Ronalds who set up an array of wires, 8 miles in length, in his garden in Hammersmith, and noted effectively zero travel time. He used electrostatic attraction of pith balls via synchronously rotating discs with the alphabet around the edge. Some experiments used underground wires in glass tubing. The response of the Admiralty was that 'Telegraphs of any kind are now wholly unnecessary; and no other than the one now in use (semaphore) will be adopted.'

Following the experiments on the deflection of a magnet by an electric current by Oested in 1820 the first system to use an electromagnetic receiver was that of Baron von Schilling in 1832. He used Schweiger's multiplier (a multiple turns form of galvanometer) with a disc white one side, black the other, attached to a suspended magnet, thus indicating polarity. In 1836 he set up a line from St Petersburg to Peterhoff which ran partly under a canal, and was insulated with silk and varnish, and wrapped with tarred hemp. This was probably the first 'submarine' telegraph. Other systems were also devised by Steinheil, Gauss and Weber in Germany.

Cooke learned of Schilling's experiments from Professor Munche in Heidelburg in 1836 and resolved to switch from making anatomical models to telegraphy. He devised a three-needle system allowing 27 combinations, which he unsuccessfully advocated to the Liverpool & Manchester Railway, and later, a single line commutator device. In 1837 he was introduced by Peter Roget (of Thesaurus fame) to Charles Wheatstone of King's College London, who had also been working on telegraphic devices and had just determined that the speed of electricity along a wire was equal to the speed of light. They immediately joined forces and patented the result of their joint labours as the five-needle telegraph (Fig. 2) and added various alarm devices.

The five-needle telegraph is an elegant system using five 'linesman's' galvanometer movements. These each consist of a pair of vertical, gravity controlled, astatic (parallel but oppositely magnetised) needles, one inside a horizontal solenoid, the other projecting through the front panel. Below these are two rows of five buttons, the top ones deflecting their corresponding needles to right stops, and the lower ones to left stops, aligning along diagonal lines. At the intersections of these diagonals are twenty letters of the alphabet in sequence, omitting CJQUXZ which can be improvised. To signal a letter one button from each row has to be pressed and the intersection of the two needles indicates the letter required. This system was used on the railway, a natural wayleave for cables, between Paddington and West Drayton in 1839 and caught the public imagination in 1845 with the arrest of the murderer dressed as a 'KWAKER.'

Expansion to the system was made using first, a two-needle instrument, then the single-needle system which formed the basis of the railway block system and later also, using a mirror galvanometer for submarine telegraphy. Morse had patented his telegraph system in the USA in late 1837 using his code of dots and dashes using the simplest signals for the most frequent letters (e.g, a single dot for 'E' and single dash for 'T'). In the single-needle and cable code versions of Morse a dot is represented by a left deflection and a dash by a right (Fig. 3a&b). It was soon found that railway use occupied but little time so that spare periods could be utilised for paid messages.

In 1846, the Electric Telegraph Company was formed and various equipment was tried, eventually settling on first a Morse embosser or inker, then a sounder as in America (Fig. 4). This was frequently semi-boxed to increase resonance and direct the sound. Operators preferred the sounder but the company initially insisted on permanent records. On the continent the Hughes printing telegraph became popular and here Wheatstone automatic senders and printers (for images of these and other telegraph instruments see Fons Vanden Berghen: *Classics of Communication* Brussels 1999). For private use the dial or ABC telegraph (Fig. 5) was also much used as it required little training. Both Wheatstone and Cooke received knighthoods (rather belatedly) and made a lot of money out of telegraphy enabling the former to buy a grand house in Park Crescent (which later became the offices of the Medical Research Council) and to leave £70,000, whereas the latter, who probably made even more profit, eventually lost it all in further ventures.

Submarine telegraph cables

Some experiments on underwater signalling had been made by Wheatstone in 1840 using a conductor insulated by tar-impregnated rope under the Thames, by Morse in 1842

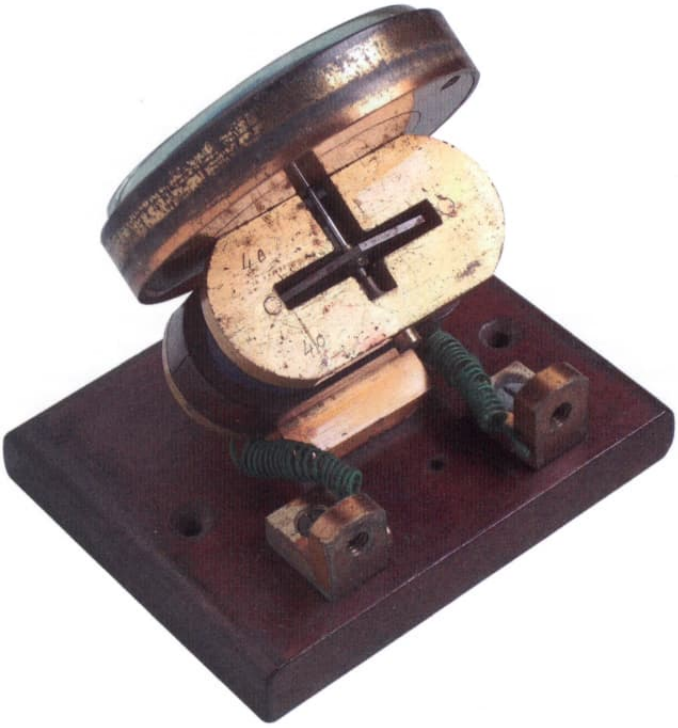


Fig. 3b: General Post Office single needle telegraph receiver

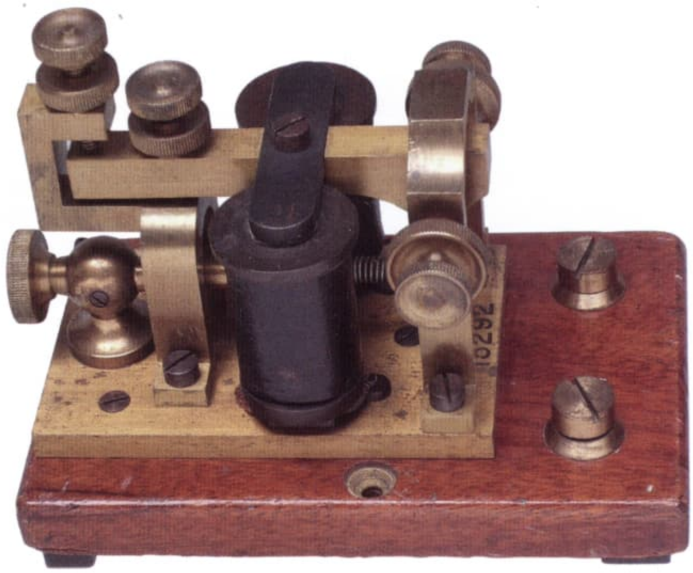


Fig. 4: GPO Morse sounder

across New York Harbor, and in 1845, by West of SW Silver & Co (later Silvertown) in Portsmouth Harbour, using a rubber insulated cable. It was not, however, until gutta percha (suggested by Faraday to William Siemens) had been introduced as an insulator that underwater transmission became practicable. Gutta percha is obtained from tree sap, like rubber, but is not elastic but becomes malleable at 70°C. It's keeping properties and insulation actually improve under water and under pressure. It has a relative dielectric constant of 2.46 (although earlier impure forms were higher). It had been brought to England in 1843, and the Gutta Percha Company formed in 1845, which started by making surgical appliances and toys. Siemens recommended it to his brother for use on the German subterranean telegraphs, and in 1849 CV Walker tested it in a line to a boat anchored off Dover Harbour.

Meanwhile the Brett brothers had jumped in and obtained a concession from the British and French governments to lay a cable to France, and formed the English Channel Submarine Telegraph Co, with a capital of £2000. One of the shareholders, CJ Wollaston, was appointed electrical engineer. They contracted the Gutta Percha Co at 18 Wharf Rd, City Rd, to supply the cable. This was formed by covering 100yd lengths of 14 Birmingham Wire Gauge (slightly thicker than corresponding SWG) copper wire with a single 1/2" diameter layer of gutta percha. Lengths were joined by exposing 2" at each end, cleaning with emery paper, and joining by bell-hanger's twist, resin and soft solder. Heat-softened gutta percha was then pressed on by a wooden mould forming a 'cigar' 2" in diameter and 9" in length. The drums of cable were then transported to Dover, crudely checked electrically during immersion in water, and finally joined and wound on to the single lateral drum on board the paddle steamer *Goliah*. Onlookers were scornful that the operators expected that a 'pull' on one end of the cable should be 'felt' on the other side of the channel!

The copper conductors

Curiously most histories of submarine telegraphy do not mention who supplied the copper conductors, which was Thomas Bolton & Sons then situated in Broad St, Birmingham. (I was astonished when I happened to mention this fact during a talk to the Hampstead Scientific and Philosophical Society when a lady in the audience revealed that this was her family's business in which her brother, Martin Bolton, had been the last family member to run it). Woolaston went to see Thomas's son Alfred who called in the foreman to brief him on the requirement for wire in 500yd unbroken lengths. 'Does the man think I am a fool?' was the response as they had never supplied this gauge in longer than 80yd lengths. This was done by slitting a bolt of copper into square rods which were then passed through rollers and then drawn through dies of decreasing diameter with frequent annealing. A typical die made from feldspar is shown in Fig. 6. At this stage the foreman won, but later they devised new manufacturing methods. Bolton's claimed to have supplied all the copper wire for the cables of the early 1850s. For the Atlantic cables of 1857, 1865 and 1866 they were unable to supply the whole quantity required in the time available so had to subcontract about 40% to John Wilkes & Co of Birmingham. By this time they had bought out the Cheadle Brass Co and moved wire production to Oakamoor (Fig. 7), near Alton Towers. They continued to supply copper wire for most of the subsequent cables including the 1956 coaxial telephone cable (TAT1).

Conductivity was unspecified in the first contracts, but tests on different samples of the 1857 cable ranged from about 50

Fig. 5: General Post Office ABC telegraph sender & receiver (Science Museum London)

Fig. 6: Feldspar wire drawing die. 30mm diameter

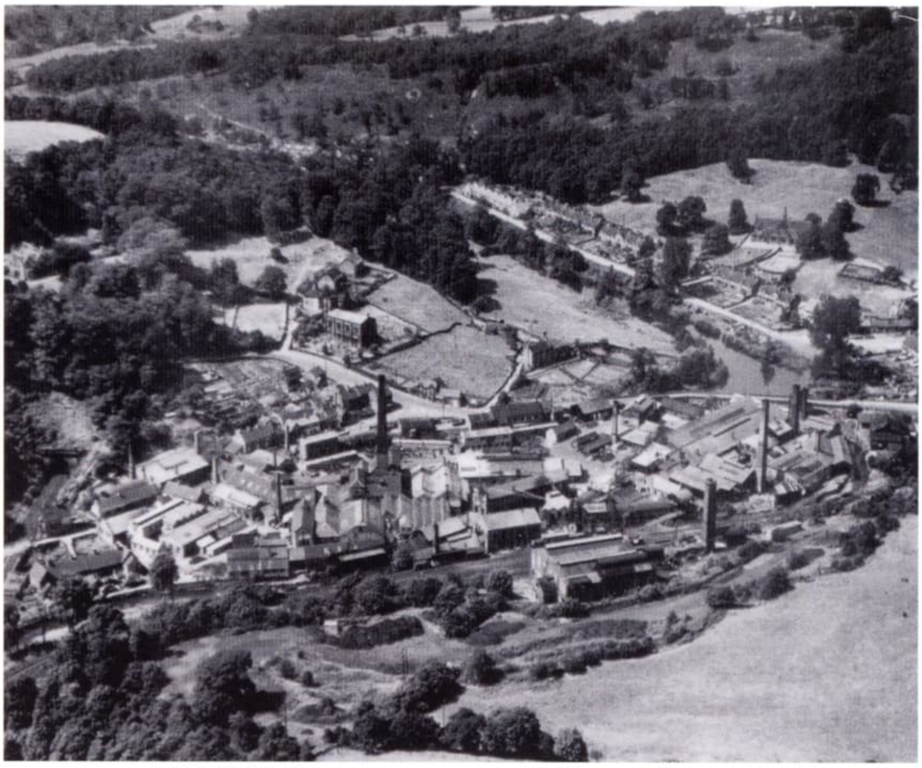


Fig. 7: Thomas Bolton's Oakamoor site in 1949 (Thomas Bolton & Sons Ltd 1783-1983, John Morton)

Fig. 8b: 1857/8 transatlantic cable by Glass Elliot & Co. (left hand lay, western half) 17mm diameter

Fig. 8a: 1857/8 transatlantic cable by Glass Elliot & Co. (left hand lay, western half)

Fig. 9b: 1857/8 shore end cable by RS Newell & Co (right hand lay, Irish end) 41mm diameter

Fig. 9a: 1857/8 shore end cable by RS Newell & Co (right hand lay, Irish end)

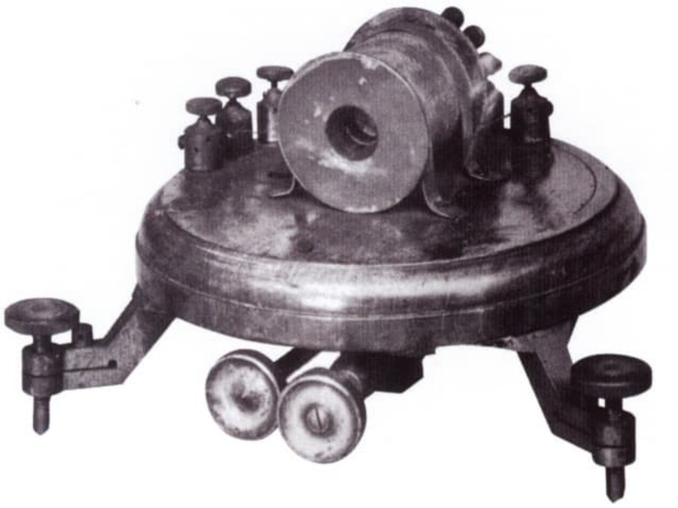


Fig. 10a: Thomson's mirror galvanometer by James White, Glasgow (terrestrial version)

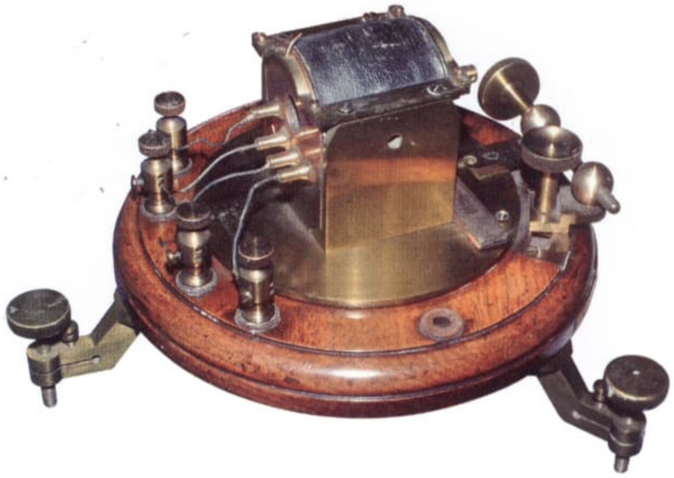


Fig. 10b: Thomson's mirror galvanometer by James White, Glasgow (terrestrial version)

to 70% of the conductivity of pure copper, so that after the abandonment of the first attempt, Prof William Thomson (later Lord Kelvin) specified >85% conductivity for the extra length required in 1858. From then on Boltons were famed for their 'conductivity' copper, achieved by selection of the purest 'Chile bars' at first, but later by electrolytic purification. They bought out the Mersey Copper Works at Widnes in 1881 for this purpose, and expanded manufacture to Froghall in 1890. This was taken over by BICC in 1961 but has now closed. Land telegraphs had early on turned to galvanised iron as a cheaper and stronger alternative to copper, but when telephones appeared Boltons supplied hard-drawn copper, and later for trolley wires. Boltons were also heavily involved with early electrical power wire manufacture but gradually dropped out of this.

Laying the English channel cable

The *Goliah* with the aid of tugs led by *HMS Widgeon* laid the first cable from Dover to Cap Gris Nez relatively uneventfully. As it was unarmoured, except for the shore ends, it had to be weighted down with lead every 100yd or so. Before landing, the end was tested on board by a modified House printing instrument that Brett had guaranteed would work at 15 words per minute (wpm). Unexpectedly only gibberish appeared on the strip. They wondered whether the Dover operator had become drunk during the wait, so decided to join up to the shore end and wait in the lighthouse until morning and test with galvanometers. Unfortunately, no signal at all could then be obtained (according to Willoughby-Smith. Other accounts suggest a short period of partial success). Apparently a French fisherman had trawled up 'a new sort of seaweed with a gold thread down the centre!'

Not discouraged, and with the financial and technical support of TR Crampton, a new cable was designed with four 16 BWG copper conductors, each with two coats of gutta percha to 1/4" diameter by the Gutta Percha Co. These were twisted, with tarred yarn in the interstices and wrapped around the outside, then completely encased in ten 1 BWG iron wires twisted around it by a small wire-rope manufacturer, Wilkins & Wetherby, in Wapping. This was loaded onto *Blazer* and towed by two tugs, again led by *Widgeon*, from South Foreland to Sangatte. Unfortunately the weather was less favourable this time, and the paying out gear allowed too much extra cable to escape, so they ran out just before reaching land. They were, however, able to attach three unarmoured wires which were taken to Calais railway station and communication established. Three weeks later a proper replacement was added, and on 13th Nov 1851 the first submarine cable was opened to the public. It is worth noting that by this time countries were by no means 'riddled' with land telegraphs. In 1850, England had 2,215 miles, France 620, Prussia 2,468 and the USA 12,000 miles. Morse code had soon become standard for land telegraphy, but was modified for 'cable code' by replacing the dot and dash by positive and negative potentials of equal duration.

In 1852, three attempts to link with Ireland failed, the first, from Holyhead to Howth, then two from Portpatrick to Donaghadee. But the following year a heavily armoured six-core cable otherwise similar to the English Channel one was successfully laid from Portpatrick to Donaghadee. Four light cables were also laid between England and Holland and a heavy multiple from Dover to Ostend. Many cables in the Mediterranean and elsewhere soon followed. It was also realised that if a cable could be run from Nova Scotia to Newfoundland, four days could be cut off the time it would take a message by ship to travel between the Old and New Worlds. In 1854 a British telegraph engineer living in Montréal, FN Gisbourne, was working on this scheme, but running short of money, when he met a recently retired American businessman, Cyrus W Field. When told the plan, and in complete ignorance of the technical difficulties to be overcome, he pressed for a cable right across the Atlantic.

