## *FROM THE PRESIDENT*

THE HRSA continues to be one of the leading historical radio groups in the world. We were recently reminded of this when we compared notes with an overseas group. Our strengths are our members, in large numbers and number one by far, is that a few members do a lot. The second stand-out is that you all participate in events, sales and auctions.

Our finances are excellent and we ensure the subscriptions pay for *Radio Waves*. Printing just four times a year keeps our membership fees very low. Another club has a monthly magazine with no colour yet charges $180 a year for membership.

We now have a new membership drive DL card, to be handed to prospective members. I will send some to each group and you can ask for a few at meetings.

Key to our Association is the Valve Bank and it is a shining tribute to Stan's contribution in time and operating it. We have over 50,000 valves, which is remarkable, considering most were made 70 to 90 years ago.

Another feature of the Valve bank is our technical manuals. A number were recently produced by Philip Leahy and a new one on transistors is coming from Ian Batty. The manuals are sold near cost, as a service to members.
Happy collecting

Sadly, after a battle with lymph cancer, our former president and life member Tony Maher died today (25 September). An obituary for him will appear in our next issue.

*Kevin Poulter*
President

**CONTENTS**



**Front cover** An AWA 45E fully restored console radio sold recently at the HRSA Melbourne Auction. Described as absolutely stunning excellent condition and working, it reached $2,800. Photograph by Andrew Marminc. Enhanced by Kevin Poulter

**Inside front cover** The HRSA will be displaying at the International Hi-Fi Show

**Inside Rear Cover** The Australian Digital Radio Retro Art Deco Radio

**Outside Rear cover** The FISK Radiola Model 265, six valve "Perfect Country Radio" Advertisement enhanced by Kevin Poulter

**HISTORICAL RADIO SOCIETY OF AUSTRALIA, Inc.**
**PO Box 674 Ringwood Vic 3134 Australia Telephone No. 0404 506 687**
**Internet: www.hrsa.asn.au**
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Please send all correspondence **except *Radio Waves* articles and *Marketplace* ads** to the relevant office-bearer (president, secretary, treasurer, membership secretary) at HRSA, PO Box **674 Ringwood Vic 3134**

## *RADIO WAVES*

*Radio Waves* is published quarterly in January, April, July and October

**Please send *Radio Waves* articles to the Editor,** either by email: billsmith@netspace.net.au *or by post to* Bill Smith, 17 Creswick Street, Glen Iris Vic., Australia 3146. Ph. (03) 9822 3456

ARTICLES AND PHOTOS are most welcome, either on disc, typed or handwritten. Articles submitted on disc (3.5inch DVD or CD), memory stick, or by email should be IBM-compatible. Suitable software: Word Pro, W4W & most common WP software running under Windows. If you are running unusual software, save files as Text or RTF. **Formatting of any kind is not to be done** since all articles will need to be reformatted to fit the available space. 

## *MARKETPLACE* ADVERTISEMENTS

**Bill Smith, 17 Creswick Street, Glen Iris, Vic. 3146. billsmith@netspace.net.au**
Advertising is free to members; see *HRSA Marketplace* for further details.
**Deadline for January 2019 *MARKETPLACE* issue: Saturday, 1 December 2018**
R*adio Waves* is printed by Metro Printing Pty Ltd, 201-205 Roberts Rd, Airport West, Victoria 3042

# HRSA ACTIVITIES: OCTOBER 2018 TO JANUARY 2019

## SYDNEY

Contact: John McIlwaine (02) 4384 5608;
jajdmac1@bigpond.com

**Meetings** are held on the first Saturday of every second month at the Winston Hills Public School hall, cnr Junction Rd & Hillcrest Av., Winston Hills Enter via car park in Junction Rd. Setup from 9.30 am, workshop 10.00 am; **Auctions begin at 11 am**.

**Saturday 6 October** 10 am Talk: Military. Theme: Military equipment. Auction at 11 am

**Saturday 1 December 9 am** members' swap meeting: bring & buy - set up your own table; mini auction if required

## NSW NORTH COAST

**Contact**: Joe Bass (02) 6656 9112
Dave Small (02) 6653 2364.
dnksmall@yahoo.com.au

**Social Meetings**
**Sunday 26 November**. Hosts: . Ross & Roslyn McMaster Theme: Crystal Sets

.

## ACT & REGION

Contact: Richard Begbie (02) 6238 2246, email rb@bordernet.com.au

**Saturday 3 November, 2018.** End-of-year, biennial BBQ Woolshed Meet on the Begbie farm. Always a great get-together with a bumper auction in the old wool shed.

## NSW CENTRAL WEST

Contact: Wal Peters 0487 114 640
tetrode@bigpond.com We meet in February, May, August and November. Any members passing through are always welcome.

**GIPPSLAND (Vic.) GROUP** Contact: HRSA Gippsland Group. Ron Bowley, yeolde@dcsi.net.au 0490 106 111. Meetings bi monthly.

## MELBOURNE

Contact: Kevin Poulter (03) 9558 3652
image@netspace.net.au

Our meeting room for 2018-9 is St Michael's Primary School, corner of Victory Boulevard and High Street, Ashburton. Entry is from Victory Boulevard. Parking is available on-site Meetings begin at 2 p,m,

**Saturday 6 October**. **Note change of date and theme.** **Bring a radio you have repaired or restored and tell us about it.** Mini auction.

**Saturday 17 November.** 1. Show and Tell: 'Pye Telecommunications'. 2. Judging the construction project. Mini auction

**Saturday 19 January 2019**. Show & Tell: Bring your favourite wooden cabinet radios and tell us about them. Mini auction

**Other events**
**Saturday 3 November** Auction at Stirling Theological College 44-60 Jacksons Road Mulgrave Melway 80 K3. Viewing begins at 11am. Auction at 12.00 pm. Food available. Send auction form to Michael Justin.

**Saturday 1 December 12.30 pm. Xmas party in Bill's back yard**, 17 Creswick St, Glen Iris. (Melway 59 F6)
**Crystal set display and contest**. Category 1 Built-in antenna; Category 2 External antenna (antenna provided). BYO food. BBQ, tea & coffee provided. Auction of radios. Sale of surplus HRSA radio items &c.

**October 12th - 14th**
**INTERNATIONAL HI-FI SHOW**
Pullman Mercure Hotel
Albert Park
https://www.hifishow.com.au/
Friday 12th October:
11:00am - 7:00pm
Saturday 13th October:
10:00am - 5:00pm
Sunday 14th October:
10:00am - 5:00pm

## ADELAIDE

Contact the Secretary Alan Taylor 08 83446708 0417859074 or email alantaylor47@bigpond.com

## SOCIETY NEWS

**SYDNEY GROUP**
**by JOHN McILWAINE**

OUR AUGUST 4th meeting the start of what was to be a very busy day for the Sydney Group. We welcomed our guest speaker, Jo Harris OAM, who gave us a most interesting and enlightening presentation of the First Direct Wireless Message from England to Australia September 23rd 1918. Wales to Wahroonga, the message sent from Prime Minister Billy Hughes towards the conclusion of World War 1.

Jo Harris OAM is a member of the Royal Australian Historical Society, Historian Wireless Institute of Australia NSW, Past President and Vice President of the HADARC, Hornsby and District Amateur Radio Club, a Paul Harris Fellow Rotary Club of Turramurra and holder of many other awards for her services to the community.

To highlight this important historical event the 'Centenary Celebration Wales to Wahroonga 1918-2018 planned for Saturday 22nd September 2018, will be held at the Fisk Monument in the Wahroonga Village, with displays of historical wireless equipment and memorabilia of the event.

Following general business, John reminded members that their subs were now due for payment and detailed the procedure as outlined in the July issue of *Radio Waves*.

With a larger than usual auction of members' goods, including radios from a deceased estate, auctioneer Ron was kept busy, clearing all the items from the hall which was then followed by a members' special auction in the car park with a large amount of radio chassis, parts, valves and finally a clearance of some 50 odd speakers donated by member Jack Meyer, the bulk of which were given away to members.

If ever there was an occasion of bargain prices this would have to be a treat for those members on the day with radios from $5, One wonders how low prices will go with so many items turning up at recent meetings with a promise of a lot more to follow.

*Special note*: Following Lou Albert's large auction of his collection there will be lots more of Lou's items not included previously and will be available at the next Sydney Group December swap bring and buy meeting on December 1st. A selection of items including early horn speakers, radios, mantels, coffins and many other Items, best offers will be considered by Lou on the day as he is anxious to dispose of more of his large collection.

### CENTENARY OF DIRECT BROADCAST CELEBRATION

THE CENTENARY event 'First Direct Wireless Wales Communication ''Wales to Wahroonga'' attracted a large crowd, including Fisk family decendants, members of the HRSA, the Hornsby District Amateur Radio Club, W.I.A .and local historical society members along with a large gathering of the public.*(Photo on page 44.)*

We were represented with our two HRSA tables manned by myself, Ron Langhans, Ray Robinson,and Dr.Peter Jensen with his replica working Marconi early spark equipment.

Two additional tables of display of AWA early wireless receivers and memorabilia from a former member Graham Tait from Parkes.

A very busy day of activities at the Fisk monument outside his original residence Lucania at Wahroonga, re enacting the first wireless message, followed by the official presentations in the Church hall adjacent to the site which also housed the displays .

Our brochures came in handy indeed with many visitors showing interest with the work of our society and the displays we provided on the day.

While the local FM radio station had an on-site studio with live streaming, noticeably absent were Telstra and the ABC It is sad indeed that these major organisations pioneered by AWA did not see fit to attend or cover the event on the day.

*John McIlwaine*

**NSW NORTH COAST GROUP**
**by DAVE SMALL**

**HRSA Social meeting, 28th July, 2018**

HELD at Morrie Carlton's place, Nambucca Heads, 16 members & wives/partners were present, with 6 apologies. When justice had been done to the morning tea goodies on offer it was decided to adjourn to Morrie's workshop area. Dave had an Astor that needed informed input on a few frustrating issues while Morrie gave an update on his on-going reception issues despite some aerial changes. Portables were the theme for the day and a number of examples were on display, including some unusual makes and models. At 12.30 pm we thought it better if we went back upstairs to join the ladies, and have some lunch.

At 1.30 pm we adjourned back downstairs for the AGM. Morrie gave the President's report. He thanked the committee, and Peter Lowe, for the jobs well done over the past 12 months. He noted that the workshops had been well attended during that period, as had the social events. Ron gave the Treasurer's report which showed we're financially quite healthy.

There being no further business, the President called for the usual spill & fill. The result was only one change, that being Dave Small taking on the Secretary's role once more. Thanks, Joe, for a job well done.

The day closed around 4:00pm, with thanks to Morrie and Jennifer for their hospitality.

# SPARK AND EARLY WIRELESS COMMUNICATION

**BIRTH, MATURITY, OBSOLESCENCE AND DEMISE**

## BY DR PETER R JENSEN VK2AQJ G4GZT

PART 1

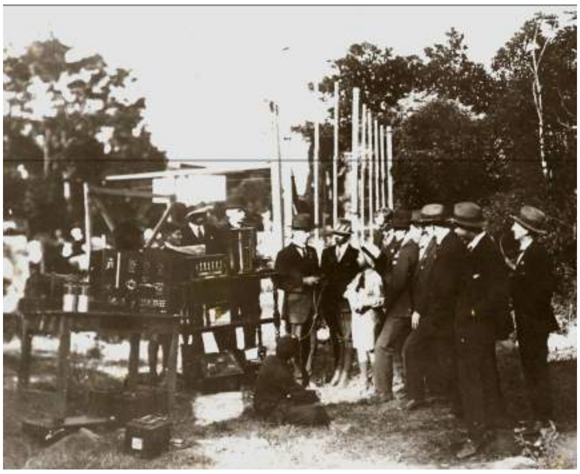
**A SIGNAL EVENT**

In the latter part of 1918, as the hideous conflagration of the First World War ground to its bitter end, a message was sent from the high power Marconi wireless station at Waunfawr near Caernarvon in North Wales to Wahroonga in New South Wales, Australia. As a potent demonstration of the reach of wireless (or radio as it has become known more commonly), the signal represented the culmination of a world-traversing network of radio linkages. In that, it can be seen as very much the start of a progress that has brought us to the 'world wide web' we now have in the Internet.

INITIALLY, wireless was seen as a major commercial threat to the established transcontinental and trans-oceanic communication cable companies. Ultimately, radio and cable systems were stitched together to form the initial components of the Internet, later to be supplemented by satellite communications.

In this centenary year of 2018, the effort involved in both sending and receiving that message in distant Australia, can be seen as a major step in removing the huge disadvantages of isolation and disconnection from Europe and the northern hemisphere that Australia had suffered since Captain James Cook sailed into Botany Bay in 1777 and settlers followed in 1788.

WAUNFAWR



WAHROONGA

Remarkably, what enabled that message to traverse the globe was the raw energy of an electrical spark generated on the hillside in North Wales and transmitted via a system of antenna cables stretching high over the Fern and Gorse covered hillside.

In leafy Wahroonga by comparison, what the engineers of Amalgamated Wireless Australasia, AWA, employed to detect the spark generated energy, was based on the device which would see the demise of spark only a few years later: the thermionic valve or tube as it is called in the USA

The signal received in Australia, although involving enormous power at the transmitting end, received no benefit from the ionosphere as later applied to shortwave broadcasting. The Waunfawr station had been conceived before the advantages of shortwave broadcasting had become apparent. It had been based on Marconi's perception that successful communication must for success rely on progressively higher power and longer wavelengths (lower frequencies). Marconi himself was shortly to correct this misapprehension and introduce to the British Government a system of shortwave communication which would revolutionise the wireless linkages between Great Britain and the Commonwealth of Nations which included Australia.

In the meanwhile, the engineers at AWA, were advised that the signal from the station in North Wales was to be sent and that they should make appropriate preparations which necessarily included the construction of a suitable long wave receiver. Unfortunately detailed documentation of their efforts and of the radio that they created has not been found and may well constitute one of the more unfortunate aspects of the dissolution of AWA in the face of overseas competition: Just another casualty of the economic drive to free trade.

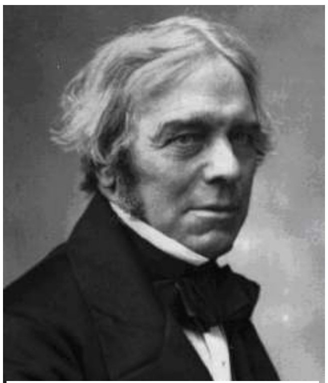
In 1918 a radio receiver was built and successfully received the signal from Waunfawr which also marked the ending of the Great War. Now it can also be seen to have marked the start of a remarkably turbulent but creative period in the history of contemporary civilisation. The world would never be the same and further warfare loomed in the not very distant future.

## 2 RADIO FREQUENCY ENERGY – DISCOVERY

In 1831, a self taught physical experimenter with no academic qualifications, Michael Faraday, discovered the relationship between a magnetic field and electric current flow in a wire circuit. Specifically, he showed that the motion of a loop of wire relative to a magnetic field induced an electrical current in the wire. He also realised that a loop of wire carrying an electrical current could create a magnetic field as it moved through space.

Though his normal human senses were incapable of detecting the physical character of this process, nevertheless, Faraday developed an impression that the interaction of electricity and magnetism could lead to what is now called the electromagnetic field. To ensure his ultimate priority in making this discovery, his theoretical contention was placed in an envelope and sealed only to be opened at a much later date – much later as it turned out - 1937!

The concept of the electromagnetic field was taken up by a Scottish physicist, James Clark Maxwell, and in 1861 he presented a paper entitled 'On physical lines of force'. In the following year, two further parts were added to this initial paper. His use of mathematics to describe the interaction of spinning vortices of fluid created an analogy of the interaction of electric current flow and magnetic fields. The Maxwell equations would become the theoretical basis of electromagnetic energy and later lead to the development of radio communication.



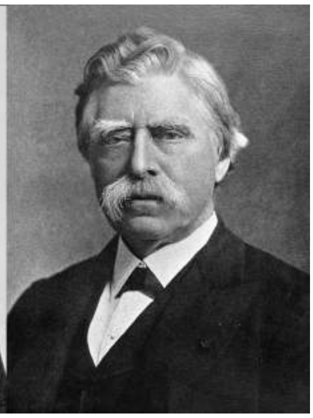
FARADAY

CLARK-MAXWELL

Over the next 50 or so years, experimenters with electricity came to accept the existence of the electromagnetic field and also that such a physical entity might be able to be created through human action. Concurrently with this developing acceptance, there were very many electrical experimenters who thought the existence of the electromagnetic field was an invalid concept and what nowadays might well be called a 'Furphy'.

One of the more significant of these naysayers was a German physicist, Von Helmholtz, who at the present time is remembered for his work in acoustics. Von Helmholtz decided to prove the electromagnetic radiation and the associated field did not exist and later persuaded one of his brightest students to work to achieve this result. Ironically the student, by then Professor Heinrich Hertz, took on the task and in 1887 managed to do precisely the reverse. His experimental work successfully demonstrated not only the existence of electromagnetic radiation but also its speed of propagation as consistent with that of light and the similarity of its behaviour too in relation to reflective surfaces.

HERTZ



HUGHES

The experimental work he undertook at that time was both brilliant in its simplicity and utterly convincing in the results produced. The tiny spark induced in a ring of metal some distance away from the spark generated by an induction coil was the clearest indication that energy had been propagated through this electromagnetic field structure that had been anticipated since the time of Faraday. The concept that radio frequency energy could be created was born at that time when the notion that energy could be propagated through empty space could be true: It was taken up by experimenters to become the basis of a completely new communication technology: Wireless or what we now call radio.

## 3 SPARK AND RADIO FREQUENCY ENERGY

The successful experimental work of Heinrich Hertz soon unleashed a deluge of experimentation by people seeking to define what electromagnetic radiation was and how it could be created and controlled.

Quite apart from the creation of this new form of energy, there was still the major problem of reliably detecting its existence. Between 1887 and 1895, very many different devices and systems were devised with the aim of revealing the presence of electromagnetic radiation. Of the very many devices that came out of this effort, ultimately the most successful involved the strange behaviour of metallic particles in the presence of electromagnetic radiation. As exhibited in the Coherer, when a tube filled with metal filings was placed in a circuit of wire connected to a battery, no current would flow. However, as soon as the filings were subject to electromagnetic radiation energy, they would immediately clump together and allow current to flow through the mass of metal: Cohere. Ringing an electric bell connected into the circuit was an obvious next step.

During this period, a limited number of persons began to consider the possibilities of using electromagnetic radiation as a means of communication. Most notable was an article presented in a popular London periodical in 1892 by Sir William Crookes. This set out his musings on the possibility that electromagnetic radiation could provide a basis for communication without wires.

