The Bulletin

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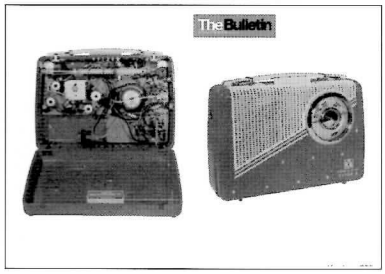

Front cover: KB Rhapsody 'Super 8' transistor set
Rear cover: KB Rhapsody 'Super 8' transistor set

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Contents

From the Chair

2004! This year we Celebrate 100 Years of the Thermionic Valve. The Society has plans for a celebratory event later on in the year so look out for more news on this.

A short time ago, we were contacted by a long standing member asking if we would like back all the old Bulletins he held as they were no longer required, the first 20 years now being on CD-ROM. We were delighted that he asked as we do have a good number of members who still ask for back numbers that are either no longer available in any quantity or Supplements we just don't have any longer. Accepting back the Bulletins means we can help others in the future, so if you have any Bulletins or Supplements that you no longer want or need then do consider handing them back in at any of the BVWS events as only this week we have been asked for a Brown Brothers Catalogue reprint which has been unavailable for some time now.

Over the last couple of years, we have been holding several larger auctions at the Wootton Bassett events. These have stemmed from many contacts to the Society to dispose of collections etc. This has made us look at and review our whole Auction position. A new suite of Auction Software that certainly rivals any commercially available and new equipment has been purchased to make BVWS Auctions fast, accurate and to give excellent details for the buyers and sellers. It has certainly halved the time taken to *cash up* at the end of the day and made our treasurer very happy as he has the accounts at the push of a button. We are now able to report on auctions and will soon be able to publish auction reviews, something we have been asked to do for some years now. This now places us in the favourable position of being able to offer the auction service for part or complete collections. Its very simple, the Society takes a commission of 10% from current members and 20% from non-members. Nothing else, no other charges.

We can also arrange to collect items and store them until the next available auction date. A *cost-price* charge for transportation is made in those circumstances. So if you have a pile of radios to dispose of then give me a call.

In this issue of the Bulletin, we have included an article written by the late Pat Leggatt (past Chairman and long standing Committee member). A prolific writer for many years. This article however was found amongst some old paper work that Carl Glover had received back in the early 1990's. The article has never been published and so we really do have a special piece to start the year with. It is the articles that make the Bulletin what it is so if you have something you would like to write about then let Carl know, you don't have to be an expert and we can accept articles in many forms. We can even arrange to do the photography for you.

Along with everything else we have on our plates, we will be working with a number of people to be able to issue a DVD at the end of the year. This should contain a large amount of radio and television material in the form of manufacturers films, promotional films, early tele-vision and radio programs etc.

The Society will be embarking on the mammoth task of scanning the complete library of service data and related documents held at the Vintage Wireless Museum in Dulwich this year. We now have the equipment, but we do need help. As you can imagine this is a very long process and the scanning is where a massive amount of time will be taken. Itís not difficult but will take us forever without extra help. If you feel you could give up some time to scan a pile of paperwork then do please get in touch with Paul Stenning who is heading this project for the Society. I know he will welcome all help with open arms.

As Chairman, it is my duty to you to ensure the Society is something that gives you pleasure, keeps you informed, arranges meetings to attend and all in all makes you want to be part of. This is usually very difficult, but with a very supportive and active Committee who put in hundreds of hours we somehow seem to get it right almost all of the time. With ever more to do and new ideas we want to make happen we need help. We need your help! So I am putting out this appeal for members who would consider joining the Committee and helping with the running of the Society to contact me.

The Committee holds regular meetings, which are not always London, based which you would need to attend either in person or by phone. So if you have some spare time to give and you think you might like to give it a try, then get in touch and come along to a Committee meeting and see what it's all about. After all, it won't cost you anything and the bonus for me is simple, it's the only time I get to eat Custard Tarts!

Here's to another splendid year for the BVWS!

Mike

Tickling The Crystal 2 out now!

This second volume complements the first, and expands on the story of the domestic crystal set during the nascent broadcast years of the early 1920s. Like its predecessor, it is packed with full-page photographs and a vast amount of previously unpublished information relating to models, manufacturers and broadcast conditions. Together, the two volumes fill a void in the much-neglected field of vintage wireless literature and are intended to provide a comprehensive reference work for enthusiasts and collectors.

See advertisement on page 2 for details

The Bridgwater Imperial Beam Station

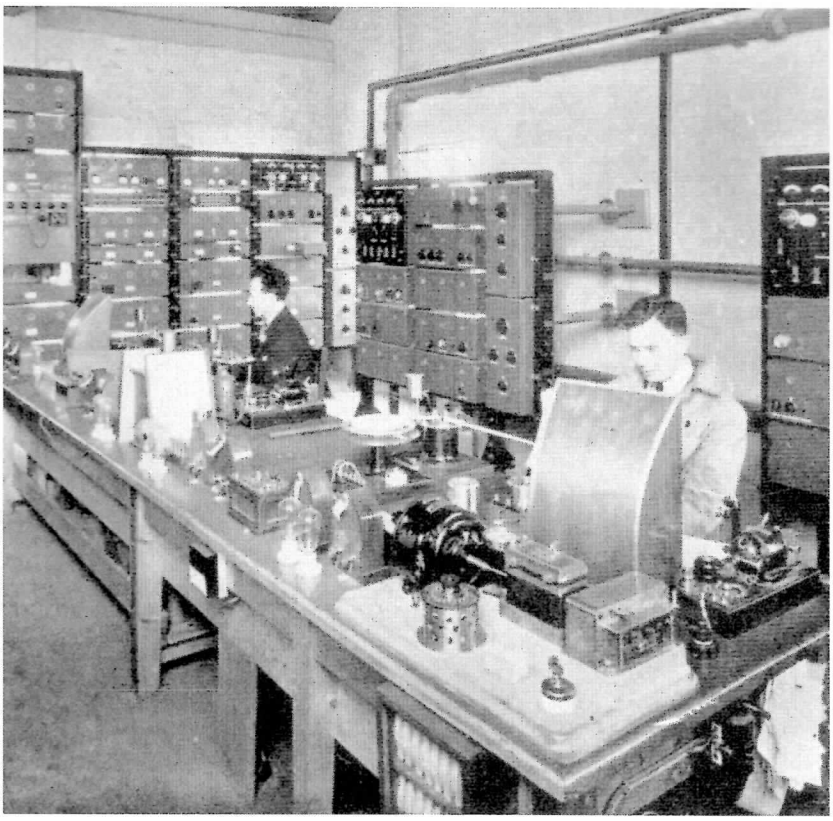
by Pat Leggatt

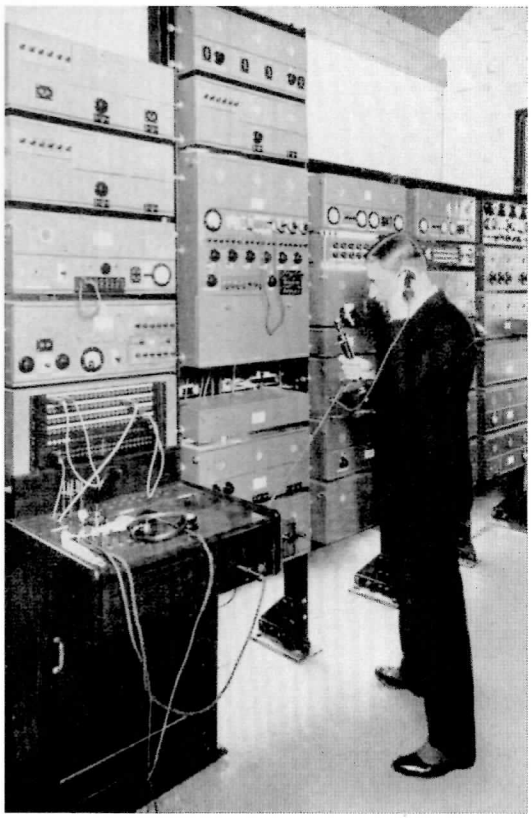
BVWS member Alex Caisey recently acted in the legal conveyancing for the buyers of the old Bridgwater Receiving Station site which has long since been converted to a private residence. Amongst the title deeds was a folder containing a number of interesting documents about the Station, compiled by the previous owner. Alex has, with the kind consent of his Clients, sent me copies of these, thinking that I might be able to use them as the basis for a Bulletin article which indeed I am pleased to be able to do.

The Imperial Wireless Scheme

Before giving details of the Station, it is worth outlining the evolution of the UK Imperial Wireless Scheme from its inception in 1910. In that year it became apparent that a chain of high-power long-wave wireless stations could be formed to link all parts of the British Empire, and an Imperial Wireless Conference was convened in 1911 to take the idea forward. The Empire delegates at the conference agreed that such a system should be created, but that the stations should be owned by the various States, by the Post Office in the case of the UK. The Marconi Company was very optimistic that it would be awarded a substantial UK contract for this work, in addition to stations in overseas parts of the Empire.

The Company's tender for UK stations was accepted by the Post Office in March 1912 but had to be ratified by the House of Commons. Far from being a formality, this did not go through, owing to allegations of corrupt dealing in Marconi shares by Government Ministers; with unpleasing racial undertones in that the Attorney-General Sir Rufus Isaacs was the brother of Marconi's Managing Director Godfrey Isaacs and that they and the Postmaster-General Sir Herbert Samuel were Jewish. A lengthy enquiry eventually exonerated the Company and all others of any impropriety, but it was mid-1913 before a new contract was signed and ratified by the Commons. However this contract was cancelled in December 1914 because of the





outbreak of World War I.

In 1919, after the war, Marconi's put forward a renewed proposal for an Imperial scheme. This was endlessly debated and subject to various committees and it was not until early-1924 that agreement was reached for UK stations to be built by Marconi's but owned and operated by the General Post Office. These, and their overseas counterpoints, were to be high-power long-wave stations and work had already begun in South America and Australia. But at this crucial moment Marconi himself became finally convinced, on the basis of recent experimental work, that a short-wave directional beam system would be technically and economically superior to 'brute force' long-wave methods. Accordingly the Marconi Company put forward changed proposals to the Empire Governments, of whom Canada, South Africa and Australia were immediately agreeable. The British Government finally came to the same conclusion in July 1924, and it was agreed that the Canadian link should be the first proving ground for the new system, with a transmitting station at Bodmin in Cornwall and receiving station at North Petherton near Bridgwater in Somerset.

The Bridgwater Station

Having set the scene, we can now turn specifically to the Bridgwater station. The first of Alex Caisey's documents is a legal Indenture dated July 28th 1924, wherein the Postmaster-General requests the Marconi Company to 'construct upon sites to be provided by him in England a wireless telegraph installation for communication with places in the British Empire outside Europe'. This agreement was signed on behalf of the Company by Marconi and Godfrey Isaacs.

The land to be acquired by the Postmaster-General for the station consisted of Copse Farm (203 acres) plus four adjacent fields. There was a debate in the Bridgwater Rural Council and North Petherton Parish Council as to whether a footpath across the area could properly be closed, but this was eventually agreed to present no difficulty. The local press in the shape of the Bridgwater Mercury in an issue of February 1925 was of course interested in the project, and seemed gratified that the locality was to be the home of the 'wonderful new beam system' and appeared impressed that 'the apparatus required would be of a very powerful transmitter with huge aerials, masts etc.'

Apart from reassuring the public that no interference with local reception of BBC broadcasts need be feared, there appeared no hint of dismay at the proposed industrial use of farmland or the environmental impact of the 'huge masts' – a tolerant attitude very different from the outcry which could be expected today!

In May 1925 the Bridgwater Mercury was able to give more details, following the Postmaster-General's statement in the Commons. Bodmin and Bridgwater would be the sites for the Canadian and South African services. The Montreal station in Canada was well advanced, the South African was under construction near Capetown, and Australian and Indian sites were under consideration.

The Mercury also mentioned the construction of a Beam transmitting station near Dorchester for communication with the Americas: not being part of the Empire scheme, this would be a Marconi-owned station (not GPO), with the receiving site at Somerton.

A month later in June 1925 the Mercury was invited to a tour round the Bridgwater site. Details

reported included a large dump for stores and a big concrete mixer, with a three mile network of light railway to all parts of the site. There would be a total of 10 masts, five each for the Canadian and South African services. Each mast would be about 290 feet high, with four supporting stays: 90ft cross-arms would be mounted some 15ft below the mast heads, between which supporting cables (triatics) would be strung and the vertical aerial wires suspended from them. A second array about 90ft behind the active wires would form a screen to give the the required directional beam effect.

The Mercury noted with satisfaction that the stone, sand and timber used in the construction was being purchased locally; and that the 105 men employed were nearly all local residents.

Details of the station

A Marconi press release dated January 4th 1926 stated that the Bodmin/Bridgwater stations would be ready for service within the next few months, while the Canadian and South African ends were similarly advanced. Transmitting and receiving apparatus was under test at Chelmsford and would shortly be installed.

At both Bodmin and Bridgwater power would be generated locally, the smaller Bridgwater requirement being for lighting and charging the receiver batteries.

Both the transmitting and receiving stations would be connected by land lines to the GPO in London, the transmitters being operated from London by remote control circuits.

The release mentions in passing that similar beam stations were being erected at Grimsby and Skegness for communication with Australia (Melbourne) and India (Poona). A separate paper gives more details of the Bridgwater installation. Power was to be obtained from two 18 horse-power petrol/paraffin engines driving 10kW dynamos for charging the 110 volt station lighting batteries, and for powering four motor/generator sets for charging the 8 volt and 220 volt receiver batteries. Thus all supplies would be duplicated. Station earthing would be to a ring of galvanised iron plates at a radius of 50 feet around the receiver building.

A comprehensive description of the Chelmsford-designed receivers may be summarised as follows. An aerial feeder termination unit comprised two tuned circuits with adjustable coupling, very loose coupling being normally maintained in the interests of selectivity. Signals from this unit were variably-coupled to the receiver input, i.e to the grids of two valves in push-pull, the valves being LS5Ds in which the grid connections were directly through the glass envelope rather than through the higher capacitance base pinch. A local oscillator (DE5) coupled to this stage produced a first IF of about 188kHz passed to a 3-stage push-pull IF amplifier using DE5Bs and giving 10kHz bandwidth. A further detector and local oscillator produced a second IF of 30kHz or, as selected by switching, an audible tone for operational monitoring. There followed three more push-pull IF stages of 5kHz bandwidth and a final push-pull anode bend detector using LS5B's. The detector outputs were combined and fed to a limiter stage and thence to a DC bridge giving 'mark' and 'space' currents for an ATM relay feeding the Post Office line to London.

The Bodmin/Bridgwater link with Canada came into operation a few months later and was tested by the Post Office in accordance with stringent conditions set out in the original contract. The Engineer-in-Chief of the Post Office issued a certificate on October 18th 1926 confirming that the UK/Canada link had passed 100 words per minute in both directions simultaneously for seven consecutive days during an average of eighteen hours per day. Following this, the service opened for public use on October 24th. The service to South Africa did not open until July 1927.

Marconi's Statement

In a speech to the press on October 20th 1926, Marconi expressed pride and pleasure at the successful start of the Imperial Beam System. In the course of his speech he emphasised the very considerable advantages of the system in terms of capital costs, power saving and freedom from interference. On power in particular he said that the effective gain in signal strength from use of the directional beam was 100 times, representing a power gain of 10,000. Thus it was possible to work with a power into the aerial of only 20kW, as opposed to the 200MW which would be necessary to give the same average signal strength with a non-directional system.

He said also that atmospheric and other forms of interference were very much reduced by the beam system, and that the relatively high received signal strengths made fading a fairly insignificant problem. Nevertheless, to avoid fading in especially severe conditions, he said that the beam links could be set to an alternative operating wavelength different from the 26 metres normally used.

Noting the benefit of short-wave working (with greater usable bandwidth) on operating speed, he said that at one point during the recent acceptance tests the Canadian station had sent a message at 250 words per minute with perfect clarity.

He forecast that the short-wave beam system would find useful application in telephony and in picture facsimile, not to speak of television.

Finally Marconi paid sincere tribute to the expertise and dediction of his senior engineers C.S Franklin and R.N Vyvyan and to their supporting staff.

Cables and Wireless

The benefit to the Marconi Company of the beam system was short-lived. The relative cheapness and superior traffic handling of the system quickly made significant inroads into the revenues of the cable companies, who made strong representations to the British and Dominion Governments. Accordingly an Empire Government Conference was convened in 1928 with the result that two new companies were formed in April 1929: Cable and Wireless Ltd as a holding company with Imperial and International Communications Ltd as the holding subsidiary. The names were later changed to Cable and Wireless (Holding) Ltd and Cable and Wireless Ltd respectively, the 's' in 'Cables' being dropped. The new companies were to take over all Marconi's beam stations, including the Dorchester/Somerton American services.

Poor health had forced Godfrey Isaacs, the strong (and ruthless) Managing Director of Marconi's, to retire in 1925, and the Company's commercial effectiveness significantly declined. Despite its potentially strong position, Marconis meekly accepted that it should be a junior partner in Cables and Wireless, with Marconi himself as their only Director and entailling considerable financial loss in the way of operating revenues.

The final paper in Alex Caisey's collection is a souvenir programme arranged in 1930 by Cables and Wireless Ltd for Imperial Conference Delegates to visit Dorchester and Bridgwater Beam Stations. It does contain a tribute to Marconi's continuing work in the development of ship-borne wireless telephony, but is nevertheless a rather sad reminder of the ousting of Marconis from international wireless telegraphy.

My thanks to Alex for providing this interesting documentation.

Televisions of the future - 1949 style!

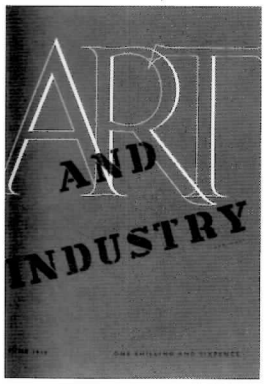
by Carl Glover

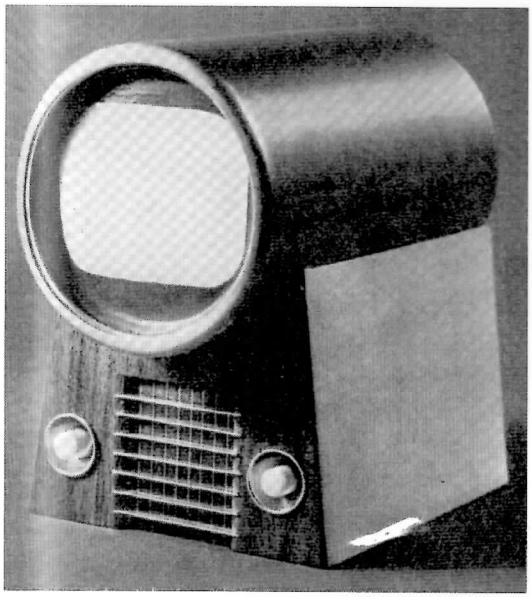
During a particularly blustery day in Greenwich I decided to take shelter in one of the many bookshops located near the craft market. A few minutes of browsing yielded a strange cloth-bound tome which when opened revealed a bound set of 'Art and Industry' - a magazine dealing with industrial, product and graphic design.

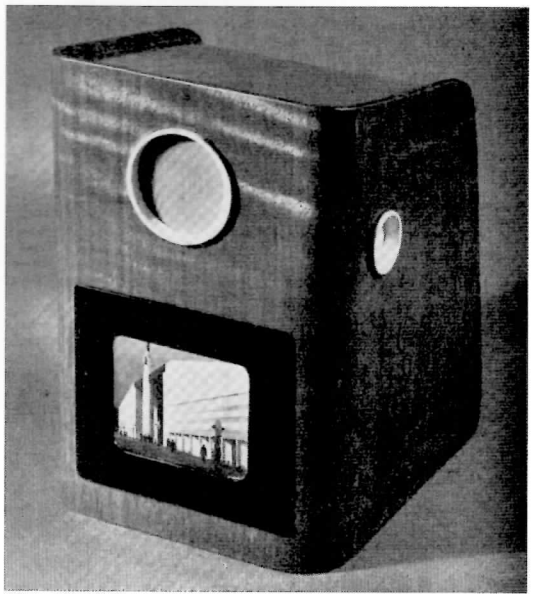
I bought the collection as it was brimming with many articles relating to television and wireless.

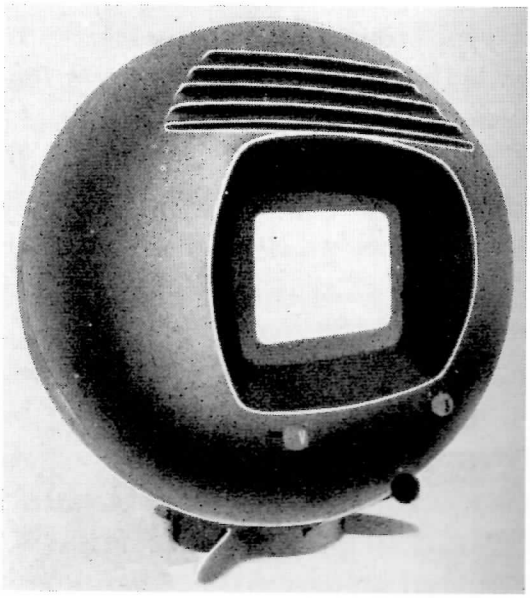
One article in particular stuck out as it was illustrating the entries of a competition sponsored by EMI to design a Television cabinet. The competition attracted eighty four entries, some of which are reproduced below.

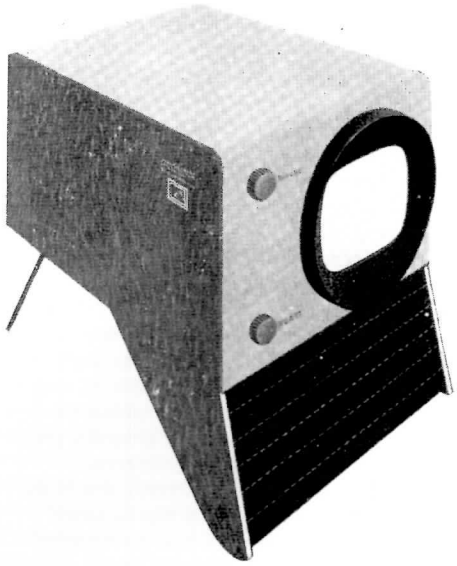
The criteria for judging were quite stringent and were guided by practical considerations, mainly the size and position of the screen and the relationship of the rest of the television to it. Consequently the more unusual looking sets didn't get a prize, but at least they were reproduced in print. Needless to say, none of these designs seemed to have reached the high street. A pity for the collector.

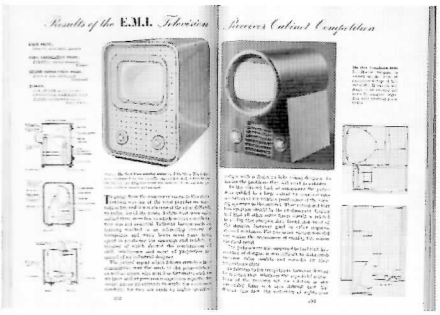


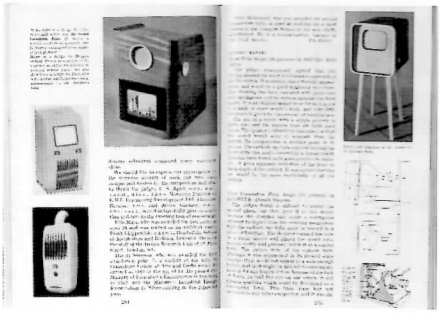


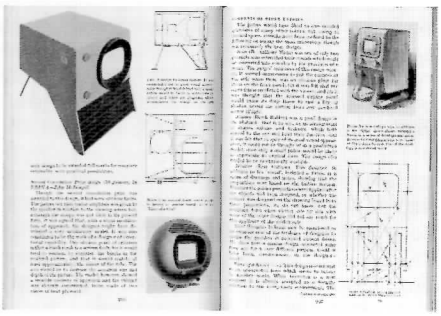






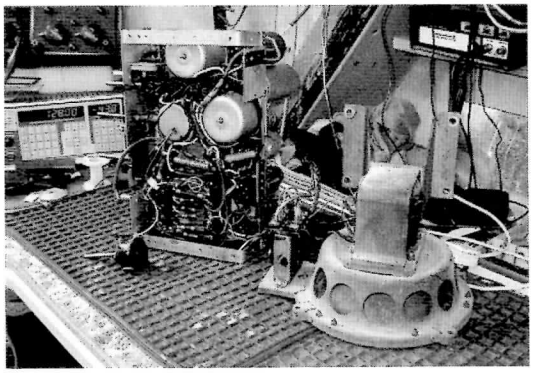


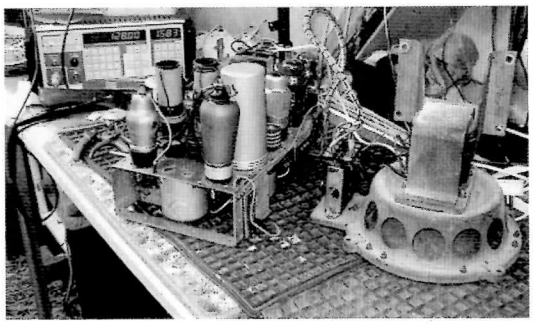




Redemption by John Holloway.

About forty years ago, when restoration was generally confined to fine art and furniture my Aunt Belle who lived in Worcester and of whom I had always been slightly in awe as a child, asked me to consider fixing or modernising her HMV 540 radiogram. As I was now an impoverished twenty year old I jumped at the chance of earning a bit of money and also showing off the few skills I thought I had acquired. This polished and much valued artefact had been bought by my aunt around 1933/4 when first married. As children, my cousin and I had listened to 78s played with great care as a special treat.





Far left: Unit in its unredeemed state

Top left: Underside of chassis showing restored condenser box and associated resistors in place.

Lower left: Chassis on bench: Chassis under test with a full complement of valves and its new wiring loom to the speaker.

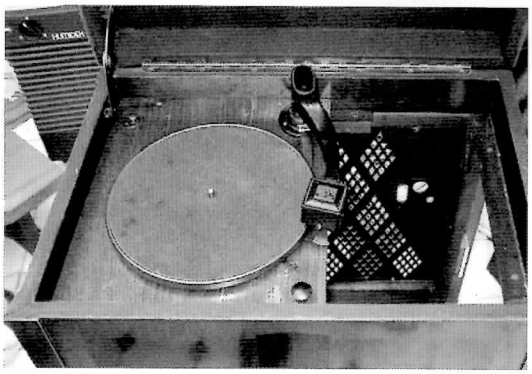
By the 1960s the radio only received BBC Midlands and the turntable mechanism was indifferent. To my young and insensitive eyes the answer was simple. She didn't want to spend a great deal of money so a cheap 4 speed turntable with a modern pick-up and a small cheap and cheerful amplifier and modern speaker were purchased. The chassis, mains energised speaker and turntable were thrown out and a new baseboard covered in black Fablon was installed in place of the original polished wood. The external volume control was left in place but not used and that was that. She was happy, I was happy with what she paid me and I went off to make my way in the world totally ignorant of what heinous crime I had just committed in the name of progress, greed and the scourge of the sixties 'convenience'. Remember all those hardboarded doors and Barry Bucknell? OK so you could argue that he saved all those original doors from the skip but I had to live with them covered in hardboard!

Fast Forward 40 years and my cousin, who had inherited the cabinet and its lowly contents, rang me to say that she was considering getting rid of it as it was taking up space in her work room and would I know where she could buy a 1950/60s record player that would play all the 78s of her mother's which she still had. My aunt had worked for the Ministry of Food in Worcester during the war and had accumulated some of the propaganda records made by such stars as Elsie and Doris Waters along with the monologues of Stanley Holloway etc. The former of these suggested ways of saving precious foodstuff and a hundred and one things to do with powdered egg! These, along with more classical and popular records of the day had, it seemed, travelled down through time. I said that I knew the very person who could help and promised to come back to her with some possible suggestions.

In matters of supply of period radios and associated equipment I contacted Bill Milne who lives close by. His stock of around three hundred, yes 300, items is always a good starting point and, as he has photographs of most items it would be easy to show my cousin just what was available. True to form Bill produced Deccalian and Hacker record players, both in excellent condition, and at a reasonable price. I sent off the photos and the sizes of the two units along with their price and waited to hear from my cousin. All this time an idea was forming in my mind which I mentioned in passing to Bill and although we didn't explore it with any more than a wishful thought, it had begun to stick.

A week or so later my cousin phoned to say that although both units were fine she was now beginning to have second thoughts about getting rid of the original unit as it looked so much nicer than the record players. I also detected a sense that to dispose of the original cabinet would be a big wrench with the past and this was not what she really wanted to do. At this point caution was thrown to the wind on my part and I blurted out what had been at the back of my mind for the previous couple of weeks. "Pat, what about restoring it back to its original condition? Give me a couple of weeks to see whether it might be possible to locate all the main bits. Chassis, speaker, turntable and pick-up."

There was a stunned silence but then her voice



Above: Speaker: Prior to fitting output transformer and wiring up.

Top right: Gram unit in cabinet showing side access panel.

Lower right: Finished unit with its accompanying promotional postcard.

returned to its usual lighter tone. Yes, that would be wonderful but is it possible? I explained about the Society and told her about Gerry Wells and the Museum and said that I would go and talk to him, ask his advice and get back to her. I think she rang off feeling a little happier than when she had phoned originally. I also spoke to Bill who agreed to help on the project if we were able to move it on and we decided to go down to Dulwich and see what the Great Panjandrum had to say. I rang Gerry to let him know we were coming and gave him some idea of what we were looking for and he immediately referred me to an article he had written on the Marconi/HMV chassis in question which I printed off from the BVWS CD. We arranged a convenient date and on a sunny autumn day in 2002 I got the Triumph out of the garage, put the hood down and Bill and I drove down to Dulwich.

Gerry was in the workshop when we arrived, putting the finishing touches to a East European set. When he had finished I made a full confession of my sins all those years ago. No penance was exacted and I was absolved of all guilt with the dismissive 'Oh, we've all done something like that at some time! Let's go and have some tea and we'll see what we can find.'

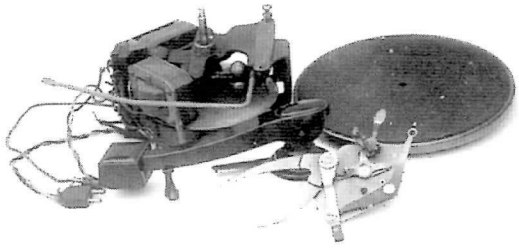
As we sat in the kitchen the possible locations in the house of most of the items we would require were fired off. 'There's definitely a chassis in the loft and the cupboard on the landing that 'smelt of gas' should reveal a motor and possibly a pick up, and there are some mains energised speakers stored down the end of the garden.'

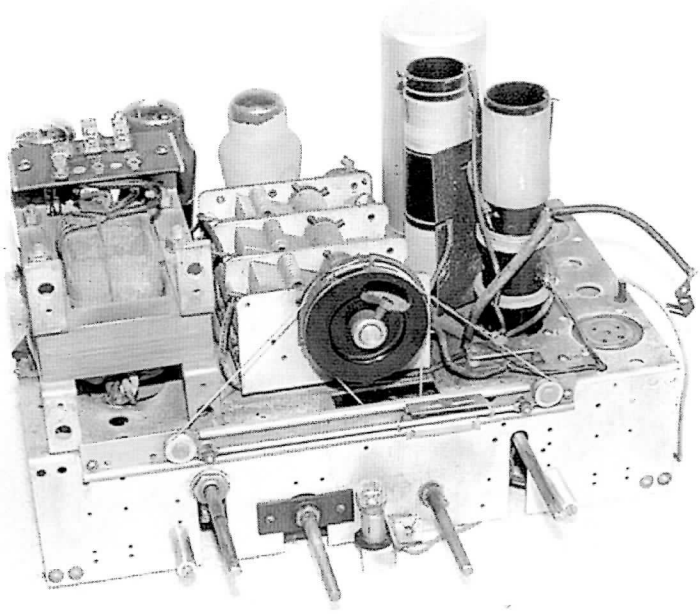
True enough a trip up to the top of the house saw Gerry dive into the loft and emerge a few moments later with a dusty chassis missing a couple of valves and a tuning scale but looking pretty useful. No charring around the mains transformer and untouched by the phantom bodger. We then moved to the next floor down, pausing to look at a version in cherry wood of the HMV540 we were attempting to resurrect. A sketch was made of the layout of the motor board and adjacent radio layout as this was missing from the cabinet and then on to 'the cupboard that smelt of gas!' It is brimful of turntables, auto-changers, pickup arms and other associated bits from across the decades and having moved most of it out onto the landing Gerry spotted the base board and the induction motor perched precariously on a pile in a far corner. This would provide the motive power to send those 78s spinning round once more.

I foolishly remarked at this point that no pick up we'd so far seen matched the original but this was brushed aside as a minor problem which would probably be solved when we returned to the workshop and stores. En route we found an exact match for the speaker minus its transformer and with a pretty tatty cone and, in the drawer holding Gram parts, the shell of a pick up arm and eventually a pick-up armature itself complete with stand, speed control, auto switch plus a few other items. A deal was done, money changed hands and both parties went away happy. There were still minor trim items to find but Gerry assured us that they were not going to be a problem. The next day I phoned my cousin to say we were on our way with the project and arranged to come down to pick up the cabinet.

