NEWSLETTER May/June 2021

Good Day Gents and welcome to another interesting Newsletter.

I must say it is nice now we are enjoying summer, although the lifting of Covid restrictions has just been extended.

- **The Railway.**

  We took The Railway out of storage for its annual maintenance, but this year it was with a view to photograph it and prepare it for eventual sale. Thank you to all who turned out to help. It was nice getting together again and we got a lot done dodging the heavy showers. We have had an offer for The Railway and that will be discussed at the EGM on the 7th July ~ see below.

- **Club Meeting Wednesday 7th July.**

  Our next Club Meeting is at the Memorial Hall in Pickering on Wednesday 7th July at 7pm for 7.30 start. The meeting will be on Zoom for those not able to attend. The evening will commence with an Extraordinary General Meeting (EGM) to discuss acceptance of The Railway offer.

  We will use the same Zoom log in details as the meeting in the Memorial Hall on 2nd June. These are:

  Join Zoom Meeting:

  https://us02web.zoom.us/j/84378190383?pwd=bzQvMlp4ZldLSnlCTnV4UEZCYTlDUT09

  Meeting ID: 843 7819 0383
  Passcode: 870032

  We experimented with Zoom at our last meeting and learnt a lot, but still have a lot to learn! We will try again on the 7th July, and if it goes wrong at our end or yours, or if you are unable to attend in person, please will you return your Railway EGM paper vote or email your vote before 7th July.
  Please contact me, Jonathan with any questions. Contact details are on the Members' List.

  - **The Mike Sayers Trophy.**

    The Mike Sayers Trophy competition was not held last year, but will be presented later in the evening.

    You are invited to submit entries to be considered for The Mike Sayers Trophy.
    This year, Zoom entries and photographic entries are welcome.
    <u>The entry requirements are that the models should have recently been built and have not been entered in this competition before</u>. Please ask if you are unsure.

  - **A Truly Well Deserved Award (Northern Association of Model Engineers).**

    I have some fantastic news to tell you and that is that Nevile Foster has won the N.A.M.E. Editor's Cup for producing our Newsletter. Frank Cooper, N.A.M.E. Chairman will be at the meeting to present this prestigious well deserved award. Frank will give us an insight into N.A.M.E. and be available to answer any questions.

- **Workshop News**

  Due to a very generous offer from George Gibbs, we are able to upgrade the *Myford ML7* lathe to a *Myford Super 7*. Ultimately, the old *ML7* will be for sale, so if you are looking out for one, I think you will have to go a long way to find a better one. Further details will be broadcast as soon as the new lathe is installed.

- **The PEEMS Calendar.**

  The calendar is now available to view on the website. We do not have any visits confirmed yet, but as soon as we have, they will be added to the calendar, and if time allows be notified in the Newsletter. We have had one or two suggestions for visits, but any ideas are welcome for a 'Grand Day Out', when we feel comfortable in doing so.

- **The Hungate Centre**,

  The old WRVS building, where we used to hold our meetings, has been purchased by **CaVCA**, (Coast and Vale Community Action). Further details are not yet available, but PEEMS have expressed an interest in hiring the Centre again for our monthly meetings. The building and its location are ideal and suit our needs.

Please keep sending in articles for inclusion in the Newsletters, it all helps Nevile to produce the Award winning publication that it has become.

Stay safe and take care,
Jonathan (Chairman).

The Restoration Of A Stable Clock Dial At Upper Helmsley Hall. A Presentation Given By Mel Doran At The PEEMS Club Meeting On The 2nd June At The Memorial Hall Pickering.

- **Introduction**

  Mel was involved in restoring the stable clock dial and hands to their original state, by repainting and regilding.

  The clock was built by Thomas Cooke of York in 1874, and the clock itself is in remarkable condition. Mel told the owner that it's probably good for 1,000 years!

Before Restoration

After Restoration

As seen in the top two photographs, this is the clock dial as Mel found it. None of the chapters were visible, and the hands can just about be seen.

Q: What is the size of the dial?

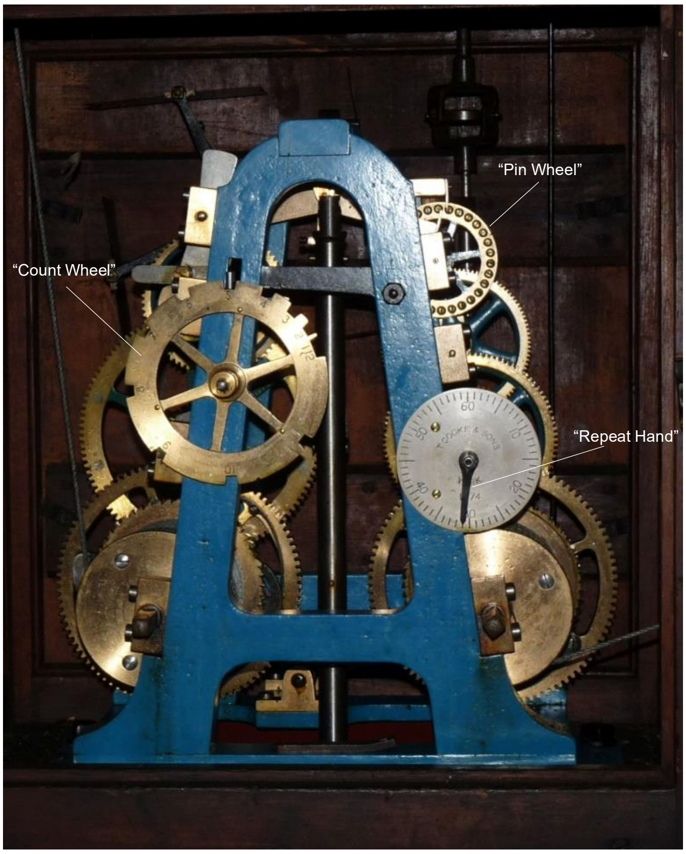
Mel: It's about 20 inches in diameter.

- **The Clock**

  The clock itself is mounted in a mahogany cabinet behind the gable end just above the door.

  It connects to the dial via a "leading off work" rod, which is described in the following pages.

