BRITISH

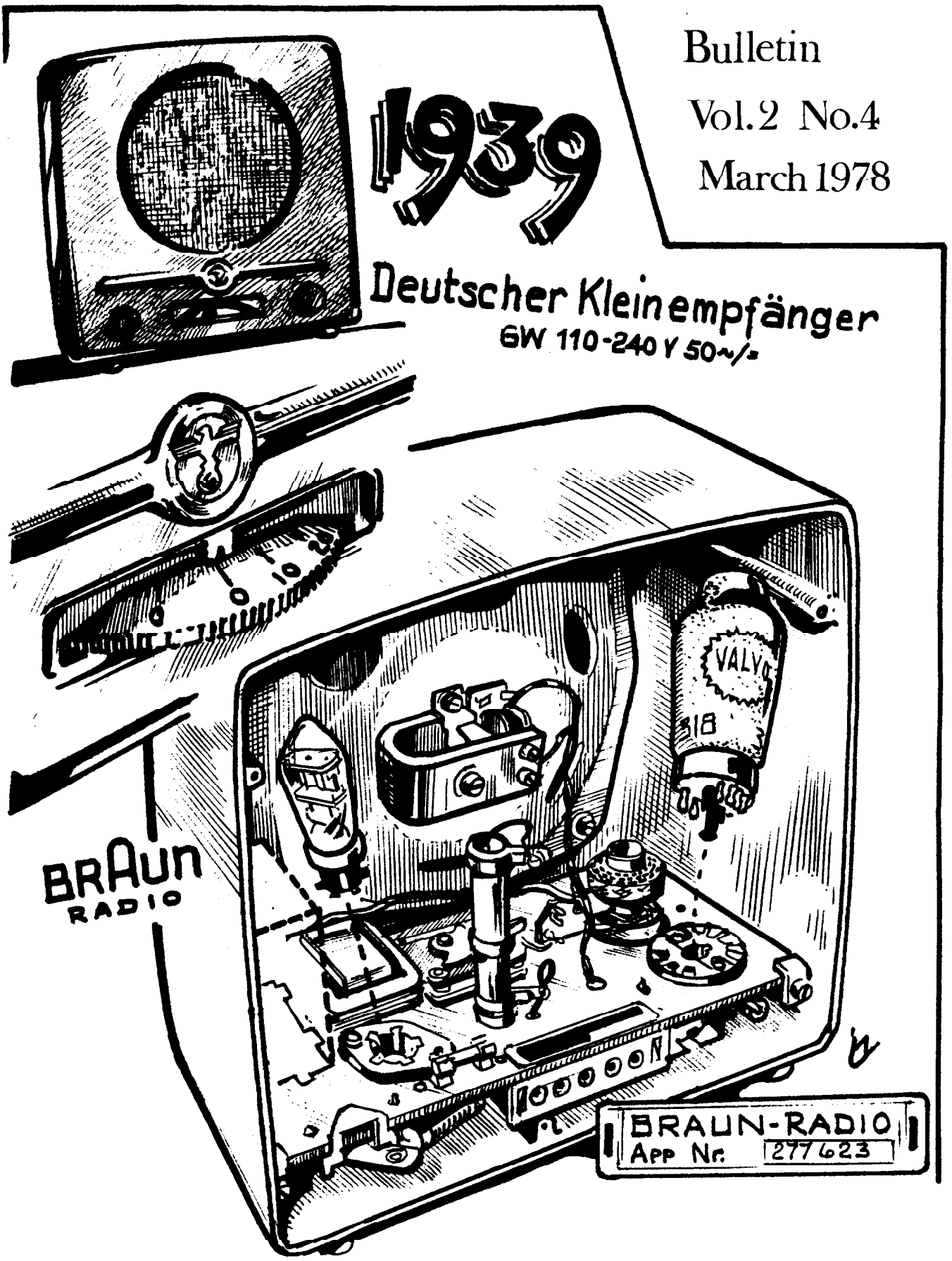
VINTAGE WIRELESS

SOCIETY

Bulletin

Vol.2 No.4

March 1978



THE BRITISH VINTAGE WIRELESS SOCIETY

All correspondence relating to the Bulletin should be sent to

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Mr. Jon Hill, Hon Membership Secretary,
14, Victoria Court,
Kingsbridge Ave.,
London, W.3.

DEADLINE FOR NEXT ISSUE ..... 1st May ... This is one month earlier than usual and must be adhered to if the Bulletin is to come out on time at the end of June.

A.G.M. ..... To be held at St. Albans this year on May 21st

See Page 56

See Page 56

See Page 56

Front Cover Illustration The German 'people's' radio came in this form in 1939 and it's evolution and circuitry are described by Maurice Chaplin in his article on page 2. Norman Jackson's cover illustration shows the front appearance, a close-up of the tuning dial and 'Eagle-and-Swastika' insignia immediately above it, and a rear view of the Kleinempfänger - the small version of the people's radio. The left-hand valve in the illustration is a half-wave rectifier and the right-hand one is a double tetrode. The loudspeaker is a balanced armature type and the speaker 'chassis' is made of moulded compressed cardboard!

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EDITORIAL

In the December 1976 issue of the Bulletin (back page) mention was made of the 75th anniversary of the first transmission of wireless signals across the Atlantic from Poldhu in Cornwall to Signal Hill, St. John's Newfoundland. This year (18th January) marked the 75th anniversary of the first two-way wireless transmission of messages between the U.S. (Cape Cod) and Europe (Poldhu) when telegrams were exchanged between President Theodore Roosevelt and King Edward VII. The history of wireless being what it is, we can, if we so wish, now celebrate anniversaries of some sort every year (and even several times in the year) for many years to come. In 1979 it is 75 years since Fleming introduced thermionics into wireless telegraphy, in 1980 perhaps we should celebrate the 75th anniversary of Marconi's discovery of the directional properties of the 'Bent Aerial' (in 1905) and in 1981 we should remember that 1906 was the 'year of the crystal'. This year it is 50 years since the screen grid valve and it is (believe it or not) 30 years since the transistor came on the scene. But we can get carried away with a sort of anniversary fever if we don't watch out and, in any case, 75th anniversaries are supposed not to be as important as 50th and centennials. And on the subject of centenaries, the first really important one (apart from the Maxwellian one of some 13 years ago) takes place next year. Yes the first transmission of wireless signals from a spark transmitter to a microphonic detector took place 100 years ago in London barely 200 yards from the site of the BBC headquarters. There is no commemorative plaque to mark the spot where Professor David Hughes first demonstrated Maxwell's predicted radio waves at number 94 Great Portland Street, W.1. nor at the house nearby at number 40 Langham Street where he continued with his experiments. David Hughes, born in London in 1831, educated in the U.S.A., Professor of Music at St. Joseph's College, Bardstown, Kentucky, inventor of the telegraph printer, the induction balance and the microphone, discovered Hertzian waves before Hertz. His enthusiasm in his new discovery was quashed by his learned friends at the Royal Society but the record stands: his experiments were observed by William Preece, Professor James Dewar, William Crookes, Mr. Spottiswoode, Prof. Thomas Huxley and Prof. George Stokes. Hughes' experiments included sending a clock-work-operated pulsed-code from his spark transmitter and receiving it on his microphonic detector and telephone earpiece up to a distance of 500 yards along Great Portland Street. So, when we celebrate the centenary next year we know that this is a well documented worth while event.

The A.G.M. will take place this year at St. Albans, just to the north of London and we hope that there will be a big turn-out of members ... see page 56 .... While last year's meeting was held at the historic two-emma-toc hut, this year's will be in the **Ex-Civil Defence Hall** - a less historic setting perhaps from the point of view of vintage wireless but St Albans has many advantages. It is comparatively easy to get to, parking facilities will be good and it is a splendid opportunity to combine our own wireless interests with a family visit to an ancient city which the Roman armies occupied in the year 43 AD and named it Verulamium. There is so much to do in St. Albans in the way of visiting old Roman sites, museums and the Cathedral that the family is bound to agree when you suggest a trip there on Sunday May 21st. Between now and then collect together all those bits and pieces you want to swap and come prepared for a grand bartering session.

VOLKS RADIO

By Maurice Chaplin

As the Hitler Government swept themselves into power in Germany in 1933 their newly formed Ministry of Propoganda and Enlightenment took over control of broadcasting from the Post Office. Anxious to get the party message into every German home it was realized that very cheap radio receivers must be made available. The Heinrich Hertz Institute of Berlin was given the task of designing suitable radios with Professor Leithauser responsible for developing the circuit to be used. It was necessary, he said later, that the receiver should be selective and powerful enough to guarantee reception at all times of the day. The receiver must not, however, be 'too good', otherwise the listener might hesitate to buy a more expensive receiver even if he could afford it, thus alienating the radio manufacturing industry.