On my return I stripped out the rather sad looking Garrard SRP10 turntable and its associated amplifier and speaker and then started on the business of cleaning up the chassis, speaker and motor. Bill was going to look after the rewiring and any rebuilding of the chassis but I decided to handle the clean up and removal of items such as the potted capacitor box (HMV's answer to the DIY merchants of the 1930s) along with working on the motor and auto-stop mechanism and repair of the speaker cone. I would also re-veneer the existing motor board and make a replacement board for the radio section, again veneered to match.

Anyone who has worked in this generation of chassis from Marconi/HMV will have come up with the tin box mounted under the chassis containing some 11 or 12 capacitors, depending on which model, potted in the tar with a paxolin cover carrying a dozen resistors. The external connections to the rest of the circuit were labelled and noted and the unit removed. Following Gerry's advice, 30 minutes at gas mark 3 loosened the tar off and leaving the resistors in place on the paxolin allowed the whole thing to be pulled out. The tar was poured off into a metal container and the dirty business of clipping off the capacitors from the underside began. Much of the connecting wire to the old caps was left in situ so that all the connection points were visible both below and above the paxolin tag board. A sketch was made of the outer side of the unit and the connection points and, as most of the





tags are numbered, these were incorporated into the sketch. The Traders Sheet notes this unit and its capacitors along with these numbers but not the resistors and so it was vital to list as much information as possible at this time.

Gerry's article in the Bulletin 'A Set for All Seasons' gives some useful background on these sets. HMV and Marconi both used these chassis, which was their first 5 valve Superhet. It started life as the 262, became the 264 then the 272 and so on. The radiogram we had was designated 540 though the chassis we were now working on was identified as a probable 262 radio chassis. It was ready to run as a radiogram except that the external sockets etc., would not line up with the original back panel of the radiogram cabinet. The Traders Sheets cover under different numbers (No.8) the 262 as an AC mains model, (600) the DC mains model, (No.39) as model 264 and finally No. 518 which is a revised version of No.8 This information was researched by Bill as he would be rebuilding the set. This paid off when he came to undertake the final re-alignment as with all these long running designs there are modifications over time. A large drawing of the condenser block was made from the notes taken and using the ERT Sheets some guesses were made as to component numbers and wiring destinations. This was because certain values had been changed. At this stage a replacement set of capacitors was ordered from Savoy Hill Publications and I started on the motor.

Like the radio chassis the motor assembly also incorporates a sealed condenser box and as previously the oven was used to loosen off the tar holding the components in place. The motor is an inductance type. Bill tells me he knows it as a Ferranti motor, similar in principle to the old fashioned electrical meter with the rotating disc taking the role of the turntable. There are two electro-magnets each with its own capacitor. The mechanism actually worked with the application of power via a variable transformer but we decided to replace as much of the existing wiring as practicable and replace the capacitors. The flying ends of the electro-magnets were replaced with modern cable and the insulating grommets replaced and new capacitors with estimated values of 0.47 microfarads were potted into the box and re-connected. Everything appeared to work so this was put to one side.

The speaker next. The cone was badly damaged but still serviceable so I stitched up the tears with glue and passed it over to Bill to identify the connections. After all these years the colour of all the cables in the speaker loom connecting to the chassis had become a dirty brown or grey colour so Bill made up a new loom, recalling the skill of lacing a loom from past experience.

At about this time another visit to Gerry's located the tuning scale, a vertical layout as opposed to the existing horizontal type fitted, a set of knobs, the receptacle for used needles and a discussion about rewinding the pick-up coils as we had discovered that one of the coils was open circuit. With the 47 gauge wire thinner than human hair this was not something that either Bill or myself were too keen on attempting but Gerry offered us the use of the workshop's coil winding kit and the wire, so we decided we would come back another day and have a go. While we were there we again looked for an output transformer for the speaker but could not find an original. However, Gerry again came up trumps and produced another speaker in better condition with its output transformer bolted in the appropriate place. Having settled up for the other items and promising to return the repaired original speaker we set off in high sprits though still knowing that the pick-up coils stood between us and success.

Back in Bill's workshop and having connected the 'new' speaker' nothing worked. The tap in the field coil had become open circuit. With some nervousness the whole speaker was dismantled and the two 'L' shaped pieces connecting the tap were found to have never been soldered. At this stage only the audio stage of the chassis was working so a 30volt field supply was made up and when the cone had been centred, a separate radio provided speech and music for test purposes. Perhaps this speaker had come from a radio which had been dumped because of the failure of this very unit.

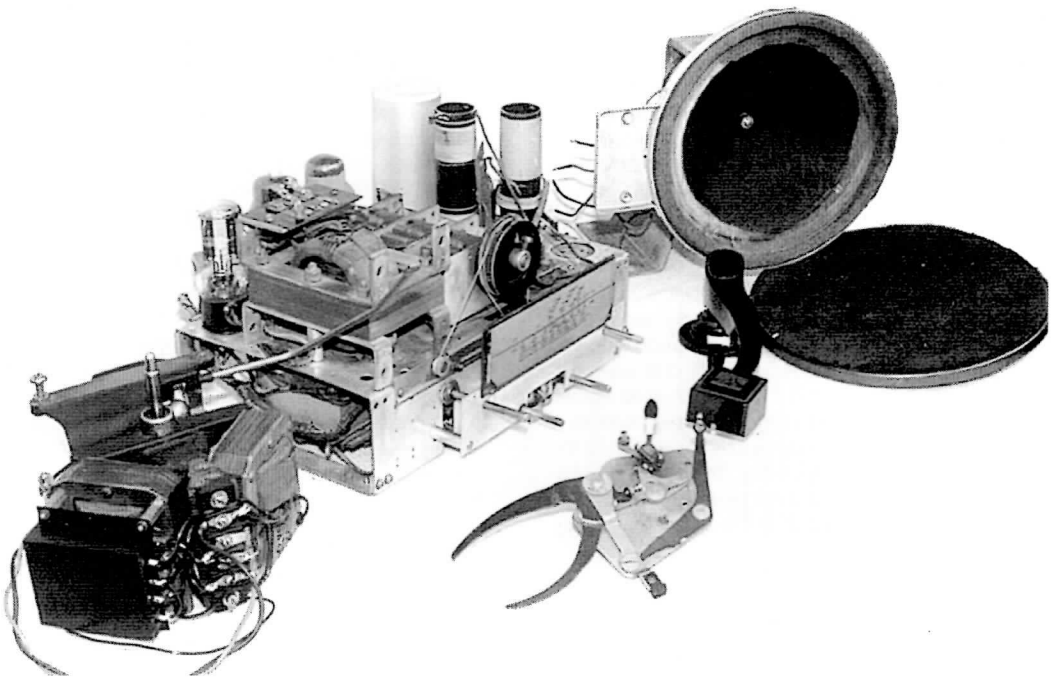
We had been putting off the dreaded day when we returned to Dulwich and attempted to rewind the pick-up coil. But we decided to bite the bullet and set off for SE21 once more. It was thought a good idea to make some small bobbins so that if we mastered the craft we could wind up a few spares to leave with Gerry for any future requirement that he or others might have. Our altruism, though well meant, was to prove over-optimistic.

I should have known what was coming when Gerry,

Top left: Gram motor, turntable and pick up with the Autostop mechanism ready from rewiring and cleaning.

Far left: The chassis and other components straight out of storage at Gerry's. Note the horizontal tuning scale which would have to be replaced with a vertical type.

Above: Cleaned up and ready for it's remaining valves.



Right: Chassis, speaker, motor and other component ready to be fitted.

having led us to the coil winding room said. 'Well, I'll let you get on with this as I've never really ever got to grips with this kit.' I now know exactly what he meant!

Age, increasing lack of patience, diminished eyesight and hands which I feel are less dextrous as the years roll by made our task a total failure. I think the best we achieved was filling about one third of one bobbin in about three hours. It was like two blind men trying to knit air! Someone put their head round the door at one point and I could see that he thought we were dealing with some invisible substance. Eventually I made an executive decision and went back to Gerry in the main workshop, told him the problem and asked whether we could check out his supply of old pick-up heads to see whether we could find another coil. 'Ah yes, I thought you might have a problem, have a look in this drawer here'. After working our way through a pile of suitable heads, checking continuity, one was found, though with a slightly different configuration of the coils and, slightly chastened, we returned to Wimbledon through the rush hour traffic.

As we had an original motor board already, the obvious next step was to assemble the pick-up, mount the motor and auto-stop mechanism and carefully place the pick up and our only needle on a 78. This latter item was to haunt me in the weeks to come. On one side was a recording of 'Come, Silver Moon' sung by Dora Labbett and Hubert Eisdell; an Anne Ziegler and Webster Booth style duo of the 1930s. In fact this is The Londonderry Air under a different title. The flip side was their version of Love's Dream or Leibestraum. I can state categorically that I would never willingly listen to either song again!

The first attempt was a total failure as we had guessed the wrong value of the phase shift capacitors as 0.47microfarads for the motor and as soon as the pick-up touched the surface of the records the motor ground to a halt. As Bill put it 'It wouldn't pull the skin off a rice pudding.' Again Gerry came to our rescue with the correct value of 2 microfarads and the familiar strains of the Londonderry Air broke the silence for the first but not last time as I spent many day trying to set up the auto-stop mechanism which basically worked but not when it was supposed to. To this day I am not sure whether what I did is correct but it now does work and the hours filing a number of trial pieces of brass into a cam to take up the slack in the linkages were worthwhile.

Meanwhile Bill had taken the chassis by the scruff of the neck. The mains transformer looked OK and proved to be so when 'megged' at over 20 megohms. The overall hum level was low but the power grid detector/amplifier V3, a MH4, did like to become unstable and the field coil phasing seemed odd. V2, VMS4, also had to go as it produced virtually zero emission and certainly did not detect the intermediate frequency signals generated from a professional signal generator. After spot tuning the IFTs on 128Khz there was plenty of gain and instability despite the recommended stagger tuning. It was also noticed that HT volts reeled about when high volume was used or the wave change switch operated. Returning to the infamous condenser block it was discovered that the smoothing capacitor C18 was floating, its negative not connected anywhere. When this was rectified the phasing of the speaker field coil windings became obvious, hum one way almost none the other. The hum bucking coil could now be correctly phased.

At an earlier stage the volume control had been found too noisy with half its track burnt out. Gerry had been able to find another half good one and the bits were cannibalised to make one good one. The RF stage could now be aligned. RF tuning worked but then leakage around the treacly insulation meant replacement. But what colour is treacle? It turned out to be brown like almost all the wiring.

Things were beginning to come together and the mains on/off switched was wired into the circuit as the fourth position on the wave-change switch which has positions for LW, MW Gram and On. It was decided to replace more of the original wiring at this point so once again Bill's expertise with lacing came into its own. V1 was also found to be low and though Bill's stock runs to some 1200 valves, an MS4B was not one of them. A call to fellow memberJohn Wakely brought forth the required item. Finally some of the resistors which sit on the paxolin tag board on top of the condenser block were changed where the passage of time had sent them high. A traditional black cotton sheath mains lead was fitted and as an extra precaution fuse holders were fitted on paxolin and attached to the spare bracket on the mains transformer, one carrying the working fuse and one a suitable spare.

It just remained to fit and line up the tuning scale and fit a new lamp. Rated 6.3 volts and running from

the 4 volt heater supply it will just get blacker and blacker but probably never fail. An aerial, earth lead and mains aerial plug and gram plug finished the job.

It was then a case of re-installing the chassis and gram unit into the original cabinet and transporting the considerably heavier cabinet back to Seaford in Sussex. The unit has a side panel which can be removed by undoing a screw on the right hand side of the radio section looking from the top. With this removed it is a fairly easy job to bolt the chassis into position albeit needing wrists of steel. 4 x 2BA bolts are required and, if you are cutting and drilling a new fascia-board for the radio to sit behind as I was, then a selection of washers to true up the unit in relation to cut outs in the new fascia are handy things to have around. I found that however much care you take there is always a slight degree of drift when making up a template from a unit which is as complex as a chassis with very little other than the controls to line up with. The cut out for the dial in relation to the rest of the fascia is always tricky. The original motor board and the new fascia were re-veneered, stained and polished to be as close to the original wood inside the lid as possible

It was at this stage that I noticed that all the knobs we had found at Gerry's were as expected, provided with holes through which a screw would pass and engage with a slot on the spindle of the controls. All the existing controls on this set had no such slot. My replacement facia was also very slightly thicker than the original plus the veneer and so the control knob spindles did not poke through far enough. Slotting the shaft was not a problem. A Dremel will do that but how to get enough of the spindle to get a fixing for the screw? Luckily there was enough clearance under the facia to lift the chassis the quarter inch needed. So the chassis mounting holes were slotted to enable the unit to move up and the facia was planed down on its under-side to keep some clearance.

The pick up, chassis and speaker were all connected in situ and the original external volume control for the pick-up added to the circuit. At this point howls of protest blasted through the house when Gram was selected so the separate earthing and shielding from the pick up were joined together.
It then worked perfectly and to celebrate Bill provided another 78, tshis time a more modern recording of Doris Day singing Que Sera Sera which showed what a good quality 78 could sound like on the appropriate equipment and could be thought of as a fitting end to six months well spent. The lady owner is enjoying her collection of records and listening to the radio on a set which is just on 70 years old and which should her children not wish to keep will be donated to the Vintage Wireless Museum in what is hoped to be the very distant future.

I know my cousin would like to take this opportunity of joining me in thanking Gerry for his advice and practical help in making this project a reality and of course thanks as ever to Bill Milne.

Roberts RIC-2 by Paul Stenning

This set was given to me, and was in a fairly sad condition. The cabinet was filthy, the tone control knob was missing (the control shaft was broken) and the base plate was broken. It was also rather battered. However, when a battery was fitted the set did work, albeit with some crackles.

The RIC-2 is electrically similar to the earlier RIC-1, which was Roberts's first set to use an IC. The changes in the RIC-2 are mainly cosmetic – clearly Roberts were bringing the model to the same appearance and form of construction as their other models at the time.

The RIC-2 circuit diagram is included in the 1971-72 edition of Radio and Television Servicing (page 667). Comparison with the RIC-1 circuit in the 1969-70 edition reveals only a couple of minor component value changes.

The set uses an IC (Mullard TAD100) to replace the entire RF and IF stages, as well as the AF preamplifier. A ceramic resonator assembly is used to set the IF passband. Three transistors (OC71, AC187 and AC188) are used to form a direct-coupled class AB output stage.

Anyone who has worked with Roberts transistor sets will know that there are three main things that will stop them from working:

- Faulty AF117-type transistors
- Poor soldering
- Electromechanical faults (controls, aerials, tuning drives, earphone sockets etc.)

This particular set did not use AF117 transistors, but the other two problems were present!

Disassembly

Most Roberts sets of this era are dismantled in the same way. The base is removed, the battery is removed, the speaker wires are unsoldered, then the two screws holding the chassis to the brackets mounted on each end of the cabinet are removed. If the set has a telescopic aerial, the screw for this needs to be removed too. The chassis can then be withdrawn from the top of the cabinet, complete with the tuning scale etc. Normally this is a bit of a struggle because it will be stuck in place with years of dirt and muck. Pushing from inside with a long screwdriver is a good way to free it.

In some sets, including my RIC-2, there is a DC

input socket mounted on the back of the cabinet. This is held in place with two wood screws that are almost impossible to remove. Rather than struggling, I chose to cut the wires close to the socket. By leaving about 6mm of each wire on the socket, I could easily see which colour went where when reconnecting later.

Having extracted the chassis, the knobs can be removed (they are generally push-on types). Care must be taken because the control shafts are sometimes plastic and easily broken. There is often an earphone socket and a car aerial socket on the top face, so the wires to these items need to be unsoldered (draw a sketch). Don't let the earphone socket get too hot or the plastic will melt and it won't work properly.

The two edge trims may now be removed and the tuning scale lifted away. Underneath there will be loads of dust!

The Base

The cabinet base is a flat piece of wood that is fitted with a turntable in the centre (so that the set can be rotated). Near one end is a round hole large enough to insert a finger. The base fits into the cabinet between a spring and a small block of wood, under some pieces of trim. By inserting a finger in the hole the base can be pulled against the spring and lifted out. On later models the spring is replaced with a piece of self-adhesive foam.

My base was broken lengthways, and the turntable was missing. The two pieces fitted cleanly together so I repaired it with woodworking adhesive then held the pieces together with elastic bands while the glue dried.

From my previous encounters with Roberts sets (my late father and I repaired sets voluntarily for the British Wireless for the Blind Fund several years ago) I still had a few spare bits and pieces. I found a suitable replacement turntable from a spare R800 base (the R800 is a much later model but the turntable is the same). This was fitted to my base using the then-standard method of melting the ends of the plastic spikes on the inside with a soldering iron.

Pot and Knob

In my collection of Roberts bits and pieces I managed to find a similar knob to the missing one. However this was for a smaller shaft than the existing control. Since the shaft was broken anyway, I either had to repair it or replace the control. Since I didn't have a spare control to hand, I decided to attempt a repair.

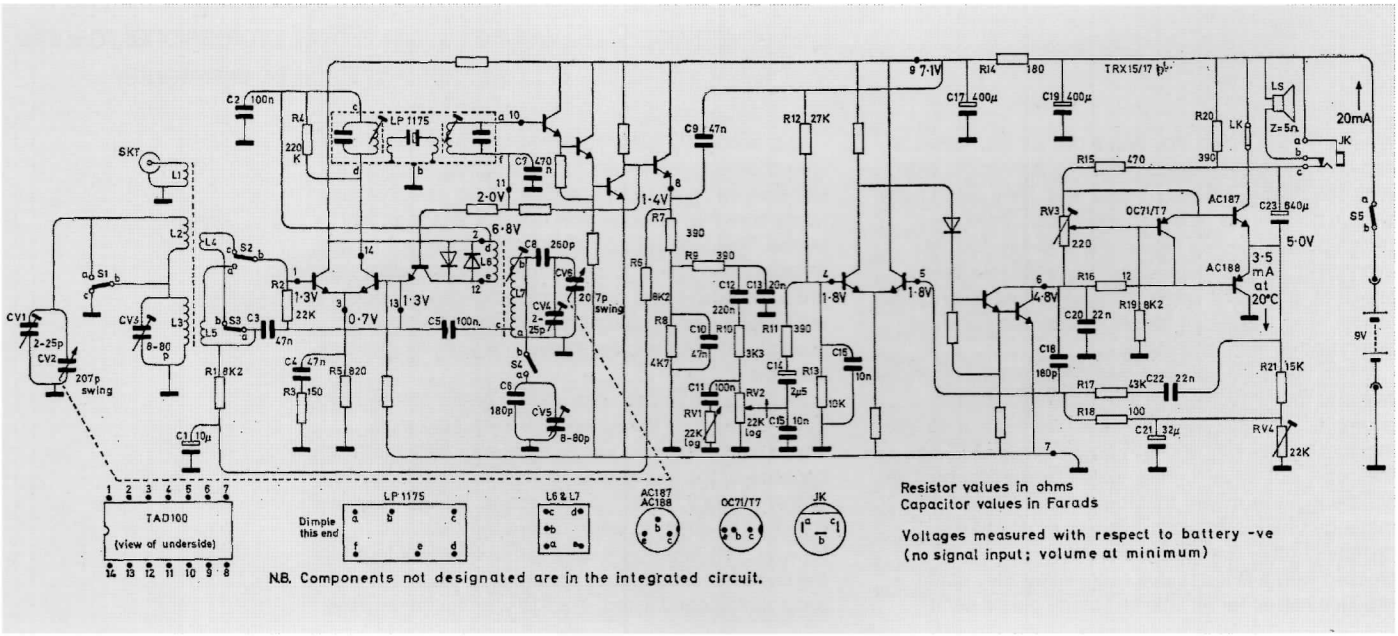
The first thing I needed was some material to make a replacement shaft. This needed to be 4mm in diameter and about 20mm long. After some searching I spotted a small model-making paintbrush. Although the plastic handle is tapered I could get a sufficient length that was close enough to the right diameter. I cut the brush section off then filed a flat onto the handle (which I will now call the new shaft) to fit the knob. Care is needed to keep this parallel otherwise the knob will not sit straight.

With this part successful, I needed to fit it to the remains of the existing control. The control was disconnected and removed from the chassis. I then dismantled it (by unfolding the four bent-over tabs) and removed the shaft/wiper section. I cut the broken end of the shaft off with a junior hacksaw, so it was square.

The next stage was to drill a 4mm diameter hole into the 6.35mm (1/4") diameter shaft. It needed to be central and straight. A lathe would have been ideal for this job, but I do not have such luxuries. However I do have a bench drill, which is the next-best option. I fitted the shaft/wiper assembly into the drill vice, ensuring it was vertical. Rather than going straight in with a 4mm drill, I started with 2mm. Generally the best method of drilling plastic is to use a fairly high speed and go very gently, lifting the drill away every few seconds to clear the swarf and prevent it getting too warm. A sharp drill is essential to prevent snagging. I drilled down into the shaft about 10mm deep, then enlarged the hole to 4mm to the same depth. Before starting I had marked the centre of the shaft with a fine marker pen, by eye.

When I tried the new shaft in the hole, I was pleased to find it was a good push-fit. The slight taper of the paintbrush handle helped here. It therefore required no additional fixing. Before pushing it in finally, I fitted the knob then rotated the shaft in the hole to get everything as close to concentric and straight as possible. No matter how carefully one does this sort of job, there will inevitably be some lack of precision, but by rotating the parts I was able to find a position where the errors cancelled each other out – near enough.

When I came to reassembling the control, I found that the shaft was a very tight fit into the bush. By pushing the new shaft into the existing one, the existing one had stretched in diameter slightly. I reduced the diameter by using sandpaper, followed by wire wool to smooth the finish. I then reassembled the control, lubricating everything with silicone grease.



Cleaning

The best way to clean the tuning scales on this type of Roberts set is foam cleanser. Spray it on, leave it to work for about a minute, then wipe off. This will need to be repeated a couple of times if the scale is very mucky. My RIC-2 had obviously spent its former life in the usual home for battery portable radios – on the fridge in the kitchen – because it was covered with brown greasy muck. Some foam cleanser will get into the earphone and aerial sockets, but this does not matter. Once the dust in these has become soggy it can all be hooked out with a small jeweller's screwdriver.

After cleaning, the scale still looked a bit dull and lifeless, so I polished it with Greygate Plastic Polish. This is specially formulated for Perspex and similar acrylic sheets, so is ideal for the job. Although the print on these scales does not tend to come away like glass scales in valve sets, care should still be taken not to get cleaner or polish on the printed side.

The cabinet and trim were also cleaned with foam cleanser, after removing the speaker. With the speaker out I was able to flatten the speaker grill metal by hand.

The vinyl covering is damaged in a couple of places, but there is nothing I can do about this apart from recovering the whole set, and I didn't think it was bad enough to justify that. The whole set looks a bit battered anyway, so to do the job properly I would need a new speaker grill, knobs, handle, wooden end cheeks etc. Not worth the effort!

Crackles

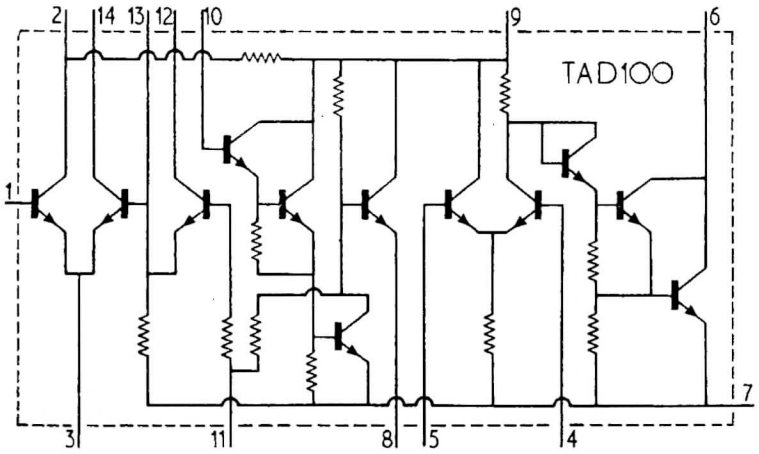
The set was then reassembled sufficiently to allow it to be tested. As expected from previous tests, it worked OK but crackled when handled. The volume control and waveband switch were treated with contact cleaner because these crackled when operated.

The PCB and chassis wiring were then examined and a number of suspect joints were resoldered. Anyone who has worked with Roberts equipment will know that they seem to use the minimum amount of solder on their joints, in particular the interwiring. There are invariably a few connections that are so delicate that you wonder why the wire hadn't dropped off years ago!

The set now behaved better, but there was still crackling and distortion when the speaker wiring was disturbed. This turned out to be due to the earphone socket. I have had problems with these previously, so it didn't surprise me. Unlike the open types used on far-eastern trannie radios, the enclosed types used by Roberts and other British manufacturers cannot be easily repaired. The earphone socket disconnects the speaker when a plug is inserted, and it is this arrangement that fails. The only sensible solution is to disable this function so that the speaker remains in circuit even if an earphone is plugged in. This is easily accomplished by moving the wire to the speaker to a different tag on the socket. It is unlikely that anyone would need to use this socket now, so the solution shouldn't cause any problems.

The set now worked reliably, but I was not happy that the alignment was correct. It sounded rather shrill - as though it was slightly off-station. As a quick check I connected a test meter across the AGC capacitor (C1) and tuned into a fairly weak station on MW. I then carefully adjusted the cores of the two inductors in the IF filter assembly for maximum reading. Tuning across both bands the set now sounded much better, so I decided to leave it at that.

The set was then finally reassembled. To finish it off I polished the case with household aerosol polish.



Top: Internal components and connections of Mullard TAD100 chip. The first used in any UK commercial portable radio.

A is for American

by Gerald Wells

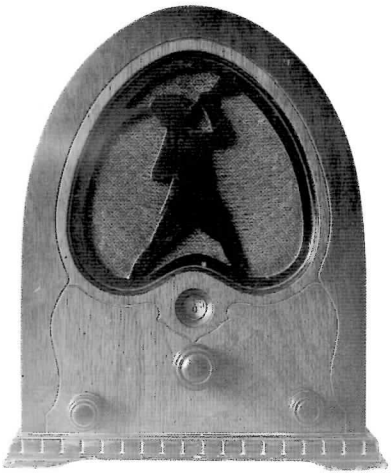
The Americans got involved with radio almost as soon as it was invented. They went into it in a truly professional manner. We went into it like a bunch of enthusiastic amateurs.

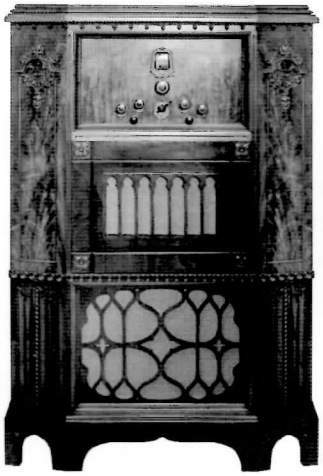
When the First World War broke out we shut down all non-military radio development. The Americans didn't. Why should they? It wasn't their war. They didn't have a valve holders tax, a British valve association or a British post office and Government to say "no" to everything. All this meant that they were four years ahead of us when it came to development, they could use as many valves (or toobs) as they liked and they didn't bother with long wave.

When the U.S.A. started manufacturing valves in the twenties they only made a few standard types ie: a power rectifier (80), output power triode (71 or 45 etc), medium triodes (27) and H.F. pentodes (24-51). As they were not English, they could standardise on their numbering, this meant that the number 27 could be made by Philco, Majestic, Sylvania or any of the dozens of other manufacturers. As they were not blessed with a British valve association they could produce valves for as little as twenty pence each.

In this country every valve manufacturer used his own numbers and letters for their valves. We couldn't standardise on our valve holders either. The BVA also made sure that no valve was sold for less than fifty pence. This may sound rather harsh but in actual fact it had a good effect; it meant that manufacturers were producing valve that did several functions at once and set makers were making sets with as few valves as possible. The Americans seemed to want as many as possible.

By 1936 the British were getting better results from three valves than the Americans were from nine. These early American valves were very reliable, mostly because of the heavy-duty heaters or filaments; most of them were 2.5 Volts at 1.75 amps. It might take half a minute for them to warm up but they seemed to last for ever. The Americans were rather reluctant to adopt the superhet circuit. They preferred to have four or five gang tuning condensers in a TRF configuration. They





Another thing I like about the American sets is their cabinets. They have an abundance of good hardwoods that they can use; they have also mastered woodcutting and carving machinery. They can produce yards and yards of the most wonderful carvings at the touch of a button. They never seemed to bother with plywood very much.

got extremely good results from these multi-valve sets. The Americans have learnt the black art of coil making. For the last thirty years I have tried to learn their secret. In 1931 they produced the Peter Pan set that was made by Jackson Bell. It used an 80 rectifier. a 47-output pentode and two type 24s. It was medium wave only and used the minimum of components; it had an attractive cathedral case with the Peter Pan motif on the speaker fret. A handful of them came into this country. Mine was found in a dustbin in Cheam. I have been making copies of it for many years. No way can I get the selectivity up to the performance of the original. The tuning coils are wound on two 3/4 inch paxolin formers with seventy-five turns of thirty six gauge enamelled wire for the grid windings and about forty turns of the same for the primaries. It was only a few weeks ago that I found the reason: it was the coil formers. Paxolin is in fact bakelised paper. Over the years the paper has absorbed moisture. This has the effect of knocking seven colours of S**t out of the Q. By baking the coil formers for a few hours I was able to get the set to work on six feet of wire or a bit of wet string. I could even separate two Asian stations. Another thing I like about the American sets is their cabinets. They have an abundance of good hardwoods that they can use; they have also mastered woodcutting and carving machinery. They can produce yards and yards of the most wonderful carvings at the touch of a button. They never seemed to bother with plywood very much. They also had some outstanding design teams.

In the early thirties they found that there was a market for these monsters that were coming out of the Philco and Majestic factory; they found that you could market a nine valve yank cheaper than you could purchase a four valve English set. As the sets were both heavy and large the cost of shipping was rather high; it suddenly dawned on the USA manufacturers that you could pack thirty small midget sets in the same space as the monsters. At about this time (1934) firms like Emerson, Fada, Detrola and RCA could produce these sets to retail in this country from about four pounds and provided that they weren't brightly coloured or looked too American they would sell. The cases were made out of catalin, best described by Mike Barker in a recent bulletin as the nearest way of having a set made out of toffee. The sets were selective but the sound quality was rather poor, it puts you in mind of a wasp in a bottle or a cat peeing into a hot tin can. It didn't matter because the Americans don't listen anyway

The American electric mains are different as well: 110 volts at 60 cycles seems to be normal apart from Washington that everybody knows is DC. This does give problems for those little American midgets, a lot of them were fitted with about 8ft of line or resistance cord to drop the UK mains voltage to 110v.; it got warm and was highly dangerous. In the States you can't even get a good shock off 110 volt mains but in this country you can blow yourself to eternity. Life is cheap; we've had two world wars to prove that. I often wonder how you can make an electric chair work on 110 volts.

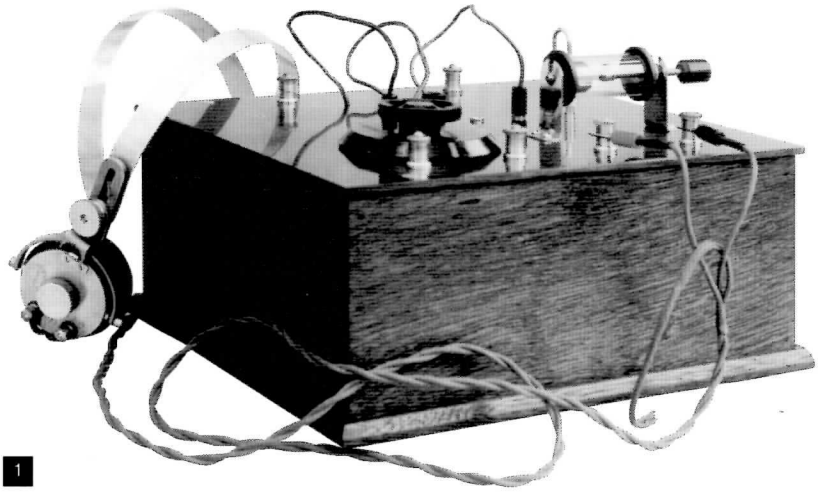
One of the most famous manufacturers was Atwater Kent. He started his career in the motor trade making car electric parts. When radio became available to the average man at the beginning of the last century he got involved with the manufacture of radio components. By the beginning of the 20's he was producing complete receivers. Atwater Kent sets were so popular with the American public that he sold all he could make. The design was so pleasing to the eye, they were simple to use, they were reasonably priced but above all else they were reliable. By the time of the Wall Street crash and following the depression his firm had grown to be one of the biggest radio manufacturers in the country. Thousands of businesses went to the wall and closed down, some never to open again. Others fired their employees and just tried to exist with management doing the manual work. Atwater Kent didn't fire anybody, he kept up production and warehoused all the product, and he was determined to ride out the storm and still pay normal wages. His hunch was right; it paid off and by 1934 he was back on top. At about this time a few of his workers who were a bit left-wing decided to demand higher wages and better working conditions and were prepared to go on strike if they didn't get their way. Atwater Kent was furious, he called a meeting of all the trouble makers, he lectured them on loyalty and pointed out that he carried everybody through the depression and he felt that this was a shabby way to be treated by his men. He there and then shut down his firm and sacked all his employees. I am sure there is a lesson to be learned there somewhere.

