The Bulletin
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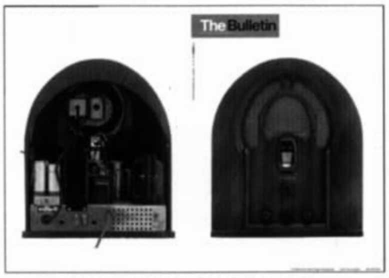

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Contents

From the Chair

As another year draws to a close, I find myself embedded in the preparation for the Winter Wootton Bassett meeting, and slowly sinking under the immense amount of equipment that we have collected recently for disposal at future auctions. The store where we keep everything is now at bursting point with narrow pathways to negotiate to get around the piles of radios and equipment. This has brought me to the conclusion that the only way forward is to hold a special auction to clear down the stock for future incoming items. This is not planned as a regular event but may happen from time to time.

A special auction has been arranged for the 14th January 2007 at the Memorial Hall Wootton Bassett. This will be just an auction event but with the usual excellent catering. A full catalogue of items and pictures of most will be available on the BVWS website from early January so make sure you have a good look.

In 2007 I would like to introduce a new series of articles to the Bulletin entitled "Collection showcase" where you have a chance to get your collections photographed and a piece written about you and your interests. So if you would like to have your collection 'showcased' then please get in touch with me.

With this Bulletin you will find your membership renewal form. Please take a few minutes to check your details to ensure we have everything in order especially if you have moved or changed your e-mail address recently.

With the demise of the Leeds radio meeting this has left a void for those living in the north of the country. Since the last Bulletin, I have been approached by John Marshman in respect to running a trial meeting in Manchester. John has worked hard to set up a meeting for the 20th January (see diary page for details). I hope that this will be a well attended meeting otherwise it will not be repeated, so please support john in his efforts and if all goes well a larger better venue may be sought for the next time.

The Committee have received no nominations for further Committee members and therefore no voting papers are included with this Bulletin. All that remains is to ask everyone to get their membership renewals in quickly to make Grahams life a little easier and to wish everyone a Happy Christmas and prosperous 2007.

Mike

Ralph Barrett Awarded Honorary Society Membership.

The Committee would like to announce that Ralph Barrett a long standing member of the BVWS has been awarded Honorary Society membership.

Ralph has untiringly supported the Society and its Objectives and given many hundreds of hours of his own time to organizing, and giving lectures in the field of Vintage Wireless and Television, both in its history, development and preservation.

In the 1950's Ralph was heavily involved with the development and establishment of the BBC Eurovision television link.

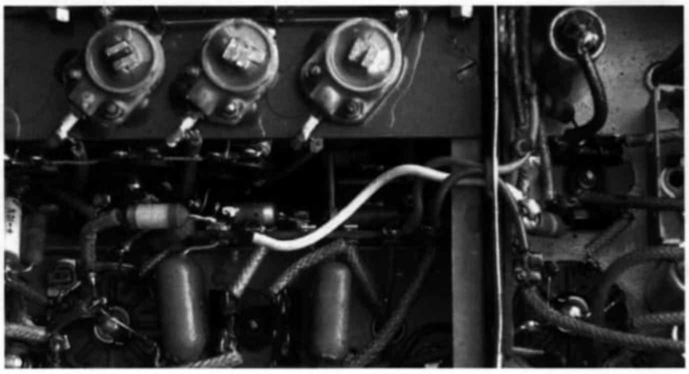
Images from Wootton Bassett

Below: 1933 ORR radio electrically fully restored by Mike Barker and, cabinet was restored and re-finished by John Sprange.

Garden Party Surprise – Another B2 spy set

Ken Brooks G3XSJ

The BVWS 2006 Garden Party at the British Vintage Wireless and Television Museum lived up to expectations and those attending were entertained and delighted by the New Foxtrot Serenaders band adding an appropriate ambience with period music which, combined with perfect weather made for an enjoyable day. I found it all the more memorable because two members, recalling my Autumn 2005 feature on the B2 spy set, had something very interesting to show me.



Left: The transmitter and receiver in parachute drop case.

Above: Still perfect after all those years – receiver chassis.

Right: Still perfect after all those years – transmitter chassis.

The B2 was one of the best known spy or clandestine sets of WW2. It was developed by Major John Brown of SOE and comprised a separate transmitter, receiver and power supply. They were packaged to make a complete radio station that could be carried either in an innocent looking leather suitcase or alternatively as two separate steel parachute drop cases. Needless to say, both types are rare finds nowadays.

My 2005 article described the problems rebuilding a modified receiver back to its original state and, although the receiver is not especially suited to modern communications, the accompanying 20 watt transmitter is quite superb and is in regular use despite the limitation of being crystal controlled..

Back at the Garden Party I was offered an addition to my radio collection and invited to one of the less known corners of the museum where a black steel box was carefully withdrawn from its hiding place under a bench. This was immediately recognised as a B2 transmitter and receiver in a parachute drop case. To come across one is quite unusual, but the bigger surprise was yet to be revealed.

Upon releasing the multiple catches the lid was lifted and inside was what appeared to be a pristine transmitter and receiver. The transmitter and receiver connectors terminate in a special six pin plug, and the plug on the receiver was still sealed up in protective paper just as it had left the factory in the 1940's. The protective paper over the transmitter connector was present but loose. If confirmation was needed of its "newness", the lip of the drop case was still coated with a sticky sort of grease like Vaseline used to seal the case from moisture. It was certainly an interesting find and after some consultations, including with my wife, who illustrated the wisdom of carrying a cheque book at all times, a deal was struck.

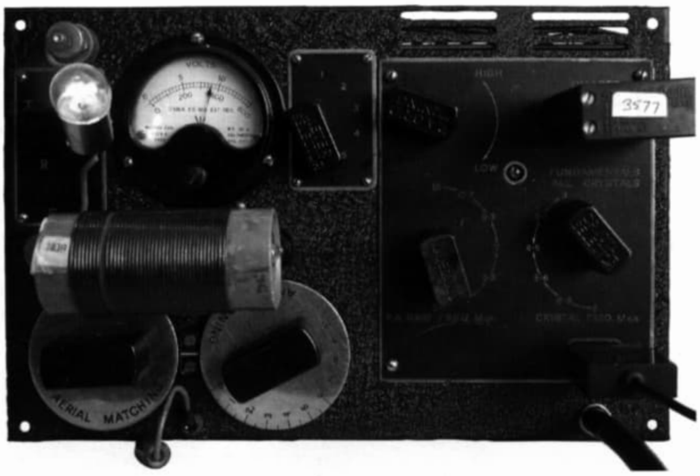
I noticed that the transmitter securing screws had been loosened and before leaving for home it seemed worth checking that there actually was something behind the front panel, so these were carefully removed and the chassis lifted out. This was not as easy as it sounds because the foam packing material between the transmitter case and parachute case becomes sticky with age, but after some movement the chassis was extracted for inspection. Clearly someone in the past had encountered similar problems removing the chassis and had been rather brutal, levering the chassis out of the case, distorting the sides and taking some paint off in the process. The motives were less noble because a previous grave robber had seemingly gone inside just to steal the 6L6 output valve. Fortunately a rusty substitute was produced from museum stocks, and other than some very light corrosion, the chassis seemed like new so it was put back together for a better look at home.

With the transmitter chassis on the bench it was obvious that other than the theft of one valve, the chassis was untouched since leaving the works. The transmitter design sensibly omitted electrolytic capacitors and it seemed quite possible that it could be made to work.

Preparatory work was performed on the moving parts with oil and light lubricating fluid. A drop of oil was placed in each of the ball races of the variable capacitors, the ball at the far end of each shaft, and also on the send/receive/tune switch, a mechanism that is likely to receive heavy use. Then some lubricating fluid was very carefully and lightly sprayed on other moving parts. The purpose of doing this is to reduce the mechanical loading, minimise wear, and improve the feel of the controls.

Some electrical checks followed. A large wax covered decoupling capacitor, Suspect Number One, is fitted near the incoming power cable and if anything was going to be faulty it would be this one. But testing with a meter suggested minimal leakage and after further checks I prepared to apply HT only from my capacitor reformer.

I will digress here and explain what these are and how they can be used with older equipment. My version of a capacitor reformer is based on an article that appeared in the VMARS Newsletter, itself based on an original Radio Constructor feature. It is just a small HT transformer feeding a rectifier, filter capacitor and resistor chain. All it does is allow various voltages to be picked off the resistor chain by means of a switch. In use, a capacitor



Far left, top: Receiver connector still sealed and the immaculate front panel.

Far left, bottom: A very personalised receiver. Ann – where are you now?

Left: Transmitter producing radio frequency power.

or even a complete radio set is connected to the output, and the current and voltage is measured as the selected voltages are applied. Small capacitors should draw no current other than at switch on as they initially charge. Electrolytics can take hours or even days as the electrolytic reforming action takes place, or may leak unacceptably indicating a failed device. If there are resistors across the HT line in complete sets the process is more complex because it is not always obvious where the current is going, but providing the capacitors can withstand HT for several hours the chance of unpleasant surprises when full mains is first applied is much reduced. It can be electrically safer for probing faults and, if nothing else, helps preserve the state of one's nerves when full power is first applied.

With the reformer connected the HT voltage was increased while keeping a watchful eye on the current. There were no surprises so with a borrowed plug in coil and crystal, heater volts were applied together with a source of HT from a variable voltage supply. As the heaters came up to temperature the crystal oscillator started to operate. Then, the set was switched to "transmit" and the transmitter generated radio frequency power, probably for the first time in more than sixty years. The photograph shows a vehicle lamp being used as a dummy load, illuminated by RF power from the transmitter. It would be an understatement to say I was pleased by all this.

Spurred on I decided to see if my luck would hold out with the receiver. As it had protective wrapping over the connector I was quite certain it had never been powered since it was tested in the SOE factory all those years ago. I was unwilling to disturb or remove the sealed connector wrapping and the only alternative therefore was to make connections via crocodile clips on an internal tagstrip.

Unlike the transmitter, the receiver looked like it had not been removed from its case since it left the factory. The chassis is held to the inner case by four screws but with these removed the front panel was stuck fast because the sticky packing foam was keeping the receiver panel in place. Seeing what someone had carelessly done to the transmitter panel I was keen not to apply excessive force and damage either the foam or panel, so a thin plastic blade was carefully moved around the periphery to break the seal. This allowed the panel to be freed and as it emerged from the case I was rewarded with the sight of a pristine chassis. It really was a time warp from the past. Other than some very light oxidation the chassis looked new with components like wax capacitors uncontaminated by adhering dust. There were the usual circular "RCD" (Radio Communication Division) inspection stamps, and I was intrigued to notice a lightly pencilled "Ann" on the RF chassis. I rather like these little personal touches that are sometimes found in hand built equipment.

Testing between HT+ and chassis with a multimeter suggested an absence of potentially catastrophic faults so the next step was to apply gradually increasing HT volts, again through the capacitor reformer. At first the omens did not look that good because the HT failed to reach the no load voltage suggesting leakage somewhere. Just to check that I was not becoming concerned about something needlessly, I checked the circuit and there were indeed no DC paths between HT+ and the chassis, so the leakage must have been passing through capacitors. Remembering having read that non–electrolytic capacitors can sometimes be conditioned by applying a voltage to their plates, I left the reformer switched on for an hour or so to ponder on the observations.

Whilst thinking about all this I was considering the stark choice of having a non working museum piece or perhaps a slightly adulterated working receiver if it was found new parts were indeed needed. The chassis was so perfect that even if capacitors had failed, I really did not want to touch it with a soldering iron just to satisfy some genetically programmed predisposition to "make it work."

I need not have worried, because after an hour or so the HT had increased sufficiently to allay my concerns. Further testing and simple Ohms Law calculations showed one decoupling capacitor leaking less than 30 microamps at 200 volts HT, and the entire chassis leaking less than 250 microamps, which even with my ultra cautious approach seemed not unreasonable for such aged equipment.

With courage summoned, HT and heater voltages were applied. As the HT voltage was raised I was greeted by a loud hiss and babble of signals. With the chassis out of its metal case signals could be received on half a metre of aerial, confirming the sensitivity of the original design.

As I had had some problems with coverage of my earlier rebuilt B2 receiver I decided to check the calibration extremities of each band but these were still remarkably accurate. I have not found these receivers that easy to use. They seem to be very lively, perhaps noisy, and the tuning is quite coarse which makes for difficulties receiving the narrow bandwidth of morse signals. It is for these reasons that when using the transmitter I have usually used a different receiver.

But back to the transmitter. With it back on the bench again I was keen to connect it up to an aerial and receiver and see if it would actually work as intended. A near period Eddystone 640 was set up and the power connections to the transmitter made with insulated crocodile clips as the power connector is special and I do not have the mating part. After adjusting the controls to match the aerial, a general call was transmitted and a reply received from a station in Morecambe, Lancashire, who reported good signals. The first contact on my other B2 was to southern Italy, and although Morecambe might not be considered quite as exotic, there was still that warm inner glow of satisfaction when something in life actually goes well.

These radios are quite unusual and I count myself very fortunate indeed to have encountered such a fine example. It may be exploring the limits of analogies and imagination but when first seeing the insides of an immaculate receiver that has not seen daylight for sixty or more years, I can appreciate how excited archaeologists must have been when opening Egyptian tombs.

Further reading

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Bandspreading the B2.
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John Brown and his SOE Radios
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Valve and Vintage
Practical Wireless July 1995
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Boyce & Everett 2003
Special Operations Executive
BVWS Bulletin Volume 30, no. 3

The 1930 Demonstration Broadcast Receiver And Loudspeaker at the Science Museum, London

by John Liffen

Fig 1 (below, left): Denman's home at 43 Ovington Square showing the loudspeaker horn looking like 'a badly bent church spire'. The title block of Denman's 1929 article for Wireless World.

Fig 2 (below): The main portions of the horn Denman designed for his home, from the same article in Wireless World.

A national museum such as the Science Museum, London, probably has more continuity and a better 'corporate memory' than most other organizations of comparable size. All the same, galleries are continually being renewed, new exhibits installed and others removed to store. Add to this a steady turnover of staff, and it is likely that interesting episodes in the Museum's existence, if not written up for a wider audience, eventually become little better than legend.

I became Curator of Communications at the Science Museum in 2003 but had begun my acquaintance with these collections as a Museum Assistant, or MA (the most junior grade), many years before. One of the stories I was told when I first joined the Museum concerned the fate of an exceptionally large loudspeaker formerly displayed in the Radio Communication gallery in the 1930s. This article describes the design and construction of the loudspeaker and its associated radio receiver, and what ultimately happened to them.[1]

At the beginning of the 1920s the rapid development of radio communication technology necessitated an expansion of the Science Museum's coverage. On 23 November 1922 Roderick Peter George Denman, BA, AMIEE (1894-1941), was appointed Assistant for the Electrical Communication collections (the title 'curator' has only been adopted in the Museum in quite recent times). Denman was a knowledgeable radio engineer and set about his job with enthusiasm. Among the early fruits of his reorganization were two printed catalogues of his collections, which should be familiar to quite a few BVWS members.[2] At this time the Museum was gradually occupying a new building, the East Block, constructed between 1913 and 1919 and which had its frontage on Exhibition Road. Behind this some old buildings, dating back to the 1862 International Exhibition, were still in use. The Radio Communication gallery, Gallery 28, was on the first floor of one of these.

Under the policy of Colonel Sir Henry Lyons, its Director, the Science Museum was broadening its appeal to the non-specialist general public. Denman thought that the demonstration of high-quality distortion-free broadcast reception would be an attractive innovation and put up a proposal in December 1925. He was on friendly terms with H L Kirke, senior Development Engineer of the British Broadcasting Company and it was probably with his collusion that the idea was hatched. The proposal was accepted by Lyons and the set was designed and constructed free of charge by Kirke and his colleagues at the BBC, the Museum providing only the cabinet. The set, later known as 'Demonstration Receiver No 1', was completed in spring 1926.[3] Initially a 'Kone' balanced armature loudspeaker was provided by STC, but later in the year a moving-coil loudspeaker specially designed for the Museum by Dr N W McLachlan was substituted.[4]

Denman's work with McLachlan may have been the cause of stimulating his own interest in the history and technology of loudspeaker design. In 1929 he gave a paper, 'Loud speakers and their development' to the Royal Society of Arts.[5] During the course of research for the paper, Denman had the opportunity of hearing a moving-coil loudspeaker drive unit newly designed by Edward C Wente and Albert L Thuras of the Western Electric Company in the United States. This was the Western Electric 555 W, which was specially designed for cinema use. For his lecture, Denman was able to demonstrate it driving a 15ft (4.57m) exponential, or logarithmic, horn, and he found the results very impressive.

Until 1924 the precise function of the 'amplifying horn' remained obscure. In that year a classical piece of analysis by C R Hanna and

J Slepian in the United States showed how a properly designed horn could convert the energy of a vibrating diaphragm efficiently into airborne sound energy and do so over a wide range of frequency with little distortion.[6] The best form of horn for this purpose was the exponential type, having a shape well known to mathematicians. To handle the sounds of lowest frequency it had to be very long with a large opening. In Britain, Percy Wilson, Technical Adviser to The Gramophone magazine, studied the theory of exponential horns and discussed them in his 1929 book Modern Gramophones and Electrical Reproducers, written in conjunction with G W Webb. Gramophones with such large horns were constructed by small firms such as E.M.G. Handmade Gramophones which kept the design before the public throughout the 1930s, but they were aiming only at the luxury end of the market.[7] For domestic broadcast receivers innovation took a different direction. C W Rice and E W Kellogg of the US General Electric Company developed an efficient moving-coil loudspeaker in 1926. This and other types of compact 'hornless' cone loudspeakers were found to be very satisfactory and were widely adopted in a very few years.[8] The horn achieved something of a come-back in the home in the mid-1930s when the Voigt corner-horn loudspeaker set a formidable new standard in sound quality.[9]

Nevertheless, before the appearance of loudspeakers such as Voigt's, the exponential horn was a benchmark aspiration for those who had the space and the money. Having heard its performance with the 555 W, Denman determined to have a similar set-up for his own home. In 1929 he was living at 43 Ovington Square, London SW3, on the corner of Walton Street and just a couple of minutes' walk from Brompton Road. The layout of the property is curious, having a single-storey ground-floor room adjoining a conventional three-storey building. This room, octagonal in shape, was that chosen for the new installation. Finding a position for a large horn proved difficult until a friend, J R Benson, suggested treating the entire room as the mouth of a loudspeaker placed above it. This meant that the greater part of the loudspeaker would be in the open air over the room, curving over to enter the main part of the house at an upper room. The horn, 25ft (7.62m) long, was made to Denman's design by Clubley and Nichols, zinc and sheet iron workers of Ives Street, London SW3, not far from Ovington Square. When installed, this highly unconventional arrangement was described by a writer in The Times Educational Supplement as having 'the curious appearance of a badly bent church spire'.[10] Nevertheless the result was highly satisfactory. Denman wrote up the project for Wireless World and decided that the Science Museum could benefit from something similar.[11]

Fig 3: Front view of Science Museum Demonstration Receiver No 2, September 1930.

Fig 4: The Science Museum Radio Communication gallery, looking west, September 1930. Receiver No 2, with explanatory diagrams alongside, is the tall cabinet to the right of the aisle. The mouth of the exponential loudspeaker is over the gallery entrance. The other two loudspeakers visible are presumably the Amplion and the McLachlan, both mounted on baffles.

Denman set out his proposals in a memorandum dated 10 June 1929 to his chief, Arthur J Spencer. He began by stating that the existing 1925 demonstration broadcast receiver, while successful, was now obsolescent. If the original policy of demonstrating with how little distortion radio reception was possible was to be continued, it would be necessary to replace the existing loudspeakers with the Western Electric 555 W unit in conjunction with a very large exponential horn. If the receiver were redesigned, it would be possible to take full advantage of the changed conditions that would come with the opening of the Brookmans Park regional transmitter in autumn 1929. Denman suggested that the work start with construction of the horn, for which he would use the same firm which had built his own. During this time he would plan the layout and final form of the new receiver, which would be built afterwards. 'The proposal therefore amounts to this,' he wrote, 'that a sum not exceeding £180 (and probably considerably less) be sanctioned for the purpose of putting the Museum receiver again in a position of national importance as the standard of excellence by which all others should be judged.'

Spencer put the matter before Sir Henry Lyons, who gave his approval for work to proceed. The estimate from Clubley and Nichols came in at £35 to build a straight exponential horn 27ft (8.23m) long and 7ft 1in (2.16m) square section at the mouth. The first 8ft 8in (2.64m) was of sheet copper, going from circular where the loudspeaker unit was attached, to square cross-section at the other end. The remaining 19ft (5.79m) was of Terne plate (sheet iron coated with an alloy of lead and tin) covered with pitch and bound with hessian to extinguish unwanted resonances. Though slightly less efficient than a wholly circular cross-section, it is probable that the square cross-section was decided upon for practicality of construction. It was designed to reproduce frequencies from 32Hz up to about 6000Hz, in other words from the lowest note on the piano up to the highest occurring in music. The work was completed quickly and in August 1929 the horn was installed with its mouth over the entrance at the west end of the Radio Communication gallery.[12] This meant that, though the horn opening was prominent, the rest of it protruded rather

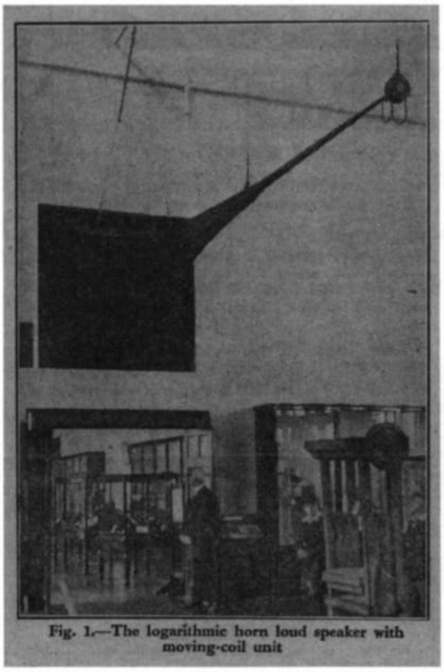

Fig 5: The Science Museum's exponential loudspeaker as seen from the adjacent Agricultural Implements gallery. Illustration from an article in World-Radio, 10 October 1930, page 540. © The British Library. All rights reserved.

Fig 6: Gallery 29 (formerly Agricultural Implements) in course of demolition, 22 April 1949, looking east. Close examination of a scan of this photograph at extreme brightness reveals the horn still in existence in the dark area just beyond the gallery entrance.

incongruously a long way into the adjacent Agricultural Implements gallery, Gallery 29. The label accompanying the new exhibit is included as Appendix One.

To begin with, the loudspeaker was wired up to Demonstration Receiver No 1. By means of a changeover switch it was possible to make comparisons with the McLachlan loudspeaker and a third, an Amplion 'Lion' horn domestic loudspeaker.[13] This Denman had added to give visitors some idea of the performance of a readily-available commercial product. The new exponential horn gave reasonably good results with the older receiver, but the quality was affected by the rather poor acoustics of the gallery. Some improvement was made when several layers of canvas were placed over the entrance at the other end of the gallery, directly opposite the mouth of the horn. These developments, which were not widely publicised, did not go unnoticed by more specialist visitors to the Museum. 'Thermion', the columnist in Amateur Wireless magazine, considered both the McLachlan and the new horn unsatisfactory.[14] Several readers followed up with their own comments, none of which really clarified the matter. At this point Denman took a hand and invited an Amateur Wireless contributor, Kenneth Ullyet, to meet him at the Museum and see for himself what was going on. Ullyet's article, 'The truth about the Science Museum set', appeared in the issue for 19 October. As well as revealing some of Denman's plans for the new receiver, the article also described an unexpected problem with the loudspeaker:

A few weeks ago the horn speaker started to 'buzz' very badly, and it did not at first seem obvious how this could happen. Then they took the giant horn down from its hangings, separated the unit, and located the culprit – a fly! This must have crawled up the horn when the set was not working, and must have been killed at once by the vibration when the set was switched on.

Having carried out tests on the new loudspeaker, Denman found that with Receiver No 1 the results were as he predicted. He then proposed a change in plan, that the Museum should itself construct the new radio receiver, purchasing the components as necessary. This was because it would be difficult to establish a precise specification for the set before having carried out actual experiments using the new transmissions from Brookmans Park. Bench testing could be carried out before settling on the most suitable circuit arrangements, after which final assembly for the gallery could take place. It was designed to run on AC, 230V, 50Hz, but as the Museum was in 1929 still on DC mains a motor-alternator was included in the specification.

Planning and constructing the new receiver took about a year. Once again H L Kirke and the BBC's Development Section were closely involved. For example, Kirke's team made the special output transformer free of charge. However, this hid an extra cost as it was found not possible to obtain iron stampings for the core. They had to be specially fabricated at a cost of £16, a largeish amount at that time, which the Museum paid. This and some other modifications put up the estimated cost to about £200.

Denman wrote a technical description for distribution to the press and this is reproduced as Appendix Two. He also wrote up the design and construction in greater detail with co-author A S Brereton in a two-part article for Wireless World in 1930.[15] Whether Brereton was a member of Museum staff has not yet been discovered.

As far as testing the new set is concerned, it is interesting to quote from the second part of the article:

By the kind permission of Mr H L Kirke, leader of a most able BBC group whose services in the cause of high-quality broadcasting are beyond praise, a special transmission was given from Brookmans Park on the morning of June 4th [1930] for the purpose of enabling the authors to determine the overall characteristics of their receiver.

The test signals, which were not billed in Radio Times, were transmitted on the London Regional wavelength of 842Hz (356.3m). This would not necessarily have involved attendance at the Museum in the small hours, as the London Regional Programme did not begin until midday.

Denman stated that the output power of the receiver was fixed at 40W. The safe power-handling capacity of the 555 W was about 13W, but he argued that efficiency took second place to frequency response and tests showed that only about 10W were transferred to the horn unit. Assuming that the efficiency of this unit was about 25 per cent, he calculated that the maximum acoustic output was about 2.5W.

The new set, 'Demonstration Receiver No 2', was on view in the gallery from Wednesday 1 October 1930.[16] It was designed for 'idiot-proof' demonstration by Gallery Attendants. Most of the controls were behind locked panels, with the Attendant having access only to the metal-clad main switch, the volume-control knob and the switch for moving between the pre-set tuning stages for the National and London Regional Programmes. Interestingly, by this time Denman was no longer on the Museum staff, having resigned on 30 June. Presumably final installation in the gallery was overseen by others, but it is curious that he was no longer around to share in the glory. (Denman's subsequent appointment is as yet unknown, but in the Second World War he was a Lieutenant-Colonel in the Royal Corps of Signals. It is

Fig 7: Detail of figure 6 at extreme brightness reveals the horn still in existence in the dark area just beyond the gallery entrance in the left of the picture. The horn is upturned.

Fig 8: The Western Electric 555 W drive unit used with the loudspeaker horn.

sad to record that in November 1941 he was killed while on active service in Libya.)

The performance of the combined receiver and loudspeaker was highly impressive. Few contemporary descriptions are available of the reactions of those who heard it demonstrated, but The Times said of the loudspeaker that 'the tone and quality developed by this output unit are exceptionally good'.[17] Demonstrations were given daily. One who later set down his impressions was John Bray, Director of Research of the Post Office Engineering Department from 1966 to 1975. He studied at the City and Guilds Engineering College at South Kensington between 1932 and 1935, and recalled:

Lunch breaks at Guilds provided a welcome opportunity to visit the various South Kensington museums – one of my favourites was the Science Museum in Exhibition Road which had installed one of the first really 'Hi-Fi' radio receivers. This was equipped with a magnificent six-foot by six-foot aperture exponential horn moving-coil loudspeaker built into a wall of the Museum and driven from a Wireless World [sic] design of radio receiver with carefully-designed band-pass tuned circuits of Litzendraht wire that enabled a wide audio-frequency response to be achieved. The lunch-time concerts reproduced were of truly magnificent quality – one's memories may be coloured by nostalgia but they almost always seemed to include Reginald Foort playing the organ at the Tower Ballroom, Blackpool – in any event they were much appreciated by my fellow students as we munched our lunch-time sandwiches![18]

Another who appreciated the demonstrations was my uncle, Ronald F Bond. He was out of work for a long stretch of the 1930s and spent much of his time in the (free admission) Science Museum. He remembers the sound quality as far surpassing anything else that he had heard up to that time.

It would be pleasant to record that it was still possible to have such experiences today, and to be able to compare the sound quality with present-day loudspeakers, but sadly this is not so. Daily demonstrations of the receiver continued until the Science Museum closed for the duration of the Second World War early in 1940. The 1862 buildings had not been intended for long-term use and were lightly-built and not fireproof. All the exhibits, including the demonstration receiver, were removed to safer storage elsewhere. The loudspeaker, however, was built into an end wall of the gallery and had to be left in place. The buildings were not affected by bombing but after the war they were quite unfit for further occupation. Demolition took place in 1949. Details in the official file are sparse, but the story as I first heard it related that during the course of demolition the horn was carefully taken down and laid on the floor ready for removal to store the following day. During the night a strong wind sprang up. The building was already weakened and the wind blew down a nearby wall on to the loudspeaker sections, crushing them beyond economic repair. The 555 W drive unit, being solidly built and practically indestructible, was rescued unharmed but the rest of the loudspeaker was fit only for the scrap heap.

However, photographs taken at the time suggest a slightly different course of events. The horn was lowered down in one piece before demolition began and was placed on the floor in the erstwhile Radio Communication gallery, now otherwise empty. It seems that the intention was to retain it in its assembled state. If so, it was presumably too big to be taken down the staircase at the other end of the gallery and would have to await an opportunity to lift it out by crane. The photograph showing the adjacent Gallery 29 in an advanced state of demolition was taken on 22 April 1949. The large square aperture over the doorway marks where the loudspeaker had been located. When I first looked at this photograph I thought that it had been taken after the accident, but a closer look at the scanned image at extreme brightness revealed the upturned horn still present just beyond the doorway. I can now only reflect that if the horn was allowed to be this vulnerable, in retrospect there can be little surprise at its ultimate fate.

The 555 W drive unit remained in the Museum collection and was displayed in the Telecommunications gallery between 1983 and 2001. Other than that no part of this legendary loudspeaker was thought to have survived. The radio receiver itself had survived the war but was not selected for redisplay as it had been built for one specific purpose and was otherwise unrepresentative of manufacturing practice. In 1958 approval was given for its disposal. Some components were retained for use by the telecommunications department and the remainder scrapped. Happily, the main chassis component of Receiver No 1 still survives in the reserve collection, though the McLachlan loudspeaker was also disposed of in 1958.

There the matter might have rested, but for a chance discovery. I had been told the story of the destruction of the loudspeaker by my senior colleague Geoff Voller (G3JUL) soon after I started at the Museum and it stayed in my memory. Some years later, at the beginning of the 1980s, I was MA for the Telecommunications collections and was asked to assist in the clearance of an 'unofficial' attic store room in the Museum. At one time all sorts of 'come in handy' bits and pieces could be kept in odd corners of the building but now a stronger line was being taken. As Geoff and I sifted through the material I came across a curious black metal tube, almost 9 ft long, about an inch diameter at one end tapering to about 3 in square section at the other. Geoff identified it as part of the exponential loudspeaker. It must have been squirrelled away by a predecessor MA unhappy to see it scrapped and who kept it as a private souvenir. I was delighted and decided that this state of affairs should be maintained. Soon afterwards, however, I was promoted to a post in another curatorial department and lost touch with the Telecommunications collections.

In 2003 I was appointed Curator of Communications and began a review and reshelving of the reserve collections in my care. These are held at the Museum's outlying store at Blythe House, near Olympia. Soon after starting, it was with great pleasure that once more I came across this surviving portion of the loudspeaker horn. I have now seen to it that its preservation is regularized and have been stimulated to research the history of the whole project. The specification and dimensions of the 27ft loudspeaker still exist in the file and in my dreams I hope for a rich benefactor who might sponsor a reconstruction. However, even if a builder with the necessary skills could be found, it would cost a great deal more than the £35 paid in 1929.

Acknowledgements

I am grateful to the Archivist of the Institution of Engineering and Technology for details of Denman's IEE membership, to the Editor of *Electronics World* for permission to reproduce the illustrations from *Wireless World*, and to the Photographic Studio, Science Museum, for new photography and preparing the images for publication.

Notes and References

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Fig 9: The author holding the 8ft 8in initial section of the Science Museum's exponential loudspeaker.

Appendix One:
Text of the Science Museum label

Moving Coil Loudspeaker with Logarithmic Horn

The UNIT is a Western Electric 555W type consisting of a duralumin diaphragm 0.002 inches thick to which is rigidly mounted a flat coil wound with a large number of turns of alumnium ribbon 0.015 inches wide by 0.0002 inches thick. The ribbon is wound on edge, a thin coat of lacquer serving as insulation between turns. The coil is mounted in the field of a powerful electromagnet, the inter-action of the sound frequency currents in the coil and the magnetic field causing the diaphragm to vibrate.

In order to avoid distortion the diaphragm should vibrate as nearly as possible like a rigid plunger and therefore the centre portion is shaped so that it is relatively stiff compared with the edge and the driving coil is fastened around the outside of the stiffened central portion. The coil is self-supporting and, as its construction facilitates heat radiation, it is capable of handling a large power input without overheating.

The HORN is 27 feet long with a cross section increasing exponentially from 11/16 inches diameter at the unit end to 7 feet 1 inch square at the mouth. The radiation is emitted very nearly as plane waves with reflection at the open end only at very low frequencies and the large aperture and shape eliminates the possibility of stationary waves inside the horn. The first eight feet is of copper tube and the remainder, of square section, is constructed of leaded sheet iron coated with pitch and bound with hessian.

A coil and diaphragm from a similar unit is exhibited separately.

Appendix Two:
Text of Denman's technical description

Demonstration Broadcast Receiver
Designed and Constructed in the Museum

One object of this installation is to demonstrate the extent to which it has become possible to detect and amplify distortionlessly speech and music transmitted by radio-telephony. Another is to provide regular opportunities for listening to reproduction of nearly uniform quality, and so to establish a standard of reference by which the performance of any given equipment may (to some extent) be judged.

These objects would be defeated if the apparatus were to be used for the reception of difficult or uncertain transmissions, liable to be marred by interference. For this reason reception will normally be confined to transmissions originating within the London area. Diagrams and photographs relating to the construction and performance of the set are exhibited.

High Frequency Amplification

By the use of two single pre-set stages, either the National or the London Regional programme can be readily selected. In each case the aerial tuning circuit is intentionally damped, and advantage is taken of the properties of coupled circuits to secure a flat topped response curve.

Detectors

The amplified signal is fed through balancing potentiometers to a pair of grid-leak detectors having push-pull input and parallel output connections. This arrangement removes the greater part of the high-frequency signal component from the anode circuit, and frees the high-frequency stage from the load which would otherwise be thrown back to it by virtue of the detector inter-electrode capacity. As an additional precaution, a Campbell low pass filter is included in the detector anode circuit to take care of any residual high-frequency component caused by an imperfect balance between the detector valves.

Two separate low-frequency amplifying chains are used, the input to the second chain being derived from the initial anode circuit of the main chain, according to the

'Paraphase' scheme of connection patented by Mr R E H Carpenter, which combines the essentials of phase-opposition working (Push-pull) with those of resistance coupling. Separate (de-coupled) grid-bias arrangements are provided for each valve by means of a variable resistance inserted between each cathode and the negative high-tension lead.

No part of the set is larger than that required to give a satisfactory margin of safety between the actual working conditions and those which would give rise to slight distortion, but an equalising network, which has been designed for use in conjunction with the large horn-type loudspeaker, absorbs considerable power, and the amplifier has therefore been constructed to give a distortionless output of some 40 watts, which is equivalent to that of a full sized talking film installation.

The following table (right of page) gives the principal data for each stage of the low-frequency amplifier. The figures are for one valve in each pair

Power Supply

Alternating current at 230 volts, 50 cycles is taken in and supplied to transformers through a clock switch which gives time for the valves to heat up before the high tension voltages are applied. The early stages of the set are supplied with current at 400 volts through an ordinary two-way valve rectifier and smoothing circuits. For the final stages a pair of hot-cathode mercury vapour rectifiers are used, the transformer being wound to give 1200 RMS volts. Metal rectifiers are used for the detector heaters and for the low voltage winding of the large horn loudspeaker.

	STAGE			
	Detector	**1st L F**	**2nd L F**	**3rd L F**
Type and make of valve	Mullard 164V	Mazda AC/P	Osram LS5	RCA UV845
Anode AC resistance	6,650	2,650	6,000	2,100
Amplification factor	16	10	5	5
Load in anode circuit (ohms)	5,000	10,000	25,000	–
Approximate stage gain	–	8	4	–
Approximate grid swing required to overload output (volts)	±3.5	±5	±37	±150
Grid bias (volts)	0	-12	-70	-150
Anode voltage	150	200	500	1000
Anode current (milliamps)	20	20	20	75

Vintage Hi-Fi exhibition at anniversary show

Some of John Howes' vast collection of audio equipment was displayed at Hi-Fi News' 50th anniversary show at the Renaissance Hotel, Heathrow. Ranging from pre–war items through to more familiar equipment, John's exhibition provided a welcome diversion from the displays of contemporary high fidelity equipment.

In praise of Philco and restoring a Model 16B from 1934

By Gary Tempest

I have four Philco cathedral style radios from this era. A 16B, a 118 (8 tube Superhet 1935) and two model 60's (5 tube Superhets 1936) of different cabinet design. But mainly this article is about the 16, at least it started out this way.

Philco History and UK Philco

If you have an interest in Philco radios then the book to buy is "Philco Radio 1928 – 1942" by Ron Ramirez with Michael Prosise. Unfortunately it deals only with the US and features just radios from over there. However, I always enjoy browsing this easy to read book. It has evolving company history, year by year, as the models changed, along with an excellent model reference with most pictures in colour.

The following is a very brief history, extracted from the book, and poor in comparison, so do try to read the real thing.

The company goes back a long way, to 1892, when it was called the Helios Electric Company making carbon arc lamps. In 1906 they changed the name along with new products, becoming The Philadelphia Storage Battery Company making batteries for industrial purposes. The name "Philco" became a trademark in 1919. Set up to make batteries, when radio came along they were well placed for this innovation. Soon they were offering battery eliminators (just like Ekco) and then it was not too big a jump into producing their own radios. This was forced upon them as other radio manufacturers introduced sets that did not need batteries or eliminators. It was a case of having to join them or go out of business.

Philco's first radio models, in 1928, were the 511 series in metal cabinets of two tone brown. However, to promote sales, sets in glorious colours complete with hand decorated flower designs were available by dealer order. There was the same two tone brown, a green, a gold and even a Mandarin Red. I have never had the pleasure of seeing any of these, only the pictures in the book. They must have been quite stunning, justifiably they are highly sought after by today's collectors. They were well made screened neutralised TRF models having seven tubes. These included antenna tuning (whatever that is?), three RF and two AF stages and a rectifier for the built–in power supply. At a time when many radios used separate awkward dials for tuning, this set incorporated a four gang tuning condenser for "one knob tuning". The colour co-ordinated speaker was separate, which was the norm, but used an inefficient permanent magnet type. This was corrected the following year when a better electro-dynamic version was introduced. Interestingly, in what we would consider technically simple radios today, these sets incorporated 37 patented features.

The company's first cathedral set, was the model 20, introduced in 1930 and dubbed a "midget", compared to the expensive and large furniture sets that had been made before the Great Depression. It sold for around $50 against their hundreds. I was surprised that it was still a seven tube design but you did have to buy your own tubes! It was the first model to introduce the Bakelite block capacitors. These are pitch sealed in a housing along with additional wiring lugs. This set was a huge success and set the company up as a major seller of radios.

The cathedral design became well established in Philco's line up during the first half of the thirties. Alongside it sold "lowboys", "highboys", "chairsides", consoles, phonograph consoles, "tombstones", clocks and other small table sets. They covered everything you could imagine putting a radio chassis into. By the way the "...boys" are Colonial pieces of furniture with legs, as against consoles, that we are familiar with, where the cabinet extends to the floor.

Several cathedral models later we come to the model 16B. "Wireless Magazine", in July 1934, had this to say about it: "Owing to the extraordinary compactness - there is not an inch of space wasted anywhere - the receiver is no larger than many English four valve sets". This is understatement in my opinion, I can't think of any four valve sets that would look as imposing on my sideboard.

Philco UK

It is difficult to find much out about Philco over here. The factory was in Wadsworth Road, Perivale, Middlesex. It was a grand art deco looking building (see picture) draped in radio aerials. Unfortunately I'm told it has not survived. I believe it was largely a plant for putting US assembled chassis into cabinets. It does seem unlikely that this would have been the case for the popular and all British models such as the 444.

Philco on the Internet

There is a lot of information on various web sites with the two best being:
Philco Radio (Ron's site) www.philcoradio.com/index.htm
Philco Repair Bench www.philcorepairbench.com/
Chuck Schwark runs this one and for a small fee will send excellent photocopies of original Service Data. He did copies for me and it even included a list of changes made to the chassis since its introduction. Some around the oscillator circuit were obviously worth including.

The 16B from 1934

This superb radio had been waiting to be restored for quite a while. I bought it in working condition and it truly was, but obviously not at its best. As already said, it was a top class radio in its day and it's still impressive even now. Well, with eleven valves and a couple of IF stages its got to be. To quote Wireless Magazine again, "Truly a set to pick up the whole world. Even picked up Sydney, Australia for a whole hour… on 30 ft of aerial 40 miles from London". It is an imported radio, having a different mains transformer from the US version. It cost £36 5s, a whopping £1300 in today's money (source Office of National Statistics). Definitely one for the Bentley Boys!

It was in excellent condition. One that the Americans would say had been a "Parlour Pet". The cabinet had just a few marks and a plinth that needed touching up from wounds accumulated over more than 70 years. The grill cloth is original as was the chassis. When I removed it from the cabinet it was obvious that I was going to be the first person to take a soldering iron to it since it was made. To me it's stunning that it still worked and says a lot for the build quality. So, thrilling and at the same time a responsibility to do the best possible job.

Interestingly the B suffix stands for Baby Grand, Philco's name for what are now table models to us. The same suffix is used for the cathedral model and the round shouldered tombstone. There was a US version of this, at the last NVCF. This has a massive ten-inch speaker that would not have looked big in a console but in a table set looked enormous. It would have been even more of a barn-stormer than mine with its eight-inch unit. For a moment I was tempted but managed to walk away. I have read of US collectors calling these sets "barn radios" the implication being that they have the power to fill a large space. The table models were specified at 10W and the floor standing models, using the same chassis and twelve inch speakers at 15W.

Wavebands and Controls

There is the Broadcast band (MW) of 520 – 1500 kc and four Short Wave bands. These are: 1.5 – 4.0 mc, 3.2 – 6.0 mc, 5.8 – 12.0 mc and 11.0 – 23.0 mc. In 1935 the number of Short Wave bands was reduced to three covering the same range. If you want a Long Wave (150 – 390 kc) version you will have to look out for a Model 116 from 1936.

The controls are: Two speed Tuning, Volume with On/Off, Waveband switch, Tone, side mounted QAVC switch and a rear control for setting the operating point for this. (QAVC is Quiet Automatic Volume Control and allows quiet operation whilst tuning between stations). There is also a tuning meter that Philco called the "Shadow Meter". In this an illuminated vane casts a shadow on a front screen narrowing as the radio is brought on tune. This is positioned above the tuning dial.

Circuit Description

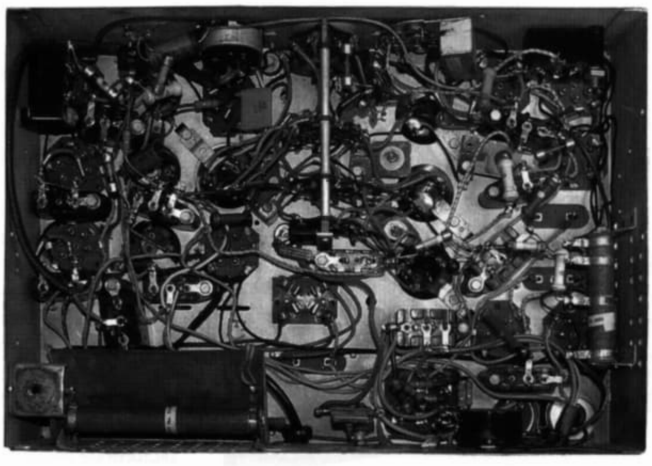
No tuned RF stage as I would have thought but straight into a pentode frequency changer with a separate triode oscillator. This is of the feedback transformer type. Grandly, this is described in the excellent book, Thermionic Valve Circuits by E.Williams, as a Tuned Grid Regenerative Amplifier with Mutual Inductive Coupling. But actually this does describe it very well from the understanding I can glean from the circuit diagram. It's beastly hard to fathom the switching but the anode feedback windings, the mutual inductive bit, have little switching and seem to be series connected reaction coils for two transformers. In the grid circuit are windings for the two transformers, one for the three highest wavebands and the other for the MW and the next band. Both transformer windings have taps connected to the switching, which no doubt not only connects them, but shorts out sections that are not in use. The switching also brings into play what Philco call "Compensating Condensers" and what we would call oscillator trimmers for setting spot frequency on each waveband. The valve has an un-bypassed cathode resistor and the output signal is taken from this to the cathode of the frequency changer in Autodyne manner.

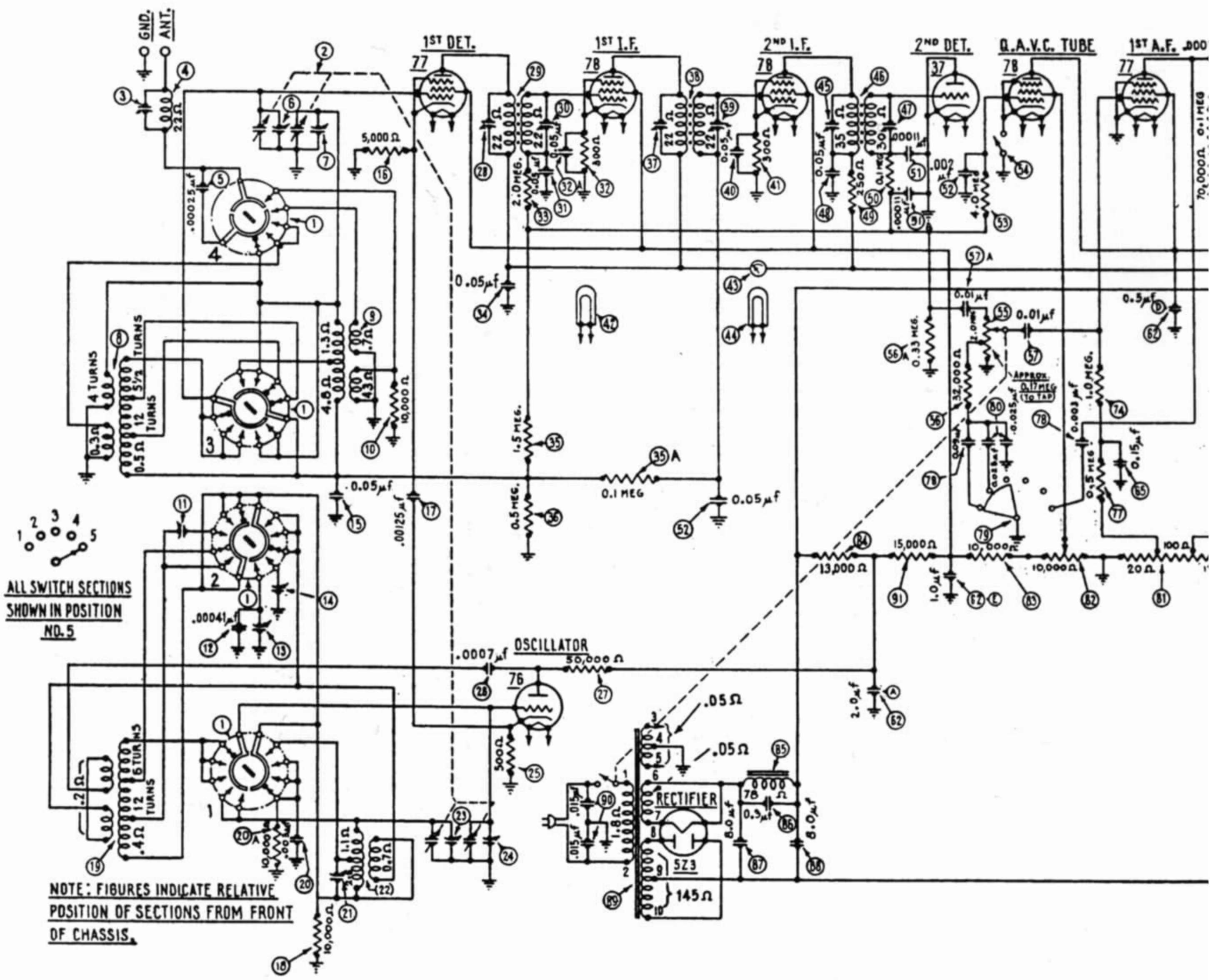
The frequency changer is followed by two stages of IF amplification

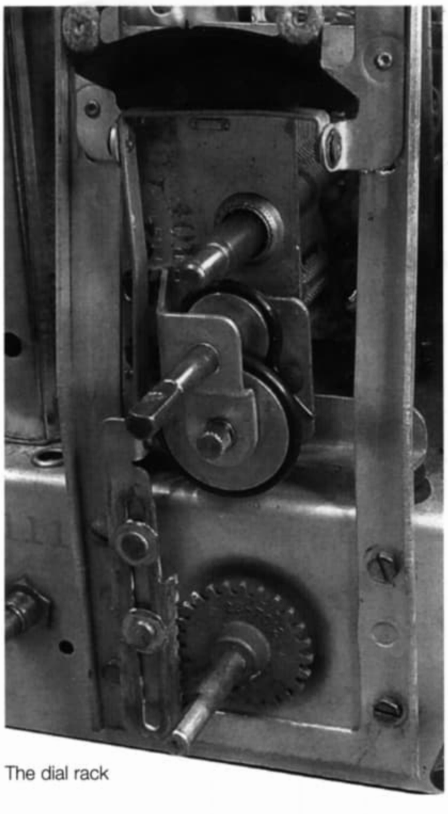
The Philco factory in Perivale

The chassis from the rear


The chassis from the front   Below: The chassis from below






The dial rack

at 460 kc/s. A triode, strapped as a diode (A-K) is then used for detection. The simple AVC from this is applied to the frequency changer, the IF stages and the "QAVC Tube" (see the separate description) for inter-station noise suppression. This, if switched in circuit, controls the gain of the AF pre-amplifier, which is coupled to a 42 audio driver. A transformer, in its anode circuit, is used for phase splitting for a pair of 42 's, strapped as triodes, in class AB2 push pull (more on this later).