Although unrecognised at the time, prior to Hertz's experiments and demonstration of the propagation of radio frequency energy, there had been an important event. This was the demonstration of the capabilities of apparatus built by David Hughes. Somewhat earlier than the article by Crookes, Hughes had in 1879 constructed some equipment that enabled him to communicate by voice over a distance of about 500 m without the assistance of a wire linkage as in the Morse electric telegraph. Unfortunately, when he invited some scientific friends to inspect what he had done, the work was dismissed as merely another example of electrical induction rather than electromagnetic transmission. Inevitably, the work of Hughes was then put aside and largely forgotten and with it, an appropriate position of priority in the history of telecommunications.

## 4 SPARK WIRELESS

By 1890, almost all the components of a primitive system of wireless communication had been discovered and were available to be assembled. Strangely however, no one had yet made the effort required to achieve that end. Later, when the new telecommunications technology was well established, there were a number of claimants to having discovered radio communication. As already mentioned, in a practical sense David Hughes had actually demonstrated radio communication, although his work had been dismissed as merely electrical induction.

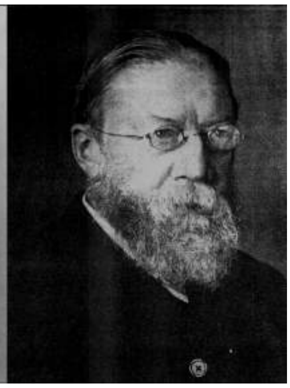
Another claimant to this priority position was Sir Oliver Lodge who on his own admission had failed to see the obvious implications of the work he had carried out. In 1894, he had transmitted some words in Morse Code across a large lecture hall in front of a large audience but he failed to act. Accordingly the honours ultimately went to an obscure Italian youth, Guglielmo Marconi.

Despite this failure to achieve priority in the race for wireless communication, in one critical area of the developing technology of radio, Lodge's work was to be immensely important. This was in regard to the understanding of tuning or syntony as it was called at that time. This was the bringing of the tunable components of the wireless transmitter and receiver to the same frequency of operation.

Lodge's understanding of the principles associated with tuning enabled him to launch a patent application in 1894 before Marconi's year of intense research had begun. Moreover, it led to an 11 year period of disputation with the Marconi Company in which Lodge's claim was finally successful. This in turn led to a massive settlement amount (£18,000), being about 2.5 million pounds in current money value.

In 1894, in the dark days long before penicillin and the application of antibiotics, Heinrich Hertz succumbed to an infected tooth and died at a ridiculously young age - 43 years. His obituary contained a description of his discovery and investigation of electromagnetic radiation and this document came to the hands of that Italian youth, Marconi. It produced an explosive result in the mind of the young inventor: rather like a photographic flash gun going off! As Marconi was later to explain, 'the idea was so simple and so obvious to me that I could not believe that someone had not already thought of it'. What he was referring to was the notion that Hertz electromagnetic waves could be used for communication without connecting wires: 'Wireless', as it would be known.

On the premise that Hertz apparatus could be used for communication without wires, young Marconi set to work and over a period of about a year converted the simple Hertz equipment into a reliable and useful communication device with a range of approximately 1 mile.



MARCONI PREECE

The rest of the Marconi story is generally well known and has been written about by many authors including the author of this article. (See References) The Italian government and its postal authority were indifferent to what he had achieved and so Marconi's mother, who was from a wealthy British Irish family of whisky distillers, took her son to Great Britain. With the help of relatives and Sir William Preece of the British Post Office, Marconi's apparatus was taken up, most successfully by the British Royal Navy.

In this environment, Marconi's abilities as a self-promoter of remarkable tenacity now came to the fore. In the receptive atmosphere of pre-wireless Great Britain, his fundamental ability to overcome problems and apparently inexhaustible energy when pursuing improvements in the wireless technology, were of fundamental importance to the development of an entirely new industry - wireless communications. It would be the driving force behind the growth of the first major industrial organisation in this field, the Marconi Wireless Telegraph Co.

Between 1895 and 1927 when the British Government forced the Co. into a commercial conjunction with the undersea cable companies to form 'Cables and Wireless', radio links and linkages encircled the world to provide virtually instant connections between the most distant places.

In the early period, from 1895 until about 1920, the energy which carried the information across the radio frequency spectrum had been generated by the raw energy developed in electric sparks. Though immensely wasteful in terms of input electrical energy as compared with the resultant component of energy that had carried the communication information and despite the intrinsic crudeness of this early system, the reality was that it worked successfully without the need for connecting wires. For ships at sea that was the fundamental issue.

Spark technology is now largely forgotten. Despite this, the fundamental science of radio communication developed during the spark era has remained valid to underpin telecommunications to the present day. Not only that, it powered the first wireless message to be sent to Australia by a Government official: Prime Minister 'Billy' Hughes in 1918.

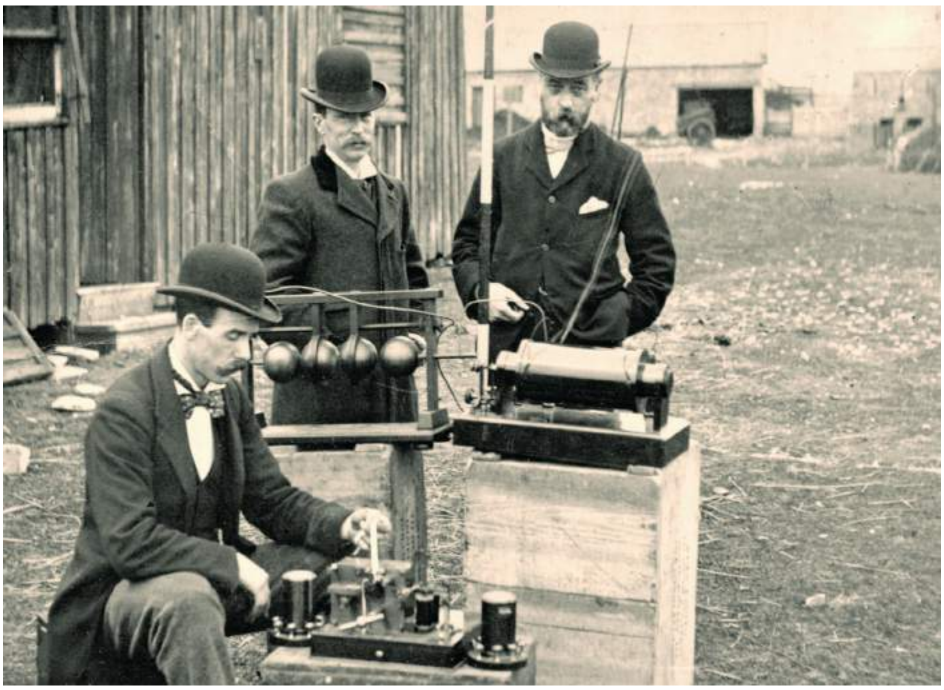
## 5 THE VITAL SPARK

Whether it be the minuscule spark between the contacts of an electrical bell or in the gigantic concussion of a lightning strike in the atmosphere, what is produced is an explosive burst of raw energy when the electrical insulating properties of air break down and this allows the passage of the electrical discharge.

As the new science of the radio communications developed and particularly with the increasing involvement of young scientists in the growing industrial enterprise of wireless communication, the characteristics and disadvantages of spark as a source of electromagnetic radiation became understood.

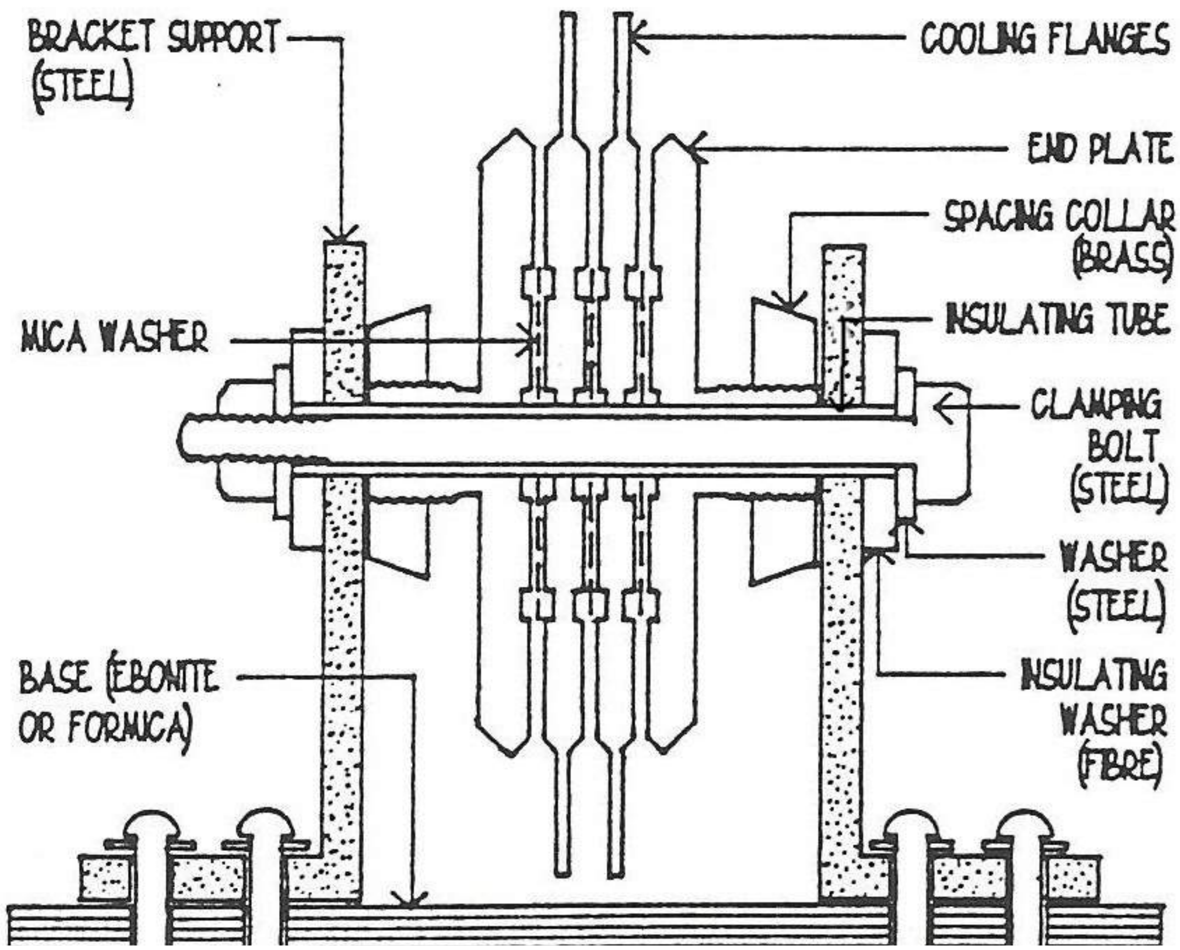
### 5.1 Plain Spark

As employed in the Hertz transmitter and later by Marconi in his Mark 1 Wireless, the spark that produced the radio frequency signal was directly analogous to an atmospheric lightning strike. Two electrodes were charged up to create a sufficiently high potential difference to break down the air in the gap between them so that a spark would jump between the electrodes.



BRITISH POST OFFICE ENGINEERS INSPECT MARCONI APPARATUS

This simple arrangement almost immediately presented perhaps the most crucial problem encountered at an early stage by Marconi. This was the absence of a means of tuning (syntonising) the electromagnetic energy produced by the simple spark. As a result, the signal produced by the spark gap transmitter was in modern terms, 'as broad as a barn door'. Finding a spark signal in the ether was really no problem, because it would spread out from a notional fundamental resonance point to be audible across the width of the




MULTIPLE GROOVED DISK QUENCHED SPARK DEVICE

electromagnetic spectrum. While there were very few radio communication links in operation, this was not so much of a problem. But as soon as more and more stations came into operation, the problem of interference grew until finally chaos reigned.

### 5.2 Quenched Spark

For successful tuning to be achieved, what was needed was a source of single frequency electromagnetic energy rather than the spark's broad blast of energy spread over a wide band of frequencies.

Over the next 25 years of wireless development, tremendous efforts were made to improve the characteristics of spark energy. Although creating a single frequency from the broad blast of frequencies present in a spark was intrinsically impossible, a number of initiatives significantly improved the characteristics of this energy source as used for communication.

The involvement of scientists with the development of wireless had allowed close attention to be paid to the problem of the spark as a source of electromagnetic radiation. It was soon realised that the character of the plain spark significantly contributed to the problem of the breadth of the signal. If, instead of allowing a spark to die away or decay naturally, it was shut off abruptly after an initial one or two swings, then in a circuit that contained inductance, the circuit would resonate at a frequency generated by that first pulse of spark energy. This characteristic of the quenched spark then allowed a significant improvement in the tunability of a spark transmitter.

Apart from this, where the energy to drive the quenched spark gap was derived from an alternating source, acoustic modulation was imposed on the radio frequency energy, which could be heard as a tuneful whistle. Given the impact of variations in the elements of a spark transmitter, where messages were transmitted using the quenched Spark device, they would have a noticeably individual character which made it extremely easy for trained operator to distinguish the desired transmission from the output of other transmitters in the vicinity. The quenched Spark system was accordingly referred to as the 'singing spark'.

With this desirable characteristic, the quenched Spark became very popular with wireless operators, known as 'Sparks' in the marine world, as they coped with the chaotic interference that pervaded the early years of wireless at sea and on land.

Quenching could be achieved by a number of different techniques. Particularly associated with the 'Singing spark' was a multiple cooling plate discharger as developed by Wien. In this device alternating current was fed to each end of the array of grooved disks between which the spark jumped and was almost immediately extinguished by natural cooling. By this means, the frequency of the alternator was imposed on the spark energy to be heard as a whistle.

Other techniques to shut off the spark involved a cooling blast of air or gas as well as the placement of a magnet in the vicinity of the spark gap. The magnetic field then had the effect of distorting the path of the spark between the electrodes, shutting it off almost immediately.

### 5.3 Rotary Spark

The Marconi Company's approach to improving the character of spark generated energy was to develop what amounted to a rotary switch and used in particular in marine installations. In ships at sea alternating current was generated by a rotary converter fed by the direct current, DC supply which was conventional in the marine service. Current from this converter was then elevated in voltage with a transformer and the Alternating Current, AC, output was then applied to a heavy duty plain spark gap. Given the noise level generated by such a device, this was frequently enclosed in a heavy, lead-lined timber box.

## NEW MEMBERS

*The President and Committee are pleased to welcome to the HRSA the following new members.*

**New South Wales**
Lindsay Morehouse, Craig Harrison, Mike Humphreys, Alezander Piggott, Russell Nightingale, Warren Gibson,

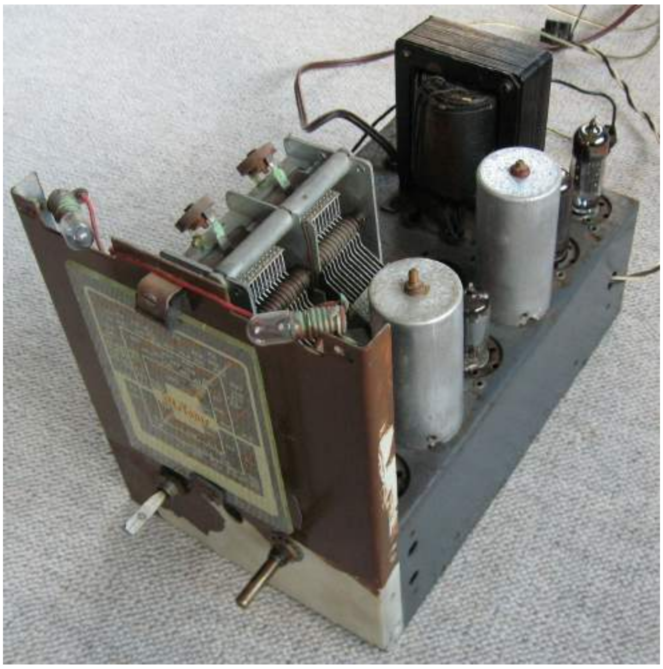
**Victoria**
Robert Storey, Damian Huss, Ian Mclean, Peter Jackman, Gary Ayre.

**Queensland**
Tony Clancy, David Tipton.

**South Australia**
Michael Mackintosh, Julian Robertson.

**Western Australia**
Nigel Hanwell.

## MYSTERY RADIO



THOUGHT to be of Australian origin, this radio has the word 'Melodia' on its dial. It belongs to Ken Brooks, who would like to know who made it. He can be contacted at kenbrooks007@btinternet.com

# IDENTICAL TWINS IN DIFFERENT CLOTHING.

## Monarch model DKL and Peter Pan model GKL

by **GRAHAM PARSLOW**

BADGE ENGINEERING has been a part of Australian radio history since the beginning of commercial manufacturing. AWA remained the biggest manufacturer of radios through the golden age of radio. AWA (Amalgamated Wireless Australasia) was a hybrid between Marconi UK and RCA USA. Between them they bought other manufacturers and used their names for offering brand choices to customers. AWA manufactured products badged as Radiola (proprietary to RCA), Hotpoint, General Electric, Bandmaster, Westinghouse, Diamond Dot Cruiser and Genalex. Sometimes only the badge was changed, but most times other cosmetic changes were involved. Second only to AWA in production volume was Astor (Radio Corporation of Australia) and they too did their fair share of badge engineering. Brands in the extended Astor family included Croyden, Eclipse, Saxon and Univox as well as the two brands featured here.

Astor released the popular Mickey model KL immediately after the war in 1946. It was cheap and cheerful, featuring only 4 valves.