Another of the large American firms that is still around in some form or another is Philco; this is the name of the Philadelphia storage battery Company. They started life by making car batteries for the motor industry. It didn't take long for them to get involved with the radio trade. They survived the depression and made a big name for themselves in the early thirties by being one of the first people to produce a car radio. It was a great success and some of them survive to this day. The main receiver and power supply were housed in a big tin box about the size of an industrial biscuit tin. It was mounted on the vertical scuttle by the gear lever. The loud speaker was either in the tin box or mounted in the roof of the car. The tuning and volume controls came out of the tin box on flexible rods and ended up on a little cluster bolted to the steering column. It was very easy to operate. The aerial was either mounted on the wing, roof or under the running board. The inside of the set was very much the same as a standard mains receiver. The filament or heater supply was taken straight from the battery. The high tension was a bit of a problem. Philco got over it by making a vibrator pack. This consisted of something similar to an electric bell but with two moving contacts; this would reverse the current from the battery at a rate of fifty times per second. It was a sort of rough AC. This meant that it could be fed into the primary of a step up transformer and would give you about 240 volts AC. This could be rectified into DC and you would be able to run your set the same way as you would run your domestic set at home. It had to be carefully designed so that the mush from the vibrator wouldn't mess up the reception. You also had to make sure that the engine was running when you used the radio. An early car radio could flatten your battery in half an hour. Philco sets were generally very good but they tended to get the British disease; this means that every new model is rougher than the one the year before.

The Percy Harris "Seven-Circuit" Crystal Set

By Peter Kyne

Percy W Harris was one of the most accomplished designers to have his work featured in the popular wireless publications of the 1920s and 30s. His designs for home constructors ranged from simple crystal sets to powerful superhets and included a wide variety of receivers for both the normal domestic broadcast bands and short waves. Each set was designed to meet a set of clear criteria based on factors such as: where it would be used, who would use it, the stations to be received (distant/local), ease of construction, cost etc.



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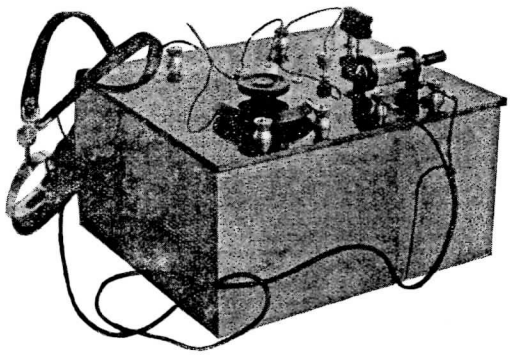


This set is designed to give the highest efficiency on any aerial.

2

Unlike many that can be seen in constructional magazines, his written articles are a model of clarity. Often when reading constructional articles we find that authors have avoided or fudged an issue, either because they cannot find a way of explaining it simply or, I suspect, sometimes they do not really understand it themselves. Percy Harris has never in my experience been guilty of this. His explanations of even the most complex issues are in simple terms that the greenest beginner can understand.

Despite this he is less well known than a number of his arguably less able contemporaries. Why should this be? Well, some designers put a lot of energy into promoting their designs and others put even more energy into promoting themselves. In the case of Percy Harris he seems to have put his energies into good designs, based on sound principles, expressed through good practice and clearly communicated. This resulted in good sets that could be constructed and used by mere mortals. To put it simply I think Percy Harris didn't dissipate his energies in self-congratulation because he possessed the virtue of modesty.

The "Seven-Circuit" crystal set appeared as a constructional article in The Wireless Constructor magazine in December 1924. Before examining this set it is probably a good idea to set the scene by looking at what was going on in broadcasting around that time and how we got there.

Pre-BBC

The First World War as with all long wars had given a tremendous impetus to technological development, not least in the field of wireless communication. In the preceding peacetime the wider availability of expertise, information and a more diverse range of less costly parts ensured the rapid growth of interest and use of this new medium.

All transmissions in the UK were for commercial purposes or as part of the activity of public utilities or by amateur experimenters for their own enjoyment. There was no public service broadcasting. Those who listened in did so either because they were involved with public utility/commercial activity or for personal interest. The latter were usually amateur experimenters and mostly used the simplest and cheapest kind of receiver i.e. a crystal set. The majority of transmissions were in Morse code; speech or "telephone" transmissions were an experimental rarity.

The Marconi Company was a key driving force in the development of wireless technology. Captain H J Round, who was assisted by W T Ditcham, headed its Research Department. They designed a 6 kilowatt telephone transmitter which was installed at Chelmsford in January 1920 and within a month the output had been uprated to 15 kW. One of its purposes was to establish the range at which these transmissions could be received under various circumstances. At Chelmsford it was soon discovered that reading out lists of railway station names was tedious and by way of variety, musically talented employees were persuaded to give impromptu concerts in front of the microphone. These stimulated the return of over 200 field reports from experimenters and ships' operators at distances up to 1,450 miles. This experimental phase of course had to come to an end to enable the operation of the intended commercial speech transmissions and on 23rd February 1920 the first telephony news service was inaugurated.

To the rapidly growing band of amateur wireless experimenters these transmissions were not only interesting but also a valuable calibration benchmark as they were of a known wavelength and power.

Figure 1: My completed replica of the Percy Harris Seven-Circuit crystal set.

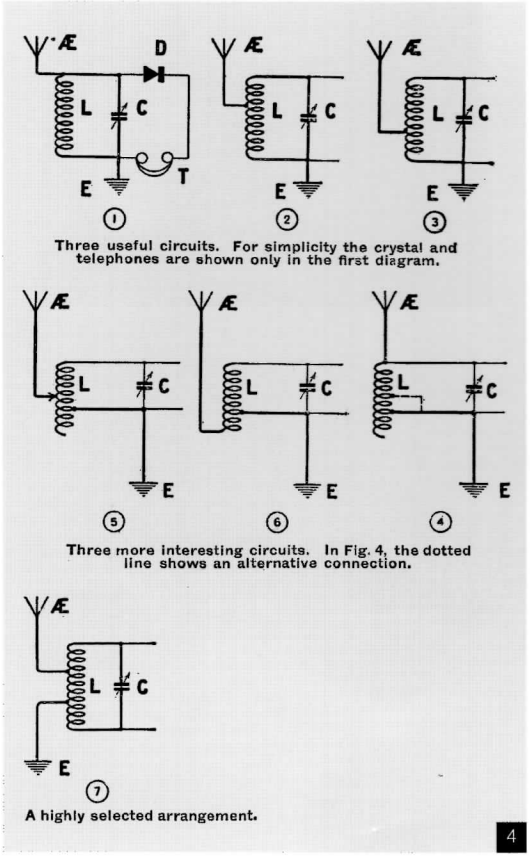
Figure 2: This is how the Seven-Circuit crystal set appeared in the Wireless Constructor.

Figure 3: Percy Harris, who designed a wide range of good receivers and presented them for the delight of home constructors throughout the 20's and 30's.

Figure 4: These are the seven circuits to which Percy Harris refers in his article.

Figures 5, 8, 9 & 10 (page 18): Some of the diagrams and pictures in the original article provided to assist home constructors.

3



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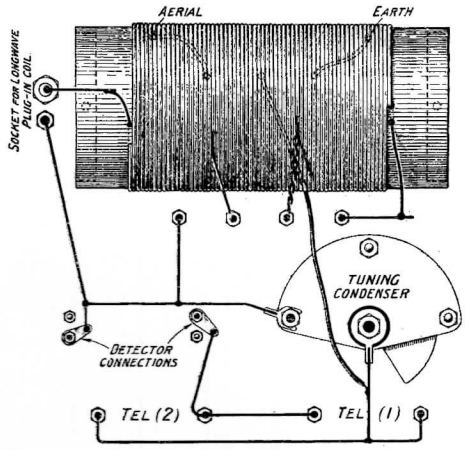


6

7

How to wind the coil. Keep the turns close to one another with the thumb, and wind tightly.

However, the Chelmsford "concerts" had given a new dimension to the interest, which was further encouraged by concerts transmitted from the Dutch experimental station PCGG. These broadcast entertainments had also captured the interest of the press. Under the sponsorship of the Daily Mail newspaper the Australian prima donna Dame Nellie Melba visited the Marconi Chelmsford Works and gave the now famous wireless concert that took place on 15th June 1920. In addition to the normal commercial activity of the station, concerts involving various artists of note continued to be broadcast from Chelmsford, ostensibly for demonstration purposes.

However the path of progress was not smooth and the British Post Office (which was responsible for such matters) withdrew the Marconi licence on the grounds of "interference with legitimate services". Wireless amateurs who had grown in number now formed a significant body and they were incensed at the loss of the Chelmsford transmissions. A long and rather acrimonious argument took place and it was not until a petition was signed by Presidents of 63 amateur societies that the Postmaster General relented on the 13th January 1922. Marconi's were permitted to transmit for a half-hour once per week with a power not exceeding 250 watts. There were other stringent conditions and it is clear that this permission was grudgingly given.

Captain Peter Eckersley of the Marconi Aircraft Development Section (based at Writtle near Chelmsford) was charged with setting up and running the station. His team included a number of now famous names such as Noel Ashbridge (later Sir), H L Kirke, R T B Wynn and B N MacLarty. The transmissions, which were scheduled for Tuesday evenings between 8.00 p.m. and 8.30 p.m. commenced on 14th February 1922. This station was of course the famous (or possibly infamous) 2MT and following military convention was announced as "Two-Emma-Tock". Initially it operated on 700 metres but this was soon changed to 400 metres. The 2MT half-hour transmissions were often hilarious and anarchic, with the result that they were very popular.

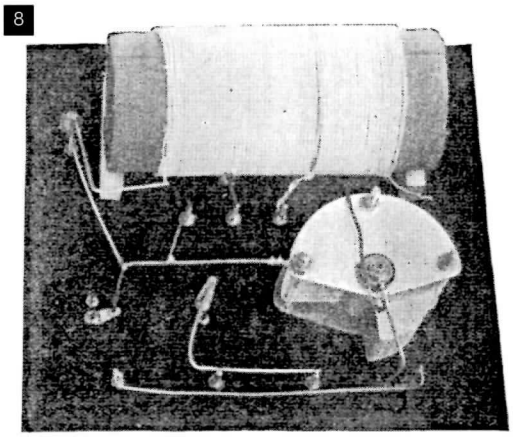
Following the establishment of 2MT Marconi's were granted a further transmitting licence for an experimental station to be set up at Marconi House in London. This allowed speech transmission for 1 hour per day with a maximum radiated power of 100 W. It began operation on 11th May 1922 on 360 metres and its call sign was 2LO. At first music was not permitted but this condition was removed and the maximum power allowed was increased to 1.5 kW.

Public Service Broadcasting

Predictably the start of broadcasting by the Marconi Company brought applications from other manufacturers for broadcasting licences. In fact the Postmaster General received applications from 23 Companies. The British establishment with its natural reserve feared the kind of broadcasting chaos that it perceived to be taking place in America and a free-for-all was not to be allowed.

The proposed solution was that interested parties should form a consortium and create a single broadcasting authority. Following meetings in May and October a company was formed by six large manufactures. These were the Metropolitan Vickers Co., the Western Electric Co., the British Thompson-Houston Co., the Radio Communication Co., the General Electric Co. and Marconi's Wireless Telegraph Co. Other manufacturers were invited to join by depositing £50 and taking up one or more shares. The new company took over responsibility for the 2LO transmissions and was registered on 15th December

8



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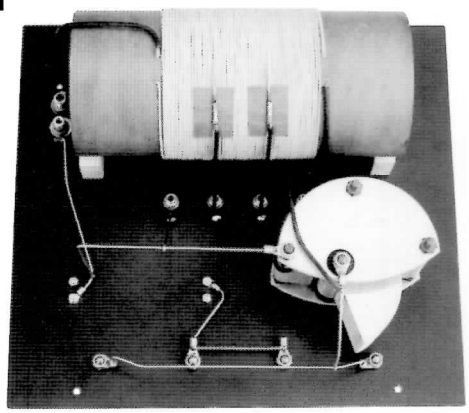

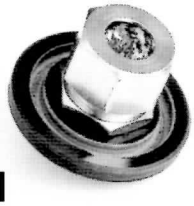

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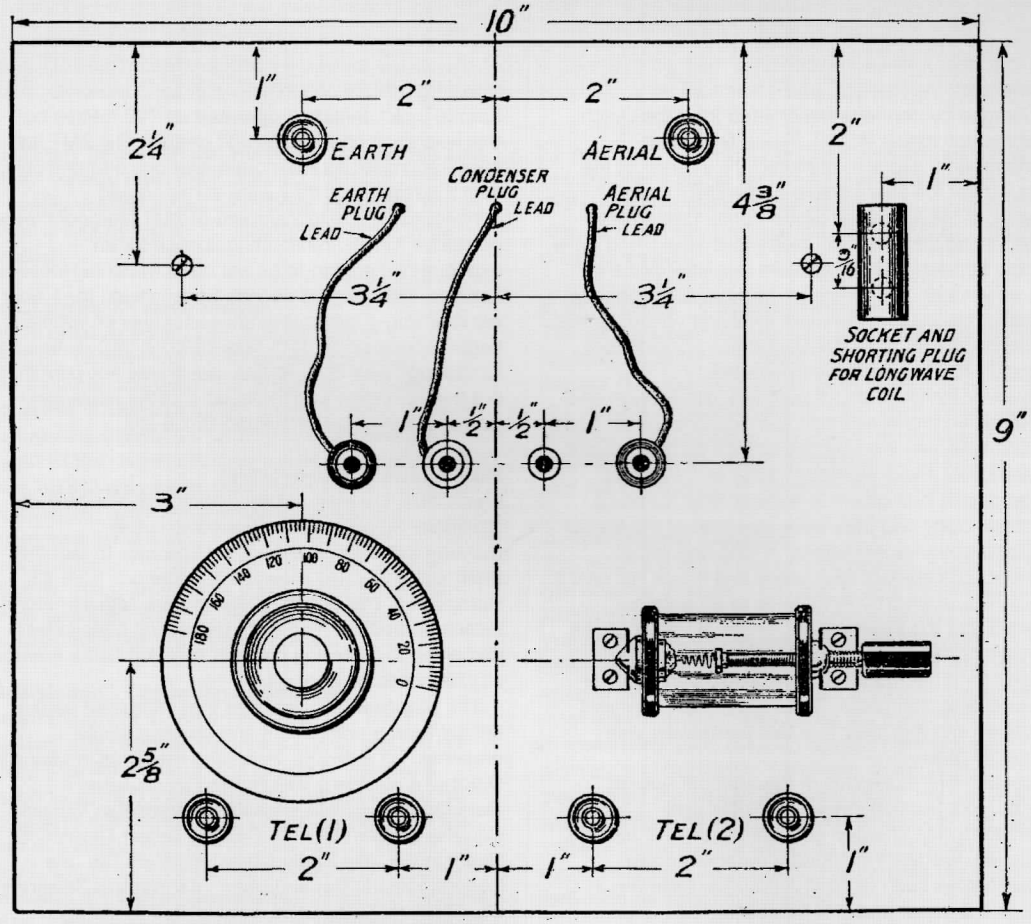


Drilling diagram of the receiver. One or two pairs of telephones are provided for.

Figure 9 – An internal view of my own effort at replicating the original.

Figure 10 – Parts of my home-made crystal detector prior to assembly.

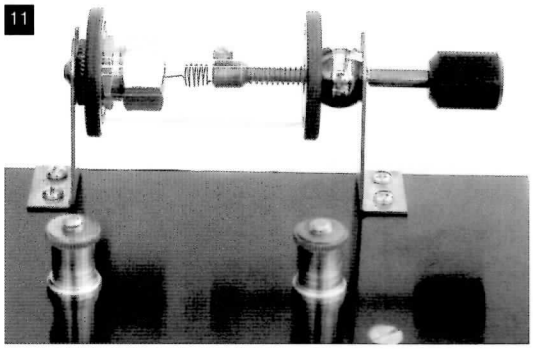
Figures 11 – The completed detector in place on the set (with white card behind for contrast).

Figure 12 – Peter Eckersley's diagram illustrating how the efficiency of an average house aerial changes with wavelength.

Figure 13 – Plan view of my replica of Percy Harris's Seven-Circuit crystal set.

Figure 14 – And finally a comment from Percy Harris.

11



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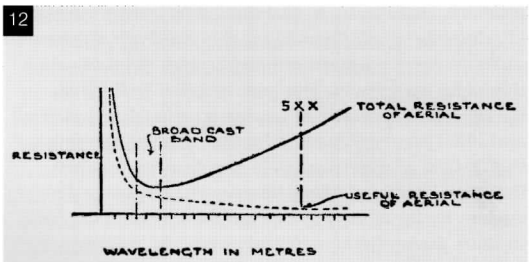

FIG. 60.—CURVE OF AN AERIAL SHOWING TOTAL AND USEFUL RESISTANCE.

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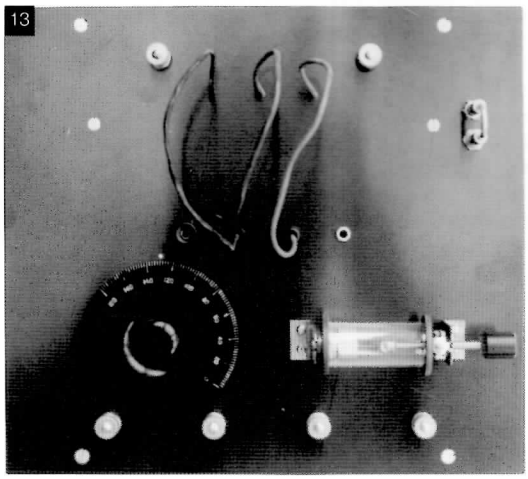


14

The various combinations of plugging are very fascinating.

Though a number of otherwise reliable sources were consulted there appears to be some disagreement over the call signs for the Hull and Sheffield stations, I'm sure someone out there can throw some light on this matter.

1922. It was named the British Broadcasting Company (this was later to be changed to the British Broadcasting Corporation when on 1st January 1927 it became a public corporation).

The new BBC made rapid progress in establishing transmitters at centres of population across the British Isles with the Birmingham and Manchester stations starting operation on only the second day of the organisation's existence. Within a year there were 9 BBC stations broadcasting to a fast growing and enthusiastic listening public. By the end of 1924 this number had more than doubled. There were now 10 main stations and 11 relay stations, which allowed many of those beyond the range of the main transmitters to receive programmes. These are listed below.

Location	Call Sign	Main Station	Relay
Aberdeen	2BD	•	
Belfast	2BE	•	
Birmingham	5IT	•	
Bournemouth	6BM	•	
Bradford	2LS		•
Cardiff	5WA	•	
Chelmsford	5XX	•	
Dundee	2DE		•
Edinburgh	2EH		•
Glasgow	5SC	•	
Hull	2HU/6KH?		•
Leeds	2LS		•
Liverpool	6LV		•
London	2LO	•	
Manchester	2ZY	•	
Newcastle	5NO	•	
Nottingham	5NG		•
Plymouth	5PY		•
Sheffield	6FL/6SL?		•
Stoke-on-Trent	6ST		•
Swansea	5SX		•

Note – although a number of otherwise reliable sources were consulted there appears to be some disagreement over the call signs for the Hull and Sheffield stations; I'm sure someone out there can throw some light on this matter.

With the exception of 5XX Chelmsford all other stations were on wavelengths that form part of what we now call the Medium Wave band. The Chelmsford 5XX station was set up in June 1924 and used a high power Long Wave transmitter, which blanketed a significant part of the South East of England. It was so successful at filling the gaps in broadcast coverage that an even higher power transmitter was set up at Daventry (close to the geographical centre of the country) in July 1925, taking over the 5XX role and call sign.

So appealing was this new medium that by December 1924 the BBC had sold around a million wireless receiver licences, it is certain that some sets were being used without licences so the number of receivers actually in use must have been greater than this.

A crystal set could be bought for a fraction of the cost, of a valve receiver and could be made at home even more cheaply. In addition there were no running costs unlike valve receivers which needed their HT batteries and valves to be replaced periodically. There was also the inconvenience that the accumulator, which powered the valve filaments, needed to be frequently recharged. So it is not surprising that by far the majority of wireless receivers in use were crystal sets.

Limitations of Crystal Sets

From the foregoing it is clear that there were hundreds of thousands of crystal sets in use in Britain at this time. For most listeners there was no affordable alternative. The limitations of using a set with no amplification were significant. Most listeners could only expect to receive one station and usually at low volume. Headphones of course had to be used and generally crystal sets would not produce satisfactory results when feeding more than two pairs.

For many listeners there was another significant

problem – interference, and this came in two forms. Interference could (then as now) come from unintended radio frequency signals emitted by industrial or domestic equipment. The best solution to this has always been to stop it at source as it is usually difficult and often impossible to make the receiver immune to this kind of interference. In practice the solution frequently involved fitting some sort of suppression system to the offending equipment and listeners had to track down the source and persuade the owner to fix the problem. However the British Post Office was supportive of complaints by applying pressure to miscreants.

The second kind of interference was due to the simultaneous reception of the desired programme and other unwanted but legitimate transmission(s). This problem rarely arises these days due to the good selectivity of modern receivers. As a crystal set has no amplification the energy needed to power the headphones has to be drawn from the signal received by the aerial; this has the effect of flattening the tuning considerably. It is possible to make a crystal set more selective by loosening the coupling between aerial and tuned circuit and/or tuned circuit and headphones but you pay for this by losing volume in the headphones. There are other factors in this equation, however they are not all under the control of the listener.

Factors that the listener has little or no control over are:
Location and power of BBC stations
Location and height of the receiver's site and surrounding structures
Location, power and wavelength of stations sending unwanted transmissions.

Factors that the listener does have some control over are:
Position, height and length of aerial (max length allowed was 100ft)
Quality of earth connection
Quality/efficiency of receiver
Sensitivity of headphones.

Even when most of these things were right the reception range of a crystal set was quite limited. The general guidance given was 15 miles maximum from a main BBC station and 5 miles maximum from a relay station. Of course there are instances of these ranges being considerably exceeded under ideal or freak conditions.

The "Seven-Circuit" Crystal Set

The Wireless Constructor magazine first appeared in November 1924 and was published monthly. Percy W Harris was the Editor and he was supported by an impressive array of highly qualified engineers in the roles of Scientific Adviser, Advisory Editors and Staff Editors. The magazine published constructional details of several wireless receivers in each issue. These attempted to satisfy the differing abilities, experience and ambition of its readership by ranging from the simplest of sets through to cutting edge designs.

In order to be prepared to invest time, effort and money in a receiver the home constructor needs to feel confident that the completed set will provide satisfactory results. Most either took the recommendation of other constructors or simply trusted the designer's reputation. However, with crystal sets results were variable due to the local factors outlined above. A set that was good in one place was not necessarily good in another. Percy Harris recognised this fact and designed an efficient crystal set that was simple and inexpensive and could be easily adjusted to give its best performance in a broad range of circumstances.

The Seven-Circuit Crystal Set appeared in the 2nd issue of the magazine in December 1924. It was tuned by a variable condenser and using the internal coil covered the whole of the broadcast band. Also a two-pin plug in coil could be inserted, which enabled reception of Chelmsford and/or other long wave transmissions where they were strong enough.

The simple and efficient internal coil is the key to the design and a plug and socket arrangement allows the user to do two things:
Adjust the aerial coupling to minimise interference from unwanted transmissions
Shift the tuning range of the set to the required part of the broadcast band.

To reduce costs and make construction more interesting the coil was designed to be home made and full instructions, suitable for even the most inexperienced, were given. The coil is a single layer solenoid composed of 60 turns wound onto a cardboard tube 3 inches in diameter with tappings at the 20th and 40th turns. Mr Harris recommended double cotton covered 16 swg wire, which reduced the two main causes of losses i.e. HF resistance and interwinding capacitance, although he did not bother the home constructor with this technical rationale. He also deprecated the use of svarnish, wax or other waterproofing agents on the finished coil due to the loss in efficiency that they introduce.

Full and clear instructions for all aspects of the construction of the set were given in both words and diagrams. There were also helpful photographs illustrating not only the appearance of the finished result but also various aspects of the construction and use of the set. Some of these are shown in the figures accompanying this article.

Making the "Seven-Circuit" Crystal Set

Although simple, this receiver interested me and I wanted to find out just how good it was. The answer of course was to just follow the instructions and make one. I already had a number of suitable parts including a mid-twenties style tuning condenser and knob, a 150 turn plug-in coil and socket, terminals, wire, BA screws/nuts etc.

Cabinet and panel were made from materials to hand. For the panel I used a piece of paper-based resin bonded material (Kite brand Tufnol), this is commonly used for making high voltage industrial electrical panels. Its appearance is not dissimilar to dark brown ebonite and its electrical characteristics are very suitable.

The cabinet sides were made from half inch plywood with simple joints at the corners; the bottom is quarter inch ply and the whole was glued and pinned together. Some scrap hardwood was cut down and planed to form a simple moulding, which was used to conceal the edges of the plywood bottom. The box was then rubbed down, stained and finished with traditional button polish. Real rubber feet were fitted (not plastic – these can still be obtained from Maplin).

The coil was made by following the instructions in the original article. Like all vintage wireless enthusiasts, I collect bits and pieces that I think will be useful at some time so the former for the coil was not a problem. I found a cardboard tube of 3 inches diameter and cut off a 7 inch length. This was placed on the top of a central heating radiator to thoroughly dry out for a couple of days and then sealed with some shellac dissolved in meths. The two ends of the 60 turn winding were anchored by threading them through a couple of 1/16 inch holes in the cardboard tube. The tappings were made by prising up the 20th and 40th turns and slipping pieces of thin fibre sheet under them, then the covering of the wire was scraped away and lengths of 18 swg wire were soldered on. Two small cradles were cut from scrap wood; these and the tube were drilled so that it could be later attached to the panel with 4BA nuts and bolts.

The detector in the original was of the enclosed type with a galena crystal. Percy Harris indicated that any

The Wireless Constructor magazine first appeared in November 1924 and was published monthly. Percy W Harris was the Editor and he was supported by an impressive array of highly qualified engineers in the roles of Scientific Adviser, Advisory Editors and Staff Editors.

Crystal detectors were fairly inexpensive in the mid 1920s and within a few years were no doubt being thrown into rubbish bins in their many thousands, as they were by then obsolete. This accounts for their rarity today and most of those surviving have been used to restore or replicate vintage crystal sets.

style of detector could be used. However, as I wanted to follow the original style I opted for this type.

Crystal detectors were fairly inexpensive in the mid 1920s and within a few years were no doubt being thrown into rubbish bins in their many thousands, as they were by then obsolete. This accounts for their rarity today and most of those surviving have been used to restore or replicate vintage crystal sets. Their rarity and consequent market value puts them beyond my pocket and even well made replicas are expensive, as you would expect given the work content involved in making them. So I decided to make my own.

A lathe is very useful when making these kinds of components but I do not possess one so all of the necessary turning was done in the chuck of an electric hand drill mounted in a drill stand. The turning tools were a junior hacksaw blade and various files. The insulated parts (the end plates and knob) are of Tufnol sheet and rod. The metal parts were fabricated from brass rod, tube and sheet or other bits and pieces in the "spares box". The transparent dust cover is not glass but a piece of plastic packaging material formed into a cylinder with the help of an electric heat gun (the sort used for stripping paint).

The end plates need to be grooved to hold the dust cover: the groove was made by cutting half way through a piece of Tufnol sheet with a hole saw. The end plates were then cut out of the sheet by cutting all the way through with a larger sized hole saw. For those who are unfamiliar this is a type of hole-cutter used by plumbers to cut holes in tanks. It has a central drill bit surrounded by a cylindrical saw blade and is used mounted in an electric drill.

If you have a lathe with the correct attachment then making the brass ball for the swivel is easy. If you don't then it's the most difficult operation. I didn't even try. I used the metal ball from the top of a discarded salt pot.

The crystal holder is a modified spindle lock (the type that's used in old test equipment to lock the position of a potentiometer) and it's attached to its end plate by the bush taken from a duff volume control. The spring is from an old ballpoint pen and the cat's whisker is a length of 38 swg copper wire formed into a spiral by wrapping it round the shank of a 4mm twist drill.

Various cutting, drilling, tapping and soldering operations were carried out to make each of the parts and I won't bore you with the details on the basis that either you're not interested or if you are you'll work out the details for yourself. The finished detector works just fine; it has a rather home made appearance but it's not bad for a first attempt.

Just a footnote to this section. The detector crystal is a natural galena crystal. I bought several pieces of this some years ago for 50 pence from a market stall selling polished pebbles and the like. The crystals were of variable quality but a couple of pieces had some active detector sites.

Assembly was straightforward. Being short on vintage solder tags I used 3mm and 5mm crimp-on tags with the plastic bushes removed. As they are of tinned copper they solder very easily. All of the under panel wiring is 18 swg tinned copper wire and the flexible leads for the wander plugs are from old rubber covered cable. Finally the panel was secured with slot-head solid brass screws (these can still be obtained from a company by the name of Screwfix).

Testing the "Seven-Circuit" Crystal Set

At my home in Chelmsford (yes I really do live in the "Birthplace of Wireless") I tried out the set with a pair of Brown Brothers adjustable headphones, a good earth and a mediocre aerial. Once you have found a transmission it's easy to establish the optimum combination of the plugs and sockets.

In his article Percy Harris indicates 7 different combinations. There are about 50 possible permutations but only 7 of them are sensible. The combinations that worked best on my aerial are shown in diagrams 5 and 2 of figure 4. In all, 7 stations could be received after dark, all were without interference or overlap and they were all loud enough to be of entertainment value in a quiet room, providing you find the programme content acceptable that is. These are listed below.

Station Name	Transmission Frequency
World Service	648 kHz
BBC Radio Essex	756 kHz
BBC Radio 5	909 kHz
Radio Cambridgeshire	1,026 kHz
Talksport	1,089 kHz
Virgin Radio	1,197 kHz
Classic Gold Breeze	1,359 kHz

There was also one unidentified transmission on 558 kHz but this was not really loud enough to be of entertainment value.

On long wave results were disappointing. A couple of French stations were received at listenable volume but the present day equivalent of 5XX, Radio 4 long wave, was so weak as to be largely unintelligible. There are several factors that contribute to this.

Firstly to receive long wave on this crystal set a commercially made two-pin plug in coil is inserted. The quality and condition of the coil used has a significant bearing on the results achieved. The second point is that the Radio 4 long wave transmitter is situated at Droitwich over 100 miles away, hence a significant attenuation of the signal strength is to be expected. Had I carried out this test in 1924 I would have been most impressed with the result as 5XX would have been sited little more than a mile away. I might not have needed an aerial at all. Thirdly my aerial can at best be described as mediocre, having nothing like the height or length of a full sized GPO approved aerial as might have been used in the mid 20s. The final point relates to aerial efficiency. The GPO approved aerial (100 feet of wire maximum including the down lead) achieves its optimum performance at medium wave frequencies or above. At long wave frequencies it is much less effective at picking up signals. This point is illustrated by a diagram which appears in one of Captain Eckersley's books (*All About your Wireless Set*) and explains this phenomenon in terms of the relative magnitudes of "total aerial resistance" and "useful aerial resistance", see figure 12.

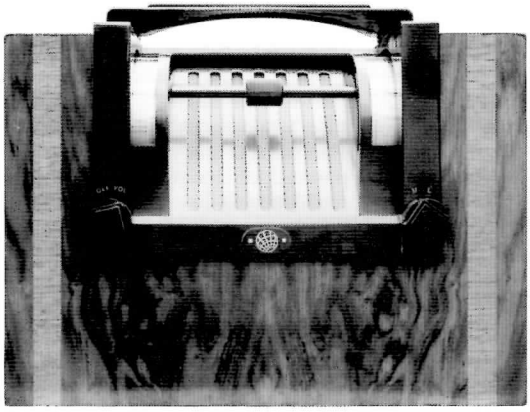
So although the results on long wave were a disappointment they were not a surprise and they do not reflect on the designer's competence as all of the limiting factors outlined were beyond his control.