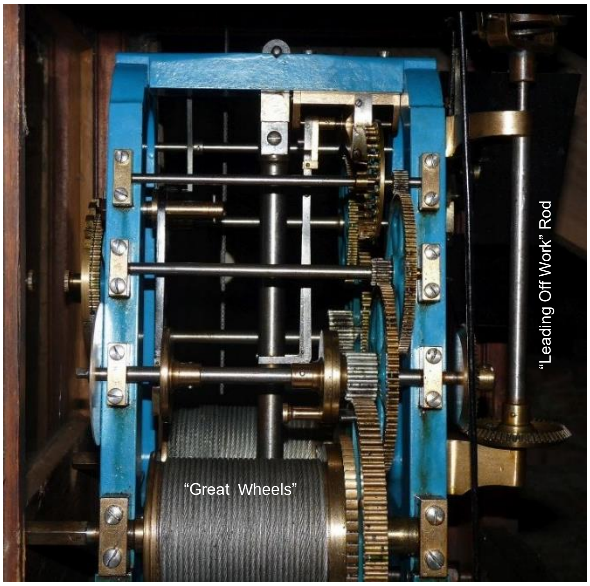
  The bells are behind the louvres, but unfortunately, the louvres allow birds to enter. A wagtail had previously nested on top of the bevel gears. Mel had to go up and put steel netting inside to keep the birds out.



This is a photo of the pendulum and the movement. From the movement there is a "leading off work" rod going up to the dial. The left-hand side of the movement, as seen above, is the "striking side" and the right-hand side is the "going side". The wheel with the cut-outs in it is the "count wheel". This regulates the bell strike so that the correct number occur on the hour.

The repeat hand (see above), only tells you what the minute hand is doing. With these types of clocks, where the minute hand is driven, you never know what the hour hand is doing without looking at the dial. The drive rotates once in an hour. From that once-an-hour rotation, there is a 12:1 reduction gear system which feeds the hour hand. This means that when you go to look at one of these clocks, the first thing you have to do is check what time it is before you go up there!

The pendulum has an arm coming off it with pallets on it. It takes two swings of the pendulum to release one tooth. 30 teeth x two swings = 60 seconds. The pendulum swings from left to right in one second and right to left in one second. That is the time base that keeps the clock going on time, and is dependent on gravity (which varies very slightly depending on global location).



This is a side view of the clock. The "leading off work" rod going up to the dial is driven off the bevel gear at the bottom.

Wire rope 'Great Wheels' are also seen. These are driven by falling weights. There is one wire on the "going train" side, which has a weight on the end of it. On the other side ("strike train"), there is a similar barrel with the wires running through pulleys to the "drop chute". Here both weights hang side-by-side. These drop down about 20 feet for an eight-day run.

Q: What are the bearing blocks made from?

Mel: The bearing blocks hold brass bearings. The wheels are brass. The pinions are hardened steel.

Q: The paintwork on the clock looks in very good condition.

Mel: Yes, it looks as good as new. The workings are in a mahogany cabinet which keeps the dirt out. It has been very well looked after over many years, and it has been cleaned and oiled regularly

Here is a back view of the clock, and again we can see the “leading off work” rod. This rotates once in an hour. It has a 1:1 ratio with the bevel gear at the other end, in the tower, which drives the shaft that drives the hands.

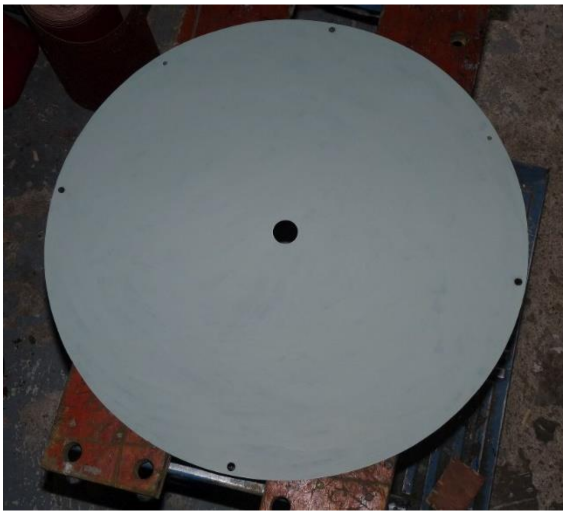
On the “strike side” (right-hand-side as viewed), there is a wheel with pins in it, and an arm interacts with the pins. As the clock comes to strike the hour, the wheel starts to rotate, and pushes the arm out of the way. When it does that, there is a wire linkage from the arm up to a hammer on a bevel gear in the tower, which makes the bell strike. This is controlled by the “count wheel” at the front of the clock, so the hammer only strikes the correct number of times for the hour.

The framework of the clock is cast iron. There is no adjustment, either the clock is right or it is wrong. It cannot be adjusted ‘in-situ”. Any wear will be on the steel pinions, and then they would have to be replaced.

Q: How is the clock lubricated?

Mel: It is lubricated with an oil can every six months.

- **The Dial.**



The dial is a copper disk (which is traditional), and is just less than 2mm thick

First of all, Mel cleaned the dial. The four holes on the periphery are for the four screws which hold it in place.

As can be seen in the following photos, the attachment hole in the minute hand is square, and the minute arbor is square with a thread on the end. A brass nut holds the minute hand in place. The hour hand is generally bolted in place and is positioned so that at 12 o’clock, the two hands align.

The photo shows the dial after Mel had cleaned it up, and removed corrosion. The dial was then etch primed (etch prime is used for aluminium), and then an undercoat was applied.

Q: How are the hands fixed to the tube which comes through the centre of the dial?

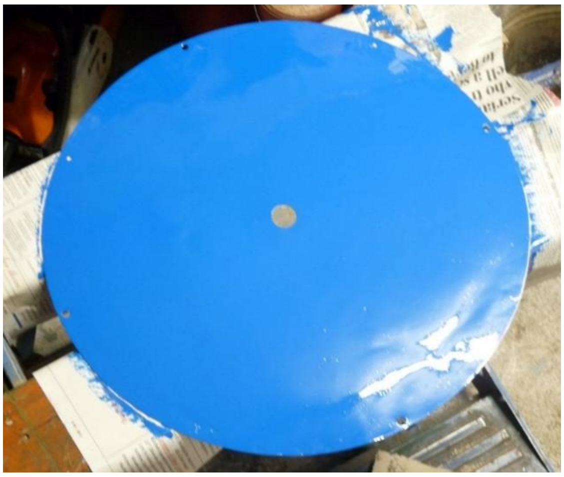
Mel: The hands are supported by a support bearing behind the dial. The bearing is seen when the dial is removed. The bearing supports the hour hand wheel tube. Inside that is the minute wheel shaft. The assembly comes through the 1” diameter hole in the centre of the dial. The dial is self-supporting, it does not support the shaft. It is important that the dial is not loading the shaft.

