NEWSLETTER February 2025

Welcome to another fascinating Newsletter, with two completely different articles to read. Thank you Colin, I know it was more than a 10-minute job! If you would like to contribute anything for the Newsletter it does not matter how brief or how long it is, I am sure it will be interesting. How about a project you were involved with?

At last month's meeting we had five guests, and I was chuffed to receive an email from one visitor saying it was a very nice atmosphere and he hoped to attend again. Thanks to Rob for telling us his way of doing things and making the evening interesting.

David has emailed you all to say he has now formally resigned as Secretary. I would like to say a huge Thank You to him for all his input and help in keeping PEEMS running smoothly and efficiently. On behalf of everyone I wish him and Pam all the best for a hopefully uneventful move.

As you know the Secretary's tasks currently have had to be shared, but ideally it is a "one-man" job and we would welcome anyone who decides they would like to be our Secretary.

We handed out some of the latest contact lists, and it has been suggested we add members' addresses (with their consent) what do you think?

Remember that the GDPR applies to the electronic storage of information. The contact list is a paper copy.

Andy Wilson is now our fully fledged Treasurer, but it wasn't all plain sailing with the online process. I am pleased to report that the Bank offered us compensation for our difficulties.

I am looking forward to The Annual Lunch at Kirkbymoorside Golf Club on Thursday10th April. Please will you let me have your menu choices at least a week before the date, so I can inform the kitchen. If you have any special dietary requirements, tell me and I will ask for you, and please pay on the day.

As on previous years, wives and partners are cordially invited.

The proposed procurement of a cutter grinder is gathering a bit of momentum, but I would like to clarify a couple of things. Paul Gammon has offered to instruct us in the safe use of the equipment, but this means that you learn to use it. Please do not expect Paul to be on call to do it for you. Doug Pickering has also offered to help where he can. Depending on what is available, we might want a volunteer to do a bit of painting or electrical work. If you can't get along to the Hungate Centre or workshop morning to let your thoughts known, give me a call. The last thing we want is an ornament after the initial enthusiasm has waned.

Kind regards, Jonathan.

- **Forthcoming Events.**

- **Wednesday March 5th A Talk About The Yorkshire Wolds Railway.**
- **Tuesday March 18th Workshop Morning**
- **Wednesday April 2nd Spring 'Bring and Brag'.**
- **Thursday April 10th Annual Lunch, Kirkbymoorside Golf Club.**
- **Tuesday April 15th Workshop Morning.**

Club Evening On 5th February 2025. Overhauling A Velocette Motorcycle Crank Shaft, A Talk By Rob Davey.

Jonathan welcomed everyone to the first meeting of the year, including the guests, Peter, Ralph, Tim, Andrew, and Christopher (from Westow,Cropton,Wrelton and Pickering).

Before Rob gave his talk, there was some business news:

- **N.A.M.E.** The Northeastern Association Of Model Engineers has asked PEEMS to put out the following message: "After the disappointing cancellation of last year's rally, Urmston and District Model Engineering Society are determined to make this year a resounding success. Can Club Secretaries share this announcement widely amongst their members to encourage attendance? They have a raised 3½" and 5" gauge 2200ft track (one of the longest in the country). It's more than just a railway. They have dedicated running areas, miniature road locomotives, static models, boats and aircraft displays. The event is on the 19th and 20th July. Urmston is in Manchester and the Society is located just off the M60."
- **Club Secretary:** It has previously been announced that our Club Secretary David Proctor is moving and PEEMS doesn't have a replacement Secretary yet.

  Club Secretary administration tasks have now been delegated, and Richard Llewellyn has taken on the role of "Membership Secretary", which formed quite a large part of the original Club Secretary's tasks.

  Jonathan and Nevile are currently sharing the rest of the Club Secretary's job.
- **Harrogate Model Show:** As of the Club evening we have still been awaiting information on the status of any show. We will inform members once the information becomes available.
- **The Monorail Project:** The Monorail Project was started up as a 'successor' to the '*Pickering Flyer'* car which was an entrant to last year's *"Bradford Challenge"*. Peter Bramley is now taking the lead on the project, but he needs two or three other people to get the project up and running so that the monorail becomes a viable entrant to the *"Bradford Challenge"* in June. It would be a real achievement for the Monorail just to circuit the track on that date.

  Andy and Tony are currently helping Peter, but a few more volunteers would be welcome.

  Peter: Basically, we need 4 or 5 members in the team. We definitely need someone who knows about gyros and radio control. If someone has those sorts of skills it would help no end.
- **Workshop:** Following on from the e-mail about the workshop last month, things have taken a 'twist'. Some members wondered if anyone had a cutter grinder, and if they didn't, would this be something that would be useful for the Club? Jonathan thinks it would.

  Jonathan asked the members present if it would be useful for the Club to have a cutter grinder, and there was some positive response. PEEMS is in the fortunate position that member Paul Gammon has offered to take the lead on any cutter grinder acquisition, as he has dealt with this tool all his working life. If it is a good idea, the Club will progress it. When we were talking about acquiring a 3D printer, no one wanted to take the lead, and we didn't know what we were doing. With a cutter grinder and with Paul's knowledge, this could be a useful asset for the Club.

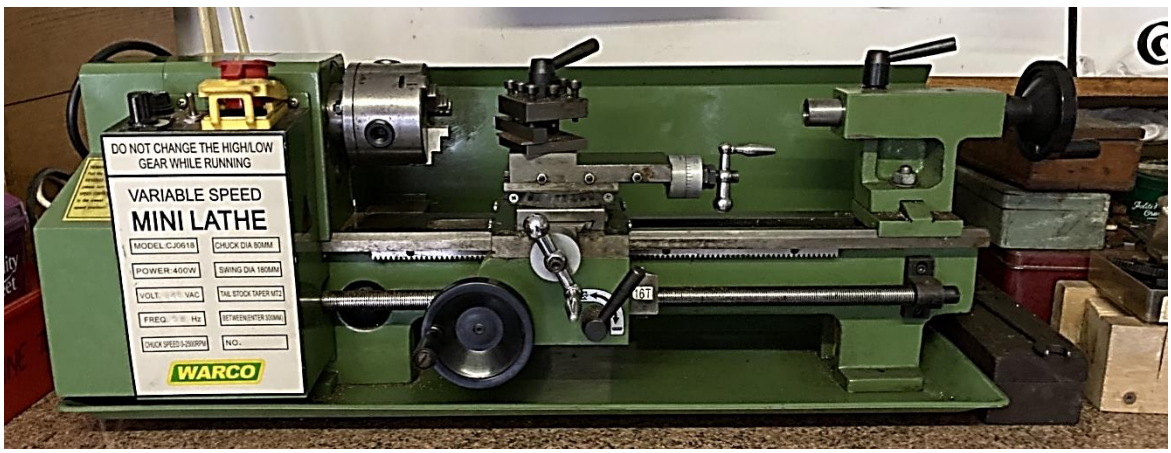
  Paul will instruct members on cutter grinders, and it will then be up to those members when they use the equipment, but they should do so with competence after instruction. Having a cutter grinder may be a catalyst to getting the workshop up and running again.
- **Some Items For Sale:**

  i) William Burrell:

  Following my recent purchase of a larger lathe I have a *WARCO mini lathe* for sale.

  Includes 3 & 4 jaw chucks, spare drive belt, plus other items.

  Should any member be interested William can be contacted on the telephone number on the Members' List.



ii Trevor Goodall

I have for sale a *Bergeon* watchmaker's lathe plus a good number of attachments and accessories.

If anyone is interested, Trevor's telephone number and e-mail are on the Member's List.

- **PEEMS Annual Lunch.**

Jonathan asked people who lived in Scarborough if they preferred a venue for the annual lunch closer to them. There had been very favourable views of the Kirkbymoorside Golf Club where we went for our annual dinner last year. There was a consensus at the meeting that the Golf Club would be a very good place to return to.

This is the menu that has been proposed:

Kirkbymoorside Golf Club

10th April 2025

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Crispy Filo Brie & Cranberry Parcel
Served with fresh salad

Classic Prawn Cocktail
Served with Marie Rose Sauce

****

Main Course

Sommerset Pork - Tender Pork fillet, slowly cooked in Cider (GF)
Served with Creamy sauce, Caramelised Apple and Mashed Potatoes

Homemade Beef Lasagne
Served with salad garnish & chips

Vegetarian Wellington
Served with Vegetarian Gravy & Chips

All served with Seasonal Vegetables

****

Homemade Treacle Sponge
Served with Custard

Homemade Lemon Meringue Roulade (GF)

****

Coffee & Mint

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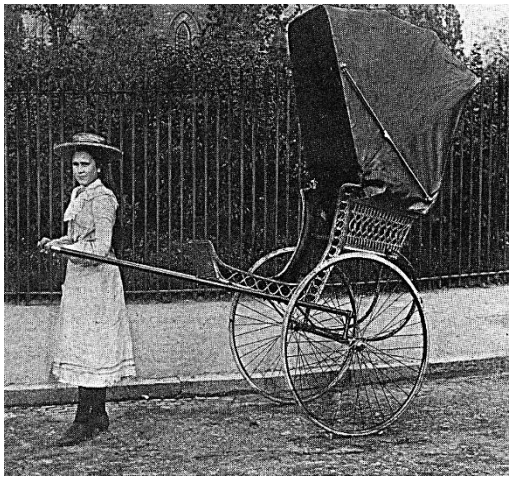
Two Course - £ 25.00
Three Course - £ 30.00

LE Velocette Main Bearing, Crankshaft and Big-End Overhaul. A Talk by Rob Davey

- **Introduction**



A rare photo of a *Veloce* rickshaw in Birmingham

The Velocette company was founded by Johannes Gütgemann who was a Prussian. He came to the UK in the 1860s. He got married and started a company making pills, and also Rickshaws.

