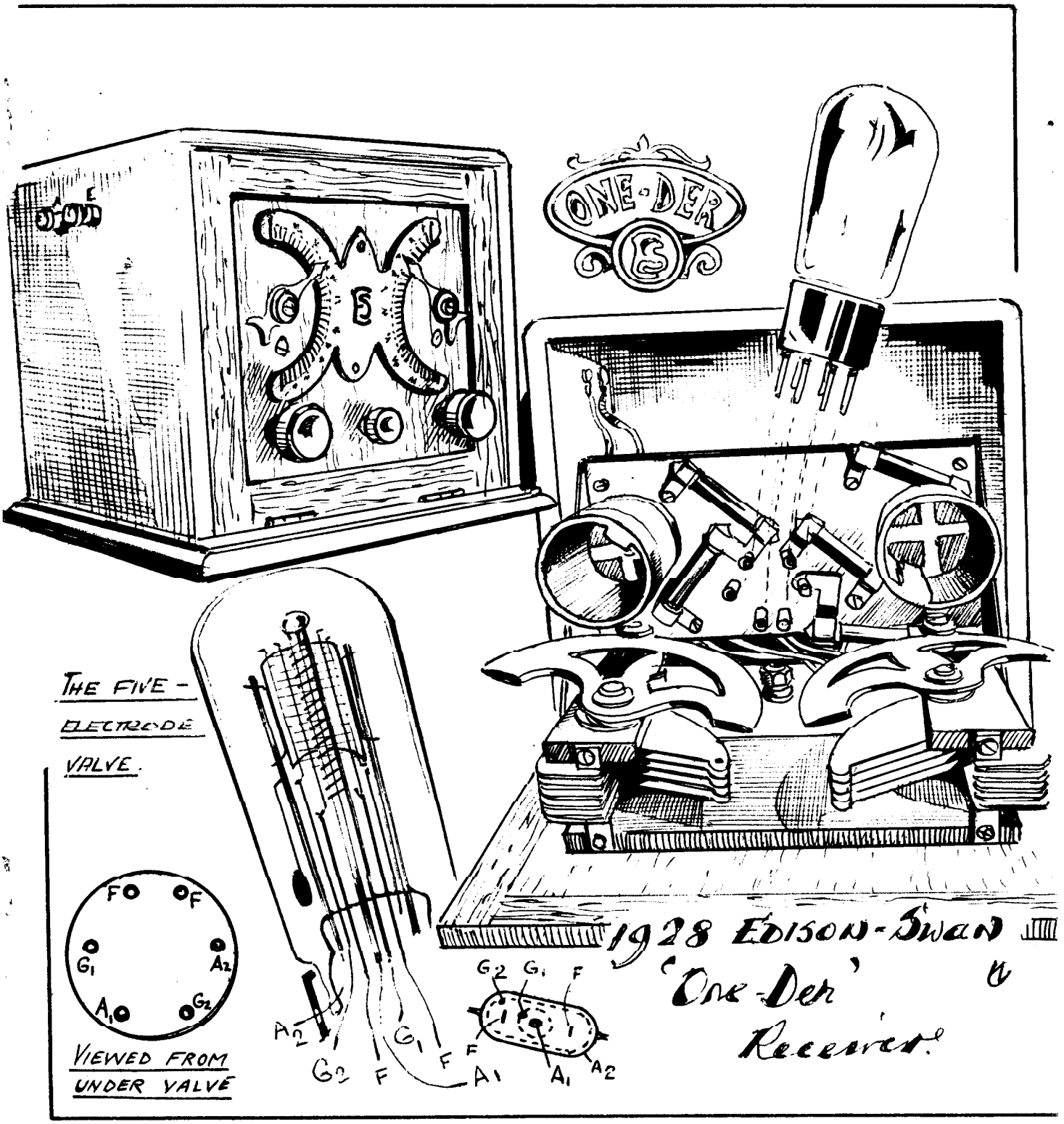
BRITISH VINTAGE WIRELESS SOCIETY



Bulletin Vol.5 No.4 March 1981

THE BRITISH VINTAGE WIRELESS SOCIETY

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Please send all correspondence concerning the Bulletin to the Editor

Deadline for next issue ..... MAY 20th 1981 ..... sooner if possible .....

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THE ANNUAL GENERAL MEETING The 5th anniversary A.G.M. will take place at HARPENDEN PUBLIC HALL on Sunday May 17th.

For those members who have attended meetings before at Harpenden, there is no need to explain how to get there. For new members .... Harpenden is on the A6 about 6 miles north of St. Albans. Arriving in Harpenden, turn East at Station Rd. and then South at Arden Grove and observe the parking area to your right. You can't miss the Hall ..... it is behind the Harpenden Arms Pub. Stalls available from 10.00 a.m.

If you require further information or directions contact the meetings organiser Roger Rayment: 22, Grosvenor Rd., St.Albans, Herts. Tel: St.Albans 50736.

Please fill in the AGM form (attached to your membership renewal form and enclosed with this Bulletin) and send to Jon Hill, Membership Secretary, by April 21st. If you wish to stand for office or wish to nominate anybody please include a note to this effect when you send your form to Jon Hill. All Committee Offices are open for nomination and elections will take place at the AGM.

As usual, stalls will be available at the meeting for swapping, displaying etc. It is hoped to have one or two good demonstartions of unusual equipment.

Front Cover Illustration The Edison Swan 'One-Der' with its unusual double triode valve. See article on page 53 for further details.

BRITISH VINTAGE WIRELESS SOCIETY

Volume 5 Number 4 BULLETIN March 1981

EDITORIAL

The British Vintage Wireless Society is now five years old ... as also is the Bulletin. Putting a new Bulletin together is always a pleasurable experience. Of course, it is not without problems and occasionally a lot of frustration. Suitable material has to be found, many facts have to be checked and re-checked, drawings have to be prepared etc etc. The process of editing our Bulletin has always been highly instructional and often positively educational and in the five years of doing this work I have learnt an enormous amount about the subject of vintage wireless.....I have also learnt that there is a vast amount yet to be explored. Wireless manufacturers in the 1920's were, like manufacturers in almost every other age, primarily concerned with making money. Some of them may have been vaguely aware that they were also making history but very few of them ever bothered to make and keep good company records. However, a lot of information can be gleaned from the literature and, as many Bulletin articles have shown, company records can often be unearthed with the help of 'Old-Timers'. More contributions from such people who have had direct experience of the early wireless trade are always being sought. Members are asked to be on the look out for old-timers and to encourage them either to put pen to paper or to relate stories that can provide us with material for Bulletin articles.

The next volume of the Bulletin will have a new editorial address and details will be announced at the Annual General Meeting at Harpenden on May 17th.I am handing over the editorship partly because five years is really as much time as anybody should be allowed the privilege, but also this is an extremely busy year for me in my professional work so I am forced to lay down the editorial pen for a while. I extend my sincere good wishes to my successor and look forward to whatever 'new look' the Bulletin may acquire. Material for the next Bulletin should still be sent to the present editorial address and you can rest assured that it will find its way to the right desk.

Some people have occasionally told me that I have adopted a hard line on the subject of renovation of old wireless equipment. It is true that most collectors of old equipment thoroughly enjoy renovating where necessary. But I have often claimed that we should aim primarily at preservation and leave renovation alone as far as possible. This view may sometimes be unpopular but I am sure that it has to be occasionally expressed in order to discourage unneccessary and sometimes unskillful renovation work .... we have all seen the bad examples - plastic wire coverings, modern varnishes, badly applied varnishes, failure to use authentic fabrics etc etc. Also, while we are all inclined to stand back and drool over our own renovation efforts, collectors will almost invariably prefer to acquire the untouched article and will reject all but the most expertly renovated item. Old wireless sets, like old furniture and old clocks, will certainly need to be renovated and I, like many other BVWS members would like to be sure they are equal to the very best that can be found in the world of antique furniture and clocks. The worst examples of renovation, in whatever antiquarian endeavour, will become nearly valueless - no matter how much pleasure was experienced by the renovator.... But our collection is our own and we are all free to do what we like with it. Make sure that when it ceases to be your own it will go on being collectible.