Before applying the top coat, Mel got some A4 tracing paper and attached the sheets together with masking tape, and then fitted them over the dial. He located and fixed the centre of the dial and put wooden pegs in at the 12 o’clock and 6 o’clock positions as reference points for the later repositioning of the tracing paper.

He then used a set of wooden compasses specially made for the job, and using a soft pencil, described the inner circle boundary of the chapters. Similarly, he described the outer circle boundary of the chapters. Finally, the lower boundary of the minute markers was described.

By hand, using a thin felt tip pen, the chapters and the minute markers were drawn as shown opposite.

Once all the marking had been done, the tracing paper was removed from the dial. A lead block was then used with a 1mm punch to mark the junction points for each of the chapters on the paper. This positioned all the chapters exactly.



This is the dial painted in blue enamel. Mel uses an engine enamel which should last at least 30 years.

Mel knows this, because he used the same paint system (etch-prime/ under-coat/ top-coat) on two dials in Riccall 30 years ago, and they look as good as new.

Once the paint was dry, the tracing paper was then put back on the dial, positioned using the wooden reference pegs.

Mel then used a washable felt tip pen (which doesn't stain), and went around the dial and marked all the punched hole centres.

This provided the chapter outlines for the next stage.

Shown opposite is the detail of a chapter, where the markings have been transposed from the tracing paper to the dial. This was done all the way around the dial, and the chapters and minute markers drawn back in.

This is the dial with the minute markers and chapters painted on with undercoat. The paint Mel uses is from Ratcliffes and it is called 'orange undercoat'.

The orange undercoat has to be painted on before the gilding is layed on, as it "reflects" the gilding which makes it stand out.

If the gilding was applied directly to the blue enamel, it wouldn't look as good.

The next job to be done was the application of the gilding. Before the gold transfer is applied, gold size needs to be applied to the chapters and minute markers. The gold size allows the gold transfer to adhere to the dial. Gold size can be bought in different types, depending on how long it takes to dry. Mel uses gold size from a Hull company called '*Coo-Var'.*

This size allows a suitable time to work before it dries off.

This photo shows the dial with the gilding applied.

The gold applied is double thickness 'transfer' gold. It is 23½ carat gold and is very thin, but once it's applied it will easily last 30 to 40 years. No varnish is applied over it, as the varnish could deteriorate and pull the transfer off.

Mel worked the dial in small sections. For example, the size was applied to the "12" and "1" chapters first, and their associated minute markers. The job was left for 10 to 15 minutes. In that time it becomes tacky, and the transfer can be applied.

The transfer is applied by finger or by cloth, and it has to be applied very precisely. Once applied, the backing paper just peels off.

Mel just worked around the dial with that sequence. It is a very tedious process.

In full sunlight, the dial looks really good. The owner of the clock was very pleased with the result.

- **Further Questions And Answers.**

Q: Does the gold only stick to the areas which have been undercoated and sized? What happens in the areas between? Can the gold transfers that overlap the chapter lines be removed?

Mel: You can remove any transfer that overlaps a line with a piece of peg wood. You have to be very precise when applying gold transfer, either by cloth or by finger.

Q: Does the gold transfer work on curved surfaces?

Mel: Yes, the gold transfer is applied to the clock hands which are ridged for strength and stiffness. If you are gilding say, a statuette, you would use gold leaf. Similar to the gold transfer, it comes on pages, but is not attached to them. A fine camel haired brush is used to apply the gold leaf, but the conditions have to be dry. The very fine gold leaf is lifted off the sheet with a charger, and applied to the statuette. It is then stippled in place with the brush.

Hour and Minute hands shown prior to gilding, with gold transfer sheets.

Hour and Minute hands after gilding.

Here are the Hour and Minute hands. They are less than 2mm thick. The minute hand has a brass boss in its centre with a tube on the back. This attaches with a square in it and a ¼" diameter thread on the end. The thread comes through the hole and the hand is secured with a brass nut. There is some lead counter-balancing the back end of the hand.

Q: Can you overlap the edges of the gold transfer applications?

Mel: Yes, there is some overlapping, but where the transfers overlap, there is no size so they won't stick together. You have to rub the overlap with a very soft cloth, and then you don't see the join.

Mel Doran has kindly given permission to reproduce his photographs in the newsletter. Many thanks to Mel for taking time to review this article.

Engine Pistons and Piston Rings ~ A 'ZOOM' Discussion Led By Stuart Walker At The PEEMS Club Meeting On The 7th April.

- **Introduction And Background.**

  The 'Zoom' meeting was an open discussion relating to 'Engine Pistons and Piston Seals'. The discussion was based on a presentation and slides provided by Stuart Walker.

  Stuart set up and organised the SMEE Engine Builders Group (see the last newsletter for information on SMEE), a few years ago. The engine group covered both IC and steam engines. The object was to share information through discussion, in order to build up a knowledge base on a range of topics. One of the topics was the subject of the evening's discussion.

- **The Purpose Of Piston Seals.**

  Piston seals:

  - Prevent suction and expansion leaks.
  - Minimise friction losses (and also heat and power loss).
  - Accommodate differential expansion between the piston and cylinder.
  - In the case of four stroke IC engines, control oil leaking past the piston. In the case of steam and two stroke engines this is not an issue.

- **Piston Seal Design Factors.**

  - The cylinder pressure and temperature range need to be established.
  - Seal Friction: In high revving engines this is a critical factor. In low revving engines it is not such a problem.
  - Material Compatibility: Electrolytic corrosion between dis-similar metals is a consideration.
  - Engine speed and balance.
  - Cylinder to piston fit and finish.
  - Lubrication.

- **Cylinder And Piston Materials.**

  Here are some typical pairings:

Cylinders	Pistons
Cast Iron (GR17)	Cast Iron (GR17)
Steel (EN1A or EN30)	Aluminium (HE15 or HE30)
Bronze (Gun Metal)	Bronze (Gun Metal)
Brass (CZ121)	Brass (CZ121)
Glass (Heat Resistant)	Graphite Rod

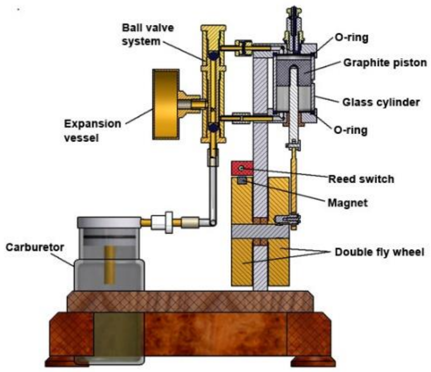
  These combinations of material are not mandatory. Cast iron pistons normally go in cast iron cylinders, but in some cases the weight issue can lead to loss of performance, in which case aluminium pistons are used.