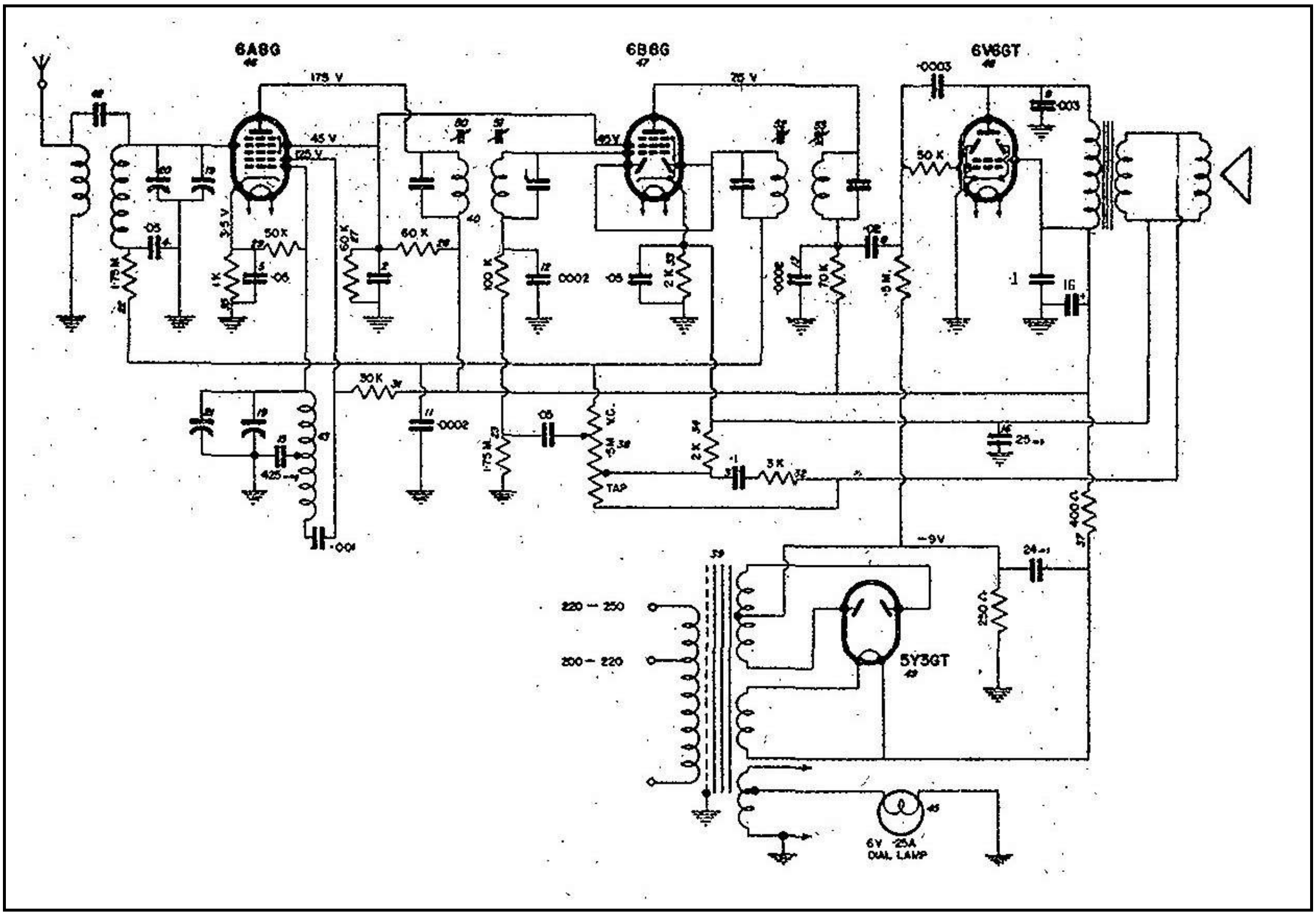

The same basic circuit as the Astor KL was used for the radios repackaged as Monarch model DKL and Peter Pan model GKL. As you can see the case work is significantly different and this required different layouts for the chassis and access to the tuning and volume controls.

By chance I acquired both the Monarch and Peter Pan radios from a deceased estate, not realising at the time that they were twins, or even part of triplets when the Astor Mickey is counted.

### THE CIRCUIT

The AORSM circuits for the DKL and GKL are absolutely identical and a copy is shown here. The essential features of the circuit are evident even though the diagram is low in definition.

The AORSM circuit for the Astor KL is drawn in a different style and to my eye only three components are different. For the KL the mains transformer has slightly different windings so the voltages are higher requiring a 450 ohm voltage dropping resistor in the HT filter circuit, rather than 400 ohm. The capacitor arrangement linking the primary and secondary of the aerial coil is also different. Other than those minor revisions all circuit details appear to match.




The following description of the circuit has been adapted from the notes published in the 1946 edition of the *AORSM (Australian Official Radio Service manual).*

**VALVE COMPLEMENT** .

6A8G Converter.

6B8G IF, Amplifier, AVC., Detector, first Audio.

6V6GT Beam Power Amplifier.

5Y3G Full Wave Rectifier.

**INTERMEDIATE FREQUENCY:** 455 kHz.

**TUNING RANGE**: - 535 to 1640 kHz

**POWER CONSUMPTION**: 40 Watts approximately.

**GENERAL DESCRIPTION**

A mantel model with 4 valves. It is a reflexed super-heterodyne receiver. The circuit which is of unusual design has overcome the usual disadvantages of reflexed circuits, i.e. low-volume distortion and failure of the volume control to cut off. The valve line up consists of a 6A8G pentagrid converter followed by a type 6B8G diode pentode used as a combined IF amplifier, diode detector and A.V.C. bias source and first audio amplifier.

A.V.C. is applied to the 6A8G only. Volume is controlled by varying the reflexed audio signal applied to the 6B8G valve. The audio output of this valve is fed directly to the 6V6GT output valve. Negative feedback is taken from the secondary of the output transformer and applied to the bottom of the volume control. A second circuit providing bass boost is connected to the tap on the volume control. Bias for the 6V6GT output valve is

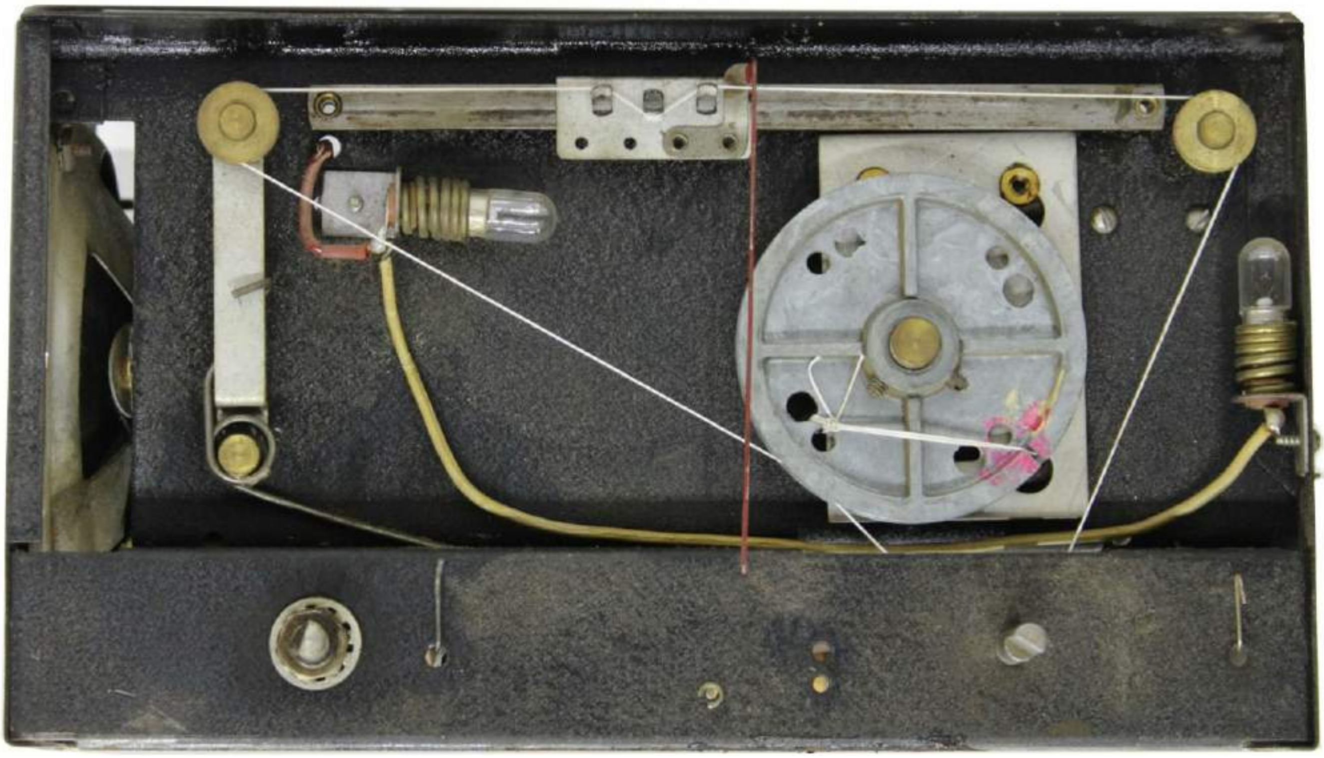
| TUBE | FIL | PLATE | SCREEN | GRID | CATHODE | OSCL. PLATE |
|---|---|---|---|---|---|---|
| 6A8G | 6.3V | 175V | 44.5V | – | 3.5V | 115V |
| 6B8G | 6.3V | 75V | 44.5V | – | 2.7V | – |
| 6V6GT | 6.3V | 165V | 175V | 9.0V | – | – |
| 5Y3G | 5.0V | 198/198V. RMS. The initial surge voltage across the first electrolytic condenser (circuit No. 17) is 255 volts, dropping to normal operating value of 196 volts. The D.C. voltage across the 400 Ohm filter resistor is 16 volts. | | | | |

obtained from the voltage drop across the 250 ohm resistor between earth and the mains transformer centre tap. High tension is supplied from the 5Y3G full wave rectifier and filtered by a resistance-capacitive filter comprising 24MFD electrolytic, 400 ohm resistor and 16MFD electrolytic capacitor.

**PETER PAN MODEL GKL**

As seen from the rear, the top right hand corner of the case was chipped off. The gap was filled with two-part car-body filler, profiled to shape, then painted ivory to match the case.

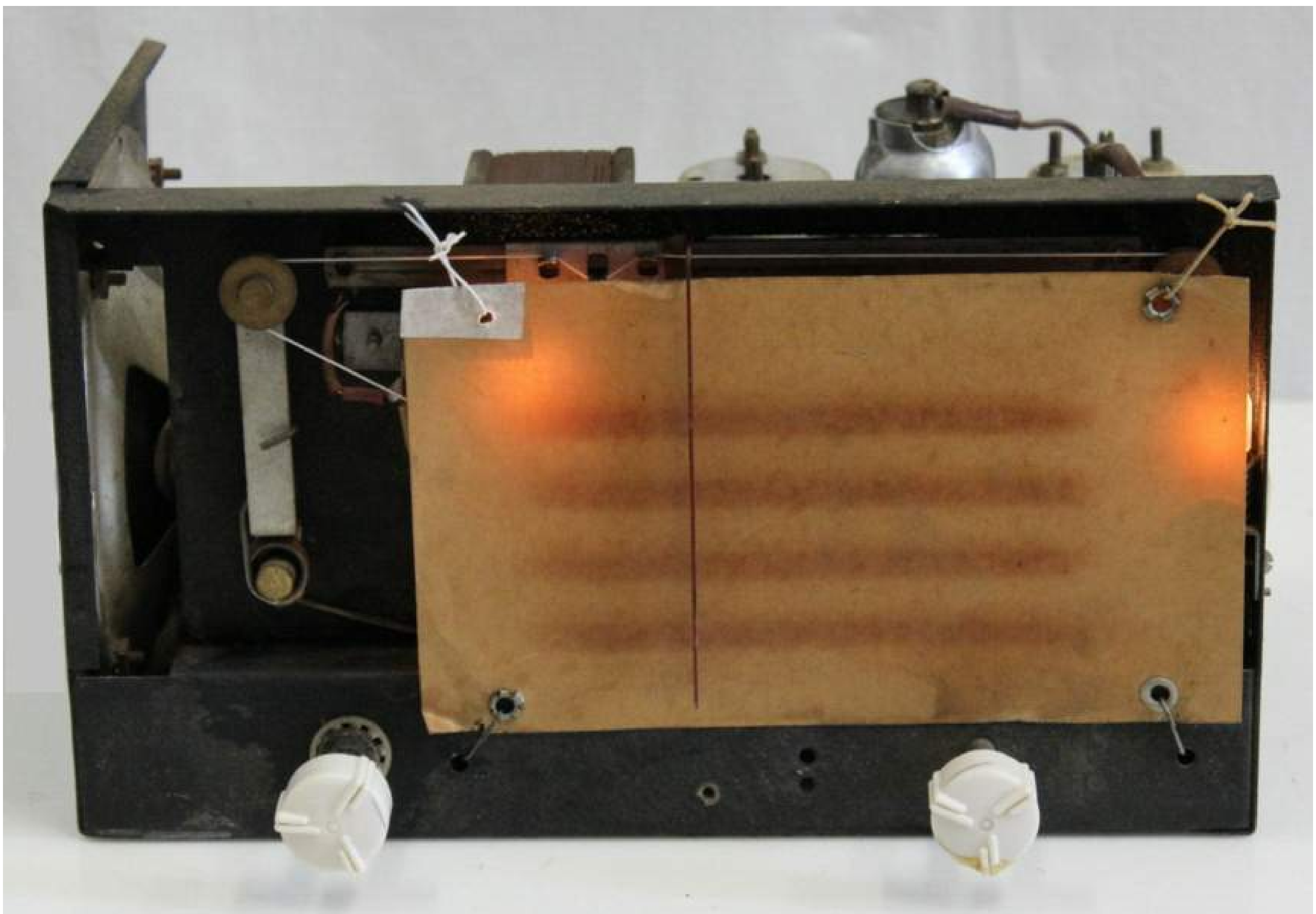
The dial string was broken. Replacement was relatively easy because the dial string has a spring-tensioned arm,

rather than a conventional spring in the dial drum. After the string is in place it is a simple matter to rotate the torsion arm and apply tension.

A diffuser card for the dial is retained by ties anchored in grommet holes.

Restoration included replacing the 0.02 uF audio coupling capacitor to the 6V6 and the 6V6 0.003 uF plate decoupling capacitor. A new three core power cable was

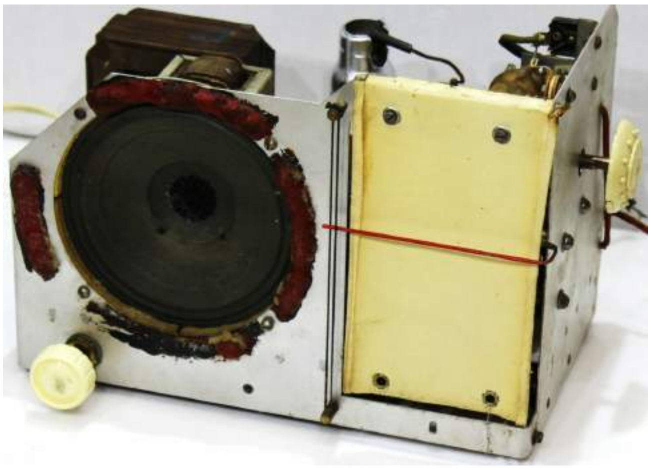


installed. With these minor changes the radio worked well, with everything performing to specification.

Unusually, the chassis is painted in black-crackle finish.

**MONARCH MODEL DKL**

This is the baby Monarch. The five valve model has a scaled-up case of similar appearance. This example has a crack extending across the left hand top. But it is a minor blemish and it was left alone.



The chassis layout is tight, but not cramped.

The underside of the chassis is well set out for easy replacements. Some critical capacitors had already been replaced so only the plate bypass capacitor to the 6V6 was additionally replaced. The radio performs well within the limitations of four valves and a five inch Rola speaker.

A wit has observed that all Mexican foods are the same; whether it is called a Burrito or a Taco only depends on how you wrap it. Astor likewise managed to wrap its products with imaginative variations.

# GECoPHONE

## 1922 to 1925 Part 1

### by EVAN MURFETT

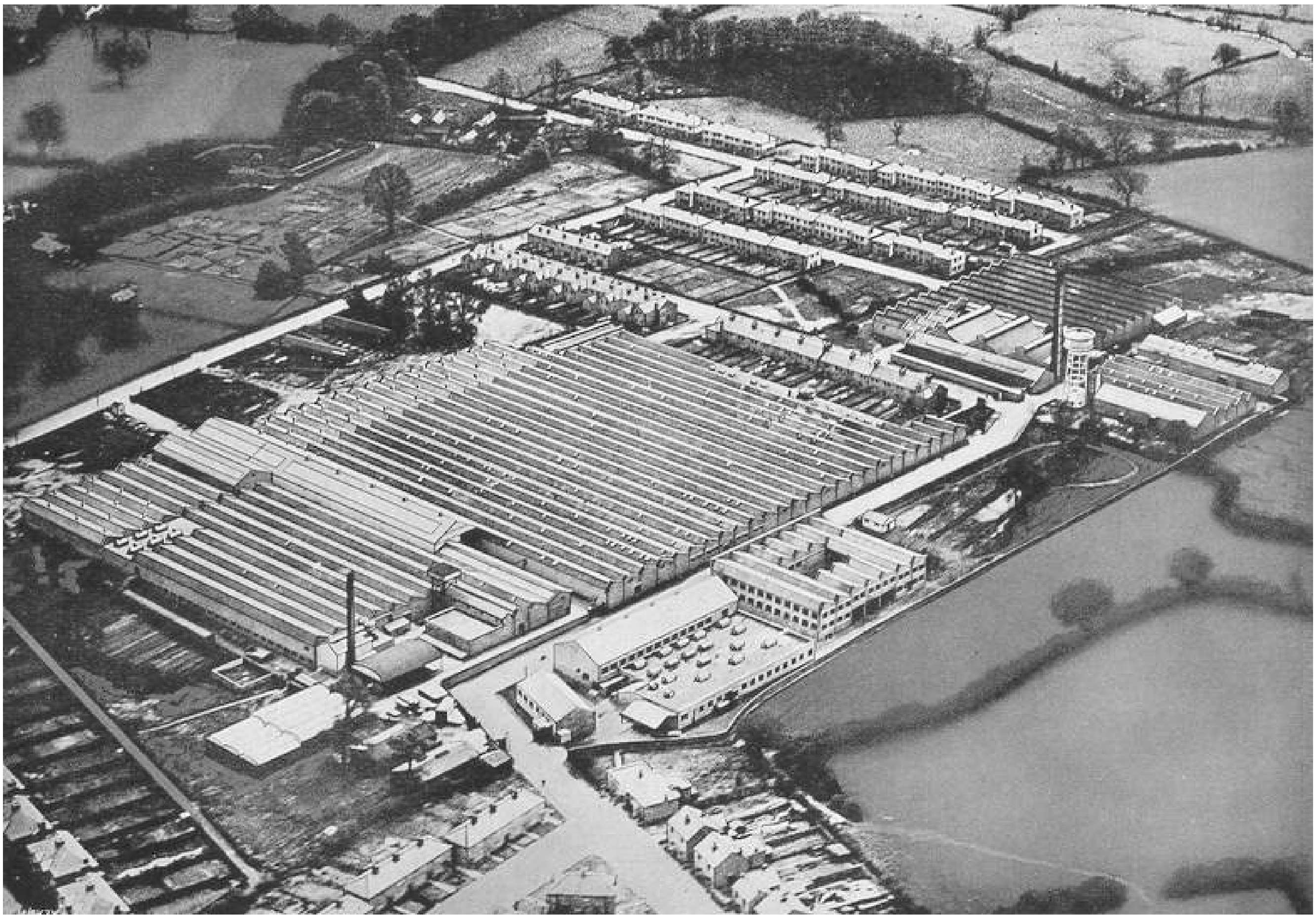
I HAVE BEEN planning a comprehensive series of articles on all the Gecophone models up to 1925 for some time for the purpose of sharing knowledge with other collectors, showcasing my growing Gecophone collection and, more importantly, to invite feedback, corrections and new information from readers in order to expand the body of knowledge.

