The Bulletin

Vol. 34 no. 3 Autumn 2009 www.bvws.org.uk

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

BVWS team

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

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

Sub Editor:
Ian Higginbottom,
5 Templewood, Ealing,
London W13 8BA
Tel/Fax: 020 8998 1594

Treasurer:
Jeremy Day
6 The Ridgway,
Brighton
BN2 6PE
treasurer@bvws.org.uk

Ordinary Committee Members:
Jon Evans
Tel: 0121 5447006

Martyn Bennett
Tel: 01252 613660

Membership Secretary:
Graham Terry
26 Castleton Road
Swindon, Wilts SN5 5GD
Tel: 01793 886062
membership@bvws.org.uk

Harpenden Organiser:
Vic Williamson,
Tel: 01582 593102

Technical TV Correspondent:
David Newman,
405alive_correspond@bvws.org.uk

Electronic Media Production:
Terry Martini,
Tel: 07947 460161

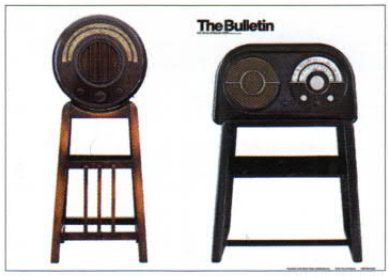
Members' Advertisements Committee Secretary
Guy Peskett,
13 Warneford Road
Oxford Oxon
OX4 1LT
Tel: 01865 247971
secretary@bvws.org.uk

Webmaster:
Paul Stenning
webmaster@bvws.org.uk
PO Box 15, Hereford
HR4 9WX

Bulletin of the British Vintage Wireless Society
Incorporating 405 Alive
Volume 34 No.3 Autumn 2009

www.bvws.org.uk

Separations and Printing by Hastings Print



Cover: front and rear – to be photographed
Photographed by Carl Glover

Graphic design by Carl Glover and Christine Bone

Edited by Carl Glover. Sub-Edited by Ian Higginbottom

Proof-reading by Mike Barker,
Ian Higginbottom and Peter Merriman

Contents

From the Chair

In the Autumn Bulletin you would usually find a "call for nominations" for Committee. This time we have omitted the form as all Committee members are within their three year terms and are willing to continue serving after the next AGM. This will reduce our costs by not having to print 1658 copies. I do however invite anyone who would like to join the Committee to make contact either by phone, letter or e-mail.

We are well ahead this year with our events Calendar for 2010 and you will see on the diary page that all of the larger events have already been booked. I have even booked Wootton Bassett until 2013 when we will be celebrating its 20th year! Where did all that time go?

We have also received large stocks of new capacitors since the last Bulletin, and the range of values has also been extended. Take a look at the enclosed leaflet for details.

Most people will already have heard about the forthcoming Bonhams Auction sale to include up to twenty pre-war televisions and associated items. You will see some pictures of the items later on in this Bulletin.

Laurence Fisher of Bonhams has arranged for BVWS members to obtain the full colour Auction catalogue directly from the Museum at Dulwich, rather than from the auction house themselves (see inside front cover for address). The Catalogue will cost £20 inc p&p. All sale proceeds will go to the Museum if purchased from there, so please buy a catalogue, even if you are not going to the auction, as it includes details about the many hundreds of items and will make an excellent reference document for the future as well as supporting the Museum.

Lastly, myself and the Committee would like to send Gerry Wells Birthday Greetings for 18th September when he will be celebrating his 80th year. Most of which he has spent electrocuting himself in houses or in the backs of Radio and Television sets.
I am sure you will all joins us in saying;
Happy Birthday Gerry!

Mike

Paul Marshall receiving the Duncan Neale award from Mike Barker at the BVWS auction and AGM, June this year

The Douglas Byrne Marconi Fellowship

Bodleian Library and Museum of the History of Science

Annual Fellowship award in the name of the founder of the Wireless Preservation Society

The purpose of this Fellowship award is to advance knowledge of the history of wireless communication. The award will provide the recipient with the opportunity for a period of uninterrupted research and collegial discussion at the Bodleian Library and the Museum of the History of Science, culminating in a public lecture at the University of Oxford on the results of this research. The award for the academic year 2009-10 will be £5,000, and is administered by the Centre for the Study of the Book, Bodleian Library.

The Douglas Byrne Marconi Fellow will be selected on the basis of the applicant's scholarly qualifications, the scholarly significance or importance of the project, and the appropriateness of the proposed study to the Marconi collections at the Bodleian Library and the Museum of the History of Science.

- The award holder shall pursue research using the Marconi archive in the Bodleian Library and/or the Marconi artefacts housed in the Museum of the History of Science.
- The holder of the Fellowship shall be expected to deliver the results of their research at a public lecture, to be known as the 'Douglas Byrne Marconi Lecture' which shall be advertised nationally, and held in the University of Oxford.
- Applicants will be expected to show that their research will lead to publication. Copies of publications will be submitted to the Bodleian Library and the Museum of the History of Science.

Eligibility:
Intended primarily for applicants at the postdoctoral level (or equivalent); postgraduate students may apply. Research ability of an appropriate standard may be demonstrated bypublications as well as qualifications.

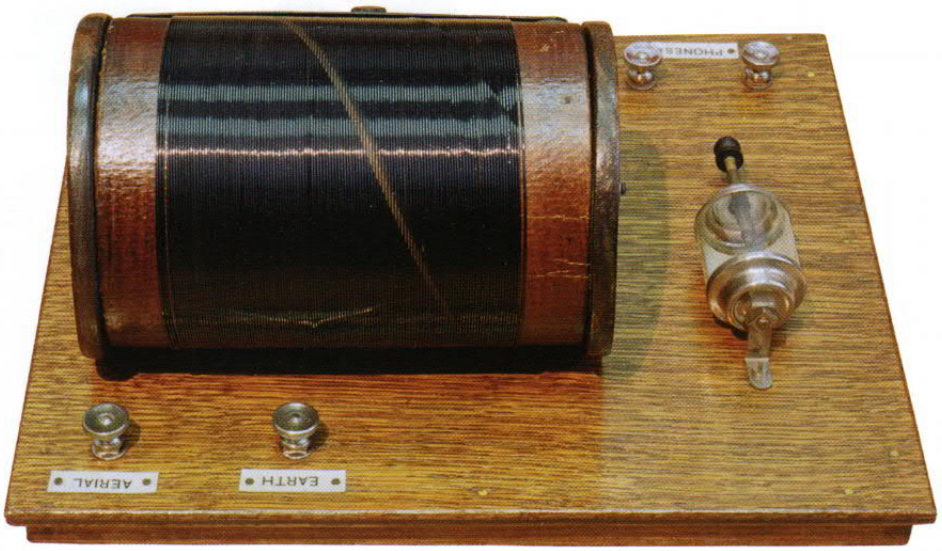
For further information contact: Dr Alexandra Franklin at the Centre for the Study of the Book, Bodleian Library, Broad Street, Oxford OX1 3BG.
e-mail: alexandra.franklin@bodley.ox.ac.uk

Closing date: September 30th

The Meccano Crystal Sets by Ian Sanders

...Any intelligent boy can assemble it (the Meccano Crystal Radio Receiving Set) in one evening. It has been tested thoroughly in London, Paris and New York and in each of these cities clear telephonic and telegraphic messages have been received. In London we have listened to broadcasted concerts from Marconi House. In New York, where the opportunities for testing are much greater than in this country, it has proved to be as efficient as the more costly and elaborate instruments in use there. In Paris we have listened to concerts broadcasted from the Eiffel Tower and have heard them with great clarity. *The Meccano Magazine*, August 1922.

Left and below: *Meccano Radio Reciever No.1*. The only standard Meccano parts incorporated in the set were the brackets supporting the coil slider and an octagonal coupling. The BBC approval stamp printed on the underside of the plywood baseboard shows the set to have been given the Post Office registration number, 186.

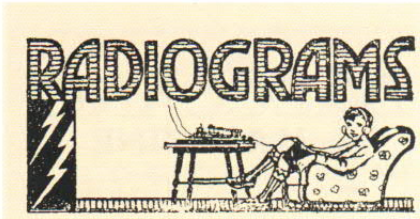


Surprisingly, Meccano supplied only a single headphone with their early crystal sets, although a double headphone was available later.

Several of the crystal receivers produced by Meccano Limited were covered in the author's book *Tickling the Crystal* (Volume 1, pages 35-36; Volume 2, page 95). This article provides a more detailed review of all of the Meccano crystal sets together with a comprehensive collection of related Meccano ephemera.

Following closely from a visit to the United States by the company's founder Frank Hornby, the first Meccano crystal set was introduced to the public in the September 1922 edition of the Meccano Magazine. The receiver was constructed largely from standard Meccano parts except for a few of the specialised components - such as the detector (with its Meccolite crystal) and inductance disks. Covering about 360–450 metres, the set employed loose-coupled inductive tuning using two hand-wound pancake coils in conjunction with a variable condenser. Of note was the latter's innovative design – made largely from existing Meccano components already used in the company's popular range of mechanical construction sets.

The original design soon ran into licensing problems with the authorities, because of the strict Post Office regulations in place at that time regarding the source of components for home-built apparatus. It also seems that the set had not been submitted to the Postmaster General's office for any formal approval and registration. In order to resolve the problem, a more conventional, factory-assembled set, known



In connection with the efficiency of crystal receivers over long distances, it may be mentioned that the opera, broadcast from Covent Garden recently, was received on a crystal set at Southport.

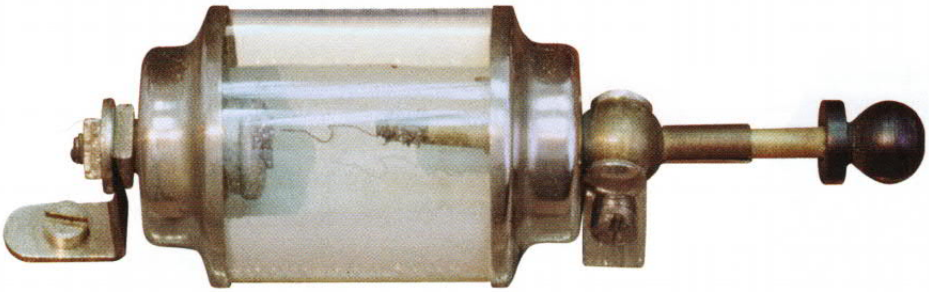
* * *

Master Guy Hare, the energetic Secretary of the Leamington Meccano Club, regularly receives London broadcasts on his crystal receiver.

* * *

Good transmission from amateur stations is to be heard every night in London, Manchester, Liverpool and elsewhere. Some of the musical items are very good and compare favourably with items from the Broadcasting Stations

Meccano Magazine, June 1923



Left: Detail of the detector supplied with the *Meccano Radio Receiver No.1*. The end-caps, crystal mounting and arm assembly indicate that the unit is of American design. Presumably the detector was chosen as a result of Frank Hornby's visit to the United States which led to his decision for Meccano to enter into the wireless business.

as the Meccano Crystal Radio Receiving Set No.1, was hurriedly introduced in December 1922, intended to meet the anticipated demand at Christmas. This set featured a glass-enclosed detector and a large horizontally-mounted slide-coil tuner mounted on a plywood baseboard, but incorporated almost no standard Meccano components – the slider support brackets and an octagonal coupling carrying the slider itself were the only actual Mecccano parts. The new receiver, which now complied with government regulations, carried the Post-Office registration number 186.

The first constructional crystal set was re-introduced in the summer of 1923 in a somewhat simplified form and renamed as the Meccano Crystal Radio Receiving Set No.2. The new version was now allowed to be used under the so-called Experimenter's Licence introduced by the Post-Office to meet the needs of amateur constructors. The wavelength coverage of the set was increased slightly to 300–500 metres, with provision for alternative coils designed for longer wavelengths to be fitted if necessary. Originally priced at £2 15s. 0d. when first announced, the Meccano No.1 receiver was shown a year later in the company's Christmas 1923 Catalogue priced at £2 0s. 0d. A Meccano Aerial Outfit for use with the crystal set, including aerial wire and ceramic insulators, was described in the same catalogue for 12/6d. On the other hand, the prices of the two receivers in summer editions of Meccano Magazine were shown as £1 12s. 6d. and £1 5s. 0. By December 1923, advertisments indicate a price of £1 10s. 0d. for the No.1 receiver, while a kit of parts for building the No.2 set retailed for just 15/- or £1 2s. 0d., including a single telephone headset. Interestingly, the No.1 set carried a "Compulsory Broadcasting Fee" – this was reduced from 7/6d. in June 1923 to 1/- by December of the same year. It is not clear what this refers to, since it was in addition to the mandatory Post Office licence fee.

In late 1923, the Peto Scott Company of High Holborn advertised components for building three units to improve the performance of the Meccano crystal set – a one-valve, high-frequency amplifier to increase range, a one-valve, low-frequency note magnifier to increase volume and a combination of both in one unit. These do not seem to have been sold as complete kits of parts, but rather as individual components.

Little development work appears to have taken place after the company's enthusiastic entry into the wireless business. An improved version of the No.1 receiver was advertised in April 1924, with a wavelength coverage up to 1,000 metres and now employing a double-slider tuning arrangement to provide "greater selectivity and clearness of reception". By this time the price of the receiver had been reduced to 15/9d., and conventional double-headphones were offered in place of the earlier single headphone. The Meccano No.1 model continued to be advertised sporadically until the end of 1927 – the retail price being reduced to only 10/6d. by October 1925 – reflecting the already declining market for crystal sets. By April of 1928, however, demand had clearly dropped to the point that the Meccano crystal sets and headphones were finally offered as prizes in a company-sponsored model-building competition, leading to the speculation that the real object of the offer was to clear out the company's remaining un-saleable inventory[1].

Meccano's final foray into the wireless field was a constructional set published in Meccano Magazine for December 1928 as the final instalment of a series entitled "Electricity Applied to Meccano". This was a much simplified set built principally from standard Meccano parts and employing loose-coupled tuning only. No specific kit of parts was offered and would-be constructors were required to purchase the non-Meccano components separately – crystal, cat's-whisker and ebonite control knobs, in addition to a sheet of insulating fibre for construction of the panel and coil formers. This, then, was to be the end of the company's efforts in radio – Meccano never progressed beyond crystal sets into the valve receiver business, despite the earlier promises made by the company's founder Frank Hornby to develop a full range of wireless apparatus. Conceived as a manufacturer of mechanical construction kits, the

THE NEXT NUMBER OF THE "M.M." WILL BE PUBLISHED ON 15th JANUARY

MECCANO MAGAZINE

PRICE 1d

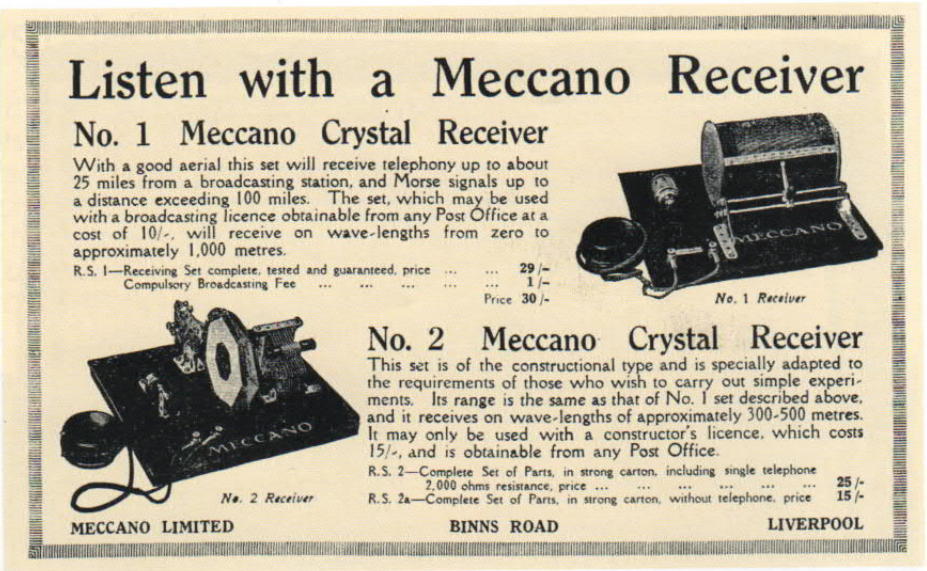
PUBLISHED IN THE INTERESTS OF BOYS.

The Meccano Crystal Radio Receiving Set

For Broadcasting and Morse Reception.

START RADIO NOW

Meccano Magazine, December 1922



Listen with a Meccano Receiver

No. 1 Meccano Crystal Receiver

With a good aerial this set will receive telephony up to about 25 miles from a broadcasting station, and Morse signals up to a distance exceeding 100 miles. The set, which may be used with a broadcasting licence obtainable from any Post Office at a cost of 10/-, will receive on wave-lengths from zero to approximately 1,000 metres.

R.S. 1—Receiving Set complete, tested and guaranteed, price 29/-
Compulsory Broadcasting Fee 1/-
Price 30/-

No. 1 Receiver

No. 2 Meccano Crystal Receiver

This set is of the constructional type and is specially adapted to the requirements of those who wish to carry out simple experiments. Its range is the same as that of No. 1 set described above, and it receives on wave-lengths of approximately 300-500 metres. It may only be used with a constructor's licence, which costs 15/-, and is obtainable from any Post Office.

R.S. 2—Complete Set of Parts, in strong carton, including single telephone 2,000 ohms resistance, price 25/-
R.S. 2a—Complete Set of Parts, in strong carton, without telephone, price 15/-

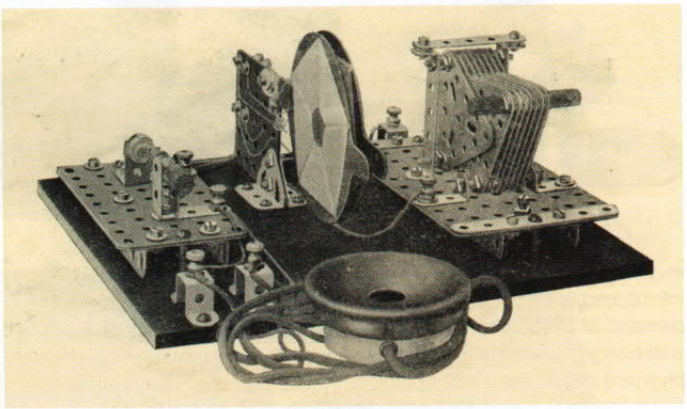
No. 2 Receiver

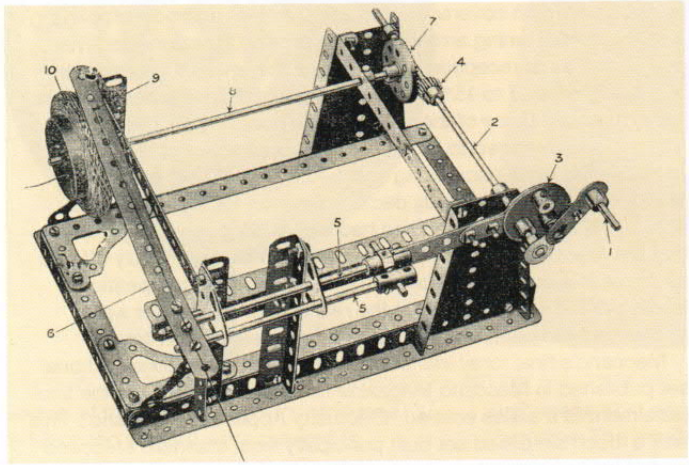
MECCANO LIMITED BINNS ROAD LIVERPOOL

Meccano Magazine (Overseas Edition), December 1923. Courtesy of John Ince.

Left: Reconstruction of the Meccano *Radio Reciever No.2* featuring loose-coupled tuning. The variable condenser and detector assembly were built from standard Meccano parts. Photograph courtesy of Tony Press.

Below: Originally referred to as the *Meccano Crystal Radio Receiving Set* in the September 1922 edition of *Meccano Magazine*, the constructor set was renamed the *Meccano Crystal Receiving Set No.2* in June 1923 following the introduction of a ready built set that met Post-Office licence requirements. *Meccano Magazine*, September 1922.





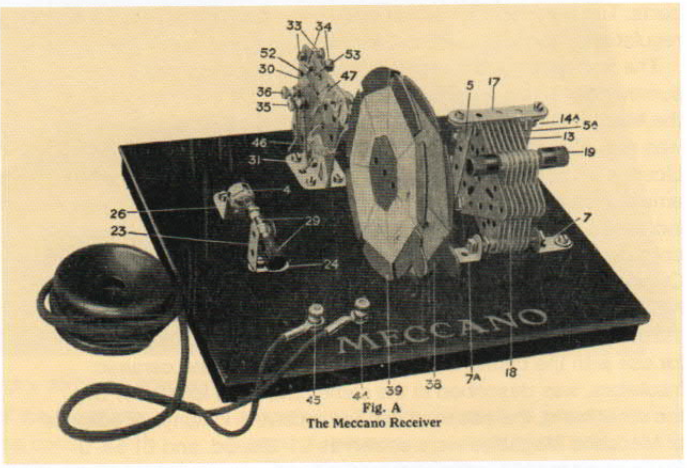


Fig. A
The Meccano Receiver

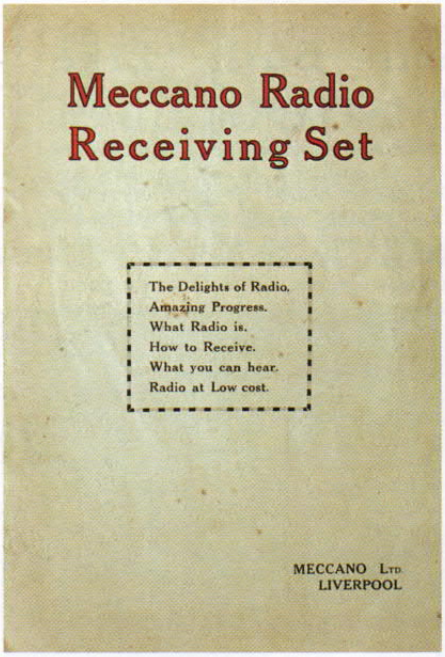
Above, left: Coil winder built entirely from Meccano parts. Designed for the adent experimenter, the cost of the parts would have been almost as much as a complete crystal set!. *Meccano Magazine*, September 1923.

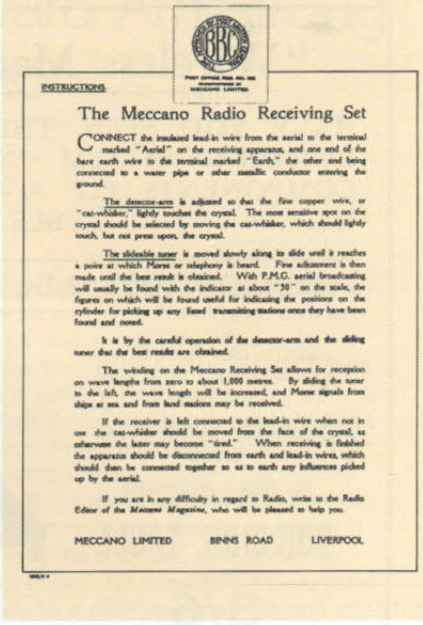
company was destined to remain as such.

Production figures for the Meccano crystal receivers are not known, but it is generally accepted that the sets were over-priced and, as a result, not particularly popular with the public especially the parents of young boys who made up Meccano's customer base. They were probably produced in small numbers. The lack of surviving examples is no doubt compounded by the likelihood that the receivers were disassembled after the crystal set era ended, to be used as parts in other Meccano projects.

1. Ince, John: New Zealand Federation of *Meccano Modellers Magazine*, February 2005.

Appreciation is extended to John Ince, William Irwin and Lloyd Spackman of the New Zealand Federation of Meccano Modellers for generously supplying information concerning the Meccano crystal receivers.





Booklet supplied with the *Meccano Radio Receiver No.1.*

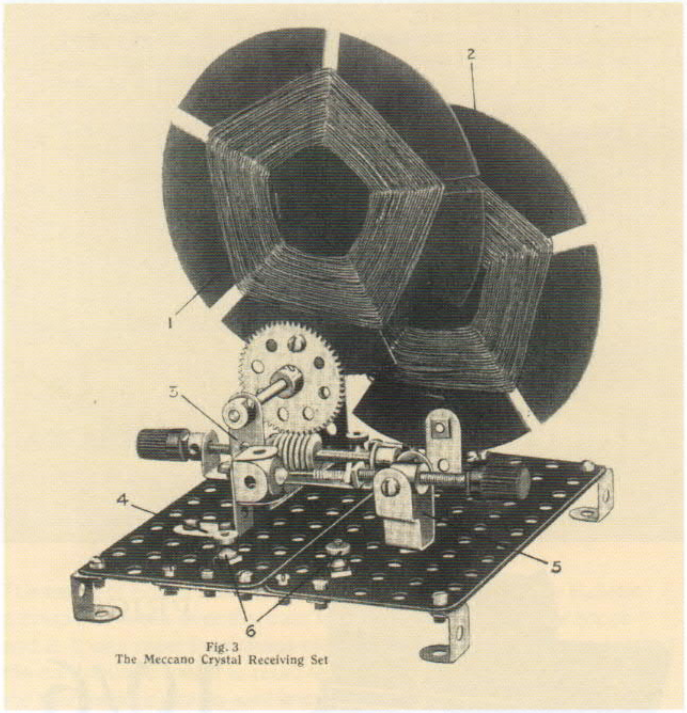


Fig. 3
The Meccano Crystal Receiving Set

A MESSAGE TO MECCANO USERS

For many months past I have been giving; very close attention to the subject of Radio, and I have become firmly convinced of the importance and possibilities of this new and wonderful science, I am anxious, therefore, that every Meccano boy shall have his share in the pleasure that I am convinced Radio is destined to bring to the human race,

In America and Canada there are thousands of boys who are at the present time owners of their own Radio Receiving sets, Every day they receive not only telegraphic messages in the Morse code, but also concerts, speeches, weather reports, etc., by wireless telephony, Every Meccano boy should make it his business to acquire as much knowledge as possible of radio matters, In my opinion, the discovery and development of wireless communication has conferred as much benefit on mankind as has any invention or discovery of modern times Not only has it established throughout the world extremely rapid and certain inter-communication over both long and short distances, hut it has made cheaper quick transmission of messages, In these, and in many other ways, its commercial value is inestimable.

Frank Hornby

Above: Late Meccano crystal set design. Constructional set using a combination of mainly Meccano parts and special components purchased separately. *Meccano Magazine*, Dec 1928.

Prices of Meccano Radio Receiving Set and Special Radio Parts.