Don't forget the Annual General Meeting at Harpenden .... see inside frontcover.

THE POWER VALVE 1920 - 1940

Part I Early Loudspeaker Valves by Philip Beckley

About 1920 a pressing need arose to drive loudspeakers so that reasonable speech and music could be obtained at considerable volume. It was necessary to design special valves for the purpose.

The ubiquitous 'R' valve could deliver only a microscopic undistorted power output (about 15mW) and attempts to obtain 'loud' signals from it produced horrible noises. Why was the 'R' valve so poor in this respect? For a start the filament current was too small (about 10mA at 4volts- the normal filament voltage) to give an adequate anode current, and its internal impedance was far too high.

The emission of an 'R' valve could be greatly increased by running its filament at 6 volts but this lead to a life which, though merry, was short. And even then the anode impedance was too high so that only by using a greatly increased anode voltage could a much greater power output be obtained. The vacua in ordinary 'R' valves were not marvellous so 100-150 volts represented a practical limit to HT voltage.

It is possible to operate a number of 'R' valves in parallel - this reduces Ra in proportion to the number of valves used, increases gm by the inverse amount and leaves μ the same. Certainly this is a possible method but it is very costly in filament current to use maybe four 'R' valves in this way, not to mention first cost.

There is much reference in the literature to the use of "a small transmitting valve" for driving a loudspeaker. Unfortunately, transmitting valves are not well suited to this role. Transmitting valves aim to get maximum power for a given filament emission by accelerating the available electrons as much as possible with a very high anode voltage - usually in the thousands. To control electron flow, the grid has to have a fine mesh giving a high Ra and high μ. This means that on a modest HT of 200 volts the transmitting valve passes only a low anode current and is of unpleasantly high impedance. The answer then, is a valve of very good vacuum able to take 200-400 volts but of lowish impedance in the range 3000 to 15000 ohms, able to pass quite a high current and give a fair wattage output at inexpensively low anode voltages.

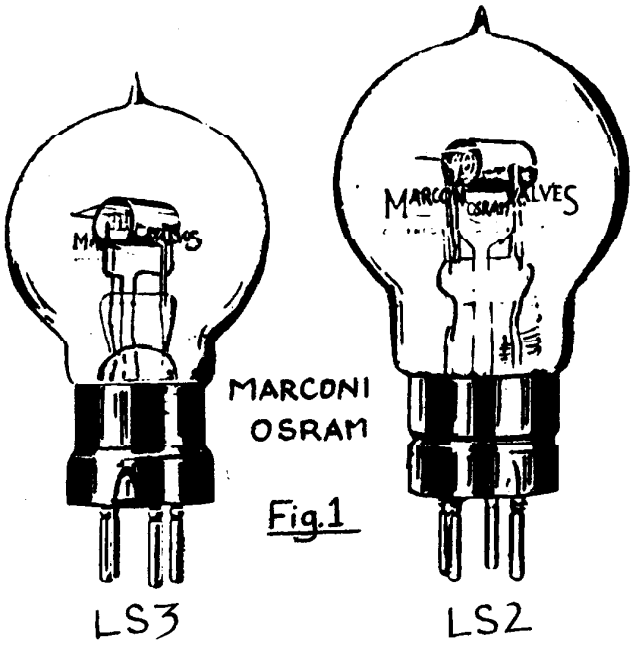


Fig.1

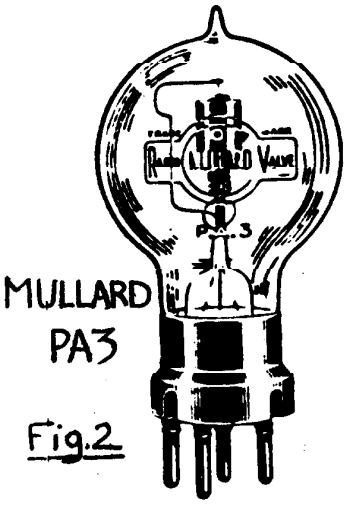


Fig.2

Up to a point this objective can be met by simply opening up the grid spiral of an 'R' valve to give fewer turns per inch and achieving the best possible vacuum. The result of doing this was the Marconi-Osram LS3 (Fig.1) able to operate as a fair 'living room' power valve at V_a = 120 volts.

Compare it to the R valve:

Type	Fil volts:v	Fil current:A	μ	R_a:ohms	g_m:mA/v
R	4	0.65 - 0.7	9	36,000	0.25
LS3	4	0.65 - 0.7	4.5	12,000	0.375

The audio output from an R valve was about 15mW and for the LS3 it was about 100mW.

Similar valves from other manufacturers were the Mullard PA3 (Fig.2) and the Ediswan PV3.

To fill a large room or exhibition hall, greater emission was required. This need was met, in the form of bright emitters by using a 6volt 1.5 amp filament (9watts as compared to 2.8 watts for an R or LS3). These valves were like overgrown R's in appearance, physically larger (see LS2 in Fig.1) and with characteristics as listed below:

Type	Maker	μ	R_a: Ohms	g_m: mA/v	max V_a
LS1	Marconi-Osram	10	16,000	0.625	600
LS2	Marconi-Osram	6	8,000	0.750	600
PV1	Ediswan	11	20,000	0.550	600
PV2	Ediswan	4.5	11,000	0.410	400
PA1	Mullard	7.5	8,500	0.882	400
PA2	Mullard	4.0	7,000	0.570	200

The Mullard PA1 is illustrated in Fig.3. Generally, this type of valve showed a family relationship to the transmitting valve and was not of very low impedance, also it gobbled filament watts at a fearful rate.

The real breakthrough was the production of a really satisfactory dull emitter power valve which took the form of the Marconi-Osram LS5; in many ways the celebrated world beater in power valve circles (see Fig.4). The LS5 employed a thoriated carbonised filament taking only about 0.8 amp at 4.5 volts, yet offering 50mA of emission:

Type	Filament	Total emission	μ	R_a:ohm	g_m:mA/v	V_a max
LS5	4.5v at 0.8A	50mA	5	5,000	1.0	400

The vacuum in this valve had to be very good to avoid damage to the filament by positive ion bombardment. Even for a thoriated filament, ion bombardement can be damaging. So successful was the LS5, introduced in about 1922, that it ran into various versions lasting till well into the thirties. Early LS5's had a clear glass envelope and top pip on a nickel plated base shell - truly an item of beauty. Later replacement types descended to a bakelite base, no top pip and a fully gettered envelope. The thoriated filament of the LS5 is very brittle when cold so that postage of this type is never safe, better by far to have the happy recipient come and fetch it.

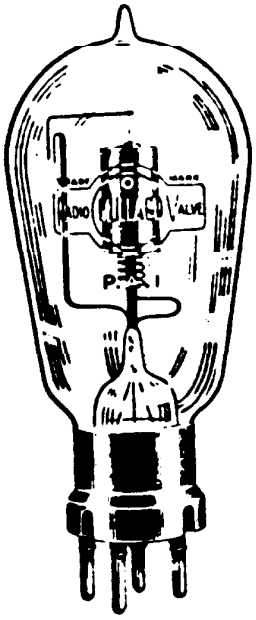
The successful LS5 filament was exploited in other ways. An even lower impedance version designated LS5A appeared for coaxing more audio watts at medium HT, and a high impedance type LS5B appeared for use in RC coupled and driver stages.

A whole high quality set could be based on the LS5 family. LS5B for neutralised RF and detector and 1st LF, LS5 for 2nd LF and a pair of push-pull LS5A's for output.