Gecophone were (and still are) seen as one of the highest quality British wireless receiving sets from this era. From the meticulously finished ‘handsome’ mahogany cases to the complete range of accessories available, GEC had an eye for quality and marketing and had few rivals for the title ‘Best of British’.

For me, the period 1922 to 1925 represents the golden age of British wireless manufacture. So 1925 is a logical cut-off date for my collection as, after then, Gecophone sets dramatically changed in style and construction, away from their distinctive beginnings when function dominated form. All of the photographs in the articles are of the author’s collection unless otherwise noted.

**In the Beginning**

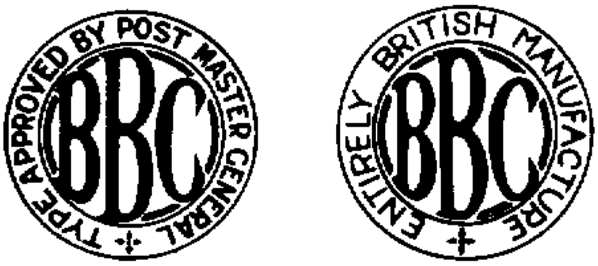
Hugo Hirst joined fellow Bavarian immigrants Gustav and Max Binswanger in 1886 to form The General Electric Apparatus Company. In 1889, the business was incorporated as a private company known as General Electric Company Ltd and in 1900 GEC was incorporated as a public limited company. GEC commenced the manufacture of crystal and valve receivers and accessories at the Peel Conner Telephone Works at the Copsewood Estate in Coventry in 1922.



Peel Conner Telephone Works at the Copsewood Estate in Coventry, c. 1926

GEC exhibited the BC1001 Crystal Set No. 1, BC1501 Crystal Set No. 2 and the two valve BC2001 HF & DET smoker's cabinet receiver at the all British Wireless Exhibition 30 September to 7 October 1922.

On 18 October 1922 the British Broadcasting Company (BBC) was formed, comprising some 300 British manufacturers headed by the 'Big Six': BTH, GEC, Marconi, Metropolitan Vickers, The Radio Communications Co and Western Electric.




Left: BBC/PMG stamp, November 1st 1922 to September 1924.

Right: BBC/EBM stamp, September 1924 to 1927.

On 1 November 1922 the scheme was introduced whereby all commercially manufactured crystal sets, valve receivers and valve amplifiers had to bear the BBC/PMG stamp together with a GPO registration number.

The small number of receivers sold between September and 1st November 1922 did not bear the BBC/PMG stamp or the GPO registration number.


**BC1001**

**CRYSTAL RECEIVERS**

**Crystal Set No. 1, Open Detector BC1001 (1922-23), BBC/PMG Stamp, Reg. No. 102.**

Originally introduced in about September 1922, the earliest of this model has 'PARIS' inscribed on the ebonite control panel as opposed to 'LOADING COIL' on later versions. The horseshoe shorting link, which was to become the GEC trademark, could be removed and replaced with a long-wave loading coil used to tune to the wireless telegraphy time transmissions from the Eiffel Tower on 2,600 metres. Early versions also have an ebonite coupling tuning dial engraved 0 - 180° as opposed to the later bakelite dial with the same inscription. Early versions of the mahogany case have clearly visible screw heads holding the lid to the sides.

**Specification** – A single circuit crystal receiving set complete with one pair of 2,000 ohm, double-headgear telephones, and with plugs fitted to take an additional pair of telephones if required. Tuning is effected by means of a variometer, which allows for fine adjustment. The set is constructed for wavelengths of 300-500 metres, and is fitted with sockets for the addition of a loading coil to give longer wavelengths if desired, and for the reception of the Paris Time Signal. The detector is a 'Gecosite' crystal, which is specially sensitive and does not require a potentiometer or battery. Enclosed in a well-made polished mahogany case, and supplied complete with two 10-ft. lengths of flexible wire for connecting to the leading-in terminal and earth, one coil of 100-ft. 7/22 enamelled copper aerial wire, two insulators, one pulley block, one aerial fixing eye, one leading-in terminal and one earthing clip. Full printed instructions for use are contained inside the case.

Approximate range (with standard PO aerial) 25 miles. Price complete, £5 10 0.

**Crystal Set No. 1, Enclosed Detector BC1002 (1923-24), BBC/PMG Stamp, Reg. No. 102,**

Introduced in 1923, the enclosed detector version is the same as the open detector version (BC1001) with the exception of the crystal detector now being of the enclosed type and the removal of the mount for spare crystal cups on the lid.

**Specification** – Deck of high-grade matt ebonite, fitted with plug and socket terminals for aerial and earth connections, and sockets for two sets of telephones. Tuning is by variometer, covering 300-500 metres, and sockets for the addition of loading coils for higher wavelengths, such as that of the Chelmsford Station, are provided. Detector is a 'Gecosite' specially sensitive crystal enclosed in a dust-proof glass cover. The whole instrument is fitted in a highly finished mahogany cabinet with cover, and all metal parts are heavily nickel-plated. Supplied complete


BC1002 - Lorne Clark'a collection

with one pair of double headphones, 4,000 ohms with connecting plug, two 10-ft. lengths of flexible wire for connecting up to the leading-in terminal and earth, one coil of 100-ft. 7/22 enamelled copper aerial wire, two insulators, one pulley block, one aerial fixing eye, one leading-in terminal and one earthing clip

Approximate range (with standard PO aerial) 25 miles. Price, £4 10 0.

**Crystal Set No. 2 BC1501 (1922-23), BBC/PMG Stamp, Reg. No. 103.**

As with the No. 1 Crystal Receiver, early versions of the No. 2 Crystal receiver have ‘PARIS’ inscribed on the control panel as opposed to ‘LOADING COIL’ and have ebonite coupling and condenser tuning dials. Also like the No. 1 crystal receiver, early versions of the case have clearly visible screw heads on the lid.


BC1501

**Specification** – For more selective tuning than Crystal Set No. 1. This set has a coupled circuit with adjustable coupling. Aerial tuning is effected by a tapping switch and the closed circuit is tuned by means of a moving plate condenser. The detector is a ‘Gecosite’ crystal, which is specially sensitive and does not require a potentiometer or battery. Fitted with a testing buzzer and key so that the crystal may be adjusted to its most sensitive position. Constructed for wavelengths of 300-500 metres, and fitted with sockets for the addition of a loading coil to give longer wavelengths if desired, and for the reception of the Paris Time Signal. Supplied complete with one pair of 2,000 ohm, double-headgear telephones, and fitted with sockets to take one extra pair of telephones if required.


BC1700

*continued on page 21*

# REPAIRING BATTERY CORROSION
## by ROD HUMPHRIS

### ALKALINE BATTERIES

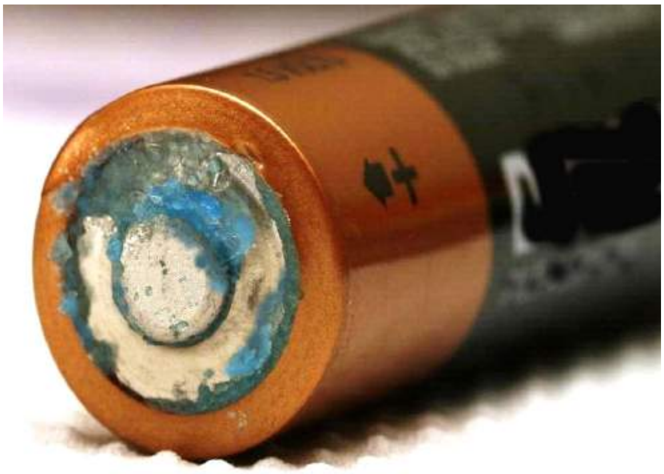
**For corroded batteries in remote controls or portable radios, etc.**

FOR typical alkaline AA and AAA batteries, you'll need an acidic solution to break down the battery leakage residue. Scrape off all visible excess with a small sharp flat blade screwdriver, but do not let scrapings get into the radio's works. Treat with white vinegar first (or lemon juice), both of which are acidic.

It's probably best to strip the unit down so that the blue/green verdigris corroded areas are exposed.

Keep the acid solution off other metal areas, PCBs (copper) will corrode with vinegar or lemon juice. It also won't do coil wires or transistor pigtails much good either.

Using a cotton bud, wipe the drop of vinegar, onto the blue green corrosion residue (verdigris left over from the scraping exercise) and wait for it to work. A scrub with a toothbrush works well, too.

With an alkaline battery, scrape off excess and treat with vinegar On a car battery, scrape, then use soap or baking soda Wash off excess with hot water, dry fully, spray with RP7 or WD40*. It is normal for a fizzing chemical reaction to occur. This is OK; simply wait for it to die down.

For alkaline batteries, take care to apply the vinegar or acidic solution *only to the corroded area.*

As before, a sharp screwdriver blade may help to scrape off the excess blue-green corrosion. Once finished with the acid treatment, wash it thoroughly with warm water, and then dry it (remove all acid).

It is permissible to use this treatment on corrosion found on printed boards - just wash the board afterwards with water and dry them thoroughly.

I suggest you put some CRC lubricant, WD40 or RP7 on your finger and transfer this to the corroded area. I also make a practice of doing this to a new radio's battery terminals to give a modicum of advanced protection. Use the RP7 / WD40, etc onto the new battery terminals (via your finger) to further protect.

I have found that this leakage has occurred, on numerous occasions with Dxxxxcel alkaline batteries. I have even sent batteries back to Dxxxxcel, and got little meaningful response, and no compensation. As potassium hydroxide is what leaks from alkaline batteries, avoid contact with this chemical.

### CARBON ZINC BATTERIES

Zinc chloride and acidic ammonium chloride leak from carbon-zinc batteries. As it is acidic, the treatment is similar to that for the removal of corrosion with lead-acid batteries. Use a baking soda/hot water solution to treat the corrosion.

Note, These are the old torch batteries we all used, half a century back in time.

**ACIDIC BATTERIES (LEAD ACID CAR BATTERIES, AND SLA BATTERIES (SEALED LEAD ACID))**

The white furry corrosion found typically on the lead-acid battery terminals is acidic. (See previous picture)

Often this is caused by a poor seal between the battery case and its terminal, causing battery acid to seep out, which will again corrode. A traditional alkaline solution of a tablespoon of baking soda mixed into a cup of hot water will neutralise the corrosion. Paint the alkaline solution onto and around the corrosion affected area. Apply liberally, wait for the fizzing to stop and then apply more. This neutralises the acid. Now clean off all remaining residue. The hard to remove acid residue may need some help with a wire brush.

Please avoid shorting out the battery with the wire brush, and be aware that a springy wire brush can spray the acidic residue around. Wash it off immediately with hot soapy water.

Finish off by giving a spray with CRC lubricant, WD40 or RP7 or similar. Wipe off excess.

*Conclusion:* Battery corrosion was just too bad, there was not enough spring steel left to make a good contact.

Solution, Ebay, $1.00 posted for 20 contacts
https://www.ebay.com.au/itm/173123787029

Battery contacts, 2 lots of these ex Ebay, $1.00 posted

**SUMMARY**

***Alkaline batteries*** leak an alkaline corrosive fluid, so treat with an acidic fluid such as vinegar or lemon juice.

***Carbon Zinc***, and lead acid batteries leak an acidic corrosive fluid. Treat with an alkaline solution of baking soda in hot water.

***Flush off all residue with hot water, dry thoroughly. give a light spray of RP7 or similar; wipe off excess.***

**Rust removal:** Scrape off excess, try soaking in vinegar from an hour to a day with a small 2cm sheet of aluminum foil. I have found limited success this way. Try CLR from Woolworths or Bunnings, (again, limited success found), or a product from Spotlight, 'Magic Metal Cream' (untested). Finally, try about 10ml (2 teaspoons) of oxalic acid with 100ml of warm water, soak for 24

(A) Rusty contact

Rusty contact

Soaking in Vinegar, 1 day

Vinegar for a week

hours, monitor it periodically. Rust converter paint is generally not suitable, as the paint is an insulator and useless for battery contacts

I also tried a paste of baking soda, over one day - no noticeable effect.

**GECOPHONE 1** *continued from page 18*

The set was enclosed in a well-made polished mahogany case and supplied complete with two 10-ft lengths of flexible wire for connecting up to the leading-in terminal and earth, one coil of 100-ft. 7/22 enamelled copper aerial wire, two insulators, one pulley block, one aerial fixing eye, one leading-in terminal and one earthing clip. Full printed instructions for use are contained inside the case.

Approximate range (with standard PO aerial) 30 miles. Price, £9 15 0.

**Junior Crystal Set BC1700 (1925), BBC/EBM Stamp, No Reg. No.**

**Specification** – The whole instrument, including the deck, is of highly finished mahogany; all fittings are bright nickel plated finish, maintaining the standard of the more expensive Gecophone models. Tuning is carried out by means of a variable condenser and fixed inductance coil. The inductance is situated under the panel, and covers the 275-600 metre wave band. By removing the shorting link and plugging in a suitable loading coil the wave length may be increased as desired. Two aerial terminals are provided, so that the set may be used on short or long aerials. Two pairs of telephones may be connected direct to the instrument by means of the three terminals shown.

Price, £0 16 0.

As I mentioned in the introduction, I welcome feedback, corrections and additions to this article. Please contact me at evan-alex@aanet.com.au .

*Acknowledgements:*

Thank you to Lorne Clarke and Martyn Bennet for their generous contributions to this article.

# ROTARY POWER SUPPLIES TYPE 32 and TYPE 34 (used with the T1154 transmitter and R1155 receiver)

## by RAY ROBINSON VK2NO

THE T1154 transmitter and R1155 receiver require power supplies when used in aircraft or sea craft, to convert the input voltage to the required voltages for the installation. They are usually of the rotary transformer type. There are two main types. One power supply (called HV) generated the transmitter plate voltage (1200 volts at 200 mA). The other power supply (called LV) generated the plate voltage (220 volts at 110 mA) and the valve heater voltage (7 volts at 13 A). These two power supplies, were available in 12 volt or 24 volt input voltage versions, to suit the battery accumulator voltage in the appropriate craft. During their life, the power supplies were modified to cater for a navigator operated receiver, and these supplies had the letter 'A' added to their type number as a suffix. The power supplies went through several modifications during their life.

| | HT | HT | LT | LT | LT |
|---|---|---|---|---|---|
| 12 v input | type 32 | type 32A | type 34 | type 34A | type 34X |
| 24 v input | type 33 | type 33A | type 35 | type 35A | - |
| Output voltage | 1200 v | 1200 v | 220 v 7 v | 220v 7 v | 245 v 8 v |

Table 1: Power Supply Types

High Voltage Supply (Type 32A)

Low Voltage Supply (Type 34)

### MECHANICAL DESIGN

The power supplies were each in a long steel case, which was identical in size and weight, (16.5 inches long, 7.625 inches wide, 6.375 inches high, 27 to 30 pounds weight). They slid into a cradle and were secured by two screws. All the cables were on the front end, so the supplies were easy to change for servicing. The only visible difference was the number of cables attached, and the nameplate. Each plug has a physical means of holding it in place, a post and clamp for the small ones and a screw for the large one. Inside the case, is a large heavy rotary transformer. There is a fan on the rear end that draws air through a gauze window. At the front of the case, are the connectors and the start relay. Along the top of the rotary transformer are the large filter chokes, wound on paxolin tubes with heavy gauge cotton covered wire. The oil filled filter capacitors are arranged throughout the case. The actual rotary transformer inside each power supply,

| | | | | | |
|---|---|---|---|---|---|
| Stores Ref. | 10K/17 | 10K/18 | 10K/19 | 10K/61 | 10K/20 |
| Transformer type | 28 | 29 | 30 | 30X | 31 |
| Stores Ref. | 10K/21 | 10K/22 | 10K/23 | 10K/63 | 10K/24 |

Table 2: Rotary Transformer Types

had a model number, that is very similar to the power supply type number, and this may cause confusion.

There are nipples on each of the rotary transformer bearings, but these are for oil and not grease. Hence there was a leaflet produced that required these to be replaced by felt plugs. They required 5 drops of oil for every 30 hours of flight.

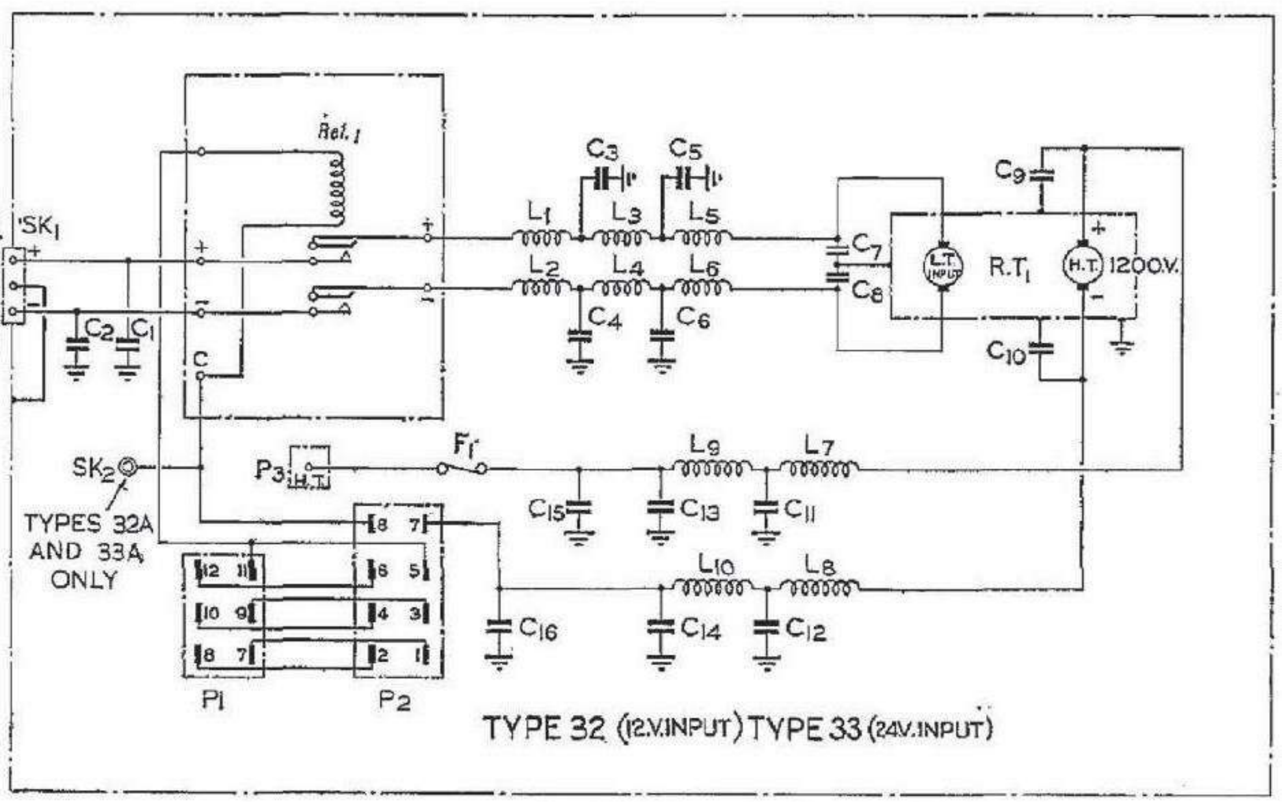
**ELECTRICAL DESIGN (HIGH VOLTAGE SUPPLY)**

The electrical design is very simple. The power enters through a large main connector, and goes to the start relay. There is a capacitor to chassis on each pin. The connector (Type 171) has 2 pins and a locating post that holds the connector in place, and also ensures the correct polarity connection. The power then leaves the relay and goes through a 3 section RF choke to the rear of the rotary transformer, to the brushes.