The company made a very early car and a motorcycle which wasn't successful. Then like a lot of people at the time, they made fittings for bicycles. They were good at this and in 1913, they started making motorcycles again.

These were two-stroke. Some may remember that in the 60s and 70s, the Japanese had two-strokes and they introduced *"posi-lube"* so you didn't have to put oil in the petrol. Velocette had that in 1913. The reason was that the oil in those days was horrible, and didn't mix with petrol very well. Velocette had a type of "*posi-lube*" and they had a system where crankcase pressure put oil in the petrol.

Mr Gütgemann naturally started changing his name to Goodman, and in 1917, because of the First World War, he became John Goodman by deed poll. He had two children, Eugene and Percy. In the 1920s, one of the sons designed the four-stroke Velocette with an overhead camshaft (ohc). They were very good.

Velocettes always made a well-engineered machine. The bikes were promoted as good value but with engineering quality.

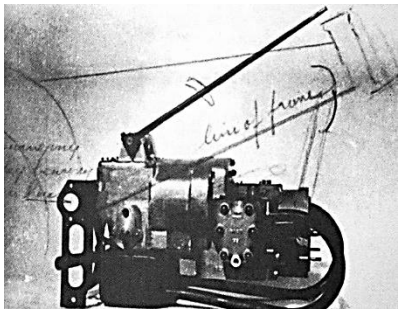
The company also made two-strokes for "the man in the street". Velocette always wanted to make a bike for everyone. Cars in those days were expensive for "the man in the street".

The ohc bikes were raced in the Isle Of Mann successfully, along with pushrod singles, and then the Second World war started. Unlike Norton and BSA, Velocette didn't get a big military contract. They did make a few war-bikes, but most of their work was aeroplane parts. Before the war, the company had installed a large hydraulic press (Lake Eyrie), and they also had a Pratt and Witney boring machine which could bore to a 1/10th thou. The company was therefore set up for good engineering.

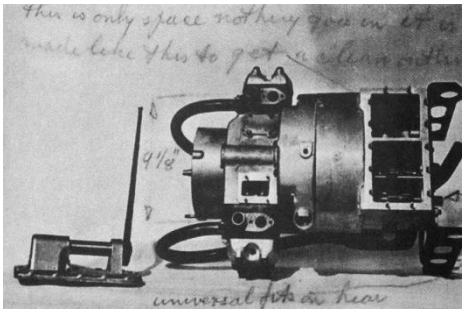
When they did contract work during the war, they could also make motorcycles. It was still their ambition to make a bike after the war for "Everyman".

Charles Udall, the Chief Designer was the quality inspection engineer during the war. In 1943, he got appendicitis, so he was off work for a few weeks. During this time, he sent for a drawing board. He laid down the design for the LE when he was at home.

Charles Udall On The Prototype LE

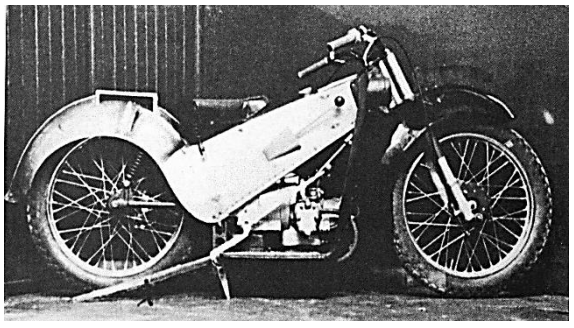


Prototype Engine with pencilled frame outline overlaid.



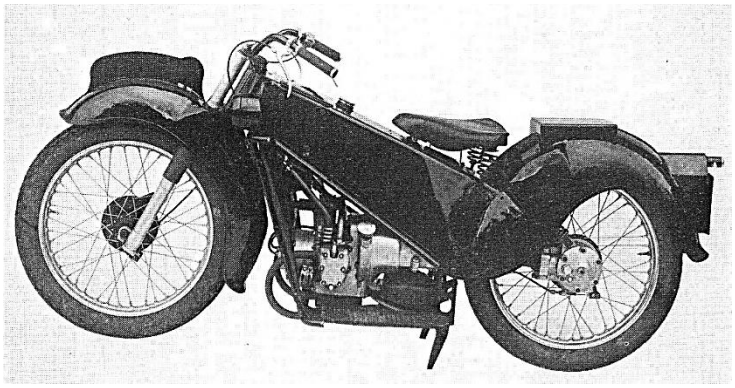
Top view of prototype engine showing openings for tappet adjustment and top of gearbox removed. Note Udall's notes.

All photos courtesy of the LE Owner's Club.



Prototype LE in 1944.

In order to make it a “bike for Everyman”, it had a shaft drive so there were no dirty chains, and it had to be smooth so the engine was horizontally opposed. The engine was kept narrow, so it had side valves. Because of the side valves, there was water cooling, as side valves run hot. The LE was also hand change and hand start. The idea was that anyone could start the bike easily, especially ladies, and you wouldn’t get your shoes dirty starting the bike.



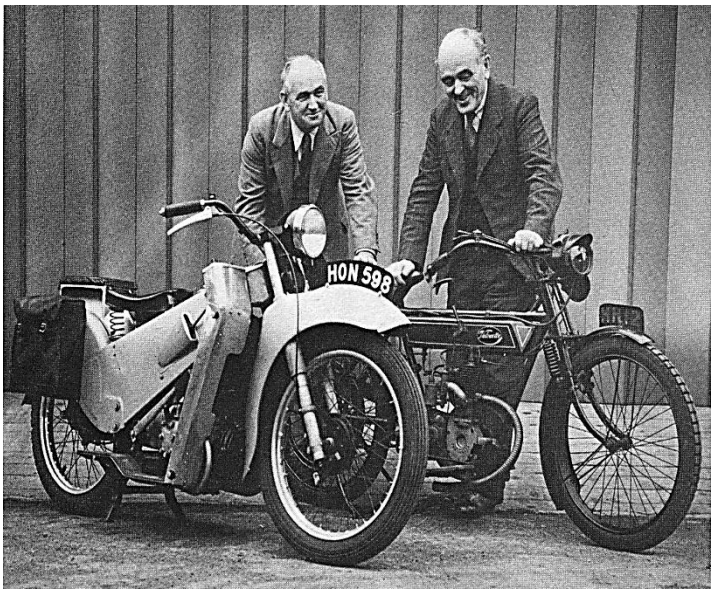
The very first Velocette LE a hand-built prototype produced in 1944-45.

This is the prototype. This was built during lunch hours and spare time. Apparently, the workforce became enthusiastic about the project.

They built up the engine from one-off castings and got the prototype running. The prototype was quite a bit different to what was eventually the production version.

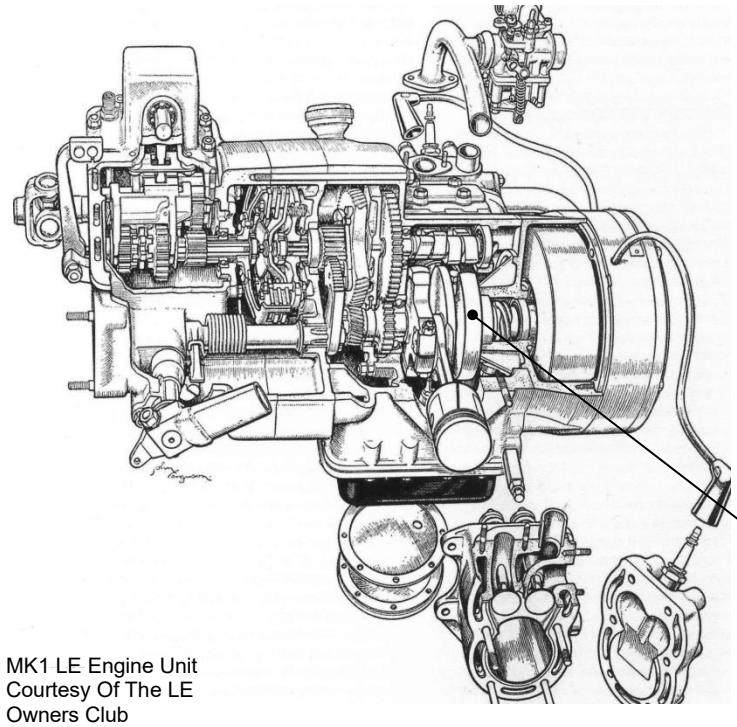
The testers took the bike all around and into Wales, travelling up to 200 miles a day.

The engine’s big-ends had tiny roller bearings and included a crankshaft with ball bearings. This is the reason Rob was giving this talk about the main bearings and crankshaft overhaul.



Percy Goodman (right) and his brother Eugene with one of the 1913 two-stroke models and one of the first production 149cc LE models.

These are the LEs being tested at the launch. Notice the testers’ clothes. Quite different to motorcycling gear today. A long coat. The idea was that ‘Everyman’ could ride this bike with normal clothing.