Hitler met with representatives of the leading radio manufacturers and decreed that some 20,000 must be constructed and placed on the market within a limited period, the cost of each not to exceed 75 Marks (approx $15, approx £3).

The final arrangements were for the manufacturer's Association to provide its members with the drawings developed by Professor Leithauser. Each Manufacturer supplied the Institute with a prototype which had to be approved before production started. To meet the target selling price both manufacturers and dealers had to agree to large cuts in normal profit margins.

The 1933 Berlin Radio Show, the 10th consecutive exhibition since Germany began broadcasting, received greater publicity and provoked more interest than any previous Radio Exhibition with the introduction of the People's Radio being the most spectacular feature. The receivers were of three types - one battery operated, one for AC line and the other for DC line operation. The receivers were small table models, with the AC version housed in a bakelite cabinet and the others in wooden cabinets. The chassis was similar in all models and practically identical regardless of which of the 28 manufacturers had produced it. Production targets had been increased to 75,000 for the AC model, 15,000 for the DC and 10,000 for the battery type. Some 30,000 were sold before the show and during the first three days demand was so heavy that a further 100,000 had to be ordered.

The schematic diagram for the AC version (Fig.1.) shows an orthodox Reinhartz-type regenerative detector followed by pentode output (3 watt rating) to the balanced armature loudspeaker. Reasonable selectivity was obtained by using Litz-wire coil and an improved low-loss valve socket. In addition to the broadcast band, long-wave coils could be switched in for reception of Zeesen on 190 kHz (1600m). The negative-rectification half-wave power supply was unusual although similar to one used by Fada in the U.S.A. in 1928.

The DC model had a similar circuit (less rectifier, of course) with the addition of capacitors to isolate the aerial-earth system from a possible live chassis. The valves differed from those in the AC receiver in that both had 20 volt heaters in the usual series-with-ballast-resistor connection. (The spec. for the DC set shows the detector as an REN-1820 r.f. tetrode but the schematic indicates an REN-1821 triode).

The battery operated version designed by Herr Nestel of the RRG (State Broadcasting Corporation) labs, used three 2 volt filament valves with the regenerative detector being followed by an RC coupled triode similarly coupled to the output pentode. The receiver in its wooden cabinet stood on a matching wooden box which housed the batteries. The L.T. supply could be from a lead-acid accumulator, from a special 3-volt dry cell battery with series resistor included in the battery, or from an air-depolarised battery. With the latter the receiver was said to be capable of 3 hours daily operation for 250 days without renewing the L.T. supply.

The battery manufacturers co-operated by making low-priced batteries available. Even so, an H.T. battery economiser circuit was included as shown in simplified form in Fig.2. The output valve was over-biased so that, in the absence of signal, the plate-current idled at about 2mA. Audio output voltage changes were rectified by the metal rectifier so that the positive voltage produced could off-set the

negative potential from the grid battery to increase anode current to around 6mA.

In 1933 there were 344,311 'Peoples' receivers sold. In 1934 the Ministry of Propaganda warned dealers to make no attempt to use 'sell-up' tactics on prospective Volksempfänger owners. In the same year the price was reduced which helped sales to increase to 811,619 units. Sales were down in 1935 to 470,743 despite a Government supported program for a fixed trade-in allowance on every pre-1930 receiver traded in. (Some 373,000 older units were handed in and destroyed by the Ministry). An AC/DC version was shown at the 1935 Berlin Radio Show as well as a converter unit by Korting for changing the People's receiver into a superhet. As shown in Fig.3. the receiver, when tuned to 375kHz, acted as i.f., detector and a.f.

Many powerful receivers were being manufactured during this period for those who could afford them. Telefunken, for example, showing some 40 different models in 1936. However, listening to transmissions from other countries where comments unfavourable to the new regime were broadcast could result in two year prison sentences for 'contemplated high treason'.

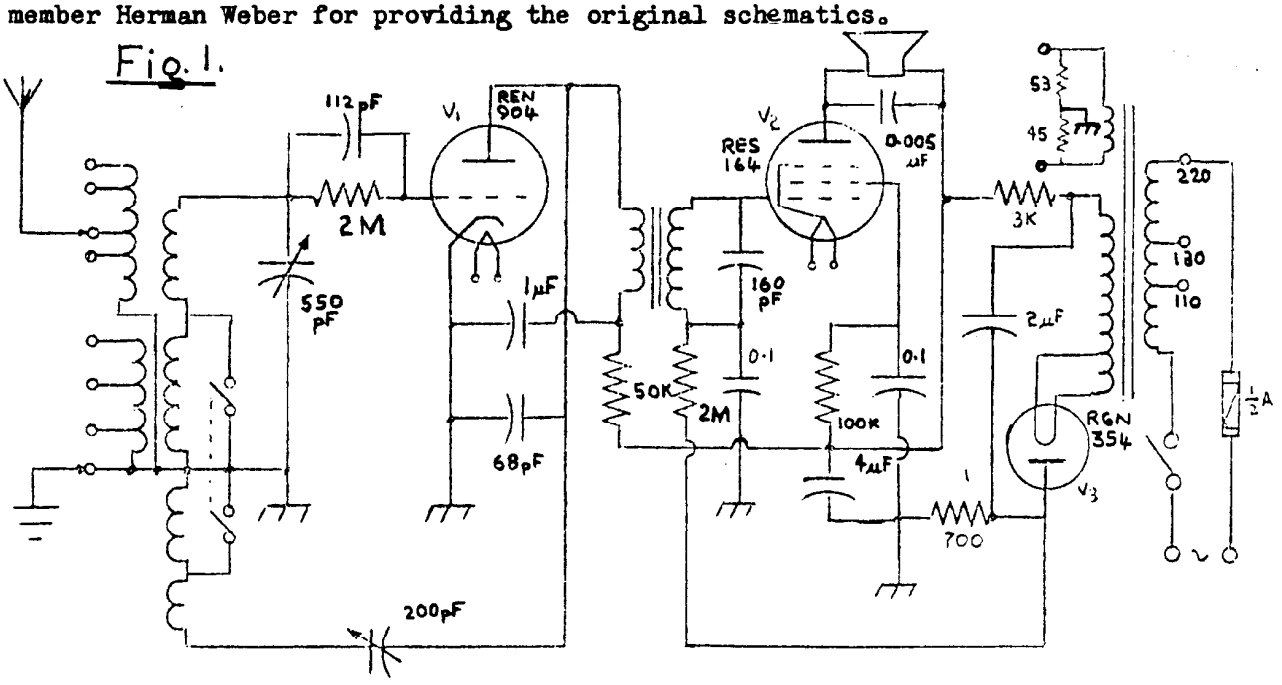
Goebels announced details of a new Volks in 1937 and it was introduced in that year's Berlin Show. Externally the same except for the dial being re-calibrated with station names instead of arbitrary numbers, the chassis now had a tetrode detector for better sensitivity and a re-worked loudspeaker, still, however, a balanced armature. The new receiver was economical to operate, consuming 18watts from a 220volt supply. Total sales now reached 2,652,223 (compare with Philco's U.S. total 'baby grand' or 'cathedral' model production of 2,029,032).

The 1938 Berlin Show produced another variation with a moving-coil speaker but the real sensation was a new 'small' receiver - the Kleinempfänger - incorporating a number of cost-cutting and material-conserving features so that it could be sold at half the price of its stable mate. The circuit was still a regenerative detector with a.f. but now used a twin triode. The usual type of balanced armature loudspeaker was fitted but amplitude distortion was reduced by adding negative feedback around the output stage. The receiver was an indifferent performer and was quickly altered to allow a twin tetrode to be used (Fig.4.). A moving-coil speaker was substituted and overall 'loudness' improved by removing the feedback circuit. Sales of this receiver pushed the total to just over 3 million.

To complete the series the People's set again became a 3-valve chassis in 1939 but this involved a mixer oscillator stage ahead of the twin-tetrode to produce the 'Kleinsuper'. A number of other countries either planned or put into production small standard receivers but only in a totalitarian country could the people's 'choice' be directed to make such a large production volume possible.

Most of the information for this article was obtained from issues of Wireless World for 1932-39, but thanks are due to Canadian Vintage Wireless Association member Herman Weber for providing the original schematics.

Fig. 1.



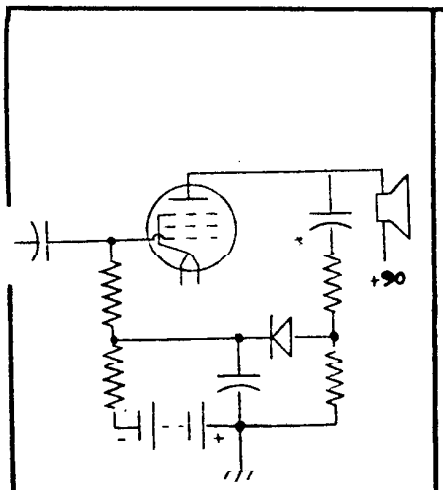


Fig.2. B - battery economizer circuit. Volksempfänger VE 301 B.

