The Bulletin

Vol. 39 no. 2 Summer 2014

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

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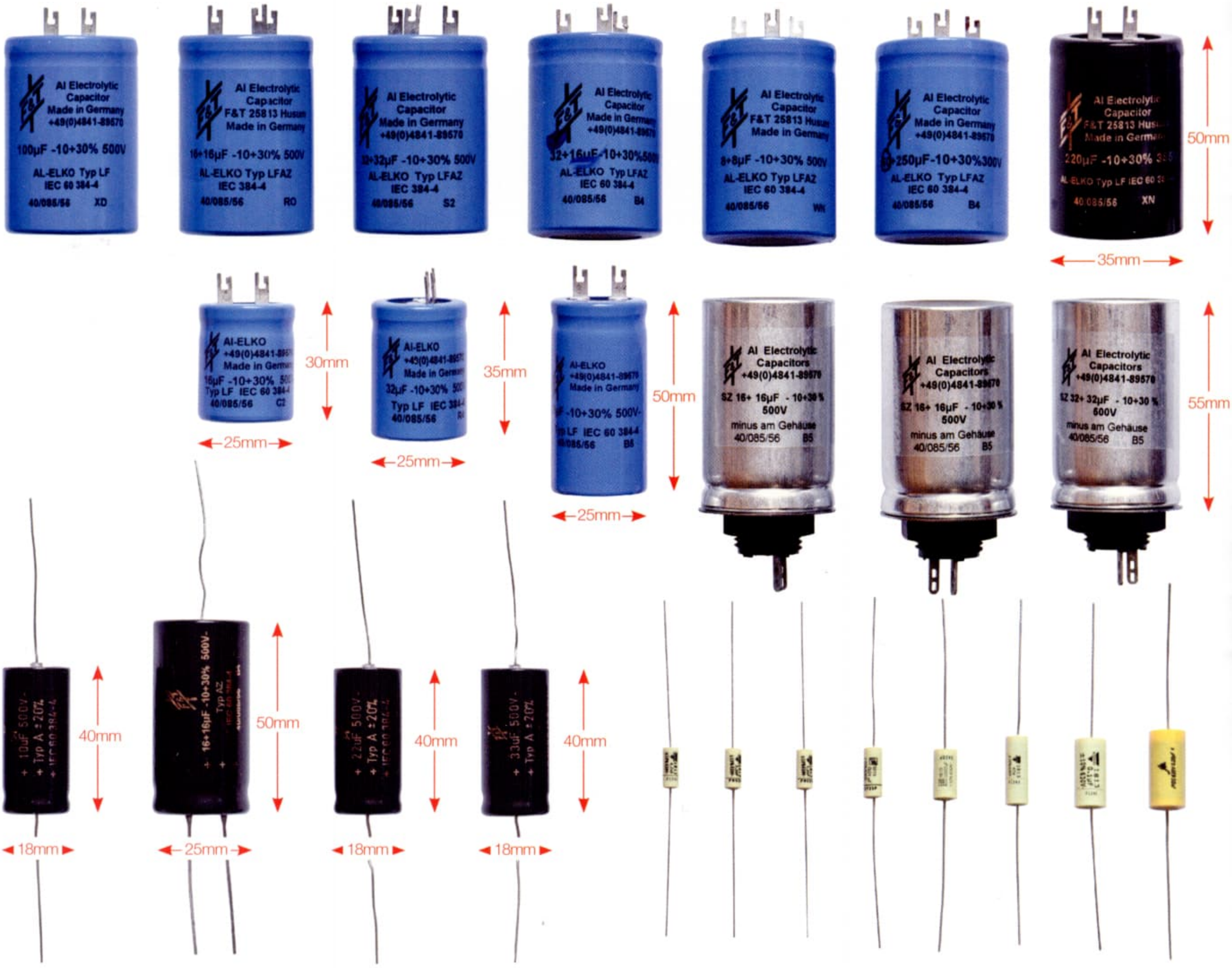


For non UK addresses, please contact Mike Barker for prices, (see below). All orders should be sent (with payment made out to BVWS) to: Mike Barker, Pound Cottage, Coate, Devizes, Wiltshire, SN10 3LG. Cheques payable to British Vintage Wireless Society. Please allow 14 days for processing, but usually quicker! The above capacitors are supplied as a BVWS member benefit. Anyone found to be reselling these items for profit will be expelled from the Society

Bulletin of the British Vintage Wireless Society
Incorporating 405 Alive
Volume 39 No.2 Summer 2014

www.bvws.org.uk

Separations and printing by Hastings Print

Honorary Members:
Ralph Barrett I Dr A.R. Constable I Jeremy Day I Ian Higginbottom I Jonathan Hill I David Read I Gerald Wells

Front and rear cover: radios from the Dave Adams room at The British Vintage Wireless and Television Museum, West Dulwich, London

Photographed by Carl Glover
Graphic design by Carl Glover and Christine Bone
Edited by Carl Glover. Sub-Edited by Ian Higginbottom
Proof-reading by Mike Barker and Steve Sidaway

Contents

From the Chair

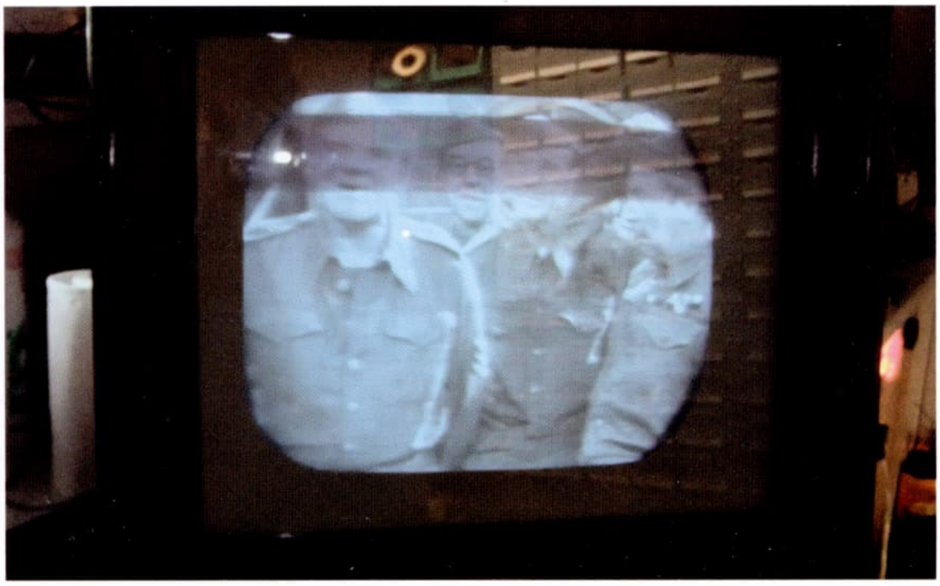
After ten years of exceptional service to the Society as Hon. Treasurer, Jeremy Day, who is also the Society Vice-Chairman has re-gained his freedom and passed the baton on. In recognition of this herculean achievement the committee has great pleasure in awarding Jeremy an Honarary Membership. We would all like to thank Jeremy for the many hundreds of hours work he has given freely, a lot of which were under difficult circumstances fitted in around a busy working life. THANK YOU.

I would like to personally welcome our new Hon. Treasurer Greg Hewitt, who already a member of the Committee, was voted in to this very important Society role at the last AGM. Greg is a very competent business man who runs his own company and is very familiar with all things financial and we are very fortunate to have him.

The Spring Golborne event was well attended with plenty of stallholders and visitors.
It was a most enjoyable event for me as I do not have to do an auction, so have time to talk to visitors and have a look around. I was surprised at the sheer amount of items we sold on the BVWS tables and just what other bargains were seen on the day. Who would have thought an AVO CT160 was being sold for £190. Of course, this did not hang around for long. There were a considerable amount of valves at very low prices as well. Of course the star attraction was the "free to a good home" fully working GEC radiogram we took along. It has found a very good home indeed and avoided the wood burner.

Recently, I was lucky enough to purchase a Murphy model V204 15" table television of 1952.
I have to say, putting a 15" tube into a table cabinet does make it rather large and awkward to handle. On getting it home, I could not resist having the back off and taking a good look at the condition. I was surprised to see that there was very little dust and grime and most of the metalwork was much brighter than usually found with practically no sign of any corrosion at all. This led me to run a few preliminary checks and then slowly wake the set up on the variac. After getting to about 160 volts, I was rewarded with sounds of frame timebase, audio sound and a weak line whistle. Signals were applied and it was found to be a channel 4 set.
A number of wax capacitors were replaced and I was eventually rewarded with a very decent picture indeed. It is now in the massive "to do" pile for a future date, but I have been told it must be displayed at Golborne in November.

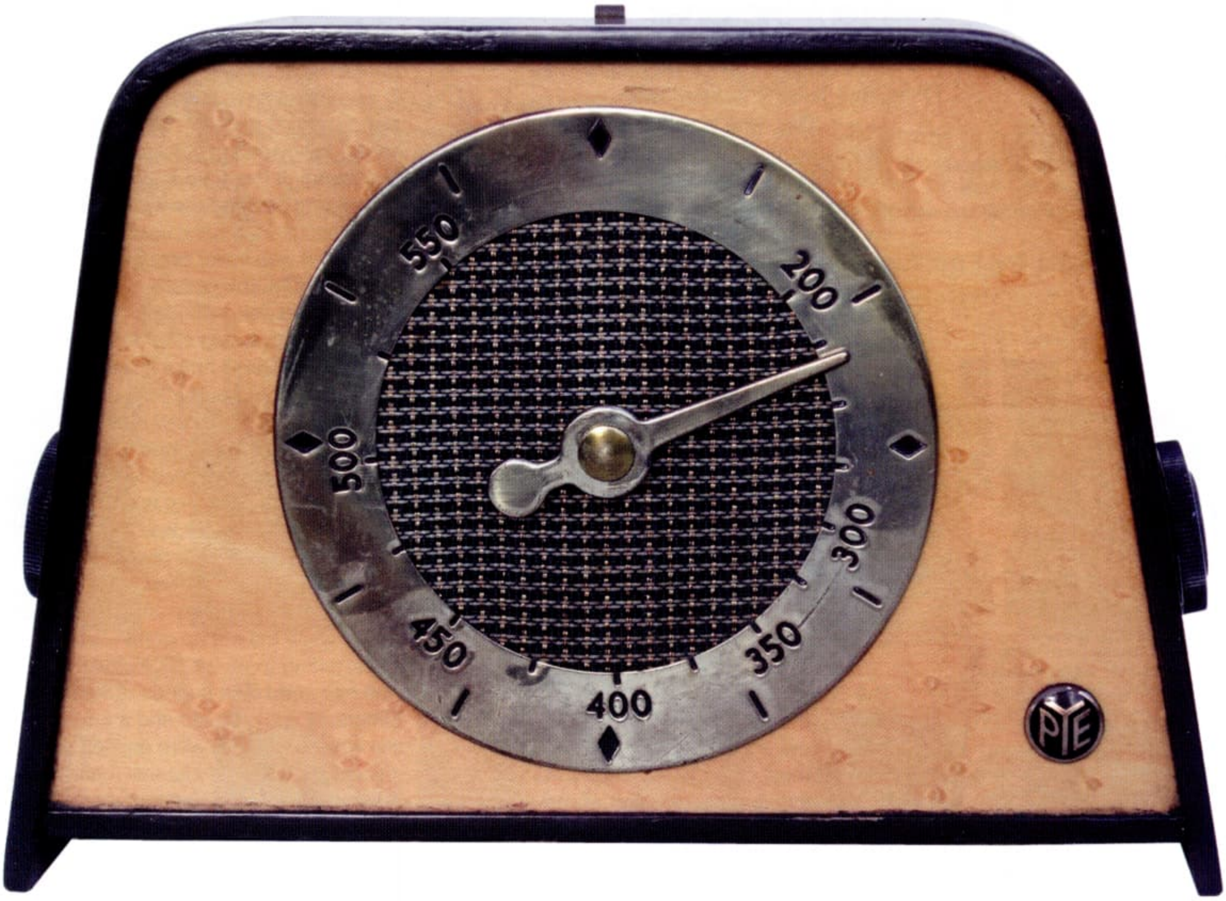
Mike...



The PYE P128 B *Slim Six* mantle radio by Roger Grant

This early transistor set is typical of the late 1950's break into the transistor set market by the big boys of the British radio manufacturing industry, this set was first introduced in 1958. My first impressions were what an ugly set trying to look like a mantle clock and seriously lacking any quality.

Removing the hardboard back, very similar to the bigger mains valve sets of the day (this set stands about six inches high), revealed the cabinet made out of plywood and hardboard with a plastic speaker cloth and brass trim, almost a miniature version of a cheap 1930's set, the only other plastic parts are the knobs.

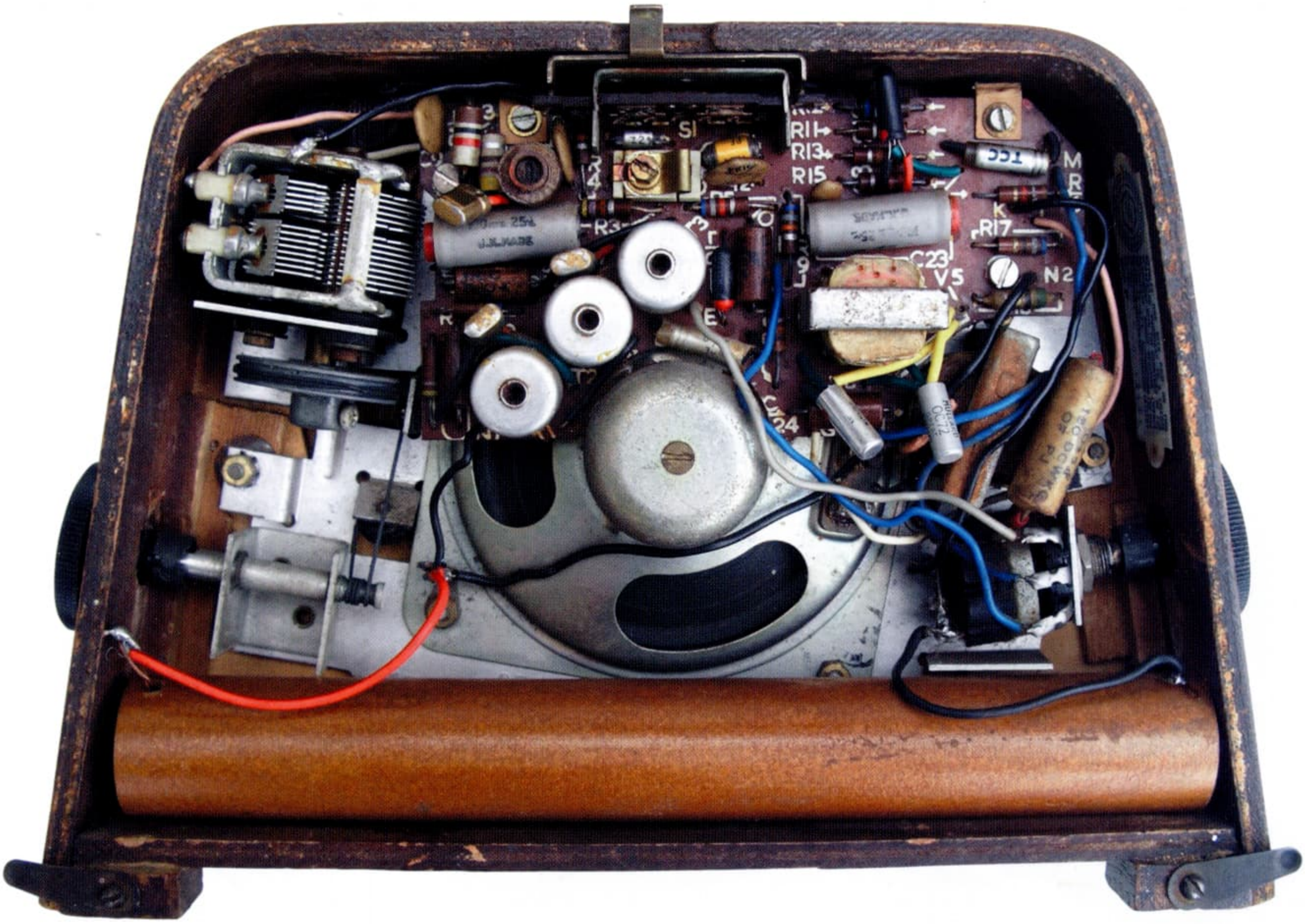


The early printed circuit contains a mixture of transistors, the RF and IF are the early "V" 6 volt series from Newmarket Transistors, V6/R2 for the IF and a V6/R4M for the RF, with the familiar oblong shape with rounded ends. "Newmarket Transistors" was a subsidiary of PYE specifically set up to produce transistors for portable radios.

The audio and output transistors are Mullard "OC" types, widely used by many other British manufacturers.
Later versions of this set are fully populated with the Newmarket "White circle" series of transistors, No 1 being the RF and No 5's for the output. These were 6 volt types and there was also a "Yellow circle" series 10 volt type.

I've also found reference to "Green Circle" (PYE Q6 61/62 Newnes) and "Violet Circle" (PYE P444 60/61 Newnes), these being the last series before Newmarket settled for the NKT prefix to their transistor numbering system in the early 1960's.

The four D cell batteries (or U11's as they were called at the time) are contained in a



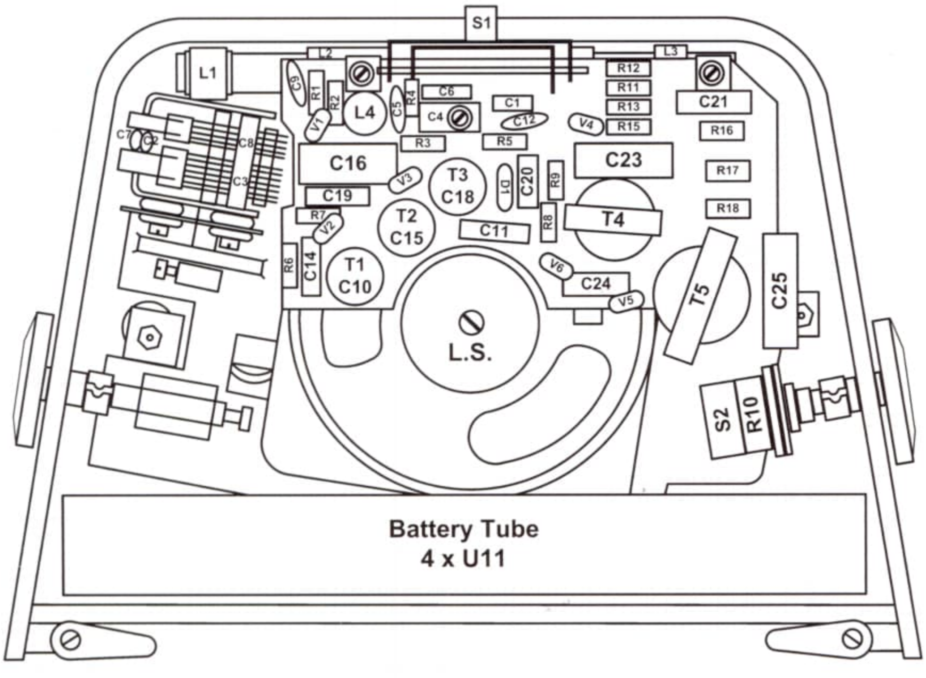
Paxolin tube, with a fixed tension spring at the negative end and a retaining split pin pushed through holes in the positive end. This Paxolin tube was not connected and floating about loose inside the set and I was surprised it was still with the set.

The connecting wires were stripped back ready for a run-up from my bench power supply, no danger on switch on with 6 volts but I set the current limit to about 100m/A to avoid any damage if there's a short circuit.

On switch on, following a "plop" from the speaker, the supply voltage dropped to about 1 volt indicating a short. Disconnecting the power supply and a run around with the AVO revealed nothing so I assumed one of the output transistors was to blame as the rest are buffered by resistors limiting the current. Both output transistors were removed and tested and appeared to be ok, I suspected one of them was breaking down on load so the output transistors were replaced but the fault persisted.

The original transistors were returned and the output stage voltages were checked for a more accurate diagnosis than the original assumption. This revealed the supply voltage polarity was reversed. I checked the wiring only to discover the battery leads were negative red and the positive black. On reversing the power supply polarity the set burst into life. I was relieved that the power reversal had not damaged the other transistors, probably saved by the current limit and the output transistors buffered by R18 5 Ohms in the output stage emitter circuit. This isn't the first time I have experienced this anomaly, I remember many years ago a similar incident of mis-colour coded battery wires on a Bush TR82.

After giving the cabinet a good clean and touching in the slightly damaged brown paint hiding the end grain of the plywood case, I replaced the too short battery leads this time with the right colours and fitted some batteries. On switch on all I got was a lot of background hiss and crackles, obviously the local oscillator was not running, exercising the wave change switch several times brought the set back to life. When the set was switched off and on again the same problem occurred, not experiencing this on the bench power supply, I measured the battery voltage only to find one of the batteries was a bit low and I only had just over five volts of supply. Replacing the battery and local



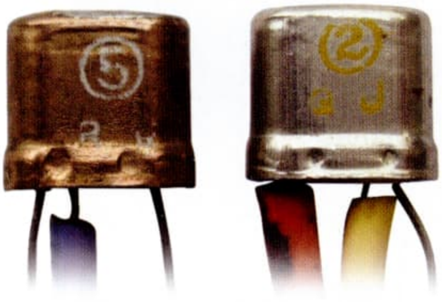
oscillator transistor solved the problem.

This was a regular problem with these early transistors as the RF frequency is just about the limit of their capability, anything less than a fresh battery and they wouldn't oscillate. Referring to the manual, I was quite surprised that this sets' IF frequency was 470kc/s and not 315kc/s normally chosen for this early series of relatively low frequency transistors.

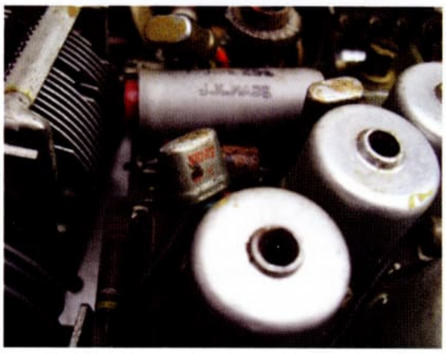
I'd had the same fault on another PYE or one of its sister companies pocket sets with a very similar printed circuit and series of transistors back in the 1960's. This was a leather cased version given to me by a friend who had found it on a bus, he had handed it in and waited the 3 months, no-one had claimed it so it was now his. Much to his disappointment, it didn't work and the estimate for its repair was more than he could afford, so it was passed on to me. It too had lots of crackles and was RF sensitive but no output. This was my first encounter with an early transistor local oscillator not running. After replacement with an equivalent RF transistor, a surplus type "white spot" as the correct one, probably a V2/R4M, was around 32/6 (£1.62p), far too expensive, the result was just the same, the new transistor also assumed to be faulty. This was replaced again with a different type of salvaged RF transistor and it was just the same, much work followed to no avail and I then suspected that the oscillator coil may have shorted turns and the set shelved until one similar would turn up.

A few weeks passed and a casual chat with the chap in our local electronics surplus shop (Precision Electronics, Windmill Hill Ruislip) revealed that he had encountered problems with these sets being very picky when it comes to local oscillators. He then gave me three more surplus type "white spot" transistors. These were hand picked and on sale or return, a risky business as these transistors are very easily damaged, but at least one of them should work. "Eureka" the first one I tried did and the set burst into life.

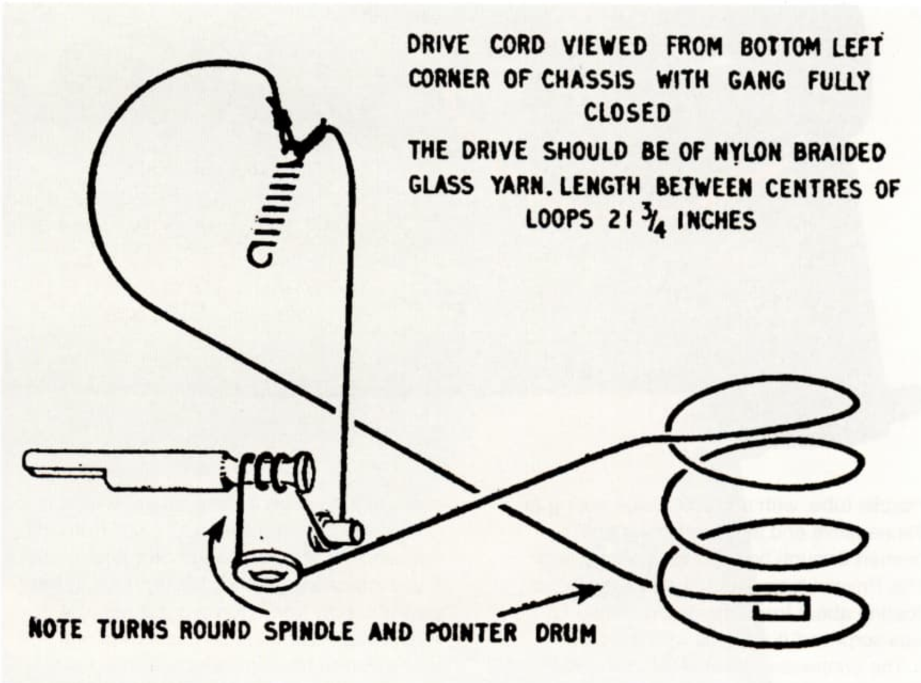
The P128's performance was much the same as any other transistor set of the time, only better than the pocket sets due to its 4" speaker. The unusual cabinet and early series of transistors makes it a very interesting example of the early transistor era, but I can't see it making an appearance in my lounge.



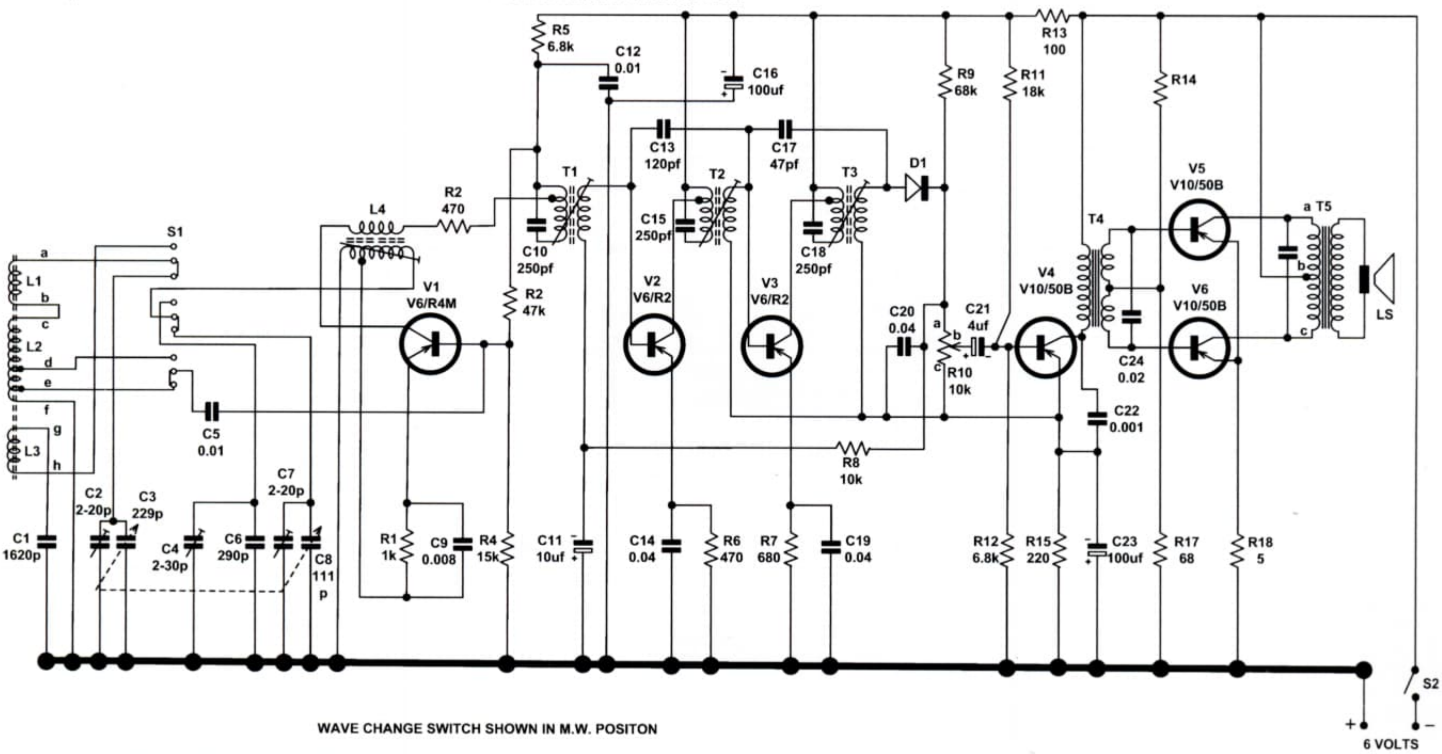
Close up of a "White circle" transistor



Close up of a "V" series transistor



How to reattach the drive cord



Pye P128 B 'Slim Six' redrawn circuit diagram

Tracking the Earth Satellite

by Stef Niiewiadomski

The article 'Tracking the Earth Satellite', published in Practical Wireless for July 1957, described how radio amateurs could prepare for the impending launch of a US satellite by building equipment to receive its radio transmissions on 108MHz. Although it was mentioned that it may be possible to receive the satellite's signal on an ordinary communications receiver and frequency converter, in conjunction with a pre-amplifier, a much more complex system was outlined, which was capable of making more valuable observations.

To leave the reader in no doubt as to the magnitude of the undertaking, the author wrote: 'Such a station would be a large undertaking and would be more suitable for a club project than for individual effort. In addition, the backing of a university or an industrial firm would be desirable as a possible source of some of the more expensive components needed for a tracking system'. If that didn't put you off, it went on: 'For a tracking installation a large, level field will be needed. The two aerials, 500 to 1,000ft apart on an east-west line, should be level to ½-inch and the aerial pattern should be free from all obstructions'. It went on to describe how the whole installation should be well clear of any sources of man-made electrical noise.

The article was a re-print from the ARRL's magazine QST and maybe the authors had assumed that prospective builders would have more space available than is typical in the UK. How many amateur groups attempted the project is unrecorded. Professional groups at Cambridge and Jodrell Bank began (or had already begun) construction of such a system, and eagerly awaited the launch of the US satellite.

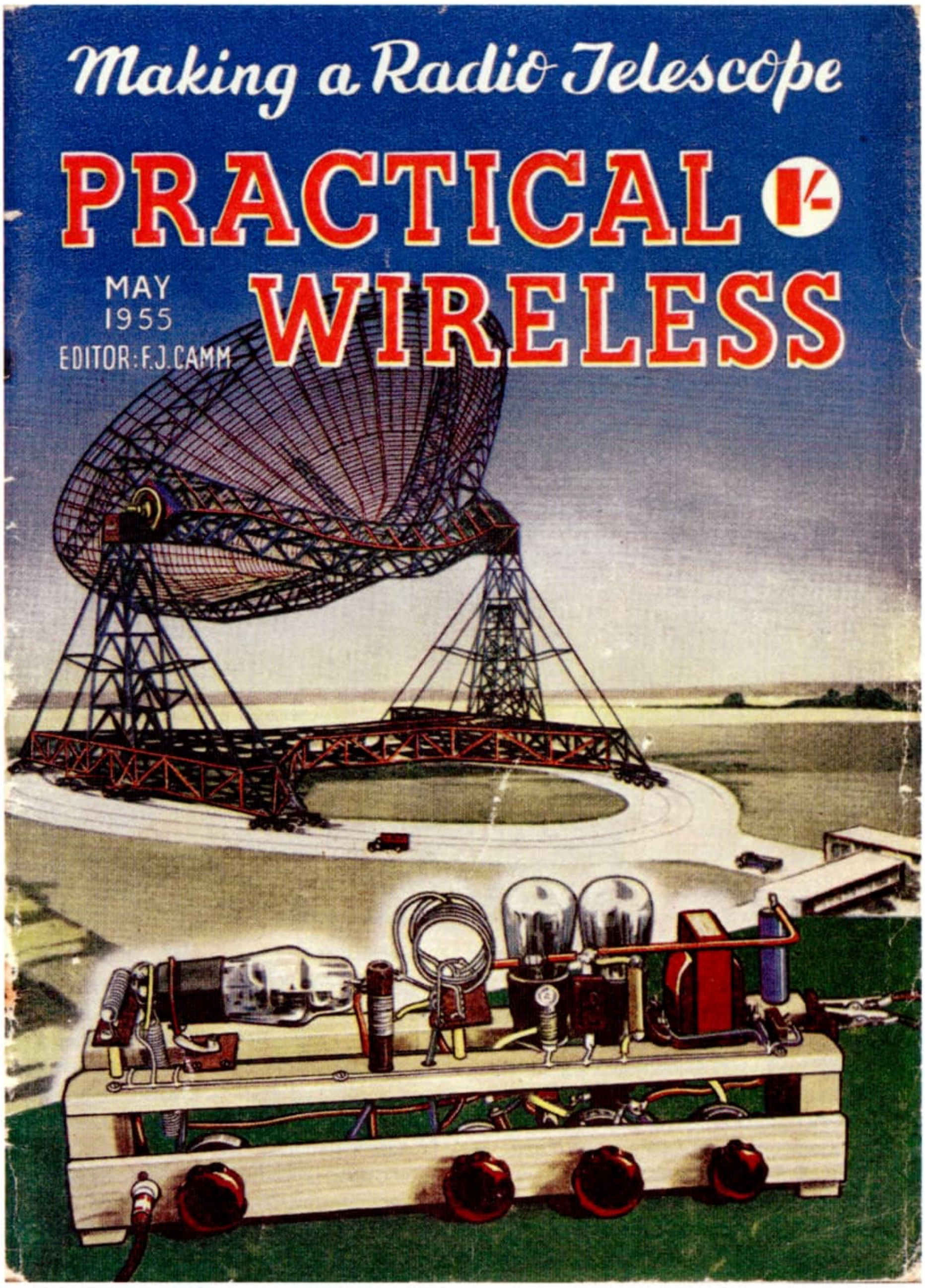


Figure 1: The front cover of the May 1955 issue of Practical Wireless featuring 'Making a Radio Telescope'.

Signals from natural sources

Practical Wireless had a general interest in receiving signals from space, from natural sources. 'Making a Radio Telescope' appeared in the May 1955 issue, see Figure 1 for the front cover. This was a fully-constructional (built on a wooden chassis), valve-based super-regenerative design, which gave extremely high gain at sufficient bandwidth, and a low enough signal-to-noise ratio to detect 'the faint signals from the Sun or the Milky Way'. And if you didn't fancy building the radio telescope, how about 'Making Transistors – how to use surplus diodes in the construction of modern transistors', published in the same issue of the magazine? It's worth taking a look at this issue, just for the impressive cover art. Heady days!

1955 was a good year for speculation on the future in space: in its November 1955 issue Practical Mechanics published its view on the subject, starting with the front cover (see Figure 2). Every shape and size of space ship that had appeared in science fiction seems to be represented, along with a space station, which looks rather like the one that eventually featured in the 1968 film '2001 A Space Odyssey'.

A proposed satellite design that featured inside the magazine is shown in Figure 3, as designed by Professor Singer of Maryland University. In 1955 it looked possible that the overall weight of the satellite could be around about 50kgs (say 100lbs) and it would be about the size of a basketball. In fact this proved to be wildly optimistic for the Americans, but wasn't that far off for what the Soviets would launch a couple of years later. The antenna looks rather small to efficiently radiate a signal at anything other than one in the GHz range. The solar power supply was based on a thermal system, rather than a photovoltaic one, that we would expect today. The working fluid (argon or mercury vapour) drove a turbine which was connected to an electrical generator.

Whether the Soviets subscribed to this magazine goes unrecorded, but they were certainly subscribing (perfectly legally) to many technical magazines in the West, and translating them into Russian for the benefit of their scientists. We in the West were very open about our plans for launching satellites and no doubt the Soviets were grateful for whatever they could glean, especially about the proposed schedule of American launches.

Figure 2: Futuristic front cover of Practical Mechanics for November 1955.

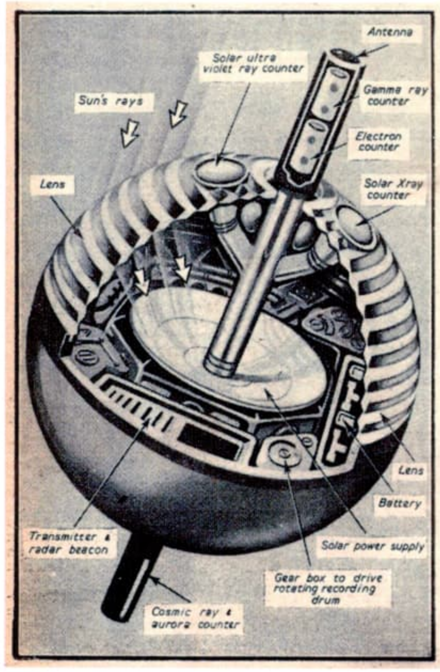


Figure 3: A proposed satellite design featured inside Practical Mechanics for November 1955.

Figure 5 (below): A representation of the 34m high R-7 rocket, surrounded by its pre-launch gantry, and Sputnik 1 as depicted on a 25th anniversary stamp/sheet. The gantry was called 'Tulip' and supported the weight of the rocket before launch. It automatically released the rocket as it started to rise, opening like the petals of a flower.

International Geophysical Year

In 1952 the International Council of Scientific Unions decided to designate the 18 months from 1 July 1957 to 31 December 1958 as the International Geophysical Year (IGY). It was meant to mark the beginning of a new era of scientific discovery at a time when many innovative technologies were appearing. From our point of view I suppose these new technologies included semiconductors and digital computers. The intention was to stimulate an international effort for the collection of new geophysical data from around the world. The idea of IGYs had its origin in Polar exploration, but the IGY planned for 1957/58 was intended to be more 'worldwide' than just concerning the poles, which had been well explored by then.

One reason for the choice of dates for IGY was that scientists knew that the cycles of solar activity would then be at a high point, and so interesting radio propagation phenomena could be explored. As it turned out, solar cycle 19 (lasting officially from April 1954 until October 1964 and peaking in about February/March 1958, when intense red aurora displays were visible around the world) produced the highest number of sunspots (both peak and averaged counts) 'since records began' in 1755, and since.

As one of the scientific goals of the year, the council adopted a resolution in October 1954 calling for artificial satellites to be launched during the IGY to map the Earth's surface. In July 1955, the White House announced plans to launch an Earth-orbiting satellite during IGY and solicited proposals from various Government research agencies to undertake development. One interesting political issue which was under debate was whether countries had the right to orbit satellites above other countries: they did not have an automatic right to fly planes over other countries. The US wanted to debate this issue from a position of strength, that is, with a satellite already in orbit.

In September 1955, the Naval Research Laboratory's 'Project Vanguard' proposal was chosen to represent the US in this endeavour, and was mandated to develop a rocket with no military overtones. It seems strange to us now that the Navy was chosen to drive this project, and indeed it was. The Air Force wasn't very interested in missiles: its nuclear bomb carrying capability was based firmly on manned bombers, more and more squadrons of which were being added every year. The Army had the famous Wernher von Braun who was straining at the bit to be allowed to develop his rockets and use them for space exploration. However the Army's missiles were regarded as an extension of the artillery, and were deliberately limited to a range of 200 miles. Despite the mess that the American missile programs were in, they didn't seem to even consider the possibility that the Soviets would have the technology to beat them into space. As we will see, events didn't quite turn out as expected.