HT is derived from a full wave rectifier with comprehensive smoothing. There is a resistor chain in the negative line to generate bias voltages for the audio stages.

If the chassis had not had QAVC then the makers would most likely have used the 75 double diode triode for detection and first AF pre-amplifier. However, the QAVC method used requires a pentode to control audio gain.

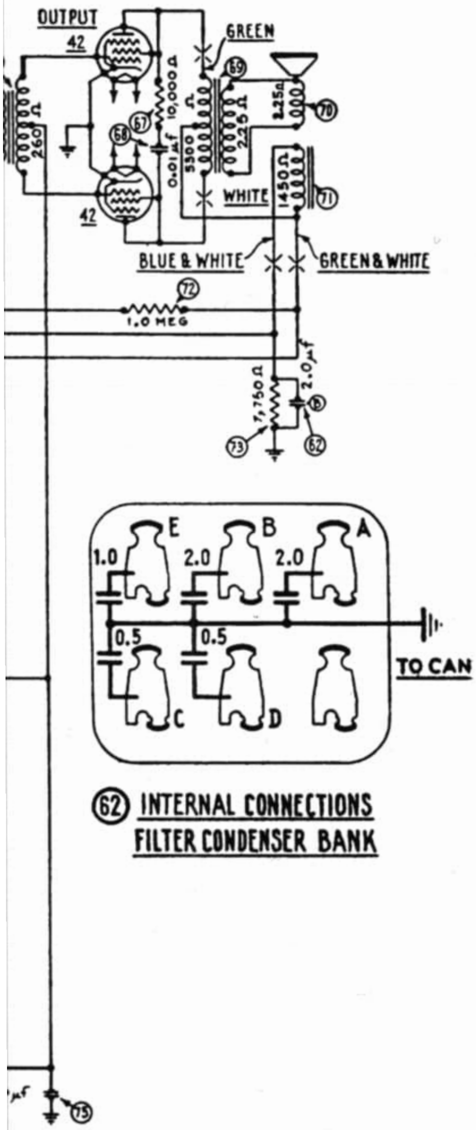
The volume control uses a tapped potentiometer that allows volume related bass boost, by the first two positions of a four position switch. The next position is no tone adjustment and the last is treble cut.

The tuning dial is calibrated in frequency and is easy to read as only the selected waveband is illuminated. This is done (see picture) by moving the bulb holder up and down using rack and pinion gearing. Of course you need a list of stations related to frequency but users back then would have had this. Station frequencies were still fluid and names on dials not commonplace until a few years later. Above the tuning dial is mounted the "Shadow Meter" which is connected in the HT feed of the first two valves. When the station is accurately tuned then AVC reduces their anode current, the vane has the least rotation and the shadow cast is narrowest.

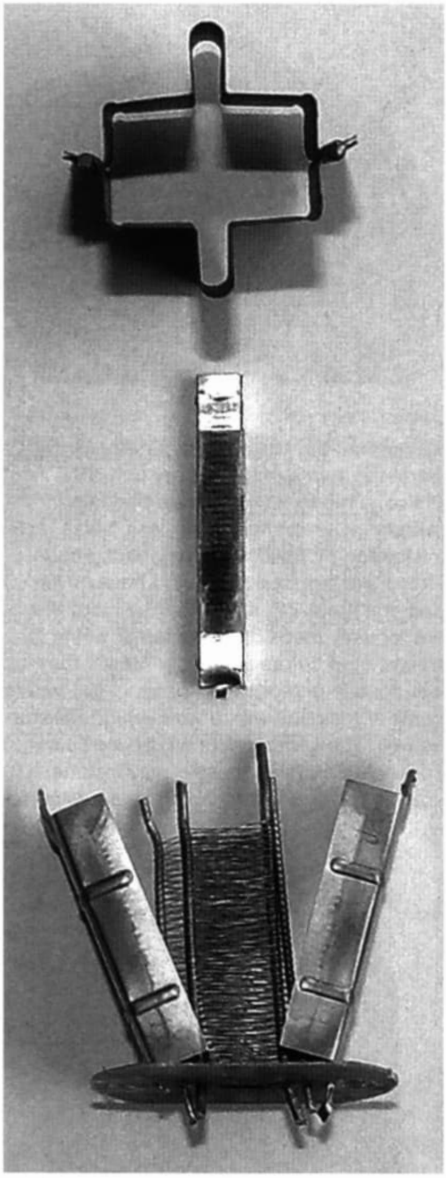
The Push Pull Output Stage

For me, it's never a bad thing to look again at circuits that I have known about for years but have now forgotten much of the detail. A read through Radio Designers Handbook, by F. Langford Smith can gradually refresh the memory cells. Probably all the detail you could want is there. It is much more complicated of course than the cursory glance we give these circuits when we repair them.

I'll attempt to give a brief summary of the important points, concentrating on triode valves or pentodes strapped as such. Triodes were preferred in those early days because their low plate resistance was easier to match to the load. What is plate resistance some newcomers may say? It is just how the



(62) INTERNAL CONNECTIONS FILTER CONDENSER BANK



The beam tetrode

anode current changes with anode voltage for a constant grid voltage. Look at a valve's characteristic curve, consider a linear part and note the current change for say a 10V change in anode volts. Divide the mA into this and you have the plate resistance in K Ohms. So why is it so much higher with pentodes? Well here you have the screen, held at a constant voltage, somewhat less than the anode. Its effect is dramatic in attracting electrons that fly through it to the anode and the same 10V change in anode voltage will cause much less change in the anode current than before. Just compare the curves: one goes steeply up hill and the other is an easy stroll on a gentle slope. The differences in plate resistance can be huge, from say 1K Ohm for a triode to 80K Ohm for a pentode. Of course, once the screen is strapped to the anode, then its stabilising effect is lost and the valve, as expected, has the characteristic of a triode.

Loudspeakers have natural acoustic damping (the cone mounting and the trapped air within the enclosure) but are also damped by the plate resistance reflected through the output transformer. Most of us have seen how a moving coil meter has the movement damped (just shake the meter around) when a low value resistor is connected across it. It's the same for the loudspeaker and the outcome is that the transient response was better using triodes. Later, pentodes and beam tetrodes were used but by then negative voltage feedback was known about and used to make the damping as good as or better than when using triodes

Briefly the beam tetrode was developed to get around the Philips (Mullard) patent on the pentode. The beam plates remove the kink in the Va / Ia characteristic caused by secondary emission from the anode. Nicely, I think, they were known as "Kinkless Tetrodes" and Marconi used this as a prefix for their valves of this type, EG: KT66.

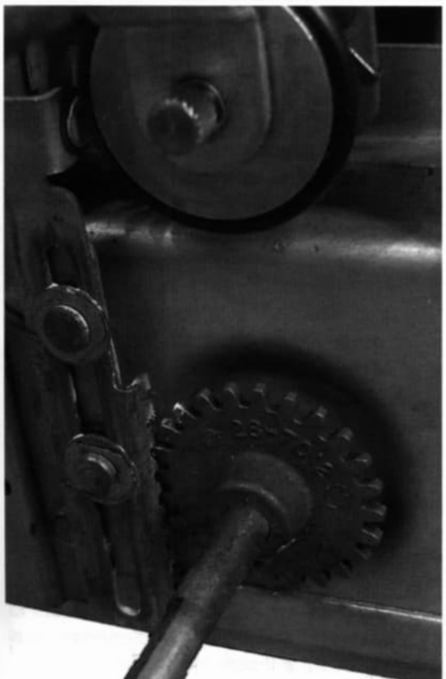
I had a dud KT and took it apart. In the picture you can see the anode at the top with the cathode and heater assembly below it. So the cathode was firing electrons out through the grid and screen meshes, seen at the bottom, into the U shaped sections of the anode. Wrapped around the meshes are the beam plates, which being at anode potential, would catch most of the secondary emission.

For push pull, even harmonics cancel out, assuming the two valves have matched characteristics but this is not true for the odd harmonics. However, for triodes operating in Class A, Langford Smith says "...only very small third and higher order harmonics remain".

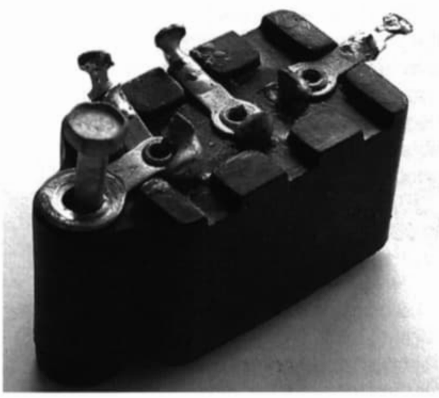
When substituting a loudspeaker for a resistive load then things become a lot more complex. A graph is given of loudspeaker impedance versus frequency. It is only resistive at two frequencies and at others is largely inductive or capacitive. Also, an average loudspeaker can have six times the impedance at the bass resonant frequency and at 5000 c/s compared to 400 c/s. A resistance capacitance filter is normally used to reduce the rise of impedance at high frequencies but does nothing at the low end. Apart from the direct effect of the varying load there is a selective effect on the harmonic distortion. The harmonic may see a higher load impedance than the fundamental and so the harmonic percentage will be greater. As to the influence of the varying load then this depends upon the types of valves used and the mode of operation. The least affected in terms of distortion are triodes operated in Class A, "...providing the highest standard of fidelity". Just to complicate things the term Class A1 is used which means the valve conducts all the time and no grid current flows. For me I'm happy to just call that Class A.

Interestingly he says that single Class A triodes are usually operated with 5% second harmonic at maximum output. Apparently third and higher order harmonics are very small. Friends have told me that some single ended radios sound better than their push pull equivalent from the same manufacturer (EG: EMI). Perhaps a few percent of second harmonic gives a brighter sound and accounts for this.

So for push pull, triodes in Class A are very attractive but the penalty is the low efficiency. Class B, where the valves are biased to cut off and only conduct with signal, would have suffered with the familiar cross over distortion, worried about by solid state amplifier designers years in the future. But they could put in lots of open loop gain and then use large amounts



The dial pinion



Bakelite block capacitor top

Bakelite block capacitor bottom

Bakelite block capacitor refilled

of feedback to minimise the distortion. The Philco approach was to use the Class AB2 method and set the anode currents for about 20 mA for the 16B. (In my Marconi 561 (Bulletin Vol. 30, No 2, Summer 05) the valves, in Class A, have currents of 30 mA). So the circuit works in Class A at most signal levels, with no crossover distortion and then gracefully moves into B mode at higher levels. However, Langford Smith does say that the distortion caused by the varying loudspeaker load, with frequency, will be greater.

According to the book there are two types of Class AB (sometimes called Class A Prime, which may be US terminology): AB1 where no grid current flows and AB2 where it does for at least part of the cycle. AB1 must be almost Class A, with just a little tweaking of voltages and bias to improve efficiency. In AB2 the driver transformer used must supply some power else distortion will occur. The16B uses a 2:1 step down. That is, half the swing at the output valve grids to that of the anode of the power valve driver. Contrast this to the Marconi 561, which uses Class A push pull, and this transformer is 1:4 step-up and driven by a low power pentode.

For the 561 the power supply has two chokes and HT feeds. One is used to supply the output stage and the separate oscillator. This works because the output stage is drawing constant current, irrespective of the power level to the loudspeaker, and so the voltage to the critical oscillator circuit (the top waveband tunes to nearly 60 mc) remains constant.

For the 16B, using Class AB2, then the output stage current is going to be constant for much of the time. There is an HT feed, using a tuned choke, for the output valves and the oscillator circuit. The speaker field is energised by the rest of the circuit but also has an additional bleed resistor to add a further 30 mA.

Coincidentally, as I was completing this article, I picked up a back issue (Issue No 90, 2004) of Radio Bygones. In it is an article "Philco (model 18) Versus Atwater Kent" by Peter Lankshire and he too writes about push pull output stages.

Bakelite Block Capacitors (See pictures)

I expect many readers will have come across these in the famous British radio, the model 444, "The Peoples Set", from 1936 which sold for just £6 6s. I have never worked on one of these so the blocks were new to me until I got my first US Philco, a model 118 (more on that later).

To me it seems that their design was influenced by Philco's battery background. They have big solid lugs and I have never had one break off. It's just as well that they are robustly made as the external wiring is well twisted before soldering. Mostly they just contain one or two capacitors but I have come across one with a wire wound resistor as well. The components will be logically connected and the housing may include spare lugs for other wiring. They are secured

Item 79. The modified tone control

by a single self tapping screw, through a boss that raises the main casing away from the chassis by a couple of millimetres.

Ron kindly e-mailed me this additional information: "Beginning in 1934, Philco slowly began phasing in more conventional cardboard tubular paper capacitors...and slowly phasing out the Bakelite blocks. The 1938 model year was Philco's last for widespread use. However, they continued to be used across the AC line (mains) until around 1949, at which time they finally switched to paper capacitors and terminal strips for the AC line (mains) bypass caps."

There is some information on Web Sites and even a comprehensive book (Philco Condensers and More, 2nd Edition, by Ray Bintliff) about the internals of these Bakelite blocks. However, if you are just doing one or two sets, it's fairly easy to work out what components are present and their connectivity from the items list and the circuit diagram. The capacitors now are poor with leakage down to 0.5M Ohm at 10V on the 16B chassis. (I measured all the resistors and only found three too far out that had to be changed. All mica capacitors were fine with 'zero' leakage)

Also to be found on the Internet are several methods of re-filling the blocks. One, which seemed extremely harsh to me, was to snip off the component connecting wires where they pass through the lug eyelets from the inside. Then, having ground down a pin punch, pass this through the eyelets and use with a hammer to shatter the pitch holding the components in place. Now remove the fixing screw and pick and vacuum out the pieces.

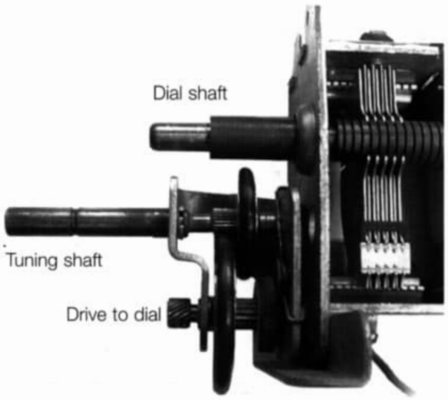
I prefer the safe way of disconnecting the external wiring and removing the block. Then solder wick the lug clean and there is a little dodge that took me awhile to find so I'll pass it on. The wires from the components are stranded and to remove them completely is tricky. What helps is to lever up the slack, from the inside first, with a pair of fine pointed tweezers. This normally gives enough wire to hang a pair of forceps on. Once the wire is broken below them, the end can be used to unwind the remainder from the reheated lug.

I recommend using a heat gun on the block for a minute or two, just to soften the pitch, and then to lever only on the post to remove the old items. Remnants of pitch can be scraped out and a final clean up made with cellulose thinners. Then it's simply a case of fitting new components.

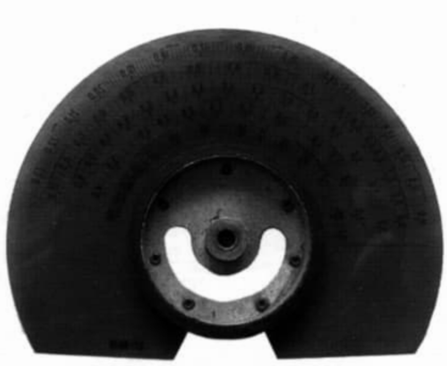
I did find some instances of external wires trapped underneath blocks. You can bet those girls of 70 years ago, were in a real hurry with bonus to be earned. Some wires, once disturbed, could become a problem and are best replaced.

Refilling Capacitor Can C62

Its fairly easy to open this up and remove the old 'innards'. I then mounted new poly items inside. However, as the can is at the rear edge of the chassis it is certain to be used as a handle. It is made from very thin mild steel sheet and is not strong enough unfilled. I got around this by soldering a couple of tinned copper wires across the inside of the can below the minimal depth needed for the new components. Then it was filled with epoxy to just above the wires. Finally, it was de-rusted, primed and sprayed satin black.



The dial drive and tyre

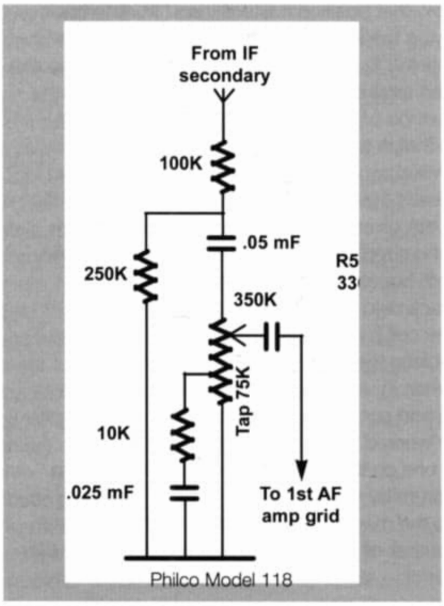


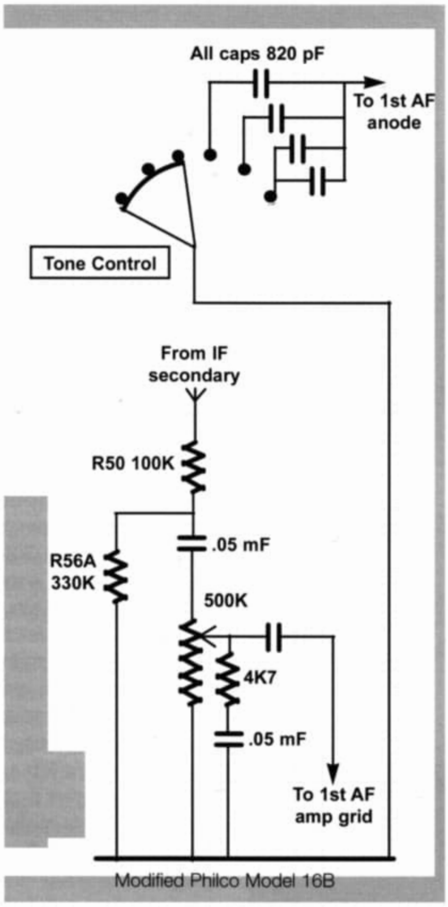
The dial and tyre

Volume and Tone Controls

I needed to replace the volume control but getting a correct one with a tap is no longer possible. The tone control uses the tap to provide volume related bass boost. It would seem that Philco were not very happy with it, as it has several change notes including two changes of part as well as external capacitors.

A look at the circuit shows how it works. The switch is shown in the maximum bass position





modified tone control circuit

with the largest capacitance in the bottom leg of the potential divider formed with the volume control. At low frequencies the capacitance will have the largest reactance and the least shunting effect on the signal passing to the first AF amplifier. As the frequency rises reactance will fall, more shunting effect will occur and the higher frequencies will be reduced in level. So saying this the other way around, the bass will be boosted. In succeeding switch positions the shunting capacitance is reduced and in the last position a capacitor comes into play, from the anode of the first AF amplifier, as normal top cut. This capacitor is also marked C78, as is that on the first switch position, both of them being built into a metal box which is part of the switch, Item 79. (See picture).

I compared the circuit to that of the model 118, which uses fixed bass boost from the tap and the tone control is a progressive top cut. After some experimentation I decided that this was my best option. I would convert the tone control and add fixed boost, from the wiper of the volume potentiometer. The advantage of the tap method is that when the wiper is below the tap, then the frequency characteristic should stay approximately constant. This will not be the case with the components just connected to the wiper. I chose them after setting the volume to what I considered a likely listening level. Then it was simply a case of measuring the resistance of the wiper to earth and scaling components from the 118.

For the tone control I used four 820 pF capacitors arranged to give no cut, 820, 1640 and 3280 pF (3000 pF was the top cut value in use originally) from the anode of the first AF amplifier.

In listening tests, over the range of volume likely to be used the bass sounds fine. The tone control is probably more useful than before as it allows putting in just the right amount of cut to reduce the odd whistle.

See the diagram for the circuit comparison and changes made to the 16B.

Tuning, Tyres and the Dial

Tuning and Tyres

Rubber tyres that engage on knurled portions of the mechanism achieve the two speed tuning. In the left hand picture it is set for slow speed and by pushing the tuning shaft in, the rear tyre will engage with the rear wheel for the faster speed. In the next picture you can see the rear of the dial which mounts on the tuning gang. It has a large tyre that is driven by the lower shaft of the mechanism. Fortunately, this was still useable but the others needed replacing by 'O' Rings which work just as well. Restorers in the US have already come up with the part numbers for these and they can be found on Ron's web site. Of course I needed a friend to go and get them and send them to me (thanks again).

The Dial

The dial had been badly dulled and bloomed, on the front, by acids and I guess nicotine over the years. It took a lot of hand polishing to get it back to a good shine. Fortunately, the markings were silk screened on the back that was just dirty. Even better it was happy to be gently washed with water with a drop of liquid soap. Of course I tested first, with a moistened cotton bud, on the part number not seen at the edge of the dial. I was fairly sure that it would be fine, as I had been there before with the model 118.

It was badly warped now and there is nothing you can do to straighten it. It rubbed in places on the felt pads over the dial pointer and bulb holder housing (on the top of the rack). This to me is unacceptable: the lettering must be preserved no matter what. I got around this by tilting the dial rack back a little by inserting 4 BA solder tags under the rack bottom screws. This just leans it back a little and stops the contact without having a detrimental affect on the waveband gear mechanism. Solder tags are easier than washers to insert in this situation. The tags can be held with tweezers whilst the screw hole is aligned and finally, when happy that they provide a cure, allowed to drop out of sight.

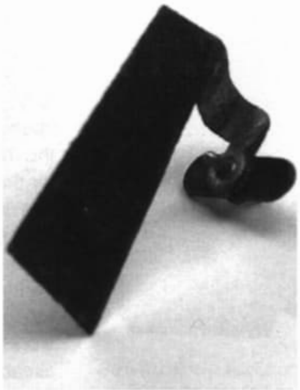
The Shadow Meter and its repair

How it works

How the meter works is on Chuck's Web-Site and is taken from the John Rider Manuals (actually the whole of this section is on the site). I'll give my interpretation of how it works here and my site input because not all our members are into computers and the Internet.

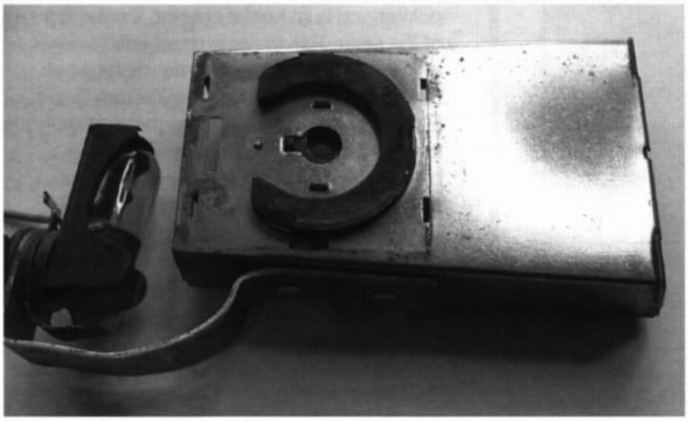
The indicator works by employing a circular horseshoe magnet having an air gap. Filling the gap and completing the easiest flux path is a moving soft iron armature. It can move because it is on perpendicular pivots. The armature also carries the vane that in conjunction with the light source casts the shadow on the front opaque surface of the meter. The armature will always take up a position that causes the maximum flux to flow through it and the horseshoe magnet. In a nutshell, it is self-centring without the aid of hairsprings. Now adjacent to the horseshoe magnet is a coil of wire that when current flows through, sets up a magnetic field that opposes the field from the permanent

The coil and pole piece

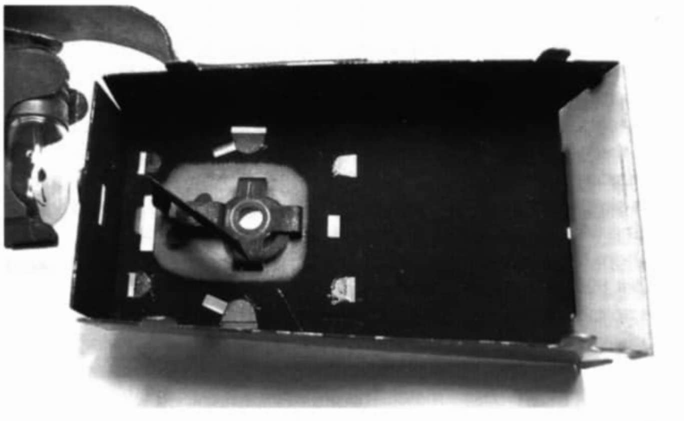


The shadow vane and armature

The meter case and coil



The meter case and magnet



The meter inside

below: the magnetic pick–up tool

magnet. Thus the more current that flows the more the armature is forced to move and so the greater the shadow cast by the vane. When working properly, the action is delightfully smooth with the indication moving as the current flow changes through the meter.

Faults and repair

The possible faults are that the coil is open circuit or the meter does not operate smoothly.

For repair my recommendation is that once you have the meter out of the chassis then bend back the tabs on the bottom plate and remove it. Before doing anything else check the movement of the aluminium shadow vane. A cocktail stick or similar can be used to push it across and then release it. It should re-centre due to the flux from the horseshoe magnet passing through the armature. If it doesn't then the fault may be mechanical. The pivot points may need cleaning or the bar may be loose. If this is so it can be fixed by applying tiny beads of Super-Glue with the cocktail stick. If it is neither of these then the magnet may not be strong enough. It will be necessary to strip the meter to correct this.

If the coil is open circuit, as mine was, then still do the vane centring check. Make a mental note of how smartly it re-centres and how many oscillations of overshoot it goes through. This gives a rough guide to how powerful the magnet is.

To remove the coil, bend back the tabs and remove its cover box (not shown in the pictures). Now take out the single screw, passing through the vane pivot bracket. Once the coil is off, the horseshoe magnet can be seen. If there is no problem with this then remove it and apply a 'keeper'; a dressmaking pin will do. The magnet is held in place by the coil but there are tabs, bent out of the box, that position it laterally and front to back. I must confess to not applying the keeper as I had not found out how it worked and anyway I was going to get it back together quickly. Of course that didn't happen as I faffed around hunting down wire and wondering if my normal battery drill method of rewinding was going to work. It's wound with 40-gauge wire that is pushing it with crude equipment. In the event I got 'Chairman Mike', who has coil winders, to do it and an excellent job he made. It needs 1000 ft of wire, which at 1.1 Ohms / ft and a typical current of 10 mA gives a 10 V drop in normal operation. Thanks to Randy Gutery who supplied this information to the web-site.

Whilst the coil is removed, hopefully the vane and its pivot bracket will stay in place held by tabs passing through the case. Before refitting the coil it is worth holding the magnet in place and rechecking the vane re-centring.

If the magnet is weak, when in use, the shadow action will not be smooth. It will jump across and not return. Fortunately there is a simple way to re-magnetise it that worked for me. Another small powerful magnet did the job. I used one on the end of those telescopic pickup aids; the magnet is about 6mm by 6mm. With the 'keeper' removed, using a circular motion, rub the magnet around the horseshoe, on one pole and off the other, a number of times. Being right handed, my motion was clockwise, on the underside of the horseshoe. I suspect that this is not critical and if north and south poles are reversed (by doing it the other way for example), then the vane will deflect in the opposite direction. However, the device is symmetrical and either way will produce the same shadow action. Check the magnet's new strength by seeing how it attracts a dressmaking pin. Laid flat, on a smooth surface, it should attract it at about 20mm +/- 5mm. It is not that critical but if necessary the re-magnetising process can be repeated. The final test is to put the horseshoe magnet in place and check vane re-centring.

Testing

To test the reassembled meter, out of the radio, a variable 10V DC supply can be used with a source of 6V to light the bulb. Once hooked up, then as the DC volts are varied, the vane should move smoothly and the shadow open and close. The vane can be carefully adjusted to give a central shadow with the best rectangular shape. This needs to be done in conjunction with adjusting the light source by rotating the bulb and tweaking the bracket. A bulb with a straight filament is recommended. The vane should be almost fully across with 10V and this is approximately 10 mA. In the radio chassis it will be more like 5-6 mA maximum reducing to around 2 mA 'on tune'. This will give typical shadow lengths of 12 mm 'off tune' and 4 mm 'on tune'. If the magnet strength is high both will be narrower and conversely wider if its strength is on the low side.

The covers can now be refitted but, if you are cautious, it can be hooked up to the radio first for a final test. The cover tags are brittle and some may well break off if bent open a second time.

The ultimate Philco. The 680X with front door down

The 680X with front door up

The 680X rear view

QAVC Circuit

When the QAVC circuit is switched in, the valve can conduct depending upon the setting of its potentiometer. When it does so it pulls down the first AF amplifier's screen voltage, so reducing audio gain. The QAVC valve gets the detector negative DC voltage exactly as used for the familiar AVC, to the front end stages. Its filter components are the 4M Ohm and .002 micro F. Off tune, when the voltage is low, then the radio will have maximum gain and noise, when the QAVC potentiometer is set to zero voltage. As this is advanced the valve will start to conduct and the audio gain (and consequently background noise) will be reduced as described.

Testing and Alignment

No problems with the radio working except that it went completely dead a couple of days later. The first IF amplifier had no cathode voltage (even with the grid earthed) so I took the valve out and tested it. Of course it tested fine and the radio played when it was reinserted. It had had a loose base that had been glued so perhaps things were not really happy down there. I changed the valve and the radio has worked reliably since.

With all voltages correct I did the IF alignment as per the Service Instructions using a signal generator. Just for the record, a Wobbulator check showed the response was a smooth symmetrical curve of 6 kHz wide at half height.

The instructions are insistent on carrying out the RF alignment in a prescribed order. The reason for this is that on the tuning gang, the antenna and oscillator short wave gangs are used alone, on the upper ranges (3, 4 and 5) and in parallel with the two larger gangs on the first two ranges (Police and MW). So ranges 3, 4 and 5 are aligned first and then not touched when doing the other two.

On the tuning capacitor there is a bracket, which has "DO NOT ADJUST" stamped onto it, covering two trimmers. These are the SW and MW antenna trimmers and they may have had some subtle way of setting them. I simply used both for best results on the MW band, leaving the SW one reasonably tightened.

The idea of using tuning gang sections in parallel is not something I have come across before but makes for a shorter unit saving about one inch on this already crowded chassis.

The Ultimate Philco

This radio was advertised, on the Internet, for sale in the US and the seller was kind enough to e-mail me really good quality images. It is a Model 680X from 1939 with a 20 valve chassis. It was Philco's top model for the year; were they taking on Scott perhaps?

It had lots of features including variable IF bandwidth and "Automatic and Magnetic Tuning". The first was station selection by means of a telephone dial, with mechanical linkage, and the other AFC needed to alleviate the inaccuracy of the mechanics.

For loudspeakers it has a twelve inch 'woofer', 2 six inch for the top end and 4 eight inch "Acoustic Clarifiers". These actually have no coils or magnets and later in the 60's Hi-FI era were called Passive Radiators. I still have a pair of Ditton 15's that use them. The idea is that they move sympathetically with the bass driver and augment the low frequencies. My understanding is that they should be in an approximately sealed enclosure. For the 680, looking closely at the pictures, back fixings can be seen. However, sealing would have been in conflict with providing ventilation for the 'watty' electronics.

What a restoration project this would be; certainly keep me busy for a whole winter or two. There is a picture, in the Philco book, of a restored model and this shows off the beauty of the cabinet veneers and how good it could look after restoration.

It wasn't that expensive either but of course the shipping would be astronomic. Then there is the problem of size and lack of space so it will have to wait for a lottery win. But what a pleasure to restore and fun to display it would be. Imagine putting it on a turntable, the inside looking immaculate and possibly even cheat a little and run some dummy wires to the Acoustic Clarifiers. Then power it up for a real blast with maybe a hidden CD player or DAB radio fed into the Gram input.

Conclusions

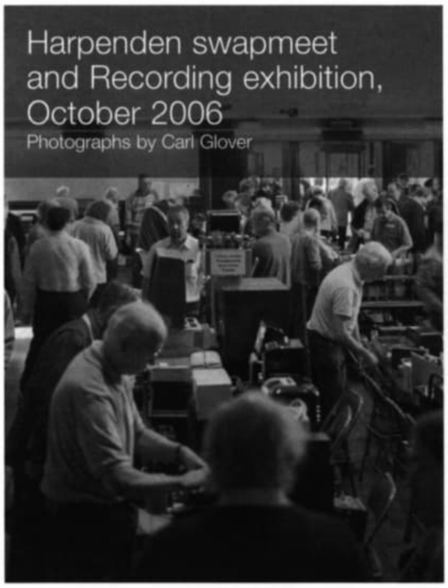
From the Wireless Magazine review: "Owing to the elaborate screening nothing can be heard whatsoever without an aerial or earth (still true apart from Virgin Radio), although with 9 in. of wire Europe can be toured with ease". On MW lots of stations can be heard with such an aerial, including Radio Tigne in Holland. Similarly foreign tongues come in on some SW bands. However, for decent performance a few feet of wire is needed.

I did try to replicate the "...listening to Australia" of the Wireless Magazine on SW. I may have 'heard it' but that's about all. My outdoor aerial though is probably inferior to that used in the tests. However, these wavebands are very sensitive and plenty of stations could be received, including many from eastern Europe, possibly Russia and "China Radio", but I expect this is coming from a relay station closer to home.

I have mentioned the Model 118 several times so I will add just a few words about it. Again it is a very capable receiver in a 30% smaller cabinet. It only has Broadcast and one SW band, 4.2 to 12 mc. It has a pentagrid frequency changer preceded by a tuned RF stage, which it needs because of the low IF frequency of 260 kc/s. There is just one IF amplifier before a double diode triode for detection and Ist AF amplifier. The push pull output stage is similar to the 16B.

Harpenden swapmeet and Recording exhibition, October 2006

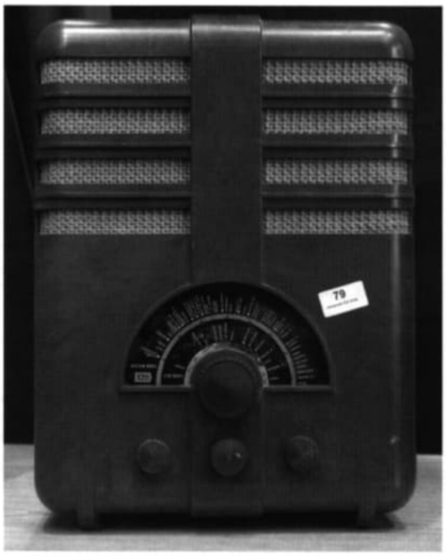
Photographs by Carl Glover




83


CRYSTAL SET


PHILCO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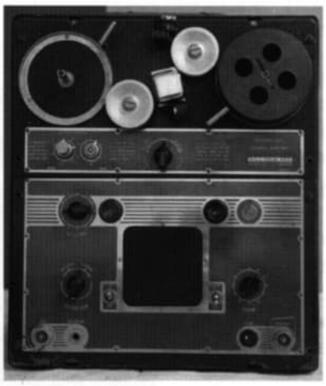
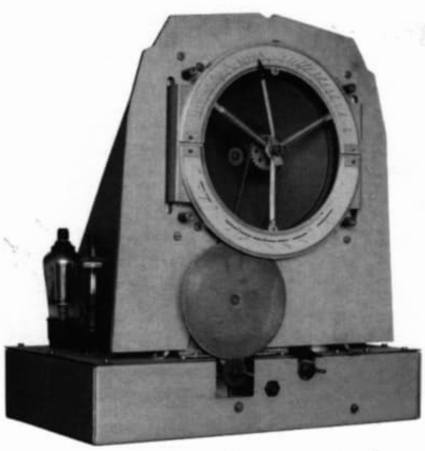
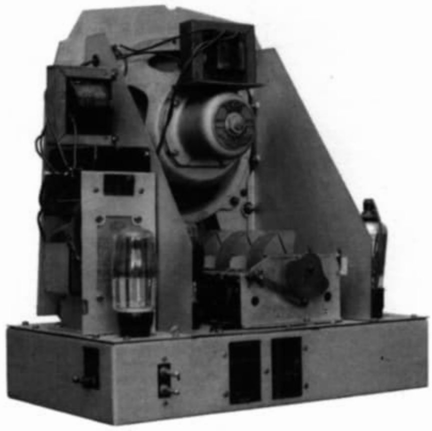
CARRIER LEVEL




Simon Equipment





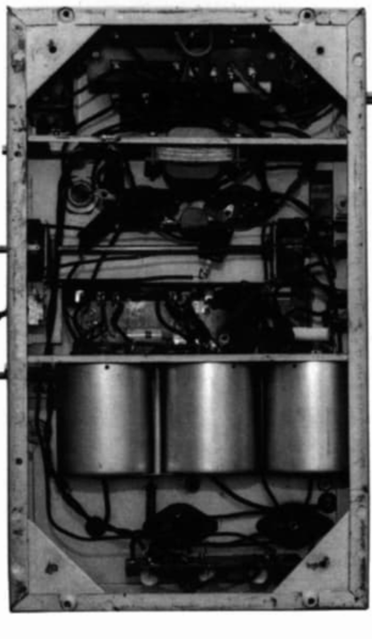
The Ecko RS3 All Electric Consolette By LL Williams

When it was launched on August 17th 1931 it probably incorporated more important technical innovations than any other new design and it was built like a battleship.

1931 is right in the middle of an era of very rapid evolution in radio technology. Over a period of two or three years sets purpose–designed for operation from the public electricity supply using the new indirectly heated valves became common (most of the earliest mains sets were really battery sets with a mains adaptor hence the name 'All Electric' to distinguish early true mains sets). In this same period, one of the earliest plastics, Bakelite (Philips called their formulation 'Philite') began to be used for cabinets. Loud speakers evolved from balanced armature cone speakers to mains energised moving coil units with much improved reproduction and the loudspeaker was incorporated into the cabinet instead of being a seperate external unit. The TRF set was reaching the practical limits of its development and with the appearance of the RS3 tuning scales with station names arrived.

I will begin my description from the outside. I am aware that some collectors consider cabinets to be an art form. As an engineer I see the function of the cabinet as being to keep out fingers and to conceal the works. If it can do this without any nooks and crannies which are hard to dust I rate it a success. If aesthetic considerations have impaired its primary functions, I do not; consequently I have never previously made mention of the cabinet of any radio. In the case of the RS3 (no pun intended) I have to make an exceotion. If Art Deco brown bakelite turns you on this is probably as good as it gets. Instantly recognisable is the large circular tuning scale with station names running right round the outside of the loudspeaker aperture and framed by the very distinctive oxidised copper grille (a superhet receiver, SH25 appeared a year later and used the same cabinet moulding. It is often confused with the RS3).

This cabinet, designed by JK White, is like no other moulded case I have ever seen. Built into the sides of the cabinet are two lifting handles; but why would you need lifting handles for a small table radio? Place your hands into the lifting handles and you get a surprise – the handholds penetrate all the waythrough into the inside and you just can't believe the the thickness of this case. Now try lifting. It weighs 45 lbs. Now you know why it needs lifting handles. With the chassis removed, the interior of the cabinet is more like an artefact designed as an iron casting rather than a bakelite moulding. The walls are unusually thick and substantial bosses just as in iron castings are fitted with large brass inserts to take fixing screws. The silver



plaque on the front of the cabinet records the set's presentation as a retirement gift in July 1932. In the present era when the natural degradation of phenol formaldehyde resins has brought some bakelite cabinets to their best–before date, it may be that the last surviving intact bakelite radios will be RS3s and SH25s due to the sheer bulk of material in their structure. I would however advise treating any old bakelite as potentially brittle.

The chassis construction is no less robust than the cabinet. A rectangular main frame made from heavy gauge sheet steel channel section with gusset plates in the lower corners for added strength carries four sub–chassis also in heavy gauge steel. These sub–assemblies are the HF amplifiers, the detector and output stage, the power supply and the speaker and output transformer. These last are fully supported off the main frame, not mounted on the cabinet. The whole set can be removed fully assembled without disconnecting any leads. The rubber feet are mounted on the gusset plates so that when the set is on a table the cabinet is mounted on the chassis, not as is usual, the chassis mounted on the cabinet. The cabinet thus supports only its own not inconsiderable weight and not as is usual chassis, transformers and speaker.

The 3–gang tuning capacitor like much of this set is as no other. It is huge. Occupying near one third of the chassis surface, it has no rotational stops so that it rotates continuously and has a large cam on the back end of the shaft and a chain drive sprocket at the front end. All this mechanical engineering forms a mechanism I have not seen on any other set, except the SH25. The chain drive couples the capacitor shaft which projects through the centre of the speaker so that as the capacitor is rotated the cursor travels round the ivorine scale with station names which run all round the outside of the speaker. The lower 180 degrees of the scale covers long waves and the upper 180 degrees medium waves. The cam on the rear end is synchronised to operate a very robust switch bank so that when the cursor is on the upper scale, medium wave is selected and long wave when it is on the lower scale. At the transition point between bands on both sides, gram is selected. The capacitor shaft is driven from the tuning knob via a cord drive with a large reduction ratio. I feel that this designer must have contemplated a gear drive, but really good anti–backlash precision gear drives like the Eddystone 898 beloved of us old amateurs are very expensive. As you may guess, I feel an affinity for this designer and suspect that like myself he may have had an engineering education before graduating as an electrical engineer (electrical engineering light current was as close as you could get to electronics). The vintage motorists among you will understand if I ask "is this the first overhead cam radio?"

The Ekco's service manual says that the sub–assemblies are riveted to the main frame and that to remove them for service you should support the main frame so that it cannot move, and cut the rivets using a 3/4 inch cold chisel and a 1lb hammer, having first removed the valves (I'm not joking, that is what the manual says). The manual also suggests that after service the rivets be replaced with 4BA nuts and bolts. My set which was produced in 1932 has nuts and bolts but shows no evidence of rivet cutting, so I guess rivets were abandoned following requests from the service trade.

The circuitry is no less impressive than the mechanical structure. It is a four valve plus rectifier TRF circuit with two HF stages. Three identical single–tuned HF transformers are used; aerial, first HF and second HF. These coils are housed in aluminium screening cans and are less impressive than Philips Superinductance units but still of good design. What they lack in size and ultra low loss construction is more than made up for by circuit design. The three single tuned circuits buffered by a HF amplifier between each one so that they do not interact, could be expected to have an adjacent channel rejection around 40dB better than a single circuit, good but not ideal. What the circuit designer has done is to apply positive feedback over two stages, greatly boosting both gain and selectivity on the medium waveband, easily equalling what unaided Super Inductance coils could do. On long waves where selectivity is adequate and any narrowing could cause side band cutting the feedback is removed. This feedback is factory preset to optimum.

A problem with all receivers pre AVC is the need to have a maximum gain sufficient for a very weak signal and then to be able to reduce it sufficiently to handle a very strong signal. With the increasing power of transmitters and the increasing sensitivity of receivers by 1931 this could be 10 micro–volts to 1 volt at the aerial making a gain adjustment of 100,000 to 1 desirable. The gain control had to be at HF or strong signals could block the receiver; consequently, volume controls varied the gain of the HF stages. A vari mu pentode or screened grid could manage a 100 to 1 gain reduction by grid bias variation making 10,000 to 1 possible with two stages, but it comes at a price. When the signal is very strong the valve gain must be minimum but when this is done the valve transfer function is not very linear and therefore unable to handle a large signal without gross distortion probably going as far as rectification. Also since this is the volume control, a strong signal cannot be reduced to give very low sound. The RS3 has a very neat solution to the problem. A simple wire–wound potentiometer is connected from the common cathode circuit of the two HF amplifiers to the aerial terminal, with the slider connected to the chassis. When the volume control is fully clockwise the resistance in the cathode circuit is zero (maximum gain) and the aerial is shunted by the full value of the potentiometer (5000 Ohms) which produces a negligible effect. As the volume control is turned anti–clockwise the bias on the HF amplifiers is raised but at the same time the grid signal is reduced by shunting the aerial to earth so that as maximum bias is approached only a very small amplitude signal is being handled resulting in negligible distortion and with the control fully anti–clockwise, volume is reduced to zero. There is a useful gain reduction of well in excess of 100,000 to 1 for a rotation of

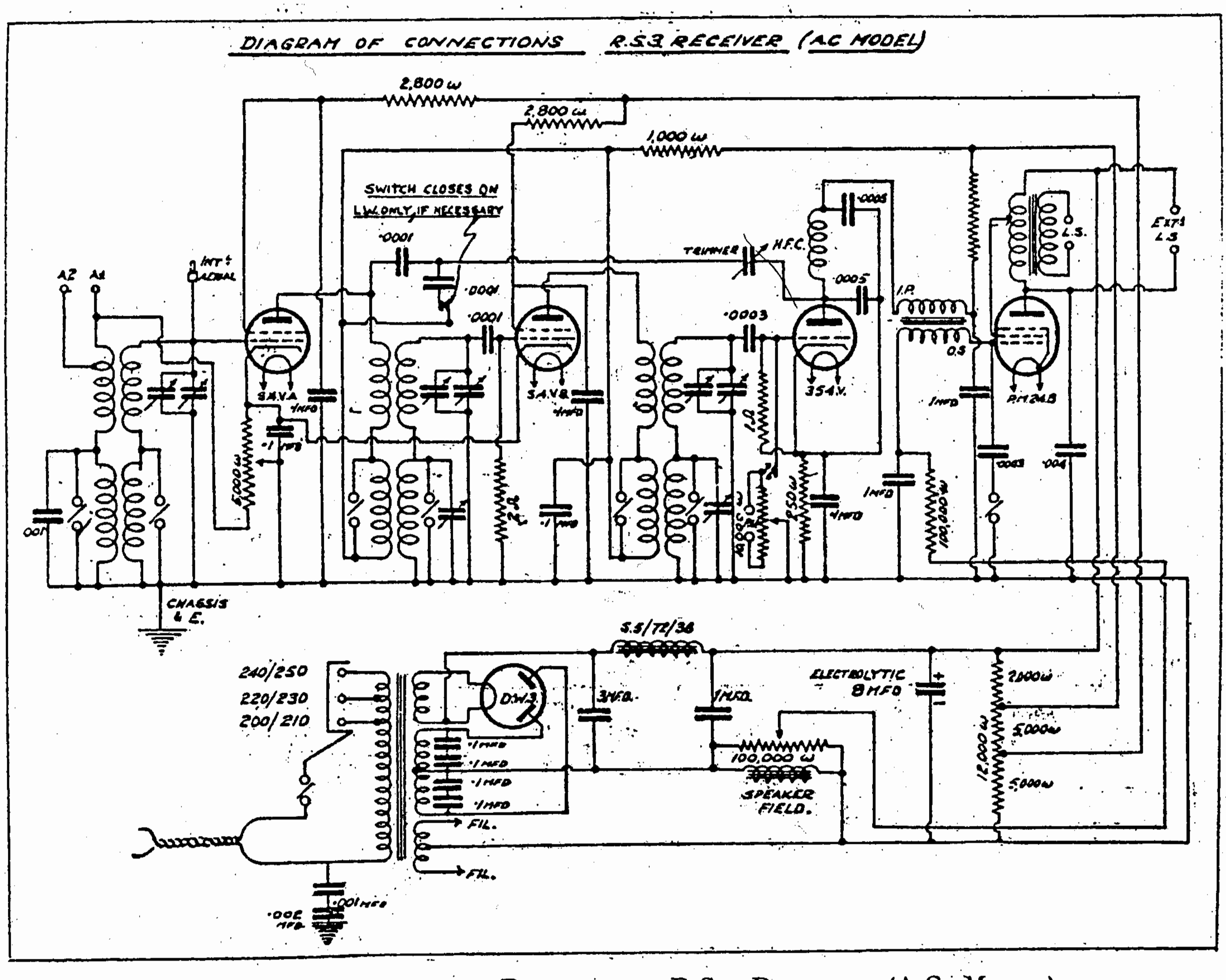
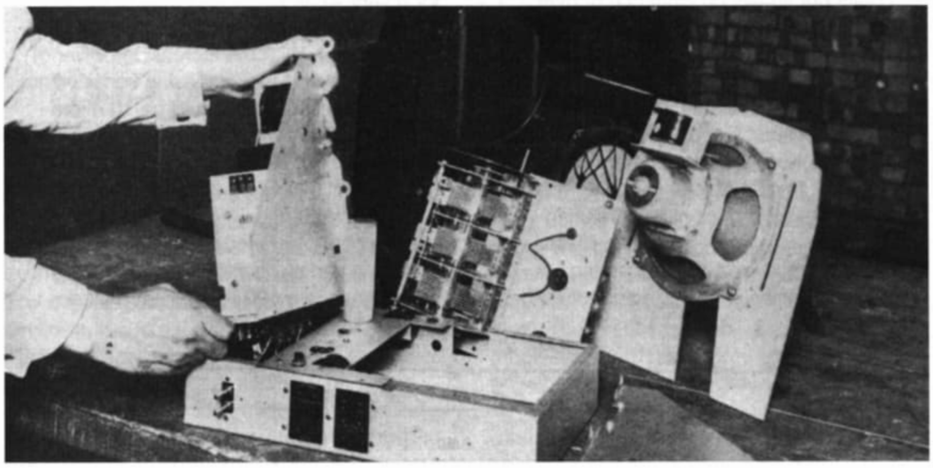


Fig. 14A.—THEORETICAL DIAGRAM OF R.S.3 RECEIVER (A.C. MODEL).