- **Seal Types.**

  - There are certain engines and certain configurations where no seals are appropriate, just a very good fit is required.
  - Graphite coated yarn.
  - Graphite modified PTFE piston rings.
  - Rubber O-Rings.
  - Metal compression rings.
  - Oil control rings.

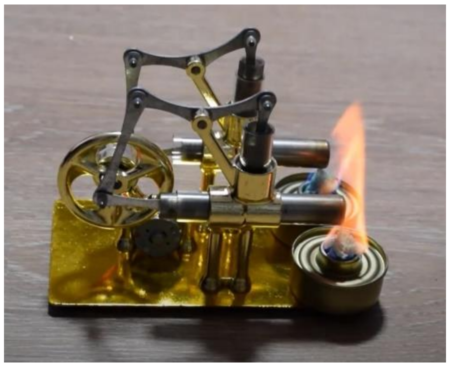
- **Types Of Engines That Don’t Require Piston Seals.**

  These types of engines are normally low-pressure steam and IC engines, such as the following examples:



Jan Ridders two stroke with a glass cylinder.
(This is just a novelty engine).

Stuart 10V.



Two Cylinder Hot Air Stirling Engine

With larger engines, people quite often use no seals at all in steam piston valves, the reason being is that running the rings over the ports can lead to quite a lot of damage.

Both the cylinder bore and the piston need to be lapped and honed, especially for model engines. This also applies to small high-speed diesel and two stroke engines, which these days don’t have piston rings at all. They are just lapped very well.

- **Graphite Coated Yarn Seals.**

  This is the traditional approach for steam engines. Graphited PTFE or graphited yarn seals are used. Different suppliers sell the graphite coated yarn seal type. It comes in different sizes and starts at ⅛” square. It can be cut into pieces which can be wrapped around to form a good ring joint.

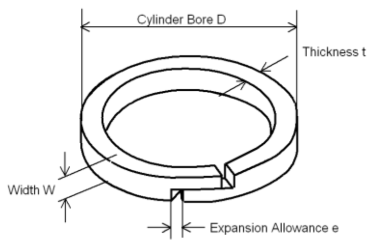
  Here is a 1” diameter piston with a graphited PTFE gland packing:

- **Graphite Modified PTFE Ring Seals.**

  The next step up is to go to a solid PTFE sealed ring. Norman Barker, who published an interesting article which can be located here, manufactured these types of rings:

  https://modelengineeringwebsite.com/Steam_piston_rings.html **

  To see article, press on link. To return to newsletter press on back arrow at the top left of the screen.



Norman used 25% carbon filled PTFE (PTFE C25). He used these rings on his locomotives “Lion”, “Maid Of Kent” and a “Brighton Terrier”. He says that these ring seals work very well.

** Norman told Stuart that the article published is incorrect. He kindly sent Stuart a copy of the correct text. Stuart will send a copy to PEEMS members on request.

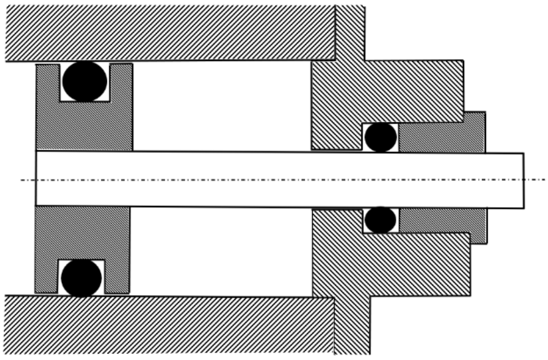
- **Range Of Bar And Tube Materials That Enhance The Properties Of PTFE.**
    - C35 ~ 35% graphite filled. This is the material that's usually used.
    - B60 ~ 60% Bronze filled. This is available, the following is recommended.
    - BM555 ~ 55% Bronze + 5% Molybdenum Di-Sulphide filled.

The BM555 is designed for low friction, low wear applications and bearings. This is recommended for piston rings and piston ring seals.

This material is available from *Bay Plastics.*

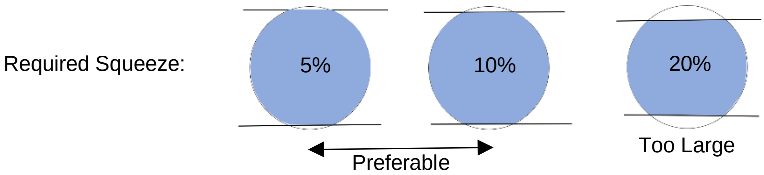
- **Rubber O-Rings.**

These are used extensively in model steam engines. Viton rubber seals, with a Shore Hardness of 70 are recommended by Tubal Cain and Kozo Hiraoka.



This is a typical application, where Viton rubber seals are used for piston rods and for the glands. The secret for using this type of seal is not to crush them excessively.

It's not only important to establish a 5 -10% diametric squeeze to the rings, but it's also important that they should not be squeezed laterally but given some room to move in that direction:



Questions, Answers and Statements:

David Proctor (DP) : With 'O' rings, can you make your own by getting a length of the 'O' ring material and using Loctite to glue it together?

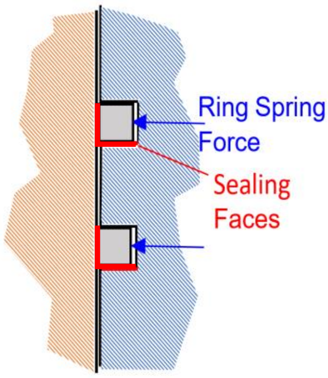
Stuart: You could, but these rings are so cheap it's not worth doing that.

DP: I was thinking of the sizing. Is there a range of sizes to fit any particular application?

Mike Sayer (MS): You can make your own 'O'-rings, doing just what you said. In fact I've just had to do that on my model. Those, however are only suitable for a static seal like a gasket. You can't get the join sufficiently accurate for the seal on a rod. The thing about using 'O' rings in this situation, is to choose your 'O' ring before you make your model. Standard ring sizes can then be chosen for the application. There is no 'overlap' on sizes supplied, just standard sizes.