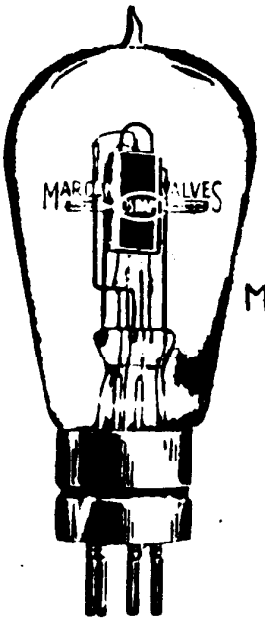
The characteristics of these valves are compared below:

Type	μ	R_a: ohms	g_m: mA/v
LS5	5	5,000	1.0
LS5A	2.5	2,750	0.8
LS5B	20	25,000	0.9

The valves described so far take us into the early 1920's. Part II will explore the impact of the oxide coated filament.



PA1
MULLARD
Fig.3



LS5
MARCONI
OSRAM
Fig.4

THE EDISON SWAN 'ONE-DER'

By Anthony Constable

Many of the wireless sets eagerly sought after by collectors have no very special features to boast of - they are simply good representative examples of the standard technology of the day. But most collectors are only too happy when they find a receiver that is a bit out of the ordinary and are particularly pleased when a new find can be described by such epithets as, 'rare', 'unique', 'outstanding', 'innovatory' etc etc.

The Edison Swan 'One-Der' is certainly unusual and, judging from the number that have been seen among collectors during the past five or six years, it certainly comes into the 'rare' bracket. About four of them have so far been tracked down among BVWS members and not all of them are complete. At first glance the set is nothing very special at all. It is housed in an unattractive oak box with three knobs on the front and a rather ugly black and white plate containing the two graduated scales and the Edison Swan monogram (see illustration on the front cover). On examination of the circuit diagram (Fig.1.) the set is a very ordinary two valver with anode bend rectification and an RC coupled LF amplifier. As far as can be determined, this ordinary simple two valve set was never seriously marketed by Edison Swans but a few found their way out of the design department into private hands. Despite an extensive search of contemporary literature, no references can be found to the One-Der and no Edison Swan advertisements refer to it. Furthermore, the single valve (a double triode) used in the set is not listed in any of the Edison Swan or other valve data lists.... as far as is known.

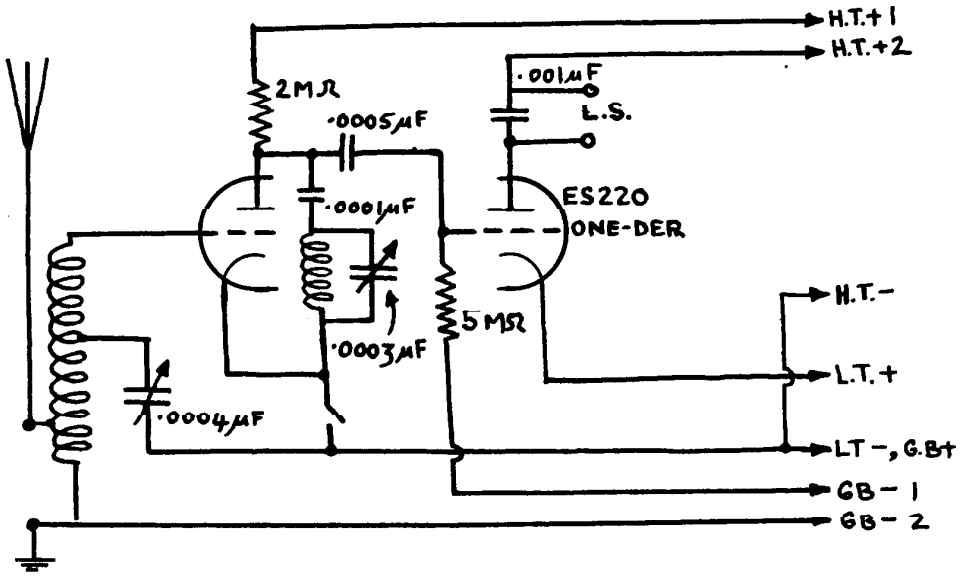


Fig. 1.

It is really the valve which makes this set unusual. Its size and shape are quite typical of the post 1926 period and it carries the BVA stamp (the British Valve Association - formed July 1926). The leads from the valve electrodes are connected to solid base pins by the old technique of bringing the wires out through holes near the pins and then winding them round the pins before soldering. It is very lightly gettered which, fortunately, allows one to inspect the electrode construction in some detail. As shown in Fig. 2, the two triodes are mounted concentrically, the first using the inwardly directed stream of electrons and the second using the outwardly directed stream (see also diagrams on front cover). This curious 'inside-out' construction is very neat but highly unusual and I have yet to discover any other valve which makes use of it. The inside anode is simply

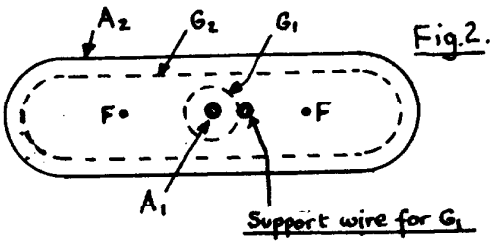


Fig.2.

a nickel rod about one millimeter in diameter. This is surrounded by a 3mm diameter spiral for the first grid. This grid is attached to a vertical rod parallel to the first anode rod and the two rods are held rigidly together at the top end by a small bead of glass. Immediately outside the first grid are two vertical filament wires connected together at the upper end. Outside these filament wires is a second spiral for the second grid and all the electrodes are contained within the outer anode. The base pin configuration is shown in the front cover illustration. The valve type number is ES220 and the words ONE-DER are also etched on the glass envelope.

No mention of this valve has so far been found in the valve literature of the late 1920's and it is not at all certain how many of them were made in the first place let alone how many have survived the ravishes of time. Two with intact filaments are known so far among BVWS members. After much searching, the original idea for this concentric construction has been tracked down to patent No. 292,218 issued to a Mr A.H.Midgely with an application date of 11th March 1927. Brief reference is made to this patent in 'Experimental Wireless & The Wireless Engineer', Vol V, No. 60, September 1968 page 533. Mr. Midgley claimed that "... the combined action of the two grids and anodes on the common electron stream gave rise to a reaction effect which increases the magnification factor." Having used the valve (under very cautious operating conditions!) I can only report that it performs moderately well in the ONE-DER set with very little suggestion of any reaction effect.

Without other information, one can only speculate about the history of this valve and receiver. It seems highly likely that they should be dated late 1927 or even early 1928 and that a small production batch was made. Perhaps this first batch was distributed to selected retailers for the purposes of 'market research'. The general appearances suggest excessive use of 'old technology', though this in itself is no reason why the set should not have been a marketing success - there were many examples of obsolescent technology retailing quite well in the late 1920's. Perhaps the ES220 was the stumbling block and did not lend itself to the new manufacturing ideas that began to emerge when Edison Swan became part of A.E.I. Ltd in 1928 .... ideas which culminated in the disappearance of BTH, Cosmos and Edison Swan valve types in 1929 and the introduction of the Mazda range.

Whatever the facts are, it is clear that the 'One-Der' must take its place in radio history as something out of the ordinary - a curiosity. Collectors of rare 1920's valves are always happy to discover that some new curiosity exists and presumably it will not be long before a few ES220's come to light.

It is possible that more facts may be discovered about this set and, when they become available, they will appear in the Bulletin and possible even replace some of the above speculation!

There was also a 'One-Der' horn speaker for use with the set. There are two speaker terminals on the right hand side of the set and the speaker output under the cautious conditions that I have operated it, is quite adequate for a small room. The aerial and earth terminals are on the left hand side and the battery leads all come out together through a hole at the rear. The ends of the battery leads are not provided with the usual banana plugs and accumulator spades. Instead, they all terminate with small solder tags as if they were intended to be connected to a special battery box or battery eliminator. Perhaps somebody will be able to throw some light on this matter by finding in their collection some such item with the Edison Swan insignia and possibly a 'One-Der' transfer. If so, I would certainly like that person to contact me.

TRANS-ATLANTIC LETTER

From Dave Brodie

The first three months of the year seems to be the period when collectors bear down heavily on restoration projects and otherwise content themselves with reviewing the buy and sell advertisements in the various Society and commercial publications. The National Societies swing into action during spring. Local societies content themselves with swapmeets to maintain interest during the winter months. For example, my own group (CHRS) held such a meet a few days ago and we enjoyed a surprisingly large turnout of about 120 members, most of whom arrived well before the ann-

ounced starting time of 8.00 a.m. Trading was quite brisk with emphasis on components which is indicative of the interest in restoration.

