

No.302

THE MAGAZINE FOR HOBBY ENGINEERS, MAKERS AND MODELLERS

MODEL ENGINEERS' WORKSHOP

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APRIL 2021



**Spin Indexers
Demystified**



**Electronic Edge
Finder**



INSIDE

- **Adjustable Tailstock for Unimat Lathes**
 - **A Brazing Hearth**
 - **Readers' Workshop - Jason Ballamy**
 - **Tools for Sheet Metal Work**
 - **Measuring and Marking Out**
 - **Myford Super 7 care**
- And much more!**

COVER STORY

Bad to the Bone - Tony Jeffree makes something different!



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On the Editor's Bench

Oral Engineering

Today my daughter had a cap, or more accurately a 'complex filling' fitted to a broken tooth. I had assumed that on this visit it would be the usual tidying up of the tooth, taking a cast, putting on a temporary cap and then returning in a couple of weeks to fit a porcelain cap made in a dental laboratory.

Instead, to my surprise, she returned with the job completed. The dentist removed the old filling from the broken molar and tidied up the remains – half of the tooth was OK, but the inner half had to be remade. This is where it got interesting, my daughter then had a 3D scanner put inside her mouth which then produced a detailed computer model of the broken tooth and mechanics of her bite. No impressions were taken. She was then able to watch as the dentist used a CAD program to design the 'complex filling' that auto-fitted itself to the tooth, turning in 3D to get the best location. The dentist fine tuned the shape and then she sent it to a CNC machine. This machine milled the 'part' from a block of porcelain entirely automatically, taking just seven minutes. My daughter then had it fitted before the original anaesthetic had worn off.

Apparently, the CNC machine cost around £85,000 but the cost was the same as for a conventional cap, so it probably represents quite a lot of teeth before it pays for itself! I was really tickled to hear about this incredible technology and impressed by the result. Interestingly, my daughter had assumed it would 3D print the tooth, but the dentist explained it was subtractive machining.

On the Move

I'm finally moving to South Wales and most of my workshop is secure in container storage, mostly wrapped in swathes of VCI paper. There's a fair bit of DIY to be done before I can start fitting out a new workshop, but I look forward to sharing my adventures here and on the forum.

CLOCK CONSTRUCTION & REPAIR

Books by:

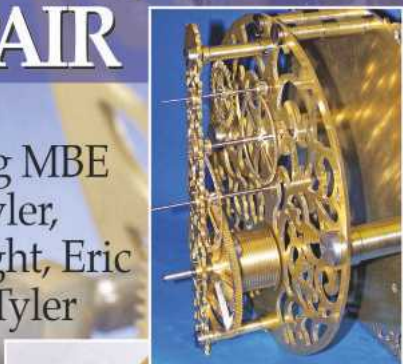
John Wilding MBE
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At this time, we would usually be announcing our next Warco Open Day. With the current Covid-19 restrictions it is not possible to hold this popular event. In the meantime, please view our Used Machine list on our website. Our showroom is now closed to the public.



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50 Sheet Metal Working

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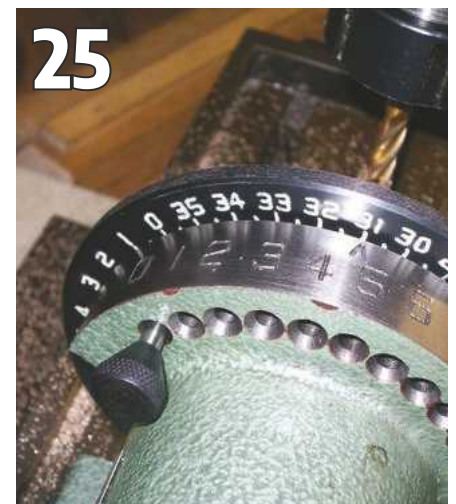
Tony Jeffree describes so off-the wall engineering behind an unusual and experimental workshop project.



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See page 48 for details.



Coming up...

in our next issue

In our next issue we feature a lathe mandrel handle, angle grinder accessories and an aid to setting up a rotary table – and much more besides!



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ON THE COVER



This month's cover shows Tony Jeffree's unconventional 'scarecrow' on the isle of Mull. See page 58 to discover the workshop shenanigans behind its creation.

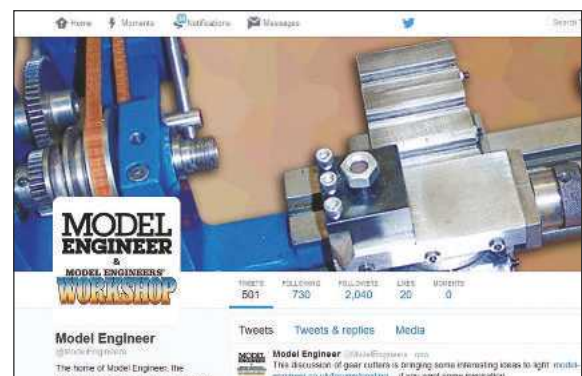


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THIS MONTH'S BONUS CONTENT

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Drilling and Tapping Size Chart

Following a request from reader Michael Belfer and the help of several readers, including Nick Farr, we have been able to produce a good quality downloadable and printable version of the Model Engineers' Workshop Drill Size Chart originally given away as a pull-out in MEW.

Wicking felt for lathe headstock bearings

Where to source felt for older lathes with felt wick oilers?

Water level sensor

Ideas for sensing the water level in small boilers.

Carbide Tooling

How much extra value comes from using more costly inserted tooling?

Come and have a Chat!

As well as plenty of engineering and hobby related discussion, we are happy for forum members to use it to share advice and support. If you feel isolated by the lockdown do join us and be assured of a warm welcome.

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"This is an exceptional model in so many respects. It is the largest 5" gauge locomotive we have manufactured to date and has the benefit of four cylinders to re-create that distinctive exhaust beat. It will be available in a variety of BR liveries and a wide choice of famous names to include Coronation and Duchess of Hamilton. A challenging model, but well worth the extensive development effort. As an award winning professional model maker I am delighted to have been involved in this very special project"

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| • Boiler feed by axle pump, injector, hand pump | • Painted and ready-to-run | • Walschaerts valve gear | • Reverser |
| • Etched brass body with rivet detail | • Coal-fired live steam | • Drain cocks | Approx Dimensions: |
| • 4 Safety valves | • 5" gauge | • Mechanical Lubricator | (L) 80"x (W) 10"x (H) 14" |
| | • 4 Cylinder | • Silver soldered copper boiler | • Weight: 116 kg |

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Developing an Edge Finder



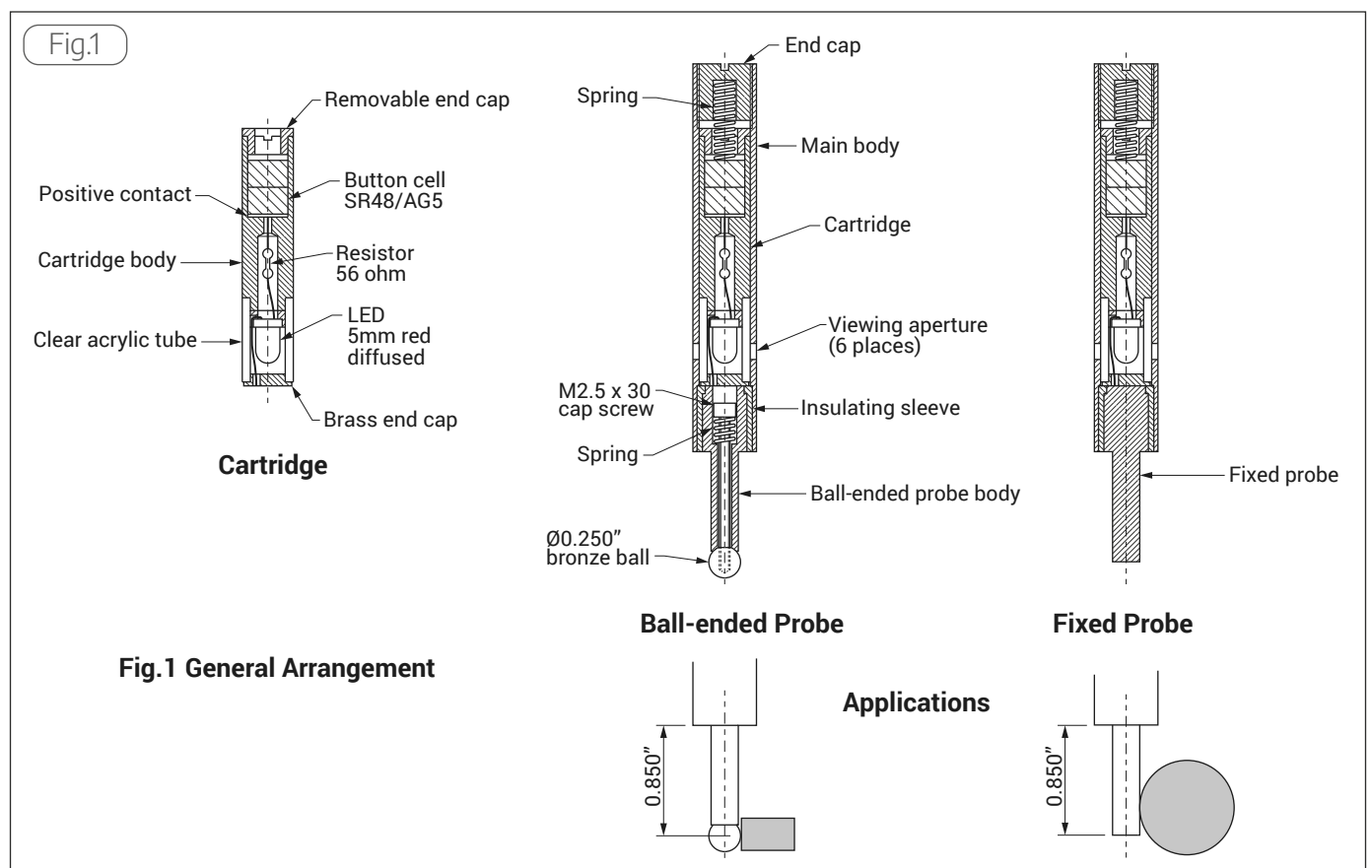
Roger Vane describes how he designed and developed an electronic edge finder, together with detailed drawings so that you can make your own

I wanted to improve my ability to accurately locate the edge of components, particularly on the milling machine, and had considered buying a 'touch point sensor'. This is the type with a ball on the end which lights up when contact is made. The ball allows for a certain amount of over-run, thereby avoiding damage in the case of a 'heavy landing'. Most of the commercially available sensors of this type have either 20mm or 32mm diameter bodies - I felt that both were far too large for my requirements.

Although my VMC mill has a 20mm collet available, being somewhat lazy I felt that changing from the drill chuck over to the collet and then back again just to locate an edge would be an



A pair of completed edge finders.



unnecessary added operation when ideally the edge finder could be held in the drill chuck. This style of edge finder with a ½" diameter body would be far more sensible, but these do not appear to be available in the marketplace.

So, I decided to design and make my own which could be held in an accurate 13mm drill chuck or a ½" collet. The word 'accurate' is important here, as I found that one of my 'big name' chucks suffers from 0.004" TIR, which makes it totally unsuitable for edge finding using this style of edge finder.

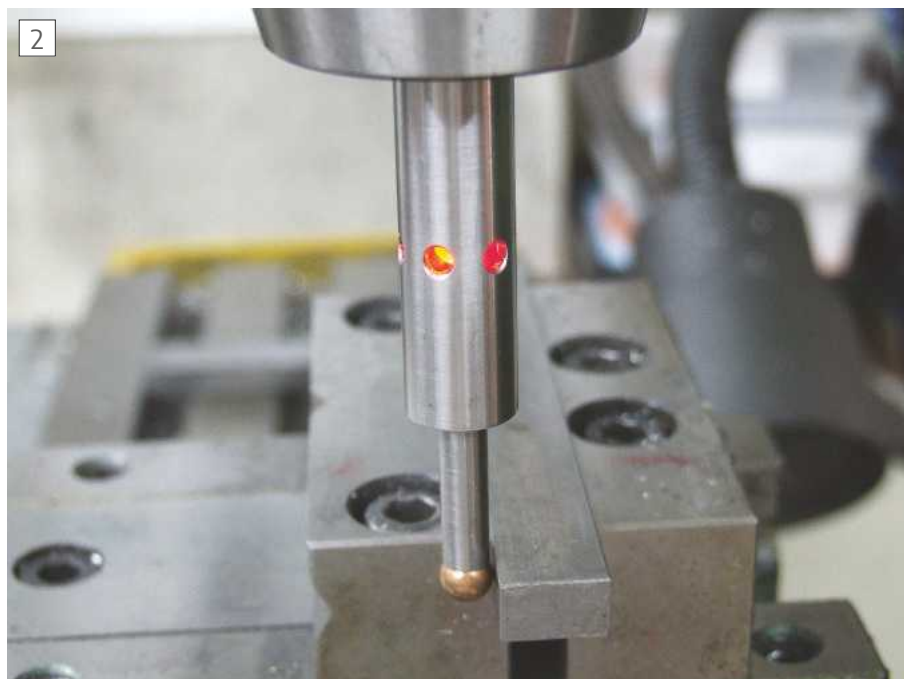
Introduction

As the design work progressed, I decided to make two different edge finders.

The ball-ended probe is only really suitable for use on flat surfaces, so a different approach is needed for sensing the 'edge' of round components held, for example, in an indexing head. I already had an edge finder with a fixed probe which had seen better days, so I decided to make a replacement for that at the same time. It is based on the same body and lighting arrangement as the ball-ended probe. Anyone considering making both edge finders will need to double-up on all components except those which form the probe itself. The finished edge finders can be seen in **photo 1**.

Firstly though, how does the edge finder work? The general arrangement drawing, **fig. 1**, shows a sectioned view of the components which make up the edge finders. It also illustrates how the probe is positioned in relation to the workpiece - you can imagine the difficulty of setting the ball exactly at centre line for a round workpiece. I guess that it could be done but would be very time consuming.

The body of the edge finder contains a light source and a battery. When the probe touches the workpiece an



Contact is made - the ball-end edge finder in use.

electrical circuit is completed and the light comes on - this light can be seen through the viewing apertures in the body of the edge finder, **photo 2**. The electrical circuit runs from the probe, through the workpiece, vice and the machine and then back into the edge finder body via the chuck or collet.

One point to mention is regarding the colour of the light - the human eye sees this as red, while the LED appears to be yellow when photographed. I guess that this is down to the actual light source within the red lens which the camera can detect, but the eye can't.

As the probe is insulated from the main body, the only way an electrical circuit can be made is via the workpiece and the machine itself. Obviously, the workpiece must be electrically conductive for this type of device to work, so no plastics.