Stuart: The diagram shows 'O' rings being used on the piston rod, but quite often PTFE is used squashed up in these applications, and that works quite well. The object in using PTFE in making rings, is that the PTFE expands where moisture is present. You may get a slight drip before the engine is first started, but that will stop when the PTFE expands.

- **Cast Iron Compression Ring Seals Using Individual Rings.**



The reason to use cast iron rings is to provide a radial seal. These rings spring out, so there is a seal on the outside between the ring and the wall of the cylinder.

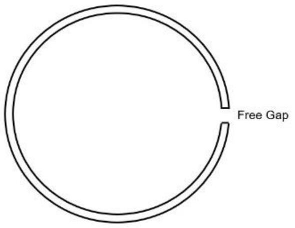
The gas leakage at the top of the ring helps provide an additional outward pressure to the spring, formed when the ring was made. It's worth noting that a good seal at the top of the ring is also needed for the suction stroke, but in this situation the suction tends to reduce rather than enhance the effective ring seal pressure on the cylinder wall.

Vertical pressure, created by the gas inside the cylinder, pushes down in the gap between the piston and the cylinder wall. This pushes the ring onto the piston groove. Usually two rings are used, because there is a bit of "blow-by"** and the "blow-by" reduces from the top ring to the next and so on.

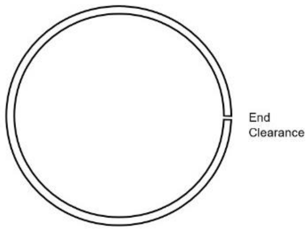
The main feature of the cast iron piston rings is the free gap, and it is important to make sure the free gap represents the amount of spring required in the ring, which in turn results in the required pressure on the cylinder wall. That tends to be between 12 psi and 35 psi. The other requirement for the ring is to make sure that the end clearance is as small as possible in order to avoid "blow-by".

*** "blow-by" is when there is a leakage of the air-fuel mixture, or of combustion gases, between a piston and the cylinder wall into the crankcase of an engine.*

Most of the rings for small engines have a straight gap, and that is made as small as possible. If it is too small, there is a tendency for binding, with rings breaking and causing serious damage to the engine.



Ring in free position (uninstalled)



Ring installed in piston and cylinder

There are two methods for making these types of rings. Both these methods require that the rings are compressed to the required gap, and clamped using purpose made mandrels, to enable final machining and lapping to the correct diameter and thickness:

- Machine the ring to the 'uninstalled' profile as shown on the left-hand side above. If that is done, the ends can be machined so there is a 'lap-over' which helps with "blow-by".

  This is an example of 'lap-over' :

- Machine the ring to the 'installed' profile as shown on the right-hand side above. The ring is then stretched out in conjunction with heat treatment, so that the ring then has spring tension when it is relaxed. This is a lengthy process.

Questions, Answers and Statements:

MS: If you make the ring's radial width between D/25 and D/30 (where D is the diameter), they are springy enough to go over the piston bands. Any thicker, that is, anything less than D/25, then they will be too stiff. Anything between D/25 and D/30 will result in a ring where the tensile strength has not been exceeded.

- **Cast Iron Double Coil No-Gap Rings.**
  - ***Clupet Rings.*** These are made to order by *Rufford Steam Works* in South Shields. These vary in diameter between ¾" and full size for full size traction engines.

These are usually used on larger scale model steam engines. They were extensively used on IC engines before the war. The main advantage was that they provided better seals on worn bores. The springiness in these rings accommodates the barrelling and wear in the bore better than plain rings. There is also not so much "blow-by" because of the double seal arrangement.

If they are used in an IC engine, there is a lot of friction to accommodate.

The method of making a Clupet ring is best demonstrated by this YouTube video:

https://www.youtube.com/watch?v=80jzsNM6olE

To see video press on link. To return to newsletter press on back arrow at the top left of the screen.

In Summary:

- The first stage is to bore the stock round cast iron bar down to the internal diameter of the Clupet Ring. The outside diameter is also machined slightly oversize.
- The tube is then mounted vertically on a rotary table on a milling machine.
- Two vertical parallel lines are marked on the tube where the tube won't be cut.
- Using a slitting saw, the tube is cut to the required thickness of the ring, all the way around, except for the region between the two parallel lines.
- Using a slitting saw, the tube is cut to the required ring thickness, except inside the lines.
- The second cut is made below the first cut (at a distance of the ring thickness) all the way around.
- With a piercing saw, the cut is cleaned up.
- The angle of the cut, within the parallel lines, is then marked on. In the video this is 45°.
- Using a razor saw, a cut is made along the 45° lines to split the ring.
- To get the tension in the ring, the lower and upper parts of the ring are pulled over each other ++.
- The surfaces are then cleaned up.
- The springs are pressed over an oversized mandrel (1.022 x inside diameter of the Clupet Ring).
- The ring is then heat treated to relax the molecules and ease the tension.
- When the ring cools, it is no longer tight on the mandrel.
- The upper and lower parts of the ring are then pulled back over each other to regain the original positions.
- The ring is then placed in an oversize "widthing" mandrel on the lathe to machine the ring to the width required.
- The ring is then placed in tooling to finish off the external diameter to the required dimensions.

++ This operation creates a good ring seal, not only against the piston grooves, but also against the rings themselves as they spring towards each other.

- **Alternative Metal Compression Rings.**

  - Bronze Rings: For brass and gunmetal cylinders. 5% bronze is recommended by Tubal Cain

Live Steam Models sell these for traction engines.

  - Stainless Steel Piston Rings: Have been successfully used in cast iron cylinders. These are used on model steam locomotives.

    Two companies manufacture these:

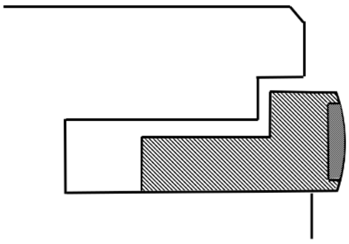
    Cross Manufacturing Co. (Bristol). They produce rings in metric and imperial sizes. They manufacture rings for pumps and not specifically for steam locomotive models.

    Zimmerman Piston Rings. These are only in metric sizes.

- **Dykes Compression Rings.**

Mr Dykes was doing research in 1947. The advantage of these rings was:

- They were ultra-light weight rings.
- With low static spring pressure.