May I call your attention to two meets of considerable importance which, hopefully, will fit into the itinery of those of you who visit the U.S. this year. The Antique Radio Club of America will hold a two-day meet at Louisville, Kentucky on June 5-6 and the Antique Wireless Association will again hold its annual conference at Canandaigua, New York, but somewhat later than usual ... October 22,23,24. This conference was originally scheduled to be held at the Ford Museum, Dearborn, Michigan. Warning ..... it can get a bit chilly in N.Y. state during October, and also a little 'damp'.

I have completed my review of recent society publications which have recently crossed my desk and would like to share with you some capsule comments of their contents. Here and there you may find ideas for similar articles for our BVWS Bulletin:

The Antique Radio Gazette (ARCA) An interesting article by Alan S. Douglas on the Federal 61 receiver (1923) which included much information on the types and prices of competitive receivers available that year. Alan warrants special mention as he is a new member of BVWS and is a prolific writer for ARCA and similar publications. I'll be after him to submit an article for our BVWS Bulletin. Alan was also the recipient of the new Ellc award presented by AWA last year for outstanding craftsmanship in receiver construction. This issue also contained an article on antique television (which is taking a hold over here) plus an interesting tabulation of comparative numbers assigned to the same valve by the U.S. Government and commercial manufacturers. This material is of real value to collectors as the tabulation extends back to the 'teens' and starts with the VT-1.

The Old Timer's Bulletin (AWA) In addition to a summary of the 1980 National Conference, this issue also includes an article on a 1938-39 portable television system, a brief history of the Kester Solder Company, a brief article on early ham radio, valve and restoration articles, and a 'Collector's Guide to Magnavox Horn Speakers' which is complete with selected photographs and a complete tabulation of 19 models.

CHRS Journal This publication, in addition to articles of special interest, provides quarterly articles on restoration problems; a valve column which provides data and photos of unusual vintage items; a Novelty Nook dedicated to photos and descriptions of novelty sets, early advertising gimmicks etc.; a featured commercial set with schematics, photos, and technical data; and a Collector Spotlight article in which a member is introduced to the membership, complete with photos of the member and his collection together with a brief summary of his background.

SOME PUBLICATIONS. A catalogue of quality reproduction parts to aid in the restoration of RCA's, De Forest's, Crosley's, Atwater Kent's etc. Available from Matson's Antique Radio Parts Supply, 388, Concord Rd., Billerica, Ma. 01821. Price $2 ... refunded with first order of $10 or more.

Reprint of 1922 catalogue. Illustrations & narratives on popular sets of period. 160 pp 8½ X 11". Vestal Press, Box 97, Vestal, N.Y. 13850. $13.25 inc. postage.

Encyclopaedia of Antique Radio - Vol.3. 40pp. soft bound 8½ X 11" ... advertising material etc on equipment from 1914 to late '30's ... including current estimated price for mint examples. Puett Electronics, P.O.Box 28572, Dallas, Texas 75228 $5.95

A Streak of Luck - The Life & Legend of Thamas Alva Edison. If I can plough through this formidable, exhaustive work of over 550 pages, I will comment on it in a future issue of the Bulletin.

I dislike closing on a sad note, yet I must inform you that I have just received word from Toronto that the Canadian Vintage Wireless Association is being dissolved. This decision was announced at the Association's Annual General Meeting on January 17th 1981. Reasons given ..... lack of participation by members as evidenced by inability to fill executive positions including that of Editor of the quarterly 'Catswhisker'. The President noted, sadly enough, that "non-participation' is a fatal disease for a hobby organisation...." Amen to that. Here's hoping for a resurgence of interest by our fellow collectors to the north.

LOUDSPEAKERS - PART V

THE MOVING COIL

By David Read

Today we take the moving coil loudspeaker for granted. Its response is tolerably linear, it can handle great power, and with properly designed enclosures its characteristics as a high fidelity transducer are excellent. This being so, one might wonder why earlier systems were used at all since the moving coil idea was proposed as early as 1898 by Oliver Lodge under his patent number 9712, which itself was based on an even earlier idea due to Siemens and patented in 1874.

In this final article in my series on loudspeakers I will attempt to answer this question in the context of how the idea was introduced, gained a foothold, and eventually bacame ubiquitous.

The application of the moving coil principle in the field of transmission was first used in submarine cable telegraphy. A mirror galvanometer was used to sense small signal currents, indicating their presence by deflections of a beam of light.

As far as wireless in the U.K. is cocerned, the moving coil principle was perhaps first applied in the famous Marconi-Round microphone at 2LO in 1923 (see Fig.1.). Earlier microphones were mainly 'carbon transmitters' of the type familiar in telephone mouthpieces or sometimes electromagnetic, differing not at all from a large telephone earpiece or drive unit used in the commonest type of horn speaker.

The 2LO microphone as it came to be known was developed by Captain H.J.Round from a patent due to A.F.Sykes, who also in his patent No. 160223 proposed (in 1921) the application of the moving coil principle to loudspeakers. It was Captain Round who also developed the first screened grid valve, the S625, and his pleasing and uncompetitive character comes across in a letter to 'Wireless Weekly' early in 1925 when he gently chastised John Scott-Taggart for attributing the moving coil microphone to himself. Captain Round pointed out that he and all his staff at Marconi always referred to the 'Sykes Microphone'.

Tracing the development of ideas and their application as far as wireless is concerned is a particularly frustrating experience as anyone who tries to distil useful information from the contemporary literature will realise. For instance, the Magnavox moving coil loudspeaker on sale in Brittain before 1924 and generally thought to be the first of its type is not mentioned in Harmsworth's Wireless Encyclopaedia under loudspeakers. One has to know of its existence in advance, so to speak and look it up under 'M'. If you know of A.F.Sykes, you will make little progress as he only gets mention for a totally obscure type of water microphone. However, his fundamentally important moving coil microphone is described under 'B' ..... for B.B.C., though not of course under 'M' for microphone! For his ideas on loudspeakers you will have to go to the Patent Office library.

The use of large cones as opposed to horns was first developed for moving iron systems, perhaps by Pathé, but most of the research into what would actually comprise a good quality sound radiator was carried out in America notably by C.L. Farand and C.W.Rice both engineers with Western Electric. Early practical moving coil speakers were however horn loaded diaphragms of mica or other non-magnetic materials such as the Magnavox in which such a diaphragm is connected to a coil in a strong magnetic field (See Fig.2).

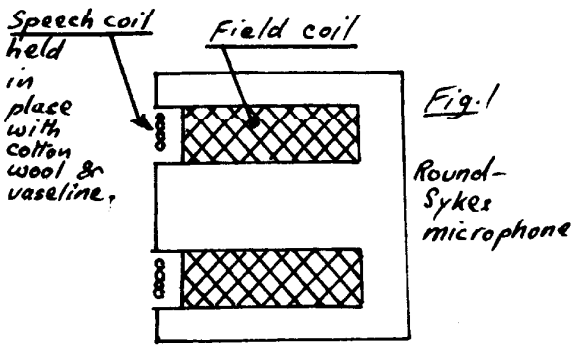


Fig.1

Round-Sykes microphone

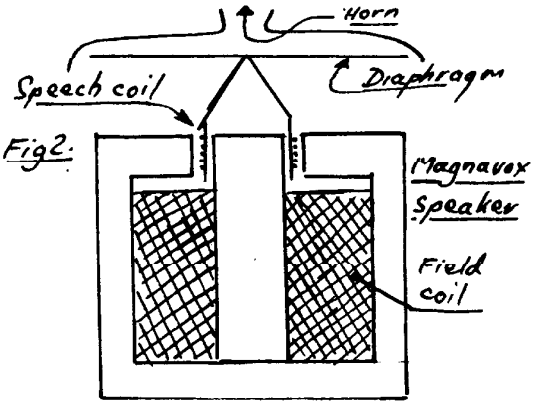


Fig2.