When edge sensing and completing

the electrical circuit it is all too easy to overrun and potentially cause damage to the probe. With the ball-ended probe the ball is spring-loaded and can be displaced within its seating by around ten thou, thus providing a margin of safety. Greater care is required when using the fixed probe as there is no overrun protection, which is probably what caused my old probe to become damaged and inaccurate.

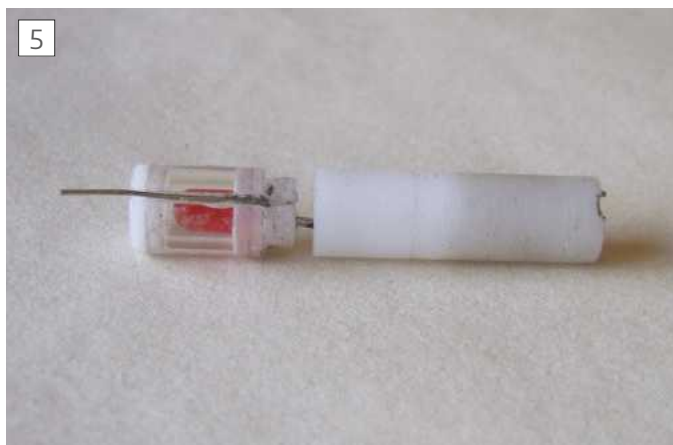
As I still work mainly in imperial units, I decided upon a ¼" diameter probe, although this could just as easily have been 8mm or 6mm. For the ball-ended probe, both stainless steel and bronze balls are available from a number of our regular suppliers - the choice is yours. However, in the interests of possible wear, I decided to use a bronze ball which I could easily replace should wear occur. It would be easy to replace the ball whereas re-machining the seat



Cartridge light unit.



The first attempt - the festoon bulb and 12 volt battery shown here complete with insulating sleeves, contact plate and main body.



5 The idea of a slot to contain the wire seemed appealing, but this version was too difficult to assemble.



6 Broken acrylic tubes, believed to be caused by machining stresses.



7 The tooling used to make the cartridge.

would be more involved. This design allows for a maximum of 0.010" overrun when positioning to an edge.

For the fixed probe design it made sense to make the probe $\frac{1}{4}$ " diameter as well.

In use, once the electrical circuit has been made the machine table can be 'zeroed' and the probe withdrawn. The user then only needs to move the table by exactly half of the probe diameter (0.125" in my case) to place the centre line of the machine spindle directly in line with the edge of the workpiece.

The light source

Much soul searching went into selecting the best light source and battery combination. I have always regarded electrics and electronics as something of a 'black art', so I chose a combination that I could easily relate to based on

a small 12 volt battery and a festoon bulb. Simple automotive stuff. I made a pair of edge finders, and they certainly worked, but I felt that the response time was far too slow as the filament heated up to give off enough light. This was a problem with an old edge finder that I found, giving the potential for overrun and damage. I also had serious reservations regarding battery life.

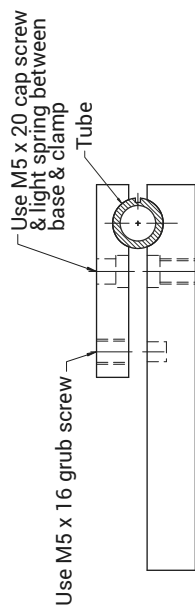
So, it was all down to 'Plan B', and using LEDs, which appeared to provide the solution that I was looking for. I needed to obtain a basic understanding of how LEDs work, and then find a suitable battery and LED combination which would fit into a body of only 0.5" outside diameter with around a 10mm bore available for the electrics. Time for the 'old dog' to learn some new tricks.

So, what did I learn about LEDs?

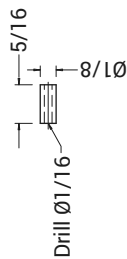
1. If the input voltage is too low, the LED just won't work
2. If the input voltage is too high then oops, it's goodbye LED
3. If the battery is connected the wrong way round then the LED just won't work.
4. Input voltage can be reduced by including a resistor in the circuit
5. Input voltage requirements and brightness produced vary with LED colour and style.
6. Light pattern varies with the shape of the LED
7. Power consumption is very low and the response is very fast - that's good!
8. Life expectancy of an LED correctly installed should be around 100,000 hours, which should be enough for most of us with this application. So that's good as well.

With that knowledge I could now finalise the internal details of the edge finder. Fitting the festoon bulb and an AAA size battery was fairly easy, but an LED with its small size and long wires was something different. Add to this the fact that I had decided to use button cells as the power source and that I needed to fit a resistor in the circuit to reduce the voltage, holding everything together suddenly became much more difficult. How was I to hold the batteries and the LED? How did I route the long wires to avoid touching the inside of the conductive body of the edge finder? How and where did I include the resistor?

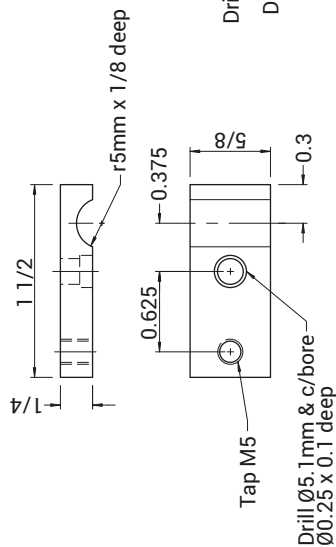
I pondered over the best design for a long period of time, and eventually decided that the batteries and LED had to be contained in some form of holder, either together or separately. In the event, because of the wiring requirements, I decided to make a combined holder where the LED and resistor are sealed in, but the batteries



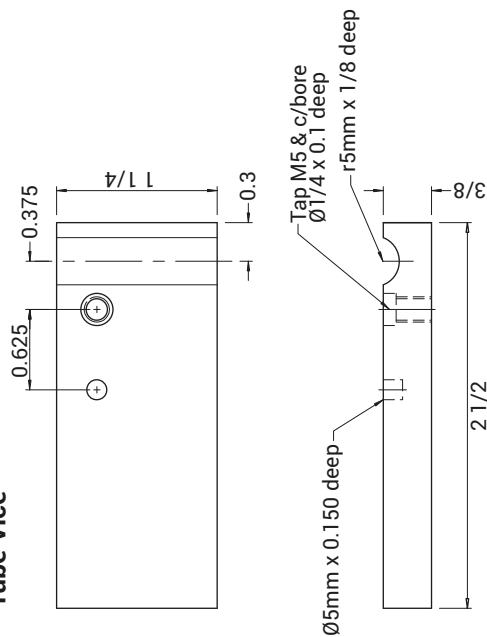
Clamp Base



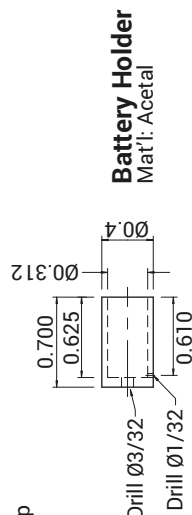
Wire Cutting Gauge



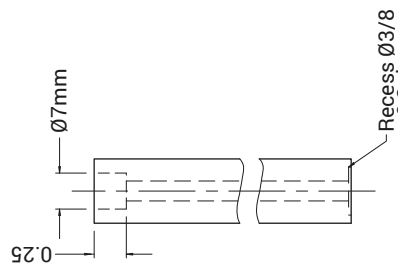
Tube Vice



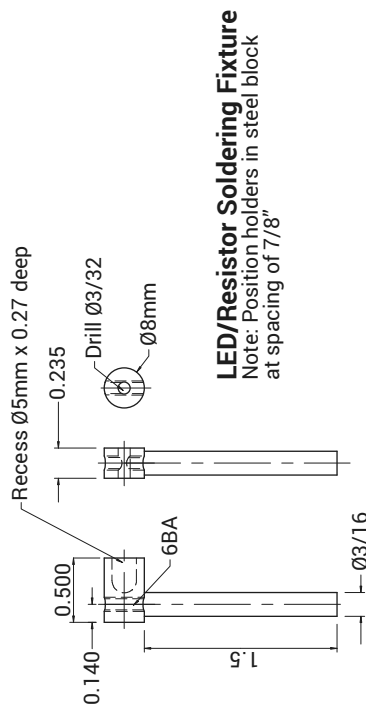
Holder For End Cap
Mat'l: Steel



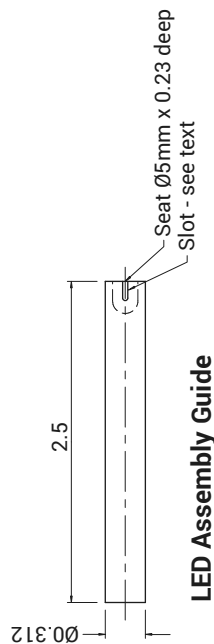
Battery Holder
Mat'l: Acetal



Holder For Drilling And Tapping Ball
Mat'l: Brass



LED/Resistor Soldering Fixture
Note: Position holders in steel block at spacing of 7/8"



LED Assembly Guide

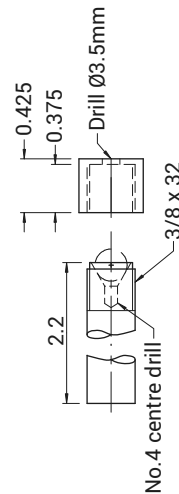
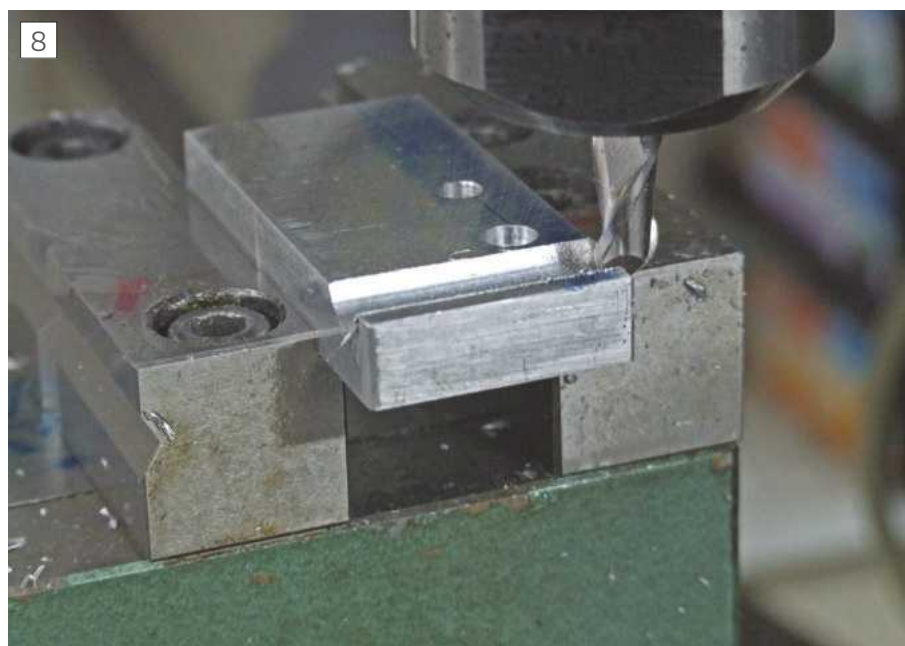


Fig.2 Tooling



Machining the tube seating on the 'tube vice' base.

can be replaced if necessary. So, the concept of the cartridge was born, **photo 3**.

Choosing the LED

LEDs are available in a wide range of sizes, colours and styles (viewing angles). The largest LED which can realistically be used for this application is 5mm. Looking for the best light output, I experimented with various styles of ultra-bright LEDs which are clear-bodied with a coloured light output. In all cases I was dissatisfied with the light pattern, which needed to be viewed from the correct angle to experience the strongest light output.

Disillusioned, I nearly abandoned the project altogether until I remembered that I had a couple of 5mm standard output LEDs with a red lens in stock, known as 'diffused' LEDs. I hadn't tried these previously because the quoted light output is below that of the 'ultra bright' LEDs, and I was looking for the brightest light output. So, I finally tried these using a 12 volt battery combined with a suitable resistor and found the light output to be ideal for my application. An order was placed for a batch of red LEDs, button cells and resistors to suit. Please be aware that different coloured LEDs may require a different resistor value to that used with the diffused red used in this article, together with additional batteries which would have to be accommodated in the design.

Cartridge design development

The cartridge design had to be finalised

before the body design could be completed. This was because the viewing apertures and other features within the body and probes were dependent upon the final design of the cartridge.

All wiring was to be routed within the cartridge to avoid any possibility of a short-circuit with the steel body, and because the holder had to be insulated it was made from acetal rod and acrylic (Perspex) tube.

One wire from the LED is fed into the battery compartment, while the other is routed to the 'probe' end of the cartridge. It was the routing of the wires that gave the greatest problems during the development of the edge finder.

As mentioned above, the largest LED which I could use was 5mm (which has a 5.8mm diameter base), and this dictated the design of the cartridge. I decided to use red LEDs which had showed up very well in my test - they also appear to have the best light output when looking at the different colours of diffused LEDs available.

The power supply consists of two button cells providing a combined output voltage of 3.1 volts which is reduced to a 'typical' forward voltage of 2.1 volts by means of a 56 ohm carbon film resistor (also contained within the cartridge). I have specified silver oxide button cells (size SR48) which have a flatter discharge curve than standard alkaline cells (AG5), although I'm sure that the alkaline cells would be perfectly acceptable (and much cheaper). The cartridge is a sealed unit, although the batteries can be replaced by removing an end cap.

Before we start making the cartridge,

I've put together a few notes regarding the evolution of the cartridge in the hope that it may help and encourage people with a similar application in mind who wish to develop a low power light source.

Original design

The initial design which used a festoon bulb and a 12 volt battery was soon abandoned. It was a simple design, with only a couple of insulating sleeves in addition to the bulb, battery and a contact plate as can be seen in **photo 4**. It was not responsive enough for the edge finding application, and I also had serious concerns regarding battery life.

Cartridge - version 1

This was my initial attempt at producing a cartridge. The main body of the cartridge was made from acetal rod, and the design enclosed the LED within an acrylic tube mounted on one end of this. The LED was mounted in a separate base, which was then glued into the acrylic tube, and this in turn was glued into the main body of the cartridge. At the probe end one wire from the LED was to make contact with the probe body, while at the other end of the cartridge the batteries were housed in an enclosed area.

An ideal solution would include a metallic end cap to contact the probe body, but this would give rise to problems with temperature when soldering in the wire - too high a temperature and the acrylic tube would melt and any adhesive bond would be destroyed. So, in this first version of the cartridge, the wire to the probe end was supposed to run in a slot milled along the outside of the tube, and then embedded using Araldite.

What went wrong? I had used 1.5mm wall tube but found that it was too weak once the slot had been milled. This weakness combined with a severe overdose of superglue meant that this version was quickly consigned to the workshop bin. In practice, it formed the basis for my next attempt.