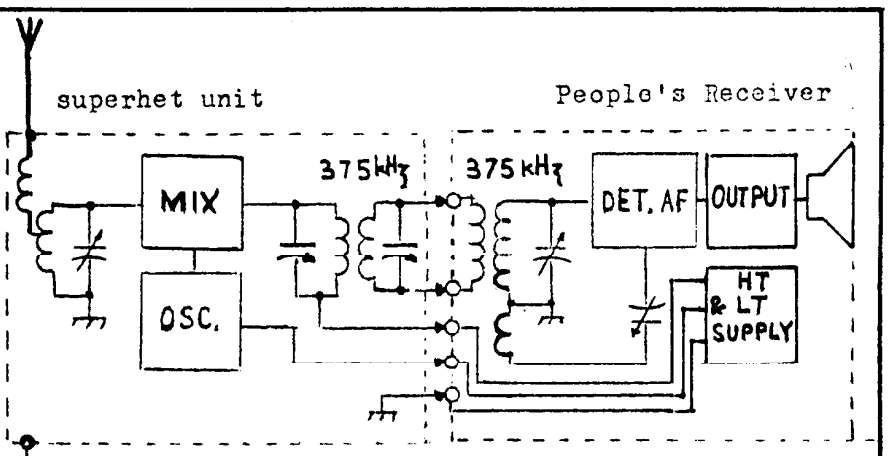


Fig.3. The Volksempfänger was placed on top of the converter and connected without soldering.

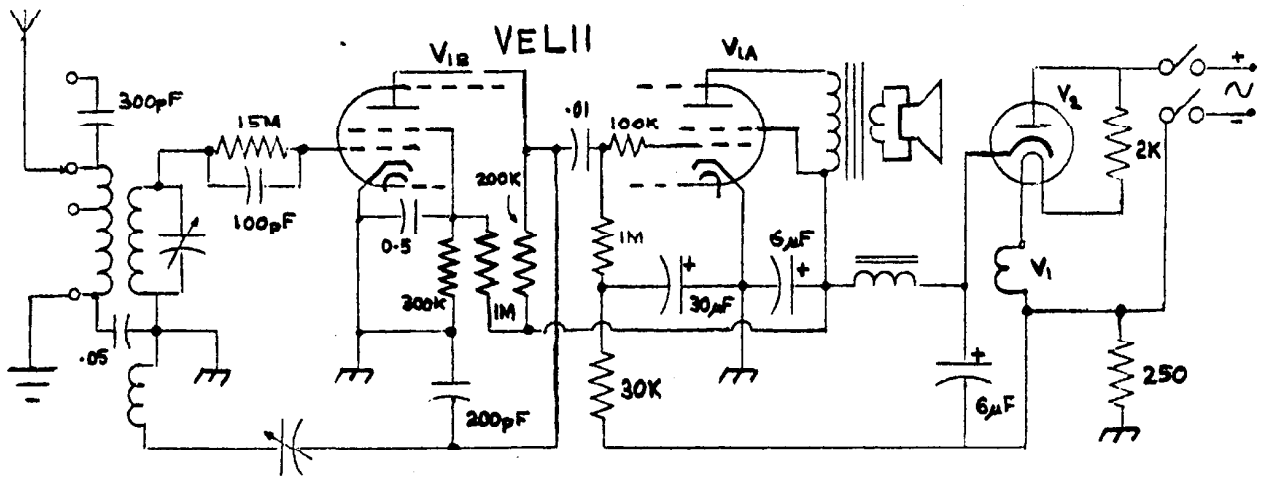


Fig. 4. The Kleinempfänger

The author of this article, Maurice Chaplin is the Vice-President of the Canadian Vintage Wireless Association and has been in correspondence with the editor of the Bulletin since it began. The article first appeared in the C.V.W.A's magazine 'The Cat's Whisker' in December 1977. We are grateful to Maurice and to the editor of The Cat's Whisker (A.D.Challoner) for permission to publish the article in our Bulletin. Ed.

THE SAUCEPAN SPECIAL....The circuit was not obtainable for the article in the last Bulletin ... but it has now turned up ... it came from Mr. J. Grahame in Rhodesia and is included on a separate sheet in this Bulletin for insertion in the Dec. issue.

B.V.W.S. WALL CHARTS These charts are still available from Jon Hill at £1.50 a set (incl. post & pack.). He will doubtless also have these at the St. Albans meeting at £1.20 per set.

CHANGE OF ADDRESS Mr. C.A.G.Herbert is now at 31B Porchester Rd.,Newbury, Berks RG14 7QH. Tel: (STD 063583) -Riverside 2034. (Mr. Herbert's name and address were inadvertantly missed out of the last official address list).

Also missing off the last address address list is Roger Rayment's Tel. No: St.Alban's (56) 50736. Please notify Jon Hill of any address changes or mistakes.

FLEMING'S CYMOMETER

By A.R.Constable

The measurement of wavelength or frequency in the early days of wireless telegraphy was essentially a laboratory procedure for which numerous ingenious devices had been available from the earliest times of Hertzian wave experiments. The range of experimental methods used and their gradual evolution into the sophisticated portable buzzer-bulb wavemeters is dealt with in considerable detail in Dr. Eugene Nesper's Handbook of Wireless Telegraphy and Telephony (Vol II) published in 1921 in Berlin. Some very splendid instruments came into being at the turn of the century though, surprisingly, it appears that Marconi did not build or use a wavemeter until quite late - about 1904. Prior to this date, and despite the many laboratory methods that were available, it seems that transmitters and receivers were tuned one against the other quite empirically using one as a sort of wavemeter for the other and adjusting until the 'best' conditions were obtained. It was often not necessary at all to know exactly what the wavelength was - it was only necessary to know that circuits were in resonance.

As we know, Marconi was one of the first to introduce the Lodge tuning ideas into practical wireless telegraphy and he and his engineers understood clearly the necessity of not only synchronising transmitters and receivers, but also for achieving good 'syntony' between the primary and secondary circuits of aerial transformers. And yet the useful little wavemeter in all its sophisticated simplicity took a long time before it became the wireless engineer's field instrument. When it did arrive it was the first instrument designed specifically for the new technology.

The first wavemeter produced by Marconi's was designed by Dr. John Ambrose Fleming who, as was remarked in the last Bulletin (p.47), had a particular liking for the Greek word Kuma = wave. His word Kumascope for 'detector' never gained acceptance but, from the same derivation, he devised the word 'Cymometer' for wavemeter and this word stuck around for quite a long time. Fleming's cymometer consists of a sliding-tube condenser which is joined in series with a variable inductance coil Fig.1. A neon tube normally connected across the condenser glowed as the wavemeter was adjusted to resonance. The sliding tube condenser and the variable inductance are so constructed that the values of C and L are proportional to the length and the two lengths are adjusted together constituting one of the first examples of 'ganged' tuning - and a very elegant one at that.

As the resonant frequency of an L C circuit is given by, Frequency = $1/2\pi\sqrt{LC}$, the corresponding wavelength is directly proportional to $\sqrt{LC}$. The value of L and the value of C are each proportional to the position of the pointer on the scale and hence the quantity $\sqrt{LC}$ (called the oscillation constant) will also be directly proportional to the scale reading. Thus a linear wavelength scale is obtained.

The Marconi-Fleming cymometers had a centimeter scale below which were calibrated scales for reading the oscillation constant, wavelength in meters and feet and the number of oscillations per 10^{-6} seconds (i.e. MHz). In order to cover the range of wavelengths adequately, four types of cymometer were manufactured as follows: No.1 measured from about 33 meters to 700 meters. The No.1a took the range up to about 1400m and the No.2 and No.3 extended it to 2000m and 3000m respectively. The prices of these instruments in the 1906-7 Marconi Catalogue were respectively £16.16.0, £20, £26.10.0 and £31.10.0d and, apart from the neon tube (£2.2.0d), one could also buy a thermo-electric junction at £3.3.0, a 50μA f.s.d. centre reading galvo at £7.10.0d and a few other accessories. So, these days, when we pick up an old AVO signal generator which is precision calibrated from 90kHz to 90Mhz (covering 3.3 to 3300m), for less than a 'fiver' we have no cause for complaint!

The cymometer was not only used to measure the wavelength and frequency of transmitters, it could also be used to measure inductance and capacitance and must therefore have been a very useful instrument for those early wireless engineers who had to make all their own components. It was not exactly a 'portable' instrument and was eventually replaced by the more compact dial instruments we all know. A very splendid example of the Fleming cymometer can be seen in the Science Museum

at South Kensington but I wonder if any fortunate collector has one? Many of them must have been made and supplied to Universities, Technical Colleges and Manufacturers and surely some of them must have survived. I personally would welcome the opportunity of doing some measurements with one in conjunction with a small spark transmitter in order to get the 'feel' of the period. It is all too easy with modern instruments.