Spanning the Atlantic

Enquiries to Morse and the US Navy both received encouraging replies, the latter having recently surveyed the route and found the bottom of the sea between Newfoundland and Ireland formed a plateau 'which seems to have been placed there especially for the purpose of holding the wires of a

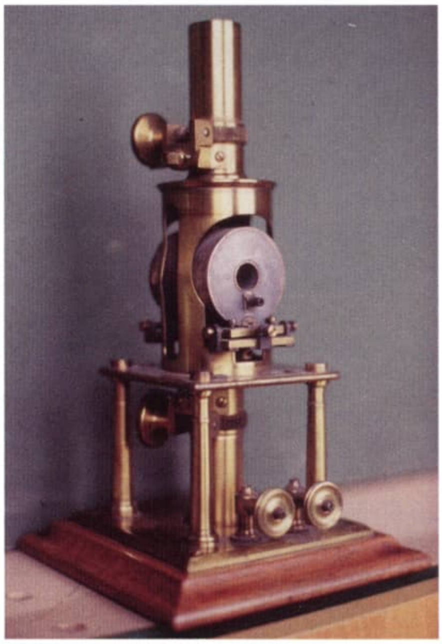


Fig. 11: Thomson's mirror galvanometer by James White, Glasgow (marine version, Glasgow University)

Fig. 12: Iron clad version of marine galvanometer by Elliott Bros (Science Museum London)

Fig. 13a: 1865 transatlantic cable

Fig. 14: Display stand for short section of 1865 cable

Fig. 13b: 1865 transatlantic cable. 29mm diameter

submarine telegraph' although reaching 2000 fathoms depth. Field promised to find the money among his investor friends, but in a complete reversal of the normal order of things, the Americans thought it was a great idea but were not prepared to put their hands in their pockets. British investors and companies in the end provided most of the finance, manufactured the cables and owned the system of this and the majority of subsequent submarine cables. The reasons for this can be attributed to the isolationist policies of the US and the world-wide extent of the British Empire.

Field set up the New York, Newfoundland & London Telegraph Co and bought up the wayleave rights which Gisborne had obtained from Newfoundland and the Canadian Government. In 1856 this became the Atlantic Telegraph Co, based in London, and besides Field, included such notable names as Charles Bright and John Pender of the Magnetic Telegraph Co, and Professor William Thomson of Glasgow University. Unfortunately they appointed Edward Orange Wildman Whitehouse, a surgeon turned telegraph enthusiast, as electrician for the project.

A cable was specified which had a number of shortcomings: Whitehouse, surprisingly with the support of Faraday but against the advise of Bright, Thomson and Varley, thought that a thin conductor (7 x 22 BWG) would have less induction (capacitance in modern parlance) and therefore be faster (ignoring the much greater consequent effect of increased resistance). It had been realised with the Newfoundland cable that it was much better to use a stranded conductor which would be more flexible and would continue to conduct with a broken strand. The armouring, which had been suggested by Brunel, consisted of 18 strands of 7 x 22 BWG bright iron wire, which proved excellent to handle but ultimately proved very susceptible to rusting (Fig. 8). Cable core manufacture was again contracted to the Gutta Percha Co, but owing to the short time scale allowed, armouring was divided between RS Newell, by then at Birkenhead, and Glass Elliot & Co (formerly Kuyper & Co) at Morden Wharf, East Greenwich.

Unfortunately the two companies wound their armouring in opposite directions so that around the join, whilst under the tension of laying, they would tend to unwind each other. Traditionally ropes and cables have usually been made with a right hand lay, like a corkscrew or screw thread. However, what Glass Elliot had discovered was that in laying down the cable into tanks and into the ships holds in a clockwise manner

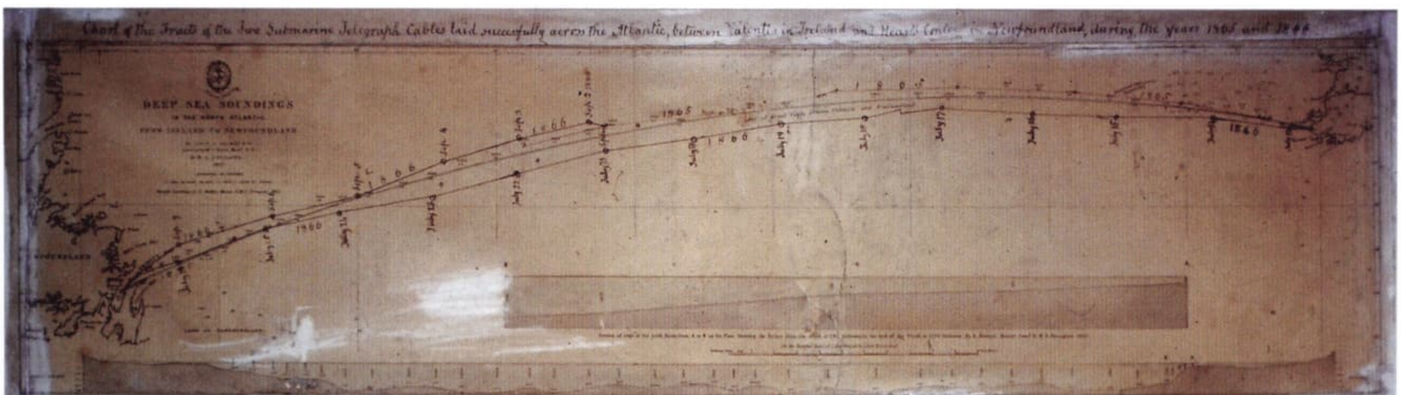


Fig. 15: Prof William Thomson's plots of 1865-6 cable layings (Glasgow University)

Fig. 16: 49 strand grappling cable for 1866 recovery of 1865 cable. 48mm diameter

(apparently the preferred way), this would increase the twist in the cable, making it stiffer and inclined to form unwanted loops. (The extra twist is of course taken out again as the cable is removed from the tank). They therefore decided to reverse the lay of the cable but unfortunately omitted to inform Newells. Thus a special weighted jointing had to be designed to prevent unravelling.

The shore ends of the cable need to be much heavier and stronger to avoid damage both from tidal and ocean currents abrading the cable against rocks, and from being caught and broken by ships anchors. This takes the cable into deep water either in one stage or sometimes with an intermediate section. An example of the shore end Atlantic cable laid in 1857 at the Irish end is shown in Fig. 9 which would have been made RS Newell.

No ship was large enough to carry the whole length so the British government lent the sail/steamship *Agamemnon* and the US Navy, the more modern *Niagara*. Further controversy arose over the laying sequence: the 'sailors' wanted to start from the middle to minimise time at sea and therefore the risk from storms; the Atlantic Telegraph Co, however, insisted on starting from Ireland so that they could be kept informed of progress through the cable as it was being laid. The *Niagara* had been due to ship the Glass Elliot length but proved too big for the Thames so was sent to Birkenhead for the Newell cable, leaving the *Agamemnon* to collect the Greenwich section.

After great celebrations, in which the Earl of Carlisle came from Dublin to a dinner hosted by the Knight of Kerry, on the 5th Aug 1857, the shore end was landed at White Strand, Ballycarberry (on the mainland opposite Knightstown on Valencia island), by small boats from the *Niagara* anchored in Doulus Bay. The *Niagara* then continued laying first, the shore end, then the thinner ocean cable, but not without incident. It broke at 4 miles, then on the fourth day at 300 miles and in water of 2000 fathoms, which was too deep to grapple. They decided that it would be too risky to recommence with the length of cable remaining so returned to Keyham, Plymouth, where the precious cable was stored over winter in the open whilst Glass Elliot manufactured a further 900 miles (reverting to the original right hand lay to match the lost section). The new section was made to the new 85% conductivity standard specified by Thomson, who had also meanwhile devised his mirror galvanometer. Improved paying-out gear including a dynamometer was also devised as that had been the source of many of the problems.

Thomson's mirror galvanometer was a tangent galvanometer produced in two forms. Both used vertically-mounted coils of many turns, usually in two sections, between which was suspended a small magnet, made of watch spring, cemented to a small, very thin mirror (see *How do they work: Part 1* BVWS Bulletin Vol 38, No. 3 Autumn 2013). In the

Fig. 17: Portpatrick cable station for Donaghadee and Whitehead

Fig. 19: Portpatrick four channel cable emerging from the sea

Fig. 18: Exposed cable, diamond cable marker & cable station

Fig. 20a: Portpatrick four channel cable emerging from beach (presumably same cable as Fig. 19)

Fig. 20b: Reconstructed section of Fig. 20a 38mm dia

Fig. 21: Donaghadee cable station under renovation and diamond cable marker

Fig. 23: Alcock & Brown landing site

Fig. 22: Whitehead landing of optic fibre cable

Fig. 24: Marconi transatlantic transmitter site of 1907-1922

terrestrial version (Fig. 10) the suspension was usually one or more filaments of silk with a restoring and centring torque provided by a rotatable magnet situated above or below the mirror/magnet assembly. The horizontal angle of the magnet determines the zero position which should be set with the moving magnet across the coil so that when current passes through, it tends to rotate the magnet one way or the other, deflecting a beam of light onto a scale. The height of the adjusting magnet can also be set to alter the sensitivity and the natural period of oscillation (Thomson later introduced 'astatic' laboratory versions of the galvanometer, with much greater sensitivity, where the effect of the earth's magnetic field (neglected in the discussion above) is almost cancelled by an oppositely-magnetised needle mounted outside the coil on the same suspension).

The second form of mirror galvanometer is the marine version (Fig. 11) which uses a taut platinum suspension above and below the magnet and mirror, which is also carefully balanced mechanically so as not to deflect as the ship rolls. In this the main restoring force is provided by the suspension. These devices were made for Thomson by the instrument maker, James White, of Glasgow. Later versions were made by a number of other companies including Elliott Bros, Nalder Bros, Muirhead, Siemens, and Yeates & Son. Marine versions were usually shielded by a heavy iron case to reduce the influence of the earth's and ship's magnetism (Fig. 12). In those days the light reflected by the mirror had, of course, to be that of an oil lamp, leading Clerk Maxwell to pen the following parody on Tennyson:

The lamp-light falls on blackened walls,
And streams through narrow perforations;
The long beam trails o'er
pasteboard scales,
With slow decaying oscillations.
Flow, current! flow! set the
quick light spot flying!
Flow, current! answer, light spot!
flashing, quivering, dying.

Thus armed, and now with the agreement of the directors to get the laying operation completed in the shortest time, by starting in the middle of the Atlantic, *Agamemnon*

Fig. 25: Commemorative plaque on Clifden site

Fig. 26: Whitestrand, Ballycarberry, looking across to Valentia Island

Fig. 27: Reconstructed cable section from Knightstown harbour with five sector conductors. 37mm dia.

Fig. 28: Knightstown telegraph station

Fig. 29a: Bringing the 1865 cable ashore at Foilhummerum Bay

Fig. 29b: Same view in 1997

and *Niagara* set sail from Plymouth on 10th June 1858 in glorious calm weather giving rise to some fear that too much coal would be needed. However, by that evening a storm had blown up which over the next ten days proved to be the worst in living memory, causing coal to break loose and be flung around the decks, the cable load to shift and all aboard to be in fear of their lives. On three occasions after rendezvous, the special splice was made, but the cable broke, the third time after each had paid out over 100 miles. Failing to meet the *Niagara* after this, *Agamemnon* then returned to Queenstown (Cork) but after a special meeting of the Company, returned to mid-ocean.

This time success was achieved and on the 5th Aug 1858 the *Agamemnon* landed the shore end in Knightstown harbour and on the following day the Old and New Worlds were in direct contact for the first time. Messages passed between Mr Field and the New York Press, to the President and to the Mayor of New York, and later Queen Victoria and President Buchanan exchanged messages. Celebrations, banquets and rejoicings followed, and Bright became 'Sir Charles'. All was not well, however, messages were taking much longer to transmit than anticipated, Mr Whitehouse would let no-one else near the Valentia end of the cable. He was keen to use his own patented telegraphic equipment, not that of Prof Thomson, and it has been suggested that an assistant secretly used the latter to receive the message and then relayed it via his own instrument. He used enormous induction coils at voltages up to 2kV to send but, even so, the signals became weaker and weaker. Eventually, after about three weeks, the cable became unusable and no form of transmitter or receiver gave any cause for hope. As the fault appeared at about 300 miles from shore the large transient impulse would have been greatly attenuated at this point and was probably not the cause of the breakdown. As electrician, Whitehouse had been expected to sail on both expeditions but after making excuses his place, but not his official authority, had been taken by Thomson.

Soon after this, a similar venture to link with India failed in the Red Sea and a Joint Committee of Enquiry was set up to investigate the failures. This reported in 1861 and identified many failures in the design, manufacture, testing, handling, and storage of the cables and this report formed the bedrock of future electrical engineering practice. In particular, future cables were always to be stored under water to protect the gutta percha. Although 'Wildman' Whitehouse was allocated the chief blame at the time, and was dismissed for going against specific instructions of the Company, later investigation places greater emphasis on unsuitable storage and handling of the cable. The cable had, however, also vindicated itself in a convincing way: troops had been ordered from Canada to help in the Indian mutiny but when this was crushed, a telegraphic message had saved the government a significant proportion of the cost of the cable. Moreover, many less ambitious projects were being completed and were reaping rewards from investment. Yet with so much money poured into the Atlantic cable it took time for confidence to return and the American Civil War provided further delay.

Second Atlantic cable venture

In 1861, Newells dropped out of cable making whilst WT Henley were forging ahead, and in 1864, Glass Elliot and the Gutta Percha Companies combined under the chairmanship of John Pender to form The Telegraph Construction and Maintenace Co Ltd (Telcon). Daniel Gooch joined the Board with an investment of £20,000 but as a former director for Brunel's financially failing ship, *The Great Eastern*, he was able to buy it for £25,000 which he promptly chartered to the new company for £50,000 worth of shares. This had cost £650,000 to build and was the only ship large enough to lay the newly designed, and considerably more bulky, cable in one length. Furthermore with both paddle and screw propulsion it was very manoeuvrable. Cyrus Field was still having difficulty in getting enough capital for the Atlantic Cable Co, but this was finally overcome by getting Telcon (the two companies shared several directors) to agree to accept payment in weekly instalments with half payment in shares.

The new cable used a seven strand conductor of 18 BWG and conductivity greater than 85% of pure copper, with Chatterton's compound to fill the interstices, and between each of the four coatings of gutta percha. The core was covered with tanned jute then wrapped with ten homogeneous iron wires of 13 BWG each wrapped in manila hemp soaked in tar, india rubber, and pitch (Fig. 13). Fig. 14 shows a display stand made for a recovered section of this cable. This gave a cable with braking strength sufficient to support 13 miles of itself in water, against the 5 miles of the 1857/8 cable. The shore ends were further armoured (by WT Henley) with hemp then 12 strands of 3 x 2 BWG iron wire and joined to the ocean cable by a 25 fathom taper section.

Eventually, after similar civic celebrations, the *Caroline* laid the shore sections into Foilhummerin Bay, SW Valentia Island, *The Great Eastern* captained by Anderson set sail on 23rd July 1865. M de Sauty was the Telcon electrician in charge of laying, whilst Thomson and SA Varley (brother of the more famous CF Varley and the younger O and FH Varleys) were electricians representing the Atlantic Telegraph Co. Thomson, a keen sailor, plotted a chart of the 1865 and 1866 layings (Fig. 15).

After only 84 miles a fault was found, which proved to be a piece of iron wire forced through the insulation. A similar fault was found at 700 miles and sabotage was suspected. This led to a watch being put on the men but ultimately it proved to be due to brittle sections of the armouring wire. A greater tragedy happened after 1186 miles where a fault in the paying out gear snapped the cable and the end was lost in 2000 fathoms of water. Although attempts to grapple it almost succeeded, they were unable to bring it to the surface before the grappling cable broke under the strain. Thus the attempt had to be abandoned with only two thirds of the distance spanned.

The Atlantic Telegraph Co became the Anglo American Telegraph Co. New grappling cable was designed in which galvanised iron wires of 12 BWG were individually wrapped in hemp, stranded in sevens, then seven of these stranded again into a cable of $1^7/_8$" diameter, capable of lifting 30 tons (Fig. 16). Interestingly this form of cable is considerably more than 49 times stronger than a single strand because the points of weakness in individual strands are distributed. It was also decided to manufacture a second complete length of telegraph cable in addition to that required for completion of the 1865 cable so that two channels would be available. The only change from the first design was to use softer iron armouring with galvanisation to protect it rather than the tar and bitumen impregnation of the manila wrapping. Ultimately this tan coloured cable proved less durable because the manila rotted.

This time, starting on the 13th July 1866, the new cable was laid without drama in fourteen days, and Europe and America were in contact for a second time. *The Great Eastern*, together with the *Medway* and *Albany*, then set out from Newfoundland to grapple the 1865 cable. After a number of attempts and failures success was finally achieved and the 1865 cable completed. As a demonstration of the integrity of the cables and the sensitivity of the Thomson galvanometer, Latimer Clark got Newfoundland to join the two cables, borrowed a silver thimble from the daughter of the Knight of Kerry, into which he put sulphuric acid and a small piece of zinc to form an electric cell. With this connected to one cable, a deflection of 12 inches was observed from the galvanometer connected to the other. More importantly, it was soon found that 8 words per minute could be sent through each cable, which with experience, was ultimately increased to 17 wpm. For this achievement six 'Cable Knights' were created by Queen Victoria: Sirs D Gooch, CM Lamson, S Canning, R Glass, W Thomson & J Anderson.

Atlantic competition

To complete the Atlantic picture in the 19th century, further cables were laid in 1869, a French cable, with British backing, again laid by *The Great Eastern*, direct to Brest, but absorbed into the 'Pool' in the same year, others in 1873 & 1874, 1875 being Siemens' first cable - for the rival, but English, Direct US Telegraph Co from Ballinskelligs direct to the US coast, joining the Pool in 1877. In 1880 & 1881/2 the infamous operator, Jay Gould got Siemens to lay two cables to Sennen Cove, Cornwall, and through influence on Western Union at the American end, forced his way into the Pool and gained considerable control. The end result being that in 1911, Western Union were able to take over all the Atlantic traffic (excepting the CCC), although not ownership of the cables. In 1884/5 two cables were laid into Waterville for the Commercial Cable Co of Gordon Bennett and JW Mackay (American but partly financed as well as built and laid by Siemens), and finally in 1887 & 1894 two fast 'jumbo' cables - the Anglo into Valentia, the CCC into Waterville. Meanwhile the 1865 and 1866 cables had lasted until 1877 and 1874 respectively, before they became uneconomic to repair, although their shore end sections were reused. The omission of tar and pitch had proved a mistake in the 1866 cable as the manila rotted and allowed the core to escape through the gaps in the armouring.