RS1 Meccano Crystal Receiving Set, complete. Efficiency tested. Packed in strong carton. price 77/6

RS2 Outfit containing parts to make Meccano Crystal Receiving Set, in strong carton...price 63/-

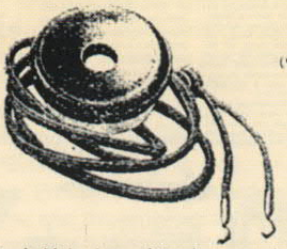
No.	Meccano Radio Parts.	s.	d.
401.	Specially Prepared Fibre Flat Plates, 4½" × 2½" ... each	0	4
402.	Specially Prepared Fibre Flat Plates, 2½" × 2½" ... „	0	3
403.	Specially Prepared Fibre Triangular Plates, 2½" ... each	0	1½


(No. 404)


(No. 410)


(No. 411)

404.	Insulating Handles ... each	0	4
405.	Brass Washers, 1/32" ... doz.	0	6
406.	9" Lengths 22s Bell-wire with Tags ... ... each	0	3
407.	Inductance Discs (wound to 250 metres) ... per pair	8	6


(No. 408)

408.	Single Telephone Receivers each	27	6

409.	Detector Arm, Complete each	1	6
410.	Meccolite Crystals Mounted (Complete with Clips, No.411) each	3	6
411.	Clips for Crystals ... ... „	0	4
412.	Mounting Boards ... ... „	7	0
	Instruction Leaflets ... ... „	0	3

Meccano Magazine, September 1922

"Wireless Made Easy"

HAVE YOU SEEN THE NEW RADIO BUILDING SYSTEM IN WHICH ALL COMPONENTS FIT A STANDARDISED TABLE

BUILDS JUST LIKE MECCANO

CIRCUITS CAN BE ERECTED AND WORKING IN A FEW MINUTES.

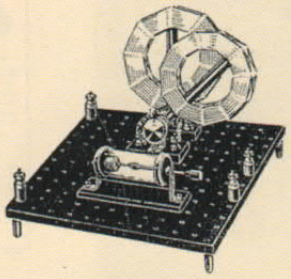
COMPLETE INSTRUCTIONS GIVEN.

NO TOOLS REQUIRED.

BUILDING TABLE

PRICE

3/6



Patent No. 185,180
(A Typical Crystal Set).

WRITE FOR BOOKLET WHICH DESCRIBES THE BLACKADDA WAY AND ILLUSTRATES FULL RANGE OF COMPONENTS AND SETS.

MANUFACTURERS & PATENTEES :

THE BLACKADDA RADIO COY. LTD.

SADLER GATE

DERBY

Telephone : Derby 1820

Telegrams : "Blackadda," Derby

Radio Sets Built Like Meccano

The Blackadda System of Radio construction is one we can heartily recommend to all readers interested in the fascinating hobby of building their own radio sets. The system of standardised components, connecting wires and nuts and bolts of only one diameter makes for simplicity and ease of construction in a remarkable degree. The Bakelite panel on which the parts are mounted is drilled with equidistant holes and all the parts—crystal detectors, coil holders, transformers, valve holders, etc.—are equipped with two or more threaded bolts set at the same centres as the holes in the panel. Thus, as every hole in the panel is numbered, it is delightfully easy to follow the makers' instructions.

The possibilities of the system are practically unlimited and anyone who can read can eonstruct by means of it anything from a simple crystal set to the most elaborate valve sets. Just as one can take a Meccano model to pieces when one is tired of it, so with the Blackadda system one can build radio sets, pull them to pieces, and rebuild them again. We ourselves constructed a crystal set from the makers' instructions in less than half an hour, the only tool used being the box spanner provided with the set. We then tested our handiwork and within ten minutes picked up Liverpool, Manchester and Daventry.

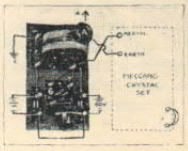
Another interesting point is that, as the holes in the panel are of the same size and at the same centres as the Meccano equidistant holes, wireless apparatus can be built into Meccano structures.

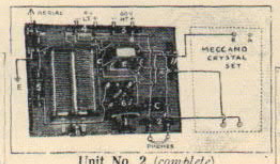
We strongly recommend those readers who are interested to obtain full particulars from the makers, The Blackadda Radio Company Limited (48, Sadler Gate, Derby), whose advertisement will be found on page 390.

Above: Blackadda construction sets – advertised in the *Meccano Magazine*. The Blackadda Radio Building System was the wireless, rather than the mechanical, version of Meccano. *Meccano Magazine*, June 1926.

Below left: *Meccano Magazine*, November 1923.
Below right: Later advertisements showed the single-slider set, while the description referred to the double-slider model. *Meccano Magazine*, November 1925.

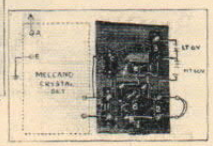
Unit No. 1 (*complete*)





Unit No. 2 (*complete*)

Unit No. 3 (*complete*)



If you have a

MECCANO CRYSTAL SET

here are three ways of improving it

TO INCREASE ITS RANGE
(See Unit 1)

As you know, boys, the Crystal Set is not much good for long distance work, although for use within 20 miles from a Broadcasting Station it gives splendid results. But there is a way to increase the range of the excellent Meccano Set to as much as 70 or 100 miles—even more under favourable circumstances—and that is by using a Valve in front of it.

Look at the illustration above, and note how easily with only four components you can build up Unit No. 1 and increase the range of your Set at least three times.

TO MAKE IT LOUDER
(See Unit 3)

No Crystal Set gives sufficiently loud speech to work a Loud Speaker, and as most of you at some time or another will want to entertain your friends in this way, we show you in Unit No. 3 how you can add to your Meccano Set an Amplifier which will give you speech five times as loud. For this Unit you only require components No. 2, 3, 7, 11, C, E, nothing could be easier.

PRICES AND KEY TO PHOTOS.

1. A and E terminal strip ..... 1½d.
2. TEL terminal strip 9d.
3. HT terminal strip .. 8d.
4. LT terminal strip .. 8d.
5. Single coil holder 1/3
6. Siemens' combined valve holder and filament resistance 7/6
11. On-par terminal strip 9d.
A. Variometer 7/3
B. .001 Variable condenser (assembled) 9/
C. .001 fixed condensers 1/6
E. Max-Amp. Transformer 18/6
Rubber-covered connecting wire 2½d. per yd.
H. Fixing Brackets 1½d. each

TO INCREASE ITS RANGE AND MAKE IT LOUDER AT THE SAME TIME
(See Unit 2)

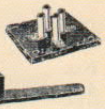
This method is a combination of Units No. 1 and 3, but only one Valve is used. The Circuit used in this set is known as a Dual Amplification Circuit, and is very similar to the famous "P.W." Circuit which you have no doubt read quite a lot about in "Popular Wireless."

Here again, you will be able to see by the illustration, exactly what components you need, but if you have any doubt, write to us and we will be pleased to tell you more.

SEND TO-DAY FOR THIS BIG CATALOGUE

Send to-day for a copy of our big 60-page Catalogue the largest in the Trade. Fully illustrated, post free 3d.

TERMINAL STRIPS
Sold in strips of 2 or 4. Engraved + HT . . + LT . . PHONES, price 8d. per pair of terminals. Ditto, but with telephone terminals throughout, 9d. per pair. Large ditto, engraved Aerial and Earth. Per pair 10d.



SWINGING COIL HOLDER
Enables coil to be moved through an angle to give coupling effects 2/3

COILS

No.	Wavelength	
1	200–350	2/-
2	350–420	2/6
3	420–650	3/-
4	570–900	3/6
5	780–1140	4/-

COIL HOLDER
Very economical method of carrying any type of coil 1/9

VALVE HOLDERS
Can be used also for carrying transformers, solid ebonite 1/3

VALVE RESISTANCES
Made in solid ebonite for mounting on board 4/-

MAX-AMP. TRANSFORMERS
Finest quality Low Frequency Transformer made to give wonderfully loud speech without a trace of distortion 18/6

¶ Please enclose postage for all orders under £2

Peto-Scott Co. Ltd.,

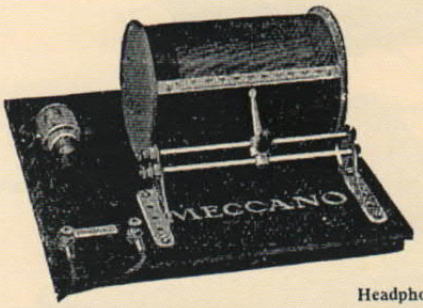
Head Office: **64, High Holborn, W.C. 1.**

Branches :
LONDON : 99, High Holborn, W.C.1.
3, Wellington St., Strand, W.C.2.
CARDIFF : 94, Queen Street.
LIVERPOOL : 4, Manchester St.

Big Reduction in Prices

OF MECCANO RADIO APPARATUS

Readers should procure their sets before the stock is exhausted, and so ensure many happy hours during the long winter evenings.



PRICE

10/6

or 11/3 post free

Meccano Receiver, including Headphones, 17/6, or 18/3 post free.

The Meccano Crystal Receiver is a highly-efficient and splendidly-finished instrument. The detector is enclosed in a glass chamber, which protects it from dust and moisture. Two slides are provided, one on each side of the inductance, giving great selectivity and clearness of reception.

The Meccano Receiver with a good aerial should give effective reception from a radius of 30 miles, according to local conditions, on which the range at over 15 miles largely depends.

MECCANO DOUBLE HEADPHONES

(BRITISH MADE)

PRICE **7/6** (or 8/- post free)

(4,000 ohms resistance)

Of the highest quality procurable, they give loud, clear, undistorted reception and add greatly to the efficiency of any type of receiver. Comfortable to wear and easily adjusted. Only a limited number available.

MECCANO LTD., Binns Road, LIVERPOOL

The Inventions and Life of Edwin Howard Armstrong
The tragic story of a great radio inventor

by Stef Niewiadomski

"I could never accept findings based almost exclusively on mathematics. It ain't ignorance that causes all the trouble in this world. It's the things people know that ain't so". Edwin Howard Armstrong.

The name of Edwin Howard Armstrong has arisen in The Bulletin a couple of times over the past few years, notably in references 1 and 2. It was clear from these mentions that the writers appreciated the contribution made to radio technology and broadcasting by the man, who is not as well known as many other early radio pioneers, and so I thought I'd research his life (and his tragic death, if that's not revealing too much too early) and write this article.

There are many references to E H Armstrong on the internet; one definitive, though perhaps slightly biased towards the subject, biography (reference 3), which also gives a fascinating layman's history of early wireless; and a significant tribute to the man from the Radio Club of America (reference 4).

When researching articles, it's often difficult to find enough material to write a reasonably long piece. The opposite was true with this article: it was difficult to know what to leave out from the fascinating professional and personal story of the man. His life tracks the development of radio technology in its formative years of the first half of the 20th century, and the invention of the art and science of broadcasting itself. I've tried to concentrate on his significant inventions, rather than the intricacies of his legal battles, though it's been impossible to leave these out completely.

Edwin: The Early Years

Edwin Howard Armstrong was born on December 18th 1890, in the Chelsea district of New York City, the first child of Emily and John Armstrong. John Armstrong was associated with the Oxford University Press, which at the time was mainly selling Bibles and standard classical works. The family didn't stay in Chelsea for long, moved house in the New York area a few times in Edwin's early years, and eventually settled at 1032, Warburton Avenue, Yonkers (then in the countryside), a house which was to figure large in Edwin's life from then onwards.

Edwin's mother (née Emily Smith) had been a school teacher before she had married John Armstrong and on the maternal side of the family, who still lived locally to where the married couple lived, there were many teachers who kept Edwin on his toes and encouraged the study of maths and the sciences.

Little detail of Edwin's early life is known, except that he was studious and 'a serious child'. He developed an interest in mechanical toys, especially for a clockwork train set, and when this was replaced by an electric engine his interest was stimulated in things electrical. He became a good tennis player and enjoyed the outdoor life spent on a big farm near Richfield Springs in upstate New York, where the family spent many of its summers. So far, nothing really indicated the direction which Edwin would take in life: he was typical of millions of adolescents of the time, and since, who need a chance stimulus to trigger their true potential.

Imagine the world of the 1890s: most of the cities were was still lit by gas-light, and electric lighting was a luxury for the few. Cars were beginning to appear, but were still vastly outnumbered by horse-powered transport. To us, no recognisable radio technology existed.

The trigger for Edwin seems to have happened in 1904 when his father, returning from a business trip to Europe, brought back The Boys' Book of Inventions for the boy. The following year he gave Edwin Stories of Inventors, and the seed was planted: at the age of fourteen Edwin decided to become an inventor. Of course there were many areas in science that were blossoming at the time, and Edwin focussed his attention on wireless. Unlike many boys who set their sights at that age, Edwin didn't change his mind, and achieved his ambition way beyond expectations.

Marconi's Influence

An inspiring figure at the time was of course Guglielmo Marconi himself. In 1901 he had succeeded in sending the first radio waves across the Atlantic. Marconi's true contribution to the then fledgling wireless industry was its early commercial development, with the creation of companies to exploit the technology and his spreading of the general excitement internationally. With his flamboyant lifestyle, fast cars, and of course the use of his yacht, the Electra, he was the inspiration for many that this new technology could be exciting and a money-maker, which is exactly what any new technology needs to stimulate its use and rapid development.

Marconi was mainly making money by operating point-to-point wireless telegraphy links in competition with cable links. Of course, one application where telegraph wires couldn't compete with wireless was in communication with ships, and Marconi's inventions were revolutionary in this area.

In his attic bedroom in Yonkers, Edwin began to experiment with spark coils, interrupters, coherers, and the other paraphernalia of the early art of the wireless telegrapher. He received much help from a neighbour, Charles R Underhill, an engineer with the old American Telegraph Company, in the form of informal education and the donation of several pieces of difficult-to-get-hold-of (for a boy) equipment. A few local boys, and others up and down the Atlantic seaboard, were also gripped by the same fever and communicated with each other by Morse Code. Wireless technology was so new that amateurs were as likely to be the originators of significant developments as professionals, though the professionals regarded the amateurs simply as generators of interference,

Howard and Marion Armstrong with the world's first 'portable' radio, Palm Beach 1923

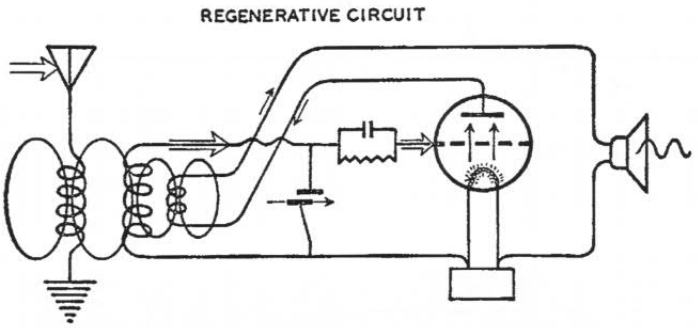


Figure 1. Armstrong's Regenerative Circuit

which is hardly surprising considering the nature of the 'signal' radiated by the crude transmitters of the day.

Even then, Edwin was different from the others. He was not content with simply building equipment and using it to communicate. He always wanted to understand how things worked (or probably more accurate for the time, understand how people thought things worked), develop his own theories and improve the equipment and techniques that came his way.

You have to imagine the state of radio in those early days: radio 'broadcasting', as we know it, simply didn't exist. There were no voice transmissions, only wireless telegraphy. The problem was that it was only possible to generate pulses of RF energy, typically from sparks or arcs, which were suitable for telegraphy, but not for the transmission of voices or music. The fundamental technology in use at the time was of course spark transmitters and coherer-based receivers, which resulted in reliable communication over relatively short distances, and relied on the sensitive ears of the 'operator' to discern signals from the background of natural and man-made electrical interference.

A note on the use of the words 'wireless' and 'radio': the word 'radio' came into use about 1910 to distinguish continuous-wave transmissions for voice use from spark-gap generated 'wireless' waves which were used for telegraph communication. I can't promise to be consistent with my use of the terms in this article, so please be tolerant. For many years in the 20th century, 'wireless' was a dated word, falling out of use, whereas more recently we regard wireless networks, wireless phones, and wireless communication generally to be the height of new technology.

The Birth of Broadcasting

In 1900 Professor Reginald Aubrey Fessenden of Harvard University became the first human being to transmit his voice by radio: having heard the professor his assistant telegraphed back that he had heard the voice, there being no return voice path available. On Christmas Eve, 1906 Fessenden stoked up the boiler (see later for why this makes sense) and 'invented' a brand new concept when he transmitted the first-ever radio broadcast, with a selection of phonograph music, readings from the Bible, and even the inventor singing and accompanying himself on the violin. Finally the 'announcer' (again Fessenden himself) ended the programme by wishing listeners a Merry Christmas. Who were the startled listeners? I suppose a few local amateur wireless 'hams' and the radio operators on the few ships in the Atlantic so equipped to receive the broadcast.

See The First Radio Broadcast, Christmas 1906 (reference 5) for a fascinating description of this Christmas broadcast. This pioneering event isn't well known, most people believing that Marconi was the one and only pioneer in wireless broadcasting. You could say that Fessenden was himself an unsung hero of radio whose contribution wasn't recognised in his own lifetime, in a similar way to Armstrong.

For the first time, Fessenden was generating continuous waves, unlike the spark impulses being used by Marconi and others in the field at the time. The source of the continuous waves for Fessenden's broadcast was a steam driven alternator producing 'RF' at about 70kHz. Fessenden had placed a water-cooled microphone in series with the transmitter's aerial feed, the water carrying away the heat dissipated in the microphone. A 'performer' had to speak (shout?) into the microphone, avoiding the water-cooling pipes.

Interestingly, Fessenden had experimented in about 1907 with what we would call today a 'direct conversion receiver', where the local oscillator frequency (produced by a carbon-arc oscillator arrangement) was very close to the transmitter's frequency, and the beat note was in the audio range. This was a precursor to the superhet, but Fessenden had not attempted to patent the idea because he was unable to make the concept work reliably as he didn't have access to a stable source of local oscillation. You can only patent a practical process, and not just a vague idea, however promising you think it might be. A direct conversion receiver is simply a superhet with an intermediate frequency of 0Hz. It goes to show how close an inventor can come to designing a revolutionary process, and miss the goal at the last step.

So hopefully the scene is now set for Armstrong's most significant contributions to radio technology. What the industry cried out for was an accurate and stable source of continuous radio waves (to which voice and music modulation could be applied) at frequencies that were not limited by electro-mechanical alternators, and a sensitive method of detection and amplification of those waves. Not much to ask for!

Off to University

In 1909, at the age of nineteen, Armstrong left home for Columbia University to study what else but electrical engineering. The curriculum on offer was biased towards the 'heavy' engineering of power stations and the measurement and switching of large currents. But that wasn't what Armstrong was interested in: he wanted to study what we would call 'electronics', and specifically the technology of radio and wireless. To satisfy his instructors he tolerated the electrical power courses, but found his true calling in the telegraphy courses and is said to have achieved phenomenal speed with the telegraph key.

He had a tendency to bend the rules of the institution and spent many hours in the faculty's laboratory, working on his own agenda. Luckily the key staff realised his potential and gave him his head, allowing him to devise his own experiments and use the instruments and apparatus as he saw fit. Even at this early age he was questioning perceived wisdom and was never happier than when confronting and exposing errors in the 'known' facts of the day. This was inherent in his personality and was a trait he showed throughout his life.

Early on he came under the influence of a great teacher, Professor Michael Idvorsky Pupin, who had the rather unusual belief for the time that students should be encouraged to use experimentation to gain a grounding in the fundamental sciences. This contrasted with the common view that engineers should be turned out in vast numbers by being taught by rote, to feed the boom in the electro-technical industries. Pupin himself was an innovator and invented, amongst other things, loading coils distributed along telephone lines,

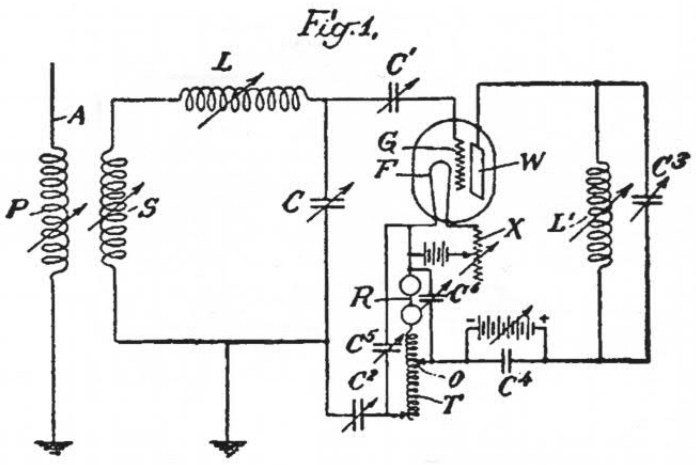
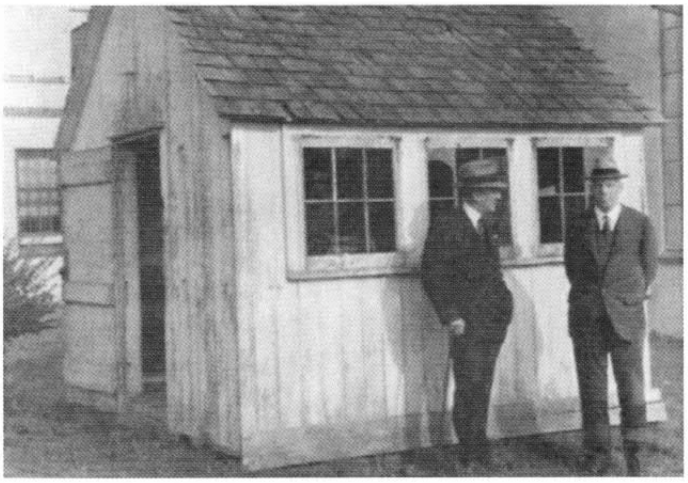


Figure 2. The patent of Armstrong's Regenerative Circuit



1929 Armstrong (right) with Marconi. Behind them is Marconi's original shack from 1900

which doubled the range of transmission.

As we've already seen from Fessenden's work an interesting connection between wireless and electrical engineering was in the generation of continuous radio waves using electrical generators whose speed of rotation and winding arrangements were designed to generate AC at the desired high frequency. Pupin was also working on methods of generating continuous radio waves, which were still elusive, by the use of big electric-motor alternators.

Like many others, Armstrong was grappling with the challenge of how to construct a sensitive receiver, which the sets using coherers and crystal detectors at the time could not be described as. It appears to be in 1912 when his ideas crystallised and he built and refined an 'apparatus', which he kept hidden in a box and away from prying eyes, that greatly amplified wireless signals. Although he demonstrated the 'box' to his friends he divulged to no-one how it worked. He dropped hints of what he had done to his instructors at the University, and they wisely advised him that if he truly believed it was a revolutionary method, then he should file a patent, and Armstrong agreed.

The cost of filing a patent at the time was about $150 and Armstrong borrowed from his friends and sold what he could to raise the money, help having been refused by his father, who simply saw this activity as a diversion by his son from completing his degree. It's said that Armstrong took this refusal from his father very personally, but before we are too hard on John Armstrong, just put yourself in his position: you get a 'call' from your son, a university student, asking for a large amount of money, with the promise that this will be spent wisely on a venture that would eventually lead to fame and fortune. What would you have done?

$150 was a considerable sum of money (worth about $3300 today) and the full amount could not be found. Keeping the idea bottled up inside, Armstrong grew more and more concerned that someone else might make the same invention and beat him to the patent. Luckily he approached his Uncle Frank Smith, who, although he was unable to help with any money, offered the invaluable advice that he draw a sketch of the device and have it witnessed and notarized, thereby pinning down the date and priority of his conception, until he was able to file the official patent. And this he did, and on January 31st 1913 for the grand sum of 25 cents a notary affixed his seal and signature to Armstrong's document.

So what was the invention, I hear you ask?

The Regenerative Detector (1912)

Armstrong's invention came from his meticulous studies of how the audion, invented by Lee de Forest in 1906, actually worked. He observed that as a result of applying an alternating signal to the grid of the device, some alternating current was being superimposed on the DC anode current, and that this alternating anode current could be stepped up by use of a tuned anode circuit, as was common practice at the time in the aerial to grid circuit. Now to the revolutionary step: what would happen if this anode tuned circuit (known as the 'wing' circuit at the time) was coupled back to the grid tuned circuit? Armstrong recorded the effect himself some time afterwards: "Sept 22, 1912 set up circuits and tuned 'wing circuit'. Great amplification obtained at once. Noticed peculiar change in tone of signal just as maximum amplification was obtained. Signals changed from clear to hissing note and audion also hissed when wing inductance was set to certain value".

What he had devised comprised in fact two distinct inventions: the 'great amplification' effect was the sensitive regenerative detector, and the change 'to hissing note' was the audion circuit beginning to oscillate as the amount of feedback passed a certain value, thereby giving us the vacuum valve (or tube) oscillator, which was to dominate the generation of wireless waves for many generations, and whose principles are extended today into transistor and integrated circuit oscillators of all sorts.

We can easily observe these effects today as we carefully adjust the Reaction (or Regeneration) control on a TRF radio. Up to a certain point, the received signal becomes louder and clearer, but once you go past that point, whistles and howls are heard as the detector becomes an oscillator.

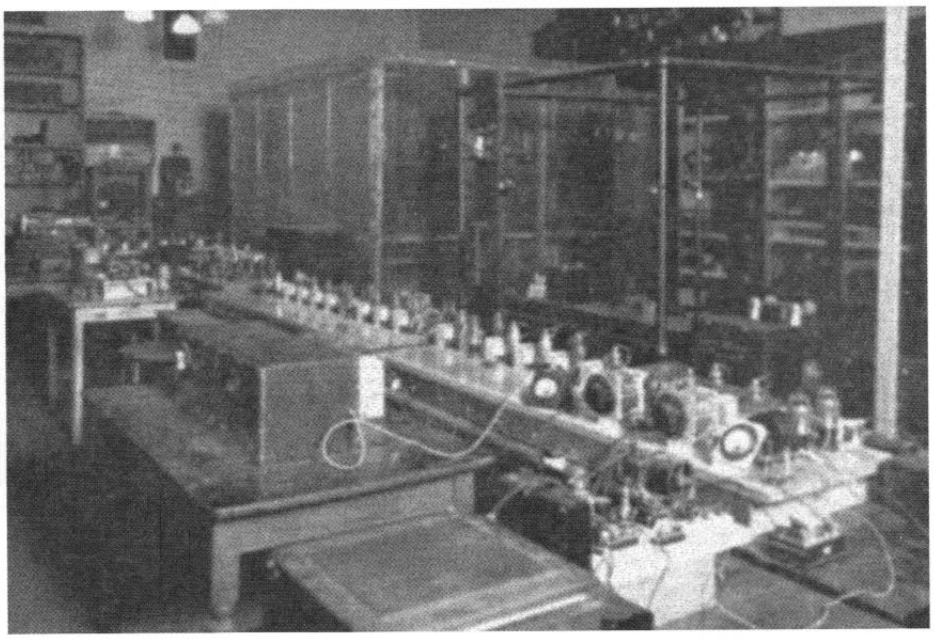
Refer to Figure 1 for a diagram of how the circuit worked. I've also shown in Figure 2 the rather harder to understand diagram from the eventual patent (specifically for the regenerative receiver circuit) number 1,113,149 'Wireless Receiving System', finally granted in October 6, 1914. Armstrong didn't patent the use of regenerative feedback as an oscillator until much later: he often stated that he was only really interested in receiver innovations. Of course when it came to his later invention, the superhet, this relied on the use of stable continuous wave oscillators, though he had no way of anticipating this in 1912.

You can imagine the effect on Armstrong in that period from September 1912 until the visit to the notary at the end of January 1913, with the idea bottled up in his head, unable to communicate the concept to anyone, not even his closest friends, for fear of its being 'stolen'. In this period he was regularly receiving clear signals from vast distance, unheard by anyone else. Here I think we see that Armstrong was a true 'professional' inventor in that he realised his idea had great commercial value and therefore needed protecting with a patent, rather than taking the 'amateur' approach and publicising the idea to all and sundry. And don't forget he was 'simply' a university undergraduate, still attending lectures and studying for his exams just like the rest of the students.