Don't try this at home folks! How to dismantle an Ekco RS3 according to the manufacturer



270 degrees which is just what is needed but it can take you by surprise. A few degrees of rotation can take a signal from very loud to very quiet, and if you have been listening to a very strong signal and then re–tune, the whole band apears completely dead; turn the knob about 90 degrees and the medium waveband is packed with signals, some very loud, but at least you can adjust the volume to your liking, be the signal weak or very strong.

The combination of variable gain with aerial attenuators returned about thirty years ago in very high performance communications receivers. The attenuator is now electronic and is controlled by the AGC circuit. The control circuit optimises the ratio of attenuation to gain reduction dependent upon the type of signal and band conditions, eg a very strong adjacent channel signal. Such a system can handle signals from less than 100 nano–volts to 10 volts with very low intermodulation distortion. It is an example of the many times the latest technology has its roots in the design of early sets.

While on the subject of the volume controls, I have a restoration tip to hand on. My RS3 as purchased, had only one failed part – the volume control. Unfortunately like much of the RS3 it is rather special. The HF gain control is integral with a second potentiometer, about which more later. Neither has a slider connection because the sliders are not insulated from the spindle which is common to both, so if you look for a lead to chassis you won't find it. A modern 2–gang linear potentiometer could not be substituted without rearranging some chassis work. I had a fair stock of ex–WW2 Colvern wire wound potentiometers. These come in different case sizes depending upon Wattage. If you prise off the tufnol disc from the back and remove the circlip from the shaft you can remove the shaft and slider. Then by removing the screws which pass through the resistor element and form the terminals you can remove the element which is wound on a mica strip. If you choose the right Wattage it will be close in size to the original. It does not matter if it is slightly wider or narrower, the compliance of the slider will accomodate this. If it is a little too long or too short you may either shorten it and re–make the end connection (5 or 10% reduction in value will not be noticeable) or you can extend either or both ends with thin brass strip for the slider to run on to. You will then have a few degrees of rotation at the ends where there is no change. Most wire wound potetiometers do this in any case. I have been able to restore non–standard wire wound units on three different early sets in this way.

Continuing our journey from aerial to speaker, the detector is a straightforward grid leak type but when gram is selected, it is biased for linear amplification. The second potentiometer I mentioned earlier is now the volume control. This is volume control at audio frequency as we see it in post AVC receivers. You will have noticed that I have used both AVC and AGC. AVC was normal usage in the UK until the end of WW2, after which AGC gradually took over. AGC is a more accurate description of the circuit function since it is gain which is controlled, the volume of sound produced being determined manually at audio frequency independently of the AGC circuit. The detector/gram input stage is transformer–coupled to the output stage. Take a careful look at the circuit; the output valve screen grid is connected to a tap on the output transformer primary. It is an Ultra Linear output stage but Ultra Linear is circa 1960; well here it is thirty years early. The screen tap is about 25% and I'll bet that is near optimum for a PM24B.

I ran my RS3 against a Philips 730A Superinductance which is a good contemporary set at the same price. Both sets were on top line for performance having been carefully checked over, serviced as required and fitted with good valves. On sensitivity and selectivity very little difference could be detected, but the RS3 did it with one valve less. In every other department the RS3 was an easy winner. The seven inch moving coil in that massive case produces very good bass for a 1931 set.

My collection is to illustrate the evolution of receiver technology from the earliest I can find or afford until the mid 1930's. It has space for only fourteen sets. All are supplied with suitable aerials and power and are operable in situ. There is only one slot for the final phase of the TRF set. I sold the Philips and installed the Ekco. The fourteen sets change if I find a better specimen to illustrate the best that could be done at a given point in time or a more interesting design. The RS3 with the first dial with station names, combined HF gain and aerial attenuator, two knob control and an Ultra Linear output stage plus some fascinating mechanics has been in its niche for twenty five years.

Some readers may think I like Ekco but not Philips. I like technology – it is what I collect. For the record my collection contains only one Ekco and only one Philips. Remember all fourteen of thirteen different makes I rate best in class. Perhaps I will write about the Philips one day if I'm spared.

Figure 1

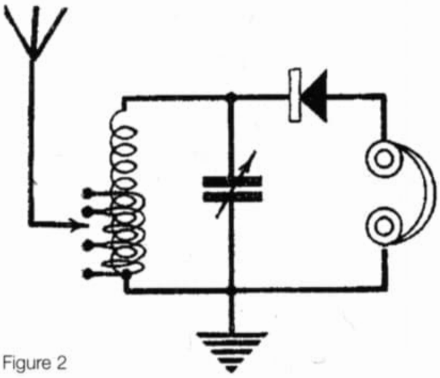


Figure 2

Using up all that old junk - the birth of the Songbird Programme

By Jim Duckworth

For some time I had been subject to the familiar domestic grumbles about the space taken up by miscellaneous Radio Components ('All that old junk'), as well as the Sets themselves ('are you selling off the big ones at last'?) and had so far managed to get away with no more than polite attention! However, an unexpected major illness and subsequent operation forced me to take stock of everything including my component mountain and recognise some validity in the comments. After all, I was now in my mid sixties and what exactly was I going to do with them? Unless I got a move on, they would probably end up in a skip one day! So I decided now was the time to act and return to what had been a major passion since school days – designing, experimenting with and building my own radios, rather than restoring somebody else's design then sticking it on a shelf! I had a couple of direction pointers to guide me. ...The recent BVWS publication of the Crystal Set volumes had rekindled my interest in the components of the late 1920's – I had a box full of them in the garage including several tuning condensers complete with the very evocative calibrated Bakelite dials. The second pointer related to a circuit design issue – I had recently been mulling over the fundamental difference between valve and semi-conductor circuits as exemplified by the classic post war 4 valve portable set as opposed to its 6 transistor counterpart. In the former and despite the fact that the Gm of the 1R5 Frequency changer and 1T4 IF amplifier were both less than one, the gain at radio frequencies was sufficient to give a very good overall performance (90v sets!), due of course to the high valve impedances allowing very high anode loads (the 'untapped' dynamic impedance of the IF transformers) and also that the entire input signal from the frame aerial was being 'worked on' – straight into the grid with no taps. This is in contrast to the Transistor circuit where for optimal signal transfer, the very low input impedance of the first device has to be matched to the high dynamic impedance of the first tuned circuit (Frame aerial or Ferrite rod), by tapping into the coil, thereby chopping the dynamic impedance, 'Q' and received input signal in half (best case!). Then dividing it down by a factor of 7-10 as part of the power matching process. If you want a useful signal voltage out of all of this, it has to be multiplied up again and the same matching/halving of dynamic impedances with its associated signal reduction goes on throughout the entire circuit, meaning that in spite of the transistor's colossal Gm, (proportional to Collector current and approx 40 Ma/v at 1 Ma), an extra IF stage is needed in the standard superhet portable.

So I had decided it was time I started to make use of my substantial stock of FETs garnered from 30 years labour in the Semiconductor Industry, along with other desirable new/old items to see if I could emulate the best characteristics of valve high impedance/ low Gm systems, combined with (high Gm) Bipolar transistors where it added to the gain without initially reducing signal levels, in relatively simple solid-state circuits using a single tuned circuit. The aim being to produce a working radio, which would probably be a portable, like 90% of my Radio Collection. All of this would need a development programme starting right back at the simplest beginnings so it got underway with the building of a breadboard.

The Development Programme

The breadboard –see fig (1) was simply and swiftly constructed from offcuts of plywood and softwood, glued and screwed together. I didn't want to get involved with serious metal bashing but intended to use a piece of printed circuit board – copper side up as an earth Bus bar and to implement the 'ugly bug' style of layout and construction which is difficult to beat for speed and excellence of RF grounding.

I had in mind to start with a basic crystal set to fully reacquaint myself with the difficulties of pulling in any signal at all and work up from there. So the first selection of components was made. I had half a dozen or so 1920's type gang condensers, some of them with nice Bakelite dials so I set about 'characterising' them for min/max capacitance using a 20 year old digital test meter which has a manual capacity balance pot making it more flexible than modern 'auto balance' instruments. I initially chose an Ormond capacitor with a capacity swing of 430pf, then switched to one from Pye having a 300pf capacity swing, and a superior 15:1 slow motion drive coming from a gear box mounted at the rear.

I wound a MW tuning coil with around 100 turns of 26 SWG enamelled copper with a selection of tapping points for the aerial and detector, on a ribbed former which also came out of my 1920's spares box. I decided to use a germanium diode as the detector in the first instance and replace this with a homemade crystal detector as things progressed.

For the aerial I erected about 30-35 feet of wire, out of the workshop door and over a pergola etc in the garden. I suspected this was not going to be nearly enough, recalling my efforts in the early 1950's when I shinned up a tall tree the other side of a 100ft lawn, but in this instance it had nowhere else to go unless I erected a special pole or something down the garden, which I didn't feel up to doing.

For the earth connection I sweated some stout flex to a copper pipe offcut and drove this into the (prewatered!) ground with a small coal hammer, just outside the workshop door.

I searched in my earphone inventory, riffling amongst 3 or 4 pairs, choosing a 1940's lightweight American headset called the 'Alnico Magnetic' by CF Cannon Co of Springwater, New York, which were 2000 ohms per earpiece. Buying vintage earphones is very much a 'Caveat Emptor' process, (especially on Ebay), as a high proportion of them are open circuit as I have found to my cost. It's best to buy them live, take along a test meter with you and insist on 'ringing them out', unless your hobby is rewinding bobbins with SWG's up in the late 40's!

First results

The crystal set circuit is shown in fig (2), so I hooked everything up and put on the earphones expectantly. The silence was almost total but not quite. There was a faint 'chirping noise', which I identified as Radio 5 on 693 KHz, coming from the Postwick 10kw Radio Transmitter in North Norfolk, which is by far the strongest signal in our area but actually unintelligible, and unfortunately that was it. I was however able to glean some information from the experiment regarding aerial matching and selectivity. Initially, with the aerial coming in at the top of the coil for max signal, Radio 5 spread over 40 – 120 on the dial. By tapping in at around 35% of the windings, it spread only from 125 – 140 on the dial with little apparent signal loss. (though hard to tell when you can hardly hear it anyway!). That was better than I expected, especially seeing that the tuned circuit was fully loaded by the Germanium diode which was one of unknown manufacture. I purchased a box of 100 from 'Greenweld' when they were a genuine surplus electronic component business in Southampton. However, the selectivity was actually irrelevant seeing there were no other stations to be had with my 35 ft aerial so I decided to abandon the pure crystal set route and add some amplification. Before doing so

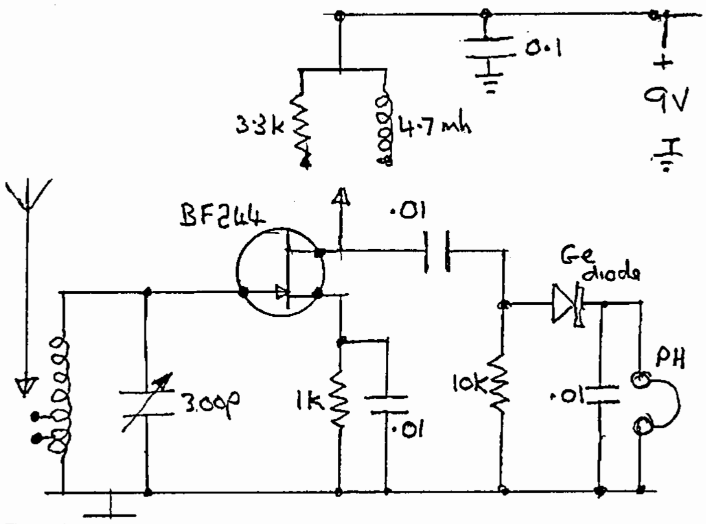


Figure 3

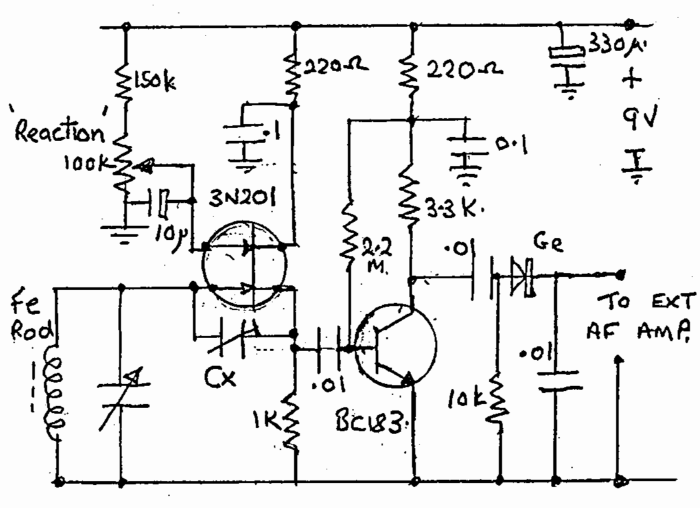


Figure 4

however, just two points for anyone interested in crystal set construction. Firstly, the basic workings of a crystal set are described in detail in an excellent article by Bill Williams in the last Winter BVWS volume. Secondly, if you want to go in deeper and build an advanced set there is a vast amount of information out there in books and on the web, but an article by a Mr P.A.Dewhurst from the Radio Constructor archive – 'A selective and sensitive Crystal Set', touched the spot for me and is quite nostalgic, having been written in the 1950's when there was a Home, Light and Third Programme on the medium wave. This describes a bandpass tuned arrangement giving a good performance along with useful experimental data.

Using a FET in place of valves
Radio constructors books and magazines of the late 1920's/early 30's abound with amplified Crystal arrangements. Some used a fully tuned RF amplifier with a two-gang condenser and screened grid valve for stability. Others used a triode with only the input tuned and a resistor or RF choke in the anode circuit feeding a crystal detector. I decided on this latter course to begin with using a Texas BF244 junction FET as I had a large bag of them in stock and could afford any number of experiments without bothering if I blew a few up. A junction FET has very similar characteristics to a triode valve – very high input impedance at MW frequencies of at least a megohm and a Gm normally in the range of 1-3 Ma/v. It has of course the benefit of safe, low voltage 'table top' construction offset by the fact that only very low gain can be achieved using a standard 9volt battery, (25v is the limit) with a resistive load, as you soon run out of HT compared with (say) 200v with a mains triode, which would allow a gain 20X higher for the same load! Figures 3-7 show the progress of my experiments.

Fig (3) – A basic FET Rf amplifier
The BF244 was first used as a very basic RF amplifier with resistive load of 3.3k ohm – about as high as I could go without losing all my 9v HT as I had set the drain current to around 1.5 Ma using a 1k source ('cathode') bias resistor. The best possible gain from such a simple arrangement is basically the Gm X the total effective load. i.e. the 3.3k resistor in parallel with anything going before and after it. Meaning the FET's ac output resistance which is very much higher than 3.3k and can be ignored, and the germanium diode circuit with phones etc, which, at around 5-6k ohm would reduce our 3.3k to around 2k ohm. How about the Gm? The quoted data sheet value for the BF244 is 3 Ma/v minimum but you have to be careful in interpreting this. It is measured with zero volts between gate and source when the drain current flowing might be as high as 6 Ma. In our case with the source ('cathode') bias resistor giving 1.5 Ma the Gm would be 2 at best so our gain a modest 4x. How did it perform? Well, I now received 2 stations during the day instead of one, but loud and clear allowing comfortable listening, and a few more stations from the Continent at night, which put no great strain on the selectivity which was much greater now with the tuned circuit going into the FET gate. The next step was to put a 4.7mH RF choke in place of the 3.3k drain load resistor to allow a higher dynamic load impedance for more gain, but our BF244 is a triode device with a relatively high drain (anode) to gate (grid) internal feedback capacitor that will give rise to instability unless suitably damped. This was achieved by the same detector arrangement as before which was more than required for stability, but still allowed us to double the effective load impedance, hence gain and resulted in a couple more stations during the day and a few more at night. However an earth was still necessary to get anything at all and we were a very long way short of the gain necessary to get rid of the earth and replace the ribbed tuning coil with a frame or ferrite rod aerial. So I decided to go up a gear and increase the gain as much as possible before adding reaction, whilst allowing for easy reaction control and even higher input impedance.

Fig (4) – Using a dual gate mosfet + high gain bipolar transistor combination
I had a smaller but very useful stock of dual gate mosfets from the Texas 3N200 family, so replaced the BF244 with a 3N201 used as a source (cathode) follower. This gives the highest possible input impedance: as the drain (anode) is grounded to ac there can be no feedback from output to input via the drain to gate capacitor, which would modify/lower the input impedance. It also has a low output impedance of a couple of hundred ohms. This mode is described as having a large power gain so what does this mean in practice? Well, the source output voltage is a little bit smaller than the gate input so there can be no voltage gain. But it appears across a low resistance with a signal current flowing in it, i.e the signal voltage on the gate modulates the conductivity of the source/drain channel allowing a significant signal current to flow in it, where there is virtually none going into the gate itself, in the same way as no current (normally!) goes into the grid of a valve. We are seeing the equivalent FET mutual conductance (Gm) in action which for this class of device is much higher than junction FETs such as the BF244 . The 3N201 has a minimum Gm of 8 Ma/v but with the same caveat as for the BF244 – it is measured with zero gate 1 to source voltage. The second gate on the 3N201 is similar in action to the screen grid of a Tetrode or Pentode valve allowing the drain current and hence Gm to be controlled, making it a useful RF gain/AGC /reaction control point. It can also be used as a local oscillator injection point in a superhet for multiplicative mixing as with multigrid frequency changer valves. All in all we have a superior class of solid-state device, which resembles a remote cut off screen grid valve in operation with a very low drain to gate 1 feedback capacitor of around .03 pf. It came out too late (around 1970) however to be part of the early Transistor Radio revolution. Indeed its very high initial cost confined it to Professional/Military markets. Since then it has become commonplace in VHF Fm tuners and UHF Television front ends. Back to our Fig 4. The 3N201 is used as a high impedance RF buffer and in effect, current amplifier and the low impedance output at the source is the ideal point to feed the BC183 transistor for good matching and signal transfer. This 150 MHz general-purpose NPN transistor was chosen because I have a large stock of it and its PNP counterpart! – but it is ideal for the job. In the common emitter mode it gives a high current gain of around 300X and high voltage gain from the 3.3k resistor Collector load (2k effective due to damping). This pair of devices is a very powerful RF amplifier combination and it gets better! The Miller effect input capacitance of the BC183 with its resistive load, allied to the 3N201 Gate-Source capacitance means there is a Colpitts oscillator waiting to happen. The Gate - Source capacity only needs supplementing by presetting a few Pf (Cx = 1-10pf in Fig 4, to allow reaction to be brought on and off by varying the device gain with the Gate 2 100k variable pot. The performance of this

combination was very good indeed, receiving most of the stations you can normally get with a superhet receiver, Cx set to bring on reaction from the middle towards the high frequency end of the medium waveband at which setting the variable pot hardly needed touching. At this point I found I could get rid of the earth connection with a small loss of volume and also decided to replace the fixed aerial coil/35 ft aerial combination with a ferrite rod aerial. I had been squirreling ferrite rods away for years, buying them from stalls at Harpenden, the Radiophile Cowbit meetings and of course the old NEC, and had about a dozen to choose from. They are a tremendous bargain for around £1-1.50 complete with LW as well as MW coils and generally suiting a 200-300 pf tuning capacitor. Now the Pye tuning capacitor max was 310 pf so what inductance was actually required to tune 550 kHz? In the library section of my warehouse I found the Wireless World book of 'Radio Data Charts' – a very clean 1940's copy bought at a Harpenden swap-meet. Using the medium wave Abac for inductance, capacity and frequency, and putting a ruler across the two 'knowns', I speedily determined that around 260 microhenries was required. Using my Maplin test meter with inductance ranges showed this was well within the sliding adjustment range of the coil on the rod. The same procedure was carried out satisfactorily for the long wave.

I now had a portable radio setup giving good results but with an inevitable loss of volume due to replacing the aerial with a ferrite rod thus forcing me to connect the detector output to a little Bench amplifier – it was high time I introduced some AF amplification anyway and switched from headphones to loudspeaker operation.
At this point in the development programme I also decided it was time to change over to a high impedance FET detector which would allow me to experiment with higher dynamic loads for the BC183 without significant damping, hence squeezing the maximum amount of gain out of this (still!) simple system which I now intended to be a full Long, Medium and Short wave portable.

Fig 5 - Adding a high impedance FET detector, Long Waves and Low end lift (LEL) circuit

A BF244 FET was brought back for the high impedance detector. The 15k source resistor allowed around 170 micro amps of source/drain current to flow for bottom bend operation, in turn allowing a high value of drain load resistor, also 15k, across which the audio output was developed. The source resistor has of course to be decoupled at audio frequencies and we need very good RF filtering on the output, which also needs to be screened along with the BC183 and its output circuitry. I used a 20k log pot with double pole switch for the volume control, obtaining some half a dozen on special offer from John Birkett's stall at the one off Motor Cycle museum NVCF in 2005. The output from this fed the Bench AF amplifier as before. This FET detector effected a dramatic improvement in performance over its germanium diode predecessor, raising the output volume substantially and imposing no significant loading on the BC183. The only snag so far with the whole circuit was the effect of overloading by Radio 5 on 693 kHz. It tended to cross modulate other stations on either side and could only really be eliminated by turning the ferrite rod to a nulling position for Radio 5.
At this stage I decided to bring the long wave on board having the coil already on the ferrite rod and to assist in this, installed a basic 4-pole 3-way switch on the front panel. I had high expectations of the performance because at LW frequencies, the BC183 current gain should still hold up most of its low frequency value – the 3db turnover point for this '150MHz' device (qv), being somewhere in the middle of the medium wave band . I was not disappointed and as well as Radio 4 being received at colossal volume on 198khz, I had 3 French stations and RTE1 all at good entertainment signal to noise ratio and volume. The MW setting for reaction trimmer Cx brought reaction on only at the very high frequency end of the Long waveband where there were no stations anyway. However reaction was not really necessary on the Long wave and the bandwidth was already narrow enough so the 3N201 variable pot was used mostly as an RF gain control to wind back Radio 4 to prevent overloading. Ideally different collector loads/values of Cx would be switched in for each band but I found that there was no possibility of doing this with simple switching as bringing leads from the BC183 output close to the 3N201 input caused dramatic degeneration/ signal cancelling due to the fact that they are 180 degrees out of phase. There is of course no howling or squealing to warn you of this loss of both sensitivity and selectivity. It regrettably wasted a lot of development time before I cottoned on to what was happening, though it should have been immediately obvious. In addition, a mysterious loss of sensitivity at the low frequency end of the MW band, was traced to the newly commissioned LW coil absorbing energy from the latter, so I used another switch pole to short it out during MW operation.
I next set about optimising a higher impedance load for the BC183 collector, which would suit both Medium and Long waves. The main purpose was to give a lift to the low frequency end of the Medium waveband where the aerial tuned circuit dynamic impedance is lowest and it is quite difficult to receive stations such as BBC World service on 648kHz and especially Brussels on 622 (whose music I enjoy on Saturdays!), at a good signal to noise ratio – most superhets struggle with this too. The optimum value of RF Choke turned out to be 1.5 mh paralleled with a 6.8k resistor for maximum gain with stability, increasing the sensitivity significantly between 550 and 750kHz. The choice of damping resistor affects the BC183 input capacitance and hence reaction setting of Cx. A smaller value of resistor gives heavier damping, meaning less Cx is needed for a given degree of reaction. This means that the low end lift (LEL) circuit can be balanced with a Cx setting to give a relatively high and even performance across the band requiring little or no use of the reaction control except at extreme band ends. I used damping resistance values varying between 2.2k (best ease of use) and 6.8k (hottest performance). The effect on Long wave was to give even more punch to existing stations and bring in more distant/lower power ones such as Deutschlandfunk on 153 kHz also the Danish station DRI on 243 kHz.

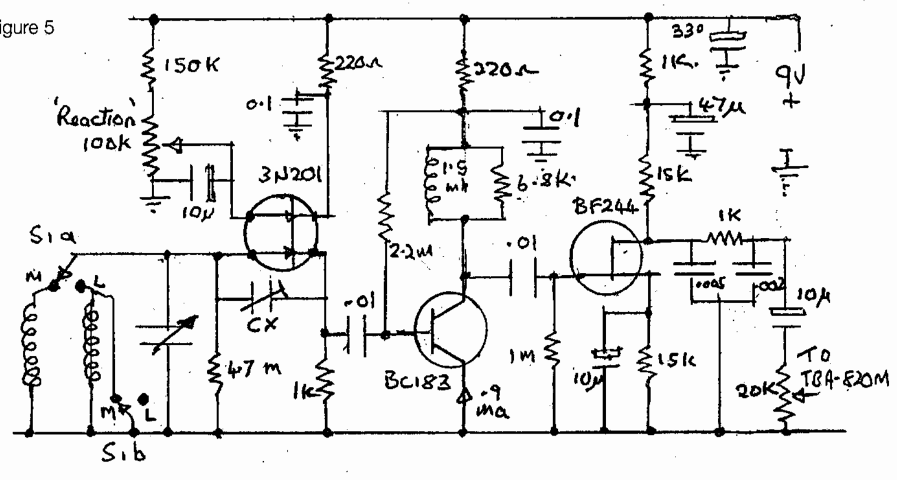
AF output stage considerations

So now I had a long and medium wave portable receiver on the breadboard consisting of 2 FETs and one bipolar device and giving a superhet type of performance from one single solenoid coil per waveband, but needing its own AF amplifier before I turned my attention to adding the Short waves to the design. I toyed with the idea of a retro class A stage with driver, having an output transformer from an early Telefunken 'Partner' portable in stock, but decided I didn't want to throw away the milliamps needlessly in a portable design. So I used the very handy TBA 820M 8 pin IC, which I had already put to use elsewhere in the last two years. This draws a modest 4-5 milliamps in quiescent state but is capable of 1 watt output and the gain and frequency response is configurable.
I had a full data sheet and application report on it to help me do so and built it up as a separate item on a small piece of matrix board thus completing the basic receiver design.

Adding Short waves

I am a lifelong enthusiast of the short wave broadcast bands which is probably why a large part of my own radio collection consists of Zenith Transoceanics, so I was determined to make my receiver a full LMS set! My first considerations were as follows. I had only one waveband position to dedicate to the short waves so wished to make the most of it by covering all the bands from 49metres down to 16 metres. i.e. around 5.8 – 18 MHz. This is a frequency ratio of just over 3:1. Now arising from the basic resonant frequency formula our tuning capacitor min to max swing must be equal to (at least) the above frequency ratio squared, which is a factor of approx 10. Our Pye minimum capacity plus strays amounted

Figure 5



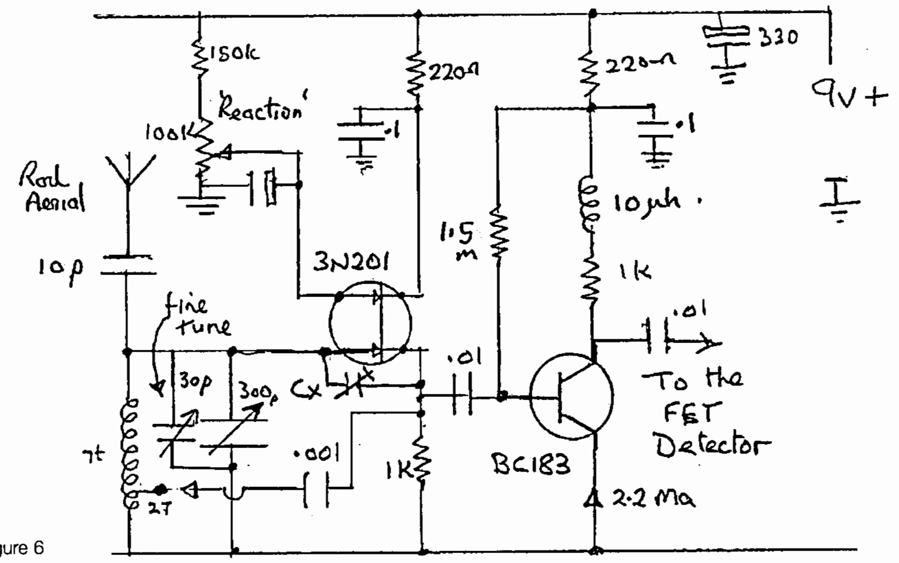


Figure 6

to around 30pf so the gang max capacity of 310pf looked as if it might just be OK for frequency coverage but not for satisfactory tuning as the rate is far too high. Even with the 15:1 vernier reduction system, you would need 'micrometer fingers', to tune in anything at the high frequency /16m end of the band - a phrase which was supposedly coined by the renowned Commander McDonald of Zenith Radio who instructed his engineers to drop continuous coverage SW designs and go over to a bandspread system for portables, hence the birth of the Zenith Transoceanic dynasty. Without this, a short wave tuning capacitor seldom exceeds 100pf or so. Anyway, I did want this frequency coverage so was stuck with the 310pf Pye and decided a fine-tuning control would have to be added in parallel to help alleviate the problem.

The next issue arising from this folly was that a 3:1 frequency range will give a 3:1 variation in tuned circuit dynamic impedance (assuming reasonably constant Q across the band), meaning it will be particularly low at the 6 MHz/49m end where the capacitor value is very large versus the small inductance and hence difficult to get reaction working. If you do get it working there, it will be incredibly fierce and difficult to manage at the high frequency end. In spite of all these objections I decided to go ahead with the coil design.

It was a simple enough matter to manipulate the resonant frequency formula with a pocket calculator as the 310pf gang put this calculation out of the range of the short wave abac in my book of charts. The sum in this case was, given 310 pf tuning ,5.85 MHz. What is the inductance. Answer, 2.4 micro henries. After a bit of cutting and trying out on the Maplin multimeter, I found that 7 turns of 26 SWG enamelled wire close wound on a 1" kitchen towel cardboard former did the trick. I had decided to go for a Hartley oscillator system rather than tinkering with the preset Colpitts oscillator, which was working very well for medium and long waves but I suspected could not easily be made to work over this large tuning range. Hartley oscillators were a very popular choice for shortwave sets in the valve era, using a cathode tap at the earth end of the coil and a potentiometer to vary the valve gain via the screen grid voltage, providing very effective reaction. My circuit was identical, substituting source for cathode and gate 2 for screen grid. So I wound on two extra turns from the earth end of the coil in the same direction as the main winding. Fig 6 shows the circuit I finally came up with.

Fig 6 – Circuit diagram, Short waves only
This diagram shows the configuration for SW only, omitting the detector circuit, which is identical to Fig 5. An extra switch pole was brought into play for the coil tap, fed from the source on the 3N201. This is of course the output feeding the BC183 so to minimize shunting of the output signal I used a .001 mfd oscillator feed versus the .01 for the main output. The big question now arising was could I get any gain out of the BC183 at frequencies between 6 -18 mhz?. My first thoughts were that I might be lucky to simply get the output signal from the 3N201 source converted from a current to a voltage at the BC183 collector with no further enhancement, but in fact I was able to do better than that. I had two stratagems to try out. Firstly to use a high-end lift circuit (HEL circuit!), in the BC183 collector – replacing the LEL circuit for the time being, then to optimise the transistor Ft, or gain bandwidth product which is collector current dependant. Wideband amplifier design is a highly specialised area, very mathematical and mostly the province these days of device designers who clearly need to get things right before blowing them into silicon. The simplest approach for my more modest requirements was to have a series inductor/ resistance combination to lift up the drooping response around the 18mhz region, the idea being that this will form a damped parallel circuit tuned by stray capacitance. Making various assumptions for strays and using the Wireless World abacs once again, I came up with inductance values in the 5-15 microhenries region and purchased a range of those very neat little small 'resistor sized' chokes for experiment starting out with 4.7 microhenries in series with 330 ohms. I fired the circuit up on this basis, was pleased to find I could get the Hartley circuit oscillating and receive stations over the entire band which in fact did just cover the spectrum from 49-16 metres. The optimum BC183 collector load turned out to be 1k ohms in series with 10 microhenries. I had already decided I didn't want an aerial wire trailing around on a portable set so used a 4 ft telescopic rod aerial with a high impedance feed via a 10 pf capacitor direct onto the top of the tuned circuit. Out of curiosity to see if the Colpitts oscillator could work I disconnected the coil tap, hooked up a 0-30 pf trimmer capacitor in parallel with Cx and fired it up once again. It came to life but could only get reaction working between the 25-16 metre bands. The 'difficult' low end would not fire up despite tinkering around with the Colpitts capacity ratios. So I decided to stay with Hartley for short waves and Colpitts

Figure 7

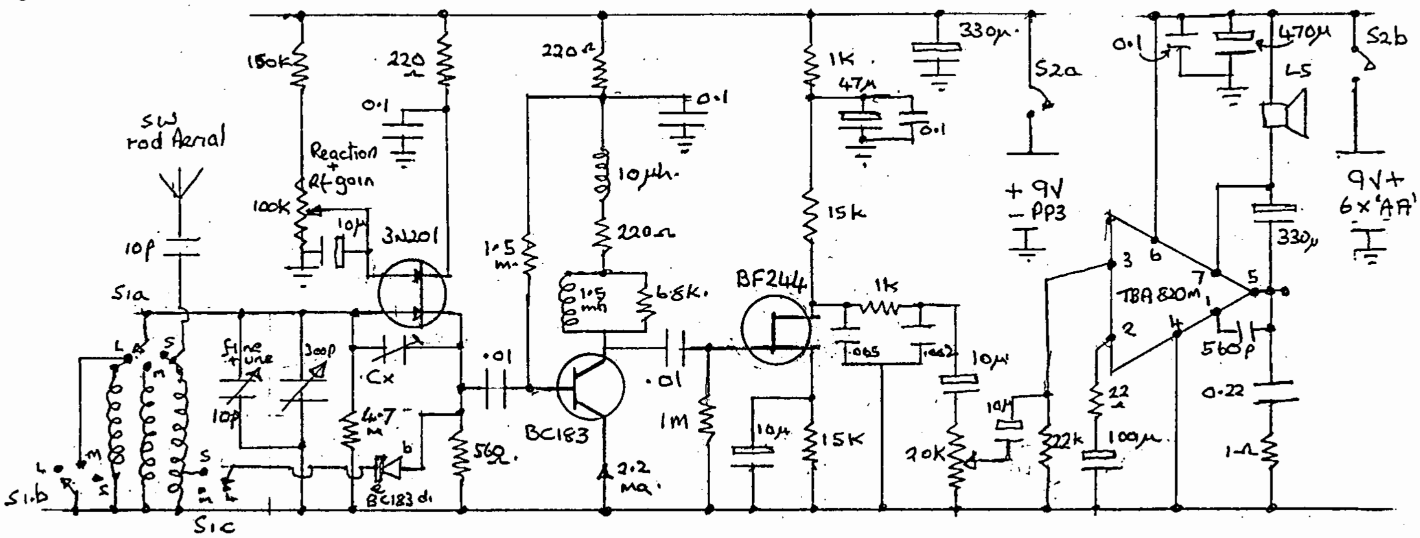


Figure 8

Figure 9

for long and medium waves, especially seeing there was no overhead in the way of coil taps etc with the latter. I then set about Ft (gain/bandwidth) improvement. I have a full set of Texas Instrument data books from the 1970's including comprehensive data on the BC183. There is a very useful plot of Ft versus collector current. It rises steeply through 1 ma where the value is around 90 MHz up to160 MHz at 2 ma and 200 by 3ma. For all the experiments so far, the BC183 collector current had been set at just under 1ma. So I cranked it up to just over 2 ma, the SW performance improved dramatically and I had a very useful set on my hands. After dark I was getting full volume output on the 49-31 metre bands with the volume control only turned up a fraction. Increasing the current from 2 to 3ma brought the noise level up so I left it at 2.2ma. The outstanding problem to resolve now was combining the LEL and HEL filters in the BC183 collector, because as previously mentioned, it was not possible to switch these with the simple 4pole 3 way switch because of signal degeneration when the BC183 output is brought anywhere near the very high impedance 3N201 input. To get round this, a much more complex mechanical design would be needed with separate switch wafers in their own compartments, which would not be justified for a set of this nature. Fig 7 shows the final circuit with all three bands present along with the AF amplifier.

Fig 7 – The final Long, Medium and Short wave circuit diagram

The HEL and LEL filters were combined simply by cascading them, as shown. To work properly, the 10micro henries choke needed to be connected directly to Ac ground (B+), as before, and the 1k series resistor reduced to 220 ohms. The increased collector current increased the MW and LW sensitivity so that Cx value was decreased to the point where it was hardly needed at all and I found that a twisted pair of wires between gate and source would do the job. One unforeseen snag was that the Hartley circuit now struggled to oscillate on the lowest (49m) band. Probably due to the fact that the BC183 input impedance was now lower (reduced by the collector current increase), imposing increased damping on the tuned circuit. The situation was resolved by feeding the coil tap from the source via the base - emitter diode of a BC183 instead of a capacitor. This half wave rectification of the feedback signal had the effect of both kick starting the reaction at the low end and smoothing out the fierceness at the high end, making the 'micrometer fingers' tuning much easier. Amazing, I seemed to have stumbled on a sort of universal aspirin 'fix all' remedy for Hartley type reaction over a wide tuning range! As a belt and braces measure I also increased the 3N201 drain current by reducing the source resistor to 560 ohms. It now varied between 0.5 – 1.8ma over the range of the gate 2 gain control.

The circuit had got to the point where it was definitely good enough to put in a cabinet so I examined my stock of suitable cabinet items.

The Songbird cabinet design

The Pye tuning condenser concentric knobs and dial were a striking feature and to set them off I commissioned a 5"x6" ebonite panel, one of three purchased from the Irish lady who always has a stall at Harpenden and other Radio events. The size was just right to be counterbalanced by a 1920's type loudspeaker grill I had made 20 years ago and never used. I found it originally in a book of fretwork patterns and was immediately taken with the Songbird carolling away on a tree branch. I had just purchased a second hand Hegner electric fret saw at the time and this was my first major project. To get the most output from what was a tricky operation, I had clamped together 2 or 3, 6mm MDF sheets, several sheets of coloured plastic and a couple of very nice ones of beech wood veneer. I laboured over cutting out this sandwich and was now pleased to be able to use one MDF piece for mounting the speaker baffle board and cloth, glued to one of the beech veneers for the outside. I had been buying squares of loudspeaker cloth from Mr Chapman's stall at the NEC for years, so had a large selection to choose from.

Now that I had a composite front panel, it was time to clothe it with a cabinet. I have no special carpentry skills but as an engineer have made up a number of jigs to allow saws, routers and drills to perform perfect right angle cuts etc over a 30" MDF top, clamped to a Workmate.

I found a sheet of 3/16" oak in the garage, bought several years ago at a craft fair and cheap because it was badly warped at one end. There was enough to cut a top and bottom, pinned and glued to softwood ends with ¼" dowelling glued inside to drop the front and back panels onto respectively. The overall dimensions were 11"x6.5"x3", and Fig 8 shows the completed Songbird Radio in its cabinet. To the left of the tuning dial are the fine tune and band switch knobs, RF gain/reaction in the centre and on/off volume on the right. The RH terminals are for the high impedance earphones, with a slide switch connecting them to a BC183 phone amplifier (not shown on the circuit) , and disconnecting the power amp from the supply thus saving a few milliamps. I also fitted a turntable to the base (ex Roberts R200), allowing the set to swivel around for best reception of weak stations and nulling out overstrong ones.

Commissioning the Songbird and alternative component choices

Fig 9 shows the rear inside view of the cabinet. A new PC board chassis for 'ugly bug' construction was built for it with the focus on effective screening between the 3N201 input and

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Leicester House, Lisle Street and beyond

by Albert Noble

In 1631, Robert Sidney, second Earl of Leicester, purchased 4 acres of land in St. Martin's Field, London, and for approximately £8000 built Leicester House. The only other buildings nearby were Newport House and Armoury House of the Military Company. The future George II lived there in 1717. In 1791 Leicester House was demolished. The open land to the front became Leicester Square and to the North, one of the most attractive streets in the parish was extended into the gardens of the old house. It was New Lisle Street. Most of the original houses in Lisle St. have now been demolished but at one time the Postmaster General, James Craggs, lived at No.44, now the site of the Empire Theatre. This was well before the GPO numbered wireless receivers!

Lisle St. formed the southern boundary of what, in later years was to become known as Chinatown. This spilt over from the destruction, during the blitz in 1940, of the original 1860's Chinatown in the East End of London at Limehouse.

For many wireless collectors now beyond retirement age, Lisle St. after the second World War in 1945 was a magnet because of about 8 shops. A number of things occurred which made Lisle St. so very attractive once again to so many, apart from the fact that it was now also part of the red light district of Soho!

Government war surplus radio and radar equipment etc. was coming on to the market. Men were being demobbed from all three services and many began to take up an interest in radio, much of which had been taught them in the services. Ham radio received a boost with surplus communication receivers. There was the R107 weighing in at 96 lbs. and who doesn't know of the R1155 with its sister transmitter, the T1154 or the Eddystone 358 receiver?

Television, from its home at Alexandra Palace, closed down for the duration in war time, began transmissions once again in June, 1946.

Less than four years later the "Practical Television," magazine began, reflecting the new demand for cheap home constructed television receivers.

Hi-Fi was the new 'in' word and quality amplifiers were being built at home. In 1947 Wireless World published the circuit and constructional details of a very high spec High Fidelity amplifier designed by D.T.N. Williamson, using a lethal HT of 450 volts! It took advantage of the new shellac records which could reproduce frequences from 20-15000 hertz. The age of the Hi-Fi fanatic had dawned and Lisle street could supply the push pull KT66's (ex war surplus VT 75's of course!) and much else beside. The BBC FM transmitter at Wrotham in Kent was being constructed in 1949 to enable 13 million listeners to receive high quality broadcasting within a few years. Many were to build their own FM receivers, and to construct reel to reel tape recorders too! Radio Astronomy was becoming of interest, much surplus optical equipment was also being bought. Even Boy Scouts were taking their Wireless and Radio Mechanics badges (test No.26) in 1948. The next generation of home constructors was being trained, maybe to become surplus enthusiasts too.

So all these things coming together during this post war period resulted in big demands for everything radio, audio, mechanical and television and the surplus market was there to help meet that demand.

Thanks to Gee airborne radar etc. some items coming to market could easily be adapted at home to enable television sets to be built fairly cheaply. The surplus Pye IF strip (unit153) had its IF at 45 megacycles, this coinciding with the vision frequency from Ally Pally. The VCR97 CRT at 35/- (£1.75 for the uninitiated!), another surplus item, was a cheap entry into a green 6 inch diameter world of home constructed TV, commercial 9 inch tubes at that time being around £12. Recently a VCR97 was sold on eBay for £5.50. The surplus type 62 unit for £4 was

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convertable as the video strip for home built television as were many others such as the 1355 with an RF 25 unit. Indicator unit 6 formed the tube assembly with the VCR97 at 90/- all boxed and in makers crates!

I wonder how many surplus EF50's were warming up just before 8 o/clock every evening in the vision strips ready to show BBC Television Newsreel's Ally Pally's radiating aerials during this period? The sound units ready to blast out Charles William's "Girls in Grey," the signature tune of the newsreel. Many surplus units were also bought just to be stripped down for cheap component parts and valves too. 'Centre Tap' writing in Radio Constructor in 1949 said, "The home construction of televisors is now well and truly in its stride." Yes, we were all at it! Those were exciting times when the first flickering pictures appeared on the CRT at home as the sets were aligned up.

Lisle St. offered much of this equipment and more and all within a stone's throw of Leicester Square tube station. How many tons of radio and television equipment were carried down the escalator on to the Piccadilly Line platforms over those post war years? I certainly carried my share as a young teenager soon after the war ended.

Prior to the outbreak of war in 1939 there were wireless shops in Lisle St. Will Day's shop at No. 19, then boasted, "The best in the West," and was well advertised in the Wireless Worlds during the 20's, selling such items as, 'The Band Box,' a six valve receiver at £16-16 shillings. At one time the shop was called, 'The Wireless and Gramophone Saloon.' Further up Lisle Street, towards Charing Cross Rd., at No.27 and 28a opposite the rear of Daly's Theatre, K. Raymond tempted one with the Kay-Ray variable condenser of the future at 6/6d. and many other items, all advertised in Popular Wireless in the 1920's. " Two shops, so you will always find one open," said the adverts. The Wet HT Battery Company sold permanent LT batteries at No.26 at one time. During the war London Central Radio advertised regularly in Practical Wireless as did Southern Radio.

But the ending of the war saw the popularity of Lisle St. reach its peak. G.W. Smith had his brightly illuminated shop with its long counter at the bottom of the street at No.3, next door but one to The St. John's Hospital for skin diseases, with its highly picturesque frontage in the early Renaissance style of northern Europe. This was previously occupied by Pathe Films of France. Mr. Smith opened another shop on the opposite south side, further up at No.34. Both windows of each shop were always full as were the brightly lit interiors and one was amazed to see how much equipment could be strung up around a shop. As a young lad I was not only excited to visit Lisle St. and G. W.Smith to buy my components but especially to gaze upon Mr. Smith's well endowed wife who always served at No.3! How wonderful it was for a youthful lad just to speak with this attractive mature woman about radio items on his wanted list! In later years Smith stores sold the Lafayette brand of ham band receivers and more new equipment as the initial war surplus market began to dry up in the late 1950s.

The Southern Radio Supply Co. at No.46, Service Radio Spares at No.4, West End Radio at No.14, University Radio at 22 and London Central Radio Stores at 23 were other Lisle St. shops to be visited. Opposite brightly illuminated Smiths, was dark and drab London Central Radio Stores. Bare wooden dirty floor boards greeted one on going inside. The floor was littered with boxes of not very attractively arranged goods, and these boxes extended right out to the pavement forming a lined path to the dark depths within. There were always plenty of items for sale but no buxom wench in there to gaze upon! University Radio, further down, where many odds and ends were festooned around the entrance. Two windows each side of the entrance vied for one's attention. At the top of Lisle St. at No.15 Little Newport St., two brothers ran, Gee Radio, where surplus ex–government soldering irons were part of the stock at 25/- and surplus 2v Exide accumulators at 3/11d in a rather cramped shop. There was also another small radio shop in Newport Place on the left but I just cannot recall its name. Surplus Naval, surplus RAF, surplus Army and surplus Government stock, were all there in Lisle St. If I had to pick a small icon of this period it would be the elegant slow motion Muirhead dial with its AM (Air Ministry) logo.

Although Lisle St. was the centre for radio surplus it did have its competitors in other parts of London. In nearby Tottenham Court Rd. in 1946 the Proops family set up shop, also selling surplus equipment, much of it medical, engineering and instruments from aircraft. The Spitfire's 16mm film camera (and rolls of 16mm film) were other items for sale. Ex aircraft Gyroscopes too. Who can remember Radio Clearance Ltd. at No 27. Tottenham Court Rd., Alec Davis Supplies at No.18 or Charles Britain in Upper St. Martin's Lane, selling RF24 units for 27/6d?

Two miles away over in Fleet St,. then home to the Newspaper industry, one could find Sterns Radio down the bottom on the left near to Ludgate Circus at Nos.109 and 115. Premier Radio had their first shop at No 169, moving to 165 and then on to No.152/153 (Electronic Precision Equipment taking over here eventually) later to be followed by a further branch at No. 207 Edgware Road right on the corner of St. Michael's Street. In 1949 at this shop, during TV transmitting hours only, could be found a working open demonstration model of their own kit built television receiver using the ex surplus VCR97 CRT to make some green with envy! I cannot recall though how they prevented the public from getting hold of the lethal EHT connection! No health and safety in those risky days! At the same time Teleradio, at No.177 near the corner with Sussex Gardens, was selling all the components for the Williamson amplifier. The expensive and weighty Partridge output transformer for £5-13-0 and all the parts for the Electronic Engineering Televisor, although cheaper surplus components could be used.

Many will remember Lasky's (307 Harrow Rd.opposite Paddington Hospital) and Henry's (5 Harrow Rd.), near to what is now the big Flyover in Edgware Road at the Underground station, selling the Pye IF strip for 45/- and the No 18 set for 17/6d. Winter Trading, the big wholesaler who stocked all the components for the home built Viewmaster television receiver, among many other items, just a hundred yards down the Harrow Road on the right. A tiny entrance and counter hid the enormous stock they carried at the rear. Lasky's were also at 33 Tott.Ct. Rd . and at 152/3 Fleet St.(same shop as Premier Radio!) at one time.

Who can remember too, big red painted Samson's Stores (now a supermarket site), again in Edgware Road just on the right past the junction with Sussex Gardens going towards Hyde Park? It was probably the biggest stocked window of any surplus store in London. Packed from the front of its two enormous plate glass windows right up high to the back it seemed to take hours to look at everthing they had to offer. Then inside to be further amazed. Truly like an Alladin's cave with the counter at the back with Mr. Samson poking his head through all the gear and components. This was the place to buy all those odds and ends in one big shop as well as surplus stock. Tag strips/valve holders/terminals/insulators/Cs and Rs/chassis, not forgetting the 1 1/8 inch international valve holder chassis cutter which we all used. Eventually on closing Samsons moved to a smaller shop just off Chapel Street nearby in the 1960s. Still with packed windows right next to the Edgware Rd. Met. Line station and if memory serves me, this shop too closed in the 1980s.

H. L. Smith at Nos.287-289 Edgware Road, opposite Bell St..with its double fronted windows going right down to within 1 foot of the pavement. Massive wooden counters within and all along the left hand side of the deep shop, trays upon trays of components to help yourself with. Laterly they had a Hi Fi section on the left hand part of the shop. "Nothing too large - Nothing too small." "Everything you need under one roof." "You'll probably get it at Smith's," ran their adverts. They even had a chassis dept. to make any sized chassis one required. Sadly, all now gone.