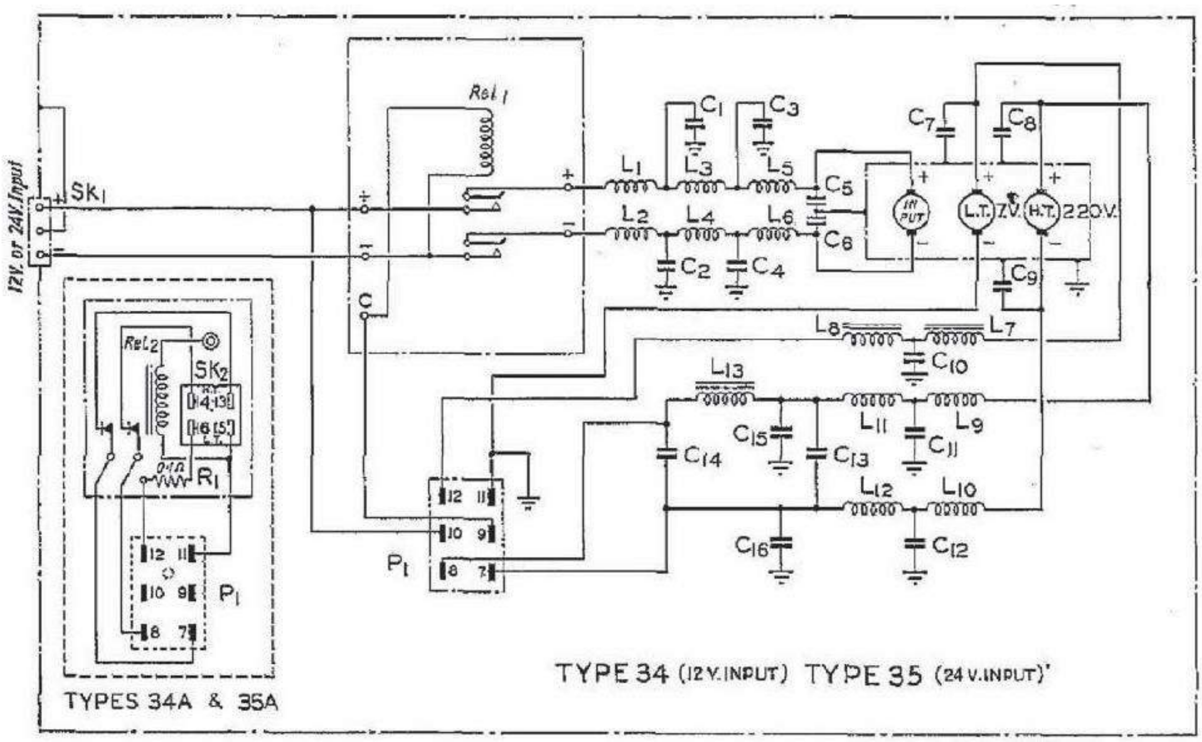
Each power lead uses large heavy gauge wire, and large chokes. The positive lead uses chokes L1 and L3 (on the same former) horizontally along the length of the case, and choke L5 vertically at the rear of the case. There are capacitors C3, C5 and C7 at the choke junctions. The negative lead is the same design, using chokes L2, L4, L6 and capacitors C4, C6, and C8.

Note that neither the positive or negative leads are connected to ground or chassis. They are direct connections as they carry heavy current. However, the capacitors are connected to chassis, and so is the frame of the rotary transformer. The capacitors are 2 uF or 4 uF oil filled type.

AP1186 shows the RF input choke as 3 separate chokes. All power supplies I have seen have been modified to a 2 section choke. The capacitor C5 has been rewired to be in parallel with C3 (effectively 6 uF), and similarly C6




High Voltage Circuit




Low Voltage Circuit

has been rewired to be in parallel with C4. This means that L3 and L5 are in series, and also L4 and L6.

The rotary transformer is an open frame type, wound on a common armature core, with a low resistance shunt field. There is a small series field winding to reduce the input starting current. The rotary transformer efficiency is 60 percent. The 1200 volt high tension output goes through a filter to the output. It consists of C9, L7, C11, L9, C13, and C15 to a fuse then to the single pin output connector P3. The negative lead from the rotary transformer is similarly filtered by C10, L8, C12, L10, C14 and C16, and connected to pin 7 on the 8 pin connector P2. The 6 pin connector P1, is connected pin for pin to P2, and is a pass through for the low voltage power supply. The "A" models have an extra socket SK2, which provides voltage output when the high voltage start relay is activated. This is for use in installations with an extra receiver.

**ELECTRICAL DESIGN (LOW VOLTAGE SUPPLY)**

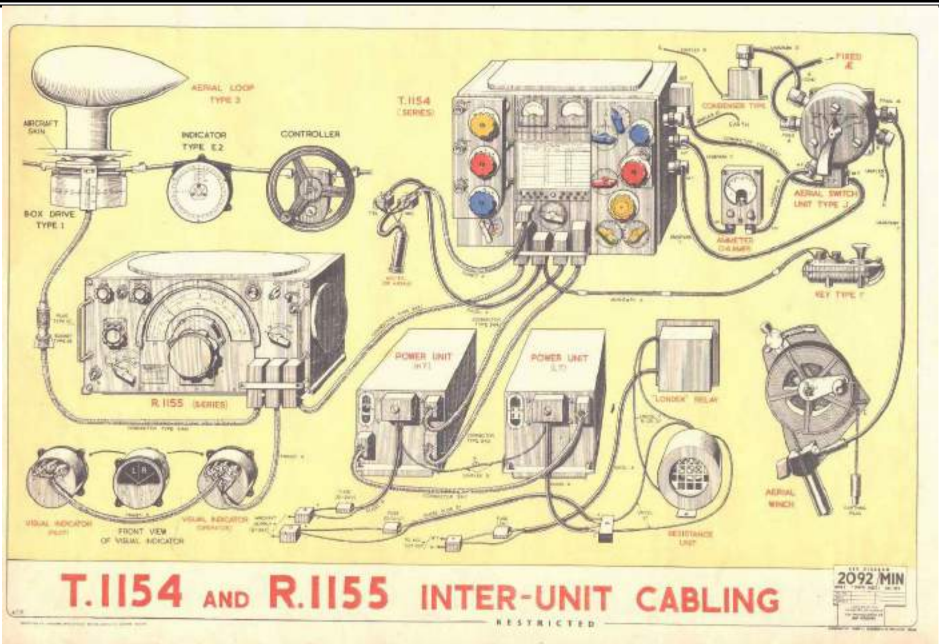
The electrical design is the same as the high voltage supply, except there are 2 output windings and brush sets on the rotary transformer, one for the receiver HT and one for the valve heaters (LT).

The power enters through the large main connector, and goes to the start relay. The power then leaves the relay and goes through a 3 section RF choke to the rear of the rotary transformer, to the brushes. Each power lead uses large heavy gauge wire, and large chokes. The positive lead uses chokes L1, L3 and L5. There are capacitors C1, C3, and C5 at the choke junctions. The negative lead is the same design, using chokes L2, L4, L6 and capacitors C2, C4, and C8. The positive and negative leads are not connected to ground or chassis. They are direct connections as they carry heavy current. The capacitors are connected to chassis, and so is the frame of the rotary transformer. The capacitors are 2 uF or 4 uF oil filled type.

The 220 volt high tension positive output goes through a filter to the output. It consists of C8, L9, C11, L11, C13, C15, L13, and C14, to the pin 8 on connector P1. The capacitors go to chassis, except for C13 and C14, which connect to the negative lead. The negative high tension output lead from the rotary transformer is similarly filtered by C9, L10, C12, L12, C13, C16 and C14, and connected to pin 7 on the 6 pin connector P1. The capacitors are 0.1uF and 2 uF. Choke L9 and L11 are small air cored RF chokes. Choke L13 is iron cored.

The 7 volt low tension positive output goes through a filter to the output. It consists of C7, L7, C10, and L8, to the pin 12 on connector P1. The capacitors go to chassis. The negative low tension output lead from the rotary transformer has no filtering and is connected to the frame of the transformer, and to pin 11 on connector P1. The chokes L7 and L8 are wound with heavy gauge wire. The rotary transformer is an open frame type, with 2 sets of brushes on the output end. The efficiency is 50 percent.

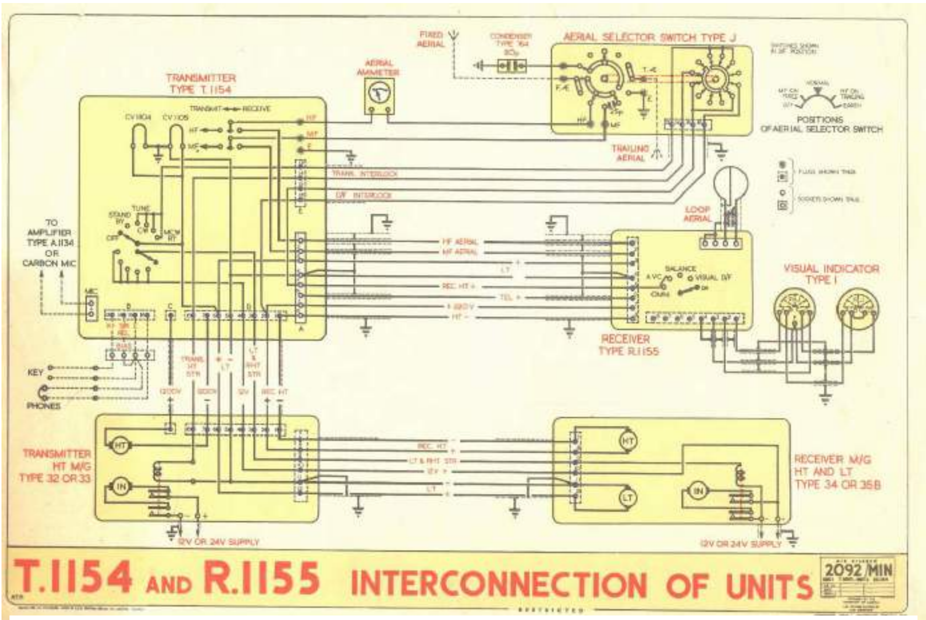
The installations using a navigator's receiver, require a modification ("A" models). The oval gauze window is cut away and a 1-pin socket (SK2) and a 4 pin plug (P2) is fitted. Behind this is a resistor and a relay. The 4 pin plug provides power to the navigator's receiver. A resistor (0.1 ohm) reduces the heater voltage to the correct value. The 1 pin socket is connected to SK2 on the HT supply. The relay turns off the navigators receiver HT, when the transmitter rotary transformer is running.




Cabling Diagram

#### INPUT VOLTAGE

The input voltage to the rotary power supplies will vary, depending on the charge state of the accumulator, and if the aircraft engine is running (thus charging the accumulator). When the input voltage changes, so will the output voltage to the transmitter and receiver. The voltage variation to the HV rotary supply, will change the HT voltage to the transmitter, and will change the power transmitted. This is not critical. The voltage variation to the LV rotary supply, will change the HT voltage to the receiver, and change its performance slightly. This is not critical. The voltage variation to the LV rotary supply, will also change the heater voltage. The heater voltage must be maintained between 6 and 7.8 volts, or the valves may be damaged.




Wiring Diagram

A resistance unit was fitted between the accumulator and LT rotary converter, which is switched in and out, to control the input voltage. Resistance Unit Type 47 was used for 12 volt systems, and Type 52 used for 24 volt systems. When charging the accumulator, the resistance unit is in circuit. When not charging the accumulator, the resistance unit is switched out of circuit. The manual mentions that the resistance units must be well ventilated. The current requirements of the Type 33 and Type 34 power supplies, can be between 10 to 30 Amps. The low voltage cable size and length affect the voltage drop, and the voltage at the rotary transformer input terminals.

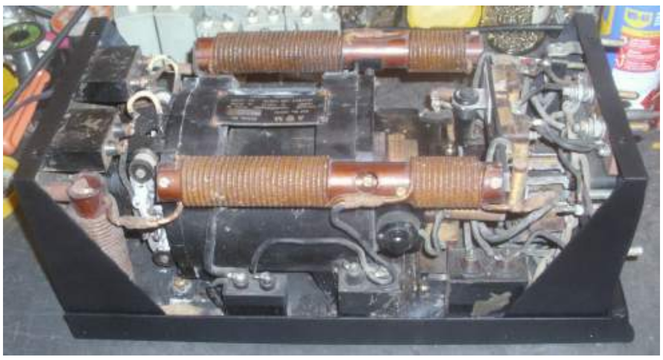
Therefore the resistance unit must be set for each individual installation. The starting current is in the order of 100 Amps. The adjustment procedure, is to measure the accumulator voltage (on charge), measure the heater voltage at the transmitter, and the resistance is then adjusted to provide 7.5 volts at the transmitter. An auxiliary switching relay will switch the resistance unit into circuit, when the accumulator is being charged. It is a Type 219 for 12 volt systems and Type 220 for 24 volt systems. The manual mentions that it "should be mounted where it is not likely to experience much vibration as it is not very robust construction". Note the LONDEX relay in Figure 3 Cabling Diagram. When used in a system with an "electrical cut out" in the charging circuit, the resistance unit is switched in and out automatically. When used in a system with a "self regulating generator", the resistance unit and relay are not required. The manual warns that this "is liable to shorten the life of the valves". When used with the older Type 34X rotary supply, "the input was boosted by switching in and out of circuit, a 2-volt 20-AH accumulator", depending on the voltage due to charging or otherwise. This was a manually switched system. The manual also states that after any flight with an 'emergency connexion' 'all the transmitter and receiver valves should be replaced'.

**HIGH VOLTAGE UNIT RESTORATION**

When received, the HV power unit was complete, but very dirty, and missing the top cover. It was cleaned thoroughly, the bent parts straightened, and the outside repainted. The inside was not repainted. A new cover was made. The wiring was checked off against the circuit, wire by wire. It was complete with no wiring changes. This model has the modification for 2 receivers so it is the Type 32A. Each component was measured and checked for value. All the joints (especially in the high current path) were tested for low resistance. So were the joints to chassis for the RF filters. The bearings were lubricated, and checked for free rotation. The brushes were removed and the commutator cleaned and burnished. It was checked for short circuits.

I had no input plug, so a temporary input cable was attached and routed out the HT connector hole. Power was applied, and nothing happened (which was good). Next, some jumpers were arranged with a small toggle switch, to connect power to pins 5 and 8 on P2. Power was applied again, the switch thrown, and the start relay clunked in. The 12 volt path was checked, all the way to the brush holders. It was powered down. The low voltage brushes were fitted. It was powered up, the switch thrown, and it started to rotate, quite loudly. The bench power supply groaned quite a bit. After some erratic running, it settled down to a steady spin. Everything was checked for heat. Several starts and stops were performed until I was confident. The high voltage brushes were fitted, and the unit powered up. It produced the 1100 volts DC, but not at the output, as one of the chokes had gone open circuit, since measuring. It was fixed, just a broken wire at the solder joint. All capacitors, chokes and wiring (and the rotary transformer and bearings) were checked for heating. A resistive load was connected, and run for a period, to test for heating under load.

HT Unit (original)



HT Unit Inside (restored)

LV Transformer

Empty Case and Capacitors

**LOW VOLTAGE UNIT RESTORATION**

The restoration of the low voltage unit was a little more difficult, as I only had the rotary transformer. I had a case made, and located the parts required from the junk box, the oil filled capacitors, the heavy wire, and the connectors. I had to make the 2 large LT chokes, and the 2 small HT chokes. I purchased a 12 volt relay capable of switching 200 Amps.

I greased the bearings of the rotary transformer, and powered it up. When I was happy with the performance, I bolted it into the case. I added the capacitors and chokes,

LV Unit Inside

and wired it up as per the manual. I used a resistive load to test the high voltage and low voltage outputs, under load.

Input Plug (Type 171) (front L) & Input Plug (Type 171) (back R)

**CABLING**

The cables were made up. The junk box provided the Jones plugs. The Jones plugs are fairly easy to find, perhaps the transmitter high voltage plug being a little more difficult. The HT unit requires three

6 pin female (HV to LV)

8 pin female (HV to T1154)

1 pin female (HV to T1154)

The LT unit requires one

6 pin female (LV to HV)

The wiring and plugs for a second receiver were not required. The main input plug for the voltage in is a Type 171 connector (10H431), It is rarer and much harder to locate. A large 2 pin female plug, it has a third hole to allow it to be screwed on and provide the correct polarity.

The wiring between the units and the T1154 can be made up of multi-core cable. If none is available, you can use the multi-core cable used for wiring up car trailers, available from automotive shops. Use the largest available. The heaviest requirement is for the heater wiring of 13 Amps, so 2 wires can be paralleled if required, for both the heater and earth return. Alternatively, you can use individual wires, and cover them with heat shrink tubing. The HT wiring to the T1154 can be made up of thick coax cable which has a high insulation covering, and only requires 1 wire. The input power should be capable of 30 Amps, so two heavy wires should be used. These can be found in an electronics shop, from the wire intended for solar installations, battery chargers, or heavy speaker cable. These cables require heavy lugs on the ends connected to your power source. I found that during testing, my connectors got hot, and the cables became warm and floppy, so I upgraded to heavier cable and connectors. There was also a 1 volt drop between the power source and the input connector, and also between the input connector and the rotary transformer brushes. Evidence of the voltage drops expected was noted from reading the LT rotary transformer nameplate. The HV rotary transformer is less critical.