The additional pressure that was needed to get the seal between the piston and the cylinder wall, was derived by having a larger gap in the groove so that there was pressure behind the ring during the power stroke, pushing it against the cylinder wall.

The theory was that friction was only apparent during the combustion stroke.

They were used in the 1950s and 60s in competition cars, and were highly thought of. However, they went out of fashion and were replaced by better rings.

The problems with these rings were:

- Special machining of the pistons was required to fit them.
- They needed more maintenance as they tended to get gummed up.
- There was higher friction and bore wear.
- Shorter Life.

The Dykes rings were used in model engines as well as in K&B two stroke engines. The ring in those engines was right at the top of the piston.

Those rings were phased out later in favour of close tolerance lapped cylinders and pistons. The cylinders were hollow and chromed. The pistons were special aluminium alloy.

- **Metal Oil-Control Rings.**

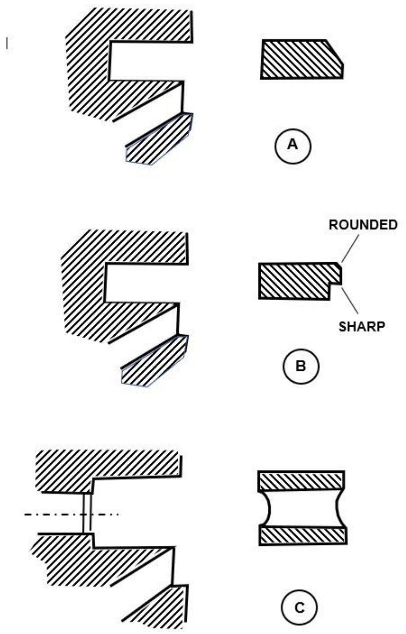
These ring types are only needed for four stroke engines where oil, which is sitting in the engine sump, needs to be controlled while it is splashing around the pistons, lubricating the little-ends and the piston seals themselves.

The purpose of the control rings is to:

- Lubricate the pressure rings.
- Minimise exhaust smoke.

Influenced by:

- Crankcase oil distribution.
- Ring pressure.
- Ring/Bore Wear.



There are three options:

A: These rings are very similar to compression rings, but are chamfered off. The rings ride over the oil as they come up, and as they come down, the bottom part acts as a scraper returning oil to the sump from the cylinder wall.

B: This is a more angular version of A. The corners are rounded off at the top so the ring rides over the wall on the way up. On the way down it scrapes oil off the cylinder wall and returns it to the sump.

C: This is the more common ring for full-size engines. It is slightly more sophisticated. The edges are rounded, and there is a double scraper action.

- **A Summary Of Metal Piston Ring Attributes.**

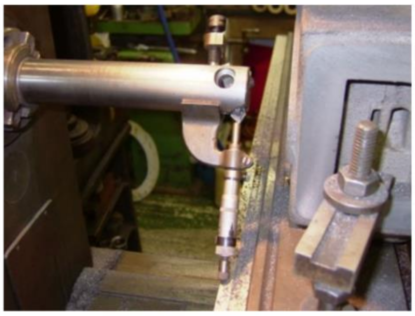
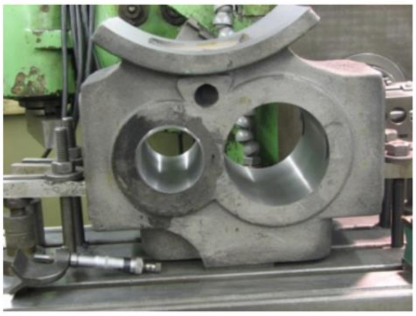
  All manufacturing methods for piston rings should end up with:

  - An exact radial fit in the cylinder bore.
  - Exact edge and end clearances.
  - Sufficient spring action to keep the ring in close contact with the cylinder.
  - A good pressure seal.
  - Low frictional drag with minimal bore wear.
  - Good heat transfer.

  These days, for full size engines, the rings are usually steel, and tend to be coated with materials like Teflon which reduce the amount of friction. This is necessary in high competition piston rings.

- **Cylinders With Cast Iron Sleeves**

  - **Machining a 4-inch McLaren Cylinder Casting**


Machining cast iron cylinders for steam engines can be tricky, especially if they're cast with complex cores, as in the case of compound engines, where the high pressure steam exhaust is used to feed the low pressure cylinder.

The photos show Stuart’s friend Eric Offen’s 4-inch scale McLaren road locomotive cylinder set up for machining on his horizontal milling machine.

Note the very useful modified micrometer screw gauge that is clamped to the boring bar, and used to set the cut depth.

One of the unfortunate features of this job was that the core inside the cylinder had shifted when it was cast, which resulted in an unexpected hole appearing in the bore as it was being machined. This was rectified by boring out to a larger size, and epoxy bonding in a cast iron sleeve. This had been experienced before with some of the original castings, but has largely been overcome with improved core design.

- **Pistons.**

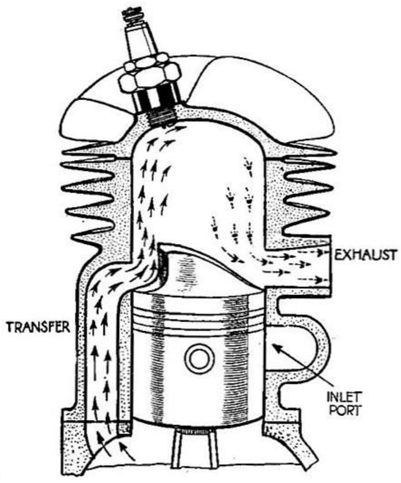
  - **Pot Piston**

This is a typical 1” diameter ‘pot’ piston for a Westbury four stroke IC engine.

Normal pistons are ‘slipper’ pistons where the bottom part of the piston is cut away, and only the bottom skirt is retained to contact the walls of the cylinder. This is done to save weight.

This ‘pot’ piston only has two rings (it doesn’t have a third control ring).

- **Deflector Pistons To Aid Gas Flow To Improve Ignition.**



Some of the fitted pistons push up inside the head to aid gas flow and combustion. The combustion gases are produced as close to the spark plugs as possible to minimise flame travel. These are used on special engines.

- **The Honda NR500 Motorbike Engine Which Has Oval Pistons.**

This engine has been included as it is an "oval pistoned" engine. The engine was developed by Honda in an attempt to compete in the Grand Prix motorcycle circuit. The 500cc two stroke engines at the time were taking all the glory.