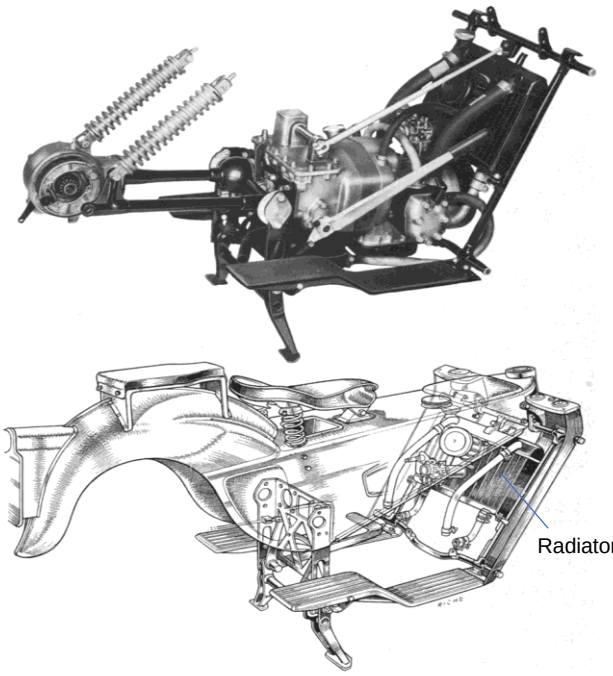


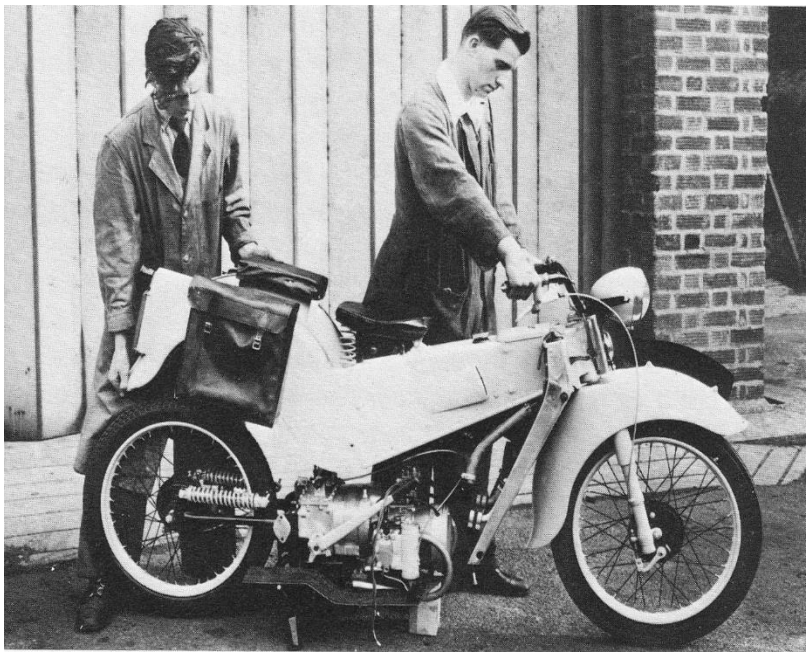
MK1 LE Engine Unit
Courtesy Of The LE Owners Club

Shortly after the introduction of the LEs, they started having a lot of problems. Crankshafts were coming back to the factory because they were ”rattling away”.

The LE engine is quite “a big lump”. At its back-end is the gearbox. Riding down the road for two or three miles to the shops, after a cold start, is never going to get the engine warm. The problem was that there was a lot of condensation in the engine, and this rusted the roller bearings.

Eventually, Velocette got rid of the roller bearings and used plain bearings. Gradually, they used plain bearings in the main shaft and the crankshaft as well.





These photos show the LE engine installation with the engine and gearbox unit, the drive and the radiator. The body can lift off completely to give access to those components. The body can be lifted off in half an hour, by undoing four nuts at the front and two at the back.

The bike is very well made, and very well thought out. The big problem was that it was twice the price of a Bantam. The LE didn't sell in the numbers that were expected. Velocette wanted to sell 300 bikes/week, but the maximum output was 191 bikes in one week.

The contract with the Met. Police kept them going. They bought a lot of these bikes.

The first LEs were hand change and three-speed. Later in 1958 they became four-speed. That was mainly due to the Police who said that for three gears, the top gear was too high and the second gear was too low, and they wanted it splitting.

About fifty Police forces ended up using LEs. This was at a time when there was a shortage of Police, and bicycles couldn't cover the ground. The LEs in the Met. would do about 25,000 to 30,000 miles a year each. They were in a pool and were operated by different officers over 24 hours a day.

Some Police forces tried other bikes out, such as *Tiger Cubs*, and *Triumph Speed Twins.* The trouble with the *Speed Twins,* was that they needed a rebore after 30,000 miles, whereas the LEs were sold on after they had done 75,000 to 80,000 miles, still on their original bores.

The advantage of the LE was there was a windscreen and leg shield, and in the winter, the radiator gave a bit of warmth. The LE also has foot boards not foot rests. With water cooling, good oil and good maintenance, once LEs are set up and running, they can be very reliable. When Rob goes out on his, he never does less than five or six miles, and usually ten at a minimum. After about a quarter of an hour to twenty minutes, the bike runs a lot better because it takes that long to get the engine mass hot.

Velocette made more LEs than all their other bikes put together, but probably didn't make much money on them. They sold a lot to the Police, but maybe with big discounts.

Rob has an oil pressure gauge on his bike. You are supposed to run 30 mph at 30psi in top gear. When he starts his up, the pressure goes up to 60-80psi. He doesn't rev too much, but as he goes along, the oil pressure drops, and it takes about 15 to 20 minutes before it's down to 30psi. There's a valve with a spring plunger, where the oil pressure can be adjusted to 30psi when it is hot.

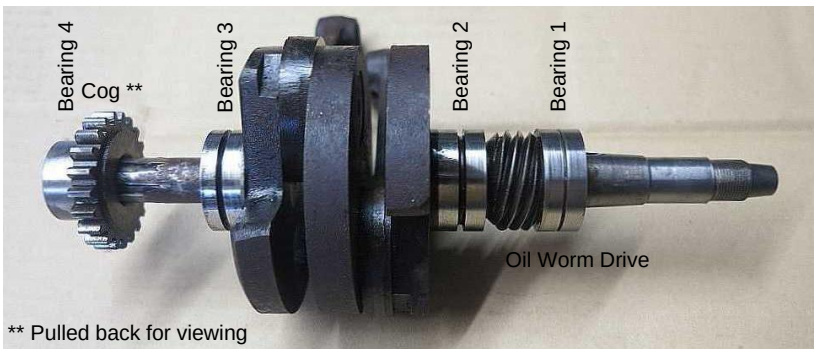
When the bike came out, monograde oil was used, but nowadays Rob uses multigrade. *ZDDP* is an anti-wear additive, and it is also 'anti-scuffing'. It was used in a lot of oils to protect the cams and cam followers. When catalytic converters were introduced, car engines had to have their cams and cam followers extra hardened, and for that reason modern oils don't contain *ZDDP*.

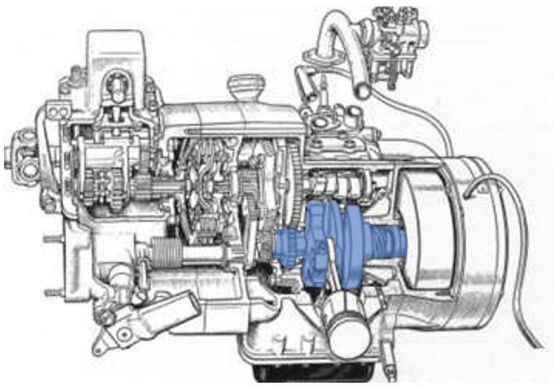
If you look for classic oils you can get oils with *ZDDP*. This is what Rob uses. You can also get fully synthetic oil with *ZDDP*. It's not cheap, but it is cheaper than engine repairs.

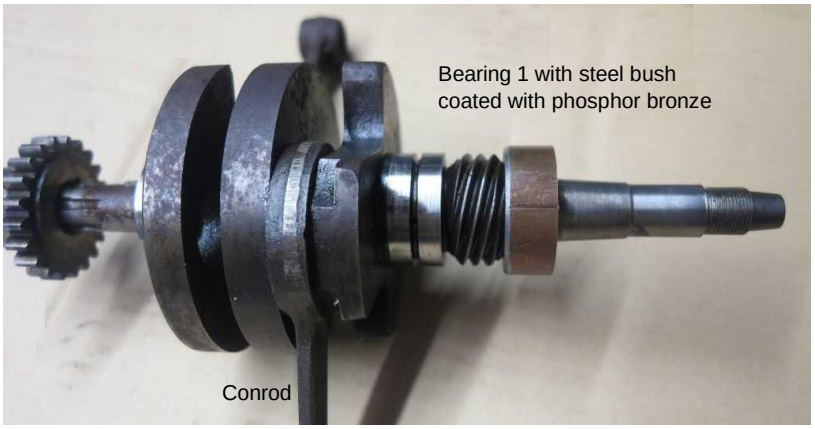
- **Main Bearings, Crankshaft And Big-End Overhaul.**

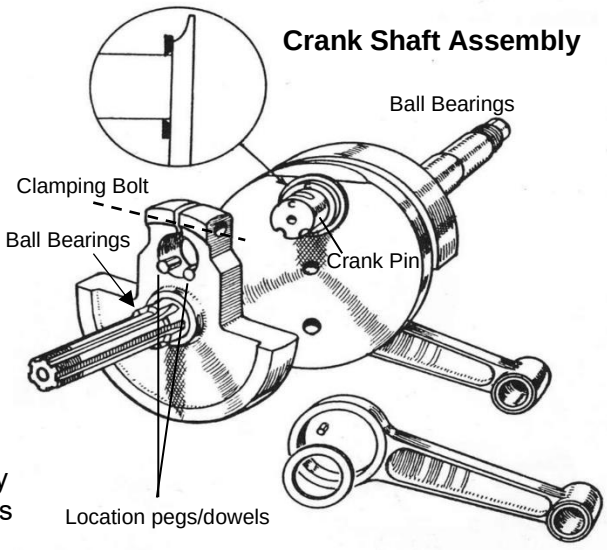
As can be seen from the engine and gearbox cut away on the previous page, the engine is quite complex and different to a normal motorcycle engine. This means it has to be approached in a different way to overhaul it.