Magnavox speakers were manufactured from about 1918 and began to be used in radio applications in about 1920. The low impedance speech coil was connected to output valves by way of a step down transformer and the field magnet was energised with a 6volt battery drawing between 0.6 and 1 amp depending on the model. The similarity between the original Lodge drawings and the Magnavox method of attaching the coil to the diaphragm is quite marked. The Magnavox speaker was made in England under licence from Magnavox U.S.A. by Sterling Telephone Co who, interestingly, also made the first commercial hornless speaker, the Primax, under licence from Gaumont of France (See part II of this series, BVWS Bulletin, Vol. 4 page 61.).

Gaumont also seem to have been first to introduce the cone to moving coil speakers. In their system, used to announce trains at Gare du Nord in Paris, the diaphragm was in the form of a cone of thin silk on which was cemented a single layer of fine aluminium wire (see Fig.3). Here was an extremely light and sensitive diaphragm which was also free from resonance. The reaction of speech currents in the aluminium coil with the radial component of the magnetic field produced the driving force.

In America C.W.Rice designed a speaker on the Gaumont principle improving the performance of low tones by provision of a more flexible support for the rim of the cone. This led to the realization that low tones of opposite phase from either side of the cone cancelled each other out and Rice introduced the baffle to prevent this effect. C.W.Rice then, in conjunction with E.W.Kellogg researched moving coil cone material, dimensions and suspensions, and the results of their work was the well known Rice-Kellogg speaker which was imported for tests by the B.B.C. in 1925. In these speakers Rice & Kellogg had determined that a simple 45° rigid cone 0.007" to 0.010" thick paper about 6" in diameter with a flexible support for the rim consisting of very thin rubber 0.25" wide and under slight tension made a satisfactory sound radiator. Here most of the elements of the modern hi-fi speaker are present.

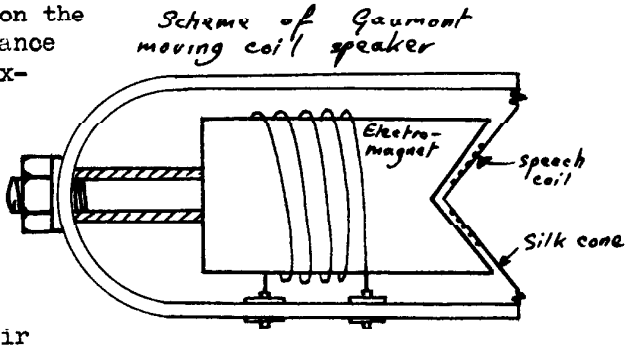


Fig. 3.

Rice-Kellog speakers required accumulators or rectifiers and transformers to provide the direct current for the field coil, and had to wait for developments in permanent magnet technology for one sufficiently strong and long lasting for this application. The less bulky and less power consuming moving iron cones therefore continued to be used for the majority of domestic radio cabinets in the 1928-1935 period, or until mains radio became common and provided easy power for the electro-magnet.

Yet the development of suitable magnets leaves me puzzled because one company at least had solved the technology problem as much as ten years earlier than popularly supposed. In March 1924, British Thomson Houston became assignees of the Rice-Kellogg patents (Brit. Pat.No. 245,796), and I guess they had good reason to want access and rights to work on cones and suspensions because their own patent 202418 of May 20, 1922 proposes a moving coil in a permanent magnetic flux. Whilst their own patent drove a flat diaphragm, in combination with the patents of Rice & Kellogg they would achieve all the component features of the modern permanent magnet moving coil speaker.

I have in my collection the only example known to me of a moving coil permanent magnet horn speaker. It is made by B.T.H. and is the one illustrated in their 1922 patent. In its base is the transformer necessary to match the low impedance moving coil to the high impedance anode load required by an output valve. The permanent magnetic field is supplied by six cobalt steel magnets which alone weigh nearly 10lbs.

The price of this speaker in 1924 was £12.10s. or almost four times that of the average speaker. So perhaps the real problem was not one of technology but rather

technology at an appropriate price. Plus ça change ..... !

David Read's article traces many of the birth pangs which accompanied the eventual arrival of the moving coil speaker. On discussion, it appeared that the following additional notes might be helpful: A recent article in the AWA 'Old Timer's Bulletin' by Floyd A. Paul & Walt Sanders mentions the very early invention of the moving coil earphone by Pridham & Jensen in 1911. The article also mentions the chance connection Mr. Pridham made in May 1915 of his moving coil telephone to a phonograph horn ... thus giving birth to the 'Magnavox'. The article goes on to provide a most useful list of Magnavox types, models, sizes, electrical characteristics and earliest advertised dates .... a most helpful list for wireless collectors.

Many articles have been written about the development of loudspeakers and one particularly good one for those interested in the hornless speaker can be found in Wireless World, Decmber 21st 1927.* This article refers to Elisha Gray's electro-magnetic 'speaker' of 1879 in which an iron pan is actuated by an electro-magnet. This loud-speaking telephone is probably the grand-daddy of all hornless speakers. The article also refers to C.L.Farrand's British Patent No. 178,862 of 1921 which includes a description and diagram of a moving coil cone speaker. This is a very nice looking structure in which the cone is directly attached to the coil .... the coil/magnet assembly being neatly housed on the inside of the cone.

Permanent magnets began to appear in about 1928 though were originally heavy, pricey things, the cobalt tungsten steel not being properly introduced until about 1933. As many sets from the 1930's show, the energised speaker remained in common use for a long time. The Rice-Kellogg or 'R.K.' speaker sold by B.T.H. from 1926 is a marvellous brute of an instrument which has the appearance of having dropped off an assembly line more usually devoted to the heavy motors and generators for which B.T.H. is perhaps better known. My own B.T.H. 'R.K.' performs very well at the task of handling the output from the two push-pull P625's in my Burndept Universal Screened Five (BVWS Bulletin Vol.5 p.4). I believe that, at the time of the R.K.'s appearance in this country, Metro-Vick were also doing some interesting work in this field.

Readers are invited to submit any additional material they have on the subject of early moving coil and other speakers to supplement the series of articles which is now complete....Editor.

*'Story of the Hornless Loud-Speaker', Wireless World, Dec.21st, 1927. pp 806-810.

MISCELLANEA

From time to time details of wireless museums are included in the Bulletin. Readers should refer to Vol. 4 No. 4 p.63 and the following number, p.10 for some general details of such museums. Here is one that was not included previously: The Norton Collection Museum, Davenal House, 28, Birmingham Rd., Bromsgrove, Worcs. B61 0DD. Tel: Bromsgrove 77934. Members will notice the Norton Collection Museum is included in the BVWS address list under D.Norton. Mrs Margaret Norton recently wrote to tell us that they plan to hold a Vintage Wireless Fair there on Sunday 25th October. Note this date in your diary and contact the Nortons for further details.

The Chalk Pits Museum at Houghton Bridge, Amberley, Arundel, West Sussex, BN18 9LT Tel: Bury 370 (079 881) will be open from April 12th to November 1st. There is a good display of vintage wireless equipment at this museum which was originally owned by Ron Ham. Ron has also written a very pleasant 8 page booklet called 'A History of Communications' (he wrote this in collaboration with David Rudram) which is available from the Chalk Pits Museum price 0.30p.

I was recently sent a note from the Canadian Vintage Wireless Association informing us that the Association is now disolved and their publication 'The Cats Whisker' is no more. This is very sad news and, according to the outgoing president, Ernie Welling, was entirely due to non-participation particularly in the form of a lack of interest in the long standing vacancy for the editorship of 'The Cat's Whisker'. Editor.