Honda wanted to show that their four stroke engines were just as competitive and could beat the two strokes (they never did). The regulations stipulated that the maximum number of pistons allowed were four. Honda produced this eight-cylinder engine with two pistons connected together. These engines were expensive to make.

Before discontinuing with this engine, Honda produced the NR750 and the pistons had a more oval profile. This was also very expensive to produce. Nowadays these engines are rare and very expensive for collectors.

Questions, Answers and Statements:

MS: Could you describe how to make the piston rings for those engines?

Stuart: I don't know, although I have tried to find out. Maybe they had springs behind the rings. In the early days, springs were placed behind the rings in order to produce a better seal.

MS: Once the engine is running, the compression pressure will push the rings out to form the seal. On all compression rings, the out springs are only there to give an initial seal for the first few compression strokes. Once it's running, it's the compression leakage which pushes the ring out and forms the seal. Brian (Rees) will remember when the drag racers used to drill a ring of holes through the top of the piston so there was communication with the back of the top ring. During the first compression in the bore, this would push the rings out very quickly and create an instantaneous seal.

- **Honing Cylinders.**

Even when machining gives a very good finish, a cylinder still needs to be honed. The honers shown are cheap types found at engineering suppliers.

This one on the right was purchased from *Bruce Engineering* and the one on the left was made from a kit of parts supplied for model makers.

Different types of stone are also available.

- **Delapena Honing Machines**

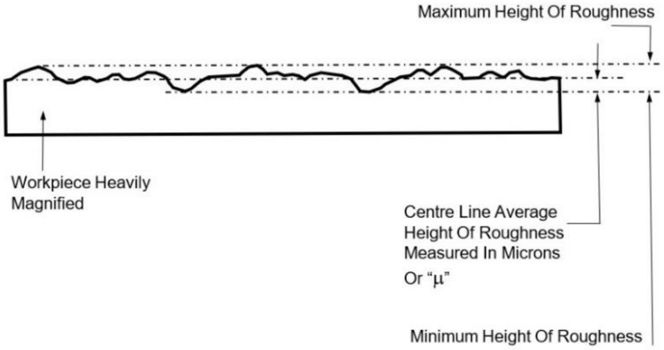
These machines are what the professionals use to hone cylinders. It is a hand-held arrangement. The left-hand machine is more sophisticated, whilst the right hand one is more basic.

The problem with these machines is that a number of honing bars are required to cover all sizes.

- **Lapping Cylinders.**

The difference between honed and lapped cylinders is quite significant. A honed cylinder wall is coarser than a lapped wall. The final finish is very important if piston rings are not going to be used, and the piston needs to have a very good fit in the cylinder.

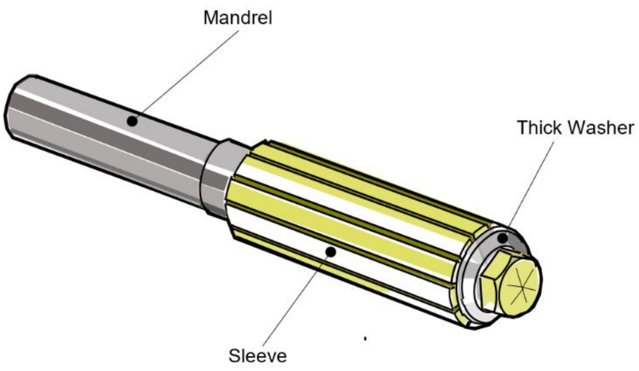
By lapping cylinders, the surface accuracy and finish is improved. A “silk” not a “gloss” finish is required.



This is the type of profile that used to be tolerated. The original idea was that all the crevices in the cylinder walls would hold oil, but it doesn’t work like that. The problem is that the engine never stops ‘running in’ and eventually the bores wear out. Old engines would run in over 2,000 miles, whilst modern engines can run 200,000 miles without a problem. That is purely due to better materials with finer limits on machining and finishing.

The objective in lapping a cylinder is to produce a parallel bore with a ‘smooth silk’ finish. In order to do that, it has to be made sure that the lap itself is at least two times the length of the cylinder.

Lapping should not be rushed, and for a typical a 25mm bore, the speed should not exceed 100 rpm. The bore should be worked slowly back and forth over the full length of the lap to help to avoid ‘bell mouthing’. With the aid of a ‘Go - No Go’ gauge, and by using progressively finer pastes, accurate sizing and a smooth finish will be the result.

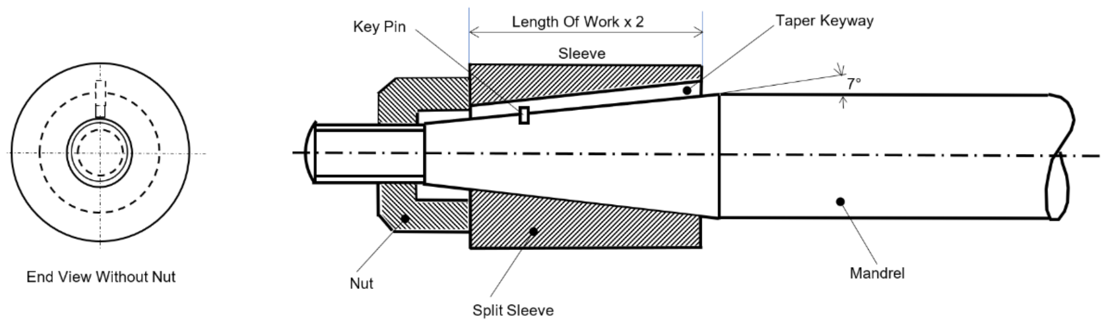


Laps can easily be made in the home workshop using either brass or aluminium for cast iron and steel cylinders. It’s important that the laps are softer than the material being lapped, to ensure that the abrasive is embedded into the lap, and not into the work being lapped. Whilst there are other methods of making cylinder laps, most model engineers favour the tapered mandrel with a matching tapered sleeve lap.
These are cut through longitudinally to make them expandable, and longitudinal groves are added to aid expandability and provide a reservoir for the abrasive, along with that all important lubricating oil to prevent the lap from drying out.

Adjustable ring clamp laps can be made and used in a similar fashion to the piston laps. For engines without piston rings, the pistons are lapped to match their lapped cylinder bores.

Where rings are used, the rings are lapped to match their lapped cylinder bores to achieve a good gas seal without the need for lengthy running-in.