*LT Rotary Transformer Nameplate*

Input 9.3V 23A,

Output 7.2V 13A,

Output 225V 0.11A

*HT Rotary Transformer Nameplate*

Input 12V 32A,

Output 1200V 0.2A

HOOVER LIMITED

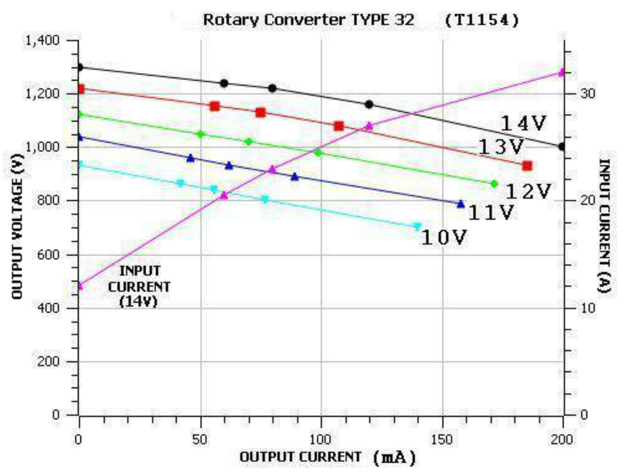
**PERFORMANCE**

The load was varied and the results graphed. The input voltage was measured at the input terminals, and kept constant during measuring. Several load curves were drawn for various input voltages, from 10 to 14 volts. Also, the input current was plotted for the 14 volt input case. The HT no load current was 12 Amps at 14 volts input, rising to 32 Amps, at full output load. Note that the output voltage can sag up to 300 volts.

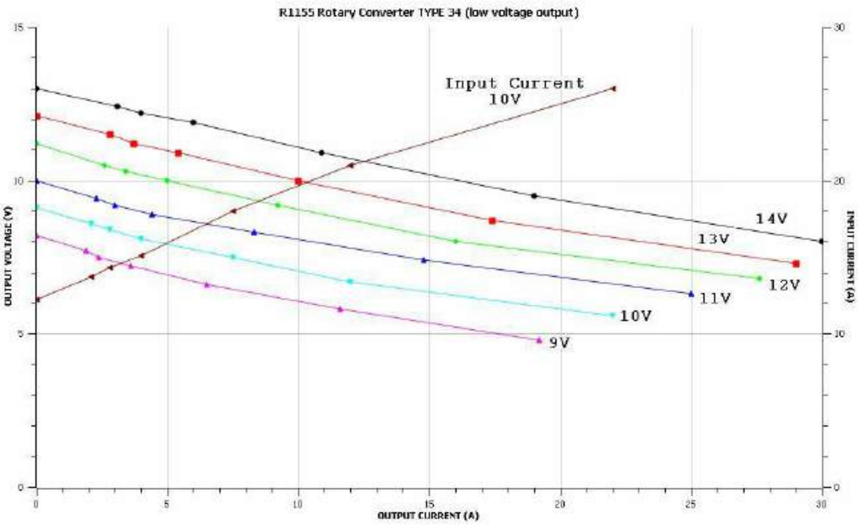
The low voltage unit was also tested with a resistive load. The LT load was several 1 ohm 300 watt resistors, which were connected in series/parallel to provide the appropriate current load. The HT load was a large potentiometer in a box, with 2 built in meters. The HT and the LT were plotted separately. The LT conditions of 7 volts at 13 Amps was met, with a 10 volt input at the unit terminals. The HT voltage for that same 10 volt input was 220 volts at 100 mA.

## CONCLUSION

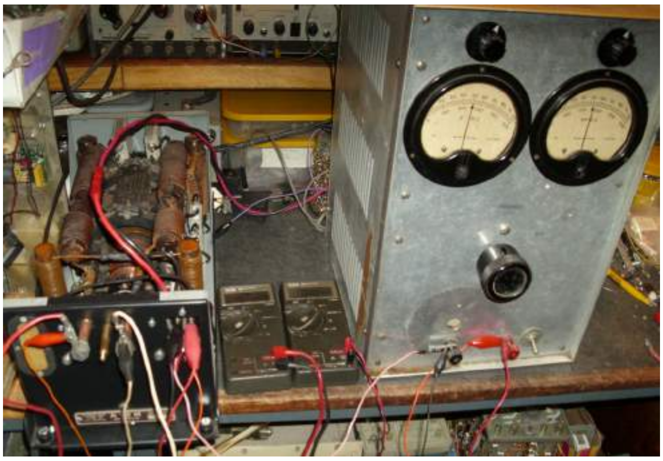
Both power supplies are featureless heavy black boxes. They contain a rotary transformer and filtering. I have tested the 12 volt versions, and provided performance curves. The 24 volt versions would have the same characteristics, but draw approximately half the current,




T1154 HV Performance




LT Performance



Testing HT

HT Performance

and be more tolerant of cabling and connectors. The regulation is in the order of 18 to 25 percent. The variations in LT voltage are a problem, as is recognized in the manual text. The control of this LT output voltage by changing the input voltage (at high current) is not very elegant. An inbuilt regulator of some design would be more beneficial, and perhaps increase the life of the valves. It would be wise to have an earth strap between each unit and the transmitter (and connected to earth), not only for the RF present, but as a safety precaution in the possible case of a broken wire or poor connection in the 1200 volt circuit. They are not very common.

REFERENCE

*Air Ministry Publication, AP1186*, Vol...... 1, Sect. 1, Chapter 7.

**From the Serviceman Who Tells**

# A SPEAKER PROBLEM

BY THE TIME you read this I will have returned from my holiday in a a northern State. Blue sky, temperature of about 28 degrees every day, perfect beach weather and *not a broken radio in sight*. Meanwhile, back at the shop my good friend and fellow serviceman **JIM GREIG** has been looking after the customers. In his own words, here is an interesting story from his files.

An ASTOR BPJ was bought in to be restored to a safe, working state.

To minimise the risk of a return in the near future many parts were replaced.

- All electrolytic capacitors
- All wax paper capacitors
- The power cord was replaced with a properly restrained 3 core cable with the earth terminated to the frame

All resistors were checked and a few that had drifted out of the allowed 20% were replaced. After the initial work it was time to test. There was no measurable resistance from the power transformer primary to secondary or frame.

Power was applied with all valves removed; the power transformer remained cool. This was repeated with all valves but the rectifier inserted and the transformer again remained cool. The rectifier was inserted and the HT measured as the set powered up. HT was 254 on the first filter capacitor, close to the specified 250 volts. The filament voltage was 6.4 AC, and there was no significant heating of the transformer.

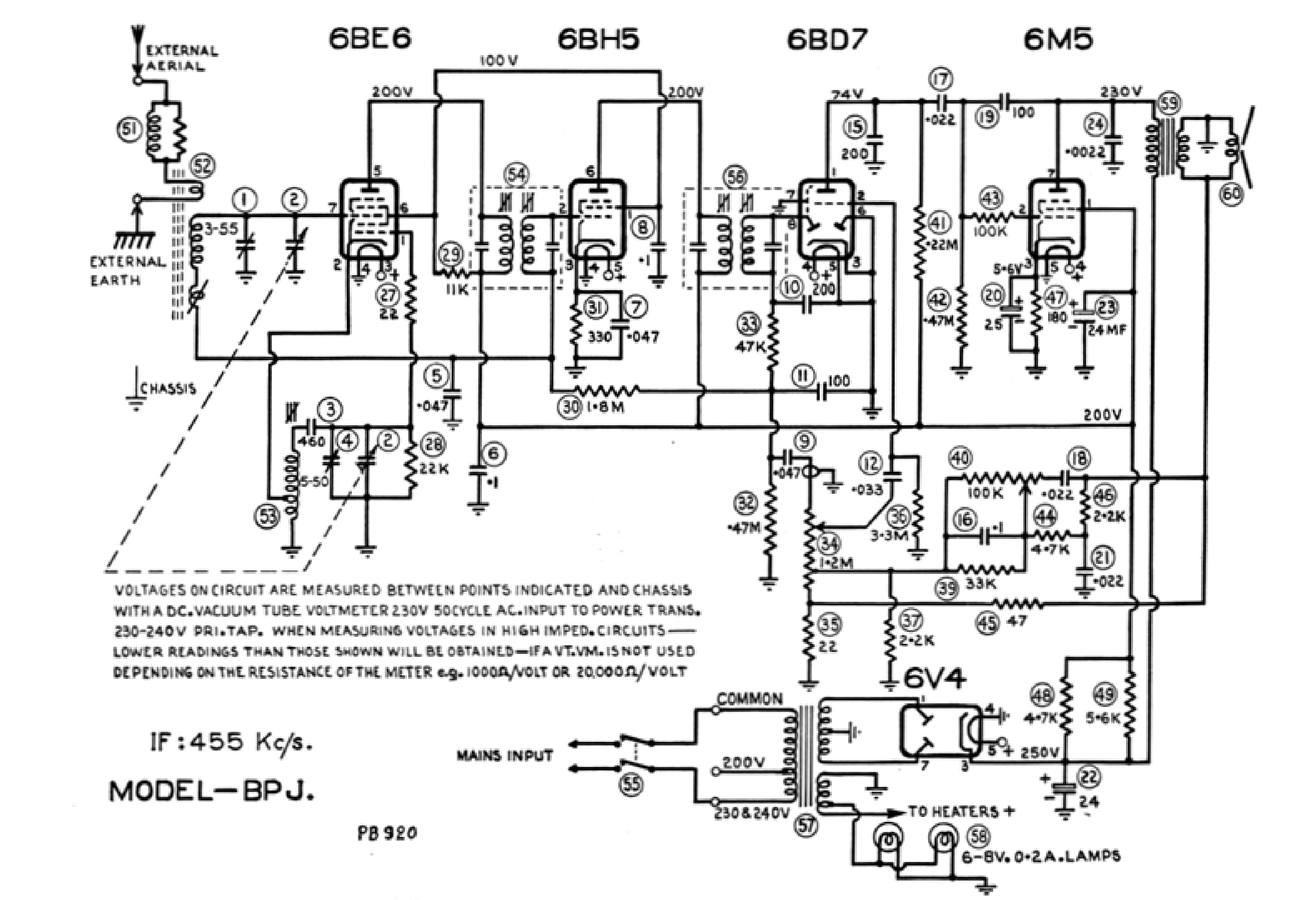
The radio was able to tune local stations with minimal aerial and acceptable quality of sound. The alignment was checked according to the manual and found to be near the correct settings. The IF transformer cores were adjusted slightly following the instructions in the data sheet. As they are double tuned, access is required to the top and under the chassis.

It was left to run on the bench. After several hours the sound gradually became more distorted until listening was unpleasant. At this time DC voltages were checked and found to be similar to those at start up. More detailed testing would be required.

An audio sine wave signal was injected and the output on the speaker viewed on and oscilloscope. It was clean for a range of audio frequencies. A modulated RF signal was also clean.

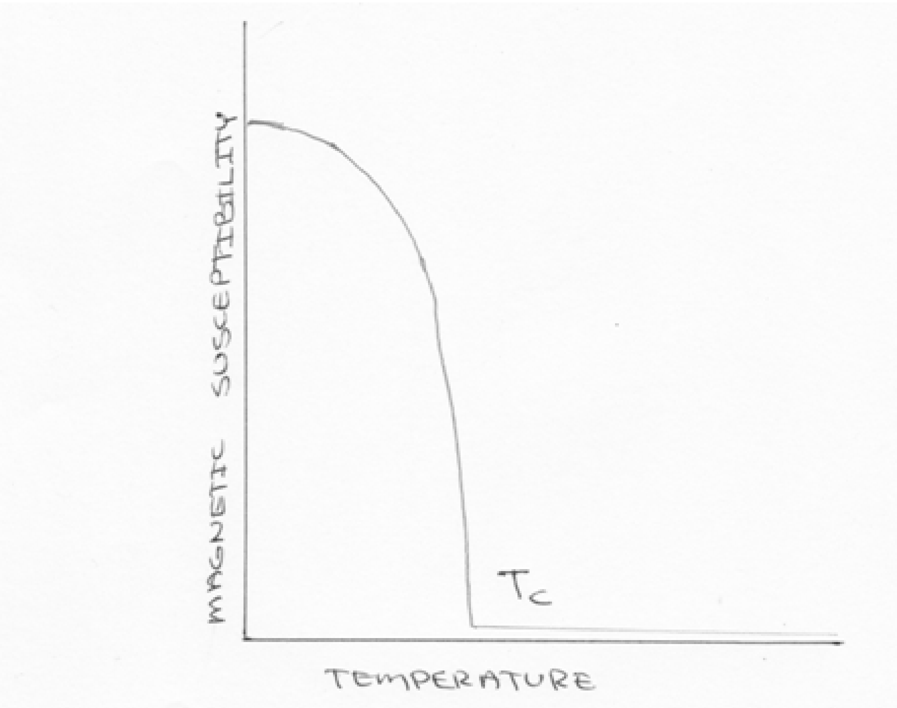
An external speaker was substituted. After several hours the output remained undistorted (at least no more than normal). It would seem to be a speaker problem, but why is there no problem when first powered on? Usually a bad speaker sounds bad when first tested.

A careful check of the speaker showed the 6M5 output valve was touching the speaker magnet.




## IF. ALIGNMENT.

| Operation No. | Generator Connection | Generator Frequency | Dummy Antenna | Instructions. |
|---|---|---|---|---|
| 1. | Remove receiver chassis from cabinet as detailed in the following pages of this bulletin. | | | |
| 2. | To signal grid of 6BH5 valve (pin No. 2.) | 455 Kc/s. | 0.01MF Mica capacitor in series with generator | Leave grid wire attached to valve socket. Peak 2nd I.F. trans. pri. and sec. for max. output. |
| 3. | To signal grid of 6BE6 valve (pin No. 7) | 455 Kc/s. | 0.01MF Mica capacitor in series with generator | Turn tuning control until condenser gang plates are fully out of mesh. Leave grid wire attached to valve socket. Peak 1st I.F. trans pri. and sec. for max. output. |
| 4. | | | | Repeat operations 2 and 3. |




In another BPJ the 6M5 was about 10 mm away from it. The speaker in the problem radio was a ROLA 57L, in the other a 57H. The radio may have started with the 57L, or it may have been a replacement. Magnets are known to lose their magnetism completely as they are heated up to the Curie Point, with this magnet likely to be around 80 degrees Celsius.

This could be the problem, with the magnet losing part strength at a lower temperature. Another possibility is warping of the speaker frame at the higher temperature. Whatever the cause, the solution was to replace the speaker with the 57H. After several hours of operation there was no apparent distortion.

# RADIO INTERFERENCE

## Dealing with troublesome EMI/RFI - One man's journey.

## by ROB GREGOR

**Understanding EMI/RFI:**

THE TERMS **RFI** (Radio Frequency Interference) and **EMI** (Electro-Magnetic Interference) are commonly used to describe different parts of one phenomenon, which is that of disruptive electrical noise generated by many items of electrical equipment and infrequently by thunderstorm or solar flares (sunspot) activity. This noise travels by both radio waves in free space and is conducted along the hard wiring that connects various items of electrical equipment in your residence.

While **EMI** is electrical noise of any frequency, **RFI** is a specific subset of electrical noise on the **EMI** spectrum.

There are two types of **EMI**. Conducted **EMI** is unwanted high frequencies that ride on the AC wave form. Radiated **EMI** is an unwanted radio frequency transmission and often this noise is most common on medium and some short wave frequencies.

Its effects, when heard on a radio receiver, vary in intensity from a nuisance level of background noise right through to severe, which is disruptive and blanks out all but the strongest radio signals. In some instances, it can be serious enough to disrupt the operation of Bluetooth and Wi-Fi devices.

On a few occasions, the emissions from very active solar flares have been known to cause major disruptions to communications and even sections of power grids. In the case of its deliberate use as a military weapon, a massive EMI pulse can cause permanent damage to many items of unprotected electrical equipment, including mains power networks, and apparently it can erase the memory storage in unprotected computers over a wide area.

In the urban situation, the levels of background EMI/RFI are often high and much of it may be outside of one person's ability to control, but consider my surprise when living in an isolated coastal location and then finding that our own power system was creating copious amounts of it.

**THE REASON FOR WRITING THIS ARTICLE:**

When I first began the process of exploring options to reduce the level of RFI in our broadcast band radio receivers, I could not easily locate straight forward guides on how to reduce it in the domestic situation and had to rely mostly on articles that were of a technical nature and for the commercial environment.

This prompted me to record the process which I have used to successfully minimize RFI from a 'stand alone' solar and wind power system so that it might provide assistance to others who find themselves in a similar situation.

**BACKGROUND:**

My wife and I are fortunate to live on a small peninsula of land situated on the shores of Venus Bay in South Australia.

It is an attractive but isolated location and is set away from the established 'mains based' power, water, effluent and stormwater disposal systems; therefore we have needed to develop a good degree of self sufficiency.

Being aware of local and international news is important to us and our main information sources are via a satellite TV/Radio system plus the internet, which in this area is limited due to slow download speed. We also much enjoy using our three vintage valve radio receivers for mostly music listening.

Owning a large block of land has allowed us the luxury of erecting a sizeable random wire/long wire antenna for these sets plus a transistorised multi band communications receiver and following a lengthy process to minimise disruptive RFI produced by our power and distribution system, we now get very good performance from all of them.

We have fringe reception of a local FM station, an ABC MW single station repeater is at 65 kilometres distant, another at about 170 kilometres is a MW commercial station.

However, the MW stations with music programs that we most enjoy are distant from us by at least 400 km or more (and on the SW band are mainly located in other countries). Therefore, the signals we receive vary from weak to medium strength only, and initially those had been severely disrupted by our locally produced RFI.

**TYPICAL SOURCES OF RFI:**

Inverters and transformers, solar regulators, electrical motors (such as in water pumps, freezers, refrigerators, washing machines) household lights (especially compact fluorescent lights and some LEDs) plus mains power lines to a residence, are among the most common sources of strong RFI.

In our situation, the strength of RFI emitted by our sophisticated solar regulator varied considerably and depending on how busy the regulator was at any time of the day as it did from other appliances that are 'demand activated'..

Less common sources of strong RFI are intermittent shorts or poor connections in house wiring, wall sockets or old electrical equipment and among the worst offenders for RFI are some makes of plasma TVs and commercial welders such as Arc, TIG or MIG. These are often the most difficult to deal with if they are located in your neighbourhood but not under your direct control.

The switch-mode power supplies for down lights, some flood lights and for powering PCs or charging batteries in various devices, which we all use on a regular basis, are also common causes of medium to strong RFI.

In our own situation, we found other everyday electrical appliances that emitted low levels of RFI, including PCs, but as we could control their time of use, we did not consider these to be other than nuisance value.