Sputnik launches

Much to the surprise of everyone in the world, Sputnik (Russian for 'fellow traveller') was launched into low earth orbit, with an orbit time of 96 minutes, on 4 October 1957. In fact the Soviets had announced in the Russian journal Radio for June 1957 (which was available in the West) that they intended to launch a satellite by the autumn of 1957, and a series of satellites during the IGY. This seems to have passed relatively unnoticed, and would probably have been regarded as propaganda had it been noted more generally. The date had been brought forward by two days because the Soviets had got wind of a rumour that the Americans were going to launch on the 4th.

The launch rocket was a Sputnik-PS, a modified version of the R-7 ICBM launcher. After two failures of the R-7 rocket in May and July 1957, the rocket was successfully launched in sub-orbital 'ICBM test mode' in August and September. This gave the scientists (and politicians, who were, of course, very much involved in the decision) the confidence to go to 'Sputnik mode' and make the 4 October launch. In some ways the satellite launch was an easier task than an ICBM launch: the satellite was much lighter, and didn't need a heat shield for re-entry (hopefully it wasn't going to re-enter the atmosphere), the design of which was proving very difficult.

In fact what made the R-7 good for launching satellites – the energy in its liquid fuel, and its size and hence its ability to lift heavy weights into orbit – actually made it a very poor weapon. It took hours to be moved to its launch site, took days to fuel and prepare and couldn't be hidden in any way. American U2 spy-planes were over-flying the Soviet launch sites, and would have detected any mass mobilisation of such a weapon system days in advance. As with many weapons, its effectiveness lay in the fact that it simply existed, and the fear that instilled in potential enemies.

Figure 4 shows the Practical Mechanics impression of the launch rocket, which was a closely guarded secret and was pure guesswork, and Sputnik, which was close to reality, as the Soviets had released pictures of what the satellite looked like. Obviously F J Camm didn't let the absence of any information get in the way of a good cover! Figure 5 shows a much better representation of the R-7 rocket on its launch stand, and Sputnik 1 as depicted on a 25th anniversary stamp/sheet. By this time, the R-7 was obsolete technology and showing its 'real' shape was not sensitive any more.

Newspapers of the day around the world reported the event of course, and Practical Wireless and Wireless World reported the launch in their next issues, dated December 1957. The December 1957 issue of Practical Wireless was published on 7 November, and so the news was a month or so out of date by then, and in fact the satellite's transmissions had already stopped, as its silver-zinc batteries became exhausted by 25 October 1957. Relying on the magazine wasn't therefore a very good way of getting up-to-date news on the satellite.

Figure 4: Practical Mechanics impression of the Soviet launch rocket (the appearance of which was a closely guarded secret) and was based on pure guesswork; and Sputnik, which was close to reality, as the Soviets had released pictures of what the satellite looked like.

Reception in the UK

In his Practical Wireless editorial entitled 'The Space Age Arrives' F J Camm graciously congratulated the Russians (although he did get the launch date slightly wrong) and wrote in a rather formal style: 'The bleep-bleep which has been received from the ingenious radio transmitter, itself a remarkable piece of mechanism, has given the whole world aural evidence that the satellite is functioning as it was designed to do. We have been able to witness its passage through the empyrean' [defined as: the highest part of heaven, thought by the ancients to be the realm of pure fire]. He also bemoaned the fact that in the UK insufficient funds had been allocated to space research, and that 'had that money been forthcoming no doubt we should have been the first to have projected an artificial satellite into the heavens'. The editor of Wireless World similarly praised the Soviet achievement.

The UK's candidate for launches into space was Black Knight, which was tested at the Needles on the Isle of Wight (see Reference 1) before being shipped to the launch site at Woomera in Australia. The programme was finally cancelled in 1965. Sadly F J Camm did not live long enough to witness the launch of the UK's first satellite, courtesy of NASA, in 1962.

Following up on the event, in the January and February 1958 issues of Practical Wireless parts 1 and 2 of 'Observing the Satellites' by O J Russell, G3BHJ were published. This was a very practical description of how to pick up the signals from Russian satellites (two had been launched by the time the magazines were published, and more were expected), and estimate their height and velocity. The author commented on how much easier it was to make observations on the Soviet satellites at 20MHz, than it would have been for an American satellite at 108MHz. He even speculated that the Americans might modify their satellite to include a 20MHz transmitter. Easier said than done, of course, and this did not happen.

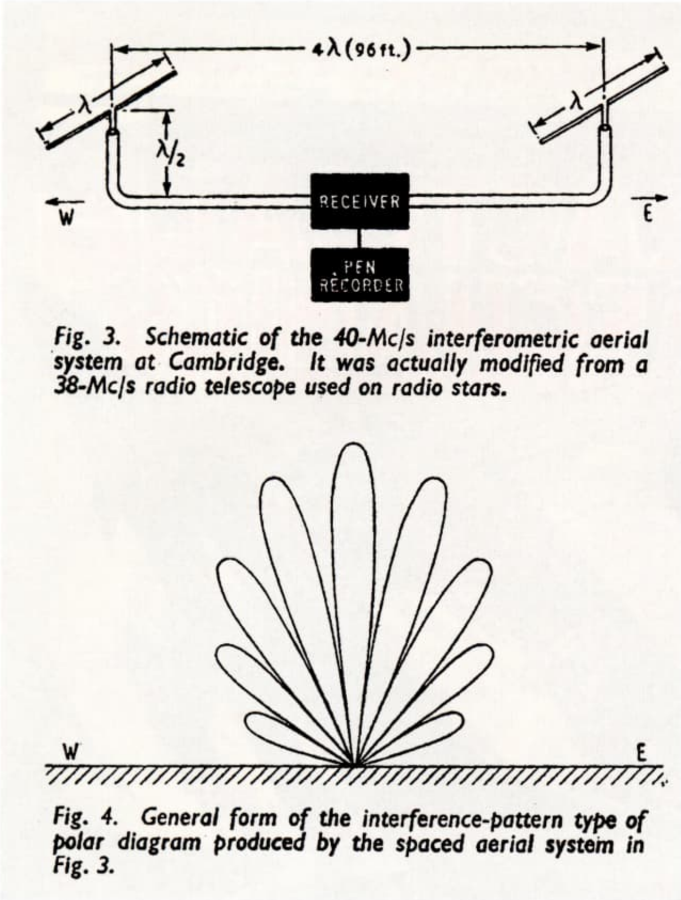


Figure 6: The interferometric aerial system at Cambridge used to make measurements on the 40MHz signal from Sputnik 1, as reported in Wireless World for December 1957.

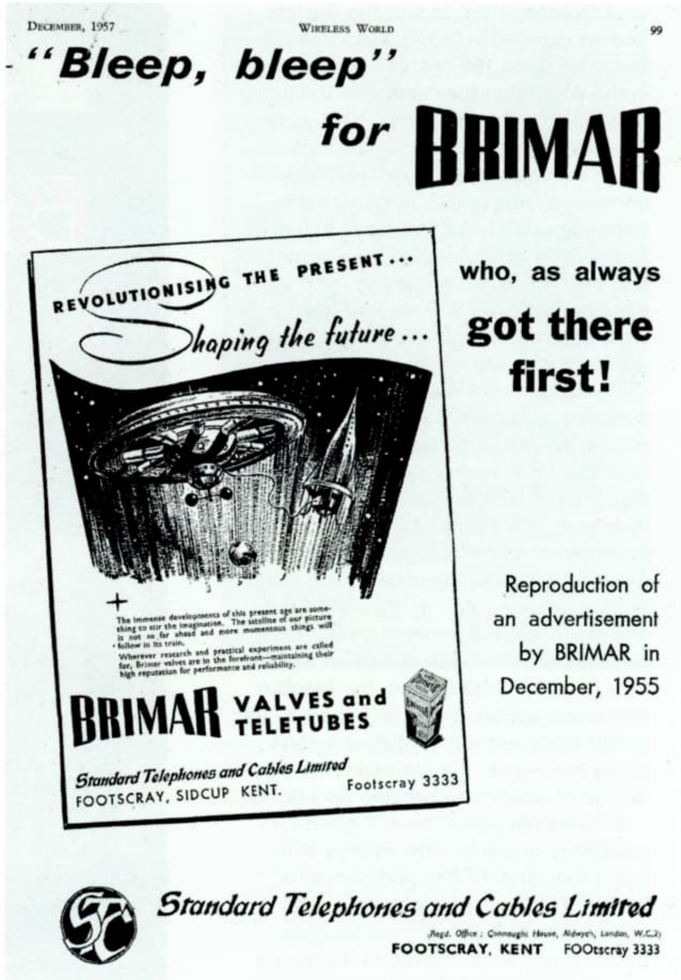


Figure 7: Brimar's advert in Wireless World for December 1957.

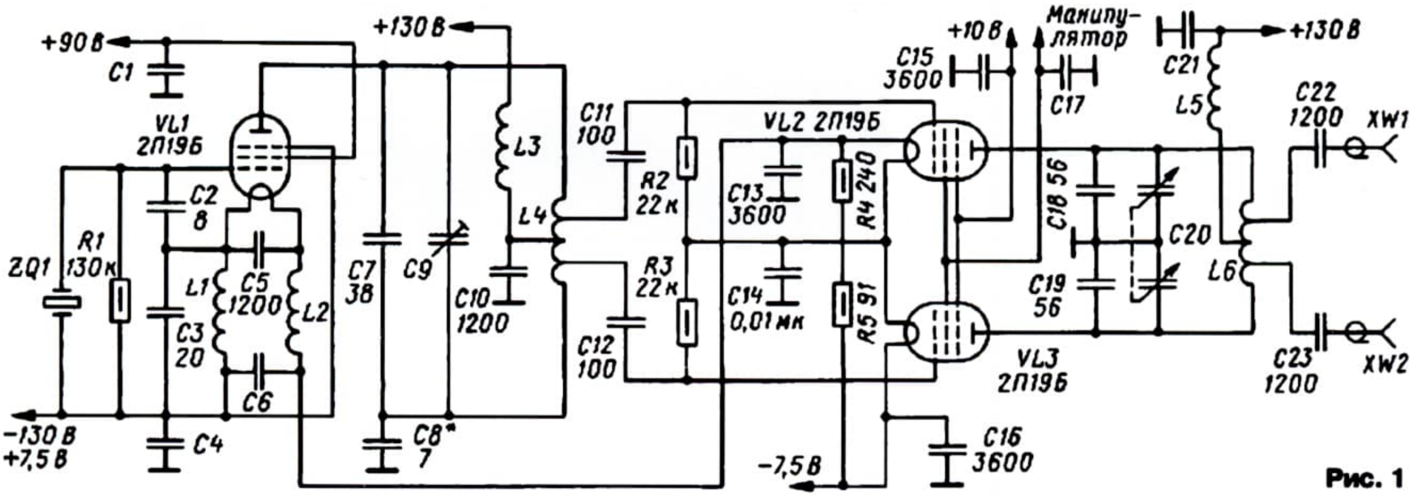


Figure 8: Schematic of what is claimed to be the original Sputnik 1 D200 transmitter design.

Sputnik 1

Sputnik 1 was a 58cms diameter polished metal sphere, with four external radio antennas, forming two dipoles. Two of the antennas were 2.4m, and two were 3.9m, long. A spring mechanism deployed the antennas to an angle of 35 degrees from the main axis of the container, immediately after the spacecraft had separated from the rocket. The shape of the satellite, with its 'swept back' antennas became iconic and featured on hundreds of stamp designs, and spawned a style of interior design that was a fusion with the symbols of the atomic age. Even today the image of Sputnik is evocative of space exploration.

The satellite transmitted signals on 20.005MHz and 40.002MHz at a power of 1W. QRP operators will know the effectiveness of a 1W signal at 20MHz to communicate around the world. From a satellite's point of view the main barrier is getting the signal back through the ionosphere in the first place, which would of course depend on the angle of incidence and the time of day. The signal may then 'bounce' between the Earth and the layers in the ionosphere.

The antennas were switched between the two frequencies at something like 0.3Hz, which gave the signal the characteristic 'bleep-bleep' (or 'beep-beep' in some people's opinion) sound. The satellite was also spinning at 750 revolutions per minute and this may have contributed to the demodulated sound of its transmissions. You can listen to the 'sound' of Sputnik 1, and make up your own mind, at Reference 2.

Not only could Sputnik be 'heard' on any communications receiver, it could also be seen at night travelling across the sky: not only had the satellite been polished so that it was highly reflective, but the rocket booster that had placed it into orbit, and which followed behind, had been equipped with reflective panels which helped announce to anyone who looked at the right place at the right time 'here we are'.

20.005MHz was cleverly chosen to be

close to the WWV 20MHz standard frequency transmissions made by the National Institute of Standards and Technology (NIST) from Fort Collins, Colorado. Radio amateurs with relatively standard receivers, which needed to include a BFO to resolve the satellite's signal, could warm their receivers up, tune accurately to the WWV 20MHz signal and then re-tune slightly higher in frequency to listen to Sputnik's signal, having remembered to turn on their BFO. Some sources state that the WWV transmitter was turned off while the Sputnik was over the US: if this is true, was it done to make it more difficult to locate the satellite's transmitter, or to make it easier to listen to it without interference?

Practical Wireless published a letter in December 1957 from a listener who had indeed confused the satellite's signal with WWV, and had succeeded in recording the WWV broadcast. Letters in subsequent months gave some rather condescending advice on how to avoid this mistake.

Jodrell Bank

The big telescope at Jodrell Bank was unsuitable for 'listening' to the 20MHz and 40MHz transmissions, but was capable of operating in radar mode, and in fact it had been held in readiness to track Soviet ICBMs, that is, the very R-7 rocket which was used for the satellite launches. The radar tracking of the Sputnik rocket bodies (and later the large body that was Sputnik 3 itself) demonstrated that the telescope had the capability to detect missiles at great range and the telescope was given an interim ballistic missile early warning role (the purpose-built facility for this role at Fylingdales in Yorkshire, became operational in 1963). When it came to tracking later probes, which were targeted towards the moon, Jodrell Bank proved to be very valuable in verifying that these probes existed all at, as they were not advertising their presence while in orbit around the Earth. Presumably this satellite tracking / detection effort provided some much needed funding for the telescope.

Measurements on the 40MHz signal were made on a radio telescope at Cambridge (now called the Mullard Radio Astronomy Observatory), originally designed to 'listen' to radio stars on 38MHz. The dimensions of the receiving antennas and their spacing were quickly modified to the new frequency, see Figure 6. The Royal Aircraft Establishment (at Farnborough) and the Royal Radar Establishment (in Malvern) were also involved in monitoring the satellite and making measurements on its orbit.

The valve manufacturer Brimar even jumped on the band-wagon with its advert in Wireless World for December 1957, see Figure 7. They claimed to have predicted the space age – of course almost everyone had believed it would happen sooner or later – and to be actually shaping the way, perhaps more than a slight exaggeration, but all good fun. For no good reason, Osmor even named their new FM tuner the 'Osmor Satellite FM Receiver'.

The satellite continued in orbit until 4 January 1958 when it re-entered the atmosphere and burnt up.

Sputnik 1's transmitter design

Sputnik 1's transmitter module was designated 'D200'. It is only relatively recently that any information on the transmitter design has become publicly available. The nature of secrets is that even very old secrets, the content of which seems to us to be trivial, are regarded as secrets for a lot longer than we would consider necessary. The exact original design may never be known, but many radio amateurs have speculated on what the transmitter design looked like and what valves were used. Figure 8 shows the schematic of what is now claimed to be the original design, taken from Reference 3. There was speculation at the time that transistors had been used, but this seems unlikely in view of the state of transistor design at the time and the fact that rugged valves, proven in stressful military applications, were available. The drawback of using valves is of course that you have to supply filament current which has an impact on battery life.

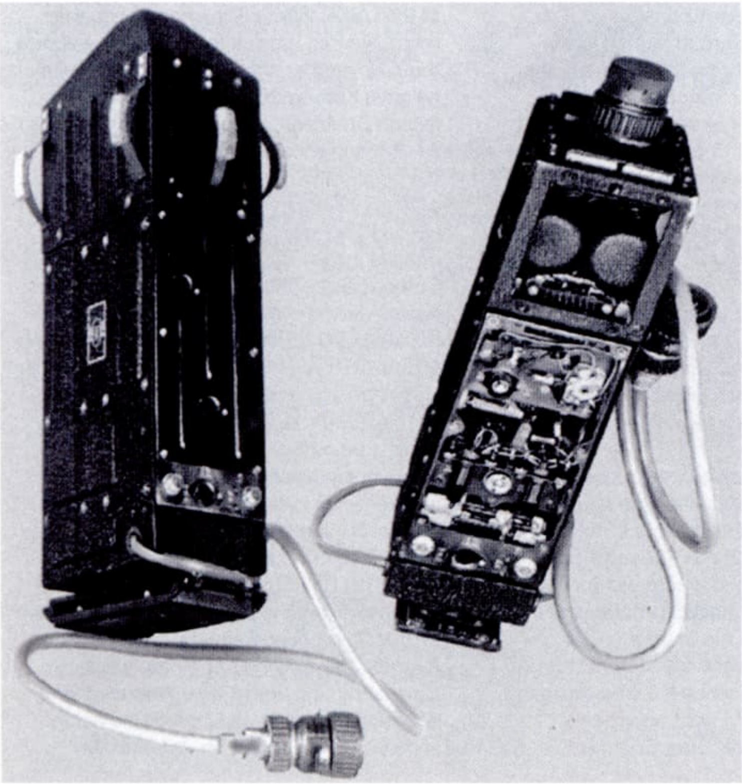
All the candidate designs I've seen show a CW transmitter which is just about the simplest design you could conceive of. Adding any form of modulation (other than adjusting the mark/space ratio of its on/off periods) would have wasted battery power, and by adding the necessary extra components would have made the design more unreliable. Figure 9 is a picture of the Sputnik 1 electronic package, including the two transmitters. The cable connected the package with the battery.

The D200 was designed to produce alternating bursts of each frequency, of nominally 0.3 second duration. The exact repetition rate of the bursts was controlled by the temperature and pressure inside the satellite and so this represented a simple telemetry channel back to receiving stations on Earth.

UK amateurs receive Sputnik 1

Many amateurs already had receivers, equipped with BFOs, capable of receiving the 20MHz signal, and presumably aerials designed for the 15m (21.0 - 21.45MHz) amateur band were close enough to 20MHz to be used. The 40MHz signal would have been more problematic. Wireless World published a useful converter design in its December 1957 issue. This design (see Figure 10) used a 6K8 crystal-controlled mixer stage to convert either the 20MHz or 40MHz

Figure 9 (below): The Sputnik 1 transmitter. Figure 10 (below, right): The 6K8 crystal-controlled mixer stage from the December 1957 issue of Wireless World.



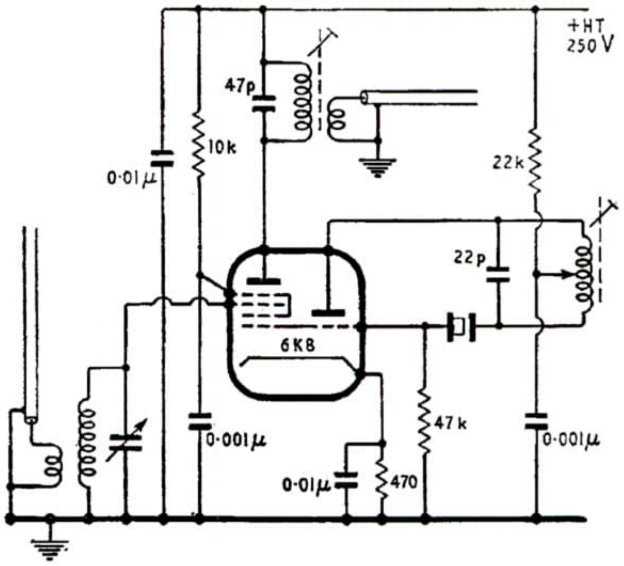


Fig. 1. A simple crystal-controlled mixer stage may be used as a frequency converter. A Squier type of overtone oscillator using the third harmonic will function with ordinary production crystals. For a 4-Mc/s i.f. a crystal with a 5.333-Mc/s fundamental will serve for 20-Mc/s reception, and a 12-Mc/s crystal will serve for 40 Mc/s. For optimum results an r.f. stage should be used in front of the mixer stage.

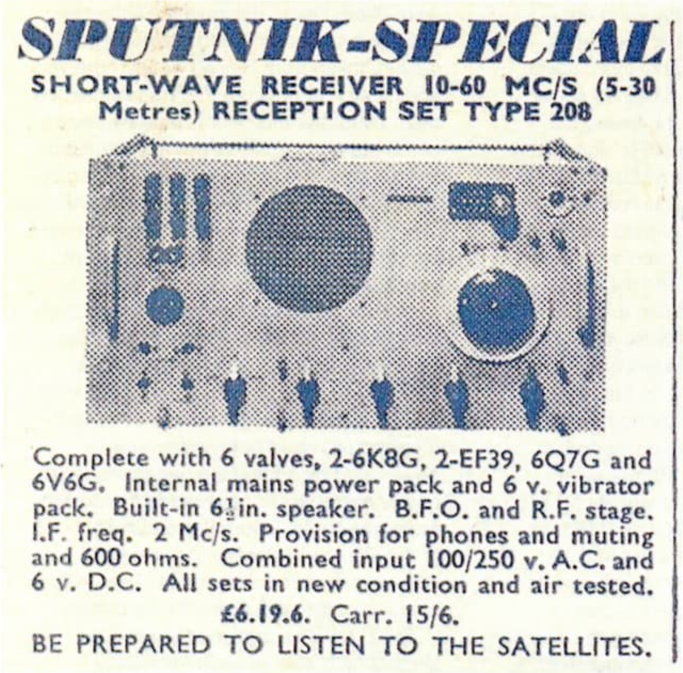


Fig 11: Henry's Radio advert of a 'Sputnik-Special', ex-Army 'reception set' R208

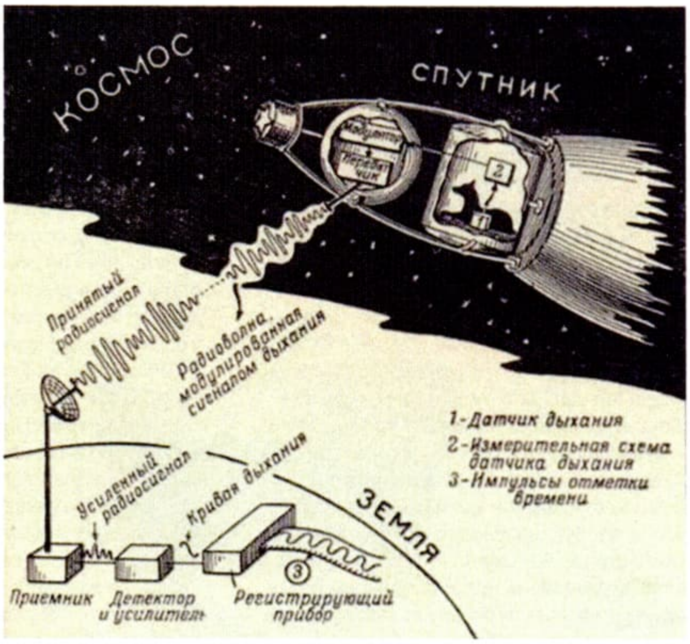


Figure 12: An artist's impression of Sputnik 2, and the way Laika's heartbeat, for the short time she was alive, was relayed back to earth.

transmissions down to 4MHz for detection on 'any conventional communications receiver' on a lower frequency band. The author also notes that reception of the anticipated US satellites on 108MHz would require 'specialised aerial systems and very low noise-factor 108Mc/s receivers'.

From about February 1958, Henry's Radio advertised a 'Sputnik-Special' (see Figure 11) in Practical Wireless and other magazines. This was the self-contained ex-Army 'reception set' R208. If you bought one immediately, you were too late for Sputniks 1 and 2, but the Soviets conveniently built transmitters operating at around 20MHz into several more satellites (see Table 1, from Reference 4), though it seems that 40MHz wasn't used again. So investing in an R208, or building a converter for your existing receiver, was not wasted effort.

Original Soviet satellite design

Having described the Sputnik 1 launch, it's interesting to go back in time a little and explore how the design of the satellite came about. Initially an ambitious specification was drawn up for the Soviet's proposed first satellite, code named 'Object D' (Objects A to C were other payloads that the R-7 rocket could carry, including nuclear warheads of course). By July 1956 the draft was completed and the scientific tasks to be carried out by the satellite were defined and allocated to sub-contractors in the USSR. These included measuring the density of the atmosphere; its ion composition; corpuscular solar radiation; magnetic fields; cosmic rays; etc. Data valuable for designing future satellites was also to be collected. A world-wide ground observation complex of up to 15 stations was to be developed, that would collect information transmitted by the satellite, observe the satellite's orbit, and transmit commands to the satellite.

Unfortunately, the complexity of this design and problems in following the specifications exactly meant that some parts of 'Object D', when delivered for assembly, simply did not fit with the others, causing delays. By the end of 1956 it became clear that the launch plans for 'Object D' would not be fulfilled in time because of the difficulties in designing the scientific instruments and the fact that the R-7 rocket was not producing the required thrust for as long as needed to lift the anticipated weight of the satellite into orbit. Consequently the government re-scheduled the launch of 'Object D' to April 1958, and in fact it would fly successfully as Sputnik 3, launched on 15 May 1958, having failed to reach orbit with a launch on 27 April 1958. The Sputnik name and serial number was only given to spacecraft that actually made it into space.

Shortcut to the simplest satellite

The Soviet government considered it to be politically important to launch in the IGY 'window', and to beat the Americans, who had made their intentions very obvious, into orbit if at all possible. It was therefore proposed to precede Object D with a 'simplest satellite' or 'prosteishy sputnik', also known by the Russian abbreviation 'PS'. With the launch mass of 'only' 80-100kgm, and with only the most essential equipment on board, it was believed that it could be launched in April or May 1957. The weight of the final design was 83.6kgm: when the American rocket scientists discovered the weight of Sputnik 1 (as released by the Soviets and reported via the press), they thought a decimal point had been misplaced. The first American satellite (see later) weighed only about one tenth of this.

The simplicity of the proposed PS design meant that the whole design could be done 'in house' and so problems with what we would call the integration of modules from different sub-contractors could be avoided. Hence PS was designed by a very small team, and was the design that would become Sputnik 1.

Sputnik 2

The Soviet Chief Designer of the missile program, including the satellites of course, was Sergei Korolev. Even his name was considered to be a state secret and at the time he did not receive the accolades he was entitled to throughout the world. The Nobel Prize committee approached the Soviets, wanting to award a prize to whoever had been responsible for launching the satellites, but the offer had to be declined as they couldn't even reveal the existence of such a person. Unlike the American space program, the Soviets had already sent home the German rocket scientists they had captured at the end of the war, and their rockets were by now purely 'Soviet' in design with very little V2 heritage left in them.

After the launch of Sputnik 1, the leader of the USSR (Nikita Khrushchev, you may recall) wanted a quick follow-up to celebrate the 7 November anniversary of the revolution: he gave Korolev 26 days to design and launch Sputnik 2, and the craft had to have a living being inside it! Not wishing to risk the possibility of a launch failure on the date of the anniversary itself, Korolev achieved his goal four days early. Dogs had already been launched in sub-orbital flights by the Soviet military (the Americans had also experimented with mice and monkeys on rockets), and so Korolev wasn't starting from scratch, but nevertheless it was a demanding challenge and a remarkable achievement.

The Soviets launched Sputnik 2 into low earth orbit on 3 November 1957. Sputnik 2 was much heavier than Sputnik 1 and very different in design, but it was still not 'Object D'. It was the first to carry a living animal into orbit, a dog named Laika, see Figure 12. The capsule was cone-shaped, four metres high with a base diameter of two metres. It contained several compartments for radio transmitters; a telemetry system; a programming unit; a regeneration and temperature control system for the cabin; and scientific instruments. A separate

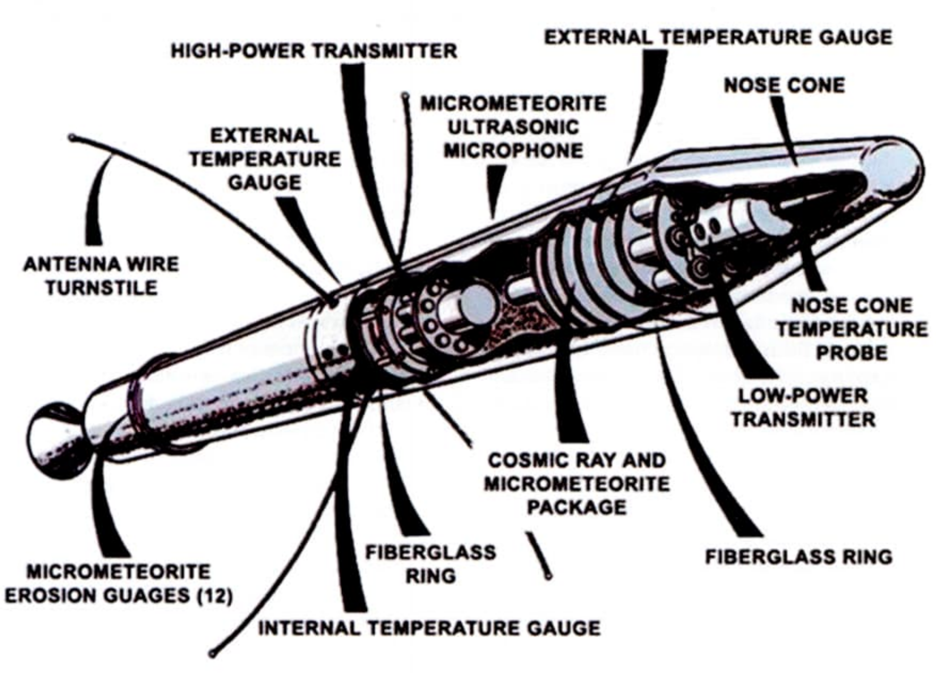


Figure 13: A diagram of Explorer 1. The satellite itself is attached to the fourth stage of the rocket.

pressurised cabin contained Laika.

After reaching orbit the nose cone was jettisoned successfully but the core of the final stage rocket did not separate as planned. This inhibited the operation of the thermal control system, and some of the thermal insulation tore loose causing interior temperatures to rise to an excessive level. It is believed that poor Laika survived for only a few hours instead of the planned ten days because of heat and stress, and she gave her life for the greater good of humanity. Some reports say she was a stray picked up on the streets of Moscow, who no doubt enjoyed a brief improvement to her life before her final mission.

The orbit of Sputnik 2 decayed and it re-entered Earth's atmosphere, along with Laika's body, on 14 April 1958, after 162 days in orbit. More details on Sputnik 2, and what is claimed to be a recording of Laika's heartbeat, can be found at Reference 5.

US Launch Failures

To go back in time a little, in 1957 things were not going according to plan for the US space program. The Vanguard Program (sponsored by the Navy, and using the Vanguard rocket) was based on the strictly non-military Viking and Aerobee research rockets. This route to space had been chosen over the Army Jupiter-C rocket because the latter was clearly based on the military Redstone rocket, which was thought to carry more of a Cold War threat to the Soviets. In fact the Jupiter-C rocket had been rather successful and had reached a height of more than 600 miles in tests on re-entry heat-shields. Of course this did not count in the 'space race' as whatever it was carrying had not achieved orbit. To the great frustration of the scientists on the project, it was not allowed to carry a fuelled fourth stage (they had been forced to ballast the fourth stage with sand rather than fuel, to ensure that it did not 'accidentally' go into orbit), which had it been allowed would probably have beaten the Soviets to orbit in September 1957.

After a mixture of successes and failures in launching rockets with and without payloads on sub-orbital trajectories, on 6 December 1957 America's first attempt to launch a satellite into orbit resulted in the Navy's Vanguard rocket rising a few feet from the pad and then falling back in a massive fireball. To the humiliation of all involved, this was shown live on TV! Newspapers called it 'Flopnik' and 'Kaputnik'. The satellite was thrown clear, but not surprisingly was damaged such that it couldn't be used in the next attempt. This satellite is now on display in the National Air and Space Museum of the Smithsonian Institution.

The whole of America felt humiliated – partly fuelled by the vitriol of politicians who opposed President Eisenhower, feeling that he had allowed the country to fall behind in the arms race, the education race, and any other race they could think up. Time magazine wrote 'In 1957, under the orbits of a horned sphere and a half-ton tomb for a dead dog, the world's balance of power lurched and swung towards the free world's enemies. Unquestionably, in the deadly give and take of the cold war, the high score of the year belongs to Russia.'

It was well known that the Soviets had used a military launch vehicle, the R-7, and that their satellite was passing freely over the US and many other countries. Now all constraints against using the Army's Jupiter-C rocket vanished, and it became imperative for the Americans to launch a satellite in the IGY, which was now looking distinctly risky, by whatever means available.

Explorer 1

Success finally came for the US when Explorer 1 was launched on 31 January

An unknown reader was kind enough to send me the circuit diagrams for the transmitters found in the Vanguard and Explorer satellites. Figure 1 shows the simple circuitry associated with the Vanguard six inch satellite. Actually, it contains two transmitters, one operating from solar cells (without energy storage devices), and the other operating from batteries which have long since expired. The crystal for one transmitter is located in the interior compartment, while the other crystal is thermally connected to the "skin". Thus the difference frequency between the two transmitters indicates the temperature of the satellite. At this writing, the 10 milliwatt solar power transmitter is still emitting *rf* and should continue to do so for several hundred years.

Although the Western Electric transistors used in these circuits are not available to Amateurs, standard 2N types can be used for ham applications. The Philco T-1324 ($1.65) or RCA 2N384 ($6.00) can be used in Figure 1, along with an International Crystals fifth overtone rock, up to about 75 *mc*. The practical limit for crystals is about 125 *mc* and the Philco 2N588 ($6.00) or 2N500 ($10.90) will work fine at this frequency.

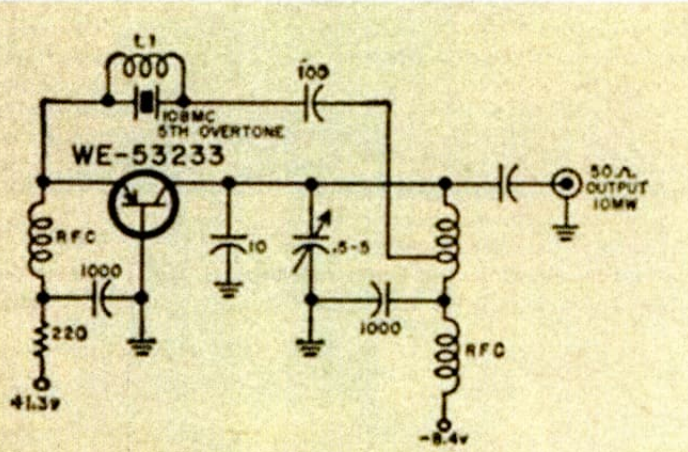


Fig. 1—Vanguard Satellite transmitter. The output is 10 milliwatts rf.

70 • CQ • May, 1959

Figure 14: Explorer 1's single transistor transmitter design, as published in CQ magazine for May 1959.

1958 at 22:48 Eastern Time (equal to 1 February, 03:48 UTC) on top of a Juno-I rocket, from Cape Canaveral in Florida. The Juno-I (note the name change, to slightly obfuscate its military ancestry) was a four-stage design derived from the Jupiter-C, which was itself the Army's liquid-fuelled Redstone ballistic missile, with extra solid-fuelled stages on top. After the successful launch of Explorer 1, the Juno-I had mixed fortunes: in 1958 it failed to put Explorers 2 and 5, and an inflatable Beacon satellite, into orbit, but successfully launched Explorers 3 and 4.

Explorer 1 was designed and built by the California Institute of Technology's Jet Propulsion Laboratory (JPL). It was the second satellite to carry a mission payload (Sputnik 2 was the first, as Sputnik 1 doesn't count as carrying a payload). A diagram of Explorer 1 can be seen in Figure 13. The satellite itself is attached to the fourth stage of the rocket. A mixture of electronics technology was used in Explorer's circuits, including germanium and early silicon transistors.

The satellite (including its attached fourth stage) was about 2m long and 15cms (actually 6-inch in non-metric America) in diameter, with a total weight of 13.4kgm, of which 8.3kgm was instrumentation. This was considerably lighter than Sputniks 1 and 2. The instrument section at the front end of the satellite and the empty scaled-down fourth-stage rocket casing orbited as a single unit, spinning around its long axis at 750 revolutions per minute.

The 6-inch diameter of the satellite was based on what was needed to carry instruments that had originally been developed to fly in high-altitude balloons. A proposal to reduce the size down to 3½-inches, to make the satellite even lighter and therefore to give more chance of success, was met with howls of protest from the scientists who designed these instruments, and was quickly withdrawn.

The Explorer transmitter

In the open society of the US, the design of the Explorer 1 108MHz transmitter surfaced much earlier than that of Sputnik. In the amateur press, CQ magazine published the design (see Figure 14) in May 1959, though it sounds like whoever had leaked the design wished to remain anonymous. As you can see, a single transistor was used for each transmitter; hence the rather low output power. If you read the text that goes with the diagram, it explains that one used a Western Electric WE-53233 transistor and was powered by batteries. The other used a WE-45011 device, and was powered by solar cells. The placement of the two transmitters' crystals gave a simple method of monitoring the satellite's internal temperature from the ground.

The hope was that the solar cell powered transmitter would continue to broadcast for much longer than the battery-powered one, which was indeed the case. It didn't quite make the 'several hundred years' hoped for, as Explorer 1 re-entered the atmosphere in 1970. Whether the solar cells were still generating power then is unknown.

Data from the scientific instruments was transmitted to the ground by two antennas. A 60mW transmitter fed a dipole antenna consisting of two fiberglass slot antennas in the body of the satellite operating on the much anticipated frequency of 108.03MHz, and four flexible whips forming a turnstile antenna (sometimes called crossed dipoles) were fed by a 10mW transmitter operating on 108.00MHz.

Explorer 1 was the first spacecraft to detect the Van Allen radiation belt, the existence of which had been speculated before the launch. Its highly eccentric orbit had taken it higher than Sputniks 1 and 2, and it was equipped with the appropriate detectors. The craft remained in orbit until 1970, when it suffered the fate of all satellites close to the Earth. More information on Explorer 1 can be found at Reference 6.

Launches in 1958

1957 had been a very difficult year for the US space program, having lost the 'race' to launch a satellite into orbit around the Earth. In 1958 the US attempted to impact, or to loop around, the moon. After the successful launch of Explorer 1 in January, the flood gates opened and a total of 23 various objects were launched by the US in the year. These included seven spacecraft whose target was the moon, all of which ended in failure. No-one knew what the far side of the moon looked like, since it keeps the same face pointing towards the earth all the time. It would have been way beyond the expectations of the instigators of the IGY had it been achieved before the end of 1958. The USSR also had the same goal, and so a race to the Moon developed.

The USSR 'won' this mini-race to the Moon in 1959 when Luna 2 crashed into our nearest neighbour, and later that year Luna 3 photographed the far side of the Moon, returned towards Earth and transmitted some the indistinct pictures back to Earth before contact was lost.