The cymometer scale is illustrated in Fig.2. showing the linear oscillation constant and the linear wavelength scales. The Mhz scale is, of course, non-linear as it is inversely proportional to the wavelength. The scales illustrated were taken directly from the Science Museum instrument which is the largest one

Fig.1.

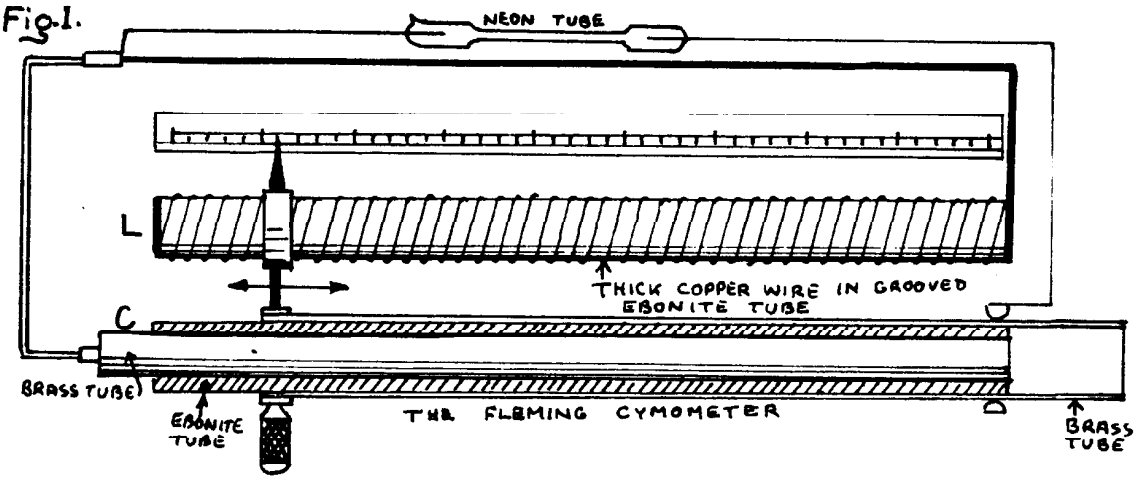
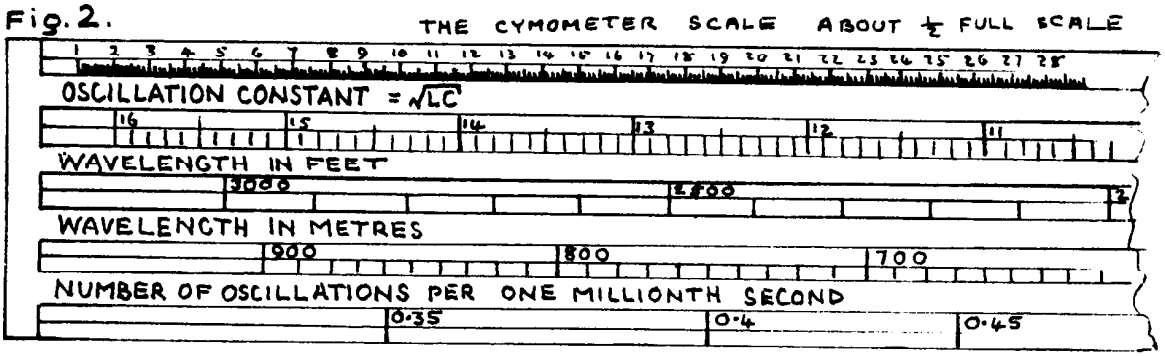


Fig.2.



covering the range up to 3000 or 3200 metres. The condenser on this model consists of four sliding tube assemblies and looks very cumbersome.

References: The Wireless Telegraphist's Pocket Book. By J.A.Fleming. 1915
Catalogue No.15. Marconi's W.T.CoLtd. 1906-7
Handbook of Wireless Teleg & Teleph. By Eugen Nesper. 1921 (in German)
Harmsworth's Wireless Encyclopaedia. 1923.
The Fleming Direct Reading Cymometer and its Applications. 'The Electrician', January 11th 1907, p495.(and Jan.18th p536)

INFORMATION SOUGHT

The GECophone 4000RP is a 4-valve (h.f.,det.,2l.f.) G.E.C. set of about 1927 and the front panel is made of ebonite set in a scalloped cut-out in a mahogony box. The owner of one of these sets is very anxious to contact somebody who also has one - but with intact circuitry etc. His had been dismantled before he acquired all the bits and he would be very grateful for <u>any</u> information.

Scott Taggart .. and all that... Has anybody got an S.T.100 for sale or swap?

If anybody can help with either of these requests - please contact the editor who will be pleased to supply all details.

NEW LIGHT ON CATHODES

By Philip Beckley

As any experimenter will testify, the fallibility of valve filaments is one of the major problems with vintage tubes. How convenient it would be if these could easily be replaced. Users of electron microscopes, demountable X-ray tubes and big transmitting valves know well that a filament change can be rapidly and easily performed.

While mourning the expiry of the filament of a rectifying diode - being used to re-examine diode performance in replacing a crystal (a la Fleming) in a crystal set - the writer considered focussing the rays of the summer sun on the expired filament to stimulate emission, while thought led on to the use of a laser to achieve this effect on an oxide coated cathode plate,.at which point the project seemed to be getting out of hand!

Non the less the idea of light sensitive cathodes prompted the use of an ordinary vacuum photo-cell in place of a crystal. These tubes typically have an oxygen-caesium cathode and offer many micro-amps of emission for a reasonable light input.

Sure enough reasonable signals came in on the 'phones with daylight reaching the cathode (Fig.1.). Since many photocell cathodes deteriorate in strong daylight, a candle was tried and worked fairly well at close range.

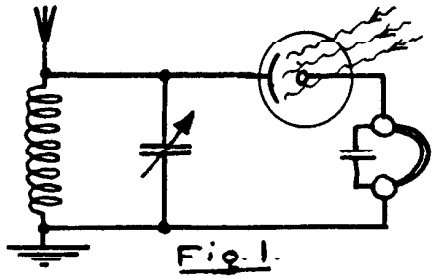


Fig. 1.

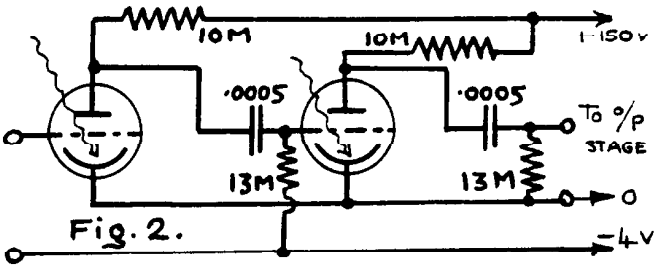


Fig. 2.

More reliable than a crystal, but wasteful of candles,though like bright emitters you can read by it! Magnetic fields affect the path of electrons between anode and cathode and a small magnet placed near the photocell had an optimum position.

Bias, which may be expected to help weak signals (a la Carborundum) was not tried as this would demand batteries, though the classical double earth battery (Foot-note 1.) or thermocouples in the candle flame are feasible!

Very seldom does one get a new idea, I suppose. Imaging my surprise to read an article a few days after my photo-electric experiments - about triode valves using this principle! The article, published in 1930, reported German work in which triodes were made up using a photo-cathode, mesh grid and anode. These were developed to the point where tubes gave μ = 30 and R_a was around 2MΩ. By using very high anode load resistances, stage gains of about 16 were possible, though care was needed to keep circuit capacity low so that severe frequency distortion was avoided. Fig.2. shows the circuit used.

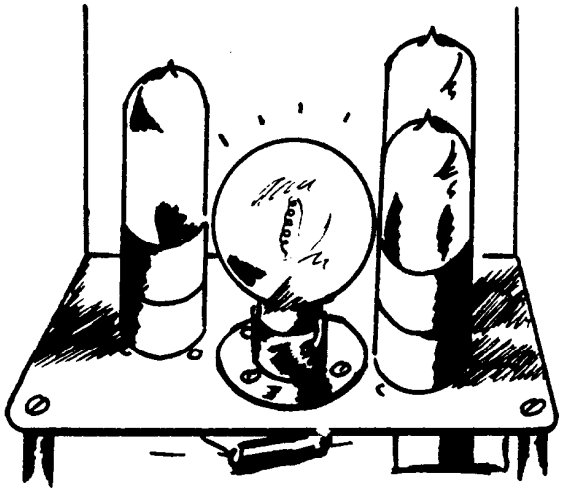


Fig. 3. $\frac{1}{2}$ watt lamp used to illuminate photo-valves.