Competition brought down prices (initially £20 for 20 words, but reduced to 4/- (20p) per word by 1872). The DUS, with fewer manual relays, was faster, bringing the price down to 2/- per word in 1880, but whenever DUS encountered a fault, Anglo would raise it's tariff. With the introduction of CCC in 1884, they reduced prices further, and Anglo replied with the uneconomic rate of 6d in an attempt to force them out. Agreement was soon reached with a uniform rate of 1/-. The press did, however, get a special rate and Reuters resold some of their allocation for private use. Users also resorted to various tactics such as concatenating words and the use of codes where a book in which commonly used phrases and sentences were each represented by a single word. Restrictions were placed on the maximum number of letters in a word and the languages that were allowed. Any deviation from normal English usage slowed the operators who relied on redundancy to read faster than the rate at which individual letters could be properly resolved.

An Irish holiday

In 1997 when the political tension had eased we took a holiday in Ireland with several objectives: family history - my grandfather, great and great great grandfathers had been born in N Ireland; we wanted to retrace a tour which my great great aunt had undertaken in 1830 (before the potato famine); to see the induction coils which the priest and scientist Nicholas Callan had made at St Patrick's College, Maynooth; to see Marconi's transmitter site and that of Alcock & Brown's landing near Clifden: and finally to investigate the cable landing sites from England, Scotland and America.

Before we crossed from Stranraer we visited Portpatrick and found the cable hut (Fig. 17), the yellow diamond shaped warning to shipping of the cable, and an exposed section of cable (Fig. 18). Two sections of four-core cable were also found, one with the four gutta percha covered conductors rising directly out of the water (Fig. 19) and the other further up the beach (Fig. 20a). The end of the latter was cut off and reconstructed with string replacing the original decomposed hemp or manila (Fig. 20b). These appeared to be part of the same cable and different from the more heavily armoured section in Fig. 18 which was left intact. It is not known when these cables were laid, but the first ones to Donaghadee and Whitehead of 1853 and 1854 were both six-core cables.

Over at Donaghadee we found the diamond cable marker and the cable station under renovation, but no sign of any cable (Fig. 21). At Whitehead we found 'Cable Road' leading down to the beach and on enquiry a local man said he remembered 'the cable' being laid. We thanked him politely and with typical Irish hospitality (for both north and south) he reappeared having found a photograph of it, clearly not the one that I had had in mind but at this time almost certainly an optic cable following much the same route (Fig. 22).

On the west coast near Clifden we found the site of Alcock & Brown transatlantic landing (Fig.23) on 15 June 1919 within

Fig. 30: Ballinskelligs Bay and Waterville

Marconi's transmitting station compound (Fig. 24) allowing immediate news of the event to be sent to London and the USA. A plaque commemorating this station (Fig. 25) had been unveiled by Marconi's daughter, Princess Ellettra Marconi Giovanelli, whom I saw, with her son, at the IEE '*100 Years of Radio*' conference in 1995 (Conf Publication No. 411).

Further south in Kerry we found White Strand, Ballycarberry Bay (Fig. 26), where the cable had been landed from the *Niagara* in 1857, and presumably where the later cables terminating on Valencia Island were linked to the mainland, but found no trace of cable. In Knightstown harbour we found a 2-core cable, probably the shore end of a much later Atlantic cable. The second conductor may have been for a sea earth, taken some distance out to sea, to avoid the electrical ground interference near the coast. It has an interesting construction (Fig. 27) with a single solid 2.3mm copper core wrapped by four copper strips bringing it up to 2.9mm, and armoured with 14 iron wires rusted to about 7mm. Fig. 28 shows the large transatlantic cable station in Knightstown.

At the west end of the island we found Foilhummerum Bay where the 1865 and 1866 cables had been landed by the *Caroline* from the *Great Eastern* (Figs. 29a&b) but no trace of any cable. Further south we skirted Ballinskelligs Bay and Waterville (Fig. 30) where the 1875 DUSTC and 1894 CCC and other cables had been landed but again no relics were found.

The final electrical part of the holiday was to St Patrick's College, Maynooth, a Catholic Seminary about 15 miles west of Dublin where Rev Prof Nicholas Callan (1799-1864) had invented the induction coil in 1836 seventeen years before Ruhmkorff. Fig. 31 shows one of his coils from 1845 producing 15' sparks.

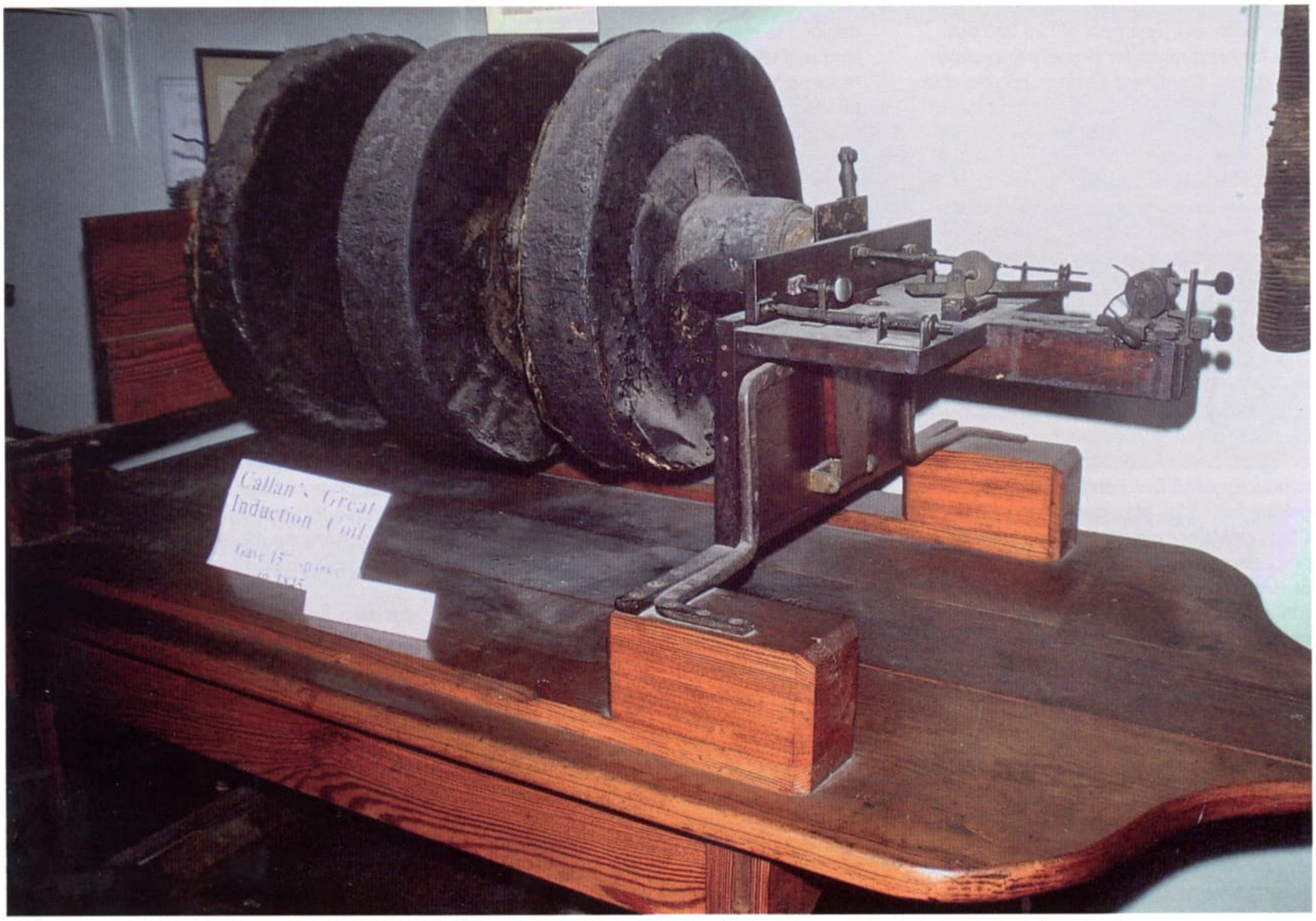


Fig. 31: Rev Prof Nicholas Callan's induction coil of 1845 on display at Maynooth

Harpenden, 6th March photographed by Carl Glover

An Alba 472 with an identity crisis by Stef Niewiadomski

I came across this neat three band radio on the bring-and-buy stall at Harpenden in September 2015. It appealed to me because of its semi-midget size, a wooden cabinet in reasonable condition and its bright semi-circular dial. The dial cord was intact, and the pointer moved freely over the dial. From the front the Aerodyne name was prominent on the dial (see Figure 1 for the pre-restoration view), but after removing the back panel (which had a permanently attached throw-out aerial coiled up on it), I could see that the chassis was labelled 'Alba 472', so its exact identity was in doubt at the time.

Figure 1: Pre-restoration view of my tired looking Aerodyne-branded (at least from the front) radio. The dial markings look out of focus, but this is because of the thick layer of dust on the inside of the dial glass.

Once I'd got the radio home, I could investigate its parentage in more detail. Looking at the pictures on the Swiss Radiomuseum website and in Jonathan Hill's *Radio! Radio!*, A J Balcombe Ltd's Alba 472 and the Aerodyne 302 cabinets are of similar size, and the positioning of the control knobs, tuning dials and speaker grilles hint at the same chassis being used for the two radios. However the Alba version should have the name 'Alba', and the Aerodyne should have 'Aerodyne', printed on its dial. Also the Aerodyne dial should have a single dial bulb, more-or-less centrally located (as on my radio), whereas, according to its service sheet, the Alba radio should have two dial lights mounted further back on the chassis, illuminating a translucent dial from behind. So a clearly labelled Alba 472 chassis (like mine, see Figure 2) should not have an Aerodyne-branded dial with its single bulb.

Aerodyne went bankrupt in 1938 and A J Balcombe acquired what was left of the company, including the brand name. Over the history of the radio industry in the UK (and no doubt in other countries), this has been a fairly common occurrence: brands have value, and the Aerodyne name was perpetuated for many years, no doubt preventing many loyal customers from straying from the brand, perhaps not even realising that the ownership had changed. Alba itself is a good example: the Alba brand still survives today, now being used by Argos on its range of low cost TVs, and FM and DAB radios. Argos also sees value in still keeping alive the well-known Bush brand on TVs, radios, mobile phones, and various domestic appliances.

For an interesting history of the Alba company, see '*The Alba Story*' by Jeremy Balcombe, published in the Spring 2007 issue of the BVWS Bulletin. Tony Thompson authored an evocative article on the trials and tribulations of Aerodyne in 'Aeromagic – The Rise and Fall of Aerodyne' in the August / September 2012 issue of Radio Bygones.

So it would seem that my radio is an Alba 472 chassis, modified to supply the single lamp on the Aerodyne dial with which it was fitted. The truth of how this happened may never be revealed, but it could be that when the A J Balcombe factory was wringing out the last few examples towards the end of the production run, they used up an Alba chassis and an Aerodyne dial, making the necessary modification to accommodate the single dial bulb. Much manufacturing sub-contracting took place, and it could be that the chassis and/or the assembled radio were made by a third party.

The Aerodyne-branded model 302 was the first of the two to hit the shops, in December 1945, at a price of £13, plus purchase tax. The Alba 472 followed exactly one year later, at a price of £14 plus purchase tax, by which time the model 302 had risen to a base price of £13 13s.

Schematic

The schematic of the Alba 472, taken from Electrical and Radio Trading, is shown in Figure 3. The radio is a conventional three band (medium, long and short wave – 16m to 50m) superhet with a CCH35 triode hexode forming the frequency changer stage, followed by a variable-μ EF39 IF amplifier at 460kHz. An EBC33 forms the audio and AGC detector / audio amplifier stages; a CL33 is the audio output stage; and finally a 1D5 forms the half-wave mains rectifier. All the valve heaters are rated at 200mA and are connected in series. This valve line-up was used in several other Alba and Aerodyne chassis: for example the October 1946 Alba 474 was a slightly 'upmarket', radio having a tone control, and sockets to enable an external speaker to be connected.

The radio was designed to be used from

Figure 2: Rear chassis view before restoration, clearly showing the Alba model 472 identity of the radio. The rolled-up throw-out aerial can be seen emanating from the left side of the chassis.

200V-240V or 100V-120V AC mains, or 100V or 200V DC mains. In the case of the higher mains voltage, the full mains line cord resistance of 700Ω was used; in the lower mains voltage case, this was reduced to 100Ω, via the voltage adjustment panel on the rear of the chassis, to supply the valves with the correct heater voltage. The CCH35 runs with 7V across its heater; the CL33 needs 35V; and the 1D5 needs 40V. Along with the two valves with 6.3V heaters, this adds up to about 96V. To produce 96V for the heater chain from 115V, 19V needs to be dropped at 200mA. Ohm's Law gives us 95Ω (say 100Ω to give a standard value), with a dissipation of I^2R = 4W.

The design was capable of running with an HT of about 230V (at which its various voltages and currents were measured for inclusion in its service sheet), or at the reduced HT voltage of about 125V when run from 115V or so, and so this made it easy for me to choose to run the radio from a nominal 115V AC, meaning that I didn't need to include a resistive mains dropper cord.

The cabinet

I normally restore the chassis of a radio first, and then move onto the cabinet, but with this radio I decided to work on the cabinet first, just for a change. I removed the chassis from the cabinet by removing the knobs and unscrewing the four fixing screws in the base. I noted that the front-to-back wooden strip feet, which should have prevented any user coming into contact with the potentially live fixing screws, were missing. I removed a stapled-on cardboard ring around the speaker grille cloth and removed the glued-on grille cloth itself. The dial glass was intact and was removed by unscrewing four small fixing brackets, after which it was given a good wash. There are no markings on the glass, so there's no need to be careful when washing it, apart from not dropping it, of course.

My first impression was that the cabinet was in good condition, with no peeling of the veneer, woodworm, or rot. Some of the varnish was flaking off, and so I gave it a rub down with fine wire wool, which brought off the loose flakes. A closer look at the base revealed a few worm holes, tucked into one corner, and so I gave the whole cabinet a good dose of woodworm killer and left it to dry.

I removed most of the varnish with varnish and paint remover, and finished it with P150 sandpaper. The veneer was sufficiently thick and well enough attached to the plywood case that there was no lifting of the veneer as I worked over the surface. I filled the corner of the cabinet with the worm damage and smoothed off the filler once it was dry.

With all the varnish off, the cabinet looked a few shades lighter and the patterning of the walnut veneer was very attractive. At the front edges there were thin strips of ebony-like wood, and these helped in the overall appearance of the cabinet. I was debating which colour to stain the cabinet, light oak being my choice for a while, and then I decided not to apply any stain, but to simply apply a clear varnish and let the wood's natural colour shine through. I gave the cabinet two coats of clear varnish, and

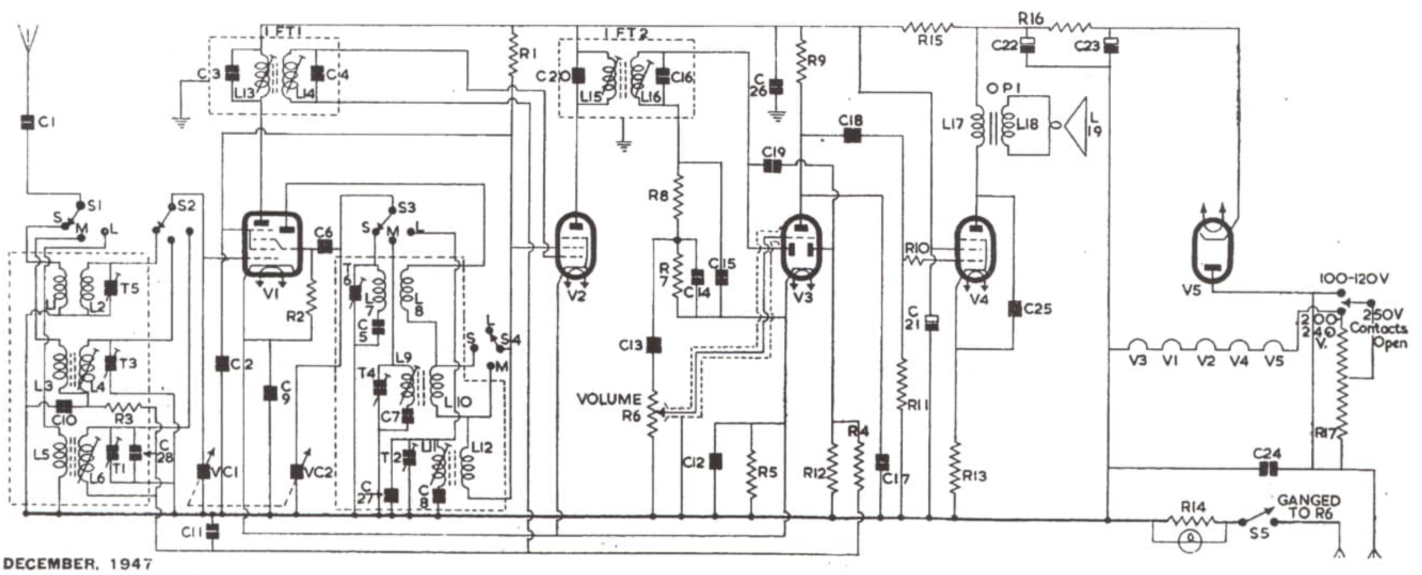


Figure 3: Schematic of the Alba 472 taken from the Electrical and Radio Trading service sheet.

Figure 4: The 'naked' cabinet after restoration.

Figure 5: Rear chassis view before restoration. The EF39 IF amplifier valve looks to be in rather bad condition, with heavy flaking of its red screening coating.

then polished it with furniture polish. The edges of the five speaker slots were touched up with brown paint to bring them back to original condition. I fitted four new rubber feet to lift the cabinet above table level, to allow air to circulate into the chassis from below. I was very pleased with the result. Figure 4 shows the cabinet after restoration and before the dial glass, speaker cloth and the chassis had been re-inserted.

The brown knobs aren't very interesting, and if anything they let the side down, but at least they are original. They just needed a wash and a polish to bring them up to the standard of the restored cabinet.

The back panel was in good condition, and only needed a small portion of the board adjacent to the hole for the mains lead to be re-attached.