**TRACKING THE SOURCE:**

As I do not have sophisticated test equipment I used a portable radio with an internal ferrite rod antenna plus my ears to track the sources of RFI. This involved walking from point to point inside and around our house and power shed and scanning across the broadcast frequencies, in order to roughly locate the worst sources of RFI.

Then, after I had undertaken measures to reduce the level of interference, I returned over the same routes and rescanned across the various broadcast bands in order to check the remaining locations of RFI.

Most interestingly, as I continued to reduce my local RFI, I found that it was not uniformly spread across the broadcast bands at all and quite a few "patches" of strong interference still remained on various parts of the bands. If I wished to reduce interference on that particular section, those turned out to be quite difficult to deal with.

**RFI noise reduction options:**

The most commonly suggested options seem to be as follows:

- Replace those items which produce RFI with ones that don't (generally only practical with a few items due to the expense involved)
- Use a Faraday cage to shield equipment from the sources of RFI
- Bury the mains power cable (also see note 1)
- Add ferrite cored RFI/EMI filters to power leads
- Use earthed metal shielding around power leads (not very practical in our situation)
- Relocate the causes of RFI to a more distant location (also not very practical in our situation other than for small battery charging devices).
- Use a strongly directional antenna or relocate the radio antenna further from the major source of RFI and if possible, with its main lobe broadside on to the desired signal. N.B. as we needed to upgrade our fixed long wire antenna, this was done and it did improve the situation.
- RFI can even vary between the various models of equipment made by the same manufacturer and it is often periodic from demand driven appliances, so for people who have sufficient free time on their hands, one simple option may be to find a time of day which is quieter and make that the time to use a radio receiver.
- In some cases, it may possible to target a reduction of RFI in only those areas of the frequency most desired for listening and to not bother with the remainder.

*Note 1:* Our main power cables are already at an average depth of 800 mm under the soil and they still produce low to medium levels of RFI; therefore I am not convinced of burial as a good solution unless you can go deeper than that and you also have 'heavy' soil rather than light, coarse-grained sand as we have.

**FIRST STEP:**

As it was easy to do, we began by replacing the CFLs in our house with LED light bulbs but disappointingly, we found the majority of the less expensive LED bulbs still emitted strong levels of RFI, although it was generally at the higher ends of the broadcast bands.

After further searching with the assistance of a helpful retailer, I found good quality cost effective LED bulbs that were made in Taiwan. But even that same manufacturer's smallest 3 watt LED bulbs still produced low to medium levels of RFI while their 9 watt models are almost silent.

**NEXT STEP:**

We have a metal framed and metal clad power shed with an internal security screen of heavy gauge welded mesh, so it was a relatively straight forward task for me to convert it into a Faraday cage which 'captures' the RFI from all of the equipment within the cage walls and directs that unwanted signal to earth, thereby reducing the level of radiated RFI signal which is usually intercepted by a nearby radio antenna.

This was achieved by adding 'bond wires' (see Photo 1) to hinged sections, which then formed a complete (i.e. electrically connected) enclosure around all RFI producing equipment (other than the roof mounted solar panels and the main power leads to the house itself).

Photo 1. Example of a bond wire

For instance, if a wiring fault should occur within any 240 Volt equipment, then any part of the cage that touches the metal housings of the equipment will cancel out its benefits and it may add serious risk of intermittent 'shorting' and even personal electrocution.

My attempt at a Faraday cage did make a noticeable and very useful reduction in RFI on some sections of the MW and SW bands but not on other sections and annoying levels of noise still remained in the main power/distribution leads. Our water supply pressure pump motor and the refrigerator motor also emitted high levels of RFI whenever they operated.

The bonding wires were used to reduce risk of leaving poorly connected areas that could leak RFI and the completed Faraday cage was then connected to the main system earth as is common practice for 240 V house wiring (also see note 2)

As the main path remaining for the RFI was then via the DC and AC power lines which ran underground from the power shed to our house, I added 10 of the largest clip-on RFI filters to the 240 V AC lead where it exited the 24/240 volt inverter (see Photo 2) plus 3 smaller filters on each of the DC leads from the battery bank which provides power to the 24 volt 'soft start' compressor motor of our refrigerator.

N.B. If building an all enclosing Faraday cage is not practical, it may be possible to build individual cages around key items of equipment that are causing serious RFI, by using light gauge welded mesh or perforated metal plate.

However, doing that generally requires a reasonable level of skills in construction and it requires appropriate expertise in understanding the risks from the electrical equipment which you are dealing with.


Photo 2. Setup of mains RFI filters on mains power lead

Photo 3. Examples of different EMI and RFI filters

**FURTHER STEPS:**
Adding ferrite core filters seemed the next most practical solution but again it was not an entirely straight forward process as it was difficult to find detailed specifications on which frequency they operated up to, unless I purchased expensive items designed specifically to meet commercial requirements.

Most sources suggested that high permeability filters with a rating of 75 or above, should be used for RFI that is below 30 MHz and medium permeability with a rating of 40 to 45 for higher frequencies.

Even then, I found two different commercial brands of filters that were rated the same but did not perform equally well in practice. So I went back to purchasing less expensive items from salvagers of commercial materials and this turned out to be the best approach for me.

In total I added in around 35 ferrite filters throughout the power distribution system within our house, including 8 to the leads on the refrigerator alone, plus I shortened the receivers' earth leads as much as was reasonable and fitted a second earth stake to their main earth in order to improve its conductivity in our often dry soils.

These actions provided a further reduction in RFI and it bought the overall level of interference to a low but still audible level.

On again checking for the source of this with my small portable radio, to my surprise, I discovered that the noisiest area remaining was in fact the earth leads throughout the house and this was evident in the radio sets' earths, even when they were switched off.

*Note 2* After further experimenting with options to reduce this problem, I then placed a *separate earth stake* on the Faraday cage/power shed and disconnected the original lead from the frame to the power system's main earth because it appeared that using the power system earth was allowing the supposedly grounded RFI to travel back along the buried power cables and into the house.

N.B. Normal practice is to connect to a single earth stake in order to reduce 'ground loops' from occurring and while I do not fully understand why, we found that a separate earth stake for the Faraday cage worked better.


Photo 4. Typical example of an RFI filter on a valve receiver power lead

Finally we had achieved the desired level of success as the RFI is now at or below the normal atmospheric noise on 90% of the MW, SW and FM bands, with only a few small areas where it breaks through and is heard as a muted purring noise.

As an example, when local weather is settled, we can now receive an Adelaide station at 1323 kHz in daytime at a level that allows reasonable audio. My understanding is that particular transmitter is based on a low level location on the outskirts of Adelaide and uses a 2.5 kW transmitter and an 86 metre tower. Given that this signal apparently travels a little over 400 km as a ground wave during daylight hours, I feel that it is a good result

**TYPES AND PLACEMENT OF RFI/EMI FILTERS:**
I have use both solid and 'snap on' ferrite core filters (See Photo 3 for examples) and while the solid filters seem to be slightly more effective, I found that using 'snap on' types significantly reduced my work time and the risks associated with disconnecting and reconnecting high voltage wiring, which is often required when fitting solid core filters.

I found it was most effective if I added them closest to the source of RFI (see Photo 4 for typical example on a valve receiver power lead) and less effective when added at the equipment operating at the end of the lead. The most effective location was to add the RFI filters to the mains lead which exited from our inverter and from our battery bank within the power shed.

To determine what spacing was best between multiple ferrite type RFI filters, I experimented by placing three together on a short extension lead then slowly moving them apart to see if I could detect any change in the level

Photo 5. Home made ferric oxide RFI filter

of RFI on my radio. In our situation, I found them to be best when placed at approximately 20 to 25 mm spacing.

I used this process to determine how many filters were needed on any one piece of equipment and I *never* found a situation where fewer than three filters were required in order to gain a good reduction in RFI. I also found that filters which closely fitted the power cable were always more effective than loose fitting ones.

Other interested persons have reported using different spacing or none at all and I suspect that it may depend on both the composition of other materials commonly added into ferrite filters and on what section of the radio frequency is being targeted, therefore the above process may be helpful in determining what works best in your own situation.

**HOME-MADE FERRIC OXIDE FILTERS (see photo 5):**

I also installed some home-made filters around the power cable conduits within our power shed and where the main cable exits the ground beneath our house.

Each filter was comprised of either 2 or 3 sections of 1 metre lengths of 20 mm OD reinforced clear plastic tubing that had been filled with ferric oxide powder, then compacted and capped. These sections were then twisted around the power cable conduits and held in place by zip ties. They are cumbersome-looking contraptions and when compared with commercially available ferrite core filters on effectiveness for a given length, they are not nearly as effective, but that inefficiency can largely be overcome by their much greater volume of RFI absorbent material and they have proved to be a simple and useful method of placing a filter on 240 V cables that were already sealed in a protective conduit.

*Caution:* This product is commonly mixed in with cement to add colour and any ferric oxide that is spilled during the handling or filling process will badly stain most things that it lands upon, especially fabrics.

**FINAL NOTE:**

Other types of good quality and effective 'hard wired' RFI/EMI filters not included in this article are available commercially and would be well worth considering for a new dwelling, prior to its being wired.

The process I used was lengthy and tedious, which was partly due to an initial lack of knowledge on the matter, but I am well satisfied with the outcome and I believe that I have included a good number of practical and cost effective methods for tracking and reducing EMI/RFI.

My best wishes if you choose to hunt down your own troublesome RFI because my experience has shown that it is an ever present but elusive and resilient quarry.

# CRYSTAL MANUFACTURE

A description of crystal production in 1968

## by RAY ROBINSON VK2NO

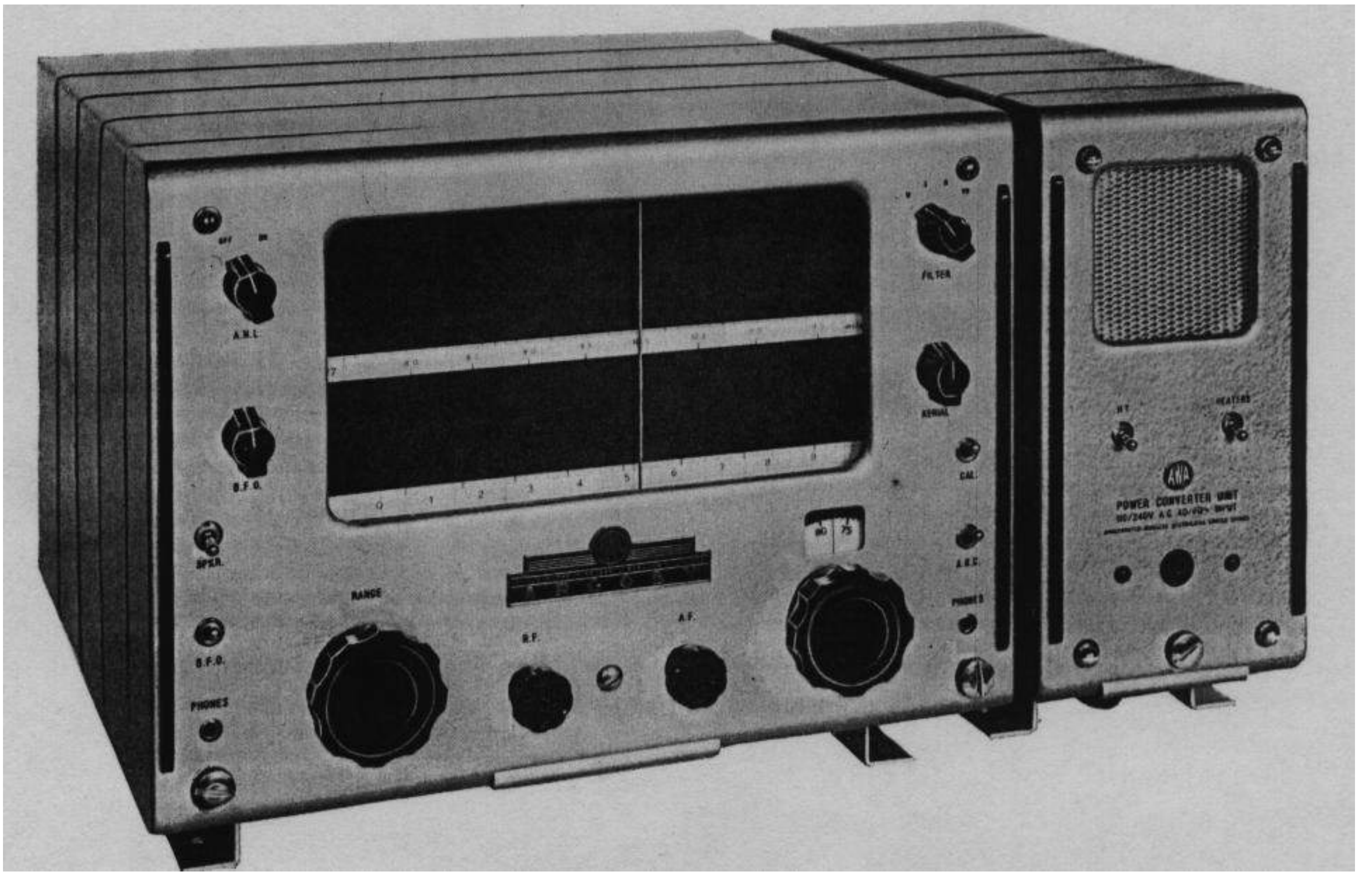
I BEGAN as a Trainee Engineer at the AWA Engineering Products factory in North Ryde, in 1968. AWA had several other factories, Domestic Products were made at Ashfield, AWV were making valves, transistors and picture tubes at Rydalmere, and several other smaller divisions, dealing with Avionics, Marine, and Two Way radios. These factories were all in Sydney, but there were several in other Australian capital cities, and also in New Zealand.

I started my traineeship and spent three months in each section of the factory, for training and experience. There were many sections - drilling, turning, drawing, estimates, short-order-shop, instrument calibration, crystal manufacture, transformer winding, assembly, and final testing. There were other sections that I did not get to see - plating, painting, colour TV transmitters, design, and accounting.

The crystal room was very interesting. It was one of the few air conditioned areas of the factory, and also had a double door air lock, and sticky floor mat, all to help with cleanliness. We all wore white dust coats, and were not supposed to bring food, or personal belongings inside. It was divided into several areas. The main area was for the final test and adjustment. The closed area was used for crystal electrode plating. At the back was the crystal blank store and the cutting area.

### CUTTING AREA

People were normally not allowed in the cutting area. It was only when the boss was away that a friend allowed me in and showed me the process. In a box under the bench were lumps of raw quartz, the size of grapefruit. They were irregular shapes, and still had red dirt on them. In those days, we imported the raw quartz from mines in South America.




Picture 1: CR3D

My friend then showed the next step, which was extremely important. He picked up a lump of quartz, and immersed it in a small tank with Perspex sides and filled with kerosene. There was a polarized light shining through the tank. He rotated the quartz, until he found the crystal axis, visible with the light. The quartz was then marked with a pen, and then checked. The first cut was done with a diamond saw. Then it was checked again. Now the crystal blanks could be cut to the required specifications, depending on the type of axial cut that was required. The crystal blanks were cut to size and thickness, depending on the contract or number of crystals ordered. A few extras were always made, to allow for breakages, or bad quartz, or just to put some in the crystal store. Of course, if there were an appropriate number of suitable blanks already in the store room, then these were used, rather than cutting some more.

**COARSE GRIND**

The blanks were inserted in a round bakelite holder, the size of large LP record. It had lots of little square holes, which held the blanks. There was a metal bottom plate underneath it, then the blank holder, then a top metal plate. The two plates were connected to an oscillator, and an AWA Argosy receiver (type CR3D) was used to listen to the oscillator. The plates were started to rotate with a motor, and grinding paste was added. As the blanks were ground they increased in frequency. The receiver was used to chase the frequency. At the appropriate frequency, the blanks were removed.

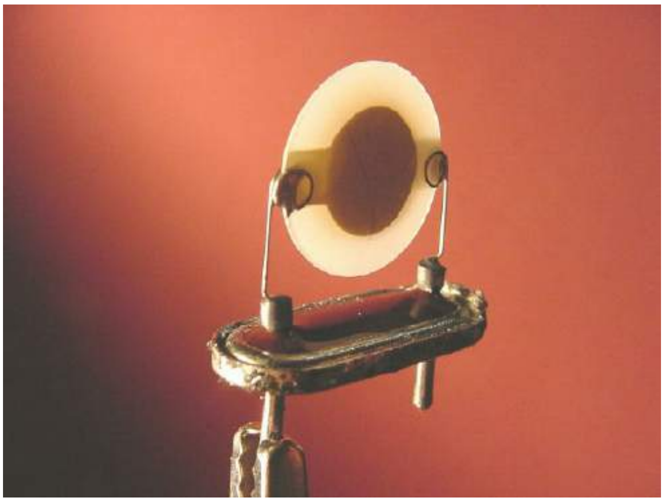
**PLATING**

The majority of crystals made then were in the HC6U holder. The crystals were sent to the plating room. They were placed in a metal mask, like a sandwich, which was about 300 mm square. It held about 25 crystals. It had holders for each crystal. There were cut-outs in each holder, with a round pad in the centre of the crystal, and a radial grove from there to the edge. The cutout on the other side was the same, but it went to a different edge.

The mask was mounted horizontally in a jig, and there were two 1-inch wide horizontal strips below the mask. These had a dimple in them to hold the plating metal. Solid gold wire was cut into 5 mm long lengths, was counted out and placed in each dimple, so as the determine the correct amount of plating metal. A large glass dome was placed over the whole jig. A vacuum pump was started, and the air was exhausted from the glass jar. When it reached a sufficiently low pressure, the operator pressed a button. One of the wide strips was energized, it glowed red hot, and the gold was vaporized. The gold was deposited on the crystal through the mask. A lever was pulled and the mask rotated horizontally, presenting the other face to the heater strips. Again a button was pressed, and the other heater vaporized the gold, and deposited it on the crystal. The pressure was reduced, and the crystals removed, and inspected.

**MOUNTING**

The HC6U base had 2 little springs with coiled ends. These were attached to the pins on the base. The crystal was inserted edgewise into the two springs, and secured. They were then put in a tray, and sent for final adjustment.



Picture 2: Crystal Mounting

**ADJUSTMENT**

This section contained four long benches, with about three girls per bench. Each operator had a view of a HP5245 digital frequency counter (with nixie tubes), which they could use, by pressing a button. Counters were very new and very expensive, so they only had one to share. Each operator had an oscillator, and they plugged the crystal into this, pressed the button, and checked whether the crystal was in the required range. If so, it passed. If not, there was a small plating bath, and more metal was plated onto the gold, to lower the frequency. The operator guessed how much time the crystal needed to be in the bath, and sometimes it was just seconds. Alternatively, there was another bath containing acid, and the crystal was etched to increase the frequency. Once again, the operator made a guess how long the crystal should be in the bath.