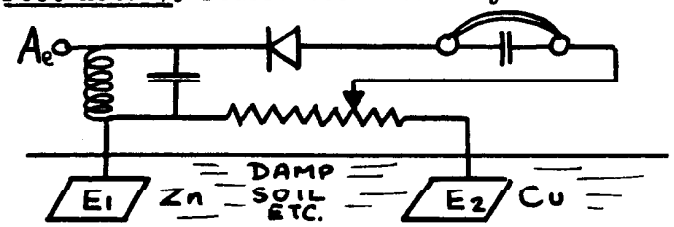
Such valves could be grouped round a simple car headlamp bulb to power the cathode, the high thermal inertia of the filament keeping hum at bay if lit on A.C. Of course, should the lamp fail, then good old daylight could take over (on fine days!). Just as some photocells use low pressure gas filling to give some electron multiplication by ionization, photo-valves used low pressue gas for this purpose. Fig.3 illustrates the sort of set-up used.

Going back to hard vacuum, the modern photomultiplier (931A and family) may offer more gain for a 'photo-diode set' if properly developed. Using photo-cathode and first dynode as rectifier then suitable H.T. applied to later

stages could be the makings of a high gain 'photo-set'. Perhaps we could re-call the Zamboni pile for H.T. (Foot-note 2.).

Older readers may recall that early internal combustion engines used an externally heated platinum tube for igniting compressed air and fuel - so what went wrong with the filament renewable from outside?? Someone must have tried it out in the dim past. Can any reader recall such a trial?

Foot-note 1. Double earth battery for bias:



Foot-note 2. Zamboni pile: Pile type layer battery capable of producing some kilovolts for image-conversion tubes. See literature.

Reference: Cold Valves, by Manfred von Ardenne, Wireless World. Sep.3 1930 p. 214

DON'T FORGET THE B.V.W.S. ANNUAL GENERAL MEETING BEING HELD AT ST. ALBAN'S ON SUNDAY MAY 21st. IF YOU WISH TO HOLD OFFICE AND SERVE ON THE COMMITTEE, LET THE SECRETARY KNOW BEFOREHAND IF POSSIBLE. THIS YEAR, WE WILL AGAIN ATTEMPT TO KEEP THE BUSINESS MEETING AS SHORT AS POSSIBLE BUT COME PREPARED TO AIR YOUR GRIEVANCES AND TO DEBATE SOCIETY POLICY ETC. Also: We will make this meeting an occasion for bartering, so load up your car with all those components, sets, books etc etc that you think might be more useful to somebody else than to yourself ... and we'll all be interested to see what happens.

The meeting will be held at the Ex-Civil Defence Hall on New Kent Rd. in the heart of St. Albans - near the clock tower - near the Town Hall - and a very short walk from the railway station.

Our 'Man in St. Albans' is Roger Rayment and he lives at 22, Grosvenor Rd., very near the railway station and has kindly offered to assist anybody who is in need - you may get lost or something! - His phone number (which was inadvertantly omitted from the last address list) is: St.Albans 50736

Although this meeting will feature bartering on a scale hitherto unheard of in the world of vintage wireless, we do ask that members refrain from using the occasion for excessive 'commercial' activity. And incidentally, if anybody wishes to simply bring a few interesting items to display, please do so - but the spirit of good honest and mutually benificial swapping will be the main theme of the occasion.

Arrive at St. Albans at whatever time you like - you can park your car in the car park at New Kent Rd. next to the hall - make a day of it - visit the old Roman sites etc in the morning - and arrive at the meeting at about 2.00 p.m. and the A.G.M., elections etc will commence as soon as we get a quorum. Look forward to seeing everybody once again....

It is expected that the 'official business' meeting will start about 2.00 p.m. and that 'bartering' will commence after the elections are over.

It would aid successful exchanges to be completed to everybody's satisfaction if items could have 'notional prices' attached to them.

TRANS-ATLANTIC LETTER

From Dave Brodie

Those of you who are planning a visit to the U.S.A. this year may be interested in the present schedule of 1978 Antique Wireless Association events:

April 22nd Western Regional Conference of A.W.A. co-sponsored by the California Historical Radio Society, Foothill, Los Altos, California.
May 5-6 Indiana Historical Radio Society and A.W.A. meet, Auburn, Indiana.
May 13 A.W.A. Spring Meet, Iona, New York.
June 9-11 South-East A.W.A. Regional Conference, Winston-Salem, North Carolina.
July 15 Southern Tier A.W.A. Meet, Breesport, New York.
Aug. 26 Central New York A.W.A. Meet, Kirkville, New York.
Sept.29-30 National A.W.A. Conference, Canandaigua, New York.

All members of B.V.W.S. are most welcome to attend any of these events.

The last issue of the Bulletin informed you of the release of the 'Saga of the Vacuum Tube' by BVWS member Gerald F.J.Tyne. This remarkable work has been enthusiastically received over here and I assume that each of you has by now a copy in your library. After a little gentle persuasion, Gerald Tyne has provided us with the following story behind the story: .....The Saga of Gerald Tyne..... extracts from his letter to me: "I was a member of the faculty of Rensselaer Polytechnic Institute, at Troy, N.Y. from September 1921 to June 1929. During those years I spent all my available time researching the development of the vacuum tube, trying to trace the genealogy of ideas which motivated Edison, Roentgen, Fleming, von Lieben, de Forest and others to experiment along certain lines.' I investigated sources back to Gilbert in the 16th century and I was collecting vacuum tubes. These years paid off, I knew what I was looking for.

...Spring 1929...I accepted a position with Bell Telephone Laboratories ..became thoroughly familiar with the New York Public Library and the Library of the Academy of Medicine. I haunted the rare book shops and 'Radio Row'. My library grew and so did my tube collection, but the greatest asset was working at Bell Labs and getting to know the men who were pioneers in tube development and the men who harnessed the power of the Audion. They were generous with information, copies of early records, and tube samples.

In ..the depression in the '30's ... rare volumes and manuscripts...appeared ...at depression prices and I acquired the works of von Guericke, Nollet, Volta, Gilbert and others. ...the work week at Bell Labs was down to three days, giving me equal time for research.

By 1940 I had a vast library...and about 1800 tubes...On October 6th, 1941 I wrote to Robin McVitie Weston of England, the owner of a vacuum tube collection, described and illustrated in the October 1938 issue of Electrical Communications, Vol.17, No.2 pp. 133-142. Weston's prompt reply was the beginning of a lively correspondence that spanned more than a quarter century. I visited him in 1967 and I accompanied him to Standard Telephones and Cables at Paignton to arrange for his tube collection to be transferred to the Kensington Science Museum....Also present ... was Mr. Gerald R.M. Garratt, Curator of the Science Museum, with whom I had corresponded for many years, and through his courtesy I later acquired a microfilm of Weston's records. Mr. Garratt also arranged a memorable luncheon with Stanley R. Mullard, who graciously allowed me to tape the interview.

In October 1942 I noticed an item in the current issue of Radio News ..'Antique Tubes Wanted'. I wrote to the Managing Editor, Mr Oliver Read in Chicago enquiring about this item ....He replied that he was assembling the collection ... for demonstration purposes in communications courses, and assured me he'd be happy to (exchange) duplicates.

On November 2nd I sent the first shipment which included French Metal, Moorhead-Marconi, de Forest, Myers, Telefunken, Osram, Mazda and Western Electric - with complete information on each tube. On Nov 6th Mr Read wrote....he was coming to New York.. Nov 16th and wanted to discuss the possibility of my writing feature articles for Radio News. I....invited him for dinner November 18th.

After dinner on Nov 18th we spent hours going over my records. Periodically he stopped and pleaded with me to write the history of vacuum tube development. I refused because I was working long hours at the Labs. But he persisted, pointing out that the research was done, my records were organised and that it would be a matter of selecting and combining material. I was still saying 'No' at midnight, then he very

subtly made it seem my patriotic duty to share my knowledge with service men who were cramming courses with no textbook on vacuum tubes; the time was ideal to publish the history because for security reasons technical publications were restricted in printing anything concerning new developments in electronics. I could arrange the material any way I wanted, and have complete freedom as to number and length of instalments and number of photos to be used. When he asked me what I would call such a series I replied "The Saga of the Vacuum Tube".

His enthusiasm and excitement were contagious and I was delighted with his deep appreciation of my years of research. He made a final plea and I said "Yes. Within ten minutes details were settled with a handshake, the 'Saga' was born, and Mr Read was gone.

This was the beginning of a long and valued association with Mr Oliver Read, the man who came to dinner."