Lee de Forest and the Audion

Most people involved in our hobby have heard of the audion (which we refer to now as the triode), invented by Lee de Forest in 1906, when he added a third electrode (the grid) to the Edison-Fleming diode vacuum tube. Because we know that the triode is capable of amplification, the often-made assumption is that the audion immediately revolutionised wireless receivers by amplifying the output of the detector stage, and did away with the need for a more sensitive detector, or even found immediate application as a sensitive detector itself. This was not the case: the action of the audion was not well understood (de Forest himself believed the anode to cathode current that the grid controlled consisted not of electrons but of gaseous ions) and

Armstrong in his Army uniform



Armstrong's equipment in Philosophy Hall, Columbia University, which first made FM possible

early devices amplified the signal very little, and so it was little used. The results of attempts to make the audion act as an amplifying detector were inconclusive, as it was impossible to differentiate between improvements in the efficiency of the detector, and real amplification.

See reference 6 for an excellent account of the early days of valve development and manufacture, including of course, de Forest's audion. De Forest was himself a prodigious patenter of his inventions: in the field of electronics he eventually held something like 200.

As late as 1954 a letter from Armstrong was published in the January issue of Wireless World trying to set the record straight on that period from 1906 to 1913. His view was that even after the invention of the de Forest triode, the preferred methods of radio detection were still the coherer and crystal detector, until Armstrong had correctly explained how the triode actually worked, and adopted it in the regenerative detector. He still argued that the triode was hampered by incorrect explanations of how it worked, until Armstrong himself had correctly explained its functioning.

After graduating from University in 1914, Armstrong stayed on as a junior instructor, an ideal position for him as it gave him access to the laboratories and allowed his pioneering work to continue. A fellowship followed, which allowed full-time access to the laboratory.

A note on the spelling of Lee de Forest's surname, which you variously see as 'De Forest' and 'de Forest': I checked on some of his audion patent applications and they show a signature of Lee de Forest, so I'll assume that's the correct spelling. From reading about de Forest he doesn't sound a very likeable person. It's easy to take shots at him and so I will as well. With the benefit of hindsight I quote here what he said about the transistor in 1952: "The transistor will more and more supplement, but never supplant, the audion. Its frequency limitations, a few hundred kilocycles, and its strict power limitations will never permit its general replacement of the audion amplifier".

In the Army

The US joined The Great War in April 1917 and many radio amateurs volunteered for the services. These amateurs were in the vanguard of wireless technology and began to form the backbone of the US Army Signal Corps and the Navy, to extend this new technology to military communications.

Armstrong's reputation was already well known and he was offered a captaincy in the Army. After putting his business affairs into the hands of his sister Ethel and Aunt Rissie, he packed up and at the age of twenty-seven, sailed for Europe in the summer of 1917. As he wrote back to his family, and this was typical of the man, on the voyage he befriended the ship's radio operator, 'borrowed' an audion and some wire, and built a regenerative receiver which of course out-performed the 'standard' radio on board the ship, to the amazement of all who heard it.

Having arrived in Southampton the ship was held up for a few days because of bad weather. One evening, Armstrong decided to make his way up to London, where he popped into Marconi House, the headquarters of the British Marconi Company. Here he met Captain Henry Joseph Round, (himself a brilliant developer of early radio circuits: I recently found a reference to his involvement in investigating oscillating crystal amplification in 1926), and learned of the problem occupying the minds of the finest Allied scientists, that of detecting and amplifying what were then very high frequency signals in the range 500kHz to 3MHz, thought to be in use by the Germans for secret field communications, knowing they were way beyond the range of detection by the Allies. No immediate solution to the problem was obvious, but the problem was well and truly planted in Armstrong's mind, when he eventually found himself in his ultimate destination, Paris.

The following weeks were busy for Armstrong as he and his staff built transmitters and regenerative receivers, radically improving the American Expeditionary Force's wireless communications network. He also drove the development of an aeroplane wireless communications system, making many of the test flights himself in the observer's seat, in the inherently dangerous aircraft of the time, let alone the fact that there was a war on.

The key to solving the problem of how to detect and amplify signals that lay beyond the range of current detection techniques is said to have been triggered when Armstrong was watching a German air-raid over Paris in March 1918 and speculating on whether it would be possible to detect the extremely high frequency waves emitted by the bombers' engine ignition systems, and hence perhaps direct anti-aircraft fire more accurately. It was on his way back to his apartment that the solution came to him. Working long hours he constructed an 8-valve receiver whose detection and amplification performance exceeded his regenerative circuit by a considerable margin. The potential of the idea went well beyond the aircraft detection system he first considered: what he had here was a brand new form of radio receiver. He called the invention 'the super-sonic heterodyne' which we commonly abbreviate to the superhet.

Armstrong spent as much time on his new invention as he could, striving to develop it into a viable military communications receiver, and field tests through the summer of 1918 showed great promise. He had no desire to keep the superhet concept a secret, but strove immediately to apply it to the needs of military communications. In November 1918, the 'war to end all wars' came to an end, with all participants exhausted, and the immediate need for the superhet declined, never having

been used as a direction finder or as the detector of the enemy's secret radio traffic, which in fact never existed.

At that time, the US Army allowed inventions made by serving staff in its laboratories to be retained by the inventor, and so Armstrong began to secure the patent on the superhet. The initial application for the superhet patent was dated December 30, 1918, in Paris.

There was no immediate return to the US for Major Armstrong (as he was by now, retaining the title for the rest of his life). There was still work to be done establishing and maintaining the military communication network as occupying forces moved into Germany. Recognising Armstrong's valuable contribution to communications in France during the war, he was awarded the medal and ribbon of a Chevalier de la Legion D'honneur by the French government in early 1919.

He was in the chateau where the armistice commission was sitting, inspecting the regenerative equipment that was keeping the American delegation in contact with the US government when he received the news that de Forest was initiating legal action against his regenerative circuit US patent, which was still pending. In fact de Forest's own Radio Telephone and Telegraph Company was using the regenerative circuit without even acknowledging Armstrong's contribution to its development. It seems that de Forest had two main reasons for attacking Armstrong's patent, one personal and one commercial. Firstly his pride was hurt at the implication that he didn't understand his own invention, and secondly, should Armstrong's patent be upheld, then de Forest's company would have to pay royalties for the commercial exploitation of the audion.

And so in September 1919, the 'Major', a civilian once more, returned to sleep in the attic in Yonkers where he had spent his early years, surrounded by his dusty old wireless gear, and began the fight for his patent rights, which was to last for the rest of his life.

The Superheterodyne Circuit (1918)

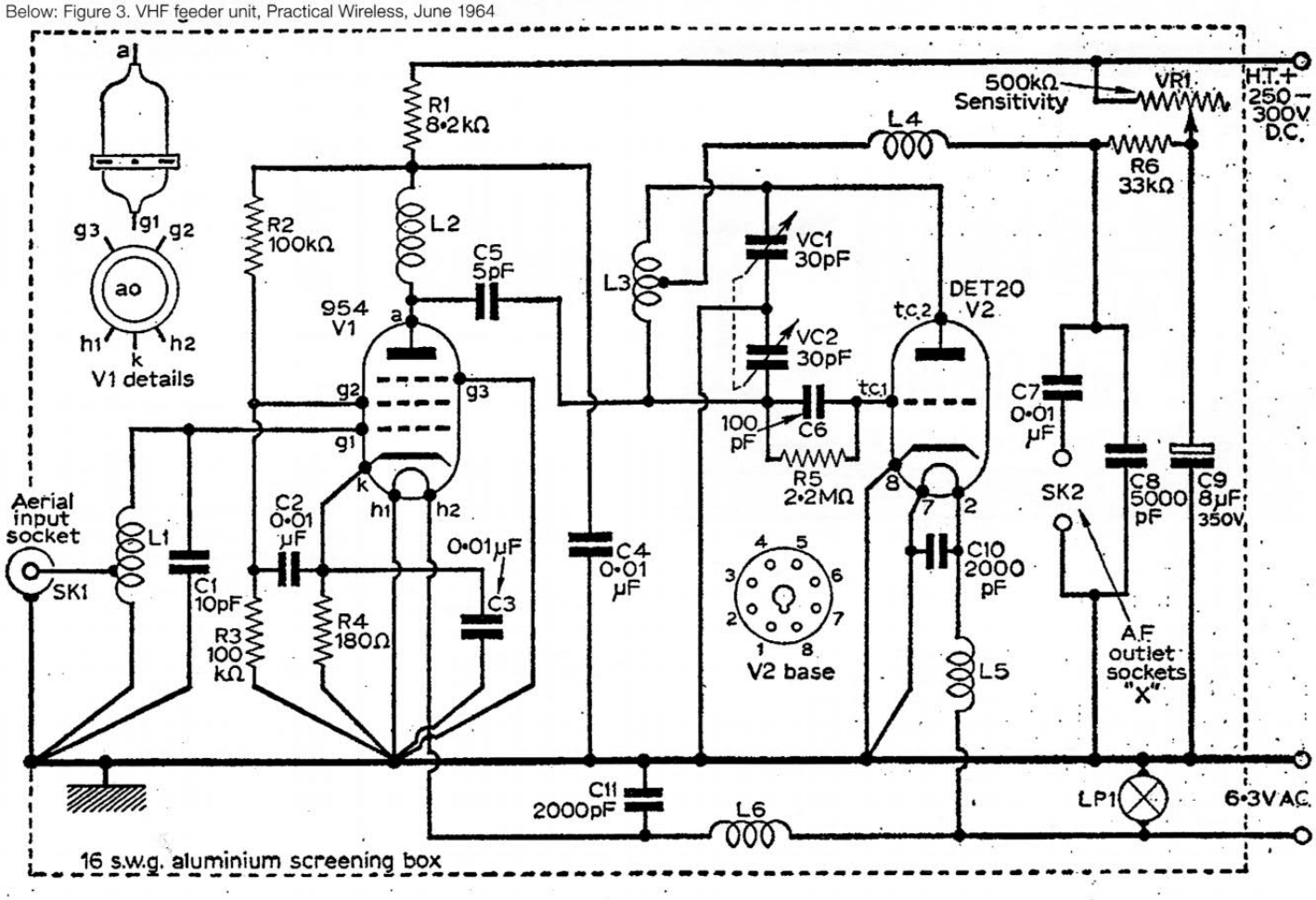
Armstrong's idea of the superhet seems to have had a smooth path to the granting of a US patent. The all-important US version was filed in the US Patent office on February 8, 1919. No issues arose with the granting of the patent and on June 8, 1920 US Patent number 1,342,885 entitled 'Method of receiving High Frequency Oscillation' became another of Armstrong's milestones in the history of radio.

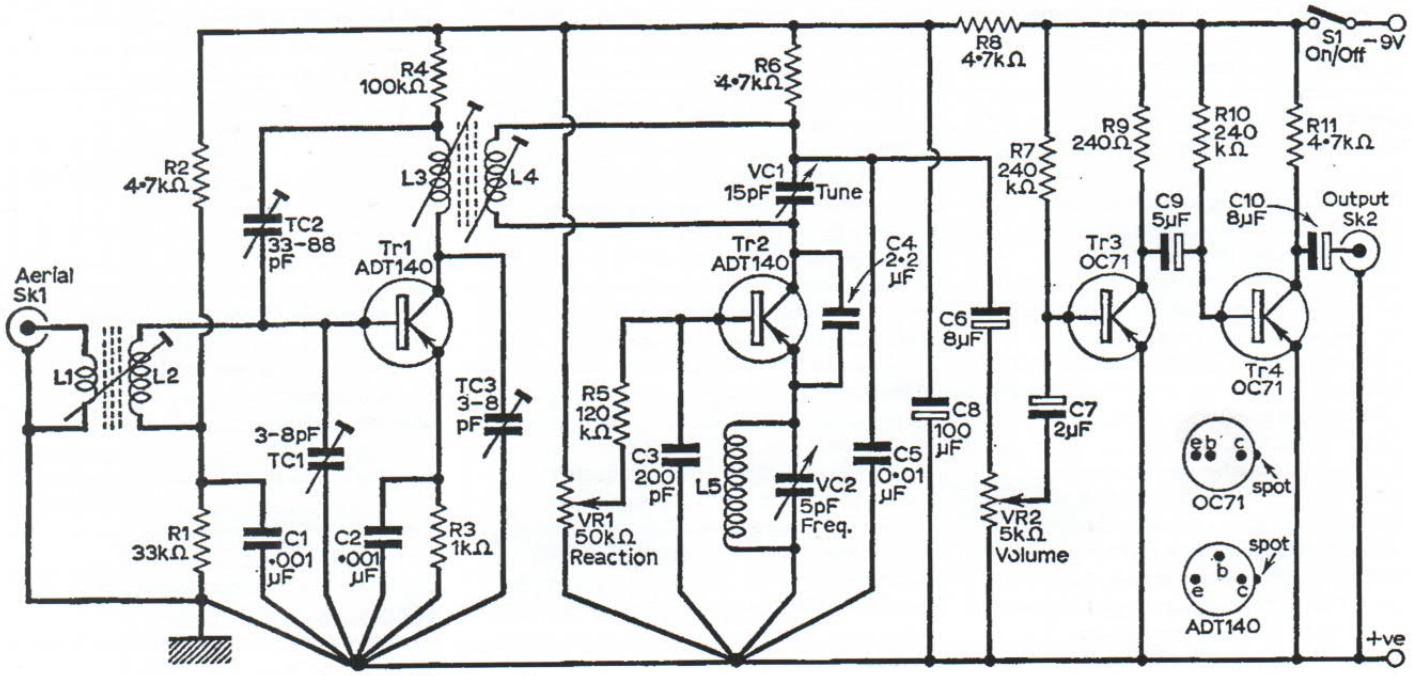
The problem that the superhet solved was how to detect and amplify signals that were higher in frequency than the regenerative detector could cope with directly. Armstrong's idea was to convert the incoming signal to a lower, fixed frequency (the intermediate frequency, or IF) where it could be greatly amplified, before coming to a conventional detector (usually regenerative itself in early superhets), and from there to the audio stages of the receiver. In fact what Armstrong's patent describes (see reference 7) is a multi-conversion superhet where the IF stages operate at 1MHz, 100kHz and 20kHz and as he says "The number of stages of frequency conversion and amplification which may be employed is almost unlimited if the frequency is lowered in small steps each time". This is somewhat of an over simplification of what we would call 'multiple-conversion', and issues of image reception and spurious frequencies arising from the many local oscillators make this type of superhet a tricky beast to tame. However a patent is intended to cover as many applications and extensions of the basic invention as possible, so as to protect against possible 'workarounds'.

Of course in the majority of broadcast superhets, only one IF is used, with maybe one of two stages of amplification, and this is very adequate for the sensitivity and selectivity needed for broadcast use. Many professional, sophisticated amateur, and military receivers (ie expensive ones) use multiple-conversion schemes, correctly anticipated by Armstrong all those years ago.

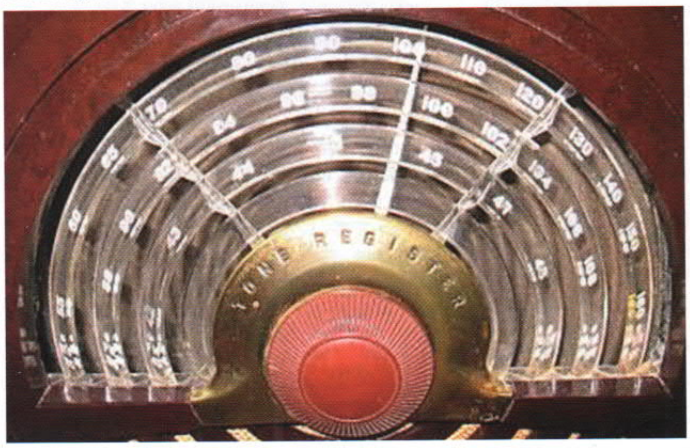
The prototype superhet Armstrong had produced was unsuitable for mass production, and the work now started to what we would call 'productise' the circuit. Ideally a superhet should have two controls: the tuning knob and the volume control (and maybe a bandswitch if you want to cover more than one band). Armstrong's prototype was a long way from this ideal: you can imagine how the input tuning, local oscillator frequency and coupling, IF amplifiers' frequency settings,

Below: Figure 3. VHF feeder unit, Practical Wireless, June 1964





Above: Figure 4. The Explorer circuit, *Practical Wireless*, January 1967



The dial of the Zenith 7H820 radio, which covers the original FM band of around about 42MHz to 48MHz

Eilen RX18 receiver, 1937

Armstrong FM label

detector regeneration control and various HT, bias and LT voltages were all variable, as you'd expect in this highly experimental set.

In fact the superhet was slow to get into commercial production. It was more complex than the good old TRF, and newer valves, capable of amplifying at higher frequencies, and the almost universal application of Armstrong's original invention, regeneration, made the TRF a continuing potent form of receiver for many years to come. It wasn't until higher IFs, the design of correct tracking of the aerial and oscillator circuits, and the need (because of more crowded broadcast bands) for better selectivity than the TRF could supply, that the superhet gained ascendency, in the late 1920s/early 1930s. The first RCA-produced set hit the shops in 1924. Reference 8 gives an excellent account of how the superhet developed and slowly gained acceptance until, by about 1934, it completely dominated receiver production.

Making Money and Litigation

In 1920 Armstrong received and swiftly accepted an offer of $335,000, payable over ten years, for both his regenerative detector and superhet patents, not from one of the established names in the industry, but from the Westinghouse Electric & Manufacturing Company. Armstrong badly needed the money to continue his development work and pay his lawyers. An additional $200,000 would be paid once the feedback oscillator patent, still held up in interference proceedings with de Forest, was issued. Westinghouse had been left out of the 1919 wireless industry agreement, but saw the potential to make money and were playing catch-up. Having purchased a large interest in a company founded on Fessenden's inventions, it now saw the importance of Armstrong's work and saw its acquisition as a way of leap-frogging the competition.

In those heady early days, Armstrong became a millionaire, but he continued his association with his well-loved Columbia University initially as an assistant professor of electrical engineering, eventually succeeding Pupin, but taking no salary and delivering very few lectures. He set up his development laboratory in the basement of the University's Philosophy Hall, which was to remain his base for the rest of his life.

During the 1920s and 1930s Armstrong was involved in what was, for the time, the longest patent lawsuit ever litigated, at 12 years. In particular, it concerned the regenerative circuit, patented, as you will recall, by Armstrong in 1914 and subsequently patented

by Lee de Forest in 1916. Needing the cash, de Forest had sold the rights to his patent to AT&T. Between 1922 and 1934, Armstrong was embroiled in a patent war, between himself, RCA, and Westinghouse on one side, and de Forest and AT&T on the other. Armstrong won the first round of the lawsuit, lost the second, and was stalemated in a third. When the case ultimately came before the Supreme Court of the United States, de Forest was granted the regeneration patent in what is today widely believed to be a totally unfair judgment, based on the misunderstanding of the technical facts.

Super-regeneration (1922)

The next significant contribution Armstrong made to radio technology was super-regeneration, and as it sounds, it's a development from regeneration,raising the potential amplification factor, and hence the sensitivity of any receiver using it, by several orders of magnitude. The clever 'trick' of the technique is that it effectively 'automates' the adjustment of the regeneration control, passing through the point of highest amplification hundreds of thousands of times a second.

The effect was discovered by Armstrong somewhat by accident whilst setting up a regenerative receiver, which suddenly burst into a previously unknown high volume level and then returned to its normal level. A less inquisitive man may have shrugged his shoulders and dismissed it as 'just one of those things', but not Armstrong. The ever inquisitive and patient Armstrong was shocked by the knowledge that after almost ten years' work on the subject, the regenerative circuit had sprung a surprise on him. After many weeks of exhaustive work, he pinned the effect down to a new form of operation of the regenerative circuit, which he called 'super-regeneration'.

Armstrong filed patent number 1,424,065 'Signaling (sic) System', on 27th June, 1921, and the patent was granted relatively quickly on 25th July, 1922. The application says: "This invention has for its object the provision of a method of operating an electric regenerative system and of apparatus for obtaining enormous amplification of varying electric currents by means of certain modifications and applications of the well known feedback or regenerative principle. The results obtainable are of striking character and are the results of a new principle which will be termed super-regeneration". As usual the detailed patent description of the principle isn't easy to understand, which always seems to be the case.

Most readers will have heard of super-regeneration, but maybe a reminder of how it works would be useful. Unlike a 'normal' regenerative receiver, a super-regenerative receiver uses a lower frequency oscillator (either within the same stage as the detector or by using a separate oscillator stage) to provide in a single device, circuit gains of around one million. This second oscillator periodically interrupts or 'quenches' the main received RF oscillation, allowing the RF signal to be built up over and over. Strictly speaking, the main RF oscillation still occurs: the detector starts to build up the incoming RF signal to and slightly above oscillation level. But the net result is that most of the time the detector is amplifying the RF signal and is creating a free running RF oscillation in only a small portion of its quenching cycle.

One way of looking at this is to think that the quench circuit is adjusting the regeneration control up and down at an ultrasonic rate, typically around 100kHz. At some stage of this rapid adjusting of the regeneration control, the circuit is going to pass through the high sensitivity of a perfectly adjusted regenerative receiver, when signals will be received at great sensitivity. In order to hear the demodulated signal, you need to filter out the RF oscillation and the quenching/regeneration frequency with a low pass filter, and all that is left is the ultrasonically sampled demodulated audio.

Of all Armstrong's inventions, this is possibly the most 'nichey' and has probably had the least commercial exploitation over the years. It's interesting therefore that in the heady days of the early 1920s, RCA valued the invention so much that they purchased it for $200,000 and 60,000 RCA shares, well before the superhet, which preceded it by four years or so, could be commercially exploited. RCA in general, and its general manager at the time, David Sarnoff (who was an old friend of Armstrong) in particular, saw in it a new receiver technology, capable of reviving their flagging sales at the time in the face of stiff competition. In fact the technique was not very suitable for use in receivers in the AM broadcasting world that was developing: specifically, it was not able to separate stations from one another when they were close together. Another drawback with the super-regenerative receiver is that the detector outputs a characteristic hiss until a signal is tuned in, when it stops and clear audio is heard. A practical receiver therefore needs a squelch circuit to eliminate this annoying hiss.

Applications of Super-regeneration

As I researched this article I found many examples of the use of this technique, which was for many years the most effective method of receiving higher frequency transmissions. I'm being deliberately vague with the phrase 'higher frequency' as of course this is a relative term, the meaning of which has varied over the years. Let's take a look at some of these applications, which may be unfamiliar to the reader, and see the types of usage where this invention had advantages over other receiving techniques.

Many of you will be familiar with the Wireless Set No.19, used mainly in armoured vehicles. The short range UHF (round about 235MHz) 'B Set' transceiver in this famous transceiver, used in vast quantities in World War II, used a super-regenerative receiver. In fact over the years, lots of military and commercial walkie-talkies have used super-regenerative receivers, because of their simplicity.

Although not found in too many commercial receivers, super-regeneration has been used in amateur designs from time to time. Writing in 1955, the author of Making a Radio Telescope (reference 9) wrote: "... the successful construction of a radiotelescope seems to be beyond the capabilities of an amateur. A TRF receiver with sufficient gain has - of necessity - insufficient bandwidth, and the input of a superhet seems to be too noisy to be of any practical use. A super-regenerative receiver can, however, easily be made to fulfil these requirements satisfactorily. It has sufficient bandwidth, extremely high gain, and its signal-to-noise ratio can be kept low enough to be employed usefully to detect the faint signals from the Sun or the Milky Way". Praise indeed for this application of super-regeneration to listening to non-manmade radio sources.

A Two Stage VHF Feeder Unit for 45-108Mc/s, using a 954 acorn pentode pre-amplifier and a DET20 triode self-quenching super-regenerative detector, appeared in Practical Wireless in 1964 (see Figure 3, from reference 10). A transistorised version of this circuit appeared later as The Explorer AM/FM VHF Receiver (see Figure 4, from reference 11), having an RF amp and self-quenching super-regenerative detector, based on Sinclair ADT140 transistors. The title of this article emphasises that this form of detector is equally at home demodulating AM and FM signals. These two relatively recent circuits show that an RF amplifier is essential to isolate the detector from the antenna, to eliminate any possibility of the oscillating detector from radiating via the antenna.

As high frequency transistors became available in the 1960s, many single transistor FM broadcast band (88MHz - 108MHz) and AM aircraft band (108MHz – 137MHz) receivers using the super-regenerative principle were published in amateur magazines. Many simple valve and transistor radio control receivers also used the technique, giving compact and low power receivers, of prime importance in radio controlled models.

If you thought super-regeneration was now a dead technology, I found many references on the Internet for such receivers, including one for a "micropower integrated super-regenerative transceiver for 868MHz, built on 0.8µm BiCMOS process"!

Radio Technology in the 1930s

Let's go back in time again and look at the major effect Armstrong's inventions had on the state of radio technology by the middle of the 1930s. An interesting snapshot of state-of-the-art amateur receivers can be gleaned from publications of the time. For example, the March 1937 edition of the US-produced Short Wave

and Television Magazine (reference 12) shows a mixture of regenerative TRF and superhet receivers. The Eilen Radio Laboratories RX-18 receiver, covering 3,000 to 2½ metres (approximately 100kHz - 120MHz), is basically a TRF with an RF stage and a regenerative detector for wavelengths between 8½ to 3,000 metres, but to quote the advert "for reception below 8½ meters, an additional 6J5G tube is used in an extremely sensitive super-regenerative circuit, whose output is fed in (sic) the amplifier in the usual manner". In the advert for this receiver (see the photograph) frequencies around the 2½ metre wavelength are referred to as "ultra-high frequency wavelengths", in the strange mixture of wavelength and frequency terminology used at the time. In the mid-1930s, this was the only way these Very High Frequencies (VHF), as we would now refer to them, could be received, being way outside the range of a superhet, which typically petered out at 25MHz or so.

It makes me wonder what was going on at these elevated frequencies in the 1930s? A list of the world's broadcast stations in 1937 shows the highest frequency in use of 31.6MHz by a handful of US-based 'broadcast experimental' stations, and then an empty gap of 10MHz or so down to regular 'broadcast service' stations round about 21MHz. Included in this category was GSJ, the BBC's short wave service from Daventry, on 21.530MHz. Certainly there were amateurs pushing the high frequency boundaries, but commercial VHF transmissions hadn't started yet.

So here we are in 1937 and all receivers used at least one, and often two, out of Armstrong's three key inventions so far, namely regeneration, super-regeneration and the superhet principle. Let's also remember that the local oscillators in all the superhets, as well as the oscillators in all the transmitters in use, used Armstrong's regeneration (or feedback, as we would call it in this application) circuit to maintain oscillation.

Wide-band Frequency Modulation (1933)

By the early 1930s Armstrong believed that the radio industry had compromised on quality for the sake of low production costs, driven to low selling prices by stiff competition, and there's some truth in the claim. We are probably all familiar with the target of Armstrong's ire: the 'All American Five' circuit was a standardised, low cost circuit, pared to the bone, and of indifferent audio performance, manufactured in its millions by hundreds of manufacturers right up to the end of the valve era (and very collectable today). Maybe Armstrong missed the point that this approach to radio design had resulted in the democratisation of communication. Radios had sold in vast numbers all over the world, and the masses now had the means of finding out what was happening in their own country and in the rest of the world. Let's not be too highbrow about this: they had also, of course, found a new a source of mass entertainment.