- **The Crankshaft.**



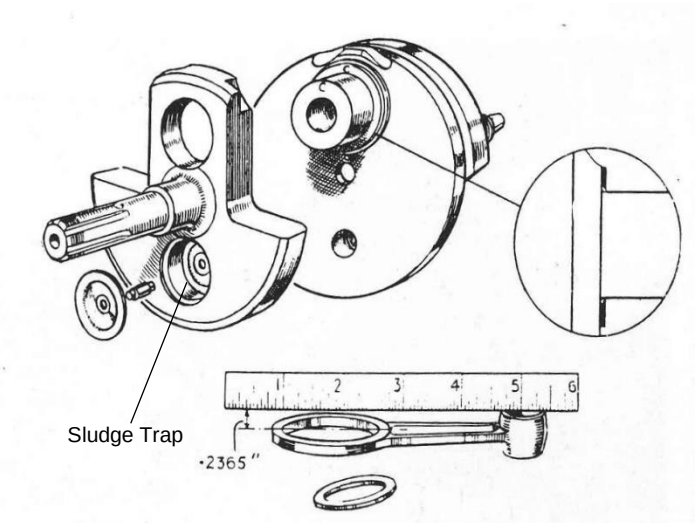




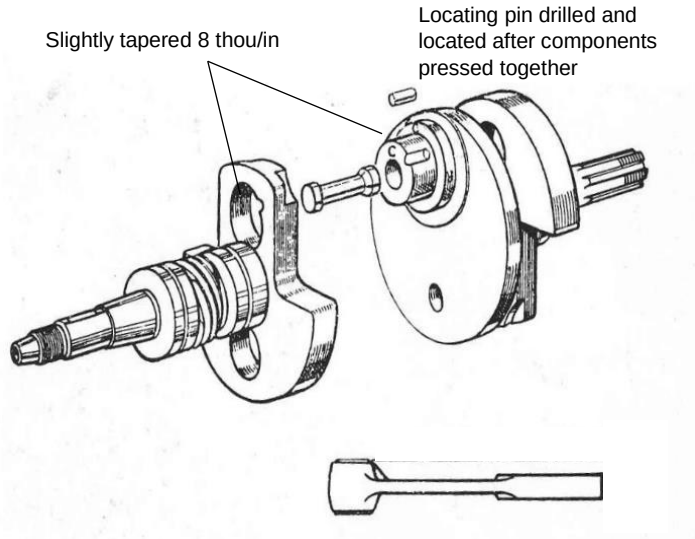


The clamped and dowelled crankshaft assembly opposite, is an early version, and was clamped up with a bolt. This one had roller bearings in the big-ends and ball bearings in the main shaft.

Clamped and Dowelled Crankshaft Assembly



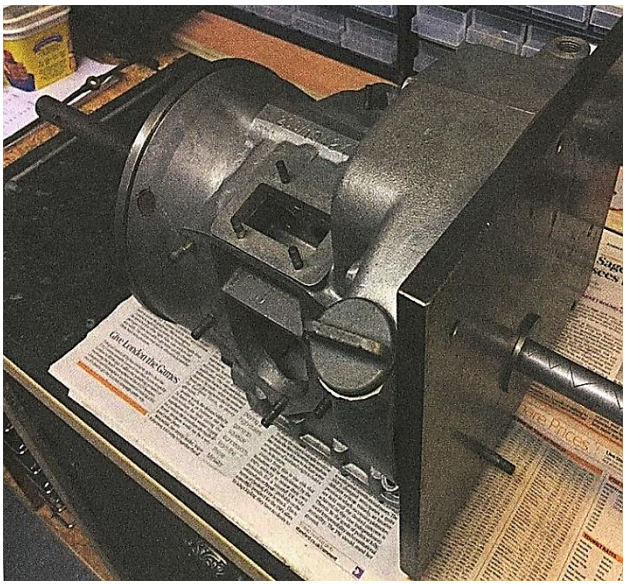
Intermediate Version With Revised Crank Web, Sludge Trap And Velocette Style Pressed Assembly



This is the version on Rob's LE. The plain bearing crankshaft. The plug in the crankpin is used to form an annular oilway.

For the plain bearing crakshaft that's on Rob's LE, it is not a parallel fit . The crank pin and its mating part are slightly tapered at 8 thou/in and they are press fitted together. Lots of those sets are in the big single engines that were built on this taper. They must have had a big machine for cutting this taper. Basically, the two components are pushed together halfway, and then the rest is pressed in. There is no problem with this assembly.
Of course in reality, things wore out, and Rob had this LE and the engine was worn out. Meanwhile he got another LE engine.

As can be seen in the first photo on the previous page, the crankshaft has four bearings, and to stop them binding, They have to be absolutely parallel and straight. The handbook says that when the bearings wear, they should be sent back to the factory to be rebushed. That could be done 50 years ago, but not anymore, So, Rob needed to replace the bearings. There was someone who used to do them, but he passed on.



Velocette apparently made a jig to be lent to the dealers to do this job. The jig consists of two big plates which bolt onto the crankcase, a big reamer is put through, and the new bushes can be reamed.

The photo (courtesy of the LE Club magazine) shows the jig with the reamer passing through into the crankcase.

The LE Club has a couple of these jigs and plates, and they wanted someone to send a crankcase to try them out.. Rob sent his crankcase in, but it didn't work out. No one knows if the dealers actually got this tool to work properly.

The bushes (see photo 2 on previous page) are steel wrapped bushes with a thin lick of phosphor bronze. The phosphor bronze is about 10 thou thick. Rob then read that some people had managed to mount the crankcase on a lathe, and had a boring bar passing through.

This is where PEEMS came in. Ken Shutt, Rob's neighbour, put him in touch with someone with a big lathe ~ David Proctor. However, David's lathe wasn't big enough. David put Rob into contact with Mike Sayers. Rob went along to Mike's workshop and spent the morning fitting the crankcase to his lathe, trying to align up the boring bar. The layer of phosphor bronze on the bush is just too thin for the job to be done correctly. In hindsight, if the bushes had been solid bronze, he may have been able to do this.

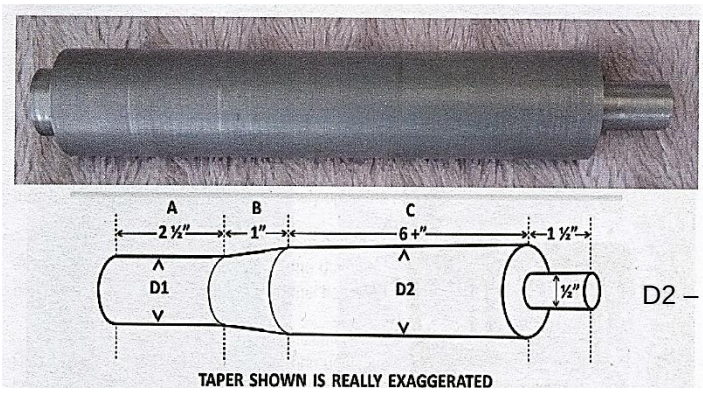
The problem was how to get the bushes in line. A thou out and there is binding. The bushes can't just be pressed in. If they are pressed in, the crank won't go through because it has the allowance.

About forty years ago, Rob read about *'Timesaver lapping compound'* in the *Model Engineer* magazine.

Carborundum can be used for lapping steel to steel, but if carborundum is used for lapping steel onto bronze, the carborundum gets embedded in the bronze, and carries on wearing the steel shaft. "*Timesaver*" is guaranteed not to embed in metals. It's been on the market since 1920.

Rob saw this product in an autojumble for £1 per tin and he's used it over the years on motorcycles and things. He wondered if he could use it on the crankcase bearings. On the leaflet for the "*Timesaver*", it stated that it was suitable for 'split bearings'. 'Split bearings' are the half bearings you put together and tighten up with nuts and bolts. You can put *"Timesaver"* in there and gradually tighten the bearing up. Rob couldn't do this because the crankshaft would not fit into the crankcase at all.