Cartridge - version 2

This version featured redesigned and simplified components, together an acrylic tube having a nominal 2mm wall thickness **photo 5**. The tube was much stronger, but I was concerned that I would have difficulties embedding the wire in the slot even though it was now deeper. I also discovered that if the joints are too tight then the acrylic will 'craze'. These issues, combined with the need for lots of adhesive, meant that this version

was also consigned to the workshop bin. It was time for a major rethink.

Cartridge - version 3

This version was redesigned and simplified when compared to the last version (and it needed far less adhesive).

The major changes were that:

1. The LED was now fitted directly into the end of the cartridge body rather than being set into a separate base as with versions 1 and 2. This saved one component and reduced the adhesive required (and therefore the chance of misplacing it).
2. The wire to the probe end now ran within the tube rather than in a slot on the outside of the tube - no adhesive required here.
3. The 'probe end' of the cartridge was made from acetal on the first two versions of the cartridge, and the contact wire was glued into a groove in the end cap, allowing it to make contact with the inner end of the probe. The end was now made from a brass disc, with the wire soldered into it, so it was much more robust and should allow for improved electrical contact. I did have concerns regarding the heat required to solder the wire into the end cap, and the potential for damage to the acrylic tube.
4. This version had two 8mm diameter recesses machined into it, which ultimately proved to be its downfall. The tube was developing cracks which resulted in it breaking up. I had originally felt that I had problems due to the method of holding the tube, so changed from using the 3-jaw chuck (gently) to a collet. The problem persisted and was also accompanied by a softening and distortion of the tube when machining the recesses. So, I thought lubrication was needed and resorted to using WD40, which appeared to solve the problem, but on cleaning up the tube disintegrated, **photo 6**, with a 100% failure rate. If anyone knows how to machine this material successfully then I would love to hear about it.

I concluded that the machining operations were causing the problem, so yet another rethink was required.

Cartridge - version 4

For this version I went back to using tube with a 1.5mm wall thickness, again doing away with the slot and soldering the wire into a brass end cap. It was now time to face the problem of temperature mentioned earlier - how to solder the joint without destroying the acrylic



The completed 'tube vice'.

tube and adhesive bond. This will be achieved, and there was now hope that the fourth version of the cartridge would prove easier to make and successful in use - this was the case.

So, further simplification had been achieved, and there was now hope that the fourth version of the cartridge would prove easier to make and successful in use - this was the case.

Tooling used

Before we start it would be useful to make some simple tooling, which is shown in **fig. 2** and **photo 7** (for cartridge manufacture) and some items of which are shown in more detail in later photos. Readers may consider this list of tooling to be something of an over-kill, but I was developing and testing a number of ideas, and probably going to make far more components than for just two sets. I would suggest that you just make what you feel that you need to hold the components safely and accurately.

2.1 The 'tube vice'

The main fixture shown is for holding the tube for a range of operations, let's call it the 'tube vice'. Although this was designed for use when machining a slot in the side of the cartridge (previous versions), in practice I have found it useful for several other operations, and as the project progressed it became increasingly useful. It consists of a base plate and clamp, both of which have seats made with a 10mm ball-nose slot drill to enable the tube to be held securely without damage. The base plate has

been made quite a lot larger so that it can be clamped in the bench vice for certain hand operations. The clamp was made wider than the tube is long so that it could 'bridge' the tube and end cap to hold them securely without crushing the tube.

Photograph 8 shows a 10mm ball-nosed slot drill forming the seating for the tube in the base. A similar process was used on the clamp. Apart from ensuring that the seats in the tube vice base and clamp are aligned, there are no real problems with making the tube vice. The completed tube vice is shown in **photo 9**.

2.2 Gauge for trimming anode and resistor wires to length

This is a nice simple job - just take a 5/16" length of 1/8" diameter bar stock and drill a 1/16" hole all the way through. It is used to cut both the anode wire from the LED and also one of the resistor wires to length in preparation for soldering. I found it easier to make this simple aid rather than holding the component and a rule, and then trying to use a pair of wire cutters.

2.3 LED / resistor soldering fixture

This fixture evolved from attempts to find an easy and accurate method of holding the LED and resistor for soldering their wires together (see section 4.2 later in this article). As I believed that I would need to make a number of such joints it was worth making the fixture, although at the outset I had no idea of quite how many I would end up making.

●To be continued

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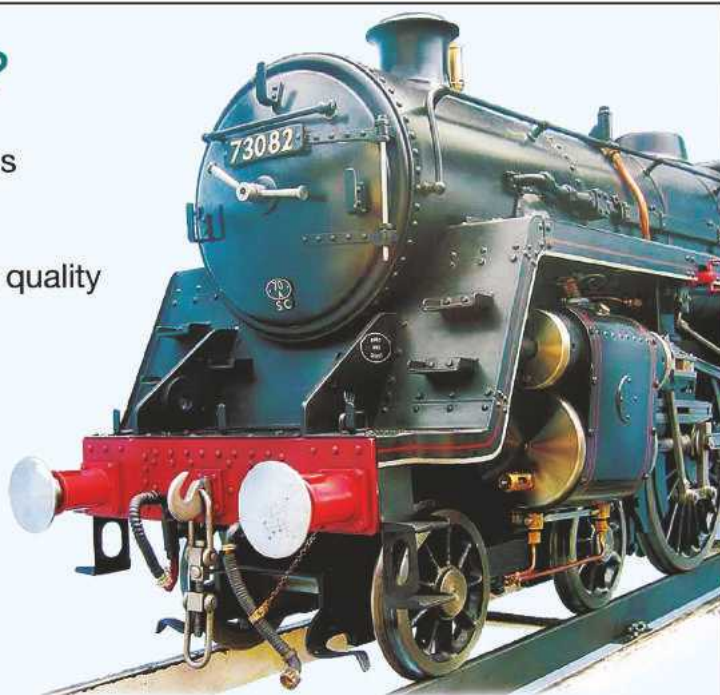
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Measuring and Marking Out

One of the questions many beginners have is 'how accurately should I be working'? Some people will say you should always work as accurately as you can because this is the way to develop your skills, but in practice the best policy is to consider each task in turn and work appropriately.

In industry you would find that every job has a specified tolerance and/or surface finish associated with it, this is because in mass production parts need to be easily interchangeable and made to traceable standards. In your own workshop, you are generally more interested in making sure parts work with each other, so as long as parts are well-proportioned small differences in size from the plans are rarely critical. What matters is the quality of fit – it is far more important for a piston to be a good close sliding fit in its cylinder than for it to be exactly a certain size. Obviously there are exceptions, such as when two sets of parts have to interact or when you are fitting your parts to bought in items, such as turning shaft to fit inside a bearing.

In practice, most measurements on plans will be specified in a way that indicates how accurately you need to work. Typically, most parts needing to be an accurate size will be specified



An inexpensive digital calliper.

to a precision of 0.02mm or 0.001 inch (universally called a 'thou'), and most machine tools will have their movements graduated in steps close to these sizes. In contrast, dimensions given in fractions of an inch or to the nearest millimetre can usually be marked off using a rule, although watch out for when you need to match two parts to the same size.

Don't Break the Rules

It's worth making a small collection of workshop rules (never 'rulers'!), from the cheap 'hack' used to check if a bar is 25mm or an inch in diameter to a more accurate one reading down to 0.5mm or 0.02". When using a rule always make sure you look directly down at the graduations, not at an angle, or the thickness of the rule can introduce



Readout of a top quality digital caliper.



This older micrometer has only a vernier scale.



This digital micrometer has a vernier scale as well as its readout.



A vintage dial gauge was made in East Germany.

a surprisingly large 'parallax' error. If resources allow, it's worth having some shorter rules for measuring in tight spaces and a thin, flexible rule for measuring and marking curved surfaces.

Calipers

In most workshops the most used measuring device is a measuring caliper, which will usually read to 0.02mm or 0.001 inch. Old-style vernier calipers are read using special scales, but the availability of digital calipers, **photo 1** and **2**, that can be read at a glance (and easily convert between metric and imperial measurements) means these are what is used by most hobbyists. As well as measuring length between the main jaws, calipers also have pointed

internal jaws for use inside holes (but beware of trusting these for small holes!) a depth rod and even the ability to measure steps using the back of the jaws.

Micrometers

It may seem that a good rule and a set of quality calipers will do everything, but from time to time it's useful to have a micrometer, often reading down to 0.002mm or 0.0001 inch, particularly when shafts and bearings have to be turned accurately. Micrometers work by gently trapping the work to be measured between two very flat anvils, one moved using a high-precision screw thread. Older micrometers, **photo 3**, can be cheap second hand but are trickier to

read and may be worn although a good example is a pleasure to use. Again, digital versions, **photo 4**, are much easier to use, but remember to check they are properly 'zeroed' before each measurement.

While these tiny distances (much less than a hair's breadth) sound impressive, the truth is that unless your measuring technique is exceptional AND you have a temperature controlled workshop, you are unlikely to be able to consistently work to such levels of accuracy.

Dial Gauges

Dial gauges (which have a plunger, **photo 5**, and dial test indicators (that operate with a small ball-ended lever) are particularly useful for tasks such



A basic digital height gauge.

as ensuring work is truly concentric with the lathe spindle. In use they are usually held on a stand with a heavy or magnetic base. It is also possible to use them in other ways such as held in the toolpost of a lathe or the spindle of a milling machine – an arrangement which is very useful for aligning a vice on the mill table.

Dial gauges can be used to make absolute measurements of distance, but, except for some specialist types, DTIs are generally for comparing measurements such as the height of two components.

Height Gauges

Height gauges come in two flavours – simple height adjustable points and the measuring type. The latter are essentially similar to callipers fitted to a solid base; the digital versions are particularly useful as they can be set to zero at any height, **photo 6**. Simple points are set to a height by comparison against a rule held vertical against a stand or a just a square block.

Surface Plates

A proper surface plate is an accurately finished flat metal or granite surface, used as a base with height gauges and other measuring equipment for tasks like marking out parts and castings for machining, or checking the size of parts. While professional surface plates are incredibly flat, for general workshop use many people get away with using a slab of granite kitchen worktop, **photo 7**, or a piece of plate glass. Another option is the very flat glass from an old computer scanner, fitted in an accurate wooden frame and supported by a thin layer of felt to stop it distorting.

Marking Out

If you are making things to any sort of



A piece of composite granite worktop used as a surface plate and a variety of marking out tools.

plan, from the back of an envelope to a computer model, you will find that you need to accurately mark some parts as a guide to machining, **photo 8**. The essential tool for this is the 'scriber' a pen-like tool with a sharp, hardened steel or carbide point, although some measuring tools like height gauges have a built in point. If using a rule watch out for parallax as described above, and if you run the scriber along a rule to mark a line, hold it at 45 degrees so it goes right into the corner between the rule and the work.

To increase the visibility of scribed lines, it helps to colour the surface to be marked out. On steel and aluminium alloy 'marking out blue' which can be sprayed on or applied by brush or cloth ensures lines are bright and clear. A usable substitute is to use a black or blue spirit marker. Cast iron doesn't give

bright scribed lines, so many people use white spray paint or even correction fluid to prepare for marking out.

This process is greatly helped when the plan takes as many measurements as possible from a 'reference point' or face. You can use a rule or caliper to scribe lines at known distances from the end of a bar, for example, or to use a height gauge and a surface plate to scribe lines on castings or even metal plate held at right angles to the plate. With castings it often pays to machine the reference face(s) flat, so the casting sits solidly without rocking.

Centre Punches

If you want to drill holes in marked out positions the best way is to scribe two lines at ninety degrees so they cross at the point where the hole is needed. A slender-pointed 'prick punch' can be run along one of the lines and will 'click' into place at their intersection. A light tap with a smaller hammer will mark the point. For best results, follow up with a heavier, blunter 'centre punch' to create an impression that will guide the point of a drill. Typically, this will give an accuracy of about 0.1mm or 0.005 inch with care.

Cutting to a line

A tip for when you need to work to a scribed line by hand is to mark it with a prick punch, then using a saw or coarse file quickly remove the bulk of the waste material. Finish off with a fine file, you will find you can accurately file away half of the punch marks more easily than trying to work down to the line. ■



An example of work needing careful marking out.

An Offset Tailstock for a Unimat Lathe



Terry Gorin describes another neat improvement to the flexibility of this popular machine

The tailstock of the Unimat SL1000 was not designed to offset and, when clamped to the bed bars, is always at dead centre. For taper turning the headstock can be rotated to offset a spindle mounted centre relative to a centre held in the tailstock. With my modified Unimat the need for a tailstock offset, for taper turning using power feed, became apparent. The original design by Michael Cox for an offset for his mini lathe looked promising, (MEW 184, December 2011), being simple to construct, and a downsized version would be more than adequate for my even smaller lathe. It was designed to clamp by cotter pin to the cylindrical tailstock quill of the mini lathe but the end of the Unimat quill is machined with a M12 x 1 thread, spacer and shoulder to replicate that of the headstock mandrel. This is excellent for mounting the Unimat chucks but not directly suitable for cotter pin clamping. I considered alternative methods of attaching the offset but found none better, for ease of set up and clamping, than by cotter pin but would need some form of quill Adaptor. The dimensions of my modified version and the numerical order in which the components were fabricated, are shown in **fig 1**. Machining, drilling and screwcutting operations of the



Tailstock, note threaded adaptor on nose.

original are fully described in the above article and have only repeated here the sequence of some operations.