Restoring the chassis

The chassis was in reasonable condition with no evidence of a previous restoration, see Figure 5. It was fitted with a full set of valves, which looked like the originals. To give me better access to the top of the chassis I removed the valves, all of which were Mullard octals, except the 1D5, which was a rather antique-looking 1935-vintage B5-based example made by Brimar. The shielded top clip of the EBC33 was tricky to remove: because of the shielding you can't ease open the clip if it's a little tight or has some corrosion which tends to stick it to the top cap of the valve, which often happens. All you can do is to gently twist and pull it, and hope that the clip comes off without bringing the valve's top cap with it. I applied gentle pressure to the clip, and happily it eventually came away without damaging the top cap. I cleaned all the pins on the valves, some of which showed signs of corrosion, as did the top caps of the three valves fitted with these connections.

The heaters of all the valves checked out OK for continuity. The red coating on the EF39 had mostly flaked off, taking off the valve's identity and its Mullard branding. There was a little rusting on the plated steel of the chassis and I rubbed this down and treated it with Kurust. I find that this liquid does a good job at stabilising steel against future rusting, but tends to dry to a strong blue colour, which I always tone down a little with further gentle rubbing down.

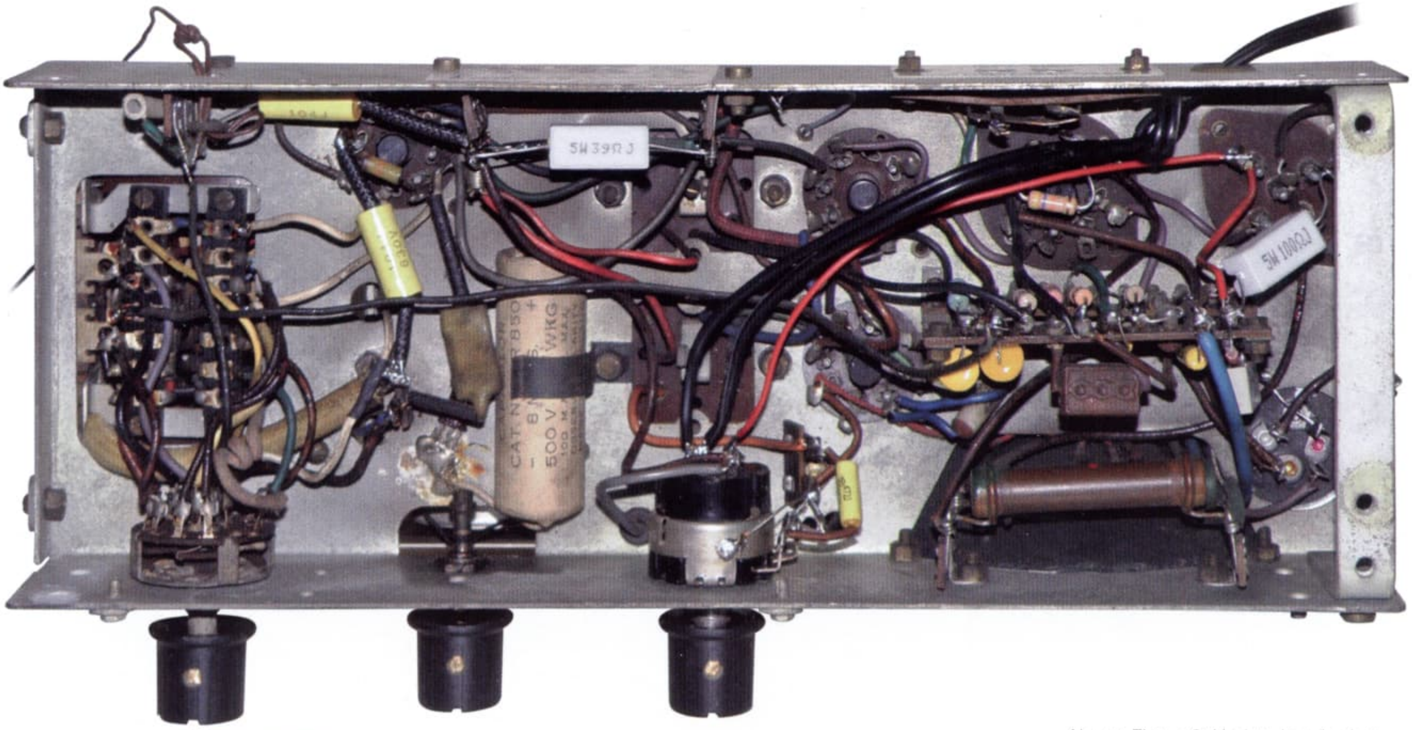
The dial bulb, mounted in a holder clipped onto a bracket riveted to the tuning capacitor, was blown, and so I changed it for a new 3.5V 0.3A bulb.

The primary of the output transformer measured 296Ω, but I couldn't get to its secondary connection to the speaker coil, which was hidden inside the cotton bag around the speaker assembly. I didn't want to remove the bag as they are often very delicate and fall apart if disturbed. So I dabbed a few volts via a 1kΩ resistor across the transformer's primary tags and could hear crackles from the 5-inch diameter speaker, indicating that the transformer's secondary and the speaker coil were intact, although this method doesn't give much indication of the integrity of the speaker cone itself.

After unscrewing the front-to-back chassis strengthening bracket to give me better access, I removed the 8μF + 16μF power supply electrolytic and measured its capacitance. Both sections gave very low capacitance readings, and after attempts to reform the component, the capacitance stayed stubbornly low and the leakage current high. I therefore changed it for a can in better electrical condition. By courtesy of Mike Barker, I had a Plessey 16μF + 16μF + 16μF electrolytic, dated December 1964, of about the same physical size, and so I fitted this, using the third 16μF section to replace C21, the final HT smoothing capacitor, the body of which I left in place under the chassis as it's an attractive feature. The 1D5 rectifier is spec'd for a maximum reservoir capacitor of 16μF, so using this value, rather than the original 8μF, was safe to do.

To fix any current, and to avoid any future, problems, I replaced all the normal suspect waxed paper capacitors with yellow polyester ones. If any future owner of the radio doesn't like this, they can replace all my obvious replacements with re-stuffed originals. The mains RF filtering capacitor, C24, was replaced with a new 47nF class X2 275V AC metallised polyester capacitor.

R15 (nominally 1.5kΩ) and R16 (560Ω) are prominent 2W dog bone style resistors under the chassis. I was pleased that they were both still in good condition and close to their original values, and so they were left alone. R14 (40Ω), connected between the neutral lead to the radio and



Above: Figure 6: Under chassis view after restoration. The coil assembly and waveband switch, later removed, can be seen to the left of the chassis.

Left: Figure 7: Rear of the chassis after restoration. The EF39 IF amplifier valve is the original, wrapped in grounded aluminium foil to restore its screening.

Below, left: Figure 8: The adjustment side of the coil pack: you can see the coil adjusters and trimmer capacitors.

Below: Figure 9: The coil side of the tuning coil and capacitor assembly, removed from the chassis. The six aerial and oscillator coils, along with a number of capacitors can be seen. Next to the wavechange switch is what looks like a yellow-insulated cable: this is a thick copper braid to connect the sub-assembly metalwork to the chassis of the radio.

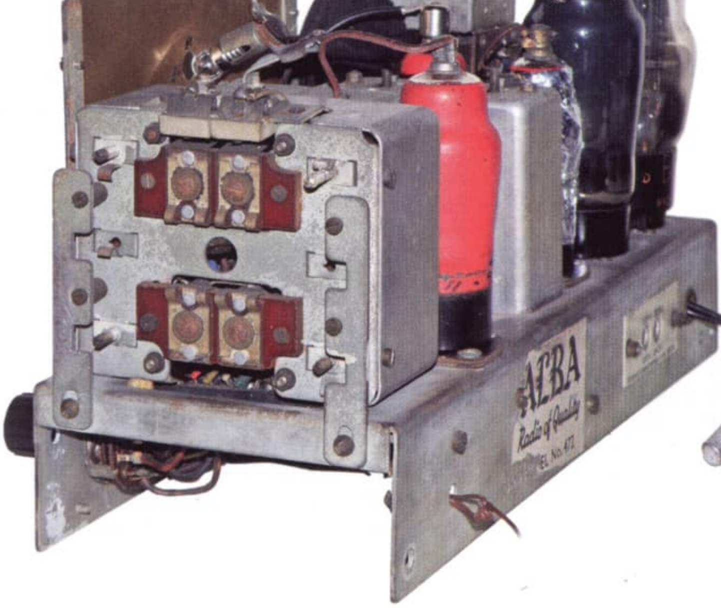


Figure 10: Restored condition of my Alba 472 with an Aerodyne dial. The knobs are original, though I think they let the side down slightly now that the cabinet colour has been lightened.

the chassis, and across which the dial lamp was connected, had not fared so well. Its ceramic body was broken and its resistance wire was open circuit. I changed it for a 39Ω 5W ceramic resistor. Most of the other resistors were within 20% of their nominal values: only two were out of spec and needed to be changed.

The resistance of the 1MΩ volume control checked out OK, but the single pole on/off switch was open circuit, and so I changed the assembly for the closest value I had to hand - a 2MΩ potentiometer - with a working double-pole switch.

The screened cable from the wiper of the volume control to the top cap grid of the EBC33 was perished, and after my fiddling around with the volume control its signal-carrying inner was shorted to the grounded outer screen. I replaced this cable, and attached a non-screened top clip, to make removal easier in the future. I was alert for any possible hum that might be induced, but this proved to be unfounded.

I fitted a two pin US-style plug and two-core mains cable, and soldered the mains live and neutral to the two-pole switch on the new volume control, removing any connections to the voltage selector panel. The live connection from the switch was connected to the anode of the 1D5 rectifier and the heater chain (starting with the 1D5's heater) via a 100Ω 5W ceramic resistor. This would ensure the correct voltage to supply 200mA through the heater chain. The neutral connection from the on/off switch was connected to the replacement R14, the other end of which is connected to the chassis. A lead for the dial bulb was already connected to the neutral side of R14, and the bulb picks up its other connection via its mounting clip which returns its current to the chassis. To remind future owners of the modification I had done to the radio, I added a label to the rear of the chassis indicating the radio's new working voltage and the fact that it was a live chassis design. Figure 6 shows the underneath of the chassis after restoration.

Switch on

I refitted all the original valves, except for using a replacement EF39 for the original which had lost all its red coating and which I thought could well cause instability, and a temporary set of knobs. After checking carefully that I had the 115V mains connection the right way round, I extended the coiled-up aerial – I measured it at about 25 feet - and switched the radio on. The dial lamp lit up brightly and then settled down to a more reasonable brightness level. After a warm up time of 20 seconds or so, I was greeted with a loud hum from the speaker, which couldn't be turned down using the volume control. Tuning around the bands I thought I could hear some heavily-distorted stations.

My first (and last, as it turned out) place to look for the problem was in the power supply area: after some searching around, I found that although I had passed the wire from the chassis to the negative side of the HT smoothing capacitors through the correct tag, I had failed to solder it in place. The result was that the radio was being fed with rectified, unsmoothed HT, hence the excessive hum and distortion. I suppose I had been lucky in that my error showed itself as a 'hard' fault, rather than as an intermittent, and it was quickly fixed. It gave me an idea of how radios could 'escape' from the factory with faults on them, only to show themselves intermittently at a later date and drive repair men mad trying to track them down.

Plugging in again and switching on, the radio now came to life on all three bands, much to my relief. The hum and distortion had gone away. I thought I'd try the original EF39, and as expected it resulted in instability on all bands, resulting in many whistles and motor-boating sounds. I thought I'd try to fix the valve, rather than simply throw it away. To fix the valve I wrapped a couple of layers of kitchen foil around the glass envelope, then wound three turns of bare tinned wire over the foil and soldered the ends of the wire together. Then I passed its free end through the hole in the centre of the rivet holding the valve socket in place, and soldered it to a tag on the chassis. I switched the radio on, and all the instability was gone, so a good repair! Figure 7 shows the rear of the chassis fitted with the 'wrapped' EF39 next to the IF transformer.

I measured the HT voltages, which

I thought would be a useful record to keep in case of problems in future. At the cathode of the rectifier, the voltage was 125V, which is what you would expect for a 115V-ish AC supply; at the junction of R15 and R16, the voltage was 111V; and at the other end of R15, it was 94V. Since all the HT current flows through R16 (measured at 475Ω), the voltage drop across this resistor of 14V indicates a total HT current of about 30mA, maybe a little lower than I would have expected.

The voltage across the heater chain measured at 94.2V, with about 2V dropped across the 39Ω resistor, R14. Once all the valves have warmed up, this is, of course, the voltage across the dial bulb. I guess this explains why the 3.5V bulb I used was rather dim: the choice of the voltage rating for this bulb is a tricky balancing act of not having it blow during the switch on and warm up period, and the final brightness it glows. In my opinion, the bulb doesn't really light up the dial, it acts more as an on/off indicator.

AGC tests

The radio now pulled in a fair number of stations with good audio quality, but produced a prominent hiss between stations on the long and medium waves, but not on the short waves. When tuned to a strong broadcast, the hiss could not be heard. My first check was to see what was different in the way the radio operated on the short waves, compared to the other two bands. If you look on the schematic at the switching of the secondaries of the aerial coils, the bottom end of L2 (the short wave coil) is connected to chassis, whereas L4 and L6 (the medium and long wave coil secondaries respectively) conduct the AGC voltage to the grid of V1. Therefore V1 is only AGC-controlled when the radio is switched to the medium or long wave. I suspected that if there was something wrong with the AGC mechanism – perhaps resulting in one of the AGC-controlled valves operating at an incorrect gain level - it would only show itself on these bands. So I thought I'd pay particular attention to the components involved in the AGC circuit, in the hope that this would eliminate the noticeable hiss level between stations.

I've often complained in the past (to myself, at least) when radio manufacturers use 'no connect' pins on valves, and various three-dimensional constructions to join together the inevitable mass of components and connections around the AGC area of a radio. In theory, the designers of this radio have been tidier with their implementation, and used a tag strip for most of these components, but they chose to stand the tag strip on end and make it almost impossible to measure any of the resistor values, and even harder to change one should it prove to be faulty. I removed the two 6BA screws and nuts that held the tag strip, and this allowed me to manoeuvre it into a position where resistors R4, R5, R9, R11 and R12 were more accessible for measurement. Most of them were out of spec, and so I changed them all because of the difficulty of reaching them once I had re-fixed the tag strip.

Coil pack

The radio has a prominent coil pack, mounted above the chassis: Figure 8 shows the adjustment side of the coil pack, and you can see the coil adjusters and trimmer capacitors. I wanted to remove the coil pack so that I could then remove its cover and get at R3 to check its value versus nominal (680Ω), and change the paper capacitor C10, nominally 0.005µF. These two components form part of the AGC circuit when the radio is switched to the medium wave, and so it's good to be sure that they are close to their original values.

All the aerial and oscillator coils and trimmers are mounted inside this box, but the wavechange switch is external to the box. The switch connections, along with the other connections into the radio, are made via 14 leads on two tag strips. By thoughtful design, the wavechange switch will pass through the hole in the chassis into which the coil pack is mounted, and so only five signal connections, plus a hefty grounding braid, need to be unsoldered, to allow the coil pack complete with the switch on flying leads, to be removed. Figure 9 shows the inside of the coil pack after I'd changed R3 (which measured rather high, at 800Ω) and paper capacitor C10, just to be on the safe side since I had the assembly apart. I then put the cover back onto the pack, remounted it and the switch onto the chassis and remade the connections.

The chassis-mounted tuning spindle was greasy and had picked up a lot of dust over the years, and so I gave it a clean and a gentle oiling, being careful to avoid getting oil onto the dial cord. After rotating the spindle a few times, the drive cord broke, which I find often happens when the cord has become brittle after many years of not being used. On the positive side, at least it broke now, and not when I had put the chassis back into the cabinet. After removing the dial and pointer, restringing the drive cord was very simple, as the spindle is mounted directly under the tuning capacitor, and no intermediate pulleys are involved.

Switching the radio on again produced much better results, with the hiss level much reduced. I concluded that as some (or all) of the AGC components had drifted away from their original values, the gain distribution in the radio had produced this high inter-station hiss level. I was happy now that, working from its throw-out aerial, the radio was as good as it could get. When I connected my workshop's long wire aerial to the far end of the throw out aerial, reception improved even more. I was of course operating my radio at a much lower HT voltage than it would receive if run from the 230V mains, and so perhaps this affected its sensitivity, and produced the hiss between stations.

Reassembly

The three colour printed brass dial was in good condition, and just needed a wipe over, being careful not to remove any markings, before being re-attached to the chassis. As you often find with radio dials, 'Cellgrave' was printed in one corner, invisible when the chassis was mounted into the cabinet. I've always assumed that this was the name of a company who specialised in making dials – perhaps there's a history waiting to be written?

The red pointer simply pushes onto the tuning capacitor's shaft through the dial, at the correct position to indicate stations at the right place on the dial. I found that positioning the pointer correctly for a known wavelength at about the middle the medium wave, gave me spot-on calibration on all three bands, without any adjustment. The IF transformers were also still peaked at very close to 460kHz, indicating very little drift since the radio was built and thankfully no fiddling by anyone during this period.

The cleaned dial glass was re-attached to the cabinet, as was the speaker cloth and its cardboard surround. The chassis could now be slid back into the cabinet and attached via its four fixing screws, and the knobs re-fixed. Because the cabinet's feet were missing, I covered the exposed chassis fixing screws with insulation tape so that they could not be touched. Figure 10 shows the restored condition of the radio. The knobs are original, though I think they look rather dated even for the mid-1940s, and let the side down slightly.

Summary and conclusions

What looked initially like a straightforward Aerodyne radio turned out to be something slightly more complicated. A peer into the back revealed an Alba 472 chassis, fitted with an Aerodyne dial. By the time the radio was manufactured, the Aerodyne name was owned by A J Balcombe – the owner of the Alba brand – and the labelling of the chassis had become blurred, as long as the front panel showed the correct branding.

Although a fairly standard three-band superhet design, the radio was well designed and built, in this difficult immediate post-war period for the industry. At this time many manufacturers had difficulty in sourcing enough components to meet the high customer demand for the replacement of radios 'lost' in the war. The coil pack was particularly neat, and only needed six connections to be unsoldered for the pack and the wavechange switch to be removed from the chassis. A couple of AGC-related components were mounted inside the coil pack, hence the motivation for removing it to get access.