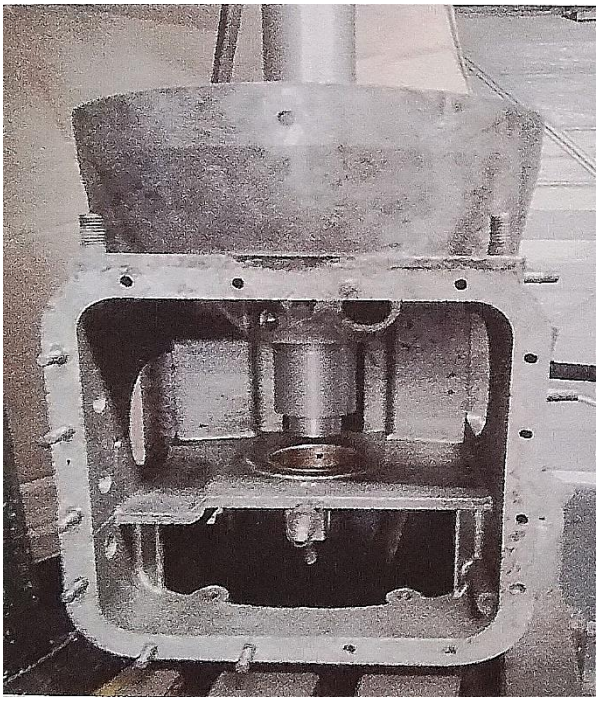
So, Rob needed to make a lap. This lap is not parallel for the full length. It has a taper over a section of the length. The taper shown below is greatly exaggerated. The front end is 4 thou less diameter than the rear end. The idea was to make the front end of the lap so that it would just fit in the newly fitted bushes. This end is just the right size to fit in the bushes (journals) of the crankcase.



D2 – D1 = 0.004"

Front Of Crankcase Showing Bearing B1 Bush

D1 just fits in the newly fitted bushes (journals) in the crankcase. D2 is the diameter of Bearing B1, B2 and B3 bushes.



Lap approaching Bearing B3 Bush

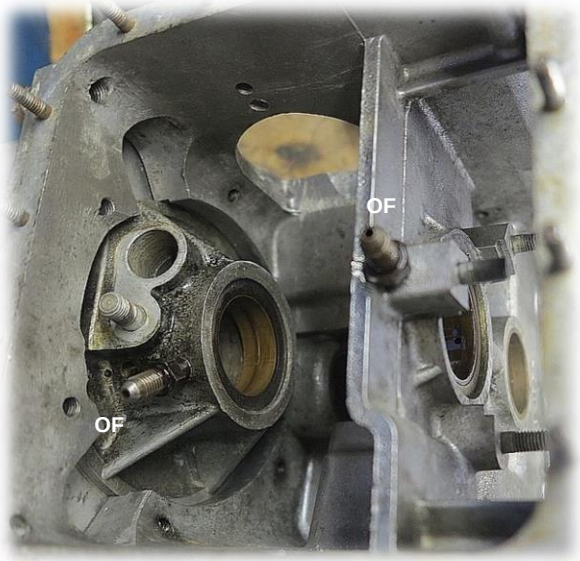
Rob held the crankcase in the milling machine. The crankcase had the newly fitted bushes for bearings B1, B2 and B3. The idea was that the lap would go through the first two bushes for bearings B1 and B2, and the hope was that they were in line. Rob didn't bolt the crankcase down on the milling machine because he wanted it to self-centre. What he did do was to make sure the crankcase didn't turn, so he restrained it with a piece of steel.

The milling machine was set up at a slow speed. The "*Timesaver*" compound is a powder. It is mixed with thin oil. The mix was brushed on the lap and the bearings, and then the lap was fed into the bearing bush B1 with the milling machine. The feed in was done so far, until the taper was felt 'catching'. As soon as Rob felt the taper catching, he brought the lap out again. He kept lashing the lap and bushes with the lapping compound mix, and eventually the lap went through the first bush for bearing B1.
The process was continued and eventually he got through the bush for bearing B2.

The length of the lap was sufficient for the first two bearing bushes B1 and B2. Unfortunately, the milling machine only has a 4" stroke, so the crankcase had to be raised up by putting a box beneath. Eventually he got through the bush for bearing B3.

- **But Will The Crankshaft Fit?**

Rob tried it. Before the lapping, the crankshaft wouldn't go in. This time it went in, but it was stiff to turn. So, Rob mounted it on a piece of wood in a vice, with the crankshaft installed.



Rubber bands were used to secure the conrods to stop them flying around. A big nut was put on the end of the crankshaft, and a socket for a big electric drill.

The bearings/bushes are provided with oil feeds 'OF'. So Rob put some plastic tubes on them, and made up some more lapping compound/thin oil mix. The plastic tubes were filled with compound and Rob started up the drill on the crankshaft.

It was slow, and the crankshaft was stiff, but eventually it started rotating. With plenty of oil on the conrod big-ends Rob gradually felt the crankshaft freeing up. After a few minutes, he could go full speed on the drill.

Once the crankshaft was free running, Rob took everything to pieces, cleaned off all the "*Timesaver*", and then put oil in the crankcase. The crankshaft was reinstalled in the case, and the exercise was repeated with the drill, and it "whizzed around".

It was "crude engineering", but it worked!

Rob's done a couple of crankshaft /case overhauls now. If he could have used a proper reamer, maybe it would have worked too.

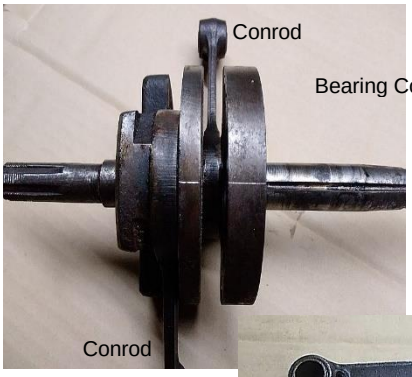
- **Big-End Collar Overhaul.**

At that time, Rob only needed to overhaul the main crankcase bearings, but later, he had to overhaul the big-ends as there was play in them. To do this, the conrods had to be removed by splitting the crankshaft. Before splitting the crankshaft, the main bearing collars had to be removed.

Rob found a tool on E-Bay for pulling armatures off dynamos. He found one that just fitted, and could be used to pull the collars off. The collars had a stiff fit on the crankshaft.

The 'puller' was then used. If the shaft is parallel, it pulls out gradually, if it's tapered it goes with a bang.

Next, the big-ends had to be removed from the crank shaft by parting the assembly. This is done by putting the crankshaft in the press which is a copy of the Velocette one. Before parting the big-ends, it is a good idea to put a mark on the crankshaft to allow lining up later as shown in the photo below.

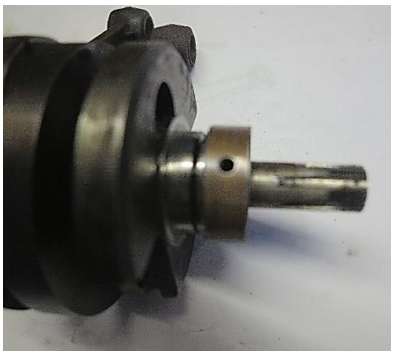


Rob got the crankshaft, conrods and big-end shells to pieces. Fortunately, as can be seen from the previous pictures, the crankshafts are dowelled with locating pins, so when the crankshaft is being reassembled, and because the same big-ends are being used, it goes together very well and is hardly ever 'out'.

As can be seen in the photo of the conrod, two half shells form the conrod bearing. The Velocette Club still have these. They can be bought and pressed back in the big-ends to replace the worn ones.

- **Turning Off New Main Bearing Bushes.**

The rear B3 bearing bush on the crankshaft is the one that usually wears out first.

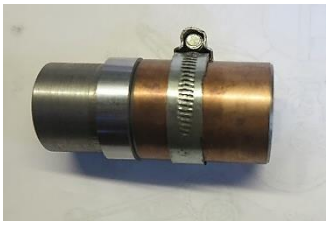


Bush Pulled Back Off The Bearing Collar To Show Groove In The Collar.

Bush In Position With Collar Groove Under Hole.

On this bearing, the oil comes in at the top of the hole in the bush into the bearing collar groove. This groove in the collar feeds the oil to the big-end. The oil also goes half the way around the groove to a smaller hole in the bush. It goes through that and feeds the camshaft bearing and also to another pipe to feed the clutch bearing.

Because of its function the bush has to be a very good fit. because if not, the oil goes everywhere. It's very important that the B3 bearing bush is correct, and that is why Rob has taken a lot of trouble to make it just that. The front bearing bushes B1 and B2 are probably not as important, but Rob still likes to get them right too.



If the bearing collar not too worn, Rob turns off the main bearing from stock on a 4-jaw chuck. Using jubilee clips and a parting tool, Rob can turn off a bearing bush/shell.

Questions And Answers.

Comment: Rob, could you tell us about the LE Owner's Club?

Rob: The LE was launched at the end of 1947, and was on general sale in 1948. Very early in 1950, an Owner's Club was formed, which will be 75 years old this year. At first, the Owner's Club was not about maintenance, because that's what you would take your bike to the local dealers for. It was more of a social club. Tony Leeming had an LE which had been owned by the Chairman of the LE Owner's Club. People would travel up to 200 miles on LEs to go to rallies and camping weekends.

When the Velocette factory closed in 1971, the Club had around 300 members.

In the 1970s, a lot of dealers were giving up on LEs, especially as the Police were the main buyers (and maintained their own). A couple of far-sighted individuals said that they wanted to keep their LEs on the road, and what were people going to do about spare parts? Up to then, spare parts were supplied by the dealers

The Owner's Club then started buying up spare parts from the dealers, who would often sell them 'for a song'. When the Velocette factory closed, one big dealer, a Mr Littlejohn in London, bought all the LE parts, and one of his sons took over. This son moved to Chester. When Rob first had an LE in the 1980s, he went over to Chester and bought some clutch plates off him. He had a massive collection of parts. When he died, the Owner's Club wanted to buy all the parts from the estate, but the relatives wanted "silly money" for them.