Tailstock Quill Adaptor (1)

This was turned, through drilled to tapping size and bored to fit the existing 12mm diameter by 5mm deep quill shoulder but not the M3 tapping or 4mm dia. hole at this point. To ensure

a firm mounting for the offset it was intended that the adaptor would need a little more than finger-tightness to close against the quill shoulder – in effect, the thread or so abutting the quill would not be fully profiled. To achieve this threading was started in the Myford lathe, from the direction shown, and completed on the bench, with the workpiece vice held. Progressive thread

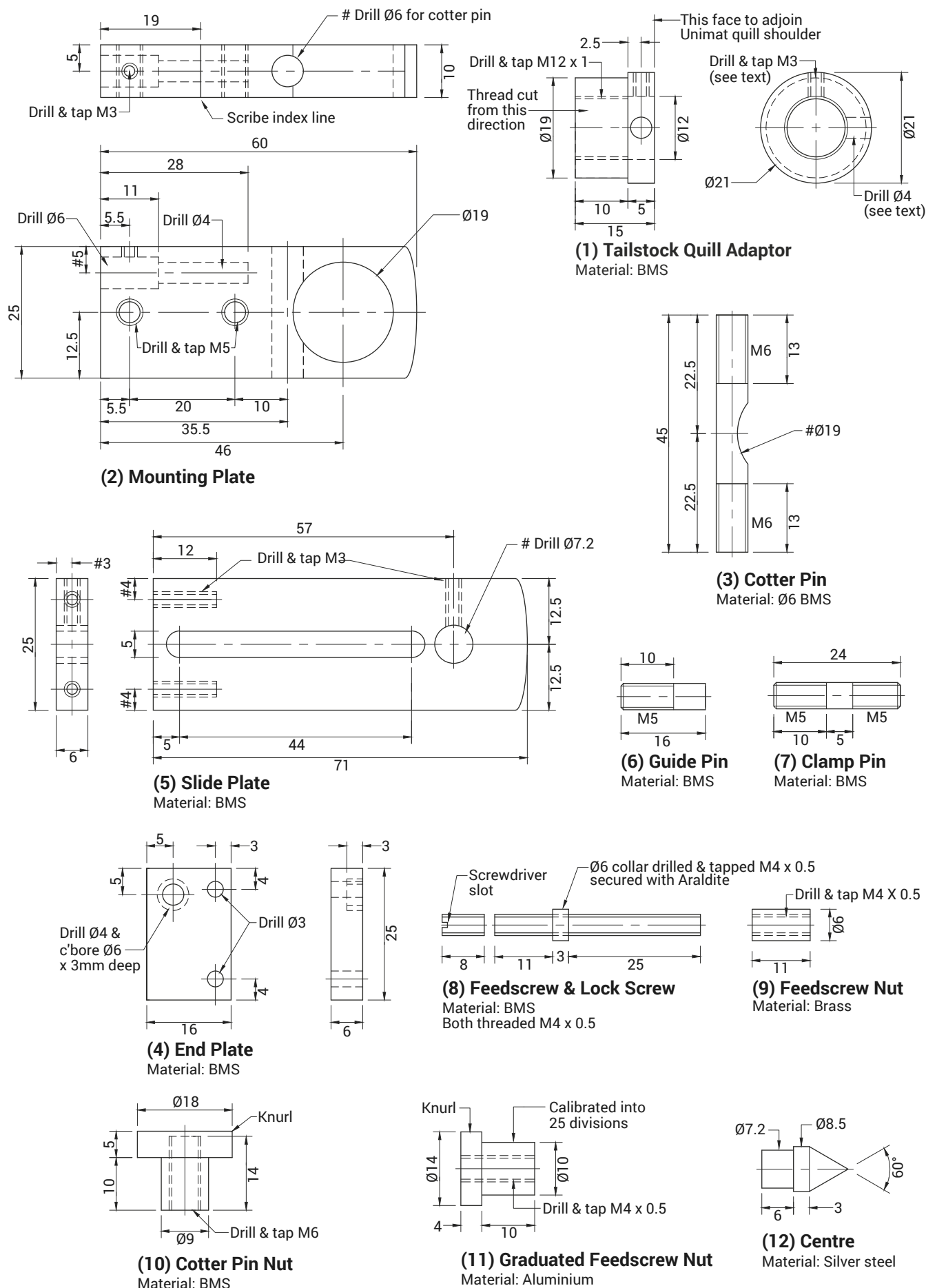


Slide & end plate.



Slide, end & mounting plates.

Fig.1



Tailstock Offset

(All dimensions in millimeters unless otherwise stated)



Sub assembly.

cutting and testing, by screwing in the existing threaded tailstock quill, was carried until the leverage of the tailstock body was needed to fully tighten the adaptor to the quill shoulder. The tailstock and adaptor then placed on the lathe and the positions of the M3 tapping at the top and 4mm dia. hole, to face the operator, then marked and completed. **Photograph 1** shows the finished adaptor tightened to the quill shoulder, by a 4mm diameter chuck key, and locked with shortened M3 grub screw.

Mounting Plate (2)

The plate was turned square to length, and the M5 threads and 6mm cotter pin hole drilled made. The 19mm centre hole was only spotted at this stage. The end drilling and counter drilled holes, M3 tapping, drilling and boring of the quill mounting hole and end profiling were carried out later.

Cotter Pin (3)

When completed the pin was inserted into the drilled hole in the mounting plate and firmly locked, in a central lengthwise position, by nuts top and bottom. The mounting plate with cotter pin inserted was next held in the four-jaw chuck and centred around the marked centre point which was then drilled and bored until the tailstock adaptor, used as test piece, slid into place without noticeable play. The cotter pin, when removed, then showed the 19mm diameter cut profile indicated in the drawing.

End Plate (4), Guide Pin (6), Clamp Pin (7)

These were next completed as detailed in the drawing and set aside.

Slide Plate (5)

This was first machined to length and the 5mm closed end slot was milled on the Myford. The End Plate (4) was next located and clamped to the end of the slide plate as **photo 2**. The positions of the M3 threads were spot drilled through the 3mm holes in the end plate and then drilled and tapped. Both plates then assembled with M3 x 10mm long socket head screws as shown. The Guide and Clamp pins were screwed

into their respective threads in the mounting plate. This and the assembled slide and end plates were clamped together, with the end plate tight to the mounting plate, as **photo 3**. Now the position of the 4mm and 6mm holes in the end of the mounting plate could be determined by spot drilling through the corresponding 4mm hole in the end plate. The 4mm hole was then through drilled to the 28mm depth and opened to 6mm diameter to 11mm depth. The position for these holes showing on the mounting and side plates in **fig 1**, prefixed with asterisks, are indications only. The precise locations were obtained from the end plate as above.



Offset components.

The M3 threaded hole for the grub screw to retain the feedscrew nut was then drilled and tapped.

Feedscrew and Lock Screw (8), Feedscrew Nut (9), Cotter Pin Nut (10), Graduated Feedscrew Nut (11), Centre (12)

These were next completed to the dimensions in fig. 1 and threaded M4 x 0.5 where shown. The centre was a spare previously turned for the standard Unimat tailstock bore of 7.2mm dia. and shortened to the 6mm thickness of the sliding plate.

Photograph 4 shows part assembly of all components. The feedscrew nut was fully inserted until flush with the end of the mounting plate and secured by grub screw. The feedscrew was then rotated by hand until its shoulder tight up to the nut and the mounting plate. The slide plate next slid until the feedscrew shoulder engaged into its recess in the end plate. Only then was the graduated feedscrew nut fitted to the end of the feedscrew and progressively screwed and locked so as to enable it rotate freely but with minimal backlash, with the rear of the end plate now tight against the end of the mounting plate.

For drilling the 7.2mm hole, for the offsetting centre, the assembly was clamped to the tightened and locked quill adaptor and checked for horizontal

Assembled on tailstock.

alignment. The overall size and spacing of the guide pins were not intended to provide more than 10mm offset either side of true central for this small lathe and therefore, with the feedscrew then rotated to advance the slide plate 10mm towards the operator, the slide plate was at its intended central position with the nearside ends of both plates flush. Ensuring that both plates were firmly clamped the 7.2mm hole was centred and drilled. While still clamped the index line previously scribed to the top of the mounting plate was continued across to the sliding plate and the flush ends of the mounting and slide plate machined to the radius indicated. This was the first use of a small rotating table purchased for the Myford. Finally, the M3 threaded

hole for the grub screw to retain the short centre was drilled and tapped. The finished components are shown separately in **photo 5** and assembled and mounted on the Unimat tailstock, with the centre offset to its rear limit, in **photo 6**.

Conclusion

For my purposes the top scribed index lines will be mostly useful as indication of when the sliding plate is at mid centre and starting point for measuring any off set. For parallel turning between centres, will not need to rely on accurate alignment of these lines but simply replace offset with standard Unimat centre returned to the tailstock, without needing to remove the quill adaptor. ■

In our Next Issue

Coming up in issue 303
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Look out for MEW 303, your May issue:



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How to Set Up a Spin Indexer

Stewart Hart explains that to get the best from these useful devices you need a little preparatory work is needed



Vernier Scale to give 360 indexing steps 1° per step

I have found my Spin Indexer to be a very useful piece of equipment, it has a 36 hole indexing ring and a 10 hole Vernier series for the indent, giving 1° indexing increments.

It is intended for use with 5C collets, but with a suitable adaptors it can be used with chucks or ER32 collets, **photo 1.**

As supplied the indexer has no provision for clamping to the mill table, I don't believe that this is an oversight on the part of the supplier,

as it is intended for use on a wide range of machines and applications, the intention being that you drill the base to suit your own particular requirements. In my case this is a SIEG X3 Milling Machine.

The first thing to do was mark the centre line of the spindle onto the base, this was done by resting the indexer on a pair of matching V blocks and ensuring the base is square. Touch on the top of the spindle with a height gauge, zero the gauge and lower it to

The first thing to do was mark the centre line of the spindle onto the base, this was done by resting the indexer on a pair of matching V blocks and ensuring the base is square.



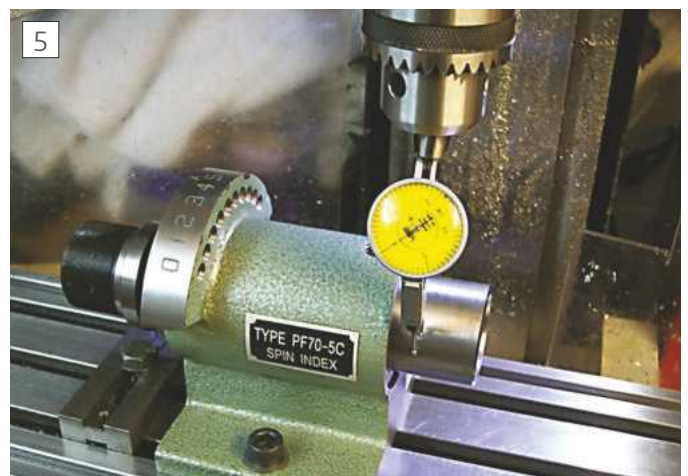
Indexer set up on a pair of matching V blocks for marking centre line



Clocking Indexer Square for drilling



Drilling clamping holes indexer base:- note use of levelling jacks



Checking alignment of setting bar

half the spindle diameter to bring it onto the centre line and scribe a nice clear line, **photo 2**.

As the end faces of the indexer are square to the bore, I found the best way to clamp the indexer for drilling was to grip it in a large toolmakers vice, set square on the mill table, then to run a clock over the base to get it square in the Y direction, **photo 3**. With

the indexer accurately clamped and supported with improvised levelling jacks, **photo 4**, a pointer was used to locate on the scribed line, it was now a relatively easy job to drill and tap.

A setting bar was now machined up for a nice location fit in the milling machines T slots, this was then clamped to the base of the indexer. The indexer was then tested for alignment on the

milling machine by clocking along the spindle, **photo 5**, the screws allowing for slight adjustment in alignment. Once I was happy with the alignment, the screws were fully tightened and the setting bar doveled to the base to ensure that nothing had a chance of moving out of line, **photo 6**.

The indexer also comes with a tail stop so that long items can be supported,



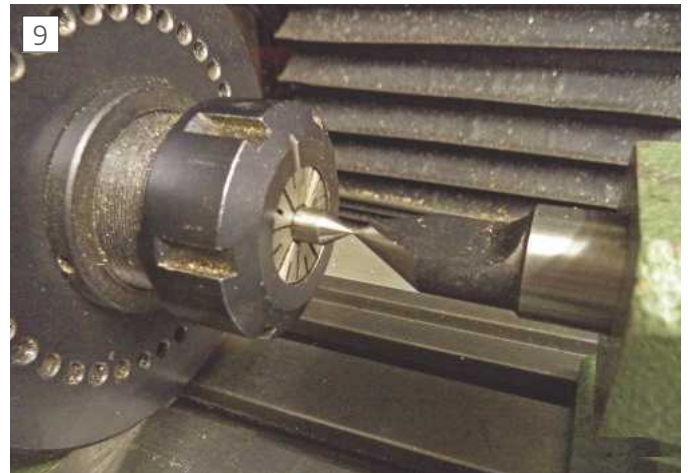
Setting bar doveled to base



Setting tail stop square



Drilling and tapping tail stop



Checking everything lines up

this was treated in the same way by following a similar process as for the indexer. But in this instance one of the faces of the base required squaring up first. This was done by clocking the spindle level on the mill and running an end mill across the face to square it up, **photo 7**. The tail stop was then clamped to the table with the aid of a through bar, and packed and clocked square, the base drilled and tapped, and the setting bar doweled in place, **photo 8**. I can now quickly and accurately bolt the indexer to the milling machine table whenever I need to use it, **photos 9 and 10**. ■



Indexer and tail stop in use

MODEL ENGINEER

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NEXT ISSUE

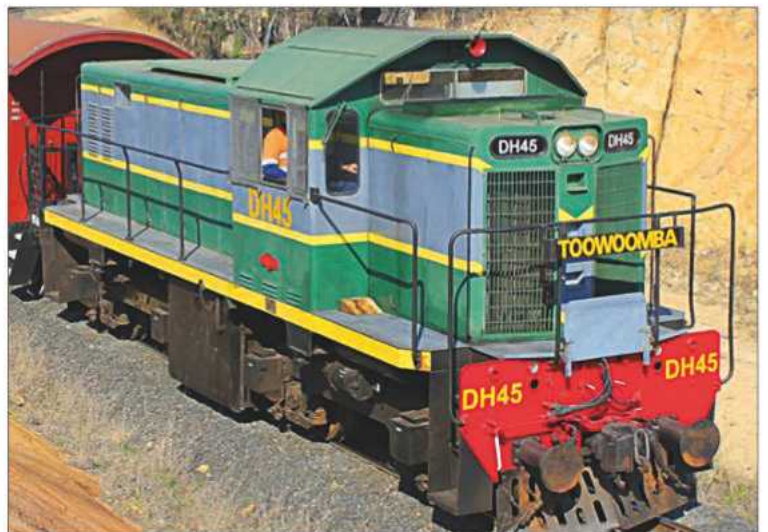
Queensland Loco
George Punter describes the construction of a Queensland DH class Diesel locomotive in 5 inch gauge.

Parlicoot
Terence Holland, aided and abetted by his wife, goes all steampunk.

Reviving Files
Noel Shelley shows you how to restore the life to your old files.

Cylinder Boring
David Earnshaw describes how he went about boring his 'Duchess' cylinders from the solid.

Content may be subject to change.



ON SALE 26 MARCH 2021

Scribe a line

YOUR CHANCE TO TALK TO US!

Drop us a line and share your advice, questions and opinions with other readers.

Duncan Webster's Tailstock DRO

Dear Neil, not surprisingly there are an increasing number of projects involving a bit of software. I suggest that authors could be invited to make the code available on the internet resource known as 'Github'. It would save them quite a bit of trouble and make things easier for those readers interested - like me!

If you want an example of just how useful this resource can be I suggest searching for James Clough's Electronic Lead Screw on Github - or just directly via Google. I've got this ELS working on a breadboard and if I can compile code at almost 71 anybody can! Incidentally, James used the same display module as Duncan Webster has, they are very cheap.