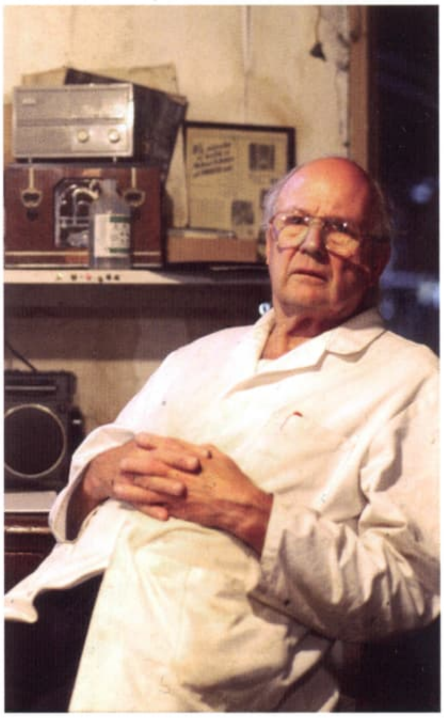
The radio's attractive mid-sized cabinet and dial made it a worthwhile restoration. Its multi-mains standard design made it easy to adapt for 115V AC mains, avoiding the need for the original mains dropper cord, which had long since disappeared. Its performance on the throw-out aerial was reasonable for local stations, which improved considerably when a longer aerial was clipped onto the end of the one provided.

An update from the British Vintage Wireless and Television Museum

by John Thompson

It has now been well over a year since Gerry Wells died. He is dearly missed by everyone at the Museum and not a day goes by without him being mentioned, normally bringing a smile to our faces remembering his cheeky comments or his mischievous looks. As well as remembering him we can look about us and appreciate his legacy. His life's work is spread over the house and the sheds. I know Gerry would appreciate all the support we have received; he was always humbled by people's generosity.

The Museum Committee. Back row – Richard Stow, John Sully, John Thompson, Dave Grant, John Wakely and Peter Sanders. Front Row – Kevin Lott, Eileen Laffey, Fred Watts and Mike Barker



Gerry Wells

My intention by putting pen to paper is to give an update on the latest position of the Museum and let people know our future plans and intentions and ensure there are no misunderstandings and that we are all doing our absolute best to protect the collection for present and future generations. To do this I will attempt to give a very brief history of the Museum. Most readers will be familiar with the details of how the Museum came about as many have seen it develop over the years.

After a career as a radio and television engineer Gerry saw the writing on the wall for the industry and in the 70's started to display his collection, collect more and specialise in vintage repairs. In Gerry's words 'if I can't move forward I will go backwards', Gerry did this with relish, collecting every radio and television he could get his hands on. Gerry soon began to fill the house and sheds with radios. When the space was full he built a shed, then another and another! Gerry established the Vintage Wireless Museum in 1974 as a must-see exhibition for anyone interested in vintage wireless.

In 2003 the British Vintage Wireless and Television Museum Trust was established, Gerry became its life president and four trustees were put in place to be legally responsible for the collection. To ensure the collection was safe for the future Gerry generously issued a 25 year lease, on a peppercorn rent, to give the collection a secure home. This lease covered the ground floor of the house and all the outbuildings. Shortly after this was instigated the British Vintage Wireless and Television Museum was granted charitable status. Gerry was very proud of this as it really gave the collection the recognition it deserved.

One of the first actions of the Trustees was to appoint a Chairman and a Committee. I accepted the chairmanship and set to appointing a Committee. The purpose was to assist running the Museum and support Gerry. The Committee was and is run on delegated authority from the Trustees. Some may remember one of the first projects the Committee undertook was to re-roof the extensive sheds. This was funded by an appeal to BVWS members and together with voluntary labour from friends of the museum, after a couple of months, the roofs were successfully restored.

The actions of the Committee are far too numerous to mention. I know Gerry appreciated its support. A 'Friends Group' was established, and at first we wondered if people would be interested. However, it soon grew, gaining friends throughout the world. The Museum 'Friends' now stands at approximately 200 members and is our single largest revenue stream.

It was a great time supporting Gerry but we all also knew we had a great burden of responsibility to plan for the inevitable future when Gerry was no longer about. As you can imagine this wasn't easy, so, as well as looking after the day to day operations we took the future planning seriously. As Gerry grew frailer the support he required got greater. Eileen cared for him personally as well as keeping the Museum open for visitors.

Sadly Gerry died in December 2014. It was a most dreadful time, and after a funeral for family and friends we turned the usual summer garden party into a memorial garden party which I know many BVWS members attended. Not only did we have the loss of Gerry to cope with but we also had to instigate our plan for the future. It was a very difficult time, but with support from friends we began to rebuild for the future.

I described earlier the legal framework and the governance arrangements. This required the collection which was located in the upstairs of the Museum being relocated downstairs. We explored thoroughly the option of extending the lease to encompass the upstairs but this wasn't legally or financially possible.

The new 1920s gallery, situated in the former transformer store in the garden of the British Vintage Wireless and Television Museum

The Quadrangle showing the two new galleries for displays

Unfortunately due to inheritance laws a large amount of inheritance tax needed to be found by Gerry's beneficiary. This wasn't a surprise but meant a lot of work to implement. Space was needed on the ground floor of the building and in the sheds to relocate some of the collection.

Many of you will have seen the splendid use of the two downstairs rooms in the house. New shelving has been installed and a lot of the collection moved down. We also, as a team, decided to thin out the collection a little. We applied strict curatorial criteria to our deliberations. You may have seen some of our surplus radios being auctioned or sold through table top sales. All these disposals were considered very carefully and we hope you agree the collection benefited.

We also turned our attention to the sheds. Some of the sheds contain what we called support areas which the Committee decided to develop. The woodwork shop and the transformer stores are now new galleries. All the contents of these areas have been sorted, this really was a momentous challenge but our band of volunteers did the difficult job of sorting, relocating or disposing. Everything was treated with respect and the whole process as part of a considered team approach. I hope you will agree the collection is now displayed beautifully.

There is still more work to be done and we have ambitious plans. In the short term some of the stores will be condensed further to create additional gallery space. After all what we are here for is to protect the collection.

Ekco sets are now displayed in the front room along with pre-war televisions

Another view of the front room

You will also be aware that as the Trust was established in 2003 we only have 12 years lease remaining. The Committee considered this may be a handicap when seeking funding and began to look at securing a longer term solution. We considered relocation, this proved to be prohibitive due to property values. We investigated merging with other museums; this would have meant that only a very small proportion of our collection would ever be on display. We have started negotiations with our current freeholder proposing that we be issued with another 25 year lease. This is currently looking very positive, it may mean relinquishing the lease on the ground floor of the house early, if we could secure a long lease on the sheds and part of the garden this really would give us a secure future. Obviously a lot of work is needed to make this plan viable but we have started slowly and steadily.

We are exploring the possibility of raising money to make this happen. The Committee have been discussing applying for funding through various agencies. It is early days but we hope help will be forthcoming. With this in mind we have joined the Association of independent Museums (AIM) and are in the process of seeking accreditation from Arts Council England. This is a lot of work but we think the collection is worthy of it.

I hope this has given an outline of our past and future - that just leaves the present. At a time of change it has been difficult to keep the Museum operational, at times it may have seemed chaotic but we managed it, all our events have carried on, our regular 'An Afternoon of Music' and Table Top Sales as well as visitors and tours. The museum is now open to the public every Friday and we have dedicated the last Friday of every month for our Friends Group members. The garden party will take place this year on 4th June. It is planned to be as big and enjoyable as ever. Our television curators, John Wakely and Peter Sanders, are planning a television event on 10th September to celebrate the 80th year of high definition television.

What can you do? We appreciate all your support, it has been marvellous, please make every effort to come and see

A former workshop converted into a gallery for wartime and post-war equipment, looking right from the entrance

us and spread the word that the British Vintage Wireless and Television Museum is very much open and staying open. We are looking to develop and expand Museum tours. If you are members of or know of any organisations who may wish to visit please put them in touch. We can entertain groups of up to about 20 and give visitors a very good half a day out. Please come along to the Garden Party on 4th June, it will be run on similar lines to previous years. It is always a good day, raffles, quizzes, table top sale plus great company and food. If you are not a member of our Friends Group or haven't renewed as yet please consider joining. At this time we really need our friends!

Our 'Afternoon of Music' with Tony Clayden and guest presenters is always very entertaining and informative. There are always plenty of bargains to be had at the table top sales. All the dates are listed below.

If you have any skills, which may help us, or wish to get involved with the Museum in any way, please get in touch we would love to hear from you. We are looking to improve our online presence, so we would particularly welcome help with electronic media. Gerry left us this wonderful legacy; you may wish to consider leaving us a helping hand after you have gone. It's hard to think about but financial help will make our future sustainable.

We all look forward to seeing you soon at the Museum and thank you for your support during this very difficult time.

A former workshop converted into a gallery for wartime and post-war equipment, looking left from the entrance

Museum Events 2016
Saturday 4th June
Garden Party 11am start. Tickets £15.00 in advance, all welcome.

Saturday 20th August
An Afternoon of Music and Museum Sale. Doors open 11am, Music 1pm, lunch during interval Entry £10.00

Saturday 10th September 2016
Television anniversary event - 10am entry, food and drink £10.00 entry. Celebrate 80 years of British high definition TV.

Sunday 18th September
Table Top Sale (£3.00 entry, stall holders £6.00) 10am entry to stall holders, 11am Sale open

Saturday 19th November
An Afternoon of Music and Museum Sale. Doors open 11am, Music 1pm, lunch during interval Entry £10.00

The GEC BC562 FM–only transistor portable

by Henry Irwin

The first UK FM transistor radios were announced in July and August 1960 and the GEC BC 562 was amongst that initial select group. Some of these radios were table models and only a few of them were portables but the GEC was unique on two counts. It was FM only and its design was unusual.

Before a transistor radio covering VHF Band 2 (87.5 to 101 MHz in 1960) could be brought to the marketplace, manufacturers had to be assured of a reliable supply of transistors that could operate at these frequencies as well as providing substantial gain at the high intermediate frequency of 10.7 MHz. Although several UK semiconductor firms, including GEC, were producing experimental devices, it was Philips/Mullard who first cornered the market in commercial quantities with their 0C 171/0C170 Post Alloy Diffused Base Transistors and practically all UK radio manufacturers designed their first FM radios around these devices or their AF114/ AF115 successors. In this respect the GEC BC562 was different, but more of that later.

Aesthetics and layout

The case consists of a sleeve of bent plywood with rounded ends which is covered in a biscuit coloured flecked "vynair" fabric. Top and bottom of this are thin bands of beige marble effect fabric and two strips of gold beading. I have seen comments on the internet vilifying this version of the radio and indeed, when the textured fabric is soiled, grubby or torn, it can be a sorry sight. There is an alternative version where most of the case is covered in wood effect vinyl with a rectangular grille. There is also a version for MW/LW, the BC 561, which uses the same basic case design. The chassis fits vertically into the sleeve and on top of this rests the fascia or control area which is an acrylic moulding reverse painted in a coffee colour with contrasting gold trim. At each end the large flat control knobs are a darker brown and match the raised switch area in the middle. Designed symmetrically it has two mirror image tuning windows which because of the angled sides can be viewed from either front, top or back.

When I got this radio the fabric was stained and torn. Also the top panel is really its 'Achilles Heel'. The acrylic moulding is too thin and the two fixing screws, hidden under the control knobs, are without compression washers and with the slightest excuse they will produce pressure fractures which radiate out to the sides. With any rough handling the top panel is vulnerable to further cracking and it is rare to find any of these completely undamaged. Despite these considerations I do have to say that I like the aesthetics of this top panel.

VHF front end

The BC562 is a 9 transistor circuit but there isn't an 0C171 in sight. The RF stages instead use transistors supplied by Semiconductors Ltd., a joint company set up in 1957 between Philco and Plessey with most of the technology borrowed from the former. These devices are Micro Alloy Diffused transistors as distinct from the Post Alloy Diffused devices used in all other UK sets of the time. The similarity implied by the terminology is confusing as the two types use completely different technology but I will expand on this later. Figures from the Mullard Data Book would indicate that whereas the OC171 struggled to provide much useful gain at 100 MHz (Ft 75 MHz?) the T1832 (Philco equiv. 2N1742) RF amp in the GEC was listed with a cut off frequency of 1000 MHz and 14db gain at 200 MHz. The VHF front end consists of a T1832 as a common base RF amp with broadband input and a tuned collector feeding a T1833 as a common base self oscillating mixer with positive feedback between collector and emitter circuits. The coils are tuned by a twin gang capacitor with miniature vanes and a slow motion drive. Common base provides better and more stable performance at VHF and does not need neutralizing. This arrangement quickly became the standard but at this early stage its use was not completely universal. The contemporary Ferranti (Ekco) BT 1037 for instance, omitted the RF stage altogether and fed the signal directly into the OC171 mixer. This seems to point to the marginal performance of the OC171 at these frequencies, however an RF stage was still useful to isolate the aerial and minimize pulling of the oscillator. Better Alloy Diffused transistors, designed for TV front ends, such as the AF102 soon followed and these were used by some manufacturers as the 1960's progressed.

Intermediate frequency stages

After mixing down to the IF of 10.7 MHz the signal is passed through three double tuned stages of IF amplification. Here again we see a divergence from what was common in other first generation transistor FM receivers. In these radios the HF performance at 10.7 MHz of an OC170, operated this time in common emitter configuration, was good enough to allow sufficient gain to provide a fully limited signal at the discriminator on a strong station after three stages of amplification. Where the GEC BC 562 differs is in using its three IF transistors (T1657) as common base amplifiers just like in the VHF front end. Although providing improved performance as the cut off frequency of the transistor is approached, this configuration, while exhibiting high voltage gain, has a current gain less than unity so that its power gain is usually lower than the comparable common emitter circuit. Therefor I am not sure why the designers, with access to high performance transistors, chose this approach. Perhaps they had problems with stability and needed the "tamer" common base design

FM demodulation

The amplified FM signal is then applied to a conventional ratio detector with matched diodes which in conjunction with the special final IF transformer (L15/L17) with extra tertiary winding L16, converts the phase changes into an audio signal. It has a built in limiting action and the limiting and AM rejection can be optimized by adjusting L17 for minimum AM response. Limiting amplitude variations is important not just for suppressing impulse interference but also for reducing the effects of multipath reception and distortion, a problem more severe with a portable set and a telescopic aerial. The audio is available across the tertiary winding and is fed through a frequency de-emphasis network to the volume control.

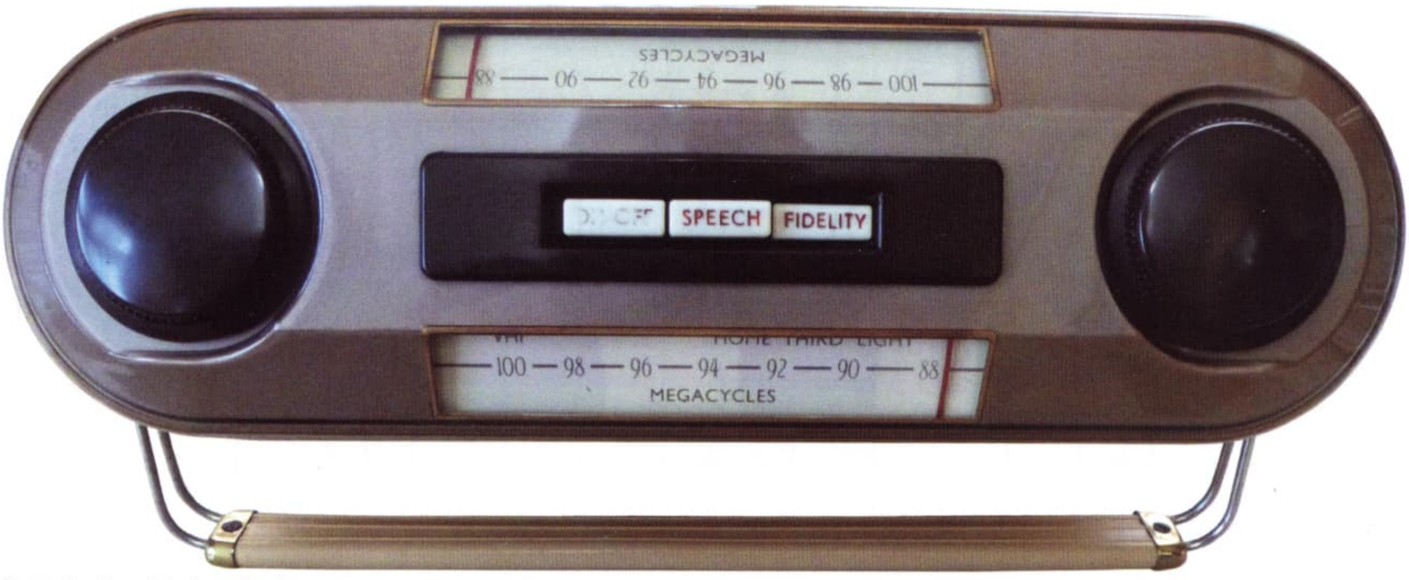
Audio stages

These consist of three stages using four of GEC's own GET113/114 transistors configured as a pre amplifier, a driver and two transistors in a Symmetrical Single Ended Push-Pull output. There is a phase splitting driver transformer but no output transformer, the 25 ohm 6 inch speaker being coupled to the midpoint of the output transistors by a 550µf capacitor. This is quite a large capacity by the standards of the day and is rated at only 6 volts. They obviously wanted to maximize the bass delivery to the speaker. Negative feedback is taken from the speaker to the input of the driver stage. The circuit shows a non polarized 2µf capacitor connected across the speaker but on my set this was not present and it didn't look as if it ever had been. The succeeding model, using the same audio circuit, does not incorporate it so maybe it was removed during production. Two of the three push switches on the top panel provide a form of rudimentary tone control. The centre button, marked "speech", places a low value capacitor (.25µf) in series with audio coupling capacitor C38 and introduces some bass cut while the button marked "fidelity" switches an extra top cut capacitor C 35 out of circuit when depressed.

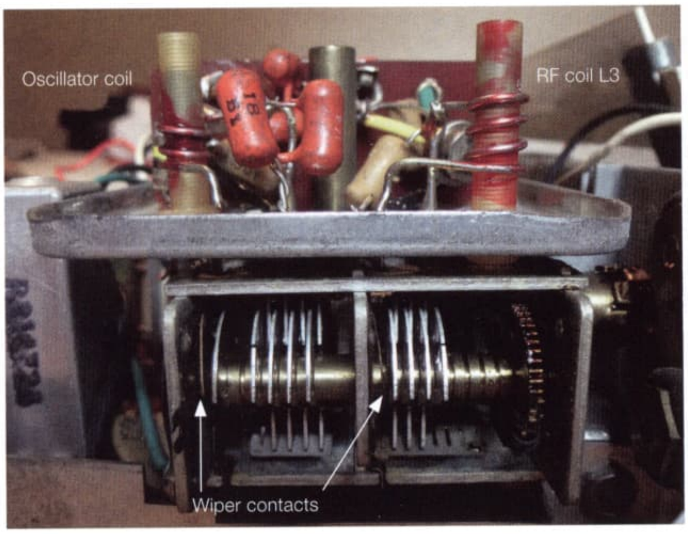
Switching on

The set was originally designed for a PP9 battery loaded through a sliding door in the base. I replaced this with six AA cells in a holder before switching on. Yes, there was life! With the rickety aerial pulled out, stations could be tuned in. The problem was they wouldn't stay tuned in! This wasn't the slow drift usually associated with thermal effects of components at VHF, it was a sudden shift in the position of the station tuned in, often after a few seconds, sometimes after several minutes. The direction of frequency movement was erratic and the extent varied from a few tens to several hundred kilocycles, enough at times to put the signal right out of the IF passband. It therefor looked as if the innards would have to come out and specifically the VHF tuner unit examined for mechanical or intermittency problems. Great!