Formation of NASA

After the perceived failure of the US in the space race, the administration had had enough and they formed the National Aeronautics and Space Administration (NASA), as proclaimed by President Eisenhower on 1 October 1958. The organisation's aim was 'to provide for research into the problems of flight within and outside the Earth's atmosphere, and for other purposes'. It was to have a distinctly civilian, rather than military, slant which was a direct result of the obvious competitive and wasteful internal space race between the Navy, Army and Air Force generals and rocket engineers. Not only was this wasteful in the duplication of resources, but it was viewed as being a system that didn't work – quite simply the USSR had beaten the US into space.

Summary and conclusions

I hope there has been enough British, Vintage and Wireless content to this article to keep your attention, and my apologies if I've wandered off subject many times because aspects of the whole story needed to be included to put the Wireless portions into context.

The story mainly concerns the Americans and Soviets, though had F J Camm had his way, the British may have contributed more to the space race, and may even have won the first lap. In fact the UK space industry is now a great success, but we stay well away from the expensive and risky business of developing rockets, and leave that to others.

Today, with a total of more than 7,000 objects of various shapes and sizes having been launched into space, one more launch is of little consequence to the man in the street, and most pass unnoticed. It's difficult now to realise how significant the launch of the first object was at the time, and how tricky it was to achieve. The launch of Sputnik 1 on 4 October 1957 was a great shock to the US, and it triggered the 'space race' which the US finally 'won' (by its own definition) in July 1969 with the first manned moon landing. When Sputnik 2, with its live payload, was launched less than a month after Sputnik 1, it was obvious that the launchings were not lucky flukes. After many public failures the Americans finally launched Explorer

Spacecraft	Frequencies (MHz)
Sputnik 1	20, 40
Sputnik 2	20, 40, 66, 70
Sputnik 3	20, 66, 70
Sputnik 4	19.996, 66, 71, 76, 182, S–band
Sputnik 5	19.995, 66, 71, 76, 182, S–band
Sputnik 6	19.995, 66, 71, 76, 182, S–band
Sputnik 7	20, 66, 71, 76, 2825
Sputnik 9	10.005, 19.995, 66, 71, 76, 83, 182, 2740, 2790
Sputnik 10	10.005, 19.9, 66, 71, 76, 83, 183, 2800
Vostok 1	9.019, 20.005, 66, 71, 76, 83, 134, 183, 2820

Table 1: Frequencies used by early Soviet satellites. The frequencies at and around 66MHz and 70MHz are recent additions to the known frequencies used during these missions. They are thought to have been used for telemetry from the R-7 rocket to the launch pad, and also for ground stations that had line-of-sight 'view' of the rocket during the early phases of its flight to send controlling commands, and correct any inaccuracies that on-board navigation had not corrected. As such they were very short lived and are very unlikely to have been detected in the West.

1, and collected the race's bronze medal.

The simple nature of the frequencies chosen for the Soviet satellites made it relatively easy for radio amateurs around the world to receive their transmissions. With some effort and ingenuity they could make valuable observations on their orbits and the propagation of signals at 20MHz and 40MHz from space to earth and within the ionosphere. Professionals in the UK, and around the world, were caught by surprise by the Sputnik 1 launch, and had prepared for transmissions at 108MHz by a US launch. By choosing a frequency close to a standard broadcast at 20MHz, the Soviets ensured that thousands of amateurs worldwide would verify the existence in orbit of the satellites (particularly the first one) and remove any doubt as to who had reached orbit first. No amount of manipulation of the facts by Western governments could hide the obvious evidence.

It's interesting to compare the weights of Sputniks 1 and 2 versus that of Explorer 1, and generally that of US satellites versus Soviet ones. It seems that the use of light-weight materials and electronics miniaturisation was more advanced in the US than it was in the USSR. Consequently Soviet rockets (developed initially to deliver nuclear bombs) had to be bigger and more powerful to be capable of lifting these increased weights, and this proved to be very useful when more complex, and hence heavier, satellites, particularly those carrying humans, needed to be launched.

The weights, much of which is contributed by batteries, of Sputnik versus Explorer had a direct impact on the technology that could be used for the on-board electronics. The Soviets were able to use well-proven valves, with the penalty of 'wasted' filament current, and maintain a reasonable RF output power of 1W, with a reasonable battery life. The Americans were driven towards transistors and the output powers of their two transmitters, at 60mW and 10mW, were relatively low. It can be argued that the weight pressures that the American space craft designers were under drove the revolution in transistors and ultimately integrated circuits, which we still benefit from today.

The big concern to most of the US population was that if the USSR could launch a satellite into space, then it could just as easily reach the continental US with nuclear-tipped missiles. The space race was just one part of the cold war which brought the planet close to disaster several times until it officially ended in a draw in 1991.

In 1958 a total of 28 satellites (five by the USSR and 23 by the US) were launched, including attempts by both countries to reach the moon with unmanned probes. So from that respect the IGY seemed to be a success in stimulating the exploration of space. How much this effort and success by the US was stimulated by the thirst for scientific knowledge, and how much by a desire to demonstrate that they had caught up with the USSR, is open to debate, but our knowledge of inner, including the Van Allen belts, and outer space was greatly increased.

In the amateur radio press there was great anticipation that the US were going to launch a satellite during the 1957-1958 International Geophysical Year. Preparations were made to receive the signals from that first satellite, which would have been a challenge in itself because of the frequencies chosen by the US. Indeed the world did track the first earth satellite in 1957, but from the western world's point of view, it was the wrong satellite!

References

Reference 1: Details of the testing of the UK's Black Knight rocket at the New Battery, close to the Needles on the Isle of Wight can be seen at: http://www.nationaltrust.org.uk/needles-old-battery-and-new-battery/history/article-1356397439404/

Reference 2: You can listen to the 'sound' of Sputnik 1 at: http://www.youtube.com/watch?v=r-bQEiklsK8

Reference 3: A discussion of Sputnik's transmitter can be found at: http://www.radiomuseum.org/forum/sputnik_1_transmitter.html?language_id=3

Reference 4: The table of newly-released frequencies used on the early Soviet satellites are taken from: http://www.svengrahn.pp.se/radioind/mirradio/earlyfxs.html

Reference 5: More details on Sputnik 2, and what is claimed to be a recording of Laika's heartbeat, can be found at: http://www.cold-war-sputnik-soviet-space-dog-laika.com/MYSTERIOUS_HEARTBEAT.html

Reference 6: More information on Explorer 1 can be found at: http://weebau.com/satellite/E/explorer%2001.htm

More information on the Explorer 1 108MHz transmitter can be found at: http://aa1tj.blogspot.co.uk/2012/06/vanguard-1-satellite-transmitter.html

An interesting history of Jodrell Bank and its role in tracking early satellites can be found at: http://www.jb.man.ac.uk/history/tracking/part1.html

A very useful source of information on all satellite launches is: http://claudelafleur.qc.ca/Spacecrafts-1958.html

An easy-to-read and informative book about the space race from the V-2 rocket to the launch of Explorer1, including the political context on both sides, is 'Red Moon Rising' by Matthew Brzezinski, published by Bloomsbury Publishing in 2007.

BVWS 2013 awards presented at Harpenden AGM

David Taylor (Award shown on left) received the Geoffrey Dixon-Nuttall Award for his article 'Designing and using a universal router jig for making replica radio backs. Stef Niewiadomski (centre photograph) received the Pat Leggat award for his article 'The development of FM broadcasting in the UK'. Steve Harris (photograph on right) was awarded the Duncan Neale award for Excellence in Preservation for his scanner truck 'North 3'.

EMI component bridge Q.D.211 Serial No. Z 56452

By Simon Tredinnick.

Whilst looking around our local auction house some time ago, I came across this rather sad looking item. I had not seen one of these units before, so I placed my maximum bid with one of the staff and left.

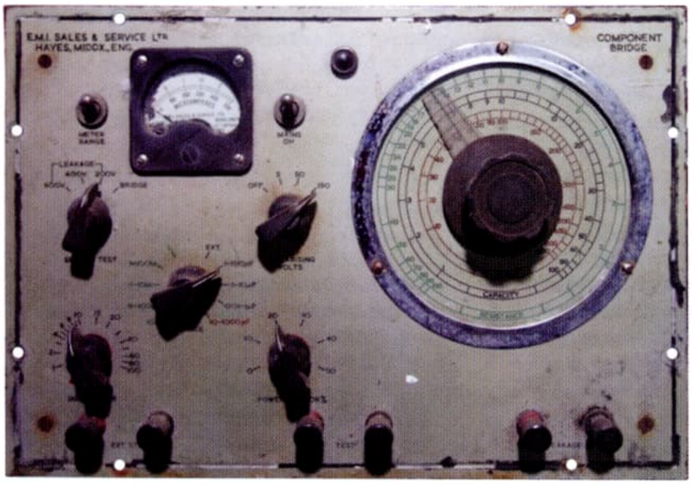


Fig. 1: Front ,as found

Fig. 2: Cabinet shell,as found

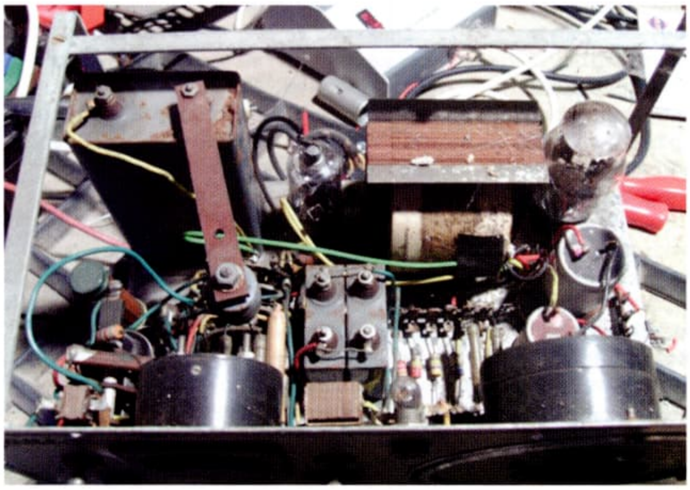


Fig. 3: Inside, as found

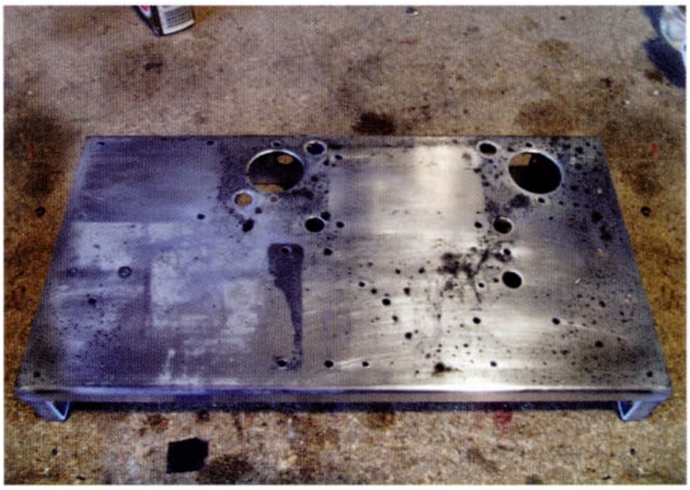


Fig. 4: Chassis stripped & cleaned

I was prepared to part with ten pounds for it, not because I was particularly looking for a component bridge for the workshop, but because I was curious to see what was inside. A couple of days later a 'phone call revealed that I had won the item for the huge sum of two pounds!

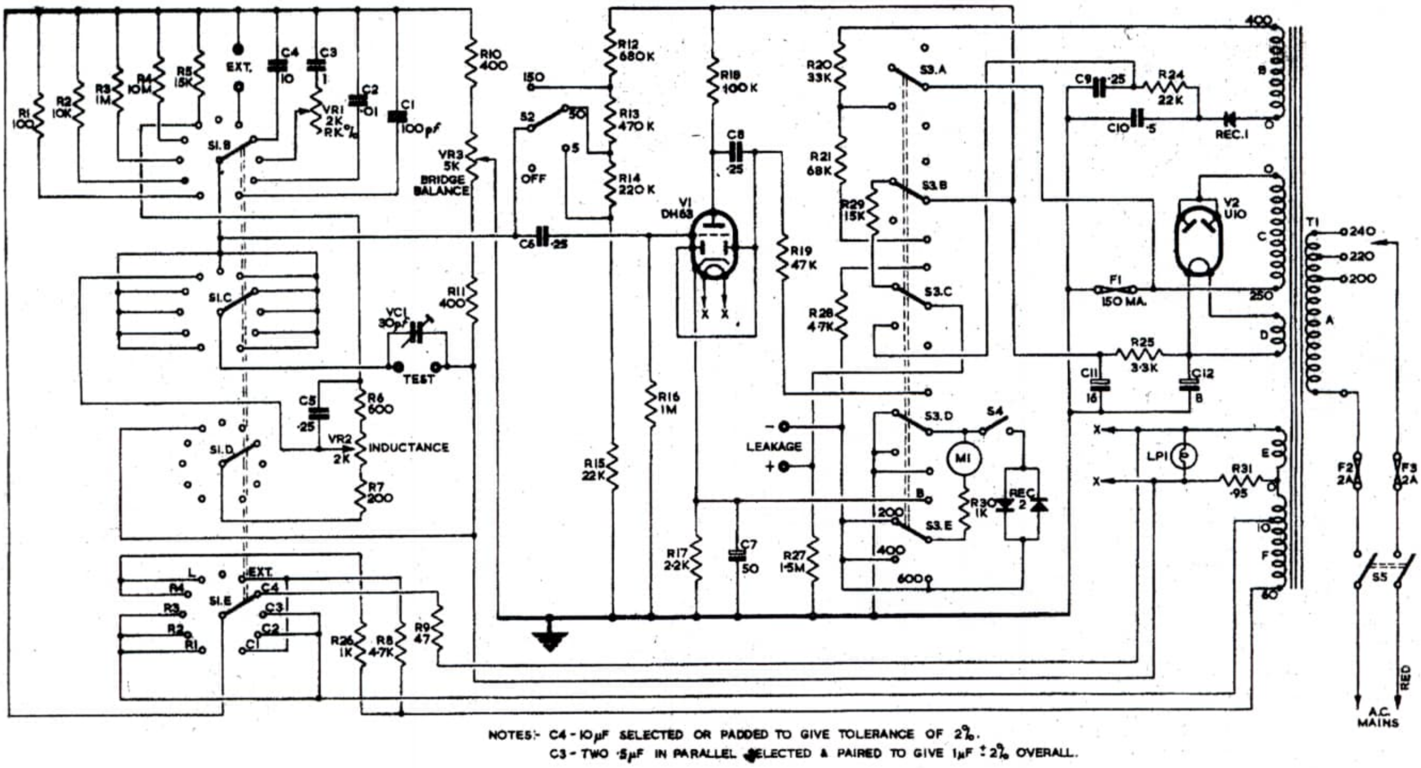
This component bridge was manufactured by EMI Sales & Service Ltd. Hayes. Middlesex. I am unaware of the amount of workshop test equipment they produced, but EMI needs little introduction to those of us interested in vintage electronics. They produced many items of top quality, notable for their top of the range domestic radio sets and radiograms under the HMV brand, but also notable for the poor design of the ubiquitous 1807 television set launched in 1949. They were heavily devoted to vertical integration, where they would manufacture a large proportion of components in house, instead of procuring from outside sources. It is documented that they even made the polish for their buildings door handles! (a)

Instrument overview

This component bridge has the following measurement ranges. Resistance: 10 Ohms to 100 megohms over 4 ranges. Capacitance: 10pF to 100uF over 4 ranges. Inductance: 1 Henry to 100 Henries. Capacitor power factor: available on the 0.1uF to 10uF range only. There is provision for a leakage test for capacitors with the following test voltages : 200, 400, & 600 volts. This facility is also suitable for the reforming of electrolytic capacitors. A 'Polarising Volts' facility is provided at 5, 50 & 150 volts for assisting in the measurement of electrolytic capacitors. As for the accuracy of the resistance and capacity ranges this is quoted as, *"The error does not exceed 5% and discrimination is within this limit."* Nothing is mentioned about the accuracy of the inductance range. The user manual says, *"Although primarily designed to provide high commercial standards of accuracy for service and maintenance work, provision is made for the use of external standards to any degree of accuracy required while this facility also allows coils, condensers or resistances to be accurately compared or matched by unskilled labour".* Whilst the resistance and capacity ranges are useful, the inductance range is very limited and I fail to imagine this could be very useful in a general repair and servicing environment.

Circuit

The component bridge comprises two main sections, one for bridge measurements and the other for the leakage tests. Common to both of these is the meter and power supplies. The bridge itself is basically a classic Wheatstone configuration with the AC test voltage being provided by secondary windings 'E' and 'F' on the mains transformer. Winding 'E' also provides heater current for V1 (DH63) and the pilot lamp. Winding 'B' provides 400 volts for the capacitor leakage tests, rectified by its own rectifier REC1. This should be a SenTerCel H4/44, but in my unit, this had already been replaced by



COMPONENT BRIDGE. STOCK No. QD 211.

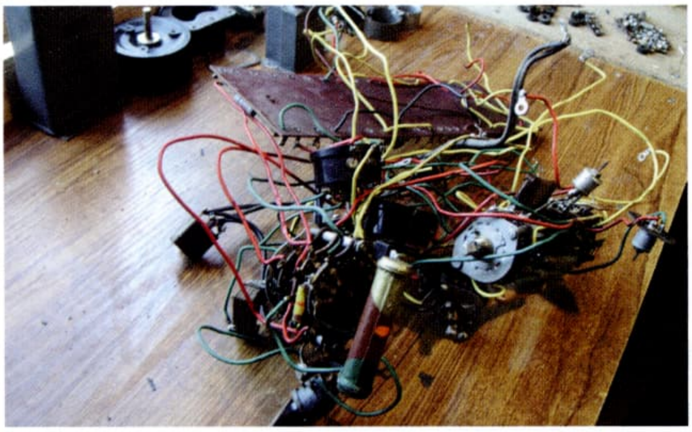


Fig. 5: A bridge too far?

Fig. 6: Front panel cleaned & ready for spraying

a silicon diode. The 600 volts leakage test voltage is developed by taking the negative end of the 400 volt winding to the 250 volt positive supply through R20, R21 & S3B. The selectable polarising voltage for testing electrolytics is provided by the main HT supply rectified by V2 (U10) through current limiting resistors, R12, R13 & R14 with R15, completing the potential divider. This 250 volt HT supply also provides the current for V1.

The AC output from the bridge measuring circuit is AC coupled to the grid of V1, a double diode triode by C6. The anode of this valve is coupled to the two strapped diode anodes by C8. For bridge measurements, the meter is switched through S3D & S3E between the diode anodes and limiting resistor R19, and returned to the cathode of V1. The 500uA meter movement is shunted by metal rectifier REC2. This gives the meter scale a logarithmic law. The shunt can be switched out of circuit by the operation of the front panel switch , labelled 'Meter Range'. This then enables the meter to indicate small leakage currents up to 0.5mA. Note that S4 is shown on the circuit diagram as a normally open switch, when it is actually a normally closed spring return type.

Evaluation

The item was soon on the workbench for inspection. The original 2 core mains lead had been cropped short and the outer case was pitted with rust. (Figs, 1,2 & 3) The chassis, complete with front panel was released from the case by removal of the 8 flat head slotted screws on the periphery of the facia and the two rear rubber feet screws on the bottom of the case. After withdrawing the chassis it became apparent that this tester had become extremely damp at some time in its existence.(Fig. 2) The inside of the outer case was rusty and the chassis was also spotted with rust. The paint on the front panel was in very poor condition and the main 'Bridge Balance' control was stiff and felt rough in operation. There was evidence that the tester had been in use in the 1960's or 70's as several of the non polarised capacitors had been replaced with Mullard 'mustard' types. The original selenium rectifier which supplies the HT for leakage tests (REC1) had been replaced with a 1N4007 silicon diode.

I had suspicions that the mains transformer had been rewound some time in the past. The original component is shown on the circuit diagram with three mains tappings for 200, 220 and 240 volts which is selectable through a threaded selector on the rear of the chassis. There was evidence that both the 200 and the 220 volt tags on the voltage selector panel had at one time accommodated a cable, but this transformer only sported a 240 volt tapping. Also, the transformer fitted to my unit had an earthed interwinding screen which was not indicated on the circuit diagram. After consideration of the overall condition of this tester, and that it had been subjected to considerable moisture, I decided that if the mains transformer was serviceable, then I would attempt a modest restoration as I

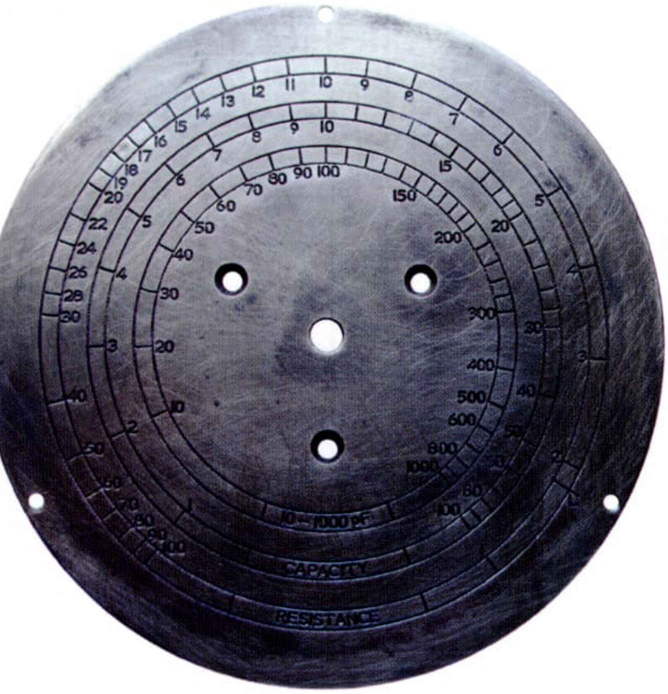


Fig. 7

felt it would be a handy companion in my workshop.

I searched the internet for some information on this unit, but drew a blank. An appeal was put out on the excellent 'UK Vintage Radio Repair & Restoration Forum'(b) and I very quickly received an offer of a copy of the user manual which was emailed to me. Now in the possession of a circuit diagram I felt I could meaningfully test the mains transformer with confidence. I isolated all the secondary windings and the primary winding from the various parts of the circuit and carried out an insulation test with a 500 volt 'Megger'. This revealed an insulation resistance reading of 1.25 megohms between the primary winding and the lamination stack. This was a lot lower than I had hoped for, and not too promising. I removed the transformer from the chassis and sprayed copious amounts of WD-40 into the windings and let this soak in for 24 hours. I hoped that this might drive out any moisture that had been trapped inside, although the transformer appeared dry. After a good soaking in period, I treated the transformer to a little heat from a hairdryer to ensure any remaining fluid was dried up. The primary was then connected to my isolated bench supply and left running for several hours. I took this opportunity to check the off load secondary voltages, which all appeared correct. A final test with the insulation tester revealed a reading of 11.8 megohms, which I was happier with.

Restoration

As I now knew the mains transformer was serviceable, I took the decision to strip all of the components off the main chassis and front panel so that these could be treated and re painted. The bare chassis was cleaned with white spirit and dried (Fig. 4 & 5) It was then rubbed down with wire wool to provide a key, then painted with silver smooth 'Hammerite'. The external case was wiped over with white spirit to remove grease & dirt, I then treated the rust with 'Rustins Rust Remover' and allowed to it to dry. I repainted the case with silver 'Hammerite' and sourced a new chrome handle from 'Rapid Electronics' (c) to replicate the original.

The next job was to re paint the front panel. Once stripped of paint it was interesting to see that this was fabricated from what appears to be brass. This has certainly been an advantage, as if this had been made from steel, then it would have surely become incredibly rusty. The lettering has been engraved into this and filled with the appropriately coloured paint for range identification. (Fig. 6 & 7) I say engraved, rather than punched as there is no evidence of any push through on the rear of the panel as is normally evident with punching. The majority of the paint came off reasonably easily, but the paint within the engraved legends took a long time to remove fully. I finally resorted to a pin to remove the stubborn bits.

To refinish the front panel, I applied 2 coats of 'Hycote' spray grey primer then 3 coats of 'Hycote' standard silver car body paint and allowed a few days for this to harden off. All I needed to do now was refill the lettering! I initially thought I could do this with a very fine paint brush, some enamel paint and a steady hand. First, I tackled the black panel surround which was reasonably easy with a fine brush, but I soon discovered the filling of the small lettering was going to require another method! I then remembered reading somewhere that a good method to paint indented panel lettering was to paint them first. With that in mind, I recklessly stripped the new paint off the front panel that I had just sprayed, bringing it back to bare brass again. I now, carefully, filled all the lettering with enamel paint and allowed it to dry. The trick, as far as I could recall, was to now overfill the painted lettering with soap, flush with the panel. This would prevent contamination of the lettering when the main front facia was now sprayed. I spent quite some time with a bar of soap, carefully filling the lettering and wiping off all the residue that might prevent the spray paint to adhere to the panel. With confidence I now applied 2 coats of primer, and 3 coats of 'Hycote' standard silver again, convincing myself in the process that the first attempt was merely a rehearsal. Again, I left it a few days for the paint to harden. Over those few days, I spent some time trying to find the source of the information that I once remembered reading about this method, but it eluded me. The more I thought about it, the less convinced I was that this would turn out satisfactorily. My initial euphoria soon turned into a dismal realisation that I would have to start all over again. Once I tried to wash away the soap protecting the painted lettering beneath, parts of the newly applied silver spray started to become detached from the panel, close to the lettering. I deduced from this that there must have been some soap residue remaining that prevented the spray from adhering correctly. Oh dear!

To cut a rather painful story short, I ended up re stripping the front panel and all the lettering and resprayed the front panel silver again . After trying several types of pens and crayons, I finally had success with my daughters 'Junior Pastels.' These were relatively soft so could be gently rubbed into the engraved letters and the surplus was easily removed. The black line that surrounds the facia was, again painted with enamel paint applied carefully by brush. Once I was satisfied, I applied 4 coats of 'Hycote' clear lacquer over the full front panel to complete the job.

The circular chrome ring which is fitted around the balance control dial was washed in warm soapy water and dried. It came up nice and shiny after a good rubbing with 'Solvol Autosol' metal polish. This can be purchased from car accessory shops, and I find it very effective.

Electronics

Before refitting all the components back onto the main chassis & front panel, I took the opportunity to test the individual components. The first candidate was the large 'Colvern' wirewound bridge balance control which was stiff in operation (VR3 - 5K). These controls are fairly easy to strip down once the thin paxolin rear cover has been teased off. It soon became obvious why this control felt rough, as the control was full of green gunge. I can only assume this is a reaction between the grease used during manufacture and the ingress of moisture over time. Thankfully the resistive element (5 Kilo Ohms) was intact. All the gunge was carefully cleaned off with the application of white spirit on a cotton bud. The wiper was re tensioned and the resistive element was given a smear of Vaseline to help minimise friction and aid electrical contact. The paxolin rear cover was re attached with a small amount of EvoStik contact adhesive which should make it relatively easy to open up in the future, if required.

With a measurement instrument such as this, the components that make up the 'standard' and bridge need to be up to scratch. All the resistors (R1 - R7 & R10 & 11) conformed to their stated 2% tolerance limits and were retained. It was obvious that R7 (200 Ohms) had been replaced some time in the past. The capacitors (C1 - C4) were also found to be within their stated 2% limits and proved not to be electrically leaky. The capacitors C3 & C4 were TCC paper in oil types which generally have a good reputation for reliability. I did treat C4 (10uF) to a new coat of grey paint as it was a little rusty in places.

The only resistors that were way off their tolerance limits and were replaced were R12 - R16 which formed the potential divider network for the 'Polarising Volts' feature. It was also noted that R17 (2.2K) was not original but was of the correct value and tested ok. The components that really let the side down were the electrolytics. Whilst they numbered only 3 in this unit, all were defective. C7,


Fig. 8: Replacement capacitor installed


Fig. 9: New leads soldered to existing tags

Fig. 10: Blanking grommet fitted to complete the job

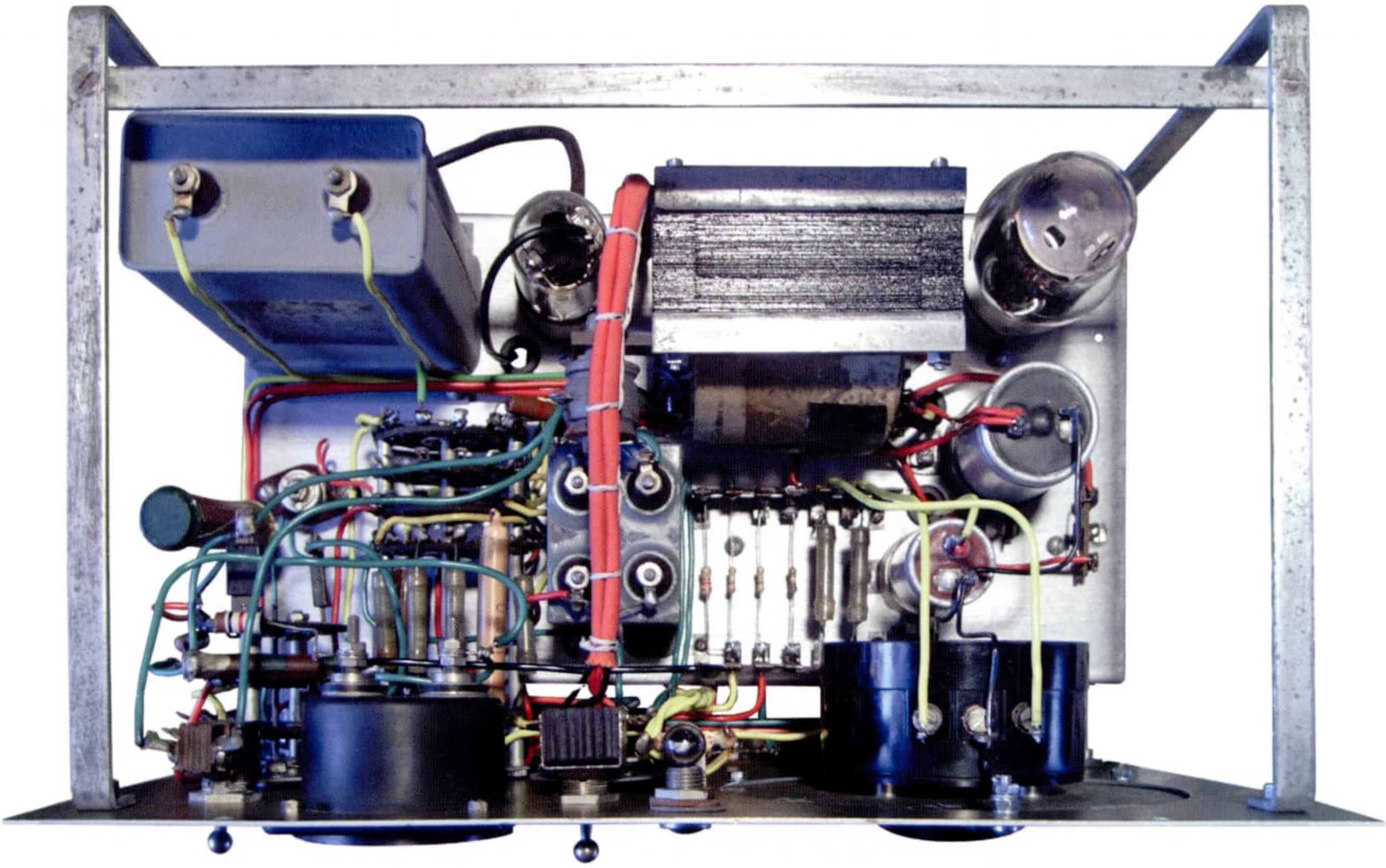


Fig. 11: Restored, top inside

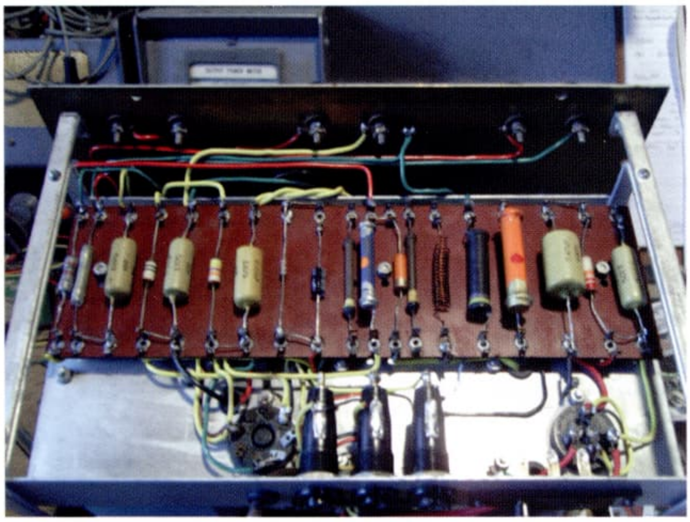


Fig. 12: Restored underside

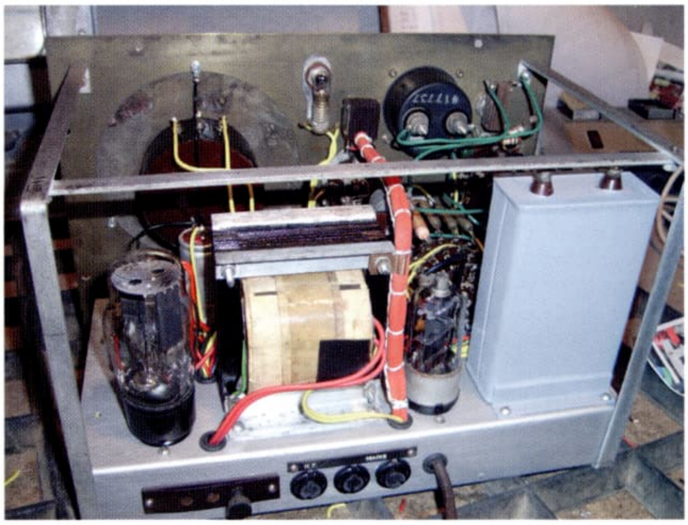


Fig. 13: Restored rear

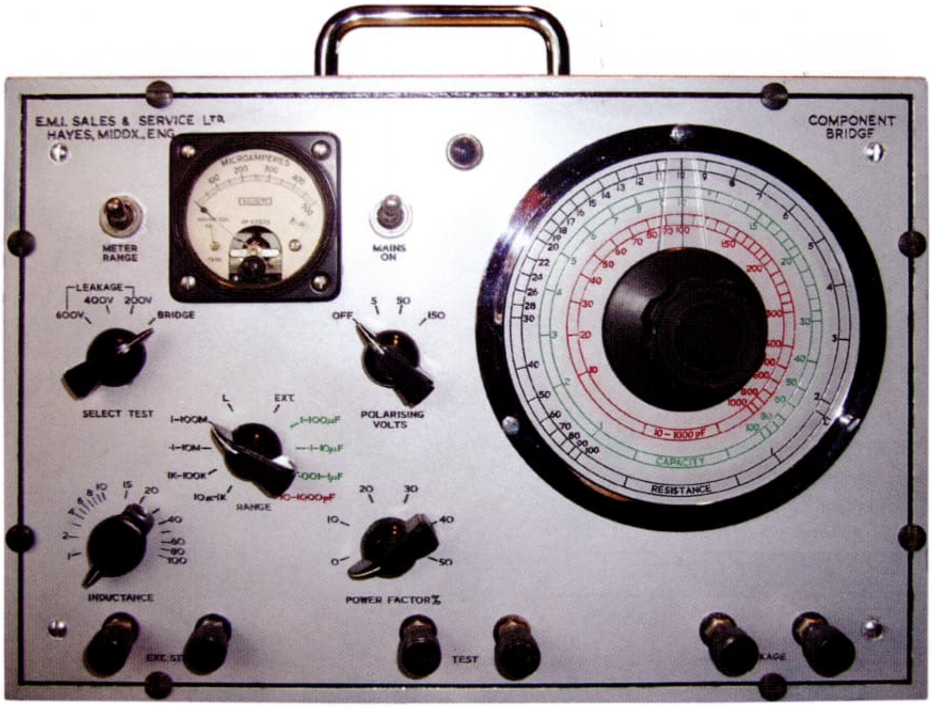


Fig. 14: Restored front

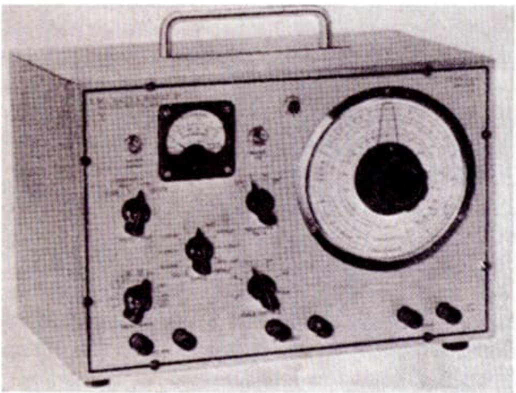


Fig. 7.—Self-contained Component Bridge

This universal bridge has been designed primarily for the Service workshop, and provides a ready means of testing most of the component parts found in a radio or television receiver. Test facilities include resistance, capacitance, power factor and inductance measurements. Leakage tests can be carried out at voltages up to 600 volts.

(E.M.I. Sales and Service, Ltd.)

Featured in Vol. 1 Radio & Television Servicing Pre-1953

the 50uF cathode decoupler for V1, was practically open circuit. This was replaced with a standard 47uF axial electrolytic on the bottom tag board. C12 (8uF) reservoir and C11 (16uF) smoother, were not very happy either. I tried reforming them but they both still preferred to act as resistors. It was interesting to note that both of these can capacitors had prominent date stamps of 'Sep '48 ' which I was keen to retain. I decided to re stuff both of these existing cans so they could remain within the component tester for some future reference. As they are mounted onto the chassis top down, I cut a 20mm hole in the top with a metal hole saw so that the insides could be removed. A wood screw was driven into the centre of the now exposed foil & electrolyte roll to enable this to be wiggled and pulled out through the hole. This can take a few attempts and the effort required seems to vary with different capacitors. Once removed, the inside of the capacitor can was cleaned to get rid of any remaining foil and electrolyte. Two, 1mm holes were drilled through the existing tag rivets so that the leads from the new capacitor could be fed through and soldered to the original tags. Finally, a 20mm blanking grommet was used to seal the top. Figs 8 - 10 show the capacitor at various stages.

An oversight!

Whilst I was initially concerned with the condition of the mains transformer that might prevent bringing this project to a successful conclusion, I had completely overlooked the serviceability of the front panel meter. I was acutely aware that the scale of the meter had lost some of its paint, but I was confident I could scan this and touch the image up in Photoshop for the printing of a new scale. This was one of the last components I tested and I was very disappointed to discover that the movement was open circuit. Carefully opening it up revealed severe internal corrosion and it was almost certainly a right off. I trawled the internet to see if I could locate a suitably vintage looking 500 micro amp FSD meter movement, of very similar physical dimensions, but to no avail. I had already invested many hours into this item of test equipment and I was kicking myself that I had not tested this earlier at the evaluation stage. I went back to the 'UK Vintage Wireless Repair & Restoration Forum' (b) and placed a request on the 'Sets and Parts Wanted' section. Within a short time I had an offer of a new, old stock 'Elliott' meter which was electrically and physically suitable. The meter itself is not quite the same vintage as the original, being dated '1956' on the scale, but I was prepared to forgive this! I was now able to finally move forward and complete the project.