Assembling the five duPont connector used to connect to the board is a right pain though and I strongly suggest using pre-fabricated single lead ones. I did modify some crimp pliers to overcome the subtle problems with these fiddly connectors

myself so as to keep the wires in order.

To mount the pcb flat behind a cut out it is necessary to remove the five pin connector and replace it with one mounted on the rear of the pcb. I have managed to do this as well. Again James' covers all this in his Github write up and on his YouTube channel.

As an aside I can't see an acknowledgement to Duncan printed with the article itself - obviously an oversight. I got his name from the index.

Bob Hawtin, by email

My sincere apologies to Duncan for not spotting we had omitted his by-line from the article, especially as it was specially prepared in response to readers' requests.

Bernard Towers' Lantern Chuck

Dear Neil, I have been reading the latest Issue of MEW (301) - very much enjoying it - thank you very much.

I am a relative beginner to Model Engineering and I have been needing something to assist with shortening screws in lathe and couldn't quite see a way through it (work holding etc.) - Mr Towers' article and design for a lantern chuck was a very timely article indeed.

I think the design he has come up with is great and I would very much like to have a go at making one to this design.

I see that Mr Towers has suggested if anyone wants an email copy of the drawing to contact him via the editor.

I am sure many readers will be able to make one from the pictures and description alone but as a beginner I think I could do with the extra support of a drawing if that were available.

Patrick Clark, by email

Thanks to the many readers who have contacted me regarding Bernard's chuck. He has prepared an excellent drawing which due to the number of requests we will publish in our next issue, MEW 302 - Neil.

Tubal Cain's Workshop

Dear Neil, regarding Chris Murphy's letter in Scribe a line (MEW 301).

Did Model Engineer issue a 'special' setting up a workshop by Tubal Cain in 1976/77? (Tubal-cain is a biblical metal worker, the author is of course Tom Walshaw).

1) A home workshop special appeared in 1985 written by Stan Bray.

2) Mr Murphy mentions the Unimat Lathe. ME 3550 Dec 1976 reviews the New Version of the lathe. Rex Tingey penned a number of articles about the lathe in 1977.

3) ME's for 1975, 76, 77 contain no Tubal Cain workshop set up articles.

4) However, Tubal Cain describes the setting up of his workshop in Cumbria in ME's 3425, 26, 27 issued in 1971. They are well worth a read.

Perhaps another reader has satisfied Mr Murphy's request? If not I can send Chris copies of the Cumbria articles.

Patrick Cubbon, Peterborough

Simple Scribe

Dear Neil, I was working in my shed the other day and using my faithful scribe to mark out lines for a holding clamp for the mill table - when I wondered if anyone would be interested in making a simple scribe - I have been using a masonry nail approximately 100 x 4mm which I hammered through a short piece of copper tube some time ago.

I have also used it as a centre punch on soft metals with a thump with the hand and I think only ever put the point on the grindstone once! Simple and inexpensive.

Dave Davison, by email

Chuck Changing Board

Dear Neil, reading MEW301, I thought that Eric Clark's idea of a chuck board designed to fit the bed of his lathe was much better than using the nearest piece of scrap wood. I made one for my Warco WM180 and then had a further idea; a small wooden cradle sized to support the chuck during the awkward operation of removing or fitting it. This was one of those jobs where a third hand was needed. Very simple but useful.

Shaun O'Sullivan, Saltford



Continued on page 64

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An exceptionally good modern book on the basics of engineering practice. Vast numbers of drawings of set-ups, rather than photographs and, as the text is based on 'Questions and Answers', it is very much to the point; it is also strong where practices have changed, notably on fastenings. Whilst American, many manufacturers have been consulted in its preparation, including Colchester and Myford, and variations in practice between countries are covered. The spread of this book is well illustrated by the Chapters: Measurement Tools, Layout & Job Planning, Basic Hand Tools, Filing & Sawing, Grinding, Reaming, Broaching & Lapping, Drills & Drilling Operations, Threads & Threading, Turning Operations, Milling Operations, Fastening Methods, Machine Shop Steel Metallurgy, Safety & Good Shop Practices, Other Shop Know-how and Sharpening Steel Lathe Tools. For the newcomer to model engineering this book will be invaluable - and even if you have been in the workshop man-and-boy you will find much of it useful. Highly recommended - as if you couldn't guess that. 518 pages. 497 drawings, plus tables. Paperback.



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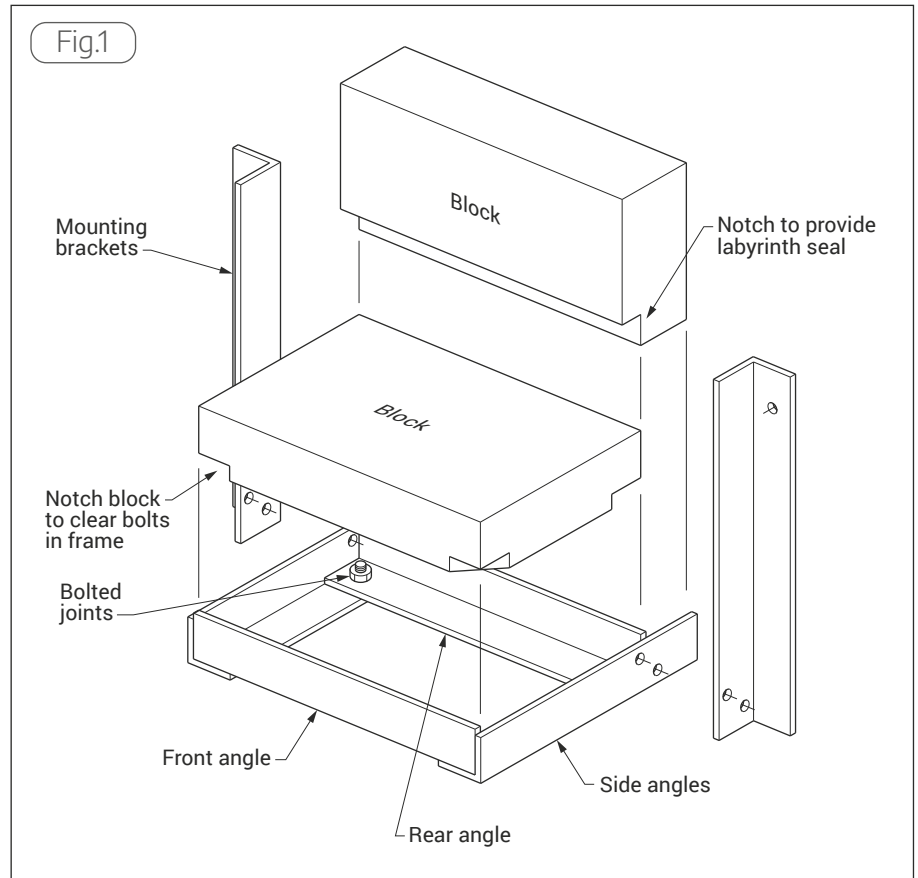
A Brazing Hearth for a Tenner

Alan Donovan makes a workshop hearth for brazing and soldering

While 'tinkering' with my projects in the shed, the necessity to braze or solder parts together has increased. I usually make a temporary brazing hearth out of a few bricks and undertake the work outside. Needless to say, the results have been poor as even a very gentle breeze carries the heat away. This was unacceptable so I decided that I needed to purchase or construct a permanent brazing hearth.

I decided to construct my own. Although cost was not really an issue, I did want to minimise expenditure while constructing a brazing hearth that was 'fit for purpose', simple to construct from readily available materials and preferably repurpose some of the materials I had accumulated over time. 'Fit for purpose' meant;

- A Compact unit.
- At a good working height for me (I am over 6 feet tall).
- To be securely attached to a non-combustible surface.
- To be installed within a well ventilated but wind and draught free environment.



My garage is well ventilated and had a 'free' wall so it was decided to adopt a style of hearth that could be bolted to the block (non-combustible) wall. A rough sketch of the concept

was undertaken, see **fig. 1**, and construction progressed from there.

Frame construction

The frame for the hearth was



The finished and installed frame



Non-rotatable bolted connection



The Labyrinth interface



The cut blocks.

constructed from steel angle which was, in a previous life, part of a bed frame. This was an imperial size and measured 1.75 x 1.75 x 0.125 inches (approximately 45 x 45 x 3mm). The hearth frame is of bolted construction, with the horizontal frame being such that the hearth base block sits within the horizontal frame members so that it is laterally restrained and is supported from two long (front and rear) horizontal angles. The rear angle, which is a smaller angle than the main frame in this case, is positioned to place the base block in the most forward position. The completed and installed frame is shown in **photo 1**.

Where the horizontal side members connect to the wall mounting angles there is a diagonal double bolt connection, **photo 2**, this connection was clamped before drilling with holes exactly sized to suit the bolts. This was to ensure a clearance free, non-rotatable connection between the two members. Bolts were fixed such that only the bolt heads were visible externally.

The frame was secured to the wall using hexagon headed coach bolts bolted through the frame into suitable wall plugs.

The Firebricks

The firebricks are not conventional firebricks. I decided to utilise lightweight (they float in water) thermally efficient wall blocks that most, if not all, modern domestic dwellings are constructed from. Additional advantages with these are they can be cut with a conventional wood saw and are a convenient size on which to base my hearth design. These blocks are nominally 440mm long x 215mm high x 100mm thick (other thicknesses are available) and are used for the base and back wall of the hearth.

The hearth would have a 'footprint'

of approximately 260mm x 440mm (excluding the metal support frame). This is larger than the block height of 215mm thus enabling the wall block that is used for the back wall to be notched along its back edge and thus form an interlocking labyrinth type interface with the base block, **photo 3**. The lower edge of this block would also sit behind the base block locking the blocks in the required positions. The labyrinth style interface removes a direct heat leakage path to the mounting wall when in use.

On final assembly, this interface should be filled with mortar or fire cement.

The base block had the four underside corners notched away to clear the protruding mounting frame bolts thus enabling the building blocks to be fully supported along two long edges by the angle frame. **Photograph 4** shows all

the hearth blocks with their edges cut to suit the frame construction. The smaller two additional blocks are the side blocks to the hearth and are freestanding on the base block and may be easily moved to suit the items being brazed.

Photograph 5 shows the finished Brazing Hearth. This was constructed with a minimum of cost, the wall blocks and the fasteners being the main expense at approximately £10, plus I was able to repurpose some materials that I had collected over time.

Whether the wall blocks are good enough to be used as firebricks – only time will tell, but so far – no problems. It is far superior to my previous 'open air' arrangement. I am sure that if you prefer to use proper firebricks then this design may be easily altered to accommodate them. ■

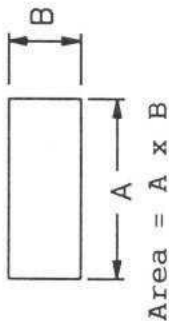


The finished Brazing Hearth

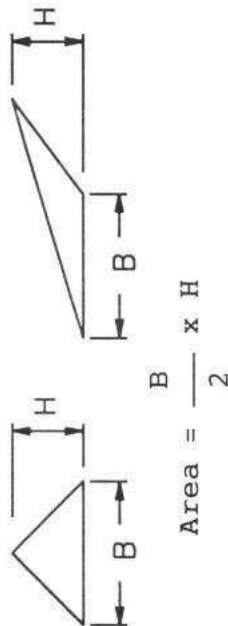
Model Engineers' Workshop Data Book

MODEL ENGINEERS' WORKSHOP DATA BOOK USEFUL MATHEMATICAL FORMULAE

Rectangle



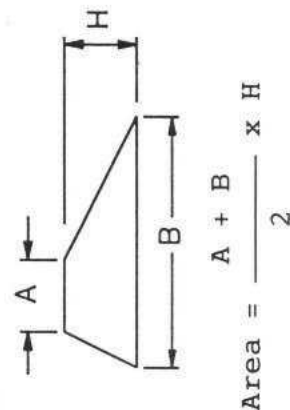
Triangle



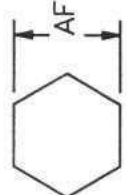
Length of the third side of a right angle triangle if other two are known.
(Pythagoras's Theorem)

$$A = \sqrt{B^2 + C^2}$$

Trapezoid

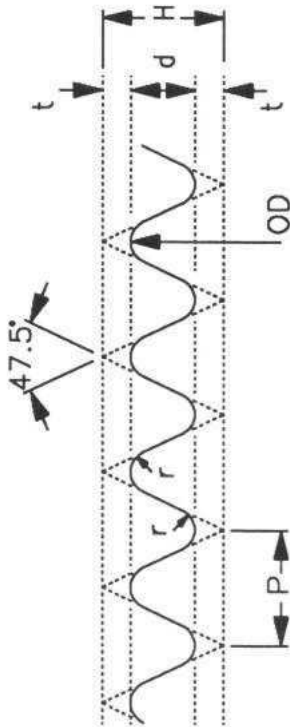


Hexagon



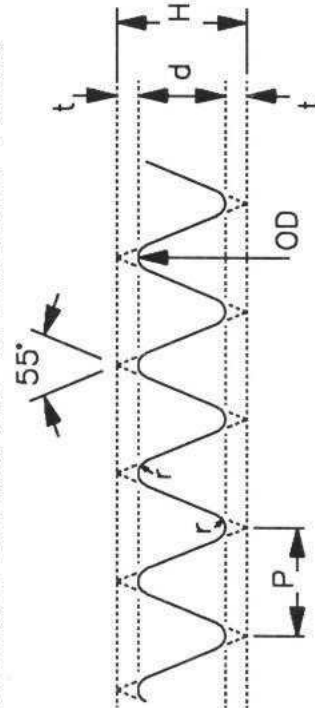
MODEL ENGINEERS' WORKSHOP DATA BOOK BASIC THREAD FORMS.

BRITISH ASSOCIATION THREAD.



OD. = Outside diameter of screw.
d. = depth of thread. = $0.6P$
t = = $0.27P$ approx
r = radius = $0.18P$ approx
H. = Angular depth. = $1.136P$
P. = Pitch. = 0.9^n mm
where n is the BA no.

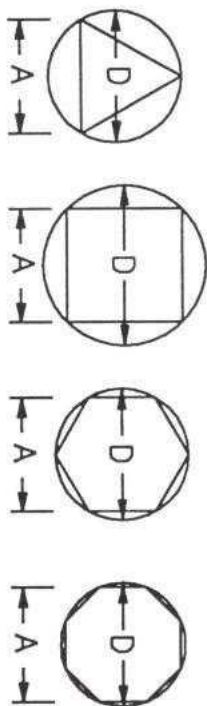
BRITISH STANDARD WHITWORTH FORM.