The knobs needed to be carefully removed with a cord puller to avoid putting further pressure on the fragile acrylic top. With this done I could see the extent of cracking around the screws that secure the top. This was put carefully to one side to attend to later. Under this is a substantial metal crosspiece which accommodates the central switches and the smoothly operating pulley system that allows the two contra moving pointers to operate. Two spade connectors to the antenna inputs to the tuner then need to be removed from tags on the cabinet inside and this allows the crosspiece and circuit assembly, after undoing its fixing screws, to be withdrawn to the extent of the speaker leads which were duly unsoldered leaving the speaker in the cabinet. The front end



Symmetrical top with mirrored tuning-scales

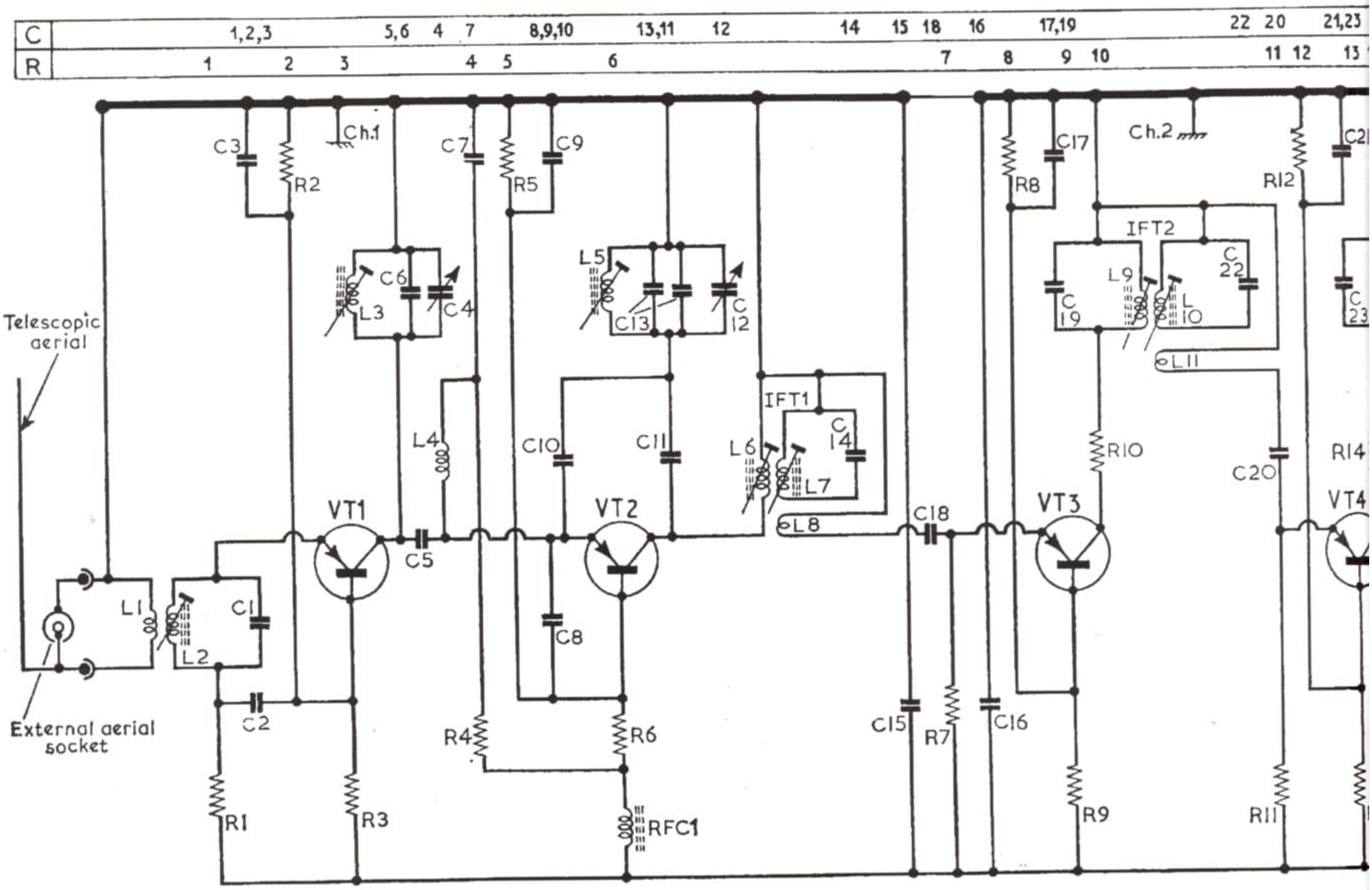


VHF tuner, cover removed

Internal fabric repair to rear cabinet vent (top, right of picture)

tuner assembly sits piggyback on top of the two gang variable capacitor which is attached to the crosspiece with screws and rubber grommets and behind this the main IF and audio printed circuit board hangs down vertically. It is worth checking the grommets for signs of perishing and replace if necessary. The tuner should be secure in the grommets since if it moves excessively there is a danger of some tags on the variable capacitor frame touching the reinforcing plate that runs down the IF circuit board. This in itself could lead to erratic frequency stability but they should not be over compressed.

I connected a separate 25ohm speaker and temporary aerial and removed the screening can from the top of the tuner. Components are assembled in point to point wiring fashion between a tag strip anchored in the middle, the nylon coil formers and connections from the tuning capacitor below. Rigidity is essential here so I checked for any mechanical weakness or suspect soldered joints. Nothing appeared to trigger the problem and I was apprehensive that the fault lay in one of the low value ceramic frequency determining capacitors that I wasn't looking forward to changing. With a certain amount of desperation I examined the variable capacitor and geared mechanism closely and noticed what I considered an excessive amount of grease on the split gear and rear bearing. I wondered if a thin film of grease had migrated down to the sliding contacts and pressure plate behind the gangs, especially the oscillator gang. Cleaning was certainly worth a try before snipping capacitors out and if not grease maybe it was oxidation. Excess blobs of grease were removed with cotton buds and the contacts at the rear of the gangs were given a good squirt of Servisol contact cleaner, the

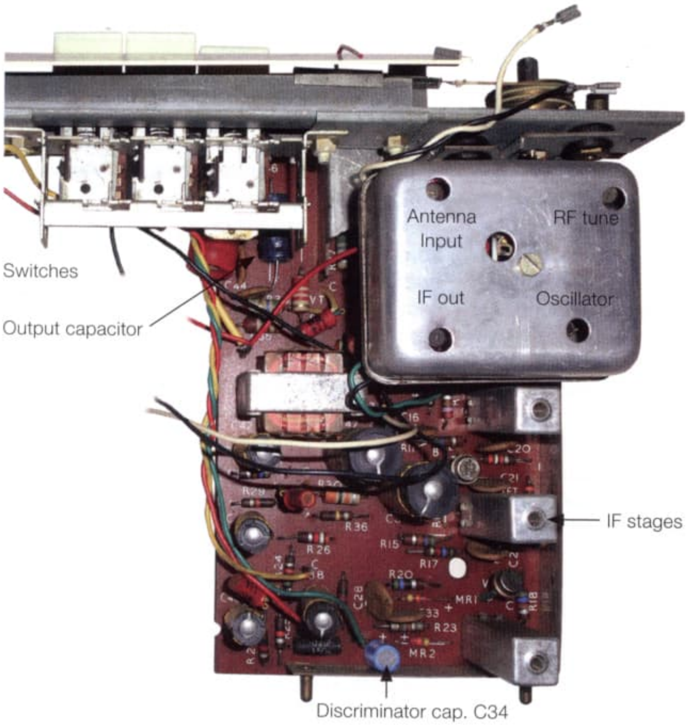


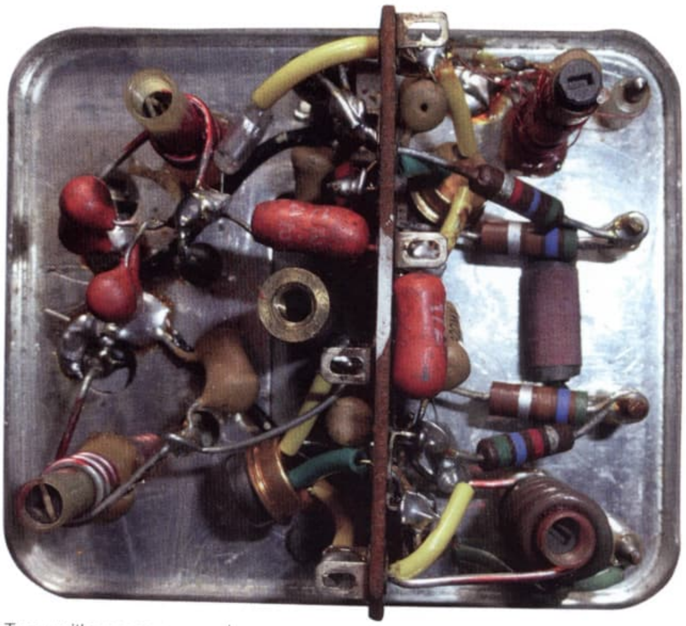
Circuit diagram of the BC562. Component numbers are the same as those printed on the printed circuit panel and, for easy reference, a key is
control. Oscillator feed-back from collecto

capacitor rotated several times and then left to dry out. This seemed to provide a cure for the erratic stability but it was only temporary and partial. Still, I appeared to be on the right track so a further session of solvent cleaning was commenced making sure that the nozzle directed the fluid onto the area of contact. This time the cure was complete and lasting.

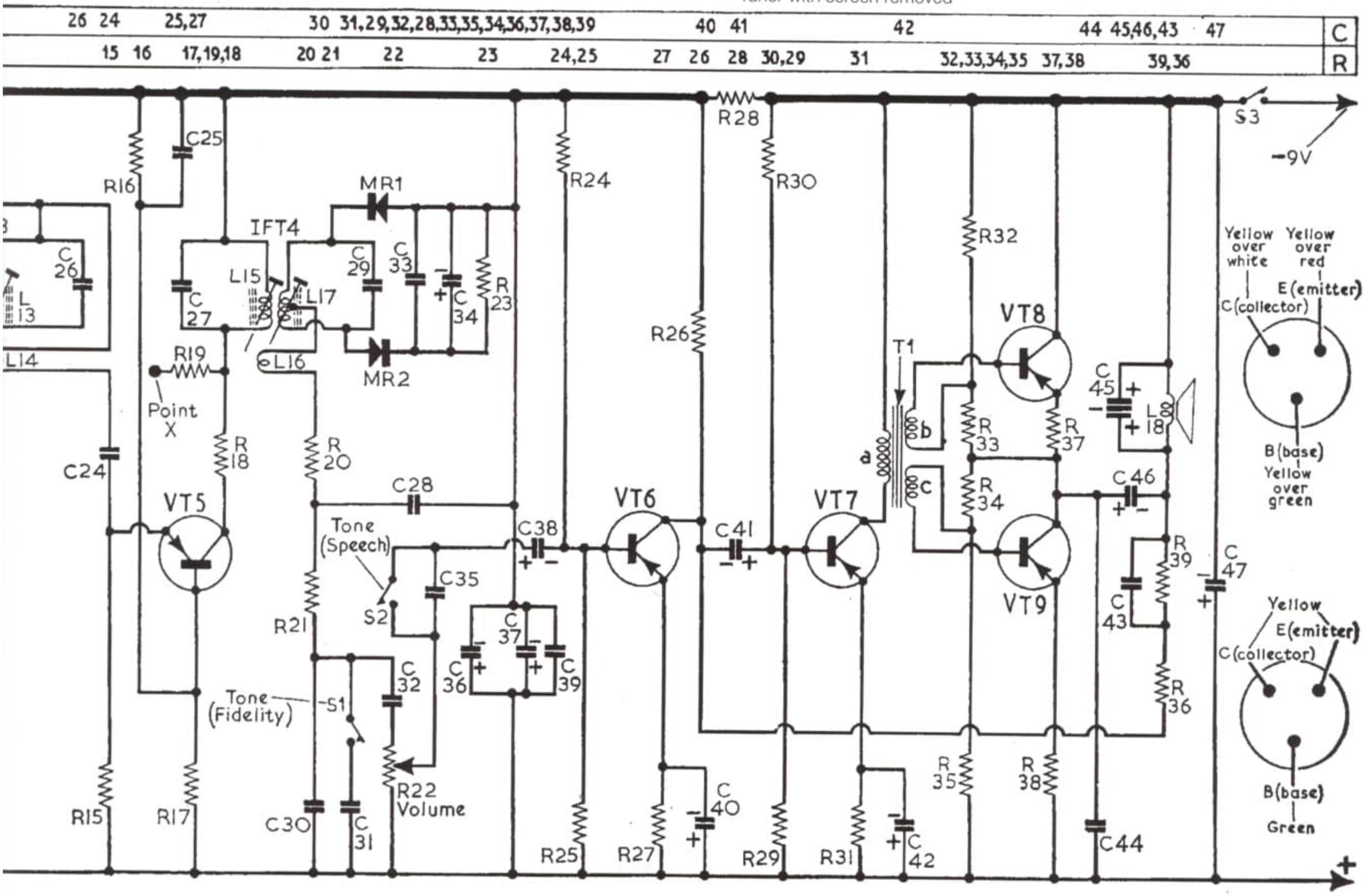
Alignment and further work

All the stations that I would normally expect were audible and surprisingly now at the right place on the scale. The scale incidentally is unusual, a minimalist display of VHF frequency readings in grey on a white background with the word "Megacycles" prominently displayed. It would have been a shock to see this on a transistor radio in 1960 in the absence of any other wavebands. After some tuning around I thought that the audio was a bit sibilant and distorted on weaker stations so an alignment was on the cards. The Trader Service Sheet recommends adjusting the two cores of each IF, starting at L15 and working backwards, by individually injecting a 10.7mhz signal into the emitter



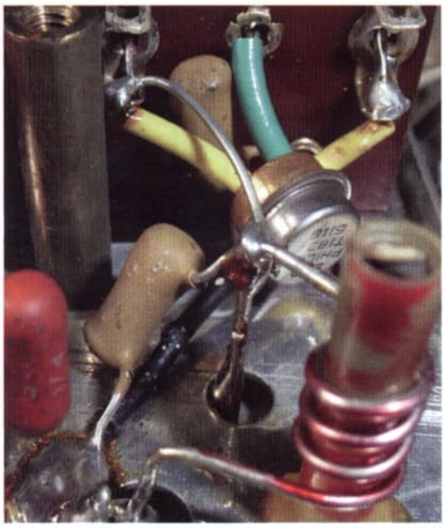


Tuner with screen removed



above the diagram. ***L2*** *tuning is pre-set for the complete band;* ***VT1*** *collector circuit and* ***VT2*** *oscillator circuit are tuned by the manual tuning*
er of ***VT2*** *is provided by* ***C10*** *and* ***C11.***

Modified antenna



RF, amp, transistor

of each preceding transistor. Then, with the core of L17 screwed out flush with the bottom of the former and 10.7mhz injected into the tuner aerial input, a pair of 27k resistors should be connected across R23 and a microammeter between the junction of the two resistors and C30/ R21 junction. The core is then screwed in, passing through a maximum, and adjusted for a zero reading on the meter and this sets the AM suppression.

The above is a bit involved but should probably be followed exactly if alignment seems completely astray. However I took a bit of a shortcut. I checked one core of each IF coil by ear on a weak off air signal and found they needed only slight readjustment. I then used a method to set the AM rejection which purists might frown on but which appears to work. A small battery mini fan, minus the blades, was brought near the aerial. The motor generates substantial wideband RF noise right into the VHF spectrum and this translates to large amplitude spikes through the IF stages. I then carefully adjusted L17 core for minimum raucous impulse noise! There may be some FM noise on the signal as well but as I said the amplitude noise seems to predominate and final adjustment can always be made by ear on a weak signal. Having completed this I decided also to replace the 8mf electrolytic capacitor across R23 in the discriminator.

While looking at capacitors I was tempted to replace all the audio stage bypass and coupling capacitors but decided to concentrate on the 550µf output capacitor to the speaker and then assess the results by ear. Given its modest rating of 6 volts and with nearly half the supply volts across it was amongst the most likely to succumb to the effects of ageing and it was also within the feedback loop. So it was replaced with a modern component of 25volt rating. Everything was returned to the case temporarily and the base response seemed quite good.

Cleaning

As received, apart from dirt, the fabric of the case had two tears of about an inch, one over the speaker aperture and one over the vents at the back. I decided to repair these before cleaning and so removed the GEC brand speaker. Small squares of tissue paper were moistened and attached to the rear of the tears with PVA adhesive. Each side was laid face down and light pressure applied from inside the case to keep the fabric flat until it had dried. The photo shows the rear of one repair. With the speaker out and the repairs dry, cleaning was then undertaken with "Vanish" fabric foam cleaner. This has the advantage that a minimum of water can be used, thus protecting the repairs and the foam is sprayed on in small areas and dabbed off with a moist cloth. Care needs to be taken with the fabric side panels and upper and lower strips as the marble effect seems only to be surface printed and too vigorous a cleaning can start to remove the marbleing.

Aerial

Other than the top panel, which I decided to leave to the end, the next biggest headache with this radio is the telescopic aerial. Designed to retract horizontally into the base of the cabinet it emerges from the side and, when the hinged knuckle is exposed, can be left horizontal or raised vertically. Unfortunately on mine the hinge had worn and had little or no grip and there is no screw to readjust the compression. Even when new this was an unwieldy arrangement to carry about with the aerial prone to flopping about and getting damaged. Remember, the idea of a true FM portable was new, all valve predecessors were table radios and all the main stations were horizontally polarized, so maybe the designers expected it to spend a lot of its time in a dedicated spot with the aerial horizontal. To remove the aerial from its socket requires loosening the retaining ring with a two prong tool to engage in its slots. I took the assembly out and tightened the jaws on the socket which were also loose and which clamp the base of the whip below the hinge. There seemed to be the remnants of a pin here which was supposed to engage in a slot. All this however didn't address the loose hinge problem.