The Club negotiated for twenty-two years and eventually bought all the stock. Some of the parts were rusty, but some were covered in grease and in protective wax. An LE owner can still buy a crown wheel and pinion, brand new, as Velocette made it. Besides all the spare parts (the Owner's Club took six transit vans to Chester), they got a huge pile of drawings. This meant that the Club has got, not every drawing, but thousands of drawings of LE parts. The drawings, importantly, have the material specifications on them. So, if an owner's LE part wears out, the Club can make new ones. The drawings have now been digitised. Included in the drawing haul were the tooling drawings as well. Owners can buy drawings from the Club.

The other thing the Club does is supply all the special tools needed to disassemble components. There is a loan scheme which means that tools are available for special tasks. Once finished with, the owner sends the tools back to the Club. Rob tends to make his own tools, because he wants them on hand when he needs them. The Club is no longer a social club, it's more of a parts supplier, but the membership now is in the region of 1200 to 1300.

Someone kept all his spare parts in a garage until the garage got very full. Twenty years ago, a derelict factory was bought in Walsall. The factory was rebuilt, and a couple of years ago there were so many LE parts, the factory next door was bought. The factory is now about the size of four semi-detached houses and three stories high.

You can get all the consumables, cables, brake shoes etc, from the Owner's Club, no problem. A few years ago, owners couldn't get pistons for the LE. They had all been used up. The Club went to Serco (Motor Sport) who make pistons for racing engines. The Club now have a good supply of LE pistons. The pistons are slightly oval and slightly barrel shaped, so once they become hot, they are circular and cylindrical. That's what the Owner's Club does, keeping the Velocette LEs on the road.

There are still local meets. Once a year there is a rally down in Rugby. The Club has a website and forum where members can discuss technical matters.

Please Note: A number of photos and illustrations in this article are owned by the *LE Owner's Club* and should not be used without their permission. PEEMS thanks Rob for giving this very interesting and informative talk to our Club.

Can Hi-fi Ruin Your Life, Will A Thermionic Valve Bring Happiness? Colin Bainbridge.

Part 2 – Days of Futures Past.

As this text may be viewed by those living outside the parish of our Club, I feel obliged to repeat the **Safety Warning** that appeared in Part 1.

Should you plan to lift the lid, or undertake construction or repair of valve amplifiers, BE AWARE POTENTIALLY LETHAL VOLTAGES WILL BE PRESENT INSIDE, and that unlike modern electronics, valve circuits operate across LIVE, NEUTRAL AND EARTH, and that means METALWORK within the box, that you might think will be at EARTH potential, may in fact be LIVE! All large capacitors SHOULD NOT be approached with the set ON, and be DISCHARGED BEFORE touching them or nearby circuitry with the set OFF.

Intro.

Now for anyone still unconvinced, or for those that may have skipped Part 1 and are desperate to understand why anyone would be interested in this old technology, I could try and persuade you to think of it as being part of our heritage, part of the journey to where we are today. Valves are to microelectronics what the petrol/diesel vehicle is to the electric car, both are essentially the same thing, but owing to their respective places in history perform their function in two very different ways, and truth be told efficiencies. Ask any heritage car owner why they choose to have one, and they'll tell you it's the whole experience, it's what it is, how it's made, what's under the bonnet. Then there's the pleasure they gain from driving it...so I put it to you, why should the valve loving enthusiast be any different? Just because it's old doesn't mean it can't give a good performance...

I will also say from the outset that if you are settling down with your mug of tea, a pile of biscuits, a note pad and slide rule, looking forward to reading a detailed treatise on how these marvellous devices work, and anticipating I am going to offer lots of formulae and graphs, alas I must disappoint you, but I do hope to convey to you something of the interesting story of the valve.

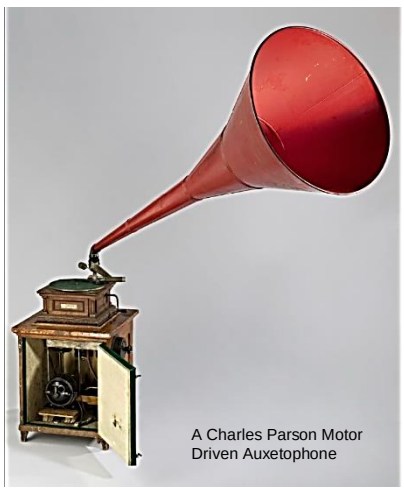
History.

Every year another crop of names is added to the tree of knowledge, of who invented what and when, sometimes muddied by who filed the first patent, but in my piece, I will be staying with the 'tried and tested' names of history and leave it to the scholars to fill in the finer detail if they so wish.

The development of valves was certainly not uniquely British, although once the science was established, Britain did take a leading role in their manufacture, (how times have changed), supplying huge markets and gaining in the process world recognition for their reliability and quality. Not surprisingly, most of the early companies to produce valves were, or had been, manufacturers of light bulbs, with the likes of *Osram, Ediswan* and slightly later, *Mullard* leading the way. In fact, Stanley Mullard started making valves almost as a sideline, whilst employed by a small company under the exciting name of *'Z Electric Lamp Manufacturing Co Ltd'*. He eventually established his own business of valve making, when the aforementioned lamp company went into liquidation. The company *Cossor* has in certain circles being credited with being the first maker of valves in England, having produced (it is believed) the valves for Fleming's early diodes.

Over time, the number of British manufacturers expanded and contracted, depending on who took over whom and who became a subsidiary of which electrical conglomerate (not always British). A scratch beneath the surface of several 'named' valve companies, especially from the later period, can be quite revealing.

Valves – In the Beginning.



A Charles Parson Motor Driven Auxetophone

Copyright: The Science Museum London.

The job of a Hi-Fi amplifier is to make low level signals bigger, big enough and with enough *oomph* to ultimately drive a loudspeaker, and depending on how much sound will be required to fill a room or hall, will define just how much *oomph* will actually be needed. In the dark days before electronics existed, amplification was achieved acoustically, where the phonograph and gramophone used horn loading to connect a stylus and diaphragm to a body of air large enough for the sound to be heard. These mechanisms became ever more ingenious, including one partially successful one invented by Charles Parsons (the turbine man) called the Auxetophone that used the stylus to control a flow of compressed air through a venturi and out through a single or a pair of twin horns.

Even though other sciences were well established by the late 19th Century and indeed electricity generation and distribution were already becoming established, the invention and perfection of early electronic components still relied largely on the time-honoured process of the individual experimenter making discoveries, sometimes by accident on his or her own, with in some cases no particular use for the end result in mind. The first thermionic valve was an example of this.

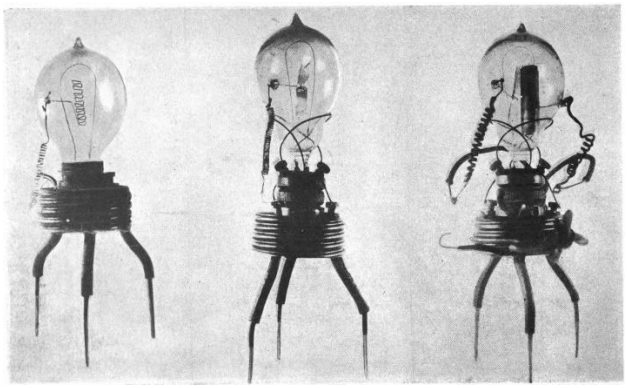
Copyright: The Valve Museum

Thomas Edison.

The starting point for the development of the valve occurred around 1880. Thomas Edison (others may also have claim), was looking to further improve his invention of the electric light bulb, when he observed a discolouration of the inside of the glass envelope occurring where particles of the light's filament had been deposited during use. He noted a thin clear line was being left beside the wire carrying the positive current to the filament, and further experiment showed that by placing a separate metal plate near to the positive electrode, a current would flow from one to the other.

Being of an entrepreneurial mind, Edison took out a patent for the process and thereafter it became known as the *Edison Effect*.

The Diode (The Oscillation Valve).



The first prototype Fleming valves, built October 1904.

Public Domain

In 1904 John Fleming (a man who knew his *'Right Hand'* from his *'Left Hand Rule'*), developed Edison's idea further by improving the heating effect of the filament (the cathode), allowing it to give off electrons more freely.

He formalised the second plate inside the glass bulb as the other electrode (the anode), and in so doing produced the first practical diode valve, this being a device that allows electrical current to flow in one direction only.

The diode found use fairly quickly, as a detector in the up to then very inefficient receiving equipment used by the early pioneers of radio telegraphy, whose own efforts up till this point had been arrived largely by brute force and ignorance, rather than by the refined science that electronics was eventually going to become.

The term 'oscillation' is believed to come from the diode's application as a detector, for its function was to rectify the oscillations coming from a receiving aerial, to produce a result that could either be heard on headphones or fed to a visual indicator. The term 'valve' comes from the way the new diode worked, for its action mimicked that of a control tap or valve used to control the flow of fluids (also I imagine 'valve' sounds sexier than 'thermionic tap').

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The Triode (Audion).

Sometime before 1910, Lee De Forest in America took it a stage further by adding a fine wire mesh, a third plate or 'grid' in the bulb between the two existing electrodes, anode and cathode, now making it a triode.

The inclusion of this grid was the significant turning point in the development of the early valve, for with its addition the steady flow of current between the two plates of the diode, could now be controlled and varied.

Using the grid in this way, changed the action of the diode into something different, for it now made the valve operate rather like a voltage controlled (variable) resistor.

Lee De Forest called this improved design the Audion valve.

The Tetrode and Pentode.

Beyond the Triode, there are only two other types regularly used in valve amplifiers, and they are both really refinements of the three-electrode valve.