Radio sales seemed to have reached a plateau: many smaller radio producers had gone bankrupt and even the mighty RCA posted heavy losses in 1932 and 1933, driving the corporation, and most others, to cost–reduce its products as much as possible simply to survive.

The other problem that the industry, including Armstrong, was grappling with was interference, both man-made (presumably from electrical machinery and motor cars), and natural noise from thunderstorms in the atmosphere. Generically these types of interference were known as 'static', and being pulses of RF energy, similar to man-made broadcast AM itself, it was readily demodulated by AM radios, and manifested itself as the buzzes, crashes and other noises we are all familiar with. Expensive professional and amateur receivers incorporated 'noise limiters' which helped to some extent, but didn't solve the problem for low cost domestic radios.

These two ideas of how to eliminate static interference whilst improving audio quality came together in Armstrong's mind and crystallised around the capabilities of FM. What Armstrong was now trying to develop was not simply a new type of, or an enhancement to, a receiving technique, but a new type of modulator, an associated receiver, and the allocation of frequency for FM broadcasts. All this, of course, was happening in the face of an entrenched AM-based broadcast and radio manufacturing industry. If that wasn't bad enough, the Depression of the 1930s militated against the massive investment needed to develop and deploy this new technology. It's a classic 'Catch 22' situation: the industry needed investment in new technology to stimulate new sales to bring it out of the Depression, but it was in survival mode and simply didn't have the money to make that investment.

FM wasn't a new modulation technique: way back in 1903 there had been unsuccessful attempts to employ it using an arc transmitter. After the invention of the valve oscillator in 1913 (by Armstrong himself of course) more attempts were made to harness what looked like a reasonable candidate for a new modulation method. However the prevailing opinion of experimenters and mathematicians until Armstrong's work in the late 1920s was that FM offered no hope of a practical communication system. In fact it was RCA's engineers who had been the most vocal in their conclusions that FM was a non-starter. This opinion was somewhat influenced by the notion that any new FM-based transmitters would have to be 'shoe horned' into the existing AM broadcast bands, between existing AM stations. As a result, any analysis of 'narrow-band' FM reached the valid conclusion that the transmission of intelligible speech or music was impossible. As was typical of the man, Armstrong didn't approach the problem from this standpoint.

Armstrong was very suspicious of mathematicians who told him something was impossible, and always took the experimental approach, believing that their wrong conclusions could easily be based on wrong assumptions. And so it was that Armstrong guided his engineers in the development of FM as a viable broadcast system from first principles.

His first breakthrough was not to allow himself to be constrained by any need for a narrow-band signal, instead allowing the FM modulator to produce a very wide output spectrum, when compared to a typical AM signal. Clearly this had serious implications on the frequency bands that would eventually have to be used, and hence the design of transmitters and receivers, but Armstrong didn't let this worry him at this stage. Wideband FM, as he was producing, turned out to be capable of transmitting with very high fidelity and clarity, and was much more resilient in the face of interference than AM.

Armstrong secured three patents covering wideband FM in 1933. They are: 1,941,066; 1,941,068; and 1,941,096: others followed as the system was refined. You can see the vast bread–boarded FM system he produced in his photograph, sitting in the basement lab of Philosophy Hall, Columbia University.

Just before Christmas 1933, Armstrong invited Sarnoff (who was by now President of RCA) to his laboratories for a demonstration of the new FM system. Armstrong was still a considerable stockholder in RCA, kept a keen interest in what the corporation did and was willing to offer the company first refusal on the fruits of his work, at a price of course.

What Sarnoff was looking for was a relatively simple circuit that could be grafted on to AM radio designs to magically eliminate static interference and hence restore RCA's fortunes. What he saw was nothing like this: indeed it was a room full of bread–boarded valve circuits and test gear. He soon realised that this was a completely new radio system, needing new transmitters, receivers and frequency allocations beyond the capacity of the currently used AM bands.

Not dismissing the system immediately, at least Sarnoff had the foresight to acknowledge the potential of the system and kept his engineers talking to Armstrong. It was suggested that the FM transmitter be moved to the top of the Empire State Building for 'real' broadcasting tests. So in the spring of 1934 the FM modulator was set up at the top of the Empire State, and connected to a 2kW, 44MHz transmitter which was already there for experimental TV purposes. The receiver was set up some 70 miles away on Long Island.

A word or two about Armstrong's FM receiver: I had imagined initially that this was an ideal application for super-regeneration, and indeed some commercial receivers that were eventually produced did use this technique, but Armstrong's design was pretty much what we would expect today from a quality FM receiver. It was a superhet, 'heterodyning' down the incoming signal to an intermediate frequency where it was amplified, and then passed through a

'limiter', which clipped off any amplitude variations, and hence eliminated any amplitude-carried interference the signal may have picked up en route. The FM signal was then converted back into amplitude variations by a 'discriminator', ready for detection and amplification by the final stages of the superhet.

Armstrong made the first public demonstration of his FM system at the end of his lecture 'A Method of Reducing Disturbances in Radio Signalling by a System of Frequency Modulation' in front of a large meeting of the Institute of Radio Engineers on November 5th, 1935. The transmitting station on this occasion was the amateur station of Armstrong's old friend Randy Runyon, W2AG, converted to operate FM on 110MHz (remarkably close to the final FM band allocations in the US and UK). Again the transmitter was seventy miles away from the receiver.

The repertoire of the test consisted of voice, music (both live and from records) and the pouring of a glass of water, the crumpling of paper and the striking of an oriental gong, intended to show off the high signal to noise ratio and high dynamic range of FM, resulting in the overall high quality of the radio link. No one who heard the test was disappointed.

However, from a commercial point of view, the reaction to the new system was low key. This was not simply a case of designing and building some new low cost radios (or modifying existing models), and selling them. There were no FM stations on the air, and the challenges of getting commercial stations on the air at frequencies around 100MHz were known to be significant.

Maybe Sarnoff was pre-occupied with the development of RCA's TV services which were planned for launch in the second half of the 1930s, and perhaps he even saw the high bandwidth needs of FM radio broadcasting to be in competition with TV's requirements. RCA certainly benefitted from Armstrong's pioneering work in proving the viability and range of transmissions in the 40MHz - 110MHz range, seen to be ideal for TV channels.

For Armstrong the battle to get FM broadcasting adopted now became a personal crusade. One view is that a commercial organisation like RCA has the right (indeed the obligation to its stockholders) to choose to roll-out services, or not, based on sound financial analysis. The corporation simply decided to give TV priority over FM, and in the end the buck stopped with the President, David Sarnoff himself, for such an important decision. It was nothing personal, that's where he saw the most market potential. In retrospect when we look at the dollar/pound size of the TV industry compared to the size of the radio industry, he was probably correct. Another view, and almost inevitably the one Armstrong took, was that a single monolithic corporation like RCA shouldn't have the right to deprive the American people of a major innovation, or dictate the order in which inventions are introduced.

FM Broadcasting Begins

The 'guardian of the airwaves' was of course the FCC and they were being successfully lobbied by RCA and NBC to resist Armstrong's request for spectrum for experimental FM broadcasting. Eventually Armstrong was reluctantly granted a license to broadcast FM in a small frequency allocation, beginning in 1939, and even created his own station, W2XMN, in Alpine, New Jersey. Surprisingly, applications for FM licenses poured in and the network built up quickly, prompting more and more manufacturers to add the FM band to their sets, and paying Armstrong royalties for the privilege. You can see 'The Armstrong System' license logo on the back of a late 1940s Zenith 7H820 radio, which covers the original FM band of around about 42MHz to 48MHz, in the photograph. This model is relatively rare, as it was only made for one year, and is very collectable, as are other sets featuring the 'Armstrong FM band'.

But RCA did not give up on harrying Armstrong's continuing efforts to promote FM broadcasting. RCA were still lobbying the FCC on the allocation of frequencies for the fledgling television industry. Although they denied any wrongdoing, RCA (and we know that Sarnoff himself was heavily involved in this process) managed to get the FCC to move the FM radio spectrum to its final resting place of 88MHz to 108 MHz, while getting new television channels allocated in that 40MHz to 50MHz range. Of course as soon as that happened, all radios covering the original 'Armstrong' FM band were rendered obsolete overnight.

When eventually RCA saw the merits of FM, they tried to get around Armstrong's patents with the use of the 'ratio' or 'Foster-Seeley' detector. This had the merit of combining the limiter and discriminator functions into a single circuit stage. There was a loss in quality, mainly in that it was sensitive to amplitude variations (which was Armstrong's aim to eliminate) for the sake of lower cost, which of course grated on Armstrong's philosophy. RCA even successfully offered their detector to licensees with claims of 'Super-FM', as entirely developed by RCA's engineers. Eventually in 1948, Armstrong debunked all the claims of the ratio detector and proved it to be what it was, a poor quality imitation of the 'real thing'.

Of course how FM broadcasting turned out was not quite how Armstrong had expected. AM is still a dominant force in popular broadcasting, with many high power stations still crammed into the relatively narrow Medium and Long-wave bands, just as they were in the 1930s. FM is reserved for high quality stereo broadcasts from a network of relatively local transmitters. The two modulation systems happily co-exist, and the threat to both today is from new digital modulation systems such as DAB and DRM.

The Second World War

When the Second World War broke out in Europe in 1939, 'Major' Armstrong was no longer the young man capable of donning his uniform and getting directly involved. Knowing of his innovative reputation the US Signal Corps came looking for advice on how they could adapt FM into their mobile communications systems. In his typical patriotic manner, Armstrong put his lab at the disposal of the military at no cost.

When the US entered the war in 1941, production of commercial radio equipment was suspended, which also meant a dead stop to the development of FM broadcasting. Existing FM stations, including Armstrong's own W2XMN continued to broadcast, but no new stations or new FM receivers were built throughout the war years.

Of course the number of years that Armstrong's patents still had to run continued to count down, war or no war. At the time a US patent gave exclusive rights to the patentee for only seventeen years from the date of grant, and so 1950 was the deadline year for the FM patents.

The Beginning of the End

In 1948, Armstrong's basic FM patents had only two more years to run. Since 1933 he had taken on himself all the technical and commercial risks of getting FM adopted as a high quality radio service. In July 1948 Armstrong's lawyers began the suit against RCA and NBC for "wilful infringement, and inducing others to infringe", the basic FM patents. Armstrong stood to win damages on all FM radios and TV (ironically TV sound used FM) equipment manufactured by RCA, and its licensees, during the full term of the patents, a vast sum of money by any estimates.

Big corporations know how to grind down individuals and employ delaying tactics in order to deplete an individual's funds and allow a patent to run out of time. And so in 1949, the exhausting process started for Armstrong, with nit-picking questioning on irrelevant detail at the preliminary cross-examinations, which were the precursor of the main court action. The contest was to drag on for the next five years, terminated only by Armstrong's death. It wasn't for another four years that Sarnoff himself, still President of RCA, appeared in the witness box and was examined by the lawyers. Remarkably he commented "I will say that the RCA and NBC have done more to develop FM than anybody in this country, including Armstrong". Armstrong was in the courtroom that day and maybe that was the day the spark died, betrayed by someone who had once been his close friend.

From time to time during the protracted proceedings, there were attempts to settle out of court. Armstrong's lawyers knew the risks of fighting a big corporation to the bitter end, when the outcome would be far from predictable. Armstrong himself was, as he had always been, convinced of the justness of his case and insisted there would be no out of court settlement, and vowed to fight on.

His wife Marion (who had been Sarnoff's

secretary at RCA in the early 1920s, and had been wooed by the young Armstrong), had learned to live with his passion, and lived a lonely life, the couple having produced no children. She was sick herself, and after a bitter argument with her husband late in 1953, she left to stay with her sister in Connecticut, where she had planned for the couple to eventually retire. Armstrong's health began to fail, and all those around him felt he was near to a breakdown. FM broadcasting was no longer making him much money, as most of the patents had expired in 1950, though royalties were still trickling in. Even Zenith, who had paid him more than $1m over the years, announced that they would pay no more royalties. RCA sensed that Armstrong was at the end of his tether and made a last offer of settlement, which was refused.

On the night of Sunday January 31st 1954, Armstrong wrote a letter to Marion, expressing his deep sadness at having hurt "the dearest thing in the world to me". He continued that the financial future was secure, especially if the currently running court cases turned out well. He then dressed himself and walked not out of the door, but out of the window of the thirteen story building. His body was found the next morning: because the exact time of death was not known, his death was variously reported as having occurred on January 31st or February 1st 1954. His gravestone in the Merrimac, Massachusetts cemetery records the death as having occurred on February 1st 1954.

In December 1954 the FM suit was finally settled, with RCA and NBC paying the Armstrong estate something like $1m, which ironically was the same amount that had been proposed to Armstrong himself way back in 1940. Who knows whether the tragic death had triggered a bout of conscience in those who decided whether and how hard to fight the case? That initial settlement didn't cover the claims against other radio and TV manufacturers and gradually throughout the 1950s and 1960s, many millions of dollars were collected from these violators of the Armstrong patents.

In Summary

Having been a professional engineer for all my working life (I still am), I know I'm biased, but surely the process of engineering 'invention' is more creative than scientific 'discovery'? After all, any discovery is by definition there just waiting to be found (OK, I admit this is a bit of an over simplification), whereas invention needs the imagining of a mechanism or process that does something that has never been done before.

The act of invention almost always leads to patenting and an attempt at commercial exploitation, which has up-front and ongoing expenses, personal pressures, frustrations and possibly tragic consequences when the inventor comes up against the realities of the commercial world of big money. If you're not convinced about this, just watch an episode of Dragons' Den to see how many 'good' ideas fail the money test. Ultimately for Armstrong, the pressures became too great, with tragic consequences.

Let's not be too critical of the process of trying to make money: as BVWS members, 99% of the radios and TVs we collect, restore and treasure were built by commercial concerns with the aim of making money, not out of a charitable desire to make communication available to the population of planet Earth. Some of these commercial concerns no doubt trampled on the hopes and aspirations of numerous inventors, Edwin Armstrong amongst them.

Armstrong never had the intention of retiring in luxury on the royalty and licensing proceeds of his inventions: he always ploughed any profits back into the inventive process, funding his own labs, to the ultimate benefit of radio itself. At the FM hearings in the late 1940s, Armstrong himself said "It is perfectly obvious that all my life I have used the proceeds of one invention to make another one, and anyone who adopts any other policy in this world will not long continue to have the facilities or the ability to do research and make invention". Let's also remember that Armstrong had to popularise FM, in which he believed passionately, by building and operating his own broadcast station, in the stubborn absence of interest and investment from the main broadcasters of the day, though they were the ultimate beneficiaries.

For the radio industry, Armstrong was the ultimate inventor, contributing five incredibly significant and potentially money-earning, improvements to radio technology (regeneration, the continuous wave oscillator, the superhet, super-regeneration and FM broadcasting), which we still benefit from today, and will continue to for many years to come. In all, he received a total of 42 patents, of which just the few most significant ones have been described here.

Like his life and achievements, the story of Edwin H Armstrong has been long and complex and I hope you stayed with me this far. Try to add up all the regenerative TRFs that were produced in the 1920s and 1930s and drove the rapid growth of the industry; then add in all the superhet-based radios and TVs produced in the following 70 years, and which are still being produced and designed today, using essentially the same principles. If that's not a big enough number, add in all the pagers and mobile phones ever made. Even the most modern DAB and DRM radios, maybe using software demodulation techniques are still superhets. Then think about all the millions (billions?) of hours of FM broadcasts ever made, and think about how that will continue for at least the next 50 years. Now you start to realise the debt we owe to Armstrong, and the sadness of his self-inflicted demise.

Unfortunately for Armstrong, no unit of electricity, or physical effect or constant was named after him. He didn't leave behind a large manufacturing corporation making 'Armstrongs' which we could collect and restore, and so the name has all but faded into history. Hopefully this article has resurrected his name and we will pay respect whenever we switch on a TRF with reaction, or a transmitter, or a superhet, or a radio with an FM band. Thinking about it, that doesn't leave many radios that won't remind us of the great inventor, Edwin Howard Armstrong.

References

Reference 1: BVWS Bulletin Spring 2005 Volume 30 No. 1. Letter from LL (Bill) Williams.

Reference 2: BVWS Bulletin Autumn 2002 Volume 27 No. 3. The Gillian 68F of 1948 by Gary Tempest.

Reference 3: Man of High Fidelity: Edwin Howard Armstrong, by Lawrence Lessing. Published in 1956, by J B Lippincott Company of Philadelphia and New York.

Reference 4: The Legacies of Edwin Howard Armstrong, by various authors. Published by the Radio Club of America. Library of Congress Catalog Card Number 90-63056, 1990.

Reference 5: The First Radio Broadcast, Christmas 1906, by W S Marcell. Radio Bygones No. 20, Christmas 1992.

Reference 6: 70 Years of Radio Tubes and Valves, by John W Stokes. Published by The Vestal Press, in 1982.

Reference 7: www.pat2pdf.org/patents/pat1342885.pdf. www.pat2pdf.org is a good patent website where you can download pdf versions of many original patents, including those of Armstrong.

Reference 8: The Coming of the Superhet by Lorin Knight, parts 1 and 2, Radio Bygones Nos. 8 and 9.

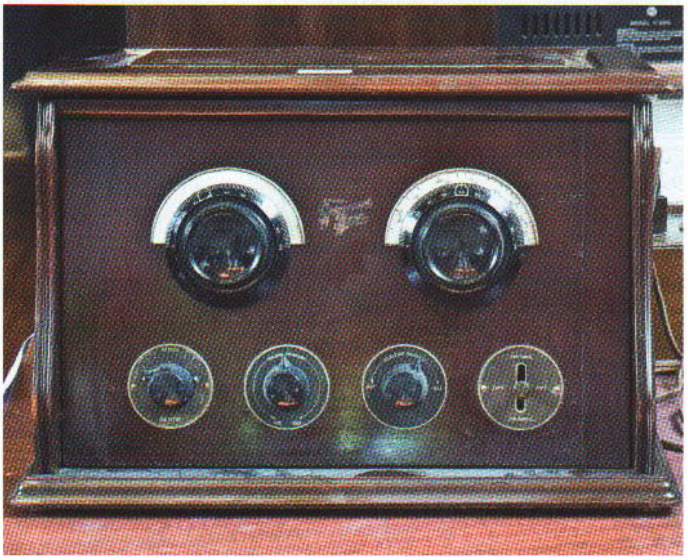
Reference 9: Making a Radio Telescope by W Schroeder. Practical Wireless, May 1955.

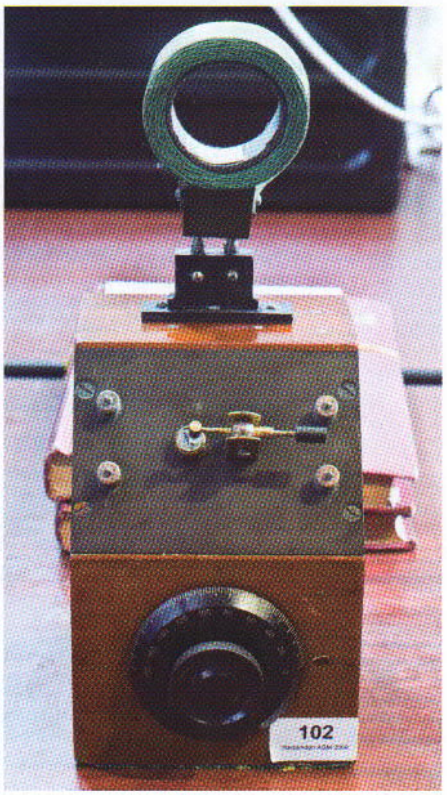
Reference 10: A Two Stage VHF Feeder Unit for 45-108Mc/s by A Sydenham. Practical Wireless, June 1964.

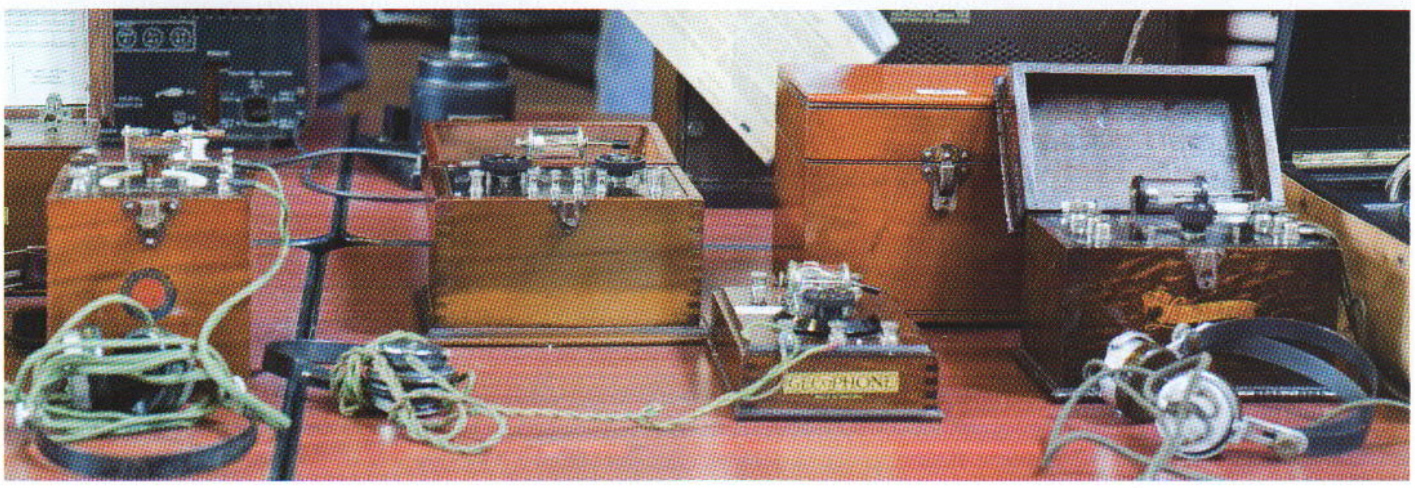
Reference 11: The Explorer AM/FM VHF Receiver by W E Bardgett. Practical Wireless, January 1967.

Reference 12: Short Wave and Television Magazine, March 1937.

Pictures from Harpenden photography: Carl Glover








86


73
BANDWIDTH
CRYSTAL


"MARCONI"
WAVEMETER
TYPE MG1E P.S. Nº 7850
INST.Nº 199014
MARCONI'S WIRELESS TELEGRAPH CO. LTD. LONDON.


97


92


76
AMPLIFICATION
STATION SELECTOR
RCA
Radiola III

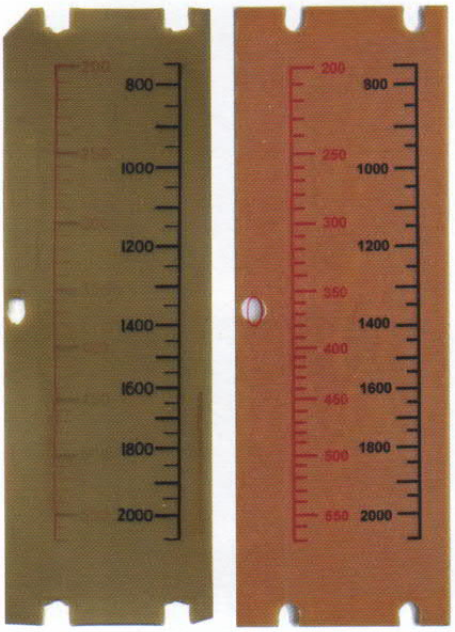

AERIAL
EARTH
PHONES
PHONES
"THE LINTOPHONE"
P.M.G.Nº 444


VALVE
CHARACTERISTIC METER

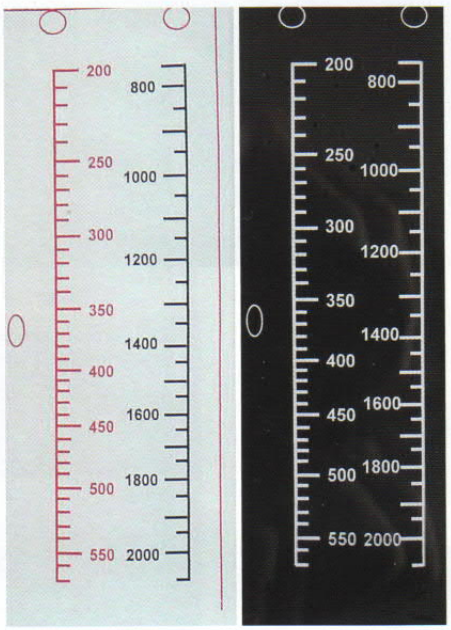
Making Dials by Gary Tempest

I have been experimenting with making dials recently using transfers (decals in the USA), Window Film and the ultimate by Silk Screening.

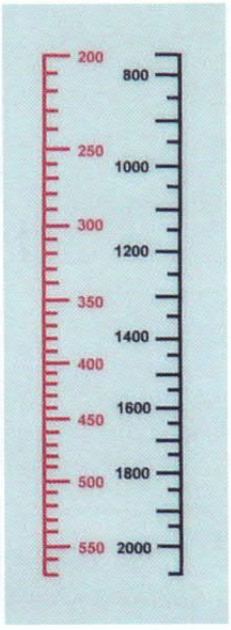
To do this you need a sophisticated graphics program and a fast computer to run it on. I'm not being snobby here, a slow minimum 'spec' one will get you there but you will lose a lot of finger nail waiting for the 'egg timer'.



1: Aerodyne Drake dials - Original and decal replica



2: Acrylic dials - Decals rear mounted, mirror and inverted



3: Front mounted decal on white styrene

Several graphics programmes are available and Adobe Illustrator and CorelDRAW are two that I know. I'm using Corel. You don't need the latest version; the previous ones are affordable now and you could chance a second-hand one from someone doing an upgrade. Beware of Educational versions though, as you may not be able to register it (unless you're a student!). Are the programs hard to learn? It depends upon your background: if you have done some PhotoShop work and used simpler drawing packages then it shouldn't be too steep a learning curve. If not you are going to struggle but there is help from lots of free on-line tutorials and books to buy.

A great strength of the program is being able to work in layers, which can be locked to avoid inadvertent changes. On the first layer you can put a scan of the original dial, which can be switched from view at the click of a button.

On the next layer can be added rectangles, lines and curves, referred to as "objects". Here the same shapes can be quickly made by 'step and repeat', adding offset from the original positions as needed. Objects can be positioned in front of others or behind. Groups of objects can be selected and moved into position and there is a zoom facility for getting things just right. Also, there are movable guidelines (with powerful measurement tools) with the option to have objects 'snap' to, which is more accurate than manual placement. I wouldn't layout the main composition over the scan of the original as errors magnify. It's much better to take measurements and create from scratch, but it's good to be able to flip it on though to check how things are going.

It's advisable to put text on its own layer, or layers, so that it can be edited without affecting the position of other objects. Text can be a whole range of fonts, sizes and colours and can be rotated to any angle you like. Normally, a font can be found that is close to the original but most likely the character spacing will be wrong. However, Corel allows words to be 'pulled' so that the spacings increase without the individual characters being changed. Here, it is essential to put the scan of the original dial in view to get this correct.

For dial work only a fraction of the programme facilities will be used. One useful one is 'mirror' where the artwork can be flipped horizontally so that the image can be applied to the rear of glass or acrylic sheet.