I decided that the radio needed some means to secure the extended aerial in a near vertical position. I came up with a modification using a small flexible plastic ferrite rod retaining clip of the type used on many sixties MW portables. The one I had was translucent white and the photo makes plain how it is used. This has a base, a loop to retain the rod and a projecting flexible piece designed to be screwed back over the base. I placed a small wood screw into the side of the cabinet about 100mm down from the top and slightly off centre which secured the clip base only and allowed the telescopic whip to be clipped into the loop and held at an angle. This gives the radio a much more secure feel when being carried about rather than relying on the friction of the knuckle joint.

Top panel

Finally the bit I left to the last, the acrylic top. Many stress cracks can be seen radiating from the fixing holes, most of them thankfully covered by the wide shallow knobs. I don't know of any cosmetic fix for these, maybe when 3D printers come down in price it will be possible to reproduce the top! There are a few ways though to stop them getting worse in this brittle plastic. One method is to drill a very small hole at the maximum extent of the crack which will relieve stress and stop its further progression. That wasn't an option here as some of these were visible just outside the knob edges. However what I did do was to cut very small grooves with a scalpel blade on the underside at the start of each crack where it radiates from the hole and carefully drip in some low viscosity superglue. It is important that it's a low viscosity type. This has permeated someway into the crack and hopefully will reduce the chance of it spreading. The other action to prevent further progression is to avoid over tightening the screws on reassembly. I left them just finger tight with a small dab of wax to prevent loosening

Conclusions

After repairs I made a stab at assessing performance. This of course is difficult to gauge and a bit subjective without sophisticated test equipment and also assumes that alignment is spot on. It is also complicated by the nature of VHF, where the average person is a surprisingly effective VHF reflector and the average room is a constantly changing pattern of standing waves. When FM was introduced it was essentially for fixed valve receivers with external aerials and it was assumed many listeners would make the extra effort to erect an aerial for improved quality reception. I don't think it was then envisaged how the explosion in portable use made possible by the transistor and ferrite aerial would affect domestic listening habits.

However I was interested to see if the difference in specifications on paper between the Mullard and the Philco semiconductors was reflected in perceptible differences in sensitivity. My comparison was with a 1962 Bush VTR103, which used the Mullard devices and which has double tuned I.F.s. However , just before this comparison, the AF115 in the oscillator mixer developed an internal "tin whisker" short and I ended up replacing both front end transistors with an AF124 & AF125 made by Seimens. My Mullard Data book tells me that 0C171, AF114 & AF124 devices are essentially the same but the figures are disturbingly vague and I am not so sure that in practice the Seimens devices are exactly comparable to an earlier OC171/AF114. So this should be kept in mind, also the fact that the Bush oscillator runs 10.7mhz below signal frequency (the norm is to run it HF of signal frequency) which might increase mixer conversion efficiency.

After a lot of "faffing" around making sure that aerials were in the same position and that nobody was moving in the room next door, I would say that the BC562 had the edge in sensitivity but that the difference wasn't as great as the specifications for the MATD's & the PADT's might have suggested. The adjacent channel selectivity of both sets was comparable but I have to say, on balance, I preferred the audio from the GEC. It had better bass and a greater depth to the sound whereas the Bush audio was quite mid prominent, in fact there wasn't a great difference I thought between its AM (which is good) and the FM sound! Neither of them of course performed as well at R.F or audio as my much later Hacker VHF Herald.

Not a completely conclusive comparison then, but offered for what it is worth. I would also say that both radios could have benefited from AFC. A form of this, using a variable capacity diode in the oscillator circuit controlled by a correction voltage from the discriminator, had already been devised but U.K. manufacturers didn't include it until around the mid sixties. I was also struck by how difficult it was to get a stable signal on moderate to weak signals indoors compared to AM, with multipath effects creating signal fluctuations as someone moved in relation to the radio. Audio quality and program choice notwithstanding and ignoring the horrendous levels of digital generated hash, AM is arguably a better mode for casual off air portable listening around home. However with that battle practically lost already, for those of us who actually get a buzz from listening to real broadcasting stations radiating RF, we should probably appreciate these FM sets before we are saddled with "internet radio" connected to short range "WiFi" or "iPhones". Who mentioned DAB?

Finally, this model was only in production for about a year and was replaced with the AM/FM BC 563 which used the same FM circuitry and which to my eye, at any rate, doesn't look as good.

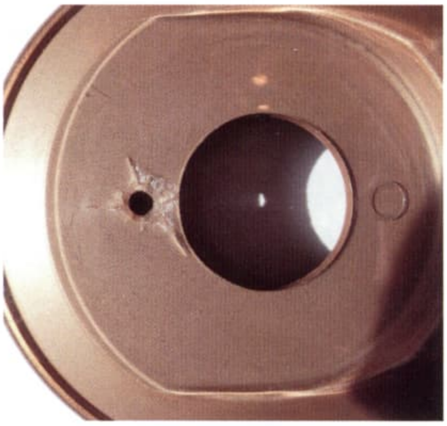
Post Alloy Diffused v Micro Alloy Diffused.

Now a brief word on these early VHF semiconductors. Both types are"Drift" transistors, a generic term meaning that an electric field is created in the base region to more quickly sweep minority charge carriers towards the collector junction. This is achieved by creating a doping gradient across the base. The following differences are shown on the diagrams.

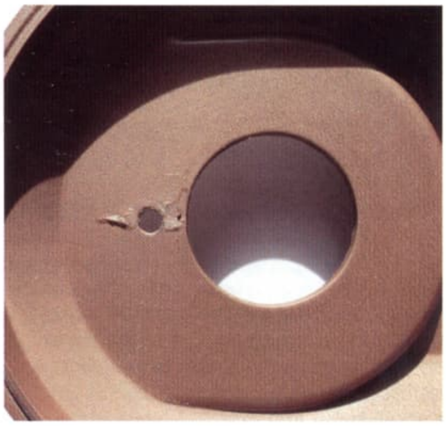
In the "PADT" device Mullard broke from precedence by making the starting crystal a P type so that it becomes the collector rather than the base. The base is then created by alloying a pellet with N type dopant on to one side which gives a thin diffused layer and better control of base thickness. A second pellet containing both P and N dopants is then alloyed on beside this. The N type dopant diffuses faster and further into the existing N type base creating a concentration gradient while the P type dopant forms the emitter layer. A final etch around the edges gives a Mesa structure.

The "MADT" transistor is a development of Philco's Micro Alloy process. They begin with an intrinsic crystal of germanium and by using a diffusion of phosphorous from the gaseous state create an N type region on one side whose concentration varies with depth thus creating a pre graded base. Using their proprietary electrolytic jet system they then etch through the wafer into the graded region creating a very thin base. P type doped regions were then alloyed to each side to form collector and emitter.

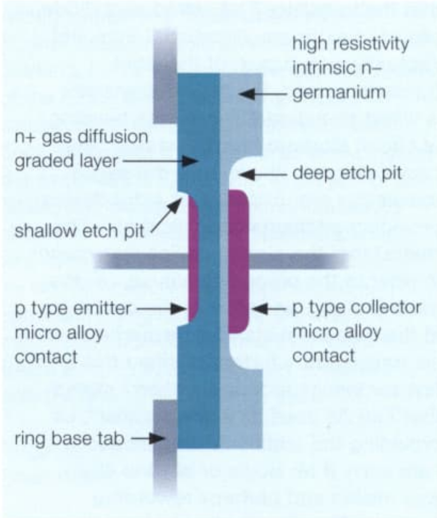
The Philco process produced devices that were reportedly mechanically fragile. Ironically, fiftyfive years later, they are still working while many OC171's have probably succumbed to "Tin Whisker Syndrome"!



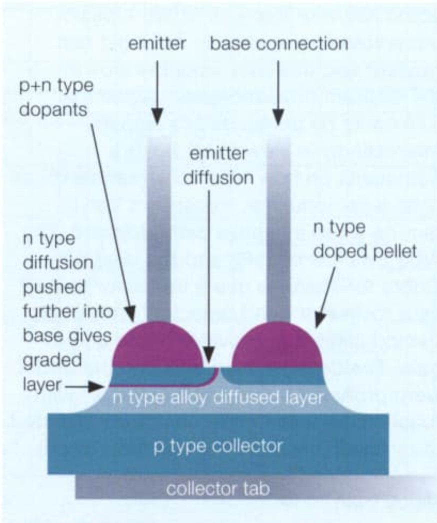
Stress cracks on fixing hole



Underside application of superglue



Micro alloy diffused transistor (not to scale)



Post alloy diffused transistor (not to scale)

Letters

Dear Editor,
I would be grateful if you could allow me, if only in my defence, a response to comments made by Alister Boyle (winter letters page) on my article, "The KB UP11 Cadet" in the Autumn 2015 issue of the Bulletin. Mr Boyle claims that I indicated that the transistor TX4, wired as a diode, provided extra amplification. I think not.
I actually stated that, of the eight transistors used, the "eighth transistor is wired as a diode". Under the heading of circuit diagram I further stated "the circuit diagram shows how the seven transistors are utilized, that extra device providing additional amplification". The "extra" (not the eighth) device was meant to refer to the preceding clause, i.e. the seven active transistors in the circuit, as at the time most standard superhets used six transistors. I further clarified this a few sentences further on when I stated that TX5 "is used as a preamplifier", i.e. providing the additional amplification.
I am sorry if Mr Boyle or anyone else was misled and perhaps rewording things differently may have removed any perceived ambiguity. I must admit however that I assumed a basic understanding of circuits amongst our readers and that they wouldn't look at the diagram provided and imagine that TX4 could be persuaded to amplify.
Interestingly in view of Mr Boyle's comments on how "vital" the humble diode is as a demodulator, transistors can in fact be wired as active demodulators. The Alba Swallow of 1963 and the later KB Cobra for instance use a transistor biased as a "collector bend detector" which both demodulates and provides some audio gain. The devices used by KB in the Cadet were probably out of spec. "rejects" with functioning base/emitter junctions included to misleadingly raise the transistor count.

Henry Irwin

Dear Editor,
Referring to the article in the Winter 2015 Bulletin by Henry Irwin about the Pye Q8 Reflex transistor radio, a common emitter transistor audio stage with decoupled emitter resistor is inherently non-linear as the voltage amplification varies with the emitter current. For a transistor having a reasonably high current gain (*hfe*) the voltage gain is approximately the collector resistance divided by the effective emitter resistance (*re*).

A commonly used approximation for *re* at room temperature for a small signal transistor is *re* = 25/*Ie* ohms where Ie is the emitter current in mA. (See, for example, the *Mullard Reference Manual of Transistor Circuits* Aug 64 p 75). For the original circuit, ignoring the output impedance of TR3 and the input impedance of the following stage, both high compared to the low added resistor value (Designated *Rb* in Mr Irwin's diagram), *re* at 1mA will be 25 ohms and, with an *Rb* of 82 ohms, the voltage gain will be 82/25 or about 3.3 times, for Mr Irwin's modified circuit, *re* will be about 7 ohms and *Rb* 82 ohms in parallel with 56 ohms, about 33 ohms, giving a voltage gain of about 4.8.

Increasing the current drawn by the stage will reduce the non-linearity as the current change due to the signal is a lower proportion of the total current and so the proportional change in *re* will be less. The designer of the set was probably prepared to put up with the effect Mr Irwin was trying to cure, as any increase of current would mean a reduced battery life.

A possible way of reducing the distortion without increasing the current drawn by the stage would be to add a small undecoupled emitter resistor (*Rx*) and increase the value of *Rb*, the audio voltage gain would then be Rb/(*re* + *Rx*), and the change in the total emitter resistance with changing current and hence the distortion should be reduced.

Mike Butt.

Dear Editor,
I refer to Alistair S.M.Boyle's critique of Henry Irwin's excellent and informative article on the KB UP11 Cadet transistor portable in the winter 2015 edition. I believe Mr Boyle has misinterpreted part of the article though may be forgiven for doing so initially, due to confusion caused by the word 'that' rather than 'the' being used in reference to the extra transistor among the seven used in the circuit. (I am discounting the 8th (Tx4), which is used as a diode). The confusion seems to arise over the sentence which is correctly quoted by Mr Boyle.
'The circuit diagram shows how the seven transistors are utilised, that extra device providing additional audio amplification '... The point is 'that' extra device is within the seven transistors and does not refer to the eighth (Tx4), connected as a diode. This has already been dispensed with by the author; see page 54 column 3, which makes this perfectly clear. And of course Tx4 cannot provide any gain! I assume 'extra', in fact to refer to an additional transistor over and above the traditional 6 transistor plus 2 x AF transformer superhet, which is of course Tx5, the pre - driver. This indeed provides additional amplification made necessary by this particular type of complimentary symmetry circuit, see below. Because of this misinterpretation following the confusion, Mr Boyle launched into what was in the event an unnecessary lecture on very basic circuit issues which were not in dispute, and about which, Henry Irwin needed no advice, being a competent engineer and long standing specialist in transistor radio circuits who has contributed many articles on the subject over the years.
The evolution and key points of the complimentary symmetry circuit are very well covered in the article. Way back in the 1960's I remember experimenting with such an amplifier as part of an home brew receiver and even ordered a custom 30 ohm 7X4 loudspeaker from Fane Acoustics of Leeds, (which you could do in those days!). However it never sounded very good for various reasons (I don't think my PNP/NPN transistors were ever properly matched!), and I reverted to the two transformer model. So I would like to make a few comments, also with reference to the Cadet above. It did indeed seem to be a seductive/cost and space saving arrangement eliminating both transformers, but when examined in detail, perhaps there was not so much to be gained in a radio of this type, which was neither very compact, nor 'high fidelity'. The removal of the driver transformer incurred a significant loss of gain meaning a pre - driver transistor (+ at least 2 R's and 1 C), was necessary if the normal 10-20 mv audio input sensitivity was to be achieved (as with Tx5 above). Extra current gain was needed in the system anyway to drive the output pair to a higher collector current than in the normal two transformer circuit. This was because the complementary symmetry output transistors were in series across the voltage supply (as illustrated in the article),

so the peak output voltage available for each was only half of it. Therefore to achieve a given output power, a (2X) higher peak output current was needed, (approx 75ma in the Cadet*). Then there is the cost of an NPN/PNP matched output pair which was fundamentally much more expensive in those days, than just two of the same standard 100 mw devices. Last but not least, the higher impedance (35 ohm), loudspeaker would have cost more than the bog standard 8 ohm device – produced in its millions in the Far East! Perhaps it was a mix of these factors which put off the Japanese manufacturers, who as Henry points out, did not in general adopt it during the discrete transistor component era of the 1960's, taking a 'why fix it if it ain't broke' attitude.
Thanks for a great article and apologies to all, if I have misunderstood the misunderstandings! Its a great journal we have!

Jim Duckworth.

*The Cadet data sheet claims an output power of 150 mw. Assuming this is based on the rms values of the respective peak voltage and current output swings, this gives a peak power of 300 mw. Thus the peak current would be given by *pk* power/*pk* volts. Now each output transistor sees only half of the supply at its emitter, i.e 4.5 v , meaning about 4 volts across the loudspeaker load. So *Pk* current = 0.3/4 = .075A or 75 milliamps, reducing to around 37ma for the standard 2x transformer circuit in which each output transistor saw around 8 volts.

Dear Editor,
I have a couple of hopefully helpful comments on Stef's Hotpoint G64MEX Radio article in the Spring Bullletin.

Stef refers to AWA as being Amalgamated Radio Australia Ltd. This is a common error. The correct title was Amalgamated Wireless Australasia Ltd. Although not used much today, Australasia was a term often used to cover combined Australian and New Zealand activities. AWA had a high profile in New Zealand and even had some equipment made here.

Stef understandably is a little puzzled by the 6G8G valve. In addition to many regular RMA American valves, AWV Ltd produced several valves created for Australian conditions. One of these was the 6B7S and its octal counterpart, the 6G8G. The reason for this seems to be that the 6B7 and 6B8 were semi remote cutoff (Typically 17volts negative bias) which was not always satisfactory with strong AGC voltages developed in IF amplifiers in large signal areas. This could lead to cross modulation in reflexed amplifiers. AWV accordingly produced a 6B7/6B8 valve with a cutoff of -35volts for use in reflexed stages. Steff will probably find a 6B8 quite O.K. if he doesn't use it with a huge aerial.

Peter Lankshear

Dear Editor,
Congratulations to Roger Grant for his excellent article "An inexpensive television using war surplus equipment". When I was 17 I built a television just like it from stuff I bought from Lisle Street. I built it in the cabinet of my father's old HMV 521 radiogram. From my home in Corwall I received a few bursts of picture from Alexandra Palace, no doubt via meteor reflection. However, I retuned it to Sutton Coldfield (?) and took it to Stoke-on-Trent, where it worked fine.

Best wishes,
Harry Woodhouse

Dear Editor,
The valve rectifier is used in much of the equipment described in these pages, but there has been comparatively little information, here or elsewhere on the performance of different types. It is generally accepted that directly heated types warm up much more rapidly than the indirectly heated types, but what is perhaps not realised is the amount of variation amongst the later types. Here then is a chart with the results of testing the following rectifiers:

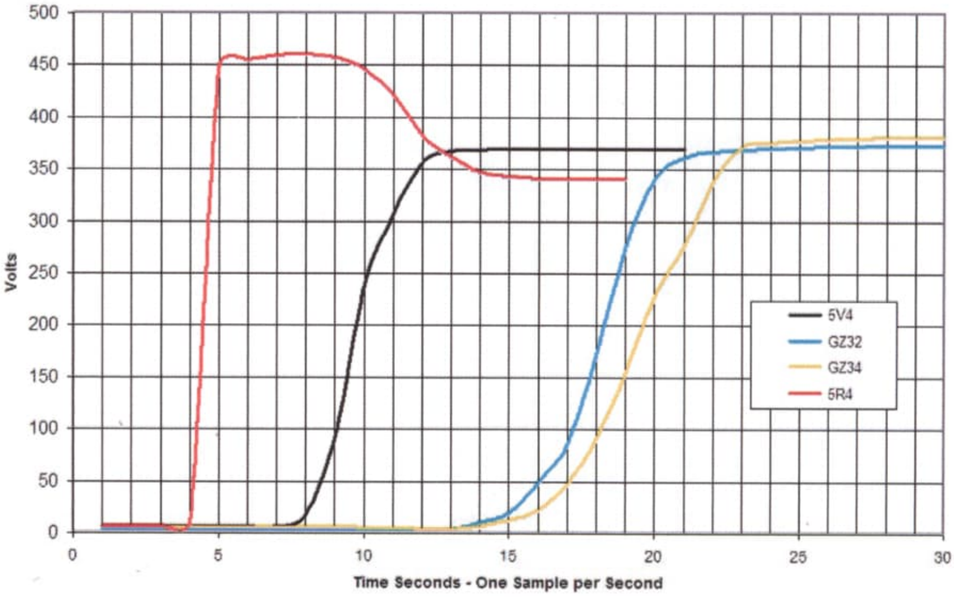
Directly heated:	*5R4*	*Philips*
Indirectly heated:	*5V4A*	*RCA*
	GZ32	*Electronique*
	GZ34	*Sovtec*

The valves were tested in a QUAD II power amplifier that had recently received new capacitors and no preamp was connected since the preamp would not take the over voltage associated with a directly heated rectifier. Output valves were 6L6GCs, so the load current was approximately 147mA. The fast heating time of the 5R4 was no surprise, but the fairly quick heating of the 5V4A was. Late valves tend to have a relatively quick and uniform heating time for use in television series heater chains without thermistors, but clearly this would not include the 5V4A! It would seem therefore that quick heating was applied uniformly to many valves in the sixties irrespective of intended use. This does not matter providing all the valves are similar, but using a late 5V4A in equipment with other valves from an earlier era might possibly cause warm-up over voltage problems.