The Tetrode has four electrodes (although a five-electrode version called a *Beam Tetrode* is also available), and the Pentode which has five electrodes. These additional 'screen grids' improve the valve's efficiency and current handling capacity, and whilst both types have similar power handling capability, the Pentode was more suitable for use in the final output stage of a domestic amplifier.

The Beam Tetrode leant itself to being used in larger power amplifiers such as those used in theatres, cinemas and halls. These four valve types (Triode, Tetrode, Beam Tetrode and Pentode) form the building blocks of audio amplification.

KT66 Beam Tetrode

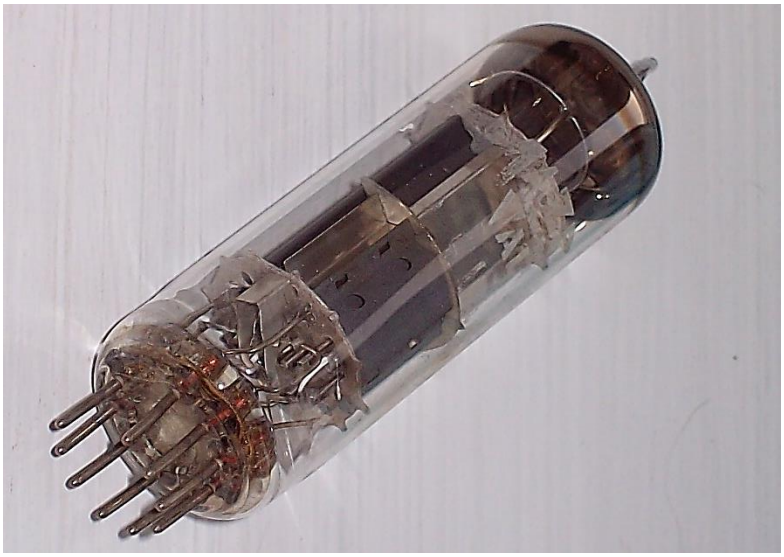
EL34 Pentode

What's Inside a Valve?

What makes valves interesting is having identified anodes, cathodes, grids and screens; they are all physical structures, some of which are visible inside the glass envelope. Perhaps surprisingly, whilst this envelope is usually tall and thin suggesting its operation is bottom to top, the electrodes are usually laid out so the electron flow is from the centre outwards, making the outermost structure usually the anode.

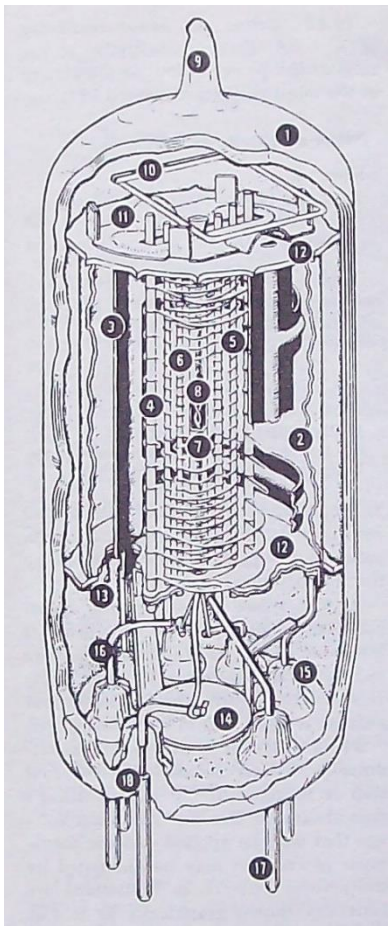
Should the view of the internal architecture be obscured however, this will probably be because the inside of the glass is coated with a grey silvery coating which is produced by the *Getter.* This is a substance created at the time of the valve's manufacture, when the air inside has been removed to create the vacuum needed, and is used to soak up any remaining molecules of air. It continues working after this, by absorbing any gases given off by the metalwork during the valves working life, that might otherwise disturb the flow of electrons.

Cathodes are made from nickel or molybdenum, with a thin coating of carbonate of barium or strontium, as they both freely give off electrons when heated. Anodes are made from nickel or molybdenum with grids and screens being made from tungsten or molybdenum wire, with supports of mica.



Combined Triode/Pentode Valve.

1—GLASS ENVELOPE
2—INTERNAL SHIELD
3—PLATE
4—GRID NO. 3 (SUPPRESSOR)
5—GRID NO. 2 (SCREEN)
6—GRID NO. 1 (CONTROL GRID)
7—CATHODE
8—HEATER
9—EXHAUST TIP
10—GETTER
11—SPACER SHIELD HEADER
12—INSULATING SPACER
13—SPACER SHIELD
14—INTER-PIN SHIELD
15—GLASS BUTTON-STEM SEAL
16—LEAD WIRE
17—BASE PIN
18—GLASS-TO-METAL SEAL

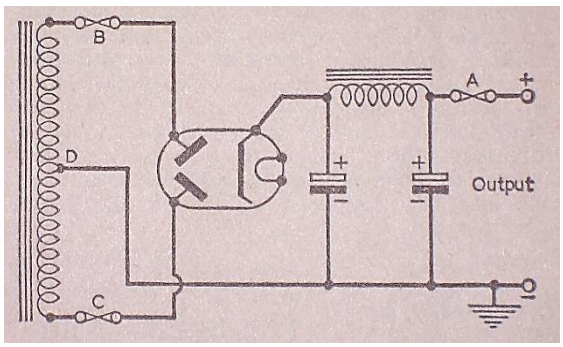


Metalwork Inside A Pentode

As valves became ever more refined over the years, they were capable of being made smaller, while still being able to do the same job, and eventually it was even possible to have two valves contained inside one glass envelope without the size of it changing significantly.

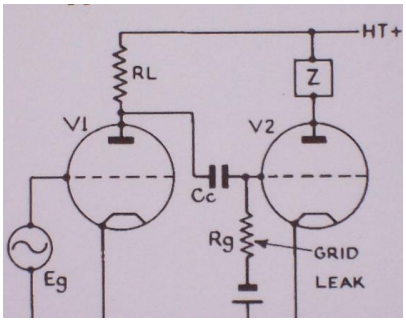
Double Diodes and double Triodes became possible, and even two dissimilar types could be combined, such as a Triode and a Pentode.

How it Works.



Diode Rectifier Circuit

In the diode valve, if an AC current is fed from a transformer to the anode and cathode, they will alternate between being positively and negatively charged on each half of the AC cycle, but as only the cathode is made of a material that allows free release of electrons, current only flows when the anode is positive.
The resultant output will however be a lumpy DC, as only one-half cycle of the AC waveform is being used, necessitating a lot of smoothing before it is in anyway usable as a source of DC. Full-wave rectification becomes possible when two diodes are used together to rectify the whole cycle (although still requiring some smoothing), to produce a steady flow of DC. Eventually rectifying valves were developed that contained two anodes operating to a common cathode, enabling full-wave rectification to be carried out within the same tube.



Triode In A Circuit

With the Triode having the addition of a third electrode (the grid), the valve now has two circuits to make it operate, one indirectly connected to the other. If instead of AC, high voltage DC (High Tension - HT) is attached between anode and cathode, (anything from 50 to 400 volts), a steady stream of electrons emitted by the heated cathode will flow from one plate to the other. With a specific voltage applied to the anode, and with the cathode giving off electrons, a small current known as the '*quiescent current'* flows through the valve, holding it in a sort of 'standby' mode.

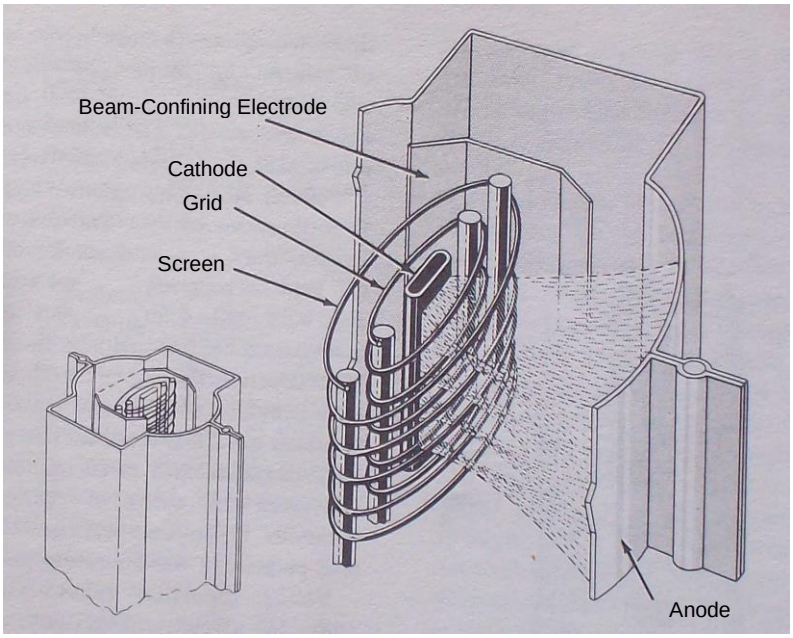
In this state a Triode can be thought of acting like a low power diode, as a current is continually passing from cathode to anode, although under certain circumstances this flow of current can be stopped completely.

The current can now only be altered if one of three things changes: The size of the HT voltage on the anode - The resistance within the HT circuit is changed - The flow of electrons emitted from the cathode is increased.

The elegant solution lies in having the grid electrode act to control the flow of electrons reaching the anode from the cathode. This is achieved by keeping the grid slightly negative, in relation to both the anode and the cathode, and in making it more or less negative, its action acts as a brake on the flow of the current. By having a resistor placed externally to the valve between the HT line and the anode, when current is varied in this way a voltage develops across the resistor, and the voltage on the anode changes allowing more or less current to flow through the whole of the HT circuit.