But Henry's, still soldiering on, selling Sinclair's calculator kit of parts in 1976 for £5.40 then onto computers and modern Hi Fi gear but you will not find any R1155s for sale there now. To this day (2006) they are still in the Edgware Road, at No.404 and now with a web site selling disco lighting etc., but it's not ex war surplus! Henry's, now the last of the many.

In Lewisham, East London, Galpins were selling off ex RAF 10 valve IFF (Identification Friend or Foe) units for 30 bob and ex Naval spark coils for 8/6d. Over in South London, Mr. Huggett and his wife opened at 2 o/clock on a Friday and men could be seen hanging around outside before then waiting to enter the old shop, with its wooden floors and stacked shelves. He always had a new line each week to tempt us all with items like a large bag of a few hundred surplus 6BA screws and nuts, all very cheap.(maybe slightly rusty!)

Over in West London, Lyon's Radio, run by two brothers, was a small shop in Goldhawk Road, selling surplus rotary converters at 42/- and ex RAF power units for 39/6d, all advertised in The Radio Constructor. Just around the corner in Hammersmith Road was Bernards in the Grampians where many little radio booklets were published over the years of ex war surplus valve equivalents and other radio subjects. VR53, VR65, VR91 etc.will be known affectionately to many. I don't have to tell you what the equivalents are I hope!

In Shepherds Bush market one could find John Gilbert's radio shop open every Saturday. John was a friendly, pipe smoking audio engineer working for H. J. Leak amplifier company in Acton during the week. His shop, just about 9 feet square boasted an early balloon PX4 push pull Leak amplifier which blasted out old music all day on a 12 inch loudspeaker mounted just on a large wooden baffle outside the shop. The Leak amplifier was not finished in black crackle paint but in a dark mauve colour! I seemed to recall that this was a Leak prototype. The shop packed quite a lot of surplus stock into its four cramped walls including large boxes of ex surplus Erie resistors and held many a chatting enthusiast too on a Saturday afternoon, including me. One guy specialised in getting the maximum volts out of home built crystal receivers tuned to the then BBC Home Service, using all the various types of surplus diodes on the market just after the war with his experimental tuning coils. Gilbert closed this shop in the late 1950s.

All over Britain similar shops could be found all selling surplus equipment after the war. Radiomart in Birmingham, Wireless Instruments of Leeds, Clydesdale of Glasgow, and Wireless Supplies Unlimited in Bournemouth, to name only four. The UK dealers list could go on, as can the list of surplus equipment being sold including such units as number 184a, 74a, 62a(the indicator unit for airborne Gee radar), 6a, 18, 3132, 1147, 145, w1095, 526, 142, 7, 1355, 231, Q fiver, 1481, 74 and hundreds more! The RAF 10/C series numbering seemed far more complex than those previous GPO numbering of wirelesses in the 1920s ever was! For example, Resistor numbers running from 10/C 1042 to 1050 were 51k,50k,20k,75k,12k,5k,350ohm,15k and 30k!

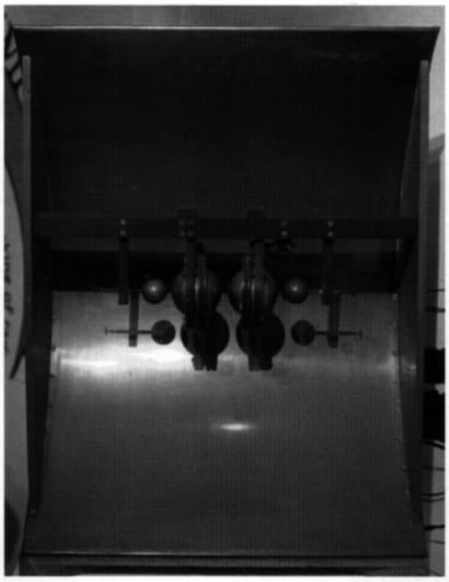
But slowly, one by one, many of these old shops began to close because the surplus market was beginning to dry up and many of them, run by ex–service men who were now retiring - or worse. In Lisle St. today, G.W.Smith's old shop at No.3 is a pub (The Hog's Head) and his other shop now a Chineese restaurant. Will Day's old shop at No.19 is in the middle of the SeeWoo supermarket and K.Raymond at No.27 another restaurant, as is the London Central Radio Stores, making ten restuarants there now in the street.

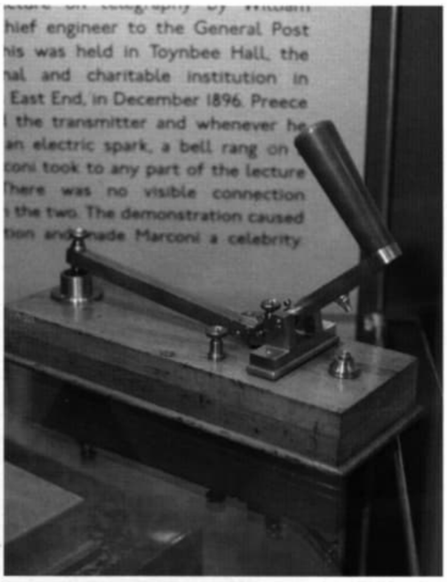
Thirty years after the start of Lisle Streets' popularity the BVWS was formed and 60 years on many of its members now collect the very same items that were sold in those war surplus days. Home construction faded away because factory built equipment became relatively cheap to buy and much too complicated to make at home. Who would venture to design and build a modern colour television, a DVD player or a PC mother board at home these days?

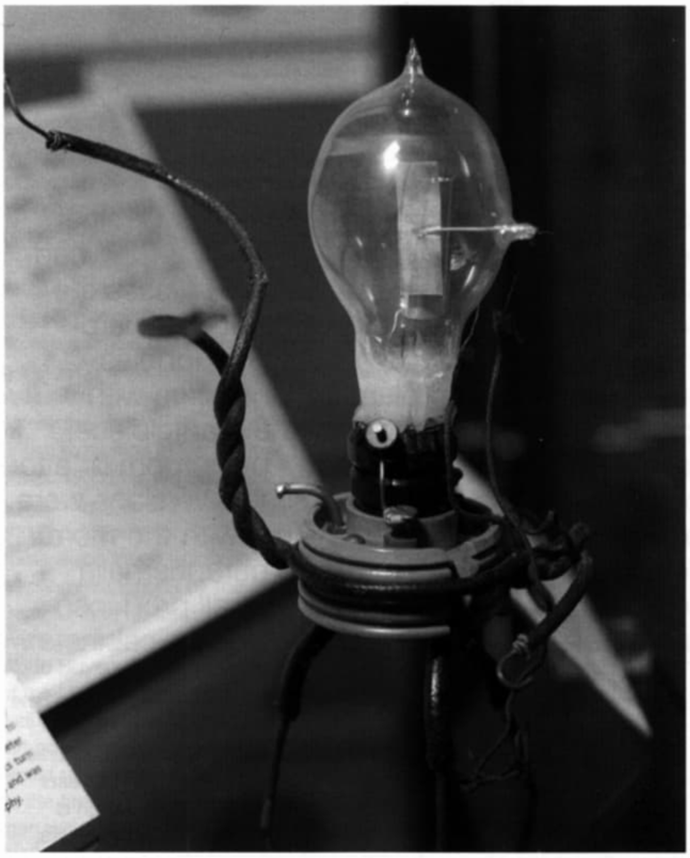
But many will still have very fond memories of those wonderful times when browsing in the old surplus shops was a weekly adventure, from the old gardens of Leicester House, Lisle Street, and beyond.

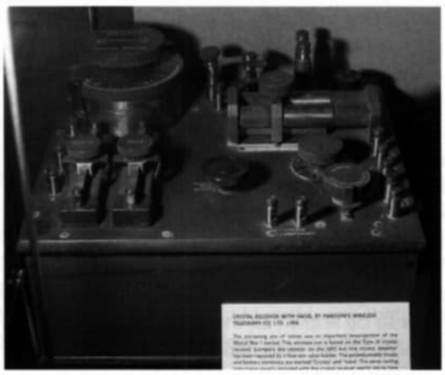
Wireless World: Marconi & the making of radio

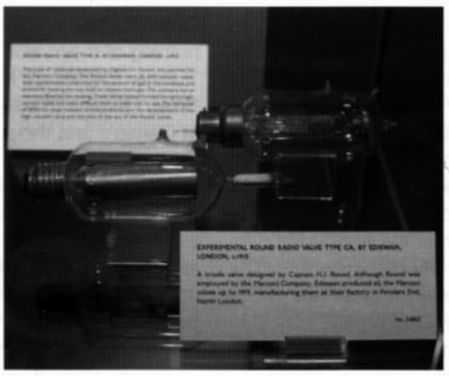
Photographs from the opening of the exhibition at the Museum of the History of Science, Oxford

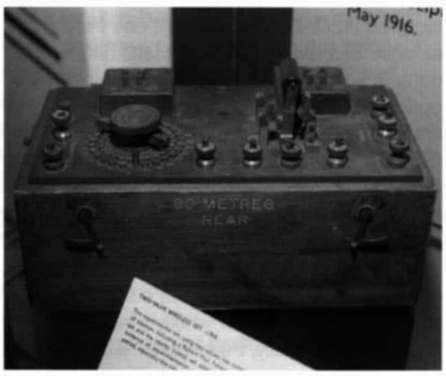












Bob Tucker's set

Gerry Wells' set

No smoking, please! by John Holloway

It's unlikely that any manufacturer today would market a radio under the name Smoker's Cabinet and, to be strictly accurate, when GEC launched the Gecophone two valve receiver in 1922 it had yet to become known under that name. However, 80 years ago when radios were wirelesses the ladies of the house demanded technology that blended with their existing furniture. Its outward design very much reflected a small but perfectly formed cabinet of a type beloved of Hobbies magazine where young boys were encouraged to build for father from plans supplied free with this venerable publication. These early efforts in carpentry finished up either on the mantelpiece, screwed to the wall somewhere close to father's chair next to the fireplace in the back room or after a decent interval, quite often consigned to the cupboard under the stairs. The simple versions were nothing more than glorified racks for those dependable coves who smoked a pipe, with the more ambitious units featuring shelves and even doors, behind which could lurk all the paraphernalia of the dedicated smoker. It must be said that none of the three manufacturers, who all produced similar models, used the term 'smoker's cabinet', merely referring to them as 'handsome cabinets'.

Dedication is perhaps the key to this particular set's popularity as it seems to inspire many to restore, or in some cases completely manufacture from scratch, all the major components in order to bring these sets back to life.

Not owning one myself, I should perhaps explain how I came to be writing this article. A few months ago, BVWS member Peter Brunning suggested that it might be a good idea, as he put it, "to do an article on Smoker's Cabinet radios" as he knew of some members who had restored or, as in his case, built one from scratch starting with an empty cabinet. In a moment of weakness I agreed and suggested he made contact with these other members to see whether they would co-operate. His powers of persuasion resulted in Peter Kyne, Bob Tucker and Ken Tythacott making their sets or components available for Carl Glover to photograph along with Peter's at Gerry's on the day of the Garden Party and for me to ask them some questions relating to their interest in the sets and their experience building and restoring them.

Ken's set is the only original of the four and includes the additional valve amplifier for speaker reception. Bob's is a mix of original and specially manufactured replica parts in an original cabinet, and Peter Brunning's set is almost wholly made up of manufactured replica components. Finally, Peter Kyne has painstakingly manufactured replicas of every item to a visually and technically very high standard. At the time of writing, the cabinet is the next thing on his list to get to grips with and no doubt it will emerge gleaming from his workshop in due course. Gerald, of course, has also remanufactured some sets over the years and has his own distinctive opinion. His view of the circuit design is more in line with Jeremy Clarkson's attitude to American muscle cars, "Interesting shape, shame about the performance." His original set is also shown here with the add-on amplifier.

So what prompts the interest and popularity of these sets, to say nothing of their value eighty years on?

Peter Brunning's reasons reflect those expressed by the others. "Well, I think in the early days when I started collecting I saw an original at Gerald's and thought it had a certain charm. The cabinet was quite elegant and the front panel looked quite exciting." Bob Tucker was attracted for the same reasons and also by the potential of starting a new project. "I could see the possibilities of remanufacture after examining an original in some detail." Peter Kyne saw the model first in Radio! Radio! shortly after joining the BVWS and as he put it, "was attracted by the silver twiddly thing that plugs into the valve base between the two valves," later to be known as the reactance unit. The fact that it was a classic early 1920s set also added to his interest.

Peter Brunning's set

Ken Tythacott's set (has had a retro–fitted switch to isolate the LT supply in the top right hand corner of the control panel).

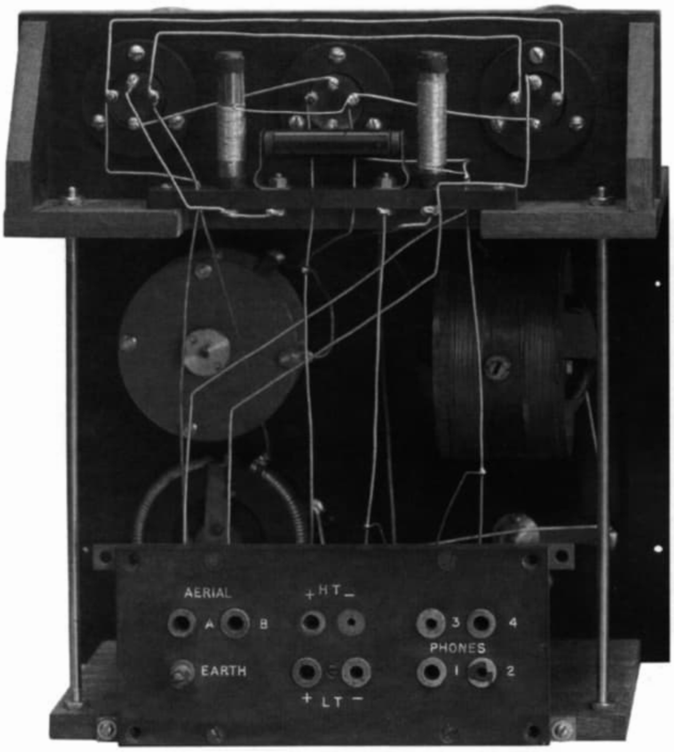
As he explained, "I wanted to produce a replica that was as close as possible, both physically and electrically, to the original so that its performance would be representative of an original set, given of course that broadcast conditions are different now in comparison with 80 years ago." The set's appearance also attracted Ken. "Quite simply it was the beautifully made cabinets and their marvellous mahogany colouring."

Long standing members of the BVWS will no doubt recall the excellent article by Ian Higginbottom illustrated by Norman Jackson in the 1983 edition of Vintage Wireless (volume 8 Number 2). As he states, the HF and detector model came on the market a few weeks before the start of BBC broadcasting and was shown at the first all-British exhibition in September 1922. In his article Ian quotes a price of £20.17.6d for the Smoker's Cabinet version. However, both the adverts reproduced here show a price complete with valves, batteries and headphones of £25.0.0d in ads dated 1923. So maybe there was some discounting going on - nothing new there! The relaxation of reaction restrictions by the Post Office at the end of 1923 prompted a Detector and LF model which ran in parallel with the original version but eventually became the only model, finally disappearing from the Wireless World Buyers Guide in November 1926. There was a cheaper version of the LF model offered in a flat topped cabinet selling at £9.12.6d as well as a similarly designed version of the HF circuit. It must also be remembered that an advertised price of £25.0.0d for the main model would make them more attractive to business or professional people. At the time, this cost represented about 8 weeks wages for a skilled man which is probably why the cheaper flat topped versions were made available.

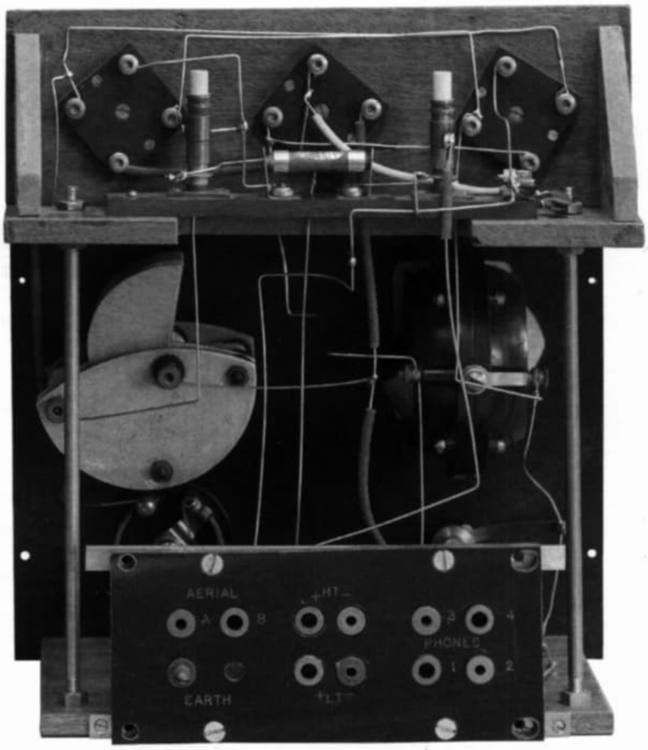
The circuit of the HF version reproduced here is taken from volume two of Dowsett's Wireless Telephone and Broadcasting published in 1923 and is that used in Ian's article which was modified to show the condenser across the reactance unit being variable which corrects the original shown in the book. Also, this same drawing shows the battery and telephone condensers as being 0.003mfd and 0.0003mfd respectively whereas they should both be 0.003mfd which is confirmed by testing both Gerry's and Ken's examples. The circuit remained the same throughout the production run and though the components changed their values, remained the same. However, the layout varied and the gauge of the connecting wire used internally changed over time according to Peter Kyne. This informed his decision on whether to copy a particular set or to make one that is representative of the sets in general. He decided on the latter course but a long term aim is to be able to receive the modern day equivalent of 5XX (i.e Radio 4 Long wave). The original sets were designed to receive 300-500 metres but they also allowed for receiving longer wavelengths by removing the shorting link at the top of the front panel and replacing it with a loading coil of a suitable inductance and at the same time replacing the reactance unit between the two valves with one designed for the wavelengths required. This second change is not generally known but is necessary as the loading coil retunes the aerial circuit and the reactance unit, which contains a tuning coil, provides the appropriate inductance for the anode circuit of the first HF valve. Having made a reactance unit already this will not be a problem but he is stuck when it comes to the physical dimensions of the loading coil so if anyone out there can help he would be very grateful.

I wondered whether these sets had ever been offered as kits, but apparently not according to our interviewees, though the circuit was housed in other cabinet styles. Ken thought it might have been sold as a kit in the flat top form though so far he's not found any evidence for it. Advertisements appeared in prestige magazines, trade and general interest publications as well as at exhibitions. As can be seen from the two shown here and from the sale price they were definitely aimed at the higher end of the market - with the use of personalities of the day appealing to not only the Jones's but also those who wished to keep up with them! Referring to the adverts, the sets were available from 'Principal Electricians, Store and Wireless Dealers'. Both Bob and Peter Brunning reckon they were popular for all of these reasons and due to the fact that they were manufactured by GEC one of the Big 6 involved with the start of the British Broadcasting Company. As Bob added, "they must have sold reasonably well for so many cabinets at least to have survived up to the present day." Bearing in mind the closeness of GEC to the newly formed BBC there must have been some 'insider trading' going in relation to circuit design and the early availability of the sets, according to Peter Kyne.

However, the critical test of a set is its performance and here we arrive at possibly the real reason that they have come to be referred to as Smoker's Cabinets and why there are more cabinets than complete sets. It also accounts in the main for the high price of a complete original. It should also be borne in mind that the buyers of these sets were not, in the main, knowledgeable. By today's standard the sets are, to say the least, fiddly and the people operating them were members of the great British public and well-off to boot. This is a fairly dangerous combination as anyone who has sat at a servicing bench will testify. Also, to put it



Bob Tucker's set



Peter Brunning's set

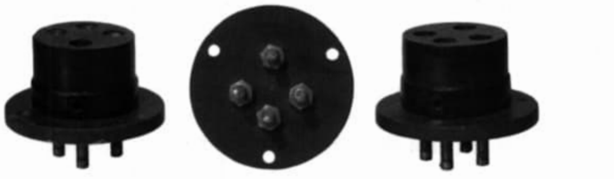
Bob Tucker's set

Peter Brunning's set

mildly, the claim of reception up to 100miles is viewed sceptically by all our owners. Peter Kyne feels the circuit design, even for its time, is rather poor due in part to GEC's liking for "weird inductance/tuning arrangements." However, Ken Tythacott reckons "they're as good as most good 2 valve TRFs and certainly better than the Marconi V2." He also points out that as ever they are very dependent on the selection of valves. He reminded me that there was a great deal of one-upmanship going on in those early days along the lines of, "I have a 3 valver – you only have a 2 valver." Peter Brunning ran into serious instability problems. He developed a theory that this was due to the more 'modern' valves he was using having a greater anode to grid capacitance than the pip top ones the set was originally designed to use. In trying to neutralise the effect he considered the Hazeltine circuit. As can be seen it has a tapped anode coil to provide an anti phase signal to cancel the feedback, anode to grid. The Gecophone circuit doesn't lend itself to this modification so he put a small variable capacitor between the anode of the detector valve and the grid of the HF valve. This was on the grounds that the signal at the detector anode would be 180 degrees out of phase with that of the anode of the HF valve and would provide negative feedback thus neutralising the signal. As he said, with a wry smile: "it appears to work after a fashion!"

So, the similarity of the wireless cabinet to a genuine smoker's cabinet coupled with some dissatisfaction with performance and operation, probably prompted the removal of the innards to make way for pipes, tobacco and sundry other knick-knacks, like the tools for removing dottle!

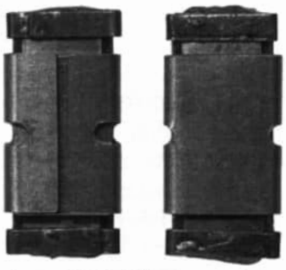
The original circuit had no means of switching off the Low Tension supply other than winding back the filament resistance to zero. Many sets were modified to include a switch in the LT isolating the accumulator after use. This was most likely done by the local charging shop, a garage or cycle shop or perhaps by the owner, as no two mods were the same. This addition can be seen on Ken's set in the top right hand corner of



From left to right: valve holder, Valve holder also used for reactance unit, valve holder

Variometer

Condensers: 0.0002mfd



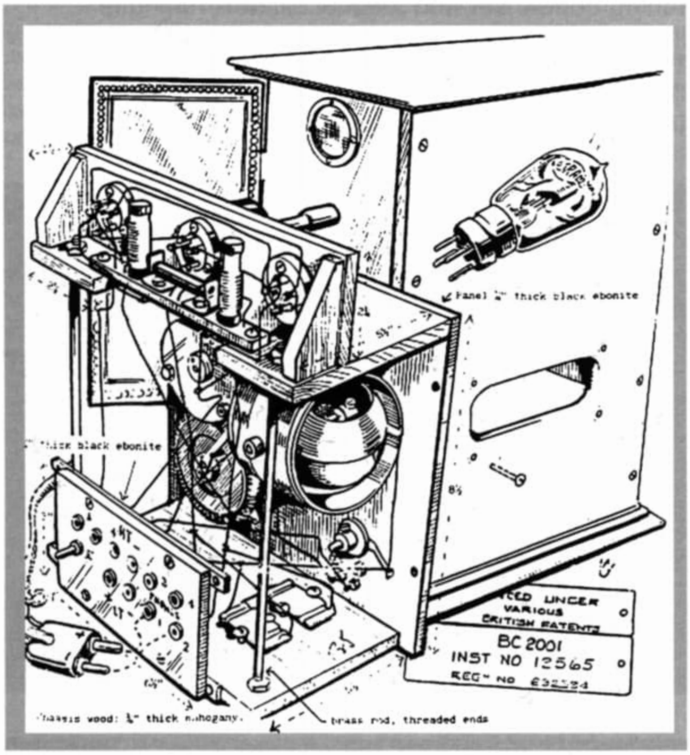
Phone Condenser: 0.003 mfd, Battery condenser 0,003 mfd

Reactance Unit

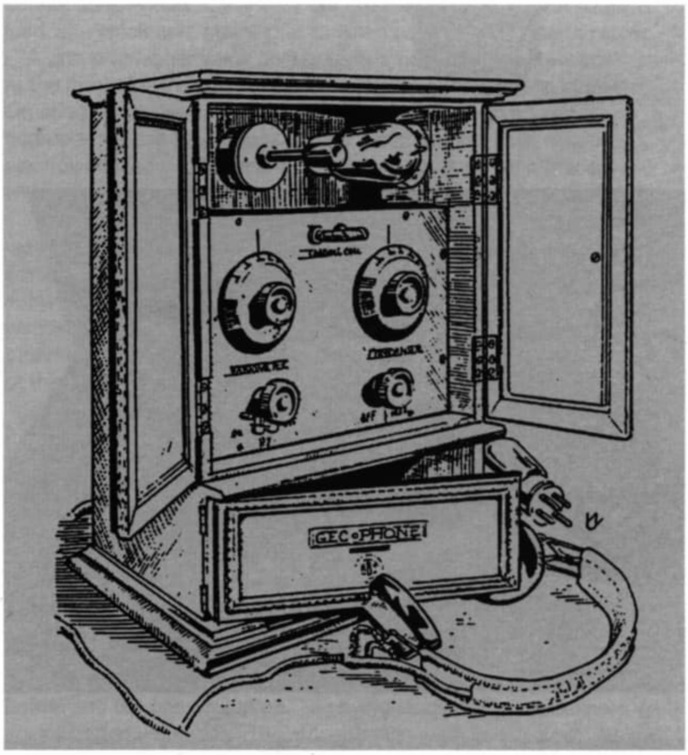
Sockets

Shorting Link

Grid Leak condenser: 2 Meg Ohms



Norman Jackson's drawing of the exploded BC 2001



Norman Jackson's drawing of the BC 2001 *in situ*

the front panel. Ken acquired his set as part of a large package of items from an antiques dealer back in 1981, "all it needed was a dust down and a good polish." In those days sets were going for around £500. Prices have, in line with many other sets, come down though it's fair to say that they are still highly prized. As Peter Brunning mentioned, they're half the price of the equivalent Marconi of the same period. He was able to buy an empty cabinet from Nigel Pollicott and worked from the drawings by Norman Jackson and the circuit published in Ian's original article. He found the dimensions quoted totally reliable: "The ebonite front panel should be .025inches thick but mine is three sixteenths. Nigel engraved it for me and it looks fine. Gerry provided access to his set, lent me the reactance unit so that I could make my own and provided some of the other components." The original article by Ian Higginbottom also provides a reference for the Operating Instructions which are shown on the inside of the doors on both Bob's and Peter's sets

Bob Tucker's cabinet is original, with the variometer taken from an old crystal set. He adds, "the shorting link, the rear connecting panel, control knob and some of the smaller parts are also original, but everything else has been remanufactured. The tuning capacitor was very time consuming."

Peter Kyne's goal of making as near an exact replica of an original as possible, if that's not a contradiction in terms, has involved making about 150 parts using metal, wood, cardboard and Tufnol, a substance with similar characteristics to ebonite. As can be seen from the pictures, the major components are now complete and have now been tested. The front panel is being drilled prior to engraving at this time.

The eight square drive screws that fix the front panel to the cabinet are the most elusive items to find. All of our restorers make a plea for anyone out there who may have some to get in touch. I only hope I am not asked to decide who gets them!

I think it's fair to say that the three restorers in our quartet would endorse Peter Kyne's tip – "don't attempt this unless you are prepared

Article continued on page 61

HMV 800 restoration by Nigel Hughes

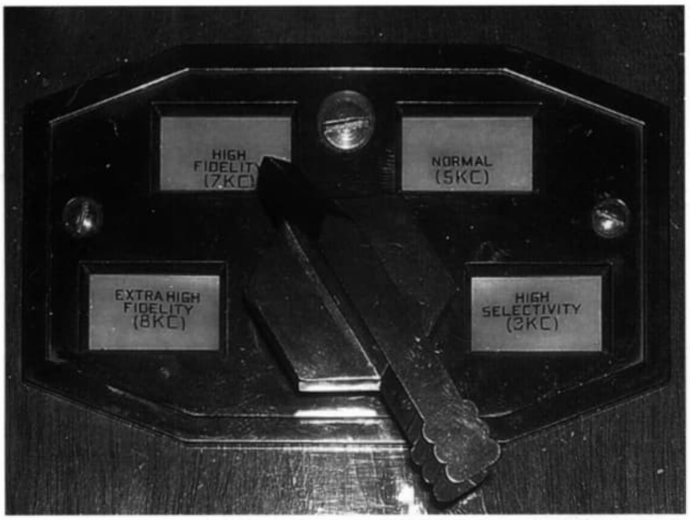
The HMV model 800 'High Fidelity Autoradiogram'was made in the mid-1930s and cost as much as a small car. While the average radiogram of the time used four valves plus rectifier, the model 800 uses fifteen valves including two rectifiers and a pair of PX25 power output triodes feeding twin speakers. The radio section has three short wavebands, covering 13 to 80 metres, plus the usual medium and long wave bands. The radio has switchable selectivity:- 'Extra High Fidelity' 8Kc bandwidth, 'High Fidelity' 7Kc, 'Normal' 5Kc and 'High Selectivity' 3Kc. Bandwidth is controlled by switching the capacity coupling of the RF bandpass circuits, mechanical variation of the coupling of the I.F transformers, switching of damping resistances across the IF coils and switching of audio filtering in the audio stages. The radio also has 'Super-Silent Tuning', sometimes known as inter- station noise suppression, and contrast expansion with which soft passages of music are made softer and vice versa.
On top of all this, for short waves, there is a separate tuning condenser and local oscillator. Tuning is indicated by a neon tube 'Fluid Light' indicator. The owners' handbook proudly announces that 'The range of the Model 800 has no limits except those imposed by the conditions of the ether'.

I like my radios and radiograms to be a bit out of the ordinary and when an unrestored HMV 800 appeared on the market, I simply had to have it. I collected it from the Nottingham area in the back of the family Toyota Corolla hatchback. It is an incredibly heavy piece of gear, comparable in weight to a piano and it was a difficult enough lift into the car with three of us doing the lifting. When we got home, it was just possible for two of us to get it out of the car and over the front doorstep. For comfort in handling, I would regard it as a four-man lift.

Initial assessment showed some missing walnut veneer from the edges of the case, so a selection of veneers was ordered from Anita Marquetry, via the internet. Savoy Hill Publications came up with circuit diagrams and the October 1945 HMV re-issue of the Service Manual, plus a bonus copy of a contemporary 'Wireless World' review of the equipment.

Physically, the set is constructed on two chassis, one for the radio tuner and audio amplifier stages and the other for the power supply and power output stages. Preliminary mechanical and electrical testing showed seized controls, a broken drive to the short wave tuning condenser and no HT connection to the radio chassis. An HT to chassis resistance test of the power and output chassis showed a low reading. At least I had already found enough reasons for the set to have stopped working.

The first stage of restoration comprised correction of the various mechanical faults. The dial drive, wavechange, selectivity and contrast switch mechanisms were all stripped, freed up and reassembled. The short wave tuning drive is via a flexible coupling consisting of two 'spiders' connected by a flexible ring of resin bonded fibre. The latter had been broken. I manufactured a new ring from fibreglass printed circuit board material machined to the correct thickness and drilled for new rivets. This should be a little stronger than the original, although I would have used the original type of material if it had been to hand. The waveband selector plate was very slack on its shaft. I guessed that a bush had been lost and turned up a new one from brass. The parts now function with Rolls-Royce precision.



Various HT and bias rails for the radio chassis are derived from a big tapped wirewound dropper resistance connected across the main HT supply. The top section was found to be open circuit. I managed to find the break near one end and re-connected it to the tapping. The bottom section was also O/C but unrepairable, so the failed section (and another that subsequently failed during testing) was bridged with an equivalent resistance. A wirewound potentiometer in series with the dropper is used to set the bias on the neon 'tunalite'. This was also O/C at one end, due to corrosion, possibly from flux, but I was able to re-solder the winding.

According to the vendor, the set had been overhauled by HMV in the 40s or 50s. Many of the valves appeared to have been replaced and there were a large number of EMI-made waxed paper condensers hanging on the under-chassis wiring, most of which were found to be serviceable. However, the manual made it clear that originally, these condensers were in cans, two or three to a can above the chassis. The sketches in the manual suggested that the cans had been rectangular, about 1"x1"x2.5". Indeed, there were holes in the chassis, bearing square witness marks confirming the 1"x1" size. Confirming the height was more difficult, until it appeared that one can had been mounted on its side, rather than upright and the witness marks gave a dimension of 2.5". I made a set of cans from an old tinplate biscuit tin, inserted appropriate polyester condensers fitted with flexible flying leads and then filled each can with melted candle wax. The cans were finished with spray primer and a couple of coats of 'steel wheels' silver. HMV did not colour code the under-chassis wiring, using a dark brown or black insulation, which was in good condition. Although I used coloured flying leads to identify the internal connections in each can – they are not all the same- I sleeved each lead with black heat shrink plastic when putting the wiring in place.

A group of higher value condensers is housed in a large can at the front of the chassis. All were either shorted or open circuit. On opening up the can, it was clear that original waxed paper components had been removed and replaced with card cased electrolytics, now long past their sell-by date. All were replaced with polyester condensers, for which there was ample space.

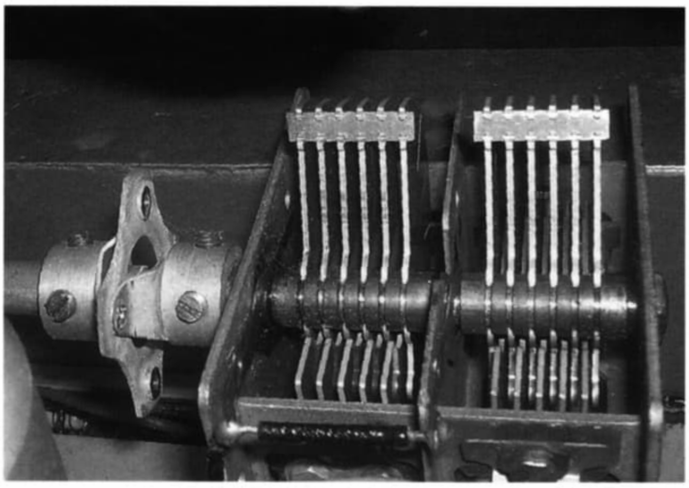
Circuit testing showed that the aerial input coil for medium wave was O/C. Removal of the screening can showed that the coil was completely missing! I wonder whether the radio had been the subject of a lightning strike which had vaporised the coil. From witness marks, I could see how long the coil had been. The main tuned coil was single layer plain wire, so I put on a single layer of the same gauge wire to cover the witness marks. It works.

The remainder of restoration of the radio chassis was the usual round of cleaning, repainting and polishing.

Turning to the PX25 chassis, I was lucky in that a TCC jelly-filled (according to the manual) condenser block of 4+8+8 mfd was found serviceable. However, a second condenser block was very leaky. I opened up the tin and found lots of cracking pitch, which I dug out. Below this were waxed paper capacitors which were also dug out. These were replaced by 400 volt polyester types from RS Components. 80% of the space in the box was left over. This was filled with wood blocks with candle wax poured round the components to hold everything securely in place. The whole was topped off with pitch as before and the can sealed up. The flying leads to the condensers were colour coded as original. The striped leads were imitated by painting the stripes with Humbrol lacquer. The can was re-sprayed silver.

The valveholders on the PX25 chassis are flexibly mounted on rubber. The rubber had perished and become rock hard and brittle. I made new bushes from various diameters of rubber tubing – actually pianola vacuum pipe tubing.

The record changer is an heroic piece of engineering. The main chassis is a steel plate about 3/16" thick, floating on spring mounts and supporting a mechanism of massive cams and levers. I was very fortunate in finding a man in the USA who was also restoring an 800. He sent me a copy of the manual for the changer and I reciprocated with a scan of my original owners' handbook. Paul Stenning's Internet Discussion Forum is a wonderful place for giving and receiving help. The turntable is a massive cast iron effort, so no chance of much wow or flutter. It is belt driven from a shaded pole induction motor in which the shaded pole drags a large copper disc round. Speed is controlled by a friction governor like those used in wind-up gramophones. There was no perceptible wear anywhere, but adjustment of pickup dropping position proved tricky. By the



way, the mains switch on the motor is a mercury tilt switch. Be Very Careful. I needed a new drive belt and made one from rubberised cloth of the type used for player piano vacuum bellows, with a scarf joint bonded with super glue. The deck has adjustable levelling pillars locked by round head screws. One was completely missing, so I turned up and threaded a replacement from stainless steel. New rubber bearings for the pickup armature completed work on the record deck.

The 50 cycle versions of the 800 have a synchronous clock. The mechanics were fine, but the coil was O/C. It has about 19,000 turns of very fine wire and Mike Barker did an excellent job of rewinding.

The speakers live behind a metal mesh grille, which was in good order. However, in front of this is a set of chrome plated slats which were very rusty. I dismantled the speaker baffle assembly and got them out to take to my local plater. He explained that he could not polish in between the slats. Clearly, the slats had originally been plated before they were assembled into their frame. So, I combined a vice and some clamps as a puller and extracted each slat from the frame ends. Two weeks later I had a set of parts which I reassembled with the help of a dab of super glue here and there. It was worth it as the grille is a major feature of the cabinet.

Cabinet repairs involved gluing back some lifted veneer with the help of super glue and a hypodermic syringe to get into the narrow gaps, replacing missing veneer and staining and polishing to match. As far as possible, I have retained the original cellulose finish, but I have repolished the top with clear French polish. There were some very deep scratches which were successfully filled with layer after layer of French polish run into the scratches with a very small artist's water colour brush. Once built up over a period of days, these were rubbed down level with the surrounding surface with 800 grade paper used wet. The whole top was then French polished.

So, how does it perform?

With just a few feet of aerial wire thrown round the skirting board, sensitivity and selectivity on Long and Medium wave is excellent. The super silent tuning only allows for a little deviation from the correct tuning point and local oscillator tuning drift can cause a station to blank out at the HF end of medium wave. I may have to play with some different temperature coefficient trimming or padding capacitors some day.

Whereas an RF stage is employed on LW and MW, none is used on Short waves. There is therefore only one tuned circuit before the mixer on SW. As the IF is only 125Kcs, image frequencies are only 250Kcs apart and image interference on short waves is frankly awful. Nevertheless, under the right ionospheric conditions, I have easily listened to Australia with the 800.

No negative feedback is used in the audio stages for tone control. However, the unusually soft suspension and long cone travel of the speakers gives a pleasing bass performance remarkably free of resonances. The sheer weight and thickness of the cabinet helps here too. The speakers have metal centre cones for good treble performance. Despite HMV's claims for their 'Duo-Diffusion' speaker arrangement, the treble is sharply directional and treble can be a little aggressive due to the use of a resonant HF boost circuit on the wider bandwidth settings. In part, I believe that medium wave music stations today also provide some treble boost of their own. This can be tamed with the treble cut action of the tone control or can be damped with a damping resistance across the boost coil, selected to taste.

Gramophone reproduction is at its best with 78s from the mid-30s. Post-war records are rather too heavily modulated for comfort. The contrast expansion circuit works well with records, provided that they are played loudly. It has little effect on 'pop' radio as such stations seem to play at constant loudness, whatever the music.

Overall, I am pleased to have rescued another significant piece of radio history and visitors who see and hear the 800 are impressed by the sound and the appearance.

Obituary - Sidney Watkins

5th November 1930 - 8th August 2006

BVWS members will be very sad to learn of the death of Sid Watkins. Sid joined the Society in time to attend its second AGM and very first Swapmeet at the old Civil Defence Hall in St. Albans on the 21st May 1978.

In those early days the membership had reached about 40 and a photograph marks the event. It is shown on page 26 of Jonathan Hill's The History of the British Vintage Wireless Society 1976 – 1996, and Sid can be seen standing behind three children including a young girl in a print dress and apron. It was at this AGM and Swapmeet that I first met Sid and began to enjoy his company and kind nature. When the members had left and the organizers on the Committee were left with the empty tables and debris on the floor, Sid immediately grabbed a broom and swept the floor. In this way a continuing tradition of helpfulness was established that was of immense value to the Society in an unseen way. Sid attended most of the Society's meetings without fail until his health became a problem and at these meetings, chatting to him over tea and biscuits, I got to know him well. He disliked woolly thinking or lack of effort; however, self importance was entirely absent in his character and his first priority was always to be helpful.

Sid's closest friend in the Society was Ron Burgess and Ron's personal remembrance together with details of Sid's career follow.

David Read

Sid was born in South London and educated at Wandsworth Grammar School which evacuated to Cornwall for a time during WW2. Later during "Doodle Bug" raids he, with his mother and cousin, were evacuated to Lower Heyford to an aunt and uncle.

When he left school around 1946 he worked in the Technical Dept. of Phillips Electrical in Mitcham, Surrey, being involved with production. During this time he became interested in valve radios and vintage cars, attending car rallies and meetings and acquired a Railton Sporty Saloon which he practically rebuilt himself.

In around 1956 Sid was called up for National Service and joined the RAF where he trained for Air Crew as a Navigator, then signed up for a further 12 years with Canberra and "V" Valiant Bombers becoming a Flight Lieutenant. In 1965 Sid became an Air Traffic Controller at Gatwick Airport and later moved to the College of Air Training at Hamble. When Hamble was closed in 1982, Sid went to the Air Training School in Kidlington Oxford where he became the Senior Air Traffic Controller, a post he held until he retired in October 1994.

During his years in Air Traffic Control, Sid had started to collect vintage radios and grandfather clocks, so that by his retirement he had built up a large collection of very good vintage radios and spare parts all of which filled his cottage and garage to the brim. There was hardly a space left even for a Crystal set, however, he always kept enough room for his one or two stray cats which he took great pleasure in looking after.

The first time I met Sid was at the Oxford Air Traffic Control tower in the 1980s when I looked after the tape recorders while a friend and work colleague was on holiday. Some months later I mentioned to Sid that I had located and repaired a Philips 787 Mono knob Radio. What I did not know then was that he knew all about Philips Radios and their history and that he had been an avid collector for many years. This prompted him to introduce me to the BVWS which enabled me to start my own collection. Sid joined the BVWS in the early days when the Swapmeet took place at St Albans which Sid said was a much smaller venue with the Swapmeet only filling a small part of the hall.

How times have changed! Since then, he attended most of the BVWS meetings including the Garden Parties at Gerry Wells', whom he knew very well. Sid and I often went together to the NEC, Harpenden and Wootton Bassett which was the last venue he went to. He became increasingly frail in the last year of his life which affected his short term memory, but his sense of humour never failed. He will be missed by many including my wife Jane and myself.

Ron Burgess

The Tri-onic Transistor Kit A By Robin Hiley

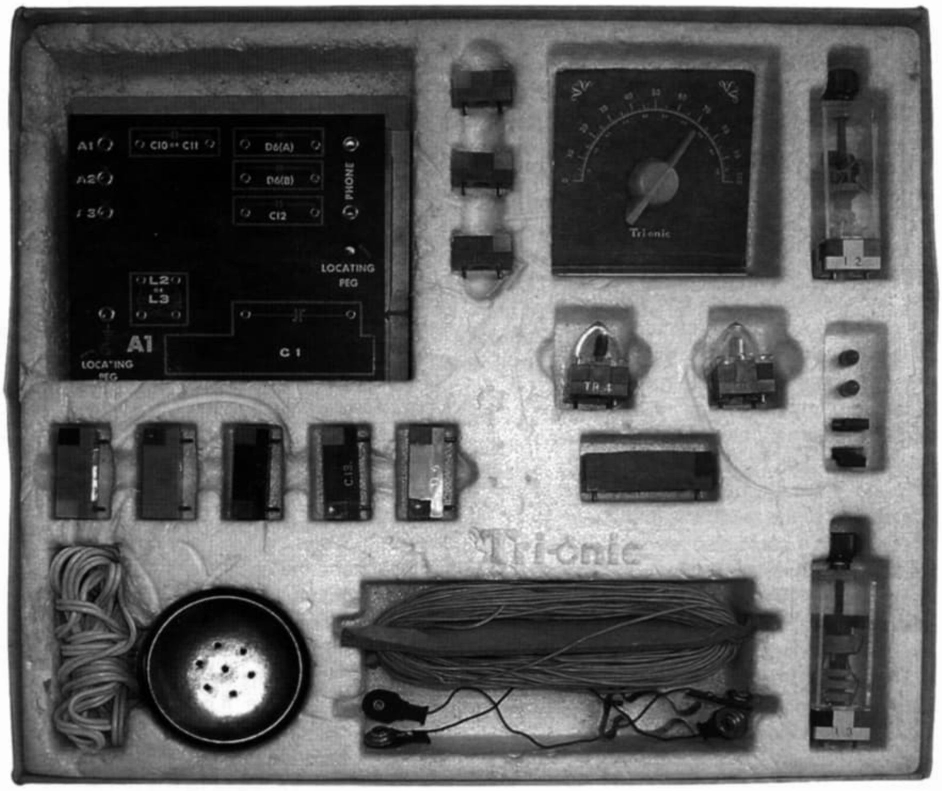
My interest in electronics, and transistor radios in particular, dates from Christmas 1961. Just before that Christmas, when I was 10 years old, my mother took me to 'Actons' cycle and toy shop - at the traffic lights near the Underground station in Eastcote, Middlesex – to buy my present. Offered the choice of anything up to five pounds I chose a Tri-onic Transistor Kit A.

The kit, sold under the Tri-ang brand and made by Minimodels of Havant, Hants, was a sort of electronic Lego. In a neatly laid out box were resistors, capacitors, coils, headphone, wires for aerial and earth and, best of all two transistors. Each small component was mounted in a brightly coloured plastic 'brick'. Six printed circuit boards were also provided. All you had to do was plug the appropriate components into one of the boards, connect aerial, earth, phones and battery, and you had a real, working radio. It was child's play!

That superb present has stayed in my memory ever since. 45 years later I have a collection of about 250 transistor radios, all from the germanium period (roughly speaking the 1950's and 60's), and recently thought it would be nice to add a Tri-onic kit to my collection. I had never seen one for sale at boot fairs and 'junk' shops, my usual sources of supply, so I started looking on e-Bay, and eventually managed to buy an example in its original box.

Restoration

The box was intact but rather tatty. I repaired the corners of the lid discretely with card and paste. The components were all there apart from the earth wire; and in good condition. Apart from a general clean of the connecting pins I only had to make two minor repairs. The sliding contact on the tuning capacitor needed a good clean, and the moving part of the long wave coil had broken. The coils are very nicely mounted in tall transparent cases, with an adjusting screw fixed into the lid that moves one coil element up and down the ferrite rod. I gingerly broke the glued lid away from the top of the case and lifted out the adjustable coil with its wires still connected. A threaded nut had come away from the centre of the plastic coil mount. I simply pushed it firmly back in and re-assembled the unit.



Mechanical design

In comparison with the various other electronic kits I have seen, this is a Rolls-Royce. The design has been carefully worked out to make assembly almost child-proof. The component holders and circuit boards are robust and generously sized. The resistor and capacitor holders are coloured according to the standard codes. Where a component must be fitted the correct way round the pins at each end, and the corresponding circuit board holes, are of different sizes. A similar arrangement ensures that the correct transistor is used. The designer has also made it possible to see the actual components, using transparent cases for the transistors and coils. The components are numbered in conventional fashion, R7, C12, TR4, etc, but to avoid any confusion there is only one sequence of numbers. The full list of components is:-

C1
500pF variable tuning capacitor
L2
Medium wave coil with variable coupling
L3
Long wave coil with variable coupling
TR4
RF transistor – a Mullard type
similar to OC44/5
TR5
AF transistor – a Mullard type similar to OC72
D6
Germanium diode – Mullard type
R7
4k7
R8
560k
R9
220k
C10
47pF
C11
330pF
C12
1000pF
C13
0.01uF
C14
2uF electrolytic

Circuit boards and mounting board

Headphone

Antenna and earth wires (including pipe clip for earth)

Battery connectors

The radio circuits

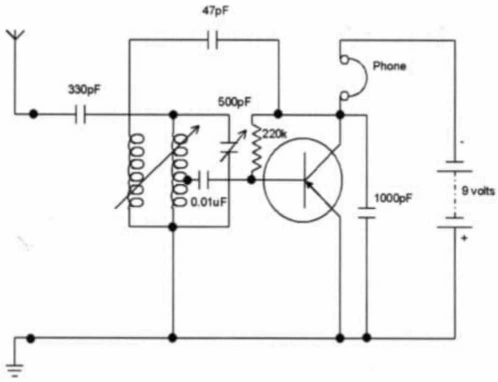
The radio circuits themselves are economical with components but have a maximum of variety. They work up from simple crystal set, Circuit A1, to a diode and two transistor circuit, A6, capable of giving significant volume from the headphone supplied.