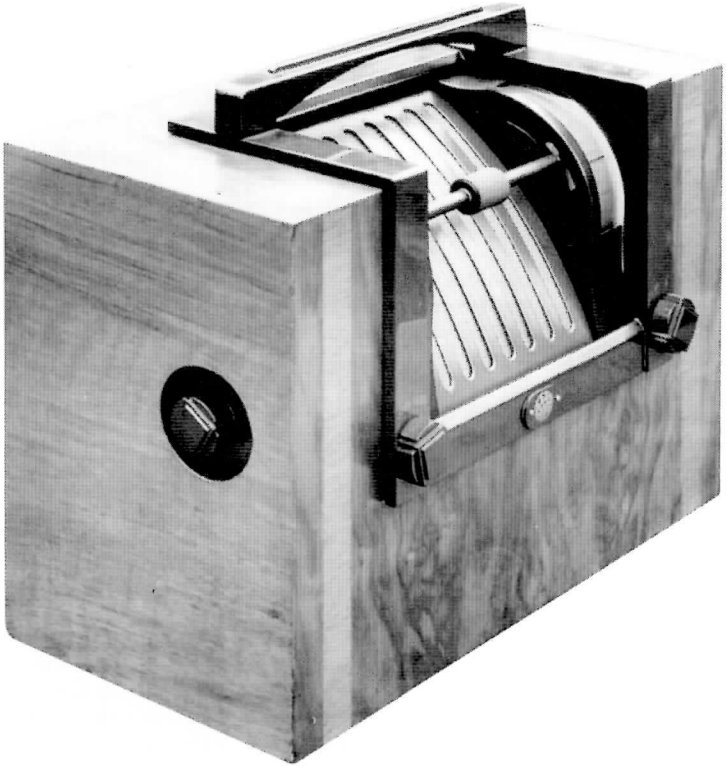
As part of my "field trials" I took the set to the Vintage Wireless Museum at Dulwich. This enabled me to use one of the full size aerials there but more importantly it gave the opportunity to seek an opinion of the set's performance from the proprietor Gerry Wells. It was clear that Percy Harris's set was giving a good account of itself when it was able to tune in several different transmissions without breakthrough from the local Country and Western station. In fact in all of the tests, both at Chelmsford and Dulwich, it was possible to tune through each of the transmissions with a sweep of 10 degrees or less of the dial. Even I with my limited experience of crystal sets know that this is good. However to me the most significant test was Gerry Wells's judgement which he summed up as "It's good – it's selective!". Say no more, well done Percy Harris – another success.

The McMichael 808 with "Rotabar Tuning"

by Gary Tempest

This neat, transportable superhet dates from the end of 1938, according to Trader Sheet 477. It is a good subject for an article as apart from the novel tuning method the construction is unusual, and I doubt that many people have taken one completely to pieces. The chassis comprises several individual panels held together with screws and spacers. It is vertical and the valves are mounted horizontally. It uses a conventional circuit: frequency changer, IF amplifier, detector/AVC and triode pre-amplifier, pentode output valve and rectifier. I'm glad to say it is AC only and to qualify as transportable has a frame aerial, turntable and a carrying handle. It uses a method of tuning known as "Rotabar". The knurled wheel, at the front, is rolled with a fingertip. It is most delightfully precise and elegant. It was this feature that attracted me most to the radio.

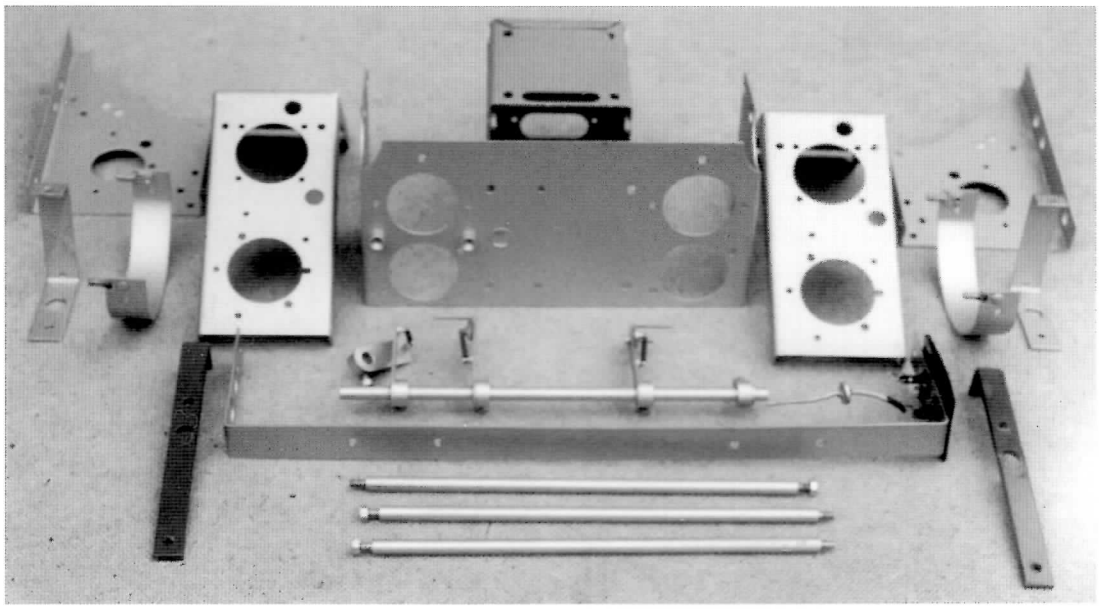


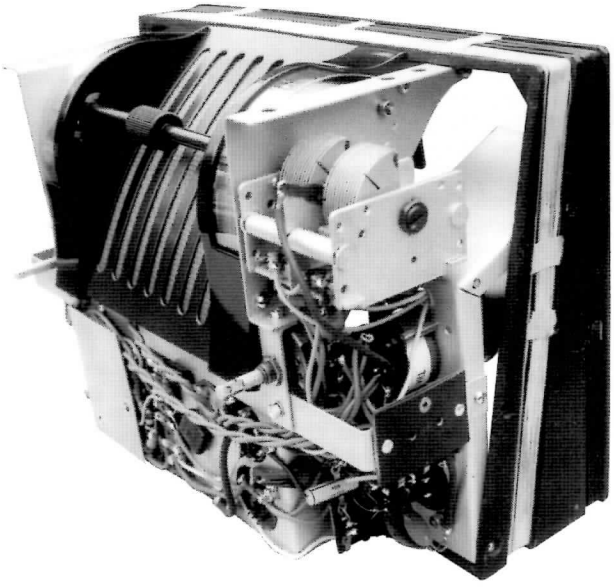


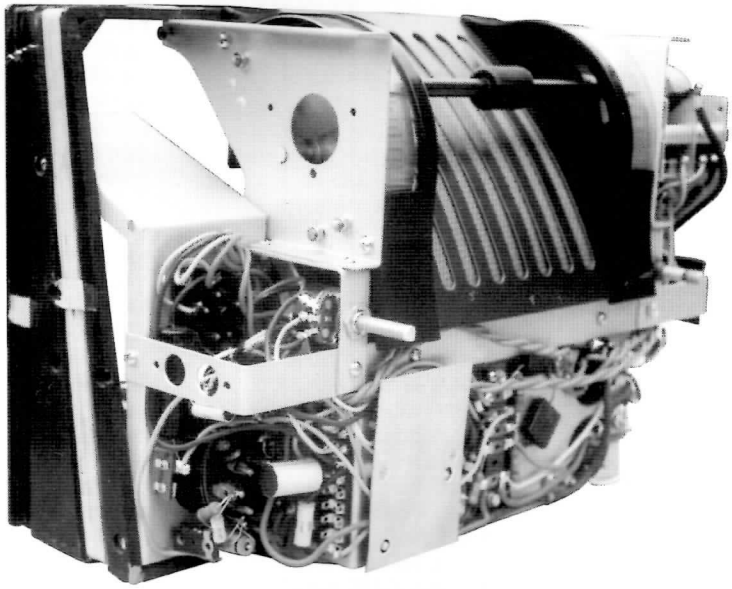
In the uncertain days of 1938 McMichael, like all the other electronics companies, would have been involved in work for the war to come. It may explain why this radio seems like a prototype rushed into production. In normal circumstances would they have simplified construction? I have studied it, over many hours, and it is hard to see how they could have reduced the number of parts. However, they could possibly have shortened assembly time by spot welding a lot of the chassis pieces. Surely they would have found a better way of fixing the carrying handle? To quote the Trader Sheet: "... Remove the two nuts inside the top of the case holding the carrying handle in position. This is a difficult operation, and involves the use of a chisel or screwdriver and a hammer, since the nuts are not accessible to a spanner." After a few services a radio is going to have some very chewed up nuts.

I would not recommend a major restoration of one of these if you are new to the hobby or faint of heart. Certainly buy one that does not have a badly rusted chassis and needs a complete strip as this one did. I only paid a few pounds for it and so expected to spend many hours on it.

Now for a short resumé of the good and bad points of this example. It was complete and had not been bodged before. Indeed, I could see no sign of any previous repairs. The cabinet was sound and the veneer firmly attached. There were many more bad points. The chassis was very rusty and the cabinet was dark, dirty and scratched. The cardboard back panel was broken in several places through the slots. The scales, for MW and LW, which are not very clear even at their best, would need re-making. The lettering had faded and crumbled over the years. The worst faults to rectify were with the Bakelite items. Apart





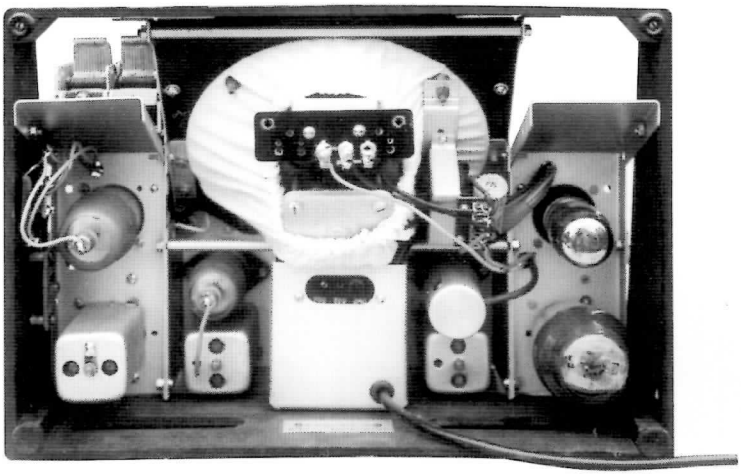


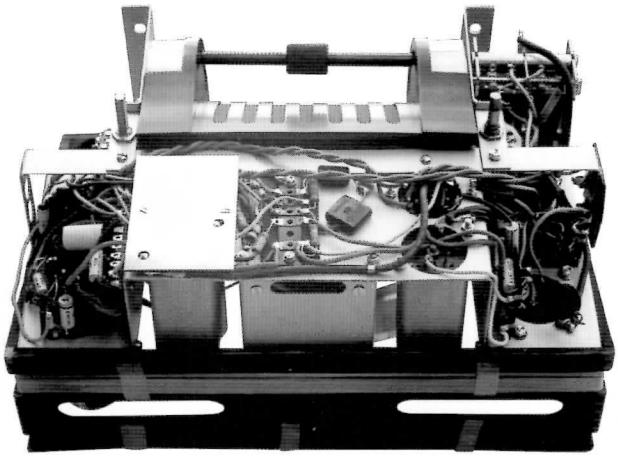
from the handle there are two pieces, enclosing the dials or scales, and a right angle escutcheon to cover the cabinet cut out. Oh! And there was only one knob. The problem with the scale covers was that they had chips where the material is very thin and directly facing the viewer. The cabinet escutcheon was sound but alas had the worse case of Bakelite sunburn I have ever seen. It had actually turned orange. The radio must have not only had the usual garden shed storage but must have been in front of a south-facing window. Strangely the handle was fine. Finally, the McMichael "World" badge was missing from the Bakelite escutcheon. The chances of finding one of these was going to be close to zero.

I started by removing the chassis from the cabinet. Now where's that hammer and old screwdriver? The cabinet is really, in modern hi-fi terms, a sleeve. It is made from thin plywood relying on the chassis and frame aerial to give much of the structural strength. Once I got it off, it gave a gasp and shrank. Well, the bottom bowed in actually. The bottom is braced internally with a piece of quarter inch ply and in order to refit the cabinet I had to shave this down with a cabinet scraper.

Nothing for it now but to take everything apart, making sure to make lots of diagrams. I don't have a digital camera, so I laid the light chassis on a scanner connected to a home PC. It's easy to take lots of images, on all faces, with excellent quality. Of course these can be full size and are very clear when printed out on a colour printer.

The components were strung between valve bases and the odd piece of tag strip. Many faults on these radios must have been due to lack of space, with components shorting and coming adrift. I did not intend to re-stuff the capacitors but to use smaller





modern items for a more reliable result. I didn't go for the smallest available but used sizes that don't look implausibly small. I also disguised their fluorescent mouldings and used additional tag strip to eliminate suspended items.

All the chassis parts were abraded with various power sanders, treated with phosphoric acid and sprayed with several coats of silver Smoothright. The chassis was rebuilt with all new resistors (I use modern 2 or 3 watt types, as the size looks about right) and period style silicon rubber covered wire. I was able to layout new dial scales on the computer. These printed in red, on gold paper, using a laser printer, look very good. They actually may be clearer to read than the originals as I used a bold font. It took no time at all to get the radio working and do an alignment. Performance is about what you would expect.

The cabinet refinish was straightforward. I have left it lighter than it would have been when new. To me it looks nicer and shows off the attractive veneers better. I could see no other way for the Bakelite parts other than to spray paint (Vauxhall Brazil Brown) them all except the handle. But first I had to repair the chipped dial covers. For me Plas-T-Pare, from Antique Electronic Supply USA, takes a lot of beating. With good abrasion it does bond well, has stood the test of time (over the 4 years or so that I have used it) and can be polished to be invisible beneath paint.

All parts to be painted were sanded with #400 wet and dry to key the paint. This includes the knobs, as the replacements I had obtained from Gerry were black. Actually, I had to sand the tops of these to remove inappropriate inscriptions.

When spraying, I found it is a good idea to do a couple of light coats first and then a heavy final one. After the paint had been left to go well hard, all blemishes were rubbed out with metal polish. It's not good to rub through the final paint coat (hence the heavier layer) as a lower layer will show up slightly, almost like a watermark. To finish off T-Cut gives a low gloss shine looking like well buffed Bakelite.

I had a problem with the escutcheon in that it had inscriptions moulded into it, above the controls. These were shallow due to the paint build up, and despite all my efforts and various methods, I could not get both to fill evenly with white paint. Eventually I gave up and hand sanded these faces, with various grades of wet and dry, until the engravings were no more. Then it was another re-spray. I had already checked that I could get decals (transfers to us) from Rocksea USA. They have several sheets of common terms including "VOL", "OFF, "L" and "M" needed by me. These are in a smart gold with black edges. After application, I masked off everything except these faces and then sprayed them with satin lacquer. This was a worrying stage for me. I really did not want to spray paint the escutcheon yet again. I had to hope that nothing would go wrong. But of course it did! I had tested a matt lacquer (acrylic), that I intended to use, on an over-spray of the paint. However, this was sometime earlier and I changed my mind and went for the satin, which was untested. At first and even 20 minutes later everything looked wonderful, but after a couple of hours disaster. The surface had crazed in art deco swirls, rather like a giant crackle finish. My wife said she thought it was quite attractive and under different circumstances I might have agreed. Fortunately, I was able to get away without re-spraying the whole estcutcheon. Just as on a car, whole panels can be done and an acceptable result achieved. I masked up first, not wanting to take the chance of damage to somewhere else; then carefully sanded, with dry paper, until I got back to the Bakelite. Then it was a re-check of the masking, leaving the low tack tape slightly sub-flush to the corners. I sprayed with the surface horizontal and didn't actually spray around them. Without consciously doing it, you get enough drift to ensure the new melds with the old. Then it's patience, until the paint is hard enough to rub out, paying careful attention to the edges of the re-sprayed area.

Now it was apply some more transfers and decide what to lacquer them with. I did read the paint and satin lacquer cans. The former was mainly acrylic, "... compatible with all cellulose and automotive finishes", and the other cellulose. Maybe the acrylic was only compatible over the top of all automotive finishes. What I did next with hindsight is obvious. I went to Halfords and bought an acrylic lacquer that had the same formulation as the paint. True, I could not get satin and so went for a gloss, reckoning that I could flatten and dull this down later. But first I did a test (beer cans, after you have enjoyed the contents, are good test vehicles) before doing the actual work piece. When I did this, it was successful and the lacquer dulled nicely with pumice powder and T-Cut.

Another good tip is to apply some spare transfers to the test piece and practice applying the lacquer over these as well. It is so easy to over spray and then bubbles appear at the edges. What I think happens is that the lacquer attacks the water-soluble adhesive and gets underneath. Once the bubbles are there, the only way to get rid of them is to sand back and apply new transfers. Some improvement can be made by sanding back, as far as you dare, to just flatten them, before re-lacquering. The way to avoid them is to apply several light coats, with time between applications. This is aided by using a partially used aerosol that will have reduced pressure.

Making a substitute for the missing "World" badge was more difficult than I imagined. I had seen an original, which is punched out of brass sheet and fixed with two brass pins. It is based on a logo used by

The cabinet refinish was straightforward. I have left it lighter than it would have been when new. To me it looks nicer and shows off the attractive veneers better.

McMichael that I found in a Wireless World advertisement. Once scanned I had to enlist the help of a friend to make artwork with the complex curves. I won't go into too much detail but I made four badges before getting one that I'm content to use. Briefly the artwork was printed onto gold paper and this was placed in a mould. I used Plas-T-Pare as the moulding material, knowing that this is transparent and can be polished to a good shine (see note below). The back of the badge was sprayed with a couple of coats of matt black paint. The result, even close up, is good with some minor imperfections. These are mainly due to tiny air bubbles or poor printing, on the glossy paper. I made the fixing pins by filing down brass panel pins using a column drill and rat-tail files. The pin fixing does mean that I can easily change the item if I ever find a real one.

Note: Subsequently, I have noticed that a couple of push buttons I made with Plas-T-Pare, have turned a golden colour after a couple of years. This is rather like the ageing that takes place with Catalin. Whether this will make the badge look more attractive or not remains to be seen.

The loudspeaker grille is a sandwich of an aluminium plate and cloth glued to a cardboard backing. The cardboard was reused with new material. I resprayed the plate with another Halfords paint called Roman Bronze. This was about the right colour but was a metallic. However, once top-coated with a couple of coats of matt lacquer (Yes! It was acrylic) it has dulled down nicely. The grille cleverly slides into slots moulded into the Bakelite dial covers.

Having all the cabinet parts prepared then final assembly could begin. The first thing was to fit the dial covers, with new 1 mm acrylic windows, and the rotabar.

This is a good point to describe how this mechanism works with the help of a diagram. The rotabar tracks up and down in slots moulded into the Bakelite dial covers. It has recesses for rubber rings to give traction. These had long ago perished but two layers of Hellerman sleeve work just fine. The ends of the bar fit into holes, in sprung arms, attached to the left and right scale pointer brackets. It is the springs that apply pressure to the rubber surfaces against the lower faces of the slots. The pointer brackets are clamped to a bar (side plate bar) that rotates between the side plates supporting the dial brackets (curved metal strips, that mount the cardboard scales; not shown on the diagram), their covers and the tuning capacitor. There is an adjustable end stop, on the bar, so that it may be set for minimal lateral movement. The last complication is the coupling to the tuning capacitor. This has an arm, with a cam follower, sprung against another arm with a cam, which is clamped to the side plate bar. There is obviously a lot more to it than a couple of wheels and a piece of string but in practice it is reliable and works very well.

Before putting the rotabar in place, I spent some time getting the pointer brackets to swing from end to end without scraping noises and without the pointers rubbing either on the scales or their windows. This is tricky as the clearances are small and the slightly proud repairs, inside the covers, just made it more difficult. Eventually I got a satisfactory result. To put the rotabar in place I loosened off one pointer bracket and moved it to the outside as far as it would go. Then the bar could be coaxed into place before resetting the bracket.

I did not expect to have a problem with the new acrylic windows. After cutting from sheet material I simply flexed these round to fit into the dial covers, reckoning that the natural spring was an advantage. It certainly held them in place. However, about a month later, I noticed when looking at an angle, tiny stress cracks. The solution was to refit the old ones, once they had been cleaned and polished. These had looked awful but came up very well, with some slight yellowing, which against the gold scales does not show.

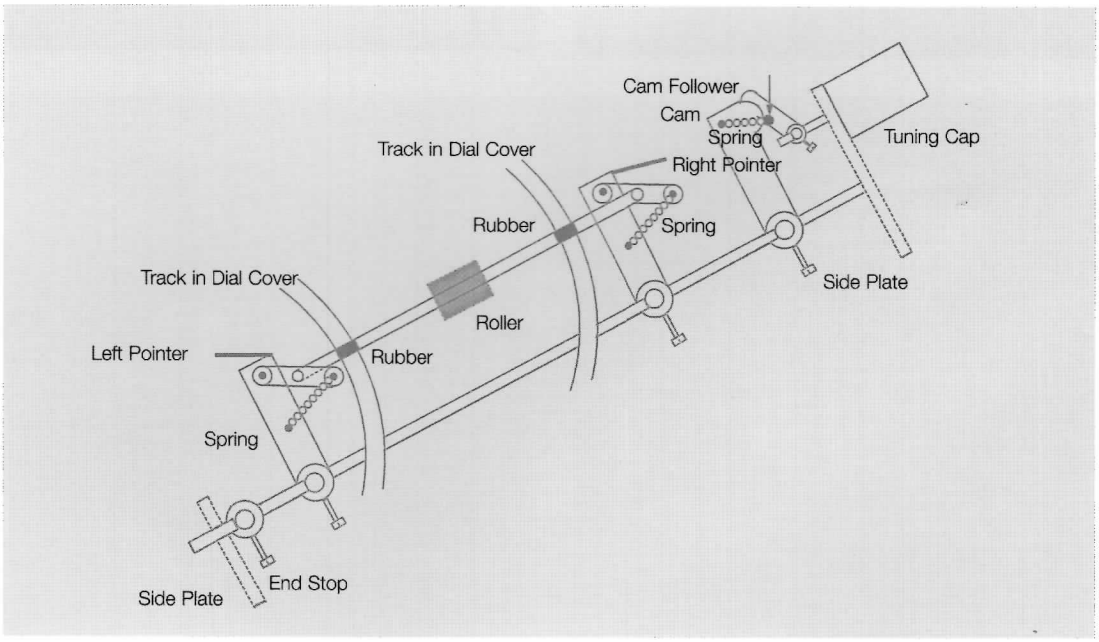
I really enjoy that moment when the cabinet can be refitted. Mind you, this is another radio which isn't easy. I think the cabinet and the Bakelite escutcheon being a little warped didn't help. Once the chassis could be persuaded to go in, then two metal bars could be fitted underneath it, at the top. Countersunk screws, which are covered by the escutcheon, go through the cabinet and clamp the chassis. I used new 2 BA full nuts for the handle and used a hacksaw to cut a vertical shallow slot across each nut face. This allows them to be easily levered round, with a screwdriver, without inflicting damage.

Almost there, but first I had to repair the back with its many broken pieces. I used glass fibre cloth and resin for this, before filing new slots and spray painting. Finishing off with a matt lacquer improved the look

I really do like this radio despite its shortcomings. It is different and has style. I could not help thinking how it could have been improved. Certainly the scales could have been made wider and it would be nice if the dial covers were a closer fit to the escutcheon.

So the end. I spent a long time on this one and it's still not worth much to anyone but me, but I did enjoy it. These 'basket cases', as the American radio restorers refer to them, really do hone your skills.

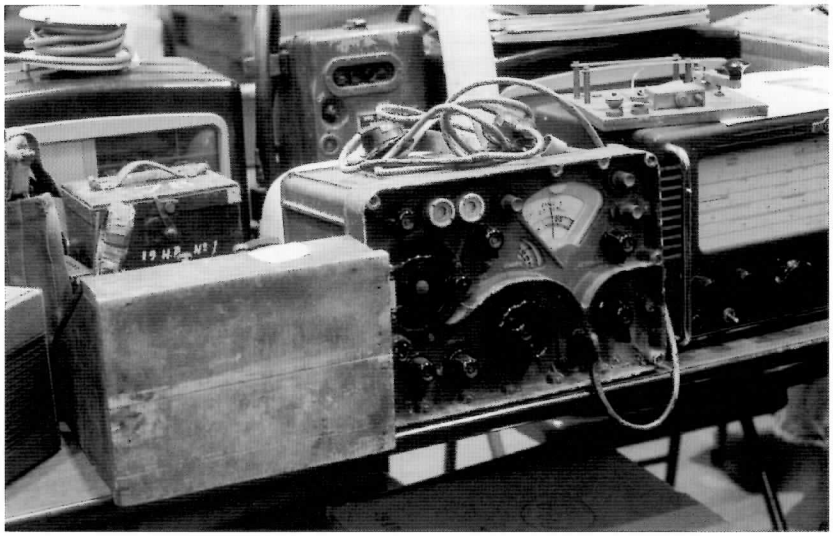
I really do like this radio despite its shortcomings. It is different and has style. I could not help thinking how it could have been improved. Certainly the scales could have been made wider and it would be nice if the dial covers were a closer fit to the escutcheon.

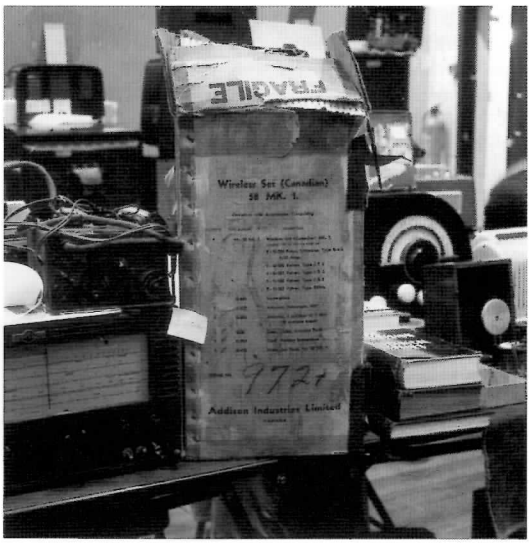


McMichael 808 Rotabar Tuning Mechanism

Images from November 2003 Harpenden

Photographs by Carl Glover

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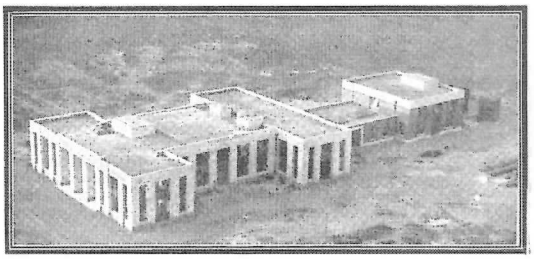
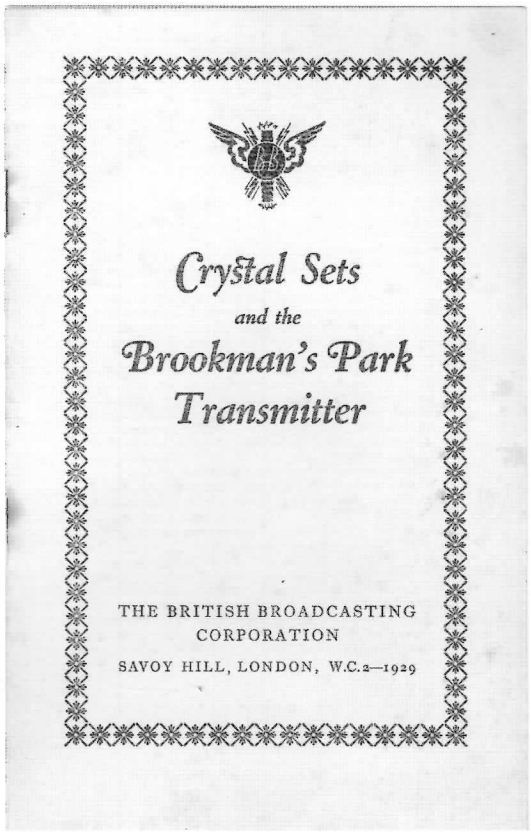
Crystal Sets and the Brookman's Park Transmitter

by Ian L Sanders

"To all crystal set users in the affected area the BBC says 'Look to your sets, whether or no you have been getting good reception'"

The British Broadcasting Corporation, 1929.





Crystal Sets
and the
Brookman's Park
Transmitter

THE BRITISH BROADCASTING
CORPORATION
SAVOY HILL, LONDON, W.C.2—1929

Far left: A view of Brookman's Park taken from one of the station's aerial masts.

Left: BBC booklet issued in 1929 at the introduction of Regional Broadcasting to assist listeners using crystal sets.

The Regional Scheme

In 1929, the Postmaster-General finally approved the BBC's 'Regional Scheme' which had been conceived as early as 1924 by the Company's first chief engineer, P.P. Eckersley. The aim was to improve the broadcast service in Britain by offering two different programmes to a wide audience *'of not only townsfolk, but of country dwellers'* listening on the *'simplest of receiving apparatus'*, in other words, crystal sets. A full description of the scheme can be found in the BBC Yearbook for 1930, but the essence was to use fewer transmitting stations of higher power, replacing the BBC's original, low-power broadcast stations, each supplying a single programme. Extension of the original concept of multiple local stations was becoming impossible, in part because of the interference caused by the large number of stations beginning to operate throughout Europe, and partly due to the fact that it would never provide for the needs of those listeners living outside the larger towns and cities.

The Regional Scheme, it was hoped, would overcome both of these limitations and provide greater coverage and programme variety without exceeding the limited number of wavelengths then allotted to the BBC for broadcasting. The intent was that the two transmissions - one regional and one national - should be available over wide areas of the country at signal strengths to allow satisfactory reception on a crystal set and sufficient to overcome interference from other sources. In order that the alternative programme would be received at similar strength to the main one, a single site was deemed necessary for the two transmissions.

In the years between 1925 and 1929, the Post-Office raised numerous objections to the BBC's proposal. With their experience of the disruption caused by changes to the country's telephone system, one of the Post Office's earliest concerns was the danger of alarming the public with the need to modify their receivers, and in particular the forced obsolescence of the huge number of crystal sets then in use. Eckersley, however, remained a powerful advocate of the need for change, predicting that the alteration of a crystal set would cost as little as five shillings. After prolonged negotiations the BBC won the day. The first regional transmitter was to be located in North London.

The Brookman's Park Transmitter

The BBC elected to set up two high-power transmitters at each of its Regional Scheme sites capable of broadcasting two programmes on different wavelengths and located so that *'an ample signal'* was available to the main centres of population in the country. The first transmitting station, the London Regional Station, was erected approximately 15 miles north of central London at Brookman's Park, near Potters Bar in Hertfordshire. An ideal location, the selected 34-acre site was exceptionally flat and stood some four hundred feet above sea level.

The station was opened on October 14th, 1929 and comprised one 30kw and one 45kw transmitter for the regional and national programmes respectively. At the time of its construction Brookman's Park was the world's first purpose-built transmitter capable of simultaneously broadcasting two separate programmes. A wavelength of 365 metres was used for the regional programme – the same as the existing low-power (2KW) BBC London station, 2LO, broadcasting from a transmitter on the roof of Selfridges department store in Oxford Street – while the national programme was broadcast on 261 metres. The higher power of the national transmitter was calculated to compensate for the somewhat reduced range due to the shorter wavelength. Brookman's Park was connected to the BBC's Savoy Hill studio by four Post-Office telephone lines, specially configured to minimise distortion.

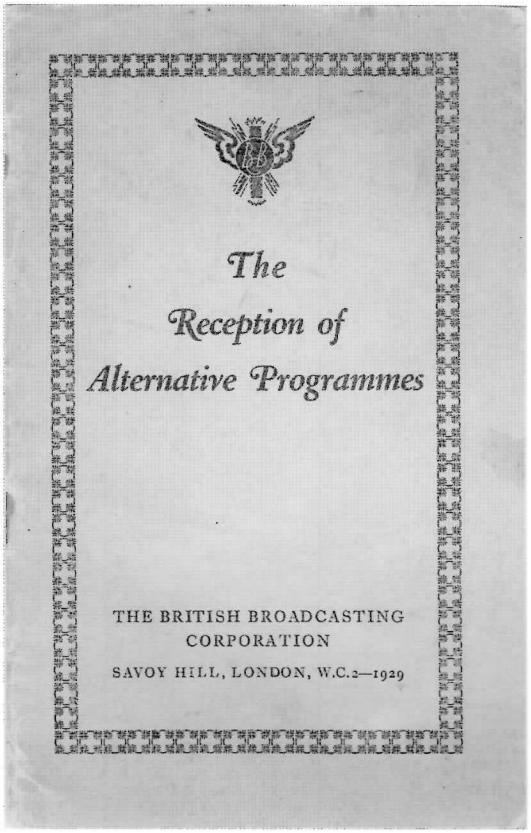
For crystal set listeners, the new station was designed to provide excellent reception quality at a service range of 50 miles, while adequate reception at 60 miles was expected. This compared to a maximum of about 20 miles for crystal set users in the London area who had tuned in to 2LO.

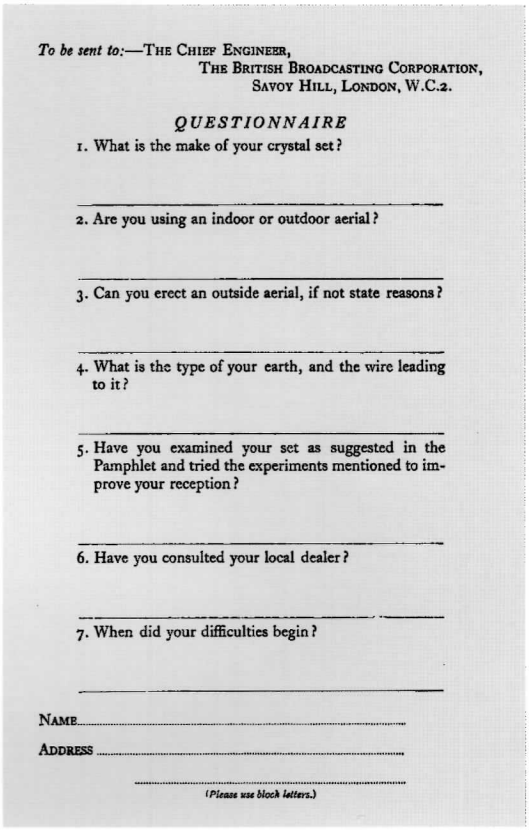
The BBC has no control over the licensing of receivers, which is, of course, entirely in the hands of the Postmaster-General. A wireless receiving licence authorises the holder to establish a wireless receiving station, subject to specified conditions and limitations, but it neither contains, nor implies, any obligation or guarantee that any particular station will be maintained or that the signal strength will be maintained abnormally high in one district to the disadvantage of the service generally.