Reassembly

All the assemblies were now re installed onto the chassis and front panel. I was able to retain a fair amount of the original inter wiring during strip down (see Fig. 5). this helped to avoid mistakes with the reassembly. I re connected the remaining components as neatly as possible within the length of the original wiring. A new 3 core mains lead was fitted, I ignored the fuse in the neutral of the mains supply (F2), retaining only F1 & F3. Originally the route of the mains cable to the front panel power switch was grouped along the top of the chassis with the other internal cables. I was not happy with this arrangement so I sleeved them with heat resisting red sleeving and routed them away from the rest of the wiring. The metal rectifier meter shunt (REC2) visible in Fig. 3 fixed to one of the terminal posts of the 10uF reference capacitor C4, was returned to its intended position using the bolts through the laminations of the mains transformer. Figs. 11 - 14 show the completed unit.

Conclusion

The Bridge works very well. I have been using it in my workshop for a couple of years and it has more than repaid me for the effort put in to restore it. Its accuracy is more than adequate for general component testing in a radio / TV workshop environment which I assume was its intended destination when it was designed. This unit had a brief mention in the 1953 edition, Vol. 1 of 'Radio & Television Servicing', indicating that this may have been in production for a few years as the electrolytics in mine were manufactured in 1948. Whilst my unit has been 100% reliable, I pondered over the service reliability of the unit when it was just a few years old. If, indeed, the mains transformer in my unit is a rewind, why would the original have failed? The U10 rectifier valve appears to be the original, so failure of this causing damage to the transformer can be discounted. If anyone can throw any light on this, I would be interested to know.

A minor blunder...

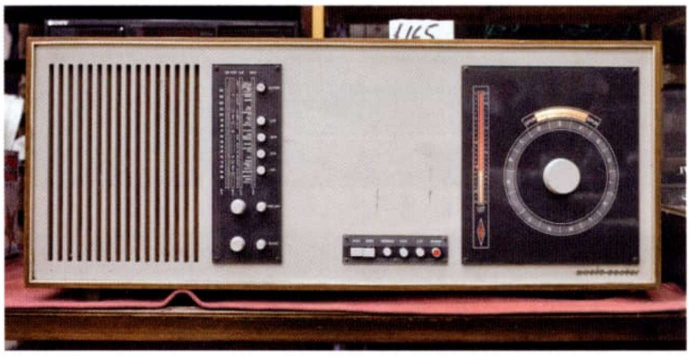
After I had finally completed this restoration and was beginning to feel pleased with my efforts, it was whilst looking though the many pictures I had taken that I discovered a mistake. This was not with the wiring or the orientation of components. This mistake does not effect the accuracy, safety or operation of the unit. Needless to say, it has not been corrected. I can live with this, annoying as it is. Maybe one day I can bring myself to rectifying the matter. Can any eagle-eyed reader discover what the mistake is?

References.
(a) 'The Set Makers' Keith Geddes & Gordon Bussey. ISBN. 0 9517042 0 6. Page 311
(b) UK Vintage Repair & Restoration . www.vintage-radio.net/forum/index/php
(c) Rapid Electronics. www.rapidonline.com Tel: 01206 751166

Acknowledgments.
Re: UK Vintage Repair & Restoration Forum. Thanks to forum members, 'Barretter' for supplying a copy of the QD211 instruction manual and to 'Mikebay' for offering a suitable replacement panel meter.

Audiojumble!

Photographed by Carl Glover




SACD MK II


NAS


Varislope Stereo
LEAK
Trough-Line II
LEAK


EL 6415

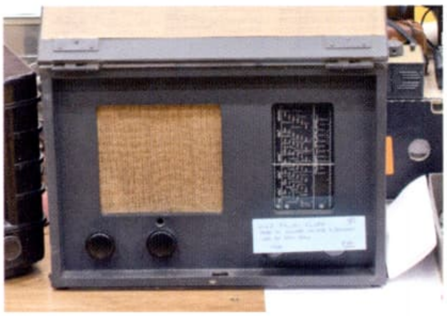

LEFT
RIGHT


Phase Linear
4000
VU
VU


Northern Electric


SATELLIT 2100
GRUNDIG


TUNE
AM
FM
KCS
MCS
OFF
VOLUME
AFC
TUNING
Beam-Echo
SELECTOR
BASS
TREBLE
VOLUME
LOUDNESS
FILTER
Avantic
RENOVATED BY CHRIS FREEMAN




Mullard
PM 252
Mullard
THE MASTER VALVE
PM 12
Cossor
Marconi Valve
Marconi Valve
GEC

How do they work? 4. Test sets & multimeters

by J Patrick Wilson

In general test sets were designed for specific applications within say telegraphy or the power industry whilst Multimeters were intended as universal devices. In both cases the term implies more than one type of measurement and not merely a multirange instrument of a particular type.

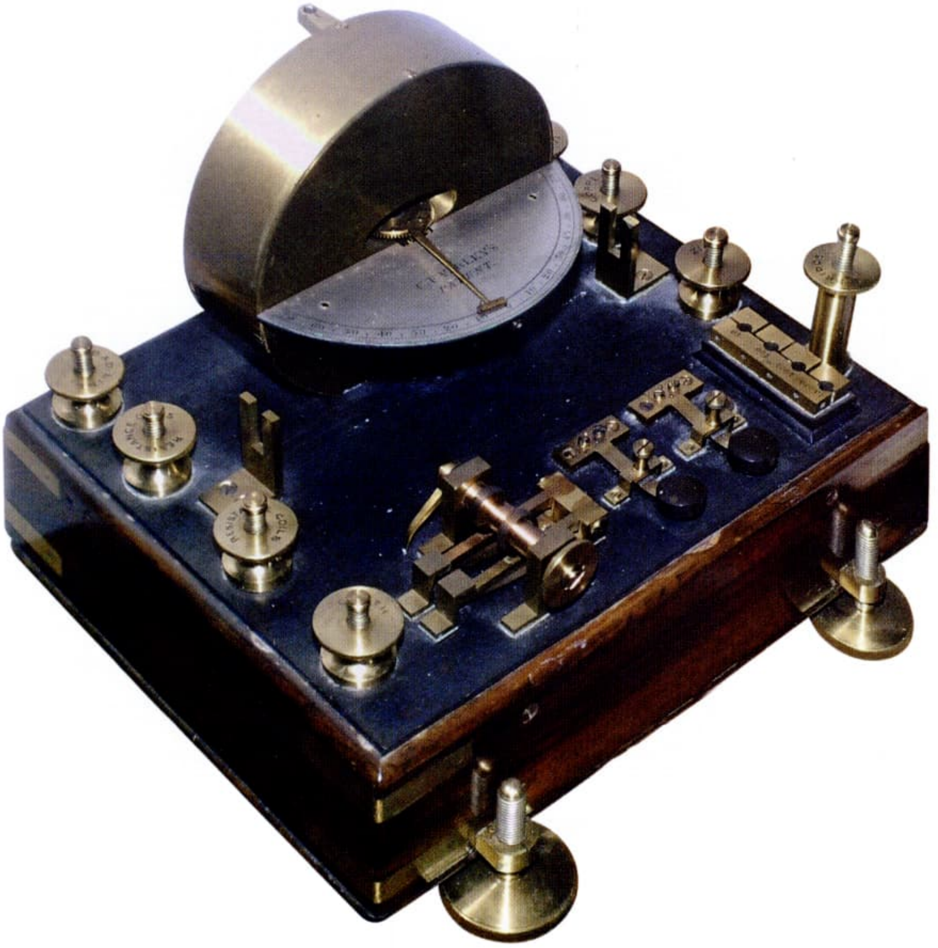


Fig.1 Varley test set (1865, Porthcurno Telegraph Museum)

CF Varley test set - 1865

This is one of the earliest test instruments designed for telegraphy (Fig.1, Porthcurno Telegraph Museum). There were at least eight Varley brothers of whom four were involved with telegraphy and were founder members of the Society of Telegraph Engineers, later becoming the IEE. Cromwell Fleetwood and Samuel Alfred were leading lights in telegraphy, whilst their younger brothers, Octavius and Fredrick Henry, manufactured telegraph instruments.

The circuit (Fig.1c) shows the tangent galvanometer with two coils, but it is not clear whether these are for differential use or are of differing number of turns and sensitivity. It is marked in degrees with a 10° rotatable stop device (pointer and right stop missing) to help bring the pointer quickly to rest, and has plugged resistors of 10, 100, 1000, 10,000Ω; battery terminals 'Copper' and 'Zinc'; test terminals 'Bad Line' and 'Earth'; 'Bridge' and 'Resistance Coils' terminals; two keys and a double cam switch. Unfortunately I have not had the opportunity to examine one properly but it would appear to measure line resistance by a bridge method in conjunction with external resistance coils and its internal plugged references, and insulation by comparing currents though the unknown with the internal 10,000Ω resistor. The (bent) pointer of the cam switch should indicate: left - 'Denominator' with front switch open; up - 'Ordinary resistance testing' both switches open; right - 'Numerator' back switch open. The two vertical brass forks do not appear on the drawing and may be a later addition.

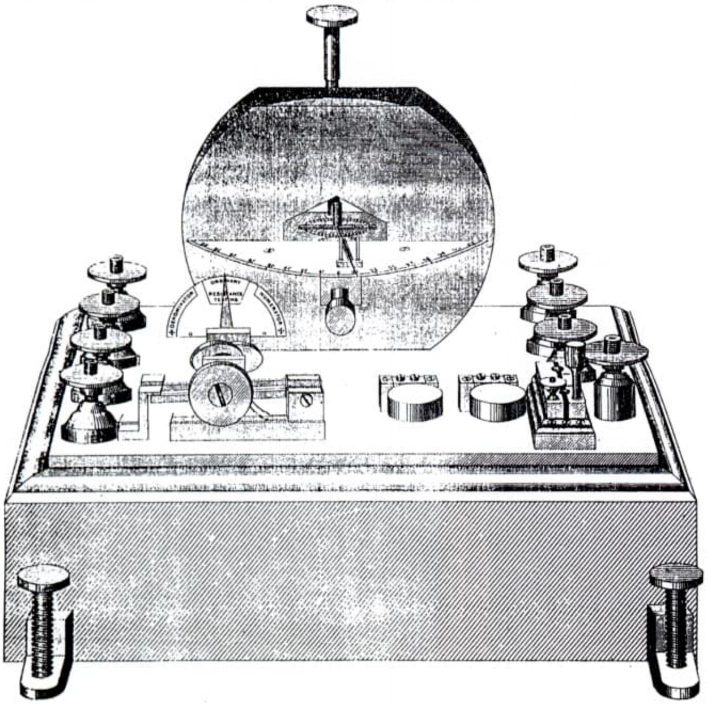


Fig.1b

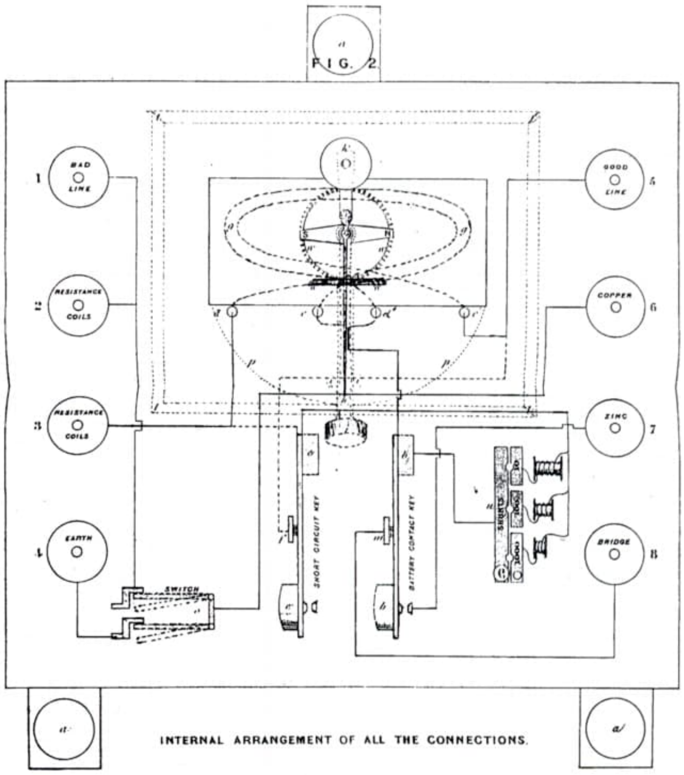


Fig.1c

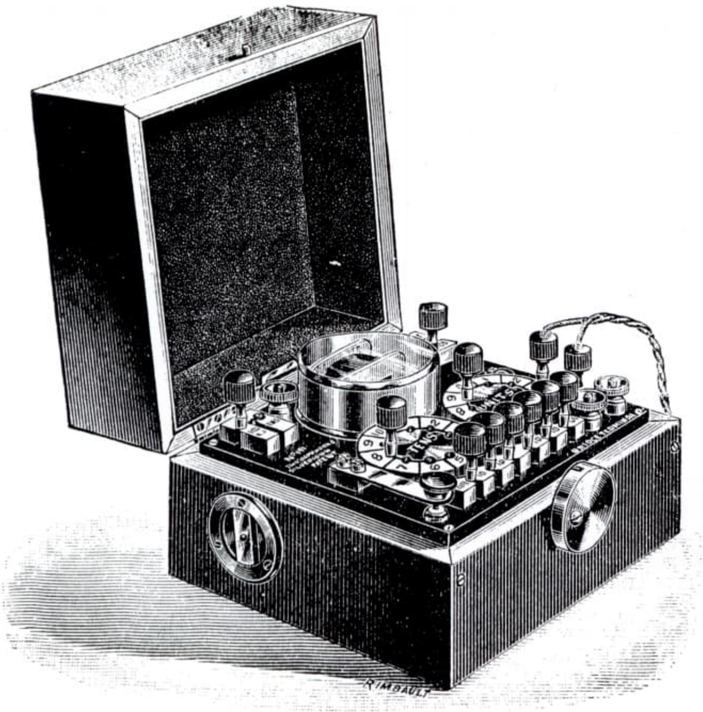
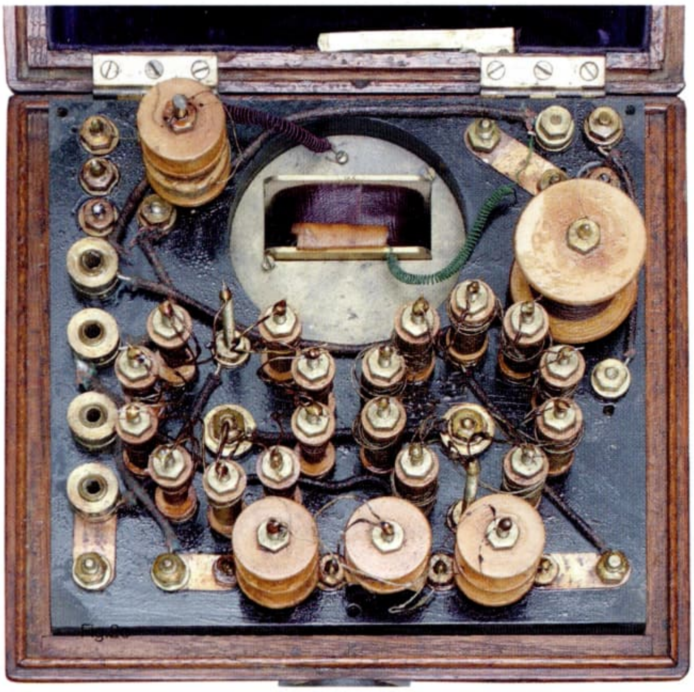


Fig.2 Silvertown portable testing set

Fig.2b



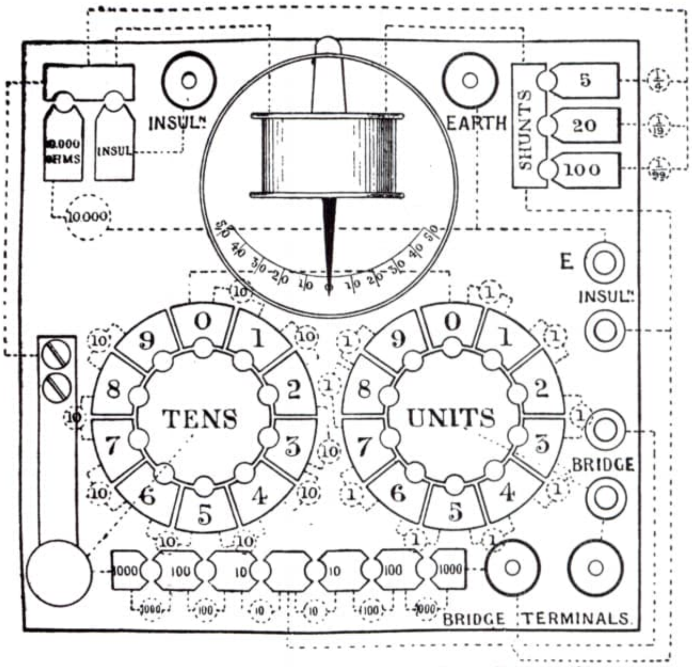


Fig. 108. Silvertown Testing Set. (General connections.)

Fig.2d

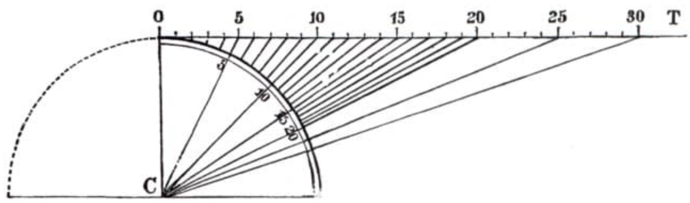


Fig.2e Geometric construction of tangent scale (SP Thompson)

Silvertown portable testing set

This is also designed specifically for conduction and insulation tests in telegraphy (Fig.2, 20.5x19.5x15 closed, No.147, Telegraph Works, Silvertown, London). It should have a companion box containing four low resistance Leclanché cells for bridge measurements (6V) and three sections of ten cells for insulation measurements (45V) with a pair of flying leads and plugs for insertion into the marked holes on the right. The 3kΩ tangent galvanometer coil can be shunted by resistances of 743, 158 or 30Ω giving sensitivity reductions of 5, 20 or 100 respectively. Another plug can be set to either the 'Insuln' and 'Earth' terminals or to an internal '10,000 OHM' resistor for the substitution tests.

The silvered-brass galvanometer scale is engraved non linearly '50-0-50' so that the reading is proportional to current. SP Thompson illustrated a neat geometric method for doing this (Fig.2e). The whole box must be oriented so that the earth's magnetic field brings the pointer to near zero. Exact zeroing can be achieved with a small rotatable magnet on the left of the box, which with N pole upwards is more sensitive (66μA fsd) than when downwards (110μA fsd). From the former we can calculate that a deflection of fifty divisions would represent 680kΩ, and one division, 34MΩ, with a 45V battery and, by utilising the shunts, magnet positions, and 6V battery, resistances down to 550Ω, well into the range covered by the Wheatstone bridge.

For bridge measurement the connections are reconfigured, giving ratios of 100, 10, 1, 0.1, 0.01 times the variable arm of 9x10 + 9x1Ω giving a range of measurement from 0.01 to 9,900Ω (precision restricted by two decade range). The intact resistors are all within 0.5% of their nominal values in BA ohms (which are about 1.35% smaller than international or absolute ohms).

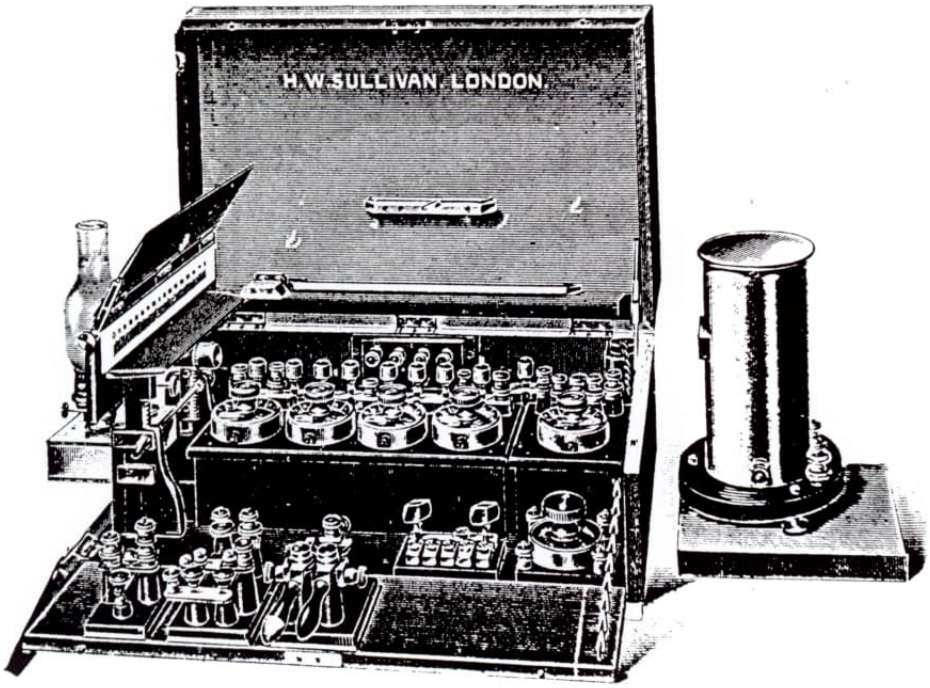


Fig.3 HW Sullivan portable cable testing set

Fig.4 Lord Kelvin's testing set

HW Sullivan portable cable testing set
Although taken from their 1921 catalogue, this instrument (Fig.3) could date from the late 19th century and is another example of a self-contained test set with a specific application. It contains a galvanometer, a thirteen position universal shunt, oil lamp & scale, 4-decade Wheatstone bridge 0000-11110Ω with ratio arms of 10, 100, 1000Ω (see Fig.1 in *HW Sullivan Ltd*, BVWS Bulletin 35 (4) Winter 2010) and a separate interchangeable 10kΩ resistor; 1/3μF (the capacitance of 1 mile of submarine cable) standard capacitor with certificate, earth plate and a variety of switches and test keys. The quality of the bridge is outstanding with silver switch contacts, ratio arms balanced to 0.005%, and decade resistors to 0.01%. The distance to a short circuit is indicated by its resistance and to an open circuit by the capacitance which can be ascertained either by bridge or ballistic methods. Voltages and currents can be calculated from the galvanometer deflections. It was listed at £180 reduced to £150, the cost of a small house in those days!

Lord Kelvin's test set, James White, Glasgow
The designation 'Lord Kelvin' places this instrument post 1892 although the design was probably earlier (Fig.4, 21.5x19.5x18.5 closed with levelling feet and tripod bush, Lord Kelvin's Patents, Testing Set No.141, James White, Glasgow). The main part of the instrument is designed for high resistance and insulation measurement, possibly intended more for the power industry than for telegraphy. Again a tangent galvanometer is employed, with a non linear printed paper scale proportional to current, backed by an antiparallax mirror. A pair of magnets is suspended directly above the needle and can be adjusted in height to alter the sensitivity and rotated in the horizontal plane to zero the pointer. These are sufficiently strong to exceed the earth's field. The current required for a deflection of 25 divisions ranges from 140μA at minimum height to 40μA at maximum. Greater sensitivity (9μA fsd) can be achieved by removing the magnets and using the earth's field alone.

The large galvanometer coil of 50,000Ω can be shunted by a network of resistors marked '1/9, 1/99 and 1/499' whilst maintaining a resistance of 50kΩ±0.4% at 18°C, reducing the sensitivity to 1/10, 1/100 or 1/500. With the front switch set to the lower '50,000' position the deflection can be set to maximum by adjustment of the height of the magnets with a battery voltage in the range 2 to 7V, or 0.6V with the magnets removed. If the switch is then set to the upper test position, the deflection will decrease in the ratio of 50kΩ to 50kΩ + X, where X is the unknown resistance connected between the 'Line 1' and 'Line 2' terminals. A deflection of 1 division would then give X=1.2MΩ. By using higher voltages and the shunts to set maximum deflection on '50,000' then switching back for the test, correspondingly higher values can be measured (e.g. with 200V and the '1/99' shunt, a deflection of 1 division would

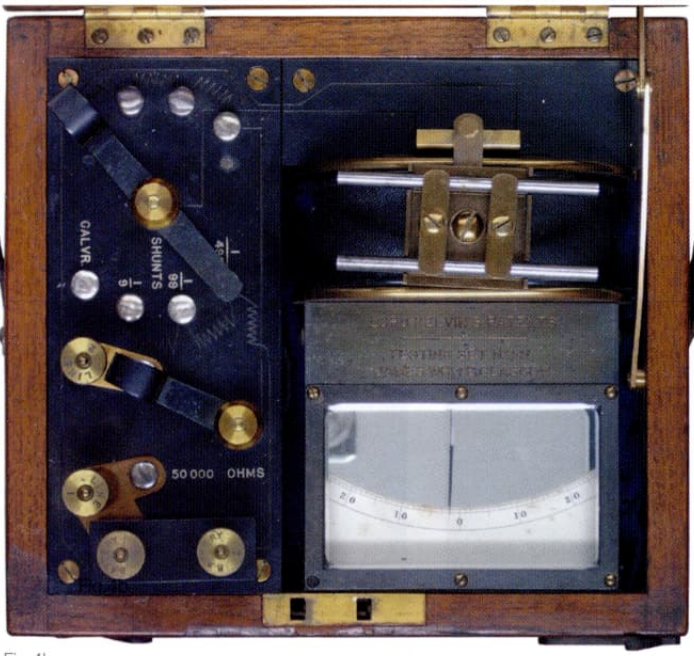


Fig.4b

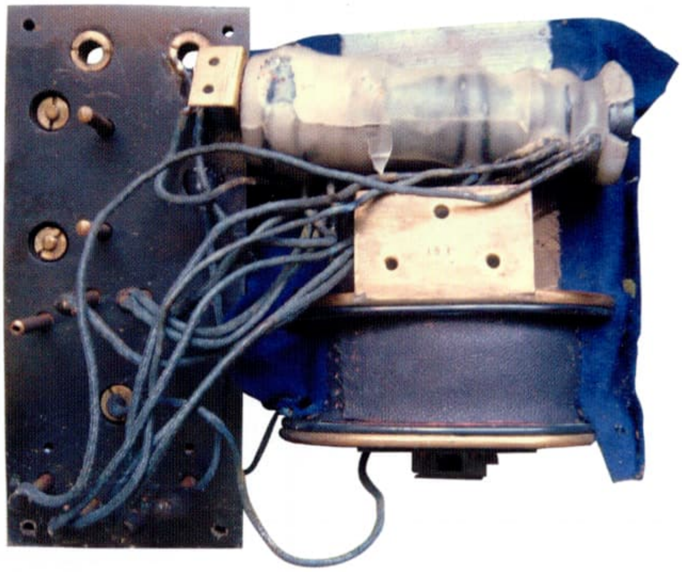


Fig.4c

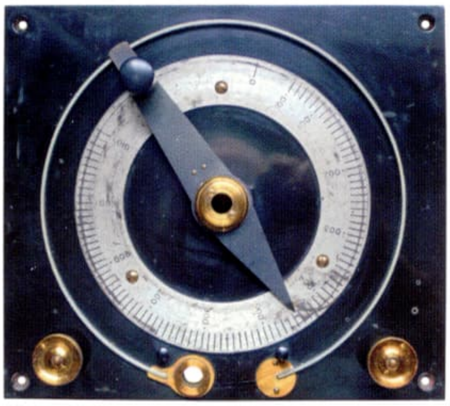


Fig.4d

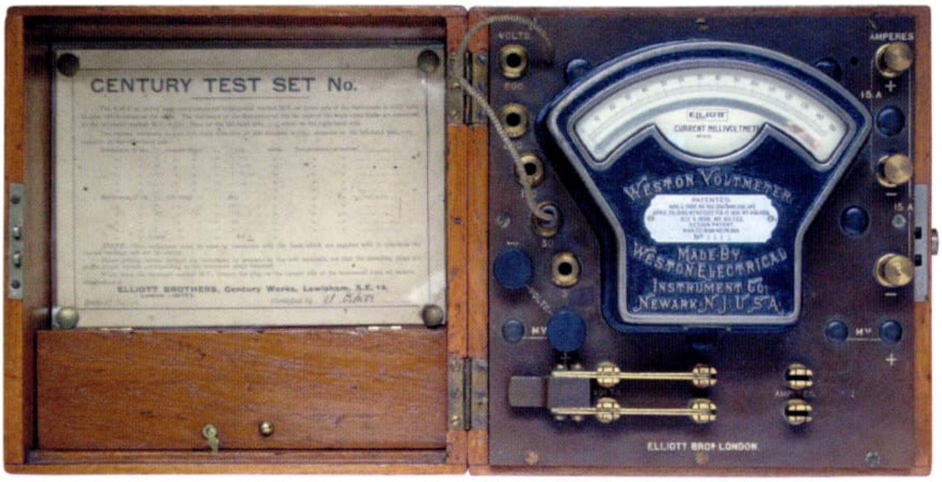


Fig.5 Elliott Bros Century test set

represent 120MΩ). It is also possible to compare voltages from say 0.25V to several kV with a known external voltage reference.

The lid of the instrument contains a potentiometer calibrated from 0.0001 to 0.010Ω. My initial impression was that this might be for measuring high currents in conjunction with the galvanometer, but this is not reasonable because a voltage drop of 2-7V implies currents of 200-700A for which the design is clearly unsuitable. Its function remains unknown.

Elliott Bros Century test set

(Fig.5, 25x25x17 closed, 13.5cm mirror backed scale 0-150, Century Test Set No.1113, Elliott Bros, Century Works, Lewisham, SE 13, certified 21 May 1930, built round an ironclad Weston Voltmeter, Weston Electrical Instrument Co, Newark, NJ, USA, for whom Elliott's were agents). This has voltage ranges of 3, 30, 150, 300 & 600V accessed by a flying lead to the appropriate socket. A distinctive knife switch is used to select either 'Volts' or 'Amperes' with two pairs of terminals for the '1.5 & 15A' ranges, and a lid compartment for shunts for 150 & 600A. Elliotts moved to their 'Century Works' in Lewisham in 1900 and by 1905 their 'Century Test Set' incorporated what appears to be their own movement

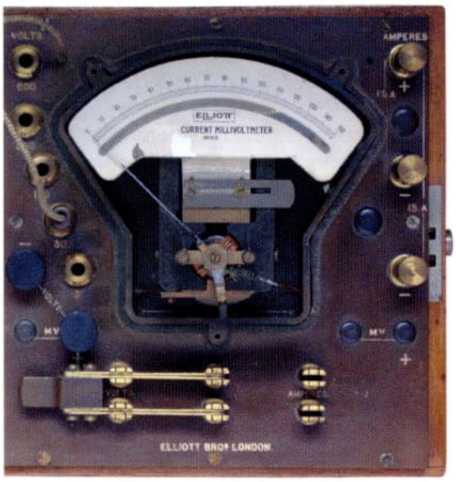


Fig.5b

and looks more modern than Test Set No.1113. Geoff Tomlin has kindly provided details for No.1312, dated 9.12.03, which appears identical to No.1113 except for the brasswork being nickel plated rather than lacquered. Thus the 1930 date must refer to a re-calibration of a 1901-2 instrument, a process which probably included remarking the dial of the Weston movement. Elliotts produced a wide range of other models in differing grades, with moving iron movements

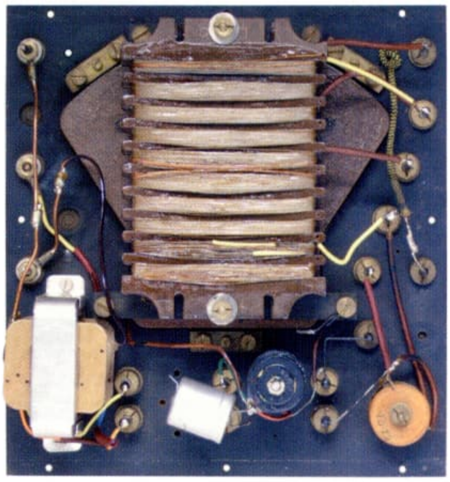


Fig.5c

for AC, dynamometer movements for AC or DC, many incorporating separate movements for voltage and current, a feature making it much easier to measure power.

In fact the Century Test Set No.1113 was converted to an AC instrument in 1961 by adding a rectifier and current transformer and removing turns from the resistance bank (Fig.5c) to give ranges of 30 (originally 3), 60 (originally 30), 150, 300, 600V and 1.5 & 15A (using a current transformer),

Fig.6 Robt W Paul universal test set pattern O

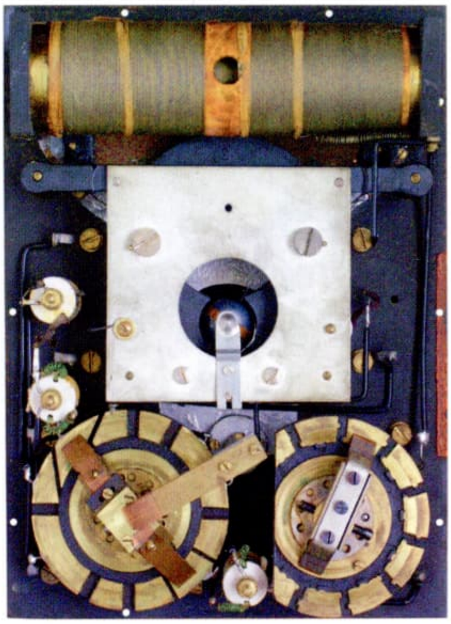


Fig.6b

Fig.7 Ayrton & Mather universal shunt, Nalder Bros


Fig.7b

and blanking off the former 'mV' terminal holes. The 1930 re-calibration certificate shows that the Weston movement took 32.4mA fsd (31Ω/V) whereas No.1312 takes 24.7mA fsd (40.4Ω/V). The AC modification is labelled 'Dorking Century Test Set' on its separate calibration certificate and is presently accurate to within 2%.

Robt W Paul universal test set pattern O

This (Fig.6, 27x20x13 closed, 11.5cm mirror backed scale -2 to +125, Robt W Paul, London N, No.O.558, 60Ω at 20°C) is an early instrument (1911 catalogue, priced at £15) claimed to be truly universal in measuring voltage, current, insulation and low resistance, power, bridge tests, capacity and cable fault location. It is, however, restricted to DC and some of the functions require two measurements, calculation and extra accessories. It is based on a very sensitive Unipivot (1903 patent) moving coil movement (125μA fsd when used with its 600Ω Ayrton & Mather universal shunt).

Ayrton and Mather showed (JIEE, 29 Mar 1894) that where shunts are arranged in series across a galvanometer, and the current fed into one of the junctions, it will give a set of fixed multiplication factors whatever the resistance of the galvanometer and regardless of whether it is a steady state or ballistic type. The overall resistance can be chosen to give critical damping on all ranges. Fig.7 shows an early 1000Ω example by Nalder Bros & Co. In a multimeter it allows a single set of switch contacts to be used for the current ranges without introducing switch contact resistance errors but at the slight cost of increasing the voltage drop across the ammeter.

Curiously in the Paul instrument it is used to determine the *voltage* ranges (0.02, 0.1, 0.2, 1, 2, 4 & 10V/div, ie, 2.5 to 1250V fsd) using a single 20kΩ series resistor (Fig.6b top). Thus the current drawn at fsd will range from 125μA to 62.5mA (which at the specified maximum of 600V would represent 18W). This method may have been adopted because on the highest range the series resistance would otherwise be 10MΩ, a value too high to be wirewound, which was the only type of stable resistor available in 1911.

There are four pairs of terminals: 'Volts', 'Millivolts' (12.5, 125mV), or used with the supplied but separate 4-terminal shunts - 0.1Ω: (0.125, 1.25A) - 0.001Ω: (12.5, 125A) for high current ranges; 'Insulation' is measured using an external high voltage connected to 'Volts' - the meter switch is set first to 'Volts' then to 'Insulation', the voltage measured is then divided by the product of the 'Insulation' deflection and the 'Shunt Power' (giving 600MΩ for one division at 600V and unity shunt power). It could be ordered with direct resistance markings for a 100V supply. The fourth set of terminals 'Bridge G' are for use as a galvanometer (whose sensitivity is set by the universal shunt) in conjunction with an accessory Wheatstone bridge. Although not mentioned in the sales literature (presumably because there would be no application in those pre-electronic days), the 'Bridge G' setting can be used as a milliammeter (0.125, 0.625, 1.25, 25 & 62.5mA fsd) giving an overall current range from 1μA to 125A. For measuring low resistance an external circuit is set up using one of the shunts (0.1 or 0.001Ω) in series with the unknown and a source of current, using the 'mV' settings to compare voltage drops.

Power is calculated using the 'Millivolt' terminals to measure the current through a shunt in series with the load, then switching to the 'Voltage' terminals across the load. Capacity (capacitance) tests are made by discharge across the 'Bridge G' terminals where a charge of 100C gives 125μA deflection. This can be used to locate an open circuit fault on a long cable. A short-circuit can be located using a fault localising accessory. This instrument now reads 2% low but apart from a missing 0.1Ω shunt is in good working order.

A slightly larger test set 'Pattern U' was also available with a longer back-lit scale extending to 150 divisions and a more sensitive movement of 75μA fsd. The circuit and number of ranges was similar.

Evershed's combined moving coil ammeter & voltmeter

This instrument (Fig.8, 17x32x10 plus terminals, 11cm scales 0-100mA & 0-130V, Evershed & Vignoles Ltd, Acton Lane Works, Chiswick W4, No.233829, certificate cards in compartment underneath) contains two separate movements with both pointers reading on the same dial which, unusually for a high quality instrument, is not mirror backed. The voltmeter section is a 10mA fsd (100Ω/V) movement with ranges of 130V x 1/1000, 1/20, 1/2, 1, 2 & 5 (0.13, 6.5, 65, 130, 260, 650V) set by a pull-bar at the front. This is locked by a knob at the side which needs turning both ways to allow advance of the bar, a safety feature to discourage using a low range for a high voltage. Another inconvenient feature is that the scale factors engraved on the side of this bar cannot be seen whilst reading the dial.

The 'current' end of the instrument contains only a 100mA 75mV movement and requires external shunts for the 1, 10, 100, 300 & 1000A ranges. The instrument over-reads by 1% on the 100mA range and the card indicates a 0.064%/°C correction with the (missing) shunts. The voltage readings appear accurate to within a fifth of a division (0.2%) with a correction of 0.075%/°C needed for the 0.13V range only. Lettering, numbering and calibration all appear to be individually drawn on a painted dial.

The evolution of the AVO

The AVO was patented in 1922 by Donald Macadie, a GPO engineer fed up with carrying round a collection of separate instruments. Basic to the design was a single pair of terminals for all ranges and the use of a universal shunt. Many of the earlier AVOs do not display their Model, Mark or Type numbers so this has to be determined from their features.

Model 1 introduced in 1923 was DC only (Fig.9, thanks to Peter Munro for this and for much of the other information on AVO; see also RP Hawes, Bull Sci Instr Soc No.37, 1993) with a 6.8 mA moving coil movement shunted to take 16.67mA at fsd on the three voltage ranges (12, 120, 600V), with taps on the universal shunt for the three current ranges (0.12, 1.2, 12A), and a directly calibrated resistance range powered from an internal 3V battery. The right hand knob controls a three section rheostat in series with the current ranges so that a particular value can be set or, in the 12 o'clock position, shorted out.