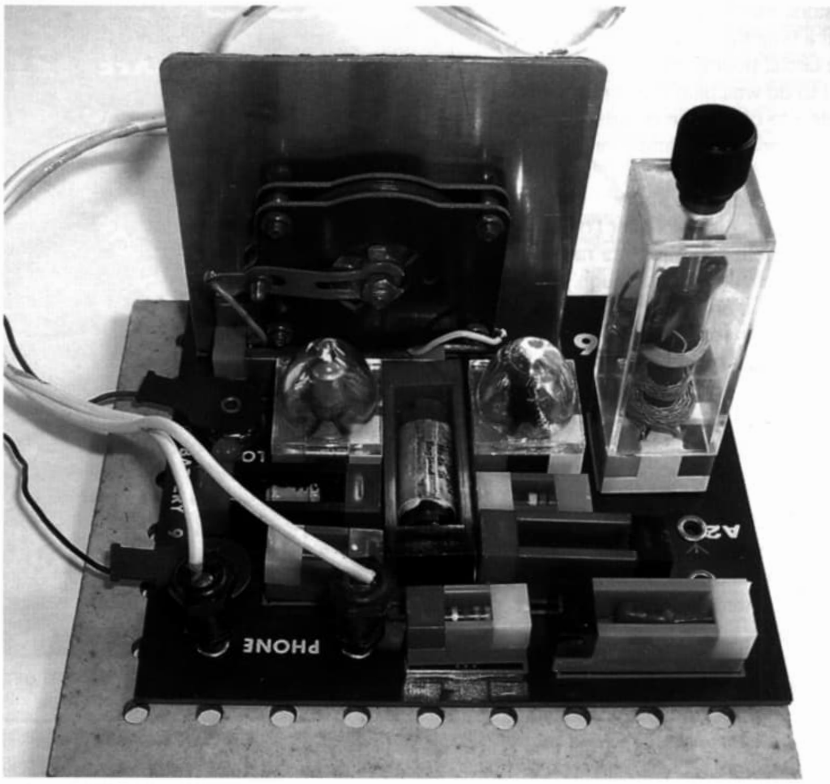
Circuit 3, illustrated here, is a one transistor receiver with regeneration. The adjusting part of the coil is used to control the amount of positive feedback. My only previous experience of regen was a Sinclair Micro Six, and that many years ago so I was very interested to explore the circuit performance. I live in Sevenoaks, Kent. Using a long wire antenna about 12m length, run from the guttering of my two storey house to a tree across the garden, I was able to receive Radio 5 and Talk Sport very strongly on MW and Radio 4 similarly on LW. By careful adjustment of the feedback, just on the verge of oscillation, I could also receive another Radio 5 transmission, Radio 4 on MW and a French station at about 1800m LW. The station separation with this circuit is probably the best of all six, but it is fiddly to operate.

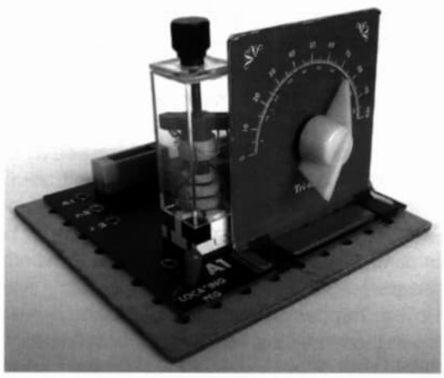
The original headphone supplied is a magnetic moving-diaphragm type, about 1kΩ DC resistance. It works well but the sound quality is not good and it is inconvenient to hold it against your ear. Since I intend to use the Tri-onic circuits as bedside radios (in place of a crystal set I built about 20 years ago) I have substituted a pair of modern 32Ω earpieces, the MP3 player type, for the headphone. To impedance match these with the circuits I use a small 6V mains transformer salvaged from a broken clock/radio. The mains winding replaces the headphone in the circuit and the 6V winding drives the earpieces, connected in series. With this setup the sound quality is very good.

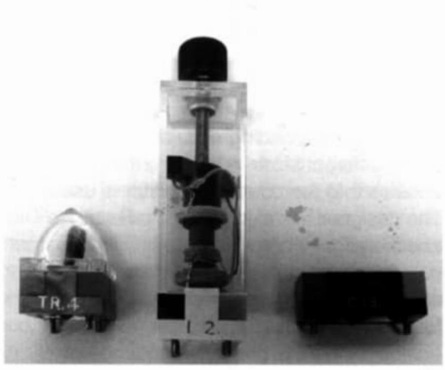
An instruction book provided with the kit is clearly written and easy to follow – I don't recall any difficulty making the radios work when I was 10yrs old. The only failing is a lack of explanation of how the radios actually operate – the RF/AF theory. I think even at that age I would have been able to understand the basic ideas from a few simple diagrams, and that would have made my toy seem even more wonderful!

The Tri-onic was an excellent and educational toy, in the best traditions of Meccano and the like. If my memory is correct it cost just under £5 in 1961; quite expensive for a toy but not at all excessive compared with transistor radios of the time. It worked well and certainly taught me a lot – in fact it started my lifetime electronics hobby.









As easy as ABC by Dicky Howett

The erstwhile Manchester home of ABC Television is but a distant memory (you remember ABC Television? – come on now, that was back in the days when ITV was ITV!). Demolition, it seems, is the pre-ordained fate of most pioneer tv establishments. For example, A-R TV's Wembley got razed to make way for a German supermarket. Lime Grove bit the dust for 'social housing' and Alexandra Palace could easily be lined up to tumble (or succumb to another fire perhaps?). However, redundancy is the name of the game and sentiment never entered the broadcasting balance sheet.

The main studio (Studio 1) was approximately 100ft x50ft. It was also a rather irregular shape. However, the studio was a relatively convenient production base (apart from the fact that the actors had to be dragged up from London each week) with all amenities on tap, not least a handy pub called The Parr's Wood located directly opposite the studio.

The aforementioned ABCtv studio home was originally a cinema called the ABC Capitol, and it was situated in Parrs Wood Road, Didsbury, Manchester. The Capitol Cinema once stood proud as the northern studio base of ABC Television with its famous top-rated flagship drama programme, 'Armchair Theatre'.

The Capitol at Didsbury was not the first choice for ABC Television. Hasty conversion of ancient theatres and cinemas into television studios was not an ideal solution. But the management of the (then) new commercial television companies couldn't afford to be fussy. ABC Television had to be 'on air' at the advertised date. Advertising cash dictated!

Howard Thomas in his book 'With an Independent Air' recounts, "We were due on the air in the North on 1st May 1956, three months after our Midlands opening. Lancashire was already promising to be a county of television addicts. ABC cinemas had several white elephants in the region which they would be happy to sell. One of their largest and best equipped cinemas (and one of the emptiest) was the Capitol at Didsbury which had been built as a combined cinema and theatre at a time when the industry was augmenting its film shows with lavish stage spectaculars.

This was the sixth cinema in the Manchester area I had visited. As I climbed to the projection booth high at the back I realised that this theatre, with its ample stage and auditorium, with dressing rooms and other facilities, was the right place for us. Adjoining was a vast car park, ideal for the housing of our three outside broadcast units and their satellite vehicles. But I did not regard ABC Television as fully on the air until we had the Manchester studios in operation. It was a tight schedule and our engineers, some of them poached from Marconi's, worked all night to complete the final wiring of the Didsbury control room. We also constructed the main studio floor above the roomy stage and into the stalls, still leaving room for an audience which could be intimately close to the performers. The outsize cinema auditorium became one large television studio, with a second and more compact studio at balcony level, where we were able to produce less ambitious programmes such as panel games and advertising magazines".

The main studio (Studio 1) was approximately 100ft x50ft. It was also a rather irregular shape. However, the studio was a relatively convenient production base (apart from the fact that the actors had to be dragged up from London each week) with all amenities on tap, not least a handy pub called The Parr's Wood located directly opposite the studio. After transmission, pressured thespians could (if they so desired) relieve tv tension at the drop of a pint. Famous stars of stage and cinema could be glimpsed at weekends tottering across the road for a swift fag and a G&T. Unfortunately, the rigors of live weekly drama could take their toll. Actors could literally die for their art, as happened once at Didsbury during a 1958 live 'Armchair Theatre' production entitled 'Underground'. An actor expired between 'part one' and 'part two', leaving the director William 'Ted' Kotcheff with no option but to wing it for the remainder of the play.

Eventually, all ABC television drama production moved south to Teddington Lock, converting the studio space vacated by Warner Bros. The ABC northern base was retained as an OB site and local programming facility. Latterly, when ABCtv and then Thames Television disappeared forever up the electromagnetic spectrum, the redundant Didsbury Capitol studios reverted to student-theatre use, run by Manchester Metropolitan University. Famous MMU alumni included Julie Walters.

Fables from a Cold Field part two And now in colour...

Being fairy-stories told to the Author as a young engineer

by Ray Cooper with further amendments and amplifications by Norman Green. Illustrations selected and sourced by Phil Marrison.

Fig 9: The open day

And Now, in Colour...

Colour came to BBC2 in the late summer of 1967. Everyone was quite confident: the transmitters were only a few years old, most of the teething troubles had been got out of the way (it was felt), and did not the advertising blurb for these transmitters say that they had been designed with colour in mind? (Fig 8)

When the first colour signals were piped down the line for test purposes, we soon became disillusioned. The 'colour in mind' that the manufacturers had was obviously not of the PAL variety. The picture looked as though it was being viewed through a fine Venetian-blind. The source of the problem was soon located to clamps within the video-corrector chassis – evidently the clamping action was much too hard, and since they were clamping on the back-porch of the waveform, which was where the colour-burst resided, they tended to push alternate lines up and down in lift as they tried to clamp to odd bits of the swinging burst that is a feature of the PAL system. Ironically they probably would have worked perfectly well with an NTSC signal, whose burst does not swing.

The modifications needed to cure this were quite simple, however – the clamps were 'softened' at subcarrier frequency by including a parallel tuned circuit in series with them.

Initially, tests were only radiated out of programme hours. It was only natural however that the studios should wish to get their hands in, and so after a while programmes in colour started coming up the line. Since transmitter modifications across the country had not been completed, these could not be radiated in colour – so the colour information was removed with a switchable filter at the transmitter input. This of course didn't stop the station staff watching any programmes in colour on their monitors...

One of the first to be seen was 'Bonanza', and very good it looked after years of monochrome. But of the home-made product, perhaps the first and finest was 'Late Night Lineup', with Joan Bakewell ('The Thinking Man's Crumpet'). Late at night, all station staff would crowd into the control room to critically assess the colour balance and, er.. the legs....

It was about this time that a local Birmingham department store (and I shall not shame them by naming them) announced that they had acquired a colour television receiver, and it was displaying colour pictures, to be seen in their Home Entertainment department. Since I knew full well that Sutton was not in fact radiating colour information of any kind, I was intrigued and went along for a look myself.

It was an odd machine, about the size of a drinks cabinet and obviously converted, possibly on a laboratory basis, from a production American model – it had a large round 'double-D' picture tube. And yes, the pictures did seem to be coloured. Unfortunately, all of the colour was spurious, and caused by gross misconvergence. That didn't stop a good many onlookers admiring it.

By the time we were allowed to actually radiate colour signals, we knew that our goose was cooked. If the drive stability in monochrome had been poor, then in colour it was going to be awful. Colour signals suffer from more distortions than do monochrome ones, and two of these are linearity-related – 'differential gain' and 'differential phase'. Quite tight limits had been set for these, which the drive was totally unable to live up to. When we connected test gear and viewed these waveforms, the distortions could be seen creeping about on a continual basis, with occasional large (sometimes very large) jumps. The only way to keep the

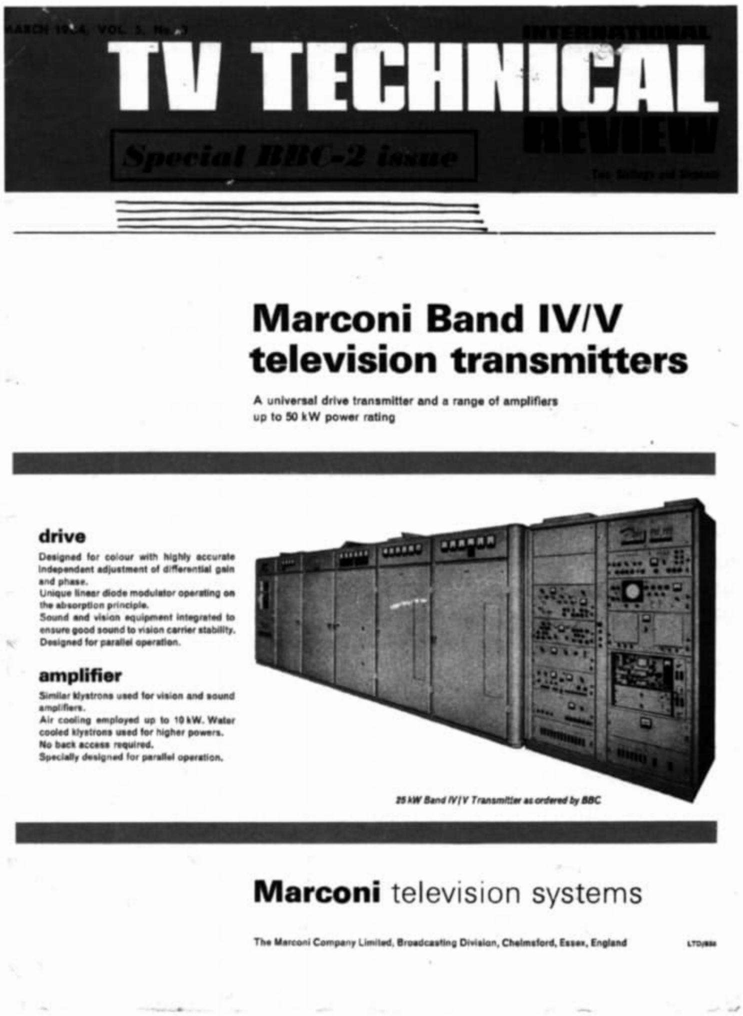


Fig 8: Marconi UHF ad

Fig 10:SC PO tube, 1949

Fig 11: November 1949, Bob Harmon taking measurements

gear anywhere near spec. was to adjust it more or less continually. This isn't practical in the real world, so we did the best we could, which was to check it every hour or so, and adjust as necessary. Sometimes it had just crept: on other occasions there had been a big jump. To illustrate, the limit on differential phase distortion at that time was ten degrees: jumps of forty degrees were commonplace, and on one occasion I personally claimed the all-comers' record of eighty-five degrees, which I suspect is close to the theoretical maximum possible.

The reason for all of this became apparent – the gear may have only been three years old or so, but it was physically worn out from over-adjustment. Whole items in the modulator assembly had to be refurbished. And we were not alone. To illustrate:-

Sutton held the (one) base spare diode modulator assembly (we were fairly centrally located in the country). There was a desperate call one day from Pontop Pike, where these units were also used. 'Please send us the spare modulator, we can't get ours to work at all'. Being kind-hearted we did so, after extracting a solemn promise that they would then immediately send the faulty unit to Sutton for refurbishment - which they did.

I must explain about these units. The cavities, which were the bits that got adjusted the most, were tuned by sliding a set of earthing spring fingers along the inner conductor of a co-axial cavity: this inner conductor was a flat bar of brass, heavily silver-plated. It is to be expected that after much adjustment, the plating wears down and the bar has to be re-plated. With the returned Pontop units, not only had the plating gone – most of the bar had been worn away as well, and the spring fingers were not contacting anything at all, just moving along inside a groove that they themselves had chewed. Possibly the rather abrasive air around Pontop (there were still many coalmines operating there in those days) may have speeded the wear.

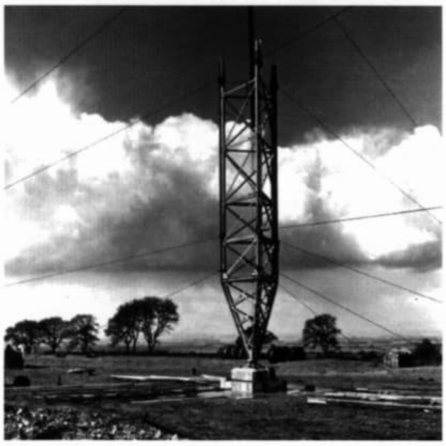
Gradually the problems were got on top of. With refurbished units, and less vigorous adjustment, the units would last a few more years before they needed attention again. But in reality, the only cure was replacement of the drives with more modern models.

Positively the Last Open Day Ever

In the 'fifties and early 'sixties, it was the BBC custom to occasionally hold public Open Days at various studio and transmitter sites around the country, where anyone could come and have a look around these sites and see how they ticked. Sutton was not immune from these visitations, though the only one that I was ever involved with was the last one of all, which was held, if memory serves, on a Saturday in the summer of 1967. The fact that it was the last one was not, I firmly believe, my own entire fault, but along with many others I certainly contributed.

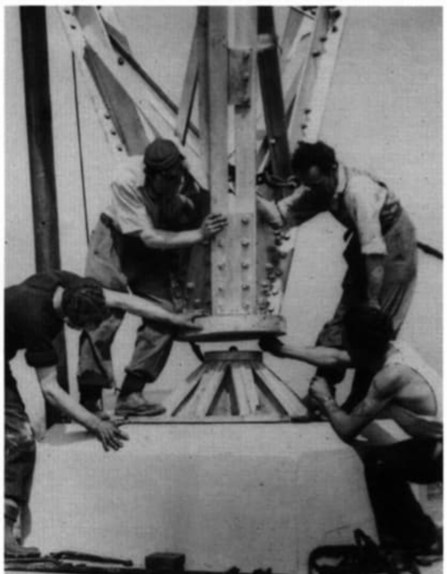
1967 was a good year for an open day, for that was when colour came to BBC2 and the BBC would have something to showcase. Now I don't know quite what public expectations were – after all, transmitters are merely impassive lines of grey humming boxes, lacking sustained dramatic impact – but evidently the thing had been got down to a fine art in previous open days, and there would be lots of display items and other attractions. In particular, there would be the 'Hall of Colour', where the public would be able to view genuine colour images on production TV sets (such items were not readily available in the shops at that time, since colour was only just starting and sets were very expensive items). Another item was a genuine Percy Thrower, loaned to us by the BBC Birmingham production studios, which people would be

Fig 12: Mobile test gear



May 1949, mast under construction

June 1949, view from mast



First section of mast

able to quiz on the fate of their begonias.

Unfortunately, with a couple of weeks to go, somebody got cold feet and thought that public attendance might be rather poor. The answer was publicity – the event was plugged mercilessly every night on the local news programmes and other opt-outs, and it was hoped that this might do the trick.

It succeeded far better than anyone had envisaged. By mid-morning (it was a Saturday) the police had to divert traffic away from the nearby A38 because the local village, Mere Green, was totally choked by cars waiting to get into the site. Cars were parked in an adjacent field, and a long queue wound its way across to the main building. (Fig 9)

It is on record that in excess of 20,000 people passed through the front door on that day, and thousands more made unrecorded entries by other side-doors. Most people had to wait for up to two hours just to get into the site. Fortunately it was a blazing hot day, and the local ice-cream salesmen did a roaring trade.

And what did folk see when they got in? Not a great deal, it has to be said. There were far too many people packed in there for anyone to see much at all. And when they finally reached the much-vaunted 'Hall of Colour', (which was the then-unused BBC1 UHF hall, decorated up and provided with three Decca CTV25 receivers on plinths) they didn't have time to stop and stare because the pressure of the crowd behind propelled them onwards. Not that there was always much to see: London had declined to make available any continuous colour programming, so what was shown were the normal trade colour demonstration films (which admittedly were of extremely high standard) interspersed with 15-minute slabs of colour test-card. If you got there when test card was showing, you would have been forgiven for feeling that your two-hour wait in the open air, followed by perhaps a half-hour of having your bunions trampled on by the crowd, were not worth it. Such were evidently the feelings of one elderly lady who, dressed in black with a floral hat and waving a brolly, looked exactly like Grandma Giles from the Daily Express cartoon strip. Since I was standing nearby and, presumably, looking slightly Official, she began ranting at me that this was no way to treat elderly citizens, together with lots of similar material, and was just about to land a good blow on my ear with the brolly when fortunately the crowd surged forward and carried her off, still waving the gamp in the air and cursing volubly.

At one point, a small bored child wedged into the press of people, found an interesting item to divert him – an intriguing switch on the outside of a cabinet. This was too good to miss, so he turned it to see what would happen. What happened was that one of the BBC2 transmitters fell off (the switch was for the 50volt DC control system supply), and it took a good five minutes for an engineer to force his way from the Control Room (where any sensible staff had barricaded themselves in – it was not open to the public) to the UHF hall, even using such off-limits shortcuts as were not blocked by a press of bodies.

Lots of people found fairly just grounds for complaint, and there were a good few letters written: the net result being that the BBC decided that enough was enough, and no more open days would be held. In any case, the deteriorating security situation in the country (the IRA were beginning to get active again around this time) meant that such open-door events would not again be feasible in the foreseeable future.

Retreat of the Daleks

This incident has no direct connection with Sutton, save that the protagonist, 'R', was later a senior member of Sutton staff. On the other hand, it's much too good an anecdote to miss. Those who met 'R' in later years would see an amiable, avuncular character radiating goodwill to all. It was hard to believe that, as a young lad, he had a scarring encounter with a Dalek....

It was shortly after the Last Open Day Ever, at Tacolneston (near Norwich) where 'R' was a junior engineer at the time. Tacolneston had also had its own open day, and whereas Sutton had netted Percy Thrower as a draw, Tacolneston had the prime attraction – a Dalek, fresh from its latest triumphant season in Doctor Who, but now 'resting'. Some reports suggest that there were in fact two of the creatures, but in the event, one proved more than enough.

After the open day, this Dalek had not been immediately removed, but pushed out of the way into the transmitter hall, and left reposing at the end of some equipment bays, awaiting collection.

The evening shift at TAC in those days was a small one – two: a shift engineer and a junior accomplice – 'R' in this case. It had been noticed that for the previous week 'R' had been casting covetous eyes at the Dalek, and was occasionally to be seen fondling it.

In the end, the SE gave in. "All right, 'R', I can see you won't rest till you've got it out of your system....". In a moment, the lid of the Dalek was off, and 'R' inside. With the lid replaced, he then spent a happy quarter-hour or so trundling up and down the transmitter hall, pushing the sink plunger in and out, and croaking "Ex.. ter..mi..nate" in the approved manner.

At this point, the front door bell rang. Now Tac is fairly isolated, and in the evening a ring on the bell was most unusual. "You just stay in there and lie doggo, 'R'. I'll go and see who it is and get rid of him."

When the door was opened, two imposing figures were standing there. "Good evening," the gentleman began, "I am Mr. _____, the Head of Department of _____," (naming a BBC department having London headquarters) "and this is my lady wife. We are on holiday in the area, and just happened to be passing. My wife remarked that she had never seen the inside of a transmitting station, and I was wondering if you would be good enough to give us a quick tour."

Well, I am sure that the SE's immediate reaction was to say, "Go away" and slam the door... but that wasn't really an option under the circumstances. So with as good grace as he could muster, they were ushered in and the tour began.

"...and over there are the Combining Units...". The SE was desperately trying to keep them away from that alien object in the corner. But it was no use – the thing was like a magnet, and before long the HoD was standing before it.

"So this is a Dalek! I've heard all about these from my grandchildren... Fun, aren't they?" – and without ceremony began to waggle the ray gun about. Eventually he pushed in the sink-plunger, and there was a distinct "ooff" noise from within. "Did you hear that?..." and he did it again, with the same result. Bending down and peering into the grille at the top, he remarked "There are a pair of eyes in there, staring at me....".

"Okay 'R', it's all up. You'd better get out." Which 'R' did, and slunk off crimson-faced to make the tea.

At the end of the visit, the HoD buttonholed 'R' and posed a somewhat two-edged question.

"Tell me, young man, do you enjoy working for the BBC?"

There Seem to be a Lot of Parts Left Over...

A transmitting site isn't just about transmitters. There are always lots of other details, which I haven't been able to fit into any of the foregoing. For greater completeness, here are a few.

The Juice

Transmitting stations use a lot of power. If that power disappears, a lot of people have blank screens. So the rule is, This Shall Not Happen. To this end, all main transmitting stations in the U.K. have two separate mains feeders, approaching the site from two different directions and fed from different sections of the National Grid. (Actually, there is one exception – it was found impossible to provide two mains feeders for the UHF station at Bilsdale except at disastrous expense. So that station has its own private gas-turbine installation as a standby. There is quite a story behind that, but not for these pages).

These two feeders may be used in different ways, but at Sutton they fed into an automatic changeover system, that in the event of a failure of the feeder in use switched over to the other feeder if the break exceeded about seven seconds. Mains came into the station at 11kV, three phase, and was transformed down to 415V three phase.

Upon the arrival of FM in the 'fifties, the station was also provided with its own diesel-alternator standby generators. These were paid for by the Government, who felt that sound broadcasting stations would be an essential link in the event of any national emergency (nature unspecified) that could cause power disruption sufficient to black out large parts of the National Grid. Whether they considered the fact that the number of battery-operated FM receivers in use at that time was minuscule, is unrecorded.

These diesels were 120kVA units by Paxman, three of them housed in a newly built detached diesel house. They could be run in parallel to provide enough juice to power the complete FM system. In fact they hardly ever did so: testing them in this mode was impossible without causing a break in programme, so what was done was to use two of them to power half of the FM system. Since the diesels were now rather under-run, adding the medium-power reserve 405-line transmitters running into test load made up the shortfall.

They were completely manual in operation. They had to be started manually (no, you didn't have to crank them by hand, they had motor starters, but someone had to push the button), synchronised together manually, load-switched manually and stopped manually. It was a wise idea for somebody to keep an eye on them whilst running, because if one of them dropped off due to some problem – overheating, low oil pressure etc., the remaining one would try to carry on manfully but of course became itself heavily overloaded and usually ended up belching dense black smoke from the exhausts. They wouldn't stand too much of that sort of thing.

Testing them may have been one thing, but it takes a real emergency to show up the flaws in the system. So when, early one morning, the juice went off on both feeders and the station was plunged into darkness (save for the emergency lights – fed from a 110volt battery), the night watchman, who was the only person on site at the time, had no option but to rouse the Engineer-in-Charge from his slumbers. Well, the EiC had no problems getting the diesels running, and shortly afterwards such services as should have been, were radiating. That is to say, the transmitters were on – unfortunately, there was no programme modulation on any of them. The subsequent witch-hunt revealed that there was just one panel of amplifiers in the Lines Termination Room that had never been connected to the diesel-maintained supply.

When the PCM link came into operation, its power supply became more critical since not only Sutton but also all points north were dependent on it. A manually started diesel was of little use in the middle of the night, and even in the daytime the Paxmans could take several minutes to be up and running. So a small auto-start Lister diesel-alternator set was provided which powered the PCM SHF links only, and lived in a corner of the diesel house. This would auto-start after about ten seconds if both mains feeders or the changeover system failed.

The Pictures

Some stations get their pictures off a microwave link, but Sutton has always used some form of cable. For the 1949 opening, the Post Office (as it then was) provided no less than two different routes from a main London exchange (MUSeum, I think, but may be wrong) to the main Birmingham exchange in Steelhouse Lane. One route used a UHF radio link, the other a co-axial landline. In any event, the links from Alexandra Palace to London, and from Birmingham to Sutton, were by co-ax cable.

The intermediate link used for the opening was apparently the UHF link, specially developed by the Post Office, using multiple hops on 900 MHz and designed to be reversible, so that programmes originating in the Midlands could be sent to London. Reversing was meant to be done in a matter of seconds, but legend states that the first time it was tried, it took hours to get it back...

GEC–Osram A3012

The BICC 750 foot high stayed lattice main mast

May 1949, mast under construction

There was a tower on the London exchange roof, linking via intermediate repeaters at Ivinghoe, Charwelton and Rowley Regis, to a similar tower on the Steelhouse Lane exchange roof. Quite large parabolic dishes were used, of openwork mesh construction.

The other method was by co-axial landline cable connecting the London and Birmingham exchanges. The cables used were a special type incorporating two 0.975inch diameter co-axes, and multiple twisted-pair circuits for sound programme, control lines and telephones. (Fig 10) The entire cable was about 2.5inches in diameter, and lead-sheathed. Initially, the vision signal was modulated onto a lowish frequency RF carrier, instead of plain video, to ease equalisation problems.

At Sutton, the cable emerged from a hole in the ground into the L.T. (Lines Termination) room, having made its way from the main Birmingham exchange in Steelhouse Lane via various intermediate telephone exchanges. The vision signal was demodulated with Post Office owned equipment and then handed on to BBC equipment. One co-ax circuit ('tube' in Post Office parlance) was used as the main feed, the other one carrying a standby signal.

The UHF link was never completely successful, seemingly. It had design problems, which meant that its performance was never quite up to BBC expectations. Quite early on, it was relegated to absolutely-last-ditch standby duties, and not long after that quietly switched off for good. The towers (well, at least the one on the Birmingham exchange) remained in place for many years, presumably having been diverted to other duties by that time. The Birmingham one remained until the new concrete Post Office Tower was completed adjacent to the exchange in the early 'sixties.

At some date in the early 'sixties, equalisation techniques had advanced sufficiently to enable the Post Office carrier gear to be removed, and vision signal distribution was thereafter done using a plain baseband video signal.

When BBC2 arrived in 1964, a new vision cable was required. This was smaller in diameter than the original, and contained four 0.375 inch diameter co-axes, rated as being colour-capable. Spare circuits therefore became available.

When colour came to BBC1 in 1969, the old vision circuit remained in use, but had to be re-equalised for colour service. This was done using tandemed equalisers: there was hardly any chroma visible on the signal coming direct from the tube, only a few percent of normal: but by using modern equaliser designs, this could be jacked back to 100% without wrecking the noise performance of the link. The circuit from Birmingham to Sutton was connected up as one continuous length: no repeaters or amplifiers, so effectively it was about a nine-mile cable that was being equalised. The benefit was that both of the 'one-inch' tubes now had no associated Post-Office equipment between Pebble Mill studios and Sutton, and so were reversible under BBC control.

One of the tubes was permanently allocated for BBC1. The other on, being reversible, could be used either as a standby for BBC1, or as a return path to the studios for OB contributions. However, there was always the possibility of losing it all. This happened on at least one occasion, when a construction worker put his digger through the whole cable. A cable of this complexity takes some time to repair, and to form an interim feed Birmingham Comms. Department hurriedly rigged up an OB link transmitter on the roof of the studios, which was picked up at Sutton by the usual OB link receivers (see TOBF).

At most transmitting sites, useful standbys are provided by using off-air reception of a nearby main transmitter. This option didn't work at Sutton – it was the only nearby main transmitter. It got excellent signals from Holme Moss, but since this was further up the distribution chain it didn't help if the failure was between London and Birmingham. (The reverse path, Sutton to the Moss, was also excellent and much more useful to our northern cousins). Neither Alexandra/Crystal Palace nor Wenvoe gave usable signals. Oxford, which could have been of use, was in 405-line days only a low-power station. However in later years, when UHF TV started, Oxford became a high-power site and the BBC2, and later BBC1, pictures were, if not perfect, at least usable. The only snag was that Oxford, in those days, re-radiated Sutton Coldfield...

There were ways round this problem: means existed to induce Oxford to use Crystal Palace as its main feed instead of Sutton. Since such methods are probably still in use, and may have slight security implications in view of the number of malcontents who seek to disrupt broadcasts, I shall not enlarge on them. Additionally, similar facilities enabled Sutton to rebroadcast FM radio signals from Oxford if needed.

Much later – around 1990, in fact – British Telecom tried to re-negotiate line rental fees across the country. Video private circuits have never been cheap, but their proposed increase amounted to a factor of about three. This was a lot for the BBC to swallow. Fortunately, the monopoly stranglehold on permanent point-to-point links that the P.O./B.T. had enjoyed for years was at an end, so the BBC went round all potential providers with the shopping bag. In the end, they decided on Energis.

Energis were at the time a subsidiary of National Grid. There had been all sorts of uninformed chatter in the press that Energis were going to 'send TV pictures down the mains'. The reality was rather more prosaic and believable – they were going to use the earth-cables running from top to top of electricity pylons across the country as support for a fibre-optic data highway: the fibre was wrapped in a very slow spiral round the earth cable. There was a suitable Grid power line handily close to the site. Transmission down the fibre was done digitally of course, and there was plenty of room for at least two TV channels and the PCM sound distribution system. All of the necessary decoding gear was provided by Energis and installed in the L.T. room. Switching the PCM distribution to another supplier meant that the BBC-provided PCM SHF link became redundant, but it was not scrapped at that point since it might have further uses.

The TOBF

What was that? Well, it stood for 'Television Outside Broadcast Facility'. In those distant days before satellite links, if you wanted to do an O.B. you had to provide a temporary land-based vision link to get the pictures back to the studios. Quite often you could get away with a single hop, so long as you could get your link aerials as high as possible.

Well, at the O.B. end you were limited to about eighty feet or so, if you used an Eagle Tower. These were basically zip-up telescopic towers mounted on a lorry, much in the style of a fire-brigade extending ladder. At the receive end, you could do much better - there were all these tall transmitting masts dotted round the country, many of them already connected to studio centres by cable or microwave...

The O.B. receive aerials at Sutton were 4 ft. parabolic dishes – two of them mounted on the corners of the maintenance platform at 600 feet, just below the F.M. cylinder. These dishes were mounted so that they could be rotated to point in any required direction under motor remote control. Of course, for a certain part of its rotation, a given aerial might be trying to look through the mast and so would be of no use: but the pair, between them, gave 360-degree coverage.

They worked in the 7 GHz band, and the masthead installation consisted of a balanced-diode mixer, a reflex klystron local oscillator and the front section of an I.F. strip. The reflex klystron could be tuned through the band, again under motor remote control, and the resulting I.F. signal was piped down the mast in co-ax to the O.B. room, where the rest of the link receiver and all of the control gear resided. From there it could be piped to Pebble Mill using one of the 'one-inch' Post Office tubes, reversed.

Mostly, all of this gear was set up and run by an engineer from Birmingham Comms. Department, who came up for the day (usually a keenly looked-forward-to visit, since the canteen at Sutton was then regarded as superior in quality to the studio one, and there were not so many annoying telephones ringing all day). But there was just one circumstance where we were allowed to get our hands on for ourselves.

This let-out came in the form of the Regional Contribution Studio at Nottingham. Which sounded very grand, and in these days has been expanded into something quite substantial: but in those days amounted to no more than a tiny studio with one camera channel, self-operated by the presenter that was going to do his piece. On arrival he would merely switch it on at a master switch on the wall, and go have a cup of tea whilst the gear warmed up. The studio was connected by landline to a fixed SHF dish mounted on a tower on the top of the nearby Technical College, and pointing at Sutton. It radiated on an O.B.-allocated frequency.

When the regional news programme (Midlands Today) wanted to do an insert from Nottingham, they would tip us the wink and somebody would shamble round to the O.B. room and switch the gear on. Probably it would not be already set up in the Nottingham direction, so he would have to pan the dish round onto the right bearing (Dymo label stuck onto the top of the bay) and tweak the klystron for the correct frequency (another Dymo label). If the Gods were with him, some sort of signal would be received, and the dish could then be nudged to and fro for the strongest signal. Then the klystron would be tweaked for best linearity of the video waveform. It's actually quite a way from Nottingham to Sutton, rather more in fact than is healthy for a link using four-foot dishes. So the pictures that you got would depend rather on atmospheric conditions. If propagation was odd, or there was heavy rain, the pictures might well not be usable, in which case the studio had to be rung with the bad news that it was all off. They would then hurriedly have to find something to plug the gap.

In later years, the studios were much expanded, and a permanent and decent link provided, using an intermediate point on Bardon Hill.

Testing Times

Most large transmitting stations need test signal generators. At Sutton, signals were needed not only to test transmitters, but also as drive waveforms for caption scanners, monoscopes, film channels and so on.

The Waveform Generator originally provided in 1949 was the most fearsome beast. It stood nearly six feet high and occupied two bays of equipment – a Mighty Wurlitzer of an instrument, larger than the average sideboard.(Fig11) It is a solemn thought that, thirty years later, most of its functions could have been replicated by a sixteen-pin integrated circuit. But it was built on a heroic scale. It was almost certainly the only waveform generator ever provided for a transmitting site that ran on three-phase mains. The reasons for this were always rather obscure. The original Alexandra Palace waveform generators, which principally fed the studios, was also a three-phase beastie, but at least it had an excuse – its master oscillator was locked to mains frequency by a control system which involved a three-phase synchronous motor. In the Sutton contraption, phase locking was done all-electronically and there was no need for three-phase.

This phase-locked system was one of the very earliest ones, wasn't tremendously stable but made up for that by being faintly entertaining. Once a shift, it had to be set to the middle of its control range, manually. To assist this there was a small CRT screen provided, displaying an interesting shape. Basically, this was a wide flat ellipse, drawn out by the 50 Hz. mains frequency, superimposed on which was a rectangular pulse derived from the field drive output waveform of the generator, also at 50 Hz. When everything was set up properly, the pulse should have been at the top centre of the ellipse, giving the display a very rudimentary resemblance to a submarine. If the conning tower was too far forwards, or too far back, a quick tweak on the master oscillator control knob would bring it back to centre – 'setting the sub'.

In addition to all the drive waveforms needed by the caption scanner (line and field drive, line, field and mixed syncs) there was also a range of outputs for the transmitter. 'Black and Syncs' – just plain mixed syncs – would keep the transmitter happy if the input signal disappeared. 'Sawtooth' – a rising ramp waveform – was indispensable for setting up the transmitter linearity. 'Flagpole' – a narrow white bar on a black background – gave its users the haziest of ideas about the pulse response of the transmitter. And, my personal favourite – 'Art Bars' (short for Artificial Bars) – a black St. George cross on a white background, the very first of all the electronically-generated tuning signals.

With the passing of years, rather more sophisticated signals became available for circuit testing. 'Sawtooth' was largely replaced by 'Staircase', a stepped waveform that was easier to analyse quantitatively. 'Flagpole' was replaced by 'Pulse and Bar', which at least gave some real information about frequency and phase response, at last.

Unfortunately, although there were some perfectly good versions of these waveform generators available (the Post Office made their own, which were very satisfactory) the BBC insisted in going its own way and designing its own. The pulse and bar generator was not too bad, but the linearity generator, used to produce 'staircase', must have ranked amongst the worst bits of test gear that I ever had to use. Not that, when working, it didn't work well: unfortunately, it was seldom working. Unlike the Post Office gear, which used delay-lines to set up all of its internal timings, the BBC version used interconnected mulitivibrators – all done with valves, of course. The thing was just not stable. If it produced an output at all, succeeding lines of the waveform could well have different numbers of risers in the staircase: or occasionally the sync pulse would be half-way up the waveform. Fixing it took patience, (usually) a complete re-valve, and days. The unit was, in the truest sense of the phrase, a complete waste of time. Later BBC versions of the gear used transistors and a completely different design philosophy, and worked well.

Having got some test signals, you now need measuring gear of some sort. There must have been some sort of test demodulator supplied with the 405-line transmitters, but it seemed not to have survived long. Certainly, after only a few years a BBC-designed test demodulator in the RC1 series was being used – all valve, of course, but its performance was pretty good – probably an order of magnitude better than the transmitter it was measuring. Other than that, test gear seems to have been pretty thin on the ground, in the early days.

FM radio measurements centred about a distinctly non-portable bit of gear supplied with the original installation, the 'Station Monitor' (believed to be by Marconi – it certainly didn't feel like S.T.&C. anyway). This was a bayful of equipment seven feet high, but it did enable you to measure almost anything. Apart from being a high-quality demodulator, you could check carrier frequencies, modulation carrier shift, FM and AM noise, and deviation. The deviation measurements were done with a Bessel Zero technique, which I'm not going to describe in these pages since it is highly mathematical and I might not understand it. But potentially it was a highly accurate technique, though difficult and subject to operator error.

Almost all fault-finding work was done using AVO multimeters, and cathode-ray oscilloscopes. Of the latter, there were two: a BBC designed and built unit, the Type B, and an EMI waveform monitor (WM series), again probably supplied with the transmitters. The Type B was a general-purpose 'scope slanted towards TV usage, and had the benefit of a reasonably large (six-inch) screen. Its performance was adequate and it made no pretensions to accuracy. The EMI unit was intended to be a bit of precision measuring gear, and to a large extent it succeeded in this. It had a quite distinctive appearance. It was trolley mounted, and had two units: the power supplies mounted at the trolley base, and the display unit, which intriguingly was trunnion mounted on top of the trolley in such a manner that it could be tilted for optimum viewing position. Measurements were done with calibrated X-and Y-shifts: the Y-shift used a centre-zero cirscale meter movement displaying volts, but the X-shift, whilst similar in appearance, was in fact only a pointer mechanism travelling over graduated scales, and coupled to the X-shift control via a belt system. The display tube was 3.5inch diameter flat-face with good focus. It had a separated pair of graticules to enable measurements to be taken without parallax error, and these were illuminated by four lamps enclosed in bulbous extensions of the display bezel: the appearance was of a stylised letter 'X', and with the circular shift meters on either side, the whole front-plate simply screamed the word 'OXO' at you. Accordingly, the machine was known on site as the 'Oxometer' – "oxo'meter n. Instrument for measuring bullshit [f. OE ox bovine animal; see –o-, -METER] - as the OED would have had it.

These instruments were adequate for 405-line use, but completely outclassed when 625 lines and later colour came along. Later instruments included a Tektronix of unknown provenance and a Marconi TF1277 'scope, both of which had vastly improved performance, but were still 'valve gear', meaning heavy power supplies, and so were still trolley-mounted. But by the 'seventies transistorised gear was becoming available, smaller and capable of being carried about (by one hand!). These were mostly from Tektronix, Hewlett-Packard and Philips.

Carrier frequency checking for TV was originally done by an intriguing bit of BBC gear, which used a standard-frequency transmission (Droitwich 200kHz) as a reference: via suitable multipliers, this drove the deflection systems of a small CRT display. The frequency to be measured brightness-modulated the display, to produce a series of dots, which would be stationary if there was no error, but would slowly chase themselves round a circuit on the display if there was one. By noting the speed and direction of creep, the error could be estimated. It was of most use, of course, for setting the frequency spot-on.

Much more impressive was a bit of genuine frequency-measuring gear that was provided towards the end of the 'fifties. This was by either H-P or Tektronix (and I can't remember which) and was again valve-operated, massive and trolley-mounted. It covered the range 0 to100 MHz or thereabouts, and the display was by neon tubes illuminating transparent numbers from behind. There were columns of these lamps. When counting, the neon lamps chased one another about in a most diverting manner, and when the count stopped, the result could be read out. The device was known, of course, as the 'Fruit Machine'.

In the 'sixties, this device was used to measure not only Sutton's own carrier frequencies, but also those of other stations. This came about because somebody realised that the new Band I aerial array would, when not in use, make an excellent receiving aerial by virtue of its great height. The idea was to connect it to a sensitive communications receiver (an Eddystone was used) and then beat the remote signal to be measured with a local signal generator, the frequency of which was then measured with the Fruit Machine. Each Monday morning before 9 a.m., 'phone calls were made to ensure that no high-power TV stations were radiating (they would have trampled the fainter ones). Then the beat-frequency technique was applied. Due to the fact that many stations sharing the same channel had in fact different offsets (small divergences, of the order of two-thirds line frequency: about 6.7 kHz – that were made to minimise visibility of co-channel interference) they could be sorted out by this technique and measured. A surprising number of distant stations were audible – Divis, in Northern Ireland, came romping in – and nearer low power stations could also be measured. Results were then 'phoned to the stations concerned.

Things like spectrum analysers were completely absent from the equipment roster of earlier days. They were exceedingly expensive, heavy, delicate and easily damaged. They were also regarded (by Head Office) as unnecessary, so far as station staff were concerned. They were for the use of specialist departments only. Should unusual circumstances dictate the use of one, it would arrive from London, together with a trained operator, and afterwards be promptly returned. Station staff were not permitted to touch the thing.

Eventually, the proliferation of UHF relay sites maintained by stations like Sutton meant that the 'unnecessary' viewpoint had to be reversed. Additionally, analysers were getting smaller, cheaper and more robust. When our first, very own H-P analyser arrived, it felt almost like the paper bag had been removed from your head – folk wondered just how we had managed for all those years without one. For example, with an analyser in one hand (you could just about lift one without risk of rupture), a frequency counter slung over one shoulder, and a suitcase of leads and adaptors to counterbalance you in the other hand, you were completely equipped to performance-test a small TV relay site. Previously, a vanload of gear would have been needed. (Fig 12)

The End of the Road

With the death of 405-line transmissions, there was a big change. By this point, the station was running fully automated and a good deal more reliably than in former days. There was no longer any requirement for a shift system, so far as the station equipment was concerned. About this time, though, the MICs (Monitoring and Information Centres) came into existence, and Sutton was to become one of the five of them. So there was still to be a shift requirement, and in general terms the staffing levels did not change much.

So it's time, as I promised at the start, to call a halt. At the present date, none of the equipment herein described remains in service.

... Tears, and Sweat

There was plenty of sweat, over the years (inside a transmitter on a roasting hot summer's day is no place to be). There were tears also: of frustration, and of rage (occasionally) but these were mostly made up for by the tears of mirth that seized us all from time to time, as from reading these pages you might well imagine.

Was it worth it? Of course it was. It was a totally fascinating job for most of the time (okay, dealing with overflowing cesspits at outstations might have taken the edge off it a bit, in later years) and one worked with such interesting people. And, as they say, it was much better than working for a living. In later years, a greybearded staff member might have been heard warning some new, young staff arrivals: 'Of course, you must bear in mind that most of the people round here are Characters. And all of them are fully accredited Weirdos.' Those were my very words.

Appendix A: The Half-Crown Tour of Sutton Coldfield, 1950 style

The station was built right on the edge of the Sutton Coldfield town conurbation, overlooking green fields to the north. As originally constructed, the buildings were rather smaller than the present spread of premises, and consisted largely of two wings set at right-angles in an 'L' formation: one was the transmitter hall proper, and the other the administrative block, canteen, kitchen and some store-rooms. Outside, detached from the main block, was a large garage and electricity substation.

Whilst we're still outside, just look up ...

Outside is the main mast: you can't miss it. It was a 750ft. stayed lattice mast, built by BICC, with the Band I TV aerials at the very top. See the appendix 'Original Band I TV Aerials' for more detail on these. All four of the original post-AP main stations used much the same design of mast, barring slight variations in height and constructional weight, to suit the prevailing geographic needs.

The other feature worthy of notice on the mast is the presence of the FM slot aerials, in position and ready for service, some eight years before they were to be needed. Somebody was evidently thinking well ahead.

As built, the mast incorporated its own lift, winch-driven. This lasted until the arrival of UHF broadcasting, when it was found that there was insufficient room for both the lift and the new feeders that were needed - so the lift had to go. Using the lift it took about five minutes to ascend: on foot, using the adjacent ladders, more like half an hour if you were fit.

Between 1949 and about 1968 there was also a 'baby' 150ft. mast adjacent. See the appendix 'The Reserve TV Mast' for its further history.

In we go...

... at the main entrance, located in the angle of the 'L'. Above the double-swing doors was the BBC coat-of-arms. Unusually, the motto beneath it was not the usual 'Nation Shall Speak Peace Unto Nation' so often seen: instead, the single word:

'Quaecunque'.

Now I am no Latin scholar, neither were most of the other staff, so I can't give you the literal meaning of this. However, I always believed that a general translation would be 'whatsoever' or perhaps 'whomsoever'. Most people felt that a translation 'What the Hell' would be nearer the mark. This was certainly the motto by which most of the inmates lived.

Everybody into the Band I Transmitter Hall, now...

This was quite a sizeable hall, long and thin. In the old AP installation, the control desk for the transmitters was sited in the transmitter hall, a location much too noisy for quality monitoring of sound output. Sutton had the benefit of a separate control room, with elegant curved glass windows looking out into the transmitter hall.

As the shift TA sat in his position of power at the desk, he could see the Sound transmitter out of the left-hand window, the Vision transmitter through the right-hand one. In front of him would be a number of picture monitors; above these, mounted on the brick wall between the windows, the transmitter Mimic Panels. These were delightful affairs that told him, in coloured lights, the state of just about every important item in the transmitters: individual power supplies, overloads, over-temperature warnings, water and airflow rates - everything a lad could want to know. On the top of all, there was a big lamp, which said simply - 'ON' - a nice touch, I always thought. The vision mimic panel itself must have had in excess of a hundred bulbs - all post-office wedge fit types - and replacing just the faulty ones was quite a maintenance effort in itself.

Outside in the main hall, were the two main transmitters - sound and vision. In typical BBC parlance these were given identifiers: the sound transmitter was known as T1, the vision T2. This was in line with the then-current BBC attitude that the sound part of the programme was more important than the pictures.

T1, the Sound transmitter, was a conventional affair. Basically it was a standard Marconi short-wave transmitter of the period, wound up in frequency to Band I, and with the modulator circuits tweaked for the extra sound bandwidth needed for TV sound. In those days television sound was of the best quality available on the airwaves. The transmitter ran at about 12.5kW output power. Being a standard unit, it gave little trouble.

T2, the Vision transmitter, was very much otherwise. A strange manufacturing hybrid, it was officially described as an "EMI-MetroVick". What this meant in practice was that the modulator sections had been made by EMI: most of the RF side and all of the power supplies (which were very extensive, and occupied another room) by Metropolitan Vickers. Each company had their own different way of doing things, which helped keep the staff on their toes. Metrovick seemed to have supplied the cubicles, into which EMI installed their units, and to round it all off there was a crystal drive unit by Marconi, but which being inconveniently located was later removed and installed in a separate external bay.

See the appendix 'How to Navigate T2' for details of the physical layout and circuitry involved.

Time to meet some of the staff

When first opened, the staff provision seemed to be somewhat extravagant, certainly so for an operation that only broadcast a few hours of programmes a day on one service. This staffing remained virtually unchanged in numbers, despite the introduction of many more services and greatly increased service hours, until the cessation of shift-keeping at the end of 405-line broadcasts in the early 'eighties.

The basic unit was the 'shift'. This consisted of four bods:

- A Senior Maintenance Engineer or SME. He was responsible for the shift, organised the maintenance, led faultfinding, generally called all the shots, and carried the can. In his spare time, if he had any, he dealt with the growing tide of technically related paperwork. Usually of a nervous disposition, he was quite often the first into the control room when the alarm bell rang.
- A Shift Engineer (properly an SE, more usually known as 'the Grade C'). He was the bloke that got his hands dirty. He was the fellow prowling round the building looking for trouble to develop. He was usually the victim selected to go into any equipment cubicle from which smoke was emanating. In Doctor Johnson's words, a Drudge (though not always a harmless one).
- Two Technical Assistants, or TAs. These, the lowest forms of engineering life, were the foot soldiers. In those days, the transmitter control desk was permanently manned (it had to be - any notion of an automatic TV transmitter was but a distant dream in those days: everything was hand-cranked). So the two TAs split the shift between them on the control desk. When on the desk, there would be quality monitoring, fault and event logging (every defect, every program start time was logged in those days), the passing of service messages by telephone to other manned transmitters, maybe originating local trade test transmissions, and of course responding to the inevitable breakdowns. When not on the desk, they would be assisting with maintenance, repairs, modifications, projects, training books, and most important of all, making the tea. This was a very important activity, and being deficient in that department dimmed many a young TA's future prospects.