Crystal Sets and the Brookman's Park Transmitter, The British Broadcasting Corporation 1929.

Right: In 1929, the BBC published a second booklet to help amateur constructors improve the selectivity of their receivers.

Far right: Questionnaire supplied by the BBC for listeners having difficulty receiving Brookman's Park on a crystal set.





To be sent to:—THE CHIEF ENGINEER,
THE BRITISH BROADCASTING CORPORATION,
SAVOY HILL, LONDON, W.C.2.

QUESTIONNAIRE

1. What is the make of your crystal set?
2. Are you using an indoor or outdoor aerial?
3. Can you erect an outside aerial, if not state reasons?
4. What is the type of your earth, and the wire leading to it?
5. Have you examined your set as suggested in the Pamphlet and tried the experiments mentioned to improve your reception?
6. Have you consulted your local dealer?
7. When did your difficulties begin?

NAME.....

ADDRESS.....

(*Please use block letters.*)

The BBC is anxious that listeners shall not be put to undue expense in making the necessary changes in their receivers, and the course will therefore be taken of suggesting the cheapest methods first, working gradually through possible remedies, and ending with the most elaborate. If it is impossible or inconvenient for you to carry out these suggestions yourself, this pamphlet can be handed over to your local wireless dealer.

The Reception of Alternative Programmes, The British Broadcasting Corporation 1929.

Plight of Crystal Set Listeners

From the very outset, the BBC had admitted that some of its listeners would be adversely impacted by the new broadcasting scheme, although it was generally held that the majority of the audience would derive a benefit at the expense of the few. As it turned out, the Regional Scheme actually created two different problems and affected a very large fraction of the listening public tuning in to the BBC on their crystal receivers. For those living within a few miles of the transmitter, separation of the two programmes posed an insurmountable difficulty for the inherently unselective crystal set circuits. The vast majority of the commercial crystal receivers in use at the time consisted of a single tuned circuit quite incapable of separating the stations. Although many of the popular amateur journals published designs for so-called 'selective' crystal circuits, incorporating multiple tuning controls, the performance was usually less than adequate and besides they were no help to the average non-technical listener with their commercially built sets.

As an interim solution to, in the BBC,s words, *"reduce the dislocation which is bound to occur to those whose sets are very unselective"*, the plan at first called for the alternative programme to be of short duration and only to be broadcast late at night when the main transmitter was not in operation. The schedule of dual transmissions was gradually increased to include both early morning as well as late evening programmes. A complete daily broadcast of two programmes did not take place until March 1930.

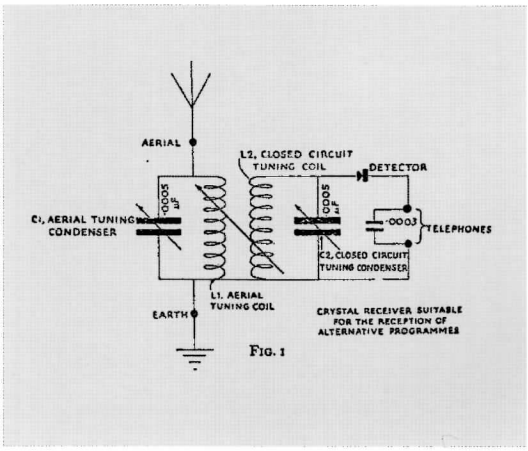
In a move to placate listeners, the BBC published a special booklet in 1929 written by R.T.B. Wynn, of the Corporation's Technical Correspondence Department, entitled *'The Reception of Alternative Programmes.'* Targeted at *'those who have built their own receivers and who are unable, for various reasons, to call in the services of a local wireless engineer',* it included a lot of technical advice particularly focused on the length and placement of the aerial. Unfortunately, this would have made little difference for most of the crystal set owners. Also described were several tuning circuit arrangements, but these required what amounted to a complete rebuilding of the receiver. For the less ambitious, a simple tuner that could be connected to the aerial and earth terminals of a commercial crystal set to increase its selectivity was described. Even if this measure did succeed in solving the station separation problem, the reduction in signal strength must have been unacceptable for most of the audience.

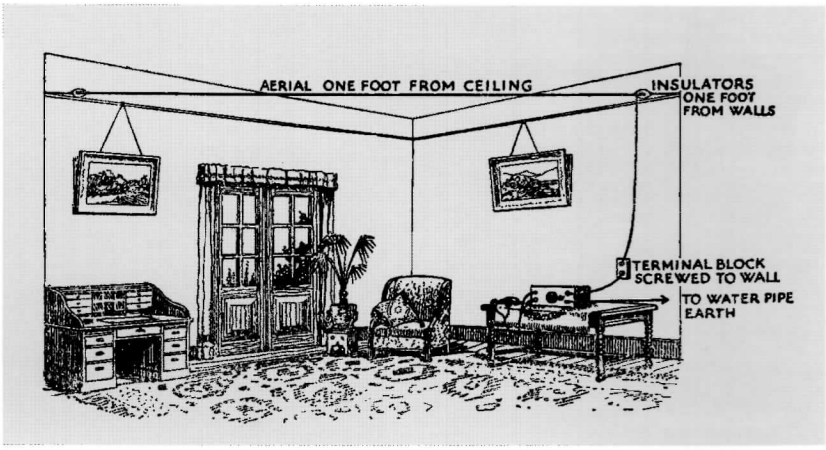
Regional Scheme Transmitters

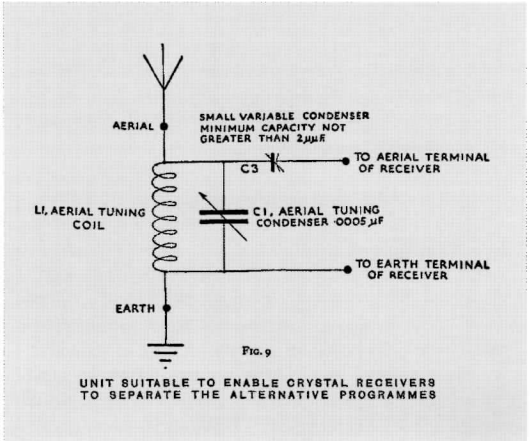
Region	Site	Year of Opening
South East	Brookman,s Park	1929
North	Moorside Edge	1931
Scottish	Westerglen	1932
West	Washford	1933

The second shortcoming of the Regional Scheme affected those crystal set owners living in central London. Listeners within a 3 to 6 mile radius of Marble Arch received a noticeably weaker signal from Brookman's Park, although the BBC argued that it was more than sufficient to give satisfactory reception for crystal set users who were *"able and willing to take the necessary measures to secure it."* In particular it was pointed out that listeners employing an indoor aerial would need to use something better.

In order to contradict accounts that crystal reception was impossible under the new conditions, the BBC investigated individual complaints from those reporting difficulties with reception in the London area. But, such was the extent of dissatisfaction with the new reception conditions, the Corporation published a second booklet *'Crystal Sets and the Brookman's Park Transmitter'* in which they attempted to quell listeners' concerns. A comprehensive list of recommendations was provided including all of the usual advice regarding cleanliness of the crystal, the importance of positioning the set near to the aerial lead-in, keeping the earth lead as short as possible and ensuring all terminal connections were securely tightened. Most of the advice, once again,







Top left: Selective crystal set for the reception of both regional and national programmes.

Above: The BBC strongly recommended an outside aerial for reception of Brookman's Park transmissions in central London. This indoor arrangement was illustrated for use in areas of high signal strength.

Left: Suggested BBC circuit to enable better station separation for crystal set users.

concentrated on the efficiency of the aerial itself. An outside aerial was regarded as essential and frustrated London listeners were advised that the fact that crystal reception on an indoor aerial had previously been acceptable was *"an accident of the listener's whereabouts, rather than the intention of the BBC"*. As a last resort, listeners could complete and submit a questionnaire addressed to the BBC's chief engineer. The level of listener concern reached a peak in January 1930, when correspondence on the subject exceeded 10,000 enquiries per week.

Despite the BBC's official position that it was committed to come up with solutions to enable its less well-off listeners to continue to use their crystal sets, individual members of its technical staff were less concerned. Peter Eckersley himself later wrote[1] that *"If we had to wait until everybody gave up using old junk and expensive toys before we could institute any new schemes we might just as well never make any changes at all."* The large numbers of the public who were reluctant to spend money on a suitable valve set would, no doubt, have vehemently disagreed with Eckersley.

In the end, however, it had to be recognised that for many living in the city the erection of a suitable outside aerial was impossible, and for those near a transmitter the selectivity problem was insoluble. In either case the only viable suggestion from the BBC technical staff was the purchase of a one-valve set. So, whether because of inadequate station separation or lack of signal, depending on the location, with the opening of Brookman's Park, the reign of the crystal set was over in London. The rest of the country quickly followed suit as the Regional Scheme transmitters displaced the local BBC stations and within a few years crystal sets were relegated to the status of an amusement for young hobbyists.

1. Eckersley, Peter P: The Power Behind the Microphone. Published by J.Cape, London 1941.

Military Radio meeting in Worthing

The Vintage and Military Amateur Radio Society (VMARS) are holding another Southern Event on Saturday 3rd April 2004 at:
Field Place Conference & Sports centre,
The Boulevard, Strand, Goring, Worthing BN13 1NP

This is the second event of this type and is a chance for members of VMARS and anyone interested in the historical aspects of Vintage and Military Radio as a hobby to get together in a friendly environment, swap a few bits and generally have a good time.

It is hoped that there will some stalls with vintage and / or military radio gear for sale (please note that this not a 'radio and computer' event).

Times are 10:00 - 16:00 and we are planning to have HF and VHF stations on air. Signage will be in place from the A27 Trunk Road.

For further details, stall prices and bookings contact Mike Hoddy, G0JXX on 01903 260291
g0jxx@aol.com.

A future classic

by Clive Hooley

Firstly I would like to mention that, apart from having a passion for collecting vintage radios, I equally enjoy listening to them as well. It constantly fascinates me how different they can sound; cabinet material, size of speaker, circuitry and many other factors all take their part in moulding the final sound that reaches our ears. What I like about most 1930s and 40s sets is the warm, rich sound they create. The best sounding radios from this period are the Murphys. But as with so much connected to 'sound quality' it's often down to personal taste and, with this in mind, brings me to the new radio that I purchased last year. To my ears it sounds very good indeed. I first heard about it when it was reviewed in the Gramophone magazine. The radio in question is the Henry Kloss model No1 by Tivoli Audio. What connects this product to sets from the past is that it's a mono mains only table radio in a wooden case. The reviewer gave it such an excellent write-up that I decided that I must have a listen and judge it for myself. I found a Hi-Fi shop selling the radio and was given a demo. I was not disappointed at all and promptly purchased one.

The first thing you can't help but notice when seeing this radio for the first time is the tiny size of it, as you can see from my photo comparing it with a Bush DAC 90A. This is very deceiving because the second thing you notice after switching it on is the amazing sound that greets you. A surprising deep bass and detailed sound is completely at odds with the size of the cabinet. This is not a cheap and cheerful retro product but a carefully thought out design – a very nicely made radio.

Henry Kloss, who sadly passed away last year was quite a notable person in the history of the HiFi business in the USA. The Tivoli radio was his last design. It's a FM AM receiver and really nice to use due to the geared tuning knob and its ability to lock on to stations with the minimum of fuss. Inside it uses components from mobile phone technology; no valves here but clever circuitry to adjust the amplifier to get the best frequency response out of the long-throw speaker. The cabinet must be remarkably rigid because no matter how high you have the volume there is no hint of any vibration to colour the sound. I think that this is quite an acheivement considering how much energy is being generated by that hard–working speaker. You only have to put your hand over the port on the underside of the cabinet to feel the amount of air being moved. I think it looks rather nice too. I opted for the white and silver version to blend in with our kitchen but a number of other finishes are available.

I've had the radio about fourteen months now and the novelty of it has not worn off; it still has the ability to surprise me with that bass response and it can be listened to all day without any fatigue setting in. The sound is very detailed and never harsh and tends to draw you into whatever that you are listening to. Any criticisms? Perhaps the volume control could be less sensitive at the low end and it is quite fussy about it's location; it can get a bit boomy when positioned in a corner. Other than that – no. I've found a place where it's happy and the sounds it produces are a constant pleasure. As you can tell I regard this radio very highly. I think I'm going to get many years of pleasure out of it. A modern classic? Time will tell but it might be the last quality analogue table radio to be produced on the eve of the digital broadcasting boom that's starting to find its feet.

More information can be found on the website: www.tivoliaudi.com

Readers' Tips

Most of us have learnt easy ways to do tasks when restoring radios and televisions, so much that it comes as second nature. This feature is for you to share your information and appeal for information. There will be more than one way of doing most tasks; let's hear what works for you. Please send your tips to the Editor.

The cream coloured bands on Philips Bakelite radios can be touched-up using Dulux 'Once' Buttermilk paint. This is lighter than the original but when dried can be aged and darkened with strong black tea. It may take two or three applications of tea to get a good match.
John Clappison

Woodworm holes should be treated with one of the proprietory treatments. Then when dry can be filled with wax. I use either wax crayons or wax bars purchased from hardware shops. Darker wax is less obvious than a lighter colour. Use a soldering iron with approximately 7 centimetres (3 inches) of 18 gauge copper wire wrapped around the bit with the last 25 millimetres (1 inch) left sticking out to melt the wax into the holes, but beware of the fumes. When cold, any excess wax should be levelled off with an old credit card. This method does not damage the surface like some fillers.

If the radio is inspected regularly, new woodworm activity will be easy to see.
John Clappison

To brighten up an old wooden radio use 'Ronseal' Brushing Wax neutral. It says on the tin 'Simply brush on and brush off'. It works on most finishes but it may be best to first try a little wax in an inconspicuous area.
John Clappison

It is assumed that anyone trying any of these tips will carry out a full risk assessment before trying any of these tips as neither the author or members of the BVWS can be held responsible for your safety.

From Crystal sets to 405 line televisions part 3

by CS Garnett

Developments of the valve continued

iv. Beam Tetrode
There was a problem with the screen grid valve outlined in the previous articles. High velocity electrons bombarding the anode sometimes caused lower velocity "secondary" electrons to be emitted; these electrons could then be captured by the positive voltage on the screen grid. This 'secondary emission' effect would lead to signal distortion if large anode (AC) voltage swings were to occur. There were two solutions to this problem; the first was the invention of the Beam Tetrode. In this tetrode "beam confining" plates, were added, typically connected to the valve cathode. These plates modified the shape of the electrostatic field in the area of the anode in a way that minimised the number of secondary electrons reaching the screen grid. Beam tetrode valves found use in high quality audio power output stages because of the linearity of their characteristics. The other solution to combat the secondary emission problem was the Pentode Valve.

v. Pentode Valves
As the name suggests, pentode valves have 5 electrodes, 1 anode, 3 grids and a cathode. The first (control) grid acts in the normal way; the second grid is the screen grid electrode (described above). An additional "suppressor grid" is added between the screen grid and the anode. The purpose of the suppressor grid is to collect any electrons that are emitted from the anode as a result of its bombardment by the stream of electrons from the filament. By doing so it prevents these "secondary" electrons from reaching the screen grid and reducing the efficiency of the valve. The suppressor grid is held at a low potential. Figure 2e shows the circuit diagram representation of a pentode valve. Commonly, to save a valve base connection, the suppressor grid was linked internally within the valve envelope to the cathode. If so, this connection would usually be shown as such inside the symbolic drawing of the valve.

vi. Integral valve screening
Some valves, especially those operating at signal frequencies (like those used in the tuners of TV sets), tended to require external metal cans around them to prevent signals from straying into other adjacent circuitry. Other valves had a coating of fine metal powder on the outer surface of the glass envelope that served the same purpose; connection to the outer coating was often brought out as a separate pin on the valve base.

vii. Other developments
As time went on a whole raft of specialist valves were designed for use in the radio and TV industries. Economics dictated that it was advantageous to keep the valve count down in equipment manufactured for mass markets, so specialist valves performing several functions within one envelope were developed. Examples of such valves are Frequency Changers for 'superhet' circuits - which enabled both an oscillator and a mixer circuit to be designed using just one valve, and Double Diode Triodes, for Detector / AGC circuits - which could supply 2 separate rectified signals and perform amplification in one device. We will be looking at some of these valves more closely a little later. No matter how complex a thermionic valve may seem, it will always operate on the basic electrostatic principles outlined already.

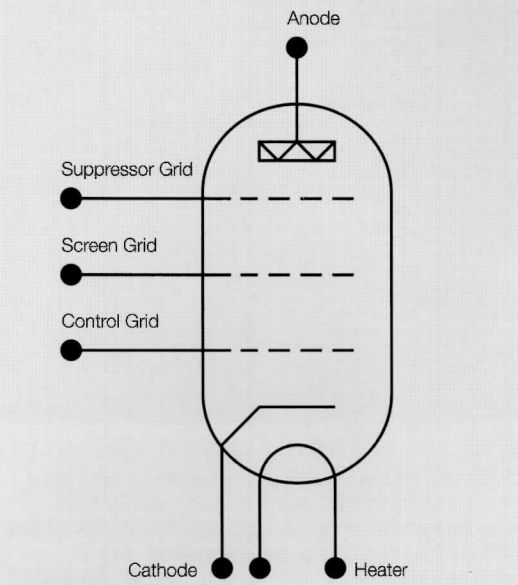


Figure 2e The Pentode

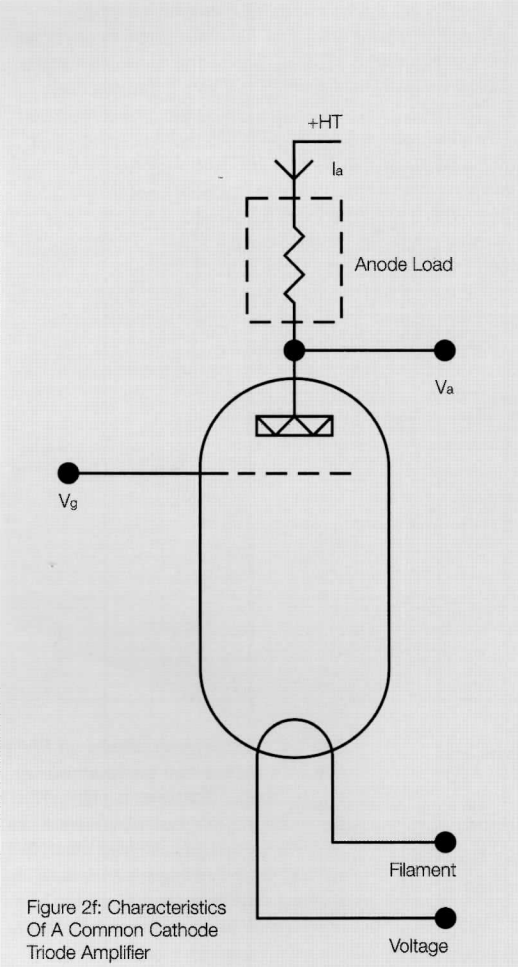
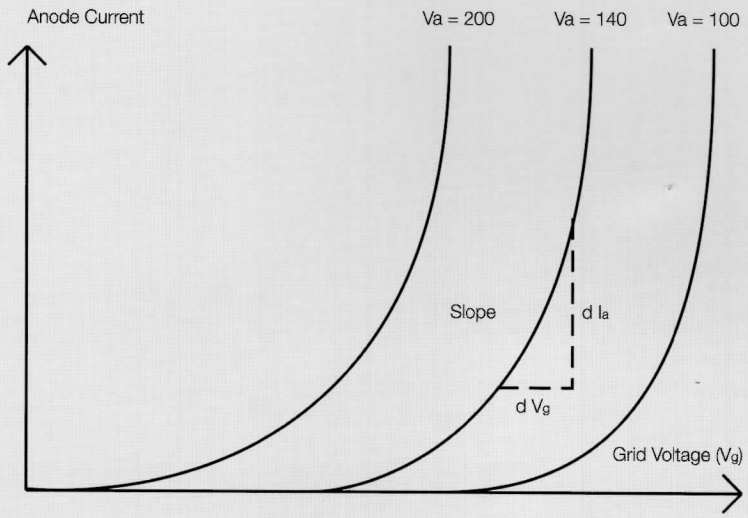


Figure 2f: Characteristics Of A Common Cathode Triode Amplifier

Figure 2g: Graphical Representation of Mutual Conductance (The Slope)



viii. Faults in valves

a. Air in valves

Valves with unwanted air in them - giving a less than perfect vacuum - are commonly referred to as "gassy" or "soft". A valve that contains a small amount of air may still work but will exhibit a blue "haze" or glow when in use; this is caused by ionisation of the air within the valve around the filament and is especially noticeable if the valve in question is used with high anode voltages. Air may be present in a valve because it has not had all the air extracted at manufacture or it has developed hairline cracks in the glass (usually around the pins on the base). If the valve becomes overheated due to excessive current flowing, "out gassing" from within the electrodes can also occur.

b. Mechanical Defects

By their very nature, valves are more sensitive to mechanical shock than semiconductor devices. Apart from the risk of external damage to the glass envelope, damage can also be caused internally to fragile electrodes, resulting in open and short circuits. Insulation breakdown (leakage) may also develop, for example between heater and cathode.

c. Open Circuit Filaments /heaters

The filament or heater within a valve can fail, rendering it unusable. Apart from failure due to normal ageing and mechanical shock, electrical failure elsewhere in a circuit can cause the filament or heater to take too much current, burning it out prematurely.

d. Loss of emission

Valves can lose emission through age. The tungsten filament (cathode) in bright emitter valves will eventually grow thin through evaporation of the surface metal, especially at the middle of the filament where it is the hottest. This in turn will lead to a higher resistance at this part of the filament causing uneven temperature along the filament length and a corresponding drop in emission. With dull emitter valves, overdriving the heater circuit can damage emission; the cathode is then taken above its rated temperature and the oxide layer is damaged.

Cathode poisoning can also cause a valve to lose emission. It occurs with valves using a barium oxide coating on the cathode. When such a valve is operated with zero or very low current flowing through it, but the heater lit, it is possible for a layer of barium compound to form over the cathode. This layer reduces emission and tends to make the valve electrically "noisy". Operating the valve at higher current levels can often repair poisoned cathodes.

Finally, valves with oxide cathodes can lose emission if "cathode stripping" has occurred; operating the valve with too high an anode voltage can cause this.

Valve Characteristics

i Anode Impedance

In a thermionic valve diode, the chief characteristic, (ignoring criteria such as maximum working voltage and required heater current etc) is the Anode Impedance (R_a). R_a governs how easily current will flow through the device. Anode impedance is given by the following equation - which is really just Ohm's Law as applied to varying currents and voltages: -

$$R_a = dV_a / dI_a$$

Where R_a is Anode Impedance
dV_a is a small change in Anode Voltage
dI_a is the related small change in Anode Current

With a triode this simple impedance measurement is complicated by the grid, which adds a controlling factor into the picture. If the anode impedance is to be measured in a triode, or other multi-electrode valve, the grid(s) Voltage must be fixed to a reasonable value. The grid voltage is then quoted along with the anode impedance. A useful characteristic in a triode that takes the action of the grid into account is the "Amplification Factor".

ii Amplification Factor

For a simple one-valve triode amplifier shown in fig 2f, the Amplification Factor is the maximum voltage swing which could be produced at the anode of the valve for a given change in voltage at the control grid (the theoretical maximum assuming an infinitely high impedance load at the anode).

Amplification Factor = $- dV_a / dV_g$ | Assuming I_a is constant

Where dV_a is Change In Anode Volts
dV_g is associated Change In Grid Volts
I_a is Anode Current

The negative sign in front of the equation indicates that the amplifier inverts the signal applied to it.

iii. Mutual Conductance, or slope (gm)

The third major parameter is called the "slope" or "mutual conductance" and is given by equation: -

Mutual Conductance (g_m) = dI_a / dV_g

Where dI_a is change In Anode Current
dV_g is associated change In Grid Voltage

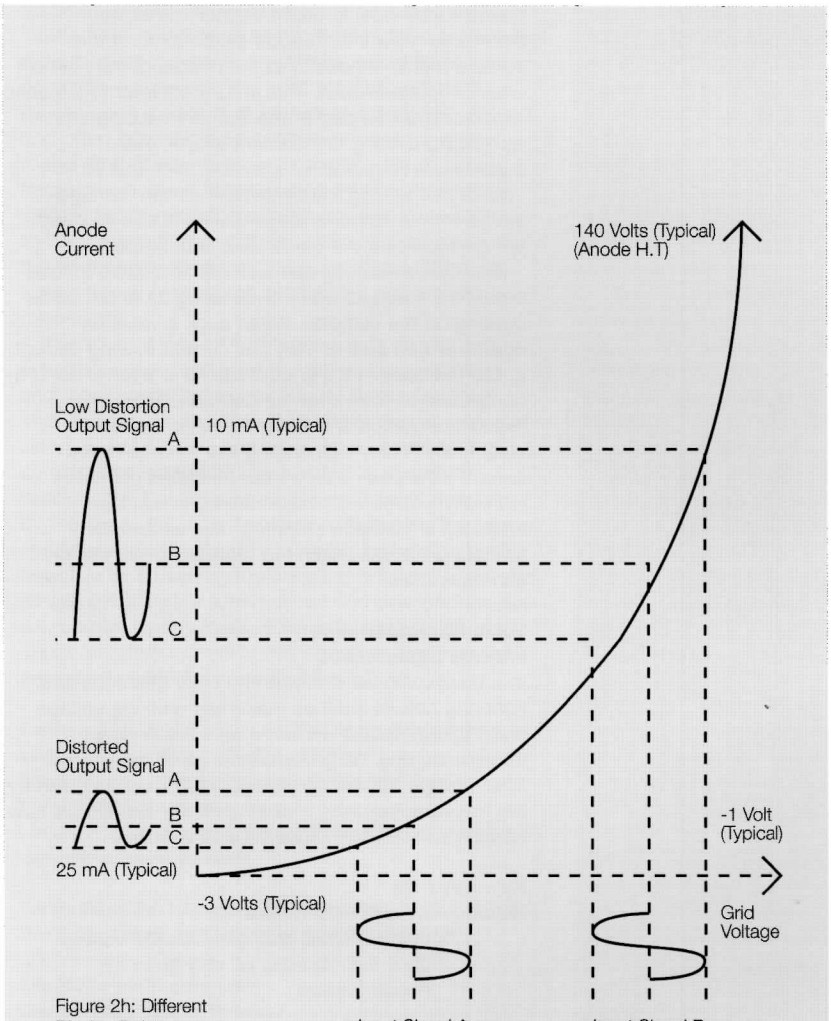


Figure 2h: Different Biasing Points

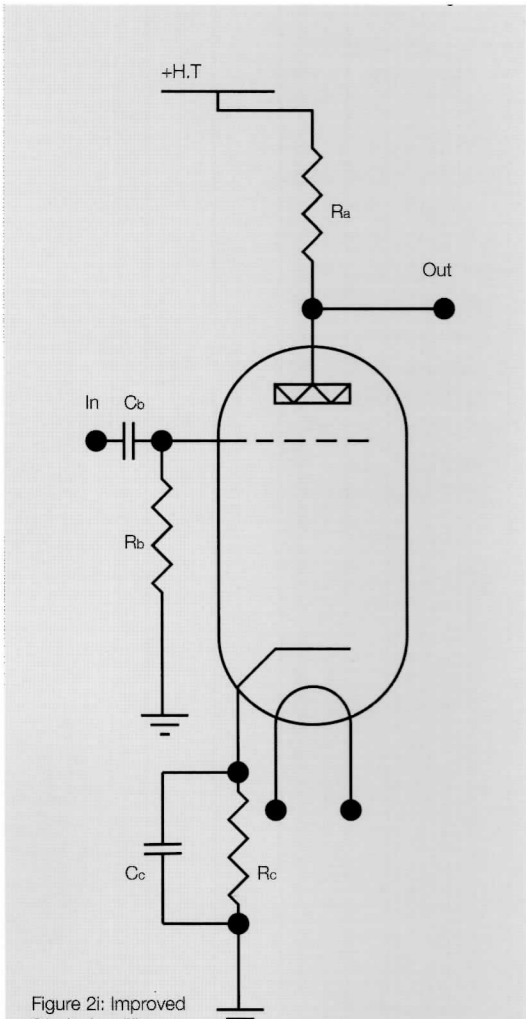


Figure 2i: Improved Triode Amplifier

In summary, the major characteristics of a triode valve are given by the equations: -
Anode Resistance (R_a) = dV_a/dI_a
| With the grid voltage held constant

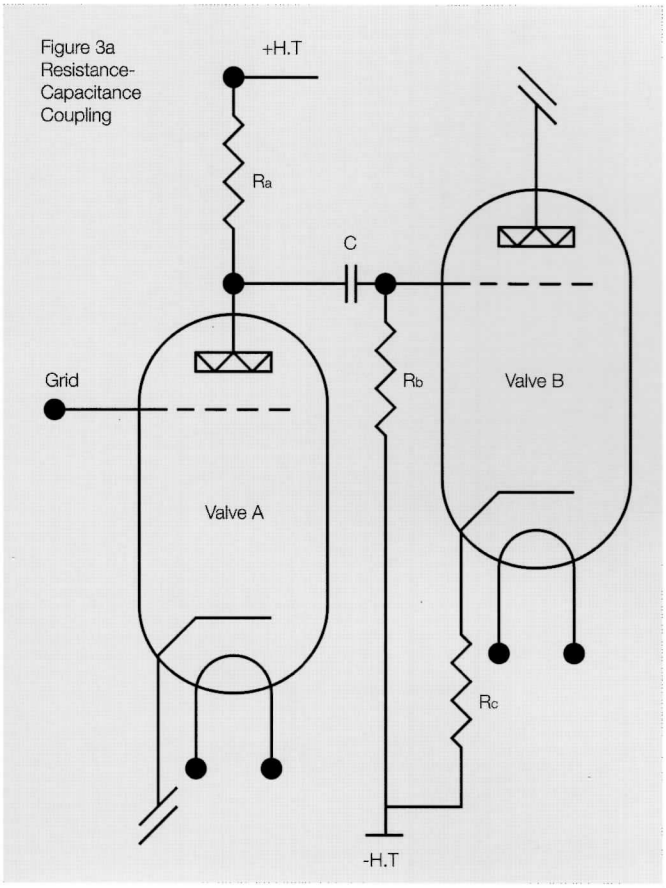
Amplification Factor = - dV_a / dV_g
| Assuming anode current is constant

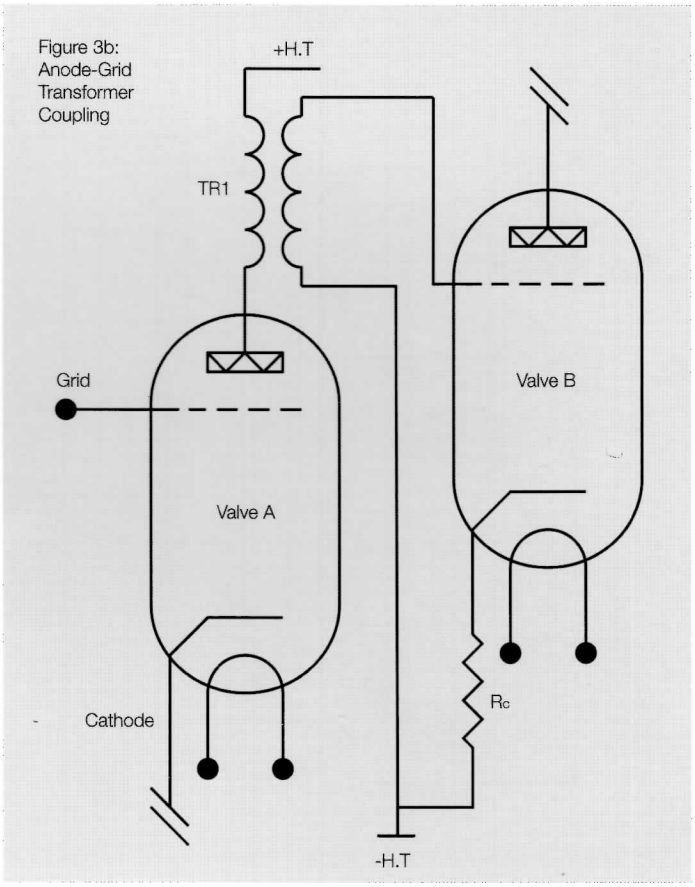
Mutual Conductance (gm) = dI_a / dV_g
| Assuming anode voltage is constant

Comparing the three equations also shows that:
Mutual Conductance = Amplification Factor / R_a
Amplification Factor = (-) Mutual Conductance* R_a

To represent mutual conductance graphically is quite illuminating, because its other name "slope" refers to the slope of the graph of a valve's characteristics.- see figure 2g. Mutual Conductance is measured in "milliamps-per-volt" – that is milliamperes of anode current (I_a) per grid Volt (V_g). It is defined for each point on the curve as the "slope" of the triangle (height divided by base) that can be drawn at that point, as depicted on the centre valve curve in the diagram. In actual fact, the "slope" of a valve's curve is never completely straight, therefore to avoid errors when measuring gm the values dV_g (change in grid voltage) and dI_a (change in anode voltage) must be kept very small..The different curves are the results for different fixed values of anode voltage (V_a).