So the 'Saga' started life as a series of 23 articles between 1943 and 1946 and appeared in its present form in 1977 at the A.W.A. Conference. We can see now that to write such a monumental work takes a long time to prepare and a lot of hard work. Would-be authors of serious wireless histories should begin now to prepare their works - for publication not before the year 2000! Ed

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EXHIBITIONS

Since the very successful exhibition at the Victoria and Albert Museum, 'The Wireless Show', others have sprung up - and not only in London. To start well north of Watford, in the Kingdom of Fife, our one (still lonely) BVWS member, Roger Shivas, held an exhibition of wireless equipment at the local Kirkcaldy Museum. The exhibition included some 35 sets ranging from the Burndept No.1 crystal set to the first of the transistor sets. The local papers gave good publicity in the form of stories and the show got off to a good start. Roger was contacted by old-timers who had happy memories of 2MT and 2LO and had a surprise visit from Larry le Duc, Official Historian for the Californian Historical Radio Society - Dave Brodie had sent him! The BBC got wind of the exhibition and sent along their ace reporter Alison McLeay. Her interview with Roger resulted in an 8 minute spot on the 'Arts in Scotland' programme on Radio 4 on January 17th. This publicity brought in letters and some offers of equipment. BBC TV also got in on the act which resulted in 6 minutes on 'Reporting Scotland', (the Scottish Regional part of 'Nationwide') on February 10th . Directly resulting from this exhibition Roger is better off to the tune of 15 more sets! These include a Lissenola radiogram, a Lotus 3 valve AC mains Bandpass set, a Pye SG3, a Hunt Phoenix model and his first true 'cathedral' set, a Philco A55. There were no V2's or BTH crystal-valve sets. Altogether he found it all a very worthwhile experience.

To come back to London, Jon Hill's exhibition 'The Cat's Whisker' (Same title as his book - see review page.) started on March 2nd at the Geffrye Museum and will continue until 28th May. This is a delightful exhibition and shows the originator's artistic leanings as well as his wireless interests. There is a lot of colourful ephemera such as cartoons, post cards, photographs (and even a pack of cards) illustrating very forcibly the strong social impact that the new communications medium had in all sections of the community during the 1920's and 1930's. The exhibition, like the book, extends from the earliest times up to the mid-1940's. It is well worth a visit. The Geffrye Museum is on Kingsland Road, London E.2. and is not far from Liverpool St Station or Old Street and Shoreditch tube stations.

Other members holding exhibitions should contact the Bulletin editor - preferably before the exhibition opens.

WIRELESS BOOK CATALOGUE. Be on the look out for Len Kelly's next catalogue - it is now in an advanced state of preparation and should be on its way to you in a few weeks time. His previous catalogues have been very popular and have become excellent 'Bibliographies' as they cover the field so well.

LETTERS TO THE EDITOR

Dear Sir, I have ordered a copy of Gerald Tyne's monumental book 'Saga of the Vacuum Tube' and look forward to reading it with great interest. Bad news travels faster than new books, so I have already had my leg pulled about an unfortunate slip on page 473, where I am said to have joined Metro-Vic in 1923 as a design engineer for 'Cosmos' valves. Alas I was aged only three in 1923 and have no memories at all of the A45 type valve.

The Engineer concerned was, of course, E.Y.Robinson, not E.Brian Munt. I think my name came into Gerald Tyne's mind because I had a lot of correspondence with him during the 1960's, while he was researching British valve history. At that time I was Publications Editor at the London Head Office of Thorn-AEI Radio Valves and Tubes Ltd., the makers of 'Mazda','Ediswan' and 'Brimar' valves and CRT's. Fleming diodes, 'BTH' and 'Cosmos' valves were all a part of our company history and I was able to provide quite a lot of information from my office collection of historical valve catalogues and commemorative company publications. After I left the company in 1972, this valuable catalogue collection was unfortunately destroyed along with my Gerald Tyne correspondence, so I cannot pin-point the probable source of the name switch.

I wish to declare before my fellow BVWS members that I have no wish to usurp the honour rightly due to E.Y.Robinson for his pioneering 'Shortpath' Cosmos valve designs. I have always felt that E.Y.R. never received adequate recognition for his lasting contributions to valve design. Indeed I can claim some credit for encouraging another BVWS member, John Ludlow, in about 1971, to write a paper on 'The Indirectly Heated Cathode', which drew the conclusion that the standard indirectly heated cathode construction used by all receiving valve manufacturers for forty years was originally due to E.Yeoman Robinson. The article was published in 'WirelessWorld' (March 1973. pages 144 to 148)

E. Brian Munt, Dover, Kent.

Gerald Tyne laments this error (but wishes that he himself could wake up and find himself 30 years younger than the book says he is!) and submits the following extra errors for members to note in their recently purchased Sagas: p.154, the W.E. VT-1 illustration is omitted; p.327 wrong photo used for UV-204; p.225 the year of the caption should be 1929; p.451 caption should be 'MS-30 WATT'. Editor

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Dear Sir, No student of the history of wireless will have failed to notice references here and there to the 'Edison Effect', although some writers do seem to have given the impression that thermionics began with Fleming. Even Fleming himself sometimes failed to acknowledge his debt in this respect. What is rarer however is any citation of the number of the patent Edison took out, or any description of the matter therein, or even the correct year. Being goaded by an electrical friend who wanted to read the patent, and despite limited local resources, I was just lucky enough to get both year and number simultaneously correct at the first attempt. U.S. patent 307,031 of 21 October 1884 is entitled 'Electrical Indicator', and has of course nothing whatever to do with wireless. By taking a filament lamp fitted with an anode, and connecting a galvanometer between the anode and the positive end of the filament, the indicated current could be used to monitor the filament voltage. Addition of relay contacts enabled the device to regulate the voltage of the generator supplying the lamp. One can guess that this closed loop automation might have been less stable than say a human being to watch the galvo pointer and turn the regulator handle! But the idea is sound, and the patent is clearly and convincingly written. Although Edison says;'Ihave discovered', and then in 14 lines describes what we now call thermionic emission, he does not further attempt to establish novelty for this, but sets out his claim to cover only his own envisaged application of the effect. Demonstrations raised some immediate interest in the U.K., Preece (in due course to sponsor Marconi) writing about it in 1885, and then Fleming in 1889/90. But it took fully 20years for the latter to apply it usefully to Mr. Marconi's invention as a 'wave indicator'.

Desmond Thackery, Byfleet, Surrey.

Owners of Gerald Tyne's book will be able to check up on these facts on p.30 et seq. and, on page 28 to read about Professor Hittorf's earlier experiments on thermionics at the University of Münster in Germany. The point is well taken. Editor.

Letters continued

Dear Sir, In Desmond Thackeray's entertaining article, 'The Vital Spark' on page 44 of the last issue of the Bulletin, he mentions that he has not encountered any references to the triggered spark gap in early wireless transmitters. On page 105 of H.M.Dowsett's Wireless Telephony and Broadcasting (1923), there is a description, accompanied by a circuit diagram, of the use of an additional trigger-spark circuit to ensure accurate timing of the main-spark discharges in Marconi's 'timed spark' transmitter of 1912. However, the system apparently worked by inducing a superimposed voltage spike at the right moment in the main-spark circuits; the main-gaps themselves were not rendered conducting by the trigger-spark, which occurred across an entirely independent rotary gap.

John Ludlow's reminiscences ('Vintage Sounds') on page 35 of the same issue reminded me of a passage on page 68 of Blake's 'History of Wireless Telegraphy and Telephony' (1928) (See p.40, last Bulletin for review), in which it is recorded that E.von Lepel arranged LC networks linked to a keyboard, by means of which the spark note could be varied at will. To quote Blake: "In the early days of wireless many experimenters will remember hearing 'God Save the King' and other tunes transmitted from the Lepel stations at Slough and Twickenham .....". Incidentally, who knows the exact whereabouts of these stations?

Ian Higginbottom, Ealing London

The triggered spark transmitter described in Dowsett is also mentioned by Marconi in an article in Wireless World (May 1914, vol.2. pp.72-78) which is a translation of his lecture to the R.Accademia dei Lincei in Rome on March 1st 1914. This system was devised to produce continuous waves and (to quote Marconi) was stated by the British Government's 'Technical Committee', appointed to report on the merits of existing systems of long-distance radio-telegraphy, to be the only one which they had seen in successful operation over long distances. Ed.

Dear Sir, A story relating to the Marconiphone V2 receiver heard recently concerned two models available late on in the set's production run. One model was advertised as 'long-range' and had two DER valves in the line up. A 'local-station' model used a DE6 as the combined RF amplifier and audio output stage, which naturally gave less RF amplification but provided enough power to work a horn loudspeaker on local stations. There was no mention of any provision being made for G.B. I wonder if any other members can add anything to this? P.S.C.Taylor, Canewdon, Essex

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THE MARCONIPHONE N.B.2.