OD. = Outside diameter of screw.
d. = depth of thread. = $0.640327P$
t = = $2/3H$
r = radius = $1/6H$
H. = Angular depth. = $0.137329P$
P. = Pitch. = $0.960491P$

USEFUL MATHEMATICAL FORMULAE

Relation between various shapes and containing circle

Equilateral Triangle

$$D = 1.155 \times A$$

Square

$$D = 1.415 \times A$$

Hexagon

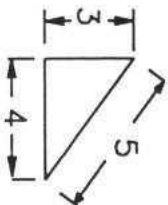
$$D = 1.155 \times A$$

Octagon

$$D = 1.083 \times A$$

In view of the likely use for the above in the workshop all constants are rounded up.

Setting out a right angle



A triangle having sides in the proportions of 3, 4 and 5 will produce a precise right angle.

A triangle having sides in the proportions of 5, 12 and 13 will also produce a precise right angle but is more difficult to lay out accurately.

USEFUL MATHEMATICAL FORMULAE

Volume of any regular shape bar
Square, hexagon etc

$$\text{Volume} = A \times L$$

Pyramid

$$\text{Volume} = \frac{A \times H}{3}$$

A = area of end,
L = length of bar
H = height of pyramid

Readers notes

DRILL SIZES		DECIMAL SIZES	
METRIC	INCH	METRIC	INCH
1.45		1.450	0.0571
1.50		1.500	0.0591
		1.511	0.0595
1.55		1.550	0.0610
	1/16	1.587	0.0625
1.60		1.600	0.0630
		1.613	0.0635
1.65		1.650	0.0650
1.70		1.700	0.0669
		1.702	0.0670
1.75		1.750	0.0689
		1.778	0.0700
1.80		1.800	0.0709
1.85		1.850	0.0728
		1.854	0.0730
1.90		1.900	0.0748
		1.930	0.0760
1.95		1.950	0.0768
	5/64	1.984	0.0781
		1.994	0.0785
2.00		2.000	0.0787
2.05		2.050	0.0807
		2.057	0.0810
		2.083	0.0820
2.10		2.100	0.0827
2.15		2.150	0.0846
		2.184	0.0860
2.20		2.200	0.0866
2.25		2.250	0.0886
		2.261	0.0890
2.30		2.300	0.0906
2.35		2.350	0.0925
		2.375	0.0935
	3/32	2.381	0.0938

DRILL SIZES		DECIMAL SIZES	
METRIC	INCH	METRIC	INCH
1.45		1.450	0.0571
1.50		1.500	0.0591
		1.511	0.0595
1.55		1.550	0.0610
	1/16	1.587	0.0625
1.60		1.600	0.0630
		1.613	0.0635
1.65		1.650	0.0650
1.70		1.700	0.0669
		1.702	0.0670
1.75		1.750	0.0689
		1.778	0.0700
1.80		1.800	0.0709
1.85		1.850	0.0728
		1.854	0.0730
1.90		1.900	0.0748
		1.930	0.0760
1.95		1.950	0.0768
	5/64	1.984	0.0781
		1.994	0.0785
2.00		2.000	0.0787
2.05		2.050	0.0807
		2.057	0.0810
		2.083	0.0820
2.10		2.100	0.0827
2.15		2.150	0.0846
		2.184	0.0860
2.20		2.200	0.0866
2.25		2.250	0.0886
		2.261	0.0890
2.30		2.300	0.0906
2.35		2.350	0.0925
		2.375	0.0935
	3/32	2.381	0.0938

DRILL SIZES				DECIMAL SIZES			
METRIC		INCH		METRIC		INCH	
		LETTER					
		NO./					
		LETTER					
2.40				2.400	0.0945		
		41		2.438	0.0960		
2.45				2.450	0.0965		
		40		2.489	0.0980		
2.50				2.500	0.0984		
		39		2.527	0.0995		
2.55				2.550	0.1004		
		38		2.578	0.1015		
2.60				2.600	0.1024		
		37		2.642	0.1040		
2.65				2.650	0.1043		
2.70				2.700	0.1063		
		36		2.705	0.1065		
2.75				2.750	0.1083		
	7/64			2.778	0.1094		
		35		2.794	0.1100		
2.80				2.800	0.1102		
		34		2.819	0.1110		
2.85				2.850	0.1122		
		33		2.870	0.1130		
2.90				2.900	0.1142		
		32		2.946	0.1160		
2.95				2.950	0.1161		
3.00				3.000	0.1181		
		31		3.048	0.1200		
3.10				3.100	0.1220		
	1/8			3.175	0.1250		
3.20				3.200	0.1260		
3.25				3.250	0.1280		
		30		3.264	0.1285		
3.30				3.300	0.1299		
3.40				3.400	0.1339		
		29		3.454	0.1360		
3.50				3.500	0.1378		

DRILL SIZES				DECIMAL SIZES			
METRIC		INCH		METRIC		INCH	
		LETTER					
		NO./					
		LETTER					
				0.80			
					1/32		
		68		0.787	0.0310		
				0.794	0.0313		
				0.800	0.0315		
		67		0.813	0.0320		
				0.820	0.0323		
		66		0.838	0.0330		
				0.850	0.0335		
				0.880	0.0346		
		65		0.889	0.0350		
				0.900	0.0354		
		64		0.914	0.0360		
				0.920	0.0362		
		63		0.940	0.0370		
				0.950	0.0374		
		62		0.965	0.0380		
				0.980	0.0386		
		61		0.991	0.0390		
				1.000	0.0394		
		60		1.016	0.0400		
		59		1.041	0.0410		
				1.050	0.0413		
		58		1.067	0.0420		
		57		1.092	0.0430		
				1.100	0.0433		
				1.150	0.0453		
		56		1.181	0.0465		
				1.191	0.0469		
				1.200	0.0472		
				1.250	0.0492		
				1.300	0.0512		
		55		1.321	0.0520		
				1.350	0.0531		
		54		1.397	0.0550		
				1.400	0.0551		

Readers' Workshop



Jason Ballamy reveals 'What's in My Shed?'



Jason's shed.

I don't know about other readers but whenever I see a photo showing something being worked on, I am always interested in what's going on in the rest of the workshop that is visible background. Those that followed the Milling for Beginners series may have got a few glimpses into the rest of my workshop and those that frequent the forum have probably seen a bit more in the photos and videos I tend to post there. So, I thought that it may be of interest to take a look around my modest sized workshop to see how I have things laid out to suit my needs.

I have an 8 x 16' shed which is a similar size to the average single garage. Of

timber construction, it is insulated with 50mm PU (polyurethane) insulation in the walls and ceiling then lined with faced OSB. The floor has a base layer of 12mm WBP ply on bearers spaced at 300mm centres, then 12mm of PU insulation, 22mm tongue and grooved chipboard all topped off with vinyl tiles. I made a new door to replace the flimsy pair that were on the gable end and changed the basic windows to double glazed UPVC. Sorry the large Bonsai are not looking their best this time of year, **photo 1.**

As you enter the workshop to the right is a bench that does not get used that much, meant for grinding and

welding and other similar dirty tasks, since getting the Femi bandsaw, that tends to live at one end and the fish food at the other. The Parrot vice is quite handy being able to swivel and it can also be mounted on its side. There are a few odd drawers below but not much engineering related stuff in those, **photo 2.**

Moving around the next section of bench has a Tormek Grinder used mostly for my woodworking tools, basic 6" bench Grinder, small belt sander and bench drill which does not do a lot of actual drilling these days being used more for honing, wire brush or polishing etc. Not much in the way of model



Bench for 'dirty' tasks.



Various smaller machine tools.

engineering items in the drawers above but a few larger M6 and over fixings, springs etc. **photo 3.**

Further along this wall was a nice bit of clear bench where a model being worked on could be kept or drawings laid out but lately it has been occupied by the Sieg SX2.7 from ARC that was used for some magazine articles that they sponsored. Smaller drawers below have steel stock and SX2.7 related tooling in, but most of the larger are again not filled with ME related items, **photo 4.**

Moving into the other half of the shed is where most of the action takes place, starting with the Warco WM280VF which I have had for about 12 years now (yes, they will last that long!) Behind the lathe are a few frequently used tools, sets of metric and imperial drill boxes with some common size stub length ones to the right, **photo 5.**

I have replaced the curved steep panel



SX 2.7 Mill.



Warco WM280VF lathe.

that fitted between the two cabinets of the lathe stand which wasted a lot of space and replaced it with a set of four drawers on full extension runners. These house the smaller items of lathe specific tooling, the top one being mostly cutting tools and spare inserts, next down are the 5C collets and an assortment in the lower two, **photo 6.**

To the left of the lathe across the end wall is the bench with my vice, saws and files are hung on the wall behind within easy reach. To the right is the modern version of the traditional wooden engineer's chest and beyond that in the corner commonly used lathe chucks, others and the faceplate are in the stand's cabinets. The opposite corner is taken up by the mill, **photo 7.**

Drawers under this bench, which are again on FE slides, have non ferrous

metals to the right and odds and ends to the left, **photo 8**.

The Sieg X3 mill sits quite nicely across the corner with a few bits related to it up on the wall and things like collets, cutters and spindle tooling easily to hand in the drawers below. I've had this since 2007 and apart from a couple of belts, one set of brushes and an LED warning light needing replacing, it continues to perform well. I have added a DRO and there is an X-axis power feed and also a spindle speed readout, **photo 9**.

The front wall with the view over the garden is taken up with a final run of bench where I can sit and fiddle with engines, mark out, etc. and the left-hand end is where most of the engines stand when being run, a few odd screwdrivers



Bench for handwork.



Non ferrous metals and short ends.



Well equipped X3 mill.



'Fiddling' bench with view over the garden.



Marking and measuring tools, taps and reamers.

I thought that it may be of interest to take a look around my modest sized workshop to see how I have things laid out to suit my needs.

in a rack behind and some hammers above, **photo 10**.

Marking out and measuring tools are kept in the drawers below and the metal ones have things like taps and dies, reamers, drills and so on. You may have gathered by now that I tend to keep most of my things in drawers, I like it that way as you can keep the swarf and fine cast iron dust off them, so you don't get black hands when you pick up a tool that has not been used for a while, **photo 11**.

I also got a CNC mill just over a year ago in the form of a Sieg KX-3 but had to put that in the garage which has worked out quite well as I can keep an eye on that running while doing actual work as the garage is my woodworking takes place. When not in use the keyboard can be stood on top of the mill and protected from dust with a bit of bubble wrap and the screen which is on a bracket pushed back flush to the wall. Once again, the drawer below stores the items specific to this machine. **photo 12**.

So that's about it, sorry there are not

vast amounts of tooling or ex-industrial machines to see but I find that is all I need to keep up a regular flow of completed and running engines and

that the far Eastern equipment is up to the job. Finally, I'm sure you are all wondering but yes, my workshop is usually that tidy! ■



CNC KX3 mill lives in the garage.

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What Lies Beneath- a World Class Museum Part 2

The Rahmi M. Koç Museum of Istanbul boasts a collection of over 16 thousand objects, all related to the history of transport and industry. Bruno Cianci explains how behind it all is a workshop for restoration and maintenance work that employs 32 women and men. Photos by Bruno Cianci, Ali Konyali and Tarkan Kutlu



Motorcycles awaiting restoration; over 30 motorcycles of British, German, Italian, French and Japanese provenance are already exhibited.



Maritime-related items are the most common decoration at the Tasdelen compound



Engines, pumps, bikes and much more: one can find any kind of mechanical item awaiting restoration.



An electric saw in action.



Maritime items include ship models and lifebelts.



The outdoor area of the workshop is big enough for big trucks to maneuver upload and download the bigger items that are restored in place.



Birbey Demir proudly shows some calipers after being restored and framed.



A seed and grain cleaning machine, manufactured by Clipper in Michigan, awaits restoration.



Rahmi M. Koç with Serra Kanyak, who is currently curating an exhibition of vintage dolls to be held at the Istanbul museum.



The shipwright Mike Summers poses next to the stem of Maid of Honour, a 1927 picket-boat of the Royal Navy now part of the museum collection.



Gürbüz Karstarli works on the restoration of a 1928 Marshall steam roller donated by the mayor of Glyfada, a suburb of Athens.



Ali Sarkan keeps himself busy restoring lamps, candle holders and other copper items.



LEFT: How a distinctive mark on an old tramway vehicle looks like before restoration.

RIGHT: The restored panel.



A scale model of a steam engine manufactured by E. Wilson of Gorton in 1909.



Ms. Ayla Aksu cleaning a delicately painted item.



Lokman Ayan is engaged in fixing a Chris-Craft marine engine.



Lokman is also working on this steam engine.



Stationary engines are a common sight at Tasdelen; many of these are now on display at the Rahmi M. Koç Museums.



A selection of wheels being inspected before restoration.



Scale locomotives are one of Rahmi Koç's favourite collectibles. It is literally impossible to count the number of such pieces scattered around his museums and private homes.



Serra Kanyak, who is a skilled restorer and curator, paints a wooden puppet in her atelier full of vintage dolls.



A 1949 Skoda full-scale steam locomotive depicted before and after restoration. The transport of this railway vehicle from the workshop to the Rahmi M. Koç Museum involved 7 trucks, over 20 staff, and took three days.



Filiz Aksu and Burak Erdogan in their workshop which is located in the basement of the Rahmi M. Koç Museum, in the Lengerhane building.



Burak Erdogan is in charge of the ordinary maintenance and cleaning of the museum items. He's been part of the museum staff since its foundation in 1994.



An engine is run for test after its mechanisms have been oiled.



Ironsmiths working outdoors.

How to find the museum and when to visit

The Rahmi M. Koç Museum of Istanbul is located in the district of Hasköy (Beyoğlu) and can be found on all mainstream guidebooks to the city. It can be easily reached by taxi or public transport, both via land and sea, from the historical centre. Apart from the winter period, the weather is good and mild all year long. The best season for visiting is spring; summers are hot in general, but there's often a pleasant breeze that blows and makes it bearable.



Gigantic machines of all sorts await restoration outside the workshop in Tasdelen.

All the Rahmi M. Koç Museums

The Istanbul Rahmi M. Koç Museum has two branches: one in the Turkish capital city Ankara (opened in 2005) and one on Cunda Island, Ayvalık (2014), on the Aegean coast. The Istanbul museum is divided in two main areas, one called Lengerhane ("House of the anchors", opened in 1994) and the other called Tersane ("Dockyard", opened in 2001). The first area consists of a former Byzantine building used as a foundry during the Ottoman period. Hundreds of manufactures and scientific instruments are exhibited here, including full-scale steam engines, toys, electric trains, dioramas and much more. The second area, the Tersane, had housed since 1861 the dockyards of the Sirket-i Hayriye, an Ottoman steamers company. This spectacular part of the museum has a horseshoe plan, with the basin and a slipway in the middle, the latter equipped with a capstan. Currently, the Koç collection, enlarged by many loans and donations, features over 16,000 items, from a razor that belonged to Kemal Atatürk (the father of modern Turkey) to the 94-metre TCG Uluçalreis submarine, which is the largest exhibit. The overall surface of the Istanbul museum is 27,000 square metres (88,000 square feet).