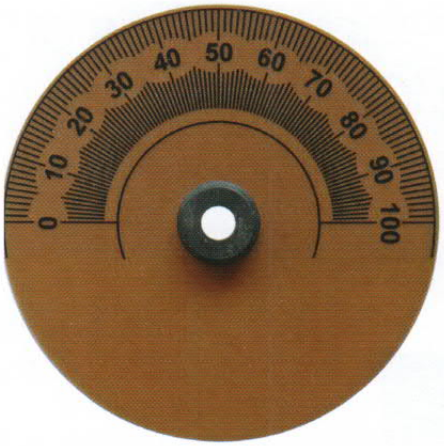
Simple rectangular dials

In Picture 1 is shown the dial for an Aerodyne Drake alongside the original. The artwork was inkjet printed onto good decal material obtained from the USA (Ref. 1). I haven't found any of this quality, with such transparency, in the UK. As normal it needs spraying with a couple of coats of lacquer before application. For me matt lacquer is best, as once the completed item is sprayed then the decal virtually disappears. It was mounted onto 22 'thou' amber phenolic stock (USA Ref. 2). It's a good idea to make the decal slightly undersize to the phenolic so that when a few finish coats are applied the edges are sealed.

Picture 2 left, shows the same artwork, as an experiment, printed in mirror image and mounted on the back of 2mm clear acrylic sheet. Once dry it was sprayed with matt white primer. Picture 2 right, is the artwork, printed in inverse, again on acrylic sheet. The letters could be painted white or any colour. Glass paint would make the letters translucent when lit from behind, but I didn't have any so this wasn't tried. The black areas of the decal are reasonably dense but would probably need extra paint over them if backlit. Picture 3 is a decal, front mounted, on a sample of white styrene 20 'thou' sheet (USA Ref.2 but similar can be obtained from Hobbie's of London). I have intentions to try this material for making dials for early EMI sets with drum dials. It will be a challenge to do this with decals; setting a 10" length down successfully seems most unlikely. Maybe it will have to be a silk screen.

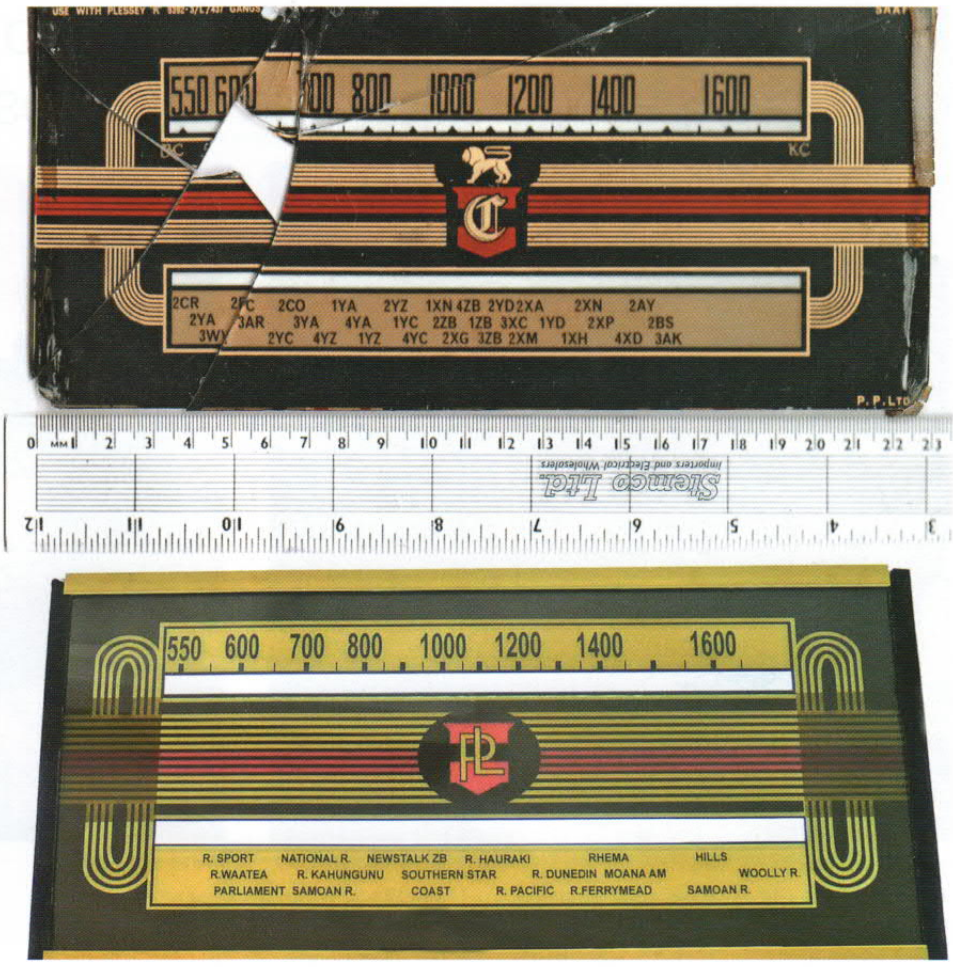
A more complex circular dial (Picture 4)

This was needed for an American TRF radio, where the dial only rotates 180 degrees and is viewed through a small peephole window. It's the same decal material and phenolic sheet but the artwork was a little more challenging. It demonstrates CorelDRAW's ability to step and repeat lines and numbers around a circle. Once it was mounted I cut out the circle using a hand operated circle cutter. I did it by taping the sheet to a piece of plywood and drilling a small centre hole for the point of the cutter. Once I had the disc I enlarged the centre hole to the 1/4" required.



4: Dial for a USA TRF (front mounted decal)

5: Window film



6: Original and finished dial using Window Film

Drills 'pick up' readily in the phenolic so it was best to enlarge it just enough to use a small, hand operated, tapered reamer.

A dial using DECAdry Window Film
(Pictures 5 and 6)
This was made for member Peter Lankshear, 'down under', who had unfortunately broken the dial on his home built radio, which is used and displayed as a freestanding chassis. The original dial had come from a scrap radio so I didn't need to make a copy and artistic licence was in order.

The dial is a two glass sandwich, with DECAdry inkjet printable window film (purchased from Staples) applied to one piece and then covered by the other. I used 2mm glass, as it is stiff and flatter than acrylic sheet so less optical effects occur; none in this instance. The film, which produces impressively dense colours, has a backing that is peeled off as it is applied. It takes a bit of practice to get it on bubble free but the final result was close to perfect. I sprayed the film before applying with a couple of coats of gloss lacquer; satin or matt would have clouded the pointer windows.

The sandwich was held tightly together with masking tape. Afterwards the rear glass was masked off and sprayed with matt white primer and a little matt black where the dial lamps are.

When attached to the chassis the ends are out of sight by the fixing method. For the top and bottom I found some brass square U channel that was a push fit over a double thickness of tape.

The Ultimate: A silk-screened dial
This dial, Picture 7, was for the HMV 650, it is the HMV version of the Marconi 561 (see Bulletin Winter 2003).

This was started with a little trepidation as there were many requirements outside of my control. I was certain I could produce satisfactory artwork as I could spend as much time on it as needed. However, the glass cutting and screening needed both companies to do accurate work to make the final outcome a success.

The glass was difficult as it has a hole for the pointer needing accurate positioning and a 45-degree bevelled top edge. The bulb and its light tube are set back from the dial and the bevel allows as much light as possible to be transmitted through the glass to illuminate the lettering. It was expensive and could have been 30% cheaper to have just had a flat polished edge, but I wasn't prepared to compromise. After a lot of searching I found only one local company, Basildon Glassworks, who have CNC (Computer Numerical Controlled) machining to do the job properly. Apart from the other requirements they also "harrised" (Yes! This is the trade term used) the other three edges by grinding them to be rounded and blunt.

For the silk screening I needed a "separation" (a clear output with black composition lines and text) for each colour on the dial.

The artwork was created in one file and used Coral's ability to view and print by switching off layers as needed. The files were sent to the silk screening company, Rayleigh Silk Screens, by e-mail and they produced the required films as they must be printed using a Laser Printer rather than the ubiquitous Ink Jet.

The films are used to create the 'silks', which nowadays are a synthetic material having the requisite fine mesh. This mesh is coated with a light sensitive emulsion that is hardened where ultra violet light can pass through the film. The areas not exposed allow the emulsion to be washed off and subsequently to pass the inks needed for printing. The areas that were exposed will screen the item from the inks. Once the screens have been made they are then mounted, above the glass, in a flat bed machine, looking somewhat like a medieval torture instrument, for the ink to be manually squeezed through where the mesh is open. Obviously alignment of the individual screens, for each colour, is critical and each screen is registered using two 'gun sights' which are outside of the finished dial viewing area. When all the colours have been applied the glass is removed and baked in an oven to set the inks. To me it's amazing that such a technique works so well but there has been plenty of time to perfect it, since it was invented by the Chinese about 1000 years ago.

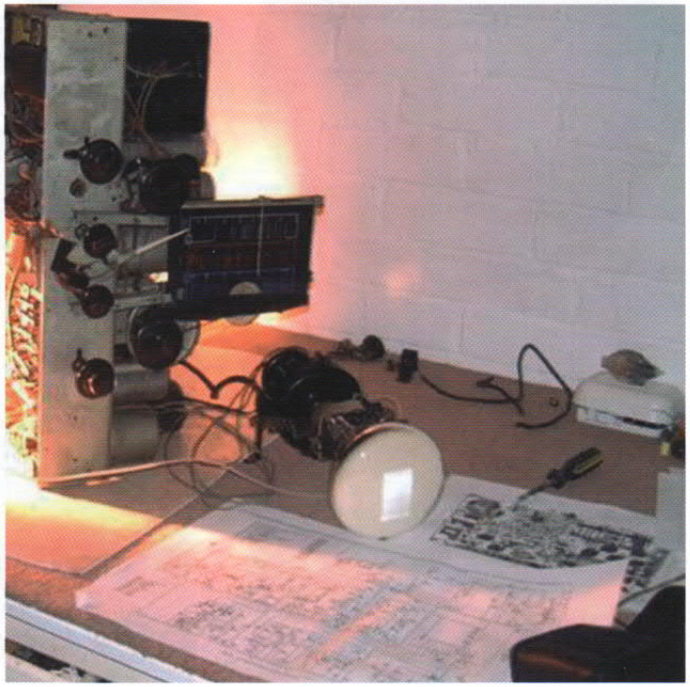
I do have a small number of dials to sell, so if anyone would like one then please contact me. Once they are gone there will be no more. A friend said "... but if there was a requirement, in the future, then you still have the artwork and the screens could be reused". Yes! I would have the artwork

article continued on page 40

HMV 904 5" TV & combined radio – how television came to be operational in the West Country

by Peter Carlton

HMV 904 and Marconi 703 Mastergram



First raster on CRT

The story of the HMV904 continued on after my previous article. I was very interested, and, I have to say, pleased to read the Chairman's comment at the beginning of the last edition of the BVWS Bulletin about the discussions of items being bought back to working life versus those which are not. Shortly after I added the HMV 904 to my collection I had sent details of the set to a personal friend, Martin Scobie, who has, I believe, been in the radio and television trade since about 1960. Martin has helped me in the past on many occasions and I asked him for his opinion on the set, I also said that if I ever had anything done to the HMV 904 then I'd want it done professionally. Martin has a superb website (www.vintagewireless.net) on which you can see many of the professional repairs and restorations that he has done. Martin is a City and Guilds qualified engineer and has a vast amount of knowledge. Obviously this set was older than any television he had worked on before, but that didn't phaze him.

I gave it a lot of consideration and we exchanged various emails. Obviously we had no idea what the electronic condition of the set was going to be like, as, whilst I knew its history right back to when it was new, the fact that it had not been used since 1953 could, of course, mean that anything could have happened during those decades.

I knew right from the start that I didn't want the set 'Restored', I didn't want anyone to make the set look like it had just been built. I certainly didn't want the cabinet re–finished, as the original finish is superb, and, as the chassis was pristine I did not want to have it looking all new and shiny. It was pointed out that, however beautiful a set may look, if it doesn't work then it is an expensive and bulky ornament. I have to say, I couldn't agree more.

It then came to deciding what to do. What I wanted for the set was a professional repair by a highly qualified and skilled person with the experience to be able to do that without destroying the 'soul' (for want of a better word) of the set. Martin very kindly offered to look at it for me, initially to see what the situation was internally, and then, if it looked possible, we would opt for the professional repair, this means doing only what is needed to make the set reliable, but not replacing anything which does not need replacing.

Martin did amazing work with much attention to detail. He fitted new condensers inside the old ones; we managed to obtain the right value condensers for the EHT, namely 0.1uf @ 3kv, and he also managed to fit those inside the original can, as he did with the original electrolytic can condensers and you'd never know it had been done. If you removed the back of the HMV you would never know it had been touched.

Martin spent a great deal of time and effort in keeping everything authentic. If anything was replaced then he would make sure that the original parts were safely put in to a box for me to keep with the set. The original mains lead was perished but the internal wiring was not affected at all, it was perfectly flexible! Martin fitted a new cloth–covered mains lead and he made sure that the original mains lead and 2–pin plug were safely put with the old condensers.

There was a great deal to do before powering up, with various tests to be made, but the time came when the set was first turned on. Initially Martin worked on the wireless and got that running first, he commented on what a superb quality radio the set had. This reminded me that Gerry Wells said when I spoke to him the fact that EMI made these sets with a very good quality radio so that if the television failed first, then at least you had a good quality radio for your money.

A little while later it was so exciting when I received an E-mail from Martin showing a nice bright raster on the set. A few days later another email showed the set running and displaying Blue Peter extremely well. Martin was then at the stage where he needed to soak–test the set for a while outside of the cabinet, which I believe he did for a few days. The results were amazing. The CRT is very good with a really nice bright picture. There is a little ion burn, but actually not enough to worry about. All original internal wiring, transformers and so on were fine, because the set had been stored indoors in a warm, dry environment.

In the previous article about this set I mentioned that it came with a spare CRT, spare scanning coils and complete set of knobs. Martin took the opportunity to test the spare CRT whilst he had everything out of the cabinet. The spare CRT gave a superb picture and, presumably it never had a great deal of use. After testing it was carefully packaged away, together with all spares, and kept safely in case it is needed in the future. It is nice having the security of a spare tube.

Whilst Martin had the set apart he checked everything over carefully with much attention to fine detail. An example of this is the tiny little green felt pads which hold the dial glass in place. These were missing or had fallen apart. Martin fitted new felt pads to the dial securing brackets. I mentioned in my previous article an elderly gentleman who had worked on these sets when they were new. He is a friend of Martin's and was

EHT condenser can rebuilt

Signature of the engineer who repaired the set in 1946

Testing before being returned to cabinet

Spare CRT and scanning coils

Set being reassembled

greatly interested in the set. His knowledge of early television is remarkable, especially as he worked with both the Baird 30–line system and also the two High Definition systems at Alexandra palace, namely the Marconi EMI 405–line system and the Baird 240–line system. His input on this set was extremely helpful and much appreciated.

Whilst the set was apart something quite amazing was found inside the cabinet. The engineer who serviced the set in February 1946, in preparation for the re–opening of television that year, had signed and dated the inside of the cabinet. Martin took a photograph of this and all of the other work he did. He really did an incredible job.

The time eventually came to carefully re-assemble the set. This was all done and then the set was left on test for quite a few days to make sure that there were no problems. All of the controls work perfectly, the picture is very crisp and clear with perfect focus, the line structure is clearly visible, and, to be honest, I didn't expect that on a five inch CRT. After Martin had soak tested the set for a good period of time it was then ready to come home. Martin showed us exactly what he had done, he made sure that he gave me anything back which had required replacement, and so that has been safely preserved. Both covers, together with their original screws, were all screwed back into place and the set then installed on its table, next to the Marconi 703 Mastergram. From what I have read the HMV 904 cost 29 Gns plus 3 Gns for the table, and the Mastergram cost 120 Gns. Both sets display perfectly focussed, bright pictures with plenty of contrast, and are a joy to watch.

One thing a little unusual on the HMV 904 is the aerial connector, it looks like the original connector plug had 2 flat pins and a shaft to ensure it was located the right way around. I found that two Wander plugs with half of the pin cut away fits these sockets perfectly. Now, when you look at the set, inside or out, you would never know that it has been repaired. In any instance like this I would personally always recommend a professional repair as everything possible is preserved and retained.

The set now sits happily in the front room next to the Marconi 703, its 'bigger brother' if you like, they look brilliant together, and now both can be watched. It impresses anyone who visits and who sees the HMV 904 running. As Martin commented, once you start watching something on the set, you completely forget the screen size, you can happily watch programmes on the set, just as you would any other. It's not hard to imagine a family in the 1930's sitting around this set watching live programmes from Alexandra Palace. Whilst little in the way of footage from those early pioneering days at Alexandra Palace in the 1930's has survived, this beautiful television is a true survivor, and is now up and running, whilst still retaining its originality and character. I know that I made the right decision, and I am extremely grateful to Martin for all of the hard work and effort he put in to this set for me to bring it back to life the way I wanted it done.

I feel that a few points need to be remembered. These sets were made to be used, those few surviving people who were around at the time and working on them feel that way even now; they were never meant to be ornaments. Having said that the preservation of their history and original appearance, both internally and externally, is vital. I'd like to thank anyone else who helped with parts, literature, advice and general knowledge about the set. The outcome has made it all worthwhile.

As for the monetary value of the set, because of the way the set has been repaired, I do not see that this has in any way affected the commercial value of it.

It's great fun when friends who are not collectors come to visit and you ask them which are the two oldest sets in the room, they usually walk right past the HMV 904, as they think it's a radio. They presume the Marconi 703 is a large radiogram, or cocktail cabinet, so it is usually rather amusing seeing them trying to work out which sets are actually the oldest.

It's been a fascinating journey from when the letter came offering me this TV set, through to to-day, where we can now sit and enjoy true High Definition Television on a genuine pre-war High Definition Television set. It's a great tribute to the pioneers of High Definition Television in the 1930's, and also to the very high quality engineering skills employed in the production of these sets. Can anyone imagine a modern day set working in well over 70 years? My conclusion to all this is, have a good read of the Chairman's comments in the previous BVWS Bulletin, and, if you have a gem like this, consider getting it professionally repaired. You really won't regret it. Just always bear in mind the massive difference between a professional repair and full restorations. If you want to preserve the history of the set whilst being able to use it for its intended purpose then it will always be a professional repair. Now I think it's time to go and watch "Television Comes To London" (1936) on the HMV 904.

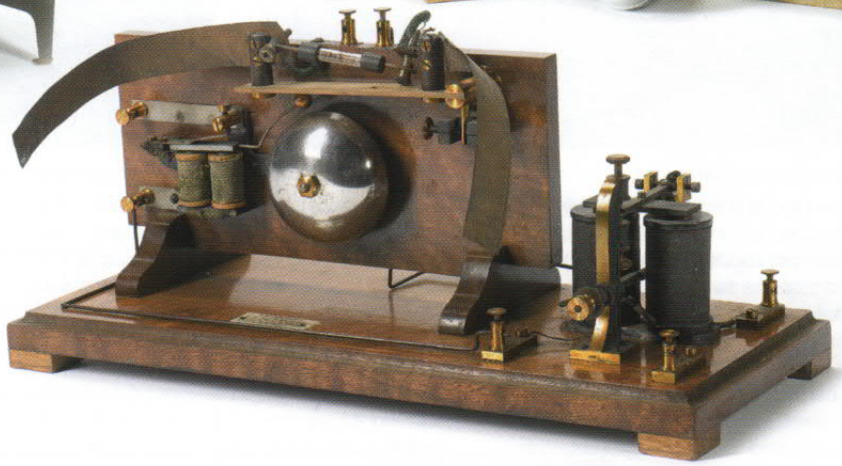
Important Television auction at Bonhams, Knightsbridge

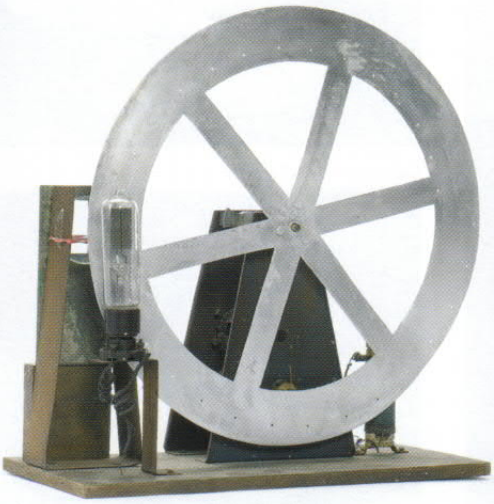
This forthcoming sale is huge. Huge because it contains so many strange, interesting, rare and historical wonders. To those who know Mr. Bennett-Levy, he has for many years managed to grab hold of some of the best examples of pre-war television equipment in the world. From a Marconi 707 to a Televisor, from the actual floor running order book used on 2nd November 1936, to the first cathode ray tubes made in the 1890s – name something to do with television, and it is most probably here.

There are over 20 pre-war televisions in the sale, one of which will be running up during the view, showing an episode of Steptoe and Son through a 625-405 converter. And should you wish to be shown on the television, an ATV camera will do the capturing.

All will be revealed when the sale goes on view at Bonhams Knightsbridge on Sunday 27th September. The sale will take place in the morning of 30th September.

For more information contact Laurence Fisher on 08700 273 633 or high tech non-valve email on Laurence.fisher@bonhams.com





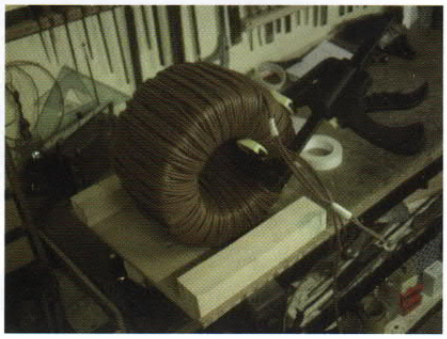
Unique three phase by Colin Wood.

Startrite Volent 10 speed

Capacitors from the USA

Correct way to wind

Ready for winding



How not to wind

Being fed up at bumping into machinery in my garage I decided to remedy the situation just before Christmas 2008 by selling four of my large industrial machines together with my 7.5KW 3 phase 415V static converter. I was sorry to part with all this gear but the space would be more useful.

I still retained my dust extractor and my wife Bronwyn bought me a huge Startrite Volent 24" bandsaw for Christmas; both these on 415V. My initial intention was to power these directly from the UK 240V supply using start and run capacitors; I have previous experience of this as I converted my universal woodworker about ten years ago. To run on three phase 240V is easy enough but requires the motors to be reconnected in "Delta" by doing this the machines run but on reducing power and are unbalanced giving similar performance to using a static converter.

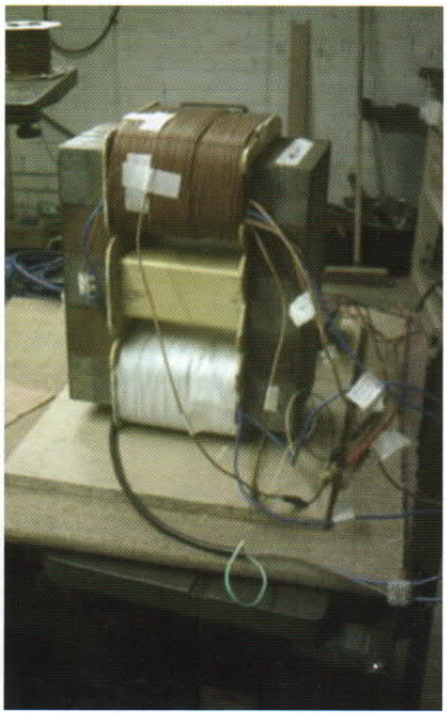
On 6th. December 2008 whilst browsing eBay I came across three DVD's for sale from a company called "Unique3phase" and these looked excellent value with a running time of six hours. The discs covered all aspects of installing high voltage 3 phase at little cost which immediately appealed to me; I viewed the sample video clips and ordered the discs paying by PayPal. A week or so later the discs arrived and I couldn't believe how good they were; they covered rotary, stator and transformer methods together with how to make a welder. I was amazed at how simple it all was. I ran the discs on TV taking a few notes then visited a number of contacts where I obtained a scrap 5.5KW motor to act as a donor giving me the laminations (stator) which would be the core of my new transformer. I stripped the motor and split the casing removing the stator; I then had a bit of a struggle removing the windings but ended up with a good clean set of bare laminations. At this point I thought that I would be smart and wound on the primary as one coil using the entire stator in similar style to a "Toroid". I felt very proud at achieving this with so little difficulty until I plugged it into the mains and promptly tripped the 30A breaker!

The creator of Unique3phase Douglas Arndt in America was absolutely brilliant when I e-mailed him and over the next four weeks he was unstinting in his generous help and guidance. Doug had tried this way of winding mentioned on the disc but saying it hadn't worked without giving a reason why; apparently the problem was the type of core; the laminations are stamped out of steel whereas the Toroid core is wound from one continuous strip and this is also twisted! I rewound as per Doug's instructions and after tripping the breaker a few more times finally could power up to take instrument readings. Each time I tripped the breaker it took the central heating out as well. The best I could achieve with this stator was 0.8V/Turn which would have worked by using more wire on the secondaries but by now I was well and truly hooked on this project so decided to follow Doug's example and obtain a much larger stator; I would now try to obtain a 25HP motor to strip!

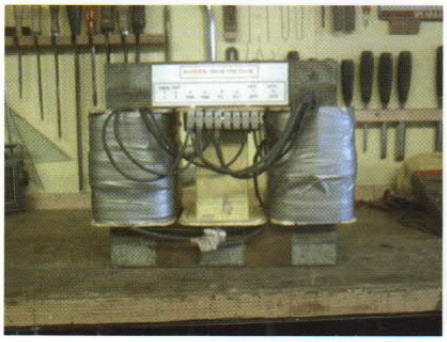
By 14 January 2009 I had tried my contacts to obtain a larger motor without success so decided to visit our local scrap yard high on the moors. As I searched the yard at 9.30 am I was blasted with horizontal rain due to the wind and it was absolutely freezing. There was a huge pile of stators but these had been burned to remove the copper wire; I also saw two small rough looking 3 phase transformers on the same pile but rejected them. I then walked across to a very high pile of scrap motors; I saw two suitable motors but the casings were cast iron and I would have to call the crane over to pull one out; I then noticed another 3 phase transformer near the top of the pile but it had no markings on it so was rejected. At this point I was soaked and frozen so went back to the car to decide what to do. I had taken a good selection of tools along in a plastic bucket but had left my gloves at home. The bucket had started to fill with freezing water and as I sat there I wondered what type of fool I was to be out on a day like this? I could go home and forget the whole project; I could get the big motor craned out and strip it then it suddenly struck me that the large transformer might be just the job as I could rewind it to my own specification? I thought to myself don't be such a wimp and get out there to do what you came to do!! I took along a tea towel from the car and climbed the pile of motors to the transformer; using the towel to prevent cutting my hands I eased out the transformer and very gently slid it down the pile all the time worried in case I got buried under motors which was a real possibility. As it sat in the icy mud I inspected it and then went to ask the price to be quoted a very fair £10. I rolled it over and over to a spot where I could reach it with the car and it took two of us all our strength to lift it into the car; it was extremely heavy. The car being a new Toyota Aygo was plane spotting all the way home and the traffic lights all at red and the road humps added to the stress. I removed the transformer on my own from

Shuttle in action

Health and safety



On test



Success!