The innovation of Macadie was a potentiometer 'P' in series with the universal shunt (Fig.9b, upper, 5.27Ω potentiometer) with the slider connected to a battery and series rheostat 'R' and fixed resistor designed to give fsd with the terminals shorted. With an unknown resistance across the terminals the deflection would indicate its value directly inscribed on the scale. Half scale would occur when the external resistance was equal to the total equivalent resistance of the fixed resistor, battery, R, and the P, universal shunt, and meter complex. Adjustment of 'P' corrects for drop of battery potential with little influence on total circuit resistance, whilst 'R' corrects for any increase in internal resistance of the battery.

The thirteen range Model 2 was introduced

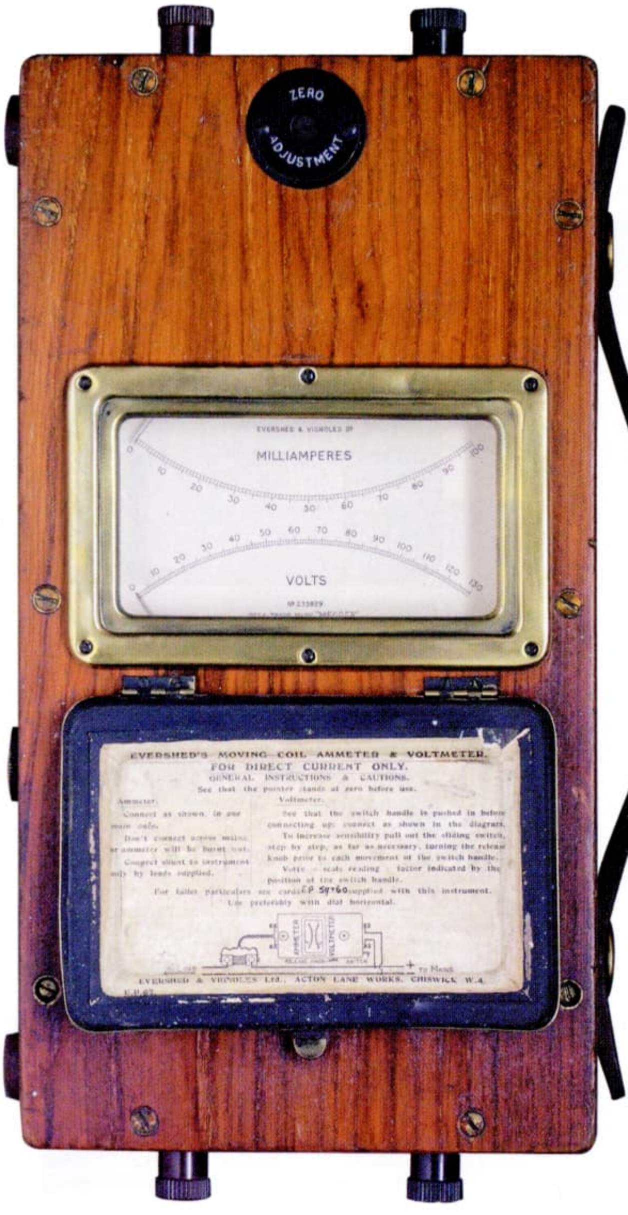


Fig.8 Evershed's moving-coil ammeter & voltmeter

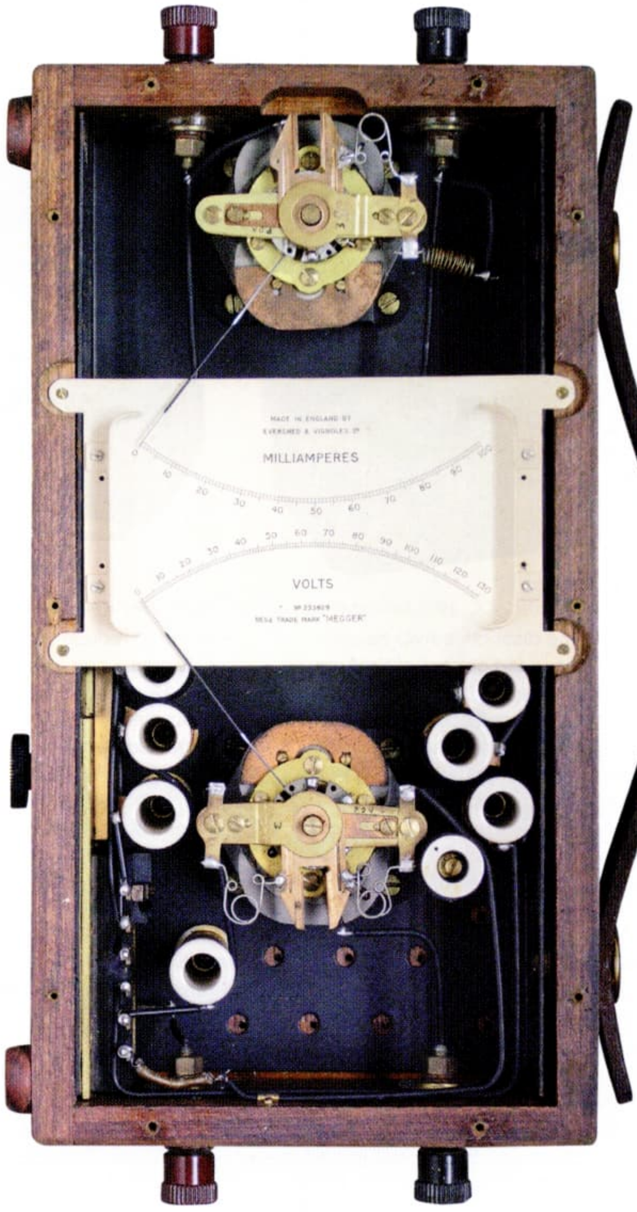


Fig.8b

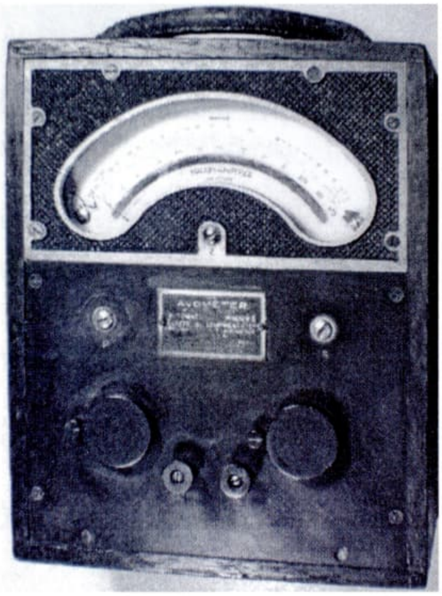


Fig.9 AVOmeter model 1 (DC, 12gns)

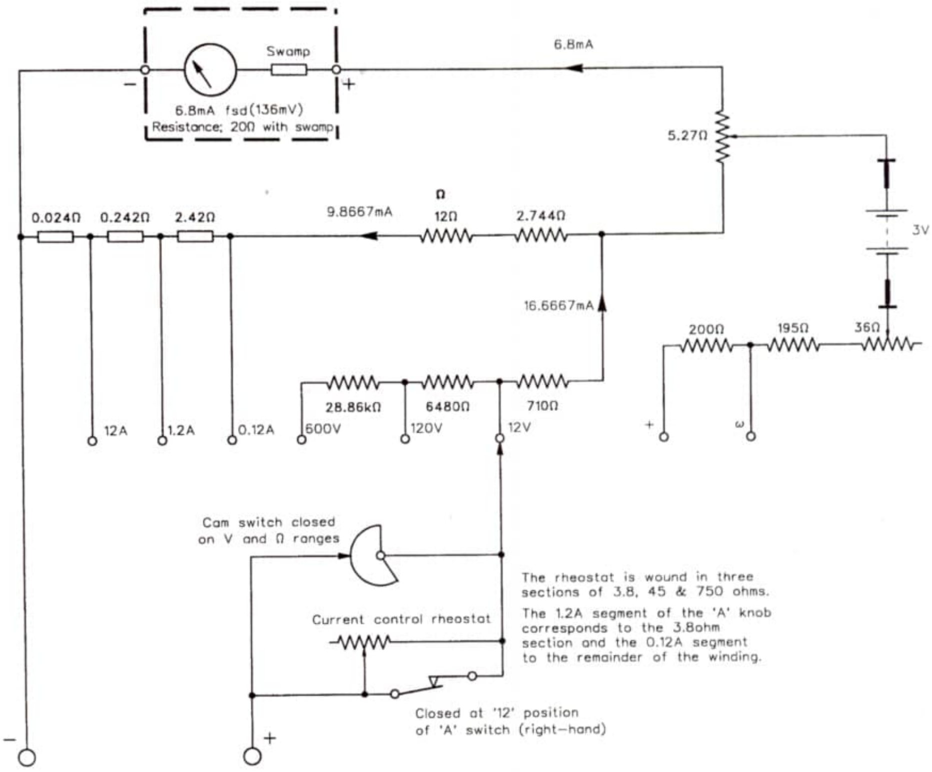


Fig.9b

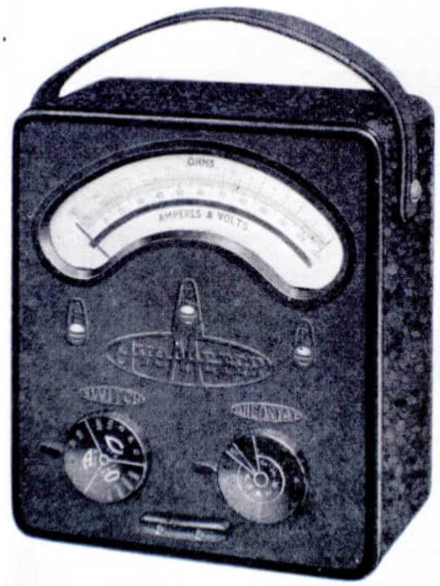


Fig.10 AVOmeter model 2 (DC, 1928 AVO advert, 8gns)

Fig.11 Universal AVOmeter model 3 (1932 AVO advert, 12gns)

Fig.12 AVOmeter model 4

in 1927 with the distinctive AVO bakelite case (Fig.10), and fsd current of 6mA on the voltage ranges of 0.12, 1.2, 12, 120 & 1200V; current ranges of 0.012, 0.12, 1.2 & 12A again with a series rheostat; and resistance ranges of 1, 10, 100k & 1MΩ.

In 1932, with the introduction of the Westinghouse copper oxide bridge rectifier, AC ranges became possible and the twenty range Universal Model 3 was introduced with a separate slightly nonlinear scale for AC (Fig.11), a fuse, and the right knob now setting the AC ranges of 1.2, 12, 120 & 1200V and 0.12, 1.2 & 12A. A current transformer was wound to divide the current down to the ratio required for the rectifier and movement and to correct for the fact that a rectifier instrument actually responds to the average rather the rms value required. On the lower AC voltage ranges the swamp is tapped into a higher current range to reduce the degree of nonlinearity.

Model 4 first appeared at the end of 1933 (Fig.12, 17x19x10.5, 11.5cm scale individually calibrated on white-painted aluminium and mirror-backed, separate AC and DC scales 0-120, and 0.1-1000Ω, mechanical zero Z, and P & R adjustors, aluminium case back, No.93-2011). This had a more sensitive 3mA movement with a shunt and series resistor, set to take 6mA at fsd at the same overall resistance, which is switched out when the ÷2 button is pressed. Thus if the deflection on any of the voltage or current ranges is less than half scale the button can be depressed for increased precision of reading. In this and succeeding models (until Models HR & 8) the universal shunt is not in circuit on the voltage ranges.

Temperature changes cause the resistance of a copper moving coil to increase by 3.93% for a 10°C rise. For a voltmeter employing a large series resistance this has negligible effect but for an ammeter with a low resistance shunt the reading will be reduced by this percentage. Usually, however, a small swamp resistance is placed in series with the coil to bring the total resistance to a specific value which reduces the coefficient pro rata. Furthermore, both a universal shunt and a ÷2 button will reduce this still more but, unfortunately, also introduce some temperature dependency on the voltage ranges. The final effect depends on the range and settings concerned and in Model 4 would be about 1-2% per 10°C.

Like Model 3 the movement is protected by a fuse but this does not protect the shunts. The transformer for the AC current ranges can be seen below the horseshoe magnet in Fig.12b with the black cylindrical instrument rectifier to its left attached to a limb of the case. After recalibration of this extensively repaired instrument the DC ranges are ±0.5% and AC ranges ±1% of fsd. Model 5 differed by the addition of a 480V AC range (240V on ÷2) for the power industry and Model 6 was a 22 range DC only instrument.

In 1936 Model 7 was introduced (Fig.13) with many new features and could be described as the classic AVO. A movement pivot must have a highly polished tip of small radius to minimise friction but this produces a very high pressure on the contact area. The jewels are therefore sprung mounted so that any shock is absorbed by the spring or in the limit taken by a more substantial part of the movement. A mechanical cut-out is introduced in which acceleration of the movement catches a trip, breaking the circuit to the instrument, before the pointer reaches a third of the scale, and has end trips as well. Connected directly across the movement is a rectifier which conducts only under overload conditions, thereby generating a DC component to operate the trip if AC is applied on DC ranges (Fig.13b, paxolin tube above magnet).

The movement sensitivity is further increased to 2mA (1mA at ÷2) and is scaled to 100 rather than 120. Full temperature compensation was introduced for the first time by a bimetallic-controlled slide-wire seen in the centre of Fig.13c. The spiral tightens as temperature falls moving the two fine contact wires to the right and adding extra resistance in series with the movement coil to maintain a constant total resistance. It covers a range of about 40°C.

The next innovation was based on the fact that the need for separate AC and DC scales is due to the increasing resistance of the rectifier as the forward current tends to zero which can be approximated by a small forward voltage drop. Thus if an offset of about a 1/3 division (2/3 on ÷2) is applied to the pointer on AC, and the sensitivity reduced slightly to counteract the offset at fsd, the same scale can be used for both. This offset is provided by the internal battery and, of course, the mechanical zero must be adjusted only on DC ranges. The required offset should, however, be proportionally smaller on higher voltage ranges which

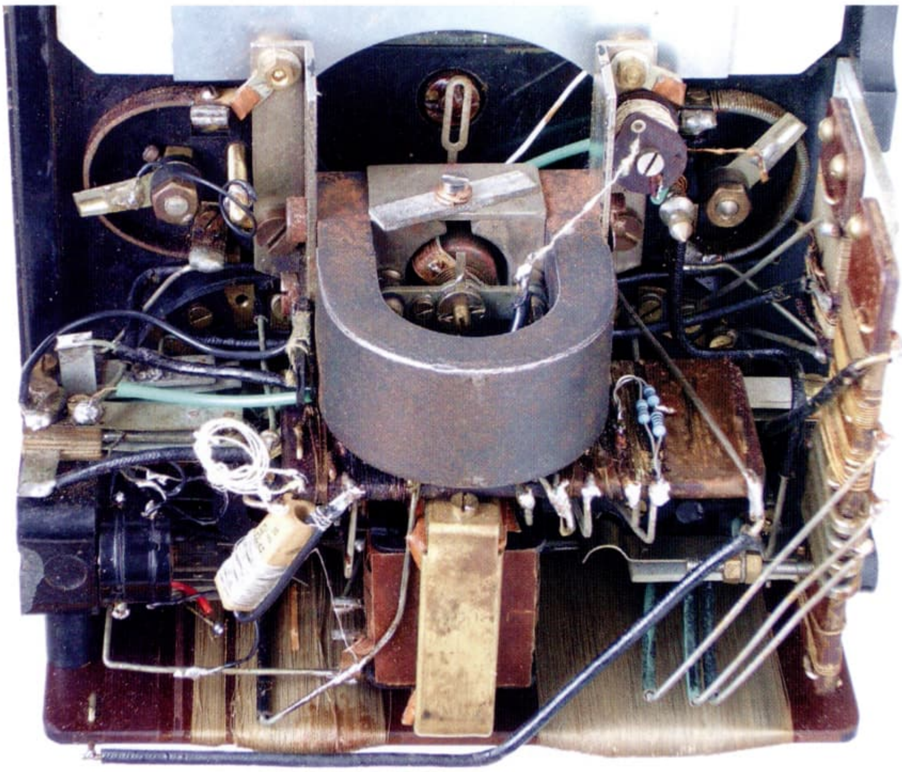


Fig.12b

Fig.13 AVOmeter model 7 [Mk I, Type I]

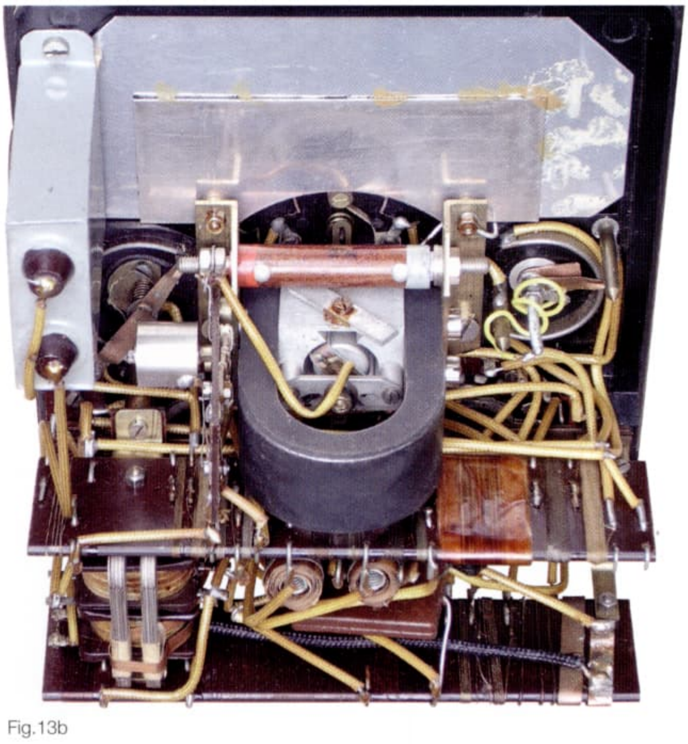


Fig.13b

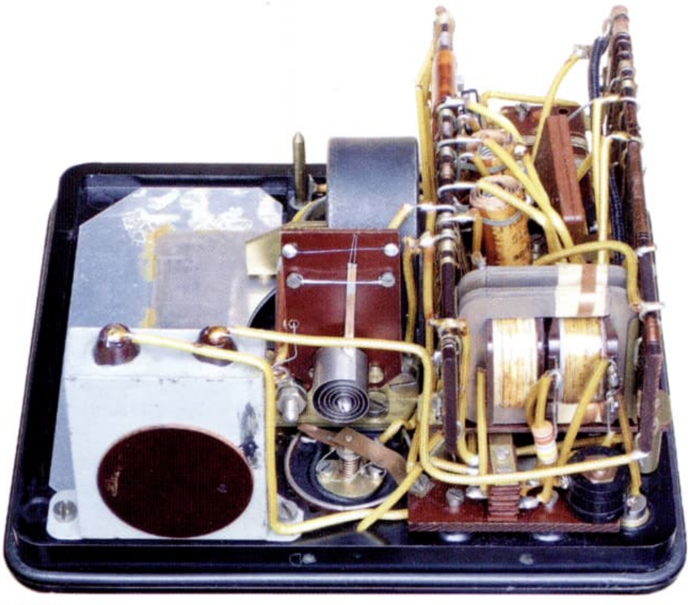


Fig.13c

Fig.14 AVOmeter model 40 Mk II

Fig.14b

Fig.15 AVO type D [1939, based on model 40]

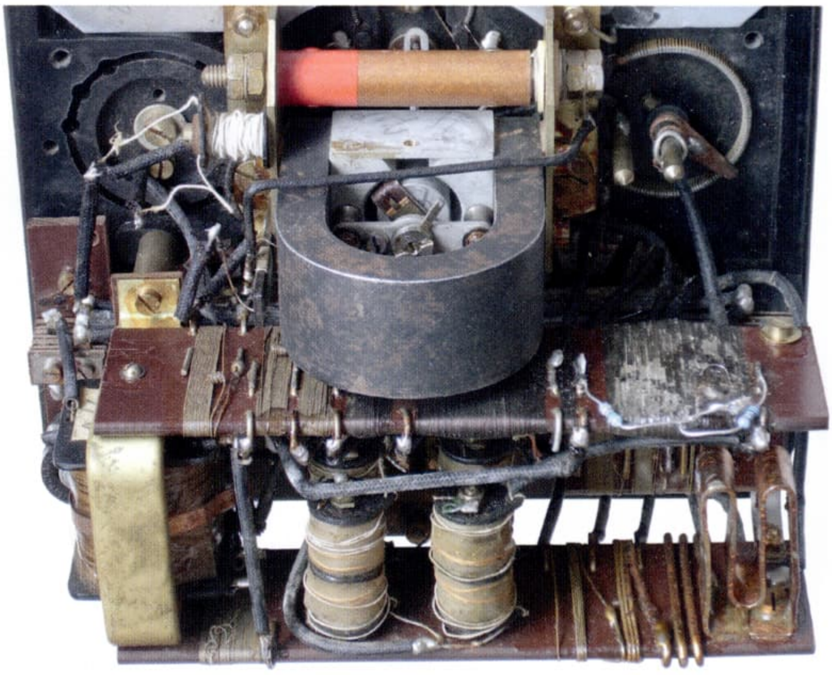


Fig.15b

does not appear to be the case. The other new feature was the inclusion of two new ranges: one for Capacity (0.01-20µF) using the AC mains and Q adjustor to set the pointer to infinity, and Power (1mW to 2W) & Decibel (-15 to +16dB) scales based on a 50mW reference level. The screwdriver operated P, R & Q adjustors were replaced by miniature knurled knobs.

A Model 7 [Mk I] Type II was introduced in 1948 with an improved Alnico magnet, some cracked carbon resistors, and a lower moving coil resistance of about 20Ω instead of 33Ω (both 50Ω including swamp). This reduced the temperature dependence (without correction) to a level now considered acceptable, and the bimetallic compensator was omitted.

In 1956 Model 7 Mk II was introduced with an Alcomax magnet and cracked carbon resistors replacing most of the wirewound ones used previously, and the copper oxide rectifier replaced by a bridge of four semiconductor diodes. In 1964 when the company moved to Dover individually calibrated scales were replaced by printed ones. One of several slightly differing scales was selected to best match any slight deviation from linearity. Power Factor sockets were also provided at the top to connect directly with the bridge rectifier.

Meanwhile in 1939, Model 40 had been introduced for the power industry returning to a 3mA movement and 0-120 scale giving a 480V range more useful for three-phase than the 400V in Model 7. The offset on AC was also dispensed with as it was probably inappropriate on the higher ranges and as the BS 89 specifications are wider for AC. A Model 40 Mk II (Fig.14) was introduced alongside the Model 7 Mk II, also with Alcomax magnets, Power Factor sockets and a diode bridge rectifier (Fig.14b on paxolin strip to left of movement).

In 1939 a derivative of Model 40 was produced for the Air Ministry known as Type D (Fig.15). This is scaled 0-75 and 0-150 with the ÷2 button replaced by a small knob which could be turned to K=1 or K=2. This has DC ranges of 0.15, 15, 150 & 750V and 0.015, 0.15, 1.5 & 15A, and AC ranges of 7.5, 75, 300 & 750V and 0.075, 0.75 & 7.5A at K=1, and double these values on K=2. The 30A DC range was useful for vehicle battery circuit testing. There were only two resistance ranges of 1000 & 10000Ω which had to be used on the K=2 setting. The movement sensitivity was slightly higher than Model 40 at 2.5mA fsd.

In 1946 the high resistance HR models were introduced for electronics use based on a 37.5μA movement permanently shunted to 50μA (20kΩ/V) by the universal shunt, but without AC current ranges.

In 1951 these were replaced by Model 8 Mk I which included full AC ranges and, in 1956 Model 8 Mk II had an improved magnet and terminals with 4mm sockets at their centres. In 1964 with Model 8 Mk III there was a return to temperature compensation with the inclusion of a thermistor, and the copper oxide bridge rectifier was replaced by a bridge of two diodes and two 406Ω resistors (Fig.16b bottom left corner). DC ranges: 2.5, 10, 25, 100, 250, 500, 1,000 & 2,500V; 50 & 250μA, 1, 10 & 100mA, 1 & 10A; 2 & 200kΩ, 20MΩ, (2.5Ω & 200MΩ with external units); and AC ranges: 2.5, 10, 25, 100, 250, 1,000 & 2,500V; 100mA, 1, 2.5 & 10A. The ÷2 button was replaced by a reverse button to avoid reversing the leads when mixed polarity circuits are being tested. Model 8 Mk IV came in 1970 with improved sensitivity on AC voltage ranges of 0.5mA fsd instead of 1mA.

Meanwhile Model 9 had been introduced in 1964 with clearer range dials and international symbols and a 0-30 scale replacing the 0-25 one thereby evening-out the overlap of ranges. In 1972 this was dropped in favour of Model 8 Mk V incorporating these improvements apart from the symbols and a redesigned case with larger window, and a centre pole magnetic assembly (DC: 3, 10, 30, 100, 300, 600, 1000 & 3000V; 50 & 300μA, 1, 10 & 100mA, 1 & 10A, AC: 3, 10, 30, 100, 300, 600, 1000 & 3000V; 10 & 100mA, 1 & 10A, Ohms: 2k, 200k & 20M). This basic design was carried through to the final 1992 Mk VII in which the 3kV terminals were removed, the main differences being internal with the use of printed circuit wiring, switches and shunts.

Voltage drop on current ranges

The use of a universal shunt for current means that many ranges have a higher voltage drop at fsd than a dedicated instrument using 4-terminal shunts. On the lower current ranges using the ÷2 button this measures as low as 60mV for Models 7 & D and 120mV for Models 4 & 40 up to

Fig.16 AVO model 8 Mk III

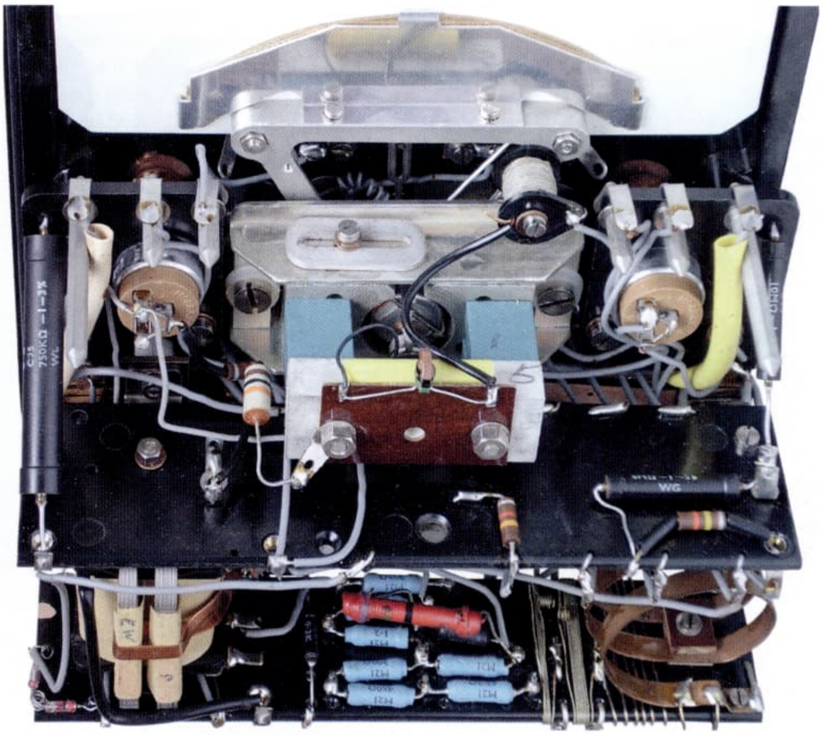


Fig.16b

Fig.17 EIL precision multimeter model 44

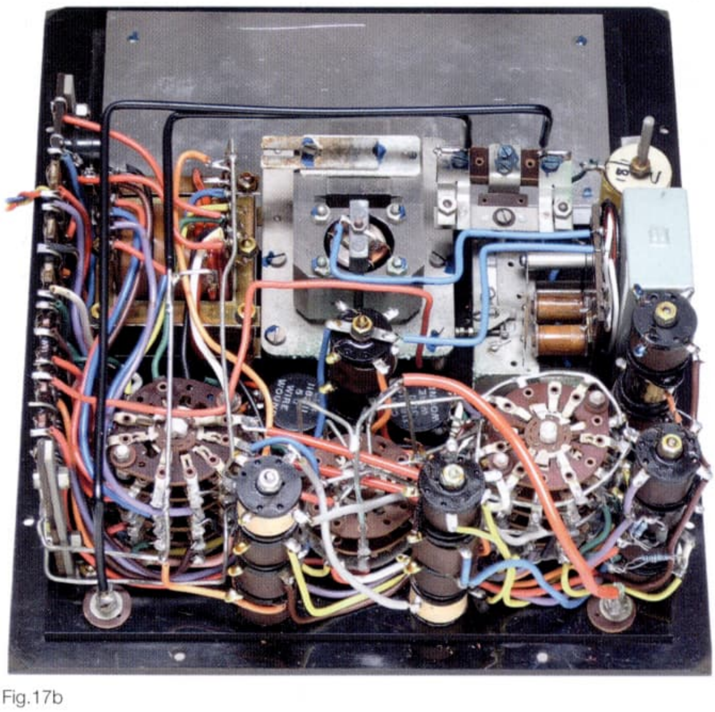


Fig.17b

Fig.18 Pifco All In One Testmeter

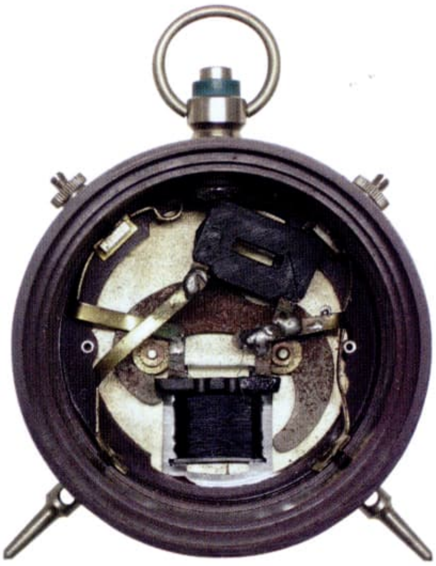


Fig.18b

Fig.18c

Fig.19 Universal AVO Minor

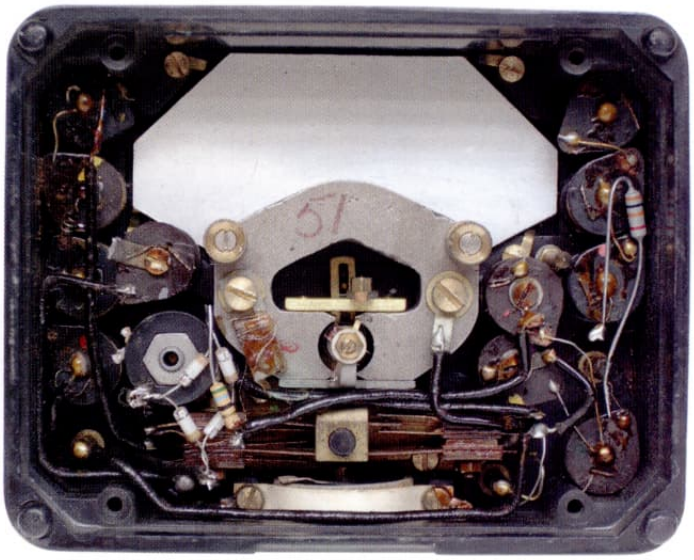


Fig.19b

about 400mV on the highest current ranges including the contribution of wiring and switch contact resistance. It is higher for Model 8 being 500mV on the low ranges up to 760mV on the 10A range. For some measurements it may be preferable to use a higher range at a lower scale reading.

By comparison the voltage drop was 75mV for the Elliott and 200mV for the Everett Edgcumbe ammeters described in Part 1 of this series. Many of the moving iron ammeters, however, were much worse with voltages up to 1.8V for the original Ayrton & Perrry, 1.7V for the Evershed and 2.4V for the NCS gravity ammeters. The lowest voltage drop on current ranges was observed with the Paul Universal Test Set above which, with its 4-terminal 0.1 and 0.001Ω shunts, drops 12.5mV on the 0.125A and 12.5A ranges, but 125mV on the 1.25 & 125A ranges.

On AC ranges using a current transformer the power at fsd should be the same on all ranges so the voltage drop becomes proportionately lower at high current settings. In practice, however, circuit resistance means that 120-220mV is dropped on the highest range in different models, with 50-120mV on the 1/1.2A range, rising to 0.8-2.4V on the lowest 10/12mA range.

EIL Model 44 Precision Multimeter

(Fig.17, 26x30x18, 16cm mirror-backed individually calibrated scales 0-50,-100,-200; DC & AC ranges: 1, 2, 10, 20, 100, 200, 500, 1000V; 1, 2, 5, 10, 20, 50, 100 & 200mA, 1, 2 & 10A; Ohms: 0.5 to 10000, 100000 & 1M; Power: 1mW to 4W, -10 to +19dB, Electronic Instruments Ltd, Richmond, Surrey, Model 44 No.44787, Certified Pr on DC and superior to Industrial on AC, at 20°C)

This instrument has a long clear scale appropriate for precision measurements. It has a neat compact Alnico magnet assembly with a 1mA movement of 13Ω supplemented by relay coils of 11Ω for the cut-out and made up to 200Ω with a swamp. This reduces the temperature coefficient on current ranges to less than 0.5% per 10°C. It does not use a universal shunt so in theory drops 0.2V on all ranges. The DC current ranges are accurate to ±0.25%. Although the voltage swamp resistors are all wirewound several of them have become open circuit probably due some corrosive action within the instrument which has affected other metalwork. Those that are intact appear to be accurate to ±0.1%. The AC current ranges are within ±0.7% and intact voltages within ±0.5%.

Instruments for amateur use

Most of the instruments described so far have been intended for the professional electrical or electronics engineer at an accuracy and cost not really justifiable for amateur use. With the interest in electronics stirred by wireless constructors a number of affordable meters were introduced. Many of these instruments have been described by Desmond Thackery in BVWS Bulletin Vol.17, No.3 (Jun. 1992) and the following issue by Ron Deeprose (Vol.17, No.4, Aug. 1992). Another fine collection of electrical instruments of all kinds may be viewed on Richard Allan's website: www.richardsradios.co.uk

Pifco All In One

This instrument (Fig.18, 7.5cm diameter bakelite case, four coloured scales, 0-240V black, 0-8V red, Valve & Circuit Test green, and 0-40mA yellow) could be described as 'creative' in offering four ranges with seven terminals when it has only one internal resistor of 5800Ω for the 240V range and a single AA cell in addition to its 200Ω movement. The needle of the instrument is held at an angle across the axis of the coil by the poles of a C-shaped magnet (Fig.18b). This holds the pointer at zero and when a current is applied the needle rotates towards the axis of the coil giving the appropriate reading on the pointer. The cream coloured celluloid back (Fig.18c) contains five holes to take a 5-pin valve to test the filament and is removed to replace the battery. Low resistance continuity would of course register 1.5V on the voltage scale, and the 0–40 mA and 0-8V ranges both connect directly across the movement but with separate terminals. The meter over-reads by 0 to 5% which is quite adequate for its purpose of checking LT and HT batteries, anode current and filament continuity.

Universal AVO Minor

In 1933 the AVO Minor was introduced to fill a similar niche in the market with many more ranges using a 2mA moving coil movement increased to 3mA by the permanently connected universal shunt, the various ranges being accessed by wander plug sockets. This DC only instrument was supplemented in 1938 by the Universal version with AC voltages added using a 1.67 mA movement shunted to 2.5 mA (Fig.19, 12x9.5x4.5 bakelite case, 7cm printed scale 0-20,000Ω, 0-50 mA&V, 0-5V AC nonlinear; 5, 25, 100, 250, 500V AC & DC ranges, 2.5, 5, 25, 100, 500mA DC only, The Automatic Coil Winder and Electrical Instrument Co. Ltd, Winder House, Douglas St, SW1, No. U86062.14S). This instrument used all wirewound resistors (although some have been replaced), which are accurate, although the movement now under-reads by 4-6%, over-reading on ohms by 10-20%.

Taylor Junior

Taylor produced a number of multimeters in competition with AVO, some with basic sensitivities as high as 100kΩ/V, the Taylor Junior (Fig.20) competing with the AVO Minor. (8x12x5, 6cm printed scale 0-2000Ω, 0-50, 0-25, 0-10, with a slightly nonlinear 0-10V AC range, Taylor Electrical Instruments Ltd, Slough, Bucks, England, Model 120A No. 97477). The DC ranges are 10, 50, 250, 500, 1000V & 5000V at 1mA fsd; 1, 10, 50 & 500mA; AC voltage ranges of 10, 50, 250, 500 & 1000, and ohms ranges of 0.5-2000Ω and 50-200,000Ω. DC current ranges use a universal shunt dropping from 250-450mV and the voltage ranges use cracked carbon resistors accurate to within 2%. The DC ranges under-read by 1.5 to 3%. The AC ranges under read by about 15% probably owing to a faulty rectifier.

Valve voltmeters

The Moullin valve voltmeter was introduced in 1922 by Cambridge & Paul as a high impedance wide frequency range instrument covering 0.5-1.5V AC, with later models covering wider ranges.

The AVO Electronic Testmeter Mk IV (Fig.21, 22x30x12, back-lit 7.5cm printed scale 0-25 & 0-100, ohms, capacity, megohms, watts & dB scales, ACWEECO No.73010-U-1155, case label No.1146 Type ETM4) appears to have been introduced shortly before 1955 but I have no information on its antecedents. Surprisingly, I have used this instrument over a longer period than any other, excepting my own homebuilt multimeter described in BVWS Bulletin, Vol.29, No.3 (Autumn 2004), as I first encountered it as a research student in 1957. I have no great affection for it, however, as it is a nuisance having to plug it into the mains, and it has to be zeroed immediately before making a measurement as its zero wanders by about one division even after long warm up. It is based on a 12AU7 double triode suspended on rubber threads (Fig. 21b centre) with the moving coil movement connected between the cathodes of a balanced pair of cathode followers, one grid being the input and the other a potentiometer to set zero. It is basically arranged to measure a voltage of 0-250mV at its input, at very high impedance.

The current ranges of 25, 100 & 250µA, 1, 2.5, 10, 25, 100 & 250mA & 1A are set by a universal shunt which because the valve voltmeter draws no current, drops 250mV on all ranges at fsd. The voltage ranges of 250mV, 1, 2.5, 10, 25, 100, 250 & 1000V are set by tapping a chain of resistors totalling 11MΩ which is therefore the input resistance for all voltage settings. A x10 socket introduces an additional resistor to give a total input resistance of 110MΩ and ranges from 2.5V to 10kV. DC ranges were specified to 2% of fsd. In fact the current ranges are accurate and voltage readings 1% low.