So, for two shifts (day and evening) you needed twelve engineers – days off, sick and holiday relief included. To administer these lads, you needed an administrative staff:

- An Engineer-in-Charge (EiC). This lordly character was the ultimate can-carrier on site, responsible for staff, local finances, and all directly non-engineering matters. Despite the latter, he was also expected to be highly competent technically, with experience gained over a long period in a 'hands-on' post, since he was the final point of reference on-site for any technical queries that the shift felt unable to cope with.
- An assistant to the EiC (A/EiC) who was deemed capable of deputising for the EiC in cases of sickness, holiday relief, conferences in London etc. Apart from deputising, he had plenty on his plate since he was responsible for local procurement (lovely phrase) of stores and supplies.
- An Administrative Assistant (AA), or office secretary to you. It was generally recognised that this was in fact the one really indispensable person on site. Quite often the AA had an assistant of his or her own, during busy periods.
- A Cook. The site had its own canteen, serving full cooked lunches during the day shift. More than this: when I first joined, this sterling lady would not only rise at crack of dawn on Christmas Day to cook lunch for her own family, she would afterwards come onto site to cook another for the day-shift staff (and make sure there was something in the oven ready for the evening shift). There was no job-requirement for her to do this - she just did it out of the goodness of her heart. Bless her.
- An Electrician, dealing with site electrics, and later on with those of outstations as well. Also responsible for the conduct of the mechanical workshop - lathes, drilling machines etc.
- A (variable number of) labourers/cleaners/night watchmen, who usually rotated the various duties amongst themselves. Also dab hands with the mowing machines, keeping the grounds looking very tidy.
- A couple (later sometimes more) of Riggers, responsible for mast work and other mechanical items.

Finally, due to the staff numbers involved, there was in the earlier days a Uniformed Chauffeur; responsible for driving the official station wagon that the site possessed and which was the reason for the presence of the Garage. This last provision must seem strange to modern eyes, but it must be remembered that in 1949 car ownership was far from universal (most of the staff members couldn't have afforded one at that time in any case). Evening shifts would end around midnight, when no public transport was available. Visiting officials would probably arrive by train, and would have to be collected from the station in appropriate style.

The Chauffeur didn't last all that long (he must have been expensive to feed), though the need for transport services did. Eventually transport was handled by setting up a contract with a local taxi-firm, who would collect and deliver any staff member living within a five-mile radius of the station. Despite increasing car-ownership, this service continued more or less until the end of shift keeping when the 405-line service closed in the 'eighties.

Of shifts, there were two: the day shift, commencing at 08:00 and running to 16:30. The evening shift started at 16:15 (there was a short handover overlap with the day shift) and ended around midnight. Unnecessary running past 00:15 was keenly discouraged by the management, but hoped-for by the shift because Half-Night Shift payments would then come into force, a nice little earner for impecunious junior staff. Shifts were of course seven days a week, all year round: no public holidays (you couldn't count on getting one, though of course you would get 'days-off-in-lieu' to compensate), and no time off for good behaviour.

Appendix B: The original Band I TV Aerials

It is interesting to remember that the Band I aerial system was designed a mere twelve years after the pioneering Alexandra Palace (AP) installation (an intervening World War caused some inconvenience, though it did speed technical progress). Despite this short period, in design terms the two systems were like chalk and cheese.

To digress a little: the original AP aerial consisted of two tiers, the top one radiating vision signals, the lower one sound. A distinct feeder fed each tier, and at no time did the sound and vision signals come together.

Now I have seen many historical photos of the AP tower, but I can assure you I have never seen the aerials - they are usually invisible in photographs, consisting of vertical wire-cage elements suspended between the ends of the horizontal support spars, which are the visible bits that most people think are the actual aerials themselves. There were also driven wire reflector elements between them and the mast structure. To modern eyes it was a distinctly odd arrangement, though it worked well enough.

The Sutton Coldfield arrangement amounted to two tiers of four dipoles arranged around a stub lattice mast cantilevered above the main mast. (The 'Transmission Gallery' (http://tx.mb21.co.uk/gallery/suttoncoldfield/index.asp) page for Sutton Coldfield shows a photo giving a good idea of the original layout). The individual dipoles were of folded construction, centre driven, and contained box channels which improved the bandwidth, stiffened the structure and contained many kilowatts worth of AC mains heating, to try and keep icing at bay during the winter months. This was only partially successful: RF got into the mains wiring and regularly burnt it out. For most of their life, the aerials just had to put up with the ice.

Unlike the AP arrangement, both tiers were fed with combined sound and vision signals, thus doubling the aerial gain 'at a stroke'. Compared with all other known sites, the sound-vision combiner was, most unusually, originally mounted at the top of the mast, fed with sound and vision signals via separate feeders. The necessity for this was due to the combiner design: originally a split-drum diplexer was used, an arrangement which works better when located near to the aerial. In the event, the combiner itself proved less than trouble-free, and its location from a maintenance standpoint was a total disaster. In later years, when the building was extended (for the FM radio expansion) the combiner was replaced with a different design, a Maxwell Bridge type located at ground level, to universal relief.

When the new UHF aerials were installed, the Band I arrays had to change, of course. The old cantilever extension was cut off, and the top of the FM cylinder extended upwards somewhat. On the outside of this extension, the new Band I aerials were mounted. They consisted of two tiers of six dipoles supported near the ends of horizontal support members. There was a little more to these supports than met the eye: in engineering terms, the whole assembly was 'a balanced dipole on a tapped stub', and the stubs (the support members in disguise) actually acted as baluns which converted the unbalanced coaxial feeders to balanced outputs, and also provided a degree of impedance matching across the channel. Another odd aspect was the proximity of the top stays to the top tier of dipoles. This caused some distortion of the radiation pattern (it actually introduced three partial nulls at 120 degree intervals). In order to overcome this, three 'scatter elements' were installed in the top tier – these were simply parasitic rods of about one-half wavelength, which made the top tier think that there were actually six sets of stays rather than three. The upshot was that there were now six nulls in the horizontal radiation pattern, but each of very considerably less depth than formerly.

Appendix C: The Reserve TV Mast

This 150ft. mast was of lattice construction, square cross-section (unlike the main mast, which was triangular in cross-section) and so had four lanes of stays. It was originally built to support a reserve Band I TV aerial array, to be used if extensive work on the main aerials or combiner became necessary. This array could not handle the same power, nor did it have anything like the service area coverage, of the main array.

When the top of the main mast had to be rebuilt to accommodate the new UHF aerials in 1964, it was deemed that the reserve aerial was not suitable to maintain the service for the extended period of the mast rebuild, and so a new set of reserve aerials were installed on the main mast, at about the 500ft. mark. This left the 150ft. mast empty, but not for long: in order to get BBC2 on-air as soon as possible, before the main mast works were complete in fact, a set of UHF aerial panels were installed on the old 150ft mast, which, fed at lower power, gave a service of sorts to Birmingham and other favoured areas.

By the time that BBC1 and ITV went onto UHF in 1969, the short mast was in the way of the new IBA building, and had to be felled. This was done by the simple expedient of applying an oxy-acetylene torch to the bottom of one of the mast stays. The mast came down quite gracefully and with full regard for tradition, bending sharply at the one-third-of-the-way-up point where most masts seem to give when felled in this manner.

Appendix D: How to Navigate T2

Imagine yourself standing in front of the central cubicle of the 405-line vision transmitter. In the centre of this was an Envelope Monitor (a CRT screen which displayed an envelope of the radiated waveform - basically, pure RF to the Y plates, and a saw tooth waveform at either line or field rate to the X plates). Flanking it were two large rotary handles, looking rather as if they had been provided to wind the thing up. They were in fact interlock handles, ensuring that you could not get inside the various units whilst they were powered. Turning one of these handles removed the power supplies and then released locks on each of the cubicle doors. Two handles: one for the modulator side, the other for the RF cubicles.

Stretching away to either side of this central panel were rows of doors, one to each cubicle: modulator to the left, RF to the right. There were similar doors, also interlocked, to the rear of each of the cubicles, reached from a rear corridor.

The RF Stages

Let us start with the RF side - this was the more straightforward. The rightmost cubicles of T2 in fact housed switchgear and fuse panels, but immediately to the left of these was the cubicle containing the low-level RF units, the output stage of which used a pair of ACT27 triodes in push-pull. To the left of this was the Disaster Area, the cubicle containing the penultimate RF amplifier and the Modulated Amplifier. Working leftwards from this were increasing RF power stages, until the penultimate RF cubicle was reached. The penultimate RF amplifier was known as the Pen RF stage for obvious reasons, and unlike the earlier stages which never gave great trouble, was the cause of much grief over the years. Not that this was all the fault of this particular stage- most of the real reasons were further on. Originally this stage used type ACT26 air-cooled triodes, but in the early days these were always a little short of wind, and touchy. In the 'fifties the stage was rebuilt to use a pair of TY7-6000 valves by Mullard. These were originally designed for use in industrial RF heating applications I believe, and were very robust – a good thing, in view of the indignities that were heaped on them. Basically all they had to do was provide about 5kW of constant power at carrier frequency to the final Modulated Amplifier (Mod Amp) stage. Unfortunately the load provided by the Mod Amp to the Pen RF stage was very peculiar, often causing the latter to indulge in fits of the sulks, which usually ended in violent instability and a flashover somewhere. When that happened, the transmitter would be off-air in short order, with a mimic panel full of overload lights and alarm bells ringing furiously.

The Mod Amp stage was the horror of horrors around which most of the catastrophes attending this transmitter revolved. It was basically a very straightforward grid-modulated RF amplifier. Originally it used a pair of CAT21 triodes with video modulation fed in parallel to the grid circuits. From an RF standpoint, it acted as a grounded-grid amplifier with RF fed to the cathodes in push-pull. Neutralisation was applied in the forlorn hope of making the whole thing stable. The valves were later replaced with a pair of BW165's, rather meatier devices which could in theory give the transmitter a rated output power of 50kW peak white (the old CATs could only manage about 35kW). In practice, you would have been very ill-advised to attempt running them at this power level - violent flashovers were much more frequent at these higher powers, and over the years the output power was quietly crept down to a level of about 43 to 44kW, at which level life became much more placid.

The valves, with their anode cooling water jackets, each sat in the top of a large-diameter plated brass pipe, the pair of which formed a resonant section. These, together with a capacitive tuning plate, which could be slid up or down between the lines, formed the output tuned circuit. Behind these lines was the output-coupling loop: this was a massive square-section loop built up out of silver-plated brass. In series with this was the output coupling tuning capacitor, again built up from plate, having very thick vanes with heavily rounded corners to prevent corona discharges starting. Of split-stator construction, the whole item was perhaps an eighteen-inch cube and the rotor was carried on an insulating glass rod about an inch in diameter. (See 'the Infamous Spacewarp Incident' to find out whether or not this glass rod was a good idea.)

To finish off the RF side of things: a high-level modulated transmitter, like this one was, had to generate a double-sideband signal, whereas what was wanted was a vestigial sideband (VSB) one. Accordingly, the unwanted section of the upper sideband was removed by a massive VSB filter, constructed from sections of coaxial feeder about six inches in diameter, and mounted on the wall at the rear of the transmitter. Effectively the filter diverted the unwanted sideband power into a water-cooled dummy load mounted adjacent. This unit was a fine example of the designers not knowing quite what to expect - this unit was, after all, the first VSB filter to be built in this country, and Sutton Coldfield was (as they never tired of telling us) the most powerful TV transmitter in the world when it opened. They thought that a 5kW load should have been big enough. In the event, this nice high-power load never had more than a few hundred watts dissipated in it. Other items of bad-guessing to be found around the transmitter were meters that never read (because the expected 50mA of current turned out to be 0.5mA in practice).

The Modulator

Time to look at the modulator side of the transmitter, another fertile field of concern. Start at the beginning - walk up to the leftmost cubicle, and open the door. You could do this, for these two end doors were not interlocked, (and a good thing too, considering the amount of time people needed to spend in there), for there were no dangerously high voltages enclosed.

The Pre-Amps

Inside you would find two identical units, coyly labelled 'Preamplifier'. Those of you of a suspicious turn of mind may feel that there was rather more to these than meet the eye, and you would be quite right. When EMI designed these units, they felt that they were going to be troublesome, so they provided a duplicate installation with a changeover relay panel, operated from the control desk. They were quite correct in their surmise.

These preamps had to do rather more than just amplify. They each had their own sync-pulse separator feeding a clamp-pulse generator, used for DC level restoration in both the pre-amp and the Sub-Modulator, which we will be meeting shortly. The pre-amp also had to provide linearity correction, pre-distorting the vision signal to compensate for the later distortion that was going to occur in the Mod Amp stage. (Those of you familiar with amplifiers but who have never worked with video circuitry may say at this point 'Why don't you use negative feedback?' A valid question, to which the answer is that it won't work. There is far much too much time-delay between the instant that the signal goes into the transmitter, and the time it comes out. Any attempt to use feedback under these circumstances will only result in a bad waveform becoming rapidly worse).

When Alexandra Palace was built, no linearity correction was provided (the signal fed to the AP transmitter had a 50:50 picture: sync ratio which gave the required 70:30 output ratio, thanks to transmitter non-linearity), so the Sutton pre-amps were very much a first attempt at sorting out a problem that had been bypassed in earlier years. Generally speaking it worked fairly well, but could have been rather more stable. All valves in this unit were small plug-in types with Loctal bases, a variety now mercifully almost extinct. They were mounted horizontally, sticking out forwards from the pre-amp panel and in clear view. Unfortunately this type of base had a bad record for poor pin-contact resistance, and due to the horizontal mounting the valves would have eventually fallen out of their sockets had they not been held in place by screw-down skirt clamps. These clamps however did little for the poor pin resistance, and merely made it impossible to waggle the valves in their sockets when the pictures became riddled with black-line flashing, the usual symptom of a bad contact somewhere. The usual cure was to switch over to the other pre-amp: if you were lucky, that one wouldn't be flashing quite so badly.

Finally, the pre-amp had to amplify the input signal (about 0.7V pk-pk, since it had been through a level-setting fader on the control desk) to an output voltage of about 50V pk-pk. This signal was then fed to the next stage, the entertainingly named Sub-Sub-Modulator.

The Sub-Sub-Modulator

It is in this stage that we first meet that strange valve, around which most of the modulator was designed, the ACM3, by Marconi-Osram. This was developed from a radar valve used in World War II. It was an interesting device, with good performance for the time, and only one serious vice. (See appendix 'The Vice of the ACM3' for details). It had a faintly futuristic look, slightly resembling the spacecraft that were to be seen navigating the screens of the B-movies of the period. Basically a glass tube about nine inches long or so, it had around the centre of its girth a set of anode cooling fins enclosed in a brass collar, about three inches in diameter. At one end, a stout brass cylinder protruded, the grid connection. At the other, a collar that was the cathode connection and also one side of the heater: the other heater connection being on a flying lead coming from its centre. The thing was indirectly heated, forced-air cooled, had a maximum anode dissipation of about 2kW, and a mutual-conductance of around 27 mA/V, a high figure for a valve of that type. In all, a handy device.

But back to the Sub-Sub-Mod. This used an ACM3 as voltage amplifier, followed by another ACM3 as cathode-follower. This arrangement was quite standard in this transmitter, and gave good performance. The main problem was the common heater-cathode connection, which in a cathode follower meant that the considerable capacitance to ground of the heater supply circuitry was visible to the signal path.

To stop this from degrading the video bandwidth, various cunning wheezes were adopted (bifilar supply chokes, padded out to a fixed loading using Constant Impedance Networks). These steps worked, at the cost of converting what was basically a simple circuit into a jolly complicated one. The sub-sub-mod took the signal level up to a few hundred volts, which was A.C. coupled into the next stage, the Sub-Mod.

The Sub-Modulator

The Sub-Mod was a repeat of the sub-sub-mod, but used two ACM3s in parallel as voltage amplifier followed by two more in parallel as cathode follower. Due to the A.C. coupling from the previous stage, the D.C. component had to be reinserted at this point, and this was done by the Clamp Unit, a diode bridge that used four power rectifiers (UU4s, I seem to remember) as diodes. The Sub-Mod took the signal up to about 1300V pk-pk. and fed the Modulator.

The Modulator

The Modulator was a straight cathode follower, and used four ACM3's in parallel. This then fed the Mod Amp grids with about 1200V pk-pk of video, flat from DC to 3MHz, at an output impedance of some eleven ohms. As you can see, a considerable amount of modulator power was involved.

Power Supplies

The power supplies round the back were quite extensive. Each modulator stage had its own shunt regulator using (you've guessed it) ACM3's. The Mod Amp was fed with unregulated DC at about 6.5kV: this came from a six-phase rectifier assembly using hot-cathode mercury vapour rectifiers. The Pen RF stage was fed with stabilised 5kV obtained from the 6.5kV line via a series regulator (ACM3's again).

Well, that was the vision transmitter, more or less as built. Over the years many modifications were made. Mercury vapour rectifiers have an unfortunate habit of backfiring if they are not operated at the correct temperature (sometimes they just backfired, anyway). A backfire (conducting simultaneously in both directions) usually blows every fuse in sight. The fuses that were used were 'Quenchol', a special high-rupturing-capacity type that were basically a spring-loaded fuse-wire immersed in insulating oil. They were evidently not quite high enough capacity, since when they ruptured they tended to blow their end-caps off, showering the cubicle with hot oil. When they became available, the mercury rectifiers were replaced with mixed-gas units which were much more placid. Later still, silicon rectifier stacks were used: strangely these did not prove to be much more maintenance-free than the mixed gas units that they replaced.

The Mod Amp filaments were originally lit with DC from a mighty rotary converter - this was done to keep hum levels down. Many years later it was found that the hum penalty incurred by using AC heating was only very marginal, and so when it wore out, the rotary converter was replaced by much simpler transformers.

The most important modification was that which (mostly) tamed the Pen RF stage. The problem here centred on the enormously varying load that the Mod Amp placed upon it. When radiating peak white, the Pen RF delivered about 5kW, and it didn't mind doing that. The problem came during sync pulses, when the Mod Amp was cut off: at these times the Pen RF stage was completely unloaded, so the RF had nowhere to go. Instability was the usual result. The cure was the installation of a gadget referred to as the 'Pen RF Load'. This was simply a resistive load, poked in between the anode tuning lines of the Pen RF stage. The idea was that instead of the loading swinging from heavy to zero, it went instead from heavier to small. This small loading proved sufficient to stabilise the system. The load itself was simply a block of stainless steel; however, in line with the tradition that power levels inside this transmitter would never be what were expected, upon first powering after the modification this load was seen to rapidly assume a cheery orange glow. Further rapid modifications involved drilling the stainless steel block to produce galleries, and circulating water through them.

A most beneficial modification that was done was to include a high-speed fuse in the anode supply to the Pen RF stage. Astonishingly, this had not been provided originally: if an overload occurred, the supply contactors would be tripped out, but there was so much energy stored in the power-supply capacitors that major damage was caused in the event of a flashover: it was not unknown for the glass envelope of both Pen RF valves to be shattered in this manner. The high-speed fuses were of the type used to protect rural high-voltage power lines: they consisted of multiple silver fuse wires wound on a ribbed ceramic former, enclosed in a ceramic tube and filled with silver sand. Stripped of their contents, with corks fitted at either end and filled with cold water, they made superb rolling-pins. Additional spark-gaps were also provided to beef up the protection in the Pen RF and Mod Amp stages.

The Vice of the ACM3

As mentioned earlier, the ACM3 was a pretty good valve but did have one problem. As it grew older, it tended to suffer from grid-emission. This phenomenon was caused by the fact that the rare-earth coating on the cathode (thorium, and all that stuff) very slowly evaporated off the cathode with the passage of time. This vapour tended to condense on anything cooler than the cathode. The control grid was a good candidate for this, so after a while the grid became provided with a little emissive material of its very own.

Since the grid also ran hot (not from grid current: it was just placed very close to the cathode) after a while it would also start to emit electrons, resulting in a small grid current being developed. In most of the stages of the transmitter, this didn't matter two hoots, but there was one stage where it was a killer - the Sub Mod. The control grid to this stage was AC coupled and in fact didn't have a grid leak at all: any leakage had to be made good by the action of the Clamp. The effect of grid current was to produce a slight tilt across each individual picture line, too small to be actually visible on picture. The problem happened when the clamp fired and pulled the grid potential back to its proper value. The result was a severe bend, or coggle, as locally called, in the back porch of the waveform. This could be visible on earlier receivers that didn't have adequate flyback blanking, as a faint wobbly band of light up the centre of the picture, colloquially known as 'rope'. A good TA on the control desk would spot the onset of this problem on his waveform monitor, and tip the wink to the shift engineer. The problem was rarely so bad that something had to be done about it then and there - usually the valve would be changed after the end of programmes.

This event tended to be a marker in the lifetime of ACM3's. The Sub-Mod always attracted new valves, young and vigorous and with no bad habits. As they aged, they fell into bad ways and started showing signs of the dreaded grid emission. They would then be retired from that spot, being replaced with another new valve. But grid emission apart, there was still plenty of life left in the old reprobate and he would be put into a socket where grid emission mattered less, releasing a still older specimen. The engineer would take this still older one and prowl round the back of the power supplies, looking for an antique ACM3 there that was near expiry, and move the tube into that spot. The power regulators were regarded as the retirement home for elderly valves: they were so lightly run that any tube that wouldn't work in them wasn't worth keeping. So, for these unfortunate valves it would be the scrap yard for most, but not all...

Over the years, various people entertained the belief that dud versions of this valve could be converted nicely into a stylish base for a table-lamp. For many years, such a lamp, locally made, was one of the standard supplementary presents made to retiring staff - "Just to remind you of Sutton Coldfield". I suspect that on arrival at home, most of these lamps went straight into a cardboard box, and thence into the attic. Mercifully, before I myself retired, Band I had closed, the supply of ACM3's had dried up, and the custom had died out, thus saving me a lot of trouble. I don't have an attic.

There was one latter-day defect that the ACM3 suffered from - suddenly, in the 'seventies, it was found that quite new specimens were failing very early on in their lifetimes - often whilst still under guarantee. Such devices were sent back to GEC with a protest note, and they investigated the matter. The result was faintly amusing. By this time, the BBC was about the only customer for these devices, and they were being hand-made in quite small quantities. The defect was traced to the grid structure: 'the old geezer who wound the grids has just retired, and nobody else quite knows how to do it properly...'. In the event they had to bring the poor fellow out of retirement just to show someone else how it was done. I hope his palm was adequately crossed with silver.

Appendix E: Musings on the S.T. & C. FM Transmitters

Each transmitter consisted basically of three cubicles, close-bolted: three such transmitters, one for each service, formed a continuous row of units. There were two such rows, separated by a short corridor for rear access.

Working from left to right, the three cubicles contained

Power supply and control systems, and a drop-coil mains regulator

Stages 1 and 2 of RF amplification

Stage 3 of RF amplification.

The RF circuits were quite straightforward. Stage 1 was a grounded-cathode tetrode amplifier: stages 2 and 3 grounded-grid triode amplifiers. All stages used a resonant-line system for the anode circuit. This consisted of a closed box, divided about three-quarters of the way up by a horizontal partition. One side of the box was a hinged door, held shut by thumbscrews, giving access to the valve and stage components.

The anode line was a vertical copper tube centred in the lower section of the box, and the air-cooled valve anode sat in the top of said tube. For the grounded-grid stages, the grid-ring of the valve made contact with a set of fingers located on the partition, and the upper part of the valve poked through into the upper box section, containing the input tuned circuitry. The anode circuit was tuned by a short-circuit loop which could be adjusted in position, so as to alter its coupling into the cavity – the usual mode of explanation as to how this worked was that the loop 'destroyed some inductance' in the equivalent circuit of the cavity, thus altering its tuned frequency. Output power was taken from the cavity by another loop, also adjustable in position.

Unusually these stage cavities were mounted in the rear of their cubicle, and accessed from the back of the transmitter. All controls and metering for the stage were however conventionally placed on the front of the cubicle. This meant that an operator had to tune each stage by some method of remote control. I think that most of the staff felt that it would have been a good thing if S.T.&C. had kept things simple, and used remote operating shafts or possibly Bowden cables to do the tuning: what we got instead was a motor-driven system. Small reversible motors drove reduction gearboxes and thence a crank: this operated a pull-rod to another crank, which rotated the tuning loops through a limited arc. A Post-office type switch key on the unit's front controlled the motors, with a pushbutton for motor braking. There was a variable resistor coupled to the drive shaft that operated a meter on the front of the transmitter, to give the operator some idea of where the loop was positioned. Altogether it was an overcomplicated system that gave much trouble. The main problem was that over a period of time both gearboxes and loops became stiff. The main output loop could on occasion become so stiff that the coupling pins on the connecting rods would shear, or a loop would slip on its shaft and start moving through an incorrect arc. A lot of time was wasted freeing up or refurbishing these systems.

The control system for this design was distinctly odd. Most transmitters are burdened with contactors: supply contactors, and two- or three-step sequencing contactors for both filament and H.T. supplies. The purpose of these was to ensure that at switch-on, excessive surge currents didn't flow. A cold valve filament has a very low resistance compared to its running value, often only one-tenth or so, and excessive currents will flow at switch-on, which can damage both valve and supply circuits. So the current is limited for a short period, either by switching-in a reduced voltage at start and later switching to a higher voltage, or by using a series resistance, which after a period is shorted-out. Similar conditions apply to the HT. Circuits – massive surges can occur if full volts are immediately applied to the smoothing capacitors, damaging rectifiers and other components, and so a similar step-switch is used. Additionally, there are filament-delay devices: applying H.T. volts to a cold valve can much shorten the life of the valve, so one has to wait for anywhere between thirty seconds and ten minutes (depending on valve design) before HT can be applied to a powering transmitter.

The S.T.&C. design avoided all of this - there were no contactors at all and no filament delay as such. Instead, the transmitter was effectively driven from a mains supply that could be slowly turned up from zero to operating voltage over a period of about one minute. This was the purpose of the 'drop-coil regulator' mentioned earlier.

Rupture on Demand

This drop-coil regulator was a feared device. It was basically an oil-filled tank transformer with separate primary and secondary magnetic circuits. The coupling between these circuits was varied by the 'drop-coil' – a short-circuit coupling loop that could be raised or lowered within the tank The raising was done by a super bicycle-chain which was driven via a sprocketed wheel by a motor-driven gearbox. In this mechanical circuit was the device that caused most problems with these transmitters – a magnetic clutch. The purpose of the clutch was to enable the drop-coil to be very quickly lowered in the event of a fault occurring. The D.C. supply to the clutch was simply removed whereupon the coil descended rapidly under gravity, with a sickening thud.

In line with this manufacturers' traditions in regard to motors, the clutch system did not work terribly well. It was satisfactory when the clutch was new: but when the friction surfaces became worn with use, the clutch would not transmit the torque required and began to slip – usually after the transmitter had got nice and hot. The drop-coil would then slide back slightly under gravity, resulting in low supply voltages to the transmitter, and so output power would fall. The very first thing to check for with these units when low power was encountered was, 'are the supply volts OK?' and if not you would then mosey off round the back to witness this slipping clutch. The cure would have been to replace the clutch, of course, but this was an operation fraught with hazard. If you got it wrong, the bicycle chain could slip off and fall into the recesses of the oil tank. This was a very good way of making yourself deeply unpopular, since fixing it usually involved dismantling the regulator, a procedure we shall shortly be making an acquaintance with... Additionally, replacing a clutch only gave a short respite, since these devices lost their youthful tenacity quite quickly.

Fortunately, there was a quick fix available: trot off to the SME's office and get the can of magic juice. This can was a squeeze-side oilcan, filled with Carbon Tetrachloride ('Thawpit', a degreasing agent beloved of dry-cleaners in years gone by). This highly toxic liquid would then be squirted into the innards of the slipping clutch, so cooling it and removing any grease that may be making life difficult for the friction plates. This usually worked like a charm (for a while) and the clutch would grab up and wind the regulator back to its proper position in no time.

Any occurrence that caused an interior fault on the drop-coil regulator necessitated its complete removal from the transmitter. This was always bad news, as you will see. Disconnecting the regulator itself was a doddle, since all connections were made by heavy-duty (Niphan) plugs and sockets. Having done that, you had finished with the easy stuff. To get it out of the transmitter meant dismantling the front of the cubicle – more plugs and sockets, all front panels to be removed and some framework members to be dismantled. The regulator could then be rolled out of the transmitter. It had small non-steerable cast-steel wheels mounted on axle shafts; the whole affair was over seven feet tall and must have weighed around two tons. If you rolled it onto the transmitter-hall floor, it would promptly sink into the floor tiles and become quite immovable, so it had to be rolled onto quarter-inch thick steel plates to spread the weight.

Having got it out into the hall, it couldn't be dismantled there since there was no lifting gear and insufficient headroom anyway – it had to be transported to the designated place, which was underneath a lifting gantry, outside, round the back of the building. The route lay as follows:

First, the unit had to be swung round by 90 degrees so as to face down the hall. Since there was no steering on the wheels, this meant skidding it round on the plates with crowbars, moving the plates about to suit. Then it could be trundled off down the hall. This involved setting up a plateway, lifting the steel sheets vacated by the trundling and laying them in front of the juggernaut.

At the end of the hall, there was another 90-degree turn to get it into the corridor beyond.

At the end of this corridor, there was a difficult doorway - too low to get the unit through. Simple enough; take the top bit of the doorframe out (it had previously been modified especially for this purpose) and then again on our way, but not for long: another 90-degree turn was needed into the next corridor. At this point the regulator would be blocking the door to the Rest Room, so anyone in there would either have to wait, or climb out of the window. The regulator would pretty well fill the corridor, causing acid comments from other members of staff trying to go about their lawful business. Along this corridor for a bit, pausing only to dismantle another low doorframe, and another turn took us through a storeroom and so into the open air. Then down a concrete ramp, steep enough to require everybody available to be hanging onto the unit to make sure that it didn't run away, because if it did then it would probably turn over when it stopped suddenly at the bottom, as its front wheels sank into the tarmac beyond.

Good news, we're almost there, only two more turns and a good deal of activity with the steel plates would bring us to the lifting gantry.

Repairs to the unit would have to be carried out in the open air and in the event of bad weather could take several days, in practice. Good news though, that large object to the side of the gantry is the spare regulator, sheeted up against the rain. All we have to do is to get this spare unit back into the transmitter...

With good luck and a following wind, if you started changing this unit before 9 a.m. you could have the spare back in, though not necessarily working, by the time the evening shift arrived. You were allowed to stop for lunch.

Round the Back

The room behind the transmitters was where all of the pipe-work lived. This mostly comprised the two combining units, mounted on the rear wall of the room. These were ring-type combiners and mercifully gave next to no trouble.

The same could not be said of the test-loads: each transmitter had its own private test-load into which the transmitter could be switched when it was being, well, tested, and so was therefore likely to radiate sounds that no listener should hear.

Most test loads consist of some form of resistive element to dissipate the power, and are cooled by air, oil or pumped water, depending on the power level involved. These test loads were oddballs, however: there was no resistive element as such, the feeder simply led into a cylindrical chamber through which a suitable electrolyte flowed. It was in effect a short but immensely lossy line.

The electrolyte used was a solution of sodium bicarbonate in water. If the concentration and temperature of this were kept right, the test load would look like a resistive 50 ohms. The liquid was pumped round a closed circuit comprising the load, a motor-driven pump, a heater, a flow meter and a heat exchanger. The exchanger gave up its heat to an external plain-water cooling circuit. The purpose of the (thermostat-driven) heater was to get the electrolyte up to its design temperature before the load was used.

The big problem was keeping the concentration of the electrolyte correct. The tendency was for the concentration to change: nobody ever came up with the definitive reason why this was so, but the best guess was that, some of the connecting pipe-work being of rubber and therefore slightly porous, water would slowly pass through the pipe walls and evaporate but the bicarb, having larger molecules, wouldn't; so causing the concentration to rise. Either way, getting it right involved tedious work with a jug of water to lower the concentration (and then maybe adding back some concentrated bicarb solution if you overdid things).

The test-load itself was provided with thermometers on the liquid inlet and outlet pipes, so the temperature rise of the electrolyte when passing through the load could be found. If this difference was multiplied by the metered flow-rate, and again by a suitable fudge-factor, the transmitter output power was the result. Amazingly, this figure was considered sufficiently accurate to set the transmitter output-power meters up by: in fact, there was no other way of doing it.

Unwanted Guests

On the ceiling of the room were mounted a series of filters. These were of two types: intermodulation filters and harmonic filters.

The intermodulation filters were necessary because the combining units were not perfect. This is no slur: no combiner is ever perfect. What happens is, for example, that some of the output power from the Radio3 transmitter which should be going to the aerial actually appeared at the outputs of the Radio 2 and Radio 4 transmitters. These unwanted signals mixed with the wanted signals, producing unwanted signals at other frequencies. Let's illustrate it with numbers, considering the Radio 4 signal:

Radio 4 was at 92.7 MHz, and Radio 3 at 90.5 MHz. In the Radio 4 transmitter, the unwanted Radio 3 signal mixed to produce sum and difference signals, namely 92.7 + 90.5 = 183.2 MHz, and 92.7 - 90.5 = 2.2 MHz. These are first-order products.

The 2.2 MHz signal was no problem as such: the aerial was hopelessly inefficient at this frequency and radiated next to none of it. The 183.2 MHz signal was no problem either: it was removed by the harmonic filter (see later). But the problem doesn't end there.

This wretched 2.2 MHz signal that hypothetically floated around but caused no trouble, made its presence felt by mixing again with the 92.7 MHz of the wanted output: this produced sum and difference signals of 92.7 + 2.2 = 94.9 MHz, and 92.7 – 2.2 = 90.5 MHz. These are second-order products.

The 90.5 MHz one was no problem: it was squashed by the legitimate and massively greater Radio 3 signal on 90.5 MHz. The 94.9 MHz one was quite otherwise: it was effectively a new radiated signal, sounding like a mangled mix of Radios 3 and 4, and if it got to the aerial through the combining unit, as it may well have done, then the listeners would be treated to a new, and rather confusing, station to listen to. Although this signal was not in any way powerful, it still comfortably exceeded levels permitted for spurious radiations in this band. There would be other signals produced as well, by Radio 2 interacting with Radio 4 and so on. So all these had to be removed.

This was fairly easily done by connecting coaxial notch filters, tuned to each of the other service frequencies, across the output feeder of each transmitter. So, the Radio 4 output had notch filters tuned to Radios 2 and 3, short-circuiting these frequencies and preventing the products from being created in the first place. (Interestingly, the Radio 3 transmitter had no notch filters: both of its unwanted products, 88.3 and 92.7, were squashed by Radio 2 and Radio 4).

The harmonic filters were there for a simple reason: any Class C amplifier such as these will produce second, third and so forth harmonics, which due to the tightly-coupled output stage will be excessive. So they have to be removed. This was done with a coaxial low-pass filter in the output feeder.

There was quite a bit of this harmonic power, so the filters ran hot. To alleviate this, they were blown with air to remove the heat: they each had their own special little blower unit, and since it is not a good idea to blow dirty air into a highly-stressed filter of this type, their own air-filter.

In the course of time, these air-filters would become choked and would have to be replaced. It was always considered good practice to switch off the blower motor whilst you were doing this: if you didn't, the filter tended to be held into its frame by the air pressure. Okay, you could work your fingernail under the filter and prise it out: but if you slipped, the filter would be slammed back into its housing by the air pressure, thus releasing a good cloud of dirt into the airflow. This would be blown into the harmonic filter, and would promptly combust. The first that you would know of this would be that a jet of flame would roar from the filter, passing about two inches from your right ear if you were indulging in the usual trick of standing on a heat-exchanger cabinet to do the job, instead of having previously fetched a step-ladder. The second thing would be that the transmitter would trip on reflected power, due to the gross mismatch caused by the flame in the filter, so you would have to trudge round to the front of the transmitter to reset it, trailing singed hair as you did so.

Appendix F: Getting Excited over FM

Now an A.M. transmitter is a relatively complicated device, driven by a simple one called a 'drive'. All the drive has to do here is produce a nice, steady continuous wave at the right frequency – all the tricky modulation stuff is done inside the transmitter.

In F.M. it's all different. Here the transmitter only amplifies the R.F. presented to it by the drive, or 'exciter' as it is sometimes called – the modulation has to be done as far back as the master oscillator. Properly speaking, this 'drive/exciter' is actually a small self-contained transmitter in its own right, producing at most a few tens of watts. If this is all you need, it can be coupled straight to the transmitting aerial (and is, at some low-power sites). That large grey box that everyone calls a transmitter is actually solely an amplifier, stepping the power up to a more reasonable 10kW or so.

It follows that in an F.M. system, the 'transmitter' (i.e. the amplifier) is a fairly straightforward piece of gear, albeit large and hot. Most of the complexity lies in the 'drive'.

The S.T.&C. drives were early examples of the genre, designed in the days when there were fewer options for crafty circuitry. All the same, they managed to make some parts of it quite devious.

The actual frequency modulator was a straight L/C oscillator (Hartley as I remember). Its output was at a fixed centre frequency of 7.5MHz, irrespective of what the actual radiated frequency was to be. A sample of the oscillator was phase-shifted by 90-degrees and fed to a balanced modulator, which was also fed with the audio programme signal. The RF current from this modulator was then injected into the tuned circuit of the L/C oscillator.

This current would have the effect of a variable reactance (sometimes inductive, sometimes capacitive, depending on the programme modulation). The effect would be to vary the resonant frequency of the tuned circuit in sympathy with the programme modulation – true frequency modulation in fact. All quite simple.

What was not quite so nice was that the frequency stability of a straight L/C oscillator used in this manner is not particularly good – certainly not good enough for a broadcast transmitter. In order to get the thing into spec, some sort of frequency controller would be needed. And that is where it all started getting rather tricky.

Having corrected your carrier frequency (and I'm skirting round that for a bit) the 7.5MHz signal would then be mixed with a signal derived from a crystal oscillator, to produce an output at one-third of the radiated carrier frequency. There would be two complete drive systems, to provide redundancy, and one of these would be selected and then split two ways. Each feed would then drive each of the two transmitters for the service via a phase corrector network (another horrid motor-driven device) and a tripler, to reach the required output frequency.I just can't put off this frequency correction business any more. What they did was to take a sample of the 7.5MHz signal, frequency-divide it down by 500 to an output frequency of 15kHz, and then phase-compare it with a local 15kHz signal derived from a bar quartz crystal. The phase comparator would then drive a bi-phase motor connected to a gear train, which would rotate the main tuning capacitor of the master oscillator in such a direction as to correct any frequency error.

Sounds a doddle if you say it quickly enough. The real fly in the ointment was this 500-divider contraption. Frequency multiplication is fairly easy to do: division was by no means as easy in the days when this equipment was new. And the way they did it was a little hair-raising.

Firstly, make the problem simpler by breaking the division ratio down. Dividers by 5, 5, 5 and 4 will do the job if tandemed up (5x5x5x4 = 500).

What they ended up with was a device called a regenerative divider. Consider the divide-by-five part (the divide-by-four worked in a similar manner). Suppose we want an output frequency of F from this divider. Then obviously the input frequency will be 5F. So feed this 5F into a mixer, with a locally derived signal at 4F. Amongst all the unwanted output products of this mixer will be a wanted one at frequency F, so pick it out with a tuned circuit. There's your output signal: all we need now is to find some 4F. Simple, just quadruple the output signal and Bob's your uncle.

Percipient readers will have spotted the chicken-and-egg situation into which we have wandered. To get an F output we need a 4F signal, but we can't make a 4F signal without an F output. Clearly the thing won't work.

Amazingly, it does. Apparently, when the mixer isn't working, there is enough noise being generated by it (mixers are notoriously noisy devices, particularly the earlier ones) to produce some noise centred on F, which in turn produces noise centred on 4F. This highly-coloured noise is enough to start the divider working.

Well, most of the time, anyway. Correct operation does presuppose proper mixer and multiplier gains, and since this equipment was totally valve operated (and plenty of them) at any given time at least one valve would be feeling rather tired, and the entire divider could give up the ghost. At this point, all of the valve feeds would change anyway, so it was difficult to spot the culprit. To stave off this unhappy occurrence, it became the custom to check the valve standing currents on a daily basis, and replace anything that looked suspect. The only alternative was to let it fail on you, whereupon you could then either test every valve till you found the bounder (very time-consuming), or replace the lot (very expensive).

Generally it was better to avoid the trouble rather than fix it. If you were unlucky enough to suffer a component failure in the dividers, quite often the entire divider would require setting up from scratch afterwards – a lengthy business, bearing in mind the number of tuned circuits, their interaction, and the possibility of getting a particular stage tuned to the wrong division ratio. These units were by no means popular.

(Before we leave these dividers for good, I may remark that when integrated circuits that could perform digital division became available in the 'sixties, no time was lost in producing a prototype replacement for the regenerative dividers. This worked like a charm and all regenerative units were replaced with the digital types throughout the BBC. These gave no trouble at all until the drives were heaved out in the 'eighties).

Young engineers were given some quite specific advice about these drives, namely, 'never swear inside the exciters'. The reason for this was that they were rather microphonic: this plagued the Third/Radio 3 service particularly, since modulation levels always seemed to be much lower there than on other services ('to preserve the dynamic range of orchestral music'). So, if you had your mouth anywhere near to the master oscillator, your obscenities could be heard over quiet programme material as a background pornographic mumbling sound. This produced several letters of complaint to Broadcasting House over the years. In addition to the bad-mouthing, there was a continuous distant rumbling caused by the cooling blowers in the cabinets, and if the blessed regenerative dividers provoked the frequency-correction motor into operation, a sound somewhat like cannon-balls rolling down and then falling off a wooden trough. Needless to say, these sounds were in no ways loud, or even noticeable, but there always seemed to be listeners out there, gifted with golden ears, who could hear them without difficulty. On Radio 3, at all events.

Appendix G: The UHF Power Amplifiers
Apart from the fact that they used klystrons rather than more usual triodes or tetrodes, the amplifiers themselves were of straightforward and sound construction. The klystrons themselves were a novelty – each 25kW unit used two, one for vision and one (heavily under run) for sound. The reason behind using identical klystrons for sound and vision was solely to reduce the spares stock holding required. Also, when a vision klystron became 'tired' and incapable of further service, it could be happily run for many thousand extra hours in a sound position. 'Tiredness' often took many years to arrive: klystron lifetimes of 50,000 hours were by no means uncommon.

The one shortcoming of the design revolved around the klystron cooling. Because these were very early high-power devices, the collectors had to be cooled by a pumped liquid coolant circulated through a cooling jacket around the collector. Later designs exclusively used much more efficient vapour cooling. The trouble was, there was a lot of heat to get rid of (early klystron designs were only about 35% to 40% efficient in power conversion terms, so a 25kW klystron could be generating nearly 50kW of waste heat), and this design specified heat exchangers mounted external to the building to remove the heat. Due to the long piping needed, pump pressures had to be high to get the required flow-rate – about 90psi. Because the heat exchangers were mounted externally, plain water couldn't be used as a coolant, else on a cold night it would freeze solid. What was used was a fairly strong ethylene glycol mixture ('antifreeze' to you motorists, except the stuff used contained special inhibitors and arrived in 55 gallon drums).

Anyone who has used glycol solution knows that it has amazing 'creep' qualities, and will search out the minutest leaks with great efficiency. The klystron cooling was connected up with 'quick release couplers', a fertile source of such leaks. When the coolant was pumped through them at 90psi, the thing became just too easy. The result was that every coupler dripped coolant: leak trays made from old cut-up oil cans swiftly appeared. These had to be emptied on a fairly regular basis. If the liquid dropped on the vinyl-tile covered floor, anybody who stepped on this liquid in rubber-soled shoes would swiftly be on his back, staring at the ceiling through a haze of stars. It was astonishingly slippery stuff.

The Black Heart of the Exciter
This early drive used an unfamiliar form of modulator – the 'absorption modulator'. The basis of this was that if a valve diode were enclosed in a suitable tuned cavity, then by varying the DC bias on the diode, the effective RF resistance of the cavity could be changed. If RF is thrown at such a diode, a proportion of the energy will be reflected, since for most values of bias the diode will not look like its nominal 50 Ohm design value. If a pair of such diode cavities are connected to two ports of a 3dB directional coupler, and RF is fed into the coupler, then the amount of RF coming out of the coupler will depend on the DC bias to the diodes. If to this DC bias you add an AC video signal, the result is that the RF output is modulated with the vision signal - just what we need. In practice it was never as simple as this - there were too many variables present. The tune-point of each of the cavities had to be correct and matched to one another. The diodes themselves had to have identical characteristics, and keep them so as they aged. In practice, thermal variations in the drives, and normal ageing phenomena (these diodes did not have very long lives, in practice), meant that both daily and long-term variations were inevitable.

The matching of the diodes was a constant pain. The closeness of matching needed was not appreciated in the earliest days, and was one of the factors that led to the 'closed-doors' fiasco. The diodes arrived from the manufacturers as unmatched items, and much time was spent using a testing-jig to find pairs of valves whose emissions matched closely enough to be usable – these pairs would then be taped together in their boxes, and if a replacement was needed, a new matched pair would be fitted. The valves themselves were made by GEC-Osram (a special item, coded A3012 I think) and were basically a DET24 disc-seal triode with the control grid left out. Their characteristics could vary alarmingly from one specimen to another, and there was not even a guarantee that two matched items would age at the same rate.

Using up all that old junk - the birth of the Songbird Programme continued from page 29

BC183 output. Copper screens were sweated onto to the chassis and a lid made removable with self tappers. Screened cable was used between the detector output and volume control and then onwards to the 820M amplifier input on the LHS. Failure to take all of these measures guarantees poor RF performance due to degenerative feedback and good old-fashioned instability from detector RF splatter – it sounds like an old mastiff growling! The short wave coil was rewound on a smaller 5/8" diameter former – 12 turns tapped at 2 and mounted on the right close to the switch. Both RF and AF sections have their own power supply, a PP3 for the former and 6x AA cells for the latter. This ensured best stability and no voltage loss across the large 1k resistor that would be required for decoupling between the 820M and other circuitry. The loudspeaker is a 4" 8 ohm Taiwan product purchased with 3 others at the NEC for 50p each and gives a good account of itself. The Songbird needs hardly any setting up – there is only Cx to adjust, which I did at the high frequency end of the Medium wave band optimising reception on Radio Humberside (1485 kHz), which is very difficult to get in our area and normally can only be received with any reasonable signal to noise ratio on a superhet with a tuned RF amplifier. But it's best to try things with the vanes completely unmeshed and no adjustment may be required. Although this article was not intended as a detailed Home Construction project (and it is definitely not a 'Retro Radio' project, but rather a report on a series of ongoing experiments), here are some comments on alternative components. The RCA 40673 was a direct equivalent to the 3N201 also the Motorola MEM616. I believe a more modern component is available from Maplin for around 50p but I havn't tried it. The ubiquitous 2N3819 should be OK in place of the BF244. In my years at the Texas Instrument Manton Lane Plant in the 1970's, the Product Marketing group were both bemused and amused at the device's popularity as it had basically failed most if not all of the BF244 parameter tests and was perilously close to being labelled a 'toy' or more brutally, 'floor sweepings' product. However it was relatively cheap when FETs were far too expensive so enjoyed a rapid take up and popularity in non-demanding applications. The BC183 is still widely available and very cheap – I've seen '20 for £1' deals around and of course there are many NPN small signal alternatives.

I did a lot of experiments not listed so far including making up cascade RF amplifiers from a BF244+ BC183, also from 2X BC183. The former gave particularly good results as a front end SW RF amplifier, but it didn't fit into this design very well, needing yet one more control, so I am holding it over for a possible Songbird superhet programme.

Conclusions
The Songbird Radio has turned out to be a very satisfying project which realised my hopes of getting superior, simple set performance by combining FETs with Bipolar transistors and exploiting the strengths of each. In particular (and as in valve circuits), to use the very high 3N201 input impedance to grab the whole signal and keep it at a high level throughout the system. Where possible in the narrative, I have tried to forge connections with equivalent or indeed identical valve circuits for the benefit of people who were brought up in the valve era and may not be so familiar with solid state. Although I have tried to write it up as a continuous logical narrative, the development was in fact strung out over a year with a three-month (operation) gap. So if in places it seems either too glib or indeed non-sequitur, that is probably the reason.
The set itself has proved to be a good companion – LMS coverage gives you a lot of stations to choose from still and hence it gets a lot of use. Of course there is more 'fiddling about' than with operating a superhet, especially on the short waves, but that's part of the fun! Another bonus is that it has allowed me to re-enter the (mostly) lost world of Radio Home Construction, which was an enormous and very active part of the Radio era with a large number of followers. I found myself buying large quantities of 'Practical Wireless' and 'Radio Constructor' issues from the mid 1950's to mid 60's during the course of the project and enjoyed reading them from cover to cover. Indeed, I have been motivated to try and continue and have in mind a Songbird LMS superhet, emulating the simplicity of an 1R5, 1T4, 1S5 valve arrangement with a 3N201 frequency changer, a cascade BF244/BC183 IF amplifier and a BF244 detector. There would be double tuned IF transformers and a tuned cascade Rf amplifier for the SW only, and I have already located a three-gang condenser in the warehouse, which despite my best efforts on this project, remains rather full! Watch this space.

Lissen 8039 By John R. Sully

Fig 1 (left): Striking Cabinet Of The Lissen 8039

Fig 2 (below): Lissen 8039 Internal View

The text for this article is comparatively short; technically this is not the most interesting of receivers. The accompanying pictures immediately indicate why this radio is such a desirable classic.

January 2006 saw me become victim of rising crime in the U.K. as my car was stolen. I have never attended the Audiojumble staged at Tonbridge, though do remember attending its forerunner held many years ago in Central London. Working one weekend and with no car, I decided to remain in London and visit the Audiojumble 2006 rather than spend hours on public transport travelling to and from home. The Audiojumble caters more particularly for those interested in vintage hi-fi and audio equipment, but I knew there are always a few old radios in amongst the Quad II monoblocks and Leak Point 1's. However one should never dismiss an event on the basis there is unlikely to be many items of personal interest. I remember chatting in the queue before opening, saying that I had no intention of buying anything, I was solely here to further my interest and knowledge.