The Mullard EZ81, GEC Z709/EZ81, and Zaeux EZ80

On a slightly different subject, the acquisition of a Beam Echo Avantic amplifier dating from 1959 presented a different problem of rectifier replacement. The amplifier in question, the SPA21, uses the ubiquitous EZ81. The valve fitted was marked Mullard, but was shorter than expected, at 60.5mm seated. The valve fitted appeared to be original because a spring retaining clip was fitted and was consequently the wrong length for a replacement rectifier. Further detective work revealed the very faint marking, U709, which was the GEC equivalent of the EZ81. The U709 was identical electrically to the EZ81, but the GEC data book states that it has a shorter body, indeed the same as the EZ80. Now at the end of the fifties GEC decided to stop manufacturing consumer valves, so the question is, was this valve part of a batch sold to Mullard for resale, or was Mullard overloaded and sub-contracting to GEC? At any event, it must have involved significant numbers for Beam Echo to make a batch of amplifiers with the shorter retainers for the U709.

Regards
Brian Weller



The BVWS Spares Dept

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

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

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

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

0.001µF	Price band A	0.022µF	Price band B
0.002µF	Price band A	0.047µF	Price band B
0.003µF	Price band A	0.1µF	Price band B
0.0047µF	Price band A	0.22µF	Price band B
0.01µF	Price band A		

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

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

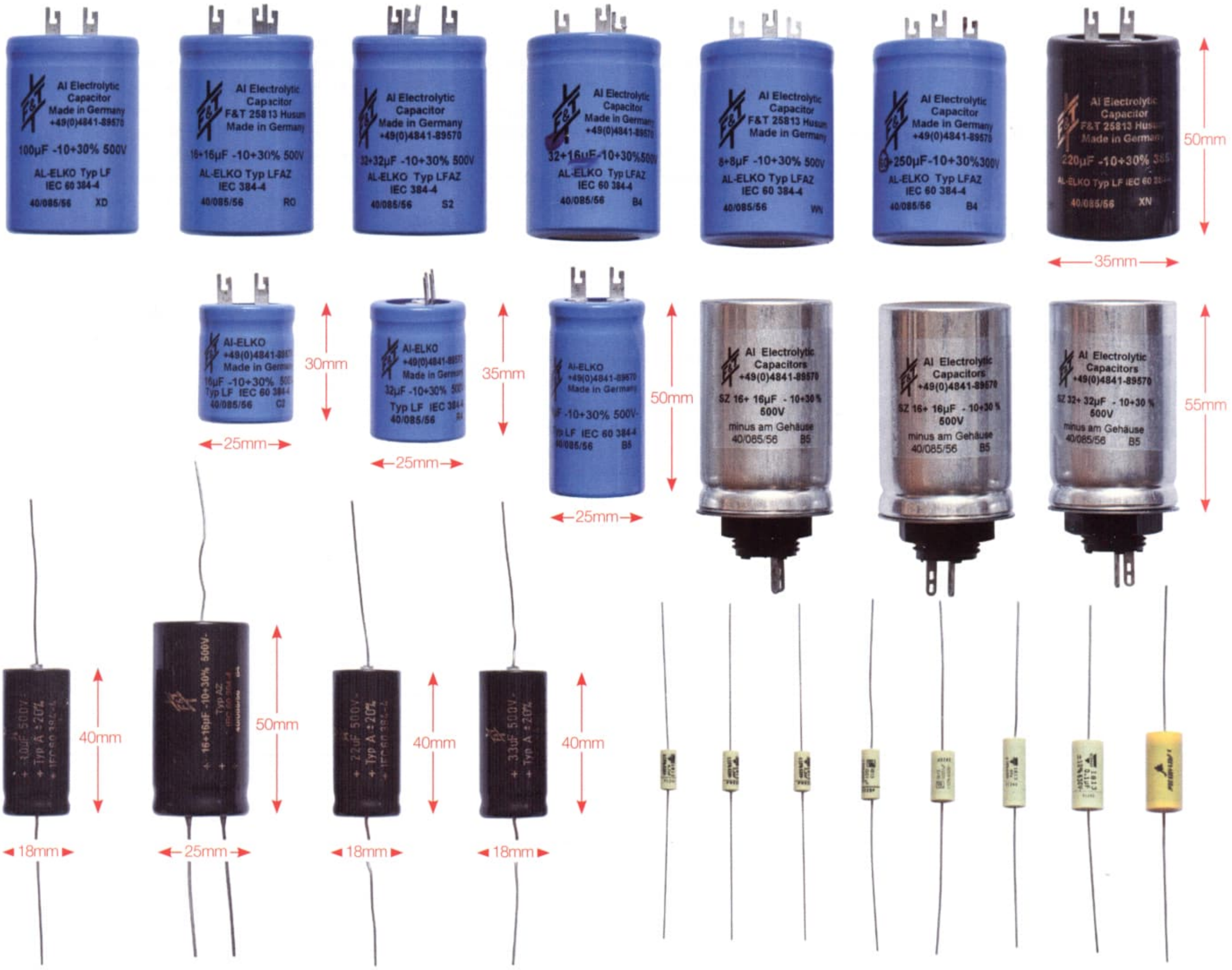
8/8µF, 16/16µF, 32/32µF £7.00 each
50/50µF £9.00 each
16/32µF for DAC90A £9.00 each
60/250µF for TV22 £9.00
8/8µF screw-type, 16/16µF screw-type, 32/32µF screw-type £9.00 each
16/16 µF tubular axial £6.50
10µF tubular axial £4.00
22µF tubular axial £4.00
33 µF tubular axial £4.00
47 µF tubular axial £4.50
70 µF tubular axial £4.50

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

8µF, 16µF, 32µF, 47µF, 500Volt DC working £5.00 each

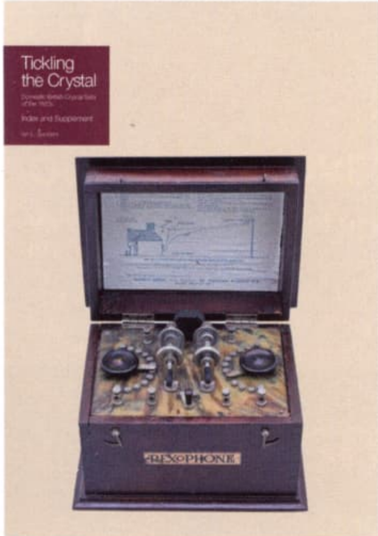
Postage and packing 1 – 4 caps £3.00 5 – 8 caps £4.50

All prices quoted are for BVWS members



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

BVWS Books



Out Now! Tickling the Crystal index and supplement

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

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

Attaché Radios by Mark Johnson An 80 page colour paperback guide to the Attaché portable

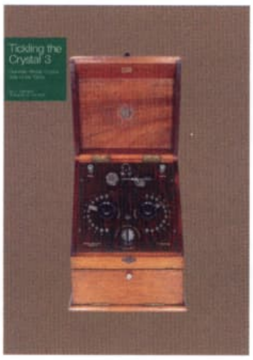
- Detailed specifications
- 140 radios in full colour
- Over 200 additional photos of sales literature, trade ads etc.

£12.00 (+ £2.50 p&p UK) £3.50 EU (rest of world £5.50)

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

Tickling the Crystal 256 pages. Over 200 full-page photographs. £14.95 for BVWS members plus £7 p&p for UK, £13 EU (rest of world £19)

Tickling the Crystal 2 Limited, Only 750 copies printed. 208 pages. Over 125 full-page photographs. £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EU (rest of world £19)



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

Tickling the Crystal 4 More Domestic British Crystal Sets of the 1920s. 280 pages of GPO No. era British crystal sets. Over 115 full-page photographs. £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EU (rest of world £19)

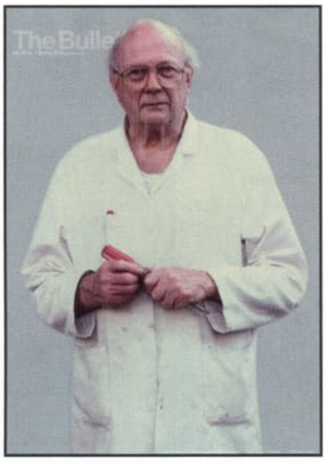
Tickling the Crystal 5 More Domestic British Crystal Sets of the 1920s The final edition in Ian Sanders' thorough five volume set exploring GPO No. era British crystal sets. 252 pages/ of GPO No. era British £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EU (rest of world £19)

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

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

BVWS Books

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 £4.00 each + postage.

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

Mike Barker, Pound Cottage,
Coate, Devizes, Wiltshire, SN10 3LG
chairman@bvws.org.uk

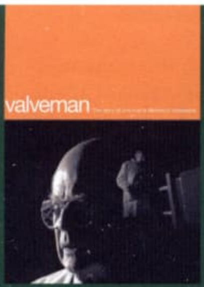
Coil and Transformer Rewinds for Vintage Radio and TV equipment

Power Transformers, Audio Transformers, Chokes, LOPTX and IF Transformers etc.

Special designs also undertaken.
Call Mike Barker on 01380 860787

The British Vintage Wireless and Television Museum

Open as usual
23 Rosendale Road, West Dulwich, London SE21 8DS
020 8670 3667 Registered Charity No. 1111516
Please make appointments beforehand



Out Now on DVD!

Valveman is the story of one man's lifetime of obsession.

Gerald Wells was Valveman. His life's work was an attempt to amass one of the world's largest collection of valves, vintage radios and other early apparatus from the pioneering days of wireless communication.

This documentary film innovatively blends, using a variety of motion design and filmed reenactments, the last hundred years since radio began through to the early days of television.

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

Mike Barker, Pound Cottage, Coate,
Devizes, Wiltshire, SN10 3LG
chairman@bvws.org.uk

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

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

The Radiophile

THE LEADING MAGAZINE FOR ALL VINTAGE RADIO ENTHUSIASTS

Each issue contains practical and authoritative articles on vintage radio as well as military and communication receivers, restoration and construction topics, all written by experts in their field. The Radiophile also hosts Vintage Radio Auctions and Expositions at which receivers, valves, components, test gear, etc., may be bought and sold.

If you are a Vintage Radio enthusiast you cannot afford to be without The Radiophile.

The Radiophile is available by subscription only, currently just £22* for four 48-page issues, or a sample may be had for £5†. To take out a subscription contact us by 'phone with your credit or debit card details or send your cheque to:

The Radiophile, "Larkhill", Newport Road, Woodseaves, STAFFORD, ST20 0NP.

Telephone and fax (business hours) 01785 284696.

** UK and BFPO only; all other territories £28.*
† UK and BFPO only; all other territories £6

Sunday 2nd October 2016
10.30AM - 4.30PM

AUDIOJUMBLE 2016

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

10.30am Standard Entry £5-00 9:30am
Early Entry £10-00 Stalls £30
Bookings/Enquiries 01435 830736
info@audiojumble.co.uk

3rd July 2016

Swapmeet at Royal Wootton Bassett

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

Events Diary

2016 Meetings

June 4th Garden Party at BVWATM
June 5th Cinema Museum London
July 3rd Royal Wootton Bassett
August 14th Punnetts Town
August 20th An Afternoon of Music and Museum Sale. at BVWATM
Sept 10th Television anniversary event at BVWATM
Sept 11th Murphy Day
Sept 18th Table Top Sale at BVWATM
Sept 25th Harpenden
October 2nd Audiojumble
November 6th Golborne
November 19th An Afternoon of Music and Museum Sale. at BVWATM
December 4th Royal Wootton Bassett

GPO Numbers

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

Martyn Bennett, 58 Church Road, Fleet, Hampshire GU51 4LY
telephone: 01252-613660 e-mail: martyb@globalnet.co.uk

The British Vintage Wireless and Television Museum: For location and phone see advert in Bulletin.
Harpenden: Harpenden Public Halls, Southdown Rd. Harpenden. Doors open at 9:30, tickets for sale from 09:00, Auction at 13:00. Contact Vic Williamson, 01582 593102
Audiojumble: The Angel Leisure Centre, Tonbridge, Kent. Enquiries, 01892 540022
NVCF: National Vintage Communications Fair
See advert in Bulletin. www.nvcf.co.uk
Royal Wootton Bassett: The Memorial Hall, Station Rd. Wootton Bassett. Nr. Swindon (J16/M4). Doors open 10:00. Contact Mike Barker, 01380 860787
The Cinema Museum: 2 Dugard Way (off Renfrew Road), London SE11 4TH, Tel.: 020 7840 2200
Email: info@cinemamuseum.org.uk
Golborne: Golborne: Golborne Parkside Sports & Community Club. Rivington Avenue, Golborne, Warrington. WA3 3HG
contact Mark Ryding 07861 234364
Punnetts Town: Punnetts Town Village Hall, Heathfield, East Sussex TN21 9DS (opposite school)
Contact John Howes 01435 830736
Mill Green Museum: Bush Hall Lane, Mill Green, Hatfield, AL9 5PD
For more details with maps to locations see the BVWS Website:
www.bvws.org.uk/events/locations.htm

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

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

The British Vintage Wireless and Television Museum celebrates

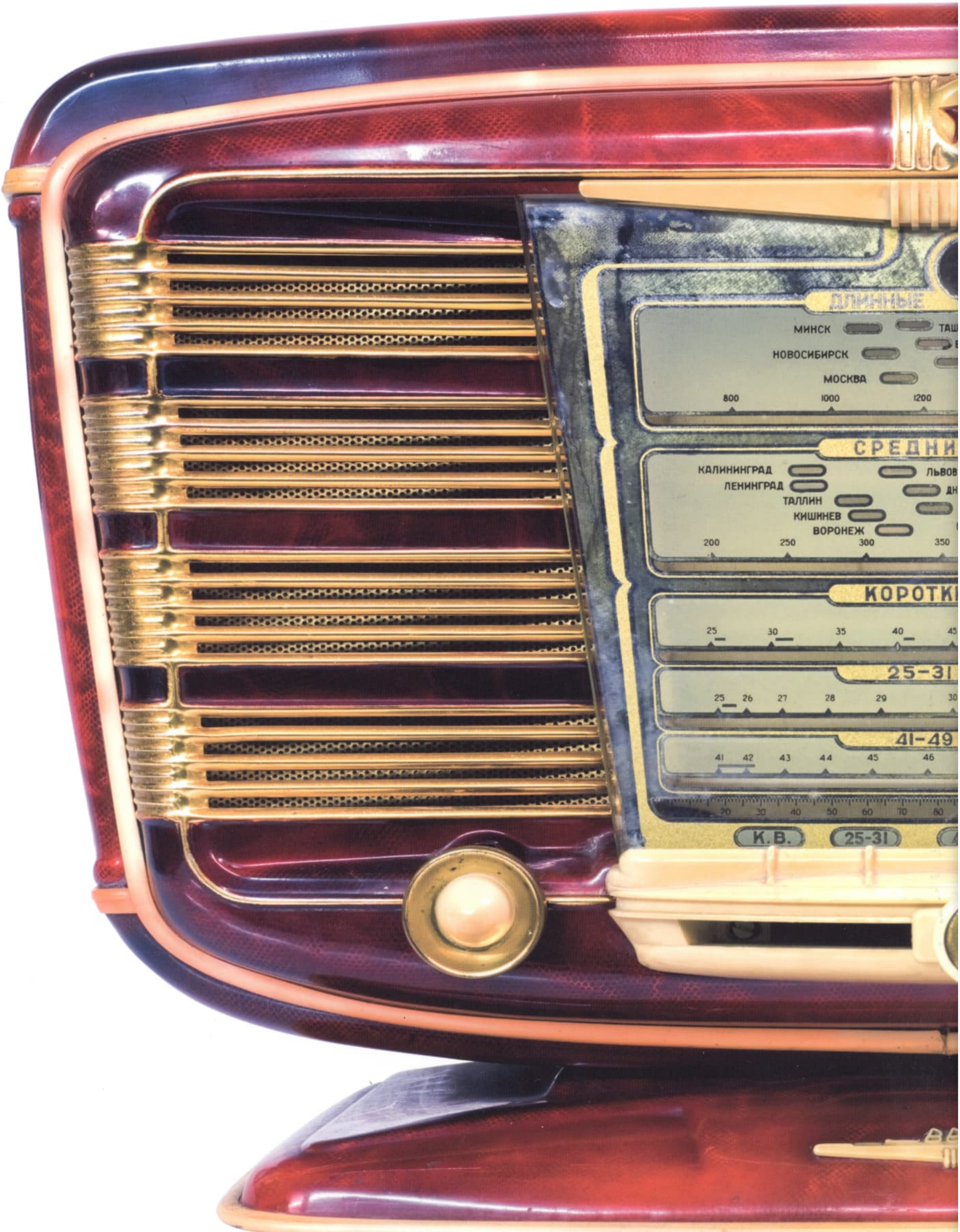
Saturday September 10th 2016 11am onwards

80th Anniversary of High Definition Television

£10.00 entry

TV Problems Solved • TV Restoration Competition • Bring and Buy sale • Working Vintage TV display • Restoration Tips • Museum Tours • Refreshments • special exhibitions to be announced

23 Rosendale Road, West Dulwich, London SE21 8DS 020 8670 3667 Registered Charity No. 1111516


ДЛИННЫЕ
МИНСК
НОВОСИБИРСК
МОСКВА
800
1000
1200
КАЛИНИНГРАД
ЛЕНИНГРАД
ТАЛЛИН
КИШИНЕВ
ВОРОНЕЖ
ЛЬВОВ
200
250
300
350
25
30
35
40
25-31
25
26
27
28
29
41-49
41
42
43
44
45
46
20
30
40
50
60
70
80
К.В.
25-31