The Ankara museum is located in a wonderfully restored han, a historic inn called Cengelhan (literally: 'Hooks inn'). According to an inscription on the main gate, the inn was built in the 16th century and was later used as a warehouse for mohair (a fabric made from the hair of the Angora goat), which was a specialty of the Ankara region. The acquisition of this complex is highly symbolic, for it was here that Vehbi Koç had started his business life in the first decades of the 20th century. All Rahmi M. Koç museums are engaged in education, especially the Istanbul venue, where a full department is allocated to teaching and getting children involved. Additionally, corporate minibuses carry teachers towards the most remote areas of Turkey for educational purposes and activities. During spring and summer, on weekends, visitors to the Istanbul museum can experience a brief navigation on the Golden Horn on board the boat Kont Ostrorog and the steam tugs Liman 2 and Rosalie. The latter was built in the Netherlands in 1873. And then, there is a small train running on a narrow-gauge railroad for brief travel back in time. For information: www.rmk-museum-org.tr

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Sheet Metal Working

Although at first sight it seems simple, sheet metal work is one of the most challenging tasks in the workshop. Most of us could cut out a piece of steel sheet and bend it to form a patch over a rust-hole, but the skill required to make something like a complex curved mudguard is considerable.

It's possible to do much simple sheet metal work with hand tools. For cutting sheet, 'Aviation' snips are available individually or in sets for straight, left and right cutting. They will tackle ordinary steel up to about 1.2mm in thickness and stainless steel of about 0.7mm, but expect sore hands if you do a lot of cutting near the limits! For intricate shapes and holes a hand 'nibbler' is slower but easier to guide.

A drill-powered nibbler is a very quick way of cutting shapes out of sheet metal, but they can be difficult to guide accurately. Some ingenious modifications which improve their handling have been published in Model Engineers' Workshop. The downside of a powered nibbler is the quantity of small, sharp curved chips they produce, which need to be cleared up straight away.

For long, straight cuts the best solution is a bench shear, or a roller shear for big curved cuts, but you can use a nibbler guided by a template at a push. Many bench shears also include a facility for folding and sometimes rolling as well, but if you do very little folding and big vice and bits of angle-iron might suffice. Some machines combine several functions, **photo 1**.

Bench or vice mounted tools are available for bending and curving strip metal. For larger, more accurate curves (such as the rims of model traction engine wheels) or for rolling tubes (such as for a tapered locomotive boiler) bending rolls are used. These typically have three rollers operated by a handle; the work is annealed and passed through multiple times, gradually increasing the curve.

If you are regularly making large curved panels such as for car restorations or motorcycle petrol tanks, then an 'English Wheel' - a large frame with opposed rollers - will be essential. For smaller or occasional items, the traditional solution is a sand-

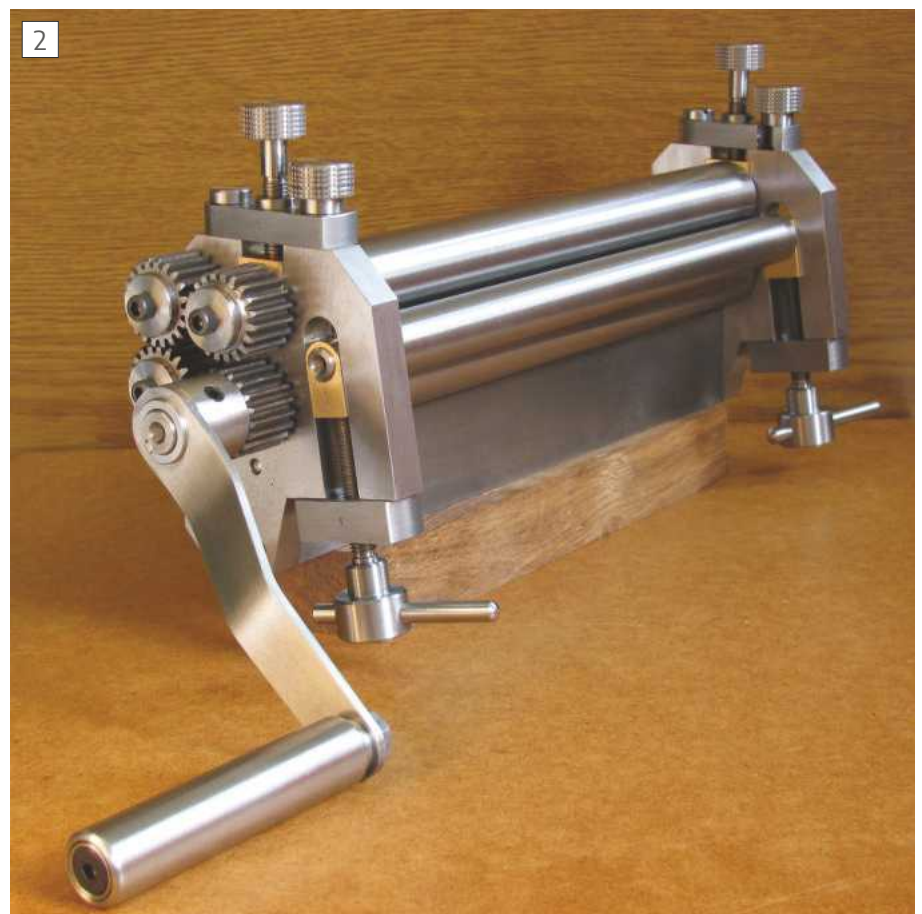
filled leather bag and a pear-shaped wooden mallet. A hammer with a large curved face or a ball pein and a set of 'dollies' can also be used or hammering against the end-grain of a large block of softwood.

George Thomas Bending Rolls

For those who enjoy making their own tools, George Thomas's bending rolls, **photo 2**, are a well proven design that is a popular choice. The workshop bending rolls will roll steel strip (cold rolled, close annealed) up to around 16 SWG (1/16", 1.6mm) and non-ferrous sheet of up to around 14 SWG (0.080", 2mm). Grooves cut in the pinch rollers permit the rolling of angle and T sections. Maximum material width for the standard kit is 10". They are available in kit form, including the materials, gears and fixings, from Hemingway Tools www.hemingwaykits.com. ■



The Formit from Warco is a multi-function machine that has bending, rolling and shear/guillotine functions



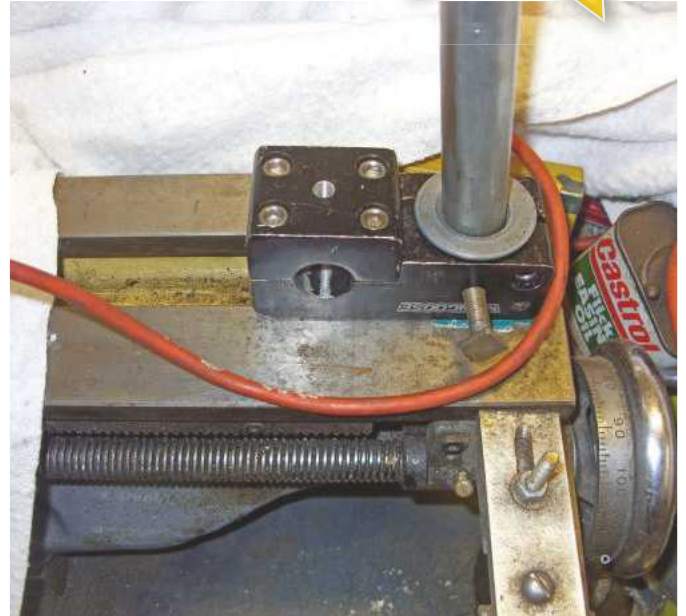
This fine example of the GHT Bending rolls was made from the Hemningway kit

Readers' Tips



TIP OF
THE MONTH
WINNER!

A Lathe Mounted Drill



This month our lucky winner of £30 in Chester gift vouchers is Kenny Mackenzie who improvised an unusual attachment for drilling on his Myford lathe.

I was rummaging through my bits and pieces and found an old Black & Decker diy/hobbyist drill press. I attached a 1 metre piece of M12 screwed/threaded rod through the column to a piece of flat plate, drilled then cut to fit under the lathe ways, retained by nuts top and bottom.

This assembly now resembles the Amolco mill suitable for the Myford.

I was further lucky to find a suitable fitting normally used to fix the handlebars onto the stem of a mountain bike, this then enabled me to use the assembly horizontally and vertically, the small bolt through the fitting is just used to enable me to quickly find the bolt to convert from vertical to horizontal working when needed. The assembly can be rotated 360 degrees around its column both vertically and in horizontal use.



We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'.

Email your workshop tips to neil.wyatt@mytimemedia.com marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 400 words and a picture or drawing. Don't forget to include your address! Every month I'll chose a selection for publication and the one chosen as Tip of the Month will win £30 in gift vouchers from Chester Machine Tools. Visit www.chesterhobbystore.com to plan how to spend yours!

Please note that the first prize of Chester Vouchers is only available to UK readers. You can make multiple entries, but we reserve the right not to award repeat prizes to the same person in order to encourage new entrants. All prizes are at the discretion of the Editor.

Looking after your Myford Super 7

Eric Clark offers sound advice to owners of the 'classic' model engineering lathe, still much lauded sixty-seven years after it was first introduced - Part 2

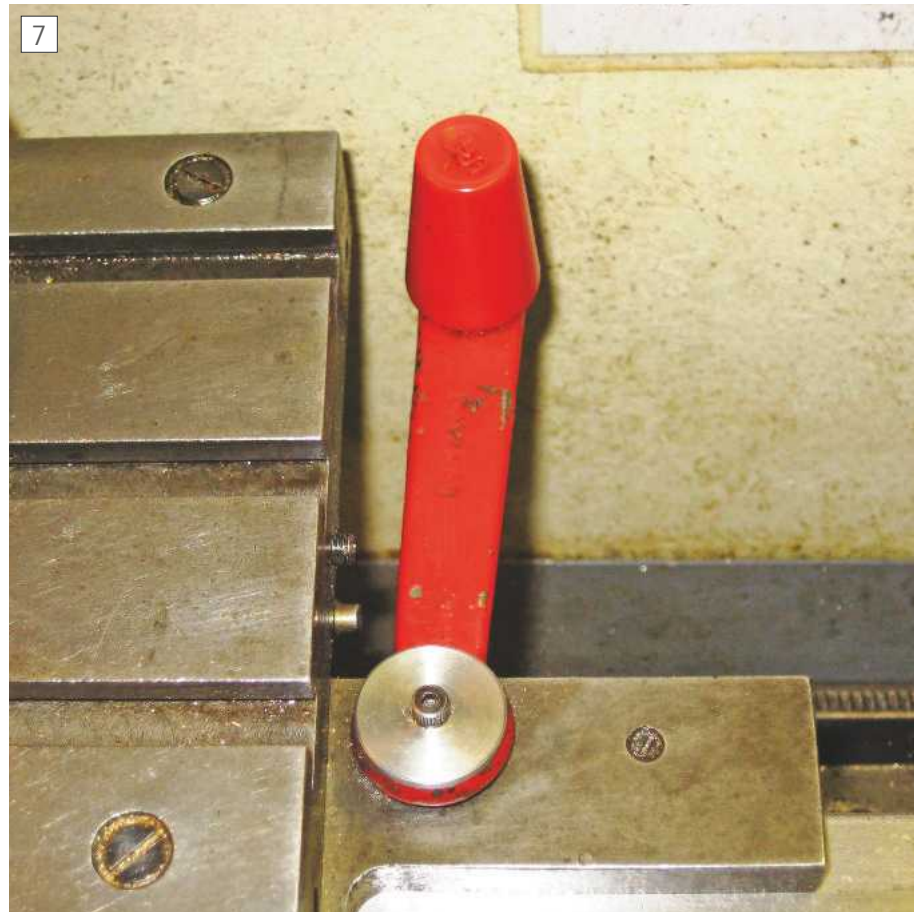
Make a tell-tale handle for the saddle lock.

The standard Myford saddle lock is deployed turning a simple $\frac{5}{16}$ " BSF bolt head. This works OK but it gives no indication if the saddle lock is on or off. Operating the axial auto feed, or screw cutting by closing the half nuts can result in damage or excessive wear if this is done with the saddle lock accidentally engaged. To make it absolutely clear, at a glance, whether the lock is engaged or not I made a red painted handle from a single ended ring spanner which I believe started life as a bed key and finished with a red Sturmey-Archer knob from a Raleigh Chopper!

To secure this I had to replace the original Myford bolt which was hardened (presumably to prevent corner rounding with much use – same philosophy as bolts on the original Grey Fergusson tractor) with a standard high tensile bolt that I drilled and tapped 6BA for a securing screw. A suitably made washer completed the job. **Photograph 7** shows the handle in the off position – a clockwise turn puts the handle in the on position bringing it about 45° to the lathe bed **photo 8**.

Unfortunately no similar simple device can be used for the two cross side locks that are simply M5 x 20 socket screws (part number KA31) located in a very restricted location requiring the use of a suitable Allen key. Vigilance is required here!

Myford do not provide any form of lock for the top slide which is unfortunate as the top slide is rather flimsy and would greatly benefit from having a lock. **Photograph 9** shows a top slide lock that I made to George Thomas's design detailed in his very useful book *The Model Engineers Workshop Manual*. This should be one of the first turning projects for a new Myford owner. Its construction and fitting is straightforward but is outside the scope of this simple article.



Saddle lock in the off position

Tumbler reverse

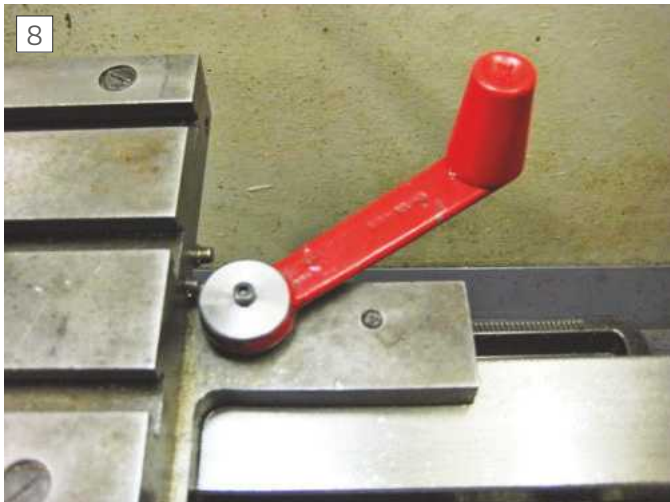
This is provided as a quick means of changing the rotation of the leadscrew to drive the direction of the lathe carriage. It is controlled by a lever that has three positions; the central neutral position disengages the drive to the leadscrew. It is best to leave the control lever in the neutral position unless the power traverse is in use. The lever also controls the direction of feed of the cross slide on models fitted with power cross feed. To make it easier to set the lever in the correct position for using the power cross feed, I bought a small sign from a fellow model engineer who had a few engraved a neat plastic data plate but

it is very easy to make yourself one and stick it next to the control lever, **photo 10**.