I could scarcely believe it when I spotted the Lissen 8039 under a table laden with hi-fi goodies. It was obviously in terrible condition, along with another couple of uninspiring and unloved radios. But the 8039 was special, and I have been looking for one of these to add to my collection for years. I have only ever seen one other example for sale, and that was on an internet auction site a year or two back. That particular example was a "loft find" in unrestored condition, I was outbid and it eventually realised a couple of hundred pounds, bought by someone from Italy as I recollect. I notice that a fair number of auctions for the most interesting and desirable radios on the internet are won by collectors from abroad, notably Germany and Italy. I suspect vintage radios are valued more highly in some other European countries as compared to the U.K.

I gave the set a quick look over, but really it did not matter what state the chassis was in, as there was a sticker on the top with a price of £18. At that price I would have bought it even if the chassis had been absent! The rear cover is polished wood and can be removed easily without screws, and a quick peek inside revealed the set to have most of the main components still present, namely an original mains transformer, Lissen branded speaker, selection of valves etc. Clearly there were problems, the speaker cloth was not original, the cabinet finish had been overwiped with varnish, one knob was missing, and the veneer was lifting along one panel join between top and side. A reduction in price of £3 to £15 was agreed; no matter how cheap a radio, it's difficult to resist the urge to haggle!

As I had no car I could only take the radio back to work. It's not that big or heavy, but after a mile or two of carrying I came to the conclusion I'd wait until I had a new car before taking it home, and would instead leave it somewhere safe at work. Back at work I did an internet search, and came up with the valve line up of MM4V, 354V, PM24A, U650. My example had only three valves, and a metal rectifier. Clearly the original rectifier had failed and had been replaced by the metal rectifier. I had never even heard of a U650. At work I had no access to my valve characteristic books etc, but even an internet search did not produce any results. A quick look under the chassis revealed more horrors, the wavechange switch had been soldered to one permanent position, and it appeared that at one time there had been a condenser block on the chassis, now gone and with components strung point to point. At least one of the other valves was incorrect, or at the very least had a much later glass envelope shape. There was no "Trader" or other service information that I could turn up.

I work within reasonable travelling distance of Gerry Wells and the British Vintage Wireless and Television Museum in Dulwich. As I knew the 8039 could not be taken home for several weeks, and I had no data anyway plus didn't know where I was going to find a U650 rectifier, I decided I might as well take it to Gerry. He might well have some

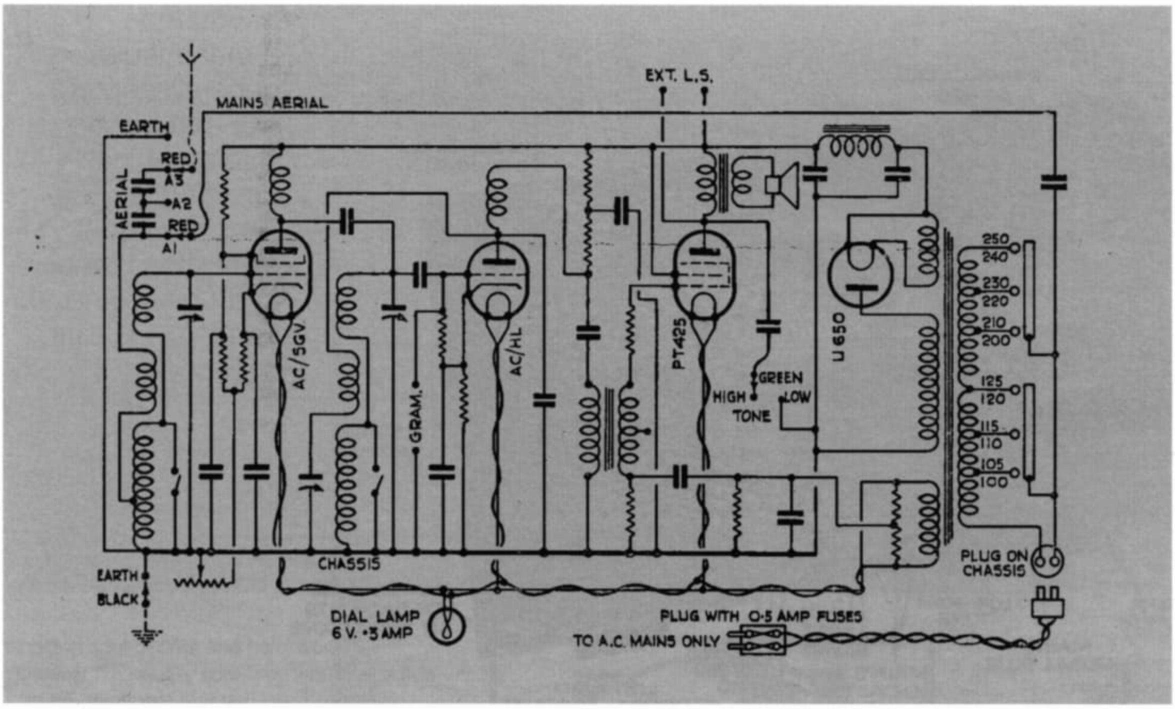


Fig 3 (left): Lissen 8039 Circuit Diagram

Fig 5 (above): Lissen Valve, Note Ridge At Base Of Valve To Assist Removal

service data, and if not I knew he also had an example of this rare radio from which under-chassis details could be copied. Therefore I took the chassis and speaker down to Dulwich for Gerry to examine. Gerry reported that he had only ever had one other 8039 in for service, but sure enough a look in the service data library produced an original Lissen instruction and service book. Perusal of the service data revealed that a condenser block was originally fitted, so use could also be made of the metalworking equipment at the Museum to construct a replica. In view of the work required and the nature of the missing parts I decided to leave this one to Gerry's expertise to deal with.

A week or so later the radio was working again. At the time I was not intending to write an article so unfortunately there are no "before" pictures, but the new condenser block can now be seen in position. The tuning capacitor was found to be completely beyond salvation, but Gerry had located a replacement. Most importantly Gerry also found a new U650 rectifier valve (there are no more though!). The service data revealed that the PM24A which had been indicated in the valve line-up from the internet was also incorrect, it should be a P.T.425. Gerry had also found one of these very rare output valves from the valve stores. A few other incorrect and faulty components were replaced, though it was decided to leave the receiver with the inoperative waveband switch. Finally a correct knob was found in the spares drawers.

There is not too much of interest to comment upon in general circuit design or construction. I like the fact that the chassis slides in between two guides at either end of the chassis, which hold the chassis in position. The chassis is fixed by two countersunk screws concealed by the lower pair of knobs, which hold the chassis from the front, plus a screw underneath the cabinet towards the rear. This arrangement results in somewhat easier chassis removal than usual in radios of the 1930s, with minimal grappling underside. Once the chassis is released the cabinet can be gently tipped and the chassis slides out of the rear. The 8039 is not fitted with an on/off switch, power is applied via two pins protruding from the rear of the cabinet. The instruction booklet indicates that the owner is expected to apply power by switching on at the mains socket, via a fused plug. This must have become tiresome, and there is evidence in my example of a toggle switch fitted to the side of the cabinet to obviate the need to switch on at the mains, where the power socket was likely to have been at skirting board level.

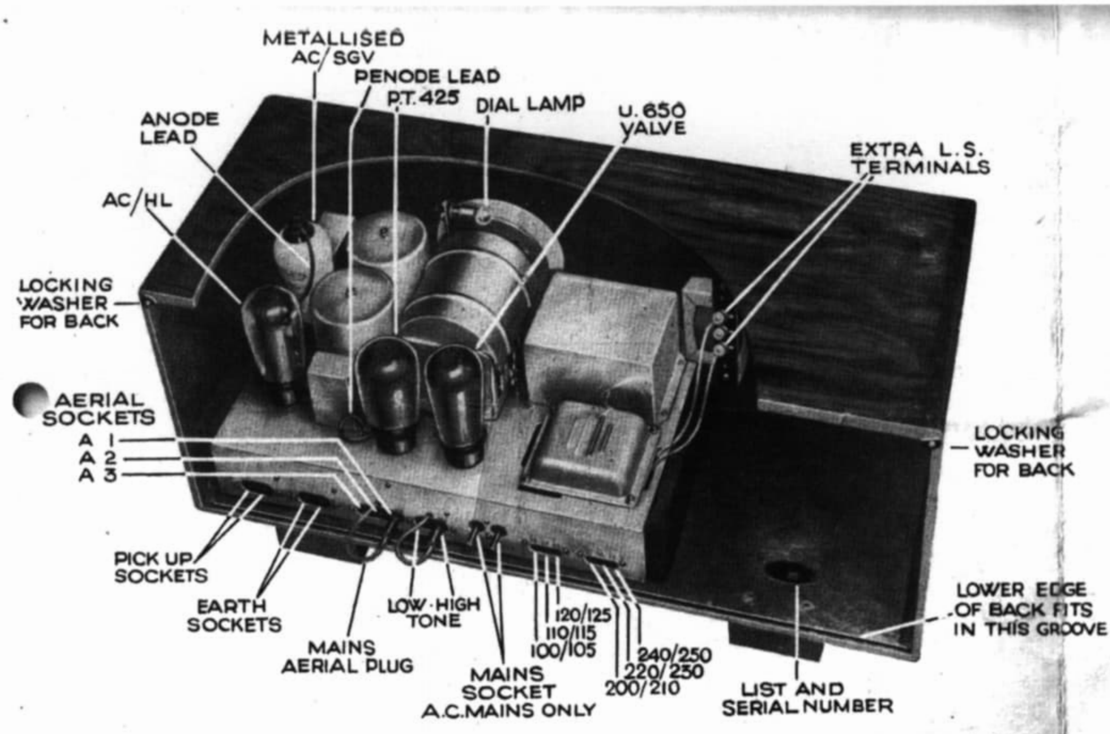
The receiver can accommodate a mains input of between 100v – 250v across six ranges, selectable by individual sockets at the receiver rear, which seems quite a high specification. It is possible to switch between high and low tone by means of a wander plug and sockets at the rear of the chassis. There was also good flexibility of signal input dependent on location of the transmitter, three aerial sockets are provided. Alternatively a wander plug could be inserted into one of the aerial sockets at the receiver rear to provide a mains aerial. If the mains aerial feature was not being used the wander plug could be stationed in an unused socket of the earth socket panel. Some of these various sockets have been removed from my example earlier in the receiver's history. Originally there was provision for a Gram Pick Up utilising a further pair of sockets situated to the chassis rear. Somewhat surprisingly, having mentioned the large number of socket panels provided at the rear of the receiver, there are no sockets for an extension loudspeaker. The owner was expected to connect an extra loudspeaker to screw terminals located on the output transformer which itself was mounted on the loudspeaker. The tuning scale is typical of the period, being an illuminated rotating scale viewed through a bakelite escutcheon. Numeric wavelengths are included across medium and long wave.

The set features a solid wood rear panel, lettered to indicate the function of all sockets and with the Lissen trademark in gold.

The radio was sold in 1933, at a price of £10gns. Sales appear to have been quite low, as there seems only to be perhaps half a dozen or less still in existence. The circuit is a T.R.F. with a combined volume and reaction control, the circuit diagram is shown in fig 3. The circuit and chassis layout appears to be very similar to the Lissen Skyscraper kit set that was available in 1933 for £7.19.6. The U650 is a half wave rectifier, with heater voltage of 6v. The other three valves have 4v heaters fed from a separate transformer winding. The PT 425 output valve delivers about 0.75w to the permanent magnet Lissen loudspeaker. Lissen valves can be distinguished even if numbering has rubbed away over the years by the distinctive ridge at the base of the valve (see fig 5). This small ridge is part of the bakelite base moulding and is designed to form a lip against which upward pressure may be brought during removal of the valve, as opposed to parallel vertical grip required in valves from all other manufacturers. This idea appears to be eminently sensible, and one wonders why other manufacturers did not incorporate this characteristic in their products. Performance from the 8039 is not that good, but it brings in a few stations with a long aerial.

Of course I was not that concerned about performance, as this radio was bought solely on the basis of the cabinet design. Lissen commenced trading quite early in the wireless era, as Thomas Cole realised the potential wireless offered, initially selling component parts for home builders. 1923 saw Lissen become a limited company, and in 1928 Ever Ready bought the company and built receivers using the Lissen name.

It would be a reasonable generalisation to say that Lissen Radio cabinet design was almost without exception bland and uninspiring. The 8039 *is* that exception. The cabinet is highly influenced by Art Deco



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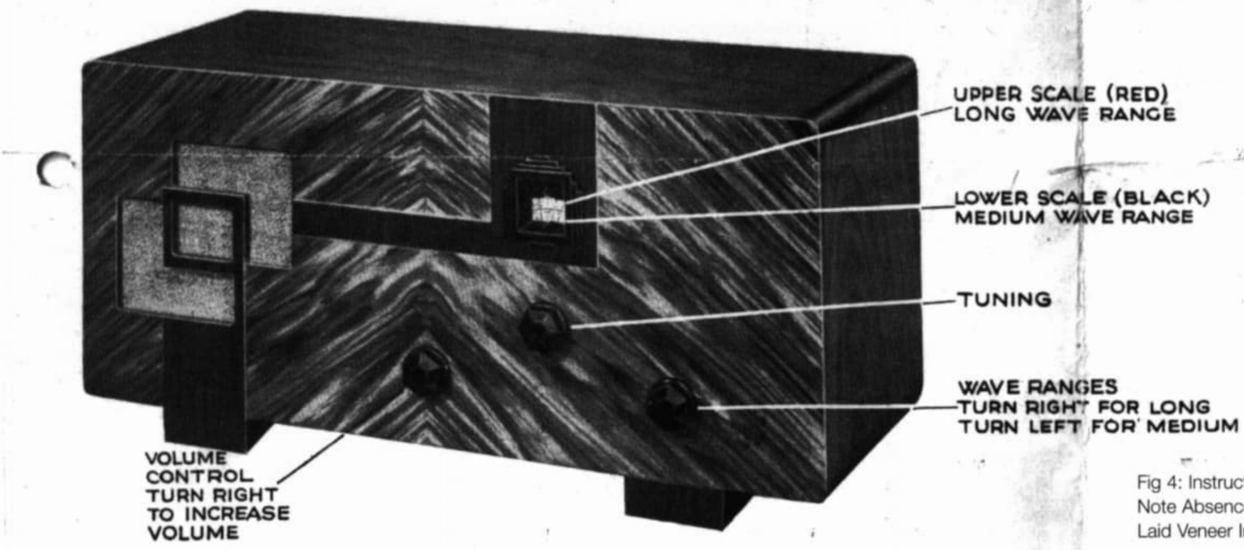


Fig 4: Instruction Book Detail, Note Absence Of Perpendicular Laid Veneer In Illustration

principles, in fact one glossy book has gone as far as describing it as "Cubist" (though unforgivably includes a picture of the radio reversed). The square cut-outs for the speaker fret design, the stepped layers around the tuning escutcheon, and the darkly stained geometric panels (probably to emulate macassar veneer) traverse the cabinet taking in one foot, passing through the fretwork, followed by the escutcheon and heading off towards the top of the cabinet. All of that design is overlaid on the major background veneer of walnut, which has been laid on the diagonal, so that it reaches a point at the centre top of the cabinet front. Along the diagonal opposing veneer has been laid so that it is perpendicular to the rising diagonal. The style of laying sheet veneer on a diagonal seems to have been briefly popular in 1932 and 1933; several other manufacturers employed the technique at that time including Ultra (Blue Fox), Ferranti (Gloria, Lancastria Magna), Unit (SW Converter), Westminster/Belcher (President SG3), Alba (Bandpass 4). Indeed the Lissen AC Skyscraper priced at £10.12.6 included a "portrait" (as opposed to "landscape" for the 8039) wooden cabinet with the kit, and this too had the rising diagonal veneer to the front, but omitted the veneer laid perpendicular to the 45° angle. Crucially the speaker grille was a fussy fretwork design of various apertures and curves, which does not have the strong geometric shapes so beautifully executed in the 8039

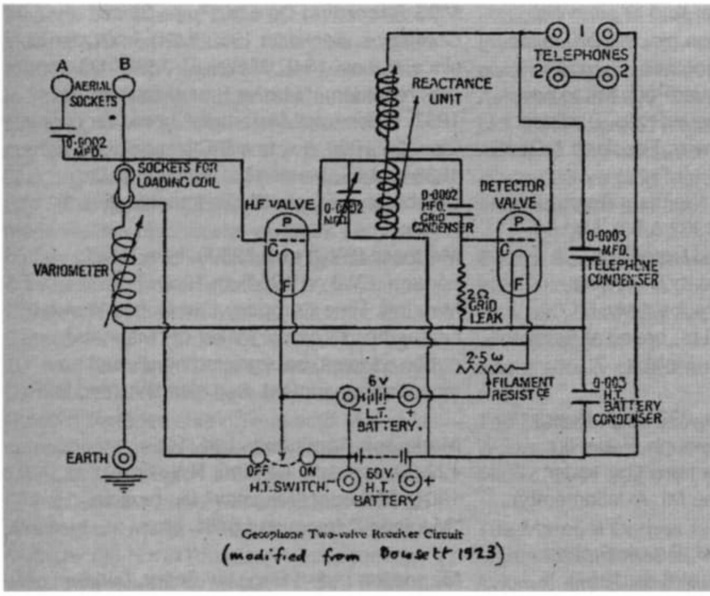
The 8039 cabinet is a very arresting design; accentuated by the fact that the cabinet is held aloft more than 3cm above the surface it is resting on thanks to the substantial wooden feet. The illustrative picture in the instruction book (fig 4) does not include the veneer laid perpendicular to the 45° angled veneer, but consists simply of veneers rising to a centre front peak. Therefore it looks as though the original design of veneer layering was similar to the AC Skyscraper kit (including cabinet) set, and during production the additional perpendicular veneer placing was added. The tuning escutcheon is typical of the Art Deco period, incorporating a heavily stepped design and emphasising the geometric angles elsewhere on the cabinet. The cabinet design has also ensured that even the control knobs are positioned pleasingly. The wavelength control is in the exact centre of the cabinet, and the volume control is positioned directly above the centre of the right hand foot. The tuning knob is somewhat elevated and equidistant between the other two controls. The top, sides and bottom of the cabinet are made of quite thin veneered plywood, though the risk of sagging of the top of the cabinet is reduced due to the tightly fitting wooden back.

This radio will not be seeing an awful lot of use I suspect, but visually it will be a long time before I become tired of it. This little tale serves to remind us that however unpromising an event might seem for your particular collecting interests, you never know what you will miss if you don't go!

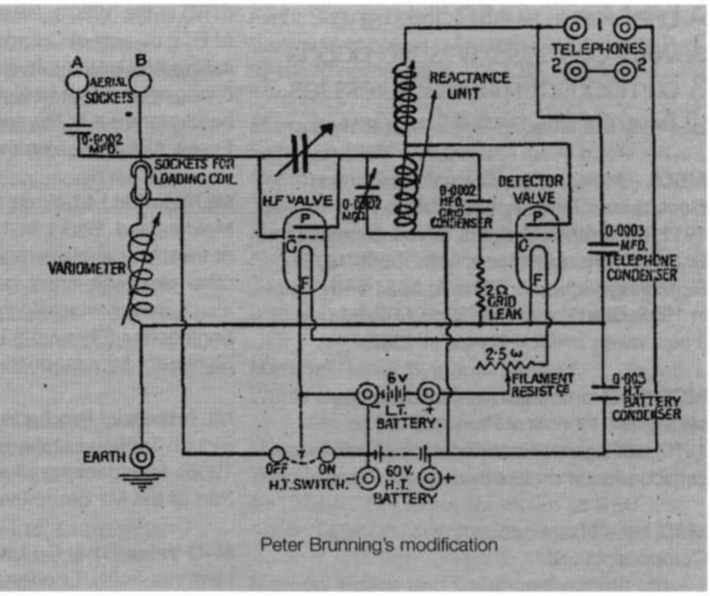
References:

The Setmakers Gordon Bussey 1981
LN 8039 Fitting and operating instructions 1933
The Wireless Show 1977

No smoking, please! continued from page 37



Gecophone Two-valve Receiver Circuit
(modified from Dowsett 1923)



Peter Brunning's modification

to put in a lot of time and hard work." However I'm equally sure they would all agree with his sentiment that you learn so much more about the set, how it was made and how it works by recreating it from scratch.

All four owners I know wouldn't give their sets up without a struggle and represent an example of best practice when it comes both to preserving and ensuring that examples of significant milestones of radio history remain visible and accessible.

I'm grateful to all my interviewees for their co-operation in writing this article. I've enjoyed collating their views and experiences as owners of these landmark sets which hold such a special place in the history of the early days of wireless in Britain. Thanks go also to Carl for his excellent photographs and of course to the author of that original article Ian Higginbottom with its illustrations by Norman Jackson.

Boys' Toys

Dicky Howett finds a couple of television novelties.

Ebay, that source of much world-wide junk, throws up the occasional interesting tv item. Recently, I acquired, for very little cash, a toy tv van and a tv ash tray. The camera on the ash tray- KXLY TV, which is an actual station in Spokane USA-represents a 1950s tv camera called an RCA TK 30A Image Orthicon (albeit with only two lenses instead of four on the turret). The green OB truck toy- again an actual station in New York NBC (WNBT)- sports a couple of single lens cameras of the Orthicon type, dating it to around the mid-1940s. Mind you, the word 'television' in the USA was so new back then, even the spelling of it varied.

A brief resumé of British (and several overseas) finished goods & component manufacturers (as at May 2005) part 11 by Dave Hazell

MBLE – Manufacture Belges des Lampes Electriques. Originally established in 1911, as Lampes Brabant, Vilvoorde, near Brussels. Changed name to MBLE in 1915. Began making radio valves in 1924 and in 1925, used the brand name ADZAM. It was taken over by Philips in 1982.

MCP Electronics Ltd, a subsidiary of Mining and Chemical Products Ltd (in 1970). UK agents for and a supplier of semiconductor metals to manufacturers.

MEC - see Miniature Electronic Components Ltd.

MEL – The MEL Equipment Co Ltd, Manor Royal, Crawley, Sussex (in 1974). A Philips company (originally called RTE and formed in 1935). In 1947, renamed Mullard Equipment Ltd. In 1964, renamed MEL Ltd. Industrial and military electronic systems. In 1990, Philips decided to withdraw from the defence and industrial electronics sectors. They sold MEL's communications division to Thomson-CSF of France (1990/91) and the radar and electronic warfare division to Thorn EMI Electronics. When Thorn EMI decide to concentrate on TV rentals and recorded music, they sold their military and industrial electronics operations in lots, to Racal plc and Thomson-CSF. In 1995, the Thomson companies Redifon and MEL were merged, to form Redifon-MEL, now called Thales Communications Ltd. When Thomson-CSF acquired Racal plc in 2000, the merged company (Thomson-CSF Racal) changed its name to Thales. In 1965, MEL were the UK distributor for Philips Test and Measurement instruments, at 207 Kings Cross Road, London, WC1 but by 1967, they were at Manor Royal, Crawley, Sussex.

MEM – Midland Electric Manufacturing Co Ltd, Reddings Lane, Tyseley, Birmingham (in 1958, 64 & 82). Long established manufacturer of electrical installation products, incl. switchgear, consumer units, etc. In 1958, they also made electric convector heaters. Taken over by Delta Metals group in 1980's. Still in business. By 2003, it had been sold to Eaton Corporation of the USA.

MFD Capacitors (1991) Ltd, Lion Lane, Penley, Wrexham (in 2001), tel. 01978 710551. Established in 1969. Maker of polypropylene, polyester and polycarbonate capacitors.

MET – Modern Engineering & Technology Ltd, 4 Station Road West, Canterbury, Kent (in 1972). Loudspeaker maker.

MK Electric Ltd, Shrubbery Lane, Edmonton, London, N9 (in 1960 & 63). In 1956 & 59, at Wakefield Street, London, N18. A former Belling & Co employee, Mr Charles L Arnold set up the Edmonton switchgear firm, circa 1919. The Multi-Kontact Electric Co was formed in 1923. Taken over by Rio Tinto Zinc (RTZ) in the 1980's. Later sold or spun out of RTZ as part of Caradon plc. In 2000, after selling its plumbing businesses, Caradon changed its name to Novar PLC. MK is now headquartered at Paycocke Road, Basildon, Essex. Novar plc also owns: Friedland & Gent.

ML Aviation Ltd, White Waltham Aerodrome, Maidenhead, Berks (in 1962 & 63). Maker of transistor analyser and tester and other electronic equipment. There was also a railway signalling subsidiary, ML Engineering (Plymouth) Ltd, based at Estover, Plymouth. ML stands for Mobbs - ?

ML Industrial Products, 292 Leigh Road, Slough Trading Estate, Slough, Berks (in 1966). Manufacturer of a transistor tester. Part of the ML group (see ML Aviation entry).

M-O Valve (The) Co Ltd, Brook Green, Hammersmith, London, W6 (in 1957). It was originally a carbon filament lamp manufacturer, based at Brook Green, Hammersmith – Robertsons Electric Lamps (originally set up by C J Robertson). In 1883, GEC acquired a stake in the company. In 1905, a new company was set on the same site, by GEC, in partnership with two German firms: Auergesellscaft and Just & Hanaman, to make wire filament lamps. The J& H share was later bought out by the other two firms. Eventually, the two operations combined to form Osram Robertson Lamp Co Ltd. The word Osram was a German one, coined from two others: Osmium and Wolfram. When WW1 started, the UK Government seized the German share of this company and sold it to GEC in 1916, when the Robertson part of the company name was dropped. Osram started making valves during WW1. In 1919, a new joint venture company was set up by The Marconi Wireless Telegraph Co and GEC, to be called Marconi Osram Valve Co Ltd – based at Brook Green. This took over the Osram (GEC) Ltd valve making operations. In 1920, the name changed to The M-O Valve Co Ltd. In 1929, Marconi sold its consumer radio business and it's share of M-O, to The Gramophone Company (HMV). HMV by this time, were closely associated with RCA of the USA. The Gramophone Company later merged with The Columbia Graphophone Company, to form Electrical & Musical Industries Ltd (EMI). In July 1956, EMI sold its 50% share of M-O to GEC. In 1958, EMI pulled out of consumer radio & TV product manufacture. Shortly after this, M-O ceased to make valves for consumer products. However, at this time, an EMI subsidiary called Electronic Tubes Ltd (ETL), of High Wycombe, were operational, making Emitron, Emiscope and Marconi CRTs and valves. M-O's operations were consolidated at Hammersmith. The factory was finally closed down by GEC in 1988. The Brook Green site is now a Tesco superstore!

Famous for their KT66 and KT88 beam power tetrode valves. In 1979, there was a special brand "Gold Lion" for HiFi valves (e.g. KT77 and KT88). They also made gas discharge type surge arrestors.

MSS Recording Co Ltd, Poyle Close, Colnbrook, Bucks (in 1950 & 64). In existence since at least 1945. Maker of "MSS" tape and disk recorders. "Master Sound System". In 1957, sellers of "Mastertape" brand recording tape. By 1960, it was a BICC subsidiary. By 1965 and 67, Mastertape (Magnetic) Ltd, Colnbrook, Slough, Bucks (manufacturers).

Magneta (BVC) Ltd, 725 Fulham Road, London, SW6 (in 1964). In 1950, The Magneta Time Company Ltd, Goblin Works, Leatherhead, Surrey. Maker of "Magneta" public address, background music and time recording equipment. See also BVC and BSR.

Magicook Appliances Ltd, 115-129 Carlton Vale, London, NW6 (in 1964). Maker of "Magicair" fan heaters, "Magicook" fryers and grills, etc.

Magnafon Ltd, 3 Baggally Street, London, E3 (in 1958). Maker of tape recorders.

Magnavox Corporation (USA). Established circa 1908, to make loudspeakers (means in Latin "big voice"). Later diversified into industrial and defence electronics. After WW2 moved into consumer electronics. In 1974 was taken over by The North American arm of Philips (Holland). In 1960, Magnavox Electronics Ltd was established, at 129 Mount Street, London, W1 – to market products manufactured under subcontract in the UK. In 1962, Magnavox owned Collaro (UK) and the UK company became Magnavox Electronics Company. Magnavox Electronics Co Ltd, Alfred's Way, Bypass Road, Barking, Essex (in 1964).

Magnetic Broadcasting (The) Co Ltd, Suffolk Hall, 1 Upper Richmond Road, London, SW15 (in 1955). Marketed "stethophones" in 1955 (earphones which looked like a stethoscope).

Magnetic Coatings Ltd, 38 Grosvenor Gardens, London, SW1 (office) and works at 25 Dashwood Trading Estate, Larch Road, London, SW12. Maker of "Ferrovoice" magnetic recording tape..

Magnetic Devices Ltd, Exning Road, Newmarket– same phone number as Power Controls Ltd! (in 1955 & 56). Maker of relays (associated with Guardian Electric Manufacturing Co of Chicago, Ill.). Established in 1952 at the Exning Road site. Later became a Pye company. Shared same site and phone numbers with Newmarket Transistor Co Ltd, in 1958! Still there in 1975.

Main (R & A) Ltd, Gothic Works, Edmonton, London, N18 (in 1964). Domestic appliance manufacturer. A subsidiary of Glover and Main Ltd, which was taken over by Thorn in 1965.

Mains Radio Gramophones Ltd (established 1929), taken over by Radio Rentals Ltd in 1945. In 1944, at Norton Gate Works, Manchester Road, Bradford. A maker of the wartime utility radio set (manufacturer code U31). In 1961, with the acquisition of the Baird brand name from Hartley Baird Ltd, the company's name was changed to Baird Television Ltd.

Mallory. P R Mallory & Co Inc, Indianapolis 6, Indiana, USA (in 1945 and 1955). Established in 1916 by Philip Rogers Mallory (who died in 1975). A maker of capacitors, tungsten filaments, batteries, switches, resistors, audible sounders ("Sonalert"), vibrators and later on, Duracell batteries (the Duracell brand was introduced in 1964). I think they also made electro–mechanical vibrators for (valve) battery powered products and possibly, radio & TV sets. Duracell established a UK plant at Crawley, UK (in 1964, Mallory Batteries Ltd, Gatwick Road, Crawley, Sussex) still going in 2004. In 1978/9, P R Mallory was bought by Dart Industries (USA). Dart only wanted the Duracell batteries division and sold Mallory's components group to the Emhart Corporation (USA). In 1989, Black & Decker (USA) bought Emhart and the Mallory components division was sold on. Mallory capacitors were then made by the North American Capacitor Co, which was bought by Vishay in 2002 (they sold off the "Sonalert" division). The battery group became Duracell International Inc., in 1978. Duracell was bought and sold several times since then (1980 Kraft Inc, 1989 Kohlberg-Kravis-Roberts). In 1996, Duracell International Inc., bought by Gillette!

Maplin Electronics. Established in the 1970s as a retail distributor of electronic components to hobbyists. Later diversified into wholesale (as per RS, Farnell, etc.). Took over the UK distribution of Heathkit kits after Heath (UK) was closed down in the early 1980s. Later taken over by Venture Capital, who sold Maplin Electronics in Sept 2004, to Montague Private Equity.

Marantz. Brand name of Marantz Company, 44-15 Vernon Boulevard, Long Island City, NY (in 1955). Maker of HiFi equipment. Later a Philips company.

Marbo. In 1965, the brand name for flex connectors and other electrical wiring accessories made by Marbourn Limited, Rosly Works, Roslyn Road, London, N15.

Marconi. Trade name of the Marconi Wireless Telegraph Company based in Chelmsford. Guglielmo Marconi (1874-1937) was a pioneer of radio communications. The company was formed in 1897 as the Wireless Telegraph and Signal Company but was soon renamed. In 1899, the first factory was established at Chelmsford. On 25th April 1900, the Marconi International Marine Communication Co Ltd was formed, to establish an international ship radio communications system. In 1928, Marconi's international wireless communications operations were merged with the Eastern Telegraph Co. By 1929, two companies emerged from the union: Cable & Wireless Ltd (the holding company) and Imperial & International Communications Ltd. In 1934, they were renamed: Cable & Wireless (Holdings) Ltd and Cable & Wireless Ltd. In 1946, English Electric bough the Marconi manufacturing operations (from Cable & Wireless). C & W was, for a long time, a UK Government owned company. GEC acquired Marconi through its takeover of English Electric, circa 1968.

Marconi made broadcast electronic equipment, radio communication systems, transmitters and avionics. The defence electronics part of Marconi was sold to British Aerospace in 1999. Marconi Instruments Ltd, Longacres, St Albans, Hertfordshire, AL4 0JN. EMI also used the brand to market valves (and Marconiphone) for TV and radio sets until the late 1950's.

Elettra Sound Systems, The Marconi International Marine Co Ltd, Elettra House, Westway, Chelmsford, Essex (in 1966). Radio microphones and public address systems. It was gradually closed down from 1967 onwards.

The Marconi Company Ltd, Wembley Works, Lancelot Road, Wembley, Middx (tel 01 902 9421 (in 1969).

The Marconi Company Ltd, Christopher Martin Road, Basildon, Essex (in 1969). Avionics and Electro-Optics.

Marconi-Elliott Avionic Systems Ltd, Christopher Martin Road, Basildon, Essex (in 1974).

Marconi Avionics Ltd, 22-26 Dalston Gardens, Stanmore, Middx (in 1978). Avionics.

Marconi Avionics Ltd, Christopher Martin Road, Basildon, Essex (in 1978). Electro-optical systems group.

Marconi Avionics Ltd, 26-28 The Hydeway, Welwyn Garden City, Herts (in 1980). Shipborne digital electronic equipment.

Marconi International Marine (The) Co Ltd, Elettra House, Westway, Chelmsford, Essex (in 1974).

Marconi Communications Systems Ltd, Marrable House, Great Baddow, Chelmsford, Essex. (in 1978). FM mobile radiotelephones.

Marconi Communications Systems Ltd, New Street, Chelmsford, Essex (in 1973).

Marconi Communications Systems Ltd, Specialized Components Division, Billericay Works, F, Billericay, Essex (in 1965 & 72). Maker of quartz crystals and oscillators.

Marconi Company (The) Ltd, Marconi House, New Street, Chelmsford, Essex (in 1969). Maker of broadcast sound and vision equipment.

Marconi Electronic Devices Ltd, Doddington Road, Lincoln (in 1982). Power transistors.

Marconi – English Electric bought Cable & Wireless' interest in Marconi's Wireless Telegraph Co Ltd, in 1946.

Marconi Instruments Ltd, Longacres, St Albans, Herts (in 1947). Established in 1936 (WW ad Dec 1981, p118). Maker of electronic test equipment. Originally formed in 1936 as Marconi Ekco Instruments Ltd - a joint venture with E K Cole Ltd (Ekco), with premises in Chelmsford and Southend on Sea. Ekco pulled out in the 1940's. Sold by GEC to IFR (of the US – originally called Instrument Flight Research Inc.), in the late 1990's. IFR in turn, was acquired by Aeroflex Inc (founded in 1937), of Plainview, NY, USA, in 2002.

Marconi-Elliott Microelectronics Ltd, Witham, Essex (in 1969) – at this site (as Marconi Company - Microelectronics Division), in 1966. In 1967 "The largest microelectronics manufacturing facility in Europe" (W.World, Sep 67, p449) was opened. Makers of 54 & 74 series TTL, etc., in 1970. In 1971, there was also a factory in Glenrothes, Scotland.

Marconi Radar Systems Limited, Writtle Road, Chelmsford, Essex.

Marconi Space and Defence Systems Ltd, The Airport, Brown's Lane, Portsmouth (in 1973 & 78). Previously known as GEC Applied Electronics Laboratories – in 1961?

Marconi Space and Defence Systems Ltd, Hillend Industrial Estate, By Dunfermline, Fife (in 1975).

Marconiphone Company (The) Limited, Radio House, Tottenham Court Road, London, W1 in 1930's. It was originally the consumer products company/brand of The Marconi Wireless Telegraph Co Ltd (they changed the name of one of their "dormant" companies, Poulsen Wireless Telegraph Co, to The Marconiphone Company Ltd). In 1929, it was sold to The Gramophone Company Ltd (which used the HMV brand for their gramophones). The Gramophone Co at the same time, acquired Marconi's 50% stake in the M-O Valve Co Ltd. With the creation of Electric and Musical Industries Ltd in 1931, to acquire all the shares of The Columbia Graphophone Co Ltd and The Gramophone Co Ltd, the brand passed to EMI. In 1952, The Marconiphone Co was based at Hayes, Middx (The EMI HQ).

Margolin (J & A) Ltd, "Plus-a-Gram House, 112-116 Old Street, London, EC1 (in 1935 & 52). Maker of "Dansette", "Broadcaster" and "Plus-a-Gram" record players and "Broadcaster" stylus and sapphire needles. The firm was in business in 1935, offering their ""Plus-a-Gram" gramophone conversion for radio sets with enough room.

Markovits (Istvan) Ltd, 34 Stronsa Road, London, W12 (in 1962 & 65). Maker of badges and emblems for the TV and radio industry.

MARL Associates Ltd, The Ellers, Ulverston, Cumbria (in 1978). LED's. Already an Oxley company?

Marriott. P A Marriott & Co., of Sunleigh Work, Sunleigh Road, Alperton, Middlesex (in 1958). Later to be AP Electronics home? In 1961, 64 & 65, at 284a Water Road, Alperton, Wembley, Middx. Maker of heads for tape recorders (traced back to at least 1958). By June 1965, the name became Marriott Magnetics Ltd. By 1967, Marriott Magnetics Ltd were at Waterside Works, Penryn, Cornwall. By 1970, it was a subsidiary of Business Computers Ltd. Maker of tape heads.

Marrison & Catherall. In 1958 and 1966, manufacturers of a wide range of permanent magnets and C cores for transformers and chokes. In 1966, at Forge Lane, Killamarsh, Sheffield. Alfred Whiteley, of Whiteley Electrical Radio Co, was also co-founder of this company. By 1968, had become Ross & Catherall Ltd, same address.

Marshall (Jim) (Products) Ltd, Denbigh Road, Milton Keynes, Bucks (in 1984). Maker of high power audio equipment for public performances.

Marston. Marston Excelsior Ltd (in 1971) – a subsidiary of Imperial Metal Industries Ltd (in 1971). Semiconductor heatsinks. Later taken over by IMI – Imperial Metal Industries.

Martindale Electric Co Ltd, Westmorland Road, London, NW9 (in 1958). Maker of voltage testers.

Martin Electronics Ltd, 154-155 High Street, Brentford, Middlesex (in 1964 & 65). Martin "Audiokits" – tape recorder, FM tuner and audio amplifier electronics modules, for the home constructor to package (a bit like Mullard "Unilex" of the early 1970's).

Marubeni-Iida Co Ltd, Moor House, London Wall, EC2 (in 1963 & 64). UK distributors for Sanyo products. Started up in 1959. In 1968, Marubeni-Iida Co Ltd, 164 Clapham Park Road, London, SW4. Later Sanyo Marubeni Ltd and located at Greycaine Road, Watford, Herts.

Masteradio Ltd. Of Vibrant Works, 193 Rickmansworth Road, Watford, Herts (in 1946 & 47) and showrooms at 319/321 Euston Road, London, NW1 (in 1948 & 58). The company relocated from London (Oxford Street area) to Watford at the outbreak of WW2. In 1950, they opened a service depot at 16-18 Edmund Street, Birmingham but, by 1958, it had moved to 103 Coleshill Street, Birmingham 4. In 1958, there were depots also at: 575-577 Pollokshaws Road, Glasgow and Victoria Buildings, 32 Deansgate, Manchester 3. In 1954 and 58, head office at 10-20 Fitzroy Place, London, NW1. In 1954 & 58,they had a factory at Vibrant Works, Treforest, Glamorgan (also their Welsh service depot in 1958). MD in 1955 was Mr H Burns. Maker of radios, car radios (particularly in the early years), TV sets, battery eliminators and vibrators. In 1956, they acquired RM Electric Ltd. Masteradio Ltd was acquired by Radio & Allied Industries Ltd (Sobell & McMichael) in 1960. Thereafter, it was used as a brand name for TV and radio sets (Radio & Allied Industries/Sobell, then GEC), but discontinued in the late 1960's.

Matsushita. A Japanese multinational set up by Konosuke Matsushita, in 1918, to make a double ended power socket. Matsushita owns/controls JVC (Japanese Victor Company) and manufactures under the Panasonic and Technics brands (and, in the past, National Panasonic). Apart from consumer and professional electronic equipment, they also manufacture a wide range of semiconductors, passives and electromechanical components. In 1952, Philips of Holland established a joint venture with Matsushita – Matsushita Electronic Components, where Philips held 35% of the company. This arrangement continued until at least 1990. However, Matsushita formed a joint venture with Siemens in passives in the 1990s – now calles NAIS.

Matthey Printed Products Ltd, William Clowes Street, Burslem, Stoke-on-Trent, Staffs (in 1971). Maker of mainly video frequency filters, delay lines, etc. Subsidiary of Johnson Matthey – the precious metals group.

Maxim Lamp Works, Hurstpierpoint, Sussex (in 1964). Lamp manufacturers. In 1968, this was J F Poynter Ltd, trading as Maxim Lamp Works. The first Maxim branded lamp was sold in 1878. J F Poynter Ltd was set up in 1938, with a filament lamp factory at Hurstpierpoint, Sussex.

Maxview Aerials Ltd, Maxview Works, Setch, King's Lynn, Norfolk (in 1982). In the 1960s, R E J Clark (Maxview Aerials) Ltd, Maxview Works, Setch, Kings Lynn, Norfolk.TV and VHF FM aerial maker, also amplifiers, filters, etc. Still going in 2002.

May Precision Components Ltd, maker of "M.P.C" potentiometers and control accessories (in 1967).

Mayra Electronics Ltd, 551 Holloway Road, London, N19 (in 1959). Later that year, they moved to 118 Brighton Road, Purely, Surrey. Marketed a kit for the construction of a hybrid car radio. In 1961, they marketed carbon film resistors.

Mazda. The brand name for valves and CRTs sold in the UK by Edison Swan (later AEI, then Thorn). The name was also used for lighting products. Murphy, Ultra and Ekco particularly favoured Mazda valves. In America, the brand name was owned by GE. The first colour tube plant in UK was opened in 1967 – at Skelmersdale - owned by RCA (GB) Ltd and Radio Rentals – cost £10M and made 300,000 tubes a year. When Thorn took over Radio Rentals, it became jointly owned by TEI Ltd and RCA Ltd

McCarthy – see Felgate Radio Ltd.

McElroy Adams Manufacturing Group Ltd, 33 Lillie Road, London, SW6 (in 1955). Maker of Band 3 converters.

McMichael Radio Ltd, Wexham Road, Slough, Bucks (in 1947). In 1950 & 52, London office at 190 Strand, London, WC2. Maker of radio receivers. Established 1921 by Leslie McMichael as L McMichael Ltd. The firm later merged with one of its suppliers, Benjamin Hesketh. Taken over by Radio & Allied Industries Ltd, in 1956 – at which point RH Klein & J A Klein resigned from the McMichael board. In 1957, same location was "Radio & Allied Industries Ltd", McMichael Works, Wexham Road. In 1978, McMichael Ltd, Wexham Road, Slough (a GEC company). In 1982, McMichael Ltd, Sefton Park, Stoke Poges, Slough – professional video products – in 1983, GEC-McMichael Ltd.

McMurdo. McMurdo Instrument Co Ltd, Victoria Works, Ashtead, Surrey (in 1948 & 64). Established in the 1937 as the UK subsidiary of McMurdo Silver of the USA (established by John McMurdo). McMurdo Silver made radio receivers. In 1939, the US company failed and the UK subsidiary was restructured as The McMurdo Instrument Co Ltd, in 1940. The McMurdo Instrument Co was a maker of valveholders (including Amphenol types, made under licence – until Amphenol established a UK factory), CRT base connectors, the "red" range of connector, volltage adjustment selectors, connectors and AF amplifiers. During WW2, McMurdo also made other things, such as panel meters and military products. Before they relocated to Portsmouth, they also produced marine safety lights and reserve batteries. In 1953, they relocated to a purpose built factory at Portsmouth, where they are currently located.

In 1964 & 69, McMurdo Instrument Co Ltd, Rodney Road, Fratton Trading Estate, Portsmouth, Hants – Tel P'mouth 35361 – a member of the Louis Newmark Group (of Croydon?). In 1995, Louis Newmark went into receivership. In 1994, McMurdo was acquired by the Chemring Group plc (who already owned Pains Wessex, a marine safety products and pyrotechnics company). Circa 1998, the connectors business was sold to ITW (a US multinational company) and is now called ITW McMurdo Connectors. The other business areas of McMurdo merged with Paines Wessex, to form McMurdo Paines Wessex, also based in Portsmouth. McM-P-W make marine distress flares, distress transmitters, etc. The Paines name comes from the same firm that used to make domestic fireworks!

Meadow-Dale Manufacturing Co Ltd (The), The Dale, Willenhall, Staffs (in 1956 & 58). Maker of "Dale" TV aerials.

Measuring Instruments (Pullin) Ltd., Phoenix Works, Great West Road, Brentford, Middx (in 1946) and Electrin Works, Winchester Street, Acton, London, W3 (in 1948 & 64). Maker of meters and measuring instruments. In 1959, R B Pullin & Co Ltd, Phoenix Works, Great West Road, Brentford, Middx – maker of Pullin plug-in thermostat and small induction motors. In 1960, Donvin Instruments Ltd and Dunmar Optics Ltd (instrument, camera and tape recorder repair firms), were subsidiaries of R B Pullin. The Pullin Group Ltd was taken over by Rank Organisation in 1960 and became Rank Pullin Controls.

Medelec Ltd, Woking, Surrey (in 1973). Maker of fibre-optic oscilloscopes. By 1980, a Vickers subsidiary.

Meggitt plc. A company which has acquired many well known manufacturers of electronic components, such as: Holsworthy, CGS, Citec, Sigma, Neohm and Piher (of Spain). Meggitt began in 1947 as a small engineering company, based in Wimborne, Dorset. It went public in 1966. In 1984, it was the subject of a management "buy-in" by two ex Flight Refuelling Ltd managers – Ken Coates and Nigel McCorkell. From that time, the company has grown substantially through acquisitions.

In 2001, Meggitt sold its passives components business (except Piher of Spain) - to Tyco?

Melco. Brand name used in 1968, for integrated circuits made by Mitsubishi Electric Corporation of Japan. Their UK agent in 1968 was Ultra Electronics (Components) Ltd, 35-37 Park Royal Road, London, NW10 (formerly a Pilot Radio Ltd site).

Merlin Communications. Bought the BBC's short wave transmitter operations in the 1980's. Now a subsidiary of VT Group plc (formerly Vosper Thorneycroft).

Merryfield (Andrew) Ltd, 29-31 Wright's Lane, London, W8 (in 1960 & 65). Maker of the "Gramdeck" – utilised the rotation of a turntable, to operate a tape deck.

Metal Industries group. By 1959, the company owned Brookhirst Switchgear of Chester and Igranic Electric of Bedford – Brookhirst Igranic Ltd. In 1959, they acquired Avo Ltd (who had recently taken over Taylor Electrical Instruments Ltd). In 1960, they owned Crypton Equipment, Foster Transformers, Foster Electrical Supplies, and they acquired Lancashire Dynamo Holdings Ltd. In 1967, they owned (amongst others) Avo, Taylor, Cutler-Hammer, Industrial Automation Controls and Waveforms. Taken over by Thorn Electrical Industries Ltd, in August 1967.

Metro Pex. MetroPex Limited, 71, Queens Road, London SE15., 38, Great Portland Street, London, N1 tel Museum 9024-5 and Kings Heath Station, Birmingham, B4 tel Highbury 2765 – Manufacturers of 'Magnavista' t/v magnifiers.

Metropolitan Vickers. The Metropolitan-Vickers Electrical Co Ltd, was created by the take-over of British Westinghouse Electrical & Manufacturing Co Ltd (which was formed in 1899) – initially, by Metropolitan Carriage and Wagon Company. A year later, Vickers Ltd acquired an interest – hence the name. Metro-Vick continued to have associations with Westinghouse (USA) thereafter. British Westinghouse was established in 1889, as the UK subsidiary of Westinghouse (USA). The US company was created by the American, George Westinghouse.

Based in Trafford Park, Manchester, they were a heavy electrical engineering company but also made "Metrovick" and "Cosmos" lamps, valves, test equipment, radio receivers and "Metrosil" voltage dependent resistors (as used in some 1950s TV receivers to assist EHT regulation). In the 1920's Cosmos valves were marketed by Metro-Vick Supplies Ltd, a Metro-Vick subsidiary. In the mid-1920's, the Metro-Vick London office was at 145 Charring Cross Raod, London, WC2. The London office was, in 1946, Metropolitan-Vickers Electrical Co Ltd, Number One, Kingsway, London, WC2. They also made lamps and valves, using the Cosmos brand name. The Cosmos brand came from the Cosmos Lamp Works – originally a German based manufacturer, which MetroVick was associated with.

In 1927, GE (USA) acquired control of Metro-Vick from Vickers Ltd. GE already controlled BT-H. In 1929, Metropolitan-Vickers Ltd became Associated Electrical Industries Ltd. At the same time, all manufacturing operations were transferred to its subsidiary, MetroVick Supplies Ltd, which then assumed its parents' former name! Around the same time, AEI also acquired most of the shares in Edison Swan. GE (USA) had a large interest in the new AEI but never actually controlled the company. With the formation of AEI in 1929, the Cosmos brand was phased out, in favour of Mazda valves made by Ediswan. In 1960, AEI decided to use its own name on the group's products, so the Metro-Vick name was phased out. Metro-Vick also worked jointly with EMI to build the Sutton Coldfield 405 line vision transmitter of 1949. AEI was taken over by GEC (UK) in 1968.