Fig.20 Taylor Junior Multimeter

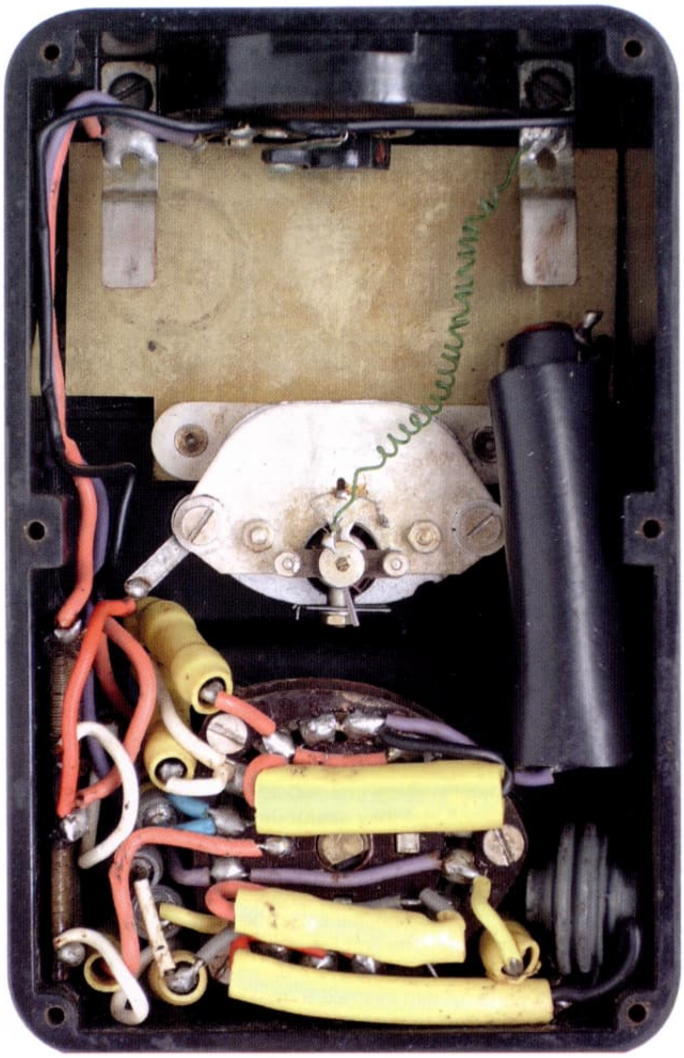


Fig.20b

Fig.21 AVO Electronic Testmeter Mk IV

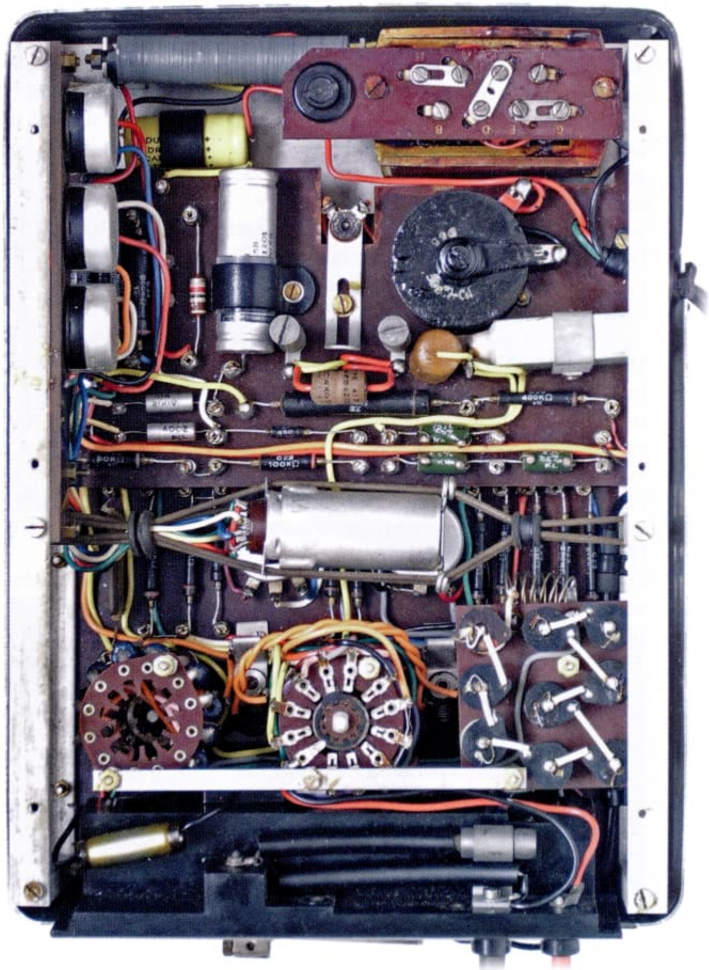


Fig.21b

There are four resistance ranges of 20Ω-100,000Ω ÷100, x1, x100 and a separately scaled 0.5-1000MΩ range, and two capacitance ranges of 0.0001-0.5μF and 0.01-50μF which compare the ratio of the unknown to internal capacitors of 0.005 and 0.5μF using the AC probe and a tapping from the mains transformer as supply. All AC and high frequency measurements are made via this double diode probe which can be removed from the case for RF measurements (Fig. 21a). A bias offset of 0.7V is applied to bring the AC readings into line with the DC markings above this level and which, unlike the Model 7 above, therefore gives less offset of the pointer on the higher ranges. There are two power ranges, 5-500mW & 0.05-5W, also marked in dB from -10 to +10, with an internal dummy load of 5, 10, 25, 600, 2000 or 5000Ω.

Footnote: My description of the galvanometers of the first three test sets as 'tangent' is not strictly true as the size of the magnetic needles and the geometry of the coils give considerable deviations from a tangent relationship.

The BVWS GPO list by Tony Constable

It all started in an article I wrote in the September 1976 Bulletin (Vol 1 Number 2. pages 6 and 7). I mentioned in the article that I had explored the GPO archives only to find not a trace of the original GPO registration list and even suggested it might have been purposely destroyed!! Therefore we should start reconstructing it ourselves. Towards the end of the article I asked readers to let me have lists of all the sets they had with registration numbers. I got a lot of replies to this request and I also made direct contact with several people I knew who had large collections and they responded very well. By the time I was preparing the next Bulletin (December 1976 Vol 1 No 3) I had gathered enough material to put together a starting list. I then set about categorising the registration numbers into crystal sets, one valve sets, two valve sets etc etc. The first list appeared in this December 1976 Bulletin on pages 7-9.

The numbering system seemed to make sense and provided a good start to the future of collecting more and more registration numbers.

Pye Ireland and the mystery transistor radios by Henry Irwin

Several years ago a friend of mine, who was professionally involved in electronics and who knew of my interest in collecting radios, was doing some work in the Republic of Ireland, just across the border from Northern Ireland. Browsing in a 'collectables' shop in the town of Dundalk he found an unusual transistor radio which he thought might interest me.

The differently styled Pam equivalent

A mixture of diverse trim and case creates a design reminiscent of the very early 1960's

The mystery Pam

A few days later my friend brought the wireless around. I recompensed him for the cost but I think he could see that I was puzzled as to why it was unusual. "Take a look inside the back" he said.

It was a fairly large Pam branded radio with a rectangular vinyl covered wooden case, not particularly striking in appearance, but not a model I had seen before. Inside however (sharp intake of breath!) was a huge 7 x 4 inch elliptical rear–facing speaker which used the slotted removable rear cover as its baffle. Certain elements shouted Pye. The antenna coil characteristically wound in the centre of the ferrite rod with PVC covered wire and the large 'Polar' tuning capacitor with reduction drive, were all common in Pye Group transistors of the late 50's and early 60's.

The mystery Pye

About a year later on eBay I spotted a Pye badged radio which superficially looked totally different. A rounded handbag type design with a brass surround frontal grille. However because of the relative positions of the horizontal volume and wave change controls and the tuning dial I had a strong hunch that inside was the same chassis as the mystery Pam above and I successfully bid for it. On receipt of the radio I was proved correct, inside was an identical chassis and rear facing speaker. To me this was the more visually interesting of the two radios and although it could be accused of using too many surface finishes and colours it was nevertheless visually striking almost despite these departures from the canon of good design practice.

And another

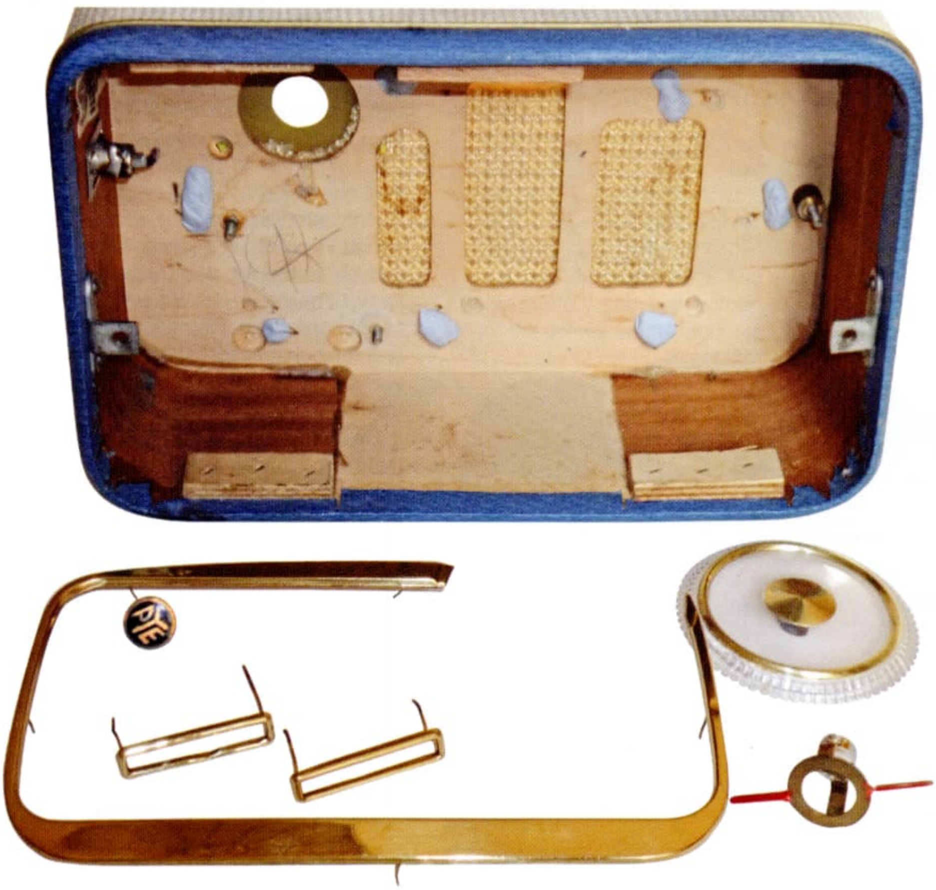
Shortly after acquiring the above sets I found a third Pye radio at a local car boot sale. It was about the size of a Bush TR82 and very heavy! The internal layout was different. It had a conventional front mounted speaker but, the construction of the circuit board was similar to the previous portables. This third radio is not examined in detail here.

So, here were three curiosities. No model numbers and no internal manufacturer's labels. Nothing like them was listed in 'Radio Radio' or in my collection of Newnes Radio and TV Servicing from 1957 through to 1968 and nothing in the Trader Year Books.

A closer look at the circuit and chassis

In some respects the chassis in both the 1st and 2nd radios looked as if it was anything other than Pye in origin. It was a substantial but compact metal assembly bolted to the inside of the case front and supporting, by means of a clamp, the mass of the large rearward facing speaker. Between the clamp and the chassis was a layer of what looked like neoprene rubber under compression, presumably to provide some acoustic decoupling. This metalwork also accommodated a printed circuit board, the tuning capacitor and the horizontally mounted volume and wave change controls

Surprise interior with rear-facing speaker



Inside cabinet & removed trim

which projected through slots in the fascia. The complexity of the construction can be seen in the chassis photographs.

Transistor leads were taken through holes in the printed circuit from the component side but these holes didn't align with the copper track on the other side. Instead they were offset and the leads were bent across and soldered flush with the adjacent copper track rather than through small holes in the copper itself. I have only ever seen this technique before in certain Perdio radios. All this was very unlike the Pye circuit boards I was familiar with which have long transistor leads straddling the circuit; it was altogether too tidy!

The service manual for these radios was not available through any of the usual sources but the circuit on inspection, although well assembled, is a completely conventional six transistor superhet. In fact by the standards of the early 60's it displayed none of the latest techniques, no alloy diffused RF transistors or no PNP/NPN Complementary Transformerless output stages. The line up uses Mullard alloy junction OC45 and OC81 transistors, the only 'oddball' being the mixer transistor (marked RFM) which is a metal cased generic device possibly sourced from Japan. The IF stages are single tuned and the output is transformer coupled to the speaker.

A circuit like this however is capable of very satisfactory performance if good quality components are used.

Acoustics

The question has to be asked, why go to all this mechanical complexity just to support a large rear-facing speaker? Was there a perceived acoustic advantage from having mid to high frequencies going rearward while lower ones could emerge from the front vents or was it just a way to accommodate a large speaker in a reasonably sized case? It seems to me that with a rearrangement of layout a front mounted large elliptical speaker could have been fitted in. It could also be argued that listening to a conventional radio, with a vented back, from behind would achieve the same effect!

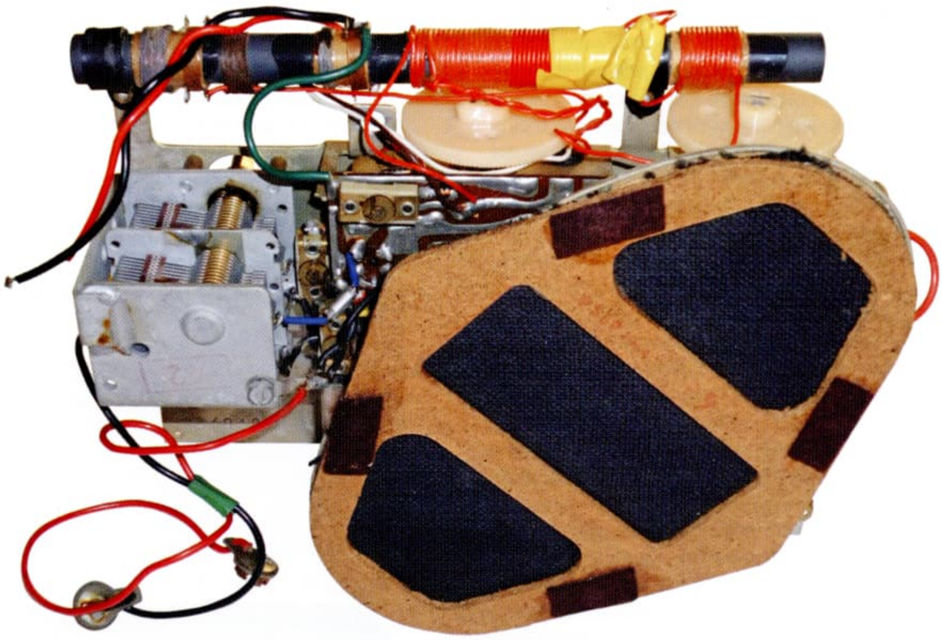
Yet a further change of material for rear baffle and slight warpage

The penalty incurred with the chosen arrangement is that consistent close contact is required between the back and the speaker each time it is removed and replaced in order to maintain a reasonable acoustic baffle. This is achieved by a hardboard spacer riveted to the speaker rim with little felt pads for the back to press against. This also places close tolerances on the positioning of the chassis in the case. As I said; a lot of trouble! In fact over time, this has created a problem. The Pam radio uses a thin synthetic material back and with over tightening of the securing screws this has warped. A more substantial plywood back has been used on the Pye badged radio and this has fared better although a slight degree of warping can still be seen.

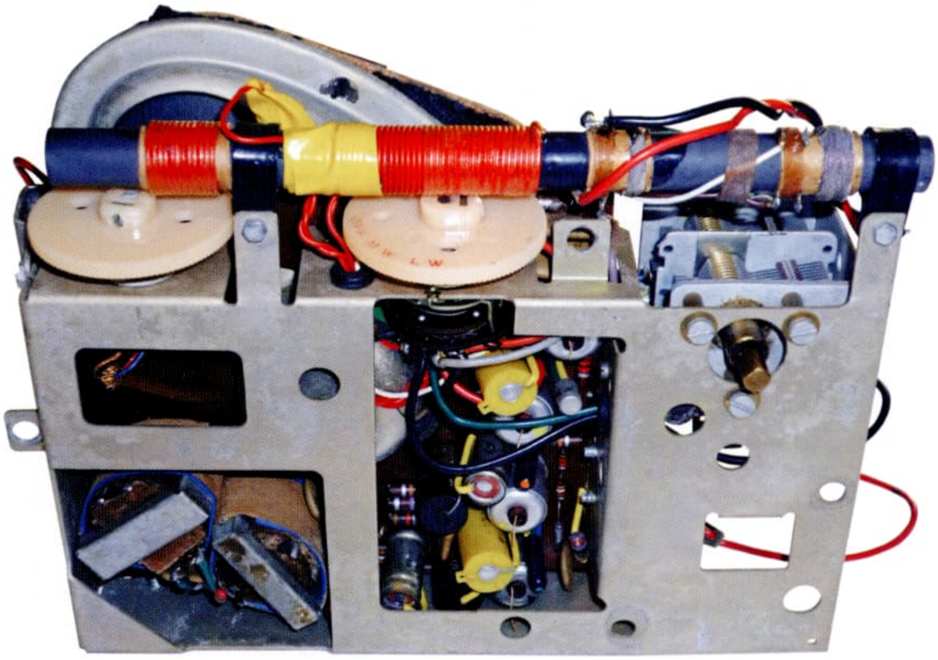
Something borrowed something blue

The red Pam was working but had a faulty speaker while the blue Pye was the more visually interesting so that was the one that I decided to concentrate on in terms of restoration. Almost immediately however I realized that the grille, the surround and tuning dial were identical to those used on one of the Portadyne transistor models from around 1961/62. A little later, browsing through pictures of various UK models online, it also became clear that the Rexine two-tone case was probably a modified version (except for the handle) of that used on the Baird 256 transistor portable of 1962.

The Pye–badged set is clad in two types of Rexine, blue flecked for the main case with a white and grey band around the sides while the back is a different textured pattern of grey Vynair. Rexine was a favourite with some makers of radios and record players in the 50's and early 60's. Wikipedia defines it as fabric weave impregnated with a mixture of cellulose nitrate, camphor oil and pigment. This surprises me a little as I always thought that cellulose nitrate was unstable. I believe more recent 'Rexine' material may have a different composition. At any rate it is a well known pain in the rear end to anyone who has tried to clean it!

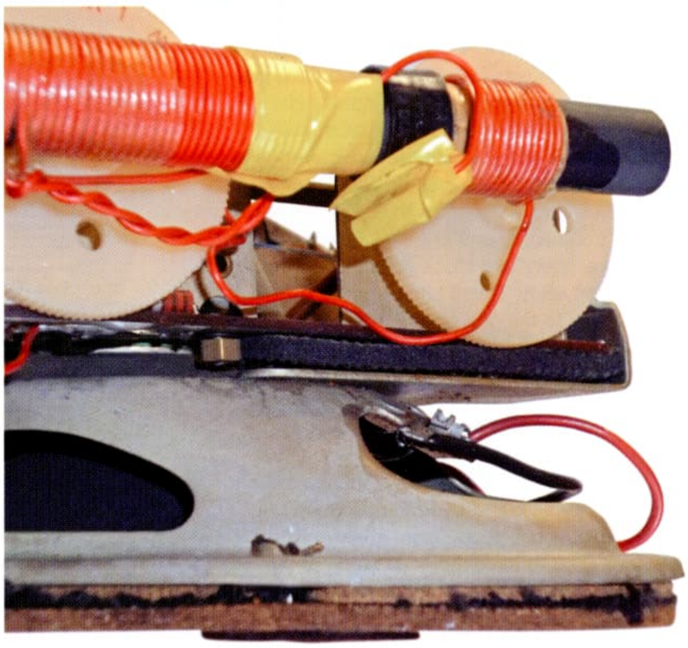


Complex compact chassis with original spacer and speaker cloth



Detail of assembly enclosing circuit board, output transistors are heatsinked on reverse side

Pye factory at Dundrum after closure



Close–up of speaker to chassis clamp with compression spacer

Cosmetics

Luckily the soiling to the case was not extensive. Most cleaners and detergents will begin to dissolve the pigmented filler of the Rexine while ordinary water will make no impression. The best approach I found is to remove all the trim, which would have been necessary anyway as it was badly corroded and to proceed cautiously area by area. A foam fabric cleaner called 'Vanish' was found to be the most benign, daubing each bit with a moist cloth and rinsing immediately with lots of water at the first sign of pigment colouration on the cloth. Some removal of the surface pigment will have to be accepted as the price for dirt removal and it is up to the individual to decide how aggressive to be and how far to proceed.

There were two areas of extensive wear at the top left and right sides of the case which were threadbare. I was lucky here again insofar as I found that Daler Rowney 'Coeruleum 111' blue acrylic artists paint was an almost exact colour match. After cleaning and drying I was able to touch these areas in with a fine brush and very thin layers.

The brass trim, including knob surrounds, had to be removed very carefully to avoid damaging the brittle plastic grille assembly. One end of the trim locates in a small recess in the plastic at the side of the tuning dial and it has to be eased out sideways. To aid this manipulation the brass wires from the rear of the trim, which pass through holes in the case and which are secured by staples in the timber internally, are very thin. I managed to get it out by only breaking one, which had to be re soldered.

After cleaning with Brasso, a difficult task due to its awkward shape and flexibility, the trim was re sprayed with lacquer and when dry the right hand edge carefully relocated in the recess and the flexible wires manipulated back through the holes. The internal staples, which had originally been snipped at one end to release the wires were protected by Blutack during cleaning and were now pressed back home to secure the wires.

The Pye badge which I originally assumed was enamelled brass, when cleaned, turned out to be plated. About 30% of the plating had gone. A search in a model shop produced a tin of Revell No 92 enamel paint which was indistinguishable from the original slightly coppery plating. Careful application of tiny amounts with a fine jewellers blade enabled the straight edge of lettered areas to be reasonably restored; not perfect but consistent with use and age.

A couple of years previous I had purchased several "new" old stock generic clear tuning dials on eBay. These turned out to be identical to the one on the Pye set, which had a badly tarnished brass trim and inset, so I was able to make a direct substitution.

Assesment and performance

The Pye badged radio had a noisy and intermittent on/off and wave change switch but this was cured by the application of Servisol and a good clean. Ideally I would have liked to have replaced some of the Hunts capacitors and/or the electrolytics but the necessity to dismantle most of the chassis assembly, with all those self tapping screws, to get access to the printed circuit, meant that I left "well enough" alone. Although well built internally, this is not a radio that makes servicing easy.

In practice the circuit performed quite well. Selectivity is good for a design with single tuned IFT's and sensitivity is also very good

Kapsch UKW Star c.1960

Baird 256 from 1962

Ingelen TRV 111

Portadyne transistor, model unknown

considering that the RF transistors are not diffused base types. This should probably not be a surprise since the Pye technique of winding the MW coil at centre of the ferrite rod ensures higher than normal signal input to the mixer transistor. Where it does lose out to a design with AF117 type transistors is that there is less gain in the IF amp within the AGC loop so that the output doesn't remain so constant during deep fades.

The big revelation was in the sound, considering the unorthodox speaker arrangement. We have to remember that this is not Hi Fi and that the AM transmissions are compressed and restricted in frequency range. Also this is a radio that is very dependent on its position in a room. Placed several feet out from a wall or near the centre of the room it produces a surprisingly powerful open sound with extended bass and little of the expected colouration. However when placed close to a wall there is increased colouration in the sound of the higher frequencies.

So, whether by accident or design, the unorthodox construction seems to have produced a radio that is less 'boxy' in sound than many similar sized competitors.

The Irish connection

The mystery of these radios was in their origin although there was obviously a Pye connection. The Pam was picked up in Eire and the Pye was purchased from an eBay seller in Dublin so here was a possible clue. The Dublin seller confirmed that it had belonged to a relative who had worked at Pye Ireland. He promised he would get back to me with further information but he never did. Later a retired service engineer in the town where I live, who worked briefly for Pye at Larne in Northern Ireland, said he thought it was made by Pye Ireland near Dublin.

Despite many enquiries in the Republic of Ireland, on Internet forums and with ex–members of the Trade, this fact has not been unequivocally established. I am almost certain that these sets were designed at Pye Dundrum independently of Cambridge for the Irish home market using a mixture of components, some Pye, and some generic trim items from other suppliers but unfortunately this remains unconfirmed.

Pye Ireland Ltd

The Pye radio business was purchased from William Pye by Charles Orr Stanley in 1928. He had originally intended to sell it on to Phillips but changed his mind. C.O. Stanley was from an Anglo Irish family and was brought up in County Cork. During the 1930's he became increasingly involved in the management of Pye Radio and in 1936 opened a facility to assemble radios in Dublin as a way of circumventing new Irish import taxes introduced by the then 'Free State' Government. In 1943 Pye moved into larger premises, a converted 'Mill' building in the Dublin suburb of Dundrum, which became home to its expanded Irish operations.

Pye Ireland was never an ordinary subsidiary of Pye Cambridge. It was much more autonomous than that, with the direct involvement of the Stanley family, and it continued as a more or less separate entity after the Phillips takeover of Pye Cambridge in 1967, closing eventually in 1985. It is not clear what proportion of Pye Ireland's output was for export but from 1965, I.E.C. (Irish Electrical Company) was formed as a separate brand to export products made at Dundrum. Radios branded thus always carry the I.E.C. identification and harp logo. However the radios which are examined in the current article appear to pre–date this arrangement and to have been designed for and sold only on the Irish home market.

The original buildings at Dundrum have been demolished and the site is now a shopping centre.

The European connection

Having established that the (false) speaker grille of the Pye badged radio is identical to that used in the Portadyne transistor radio it is tempting to assume that Pye Ireland were adapting surplus trim and mouldings from other UK manufacturers rather than designing cases from scratch. However during the period of research to try and authenticate my theories extensive browsing of internet sites revealed even more intriguing links. Consider the following: The fascia moulding as illustrated, used by both Pye and Portadyne, was also used by the Austrian firm Ingelen in their TRV111 transistor portable circa 1960. The large Pye transportable set referred to earlier in the text used identical fascia and trim to the UKW Star produced by the Austrian firm Kapsch, also in 1960. Finally, Portadyne's 'Minx' of 1962 used an identical fascia grille and surround to the Nordemende 'Mambo' of 1961. You can observe all this in the relevant photographs, only the manufacturers stampings in the metal have been changed!

Summary

There is nothing particularly unusual in Irish assembled radios. Murphy, Bush and Philips set up factories around Dublin while Sony assembled some of their products near Shannon. However all these enterprises essentially assembled almost exact copies of the parent company's main products. Indeed through the 40's and 50's Pye Ireland produced a series of radios and radiograms almost exactly like their UK counterparts. What the radios described here seem to represent is an independent design initiative, reconfiguring bought in case parts and aimed, at least initially, at the Irish domestic market. It should be appreciated that by the early 60's rural electrification or reliable TV coverage had not yet come to all parts of Ireland, especially in the remote west, so there was probably a market for solid, powerful, sensitive battery receivers that could double as a domestic and portable set.

Again I emphasise that I am making some assumptions in this article as well as posing some questions. However I would be pleased to hear from anyone with corrections or additional information or from anyone who owns any of the radios described.

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Radio Man, The rise and fall of C.O. Stanley; Pub. I.E.E.
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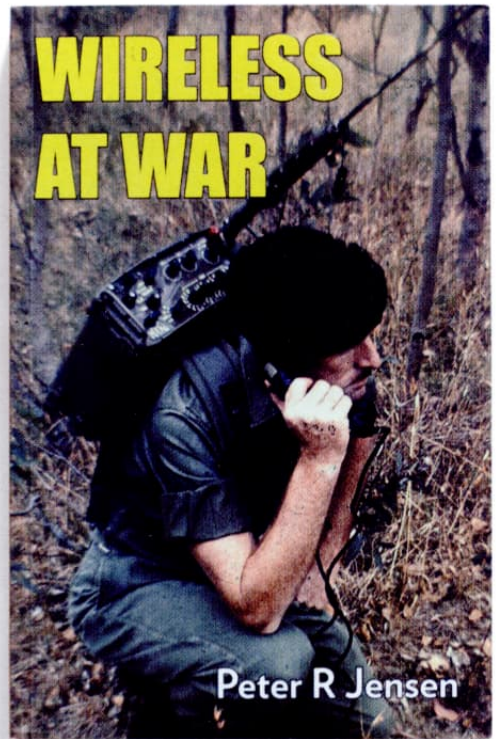
Book Review Wireless at war by Peter Jensen reviewed by Carl Glover

Rosenburg Publishing, 352 pages, isbn 9781922013477, £23.00 from Gazelle Book Services www.gazellebookservices.co.uk



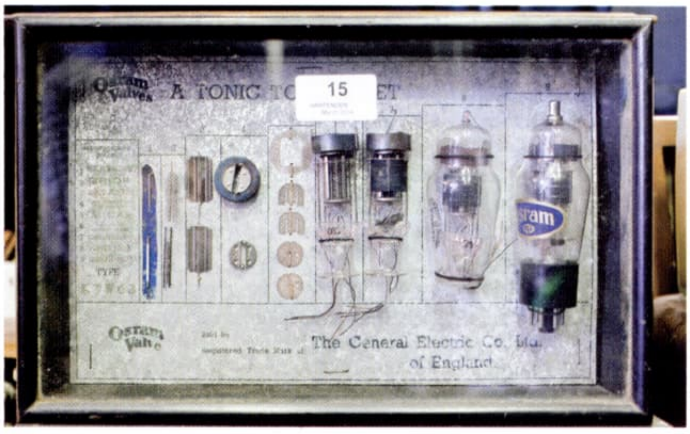
This book on the history of Australian military communications has turned out to be a bit of an eye-opener. As well as writing very clearly on the development of wireless technology, starting in 1895 and the effect it has on military communications worldwide, Peter has also managed to show Australia's role in various world conflicts. His description regarding the sequence of events leading to the Korean War is impressive, the same applies to Vietnam.

An interesting addition to a book of this nature are three home-constructor projects where the reader can have a go at making: a Wilson transmitter replica, a Paraset replica, and a solid-state double-sideband transceiver. The projects are presented in a similar way to articles in The Bulletin and will probably be a rewarding experience for those who wish to try it for themselves.

Peter's book is filled with interesting information, one that sticks out is the piece on Lancelot De Mole's invention of the tank in 1912, several years ahead of the inferior British Mark I's debut at the Battle of Flers-Courcelette in September 1916. Peter also has a brilliant piece on the battle of Tsushima in 1905, where the Japanese navy were able to defeat the second and third Pacific squadrons of the Russian Fleet due to having better wireless communications. Clandestine communications are brought to life with chapters on the Rjukan Raid and Operation Jaywick.

The strength of this book is in the clarity - it does not get lost or bogged down at any point and kept my attention throughout. It also has 250 photographs and diagrams which is no mean feat. I recommend this book and will certainly read it again when the fancy takes me.

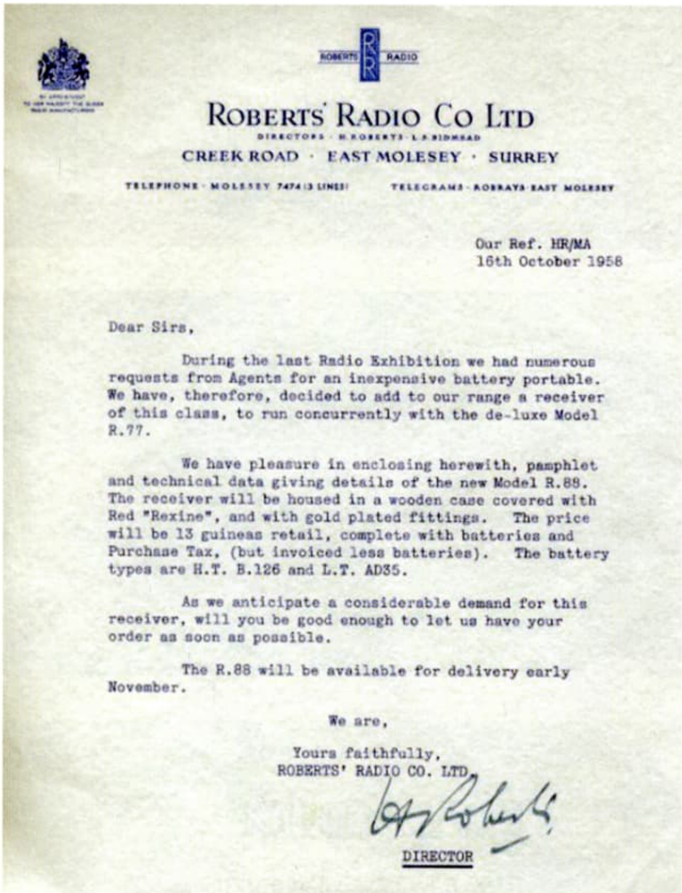
Harpenden Photographed by Carl Glover


15
The General Electric Co. Ltd.
of England

The R88 – Roberts' final fling at the valve portable

by Stef Niewiadomski

When the design department at Roberts Radio signed off the de-luxe leather-coated 'binocular' cased R77 into production in May 1957, they most likely thought that was the end of a long line of valve-based portables, and a new era was about to begin. Release of the transistorised RT1, in April 1958, was less than a year away, and no doubt all the designers were learning the new technology, so as not to be left behind.



ROBERTS RADIO

ROBERTS' RADIO CO LTD

DIRECTORS · H. ROBERTS · L.S. BIDMEAD

CREEK ROAD · EAST MOLESEY · SURREY

TELEPHONE · MOLESEY 7474 (3 LINES)   TELEGRAMS · ROBRAYS EAST MOLESEY

Our Ref. HR/MA
16th October 1958

Dear Sirs,

During the last Radio Exhibition we had numerous requests from Agents for an inexpensive battery portable. We have, therefore, decided to add to our range a receiver of this class, to run concurrently with the de-luxe Model R.77.

We have pleasure in enclosing herewith, pamphlet and technical data giving details of the new Model R.88. The receiver will be housed in a wooden case covered with Red "Rexine", and with gold plated fittings. The price will be 13 guineas retail, complete with batteries and Purchase Tax, (but invoiced less batteries). The battery types are H.T. B.126 and L.T. AD35.

As we anticipate a considerable demand for this receiver, will you be good enough to let us have your order as soon as possible.

The R.88 will be available for delivery early November.

We are,

Yours faithfully,
ROBERTS' RADIO CO. LTD.

DIRECTOR

Figure 1 (left): The letter of 16th October 1958 announcing to Roberts' agents the impending introduction of the R88. The signature is that of Harry Roberts, who was the joint-founder (with Leslie Bidmead) of the Roberts Radio Company in 1932.
Figure 2 (above): The restored radio. I believe red was the only colour available.

See Figure 1 for a letter from Harry Roberts, dated 16th October 1958, announcing to Roberts' agents that the R88, a low cost valve portable, was about to be launched. There had clearly been concern that Roberts' current models were too expensive, even for such a premium brand. The letter indicates that the price of the R88 would be 13gns (£13 13s 0d), including purchase tax and batteries, for delivery in November of that year. So as not to tease you for too long as to what an R88 looks like, Figure 2 shows my R88, in restored condition.

I'd guess that the R77 had rapidly become a difficult set to sell with the coming of transistor models from UK-based and foreign competitors, and the R88 was something of an afterthought. In fact the R88 used a chassis identical to that of the R77, and so it must have been in the cost of the case where the savings were made over the R77. Also it may have been that Roberts had many R77 chassis sitting in the factory in East Molesey, Surrey (on the opposite side of the River Thames from Hampton Court Palace) waiting for orders which weren't forthcoming, and the R88 was intended to use up remaining parts without having any more coach-built leather cases made. This also meant that a new chassis did not have to be designed, with the extra effort and time that would entail, and the introduction of the R88 was mainly a packaging exercise.

In fact R88 production was very limited, probably somewhere around 400 sets, according to some sources. Roberts' service sheet for the R88 is available at Reference 1, but I'm not aware of any significant circuit differences from the R77. As a far as I can tell there was no 'Trader' service sheet published for the R88, and presumably servicemen were expected to use the R77 Trader sheet, and work out any mechanical differences – such as how to remove the chassis from the cabinet – for themselves.

The design

The circuit diagram of the R88, taken from Roberts' own 'Technical Data' service sheet, is shown in Figure 3. The design is a four-valve 'all-dry' superhet covering the medium and long waves via a ferrite rod aerial, with an IF of 470kHz. The valve line-up is standard for a valve portable of the day, using 25mA filament valves: a DK96 self-oscillating frequency changer; DF96 IF amplifier; DAF96 detector and audio amplifier; finally a DL96 (with a 50mA filament) forms the audio output stage.

The cabinet accommodated separate 90V HT (an Ever Ready B126, or equivalent) and 1½V LT (AD35) batteries. Using separate batteries had the advantage that the batteries could be changed independently as each 'wore out', rather than having to throw away a combined battery with say an HT section still with some life in it, when the LT section was exhausted. The two batteries fit into the cabinet either side of the chassis PCB.

The restoration task

The radio as handed to me was a challenge, to say the least. Figure 4 shows the state of the case. You might not be able to see the numerous wood worm holes in the main part of the cabinet (how come these creatures seem to like chewing through Rexine, as well as wood?) and the lid was very eaten, and falling apart from what looked like water damage.

I removed the chassis from its cabinet by releasing the case bottom, unscrewing the two 6BA chassis securing rods and loosening the two clips that clamp the chassis plate to the front of the case. Luckily the front panel and the chassis hadn't been affected by whatever had caused the damage to the cabinet, and all the knobs were present and correct. On R77s the wavechange switch's knob has a habit of becoming separated from the radio and sometimes you see a white 'chicken head' substituted, which is fairly close to the original, but definitely recognisable as the wrong knob.

I decided that the remnants of the lid were not salvageable and that I would have to make a new one. Using ¼-inch plywood, and gluing and pinning the sections together, and filing to the final shape, this wasn't as difficult as I had anticipated, though I must admit I didn't attempt the dovetails of the original. Rather than try to source a new piece of Rexine material, I decided to try to re-use the existing covering (which seems to be thinner than the modern replacement you can buy) for the lid, which had completely detached itself from the old lid. The covering had a few holes in it and was badly faded but I thought it was worth a try. First of all I glued the material to the lid, folding it carefully round the corners, and then filled the worm holes and any obvious gaps in the Rexine. Then several coats of Woly red coloured shoe cream were applied and polished, which brought the colour back to a reasonable state.

I then drilled the holes for the handle fixing brackets and recessed the fixing lugs on the inside of the lid. The lugs were bent over on the inside of the lid before re-gluing the inside sheet of Rexine. The leather handle wasn't in bad condition and a good polish brought it up to a reasonable finish.

The main part of the cabinet had several worm-holes in it: I filled these with a mixture of fine surface filler and shoe cream. After removing the speaker grille (so that the polish didn't spoil the shiny metallic finish), the whole cabinet was then treated to several coats of red shoe cream and finally buffed to a shine.