If the voltage supplied to the grid is a low level (ac) audio signal (i.e. Nat King Cole etc), it will have the effect of modulating the DC current flowing through the valve - rather like the accelerator opening and closing the throttle valve of a car's carburettor. By tapping off an output via a second circuit before the anode resistor, this new modulated and 'amplified' DC signal can be passed through a capacitor to remove the DC component, leaving only the enlarged ac waveform to go on to the next part of the circuit.

Tetrodes and Pentodes still only have one control grid, as the other connections are extra screens used to streamline the flow of electrons within the valve. When used in an audio circuit, this might usefully be thought of as having a sort of focusing effect, by encouraging the electrons to migrate only toward the anode, making it work more efficiently.



Tetrode Valve Electron Flow

Whilst it's not possible to actually see electrons flowing between the plates, those aged over 30 will have seen something not too dissimilar in the form of the old pre-flat-screen TV sets. The tube used to view the picture, was a type of valve, having a (heated) cathode and spaced anode plate(s), with the resultant picture being formed by a stream of electrons leaving the cathode heading for the (in this case hollow) anode, passing through and striking a phosphor coated screen at the front of the tube. The magic eye indicator of many an old radio or tape recorder was also much the same thing.

Transformer Output.

Unlike transistorised amps, one of the most important parts of a valve amplifier used for audio, is the output transformer which is there to interface between the output circuit and the loudspeakers. A transformer is required, as valves essentially produce a high voltage low current output, but loudspeakers require low voltage high current to operate successfully. So, the job of the transformer is to keep both parties happy by having the impedance of the 'primary' winding, matched to the valves output stage, and the 'secondary' matched to the requirements of the loudspeaker.

Straight forward though this device appears, seemingly its design is as much an art as it is a science, and the transformer's ability to correctly satisfy both requirements under all conditions is said to have a very big influence on the overall quality of sound coming from this type of amplifier.

Early Uses.

Following its introduction around 1906, the diode was successfully used to improve the reception of the aforementioned early radio telegraph, and once the Audion valve became available later in the decade, history records several individuals were experimenting and working with it, in the transmission of the spoken word.

After the First World War, when the Audion had undergone further improvement (possibly this is also the time when the name Audion was dropped in favour of just Triode) and importantly the theory of its operation had become better understood, an updated Triode valve, the 'R' Type became widely available for use in audio amplification.

If the Audion was the inventor's valve, then the 'R' Type was the improved production model that followed it. This kick-started a whole manufacturing industry that was to last for the next fifty years.

'R' Type Valve

R Type photo supplied by Great British Valve Project

Lee De Forest did however use the Audion / Triode valve himself, in developing a sound on film process for early (silent) cinema, which he patented under the name *Phonofilms* around 1919.

Cinema was in fact an early adopter of the new technology, with the *Western Electric Company* in America (whose original market had been line communications) and other companies continuing development in the design of amplifiers, in this case to provide sound for talking pictures.

The Netherlands became one of the first nations to initiate a public radio service, also around 1919. Britain followed in 1922 when the British Broadcasting Company, formed by Marconi, and half a dozen of the great and the good of the early electronics industry, used the transmitter 2LO running from Marconi's premises in London..... Corporate 'Aunty' only later moved in, in 1927.

Even though radio transmission was improving, most home receiving sets were still very rudimentary, as they used 'Cats Whisker' detectors, only later adopting the diode valve. The received signal would also only have been heard using headphones on these early sets, as they had little in the way of amplification, and loudspeakers as we would understand them today were still in their infancy. However, as Tetrodes and Pentodes developed during the 1920s (Beam Tetrodes appearing in 1933 – 35), their introduction allowed much more power to become available to the designer, making better signal detection and amplification possible. The next generation of radio sets started to appear from the mid-1920s as these developments were worked through, helped now by the continuing improvements in loudspeaker design leading to better overall quality.

By the 1930s many new designs of radio were appearing, which also offered the ability to amplify the output from a gramophone. Those with more money could now buy a combined radio and gramophone (a radiogram), where the radio and record playing device were built into the same cabinet.

Post Second World War.

The first real interest in stand- alone audio amplifiers for the home, came after the Second World War from amateur electronics enthusiasts, whose initial interest prewar had been in building and improving their own radio sets. They now were helped in their quest by magazines, such as '*Wireless World',* publishing designs of amplifiers from the likes of the now legendary David (Theo) Williamson and others, aided by the arrival of a lot of war surplus equipment and components coming onto the market following the end of hostilities.

With only one or two commercially made amplifiers available in the late 1940s, from the likes of *Leak* and *Quad,* for those that could actually afford them, the push for equipment of greater quality for the broader market didn't really happen until the micro-groove record arrived in England sometime after 1950. There was a further pick-up in interest when stereo records and tapes started to appear in the mid to late 1950s.

The 1950s up to the late 1960s, was considered to have been the 'Golden Age' of valve Hi-Fi.

So, what does it sound like?

Before I attempt to answer that, I can't ignore the elephant in the phone box, and feel I should say something about the so-called *Valve Sound*. Now, there is a body of opinion that says there is a certain *Je ne sais quoi* about the way these amps sound and putting aside 'snob value,' one reason put forward is due to the type of harmonic distortion that is associated with using thermionic valves. I have to say that even though my knowledge and experience in such matters is limited to say the least, the case put forward does sound (no pun intended) fairly compelling.

It appears that like bacteria, there are good harmonics and not so good harmonics, and it seems each type of valve appears to exhibit its own preference as to the type of harmonic distortion it likes to produce when driven.

Triodes apparently like to produce pleasant even-order harmonics, whereas Pentodes like to throw in a handful of odd-order as well, and Tetrodes, well they can't really decide which way to go. As if that were not enough to grapple with, when we are striving for that elusive *oomph*, the final output stage of an amplifier, whilst contending with which class it comes from, will most likely be configured 'push-pull'; and in a magic that defeats your author,

the semi-amplified ac audio signal is duplicated, with one leg turned 'upside down'. Then each signal is sent to its own personal valve (usually Pentodes / Beam Tetrodes) where the signals emerge looking slightly lop-sided, only to be recombined inside the *all-embracing* output transformer, (that place of sanctuary that will also calm a bit of the harmonic issue as well), and finally sent effortlessly into the arms of your *JBL 4345* speakers which pin you to the sitting room wall and your neighbours to the Police to complain.

Despite their deceptively simple layout, with so many 'tweaks' available to the designer of valve amplifiers, not least three or four variables per valve to shuffle (not to mention how much feedback to use), I think it is reasonable to assume that there will be (at least) subtle differences in sound between manufacturers and between valves versus solid state amplifiers.

Now, lest I be accused of romanticising, most lead guitarists in today's 'Popular Beat Combos' wouldn't be seen dead using anything other than a valve PA, and the modern recording industry would be bereft if it didn't have access to at least one or two makes of valve operated microphone, to produce a *smooth* mellow sound.

And my amplifier? Bearing in mind it is a *Rogers Cadet* and therefore a humble machine in comparison to the 'big beasts' of England's finest, such as the *Radford STA25* (series 3 of course) or the *Quad 2*, I would say the sound is like:

"Lying on a sun-kissed beach, a gentle warm breeze wafting past you, stirring the leaves on the palm trees nearby; waves swishing onto the shore bring with them the tantalising prospect of you having a cooling swim later. You shut your eyes and your heart swells as you hear the warm mellow tone of a piano starting to play, followed shortly after by, *'' Unforgettable, that's what you are....."* well, it sounds like that really.

But then of course it couldn't sound anything but good now I know valves use only 'happy' electrons that have been allowed to roam 'free range' inside their own warm environment, sweetened with just a touch of harmonic distortion. How I do feel for those less fortunate ones that have been subject to the sterile straight jacketed confines of a transistor or integrated circuit, forced to perform, only to be sent out sounding cold and thin into a modern harsh digital world.

Epilogue.

I have attempted in this month's offering to give you a flavour of what valves are and their use in audio amplifiers, but a whole other world exists for those that wish to take it a step further and to understand HOW these circuits are designed and work. Should you therefore be the sort of person who likes to read log tables, graphs and circuit diagrams (like reading the latest Richard Osman novel), I promise you will be both delighted and surprised when you see how many of the valve circuits were configured in things like old FM tuners (radio in Hi-Fi speak), and old television receivers where the various 'quirks' of the individual types of valve and associated circuitry were put to good use.

Note from the Editor**:** *You said last month something about Nat King Cole sounding like Cleo Lane AND you said you would mention model engineering this month…….*

Ah, I promise I will make amends ....in Part 3.

Postscript.

Since writing Part 2 I have been reading a history of the BBC's Daventry transmitter site which from 1932 to 1992 transmitted radio programmes around the world. My eye was caught by comments made regarding the valves used in these transmitters, for they too used Diode, Triode, Tetrode and Pentode valves, though handling and producing much greater power with sometimes up to 22,000 volts applied to their anodes. This in turn required them to be water cooled. Not for the faint hearted I feel.

I wonder if my best beloved will let me have one of those in due course.....Meantime I think I'll stick to Hi-Fi.

Next month and subject to Editors approval: Is there a valve in the house, has my recent passion for valves been the real thing or just a fling, and might vinyl re-enter my life after nearly a 35-year absence? All this and (model) engineering too – Available March.

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