RE-INVENTING THE WHEEL

By Desmond Thackeray

There is an old saw that engineers are apt to cite beginning, "If it is worth doing, it has already been done .....". However, no inventor worthy of his salt has ever been deterred or discouraged from presenting his supposed novelty to the world, how ever many times it has been invented before, however long ago it ceased to have any value to a developing technology. By contrast, the genuine innovators, the Hughes and Edisons of this world, can find that their ideas hang fire for decades waiting for technology to catch up. Even if history is not 'bunk', it certainly is confusingly irrational. So I wondered what possible motive there could have been for Dowsett to publish an article on 'Carborundum and its Rectification Effect' towards the end of 1921. The Marconi Company had at various times introduced alternative detectors in marine wireless receivers, so that by 1915 the second edition of 'Hawkhead and Dowsett' (Handbook of Technical Instruction for Wireless Telegraphists, Iliffe.) describes the 'Maggie', the Fleming diode and the Marconi carborundum detector, any or all of which an operator of the time might be expected to use routinely. Five years later, professional wireless men were using valve receivers increasingly and the old equipment was being relegated to emergency use. An advertiser in Popular Wireless Weekly in 1922 was trying to sell no less than 100,000 ex-government crystals, but none of these was carborundum. Marconiphone did however keep their carborundum detector alive by putting it in the 'Crystal A' for the domestic market; they also used it in the RB10 together with a reflexed DEV valve; and in the 'Crystal Junior' it had a galena detector as stable mate, perhaps as a concession to the widespread popularity of galena (it needed no battery). It may seem therefore that 1921 would have been a good year for writing an obituary on the carborundum detector, but Dowsett wrote as if it still had commercial viability.

The Carborundum Company would have had more reason to promote the article, since they had the raw materials available at cost in unlimited quantity, but their permanent carborundum detector does not appear on the scene until the late twenties. They revived some of the suggestions made by Pierce twenty years before, and engineered an article which superficially resembled one of their own sealed resistors, but which contained a suitable chosen and mounted piece of crystal permanently held against a spring loaded steel counter-electrode. The consequent stability of mechanical and electrical characteristics coupled with reasonably low distortion must have made it very suitable for detection following radio frequency amplification; so that it is not at all strange to find such a detector around at the time of the birth of the screened grid valve. Company literature (both English and American) went so far as to provide circuits in which they expected the detector to excel. Presumably reflex circuits and the use of reaction were never as successful with the relatively unstable galena and catswhisker as detector.

I have been curious to establish whether this permanent detector failed in its turn because of some technical inadequacy in performance or reliability; or whether it was killed because of those mysterious adversaries 'market forces', by which we mean perhaps "was it cheaper to put a diode anode into some valve already present?" I think a clear answer to the latter question may well be "yes"; but this would not explain why the Westector, a permanent diode of mediocre performance and little reliability compared with say a modern semiconductor diode, managed to keep a market for so long (other applications of Westectors described in BVWS Bulletin Vol. 4, p.50 & 51 Ed). By making up four permanent carborundum detectors myself with a certain similarity to the ones made by the Carborundum Co., I am fairly certain that the Company could have produced detectors with very desirable electrical characteristics, and so I have no reason to doubt the accuracy of the characteristics they published. Similarly, I can see no reason why most of them should not have had very good short term stability. It would however be excusable if a product of this kind had a half-life of only ten years, and this is a judgement we should apply to all vintage components. It is a constant surprise to discover how well many components have stood up to fifty years of misuse and neglect; so how about that Carborundum Co. detector in your display cabinet - or bank vault? Oddly enough, they do not seem very common in th U.K., one of the originating countries. Perhaps they were all exported (a nation of shopkeepers). I hardly think

that many went to the U.S.A. to compete with the indigenous ('Niagara Falls') product; but since both countries exported to Australia, annihilation of momentum should have produced a considerable fallout somewhere in the middle of that great island.

I was delighted therefore to get a letter from Paul Groom to say that he and his friends still have these detectors, zealously preserved and still usable. Some are the U.K. 'Carborundum' product and some are 'Niagara' from the U.S.A. - and only one of them doesn't work at all, having gone high resistance in both directions. Paul has now measured their static characteristics for me on numerous occasions, for which data I am eternally grateful. There is some variability in characteristic which is affected by tapping the more vulnerable detectors, suggesting that the contact area has not entirely resisted the ravages of time. But at their best, the characteristics are not very different from my home-made ones or from one constructed by Paul himself in an old 'Red Diamond' case. For very small signals, somewhat better performance would be obtained from a Gilfillan FeS2 detector, possibly almost equalling that of a modern semiconductor diode. This merely reinforces the not unusual comment that carborundum detectors were not necessarily the best for small signals. But undoubtedly the two Carborundum Companies "builded better than they knew" when they constructed these detectors.

I am indebted to Ms Donna M. Rogers and Mrs K. Poplawska for the information they sent sent me, and to Paul Groom for his indefatigable efforts.

LETTER TO THE EDITOR

Dear Sir, I really must write and congratulate all those concerned with the continued excellence of the Bulletin. It has just the right mix of technical information, historical material, hints, ads, stimulating comment and miscellanea. Like many people, I'm a few copies short of a complete set of back numbers and only wish it could be possible to have some of the earlier issues reprinted. Perhaps members of BVWS might like to give the Committe some indication of possible demand.

I must say that I find most members are marvellously helpful in supplying information to each other but am a little disappointed that just a few fail to make acknowledgement when one takes the trouble to send them details following a 'searching' enquiry - perhaps these are just oversights, but replies ought to be encouraged, otherwise information exchange might suffer.

I don't know about other members, but I always feel a bit guilty that we continue to let the 'willing horses' do all the Society work year after year. But the reason, I'm certain, why we are happy to re-elect the same people at each annual meeting isn't just that we are all work shy - but that we honestly feel the officers and Committee always do the job so well that we don't want a change, and we feel we can't possibly emulate their excellence. Even so, we can't go on relying always upon their kindness and industry: we ought to be helping. I'm resolving this year at least to consider lending a hand. Bob Hawes, 63, Manor Rd., London, N.7.

Thanks a lot for the kind words and for the offer of help. During five years of editing the Bulletin, I have always found members to be most helpful when called upon to provide information - although a bit of 'bullying' is occasionally required! At the A.G.M. this year (see below) there will be ample opportunity for members to offer their services. Regarding the question of re-issuing back numbers, I am not at all sure what can be done about it. Of course, if there really is a large demand we would have to find a way of doing it. At present it seems that 'Xerox' copying is the most practical way of doing it though the cost (approx £1 per issue) might seem a bit high. But furthermore, copying in this way means that somebody has to spend a lot of time doing it .... any offers? Editor.

Don't forget the AGM ... see inside front cover. And don't forget membership dues.

FROM THE EDITOR'S BOOK SHELF

Early Radio Wave Detectors. By Vivian J. Phillips. Peter Peregrinus Ltd in ass'n with the Science Museum, Institution of Electrical Engineers, London 1980 pp 223

To most people in the radio field the term 'detection' is synonymous with rectification and is the fundamental process whereby the signal is extracted from a radio frequency carrier. Those of us who have a special interest in the history of wireless will know that many of the early detectors were not rectifying devices but were still very much 'detectors'. Vivian Phillips, in his comprehensive study of early radio wave detectors brings out this point very clearly. He explores the early wireless literature very thoroughly and presents for the reader a well documented summary of virtually all radio wave detectors and their inventors. The principle of operation is dicussed in each case primarily by reference to historical material but also, to some degree, from the viewpoint of the modern electrical engineer. The coherer will come to most people's minds when thinking of early detectors but the author has much more than coherers to write about. His book includes chapters on Magnetic detectors, thermal, electrolytic, thin film, capillary detectors as well as tickers and tone wheels. Crystals and the Fleming valve are mentioned but, ah well! such devices are altogether too modern....and, after brief inclusion in order to complete the story, the author rests his pen. The book is well illustrated with about 193 photographs and diagrams plus an interesting inventor's 'portrait gallery' at the beginning of the book. Disappointments were few. There are no glaring factual errors and very few typographical mistakes. I do consider that a historian, even a historian of science, should not only record the facts but should also express his own view point. The present work has just a little of the author's view point and I think we could have done with more. Having read the book fairly thoroughly, I do not see any major omissions - perhaps the author should have donned his modern electrical engineer's hat a little more frequently in discussing for example the action of the coherer, the telephony mode of operation of the magnetic detector and the relative sensitivities of the full range of detectors. Maybe there is a need for a companion to this fascinating book entitled: 'Some Modern Measurements on Early Radio Wave Detectors'. The book is thoroughly recommended and it will become a first class source for all wireless historians. Price: U.K. £17.60; Americas $49.50; Elsewhere £20.60. Editor