Fully installed

the car using a short scaffolding plank and taking a week to start talking normally again.

I couldn't use the transformer as it was because it was soaking wet so I chopped through the coils totally removing them but leaving the laminations and three fiberglass formers intact. I wiped it as dry as possible then let a fan heater warm it up for a couple of hours. I followed the instructions on the discs and wound the primary coils using 2.5mm stranded copper insulated conduit wire; Doug stresses that it pays to get this part right so I spent some time experimenting with the number of turns and found that I could achieve 1.8V/Turn but with increased idle amps so I added turns bringing it down to 1.5V/Turn and now the amps were very impressive giving me 0.8A at idle. This was perfect for me and I then wound on the secondary coils using 1.5mm Stranded copper insulated conduit wire. With a bit more experimenting with the number of turns I obtained perfect voltage readings and had myself a fully working single phase transformer wound as per Doug's instructions that would now give full power at 415V with the use of capacitors. Each machine would be switched and phase balanced to the transformer. I bought a selection of capacitors shipping them in from America from a company called Surplus Center and they worked out cheaper than buying new in the UK even with the high shipping costs.

Doug has indeed come up with something "unique" in his methods of supplying 3 phase power; with the DVD's explaining in great detail each stage it is hard to go wrong although I managed it a couple of times but Doug was very prompt at helping me out. I tried his stator method which avoids the problem of trying to find a 3 phase transformer and I also tried his transformer method both of which work. The methods are incredibly versatile as you can control fully the voltage you need for the 3 phase whether it be 240V or 680V. In my case I wanted 415V which is exactly what I now have. Due to copyright I haven't gone into great detail regarding how the 3 phase is achieved indeed it wouldn't be fair to Doug. In basic terms though to use the stator method you wind both primaries and secondaries from scratch onto the bare laminations (covered with insulation) but if the transformer method is used and a suitable transformer is found this saves a lot of work and wire. Both methods involve winding as a single phase transformer but Doug's unique method then converts them to full 3 phase. I've wound mains and output transformers in the past for wireless work but never seen anything like this. I spent a month on this project but could have completed it much quicker had I not been hampered by doing it in the middle of a Yorkshire winter. At times the project has been hernia and pneumonia inducing requiring real will power to continue but what a learning curve it turned out to be; the final test of my stamina was to locate the finished transformer in a safe place in the garage. To this end I welded up a pair of very heavy duty brackets fixing them near the ceiling in the garage with large anchor bolts. Getting the transformer into position almost put my light out permanently. It was pure pleasure to run a ring circuit to the machines and see them burst into life at a touch of a button; balancing the phases to each motor has to be tried to be believed; by putting capacitors in and taking capacitors out it was just incredible to watch the volts and amps change and was so easy; this system puts the static converter to shame; my dust extractor used to take ages to wind up with the static converter but now with the transformer it's immediate. Running costs are low compared to a rotary converter. Briefly to run a 10HP motor through a rotary you would in fact be running something like 30HP due to the required idler motor; my transformer is brilliant and idles at 0.8A it is also silent in operation. For safety and to let me know it is switched on I will fit a panel indicator lamp.

I hope Doug doesn't mind me mentioning but when I first saw his DVD's I thought he was producing bird's nests as the wiring was all over the place, also his method of winding the wire is totally different to mine. Doug lets his son run the wire out using a pulley system taking the two of them to wind. I work on my own and winding the wire was a real problem I faced; I lay awake most of one night in bed trying to think up a solution that would work for me. I came up with my "shuttle" idea which is so simple but very effective in use. I used an off cut of 3/8" plywood 44" long by 3" wide, at each end I cut out a rectangle leaving a pair of horns 1" long by ¼" wide this would prevent the wire slipping off. This was sanded smooth as it would be handled a lot. I found I could get a full 100m coil of 2.5mm wire on the shuttle taking care to wind the wire on neatly by turning the shuttle end over end so that no twists were introduced then with a little practice I could wind 2 turns per minute onto the transformer. I would wind on about 7 turns; place the shuttle down freeing both my hands then I could gently arrange the wire pulling it tightly before clamping the loose end with a spring clip to prevent it from springing loose. One point is that I would now put a first aid sticky plaster around my finger to pull the wire tight with as I opened up a wound that really made me jump when I washed my hands in soapy water. In the stator method I made a pair of flanges out of plywood and these were mounted securely allowing neat winding.

Costs; in all I had change out of £120 with my transformer, this included the capacitors,

Article continued on page 40

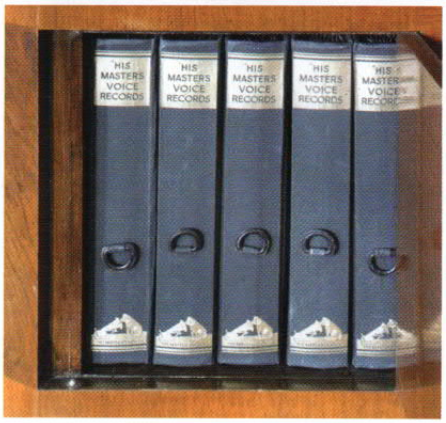
The HMV 801 from 1937 by Gary Tempest

This beautiful radiogram has recently been restored by friend Paul Barneveld. He was lucky to find one in such excellent condition. All the cabinet needed was a wipe over with scratch remover and a good polish.

This is from a Technical Report published in the Gramophone Magazine in May 1937

So far as the reproduction is concerned we have no hesitation in declaring the 801 to be easily the finest self-contained radio-gramophone that has ever been in the London Office of THE GRAMOPHONE

How it looked before a good polish



All mint condition records

Beautiful inside

These are some notes made by the Magazine in September 1933, quite a few years before, so they were obviously thinking ahead.

'If manufacturers were to reduce the number of H.F. stages, compatible with reasonable selectivity, and concentrate a little more on the design of the L.F. amplifier, the pick-up and the loud-speaker, and thus provide ' de-luxe' quality also, then not only would the radio enthusiast enjoy his home and foreign transmissions more, but the gramophone lover, whose tastes have hitherto been somewhat neglected, would take a real interest in electrical reproduction. Distinguish the de-luxe class by quality and not by quantity of valves or of noise.'

Perhaps HMV designed the 801 with this in mind and along with a lower cost hoped to boost sales. It majored more on audio performance than RF unlike its predecessor the HMV 800 of 1935 (see Bulletin article Winter 2006). This had 15 valves, as compared to 10, and was about a third more expensive than the 801.

Comparing the two, they both have tuned RF stages but the 801 just has a frequency changer whereas the 800 has separate oscillator valves for MW/LW and SW followed by a mixer. There are three IF stages for the 800 but only one for the 801. Both get a little more alike with detector and first and second AF pre-amplifiers into power amplifiers using push pull PX25's. But the 800 has more valves up its sleeve for frills like audio contrast expansion and QAVC silent tuning.

However, despite the extra complexity of the 800, the Gramophone report claims that the radio performance of the 801 is nearly as effective. It puts this down to the advances made in Superhet design and the performance of valves.

As to the audio performance it had this to say:

'... for the first time in any HMV radio-gramophone we get a three stage low frequency amplifier... tone correction, a high fidelity pickup matched to the amplifier input impedance, and loudspeakers (one very large electro-magnet and two elliptical permanent magnet) of special design accurately matched to the push pull output stage.'

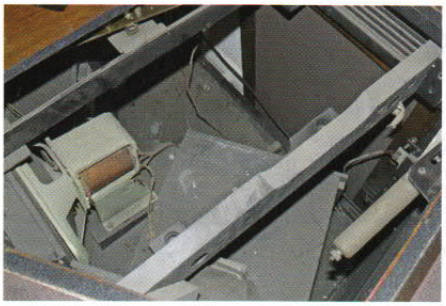
Let's hope that owners of 800's won't start writing in and saying that this summary of mine is "Nonsense! The 800 is far superior" and that the Gramophone was only trying to please a major advertiser, although this factor is somewhat true even today. I'm sure that anyone lucky enough to afford and have the space for either, yet alone the pair, considers them both wonderful examples of top of the range radiograms owned only by the very rich. I'm told that back in the mid-30's a new family car could be bought for the cost of the 800.

Work done

Inside the cabinet and electronics

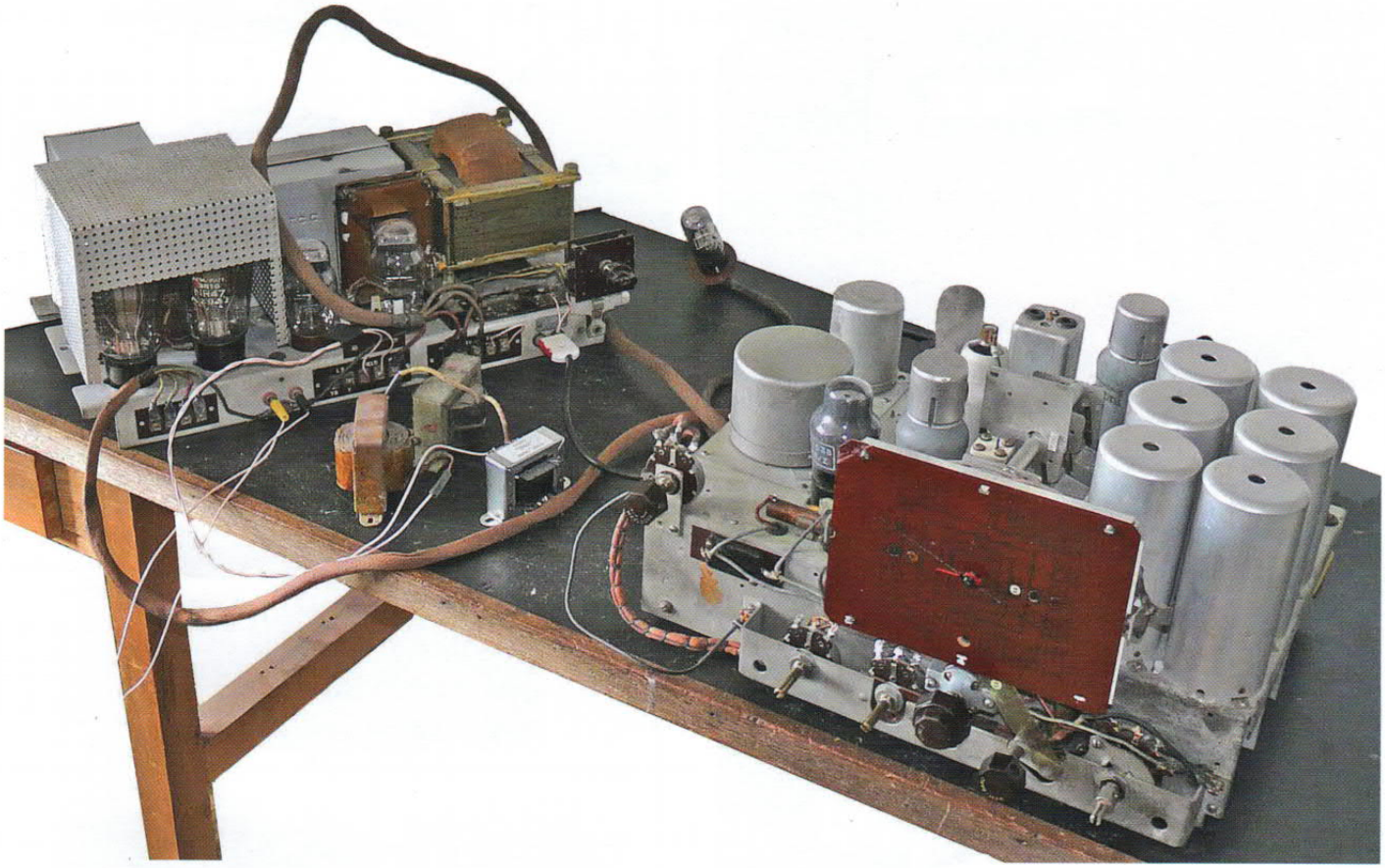
This was such a wonderful rust free example that only a vacuum cleaner and soft brushes were needed to clean things up. Time could then be spent on 're-stuffing' the electrolytics and wax paper capacitors. All resistors were measured and just a few changed as being too far out of tolerance. Then with all tested and some new replacement valves the electronics could

The art deco pickup



Two of the speakers can just be seen

Braced with angle-iron



Bench testing of the electronics

be powered up and alignment carried out.

In the picture of the electronics the RF chassis is basically EMI's 6 valve unit used in many models. Here though, the audio output stage and power supply is omitted and the chassis hard wired to the second chassis containing the power supply and amplifier.

The bench hook up was to a test permanent magnet speaker and the series connected chokes are used to simulate the field coil of the bass speaker.

Turntable

Firstly, a good clean of all the intricate cams and levers underneath was made before re-lubricating. Looking under here amazes me: how did they imagine the operation and then come up with a design. I suppose like many things it was evolution but perhaps we don't give the early mechanical engineers the same admiration that we do those of the electronic persuasion.

The motor is an induction type, working on the eddy current principal, into a copper disc rotor. Unfortunately the hub of this is a die-casting that had warped badly but the rivets could be drilled out and then the face trued up on a lathe. The disk was also no longer flat but this was corrected, by placing it between blocks of wood, with judicious use of a hammer. The motor uses one capacitor to create another phase, into a second winding, and this capacitor was replaced.

Unfortunately the turntable is yet another casting and again no longer ran true: the only way around this was to have one turned from solid aluminium.

The elegant counter-balanced pickup was dismantled and new rubbers made for the armature suspension.

Performance and Conclusions

Did the Gramophone get it about right or did they exaggerate? In my short listening time, and my friend's opinion, performance is much as they said. It works very competently on radio, with the mostly poor quality stations now available. As usual a low powered MW transmitter and a CD player gets around this. Audio performance is very pleasing with lots of clean bass. The shape of the cabinet is almost ideal for this along with massive cross bracing. Where it comes alive is in playing records. I was most impressed with the turntable, which operates smoothly with the pickup doing a slow motion waltz on its way to the disc surface. The whole motor board is softly sprung mitigating any feedback from the speakers even at a neighbour-upsetting volume. Under the lid, by the way, gives a true appreciation of how the cabinet would have been finished originally. It has a deep, high gloss lustre that wouldn't look inferior on an expensive piano.

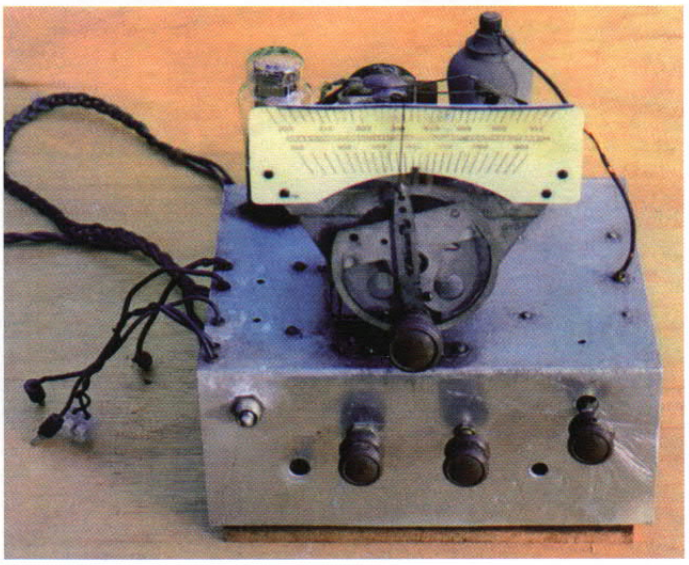
I like very much the design of the auto-change mechanism with the twin turrets. It's so easy to add another record or take one off even when the unit is playing. To drop a record, two supporting levers, at the top of the turrets withdraw for just sufficient time for a disc to drop.

By using long play needles, now getting almost impossible to find, of the (when new) 60 play type, then a whole stack of 8 records can easily be played both sides before changing.

One thing leads to another by David Bickerton

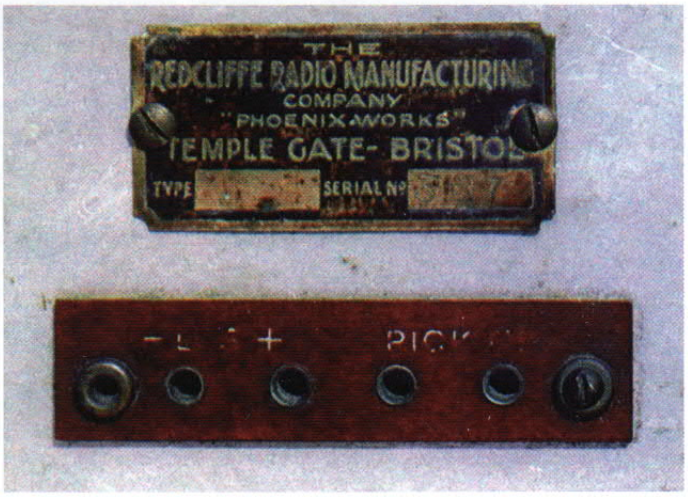
A few years ago a relative of mine was working in a firm in Bristol and in a conversation with the managing director mentioned that I was a collector of vintage wireless sets. Apparently the firm had originated in Bristol in the early days of wireless manufacture as The Redcliffe Radio Company. The Director said that he would very much like to own an early example of the Company's wireless sets should one turn up. This desire was passed on to me.

A rare surviving example of a Redcliffe Radio Company wireless



The finished, cleaned up chassis

Inside the set



The plate attached to the chassis rear

At the time I was unaware that such a company existed. Perhaps this was not altogether surprising as although there were a very large number of small manufacturers who had set up during the late 1920's and into the 1930's relatively few continued to manufacture beyond 1935. This reduction reflected the considerable advance in the technology and the greater complexity in producing a wireless set at the time.

Of all the sets which I had collected or restored and disposed of at Society swapmeets I had never encountered a Redcliffe radio. Furthermore my enquiries to various members of the BVWS who might be expected to have come across such a set, including my contact with the Dulwich museum, drew a complete blank.

Nevertheless several years later, lo and behold, in a junk lot which included a few early 1930's wrecks, I found a battery set with a plate on the chassis bearing the elusive name of: 'The Redcliffe Radio Manufacturing Company, Phoenix works, Temple Gate, Bristol'. Temple Gate is the district adjoining Redcliffe in Bristol. Why 'Phoenix Works' remains a mystery but it would turn out to be relevant at a later date when Bristol was severely blitzed in 1940.

The set was cased in a wooden cabinet typical of some early 1930's sets but it was totally riddled with woodworm. Although I had a reasonable amount of practical experience of restoring items which had suffered from woodworm this cabinet was beyond recovery. It was entirely of plywood construction and I recall my grandfather, who was a cabinet maker, saying the day would come when the industry would rue the day it ever used plywood because the animal glue used in those days to bond together the individual sheets of provided an added attraction to woodworm; it was sauce on the main course!

As a result, apart from noting the style of the cabinet and because I had plenty of other sets to restore at the time, I removed all the components, absolutely everything, and disposed of the cabinet before other items were infected in my workshop and store. The chassis and all the bits and pieces were boxed, stored away and temporarily forgotten.

Two or three years passed and during one of my periodic attempts to tidy my store I came across the Redcliffe chassis. Although technically the set could not be considered anything unusual or of general interest, nevertheless it was a rarity and there was a Company Director who had, in the past, expressed an interest to own one. Further enquiries amongst BVWS members again failed to provide any knowledge of such

a set or the early company. Accordingly I embarked on a restoration job and possibly an investigation to find the origins of the Company who made the set.

The set is relatively simple, being a three valve tuned radio frequency receiver. The restoration work really only entailed a thorough clean up of the aluminium chassis and removal of dust and grime by gentle brushing of the various components. Almost all the wiring under the chassis was satisfactory being tinned copper wire encased in old fashioned 'systoflex' sleeving. External HT and LT leads were in reasonable condition being braided flex but the grid bias leads required replacing. On completion of this work, connection to an eliminator providing HT, LT and grid bias supplies together brought the set to life. The 'Varley' coils are connected by a ganged wavechange switch. Reception on the medium wavelength was good but poor on longwave. The reaction control produced a good response.

Precise dating of the receiver within a range of years in the very late 1920's or early 1930's is somewhat difficult. The two 'Varley' coils seen on the underside of the chassis were of the type supplied in wireless kits and very common for home constructed sets. The graduation on the dial suggests wavelengths in metres. The valve line–up of pentode, triode detector and pentode output was common and does not enable the set to be dated precisely.

This was not a set which I was interested in keeping in my collection. In fact its main interest is in the nameplate of a rare specimen of a little known company. The separation of the chassis and speaker made it a somewhat cumbersome relic. I intended to give this to the present company from which this set had originated. Therefore I decided to give the set a housing and my next actions are not for the purists. From a scrap cabinet of the size and shape similar to the original I cut out the front using a jigsaw and replaced it to suit the chassis and speaker and to be as close to the original as I could remember; by doing so the quality of the sound from the speaker improved. In a way, a rare scrap set had been saved but in no way was the cabinet to be passed off as the original; it was however a close replica.

The present company, whose origins were in Redcliffe Radio, is now 'Redcliffe Magtronics' located on the Brislington trading estate in Bristol. I contacted the Managing Director who had expressed an interest in owning such a set and offered it as a gift to him. He was delighted to accept and undertook to give a donation to a charity of my choosing. In due course I visited the factory and presented it to him along with two of his colleagues. Just before doing so I displayed the set at the BVWS swapmeet at Wootton Bassett suitably labelled: 'Of all the sets on every stall, is this the rarest of them all?' The Managing Director sent me a few details he had on the origins of Redcliffe Radio which were displayed with the set at Wootton Bassett and raised some interest amongst the BVWS members present.

When I received the BVWS Bulletin, Winter 2007 which included the list of British Manufacturers with names beginning with the letter 'R' there was, not surprisingly no reference to Redcliffe Radio. This omission gave me an added incentive to investigate and record the origins and history of the Bristol radio firm which had survived for some 80 years. In the outcome the quest was I imagine, similar to that carried by persons researching their ancestry.

Early records which may have been kept by the Company were not available. However I was provided with some notes by the present Chief Executive of Redcliffe Magtronics; he had also passed a copy of my letter to him to the widow of the company's founder, RG Hawkins. I was able to have a long telephone conversation with her.

Rob Hawkins was born in 1904 and attended school in Exeter. He served an apprenticeship with the firm Glass & Co., agricultural engineers in Oakhampton, Devon. Family money set up a company in 1927. Sometime at the start of the 1930's the business was installed in premises in Redcliffe Hill in Bristol. This is an area in which commerce and industry had been centred over several hundred years and is closely associated with the 450 years old Society of Merchant Venturers.

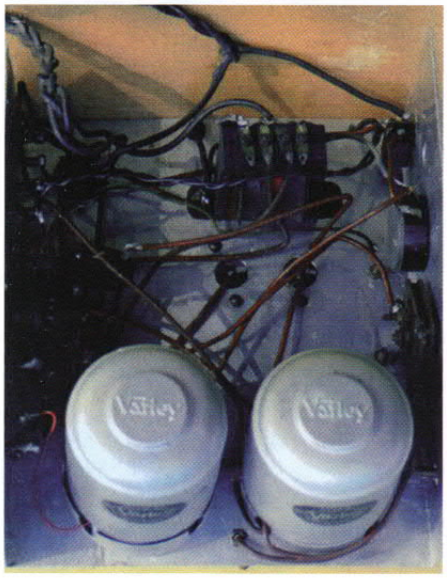
Redcliffe takes its name from the red sandstone cliff on the bank of what was once the natural course of the then tidal Gloucestershire river Frome. This waterway is now part of the floating harbour throughout central Bristol which was created in the early part of the 19th century to prevent ships grounding at low tide. In the centre of the district stands Saint Mary Redcliffe church, once visited by Queen Elizabeth the First, who described it as 'the finest parish church in all England.'

Before the age of wireless the district had housed several significant industries. William Watt, a plumber, in consequence of a dream, built a square shot tower opposite Redcliffe Church and devised the manufacture of lead shot by allowing molten lead to fall from a height into a vat of water. He patented the idea in 1872 and made his fortune. In the same street a Mr Stiff is credited with the invention and manufacture of 'Stiff's Starch'. However by 1930 the street housed the Mullard Wireless Service Co. Ltd., Kolster Brandes Ltd., Wireless Apparatus Merchants, Bristol Wireless Accessory Dealers, Marconiphone and Brown Bros. Within two to three years Murphy, Philco, Cossor and EK Cole were to establish a presence nearby.

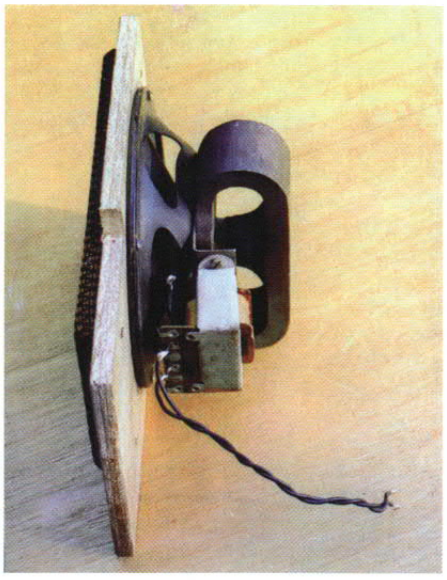
It is therefore not surprising that Rob Hawkins should choose the Redcliffe area for his first radio business. Perhaps what is surprising is that all references in the trade directories of that time and the names of the firms use the term 'wireless'. Not until 1953 do the trade directories start using the term 'radio' and yet Hawkins incorporated it into the name of his firm from the outset. Of course the BBC were using the term in publishing the 'Radio Times.

By 1934 the company name of 'Redcliffe Radio Supplies' was in use and located in Redcliffe Street, a continuation of Redcliffe Hill. In 1936 the company established itself in the adjoining Victoria Street, with a change of name to Redcliffe Radio Services (RG Hawkins) and Redcliffe Radio Mfg. Co. Thus there was a developing

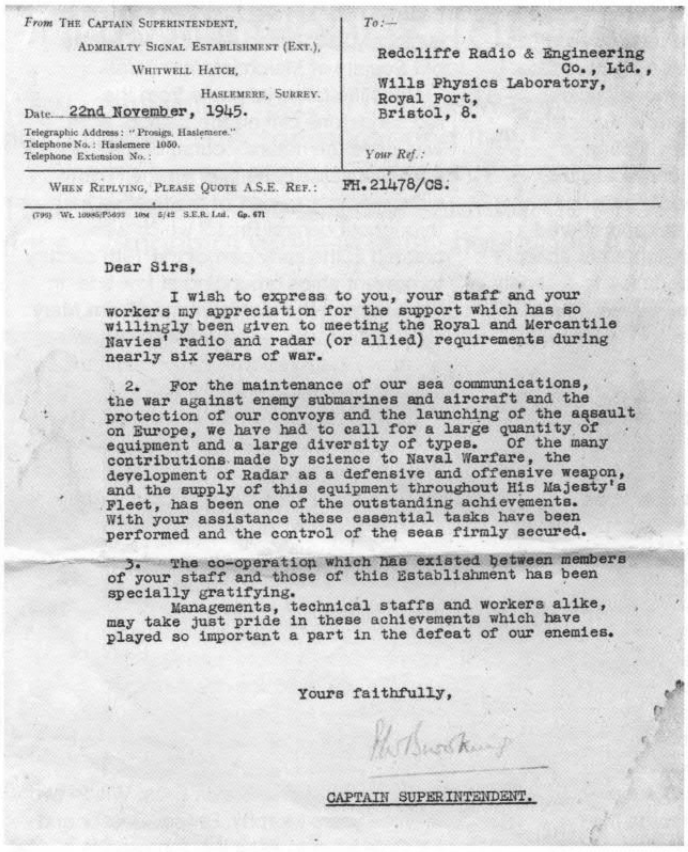
The underside of the chassis



The permanent magnet, moving coil speaker



RG Hawkins in the laboratory



From THE CAPTAIN SUPERINTENDENT,
ADMIRALTY SIGNAL ESTABLISHMENT (EXT.),
WHITWELL HATCH,
HASLEMERE, SURREY.
Date 22nd November, 1945.
Telegraphic Address: "Prosigs, Haslemere."
Telephone No.: Haslemere 1050.
Telephone Extension No.:

To:—
Redcliffe Radio & Engineering Co., Ltd.,
Wills Physics Laboratory,
Royal Fort,
Bristol, 8.