Grid Biasing Voltage
Remember the triode amplifier outlined earlier? The grid voltage was held at the "correct" voltage (see fig 2c) by means of a Bias Resistor, R_b, connected to a suitable DC potential. There are ranges of grid voltages that are acceptable. Below this range (grid voltage too negative) an input signal applied to the grid will result in a distorted current output at the anode. Above the range (grid voltage not negative enough) the valve takes too much current from the supply (especially critical if the equipment was designed to work from batteries). If the grid voltage is biased higher (more positive) still, the electrons leaving the cathode of the valve will no longer be repelled by the grid, but become attracted to it, and seek to flow out of the grid. This badly impairs the input characteristics of the amplifier and leads to distortion of the signal. Fig 2h shows an expanded mutual conductance curve, being used to predict the performance of a triode amplifier. The varying Input signal is shown acting upon the Grid Voltage along the bottom line. Its effect on the Anode Current will vary according to the slope of the characteristic curve, which "reflects" it at each point to determine the 'Output' signal along the vertical line as shown. Signal A is biased too far down the curve. The curve at this point is extremely non-linear and the result is an anode current that is also non-linear. Additionally, the magnitude of anode current is low for a given grid voltage. This means the gain of an amplifier biased at this point will be low. By contrast, signal B is biased at a more linear point on the curve, the curve is also steeper at this point resulting in a much more linear signal and a larger flow of anode current for a given grid voltage.





The Cathode Biasing Resistor - An improved Triode Amplifier

Figure 2i shows an amplifier configuration that incorporates a resistor (R_c) between the valve cathode and earth. Across this resistor is coupled a capacitor (C_c). Rb is connected between ground (ie. zero volts) and the grid, and capacitor (C_b) is connected in series with the signal input to block any DC voltage present on the signal being fed to the grid.

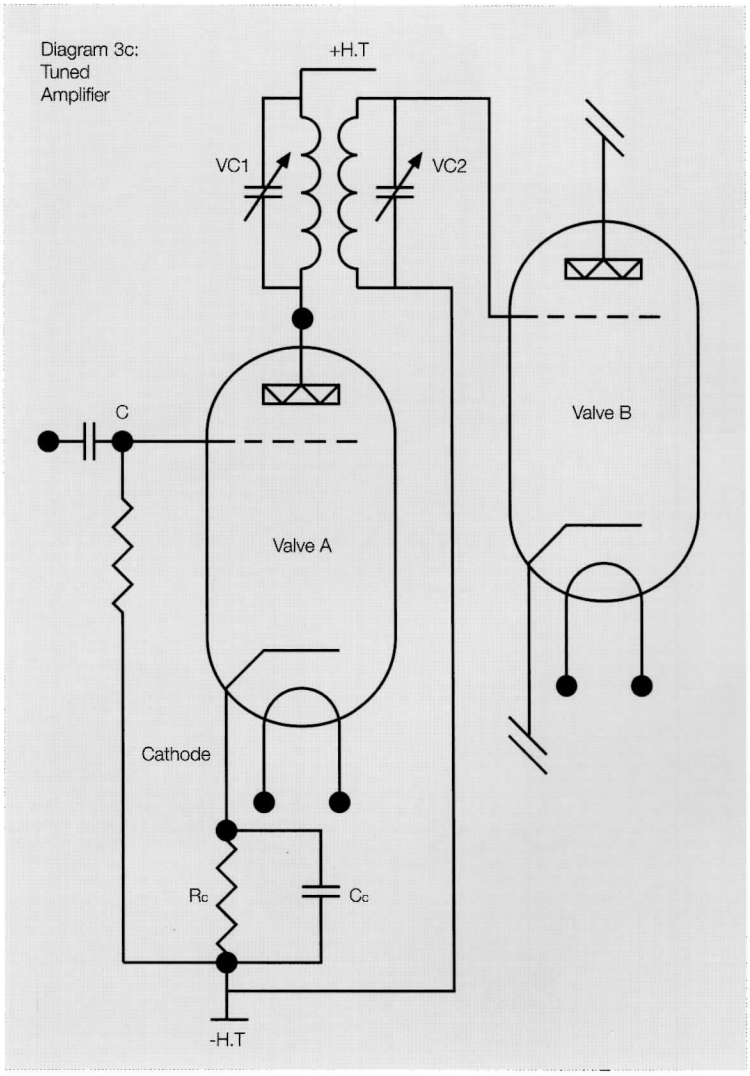
Cathode resistors provide a working DC bias voltage and act to stabilise valve amplifier stages. In a single stage amplifier with a simple anode resistance, the voltage output at the anode is in anti-phase with the voltage applied to the grid. The current flowing through the valve is basically dependent upon the voltage on the grid. Actually this statement is not quite complete: the current flowing through a valve is really dependent upon the voltage difference between the grid and the cathode. When the cathode is grounded (ie. at zero volts, as in the case of our former amplifier) this distinction does not matter, but it does now.

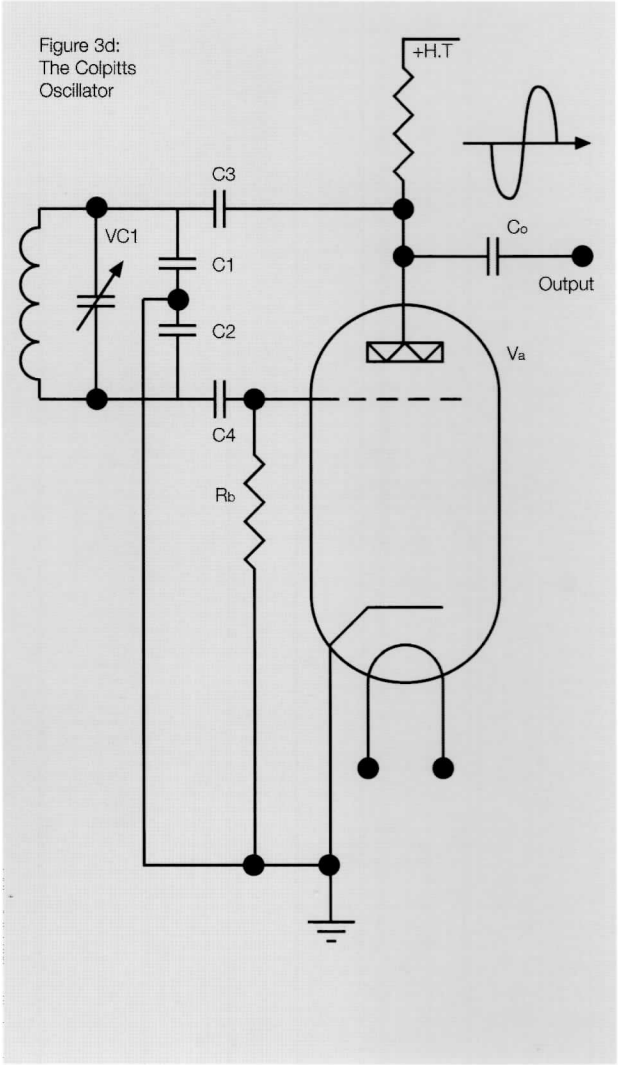
Looking at diagram 2i, in this configuration, current through the valve is approximately equal to the current flowing through R_a which is approximately equal to the current flowing through R_c. Now assume that with no signal applied, the steady current flowing through the valve is a function of the Grid to Cathode voltage, which depends upon the two resistors R_b and R_c. Supposing a positive signal is now applied to the grid, this will make the grid more positive with respect to the cathode, more current will flow through the valve and cathode resistor R_c, and this will increase the voltage drop across R_c and hence the voltage on the valve cathode with respect to ground. But the Grid is also connected to ground via R_b and so the increased cathode voltage is in effect subtracted from the input signal, tending to counteract the original positive change.

As a result of this the current flowing through the valve is reduced. The magnitude of the reduction is dependent on the value of the cathode resistor. Now assume that through ageing, the valve's gain decreases. For a given input (grid voltage), less current will flow through it. This will create a smaller voltage across R_c and hence a smaller voltage will be subtracted from the input to compensate for the changed characteristic. The same thing in reverse occurs should the valve increase its gain (more cancelling voltage will be fed back). A cathode resistor samples the output of a valve amplifier and feeds it back in a negative (subtractive) way. Such a design makes an amplifier less dependent on the characteristics of individual valves. In a practical amplifier the capacitor Cc provides a path to earth for signal frequencies covering the working frequency range for which the amplifier was designed. These frequencies therefore do not flow though the resistor Rc and artificially raise the cathode potential, which would otherwise reduce amplifier gain. The cathode resistor therefore controls the steady-state DC conditions of the valve only.

Grid Biasing From Positive HT Supply

With the improved biasing arrangement outlined above, the practice of supplying the grid with a separate negative voltage (relative to earth as opposed to the cathode) became less prevalent over time, thus making the design of power supplies





and battery packs simpler. However, the cathode bias resistor voltage does itself subtract from the useful HT supply voltage available to drive the anode circuit, and so a slightly higher HT supply may need to be provided.

The Coupling of Valve Stages

A valve radio receiver in its crudest form is a frequency determining tuned circuit, (consisting of an inductor and capacitor in parallel) followed by a series of valves coupled together. Each valve is usually considered as belonging to a particular "stage" of the receiver having a defined purpose, acting on the signal and providing high frequency amplification, detection (rectification) and low frequency amplification (audio amplification).
A loudspeaker or headphones terminates the line of valves. There are several ways in which linkage can be provided between the separate stages; the basic methods will now be shown.

i. Resistance - Capacitance Coupling

This arrangement is shown in Figure 3a. There is a resistor (Ra) between Valve A's anode and the HT supply. The AC signal on the anode of valve A is passed to valve B via capacitor C, which should be well able to withstand the H.T supply voltage. In the event of a breakdown of this component, the grid of Valve B would be exposed to damaging HT voltage from Valve A's anode. Resistor Rb (which we have met before in the previous section) is to provide a path for electrons from the grid of valve B (the so-called grid leak resistor). The capacitance value of C is chosen to present low impedance to the signal to be processed. Resistance-Capacitance coupling is usually only suitable for use at audio frequencies (20Hz-20KHz); above these frequencies capacitive effects in the valve reduce the gain possible from the coupled stages.

ii. Inductance - Capacitive Coupling

This arrangement follows the form of the capacitive-resistive coupling illustrated in diagram 3a but the resistor R_a between the first valve's anode and the H.T voltage is replaced by an inductor (choke). The inductor and Capacitor values will depend on the frequency that the stage is required to operate at and the impedance of Valve B's input circuit.

iii. Transformer Coupling

This arrangement is shown in figure 3b. It requires the use of a transformer (TR1) that is able to withstand the anode current from the first Valve A flowing through the primary without its inductance being badly affected (potentially resulting in distortion). The high tension DC voltage on Valve A's anode is prevented from reaching Valve B's grid by the transformer (transformers pass only AC signals between their primary and secondary windings). In addition to passing on the signal between stages, the transformer windings may also be arranged to 'step-up' the signal voltage (according to the turns ratio) to assist in increasing gain, and at radio frequencies the windings may also be tuned (see below).

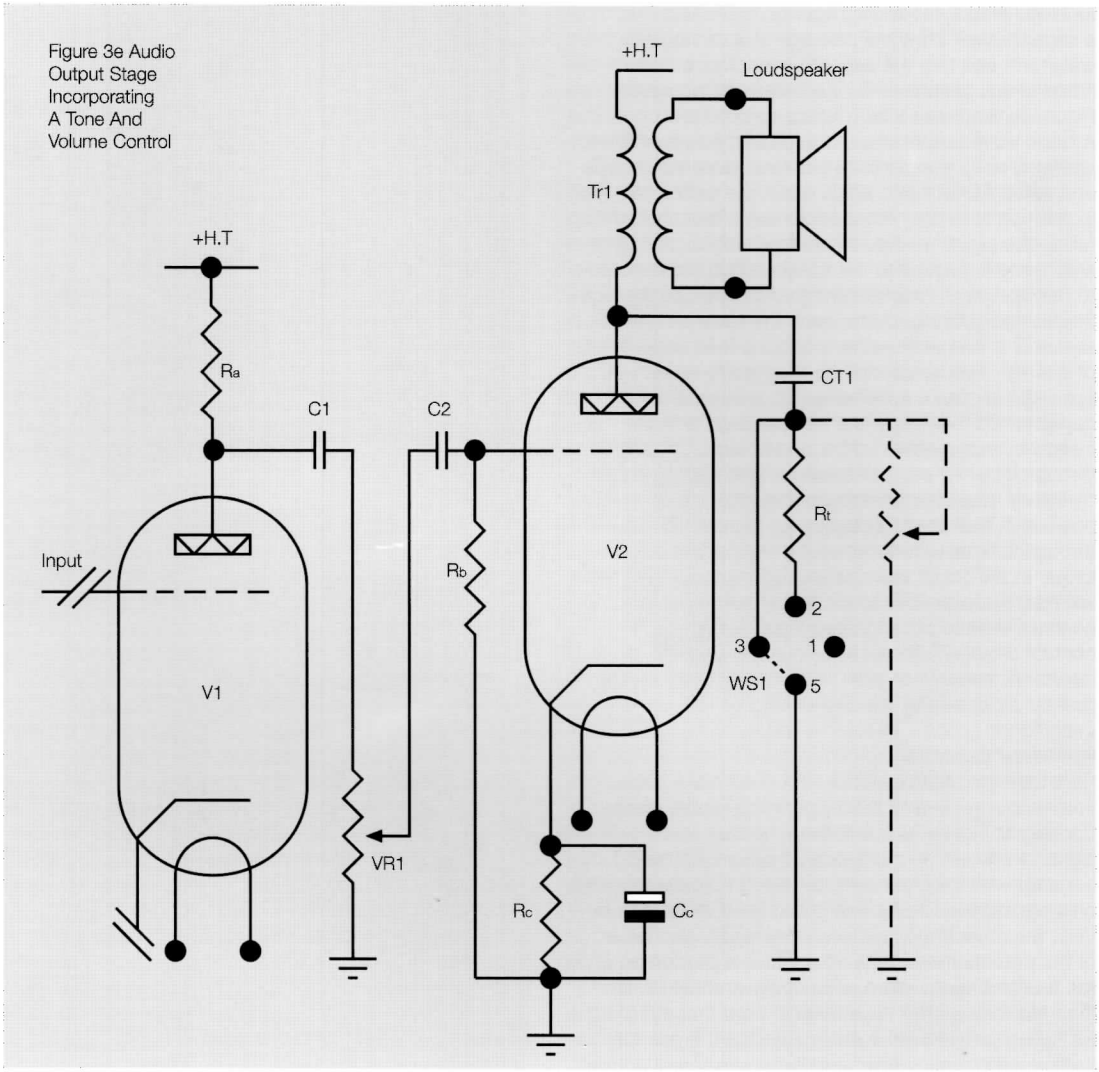


Figure 3e Audio Output Stage Incorporating A Tone And Volume Control

Valve "Building Blocks"

i. Tuned Amplifier

This is usually a simple valve amplifier stage, similar to the amplifier discussed in Part** but with the anode resistor being replaced with a parallel tuned circuit (see Part**). Often the inductive element is the primary of a coupling transformer, the secondary of the transformer may also be tuned with a capacitor.
A tuned amplifier is shown in figure 3c. It has to be understood that as far as a varying signal voltage is concerned, any steady DC voltage (such as the H.T supply) is regarded as "earth", owing to the 'decoupling' capacitors which are always provided between power supply terminals and earth. This makes the tuned amplifier easier to understand.
At a specific frequency, the impedance of the parallel tuned circuit is maximised and the varying signal at the anode will be maximised. Other (unwanted) frequencies will see the tuned circuit as low impedance and hence will not appear at the valve anode. Variable capacitors VC1 and VC2 allow the frequency to which the circuit is tuned to be altered. Tuned circuits are useful at high frequencies because any "inherent" (stray) capacitance present in the valve or wiring will in form part of the capacitive element of the tuned circuit and not degrade the performance of the amplifier.

ii. R.F Oscillators

An oscillator is a device that produces a repetitive waveform from a steady DC supply. In a radio receiver they usually produce sine waves. At radio frequency (R.F), oscillators generally incorporate an LC tuned circuit. Many oscillators utilise an effect known as positive feedback,. when a sample of an amplifier's output is added back into the input; the effect of this is to increase the gain of the amplifier. Above a critical feedback value, oscillations in the amplifier become self-sustaining without any external signal input, at some frequency determined by the values of inductance, resistance and capacitance in the circuit. For positive feedback to occur, the feedback signal must be in phase with the applied signal.

Figure 3d shows a Colpitts Oscillator circuit. An LC tuned circuit comprising VC1, L1, C1, C2 provides a feedback path between an amplifier output (V1 Anode) and its input (V1 Grid) the components also shifts the phase of the signal, which is already shifted 180 degrees by the valve. C3 blocks the anode HT voltage from interfering with the input circuit and C4 isolates the grid circuit. No signal needs applying to the circuit as it "self starts" by oscillations building up in the LC circuit. The output of the circuit should be a single frequency (i.e. a pure sine wave), in practice though such signals contain impurities called "harmonics". In most domestic valve radios, the use of such "discrete" oscillator circuits is rare; more commonly they form part of a combined mixer/oscillator arrangement where both the mixer and oscillator circuitry are catered for by a single multi-electrode valve (more on this later). Lower frequency oscillators that work on a different principle are used in TV time base circuits; these will be covered later in the series.

iii. Tone Controls

A tone control is a form of filter; it usually operates after or just prior to the audio output valve on a valve

receiver. Broadly speaking, it relies on the fact that a capacitor will allow the passage of a varying AC waveform and that the capacitive reactance (impedance) decreases as the frequency increases. Figure 3e illustrates a fairly crude tone control.
A basic valve output stage is depicted; however there are three extra components between valve V2's anode and earth: Rt, CT1 and WS1. When the switch (WS1) is in position 1, neither R nor C has any effect and so the full anode signal reaches the output transformer (Tr1) and hence is passed to the speaker. This corresponds to the maximum "treble" setting and allows all the high frequency audio signals to reach the speaker. If the switch is in one of the other positions then some or all of the high frequencies will be diverted to earth, by-passing the output transformer. Thus in position 2, capacitor CT1 will allow the free passage of high frequency components of the anode signal to pass through it but Rt will limit this flow. This setting is for "medium" tone. If the setting of the switch is in position 3, then the high frequency signals will pass through CT1 as before but as the resistor Rt is no longer in the circuit more of the high frequency signals will pass to earth. This is the "bass" setting of the control. An alternative 'continuously variable tone control' arrangement could be the replacement of resistor Rt and switch WS1 with a linear law variable resistor as shown by the dotted lines.

v. Volume Controls
Part 1 showed the operation of a potentiometer; a volume control is a typical application of this device. Looking at Figure 3e again, the amplified audio signal is present on the anode of valve V1. The DC component is blocked by capacitor C1. Audio signals only are applied to one end of the fixed resistance in VR1; the other end is connected to earth. The wiper of the potentiometer taps off a variable proportion of the total voltage present at its upper end, which is then fed through the capacitor C2 onto the grid of V2 for further amplification. Assuming that the gain of both valve stages is fixed and the audio signal on the grid of V1 is constant in size (amplitude), then the loudness of the sound (or volume of the air moved by the speaker cone) is dependent on the setting of the potentiometer. The volume control can be said to set the gain of the audio stage of the receiver; as explained earlier, volume controls usually follow the logarithmic law to match the response of the human ear.

vi. Automatic Volume (or Gain) Controls (A.V.C or A.G.C)
The purpose of an A.V.C system is to automatically adjust the gain of a radio set so that variations in signal strength are not passed through the set resulting in annoying "booming and fading" of the audio output. Figure 3f shows a basic A.V.C system. V1 is a 'variable mu' Pentode RF Amplifier (Pentodes of the variable mu type have special characteristics and are often drawn with an arrow through them – more on this later). V2 is a Diode Detector. The diode rectifies the radio signal and the resultant audio signal is passed to the receiver audio stage via a 'volume control' potentiometer VR1. The rectifies audio signal is also passed to filter components Rbias and Cbias to produce a negative biasing voltage; this signal is fed back to the Pentode grid. The signal has to be filtered by Rbias and Cbias so that it provides a slowly varying DC signal which only reflects the general trend of the audio signal as opposed to every peak and trough in it.

This biasing voltage has the effect of varying the gain of V1. As the signal fades, the rectified audio signal drops in amplitude and the biasing voltage becomes more positive. The gain of the Pentode stage is therefore increased to compensate for the

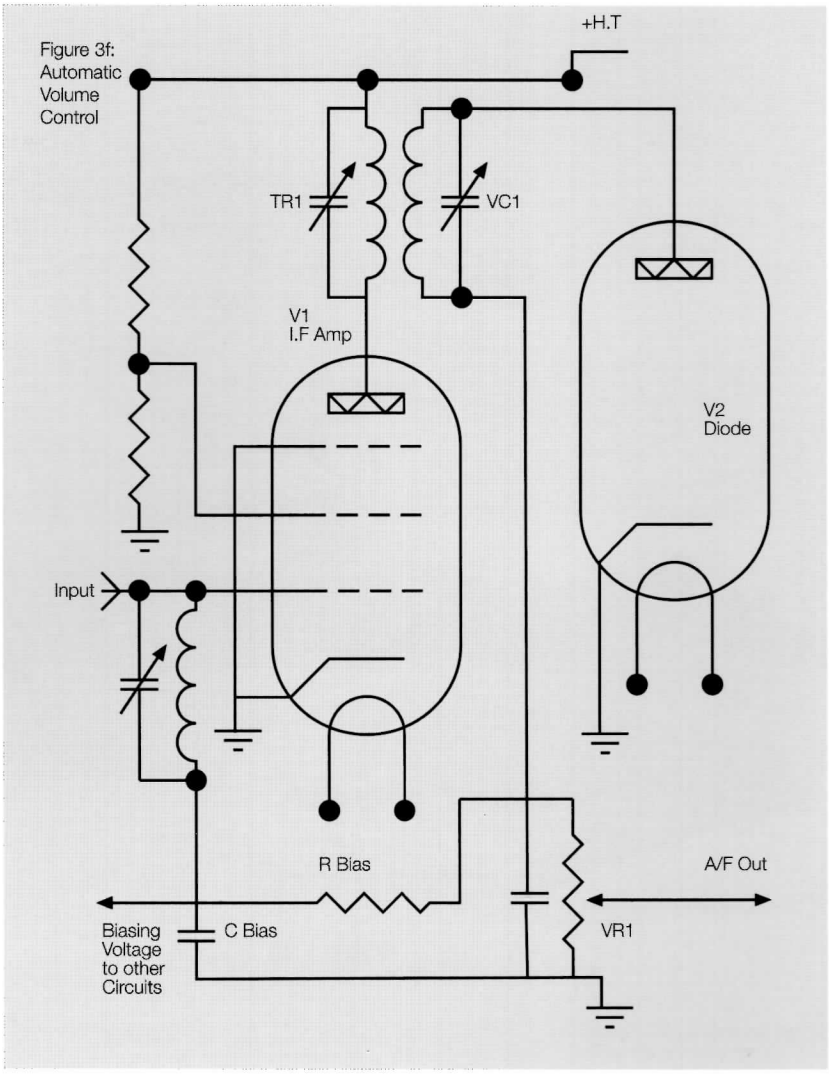


Figure 3f: Automatic Volume Control

weak signal. As the signal strength increases, the voltage goes more negative and the gain of the Pentode stage decreases. The biasing voltage can also be used on other stages of amplification prior to the final stage just described. Systems such as those just outlined have a disadvantage; even with very weak signals the diode will conduct some current, therefore some negative voltage is fed back and maximum gain from V1 is not available when it is needed most. To get around this problem two diodes are sometimes used, one for audio signal detection (this will need to work even on small signals for the radio to be satisfactory) and one to generate a bias voltage for A.V.C use. The diode for A.V.C use can be biased slightly negatively, this will mean that no negative A.V.C voltage will be applied to the amplifier(s), therefore no gain will be lost when very small signals are received. Practical A.V.C circuits often have both diodes in the same valve, sometimes with a triode grid as well for low frequency amplification (double diode / triode valves).

Variable Mu Valves
For better results in A.V.C applications, pentode valves with special characteristics were developed. If you remember back to Part 2, when the grid biasing was too negative, distortion became a problem. The distortion was bad because a (relatively) large signal was applied to a point on the Ia - Vg valve characteristic curve where there was a sharp "bend". This could also be a problem with an amplifier whose voltage gain is being controlled by varying a valve's grid biasing voltage (as in A.V.C circuits). Variable Mu valves have no such sharp "bends" in their Ia - Vg

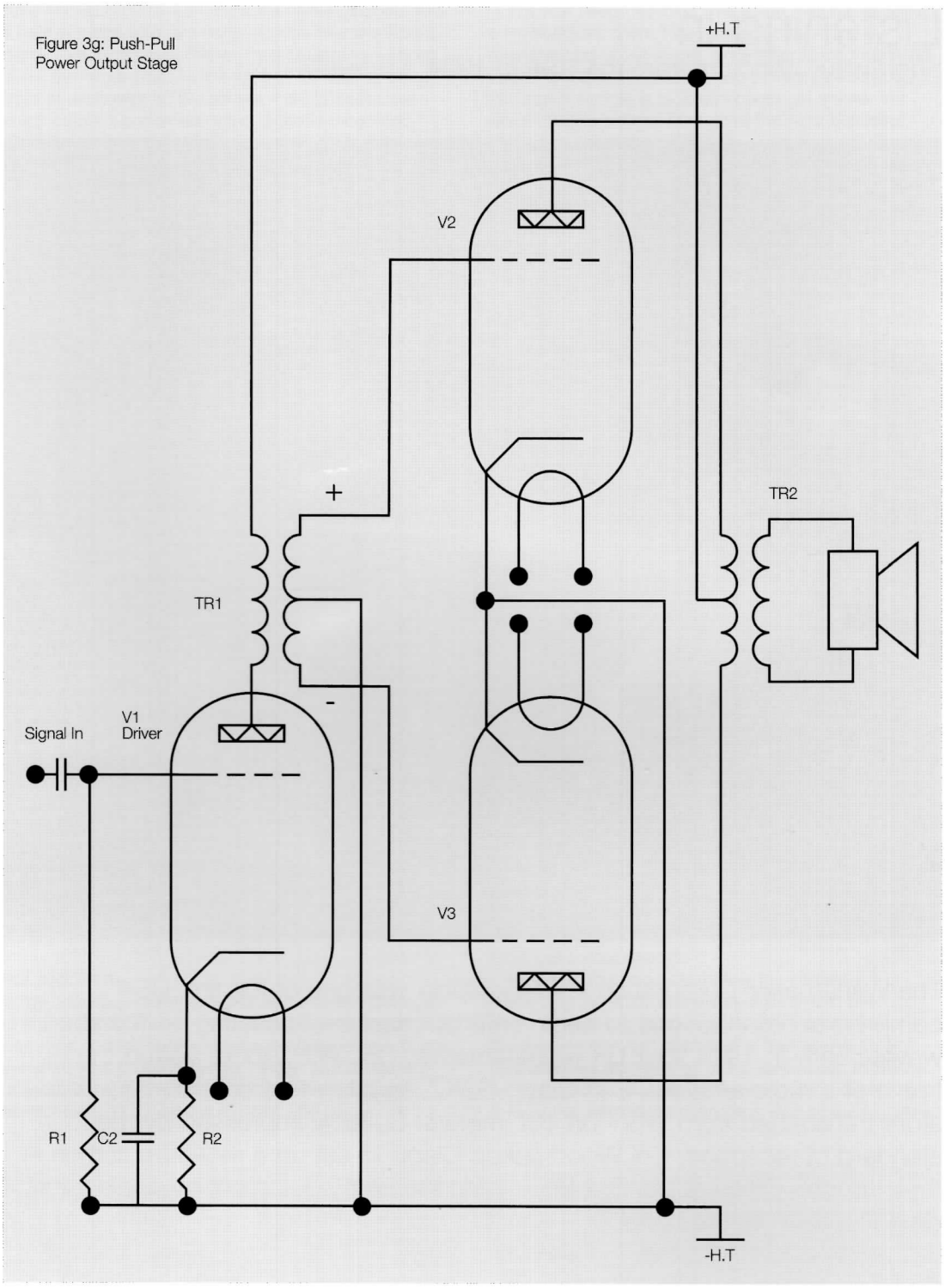


Figure 3g: Push-Pull Power Output Stage

curve; therefore they exhibit a much smoother change in gain over a wide range of grid voltages.

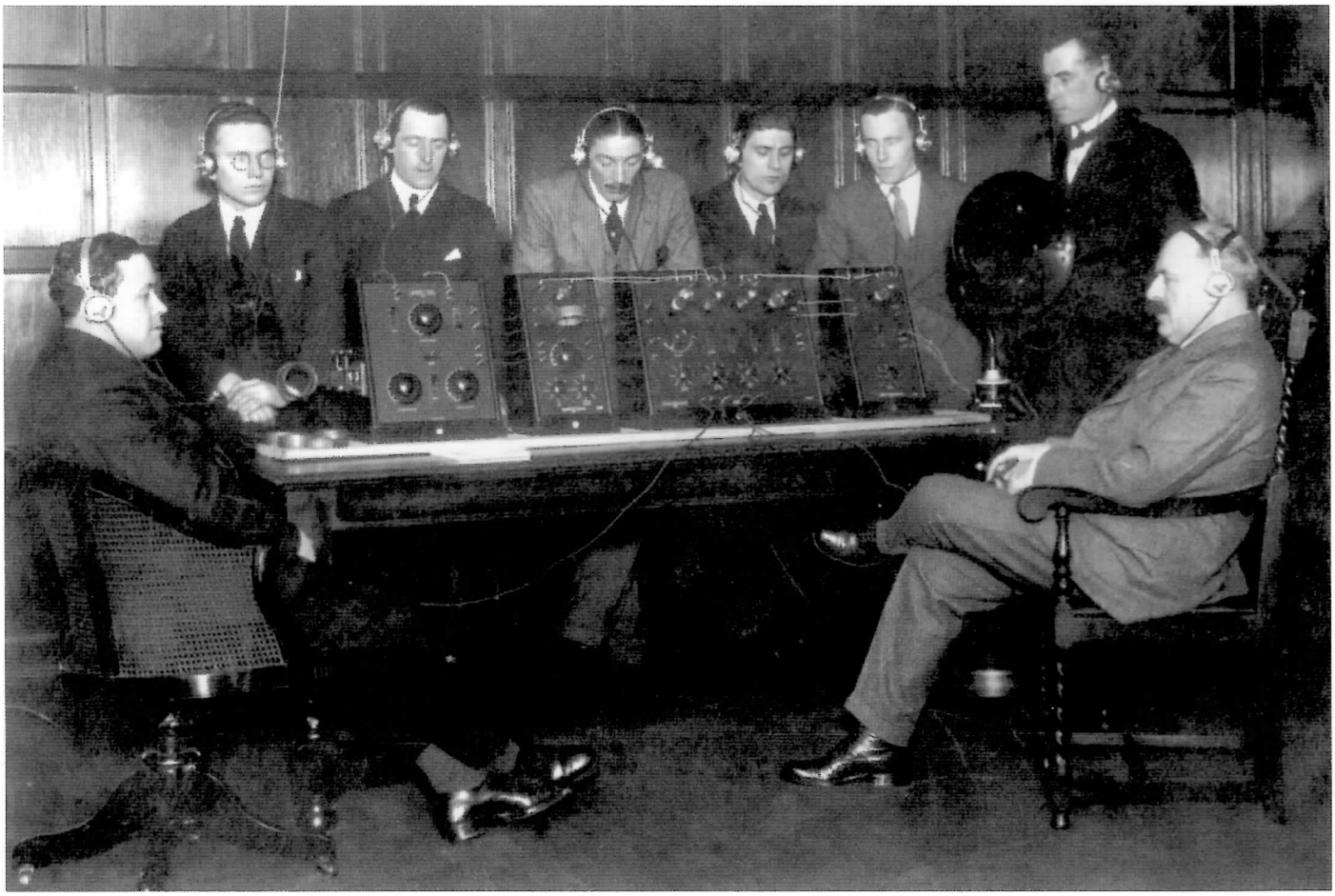
An Improved Efficiency Audio Output Stage

The amplifiers introduced so far have been what are known as "Class A" amplifiers; this means that they contain valves that are always in conduction. Put another way, current is always flowing through the valve even when no signal is present. Class A amplifiers are fine for low power applications such as signal amplification or small audio amplifiers. However if larger powers are to be dealt with, as in quality audio or public address equipment, the valve will have to dissipate large quantities of heat in relation to the power output it can deliver into the load. Constructing an amplifier with a "push-pull" output arrangement gets around this problem. A push-pull.