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Early Wireless. By Anthony Constable. Midas, London 1980 pp 160

Ron Ham, columnist for Practical Wireless and noted for his vintage wireless interests through his exhibits at Chalk Pits Museum writes the following review:

My immediate reaction to Anthony Constable's book was one of sheer delight, because here is a book in which there is something for everyone and, although concerned with a technical subject, it is fascinating to read. There are 166 illustrations with over 130 pictures of vintage sets and loudspeakers for the enthusiast to drool over. This book must be a winner. For many, the story of wireless, or radio, call it what you will, had unfurled within their own lifetime and technology advanced so rapidly from the spark transmitter and coherer detector receivers, through the era of the thermionic valve to the transistors and microchips we use today - the author was so right to devote chapters 1 (Electromagnetic Ripples: From Earliest Times to c.1900) and 2 (From Coherers to Valves: From 1897 to World War I) of his book to remind readers in such detail of the early days and how it all began. Apart from collectors and enthusiasts, Early Wireless should complement the bookshelf of any modern historian because, within the history of radio is contained the great social changes which have occurred over the years. For the newcomer to wireless there are about 30 drawings to explain the workings of the spark transmitter, coherer and crystal detectors and the early thermionic valves. For the collector, the author has prepared a 33 page list of wireless sets, with prices, some technical information and details of manufactures that were around in 1926. In my view, 'Early Wireless' at £8.50 is a worthwhile purchase and is attractively presented in hardback.

Author's apology: Sorry for the few glaring errors which were quickly picked up by vintage wireless enthusiasts. An errata slip is included in this Bulletin for owners of the book to insert.

THE COMPACT VARIABLE DISC CONDENSER.

By Anthony Constable & Roger Snelling

It seems that the compact disc condenser was one of C.S.Franklin's brain waves. During the Russo-Japanese war, C.S.Franklin went with three other Marconi engineers to Russia to St. Petersberg to demonstrate low power transmitting stations mainly for field use. While there he sent home several drawings some time in 1904 from which were developed the disc condenser and the multiple tuner. The latter was patented in 1907. The condenser itself is a very well constructed high capacity, small volume device and it is quite surprising to see a condenser no bigger than the usual 0.0005 µF tuning condenser of later years yet having a capacity 10 or even 20 times bigger. The higher capacity was required because of the longer wavelengths then in use. Roger Snelling recently decided to investigate the construction of an old ship's condenser. He writes:

"The old spark transmitters used very long wavelengths which resulted in the use of large value inductance and capacitance. The condensers were usually mounted on the bulkheads of ships and were fitted in teak boxes. Even on a ship, space was at a premium and efforts were made to reduce the size of components.

I have such a condenser, made by Marconi c.1920 and it is contained in a teak box measuring 5X5X5 inches and its capacity is 0.005 - ten times a 'normal' radio tuning condenser and not much bigger. This condenser did not even use solid dielectric.

The rotor has two sets of separate plates mounted on a common shaft. The plates are insulated from each other ... see Fig.1.

The stator has two similar separate plates and each stator set is connected by way of slip rings to one set of rotor plates.

Therefore we get the two positions: (Fig.2.)

(a) Minimum capacity
  1 connected to 2 & meshed
  3 connected to 4 & meshed

(b) Maximum capacity
  1 connected to 2 but meshed with 3
  4 connected to 3 but meshed with 2

This arrangement doubles the capacity of the component. The patent number of this particular condenser (c.1915) is 5321/15."

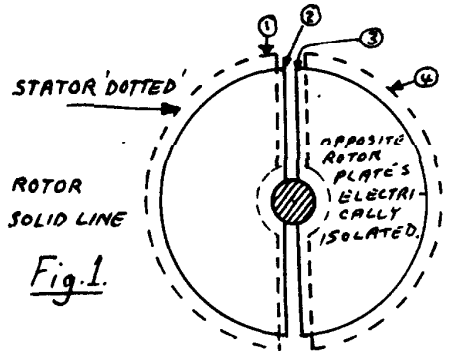

Fig.1.

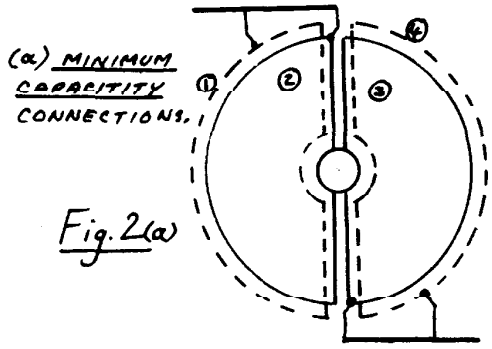

Fig.2(a)

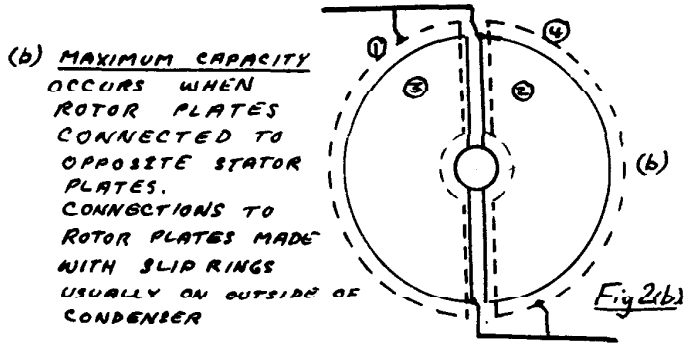

Fig.2(b)

This compact condenser is basically the same as those used on the very early multiple tuners which were able to pack ten jars (=0.011µF or 10,000 cm) into a 4" diameter cylinder 1¾" high....in this case using thin ebonite for the dielectric. High voltages were occasionally used on these condensers and the dielectric was protected from puncture by small (0.01" spark gaps - two of them) across the condenser. A complete description of one of these condensers (Pat.No. 15906/06) is given on page 215 et seq. of 'Handbook of Technical Instruction for Wireless Telegraphists' by Hawkhead & Dowsett, Iliffe, 1925. Variable condensers of some sort had been in use since the 1890's and, according to G.W.Pierce in 'Principles of Wireless Telegraphy', McGraw-Hill, 1910, such devices were first proposed by Korda in 1893 but it is believed that they were first used somewhat later than this for radio work - by A.Köpsel ('Wireless Telegraphy' by J.Zenneck, McGraw-Hill, 1915.)

EXCHANGE

SEARCHING

Components & circuit for Lotus SPG receiver (1929/30). Loan or photocopy of booklets: 'Meccano Crystal Receiving Sets', c. 1922; Radio Press 6.'Crystal Receivers' by Douglas; Also No.18, 'Tuning Coils' by Kendall, c.1924. Muirhead slow motion drives (recently offerred for 75p at Harpenden). Broken bits of black bakelite from Lewcos coils. Information on the BING toy wireless set (Tx & Rx)c.'23.
Desmond Thackeray, 7, Beech Close, Byfleet, Surrey, KT14 7PS. Tel: 91 - 41023

Philips 'Superinductance' 634A. Also Ekco SH25 or RS3 and Philips 930C, 834A, 830A.
Allan King, 31, Middle Road, Denham Uxbridge Middx., UB95EG. Tel: 0895-834358

Plug-in coils by 'Gambrel' - one hole fixing.
Reg Dykes, 312, Carterhatch Lane, Enfield, EN1 4AL. Tel: 01-363-7494

Information on original valve line-up for Gambrell AC receiver SG4AC. Valves: Mullard PM13, PM24DC & equivs, Mullard PM22C, PM4DX, Osram PT2K, Edystone coils, 6-pin: grey spot, 4-pin: white, pink, green, brown, grey spot.
Philip Taylor, 14, Willow Walk, Canewdon, Rochford, Essex, SS4 3QH. Tel: 03706-598

Top cap connector (copper) for Philips Superinductance set. KB Black Cat Kitten 2v battery set. Kensitas 3v + metal rect straight mains set ... also matching extension speaker and/or information on this set.
D.C.Turner, 3, Sackville Way, West Bergholt, Colchester, CO6 3DZ. Tel: 0206-240911

Harmsworth Wireless Encyclopaedia (3vols) Condition not important .. must be complete.
R.M.Chacksfield, The Old Telephone Exchange, South Town Rd., Medstead, Nr. Alton, Hants, GU34 5ES. Tel: 0420-63760.