Your Ref.:

WHEN REPLYING, PLEASE QUOTE A.S.E. REF.: FH.21478/CS.

(795) Wt. 10985/P5693 10M 5/42 S.E.R. Ltd. Gp. 671

Dear Sirs,

I wish to express to you, your staff and your workers my appreciation for the support which has so willingly been given to meeting the Royal and Mercantile Navies' radio and radar (or allied) requirements during nearly six years of war.

2. For the maintenance of our sea communications, the war against enemy submarines and aircraft and the protection of our convoys and the launching of the assault on Europe, we have had to call for a large quantity of equipment and a large diversity of types. Of the many contributions made by science to Naval Warfare, the development of Radar as a defensive and offensive weapon, and the supply of this equipment throughout His Majesty's Fleet, has been one of the outstanding achievements. With your assistance these essential tasks have been performed and the control of the seas firmly secured.

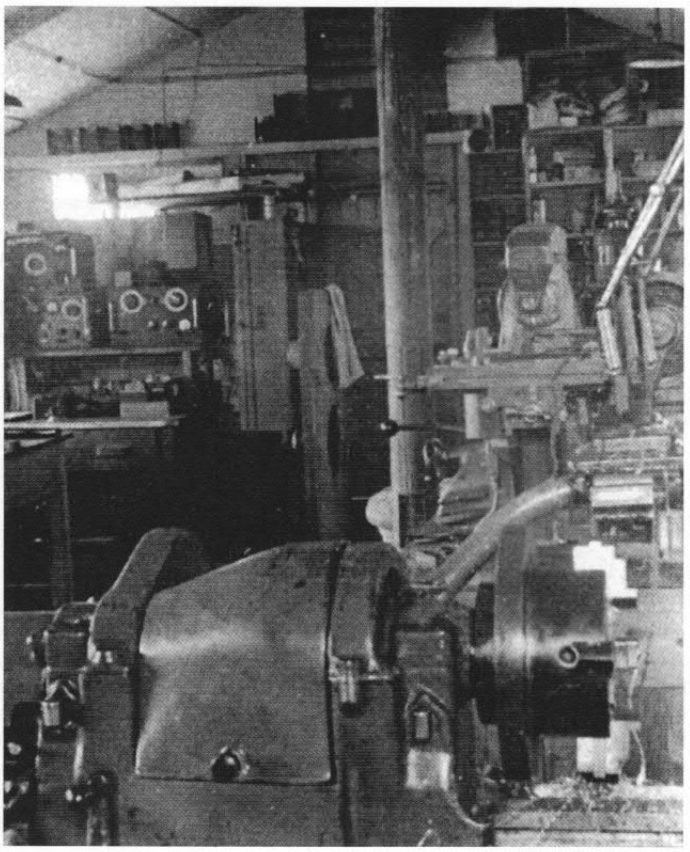
3. The co-operation which has existed between members of your staff and those of this Establishment has been specially gratifying.

Managements, technical staffs and workers alike, may take just pride in these achievements which have played so important a part in the defeat of our enemies.

Yours faithfully,

CAPTAIN SUPERINTENDENT.

A letter acknowledging Redcliffe radio's contribution to the war effort



A view of the Redcliffe Radio laboratory

and changing role with a change of name, a process which would continue for many years. Perhaps this relocation and rebranding explains the reference to 'Phoenix Works' on the plate on the chassis of the restored set as the company arose anew. 'Temple Gate' on the plate adjoins the address in Victoria Street and perhaps made it appear a little more 'upmarket'!

What seems clear from the early and subsequent changes of name is that the firm only manufactured complete radio receivers for a very short period. It operated as a service company and a component manufacturer. How few sets were made is unknown but in all probability the number was very small and is the reason why only one has appeared so far for restoration. The simplicity of the set which has been restored would, at the time it was built, have found the competition difficult when compared with the rapid, development of more complex models appearing in the nationally named firms in the premises nearby. The company continued to trade in Victoria Street under the two names for the remainder of the 1930's and during 1940, the first year of the second World War. On the 20th of November 1940 the company's premises were bombed during the blitz on the centre of Bristol. Redcliffe Radio were undertaking work considered to be essential to the war effort. As a result the staff and apparatus were moved to the Royal Fort at Tyndall's Park which, in peacetime, was the physics department of Bristol University. Thus started a new chapter in the life of the company.

This period is well documented in 'The History of the Department of Physics in Bristol 1876–1948' written by Professor AM Tyndall FRS. RG Hawkins and his team joined a group of Admiralty staff who had moved into the laboratory. Under the fruitful leadership of Dr RW Sutton the group achieved important developments in Klystrons and other radar devices. Klystrons are high vacuum devices based on the interaction of a well focussed pencil electron beam with a number of microwave cavities that it transverses (resonators) which are tuned at or near the operating frequency of the tube. They are often referred to as the Sutton tube. One of the photographs accompanying this article shows RG Hawkins in the laboratory and also a picture of the laboratory itself. The contribution by Redcliffe Radio was acknowledged in a letter dated 22nd November 1945 from the Captain Superintendent of the Admiralty Signal Establishment, illustrated in this article.

With the end of hostilities the Royal Fort reverted to the Physics department of Bristol University and the specialist team which had assembled during the war for radio and radar research was dispersed. Redcliffe Radio set up business again at No.3 William Street near the centre of Bristol in premises which had once been a public house. It had a disused skittle alley which provided space for a laboratory and workshop. The company now styled itself as Redcliffe Radio and Engineering Co. Ltd. The war years had established the Company's reputation and expertise. It was recognised by Government departments as a valuable sub–contractor, that would play a continuing role throughout future years. Whilst at William Street the company undertook work for the new Atomic Energy Commission at Harwell through its contact with Sir WRJ Cook who RJ Watkins had known at school in Exeter and had, at one time, shared lodgings with in Bristol.

In 1956 the company address was still at William street under the same title. However they were now listed in Kelly's viz;– 'Manufacturer of Electronic Equipment'. This early adoption of the term 'electronic' was similar to the way the company had used 'radio' in its early days when others used the term 'wireless'.

It was about this time that the company undertook work for the well known Bristol company of Brecknell, Dolman & Rogers. This latter company manufactured coin operated machines and had provided ticketing machines for the London underground. With post-war extensions to the underground then being constructed the award of the contract to Brecknell Dolman and Rogers was conditional upon them having electronic engineering expertise. Redcliffe radio were engaged to fulfil this role.

In 1957 Redcliffe Radio moved to modern premises in Emery Road on the newly developed Brislington trading estate. They were now listed as 'transformer manufacturers' but by 1960 the company comprised two arms: 'Redcliffe Radio & Engineering Co. Ltd. Electronic Equipment manufacturers)' and 'Redcliffe Industries (Bristol) Ltd. (Electrical Transformer manufacturers).

In 1961 the work carried out under the direction of RG Hawkins, the founder of Redcliffe Radio, was recognised in the Queen's birthday honours when he was awarded the MBE. Rob Hawkins retired from the company in 1972 at the age of 68 when over 200 people attended the occasion.

In 1974 the company, under new directors, was again renamed Redcliffe Electronics Ltd and continued to trade under this

until 1981. Then with further changes in the management the present name of Redcliffe Magtronics Ltd was adopted. This made-up term reflected the considerable work and expertise of the Company in magnetism, demagnetising equipment, magnetic scanners and electronic control systems. Further moves to nearby premises took place in the 1990's culminating in the present location at No. 20 Clothier Road as the Brislington trading estate grew in size. The new building was opened on November 25th 2004 by Rear Admiral R. Cheadle. Thus the Company not only retains its link with the Admiralty as a subcontractor but also with the Ministry of Defence generally and particularly Rolls Royce. The range of the present activities and expertise of the company is evident from its website: www.redcliffe.biz.

Thus from a chance conversation by a relative that I was a collector of vintage wireless one thing has led to another. I have had the pleasure of restoring a rare vintage wireless and returning it to the successors of the company who built it together with a fascinating search to record the history of a local company which has grown over the last 80 years.

Rob Hawkins died in 1985 at the age of 81 years.

Pictures from Gerry Wells' garden party

photography: Carl Glover

Alphabetical Tuning And The K.B 630

By John R. Sully

Mention alphabetical tuning, and probably most British vintage wireless enthusiasts' minds will think of the drum system pioneered by Murphy in the late 1930s. It is a fair bet that few readers will have recalled 'Alphadex', this article may remind readers that Murphy were not the only company to come up with the idea.

Of course until the early 1930s no receivers featured station names on their tuning dials. Receivers from the 1920s were likely to have circular dials calibrated in degrees, namely 0-180. Towards the latter half of the 1920s and first years of the 1930s control knobs tended to operate scales, discs or drums that featured wavelengths marked solely as numbers. To facilitate easy location of a desired station a small booklet or card would often be provided with the radio, and may even have been incorporated in the cabinet design. An example of this practice can be seen in the Ultra 25 receiver which incorporated a chromium plated drawer revealing a look-up chart of stations and wavelengths, but sorted by metres rather than station name. Murphy radio also supplied booklets with their '26 series (1935) onwards which were sorted both alphabetically and in metres. These booklets could also be used with earlier receivers such as the A4 (1933) and A24 (1934) together with console and radiogram variants.

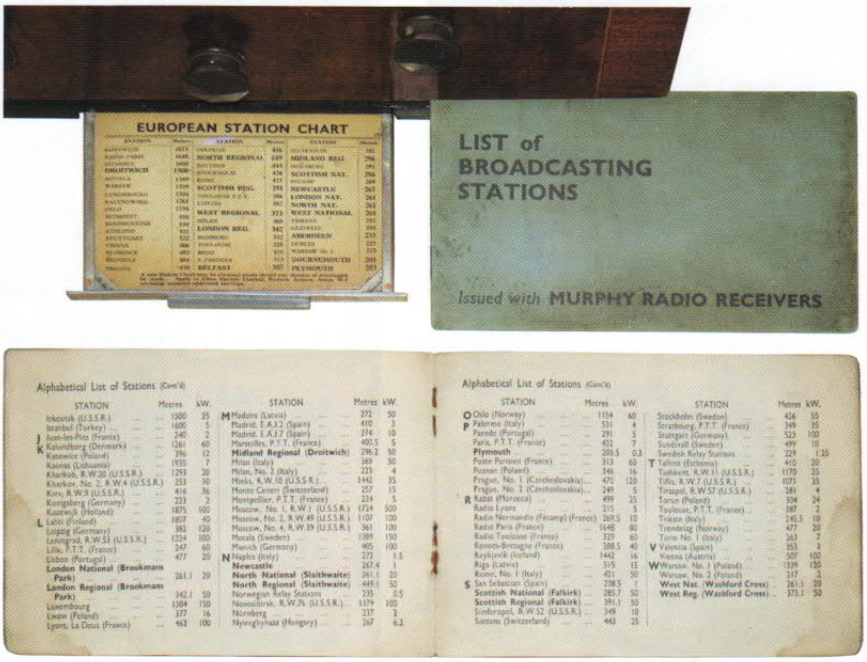
Some manufacturers had started adding station names to the dials themselves. The first manufacturer to do this is generally accepted as being Ekco with their 1931 model RS3. A few manufacturers held off adding station names to dials until as late as 1936. A well known example was Murphy who introduced their model '30 series of radio/console/radiogram still employing the look-up booklet. This had the advantage that a new booklet could be issued, or the current booklet updated, if stations moved frequency or wavelengths, or new stations commenced broadcasting. In spite of the logical reason to continue solely with frequencies marked on the dial it was perceived as dated by the wireless buying public, and a new system was required.

Murphy aimed to simplify station location and tuning by alphabetically listing the stations on a panel adjacent to the tuning drum. The drum itself was printed in such a manner that as the tuning knob was turned the drum would rotate, and a line either present or missing from the drum would indicate which way the tuning knob should be turned. Once the station was tuned the horizontal line would become a small circle with a vertical line at its centre to indicate that the station was correctly tuned-in. On later versions once the station was tuned in the horizontal line on the drum would become a rectangular block, and would "fill in" an equivalent sized space next to the station name in the panel adjacent to the drum. The foregoing description of operation is reversed for horizontally mounted drums. I am sure most readers will have seen this system.

It was first seen on Murphy radios in 1937, on the '33, '34, '36, '38 and '40 series of models. In 1938 the '47, '48 and '50 series models included the drum system. The idea must have been popular with the buying public because in 1939 the '71, '72, '74 and '78 series models were offered with the alphabetical drum system. To summarise, for three seasons nearly all the mid-range to top-of-range models from Murphy incorporated the drum system, with only the cheapest receivers not justifying the expense and extra engineering required. The cheapest models in the range simply had station names printed on a translucent material and backlit for viewing through a piece of plain glass (e.g. model AD32). Battery receivers (e.g. model B69) did not even have any means to illuminate the scale. Cheapest models in 1938 and 1939 included scales that were screen printed on glass and illuminated from the rear. The extremely well specified and expensive model A52 from 1938 also did not incorporate the alphabetical tuning drum, even though the model A48 and A50 lower in the range did so. Possibly it was found to be too difficult to integrate the drum mechanism with the motor tuning system. Alternatively perhaps Murphy wanted to include the maximum number of Short Wave stations by name, which was clearly not possible within the limited space available from the drum system. This latter possibility would seem to be borne out by the appearance of the 'Short Wave Special' model A76 from 1939 which was not motor tuned but did not incorporate the drum system.

Murphy's drum system of course required more components and increased construction time and costs per receiver. One presumes it was reliable for the anticipated lifespan of these radios, though now decades later it is not always standing the test of time so well (and of course was not designed to). Examples of receivers have been noted where the vertical cursor line of cotton is missing, broken, stretched,

Below: Ultra 25 with station chart drawer open, & close-up of station chart together with Murphy station look-up booklets.



or shifted to the wrong position, which of course totally nullifies the concept of simple accurate tuning. The example shown on this page is from a Murphy A36, and it can be seen that in this case the cursor cotton has stretched to a "curved vertical" instead of an absolute vertical, with the result that accuracy of tuning is lost or has to be compensated for by the user. As well as the foregoing problems, the drum itself is prone to expanding or bulging around the centre of its vertical section. Initially this causes the indication circle or position block to be rubbed off the drum by friction, and as the problem worsens the mechanism simply seizes up.

So, having looked at the Murphy system, was there a cheaper and equally effective alternative alphabetical tuning system available?

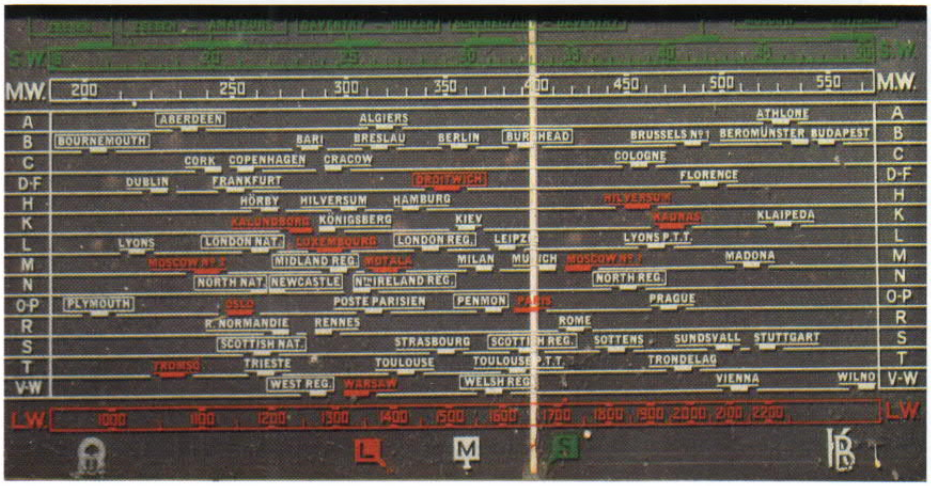
Arguably the "Alphadex" system as used by K.B. could be put forward as a contender. K.B.'s system was certainly far simpler and cheaper to include in a receiver. The cost was no greater than that of an ordinary screen printed tuning scale. The mode of operation is simple; the first letter(s) of the alphabet is vertically run downwards at each end of the tuning scale, and along the horizontal axis adjacent to the initial letter, station names are placed at the appropriate position on the scale. The tuning scale never had more than a few stations on each letter level, and the operator can intuitively turn the tuning knob in the correct direction. The "Alphadex" scale can be seen in close–up on this page. This is surely a very good example of neat, efficient and cost effective design. It performs the alphabetical tuning function just as well, and the money saved by eliminating the drum system could pay for a few more components to increase the receivers' performance.

The "Alphadex" scale pictured is from a K.B. model 630 from 1937. As this radio has the honour of featuring the "Alphadex" scale described in this article a brief look at the most interesting aspects of the radio follows: The receiver itself is not a decorative design, but looks quite sturdy and businesslike. The cabinet is quite substantial at 19½" high, 17" wide, and 12" deep. (49 x 43 x 31cm). It is quite well specified, featuring five valves plus rectifier with two I.F. stages. Sound is delivered via an 8" energised loudspeaker.

As was usual at this time K.B. were generally using Brimar branded valves in their receivers. Somewhat unexpectedly the valves utilised in the model 630 are those with 13v heaters. This is surprising as valves featuring 13v 200mA heaters were often designed with AC/DC (series) operation in mind. The use of 13v heater valves is all the more curious because K.B. felt the need to utilise a Mullard TH4A as a frequency changer. The choice of TH4A is understandable; this was known to be a very good valve which was particularly able to maintain the correct oscillator frequency irrespective of the incoming signal from the aerial. This meant that even if a strong local station happened to be directly adjacent to a much weaker distant station, that the operator wished to hear, the local station was less likely to influence the oscillator and not allow the receiver to drift to the strong but undesired station. So the TH4A is an excellent choice, but as implied by the type number it utilises a 4 volt heater. Therefore the cost of that strong frequency changer performance is the requirement to have a separate 4 volt winding on the mains transformer solely for this valve. Two 9D2 valves provide two stages of I.F. amplification. Detection is performed by half of double diode 10D1, the other

K.B. 630 Receiver

K.B. 630 Internal View



Above: K.B. Alphadex scale, below: Murphy Alphabetical Tuning Drum. (Note Vertical Cursor Cotton Has Lost Tension)

article continued on page 42

Letters

Dear Editor

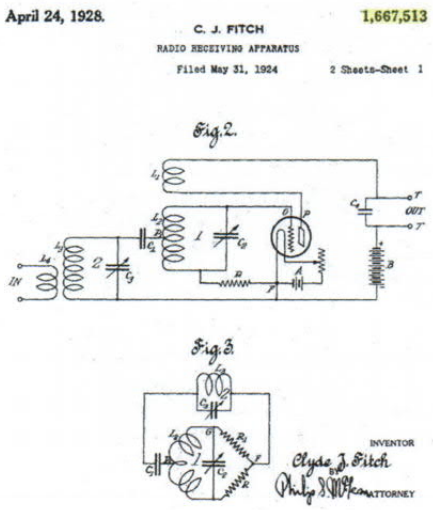
Once again another enthralling article by L.L Wiiliams (he has had my vote time and again for the Pat Leggatt award). In the last Bulletin he wrote about the McMichael 7 valve Supersonic Hetrodyne receiver and now I would like one to restore.

In it he discusses the oscillator used which he says is a Tropodyne, a variant and improvement of the Autodyne. McMichael called it a Centre Point Autodyne, most likely to not advertise the fact that they were using a circuit that was patented (1667513), and radios were manufactured called Tropadyne (Ref. 2), by C.J. Fitch, in the USA in 1924. In another patent (1762221 Filed Nov. 1924), is given a radio IF amplifier circuit that the McMichael is almost identical to, including returning the grid windings to a potentiometer across the filament supply.

Actually an American friend found the first information on the Tropadyne, in a book scanned to an Internet site (Ref. 3). The exact circuit is on page 262 of the file. The book, Radio Engineering Principles, is by Lauer and Brown. It's a second edition printed in 1928 ("Copyright 1919 and 1927") and when the first edition was printed isn't given. However, it does say in the Preface, that the first edition "...was written after the conclusion in 1919 of the authors work... in the Signal Corps, USA". I bet these engineers knew and probably worked with Major Howard Armstrong.

We are talking really early here. In the book, the Autodyne circuit, is discussed (at great length), for use in radio telegraphy and would have been used to heterodyne bursts of damped unmodulated RF into dots and dashes, that could be heard as an audio tone. Today we would call it a Direct Conversion Receiver.

The circuit used as an example has an antenna-tuned circuit connected to the triode tube grid. In series with the antenna coil is another coil having a second 'tickler' winding connected in the tube anode circuit. The simple circuit explanation, is that for oscillation all that is needed is to increase the 'tickler' coil coupling. If the coupling is negative, then with the tube, a negative resistance is introduced into the would be oscillatory circuit to cancel out the positive resistance that prevents this from happening. The oscillatory circuit (the antenna tuned circuit plus the extra coil) has to 'be adjusted' to a frequency slightly different from the antenna tuned circuit to produce a beat note. Quite a lot is written about Automatic Synchronization where this mis-tuning fails; the incoming frequency equals that of the oscillations, and no output is produced.


April 24, 1928. 1,667,513

C. J. FITCH

RADIO RECEIVING APPARATUS

Filed May 31, 1924 2 Sheets-Sheet 1

Fig. 2.

Fig. 3.

INVENTOR

Clyde J. Fitch

BY

ATTORNEY

The Autodyne had the disadvantages, as given in the Bulletin article, of signal and oscillator circuit interactions. It led to variants, one of which was the bridge circuit of the Tropadyne. In this some isolation is achieved between the signal circuit and that of the oscillator. How much will depend, as always, on the balance of the bridge. In the book they say that it is the balance of the "average internal grid to filament resistance" and the resistor connected from the bottom of the oscillator coil to the filament (I M Ohm in the McMichael circuit). Note now that the antenna and oscillator circuits are independently tuned making adjustment of a difference frequency much easier. For use with modulated waves then this difference would have been large and equal to the IF frequency.

Fascinating stuff that shows the ingenuity of the early engineers, to achieve as much as possible with the fewest active elements. In the next decade they just used more tubes.

References:

1) www.google.com/patents

2) www.antiqueradio.com/corkutt_superhet.html
An excellent read of several US Superhets restored by Bill Corkutt

3) www.pmillett.com/Books/lauer_radio_eng.pdf

Gary Tempest

Dear Editor

This is a first for me: two articles and two letters in one Bulletin. But it gives me real pleasure to write and thank the Members for the G. Dixon-Nuttall award for restoration of the Stewart Warner 950.

I liked Geoffrey a lot and he was also a fine engineer so the award is just a little more special.

This is actually an opportunity to clarify and correct a couple of things in the article (Winter 2008), for those who are interested. I had no replies from members to my pondering on the stability issue, but have since, from that friend in America (see other letter). As he keeps cropping up he should be named: take a bow Mr C. Doose.

Chuck took an interest after I sent him a copy of the article and made two excellent points:

The first was that using the square of the turns ratio to transfer impedance from secondary to primary of transformers would be very approximate for loosely coupled transformers at RF.

The second was my misunderstanding of the Selectivity versus Signal Level in the graph reproduced from Radio Magazine 1930. I was misled by the way it was expressed, thinking that selectivity got worse as the field strength got greater. This is not so, it's the method of measurement where the field strength has been increased to get back to the same (reference) output. I subsequently annotated the field strength scale to dB's and then it looked more usual.

Gary Tempest

Dear Editor,

I recently spotted this advertisement (see above) whilst on a stroll in my home town. Can any eagle eyed readers guess where it was taken and do any members have any similar "vintage" photographs?

Regards,
Steve Stares

Dear Editor,

I am forwarding a message that I received last week from Dr.Alex Magoun of the David Sarnoff Library.

You may already be aware of this news, which is important to anyone who is interested in radio/TV history, regardless of the fact that it is dedicated to the RCA viewpoint.

I visited the David Sarnoff Library back in 1996 and was impressed by the size of the collection and its immaculate condition.

Sincerely,
Malcolm Baird

Above: photograph of Philco assembly line, Perivale 1936. Courtesy of Tony Clayden.

A special announcement from the David Sarnoff Library

This Sunday the Times of Trenton will run a story on the closing of the David Sarnoff Library by the end of the year.

The Library s success in attracting field trips and tour groups has outgrown our host Sarnoff Corporation's ability to accommodate the attendant security and access issues, especially given its expanding business in government security technologies. When I started working here in 1998, the Library received perhaps 100 visitors in a year; in the last year, that number has multiplied to 1,400 through our field trips, programs, and tours. That still small number, magnified by the hundreds of thousands of visitors to our website, promised only to increase as we continued to promote the Library s offerings to tour companies and regional school districts.

My board and I are meeting with a variety of institutions. We are focusing on and meeting with representatives of those that will enable greater access to the remarkable and inspiring stories told by David Sarnoff and the people of RCA in research, invention, and innovation, the mainstays of American economic success. We are exploring opportunities in-state and out, and while it is too early to discuss these options, we look forward to making an announcement in the next month.

For now, we are eternally grateful to Sarnoff Corporation's executives and staff who, over the past nine years have done so much to help make the Library a destination for educational, professional, and scholarly audiences. I am also especially grateful to our board members who, in that nine years, have guided the Library's growth; to the New Jersey Historical Commission

Continued on next page

and the Secretary of State for their operating support grants; to many other grantors and donors for their financial support; to the allied organizations who share an interest in promoting science and technology; to the teachers and principals who brought their classes to our new field trip programs; to the contractors and dozens of volunteers who helped rebuild the museum, organize and preserve the archives, and stage our amazing variety of educational programs; and of course to you, the many friends of the Library, from all these areas and more. Thank you all!

Sincerely,
Alex

Alexander B. Magoun Ph.D.
Curator and Executive Director
David Sarnoff Library
201 Washington Road
Princeton NJ 08540-6449

Unique Three Phase continued from page 29

brand new wire and scrap transformer. The only downside was our UK climate; some days it didn't get light at all and as I tried to take pictures of work in progress the flash would wash the picture out whereas a normal picture came out dull. I wasn't considering writing this up as an article until Martin Scobie suggested it would be of great benefit to other members wishing to install 3 phase into their workshops. With 7.5KW static converters costing in the region of £600 new and rotary converters costing in the region of £1,000 new this transformer method is an absolute bargain for those willing to put the time and effort in. I found this project to be addictive and very interesting and am now looking for a very large stator to experiment with as I have a number of ideas I would like to try out.