The Marconiphone N.B.2. two valve amplifier, like the V2, (see Philip Taylor's letter on this page) came with two different valve line-ups. The first N.B.2., as illustrated on page 1399 of Harmsworth's Encyclopaedia (vol.2), uses an R valve for the first stage and the L.S.3 for the power output stage. This version required 6volts for the L.T. and 120volts for the H.T.

A later version of the N.B.2. used the D.E.R. and the D.E.6 and the appropriate small ivorine labels near the two valve holders show this. Also, this amplifier requires only 2volts L.T. and 80volts H.T. and the power panel at the back of the set clearly indicates the correct voltages.

A careful inspection of one of these 'later' amplifiers recently revealed that it had been originally manufactured for the earlier valve line-up but that it had been suitably updated before leaving the factory. Thus it was possible to see exactly what the differnces were between the two versions.... After the original set had been made with the higher voltages engraved on the power panel ebonite, a piece of 1mm thick ebonite had been engraved with the lower voltages and then slipped over the original one and screwed in place! It rather reminds me of the way in which some soap powders were once converted from the regular brand to the new-super-brand .... it was during a vacation job one Easter .... it took a whole day to stick on the labels! A.R.C.

FROM THE EDITOR'S BOOK SHELF

Saga of the Vacuum Tube, by Gerald F.J.Tyne, Howard W. Sams, Indianapolis, U.S.A. 1977, 494 pp. $9.95

Little more need be said about this book .... it is monumental .... it has no near equivalent. The B.V.W.S. has ordered copies from the U.S.A. for those members who requested it. If a collector had only this book on his shelf, he would have a good wireless library.

The Cat's Whisker, 50 year of Wireless Design, By Jonathan Hill, Oresko, London 1978

This book was published on 1st March on the occasion of the opening of Jonathan Hill's exhibition of the same name at the Geffrye Museum, London. The book is well illustrated to show the changing patterns of wireless equipment from the earliest times up to the period immediately following the second world war. The historical origins of wireless are discussed in the first chapter with sufficient depth to introduce a newcomer to the subject. Chapter two goes on to recount the well known story of the beginnings of broadcasting and chapter three presents a nicely illustrated account of the crystal set. The book then continues to describe early valve receivers from 1922 to 1927 and this is followed by an informative chapter entitled Wireless for the Home 1927-1938. In this chapter the author is on surer ground than previously and his own ideas begin to emerge with some confidence as he discusses the development of furniture styles developed by the various manufacturers during the 1930's. During these years manufacturers began to understand and appreciate the unique design possibilities of Bakelite and new and exciting shapes began to appear. This chapter is very informative as it advances through those pre-war years into the era of the push button tuning models. In the following chapter we are taken rapidly through the war years and introduced to a few of the sets on which listeners could tune in to the new Light and Third Programmes. At the end of the book there is a brief list of the important dates in wireless history followed by a very useful concluding section on how to date a receiver. This last section is well conceived and very clearly gives some of the main indicators to the person trying to date his old wireless set - particularly of 1930's vintage. Apart from one or two of the photographs being a shade too dark, a certain lack of depth in the earlier historical sections and the occasional minor error, this book makes pleasant reading and is a first class introduction which is sure to whet the appetite of newcomers to wireless collecting.

WIRELESS MONUMENTS OF GREAT BRITAIN (3)

By I.E.Higginbottom

The monument to Jack Phillips of the Titanic mentioned in the first article sets a precedent by which we must also record the plaque, unveiled by Godfrey Isaacs on 21st June 1922, to the memory of the 348 Marconi employees lost in the First World War, most of them Merchant Navy operators like Phillips. The plaque is described in lapidary style, "They dying so, live". It was originally placed on the old Marconi House in the Strand, but many years later was removed to the entrance hall of the new Marconi House at Chelmsford.

From the end of World War I we enter the broadcasting era, by way of the venerable hut at Chelmsford familiar to those attending our first A.G.M. The hut's unique history is commemorated by the following inscription beside the entrance:

" Kings Road County Junior School. History of this Pavilion. This building, an army hut of the First World War stood from 1919 to 1960 on the Marconi Company's development site at Writtle. The first radio equipments for use in commercial aircraft were developed in it in 1919 and for the next forty years it was the centre of this work. From February 1922 wireless telephony test transmissions - Britain's first regular broadcasting - were made from this hut and continued until January 1923 using the call-sign 2MT"

The old Marconi House in the Strand is now owned by Citibank, but one wing has been named Marconi Wing and bears a memorial plaque to the original 2LO broadcasting station which made 2MT redundant. The plaque reads:

" Within this building Marconi's Wireless Telegraph Company Limited operated their famous broadcasting station 2LO from May 11th to November 15th 1922 when it became the first station of the British Broadcasting Company."

The original 1½kW transmitter remained in use until March 1925 when it was superseded by a 6kW transmitter at the eastern end of Selfridges roof in Oxford Street.

EXCHANGE

SEARCHING Internal parts for G.E.C. cabinet of B.C.3300 (3valve - det + 2L.F. same exactly as B.C. 3350 but in de luxe cabinet). Also coils and components for S.T. sets....and box for Fellowphone Super One.....horn for a Sterling 33 Drive Unit.....tubes WD-11, 199 for Radiola IIIA.....early valves of any type. J.F.BURTON 162, Mawney Rd., Romford, Essex.

Valves: Osram PT2K, Mullard PM22C. Also Sterling 'non-pong' valve holders and, for Sterling 'Anodion One',a bayonet-action aerial reaction unit - contains small reaction coil inside the plug-in coil. Also 'Baltic' components for Swedish made Joel Ostlind set: tuning coils, audio transformer, rheostats. Also any information about Joel Ostlind...the set has a Telefunken licence plate. P.S.C.TAYLOR 14, Willow Walk, Canewdon, Rochford, Essex...Canewdon 598

McMichael DIMIC-3, Marconi Type 34, or similar all-wave receiver of the period 1928-30. A.P.CARTER Trellis Cottage, Nr. Guildford, Surrey. 0483-4213

Regeneration Unit and Range Blocks for Marconiphone V.2. J.G.BARNES 5, Prospect Drive, Hale Barns, Altrincham, Cheshire. 980-2415

Regeneration Unit and Range Blocks for V.2. also required by: Mariano Gomez MONTEJANO c/ Clavileno, 42 Tpdo, Madrid-2. (Also wanted early 'R' valves or other with 'pip')

L.F.Transformer for Marconiphone V.2. Also Dowsett,Wireless Teleg. & Teleph., vol.II, (1924). Also, a big 'prestige' model radio of late '30's like RCA C-13-2, Philco 116RX-SU or Scott, Roebuck etc with 'lots' of valves and all-waves. Also, Wireless Constructor: Vol3 Nr 1 (1926), Vol4 Nr's 7,8,11, Vol5 Nr's 14,16,17, Vol6 Nr's 20,24, Vol7 Nr 26, Vol8 Nr 32,34,35,36. Modern Wireless, most early numbers up to 1929. QST Vol 15 (1928) Nr's 3,6,10,11, Vol 16, Nr's 2,3, Vol 17, Nr's 1,2,3,4,8,10,11,12. Can offer in exchange about 25 numbers of W.W. 1920-1923 (2 W.W.'s to one!). Can offer also Dutch and German valves like A415, RE074 (new) and many other spares from 1920's F.DRIESENS De Wijer 6, Hapert, Holland.

Radiogram made by Whiteley's of Bayswater .. upright 5 valve superhet..called 'Latimer' GERALD WELLS 23, Rosendale Rd., West Dulwich, London, S.E.21 670-3667

DISPOSING Part stripped Marconiphone model 22 (Det.+ L.F.) 1927. Cabinet in fair condition with valve holder, coil holder, some wiring, two control knobs and rear terminal panel with two broken terminals. Uses some Sterling components. Also, Pirelli synthetic rubber red/blk/yellow + other 2mm 2amp flex lead P.S.C.TAYLOR address as above

Four valve mains T.R.F. receiver by H.S.P. of Weston-super-Mare. A.P.CARTER as above.

Handbook of Technical Instruction, by Hawkhead & Dowsett, 2nd Edition, lacking covers but textually complete. Glad to swap for similar material on early wireless telegraphy, for example battered but legible copies of Bucher, or Blake very welcome. What have you? DESMOND THACKERAY, 7 Beech Close, Byfleet, Surrey. Byfleet 41023.

Radiograms and television sets ..... is any member of B.V.W.S. collecting these??? Bulletin editor very frequently gets information about post-war radiograms and TV sets and occasionally pre-war.....owners wish to get rid of these large items when moving home etc and we can rarely find homes for them. If any collector has any interest in such items would he please contact the editor who will be pleased to pass on any information as it arrives. Ed.

Philips A 425, A 415, Telefunken RE 074N valves in exchange for early French valves or other types with 'pip' on top .... could supply one or two new and boxed of type mentioned in exchange for one 'dud' of type required. Or...would exchange three or four for one in working order. (Fair exchange rate??). Mariano Gomez MONTEJANO address as above.