"Class B" output stage consists of 2 valves coupled together, each of which conducts for only one half (positive-going or negative-going) of the signal waveform. Each valve is only passing current when it is being driven; it is therefore not dissipating any heat in the "off phase". Figure 3g shows the basic idea of a push-pull stage. Valve V1 is operated in the normal "class A" manner; it is what is known as the driver valve. V1 drives V2 and V3 through transformer TR1, this transformer ensures that the signals fed onto the grids of V1 and V2 are complementary, i.e. when one is positive, the other is negative and vice versa. The audio signal is passed via impedance matching transformer T2 to the 'speaker. In practice the valves used are likely to be Pentodes because of their superior characteristics for this kind of use, also the biasing arrangement of V2 and V3 is likely to be more elaborate, to reduce distortion levels.

Listening in

Short wave concerts from the USA in 1924. by Ray Herbert



The Wanamaker Corporation in Philadelphia was one of the first USA commercial organisations to begin entertainment broadcasting on the short waves. Early in 1924 their UK representative, Col. W.E.Wood, visited the home of a radio amateur, Ben Clapp G2KZ, to listen to a concert from their store transmitted from WGY on 107 meters. Suitably impressed by the standard of reception, Col Wood asked Clapp to set up a receiving station in their London Office at 26, Pall Mall, using the best equipment available for a demonstration to the press.

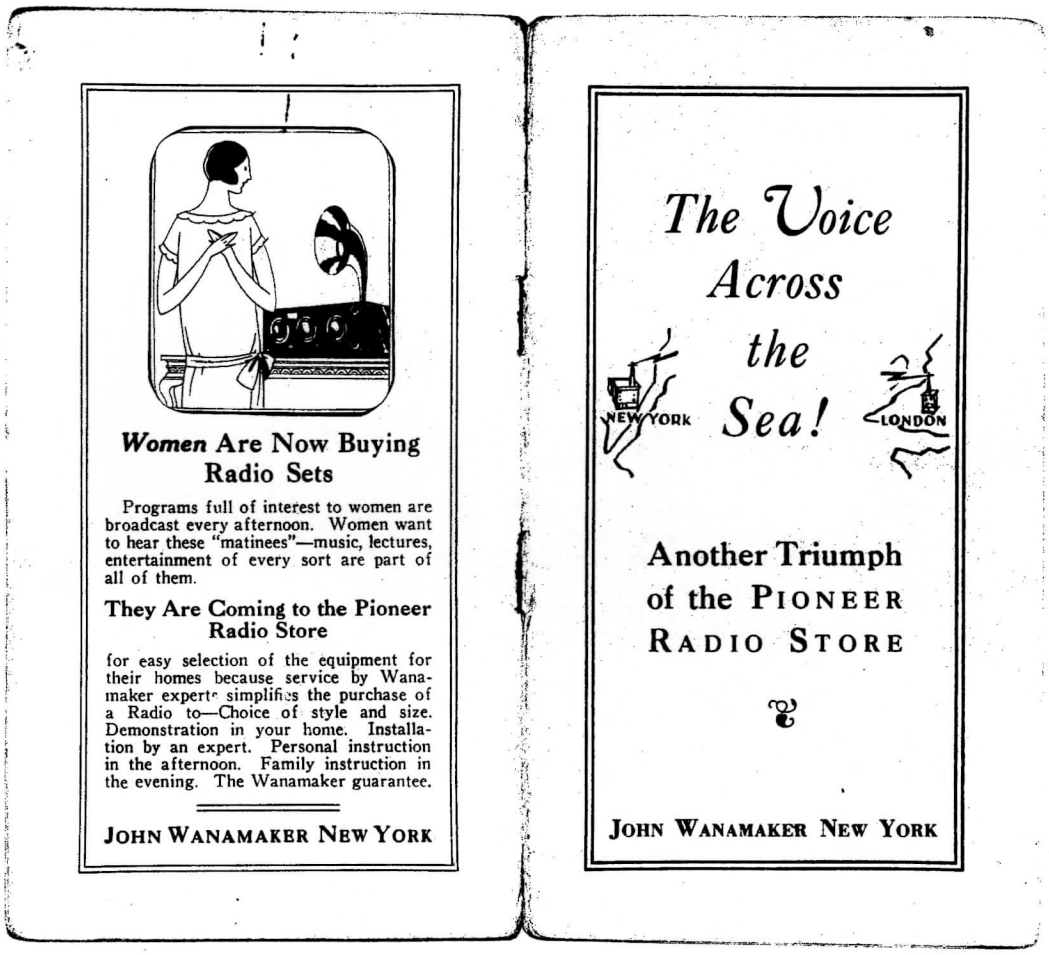
An aerial was strung up across the road to the Carlton Club and connected to Burndept receiving equipment in the Wanamaker office. A special concert from the shopping complex had been arranged for 1 April, featuring Marcel Dupré, the renowned French organist. The auditorium in this large store contained one of the biggest organs ever built. It weighed 287 tons, had six manuals and required seven blower units to provide wind for the 28,000 pipes.

The concert commenced at 9.15 PM, Central Standard Time, which meant that the listeners in London had to turn out at 2AM. In the photograph, the press men are lined up wearing headphones and they represented the Times, Daily Telegraph, Morning Post, Daily Express, Evening News and the Daily Graphic. Ben Clapp is sitting extreme left and Col. Wood is at the right

The concert was well received both in the UK and France. The Wanamaker organisation wanted to arrange reciprocal concerts from London and were reluctant to accept that the BBC had an absolute monopoly on public broadcasting. They felt that isolated musical presentations could be transmitted on an experimental basis and Clapp was asked to design and build a high power, short wave transmitting station. This was to be situated on a plot of land near his home at Coulsdon, in Surrey. With his wedding only weeks away, the prospect of spending several nights each week alone in a field was particularly unattractive and Wanamaker agreed that a larger house should be obtained with a garden of sufficient size to accommodate the aerial system and generator outbuilding.

Due to the heavy electrical demand imposed by the generators, the electricity company would not allow transmissions to be made between 3PM and midnight. Erecting two 60 feet masts in a limited space required special lifting gear and in all, 16 men were engaged in different aspects of construction.

Producing high power at these low wavelengths involved exploring unknown territory. Difficulties were



Many transmissions were made during 1925 and some included musical items. William Hamilton, a listener in Glasgow, sent in a report on 16 March commenting, "Your song 'Until', I switched to the loudspeaker and got into trouble for disturbing the household. My wife was interested enough however, to comment on the fact that you came in half a bar too early towards the end of the song."

experienced with RF feedback into the speech circuits and many of the components could not withstand the high frequency voltages. The station had been completed by December 1924 and on Christmas Eve, G2KZ became the first radio amateur to achieve two-way speech communication with the USA.

Many transmissions were made during 1925 and some included musical items. William Hamilton, a listener in Glasgow, sent in a report on 16 March commenting, "Your song 'Until', I switched to the loudspeaker and got into trouble for disturbing the household. My wife was interested enough however, to comment on the fact that you came in half a bar too early towards the end of the song." It should be remembered that these events took place two years before the experimental transmissions from Gerald Marcuse's station, G2NM which paved the way for the BBC Empire short wave broadcasts in 1932.

A seven page report to Wanamaker on 24 September 1925 described the progress of this project from November 1924 and it provided a unique account of amateur short wave transmissions at that time.

About the middle of 1925 Col. Wood died and the interest in this work lapsed. Ben Clapp was left with a large and powerful 1kW transmitter on his hands which he used to communicate with all parts of the world. Television began to hit the headlines in 1926 and Wanamaker asked him to visit J.L.Baird to find out some details. During this meeting Baird quickly realised that he was talking to someone who had the necessary equipment and expertise to bring to reality his ambition to send live television pictures across the Atlantic. Clapp was engaged on the spot as Baird.'s first and only technical assistant and he started work at the Motograph House laboratory in November that year. Within two months the Coulsdon transmitter had been connected by landline to the Baird equipment in London and the distinctive sound of 30-line video signals was successfully received in New York by Robert Hart, W2CVJ.

No attempts were made to send pictures across the Atlantic until the winter months when propagation conditions woud be suitable. Ben Clapp went to the USA in October 1927 with a television receiver and after months of test transmissions, live television pictures from London were demonstrated to the press in Hartsdale, New York on 9 February, 1928. A full account of these experiments can be seen in the February 2003 edition of *Radio Communication*.

By the middle of 1928 the Baird company had their own transmitter running from the roof of the Long Acre premises in London, using the call-sign G2TV and Ben Clapp was on his way to Australia with seven crates of equipment for television demonstrations over there. The Coulsdon transmitter fell into disuse and Wanamaker offered the entire installation to the Baird company for £200, a fraction of the original cost. Within a short time it had been moved to the Kingsbury Manor site and by 1929 television tranmissions were being sent out on a wavelength of 49 metres.

Wireless and the Art of Magic:

A Reappraisal of Nevil Maskelyne and His Contribution to Wireless Telegraphy. Part 2 by Graeme Bartram

8. The Maskelyne System : Mark II

8.1 Transmitting and Receiving Circuits

Soon after the Royal Institution jamming incident Nevil made a patent application on 21 July 1903 (British Patent No. 16,113 of 1903)[86]. What distinguished this patent was that in both the transmitting and receiving circuits oscillation occurred in a closed circuit or loop rather than the more conventional antenna forming an open circuit (Figure 11). Nevil reasoned that the closed circuits ensured that the points of highest potential difference were found and most efficiently exerted. In the case of the transmitter the greatest energy would accumulate in the radiating circuit and in the case of the receiver the greatest potential difference would be produced where it would be most readily detected. This avoided the necessity created in open-circuit methods of using various subsidiary devices to create secondary maxima. In his book *A Handbook of Wireless Telegraphy* (second edition) James Erskine Murray noted the similarity between this aerial arrangement and that devised by Slaby-Arco, but indicated that by 1909 neither continued to be in general use[87].

By means of a pivoted Morse key lever which acted as a switch, the transmitting or receiving circuit could be activated by simply moving the key to the left or the right (Figure 12).

8.2 The Maskelyne 'Conjunctor'

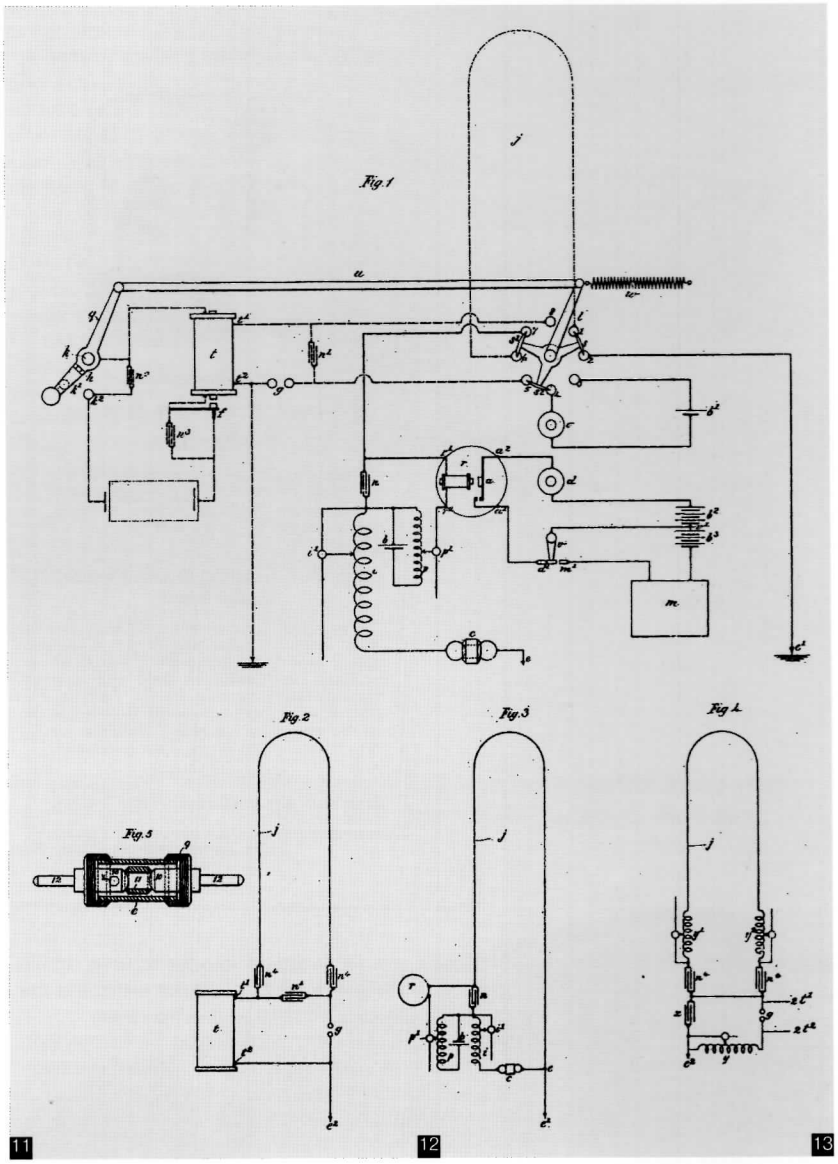
Central to Nevil's new wireless telegraphy system was the use of a detector known as a 'conjunctor' in the receiving circuit. The conjunctor consisted of a oxidised–steel cylinder with bevelled ends resting on two rounded spherical hemispheres. This was enclosed in a glass tube. One hemisphere (or 'plug' as Nevil called it) was provided with a cavity for holding anhydrous calcium chloride to absorb any moisture in the air enclosed inside the tube (Figure 13). Nevil preferred the term 'conjunctor' to distinguish his detector from "the irregular and heterogeneous point-and-surface contacts known as coherers"[88]. A note from Mr Ash, the ETC's Superintendent at Porthcurno, indicates that this Maskelyne-designed detector was in use at the wireless telegraphy station in July 1903 when he wrote "could you please ask Mr Maskelyne to send me a few more conjunctores [sic], as I find different conjunctores [sic] give different results according to other conditions"[89].

8.3 Receiver Mechanism

In the receiving apparatus one end of the main circuit was earthed whilst the other was connected to one plate of the condenser. The opposite end of the condenser was joined to one end of a variable self-induction coil which in turn was connected directly to one side of the 'conjunctor'. The other side of the conjunctor was connected to earth forming a complete circuit. In order to "tune" the transmitting and receiving circuits the self-induction coil was made adjustable (Figure 14). Like Nevil's earlier patent of 1901 the receiving circuit operated a relay-actuated armature that operated a rocking arm connected to a Morse recording instrument (Figure 15).

9. The De Forest Wireless Syndicate

After the jamming incident at the Royal Institution in June 1903 Nevil's career in wireless moved progressively away from the promotion of his own systems of wireless telegraphy to involvement in large-scale wireless systems that rivalled those of Marconi. His first involvement of this kind was in the promotion



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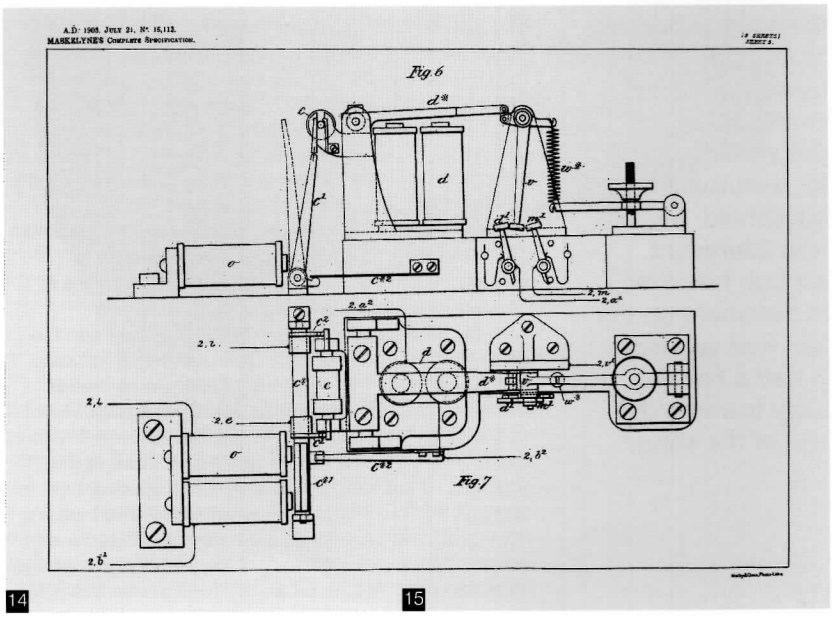

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86. British Pat No. 16,113. 1903.
87. James Erskine Murray A *Handbook of Wireless Telegraphy* Crosby Lockwood & Son London 1909 at p.46.
88. British Patent No. 16,113 of 1903 at pp.2-3.
89. Packer (2001) op. cit. at p.6.
90. *The Electrician* 52 27 November 1903 at p.193 ; The Electrician 4 December 1903 pp.240-242 at p.242.
91. *The Electrician* 52 30 October 1903 at p.40.
92. Frank Fayant 'A Fool and Their Money Part I' Success Magazine June 1907.
93. Ibid.
94. The Electrician 62 5 February 1909 at p.669.
95. Packer (2001) op. cit. at p.7.
96. British Library (India Office Library) L/PWD/6/696, PW 1175/05 Letter from Nevil Maskelyne to The Director of General Stores, India Office, 8 June 1905 ; Jolly op. cit. at pp.140,150-151.
97. *The Electrician* 56 27 October 1905 at p.47 ; *The Electrician* 62 5 February 1909 at p.669.
98. *The Electrician* 56 27 October 1905 at p.47.
99. The Electrician 63 4 June 1909 at pp.289-290 (Report on Cullercoats) ; The Electrician 57 10 August 1906 at p.645. (Reports on Huntstanton and Skegness).
100. The Electrician 57 13 July 1906 at p.503.
1. Report from the Select Committee on Radiotelegraphic Convention Evidence of Owen Phillips M.P. (Chairman and Managing Director of the Royal Mail Steam Packet Company) 30 April 1907 at pp.195-198 ; Packer (2001) op. cit. at p.8.
2. Packer (2001) op. cit. at p.8.
3. *The Electrician* 57 13 July 1906 at p.503.
4. Ibid.
5. Public Records Office BT31 17861/90129 Agreement between Amalgamated and De Forest Wireless Syndicate Ltd 15 November 1906.
6. *The Electrician* 58 9 November 1906 at p.119.
7. *The Times* (London) 18 January 1911.
8. B.L. Jacot and D.M.B. Collier *Marconi-Master of Space* London 1935 at pp.87,105.
9. Report from the Select Committee on Radiotelegraphic Convention Evidence of Nevil Maskelyne 25 April 1907 at p.180.
10. Hans Buhl The Arc Transmitter-A Comparative Study of the Invention, Development and Innovation of the Poulsen System in Denmark, England and the United States (English summary of the Danish Ph.D. dissertation) 1996. Copy available at www.stenomuseet.dk
11. *The Electrician* 58 30 November 1906 at p.237.

of the De Forest system in Great Britain.

Lee De Forest visited the United Kingdom in November 1903 and conducted a series of wireless experiments between Holyhead and Howth in Ireland. At one demonstration Nevil Maskelyne attempted to operate a detector of his own design. This in all likelihood was a 'conjunctor', although no description of the instrument was made at the time due to patent considerations[90]. The press in late 1903 carried some speculation about an intention to incorporate a British Empire De Forest Company although it was not until July 1905 that the De Forest Wireless Syndicate was actually formed[91]. According to contemporary reports it was De Forest's infamous business partner Abraham White who visited the United Kingdom to float such a company[92]. Originally the De Forest company was to be purportedly headed up by Lord Brassey with the Board members Sir Hiram Maxim, Arthur Brand M.P., Dr Thomas Cochrane and Charles Bright C.E. Due to disagreements with White this Board eventually withdrew and was replaced by Lord Armstrong as Chairman with fellow directors Arthur M. Grenfell and Nevil Maskelyne appointed[93]. Mr Sigurd Svend Bojesen was made General Manager of the Syndicate[94].

During 1904 Nevil initially acted on behalf of De Forest interests in the United Kingdom and was involved in a range of wireless-related activities. In July 1904, for example, Nevil contacted both the Eastern and the Eastern Extension Telegraph Company (an ETC subsidiary) proposing that they work jointly with a new company, presumably representing De Forest interests[95]. Later, in June 1905, Nevil represented De Forest interests as an agent in negotiations with the Indian Government for the proposed installation of wireless telegraphy stations in that country and was interviewed by the British Government's India Office regarding the potential impact of Marconi-De Forest litigation being pursued in the United States. Nevil claimed that the De Forest receiver, used in conjunction with his own closed circuit system, did not infringe Marconi's patent rights[96].

Upon its formation in July 1905 the De Forest Wireless Telegraph Syndicate embarked on an ambitious plan for expansion with a nominal capital of £120,000[97]. In October 1905 the Syndicate added the European and Colonial rights of the American De Forest Wireless Telegraph Company to the United Kingdom rights it already held[98]. The first of the Syndicate's wireless telegraphy stations commenced construction at Cullercoats near Newcastle in February 1906 followed by the erection of installations at both Huntstanton and Skegness later that year[99]. In addition the Syndicate applied for wireless telegraphy licences for Hartland Point and Mouth of Tyne[100]. The ETC's Porthcurno wireless telegraphy station remained an important link for both Nevil and the De Forest interests in the United Kingdom until the completion of the Cullercoats station in June 1906. As late as October 1905 Nevil sought permission from the ETC to use Porthcurno for experimental work with the Royal Mail Steam Packet Company who later adopted the De Forest system for their Southampton, West Indies, Central American and New York services[1]. In exchange for continuing access to Porthcurno, Nevil agreed to facilitate communication with the ETC's cable-laying ships[2]. The Syndicate went so far as to propose taking over the ETC's station at Porthcurno for ship to shore communication[3] and during 1905-06 the ETC Porthcurno station was overhauled and converted to a hybrid Maskelyne - De Forest System[4].

10. The Amalgamated Radio-Telegraph Company Ltd

Nevil Maskelyne's responsibilities were further expanded in 1906 when a new company was formed to manage the interests of both the De Forest and Poulsen systems. This new company had significant potential given that it now had access to both spark and continuous wave technology.

In September 1906 the De Forest Wireless Syndicate was liquidated and the Amalgamated Radio-Telegraph Company Ltd (hereafter the Amalgamated) was formed to acquire the undertakings and patent rights of the Syndicate. Lord Armstrong acted as Chairman of the new company with Bojesen appointed Managing Director. Valdemar Poulsen and Peder Olaf Pedersen were appointed engineers to the Amalgamated for five years with annual salaries of £1,000 and £500 respectively[5]. Nevil Maskelyne was Technical Advisor to the company but did not hold a Board position. The Amalgamated was a large wireless telegraphy enterprise. It had a partly-subscribed share capital of £500,000 and operated up to five wireless stations in Britain and a further three on the Continent. Contracts had been completed with Government departments in Great Britain, India, Germany and Russia and with the United Shipping Company for four transatlantic liners. By November 1906 the Amalgamated had completed the installation of wireless telegraphy equipment at Huntstanton and Skegness for the British Post Office employing the De Forest System[6]. This work was personally supervised by Nevil Maskelyne[7].

Nevil Maskelyne became a strong advocate for Britain signing the Berlin Radiotelegraphic Convention in October 1906[8]. Amongst other provisions, the Convention required signatory countries to insist upon intercommunication between commercial wireless telegraphy systems. The Marconi Company opposed these terms of the Convention. Nevil was critical of the Marconi position on non-intercommunication and publicly rebuked his old foe Cuthbert Hall:

Mr Hall ... says "I think the policy [of non-intercommunication] is justified to a certain extent by the results." Well, then I say the policy is not justified. The only possible justification for any policy consists in its results, and so far the principal result produced by the Marconi policy has been to hasten the establishment of an International Convention to which that policy is entirely opposed[9].

In late 1906 the Amalgamated became very active in developing and promoting wireless telegraphy in Britain. At this time the Amalgamated acquired the British and American rights to the Poulsen system. The formation of the Amalgamated Radio-Telegraph Company Ltd had been largely the direct result of Poulsen and Pedersen seeking foreign capital to finance the commercial exploitation of the Poulsen system[10]. Nevil Maskelyne read an address prepared by Poulsen at a public promotion of the Poulsen system hosted by Lord Armstrong at Queen's Hall in London on 27 November 1906 to launch the new company in Britain[11].

Outside the United Kingdom the Amalgamated held extensive wireless telegraphy interests in Germany and Denmark. The Berlin laboratory situated at Matthieustrasse attracted many disaffected scientists and engineers from Telefunken including Dr Hans Rosenthal as Chief Engineer, Dr Georg Seibt as Laboratory Head and Dr. Heinrich Rausch von Traubenberg to all work on developing the Poulsen

arc. Within a year improvements achieved at the Berlin laboratory resulted in experimental wireless telegraphy transmissions from Lyngby near Copenhagen to Cullercoats, a distance of 600 miles[12].

In giving evidence to the Select Committee on the Radiotelegraphic Convention on 25 April 1907 as Technical Advisor to the Amalgamated, Nevil Maskelyne was optimistic about the company's future, citing potential contracts with the governments of Great Britain, India, Cape Colony, West Indies, West Africa, Egypt, Norway, Sweden, Austria, Denmark, Italy, Russia, China, Turkey, Manchuria and Borneo as well as numerous private contracts for land and ship based wireless installations. In all Nevil estimated that the number of contracts would amount to between 60 and 70. Nevil claimed that the Amalgamated controlled a total of 224 patents, 30 of which were still awaiting acceptance by various patent offices[13]. During the second half of 1907 the Amalgamated's Poulsen wireless telegraphy stations at Lyngby, Knockroe and Cullercoats were given extensive coverage in the technical press in both the United Kingdom and Germany[14]. In addition, transmission distances continually improved, with the Amalgamated claiming that a Poulsen-equipped vessel transmitted a 21 word message 2,050 miles to a temporary station in Steglitz in Germany[15], the automatic Poulsen arc for small station work was perfected and Rausch von Traubenberg made significant improvements to the Poulsen generator at the Berlin laboratories[16]. In late 1907 the Amalgamated appointed John Graeme Balsillie as Resident Engineer in Russia to demonstrate the Poulsen system to naval and military authorities and contracts were later secured for the erection of wireless stations in China[17].

Nevil's optimism for the Amalgamated was not to be sustained. Telefunken, Lorenz A.G. and the Amalgamated all competed in the same European market for mobile Army wireless telegraphy units. Whilst some significant technical advances had been made by the Amalgamated at the Berlin laboratories in 1906-07[18], competing systems like the "Tonende Funkensystem" by Telefunken and the Goldschmidt generator, were starting to dominate the market. By March 1908 the German Poulsen patents had been relinquished to Lorenz A.G.[19]. Such a loss of presence in the portable station market was a severe blow to the Amalgamated as it would have resulted in a decline in its European revenue stream.

Meanwhile in Britain construction continued in 1908 on the purpose-built Poulsen station at Knockroe in Ireland and the company evaluated sites at Cape Canso, Nova Scotia, Canada to serve as the base for its North American service[20]. These stations were earmarked for a proposed transatlantic commercial service to be operated by the Amalgamated. However the first signs of trouble had already begun to appear in Britain in late 1907 when two significant figures in the Amalgamated stepped away due to financial difficulties. In October 1907 Bojesen resigned as Managing Director of the Amalgamated and Lord Armstrong's own financial position deteriorated significantly. With Lord Armstrong's withdrawal of funding the Amalgamated had insufficient funds to continue its expansion. Technical work continued to progress at the Berlin laboratories in 1908[21] but the Amalgamated struggled to fund the completion of the Knockroe station in Ireland. Finally on 16 October 1908 a private meeting of the Amalgamated was held to consider the financial position of the company[22]. In December 1908 the Amalgamated was wound up voluntarily and a meeting of creditors was called. By February 1909 Bojesen had been adjudicated bankrupt and in March 1909 the Amalgamated was liquidated[23]. Whilst completed, the Poulsen-equipped Knockroe station had never operated commercially for the Amalgamated.

11. Nevil Maskelyne and the Events of 1911

The collapse of the Amalgamated scattered its personnel to the four winds. Dr. Georg Seibt took up an offer from Lee De Forest and went to the United States in January 1909 to work on the quenched spark gap[24], Poulsen interests in Denmark finally established their own company in 1908 and Sigurd Bojesen eventually re-emerged from bankruptcy to head up a photographic venture[25]. John Graeme Balsillie (ex De Forest Wireless Syndicate/Amalgamated) teamed up with George Pascoe Grenfell (ex Eastern Telegraph Company/De Forest Wireless Syndicate/Amalgamated) and Tom Vincent Smith (ex Amalgamated) to form the British Radio Telegraph and Telephone Company in 1909 to promote and manufacture the Balsillie system of wireless telegraphy[26].

Nevil Maskelyne had remained involved in the profession of magic throughout this period. Remarkably, magic had still been Nevil's main occupation during the first decade of the twentieth century despite his extensive involvement in wireless. In fact in 1906 Nevil became the second President of the prestigious London-based Magic Circle and remained its President until 1924.

However it is the year 1911 that appears to be a watershed for Nevil and his career in wireless. In early 1911 Nevil gave evidence in support of his former colleague John Graeme Balsillie in the court case Marconi v. British Radio Telegraph and Telephone Company[27] on 17 and 18 January before Mr Justice Parker of the High Court of Justice in London. In this court case the Marconi Company had brought an action against Balsillie's British Radio Telegraph and Telephone Company (hereafter "BRT & T Co.") claiming that the Marconi 7777 patent was in effect a master tuning patent capable of excluding all competitors from the field.

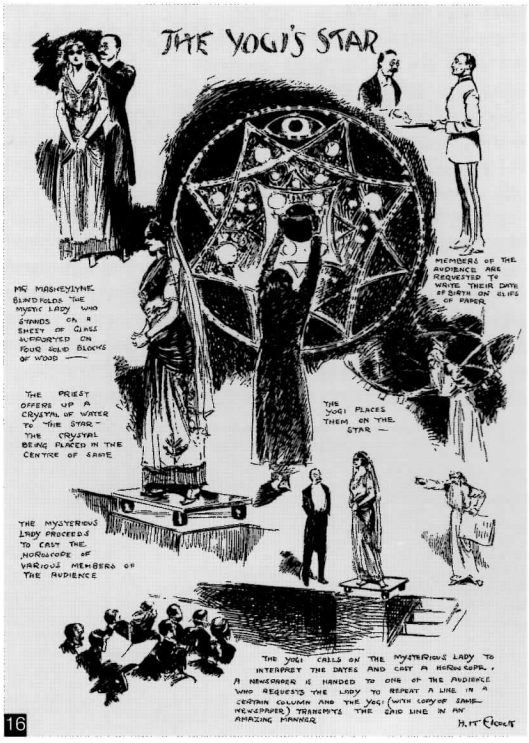
On 21 February 1911 Mr Justice Parker handed down his decision in Marconi v. British Radio Telegraph and Telephone Company finding against the BRT & T Co. and beginning a process which would quickly elevate the 7777 patent to master patent status within a few years. Like many others involved in the fledgling wireless telegraphy industry at that time, Mr Justice Parker's decision seems to have brought Nevil's career in the public promotion of wireless telegraphy to a premature end. This litigation had achieved what the Marconi Company had sought for many years – it finally squeezed out many rivals including Nevil Maskelyne[28].

This event in 1911, more than anything else, finally forced Nevil back into his work at the family theatre at St George's Hall and into the more closed world of magic. In July 1911 Nevil's mother died and in December that same year J.N. made a decision to retire from the family business. With avenues to pursue wireless telegraphy rapidly disappearing, Nevil (with his brother Archie) took J.N.'s place on the management team at St George's Hall, with Nevil undertaking the role of Technical Director. His continuing commitment to magic after 1911 is further evidenced by his co-authorship of a three-part book (with David Devant) entitled Our Magic in 1912[29].