Metro-Sound Manufacturing Company Ltd, 19a Buckingham Road, London, N1 (in 1957 & 64) – maker of Metro-Sound "Masterpoints" replacement stylii, tape splicers, tape head cleaners, etc. In 1966, Metrosound Manufacturing Company Ltd, Bridge Works, Wallace Road, London, N1 (and a distributor of Sonotone cartridges). In 1968, at Audio Works, 35-37 Queensland Road, London, N7. Metrosound Audio Products Ltd and Metrosound Manufacturing Co Ltd, both of Audio Works, Cartersfield Road, Waltahm Abbey, Essex (in 1970-1). Audio equipment.

Metway Electrical Industries Ltd, Metway Works, Canning Street, Kemp Town, Brighton 7 (in 1962 & 64). In 1948 & 50, at King Street, Brighton 1. Connectors, tag strips, heating elements for electric fires, insulators, etc. In 1964, they made a range of Metway small electrical appliances: kettle, iron, toaster & fan.

Mial Spa, Milan, Italy (in 1965). Capacitor manufacturer. In 1965, they appointed Waycom Ltd as their UK distributor.

Micamold Radio Corporation, New York, NY (circa 1940's). Maker of resistors and capacitors.

Micanite & Insulators Co. The Micanite & Insulators Co Ltd, Empire Works, Blackhorse Lane, London, E17 (in 1948). Maker of insulating materials and sleeving and varnished materials. Became a part of (AEI and then ?) GEC. Still listed in 1982 GEC Directory but now defunct?

Mica Products Ltd (acquired by Crystalate Ltd in 1952). Maker of SRBP boards and tubes, bobbins and formers, machined and stamped parts and "Perspex" fabrications for the electronics industry.

Michael Cox Electonics Ltd, Hanworth Trading Estate, Hampton Road, West, Feltham, Middx (in 1979). Broadcast TV equipment maker.

Micro Electronics Ltd, York House, Empire Way, Wembley, Middx (in 1967 & 75). A Hong Kong based maker of silicon planar semiconductors ("μE" brand). The UK office was set up in 1967.

Midland Silicones Ltd, 19 Upper Brook Street, London, W1 (in 1955).

Miers (N) & Co Ltd, 115 Gower Street, London, WC1 (in 1950). Retailers of surplus equipment? Later on (by 1964), when at 28 Piercing Hill, Theydon Bois, Epping, Essex, spares for Perdio (after the original firm went bust).

Miles Hivolt Ltd, 13 Mortimer Road, Hove 3, Sussex (in 1960). Maker of 20 million Megohm insulation test set. In 1967, at Riverbank Works, Shoreham-by-Sea, Sussex and producing a bench type EHT meter for use with colour TV sets.

Mills & Rockleys (Electronics) Ltd, Swan Lane, Coventry (in 1960 & 62). The PCB division of Mills & Rockleys (Production) Ltd. In 1969, Mills & Rockley (Electronics) Ltd, were at Skelmersdale, Lancs. PCB makers, as used by Murphy Radio and Rank Bush Murphy ("MR" logo on PCB). See WW Nov 62, p546.

Miniature Electronic Components Ltd (MEC), The Lye, St Johns, Woking, Surrey (in 1966 & 69). Merged with Electrosil in 1969. Maker of (passive) electronic components – pots and wirewound resistors. In 1966, they were the UK distributors for elapsed time meters made by Curtis Instruments Inc, USA. In 1968, at Copse Road, St Johns, Woking, Surrey. Miniature Electronic Components – taken over by Electrosil Ltd, in 1970.

Minnesota Mining & Manufacturing Co Ltd, 167 Strand, London, WC3 (in 1952). By 1957, at 3M House, Wigmore Street, London W1. "Scotch Boy" magnetic recording tape.

Mitchell Electric Ltd, 88-90 Tennant Street, Birmingham 15 (in 1948). Maker electric tabletop cooker.

Mitel. A Canadian telecommunications and semiconductor company. It is believed that the name – Mitel - was derived from Mike and Tel (Terry) – the forenames of the two men who established the company (possibly an apocryphal story!). The company refocussed on semiconductors in the late 1990s and it was renamed Zarlink Semiconductor.

Mitsubishi. A Japanese mulitnational, with interest in heavy engineering, automobiles, electronics and shipping. Founded by Yataro Iwasaki in 1870, as the Tsukomo Shokai shipping company. By 1973, the company had changed its name to Mitsubishi Shokai. Mitsubishi comes from the words mitsugawisha and sangaibishi – the emblems of the family crests, whose flags flew on their ships. In 1921, a subsidiary company, Mitsubishi Electric Corporation, was formed to make electric fans. Mitsubishi set up the Nikon Corporation in 1917. When Tandberg of Norway ran into financial difficulties in the late 1970s, it sold its Scottish TV factory at Haddington to Mitsubishi. Mitsubishi later opened a VCR factory at Livingston.

Modac – Modern Acoustics Ltd, Manor Way, Boreham Wood, Herts (in 1958). Maker of "Tuchel" connectors in the UK, under licence. Later (by 1960) associated with Plessey, who relocated production to their site in Swindon.

Modeq. Brand name of Modern Equipment Ltd, West Hendford, Yeovil, Somerset (in 1962). manufacturer of clothes driers.

Modern Techniques, Wedmore Street, London, N19 (in 1958). Maker of the "Motek" tape deck.

Molex Inc, Downers Grove, Illinois. Connector maker. Founded circa 1945?

Monogram. In 1967, Monogram Electric Co, Lincoln House, 296 High Holborn, London, WC1. Brand name used by General Electric (USA) for consumer electronics.

Monolith Electronics Co Ltd (The), 5-7 Church Street, Crewkerne, Somerset (in 1977). Tape head (maker or just distributor?).

Monolithic Memories Inc, 1165 E Arques Avenue, Sunnyvale, California (in 1978 & 82). Semiconductor memory maker.

Mordaunt-Short Ltd, 12 Hollywood Road, London, SW10 (in 1968) – set up in that year, with Norman Mordaunt as technical director. In 1970, moved from London to The Causeway, Heath Road, Petersfield, Hants. Maker of loudspeakers.

Moreton Cheyney (The) Co Ltd, Stafford (in Feb 1947). Maker of the "Silver Dragon" communications receiver – at that time. By June 1947, the company had relocated to Darkhouse Lane, Deepsfields, Bilston, Staffs. It looks as if this firm had a rather short existance, as nothing further appeared in the relevant radio trade press thereafter.

Morgan Crucible (The) Co Ltd, new HQ (in 1969), 98 Petty France, London, SW1.

Morganite Carbon Co Ltd, Battersea Church Road, London, SW11 (in 1964). In 2000, a housing estate!

Morganite Resistors Ltd, of Bede Industrial Estate, Jarrow, Co. Durham. Formed in 1948 to take over the radio resistors department of Morgan Crucible Co. Ltd. (with a factory at Battersea Church Road, London, SW11 – now a select housing development!). Manufacturer of fixed and variable resistors. Still in business in 1970. Sold to Allen Bradley (USA) by 1975 – Allen Bradley Electronics Ltd, Pilgrimsway, Bede Industrial Estate, Jarrow, Tyne & Wear. In 1975, they stopped making "Morganite" carbon composition resistors.

Morphy Richards Ltd, St Mary Cray, Orpington, Kent (in 1945 & 55). Maker of small electrical appliances (toasters, fan heaters, irons, etc) and "Astral" refrigerators. In 1965, Morphy-Richards (Cray) Ltd, also marketed an electric iron pyrometer. In 1960, EMI owned Morphy Richards. Known as Morphy-Richards (Cray) Ltd and Morphy-Richards (Astral) Ltd in 1962. Later became part of Hotpoint (British Domestic Appliances Ltd) for a time. In 1982, Morphy Richards Ltd, Mexborough, South Yorkshire (possibly the old GEC domestic appliances factory? – same town).

Morris (B H) & Co (Radio) Ltd, 84/88 Nelson Street, Tower Hamlets, London, E1 (in 1969). UK agent for Trio (Kenwood) Japanese communications receivers and TEAC tape decks.

Morton Cheyney. A radio manufacturer (e.g. the Silver Dragon), circa 1947, based in Stafford. Nothing else known.

Moss (Robert) Ltd, Langford Lane, Kidlington, Oxon (in 1961 & 82). Plastics injection mouldings (grommets, feet, ferrules, end-plugs, tips and ball knobs). Made the plastic cases for Labgear masthead preamps.

Mostek Corp, Carrollton, Texas, USA (in 1972). Semiconductor manufacturer.

Motek. Motek Products made by Modern Techniques, London. "Manufacturers of tape decks and heads, tape amplifiers, microphones, telephone adaptors, cabinets etc". In 1959, Modern Techniques, Wedmore Street, London, N19.

Motorola. The company was originally established in the 1928 by Paul V Galvin (as the Galvin Manufacturing Company). The first products were battery eliminators for radios. Galvin made car radios from the 1930s, branded "Motorola".The name was changed to Motorola Inc., in 1947. The colour TV receiver manufacturing business was sold off in the 1970's. They also branched into cellular radio in a big way in the 1970s and 80s. They have UK production sites in Swindon, East Kilbride (opened in 1969 but recently closed) and Hitchin (where they used to make car radios). Smiths Radiomobile used to make Motorola branded car radios in the 60's, as World Radio Ltd (same address as Radiomobile Ltd – North Circular Road, London). Motorola Limited, Automotive Products Division, Taylors Road, Statfold, Hertfordshire, SG5 4AY. Motorla acquired the cable TV division of General Instrument (formerly Jerrold) in 2000.

Motorola Automotive Products Ltd, Taylors Road, Stotfold, Hitchin, Herts (in 1982). Maker of in car entertainment. Later became a cellular telephone factory!

Motorola Semiconductor Products, Phoenix, Arizona (set up in 1953). In 2004, Motorola renamed its microelectronics business as Freescale Semiconductor, prior to its separation and separate stock exchange listing. A few years prior to this, the company spun off its non-micro semiconductor business as "On Semiconductor".

Motorola Semiconductors Ltd, York House, Empire Way, Wembley, Middx (in 1970). In 1969, they opened a semiconductor factory at 212 Hawbank Road, College Milton North, East Kilbride, Scotland.

Muirhead & Co, Beckenham, Kent (in 1911 and 1953). In 1911, makers of "high voltage condensers, test equipment, telegraph apparatus and standards for all purposes". Mufax facsimile units. In 1962, it had a subsidiary – Addison Electric Ltd. Muirhead & Co, Elmer's End, Beckenham, Kent (in 1947). Maker of test equipment (and facsimile machines?).

Mullard. Founded as a valve manufacturer by Captain Stanley Mullard in September 1920 as the Mullard Wireless Service Co Ltd. Production started in Hammersmith and two years later, moved to larger premises at Balham. The Dutch NV Philips Gloeilampenfabrieken company took a 50% share in the company (Mullard required funds to develop his company) in 1924 and acquired full control in 1927. In 1929, Stanley Mullard resigned as MD of the company but remained connected with it (as a director) until he retired in 1970 (aged 87). He died on 1st September 1979, aged 95. He joined Ediswan in 1915, saw service in WW1, where he was involved in transmitting valve development. In 1920 he set up the Mullard company, to produce these.

By 1946, the Mullard HQ was at the Philips HQ at Century House, Shaftesbury Avenue, London.

Circa 1950, the name was Mullard Electronic Products Ltd for equipment and Mullard Ltd for valves, CRTs and components.

In the mid-50s, Mullard Ltd had the following wholly owned subsidiaries:

The Mullard Radio Valve Co Ltd, Mullard Blackburn Works Ltd, Mullard Overseas Ltd, Mullard Equipment Ltd, Mullard Telecommunications and Marine Telecommunications Ltd. At this time, Mullard had factories at Mitcham (in Surrey), Blackburn ans Simonstone (both in N E Lancashire). It also had factories or feeder units at: Fleetwood, Rawthenstall, Lytham St Annes, Southport, Padiham, Hove, Whyteleafe and Waddon.

In 1957, Mullard moved into a new HQ building at Mullard House, Torrington Place, London, WC1, where they were until the 1990's, when they relocated to Dorking (but by then, as Philips Components Ltd – the name change took place circa 1988).

The Mullard brand was dropped in favour of Philips Components on 27th April 1988.

Mullard had an association with the (British) Ever Ready company, insofar as valves were concerned. All Ever Ready branded valves were supplied to them by Mullard and Mullard nominated one member of the board of directors of Ever Ready.

In the UK, Mullard/Philips manufactured a wide range of electronic components and assemblies, including valves, semiconductors, CRTs, wound components, magnets, ferrites, loudspeakers and tuners. They also made a valve tester.

Mullard factories:

Blackburn – Philips Road, Blackburn, Lancs. Valves, capacitors, delay lines – in 1973. Opened shortly before the start of WW2.

Crossens – Balmoral Drive, Crossens, Southport, Merseyside (in 1974). Magnetic materials.

Dunfermline – Queensferry Road, Dunfermline, Fife. TV components and sub-assemblies (in 1979).

Durham (opened in 1972) – Belmont Industrial Estate, Durham. Colour CRTs. LG Philips (the CRT/LCD joint venture between Philips of Holland & LG of South Korea) announced in March 2005, their intention to close this factory by July 2005, with production moving to China.

Hazel Grove – Bramhall Moor Lane, Stockport, Cheshire. In 1979 – power and microwave semiconductors. Originally, a GEC semiconductors site (in 1960 & 61).

Mitcham – New Road, Mitcham, Surrey. Night vision and low level TV devices, modules, professional tubes, colour tube rebuilding, central applications laboratory and materials laboratory (in 1979).

Southampton (Millbrook Trading Estate), opened in 1957 for the manufacture of semiconductors

Stockport (Hazel Grove), Blackburn and Thornaby, Yorkshire (in 1969) – semiconductors

Simonstone – Simonstone, Burnley, Lancs. CRTs and glass

Thornaby (in 1973) – varicap TV tuners.

Washington – Stephenson Estate, Washington, Co Durham. Deflection/convergence wound components for CRTs (in 1978).

Croydon Service Dept, PO Box 142, Beddington Lane, Croydon, CR9 4NA. In 1958, they opened a new Service Department at Purley Way, Croydon.

Mullard valves were favoured by Ferguson, Pye, Bush and (of course!) Philips. There was also a company called Mullard Equipment Ltd. which sold Philips Industrial products in the UK, as well as making their own (e.g. "Norbit" logic modules- still giving sterling service in certain BBC transmitters!). In 1964, the name changed to The MEL Equipment Co Ltd and was sold by Philips in 1990/91 to Thomson CSF of France. Thomson merged MEL with Redifon (whom, by then, they also owned) to form Redifon MEL Ltd. When Thomson CSF changed its name to Thales in 2000, they Redifon MEL name went. In 1946, Mullard opened research laboratories in (Salfords) Redhill, Surrey and they were expanded in 1957 (still in business as Philips Research Laboratories).

Mullard Equipment Ltd, Manor Royal, Crawley, Sussex (new factory opened in 1961). In 1964, its name was changed to MEL.

Mullard Radio Valve Co Ltd (in 1957), New Road, Mitcham Junction, Surrey.

Mullard Radio Valve Co Ltd (in 1957), Queensway, Waddon Factory Estate, Croydon, Surrey.

Mullard Blackburn Works Ltd – formed in 1951.

Multicore. Multicore Solders Ltd, Multicore Works, Maylands Avenue, Hemel Hempstead, Herts (in 1952). Founded in the 1939 by Mr Richard Arbib. Richard Arbib entered the radio industry in 1929, in the electrical reproducer department at HMV. At the age of 25, he was appointed advertising manager of HMV. Developed the patented "Ersin" multicore self-fluxing solder wire still used today. By 1956, it was a subsidiary of Kelsey Industries Ltd but Richard Arbib was still MD. It became part of the US Loctite Company, who were in turn taken over by Henkel (of Germany) in the 1990's. By the 1960's, Multicore Solders had diversified into the HiFi accessories market with their "Bib" range of products. Gordon Arbib runs the company today (2002).

Multimusic Ltd, Maylands Avenue, Hemel Hempstead, Herts. Established in 1958 as a wholly owned subsidiary of Multicore Solders Ltd, to take over the manufacture of "Reflectograph" tape recorders, previously produced by Rudman Darlington & Co Ltd and Rudman Darlington (Electronics) Ltd, of Wednesfield, Satffs (and from which companies the patents, goodwill and trade marks had been acquired). Richard Arbib was Chairman & MD of both companies. Still going in 1961.

Multitone Electric Co Ltd, 92 New Cavendish Street, London, W1 (in 1947). In 1958 and 1973, 12-20. In 1961 & 65, at 12 Underwood Street, London, N1. In 1980, 6-28 Underwood Street, London, N1. Founded in 1931 by Joseph Poliakoff, who died in 1960, aged 86. Maker of hearing aids and later on, wireless paging equipment.

Murata. The Manufacturing Company, was founded in Japan in 1944, by Mr A Murata (whose father ran a ceramic pottery company). Initially, Murata developed steatite and titanium capacitors. Later, Murata, like Clevite in the USA, developed ceramic filters and resonators, there being co-operation between the two companies. In the 1960's Murata produced small filters for use in AM & FM radios. They also made ceramic resonators (as used in infrared remote controls and low cost clock oscillators for digital circuits. By the 1980's Murata were a very big force in resonators, filters and allied products. Circa 1984, Murata took over Erie Technological Products of the USA. As at 2004, Murata is still in very much in business.

Murex Ltd, Rainham, Essex (in 1948 & 50). Producer of Alnico, Hycomax, Sincomax and Alcomax magnetic materials – for relays, speakers, etc. Any connection with BOC Murex?

Murphy Radio Ltd. Established in early 1929 by Frank Murphy in Welwyn Garden City, who left the firm in 1937. E J (Ted) Power (who was already a senior person in the firm) became MD - until 1962. It became a public company in 1949. The firm was originally established at Broadwater Road, Welwyn Garden City, but built a new factory and HQ at Bessemer Road (W.G.C) in 1956, where the bulk of its operations were centred. In 1947, it acquired a factory at Hirwaun, South Wales. In 1952, it opened a factory in Skegness. By the middle of the 1950's, Murphy also acquired three other companies: General Radiologhical Ltd (nucleonics), Solus-Schal Electronics Ltd (x-ray & ultrasonic inspection equipment) and Solus Electronic Tubes Ltd (mainly x-ray tubes). Although mainly a radio and TV maker, by the end of WW2, it also made radiotelephone equipment and military and industrial electronics. On 4th June 1962, it was taken over by the Rank Organisation and the radio & TV operations were integrated with those of Bush Radio Ltd, to form Rank Bush Murphy Ltd. Murphy Radio announced in Aug/Sept 1962, that it was closing its factory in Hirwaun Industrial Estate, Aberdare, Glamorgan.
All future production of TV and radio took place at the Bush factory in Plymouth and the Murphy factory in Scarborough. The radiotelephone and industrial electronics operations moved out of its WGC site circa 1970, to allow Rank Xerox to move in.

Mycalex Co Ltd, Ashcroft Road, Cirencester, Glos (1946 and 1950 and 64). Maker of Mycalex (insulation) mouldings (e.g. for TV aerials) and high voltage capacitors. Did this become Ashcroft Capacitors????

Letters

Dear Editor,
I was interested in Anthony Hopwood's letter about compact receivers.

Some years ago I was given two little radios made by Pam which may or may not pre-date any in his collection but they may also interest him. They are labelled 'Personal Portable by Pam of Guildford' and they are in particularly neat, though heavy, bakelite cases and have a single, geared tuning control and small earphones in a clip formed in the bakelite panel.

Not wanting two for my collection I gave one to Gerry where Anthony Hopwood may wish to see it on display. I should be very interested to know approximately when this model was made.

Yours sincerely,
Julian F. Alderton.
julian.alderton@sweethaven.biz

Dear Editor,
May I take this opportunity of thanking both Steve Knowles and Graham Dawson for their kind comments in respect of the series of articles under the title 'An Unofficial History of Broadcast Television.' May I also address a couple of errors which they have kindly drawn attention to.

With regard to the 'Larkins', I have to confess to falling into the trap of accepting a published source as gospel without checking further. I'm afraid my dim recollection of the series itself and the printed word led me astray!

Insofar as the comment on colour transimissions is concerned, apologies are also due for a lack of clarity, some confusion in the notes I was working from and my own sub-editing. The section should have read as follows:

'The 1962 White Paper also encouraged the development of colour transmissions. Initially using the NTSC system in 1963 the BBC also began testing the French Secam in co-operation with the GPO, the ITA and the industry. There was also interest in the system being developed by Telefunken which was based on the NTSC system. Following months of tests with 625 line PAL transmissions from Crystal Palace, the BBC, in November 1967, began some 7 hours of colour each weekday'.

I'm grateful for this opportunity of clearing up these points.

Yours sincerely
John Holloway

Dear Editor
A new generation of enthusiasts ?
I have noted recent letters bemoaning the shortage of younger members – I have also seen reference to a shortage of members wishing to become actively involved. I think caution is required before bringing in some new initiative for the Society. The problem lies with the nature of the "traditional" radio and electronics hobby, and the opportunities afforded for people of all ages to learn about it, and even to become practically proficient and/or academically qualified.

I am fortunate to have commenced my career in 1976 as a humble repairman working for a small company that retailed radio, tv and home appliances as well as repairs – including items we had not sold. One moment I could be repairing an old valve radio or even the odd 405 set whilst studying the circuit for the latest Thorn 9000 or Philips G11 chassis and the circuits that came with ERT. The next minute I could be repairing a Roberts radio as we were a dealership. Throughout this period I also constructed items mainly from published magazine designs. After 5 years of this I think I can say I was confident to fix almost anything, especially if I had the circuit.

Although many of us are self trained many adults attended both day release and evening classes provided by FE colleges which enabled them to obtain relevant C&G or EEB qualifications which employers liked. Sadly this whole system has been dismantled, although I would strongly recommend a practical course, such as Foundation Radio Amateurs which is run by the RSGB and offered by volunteers (ie training is free), even if it is not your intention to actually go on to become a licenced ham (licences are free now, by the way)

If, as I would recommend, the BVWS were to organise classes or workshops this would also be a good idea. Many have attended Gerry's workshop, but I must state that I do not think it is possible to assimilate a huge range of restoration skills in a single day.

It would be in the BVWS interest to develop an education and training section, with the possibility of developing a knowledge base (us lecturers call it a syllabus) so not only could we raise awareness of the members in general but also to encourage newer generations to this hobby. Otherwise it will only remain in dusty books, museums, and memories. Those wishing to take up the initiative may need to set up or make use of existing communal facilities, possibly approaching your local adult education centre and start recruiting.

Those who don't can stay at home polishing the cabinets.

Yours sincerely
Tony Fell

Dear Editor,
With regard to Graham Dawsons doubts concerning BBC colour TV transmissions after Nov 1962 (Autumn2006), I can confirm that they did take place throughout 1963. At the time I was working on receiver development at Wembley. The transmissions could occur at any time, were short at around 30 minutes and in one of the following systems: NTSC, PAL or SECAM. As the signals were a major test facility for us, the 30 min was a period of high activity!

My main memory of the events was how relatively easy it was to obtain good pictures on PAL and how poor the SECAM results, which were degraded by noise on the chrominance signal. This was fm modulated onto the sub carrier, requiring a wide band (1MHz) discriminator at 4.43 MHz to recover the modulation. Today digital techniques would be used, but we employed a Round Travis circuit, which used tuned circuits above and below the sub carrier frequency.

I left the industry at the end of the year and often wonder if the bad results were caused by something we did, or by a defect in the signal.

Yours sincerely,
Tom Bates

Dear Editor,
As a new member to your organisation, I was very interested in the letter on membership in Vol. 31 issue 3 (Autumn 2006), particularly as I experienced considerable difficulty in joining recently. The original details I had been given by a friend were wrong. I then had to resort to the internet at my local library to eventually find the correct details.

Connecting with the under 50's is the obvious thing to do. Unfortunately today's youngsters are geared up to ipods, MP3 players and music from their computers. I think that they regard wireless as something which grandad listened to during the war and has no relevance to them or their lifestyle.

As an aside, I also build models from Meccano. This has brought in a modest amount of money over the years from plans I have designed and sold. This is another hobby which is suffering from apathy/ignorance of the wider public. Mention Meccano to most people and the conversation goes along the line of "Can you still get it?" Yes. "I used to have some which ended up in the shed/got thrown out/given to a jumble sale." The overall reaction is that people still use the stuff.

Back to the wireless conundrum. Better publicity for a start. Show people that the modern DAB radio had its origins in valve receivers and that valves can still work . Whilst not being as portable as modern radios, illustrate a nice bakelite or wooden cabinet wireless, or even a 1960's radiogram as a piece of furniture that can be used and admired. Where to display Bulletins is another problem. The obvious ones, such as folk museums may not attract the right sort of person. Another obvious area might be schools with emphasis on the 15 or 16 year old pupils.

Start off with early battery powered transistor types, as they are not lethal unlike a mains set! A friend has informed me that the Science Museum puts out leaflets of what is available for sale from them. This includes simple crystal sets. (No chance of being electrocuted there). How about throwing open the issue to members and see what they can suggest? Asking younger members of the family what they think of the hobby should prove very illuminating. Even if the views expressed are not what the questioner wants to hear!

Hope this is of use,
Ralph Rigg

Dear Editor,
Some US midget radios of the 1930s
A small technical point relating to an otherwise very interesting and informative article.

When I turn a page and see a circuit diagram it instantly gets my undivided attention. I read it like most people read text and it tells me everything about the set and how it works.
It comes from 40 years as a professional

engineer (not radio but circuit theory is the same for all applications of electronics).

The small diagram at the bottom of page 7 stopped me dead in my tracks. The title is 'autodyne converter' but I'm looking at a cathode injection screened grid frequency changer. The autodyne is a very different circuit using a triode and as Mr Tempest says, was invented by HJ Round in 1913. Autodynes have to be triodes because the screened grid was not invented (also by HJ Round) until 1927. With only one grid and no indirectly heated cathode, in 1913 the autodyne uses a radically different circuit. A minor point probably to most readers but of course of fundamental importance to me because the autodyne is usually taken as the starting point for most texts on the early development of the superhet.

Both the main circuit and the small diagram show the early form in which the valve is biased almost at cut off to perform anode bend detection (rectification was believed to be necessary to frequency conversion and early texts refer to the converter as the first detector hence superhets have a second detector).

Many British sets used cathode injection converters, eg Marconiphone 262, 272, 274, 286 and 288 and HMV 438, 440, 512, 540 and 542. These circuits do not apply bias to the converter which runs at an anode current of about 3mA and has a higher conversion gain.

On the subject of the circuit diagram, the type 39 and type 43 have both pentodes with suppressors internally connected to cathode which is why Mr Tempest found the 39 didn't have a tetrode kink. No problem on this circuit because it operates on 120v but be careful when substituting modern electrolytics much larger than the original 8 or 16 μF reservoir capacitors, you may shorten the rectifier life. Always refer to the valve data.

Yours sincerely,
LL (Bill) Williams

Dear Editor,
Some US midget radios of the 1930s - reply
My thanks to the writer for his complimentary remarks and comments on my article.

Firstly a curiosity: I never wrote the words "invented by HJ Round in 1913." (I have never read anywhere that he invented the Autodyne Converter. Perhaps someone has documentation that shows that he did?)

In my *final proof* of the article it reads "The frequency changer was unusual to me, and is an Autodyne, and not much seems to be written about it. I did find out, via an article (now lost) by Roger Johnson, Taming the Autodyne, that the name derives from two Greek words, 'autos' meaning self and 'dunamin' meaning force or work, hence an Autodyne is a self-working Superhet." So between me and the print works, Capt. Round got a mention and Roger Johnson lost his credit. I'm glad to have been given the chance to reinstate it.

As to "the small diagram at the bottom of page 7", it would be nice if the writer could talk to the obviously brilliant F.Langford Smith about it (attributed to him on my diagram and in the text). It is copied, less some insignificant details, from the bottom of Page 107 in Radio Designers Handbook, "The Application of Converters". He says, "Fig. 6 shows a typical autodyne circuit using valve type 6C6 although almost any other screen grid or pentode valve could be used."

The circuit diagram, as changed, does omit the suppressor grids for the 39 and 43 tubes. Of course without it the 39 would have had a tetrode kink as indeed the 36 does.

In my articles I have always tried to give the impression that I am not setting myself up as an expert in valves and old radio. But I'll say it clearly here: I'm not. I was away from them for more than 35 years, almost until retirement, doing many other things in electronics. I could say I'm re- learning and learning and when that ceases I shall probably take up another hobby. From memory, the request for articles once said "If you find something interesting then the chances are other members will also." That's the spirit in which my articles are written.

Yours sincerely
Gary Tempest

Dear Editor,
Many thanks again for a jolly good 'borrowed' read of the Summer issue of The Bulletin. 'Brother' Williams' article took me back over 60 years! Alas, like me he opted for an economic solution to the (ever present?) HT battery choosing as I did, the gradually acquired HT pack of grid bias units. I never bought any at 'Woolies', but in the adjoining village's cycle shop where my (shadily acquired) ex RAF gel-cell accumulators 'lived' alternate weeks; me doing a little shop–keeping in return for seven hours worth of recharging (via a glowing Tungar rectifier). 'One-and-six' rings a bell for a GB unit, with 'flame–hardened' matchsticks to aid connections, to each week and a half's worth of paternal pocket money. Much later, I discovered such flatpacks were designed to maintain steady potentials for a year or so (depending on local temperatures evaporating the gooey electrolytic paste) at zero current! A quarter of a century later I had the job at WA–X of being 'battery boy' caring for 115 lead–acids, of 400 hefty Nicads for cranking diesel engines. A grid bias battery gave me the most 'aggro', having a habit of drying out, depending on how hot the other shift engineers liked their 'abode' in the control room.

The PM22A referred to in LL Williams' reaction article had more grids than my (second–hand) PM2A but, ever so late one Saturday night it overloaded my newly–bought SG Brown headphones.

Trust the (ahem) 'national' society to omit the most important connection... to the aerial (fig 7), even Scott Taggart developed a specially shaped vane (case squared) for an isolated, low capacitance AC variable coupler, to the top (hot) end of a tuned circuit, even the reaction condenser.

It was nice to see a Bush TR82C – unbelievably clean! Ours got retired on my recent birthday in favour of the three band (2003) Golden Coronation one, having stood in whatever sunshine the shop's window collected, resulting in dried–out electrolytics and odd whistles. Hardly does justice to a once–great brand.

As a one–time EMI (research) 'erk', I felt duty–bound to read all about the the old firms 'telly–bashing'. An eternal pity that AB had a bad day when it came to frame syncs. But wasn't CH (radar) being quietly developed around then? But by Marconi (rather than Marconiphone) using high slope SP41s, huge, round CRts and pumped TX valves at two thirds the frequencies? I'm surprised at KT44s being derived from (octal–based) KT66s. I can still hear the 10125Kc kilocycle whistle from Alexandra Palace's double–sideband Tx (the original was below the prototype tower at Hayes). Just imagine the 'kittens' had by Health and Safety officers at 5kV 'trannies' in home–constructed televisions? My immediate senior had one, voltage–doubling, below his 12" set in a dexion frame with 12E1's (in pairs) on thirds as 'tails' for PP deflection, another for 'video' in 1949 (!) Ugh! It hissed and glowed during foggy weather if his tiny bedroom window was open.

Yours sincerely
Wyn Mainwaring (Wales)

Dear Editor,
After reading various articles from your fascinating CD 'BVWS, The first twenty years' and having erected a very good Medium and Long Wave aerial of the old type used in the 1920's/30's which, because I can terminate it at both ends if needs be, acts as a tuned circuit in itself, and having got tired of the usual galena crystals, even those which I make myself and shown in file 25 on the CD and a letter to you which I was surprised to see printed in full in the Autumn 2005 Bulletin, I decided to experiment with various crystals which can be bought from a local shop which sells a wide variety of them, as well as books about them.

It is an unassuming little shop called 'Crystals", situated in a side road in Wells, Somerset, but inside it is like a fairy grotto and the young lady assistant was very surpised that someone of my age was showing an interest in them because I was obviosly not an ageing hippy. However, a few words informed her why I have visited her shop several times during the Winter in order to carry out experiments determining which crystals are likely to make effective radio wave detectors.

Firstly, I purchased a book entitled 'The Encyclopaedia of Minerals'. It is a mineralogists book and contains details of over 600 minerals with colour plates.

One really good crystal I obtained from the shop was a piece of silicon, which came from China. On this particular piece almost any part of it will act as a detector. The contact in my home–made 1910 style holder is a steel gramophone needle. Incidentally the needles are now manufactured in India and retail at £1 per 100. I bought mine from a car–boot sale.

Pink Carborundum (A1203) is also listed as a detector but the piece I obtained didn't work. When a meter was connected to it the readings were a minimum 2.5 ohms. I have learned to always carry a meter with me now when purchasing crystals.The readings are from 500 ohms up to a few thousand ohms forward resistance, they will usually work, it depends on the impurities; crystals such as Bornite give readings of only tens to a few hundred ohms and will not work in rectifiers in their own right but work as the complementary contact in conjunction with Galena (PbS) or Zincite (ZnO) and some other crystals such as 'Perikon' (a two different–crystal combination). So far I have not found any carborundum which works.

Zincite is rather expensive but a red piece can be broken into half a dozen bits (although it went against the grain to do it), cost £7.50. Zincite can be used with a wide combination of other contacts ie Bornite, Chalcopyrite or even steel like the gramophone needle. The piece I have came from a factory chimney in Poland. Although the lady assistant, a mineralogist herself, could not tell what the factory produced, I would guess that it was probably a zinc ore smelter or handled Calamine ore. That would make it a synthetic Zincite which, according to 1920s reports was better for the purpose of radio reception than natural zincite which, at the time was only found in one place – New Jersey, USA. This piece is very good and like the silicon is radio–sensitive over any part of it, even tiny fragments. I would describe the colour as an orange/red. As a fixture I mounted pieces in brass collets, some with grub screws to hold it in and others mounted in ordinary solder. Woods metal, which should be used is extremely high priced , but maybe the silver–loaded epoxy sold by Radio Spares would suffice. Ordinary solder did not appear to damage the crystal, after all it takes around 1300 degrees Fahrenheit to make it synthetically. Although Zincite will work with a range of complementary contacts, I found the loudest and clearest reception was with a Bornite crystal; about as good as a fairly modern diode such as an OA81.

Zincite is not easy to obtain though and I had to order it but whilst waiting I cut open a dud 1.5 volts 'D' cell and made the corroded inside of it into a contact, the other being a piece of Bornite. The circuit was a typical crystal set with no battery bias. By very carefully dragging the Bornite (with an insulated clamp) over the corroded Zinc I obtained several sensitive spots and had good reception on Medium Wave. It was a very precarious contact though. Whilst a made–up holder for the Bornite improved the stability it was not an ideal setup. I was able to meter three pieces of Zincite in the shop and found that the more yellow types gave very high readings and were so unlikely to give noticeable readings, as far as I could determine they were natural ones.

Recently I was thinking of my younger days in the 1950's when so much was in electronics was new and making one's own devices was 'hands–on' and exciting. Although wages were low there were plenty of cheap war surplus supplies in such shops as in Lisle Street and Edgware Road, London. It was also a time when some districts still had DC mains supplies which caused problems in the emerging modern world.

I lived in Isleworth then and had a 230/240 volts AC supply where I lived but some parts of Isleworth where I wanted to operate an amplifier and record player had DC supplies. What was worse, some parts had a negative ground but other parts had a positive ground. The club I belonged to held American square dances and English folk dances, we moved between two halls with different ground. My friend was compere and worked as an electrician, I was the electrical adviser and made various odds and ends. At least two people had destroyed their AC only film projectors and gramophones because they weren't told about it. So I constructed an AC/DC amplifier using four KT33C valves in the push–pull output which I purchased in Lisle Street, that sorted the amplifier problem. It was going to be harder with the record player.

Initially my friend used a wind–up gramophone and an electrical pickup but that was limited to using the easily–broken and short playing 78 rpm records which were fast becoming obsolete in the wake of the new vinyl 45rpm single and 33rpm long–playing album. It might have been possible to obtain a heavy prewar brush–type mains motor but none seemed to be available at the time, they would only have worked on the '78's anyway.

Around that time the first battery powered reel to reel recorders came onto the market and I managed to purchase a Cossor one which I still have. With the tape recorder we could then record music off the records, the tapes would last about 20 minutes at a speed of one and seven eighths of an inch per second. At the low tape speed the frequency range was limited to little more than speech, which whilst good wasn't good enough for music.

Then I had a crazy idea. having two AC/DC home built amplifiers, the other one with only two KT33Cs in push–pull, I fed two high voltage 2 microfarad capacitors; one from each anode to my BSR three–speed motor deck. They could be bought as a separate unit in a case in those days. Then I recorded from a low voltage the mains frequency and fed the tape player output to the amplifier input. Almost to my surprise it worked! We used that system for a year.

The amount of power we used to drive two AC/DC amplifiers was wasteful and later on I obtained some of the Mullard OC70s series transistors. They were not up to spec but were going cheap, I then had another idea and made a phase shift oscillator with one. It took a little empirical experimentation to obtain 50Hz because it did not quite answer to the computed time constant. Maybe due to parallel leakage the sinewave was a good one and worked the motor well via the amplifier. Strangely it would occasionally fail in the middle of a record. I never found out why because it would start working again whenever I tried to work it out. It could have been transistor thermal drift or a change in frequency, the transistors were out of spec seconds. The power for the oscillator which was only a few milliamps came from a tap down the resistor chain on the HT of the amplifier. As a failsafe, I fitted a switch which would change the input to the tape recorder. All this mass of equipment plus four speakers had to be ferried a couple of miles each way on our bicycles whatever the weather. My friend had a small trailer on his bicycle. Ah! the halcyon days of misspent youth!

In the school hall where we operated there was no warning notice about using AC only equipment on the DC mains, although I seem to remember one in the municipal hall, so I pinned one up on the notice board. It was taken down twice. When I asked the caretaker why he said that only school notices were allowed and in any case it was bad for business. Huh? Strange is the logic of some human beings. I later found out that he had seen us rig up and succesfully operate our gramophone as well as a small Dansette record player which we sometimes used as a monitor and had told another group that it would be ok to use theirs because he had seen it done. It burned out and he had no idea at all that our equipment was AC/DC. I tried to explain to him but to no avail. To the uninitiated, we are mighty devious, us electronics people.

In 1952 I had finished the two years conscription in the RAF and got a job with EMI. The first two years were spent as a wireman before I was allowed to be an electronics engineer. We made equipment for the forces and NATO and amongst it were 25 way cables fitted with Plessey Mk5 plugs and sockets for coupling radar units in aircraft. When complete, the inspection section did a point–to–point on them before the plugs and sockets were injected with epoxy adhesive. That was usually where the problems started because it put a strain on the joints when it set, especially when they had 90 degree outlets. I had little trouble with them probably because I carefully tapered the wires before assembly. We often had open circuits and the inspection section could not tell at which end which was important because the cables were made to a length tolerance and on the longer cables we could get away with sawing one end off and renewing it. An expensive cable was scrap if one guessed the wrong end. It annoyed me because I was often given the rejects to repair.

I was aware that there is usually a small and dirty voltage between earth and neutral. It varies from place to place but is usually between 110mv and 400mv peak to peak, it occured to me to feed it into the low impedance side of a valve speaker output transformer and I got several volts output at a very low current from the hi Z side. It gave a strong hum into a pair of 2000 ohms headphones. I then fed one lead from the transformer into the faulty connection of the plug or socket pin of the cable and the other one to any other pin which had a good connection. With a piece of silver paper over the insulation of the cable I could just hear the hum on the headphone connected to it. The difference was faint but noticeable. It was obvious to make a transistor Darlington pair and clamp a short brass strip with a spring to fix it round the insulated cable and feed the strip to the input of the Darlington pair. Eureka! another crazy idea worked.

Grudgingly I got a reward of £10, although they must have saved hundreds of pounds in lost time and scrapped cables.

After I left that department I later learned that faulty cables were tested using my idea but using a square wave generator as the signal source.

To this day I exploit the difference between earth and neutral and rectify it to drive a transistor following a crystal wireless wave detector. Even at 500mv a BFY50 will give approximately three times the volume compared with a diode alone.

These days, once a month I meet up with four amateurs for an evening's chat. As amateur radio is not my scene I am still the odd one out but we all speak the language of electronics and converse happily.

Yours fraternally,
Ray Mason

Minutes

Minutes of the Committee meeting held at 13 Warneford Road, Oxford on Friday 21st July 2006

Present: Mike Barker (chair), Graham Terry, Jeremy Day, Martyn Bennett, Guy Peskett, Terry Martini (part time on telephone).

1. Apologies: Jon Evans, Ian Higginbottom, Paul Stenning, Carl Glover.

2. Minutes of meeting held on Thursday 11th May on the conference telephone: approved.

Matters arising: Item 6, Chairman to write to Michael Grade.

3. GT reported that the membership stood at 1622.

4. The Treasurer reported that the balances on the Society's accounts stood at £12,298 (current) and £36,372 (deposit). He explained that the unusually high figure for the latter had been swelled by auction proceeds to be paid out (amounting to about £15,000).

5. The Chairman reported for the Bulletin Editor that the Autumn issue was complete and ready for proof reading.

6. TM reported by telephone on the content of the 2006 Christmas DVD. Sufficient material was available for the forthcoming production. He also said that JE had suggested a two layer disc which could possibly be used for mixed media, giving the option to have a data section for service information on the same disc as the usual films etc.

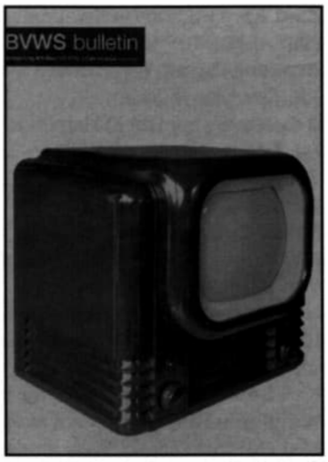
7. GP reported on the planning for the 2007 NVCF. After consultation with the other organisers affected the date has been set for Sunday 29th April. It will be followed by the French fair on its usual date of the first weekend in May and the Dunstable Downs meeting on the following weekend.
The question of whether or not to mount an exhibition was discussed but no decision was taken. The Treasurer tabled a paper suggesting ways in which the tax liability could be minimised; GP and JD will continue discussions.

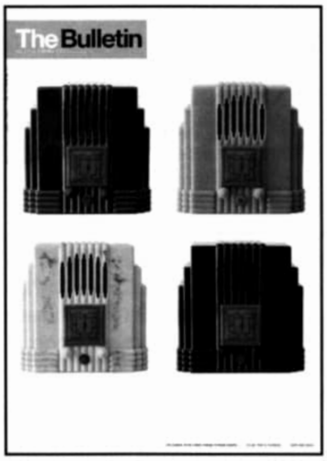
8. AOB
(i) The Chairman reported the possibility that the costs of mailing the Bulletins might actually fall as a result of the liberalisation of the mail delivery business due to take effect on 21 August.
(ii) The Chairman reported a vote of thanks by the Trust Committee of the BVWaTM for contributions to the last garden party.
(iii) The Chairman will investigate the possibility of using Skype for conference calls

9. Date and time of next meeting: Sept 27 on the conference telephone.

The meeting closed at 9.10 pm.

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





Back issues

Vol 10 Numbers 2, 3 & 4 Inc. The KB Masterpiece, Extinct Species "A Monster Defiant".

Vol 11 Numbers 1, 2, 3, 4 Inc. BTH VR3 (1924) receiver, Marconi's 1897 tests, Origin of the term 'Radio', Baird or Jenkins first with TV?

Vol 12 Numbers 1, 2, 3, 4 Inc. the Emor Globe, The Fultograph, Ekco Coloured Cabinets.

Vol 13 Numbers 1, 2, 3 Inc. Direct action tuning, The Philips 2514, Noctovision.

Vol 14 Numbers 1, 2, 3, 4 Inc. Cable broadcasting in the 1930's, The story of the Screen Grid.

Vol 15 Numbers 2, 3, 4 Inc. The wartime Civilian Receiver, Coherers in action, Vintage Vision.

Vol 16 Numbers 1, 2, 3, 4 Inc. The Stenode, The Philips 2511, Inside the Round Ekcos.

Vol 17 Numbers 1, 3, 4, 5, 6 Inc. Wattless Mains Droppers, The First Philips set, Receiver Techniques.

Vol 18 Numbers 3, 4, 5 Inc. The First Transistor radio, The AVO Valve tester, The way it was.

Vol 19 Numbers 1, 2, 3, 4, 5, 6 Inc. The Birth of the Transistor, Super Inductance and all that, reflex circuits, A Murphy Radio display, restoration.

Vol 20 Numbers 1, 2, 4, 5, 6 Inc. Radio Instruments Ltd., Japanese shirt pocket radios, Philco 'peoples set', notes on piano-keys, the story of Pilot Radio, the Ever Ready company from the inside, the Cambridge international, the AWA Radiolette, this Murphy tunes itself!

Vol 21 Numbers 1, 2, 3, 4 Inc. Marconi in postcards, the Defiant M900, GPO registration No.s, Personal portables, the transmission of time signals by wireless, the Ekco A23, historic equipment from the early marine era, the birth pains of radio, inside the BM20, plastics, Ferdinand Braun, pioneer of wireless telegraphy, that was the weekend that was, the first bakelite radios, BVWS - the first five years, the world of cathedrals, Pam 710.

Vol 22 Numbers 1, 2, 3, 4 Inc. Another AD65 story, the Marconiphone P20B & P17B, listening in, communication with wires, the story of Sudbury radio supply, French collection, Zenith Trans-oceanics, Farnham show, Alba's baby, the first Murphy television receiver, AJS receivers, Fellows magneto Company, Ekco RS3, Black Propaganda.

Vol 23 Numbers 1, 2, 3, 4 Inc. Sonora Sonorette, Bush SUG3, RNAS Transmitter type 52b, North American 'Woodies', Why collect catalin, Pilot Little Maestro, Theremin or Electronde, The Radio Communication Company, Early FM receivers, an odd Melody Maker, Black propaganda.

Vol 24 Numbers 1, 2, 3, 4 Inc. The Superhet for beginners, Triode valves in radio receivers, History of GEC and the Marconi - Osram valve, KB FB10, Great Scotts!, Riders manuals.

Vol 25 Numbers 1, 2, 3, 4 Inc. Repair of an Aerodyne 302, Henry Jackson, pioneer of Wireless communication at sea, Zenith 500 series, Confessions of a wireless fiend, RGD B2351, John Bailey 1938 Alexandra palace and the BBC, Ekco during the phoney war, Repairing a BTH loudspeaker, The portable radio in British life.

Vol 26 Numbers 1, 2 Inc. How green was your Ekco?, The Amplion Dragon, Crystal gazing, The BVWS at the NEC, Installing aerials and earths, novelty radios, Machine-age Ekco stands of the 1930s, Volksempfänger; myth & reality.

Supplements:

1 'The story of Burndept'.
2 'WW 1927 data sheet'
3 'Seeing by wireless' the story of Baird Television
4 Reproduction Marconi catalogue

Earlier Bulletins and supplements are priced at £2:00 each + postage. Bulletins from volume 21 onwards are priced at £2.50 each. + postage.

Postage: for individual Bulletins add 50p, for 2-5 bulletins add £1, for 6 or more add an extra 20p each. 23 Rosendale Road, West Dulwich London SE21 8DS Telephone 020 8670 3667.

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

News and Meetings

GPO registration Numbers

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

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

2006 meetings

3rd December Wootton Bassett
13th December Heinrich Hertz – Sparks that Changed the World Presentation by Ralph Barrett at The Institute of Physics, 76 Portland Place, London W1N 3DH. Starts 6pm, open to non–members, tickets not required.

2007 meetings

7th January Radiophile workshop at Sambrook
14th January ***Special auction*** at Wooton Bassett
20th January Swapmeet at St Annes Church Hall, Trinity Road, Sale Manchester M33 3ES. Telephone 0161 973 9261 for details.
28th January Gerald Wells Workshop British Vintage Wireless and Television Museum
28th January Radiophile auction, Wetwood
11th February Audiojumble at the Angel Centre, Tonbridge
4th March AGM and Auction at Harpenden
18th March Radiophile Swapmeet Shifnal
15th April West of England Vintage Wireless fair
22nd April Gerald Wells Workshop British Vintage Wireless and Television Museum
22nd April Radiophile Swapmeet, Cowbit
29th April NVCF at Warwickshire Exhibition Centre
2nd June Garden Party: British Vintage Wireless and Television Museum
3rd June Swapmeet at Harpenden
1st July Swapmeet at Wootton Bassett
8th July Gerald Wells Workshop British Vintage Wireless and Television Museum
22nd July Radiophile Swapmeet Sambrook
17th August Friday Night is Music Night, British Vintage Wireless and Television Museum
2nd September Audiojumble at the Angel Centre, Tonbridge
16th September Table top sale, British Vintage Wireless and Television Museum
23rd September Radiophile Swapmeet Shifnal
30th September Swapmeet at Harpenden
21st October Gerald Wells Workshop British Vintage Wireless and Television Museum
21st October Radiophile Swapmeet, Cowbit
2nd December Wootton Bassett

Workshops, Vintage Wireless and Television Museum:
For location and phone see advert in Bulletin. 11:00 start.
Harpenden: Harpenden Public Halls, Southdown Rd. Harpenden. Doors open at 10:00, tickets for sale from 09:30, Auction at 13:30. Contact Vic Williamson, 01582 593102
West of England Vintage Wireless Fair:
Willand Village Hall (J27/M5). Doors open 10:30.
Contact Barrie Phillips, 01392 860529
NVCF: National Vintage Communications Fair
See advert in Bulletin. www.nvcf.co.uk
Wootton Bassett: The Memorial Hall, Station Rd. Wootton Bassett. Nr. Swindon (J16/M4). Doors open 10:30.
Contact Mike Barker, 01793 536040
For more details with maps to locations see the BVWS Website:
www.bvws.org.uk/events/locations.htm

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