THE MARK III TUNER

By A.R.Constable

Of all the very early items of wireless equipment of First World War vintage, one of the most collectible is the Mk III tuner. This crystal set was used throughout the war - mostly for the reception of messages from aircraft engaged on patrol or short-range reconnaissance duties. It was used a great deal for receiving messages from aircraft engaged on 'target spotting' for directing the gunfire of the artillary. It is often referred to as a 'Short Wave Tuner' and covered the range 100 - 700 metres. Many of these instruments appeared on the surplus market after the war and must have provided the first experience of 'home listening' for many people both before and during the broadcast era.

The set could be used simply as a crystal receiver or it could be used in conjunction with a valve amplifier or an S.G.Brown microphone amplifier. Many of the sets which have survived to the present day probably never saw 'active service' but were simply bought on the surplus market. 'Experimenters' were very fond of converting even these beautiful instruments into 'something better' by adding and/or subtracting components. But even some of those which did see active service could well have had the modifications made in the trenches. Some wireless men had learned a few things about the new French valves and went round to the various listening posts drilling holes in Mk III tuner panels and adding bright emitter valves to give the operators a bit of gain. I suspect the one I acquired had been 'got at' by a later 'experimenter' - who had not only removed the buzzer and perikon detector but also the fine rheostat and tuning coils! A valve base had been added and the whole thing converted into a rather poor quality one-valve receiver. But, back to the trenches, these tuners were extremely well made and could be used to separate transmitters sending out their messages on what,in those days, must have been thought of as fairly closely spaced wavelengths.

Lieutenant J.J.Honan, writing in Wireless World (January 1920, p 605 et seq.), says that the three flights of one squadron would employ wavelengths of, say, 140, 180 and 220 metres while an adjacent squadron would be allotted wavelengths of 160, 200 and 240 metres. And an operator was expected to keep track of his own 'kite' and not give firing directions from one of the other planes to the gunners!

The circuit, as can be seen from Fig. 1. was constructed in the usual way with the 'stand-by' and 'tune' alternatives. In the 'stand-by' position, the detector is connected directly to the aerial circuit and is comparatively unselective. In the 'tune' position, the detector circuit is loose-coupled to the aerial circuit and the coupling can be varied. The two coils are mounted with their axes horizontal and one of them is fixed. The other can be rotated about a vertical axis through 90°. The coils are wound with Litz wire on very thick ebonite formers and the condensers are extremely well made and housed in ebonite 'cans'. There is a perikon detector as well as the carborundum detector and the latter has a biasing potentiometer & battery. The buzzer is provided as a local oscillator to aid in adjusting the crystals to optimum settings. (One assumes that cat's whisker crystals would have been pretty useless in the presence of all those spark transmitters! - and that even perikons and carborundums would have required frequent re-settings.) The buzzer would also be used in conjunction with a wavemeter (such as the Townsend - see Bulletin vol.1, No.2, p.10.) to calibrate the closed circuit L & C settings against wavelength. Once this had been accomplished, the calibrated closed circuit can be used as a wavemeter for the open circuit. When used properly with the calibration cards, an operator was able to say fairly accurately what wavelength an incoming signal had when it arrived on stand-bay - and then to transfer to 'tune' without loosing the signal.

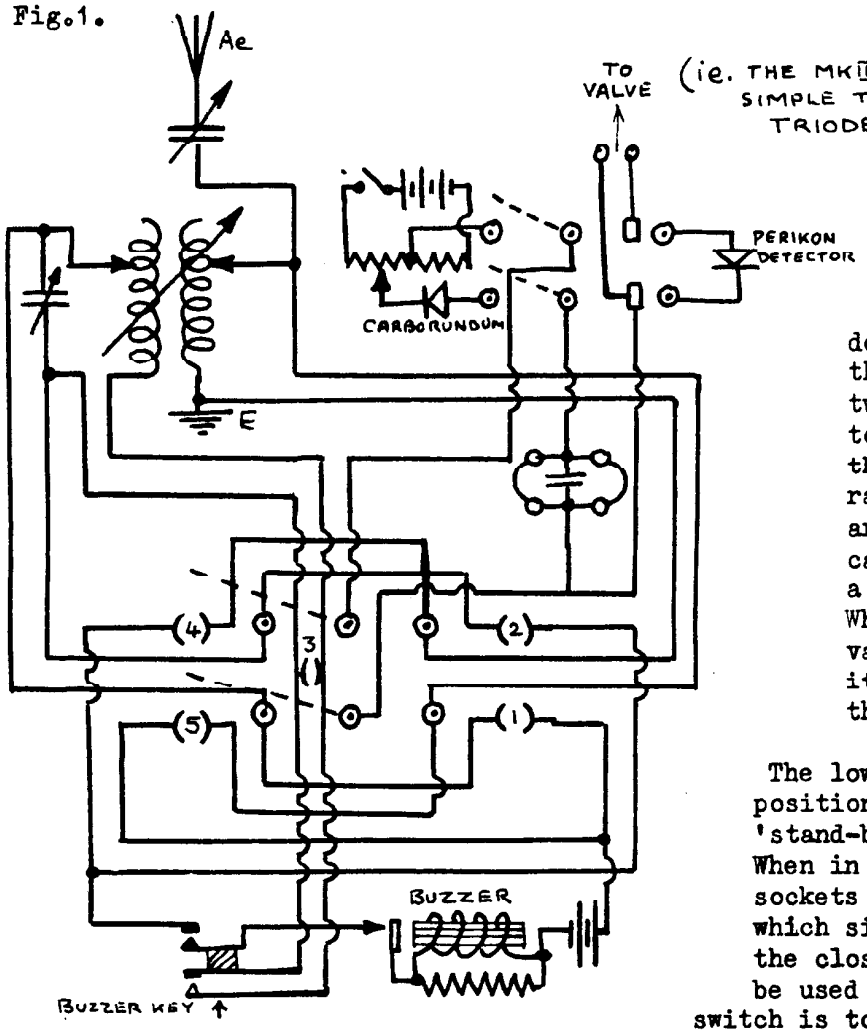
The buzzer used on these tuners had a non-inductive resistance shunting the windings. This had two effects: It allows the 'break' to occur more rapidly as it provides a current path for the high induced e.m.f. during the break. The rapid break thus achieved results in a larger inductive impulse into the LC circuits with which it is being used. The resistance also has the effect of allowing a larger current to flow when the contacts are closed (as the resistance is in parallel with the windings). The magnetic field in L is proportional to the square of this current and thus the effect of the shunt is quite marked.

In the W.W. article referred to above, J.J.Honan gives the impression of having had

first-hand experience of front-line conditions and gives us some highly technical information concerning the actual signals used .... for example: "...a petulant succession of B's would signify that observer number so and so of X Squadron was sitting up aloft over a certain Hun target waiting for our battery to finish breakfast and show by means of the usual ground strip that they were ready to carry on the good work. When this was forthcoming, there would ensue a busy time for the short-wave tuner and its attendant slave, until after an uncertain spell of more or less eloquent Morsing, the aerial spotter would recollect that there was a matter that required his immediate attention in the Mess, and the 'pack up' signal (CI) would indicate that he was going back ... to see the bar-orderly about it." It sounds fun, but it was a very serious business these men were up to, and the Mk III Short-Wave Tuner of World War I played a serious part in it.

Incidentally, there is also a MkIV tuner - considerably smaller than the MkIII. But information is lacking - has anybody got any information on this attractive little instrument??

Fig.1.



The top switch is used to select either the perikon or the carborundum detector. Also when it goes to the right-hand-side it meets two raised contacts en route to the perikon position. If the switch is left at these raised contacts, the phones are shorted and the output can now be fed straight to a triode detector/amplifier. When the switch is then advanced into the perikon position, it disengages from the raised contacts.

The lower switch is in the 'tune' position to the left and in the 'stand-by' position to the right. When in the stand-by position, the sockets 1 and 2 are also shorted which simply puts the buzzer into the closed circuit - which can then be used as a 'wavemeter'. When the switch is to the left, in the 'tune' position, the sockets 3,4 and 5 are shorted which puts the buzzer into the aerial circuit. In each case, of course, the buzzer key has to be pressed when it is being used.

Mk III tuners normally came in mahogony boxes with a polished interior and the outside covered in a hard-wearing canvas which was then painted grey. Some came in boxes polished on the outside. Inside the hinged lid there was a small compartment for a collection of crystals as well as a nickel plated circular 'dish' with a screw top for holding a watch and a small wooden turn-clamp for holding the charts of calibration in place. Finally some sets are made by the A.T.M.Co.Ltd and some are made by Robert W.Paul.

While these tuners are so hard to find nowadays, it is always a bit galling to see them advertised in, for example, the Electradix catalogue for a mere £4!