Loading coil for BTH Typw 'C' twin crystal set. 'Works' for Ericsson Typw 0/1002 crystal set. Coils for Marconiphone Type 31 receiver. Valves: Osram R2A, KL1, or KH1, Cossor AC/G, AC/R.
A.P.Carter, Trellis Cottage, Horsham Rd., Shalford, Guildford Surrey. 0483-504213

Pye Mozart amplifier Type HF 10M. Circuit diagram for Tannoy PA amp Type 220.
K.H.Flemming, Old Quarry, Dalkey, County Dublin, Ireland. Tel: 858567

Information on Pye 250AC 2v. 1928 ... i.e. valve types etc. Also: early Lissen Popular AC Batt.eliminator valve type & circuit. Also Pye Model 222 or similar.
Ron Jones, 2, Rose Ave., Alvechurch, Worc. B48-7PG. Tel: 021-445-3264.

H.M.V. Radiogram 531. Stenode. R.G.D. radiogram 1201. (Mon & Wed only)
G.Sexton, 46 Chart House, Sadler Close, Western Rd., Mitcham, Surrey. 648-07365

Early frame aerial - any make, any condition. Also L.F. valve PM1LF for Brownie 'Dominion Three'. Also pair of ladies hand-held headphones.
Ian Cox, Heathcote, Camel Green Rd., Aldershot, Fordingbridge, Hants SP6 3AT.T:52627

Plug-in swinging coil holder for AJS Type F. Also cradle for GPO No.16 Tel. set.
Bill Pozniak, 32, Worsley St., Oldham, Lancs. OL8 2DE. Tel: 061-652-4251

Tuning scale for Ekco SH25. Pre-war Ekco or Philips set in any condition. Complete globe section for Emor Globe plus any info. Will buy or swap for wireless items.
G.P.A.Duc, 49, Bradmore Park Rd., London, W.6. Tel: 01-381-2038

Has anybody got one of those Sterling crystal detectors adjusted with a wheel edge? Collector requires one for his A1 Sterling receiver. Will buy or exchange.
Desmond Thackeray,7,Beech Close,Byfleet,Surrey,KT147PS. Tel: Byfleet 41023

Pilot 'Blue Peter' c.1948 and Ever Ready 'Sky Monarch - both AM & AM/FM versions. Also wanted, Ekco SH25 or RS3 .. must be good cabinet & dial.
J.E.Butterworth, Woodcombe,Grove Rd.,Blue Anchor,Minehead,Som't. Tel: Dunster 461.

BVWS Bulletins wanted: Vol.1 No.1,2,3. Vol.2.Nos 1 & 2. Vol.3.Nos 1,2,3. Also wanted, Rice Kellog RK Amplifier Circuit.
Ray Turner, 5, Squires Walk, Northampton. Tel: (0604) 32334 or 43128.

SEARCHING CONT'D

Amplion Horn: Miniature Dragon, AR114 or AR113 in oak; Dragonfly, AR102; Extra drive units for both. Also wanted, the record 'Sandy Powell buys a wireless'. BBC year-book 1935. Marconi-Osram DER pip-top valves for V2 (cash or rare valves for swap). GECophone horn speaker. Record by Flotsam & Jetsam, 'Little Betty Bouncer Loves an Announcer Down at the BBC'. Valves for GECophone 'Smokers Cabinet' set (R5V) and matching amplifier (DE5). Transformer for V2. Plug-in coils & range blocks for V2. Transformer for Gecophone set and amp. Crystavox speaker-amp. Crystal tins. Swaps?
Bob Hawes, 63, Manor Rd, Tottenham, London, N17 OJH Tel: 808-2838 (Office: 801.2111)

GECophone horn speaker & Edison-Swan 'One-Der' speaker wanted. Will exchange for other horns, e.g. S.G.Brown H.1. or Edison Swan 'Dulcivox'....both working.
A.R.Constable, 18, Ravensbourne Gdns., London, W13 8EW. Tel: 01-997-7564

DISPOSAL

Three Edystone Duplex coils: 15+5, 8+4, 4+3 turns..boxed. Two Edystone 4-pin coils, yellow spot 9turns and blue spot 4 turns, black formers, boxed. Four Raymart 4-pin coils, CA 11-25 metres, CB 20-45 metres, brown formers. Six 'P' coils, PA3, PHF3, PO3 and PHF4, PA4, PO4. Desmond Thakeray, see address above. Tel: Byfleet 41023.

Rare V24 valve (Capt. Round) £10, Fil O.K. Also type QX (Fil. o/c) £5.
Reg Dykes, 312, Carterhatch Lane, Enfield, EN1 4AL. Tel: 01-363-7494.

Vol. 1 and 2 'Experimental Wireless' (1923-1925) ... bound copies.
Philip Taylor, 14, Willow Wk., Canewdon, Rochford, Essex, SS4 3QH Tel:03706-598

Marconiphone pick-up No.17 in original box. 'Radiolab' complete valve and set tester by Everett- Edgecumbe Ltd.
A.P.Carter, Trellis Cottage, Horsham Rd., Shalford, Guildford, Surrey. Tel: 0483-504213

Marconi magnetic detector. Baird televisor. Marconi 81 (straight eight). Pye 750. First W.W. two valve H.T. unit (100watt). All in first class condition. Exchange for pre-1923 wireless equipment. Might sell the 81 and 750.
Dennis A.Yates, 327, Coppice Rd., Arnold, Nottingham. Tel: 205441.

Ekco M23 (1931), Marconi 252 (1931), 2v home-made c. 1929, Ekco eliminator AC/12 1933, BTH-MV eliminator type 'C' (1928). Above for exchange deal ... for 1925/26 set (any restorable condition), or GEC stork speaker 1931/32 model, or GEC 1-v-1 cabinet only c.1928. I.Macwhirter, 18, Syddal Rd., Bramhall, Stockport SK71AD. Tel: 061-439-6996.

Ultra FM950. Regentone HT/LT battery eliminator, working, £10. Various block mounted components, chokes, condensers etc. Enquiries welcome.
Ian Cox, Heathcote, Camel Green Rd., Aldershot, Fordingbridge, Hants SP6 3AT. Tel:52627

Numerous sets including: Ekcovision 17" T284, Cossor 485, Bush DAC10, Murphy SAD945 Philco 444, Murphy A72, Marconi 262. Also test gear: Avo test meter Taylor 20B etc etc.
A.Andersson, 6, Beech Rd., Barton's Village, Newport, I-of-W PO302AH Tel:N'pt,527103

H.M.V. Model 658 push button working...Free!
Tony Constable, 18, Ravensbourne Gdns., London, W138EW. Tel: 01-997-7564

American 18 valve consul radio - 6 wave bands - working. Dimensions: 4ft high, 2ft wide. 12" speaker Offers or exchange for Ekco SH25 or 23 or round Ekco.
Bill Caten, 8, South Ave., Southend-on-Sea, Essex SS25 5JB Tel: 0702 65987 even'gs.

Art Deco Murphy wing baffleboard - beautiful condition, rosewood, Type A146CM. Philco Radio Service Bulletins..Practical Wireless (1932-1937). Philips early television. Philco People's set (brown). Early Pye, new in box, walnut. All v.g. condition ..... For trade on crystal sets etc.
A.R.Nolf, 7, Cambrian Way, Ewloe, Clwyd, N.Wales. Tel: 0244-534-329.