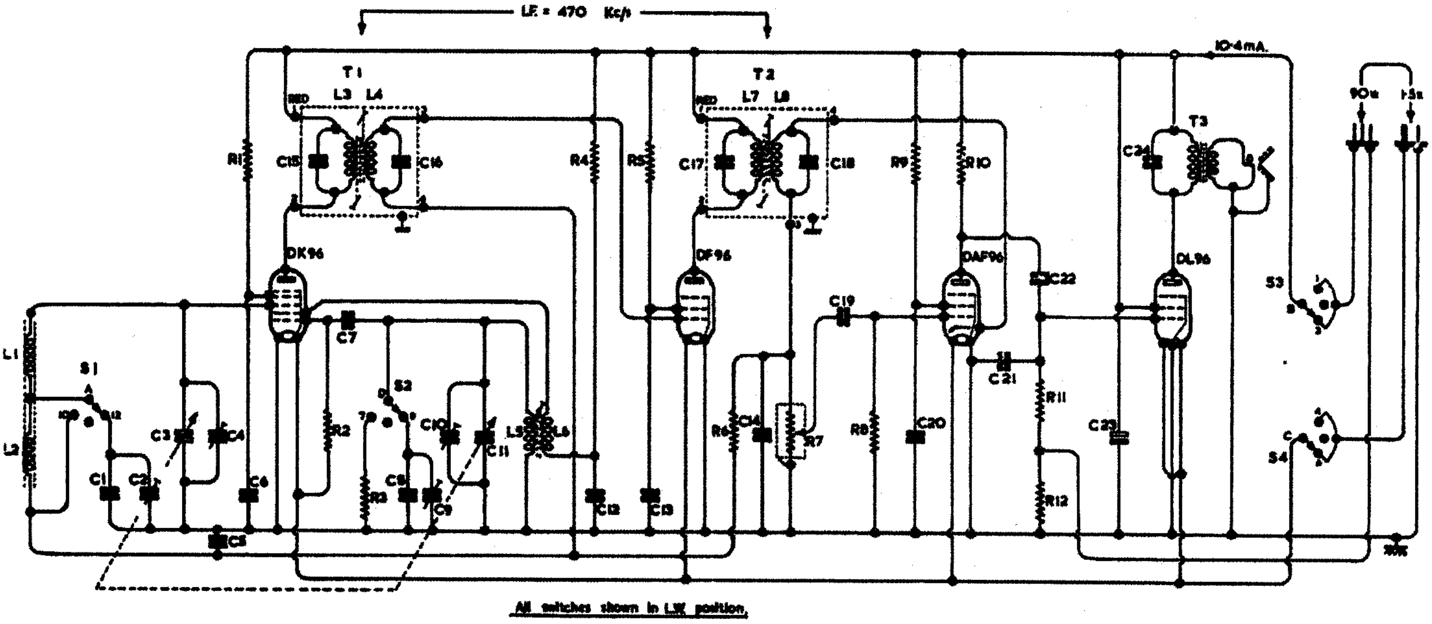
Small Screws

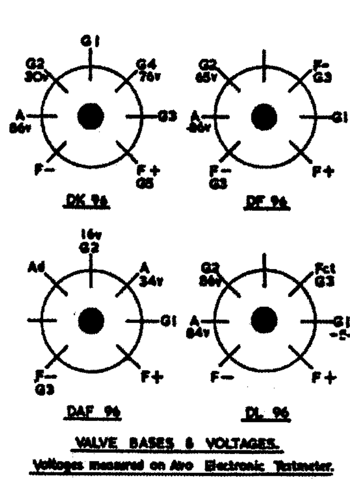
The hinges and lid catches (manufactured by Cheney) were all in reasonable condition, but the same could not be said for their fixings. One thing I definitely needed was a supply of small roundhead screws to re-attach the hinges for the top lid. The lid's original hinge screws had all but rusted away, there being very little thread left on them. After looking unsuccessfully at some suppliers of hinges and screws for dolls' houses, I found the right screws on eBay: they are No.2 by 5/16-inch long. I decided to use brass screws rather than the original plated steel ones, to ensure that they would last well into the future. Figure 5 shows one of the new screws alongside the rusted originals. The original screws for the bottom cover hinges were still in good condition, and didn't need any attention.

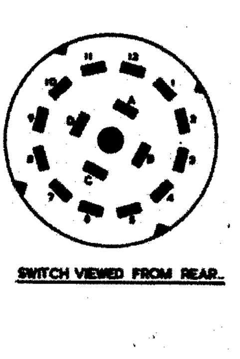
Originally the fittings on the radio were gold-finished. Most of this had worn off on my radio, but generally they were rust-free and polished up well to a silver finish.

The lid catch was secured by small pins, and these were rusted, so I decided to re-secure the catch with the same No.2 by 5/16-inch screws used for the lid's hinges. I needed to drill out the original holes in the catch, but this was no problem in the soft brass material used. It was this use of brass for the hinges, rather than steel, as the base material that had prevented them from rusting away as had the steel screws.

The restored cabinet is shown in Figure 6. It's by no means a perfect, as new, restoration and close-up it definitely reveals the rough history of the radio.







CAPACITORS				RESISTORS		OTHER COMPONENTS	
C1	120pF	C13	10000pF	R1	120KΩ	L1	0·5Ω
C2	3–30pF	C14	100pF	R2	27KΩ	L2	5·5Ω
C3	12–413pF	C15	100pF	R3	27KΩ	L3	8Ω
C4	3–30pF	C16	100pF	R4	33KΩ	L4	8Ω
C5	0·05uF	C17	100pF	R5	39KΩ	L5	2·7Ω
C6	10000pF	C18	100pF	R6	2·2MΩ	L6	0·9Ω
C7	100pF	C19	10000pF	R7	500KΩ	L7	8Ω
C8	280pF	C20	10000pF	R8	10MΩ	L8	8Ω
C9	3–30pF	C21	100pF	R9	10MΩ	T1	1st I.F. Transf.
C10	3–30pF	C22	10000pF	R10	2·2MΩ	T2	2nd I.F. Transf.
C11	12–177pF	C23	8uF	R11	2·2MΩ	T3	Pri 512Ω Sec 2·6
C12	10000pF	C24	2000 pF	R12	560Ω	S1-4	W.C. On Off
BATTERIES :– H.T. EVER READY B126.–L.T. EVER READY AD. 35.							

Figure 3: Circuit diagram of the R88, taken from Roberts' own 'Technical Data' service sheet.

Figure 5: One of the new small brass screws, and the rusty old ones.

Figure 6: The restored cabinet before the chassis was re-fitted. The batteries are inserted through the case bottom and I think were originally held in place inside cardboard tubes. My radio has the serial number B5551, engraved on a small plastic plate, attached to the inside of the bottom cover.

Figure 4: My R88, as donated for restoration by Mike Barker. The radio has a hinged lid over the controls and a hinged bottom cover, giving access to the batteries, and the chassis fixing screws and brackets. The lid looks as if it has been immersed in water for some time, and has also suffered considerable woodworm attack.

The chassis

There was some rust in two areas on the metal sheet to which the front panel and PCB are attached: I rubbed these areas down and treated them with Kurust. Happily the metal chassis and PCB were in good condition, and didn't seem to have been damaged by the damp which had attacked the lid.

The R77/R88 chassis was advanced for its time. The use of a ferrite rod aerial and a PCB pointed the way towards transistor designs. Ferrite rods had been used in previous models, but the use of a PCB was novel for Roberts. After soldering, the PCB was covered in a thin coating of wax to prevent corrosion, and this had probably saved my chassis from damage. The magnet of the 3-inch Rola speaker passes through a hole in the PCB and is secured via a bracket.

Using external 90V HT and 1.4V LT supplies I powered up the chassis, and no output could be heard on either band. Contrary to a commonly-held view I don't find the filaments of these battery valves to be a weak point, as long as you don't do anything really stupid with them.

In my experience the weakest valve in the D-series is the frequency changer: if it isn't capable of oscillating then you will get nothing from the radio, whereas with the other valves, if they are low on emission, then you'll get reduced output but at least you'll hear something. So I changed the DK96 – and now it worked, but only on long wave. I noticed that the tuning knob was slipping on the shaft of the tuning capacitor – tightening this up fixed the problem and now it worked on both bands. I checked the DC voltages on the valves to make sure that the resistors were still close to their original values, and that the capacitors weren't leaky. All seemed to be well. Rather than using paper capacitors, Roberts used radial tubular ceramic capacitors, which help give a compact PCB assembly and seem to have lasted very well into the 21st century.

The tuning capacitor is designed to have different maximum capacitances for the aerial and oscillator sections - 413pF and 177pF, according to the components list. This makes good tracking across the bands very easy to achieve. I believe this was the first time this arrangement was used in Roberts designs. Figure 7 shows the chassis: the dual-gang tuning capacitor can be seen at the extreme left, and Figure 8 shows the service sheet diagram of the chassis/PCB layout, to help identify where the components are located.

Figure 9 shows a front view of the chassis and front panel before being mounted back into the cabinet.

Related Roberts models and competition

In April 1956 the R66 (a two band battery / AC mains valve portable) was being sold for £13 19s 9d, batteries and purchase tax extra. Purchase tax on radios at the time was about 38%, so that came to about £20 in total for a working radio.

In the 1959 Wireless and Electrical Trader Yearbook (see Figure 10) the R77 (successor to the R66, but operating from batteries only) was then selling for something like £20: note that the R66 is still being sold, it being the only mains / battery model. And there is also Roberts' first transistor model - the RT1, which had been released in April 1958 - commanding a price of about £24. Thirteen guineas for the R88, including tax and batteries, was definitely a bargain.

Roberts traded on quality, rather than price and quantity, and it was typical for them to have only three or four models in production at any one time. One of Roberts' selling points was their association with the Royal family which brought about their receiving several Royal Warrants over the years. Reference 2 describes this long drawn out process rather well.

Other than Roberts, there were two major radio manufacturers in the UK who focussed on portables: Ever Ready had nine models listed in the 1959 Yearbook (including two transistor models), and Vidor had ten models listed (including one using transistors). Strangely, from such dominant positions both companies were already on a downward slippery slope: Vidor's sales declined rapidly and radio production stopped in 1960. Ever Ready faired only slightly better: they made it to the mid-sixties before they stopped manufacturing

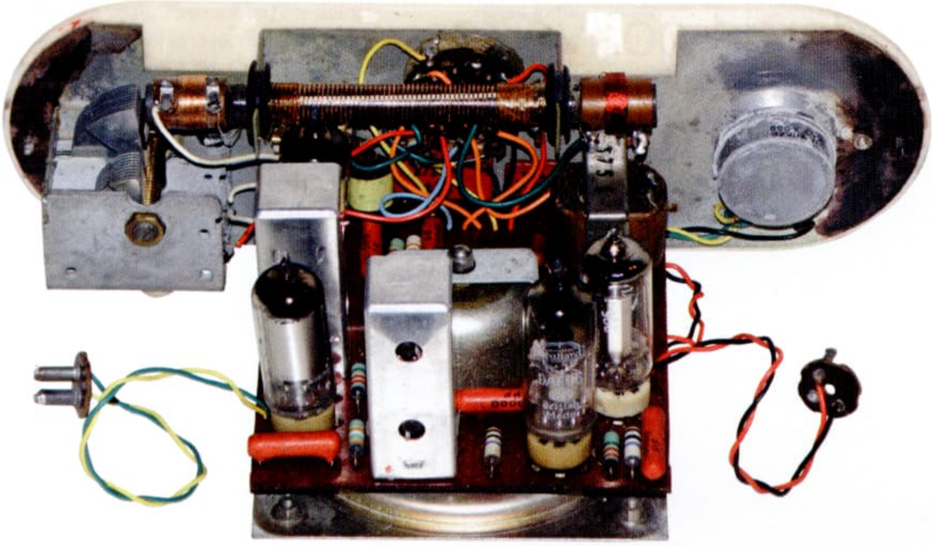
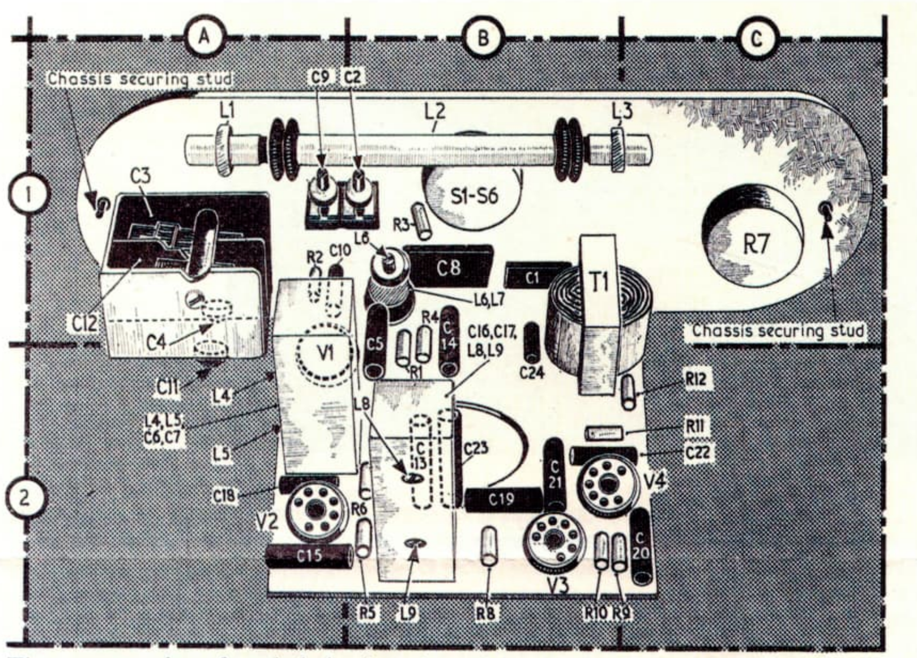


Figure 7: Rear view of the chassis of the R88 removed from the cabinet. This is identical to the R77's chassis. The bell-shaped object protruding through the PCB is the magnet of the Rola speaker and its fixing bracket.



Three-quarter view of vertical chassis and panel showing component positions. Chassis securing studs in A1 and C1 are referred to under "Dismantling."

Figure 8: The service sheet diagram of the chassis/PCB layout, to help identify where the components are located.

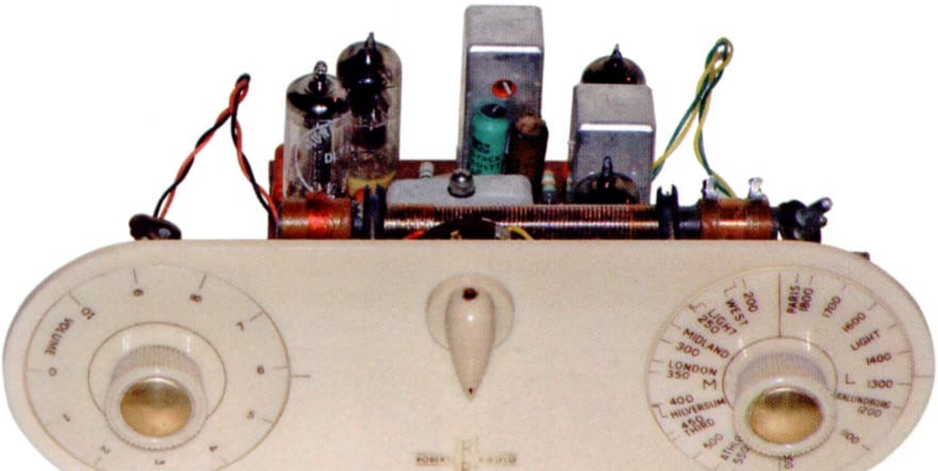


Figure 9 (above): Front view of the chassis and front panel. I can't see any moulded markings for the On/off – bandswitch positions: perhaps this was originally a transfer that has now worn off?

Figure 10 (right): The Roberts entry in the Wireless and Electrical Trader Yearbook for 1959. Note that the R66 is still being sold (it being Roberts' only mains/battery model at the time) alongside the R77. Their first transistor model - the RT1, which had been released in April 1958 – is considerably more expensive than the R77. The R88 doesn't get a mention

radios in Wolverhampton. The two companies continued to make batteries for many years, and the brand names are still in use.

Of course Roberts Radio is still with us, making AM, FM, DAB and Bluetooth radios. Their 'Revival' radios, based on the classic 1950s cabinet designs and using modern electronics, are amongst their best sellers.

Conclusions

The cabinet of my Roberts R88 was a challenge to get into reasonable restored condition, but well worth the effort to save a relatively rare valve portable radio. It is generally accepted that about 400 examples of this radio were ever produced, and only a few still survive.

The R88 was launched at the end of the valve era, as far as Roberts were concerned, and based on the chassis of the more familiar R77 model. It seems to have been a response to Roberts' agents who were asking for a low cost valve portable, to sell alongside the R77 and the new, transistor-based RT1. Whatever the rationale behind the R88, it was definitely an afterthought and not very well planned.
To me, aesthetically the semi-circular ends of the front panel - designed to match the shape of the R77's 'binocular' leather case, and the circular dials don't sit well with the rectangular cabinet of the R88, and the whole combination is not exactly a match made in heaven.

It would have been interesting to have been a fly on the wall at the design meetings for the radio, and to have recorded the reaction of whoever was responsible for the styling of Roberts radios. No doubt he was not very happy with the outcome. The only positive result was that Roberts survived a critical period for UK radio manufacturers and went on to thrive as domestic and portable radios switched to transistors, and later to ICs.

References

Reference 1: The Roberts' service sheet for the R88 is available at: http://groups.yahoo.com/group/robertsradiogroup/

Reference 2: 'The History of Roberts Radio' by Keith Geddes and Gordon Bussey, published by Roberts Radio is a brief, illustrated history of the company. I believe there were several editions of this book: my edition is dated 1987. The R66 and R77 are described in the book, along with pictures, but the R88 isn't mentioned.

The Lucerne, Switzerland-based Radiomuseum contains a wealth of online information or radios, TVs, etc. A good starting point for exploring what they have on Roberts sets is: /www.radiomuseum.org/r/roberts_r88.html

Roberts Radio's current range, including many 'Revival' models can be found at: www.robertsradio.co.uk/index.htm

Roberts

ROBERTS' RADIO CO., LTD., Creek Road, East Molesey, Surrey.

Distribution policy:—Selected dealers.
(Prices include batteries unless otherwise indicated.)

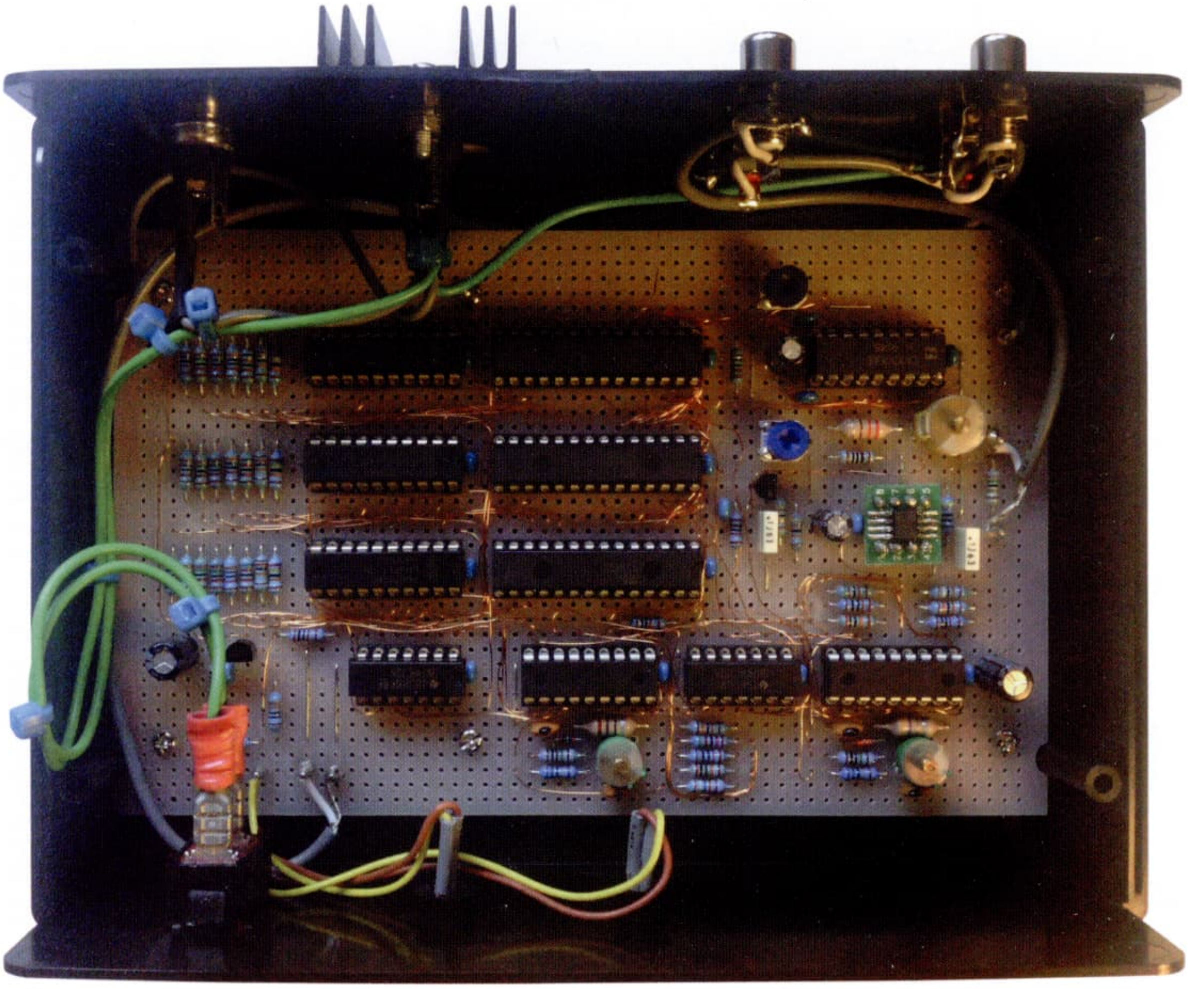
R66.—4 v (plus two metal rects.) AC/AD 2-band portable. Int. aerial. DK96, DF96, DAF96, DL96. 470 kc/s. ML. 200–250 V. HT (90 V). Ever Ready B126; LT (1·5 V) Ever Ready AD35. £13 19s 9d., plus tax £5 7s 9d. Batteries 10s 6d. Cover £1 11s 6d extra. April, '56. (Service Sheet 1273.)

R77.—4 v AD 2-band portable with printed circuit. Int. aerial. DK96, DF96, DAF96, DL96. 470 kc/s. ML. HT (90 V) Ever Ready B126; LT (1·5 V) Ever Ready AD35. £13 4s 7d., plus tax £5 1s 11d. Batteries 10s 6d extra. May, '57. (Service Sheet 1321.)

RT1.—6 transistor (plus diode) 2-band portable. Int. aerial. OC44, OC45 (two), OC71, OC72 (two). 470 kc/s. ML. PP8 6 V battery. £17 8s 9d., plus tax £6 14s 3d. Waterproof cover £1 11s 6d. extra. April, '58. (Service Sheet 1357.)

A 625 to 405 standards converter

by Karen Orton



Disclaimer

I must begin by explaining that this design uses techniques to which there is either scant or no reference in manufacturers' data sheets. For example, my use of LC tuning of PIC oscillators is not mentioned at all in Microchip literature. More seriously, Microchips do not guarantee the timing relationship between the PIC oscillator and PIC I/O state changes sufficiently for what I have done in this design, namely, gate the PIC oscillator using a logic gate controlled by an I/O line. I have used a software strategy to minimise jitter on my phase locked loops. This strategy might already be patented. I offer this design information purely for personal interest and/or educational purposes. I offer no guarantee or warranty of any kind whatsoever in connection with this design and I make no statement, either explicit or implied, regarding the fitness for purpose, reproducibility, originality, accuracy or safety of this design. This standards converter produces a non-standard video waveform, and while it is not the first to do this, be aware that some TV sets may react badly to this non-standard signal, possibly resulting in damage to the TV. There is a small risk that the non-standard TV waveform produced by this converter could lead to excessive EHT with attendant risk of electrocution. Persons or organisations make use of the information contained in this article entirely at their own risk.

I would further add that this is not a polished design that could be expected to work 'straight out of the box'. A significant level of expertise and skill will be needed, along with some professional test equipment, to reproduce this converter and make it work reliably. If you don't have these skills or equipment, or if you want something that will work without fuss, then I recommend you purchase an Aurora converter from Darryl Hock.

Even a cursory examination of the needs of 625 to 405 standards conversion reveals the enormity of the task: while the frame and field rates are unchanged, the difference in line rates results in many and varied timing relationships between input lines and output line - timing relationships that only re-align (and therefore repeat) every 125 input lines or 81 output lines. As a consequence, true conversion between these two standards requires very serious attention to interpolation in order to avoid visible artefacts in the converted video. Only a few converters have implemented this interpolation fully (the currently available Aurora converter being one of them).

To avoid a heavy interpolation overhead some converters opt to produce a modified video signal which, while not standard, can be tolerated by most 405 line TVs. The modification is based on shifting the input/output line ratio from the standard 1.54 to precisely 1.5 that is, forcing the output line duration to exactly 1.5 input line durations. This results in a line frequency which is 3% higher than standard and a line count which is closer to 417 than 405. A less obvious consequence of this scheme is that the video signal so produced is triple interlaced. With 208.33 lines per field, a new field can begin at any of three different places within the last scan line. Thus, although this non-standard video signal can be thought of as 417 lines, it is really 625 lines with a 16.67Hz frame refresh rate.

Apparently, such a triple interlace scheme was seriously considered back in the 1960s as a means of increasing resolution on existing 405 line TV sets. The method was rejected on the grounds that the resulting 16.67Hz localised flicker would be objectionable. Anyway, a triple interlace scheme is the method employed by this converter and serves to simplify the conversion process: At the line level it is a straightforward matter of turning three input lines into precisely

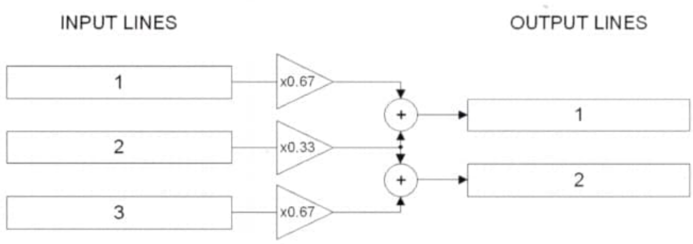


Figure 1

two output lines. The method for doing this (interpolation) is described by the associated diagram. As can be seen, each input line features in the output to the extent of 0.67, with the middle line being split and used in both output lines with a weight of 0.33. This ensures equal presence of all input lines while maintaining some measure of correct vertical position within the output field. It is a simple interpolation method that works well (see figure 1).

My converter uses three line stores based on 1k by 9 bit asynchronous FIFO memories, these devices having the advantage that they can perform input and output simultaneously. They also provide all of the address generation that would otherwise be needed if static RAMs were the basis of the line stores. Most significantly though, these FIFO memories have a 'retransmit' feature which is exploited for the purpose of repeating the second of each input line triple, so that it can contribute to both output lines as required by the outlined interpolation method.

This is a 'partial field store' approach to standards conversion which avoids the large memory requirement of storing entire fields or frames. There is a one or two line delay in the video signal due to the interpolation processing but this is compensated for by adjustment to the timing of the field synchronisation signals in the output video. The modified standard will probably result in a narrower picture due to the shorter line duration. This can usually be corrected by adjustment to the set's width control. If this is an internal control then this adjustment must be done by a suitably qualified professional because there are lethal voltages present inside 405 line era television sets. Alternatively, correct aspect ratio might be restored by adjustment of a set's height control.

Two 16F series PICs are employed in my converter. The first has its clock running at the 625 line pixel rate (13.5MHz) and manages a six bit flash analogue-to-digital converter (ADC). It also manages the capture of input lines in the three line stores. This capture is done on a cyclical basis such that there is always a history of the last three input lines in the line stores. The second PIC has its clock running at the 405 line pixel rate (9MHz) and manages the retrieval of lines from the stores, their interpolation, and their mixing with output synchronisation pulses for delivery to a modulator. Both PICs implement a phase locked loop (PLL) which locks their clocks to input synchronisation pulses. I have used a simple one transistor synchronisation pulse separator in previous converter designs and found this to be reliable.

Finally, the whole converter is preceded by a 625 line signal conditioner IC which includes out-of-band filtering, automatic gain control (AGC), DC restoration and buffering. The converter has twelve ICs in total and fitted comfortably onto a Eurocard-size prototyping board. The board is powered from a single 5V regulator, which in turn is powered from a 9V 'wall wart' power supply. The board draws something in the region of 100mA.

The weakest part of the design centres around the aforementioned poorly defined timing relationship between the PIC's oscillator waveform and state changes on the PIC's I/O pins. The converter design requires that the clock waveform be gated, under the control of PIC I/O pins, and this could potentially give rise to short duration spikes on the gated waveform which in turn could lead to erratic behaviour of attached logic. It was anticipated that small delay networks might be required on these gating I/O lines, in order to align the I/O pin state changes with the low period of the clock waveform. This will then ensure clean starts and stops of the gated clock signal.

As things transpired I didn't need these delay networks but that doesn't mean that all PICs from all batches will be so obliging. Any delay required to eliminate spikes in the gated clock waveforms will be small - of the order of 50 nanoseconds - and will involve a resistor of a few kilo-Ohms in combination with a capacitor of a few tens of picofarads. It may even be sufficient to use a resistor alone, as this will form a time constant with the small but significant pin capacitance of the 74HC132N.

The converter's preset adjustments are best done after the unit has been powered for some minutes, so that the temperatures of ICs have stabilised. On no account should the converter be connected to a TV until all preset adjustments have been performed and tests have established that the converter is outputting a valid, stable signal. With a 625 line signal present on the converter input, the 22pF trimmer capacitors are adjusted with an insulated tool until a steady 2.9V (or thereabouts) is present on the respective test point ("TP"). The preset resistors control the references to the ADC and are set to span the range of the incoming video waveform. Pin 10 of the ADC should be at the same level as the tips of the synchronisation pulses while pin 9 should be at peak white level. The conditioner IC stabilises these at around 0.8V and 1.8V respectively.

The 65pF trimmer tunes a filter on the ADC input for attenuation of the colour subcarrier. Optimal setting can be determined by observing the filter's effect on the colour burst however, it is not 100% effective. Fortunately, the high sample rate employed by the ADC obviates aliasing of any residual subcarrier, which would otherwise give rise to patterning on the converted image.

The output frame synchronisation waveforms are simple extensions to the original 405 line (System 'A') specification, adapted for the triple interlace requirement of the converter. Interlace was found to be quite adequate without equalisation pulses. The following diagram details the waveforms for the three fields of the modified standard (see fig 2)

Acknowledgements
The interpolation method employed in this converter was explained to me by Darius Mottaghian and is used unmodified in my converter. The TV9-90 I used during development and testing of this converter was kindly donated by Jay Oldstuff. I am also indebted to Vic Brown, Peter Smith and Jeremy Jago of the NBTVA for their encouragement and patience.

Photos
Below are some screen shots of the converter in action.

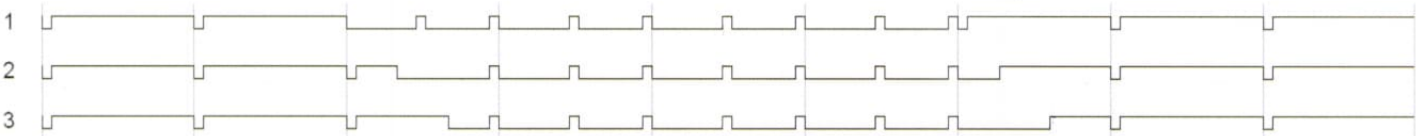
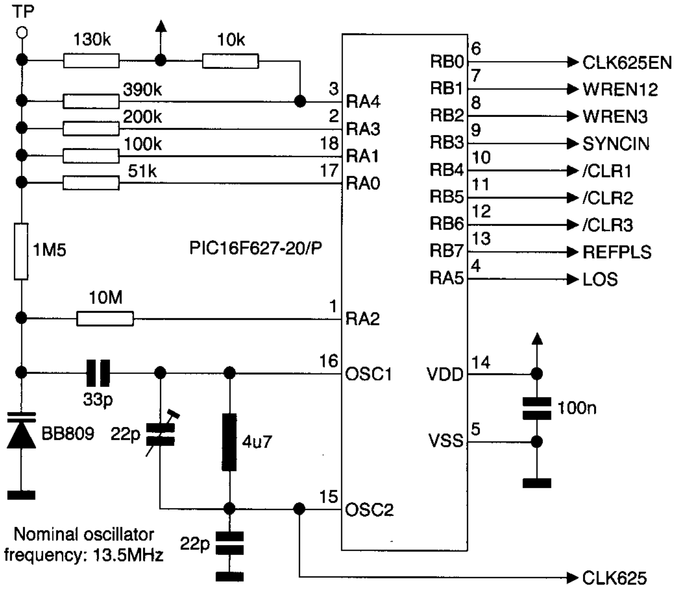
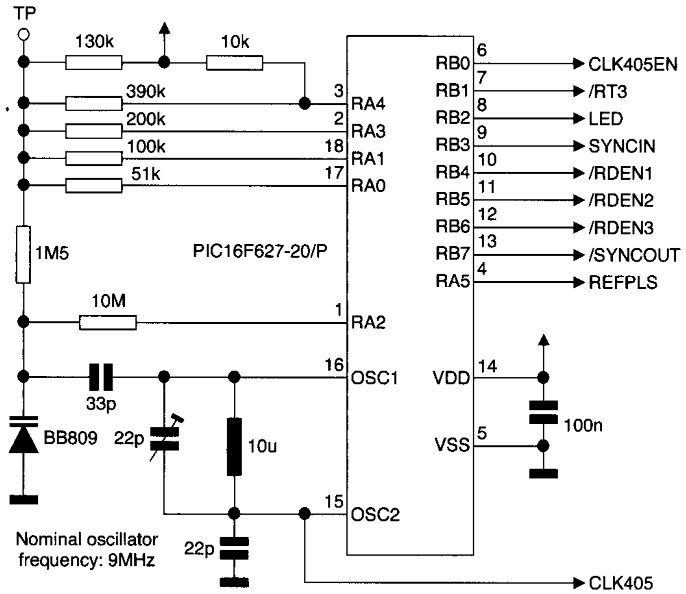


Figure 2

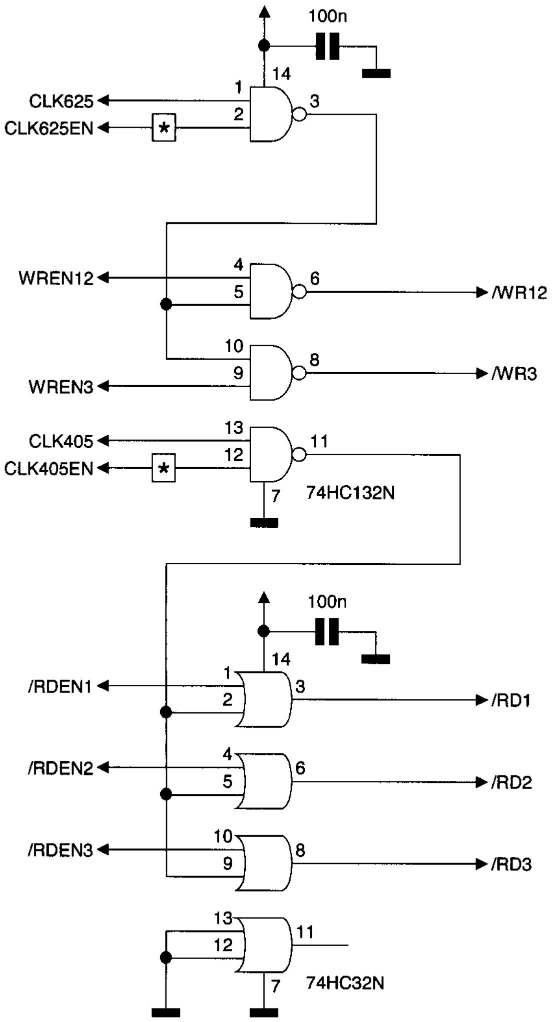
Circuit - PIC A



Circuit - PIC B

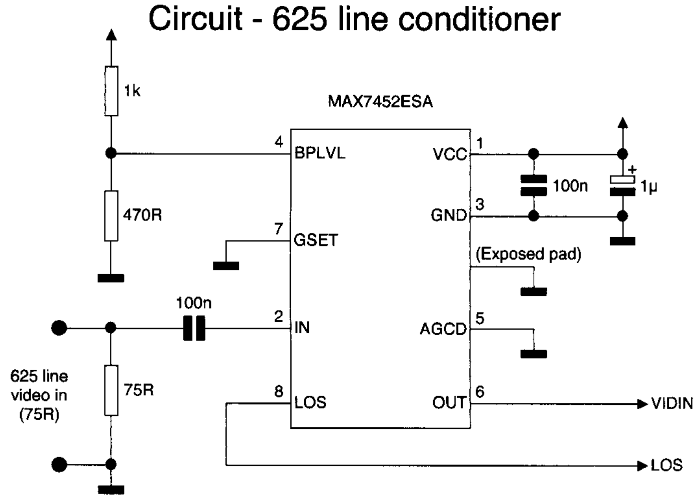


Circuit - Clock gating

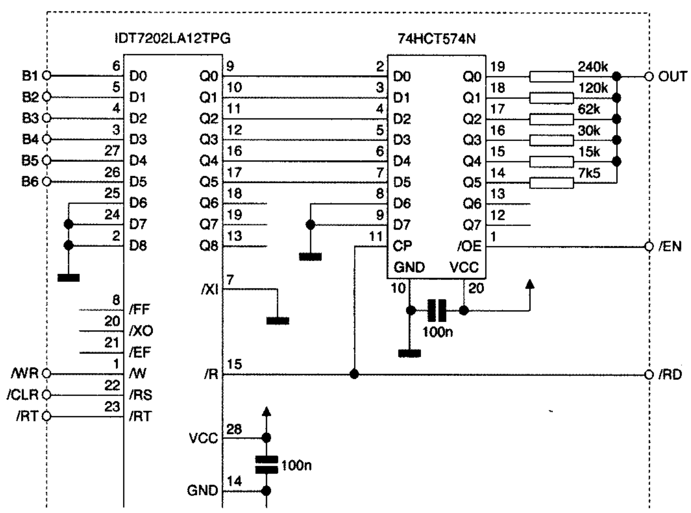


* Delay elements (as required):

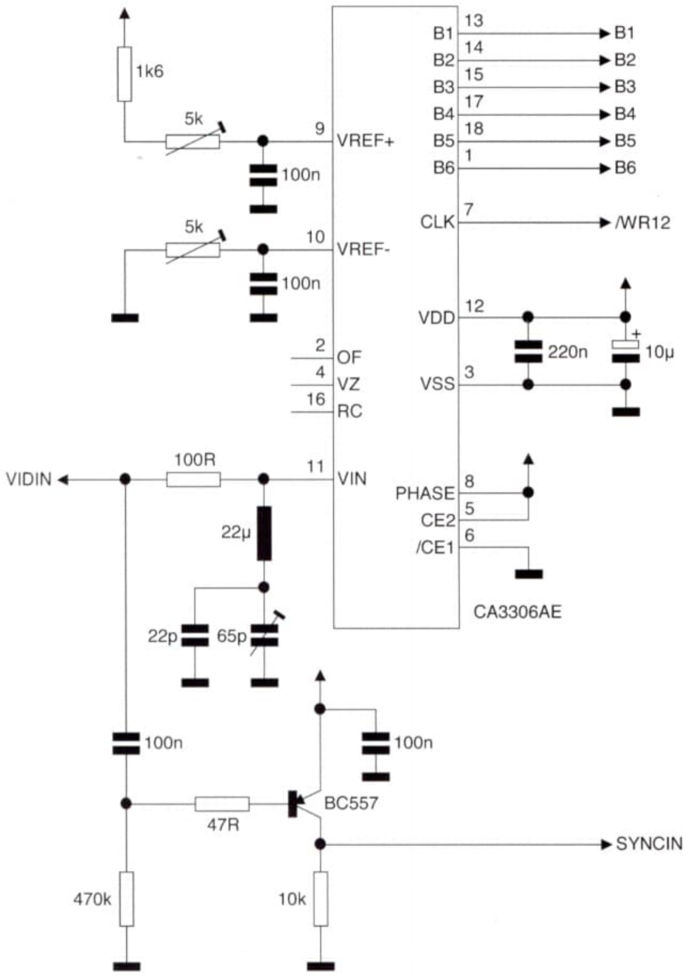
Circuit - 625 line conditioner



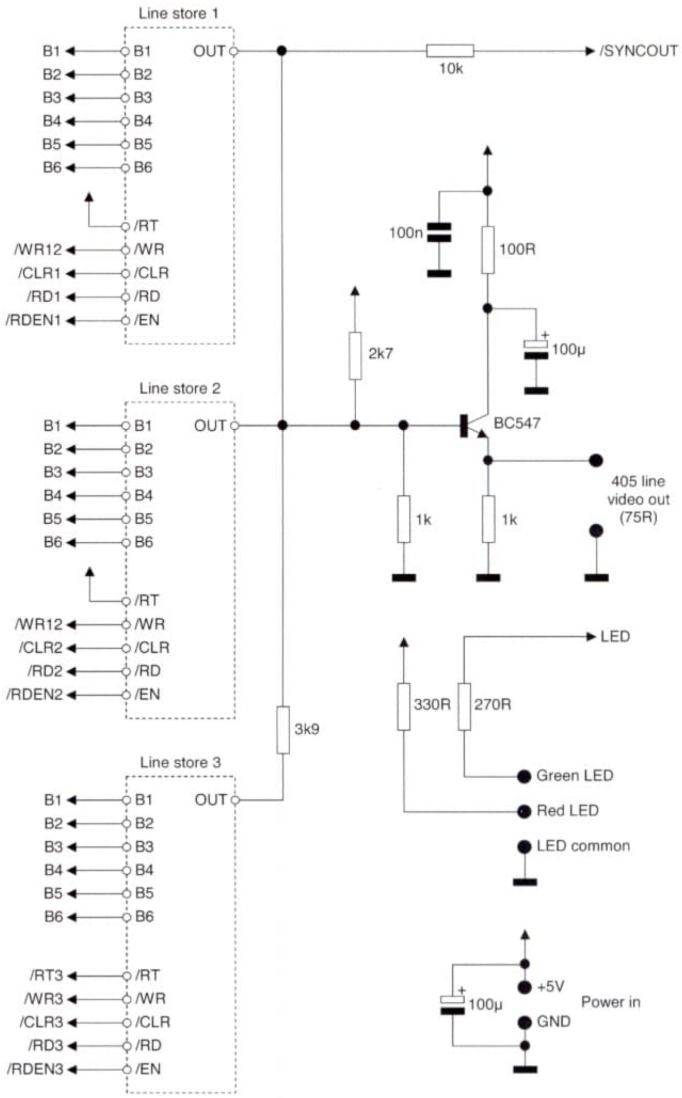
Circuit - Line store template

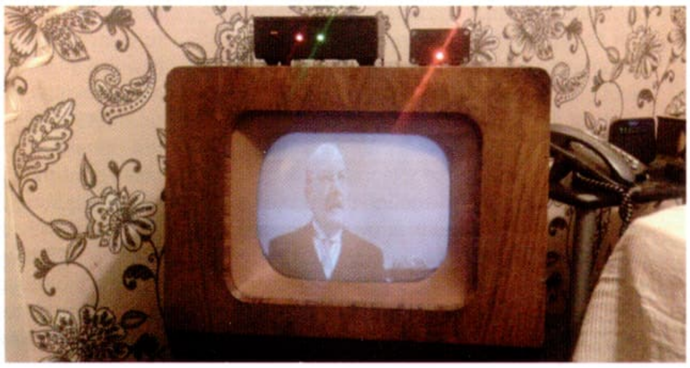


Circuit - ADC & Sync Separator



Circuit - Line stores and video output





Humble beginnings - the story of EMI's first magazine

by Steve Kennedy

82 years ago the newly-formed EMI published their first magazine for their own 'Radio Society'. Membership was open to anyone involved in the making, selling, or promoting of EMI products. This first (unnamed and without any discernable cover design) attempt at a publication is remarkeably low–key for such a large organisation and could be compared to almost any radio-club type magazine of the 1930's or later.