Wireless, however, was kept alive by Nevil on the stage of the St George's Hall. An illusion called The Yogi's Star (Figure 16), which relied on the use of inductive telegraphy in a telepathy act, was proposed in May 1911 and first performed at the St George's Hall in October 1913 under Nevil's supervision[30]. Raymond Phillips appeared at the St. George's Hall in April-June and September 1913 demonstrating a wireless controlled airship in the auditorium of the Hall and also gave a further demonstration of a new wireless alarm signal for use at sea[31]. Twenty years later Phillips described the design of the airship and its wireless controlled circuits in great detail in his

12. Buhl op. cit.
13. Report from the Select Committee on Radiotelegraphic Convention Evidence of Nevil Maskelyne 25 April 1907 at p.177.
14. See e.g. *Jahrbuch für Drahtlose Telegraphie* 1907/08 at pp.154ff (Lyngby) ; *The Electrician* 60 15 November 1907 at pp.165-166 (Knockroe); *The Electrician* 60 20 December 1907 at pp.355-357 (Cullercoats) and *Elektrotechnische Zeitshrift* 2 January 1908 at pp.430ff (Knockroe).
15. *The Electrician* 61 14 August 1908 at p.669.
16. Australian Archives (ACT) A432/86 29/2756 PT2 , Patent Applications 6523/12 and 6524/12. Mr Balsillie Part 2, Statutory Declaration by J.G. Balsillie 12 December 1913 in the Matter of an Application for Letters Patent No.6524 of 1912 at pp.14-15 ; J. Zenneck *Wireless Telegraphy* McGraw-Hill New York 1915 at p.222.
17. Australian Archives (ACT) A2911/1 ; 1411/1911, *Wireless Telegraphy*-Appointment of J.G. Balsillie as Wireless Expert, Letter of Application by J.G. Balsillie to High Commissioner's Office for position of Commonwealth Director of Wireless Telegraphy, 16 May 1911.
18. Eugen Nespar Ein Leben Für Den Funk Munich 1950 at pp.49-58 ; Correspondence to present author from Professor Berthold G. Bosch 27 February 1997. See also Amalgamated patents under British Patents Nos. 9,028 of 1907 (Hans Rosenthal), 9,051 of 1907 (Hans Rosenthal), 11,695 of 1907 (Georg Seibt) and 27,379 of 1907 (Georg Seibt)
19. *The Electrician* 60 13 March 1908 at p.823.
20. *The Electrician* 61 14 August 1908 at p.669.
21. See e.g. British Patent No.889 of 1908 (Amalgamated) and 3,583 of 1908 (Georg Seibt). Nevil Maskelyne also lodged a patent in 1908 on behalf of the Amalgamated for a method of transmitting and reproducing pictures by code under British Patent No. 658 of 1908.
22. *The Electrician* 62 23 October 1908 at p.76.
23. *The Electrician* 62 4 December 1908 at p.324; *The Electrician* 62 1 January 1909 at p.480 ; *The Electrician* 62 22 January 1909 at p.595; *The Electrician* 62 5 February 1909 at p.669 and *The Electrician* 62 12 February 1909 at p.703.
24. Thorne L. Mayes Wireless Communication in the United States: *The Early Development of American Radio Operating Companies* The New England Wireless and Steam Museum 1989 at pp.49-50.

25. Australian Archives (ACT) A2911/1 ; 1411/1911 , Wireless Telegraphy- Appointment of J.G. Balsillie as Wireless Expert, Letter of Application by J.G. Balsillie.
26. Graeme Bartram 'Marconi v. British Radio Telegraph and Telephone Company : The Patent Case that Changed the World' *AWA Review* 13 2000 at pp.39-80.
27. Marconi v. British Radio Telegraph and Telephone Company, Ltd 28 Reports of Patent, Design and Trade Mark Cases 181.
28. Bartram op. cit. at pp.69-73.
29. Bartram op. cit. at pp.69-73. Nevil Maskelyne and David Devant *Our Magic* George Routledge and Sons Ltd London 1911.
30. Davenport and Salisse (2001) op. cit. at pp.137-138 ; Correspondence to the present author from Anne Davenport 22 February 2002.
31. Correspondence to the present author from Anne Davenport 6 March 2002.
32. Raymond Phillips Ray *Controlled Mechanism* P. Marshall & Company London 1933 at pp.8, 31-38.
33. Davenport and Salisse (2001op. cit. at pp.200-201.
34. Jasper Maskelyne op. cit. at pp.148-149.
35. Ibid. at p.190.



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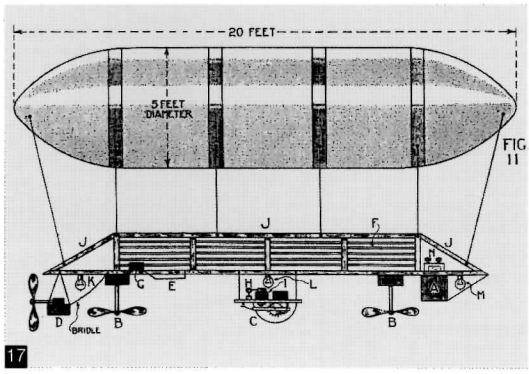

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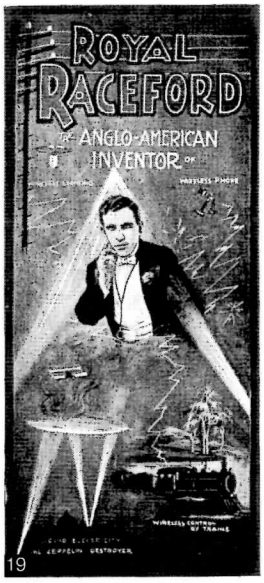

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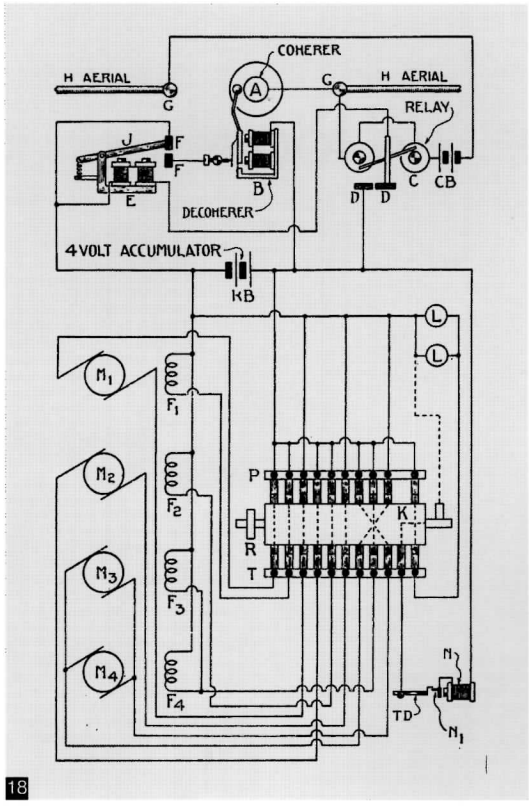


18

book Ray Controlled Mechanism[32] (Figures 17 and 18). Later Royal Raceford opened at the Hall with "a marvellous demonstration of electricity" including wireless lighting, wireless telephone and the wireless control of trains (Figure 19). Raymond Phillips also used "an electrical act of wireless appliances and apparatus" which opened with a demonstration on the effects of wireless, such as ringing of bells and the blowing of motor horns"[33]. As late as 1924 an illusion known as Broadcasting a Body (or Broadcasting a Woman) was introduced at the beginning of the broadcasting era. Whilst this illusion did not use wireless telegraphy or wireless broadcasting, it is indicative of Nevil's ongoing interest in wireless related matters – including the commencement of the broadcast era. With the staging of such acts at the St George's Hall wireless and the art of magic had once again become strangely fused.

12. The Wireless Legacy of Nevil Maskelyne

J.N. Maskelyne had died in May 1917 and Nevil passed away in September 1924. Nevil's son Jasper dropped a tantalising hint in his somewhat unreliable book *White Magic* that his father had continued to work on wireless privately to the point of developing a broadcasting system under the name of the Western (or perhaps Eastern) Telegraph Company[34]. More poignantly perhaps, Jasper speculated about what his father might have been if he was not a Maskelyne:

I believe that he might have made a name as famous as that of Marconi had he had the courage of his convictions, and, as J.N. himself did, thrown over everything for the one profession on which his mind was set. Instead, he kept one foot in the theatre and one in the laboratory. What my grandfather, whose magic was his life, would have said had his son cut himself off from St George's Hall, I cannot imagine. Yet such a course might have been the happier one in the end[35].

The contribution of Nevil Maskelyne to the history of wireless can be easily overlooked. Nevil (with J.N. assisting) had managed to use wireless telegraphy signals as early as 1899 in a practical demonstration of the new technology. In 1901 Nevil was further involved in pioneering experiments on the Thames with H.M. Hozier of Lloyd's. This was quickly followed by a series of monumental clashes with Guglielmo Marconi and his company culminating in the Royal Institution jamming incident of June 1903. Along the way Nevil had introduced wireless telegraphy to the powerful Eastern Telegraph Company and damaged the credibility of the great Professor John Ambrose Fleming in the process. This led Nevil into the emerging commercial world of wireless where he had the opportunity to work with both Lee De Forest and Valdemar Poulsen in businesses that eventually failed in an increasingly competitive marketplace.

Yet this was not the path Nevil Maskelyne had probably wanted to travel. Nevil the mechanician had identified the opportunity wireless technology presented in the new century. Nevil the magician, steeped in the Maskelyne family traditions established by his father J.N., saw the potential for deception of the general public in the way the new technology was promoted. His natural inclination was to root out that deception and he used his knowledge of both wireless and the art of magic to attempt to do just that. The mistake Nevil made was to take on Guglielmo Marconi and his company who were ultimately able to demonstrate superior technical, commercial and promotional skills. As wireless became more commercial in nature, Nevil was increasingly alienated from his true scientific interest in the new technology and progressively retreated into the world of magic. Here wireless and the art of magic were once again fused on the stage of the St George's Hall.

Letters

Dear Editor,

re Two Crystal full-wave Crystal Set (BVWS Bulletin 2003 issue 4)

Mr Slade is doing nothing wrong. This circuit appeared many times in publications in the 1930s and 1940s. The accompanying text often contained a statement such as 'Ordinary (half-wave) detectors only use half of each cycle of the signal and waste the other half. Full wave detectors use both halves, thus doubling the power in the 'phones'.

This is totally untrue.

Energy from the aerial-earth circuit is stored in the tuned circuit which usually contains the accumulated energy from many cycles of the signal. This energy oscillates between the capacitor and coil at signal frequency. When energy is passed through the detector to the phones it is replaced from the aerial but you can never take out more energy than flows in from the aerial over a period of time.

With a half-wave detector, when the rectifier is forward biased, energy flows from the tuned circuit to the phones. When the detector is reverse biased no energy flows to the phones but the energy from the aerial is stored in the tuned circuit and a half cycle later will have reversed its flow and be available together with the continuing flow from the aerial to the phones. There is no wasted signal. Hence two detectors are not better than one.

For completeness, that is not the whole story,' it is a fact that the efficiency of any rectifier (Crystal, Westector or diode) depends upon the signal amplitude. Efficient rectification requires the signal voltage to be high. Note that the full-wave circuit applies only half of the potential across the tuned circuit to each detector, reducing efficiency. Add the practical problems that to function properly matched detectors and a balanced signal are required. The common terminal must be the electrical centre of the tuned circuit and this is usually not quite the same as the mid-point of the coil.

Don't waste your time Mr Slade. Full wave detection only had one application that I know of some early high-performance superhet receivers used a very low IF to obtain very high selectivity by using complex LC filters to define the IF bandwidth. After rectification the signal must be filtered to remove the carrier frequency and leave the audio. When the IF frequency is only a little higher than the upper audio frequencies, effective filtering is difficult. Full-wave detection produces an output at twice the carrier frequency, greatly improving the filter's performance. I should add that they never used Westectors and high signal voltages.

Your sincerely
LL (Bill) Williams

Dear Editor,

Dr. Desmond Thackeray

I was saddened to read the obituary in the Winter Bulletin. Although I was not a personal friend I had considerable correspondence in the late 1980's and early 1990's. I cannot remember how it all started but at that time I had decided to try out the Scroggie dynatron negative resistance method as set out in *'Radio Laboratory Handbook Second Edition'* to measure the goodness of coils.

Although I was able to produce some very useful results I needed checks against other methods - and an explanation about the theory behind the bridge method used. Desmond supplied both with alacrity. We exchanged coils for measurement on the dynatron and on the 'Q' meter I had purchased. We eventually secured agreement between all the methods of better than 10%. Perhaps I ought to try to put on record what it was all about!

The correspondence was extensive. A letter from Desmond was very thorough and detailed. Not something to be set aside lightly. Later he learned of my background with BT and I was drawn into his interests in creating working mock-ups of vintage telephones.

His letters often quoted from 'The Directory of Huntingdonshire Cabmen' which some may remember from the 'Beachcomber' column in the wartime Daily Express. I suppose this together with the duffel coat qualifies him as an eccentric but we need more like Desmond.

Your sincerely
Don Turner

Dear Editor,

It was suggested to me by Ray Herbert that I drop you a line concerning 2LO and its rescue.

In 1998 a letter by a retired BBC engineer, Mr Stickley, appeared in *Prospero* entitled 'Scrap of History'. That is exactly what it was when I first saw 2LO in 1952 in a back room in Brookmans Park – broken scrap piled high! I enclose a press cutting from *Prospero*, April 1998, which includes an edited letter from me giving an outline of its rescue.

2LO appeared subsequently, and briefly, in the foyer of Broadcasting House some years later and once on TV which I again glimpsed quite by chance – on Channel 4! It was not deemed worthy of exhibition on the BBC's 75th anniversary in 1997 even though in the beginning it made the whole business of communication with the general public possible. Some early microphones *were* in the exhibition I believe.

Next thing I heard, by chance once more, 2LO was lying under sheets in a hut at Daventry and was now owned by Crown Castle Transmission, an American company, and fear existed that one day 2LO would bite the dust forever.

I saw an article by the Guardian's heritage correspondent, Maeve Kennedy, April 12th 2002 on the potential loss of historic telephone equipment which prompted me to write to her on my fears of the imminent loss of 2LO. Within weeks plans to present 2LO to the Science Museum appeared! I cannot think that this was not due to an effort by herself.

I was given the task of 2LO restoration and the worthy assistance of Charles Sutton who, as a senior engineer on a visit to Brookmans Park in 1954 spotted the scrap lying in a back room – again by chance. Charlie and I identified the bits slowly with the aid of a 1923 photograph and a 1926 circuit diagram, repaired (and replaced when totally missing) and reassembled 2LO with help, when they could from Dick Thurgood, George Perry, Christie and others, some of whom came in on days off, unpaid, to further this worthwile effort.

With it 90% completed, and plans being made to do a short out-of-hours broadcast of the old recording "This is 2LO Calling" I was suddenly transferred to Rampisham.

Years later Charlie told me that no further progress was made from that time. We were left with the fear that one day all would be lost. 5XX Daventry Steam Laundry long gone! Now the Science Museum has 2LO and there must be many, like myself who are mightily relieved. I hope to see it one day in Exhibition Road, and look forward to the occasion.

Your sincerely
RJ Milligan

Piecing together radio's past

The story of the original 2LO transmitter continues with Ray Milligan's memories from the early 1950s. Mike Brown reports....

Ray Milligan came across the 2LO transmitter when it lay as a heap of old scrap in a back room of Brookman's Park in the early 1950s.

'One day in 1954 a senior engineer from Head Office (Mr West?) paid us a routine visit during which he managed to evade his escort and entered the back room where he saw piles of largely broken antique bits and pieces,' recalls Ray, who was with BBC Transmitters from 1941 to 1982 with a four-year break in the RAF. 'On being told it was, or rather had been, 2LO he decided that it must be rebuilt.'

Mr Wilkins, who was in charge at Brookman's Park at the time, looked out of his office door, spotted Ray, and gave him the job of 2LO's restoration, helped by Charlie Sutton.

'Our first hurdle was the identification of all the bits, helped by a 1923 photograph of 2LO and a 1926 circuit diagram. By comparing the two under a magnifying glass, counting the turns in the various printed coils with a pin and comparing our results with broken items in our pile of debris, we slowly made progress. We then had to piece together numerous bits of this and that and repair them. This took weeks.'

But 2LO began to grow. 'We intended to make it workable, and this meant that every component had to be tested.' But Ray remembers having to 'make do' when original components failed tests.

'We replaced a 1923 rheostat in the sub-modulator with a 1929 rheostat which we "found" in one of the transmitter stores. We had none of the original valves but some of similar appearance which served. We had all the original meters, but none of the terminals. So we re-cut the threads on every meter to use modern terminals.'

Ray remembers that one of their main problems was that in the heap of junk were period pieces of wireless which had not formed part of the 1923 2LO and took some identifying as being surplus to their requirements.

'We finally got 2LO looking right and were working on arranging power supplies from Brookman's Park's reserve sources and some kind of safety barrier. 2LO's safety device had originally been only a DANGER sign hanging in the middle.

'The whole project had hooked us both, together with various other members of staff who gave us their time and energy on days off. I remember Christie, Thurgood, Perry and others of 45 years ago. It was only then that we learned that £1000 had been set aside for this job; we had spent only £15!'

It was at this stage that Ray was transferred to Rampisham. 'Years later Charlie told me that 2LO had once or twice been exhibited in the late 50s but no further work had been done on it. 2LO did appear briefly in the foyer of BH in a show a few years ago when I was told that the names of Charlie and myself would appear on a plate. Did they?

'By chance a few years ago I switched on a Channel 4 programme and saw 2LO with its valves lit – and heard a voice saying 2LO was rebuilt by BBC engineers in the 50s. That was us!'

Ray expresses great sadness that 2LO is now back under sheets again in a shed at Daventry. 'Does no-one see its value?' he demands. 'It should be in the Science Museum to be cared for.'

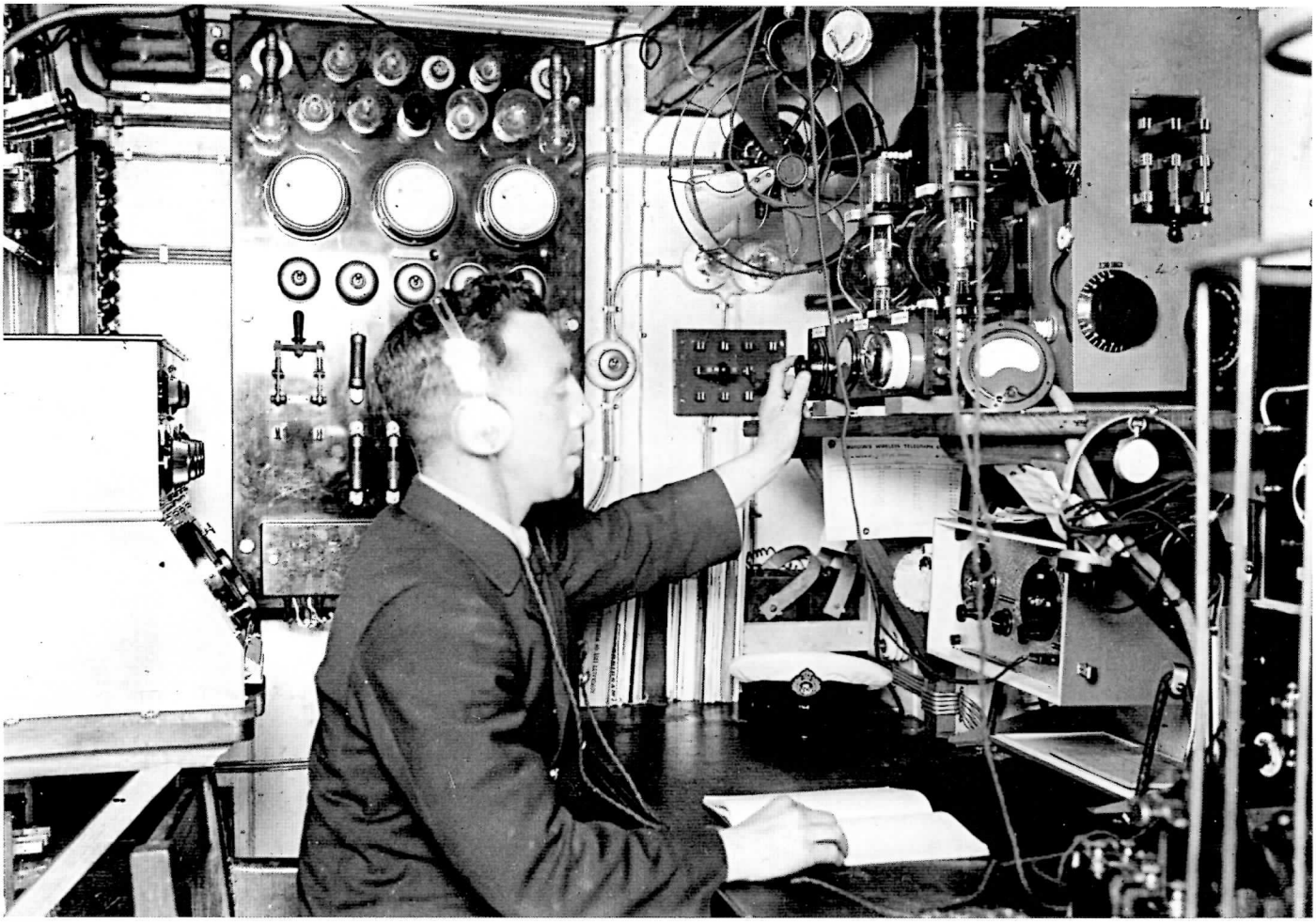
Ray says the public at large is almost completely unaware of the fascinating history of wireless. 'What happened to the 1925 Daventry 5XX? Is it under another sheet in another shed? And was an Empire Station SWB 18 from the 30s preserved anywhere at all?' He adds that Daventry town museum does have a small room with a few BBC fragments of Marconi's SWB 18 in it – 'so some Daventry folk care'.

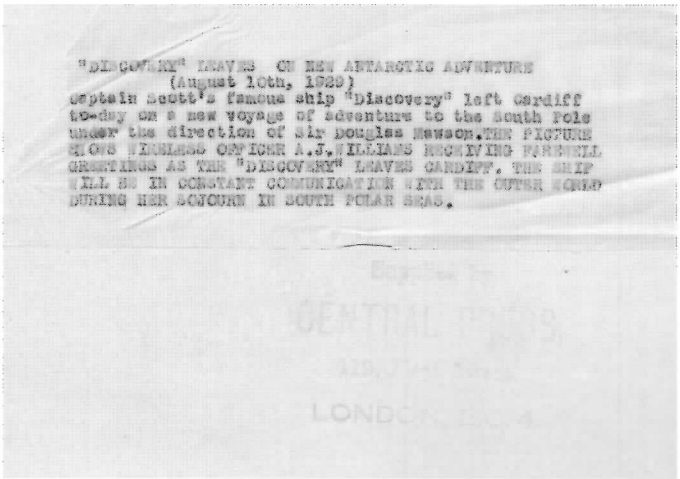
But Ray is worried that enough people do not care about the early achievements of BBC engineers and transmitter staff.

'A history of early personalities who made a contribution to BBC history would be fascinating and I'm sure folk would respond if you made an appeal in *Prospero* before it is too late.'

So, *Prospero* readers, it is over to you!

April 1998





"DISCOVERY" LEAVES ON NEW ANTARCTIC ADVENTURE
(August 10th, 1929)
Captain Scott's famous ship "Discovery" left Cardiff to-day on a new voyage of adventure to the South Pole under the direction of Sir Douglas Mawson.THE PICTURE SHOWS WIRELESS OFFICER A.J.WILLIAMS RECEIVING FAREWELL GREETINGS AS THE "DISCOVERY" LEAVES CARDIFF. THE SHIP WILL BE IN CONSTANT COMMUNICATION WITH THE OUTER WORLD DURING HER SOJOURN IN SOUTH POLAR SEAS.

Above: Front and back of a photograph kindly sent by BVWS member J. Robinson of Shirley, Solihull who found it whilst tidying up.

The photograph dates from 1929 and reads:
"DISCOVERY" LEAVES ON NEW ANTARTIC ADVENTURE
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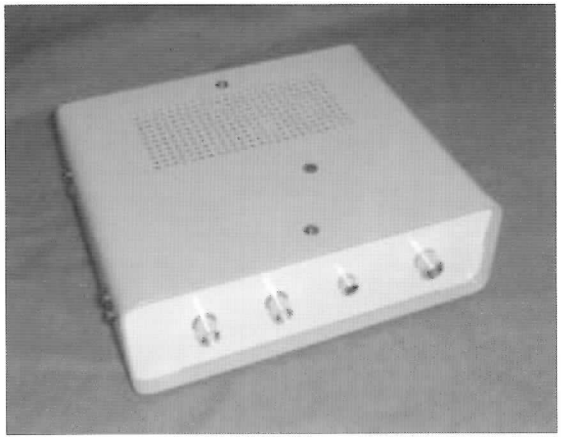

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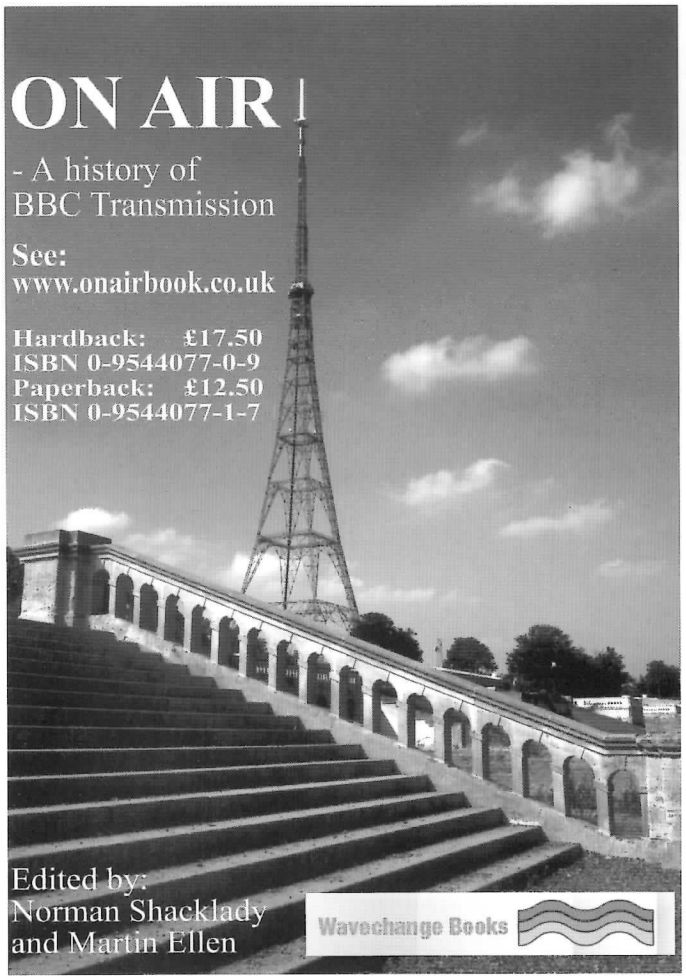

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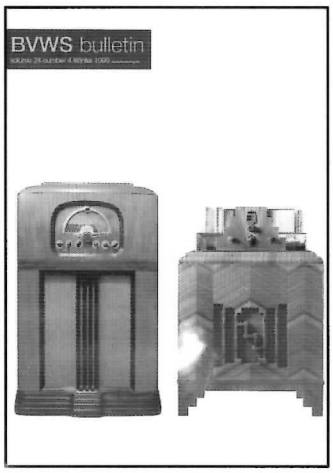

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Cheques to be made payable to 'The Vintage Wireless Museum'.

News and Meetings

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

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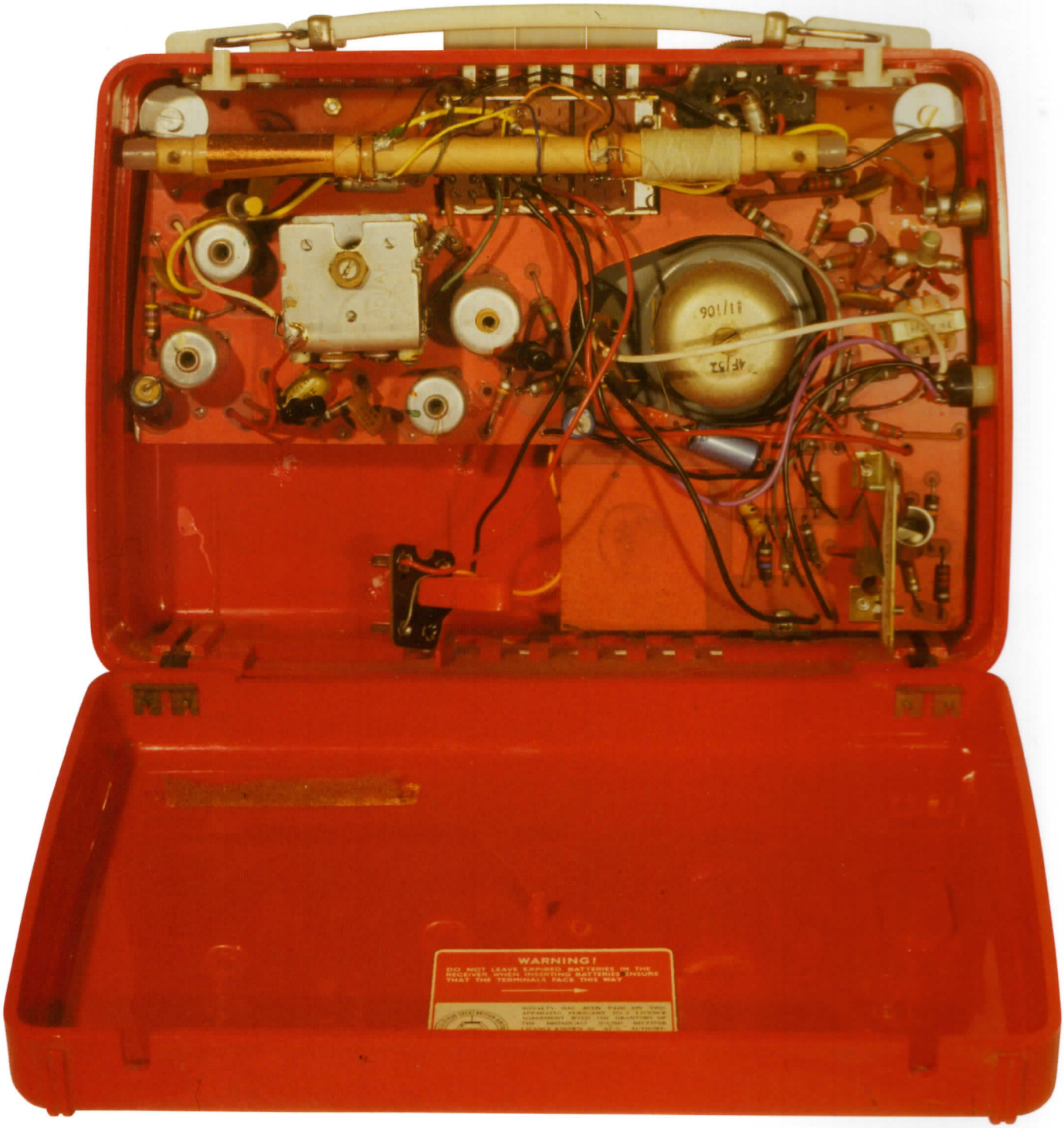
telephone: 01252-613660 e-mail: martyB@globalnet.co.uk

2004 meetings
7th March Harpenden auction and AGM
7th March Vintage Valve Technology Fair at Haydock Park
21st March Auction at Wetwood (Radiophile)
4th April Radiophile swapmeet at Shifnal (Radiophile subscribers only)
4th April Vintage Audio Show at Ramada Jarvis Hotel, Seacroft Roundabout A64, Leeds. Tel 0113 273 2323. 10-5 £2 after 10, £5 before.
18th April Workshop at Vintage Wireless Museum
18th April West of England Vintage Wireless Fair, Willand Village Hall (5 minutes from junction 27 of M5) See advertisement on page 47.
25th April Radiophile swapmeet at Cowbit (Radiophile subscribers only)
2nd May NVCF
Stall bookings/Details: NVCF: 122B Cannon Street Road, London E1 2LH
Tel: 07947 460161 http://www.nvcf.org.uk
5th June Gerald Wells' garden party
6th June Harpenden swapmeet
4th July Wootton Bassett, Swindon
11th July Workshop at Vintage Wireless Museum
5th September Harpenden swapmeet
12th September Vintage Valve Technology Fair at Haydock Park
3rd October Radiophile swapmeet at Shifnal (Radiophile subscribers only)
10th October NVCF
Stall bookings/Details: NVCF: 122B Cannon Street Road, London E1 2LH
Tel: 07947 460161 http://www.nvcf.org.uk
17th October Southborough (BVWS Members)
24th October Workshop at Vintage Wireless Museum
24th October Radiophile swapmeet at Cowbit (Radiophile subscribers only)
7th November Vintage Audio Show at Ramada Jarvis Hotel, Seacroft Roundabout A64, Leeds. Tel 0113 273 2323. 10-5 £2 after 10, £5 before.
21st November Harpenden Swapmeet
5th December Wootton Bassett, Swindon

Italian Meeting
Italian Vintage Radio Association presents Vimercate Swapmeet and exibition on 17th April 2004 at the Marconi Commercial Center, Vimercate (near Milan). Fifty stalls, radio exibition and Workshop. Starts 8.30am, free access for foreign exibitors (one table) and visitors. e-mail claudiogatti.aire@libero.it

2005 meetings (Provisional Dates)
Mar 6th Harpenden (BVWS Members)
Apr 3rd Leeds (Andy Wilcox) (Open to all)
June 5th Harpenden (BVWS Members)
July 3rd Wootton Bassett (BVWS Members)
Sept 18th Harpenden (BVWS Members)
Oct 23rd Southborough (BVWS Members)
Nov 6th Leeds (Andy Wilcox) (Open to all)
Nov 20th Harpenden (BVWS Members)
Dec 4th Wootton Bassett (BVWS Members)

New Articles
If you have anything interesting to say concerning Wireless, Television, Broadcasting, Collecting etc. please send it to the Editor for future publication in the BVWS Bulletin. Your article can be just a few paragraphs long if you think it conveys its message to your fellow members. Also if you have any photographic material that would look good in the Bulletin, don't hesitate to post it to the Editor. The chances are that I will definitely use it! Please send to: Carl Glover, 33 Rangers Square, London SE10 8HR.
Tel: 020 8469 2904 email: choris.b@virgin.net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