- **Section Through A Lapping Cylinder**



The key pin stops the sleeve from rotating. As mentioned on the previous page, the sleeve is cut longitudinally at one point on the circumference so it becomes split. A wedge (tapered key) is then used to further expand the sleeve out. That is done by tightening the nut on the end.

- **Lapping Compounds**

  These are the types of lapping compounds available:

All images for illustrative purposes only

These are a typical selection of lapping pastes and the lubricating oil often used by model engineers.

Whilst carborundum paste usually comes in coarse and fine, a larger range of grit sizes are available for the longer lasting diamond pastes. Both these products must be washed off thoroughly before the engine is assembled, and should never be used for running-in an engine.

'*Timesaver*' compounds can be used in the same way for lapping cylinders. However, unlike the former abrasives, they're softer and progressively break down into finer particles during use, so don't cause premature wear if they're not removed. Because *'Timesaver'* doesn't require such rigorous cleaning it's often used for running-in tight shaft bearings and smoothing noisy gears.

- **Sirius Engine Cylinder Bores**

  A friend of Stuart's made this engine and was concerned about the chatter marks in the bores.

  He undertook some lapping with diamond paste. On the right it can be seen where the 'chatter' marks have been removed. This is a "work in progress", and the chatter marks have now been removed in both cylinders. It was eventually a very nice finish and the engine ran beautifully too.

As Bored

After Lapping

- **Lapping Cylinders And Pistons For Model Diesel And Two Stroke Engines.**

These days, these sorts of engines are made with lapped pistons and cylinders. Some of the competition engines use hardened piston sleeves which are chromed and with special alloys for the pistons.

Questions, Answers and Statements:

Brian Rees (BR): Are the bores tapered as well?

Stuart: Yes they are. They are almost a fit at the very top.

- **Piston and Piston ~ Review Summary.**

Piston Seals:

- Prevent suction and expansion leaks
- Minimise friction losses
- Control oil leaking past the piston.
- The talk has also described the best use of different materials.

- ***Questions, Answers and Statements:***

Jonathan Milner: Going back to the Sirius engine cylinders, which had 'chatter' marks, when the chatter marks were removed, did that increase the bore size?

Stuart: A little bit, but not a lot. It is a steam engine bore so shouldn't matter too much. The 'chatter' marks were quite deep, so it probably did increase the bore diameter by a few thou. It wasn't worth putting a sleeve in for that.

BR: I have a comment on the piston ring sizing. I made a 'V' twin engine and put rings in it. I then made a 'Flat 4'. The 'V' twin has a 22mm bore, and the 'Flat 4' has a ⅞" diameter. There's not a great difference between the diameters. It's only about 9 thou and the ring thicknesses were the same. However, when I was making the piston rings for the 'Flat 4', I broke a lot, even when I used the same piece of cast iron for the two engines. I talked to Mike and he told me I should have reduced the inside diameter.

DP: I have a comment on piston ring shape. I was talking to someone today who was involved with machining piston rings for big marine diesel engines. They were a 'formed' shape, but they weren't round. When they were "squashed" they fitted nicely. They were done that way so that whenever a gap coincided with the ports, the rings would not put undue pressure on them and try and drive through and crack them. The engine was two stroke.

Stuart: They were keyed sometimes to stop them rotating.

DP: Should they not make non-circular rings for model engines?

BR: Circular rings can be cut and then expanded, and only become circular when they are compressed. The other problem is getting the right temperature when they are being heated up. Usually dull cherry red will be right.

Stuart: Mike, do you have oil control rings on your Delage engine?

MS: It's a three-ring piston, so yes. The lowest one is a scraper ring. It's the slotted type C (ref page 12). The Bentley engines have the same arrangement.

- **References:** Stuart has undertaken an extensive review of available publications, and also widely discussed the topics with fellow model engineers to produce a comprehensive list of references for those wanting to further their understanding and add to the existing knowledge. Copies are available to PEEMS members on request and additional contributions are welcome.

Many thanks to Stuart Walker for taking the time out to review this article and give guidance.
The following photographs in the article have been kindly provided by Stuart and should not be used without his permission: *Page 13: McLaren Cylinder Casting. Page 16: Sirius*

News From Elvington From Paul Windross

When I was at Elvington, I was talking to Alex Macfadzean about his *Gem Turbine Streamliner*.

It will be piloted by Guy Martin and the land speed record attempt will probably be in Bolivia.

The streamliner ‘unclothed’:

It is powered by a 1,200 shaft horsepower engine as used in Lynx helicopters.

Graham Sykes made the rear drive assembly and a lot more.

Here is the link to the Facebook page to see the streamliner ‘clothed’ and much more:

https://www.facebook.com/The52Express/

To see page press on link. To return to newsletter press on back arrow at the top left of the screen.

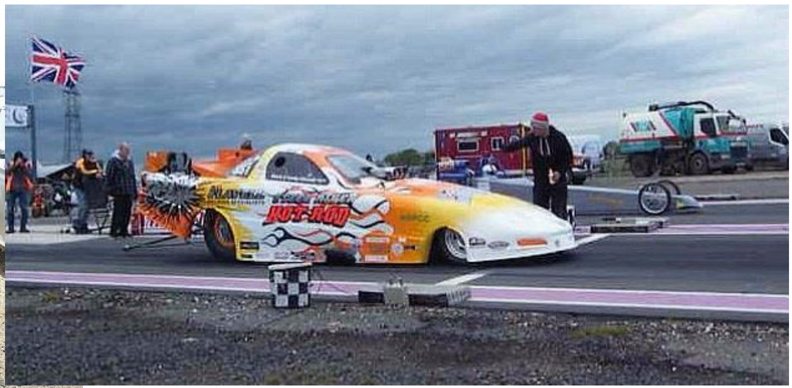
19th April 2021 Elvington Speed Test Day.

An ex TT Velocette, 750cc TZ, Hayabusa motor grass cutter, 2 Mono wheels, one electric powered and Guy Martin’s hopefully 300 mph attempt motorcycle. It has lead weights at the rear to help traction.

Melbourne Raceway May 22nd to 23rd 2021.

I was taken to Melbourne Raceway on May 22nd to 23rd and there were many car and motorcycle standing start speed machines.

Here are a few:



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Item For Sale.

A table top drawing board 25" x 18". Plastic faced and inclinable. Has parallel motion and folds up for carrying.

£10

If you are interested, please contact Ken Hillier. Contact details on Members List

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