Safety is a major consideration on this project and I only offer my experience having completed both stator and transformer methods successfully. Anyone wishing to have a go does so entirely at their own risk as dangerous voltages are ever present together with large fully charged capacitors. Capacitors should each be fitted with a discharge 2W resistor and the resistor should not be fully trusted; it pays to double check by bridging the capacitor terminals (power turned off) with an insulated handled screwdriver; take extreme care when handling capacitors. Work slowly and unplug before handling anything; my transformer is silent just waiting to put me on my back and the high voltage will kill without warning. If in any doubt whatsoever do not attempt this project.

I can't thank or praise Douglas Arndt enough for creating Unique3phase and for all his help during the project. I will be happy to help anyone who buys the DVD's from Doug and can be contacted by e-mail at; c.wood340@ntlworld.com

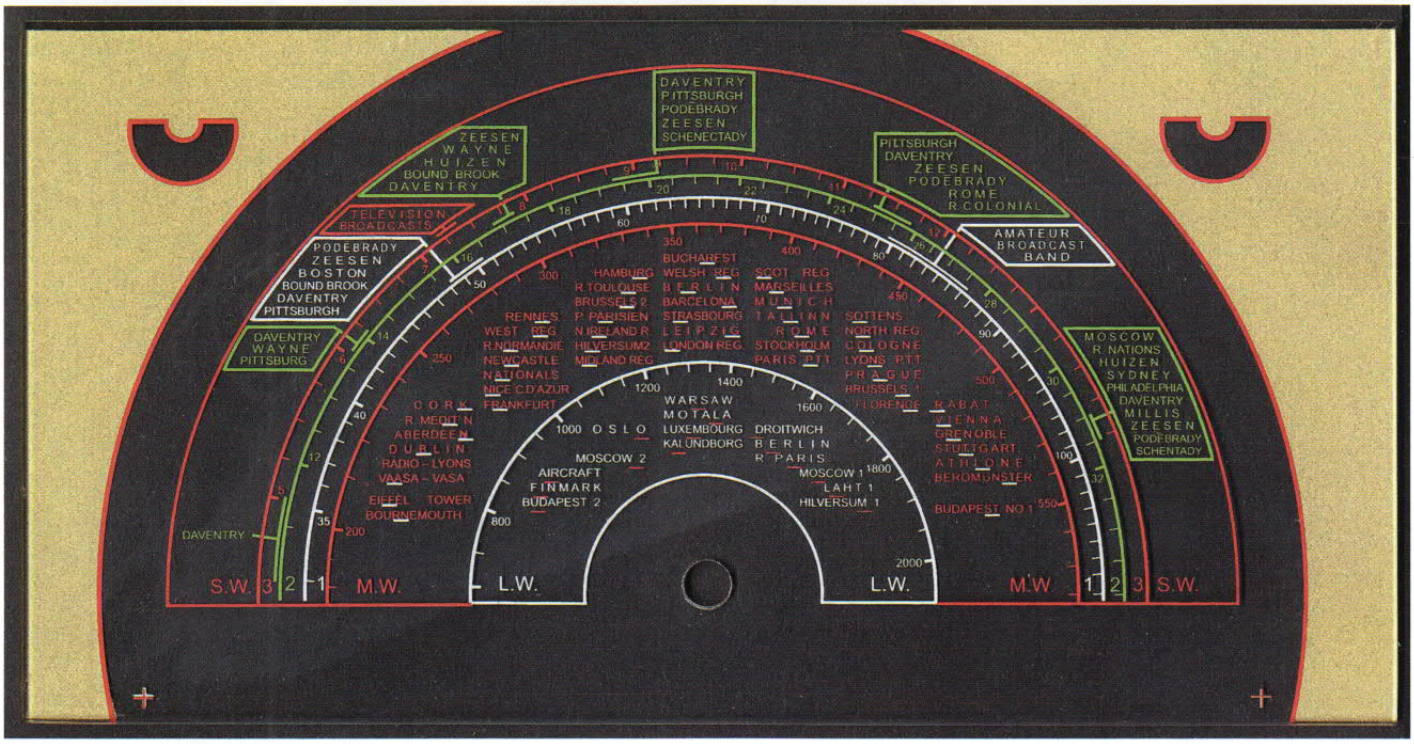
The DVD's cost me a total $25.52 USD at the time this converted into £17.76GBP

By Post: Douglas Arndt. 10671 N.Idaho RD, Post Falls, Idaho. 83854 USA.
By Internet: http://www.uniquethreephase.com/

http://members.ebay.com/ws/eBayISAPI.dll ?ViewUserPage&userid=unique3phase

Wire in the UK; Screwfix.com

Making Dials continued from page 23



7: HMV 650 silk–screened dial

but the screens, even if they could be found, wouldn't be clean enough to use again. Also, I was told most of the cost of screening is in the setting up, "... it can take a couple of hours to get this perfect".

Conclusions

I have thoroughly enjoyed myself making these dials and acquiring new skills using CorelDRAW. The silk-screened dials turned out really well and look beautiful lit up in low light. I have no hesitation in recommending the glass cutting and silk screening companies if any other members want to do a dial.

The silk screener said to me "... if you can do the artwork yourself then you have eliminated the most expensive item". Even skilled graphics designers would spend considerable time in doing a large dial and of course they need to earn a living. However, don't expect to make a profit unless it's a very common radio and a dial that uses a simple and therefore cheap glass. If this is the case then you can get many screened (within reason the silk screening charge remains the same), the unit price will be less and you are likely to sell more. I never set out to make a profit but if I get somewhere near breaking even then that's good enough.

Reference 1: www. Kustomrides.com

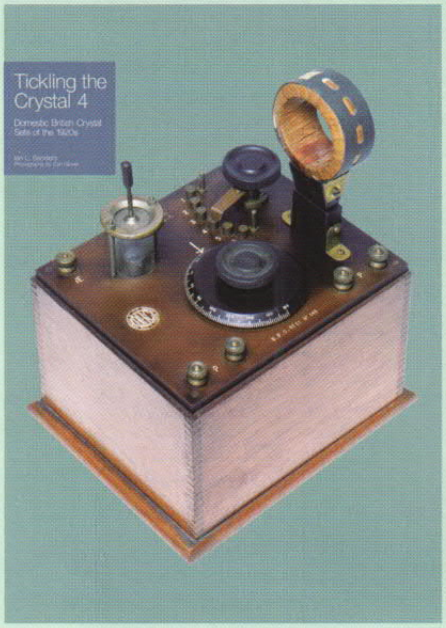
Reference 2: http://www.oldradioparts.net/ (Mark Oppat)

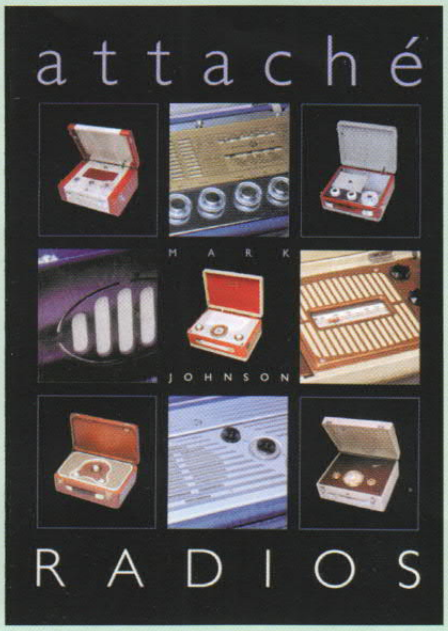
Rayleigh Silk Screens: Unit 16 Brook Road Industrial, Brook Road, Rayleigh SS6 7XL

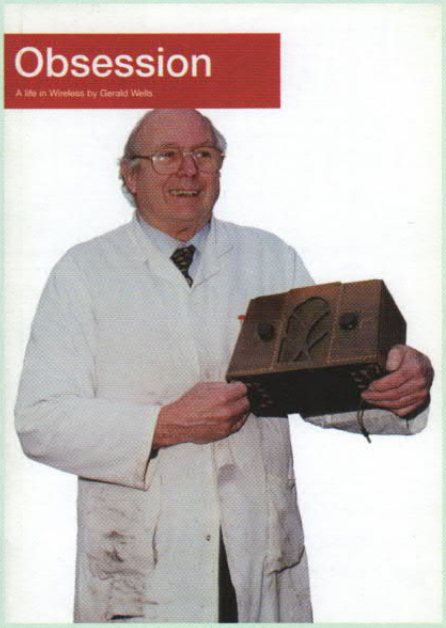
Basildon Glassworks: 12 Winstanley Way, Howard Chase, Basildon, SS14 3BP

BVWS Books

Out Now!







Tickling the Crystal 4

More Domestic British Crystal Sets of the 1920s

by Ian L Sanders. Photography by Carl Glover

Full colour throughout.
Strictly Limited Edition! only 500 copies printed
£5 discount for BVWS members

280 pages of GPO No. era British crystal sets. Over 200 full-page photographs. £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EEC (rest of world £15)

Attaché Radios

by Mark Johnson

An 80 page colour paperback guide to the Attaché portable

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

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

Obsession

by Gerald Wells

Gerry Wells had led an extraordinary life. Growing up in the London suburb of Dulwich in the inter–war years, he shunned a conventional 1930's childhood, preferring wireless and other household items. After the war he managed a career as a radio and TV service engineer and even designed and managed amplifiers, PA equipment and TVs. Today he runs the Vintage Wireless and Television Museum from the same family home from where he was born in 1929.

In this book Gerry brings to life his colourful past. This is the story of one man's dedication to wireless

£6.00 196 pages paperback

Slipcase to house the first 3 volumes of 'Tickling the Crystal' £9.95. Buy all 3 and get slipcase free! (postage £12 UK, £35 EEC £55 US)
BVWS Members buy 2 and save £12! (postage £9 UK, £24 EEC £28 US)

Tickling the Crystal
256 pages. Over 200 full-page photographs. £14.95 for BVWS members plus £7 p&p for UK, £13 EEC (rest of world £15)

Tickling the Crystal 2
Limited, Only 750 copies printed. 208 pages. Over 200 full-page photographs. £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EEC (rest of world £15)

Tickling the Crystal 3
Limited, 500 copies printed. 240 pages of GPO No. era British crystal sets. Over 200 full-page photographs. £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EEC (rest of world £15)

BVWS, 26 Castleton Road, Swindon, Wilts
SN5 5GD
Tel: 01793 886062

BVWS Books

Alphabetical Tuning And The K.B 630 continued from page 37

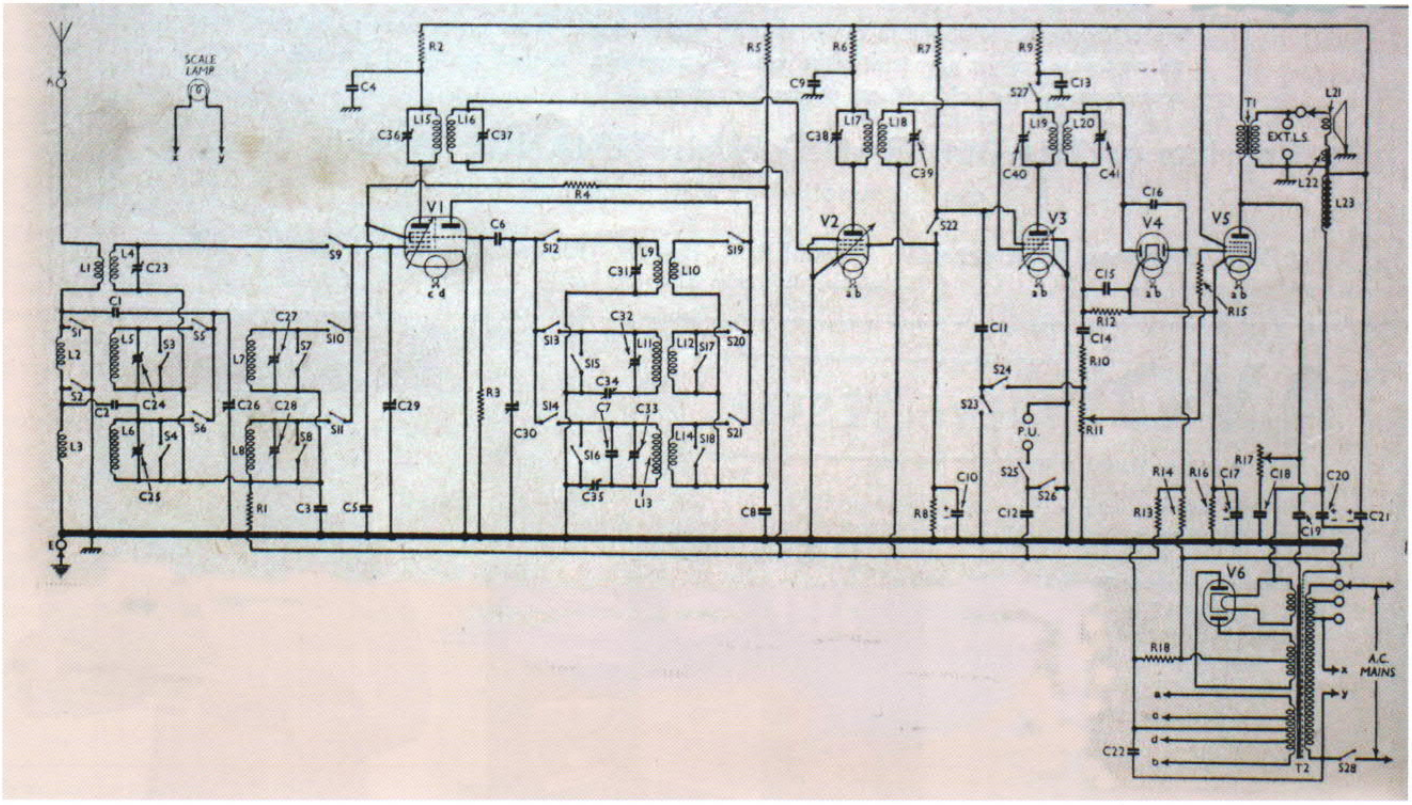


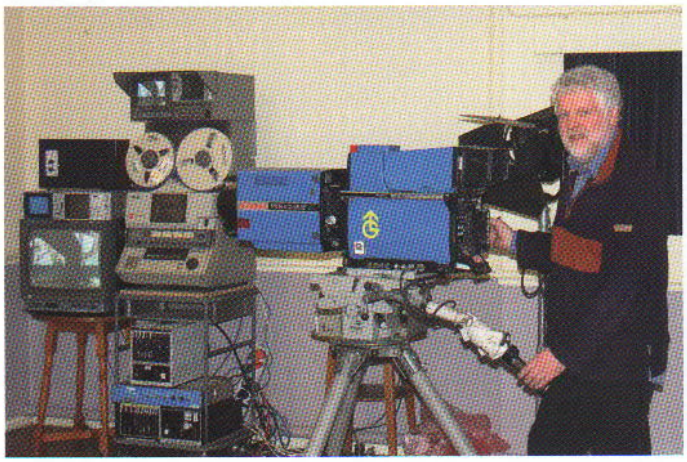
Fig 6. K.B. 630 Circuit Diagram

diode providing the D.C. signal for A.G.C. purposes. The output valve is a 7D8 pentode, giving a probable output of about 4w. Full wave rectification is supplied by an R2.

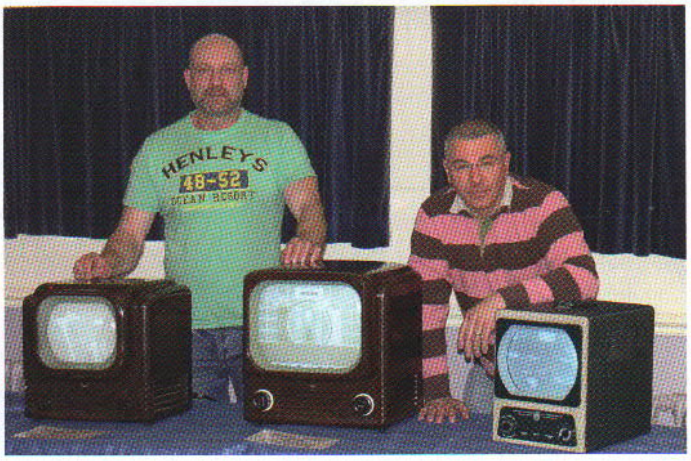
Provision is made for the connection of a gramophone, with a dedicated switch at the rear of the cabinet to bring it into circuit. One of the 9D2's provides an extra stage of amplification when used in the Gram position. Whilst in Gram position only, the screen grid of the 9D2 becomes an anode, and the signal from the pick-up is fed to the control grid via a coupling condenser. Further contacts on the radio/gram switch disconnect the radio signal from the previous 9D2 I.F. stage. An extension speaker can be connected and the internal speaker silenced by means of a wander plug and socket at the rear of the cabinet. The scale lamp was missing from the example pictured, but is a 15w tubular lamp that fits into a tube positioned directly next to one end of the dial glass. A paper label inside the cabinet advises the owner to position the filament of the tube such that light output is at a maximum in relation to the scale edge. One presumes this is to light the scale "stereoscopically" whereby the lettering itself appears to be glowing. As is to be expected with a 15w lamp, a lot of heat is generated in a confined space. To that end a 16 square inch piece of unprotected asbestos has been provided to keep heat off the front panel of the receiver. (Though perhaps warmed control knobs together with the Alphadex scale could have been used as a selling point in providing a totally luxurious tuning experience!). Unusually the dial escutcheon and knobs are a creamy white plastic instead of the more common brown bakelite. The wavechange knob also aids the simplicity of tuning. It is concentrically mounted behind the tuning knob, and incorporates a pointer that indicates which band is selected, using legends on the glass scale.

This article cannot describe the performance of the K.B. 630. The reader will see from the pictures that rampant woodworm is evident. The chassis has obviously been subjected to damp conditions for some considerable time. The cabinet is weakened in places by woodworm, and the veneer is lifting although fortunately is largely all present. I do not recollect seeing one of these receivers before, but I imagine there must be others in existence. This example is not beyond restoration, but I feel inclined to rely on the fact that other BVWS members may be preserving one. For the moment the best it can hope for is a heavy dose of woodworm killer. If nothing else, this particular radio has provided a platform for "Alphadex" tuning, and proved that Murphy were not the only manufacturer to implement alphabetical tuning in the mid 1930s.

Pictures from Lowton courtesy of Steve Harris

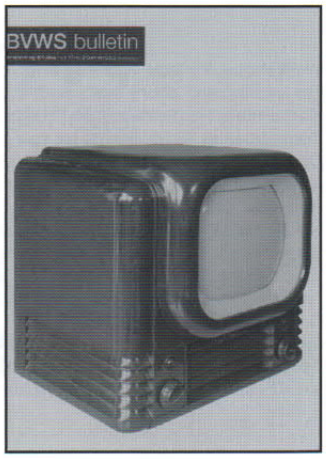


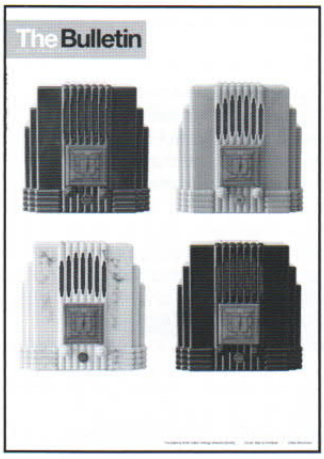
Steve Harris televising the Lowton meeting with studio camera



Russell Atkinson and Mike Barker running the vintage TV display

The running studio camera and recording equipment





Back issues

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Vol 24 Numbers 1, 2, 3, 4 Inc. The Superhet for beginners, Triode valves in radio receivers, History of GEC and the Marconi - Osram valve, KB FB10, Great Scotts!, Riders manuals.

Vol 25 Numbers 1, 2, 3, 4 Inc. Repair of an Aerodyne 302, Henry Jackson, pioneer of Wireless communication at sea, Zenith 500 series, Confessions of a wireless fiend, RGD B2351, John Bailey 1938 Alexandra palace and the BBC, Ekco during the phoney war, Repairing a BTH loudspeaker, The portable radio in British life.

Vol 26 Numbers 1, 2 Inc. How green was your Ekco?, The Amplion Dragon, Crystal gazing, The BVWS at the NEC, Installing aerials and earths, novelty radios, Machine-age Ekco stands of the 1930s, Volksempfänger; myth & reality.

Supplements:

1 'The story of Burndept'.
2 'WW 1927 data sheet'
3 'Seeing by wireless' the story of Baird Television
4 Reproduction Marconi catalogue

Earlier Bulletins and supplements are priced at £2:00 each + postage. Bulletins from volume 21 onwards are priced at £2.50 each. + postage.

Postage: for individual Bulletins add 50p, for 2-5 bulletins add £1, for 6 or more add an extra 20p each.
23 Rosendale Road, West Dulwich
London SE21 8DS
Telephone 020 8670 3667.

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

News and Meetings

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

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

2009 meetings
13th September Table top sale at Vintage Wireless and Television Museum
11th October Audiojumble, Tonbridge
18th October Harpenden swapmeet
1st November Workshop at Vintage Wireless and Television Museum
22nd November BVWS North West meeting, Lowton
27th November 'A Festive Music Night' at the Vintage wireless and Television Museum
6th December Wootton Bassett

2010 meetings
February 14th Audiojumble
March 7th Harpenden
May 9th NVCF
June 5th BVWS Garden Party
June 6th Harpenden AGM & Auction
July 11th Wootton Bassett
October 10th Audiojumble
October 17th Harpenden
December 5th Wootton Bassett

Workshops, Vintage Wireless and Television Museum:
For location and phone see advert in Bulletin. 11:00 start.
Harpenden: Harpenden Public Halls, Southdown Rd. Harpenden. Doors open at 10:00, tickets for sale from 09:30, Auction at 13:30. Contact Vic Williamson, 01582 593102
Audiojumble: The Angel Leisure Centre, Tonbridge, Kent. Enquiries, 01892 540022
NVCF: National Vintage Communications Fair
See advert in Bulletin. www.nvcf.co.uk
Wootton Bassett: The Memorial Hall, Station Rd. Wootton Bassett. Nr. Swindon (J16/M4). Doors open 10:30. Contact Mike Barker, 01380 860787
Lowton: Lowton Civic Hall, Hesketh Meadow Lane, Lowton, WA3 2AH
For more details with maps to locations see the BVWS Website:
www.bvws.org.uk/events/locations.htm

We want your articles!

Share your interests with your fellow BVWS and 405 Alive members.

We accept: Type, handwriting, fax, email, floppy disc, CD

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

Bonhams
Knightsbridge

Mechanical Music Sales at Bonhams

The leading mechanical music auctioneers in the UK

Entries currently invited for each of our 2009 dedicated sales:

Knowle
29 September

Knightsbridge
10 November

New Bond Street
25 November

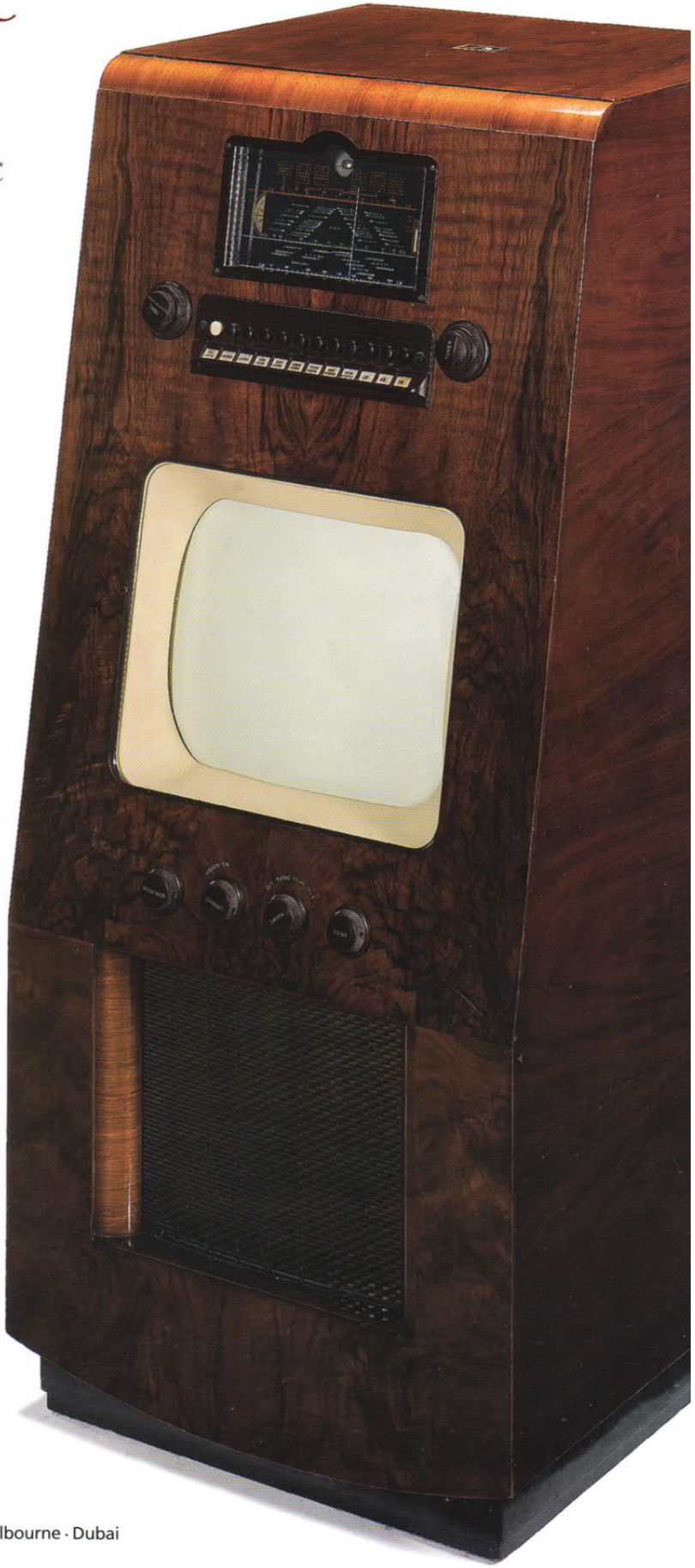
Enquires
Laurence Fisher (London)
+44 (0) 8700 273 633
laurence.fisher@bonhams.com

Mark Hannam (Knowle)
+44 (0) 1564 732 968
mark.hannam@bonhams.com

Catalogue
+44 (0) 1666 502 200
subscriptions@bonhams.com

Illustrated
A rare HMV Type 1850 Television and Wireless consolette,1939, No. 15016, 14-inch screen with white mask, the 3-band wireless with magic-eye and fine-tune SW dial having preset and waveband button select, launched two days before the transmission suspension.
Estimate: £1,500 - 2,500

To be offered at Knightsbridge on 30 September, as part of the single-owner sale The Michael Bennett-Levy Collection of Early Technology, which includes the largest and most complete collection of pre and post-war televisions ever to be offered on the international auction market.



Bonhams
Montpelier Street
London SW7 1HH
+44 (0) 20 7393 3900
+44 (0) 20 7393 3905 fax
www.bonhams.com/mechanicalmusic

London · New York · Paris · San Francisco · Los Angeles · Hong Kong · Melbourne · Dubai