**SEALING**

The crystals were now sent to be sealed. The metal can was soldered on, and it was filled with inert gas and sealed.

**FINAL TESTING**

There were two operators for final testing, the boss, and the trainee, me! We each had an oscillator, but we had our own frequency counter, of the same type. First, the frequency was checked at room temperature, to make sure it was within specification. Then the frequency was checked over the temperature range, from the cold lower end to the hot upper end. We had a small crystal oven (about the size of an apple), which had a temperature sensor in it. There was an insulated container next to us, filled with dry ice. The oven was pushed into the cooler, and we watched the temperature fall. When it was at (or beyond) the lower temperature, the frequency was checked. The oven was turned on, and when the crystal reached the upper end of the temperature range, the frequency was checked again. This was commonly 0 to 50 degrees C for commercial crystals, or -30 to 100 degrees C for military crystals.

Two other checks were performed. It had to meet an activity level, in other words, the output level. It also had to have good activity at zero degrees C. If there was water vapour inside the crystal holder, it would freeze at zero, and the activity would dip, or even stop.

This testing took some time for each crystal, as the crystal had to be checked at every temperature in the range. The boss showed me an easy way to perform the test. The oven was placed in the dry ice. When it exceeded the lower temperature, the oven was switched on, and you pressed (and held!) the button, and you watched the frequency counter. You looked the frequency counter with one eye. You watched the temperature readout with the other eye. You also watched the activity at the same time (a third eye was useful). The frequency would change as the crystal heated up. It would move in one direction, then slow and stop, then start moving in the other direction. Provided it stayed within the frequency limits (which you had memorised) the whole time between the lower and upper temperatures, the crystal passed test. You also watched the activity level change, and it should stay above the minimum activity limit, the whole time. Particularly important was when it passed through zero degrees C, there should be no activity dip.

If the crystal was within frequency tolerance, and in excess of the minimum activity level, it was passed, and sent to dispatch.

This was an interesting period in the traineeship, much better than operating a turret lathe or a drill press.

## HANDY HINT: SOLID STATE AUDIO POWER AMPLIFIERS

**by ROD HUMPHRIS**

HERE I make particular reference to **speaker cable wiring** and lead dress used with solid state amplifiers:

Most audio amplifier power output stages are caused to be ‘BLOWN UP’ by faulty speaker wiring.

The most common cause is poor speaker cable lead dress, where some of the loose strands of copper wires touch onto the wires of the other speaker twin (figure 8 cross section) cable.

It only takes a fraction of a second to cause excessive current in the output stage IC/transistors, thus causing irreparable damage to these output stage ICs or transistors, thus necessitating further replacement of them. The product/appliance manufacturer will not provide any sort of warranty for replacement of such damaged output stage ICs or transistors following shorted outputs.

So it is absolutely essential that all of the speaker cables be checked for short circuits, joins and proper lead dress. Always suspect dodgy looking insulation tape.

If you fail to fully check the speaker cables' wiring for correct workmanship of lead dress, the amplifier output stage ICs or transistors will be damaged again and again (and no warranty will apply).

Other causes of an amplifier’s output stage IC/transistor damage can be

1. Faulty or poling or burnt voice coil loudspeakers.

2. Too low impedance loudspeakers used on the amplifier. (4 ohm speakers used on an 8 ohm output amplifier is pushing the envelope).

3. Too many speakers used on the amplifier, this lowers the total speaker impedance.

4. The amplifier being run continuously too loud, especially when the sound becomes distorted. This sustained high level loudness can also damage the loudspeakers in as little time as a few seconds.

*Summary*:

Carefully check and inspect the speaker wiring for shorts and joins and loose copper strands before connecting electricity to the amplifier.

*It may save you from destroying your amplifier.*

# Letters to the Editor

### AM, FM AND DIGITAL RADIO.

*from Christer Hederstrom*

I have read two items in your magazine *Radio Waves* April 2018 about 'AM, FM and Digital Radios'.
I would like to put your attention to the fact that a very similar debate is raging in the Nordic countries, although Finland and Sweden already have rejected an FM switch-off.

You can follow the discussion, which is guarenteed free from DAB lobby influence (WorldDAB etc), in the news blogg
Digital Radio FM Insider
http://digitalradioinsider.blogspot.com/

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### SAFETY

*from Bob Forbes*

For fellow members' interest is this death trap I picked up recently. Actually the radio itself isn't the death trap, it is what some lunatic has done and serves as a timely reminder of why we should always take precautions when first powering our latest pride and joy. I picked up this Kriesler 11-57 from an antiques shop, mainly because I was fascinated by the roller door over the front. No brand was visible but the components in the chassis were clearly, to my mind, Kriesler so I delved into my AORSM files and the nearest thing I could find was the 11-57 and so it turned out to be this radio which originally had a turntable attached and that part had been hacked off for some reason. Armed with the circuit, I plugged the power cord into my mains lamp tester and watched the lamp grow steadily brighter. Switching off immediately and everything unplugged I proceeded to investigate, there was a red wire which I had mistaken for an aerial lead but was in fact connected between chassis earth and the mains transformer side of the mains switch. . Other than the fact that the mains cord appears to be an addition and the idiot who made this connection assumed there was now a live chassis, as a result decided to ground one of the mains leads (I'm only guessing here). I am surprised there wasn't a loud bang when the power was applied.

Of course there are odd bits of mains lead which belong to the now missing turntable assembly, so much work will need to be done before I try any more and I do have some more serious projects underway which means a rebuild into the interesting case will have to wait a while.
*Bob Forbes*

### THE WRONG RADIO?

*from Gary Cowans*

I think the radio described by Tony Smith is an HMV, dual wave, model 209 and not a Model 660.

Model6660;
https://www.radiomuseum.org/r/hismasters_dual_wave_660.html

Model209;
https://www.radiomuseum.org/r/hismasters_dual_wave_209_660.html
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### GIVING YOUR COLLECTION A NEW HOME

*from Harold Norrie*

The various methods of disposing of a collection have indeed been discussed many times, as described in Richard's letter in the last issue. His remarks are spot on, in my opinion, and reflect my thinking up to my auction in March 2016, also MC'd by Richard.

I would like to add the element of timing, that is, when to do it and offer my experience with two auctions. The first one was the sale of Ted Baker's collection and I was heavily involved with cataloguing, selecting an auctioneer and advertising. Sadly, it was done after Ted had died. The day of the event was a great success, clearing his entire collection in one go and seeing the radios all going to their new homes.

On that day, I decided that I wanted to be around for the sale of my collection and to take part in what I hoped would be an equally enjoyable day. There were many other benefits to my involvement. Cataloguing was already done, my family would not have the responsibility, it was a further opportunity to meet fellow collectors and I could see how much my collection was of interest to others.

The sale was indeed a great success and my feedback was that those attending also enjoyed the day. From Lou Albert's comments also in the last issue, he was equally pleased with his sale.

So, my suggestion is to seriously consider your collection's disposal while you can be involved. It should not be seen as a sad occasion, but rather as new custodians' taking over your radios and looking after them.
*Harold Norrie*

**RADIOLA'S 'HUM' PROBLEM**

*from Peter Lankshear*

I enjoyed Jim Greig's article in the July *Radio Waves* about his AWA Radiolette 500MY. A tidy and nicely serviced little example of what was known in Britain as a Short Superhet . I.e. there is no audio stage between the detector and the output valve.

Jim says that he has a problem with a small amount of residual hum. The remedy was standard practice with back biased receivers. There is in these sets a significant hum voltage developed across the bias resistors by the ripple current in the input filter capacitor . This hum voltage is coupled into the output valve control grid by the grid resistor. (in this case R7).

In receivers with larger speakers this hum is most noticeable and is remedied by adding some filtering at the bottom end of the grid resistor. In this case all Jim needs to do is disconnect R7 from R10 and insert a resistor of 50k to 100k between them. Bypass the junction of R7 and the new resistor with a capacitor of about .25uF to earth.

Of course, an alternative but arguably less elegant remedy is to bypass the bias resistors (R9, R10) with a low voltage capacitor of 10uF or larger, earthing the + end.
*Peter Lankshear*

**A STROMBERG-CARLSON FROM YALLOURN**

*from Ken Tate*

In 1936 my grandfather, Sid Tate, bought a new Stromberg-Carlson A.C. Dual-Wave Radio Model 635 from the local radio repair man in Yallourn (a nearby neighbour), with the money he earned from working overtime at the Yallourn Power Station. This provided news and entertainment for the family and was very useful during the War for listening to the BBC on the short wave band as they had family in England.

When the radio repair man retired he allowed my father, Ray, who was experimenting with radio, to help himself to anything he wanted from under the house in the way of valves, components, etc.

My grandfather was a welder by trade, but experimented in making his own pickup cartridges to enable him to play records through the PU input of the radio, but the radio's audio amplifier did not have enough gain to be successful and would have required a preamp. Eventually he converted the Stromberg into a radiogram by splitting the cabinet and widening it to add a turntable.

The now Stromberg radiogram was eventually handed down to my father and when a new Precedent Radiogram was purchased the Stromberg was retired to the back shed. This is about the time that I remember the Stromberg Carlson. It was shortly before the radio chassis was extracted and kept whilst the remainder went to the tip, as we were shifting house.

As a teenager in the late 1960s, I set up the Stromberg chassis in my bedroom as I was dabbling in electronics. We used a 15W globe in place of the power supply filter choke on the Stromberg. As I only had a permanent magnet speaker at the time. I managed to get an electric shock from the exposed terminals on the tuning signal strength meter, which dad promptly removed.

In 1975 we shifted house again and the Stromberg ended up in the garden shed at the new house and stayed there for many years. In the early 1990s I placed a wanted advertisement in the HRSA newsletter for a cabinet or photos and dimensions so I could have a replica cabinet built for the Stromberg Carlson, but no one come forward.

I also remembered that Arthur Hamilton from Yallourn used to have a Stromberg Carlson hanging up on the wall of his open fronted garage. The radio had severe weather damage down one side.This was around 1971 as I used to be friends with his sons. However the SECV town of Yallourn was demolished for the brown coal under it to supply the Yallourn Power Stations and all the residents had to move out.

I tracked down Arthur's youngest son and asked him about the radio. He did not remember it but said his father moved to Bendigo and would most likely still have it. I contacted Arthur and he agreed to sell me the Stromberg Carlson for $75 and even delivered it as he was coming down my way in the near future.

I don't know how I knew or remembered from 20 years earlier that Arthur's Stromberg Carlson was the same model as my grandfather's, but it was. Maybe the dial, tuning indicator and knob layout was the clue burnt into my brain.

I then had a friend who was handy with timber refurbish the cabinet. Most of the veneer was missing on the weathered side plus other damage and it was missing one leg. Then, when my parents went on their annual Queensland holiday, I secretly removed our original Stromberg Carlson chassis from their garden shed. I replaced the necessary capacitorss and the detector/1st audio valve (75) as it was missing its top cap and then fitted our original chassis to its new cabinet.

Then on my father's 65th birthday I presented it to him, gift wrapped, which was quite a surprise and it now resides in his study and the chassis from Arthur's set is safely stored in a cupboard in my shed.

*Ken Tate*

## VINTAGE TEST EQUIPMENT

*from Bob Forbes*

I have spent the last several days 'trolling' this website, https://www.ietlabs.com/genradhistoricalsociety?SID=bfjh32d992lsfnns60hlcmj020
and would suggest that any member who is interested in vintage test equipment should have a look.
The current owners of Genrad have provided a substantial listing of General Radio equipment (although not specific information on the 487) and there is some interesting information on the design both of components and complete designs. It is truly a historical site worth investigating.

*Bob Forbes*

## RADIOGRAM REPAIRS

*from Stuart Horsburgh*

From time to time, I repair and service radios and turntables for others. A few weeks ago I thought it was high time I did something for myself, so digging around in the shed, I discovered a nice Philips 147 with timber encased turntable which, as far as I can recall, I purchased some years ago from a club auction.

Although there was evidence mice might have visited the inside of the cabinet, they hadn't taken up residence, thankfully, and everything seemed in order. A quick check and power up, and the radio came to life. The pots needed a bit of juice, but that was about all.

The turntable was a different story. Although the mechanics were running OK, the cartridge was dead, which wasn't surprising given its condition.

Actually, a dead phono cartridge is the main problem with old turntables, and it's the reason why people throw them away. New cartridges are surprisingly cheap, if you want to play LPs and 45s, however 78 compatible cartridges can be dearer. Almost every turntable set I have restored has had a dead cartridge, or, in the case of stereo sets, the cartridge has one channel out. Sometimes the cartridge is functioning, but gives poor audio gain.

This set had a Philips GP16 cartridge (or similar) where instead of flipping the needle to enable LP or 78 play, you just swivel the head a few degrees, as both needles are mounted about a quarter of an inch apart. I don't think I have ever come across one of these Philips cartridges which was still functioning, and this one definitely wasn't. When I cleaned it up and attempted to remove the four tiny screws which hold the underside in place, I found that although these screws were turning, they weren't coming away, and finally I had to pull them out like nails. Inside I found out why the cartridge was dead - the conductive material had turned to goo.

Luckily, this goo provided a soft, malleable base for the new cartridge, considerably smaller and lighter than the original, to be mounted and glued in. The presence of the original material also ensured that there wouldn't be a noticeable change in tonearm weight, which was rather important, as I couldn't find any weight adjustment on the tonearm mechanism.

A quick rewire at the pickup end was completed, in this case directly soldering the contact wires to the pins of the new cartridge. (*Note* - be very careful when performing this solder job, as too much heat can melt the plastic cartridge case and change the position of the pins, and in the worst case can render the cartridge nonfunctional, as the heat gets inside and destroys the conductive material).

Interestingly, someone had previously joined the ground connection and the left channel connection, so the original cartridge (being stereo, although the audio amp in this set is mono) would have provided only the right channel audio.

An interesting feature of this set is it has three speakers - a central driver and two smaller drivers connected to the output via a capacitor and wired out of phase, which gives a mock stereo effect when the listener sits directly in front of the centre speaker. To take full advantage of this simulated stereo it is necessary to change the position of your head slightly, so it only works when you constantly shake your head while listening.

The 147 is a quality set, which gives satisfying reproduction and a fair amount of high frequency response, even from AM radio, thanks to the two extra small speakers,. Not a true wideband receiver, but more than comparable with many modern radios. A nice set, and the timber veneer being in good nick makes it pleasing to the eye, so it's got pride of place in my sitting room. For the moment, anyway.

*Stuart Horsburgh*

# Looking Back: AWA RADIOLAS IN NEW ZEALAND
## by JOHN MCILWAINE, AWA HISTORIAN

AMALGAMATED WIRELESS (AUSTRALASIA) LTD better known as AWA, had established a branch in Wellington in 1913 to handle Marine Wireless Communication Apparatus and in 1922 sold components branded EXPANSE for the amateur radio enthusiast; these items were distributed also from the Wellington branch ''Wireless House".

Having set up and operated the Coastal Radio station's in the Pacific Islands, with the start of radio broadcasting in New Zealand in 1928 with the opening of RNZ, Radio New Zealand AWA would play a major role in development of the Wireless industry in New Zealand having supplied the early transmitter equipment.

In 1937 AWA designed and supplied the new high powered 60 kilowatt transmitter and 700 foot aerial array for the National Station 2YA in Wellington at Titahi Bay; this was the largest powered transmitter in NZ at that time and could be received in Australia, the Transmitter and Aerial array all manufactured at the Radio Electric Works Ashfield NSW, shipped and assembled in NZ.

Although Australia had strict import restrictions since 1930 with heavy import duties against imported receivers, the situation in New Zealand was different in that similar restrictions were not introduced until much later; this allowed AWA NZ to import Radiolas from Australia or USA and with the AWA RCA relationship imported and sold both brands.

This was not the case in Australia and AWA did not import or sell RCA receivers but imported and distributed RCA valves.

In spite of preferential tariff in favour of British goods AWA NZ seemed to prefer to import American RCA receivers due to its close relationship and agreements between AWA and RCA.

As both Australia and New Zealand were British colonies at that time, notably the Radiolas exports from Australia had a gold transfer on the chassis ''British made' this was to entice buyers to buy British goods rather than foreign makes.

AWA commenced export of complete Radiolas to New Zealand from 1932 the first being the 46E 6 Valve TRF console of 1931 and the C92 Table set and continued supplying Radiolas until 1938.

Radiolas were not seen again until 1952 with two models being made by Radio Corporation of New Zealand, no further Radiolas were produced until 1960, following the establishment of Allied Industries Ltd and the advent of Television AWA teamed up with Allied and would again become a major manufacturer of Radio and Television in NZ up until the time radio manufacturing was no longer viable in the 70s and imported sets dominated the market.

Due to financial difficulties in the 1970s Development Finance Corp. a NZ Government Dept. purchased a 40% shareholding in AWA NZ, then the company was sold to Exicom Ltd who took over the building at Porirua in the 1980's and continued to manufacture some AWA designed products such as the ''Country Set" for rural telephone services finally closing in the late 80's a similar scenario to what happened in Australia. Exicom NZ finally went into liquidation in May 2015.

# MAGAZINES RECEIVED
## COMPILED BY SANJAY JAIN

1. *Wireless Review* Volume 21 Issue 1. 'Problems with Airzone Moel 576', 'Effects of Dead End'

2. *Radio-Gram* Issue 132 June 2018. 'HMV Model 660, 1940', 'Astor QN Rebuild'.

3. *HRSA South Australia* Volume 27 No. 5. 'Short Wave Crystal Set'

4. *The Exchange* . Volume 3 Issue 3. May 2018.

5. *Radiofil magazine* no 86 May-Jun 2018 In French

6. *Radiofil magazine* no 87 Jul-Aug 2018 In French

7. *The AWA Journal* (Antique Wireless Association, USA. Vol..... 58 No.4 Winter 2018. 'The B2 British WWII Suitcase Spy Radio –Part 1', 'Constructing a Non-Manufactured Atwater Kent Bread Board '

8. *The Michigan Antique Radio Chronicle* Vol..... 32 Spring 2017 ,'Notes form the Service Shop No. 99'; 'Hayes Products Company Battery Radio 1926'

9. *Antique Radio Magazine* No.142 In Italian

10. *Antique Radio Magazine* No.143 In Italian.

11. *Antique Radio Magazine* No.144 In Italian.

12 *The British Vintage Wireless Sosiety Bulletin* Vol. 43 Autumn 2018. 'the Kolster-Brandes GR10T export model'; 'The Champion model 800 Radio'; 'The Marconiphone 255 and 256'; Heathkit RF1U Signal Generator'; 'Lars Magnus Ericsson - His life and company'; 'Arthur Atwater Kent and his radios'; 'On the Trail of the Perdio PR3'.

A centenary reenactment at *Lucania* at Wahroonga, Sydney, of the first official radio message sent from Britain to Australia on 23 September 1918

*Photo by John McIlwaine*