12 SEPTEMBER, 1932

OUR COMPETITION

WANTED:

1. A Cover Design 2. A Title

PRIZES:

1. Two seats for a Variety Show at Broadcasting House
2. A visit to an Aerodrome and/or a ride in an Aeroplane

RULES:

1. All entries to be in by October 7th
2. Committee's decision to be final
3. The Committee reserves the right not to make any award if entries are not up to standard

WHAT THE ELECTRIC AND MUSICAL INDUSTRIES RADIO AND GRAMOPHONE SOCIETY OFFERS YOU

1. The use of a fully equipped laboratory
2. The opportunity to gain experience in Radio Transmission
3. Lectures both technical and non-technical
4. Visits to places of unusual scientific interest
5. A Technical Library

JOIN NOW!

Address your Entries to:

Any member of the Committee or The Editor, Room 314, P.E.D.

In the Situations Vacant section [comprising of a single vacancy!] a job is available for a Hut Watchman (Army experience definitely a drawback). The rear of the magazine carried a competition for naming the publication and giving it a cover design, the prizes offered were quite impressive – one of them being a flight in an aeroplane.

Like any other club or society EMI had it's usual prearranged outings, one being a visit to the Brookman's Park transmitters in Hertfordshire. This pair of transmitter masts had only been erected two years prior to the publication of the magazine. It also mentions that some members paid a visit to Lots Road power station in Chelsea. This coal–powered plant supplied electricity practically the whole of the London Underground system.

One item EMI never really got to grips with was the issue of people making illegal recordings. It was bad enough that some individuals constructed their own wirelesses, but recording EMI's copyrighted material was downright unforgiveable! What now follows is the text of the aforementioned article entitled 'A menace to the industry'.

A menace to the industry - home recording

Attention should be drawn to the dangerous articles of a class of society which threatens the prosperity of our industry even more than the 'Home Constructor'

The Home Recorder' is here in our midst surrounded by gadgets of every description and imbued with fiendish enthusiasm. Why I don't know, but I seem fated to have been drawn relentlessly into the business.

People I hardly know fix me with a glassy stare and enquire frantically after my health as they wring my hand and ask me to tea. Years ago when I was asked to tea like that I learnt the precaution of slipping a pair of pliers and a bit of insulating tape into my pocket before I went, for the benefit of the inevitable broken–down radio set lurking innocently behind the tea table. Today it is 'Home Recording'.

"you're with the Gramophone Company?" they say. I murmer "Yes." "Well now, do you know, old chap, I've got a 'Blank' home-recording outfit here and it doesn't seem to work awfully well." I bow again and try to explain that there are several people besides myself in the Gramophone Company's works who are as remotely connected with the eventual manufactured article as, for instance P.E.D. or the Drawing Office. But it is all to no purpose; they smile politely but incredulously – and I give in.

My first experience of this home recording business was at the home of an acquaintance – I can hardly say friend, although he claimed to have met me before. I found him almost submerged in a litter of inconceivably ingenious gadgets and highly-plated knick-knacks of every description, which included two bottles of oil of different colours and a dear little trinket of a microphone.

This man, who has the disease in an advanced stage, started to "show me a thing or two" in a flowing, "you watch this, it's easy" style, even before I had got outside my tea.

There were 'results' as the saying goes, but with a rather bad 'cut off" over most of the scale. To begin with, the speaker

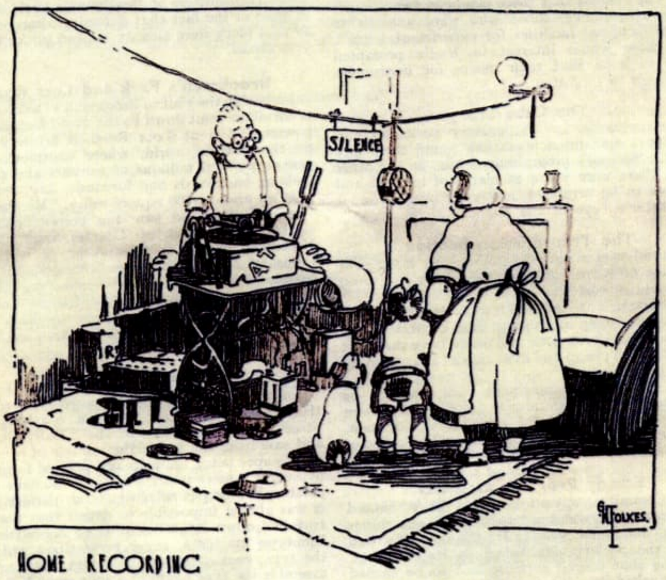
Lectures

The provision of a programme of suitable outside lectures is not easy. Good lecturers are few, and there is the ever-present problem of hard cash. As we go to press, however, we hear that the first of the series of technical lectures has been arranged. This is to be on the Westinghouse Rectifier and will be illustrated by a film as well as lantern slides. Arrangements are in hand for further lectures by experts from outside. Details will be announced later.

Less technical members will be glad to know that a series of weekly lectures on Elementary Radio will shortly be arranged; they will deal with early experimental work and the explanation of what Radio is. For the more technical the Committee are hoping to arrange a series of bi-weekly lectures by heads of sections in the works, dealing with specified subjects such as loudspeakers, pickups, coil winding, works testing, etc.

Watch the notice boards.

A MENACE TO THE INDUSTRY



HOME RECORDING

ATTENTION should be drawn to the dangerous activities of a class of society which threatens the prosperity of our industry even more than the "Home Constructor."

The "Home Recorder" is here in our midst surrounded with gadgets of every description and imbued with fiendish enthusiasm. Why, I don't know, but I seem fated to have been drawn relentlessly into the business.

People I hardly know fix me with a glassy stare and enquire frantically after my health as they wring my hand and ask me to tea. Years ago when I was asked to tea like that I learnt the precaution of slipping a pair of pliers and a bit of insulating tape in my pocket before I went, for the benefit of the inevitable broken-down radio set lurking innocently behind the tea table. To-day it is "Home recording."

WANTED

A COVER design and a name for this magazine. See back page.

SITUATIONS VACANT

HUT watchman required, previous experience not essential. (Army experience definitely a drawback.—ED.)

was permanently connected, so that the microphone had to be snapped into circuit and the dirty work done before a fruity howl built up which would have left C.M.S. Inspection green with envy.

The output of the set was the usual push-pull arrangement. After fitting a switch to cut out the loudspeaker I put in two 2 microfarad condensers, one side of each to the plate of each output valve, the other side to sockets into which the cutter could be plugged.

Whenever you receive a suspiciously gratitious invitation these days it is as well to remember, in addition to the pliers and insulating tape, to take a few iron weights with you – not for bashing your host's head in but to drape round home recording cutters whose designers had a better eye for nickel plating than performance.

As this was my first introduction to the vice I had no weights with me, but we found one on the premises – an old magnet which had seen better days in a meter of some sort – and lashed it securely to the back of the cutter like a drunken jockey on a donkey.

Then we got 'results' which *were* 'results'!

My next adventure was to help unpack a brand-new gadget using pre-grooved blanks which proved to be admirable apart from the fact that it was entirely useless for home recording, without a fat output valve – and, of course, weights; this time lots of weights. But the surface noise! Have nothing to do with pre-grooved records – at least, not that kind – if you want to hear anything. Some of the 'addicts', of course, don't mind; they are too far gone for that.

The fun starts when you get 'big money' at the game, in deadly earnest.

There was a stockbroker I landed against once – a hard working fellow whose modest income only allowed him to buy the best of everything. The kind that buys a 531 on the way to the station in the morning and another one for the kitchen on the way back.

This fellow had accumulated at various times two super radiogramophones, an assortment of fairly good receivers of one sort or another. Then, hearing of the home recording idea, he had plunged, as only a stockbroker can plunge, lashing out right and left with every conceivable tool and gadget money could buy and wallowing in enough spare needles (special, 'home recording') to make steel close firm a 'plus' 3/16.

As both his radiogramophones were in special matched cabinets to 'fit his lounge,' out he went and had an all mains A.C. chassis built for him to fit in his acoustic model, which he duly installed after spoiling a good deal of perfectly good aluminium.

When I arrived the poor fellow had had his first collapse. This usually occurs in the early stages of the disease after the first bout of work, which may last anything from 10 to 20 hours in duration.

At last, when, after many hours of weary failure, a spirited recitation of the 'Charge of the Light Brigade' was reproduced like the more native parts of a jungle film, I was called in.

As home recorders go, the gear was not at all bad. Several bits of it were really precision jobs, and there did not seem to be any particular reason why it should not work. But with a stockbroker let loose on recording, anything may happen, although the row was so horrible that the man must have had a real genius for noise.

There was plenty of power and the lead screw arrangement was a good piece of work, cutting about 50 to the inch.

Finally, the trouble boiled down to the spring motor (vintage 1924) with a turntable which wobbled and rocked in every direction at once – not too good when you are trying to cut 50 to the inch.

But was that stockbroker beaten? Not a bit of it. He rushed to his safe, snorting like a bullock, and emerged with several thousand slips of paper neatly bundled and ticketed. "Shares," I thought. "He's going to make me a director."

But he didn't. He rushed to his writing desk, and grasping an enormous evelope he poured the slips of paper into it and dashed out to the pillar box shouting "I'll soon settle that!"

In two days' time there arrived, by post, a nice new induction motor, with the compliments of the ——— Tobacco Company. C.A.J.M.

Pictures from Golborne April 14th

by Greg Hewitt



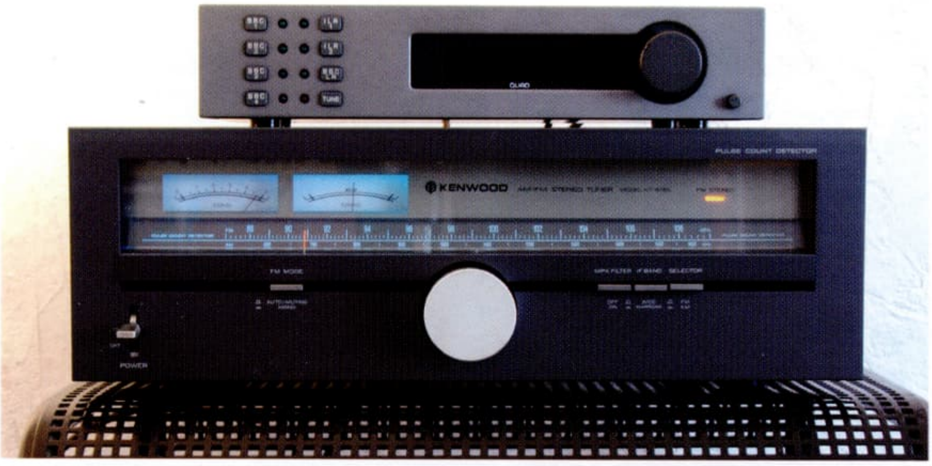








Letters



Dear Editor,
Pulse Counting FM

The Wireless World article referred to by Patrick Wilson is almost certainly that by M.G. Scroggie in June 1956[1]. This was actually preceded by an article describing the way pulse counting discriminators work in the April[2] edition. However, it is possible to go back even further than that to one by Thomas Roddam in 1948[3] in which the method was fully described even though at that time only experimental transmissions were being made by the BBC. Clearly, for the amateur, pulse counting has considerable advantages in ease of alignment, whilst the poor image performance mattered little given only three BBC stations were then available in Britain. Other valve designs, very similar to Scroggie's, appeared in magazines over the years as, for example, in Practical Wireless in 1965[4].

When transistors became available having adequate ft for VHF operation, interest arose in applying Scroggie ideas, again because of ease of alignment. However, a slightly more complicated circuit was necessary because of the lower supply voltage, meaning only a small charge per pulse, and this problem was overcome by use of a diode/transistor pump. Thus during the sixties the circuit was first adapted for use with transistors and finally using ICs. Several transistor versions appeared, such as reference 5, and as TTL became available, an IC discriminator based on a monostable in 1968[6], followed closely by an all IC design in 1969[7]. Most of these used the same intermediate frequency as Scroggie, namely 150 kHz. This was fine for mono, being roughly 10 times the highest modulation frequency and thus well filtered by the de-emphasis network. Better image rejection required double conversion (10.7 MHz followed by 150 kHz) and a design on such lines appeared in the Radio Constructor in 1967[8].

Stereo reception was different, the sidebands of the sub-carrier extend to over 50 kHz and must be correctly recovered in amplitude and phase for good stereo separation, and this is impossible with such a low IF (reference 7 reported only getting 6dB separation). An early solution appeared in Wireless World in 1965[9], this design used a double conversion superhet with the first IF the conventional 10.7 MHz and the second at 300 kHz. Even that may have been a bit low and the circuit, which used germanium transistors, does not appear to have been updated to silicon.

However, the Japanese company Kenwood did use a double conversion design in the late seventies with pulse counting to provide very low distortion and good RF performance. The receiver (type KT-6155) used mechanical tuning through a four-gang capacitor (tuned aerial plus band pass RF to first mixer), 10.7 MHz first IF, alternative broad and narrow IF filters and then conversion to a second IF at 1.95 MHz before the pulse counting discriminator. With flywheel tuning and an accurate scale with a length of 10 inches, it has to be the ultimate DX broadcast FM tuner. The only snag is its size, a large box filled mostly by air. I acquired one last year on eBay in immaculate condition requiring only new dial bulbs. The illustration shows the Kenwood with a QUAD FM4 for size comparison.

Yours sincerely
Brian Weller

References:
1: M.G. Scroggie, Unconventional F.M. Receiver, Wireless World, June 1956.
2: M.G. Scroggie, Low Distortion F.M. Discriminator, Wireless World, April 1956.
3 :Roddam, Why Align Discriminators? Wireless World, June 1948.
4: W. Groome, Fidelity F.M. Tuner, Practical Wireless, April 1965.
5: J.C. Hopkins, A Simple Transistor FM Tuner, Wireless World, September 1965.
6: B. Parsons and J. Slomkowski, Applications of the SN74121 TTL Monostable, Texas App. Report B50, 1968.
7: G.J. Newnham, FM Tuner using Integrated Circuits, Wireless World, June 1969
8: T. Snowball, High Sensitivity VHF Portable, Radio Constructor, February and April 1967.
9: ED Frost, Pulse-Counting FM Tuner, Wireless World, December 1965.

Dear Editor

I was interested to read Mr J Patrick Wilson's letter referring to a "pulse-counting" FM receiver. I first came across this design on a most interesting web-site: http://members.iinet.net.au/~cool386/ in which there is a great deal of information about both this, and other designs, of FM receivers.

I have not yet tried anything out, but I have begun collecting components and hope to build a receiver sometime soon.

D.A.Cooknell

Dear Editor
How did I get interested in vintage radio?

Apart from listening to ITMA and Much Binding-in-the-Marsh on my parents' Wartime Civilian Receiver, my first experience of wireless was a meeting with friends who had a crystal set. I was fascinated and wanted to make one. The first break came when Woolworths were selling ex-army balanced armature, high impedance, headphones for one shilling and eleven pence. I badgered my mother until she bought a pair for me and my brother. A crystal set kit followed and, despite being extremely rudimentary, it worked well with a 50 foot aerial and a mains earth.

The local public library had a few books for boys on radio, including several by F J Camm, and I wanted to take the next step into a valve set. Imagine my surprise one Wednesday when my father came home with a 3-valve (6K7, 6SH7, 6V6) plus metal rectifier mains TRF kit from Premier Radio in Praed Street. The description of what followed is from my school boy diary when I was thirteen years old.

"26 April 1950. Daddy arrived with a wireless kit for me to make. I looked through the plans and I think I will be able to make it. I did not start that evening.
27 April. I got up early, but nevertheless, it was not until after breakfast that I started making my radio. I found that once I got started, it was easy to find out which pieces were which. In the afternoon, I started wiring up.

28 April. Today, I ran out of solder and in the morning went off to buy some. I am getting on quite well with the wiring, but one resistance is missing and Daddy went off to get one. I think that I will finish on Saturday, but I am not quite sure.

29 April. I thought right. I did finish. However, it does not work. We think it must be one of the valves because it does not light up. In the afternoon Daddy took me to the shop but they said the valve was all right. I found that V2 was wired wrongly.

30 April. We keep checking the connections but we cannot find what is wrong. We suspect that a pin has come out of one of the valves and I am

going to take it back to the shop.
1 May. Nothing was wrong with the valve. I suspected the trimmers. Then I found that one wire was missing. I put it in and it worked. I was very pleased. We tricked Daddy into thinking it didn't and then we surprised him by turning it on.

2 May. My wireless has not exploded yet. "

The process of construction taught me about soldering without dry joints and also the resistor colour code. I remember being fooled by an all red resistor, where the lack of spots or stripes caught me out. A year or so later I was given a partial second hand kit for a five-valve three-waveband superhet, using Weymouth coils. The set had been built using acid flux and this had damaged some of the components. Also, several important parts were missing. It was an AC/DC, live chassis circuit, using a 6A8, 6K7, 6Q7, 25A6, 25Y5 line up. There was no mains dropper or smoothing choke in the kit and the 350 volts or so from the rectifier seemed a bit high until I discovered how to tame it with a resistor from the rectifier cathodes. I got the set working well and rebuilt it several times to make it tidier, as experience grew, collecting a number of electric shocks on the way. The final modification added a mains transformer and the necessary changes to the rectifier (5Z4) and output valve (6V6). I got to the stage where I could rebuild the set, without the help of the circuit diagram. The radio introduced me to short wave listening and I was excited to hear the amateurs chatting on 40 meters.

At the time, our family had no television and, at the age of 16, I was very keen to do something about that. I studied several kit designs available at the time and finally persuaded my father to trust me to build a set. I argued that building a TV kit would not be more difficult than building four five-valve superhets. I chose the expensive option of building a set called the Tele King. This used a 16-inch T 901 English Electric metal cone wide-angle tube and line fly back EHT. Given my propensity to dig around inside a working set and the many shocks I had so far received, I was keen to avoid using lethal, mains-derived EHT. We bought the kit from Lasky's in the Harrow road. To spread the cost, the kit was bought in stages, starting with the chassis hardware and valve holders, moving on to the coils and transformers, the Cs and Rs, the valves, cabinet and finally the CRT. While waiting for CRT delivery, I fired up the set, connected to an aerial made up from Meccano strips, and received Alexandra Palace sound. During this stage, only one problem emerged from a non-insulated resistor which shorted to chassis. Later on I found two dry joints, one down to me and the other down to the IFT manufacturer. With the CRT installed, I had great hope for a picture, but all I could get was a very dull, out of focus image. In the end, and following help from an English Electric engineer at the Radio Show, I found out how to set up the ion trap magnet and instantly all was well. I spent many saturday mornings watching Test Card C and tweaking the set for the best possible picture. Ultimately, I achieved clear 3 Mc/s bars without much ringing. The set served well as the family TV for nearly fourteen years, receiving an ITV converter along the way. My experience allowed me to do a couple of vacation jobs with EMI Electronics in the oscilloscope development laboratory, while I was at University reading physics. However, I decided on a career in Aeronautical Research and Defence Science and had no time for electronics as a hobby, having become very absorbed in Vintage cars. It was only when I retired that I thought it might be interesting to have a valve radio again and, by chance, I found Philip Knighton's shop in Wellington. He found me a nice Philco set, with an RF stage, to restore. The job took very little time and I went back to Philip for another challenge. He had a very beat-up HMV 443 in stock and he said that if I could get that working, I would be able to manage anything. I rose successfully to the challenge and the rest, as they say, is history. I have resurrected some 25 or so radios, TVs and radiograms, finding that I had not forgotten the lessons I learnt some 50 years ago. The discovery of the BVWS has been of enormous assistance and, even though I have no space to allow my collection to grow, I thoroughly enjoy reading in The Bulletin of other people's restoration work.


Above and opposite: a sample of Phil Rosen's wireless collection

Nigel Hughes

Dear Editor
How did I get interested in vintage radio?
I have a tolerably large and comprehensive collection of domestic radios (some 110 in total) dating back to the early 1920s. I have been collecting since my retirement as a consulting electrical engineer in 1996. My interest stemmed back to my childhood during WWII. I was then chronically ill and unable to attend school until I was almost 14 years of age. Until then, my only contact with the big world outside was our KB Rejectostat wireless which I listened to avidly for many hours each day.

School broadcasts, talks, concerts, children's hour, variety shows, comedy – they brought into our home the exciting outside world of people and places. I shudder to think how I might have coped mentally without this BBC lifeline.

Eventually, something approaching normal health returned and as an adult I was able to take up a career as electrical engineer. Many years later I was looking for an interesting hobby to pass the time during retirement. I was attending a sale at our local auction house one day and noticed a pre–war Marconi radio. I bought it, restored it and never looked back. Perhaps I felt I owed something to these discarded old sets, one of which had meant so much to me as a child. I became a regular visitor to the local action house, joined the BVWS and Radiophile and gradually built up quite a decent collection.

The majority of sets are in good working order and are permanently wired up to the mains, aerial and earth. I have been on local radio and even East Midlands TV to proudly show off my collection. They stand in serried ranks in a spare room and look rather impressive – though I say it myself!

A visit to collector Louis Coakely secured a KB Rejectostat model which had cheered up my youger invalid days and now it stands in pride of place in my collection.

Further to my home collection...
Shortly after retirement I got to hear of a large collection of old radios in storage in a warehouse belonging to Nottingham City Museums. After much wrangling with the relevant authorities I got permission to remove them, restore them and put them on display in part of the Industrial museum at Wollaton Hall. I recently calculated that some 40,000 visitors from home and abroad must have seen and admired these radios and items of vintage audio equipment.

I toured the UK visiting radio museums in the Isle of Wight, Cork, Somerset etc. My aim was to gain ideas and pinch them for

what I now regarded as my own museum at Wollaton Hall. The Nottingham museum finished up with lots of hands-on stuff for young visitors eg. crystal sets fed from an aerial booster amp, 'talking pictures' from a microphone and oscilloscope, a spark transmitter, Morse code buzzer, reel-to-reel tape recorder, 78rpm record player, exotic sounding foreign stations to twiddle for on art-deco style radios etc.

I tried to get local schools interested in formal visits to the collection but was given the cold shoulder on the basis that old radios weren't on any part of the school curriculum!

Recently the dreaded 'Elf and Safety gremlins have stepped in and put all the exhibits behind glass in locked cabinets where they lose much of their interest as nothing can be touched or twiddled.

As a doddery 82 year old I still get lots of pleasure from my own collection of old radios and am always delighted to show them off to anyone with the same barmy interest and half an hour to spare.

Phil Rosen

Dear Editor,

Just a little note to say how delighted and surprised I was to learn that I had won this award for my BVWS Bulletin article 'A Universal Router Jig for making Replica Radio Backs'. I'd like to say a personal 'thank you' for your encouragement and support and for doing such a fine job in setting out articles, fitting the text around the picture and making each issue of the Bulletin such a joy to read. (Gary Tempest is a great encouragement and keeps badgering me and others to write more stuff!).

I've received the award from Mike Barker, and will take it to the NVCF for him to present to me to get a pic for the Bulletin.

Kind regards,
David Taylor.

BRITISH VINTAGE WIRELESS SOCIETY

STATEMENT OF ACCOUNTS - YEAR TO 31st DECEMBER 2013

		year ended 31st December 2013		year ended 31st December 2012
Receipts		£		£
Subscriptions (net)		42,620		35,437
BVWATM Friends Group subscriptions (net)		(1,190)		(130)
Sale of publications		2,497		1,502
Capacitor sales		4,561		5,415
Deoxit sales		857		498
Meetings		3,136		2,318
Estate sales receipts		47,535		34,738
Valveman DVD sales		69		130
Donations		252		316
Bank interest		3		12
Corporation Tax refund		-		146
NVCF Profit/(Loss)		(482)		72
Total receipts		99,858		80,454
Payments				
General expenses	12,289		11,270	
Stationery	2,286		2,343	
Storage Facilities	2,520		2,400	
Postage (net)	9,638		10,883	
Meetings	1,840		2,140	
Bulletin costs	23,920		19,005	
Estate sales payments	43,721		39,983	
Capacitor costs	1,815		5,042	
Deoxit purchases	983		979	
Valveman DVD sale proceeds transferred to BVWATM			-	
Other publication costs	558		488	
Total payments		99,570		94,533
Surplus for the period (2012 - deficit)		288		(14,079)
Total assets at beginning of period		25,810		39,889
Total assets at end of period		26,098		25,810
Assets				
HSBC current account		16,380		7,614
HSBC deposit account		2,221		10,217
NVCF assets (held for the benefit of the B.V.W.& T.V. Museum)		7,497		7,979
Total assets		26,098		25,810

At 31st December 2013 £936 (2012 - £661) was owed by the BVWS to the authors of various publications that the BVWS sell on behalf of these authors and £NIL (2012 - £898) was owed to the beneficiaries of estate sales. These liabilities are not recognised in the accounts.

The accounts of the Society reflect the receipts and payments on a cash basis and do not reflect any prepaid or accrued income and expenditure. As an unincorporated club, all surplus is passed to members by way of bulletins, supplements and events. At the same time a prudent asset balance is maintained in order to provide for the unexpected.

Treasurer

AUDITORS REPORT TO THE MEMBERS OF THE BRITISH VINTAGE WIRELESS SOCIETY

We have examined the above Accounts and the attached Accounts of the National Vintage Communications Fair for the year ended 31st December 2013 together with the accounting records and supporting documents and vouchers and confirm the same to be in accordance therewith.

Christchurch House
Upper George Street
Luton Beds

KEENS SHAY KEENS LIMITED

3rd February 2014

NATIONAL VINTAGE COMMUNICATIONS FAIR

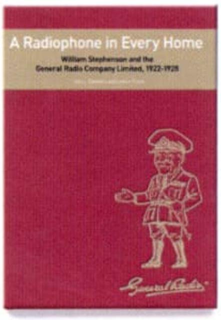
STATEMENT OF ACCOUNTS - YEAR TO 31st DECEMBER 2013

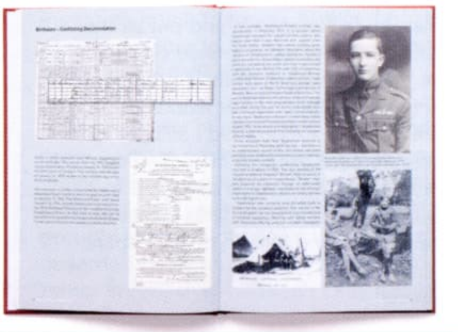
		year ended 31st December 2013		year ended 31st December 2012
Receipts		£		£
Table bookings				
Members		7,259		7,365
Non-members		8,569		5,733
Total receipts		15,828		13,098
Payments				
Event management	13,025		12,141	
Miscellaneous	385		385	
British Vintage Wireless and Television Museum	2,900		500	
Total payments		16,310		13,026
Deficit for the period (2012 - surplus)		(482)		72
Total assets at beginning of period		7,979		7,907
Total assets at end of period		7,497		7,979
Assets				
HSBC current account		7,497		7,979
Total assets		7,497		7,979

Out Now!

A Radiophone in Every Home - William Stephenson and the General Radio Company Limited, 1922-1928

by Ian L. Sanders and Lorne Clark, with foreword by Jonathan Hill. Published by Loddon Valley Press. ISBN 978-0-570773-0-0.



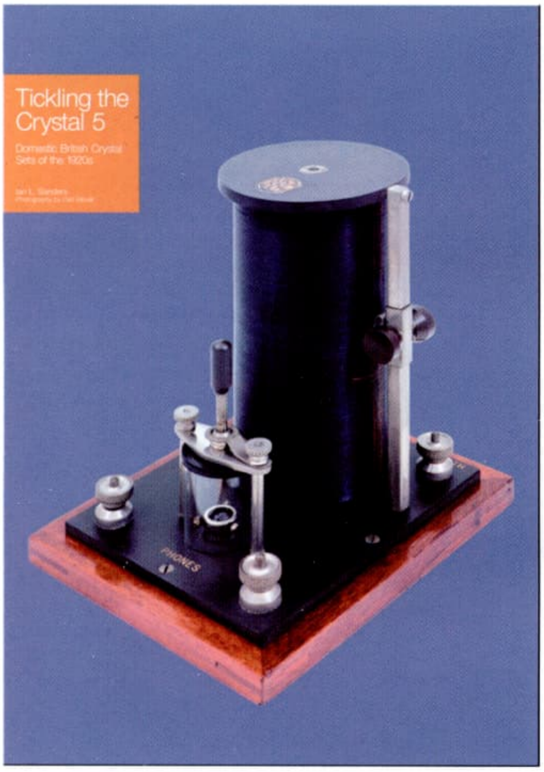


Between 1922 and 1927, during the life of the British Broadcasting Company (forerunner of today's British Broadcasting Corporation), literally hundreds of wireless manufacturing firms sprang up to take advantage of the new craze for 'listening-in'. In the fiercely competitive market of those pioneering days, many of these businesses were to disappear within just a few years. While much has been written on the history of the larger companies during this period of attrition, names such as Marconi, British Thomson-Houston, Burndept and General Electric – very little has been published about the smaller to mid-sized enterprises.

In their superbly illustrated new book, Ian Sanders and Lorne Clark tell the fascinating story of one of these smaller firms, the General Radio Company Ltd., and its enigmatic Canadian founder, William Samuel Stephenson, WWI air ace and WWII secret agent, thought to be the model for Ian Fleming's James Bond character. As well as producing an extensive range of radio receivers, the company also worked on the development of mechanical television.

This high quality publication is available for immediate despatch, price £19.95 (£17.95 for BVWS members) plus £4.95 P&P for UK, £7.50 P&P for EEC. BVWS members should quote their membership number in order to secure the discounted price. Payment via PayPal accepted.
For North America/Asia Pacific enquiries and orders: loddonvalleypress.us@gmail.com or write: Loddon Valley Press (North America), 1175 Teresa Lane, Morgan Hill, California, 95037, USA.
For UK/EEC/RoW enquiries and orders: loddonvalleypress@gmail.com or write: Loddon Valley Press, 16 Kibblewhite Crescent, Twyford, Berkshire, RG10 9AX, UK (note on paying by cheque: only sterling cheques drawn on UK bank, made payable to 'Loddon Valley Press' will be accepted).
Also available from BVWS stall and BVWS: Mike Barker, Pound Cottage, Coate, Devizes, Wiltshire, SN10 3LG chairman@bvws.org.uk

BVWS Books



Out Now!

Tickling the Crystal 5
More Domestic British Crystal Sets of the 1920s
by Ian L Sanders.
Photography by Carl Glover

The final edition in Ian Sanders' thorough five volume set exploring GPO No. era British crystal sets.

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

252 pages of GPO No. era British crystal sets and many previously–unseen models in print for the very first time. £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EEC (rest of world £19)

Attaché Radios
by Mark Johnson
An 80 page colour paperback guide to the Attaché portable
- Detailed specifications
- 140 radios in full colour
- Over 200 additional photos of sales literature, trade ads etc.

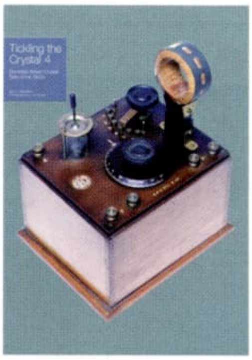
£12.00 (+ £2.50 p&p UK) £3.50 EEC (rest of world £5.50)

Gerry Wells
Growing up in the 1930s, young Gerry Wells preferred wireless to toys. He had a postwar career as a radio and TV engineer designing and managing amplifiers, PA's and TVs. He now runs the British Vintage Wireless and Television Museum from the home where he was born. This is the story of one man's dedication to wireless £6.00 196 pages paperback (+ £2.50 p&p UK) £3.50 EEC (rest of world £5.50)

Tickling the Crystal
256 pages. Over 200 full-page photographs. £14.95 for BVWS members plus £7 p&p for UK, £13 EEC (rest of world £19)

Tickling the Crystal 2
Limited, Only 750 copies printed. 208 pages. Over 125 full-page photographs. £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EEC (rest of world £19)

Tickling the Crystal 3
Limited, 500 copies printed. 240 pages of GPO No. era British crystal sets. Over 75 full-page photographs. £29.95 (£24.95 for BVWS members) plus £7 p&p for UK, £13 EEC (rest of world £19)



Tickling the Crystal 4
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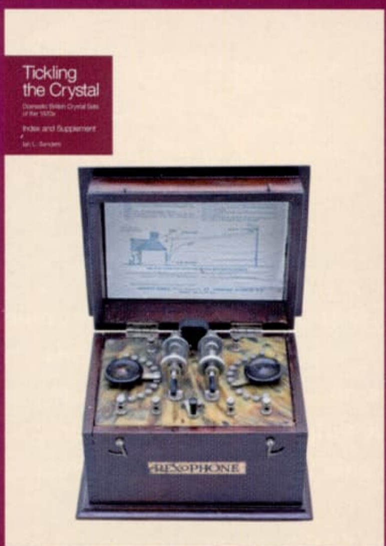
Out Now! Tickling the Crystal index and supplement



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7th July
Royal Wootton Bassett

The Memorial Hall, Station Rd. Wootton Bassett.
Nr. Swindon (J16/M4). Doors open 10:30.
Contact Mike Barker: 01380 860787

News and Meetings

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

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

New BVWS Regional Meeting.

A new BVWS regional meeting has been arranged for August 2014. This meeting will be held in Punnetts Town Village Hall, Heathfield, East Sussex. The date is 10th August 2014 and it is expected to be a yearly event. This new meeting has been arranged by John Howes and his family and is a very welcome addition to the BVWS Calendar.

2014 Meetings

May 31st Garden Party at The Vintage Wireless and Television Museum, West Dulwich
June 1st Harpenden
July 6th Wootton Bassett
August 10th NEW Punnetts Town, Heathfield, East Sussex
September 14th Murphy Day, Mill Green Museum, Hatfield
September 28th Harpenden
October 5th Audiojumble
November 2nd Golborne
7th December Wootton Bassett

The British Vintage Wireless and Television Museum:
For location and phone see advert in Bulletin.
Harpenden: Harpenden Public Halls, Southdown Rd. Harpenden. Doors open at 9:30, tickets for sale from 09:00, Auction at 13:00. Contact Vic Williamson, 01582 593102
Audiojumble: The Angel Leisure Centre, Tonbridge, Kent. Enquiries, 01892 540022
NVCF: National Vintage Communications Fair
See advert in Bulletin. www.nvcf.co.uk
Wootton Bassett: The Memorial Hall, Station Rd. Wootton Bassett. Nr. Swindon (J16/M4). Doors open 10:00. Contact Mike Barker, 01380 860787
Golborne: Golborne: Golborne Parkside Sports & Community Club. Rivington Avenue, Golborne, Warrington. WA3 3HG contact Mark Ryding 07861 234364
Punnetts Town: Punnetts Town Village Hall, Heathfield, East Sussex TN21 9DS (opposite school) Contact John Howes 01435 830736
Mill Green Museum: Bush Hall Lane, Mill Green, Hatfield, AL95PD
For more details with maps to locations see the BVWS Website:
www.bvws.org.uk/events/locations.htm

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