It is possible to engage both the carriage travel and the power cross feed together, but this has no practical purpose and I do not recommend it.

Always stop the lathe before engaging, disengaging or altering the position of the tumbler reverse lever. Not to do so risks breaking teeth off one of the Tufnol gears.

The two Tufnol tumbler gears (28 and 30 teeth) are specially designed to make the drive quieter and to fail as "weak links" in the event of a crash-up. They should never be replaced by metal gears.



Saddle lock on



Top slide lock

I have a spare pair of these gears in stock on the principle that if I have them, I will never need to use them.

Protecting the tailstock taper socket

The tailstock barrel has a number 2 Morse taper socket which can be easily damaged if drills, drill chuck, reamers or other accessories having damaged shanks are fitted. Even drills with good shanks can cause damage if they are allowed to lose their grip and rotate with the workpiece. This can suddenly happen when large drills are being used to produce deep holes. Used, worn, drills that have been re-sharpened will often drill a hole of slightly smaller diameter than the unused section of the flutes behind the tip area. When such a drill is used for making a deep hole, as soon as the slightly larger un-used section enters the hole the drill will "grab" and rotate with the workpiece and potentially damaging the tailstock socket. Even new drills can grab especially if being used on brass or bronze.

If drill shanks are allowed to rotate in the soft tailstock socket too frequently soon the socket may no longer be able to function properly due to scoring and other damage that reduces the area of contact between the socket and any shank fitted to it. So the problem gets progressively worse. Most second-hand lathes will be found to have damaged sockets.

Small amounts of damage can be removed using a No 2 Morse reamer, however this must be done very gently so as to not remove too much metal.

Prevention is better than cure. I have devised a simple way of preventing damage to the tailstock socket by tightly clamping a lathe carrier (as used in between centres work) onto

the drill shank and providing a metal "track" fitted to the lathe carriage for it to run along on as work progresses.

Photograph 11 shows the general set up and **photo 12** shows the individual components consisting of a piece of $\frac{3}{8}$ " x 1" steel strip about 5" long that fits snugly into the T slot of the carriage just in front of the top slide and a convenient sized carrier.

The problem is easily controlled on the earlier ML7 by using a suitable drawbar to secure the taper in the hollow tail stock barrel.

Electrics

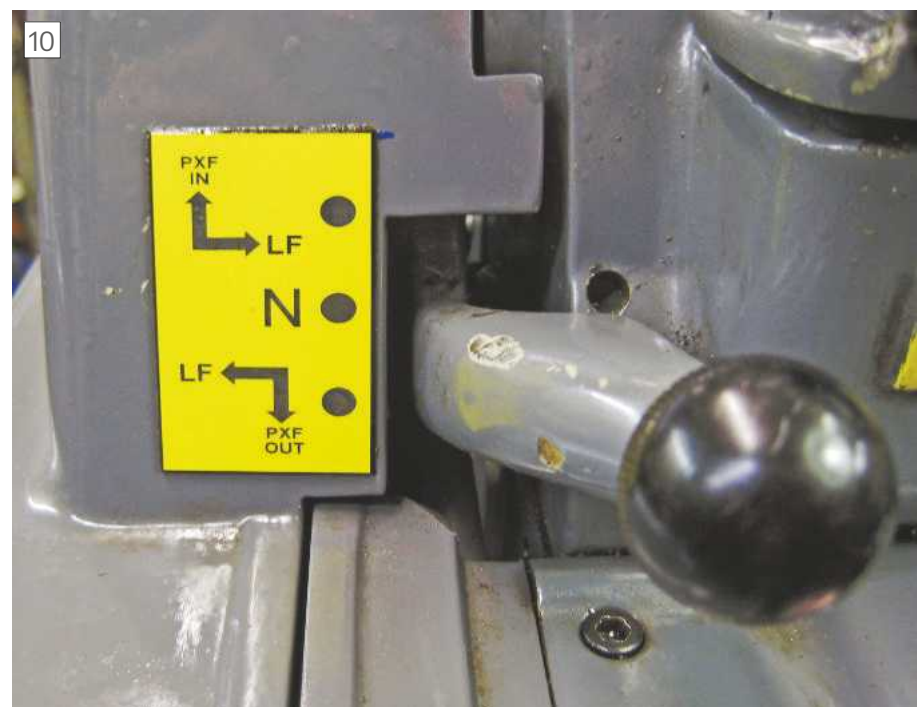
Any electric work should be carried out by someone who is competent to do, otherwise employ the services of a professional electrician. If you are able

to do such work, there are certain basic checks and simple action that can be safely undertaken whilst the machine is fully disconnected from the mains supply. Take particular care if dealing with a three phase supply that all phases are disconnected.

Initial safety checks

Before being tempted to turn on a second-hand machine for the first time check the following:

- That the cable, plugs, switches, earth bonding wiring, lights etc. are in good physical condition also checking for any loose connections.
- Check the earth continuity using a good quality multimeter (preferably a Megger) between the incoming earth wire and all parts of the machine.



Tumbler reverse label



Preventing damage to tailstock Morse taper

- If a resiliently mounted motor is fitted i.e. one mounted on rubber bushes in a cradle, ensure the actual motor body is bonded to the main machine (this is usually by a short rather than flexible wire).
- Ensure all covers to electrical terminals are securely in place e.g. on the motor, switchgear, junction boxes etc.
- Any deficiencies found must be corrected before attempting to use the machine.
- Check the condition of the drive belts and ensure the covers to belts and gears are in place and secured.

If all is well the machine can be tested. A common problem that develops with a used single phase motor is that it will not rotate when energised, instead it buzzes loudly, and the spindle vibrates. There are two common causes:

Faulty centrifugal switch

Single phase motors sometime have starting problems due to a faulty centrifugal switch (housed under the rear end cover) not working correctly. This switch is there to allow the separate start winding to be energised for a few seconds, just to get the motor running. Once up to speed the centrifugal switch opens and disconnects the start winding. A warning – the start winding will quickly burn out if it is left energised for too long.

It is difficult to check a centrifugal switch properly without dismantling the back end of the motor as it can only be heard to operate when the

motor is running down after switching off as it gives a distinctive click just before the motor comes to rest. However on start-up the switch cannot be heard to operate due to the much louder motor noise. So unfortunately this test only confirms that the switch is working properly and will not help with a dead motor. If the centrifugal switch is faulty then the motor must be dismantled to correct it.

Open frame motors are vulnerable to dust, swarf and general debris entering

the inside of the motor rear end causing sticking problems with the centrifugal switch contacts.

Faulty Dewhurst switch

In its day, the Dewhurst switch was a useful and very well constructed item and is still desirable today. It does not however comply with current legislation for new machines and it has some important limitations as it only offers start, stop, forward or reverse options. But you will probably ask what more is required?

At typical simple installation supplies mains power, either single or three phase, to the motor via the Dewhurst with probably a fuse rated high enough to withstand the heavy starting current as the only form of protection.

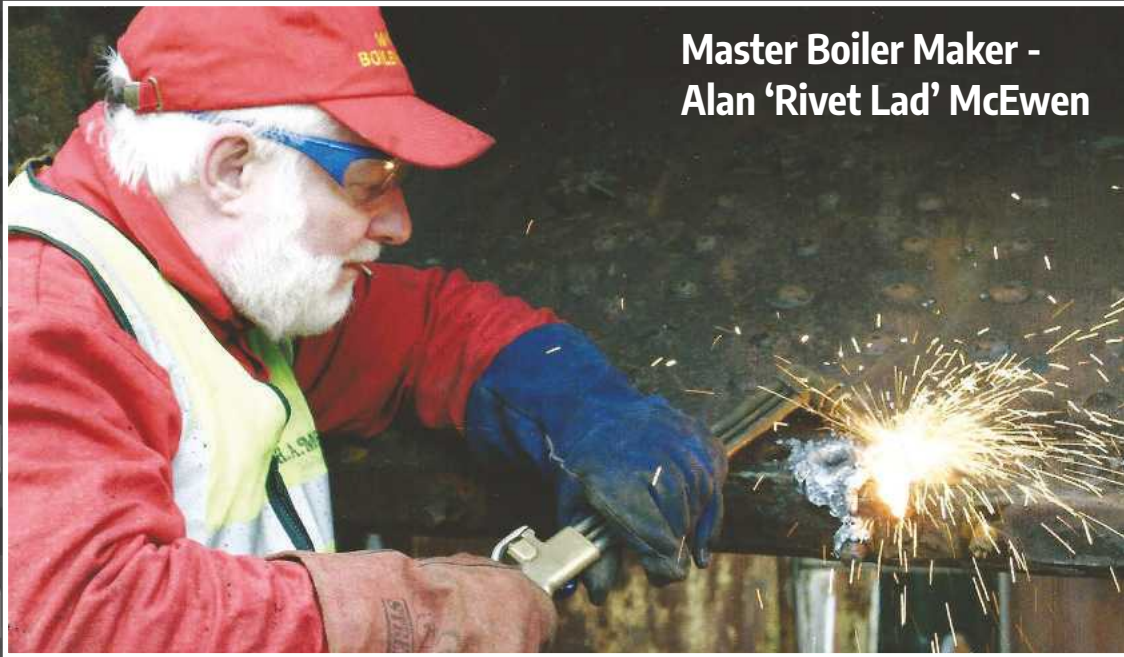
Fusing is of course essential, but it is designed to protect the wiring in the event of a dead short or other major short circuit and will not protect the motor in other circumstances that could cause it to burn out. Any fuse, even a slow blow or anti-surge type, will have to have a high enough rating to withstand the high starting current and will therefore continually allow a current to pass that is sufficiently high to burn out the motor.

●To be continued



Lathe dog and steel bar to prevent rotation

Bringing British industrial history to life

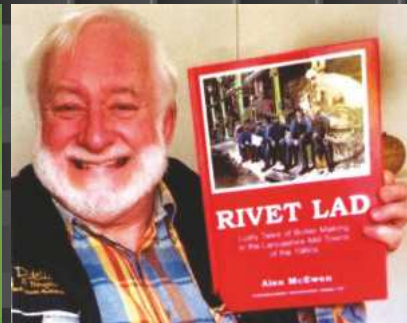
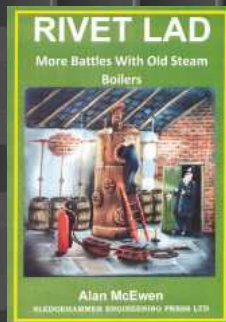


Master Boiler Maker -
Alan 'Rivet Lad' McEwen

When Master Boiler Maker and author, Alan McEwen was a young sprog, he loved banging and hammering on rusty old boilers; now that he is an old hog, he just prefers others to bang and hammer!

Alan McEwen's Boiler Making adventures and also 'potted histories'

of several Lancashire and Yorkshire Boiler Making firms, can be read in **RIVET LAD - Lusty Tales of Boiler Making in the Lancashire Mill Towns of the 1960s**. The book is crammed with 'hands on' technical information of how Lancashire, Locomotive, Economic, and Cochran Vertical boilers were repaired over 50 years ago. The book's larger-than-life characters, the hard as nails, ale-sipping, chain-smoking Boiler Makers: Carrot Cramphorn, Reuben 'Iron Man' Ramsbottom, Teddy Tulip, genial Irishman Paddy O'Boyle, and not least Alan himself, are, to a man, throw-backs to times gone by when British industry was the envy of the world.



Alan McEwen's first RIVET LAD book: **RIVET LAD - Lusty Tales of Boiler Making in the Lancashire Mill Towns of the Sixties** published September 2017 is now priced at £25 plus £3.00 postage and packing to UK addresses.

Alan's second RIVET LAD book: **RIVET LAD - More Battles With Old Steam Boilers** was published in September 2018. Now priced at £25 including postage and packing to UK addresses.

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■ Myford shallow drip tray for ML7/ML7R. Grey Hammerite finish, with drain plug. NB there is a surface rust patch about 3 x 2 inches on one end. £25 plus postage, or buyer collects from mid Bedfordshire.

T. 01462 701055 Biggleswade.

■ Centec 2 Milling machine, screw feed table lift mod fitted. Loads of tooling included, cutters, arbors, boring head, two vices etc. Just totally reconditioned, not just a paint job. Single phase ready to use. Price £700. **T. 01423 780359. Nr Harrogate, N. Yorks.**

Models

■ American locomotive, £5,750. A John Clarke designed 5" gauge 4 4 0. It has a new GB boiler with shell test certificate. Completed and track tested last year and

fully working. Water feed is 2 crosshead pumps, injector and emergency hand pump. Oil feed by pump. Superheaters and steam brakes. Pictures if required.

T. 017844 56938. Staines upon Thames.

Parts and Materials

■ Dart 7 1/4" machined parts, including cylinders, pistons, valves, valve chest, eccentrics and frame parts. No crankshaft, no wheels. Parts have been

in loft for 35 years; surface rust on some parts. Photos available. Offers.

T. 01631 770255. Oban.

Wanted

■ Myford ML7 or Super 7 lathe with accessories. Retired toolmaker. **T. 01943 877455. Ilkey. West Yorkshire.**

■ Set of change wheels for a Murad Cadet lathe. 1/4" pitch, 3.8" thick, 3/4" bore. Also 4 jaw chuck, thread 1 7/7" x 8TPI for above.

T. 01227 272039. Whitstable.

■ Pre used copy of John Wildings book, 'Clock construction and the Rehousing of Discarded Movements', I am hoping to build a Skeleton Clock out of one of the now defunct pigeon Timer Clocks I have. **T. 01298 85456. Buxton.**



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BEGINNERS WORKSHOP

These articles by Geometer (Ian Bradley) were written about half a century ago. While they contain much good advice, they also contain references to things that are out of date or describe practices or materials that we would not use today either because much better ways are available or for safety reasons. These articles are offered for their historic interest and because they may inspire more modern approaches as well as reminding us how our hobby was practiced in the past.

Marking centres, squares and hexagons

by GEOMETER

HERE ARE THREE methods employed for the essential work of finding the centres of shafts or discs without setting them up in a lathe: 1, by the centre head of a combination square; 2, by jenny calipers-also called odd-leg or hermaphrodite calipers and 3, by surface gauge and vee blocks on a surface plate.

The first two are hand methods while the third is a shop or toolroom method. The use of a bell centre punch (a metal cone with a punch in the centre, placed on the shaft and struck with a hammer), which is a fourth way, is neither so universal nor so accurate as the others.

Hand methods

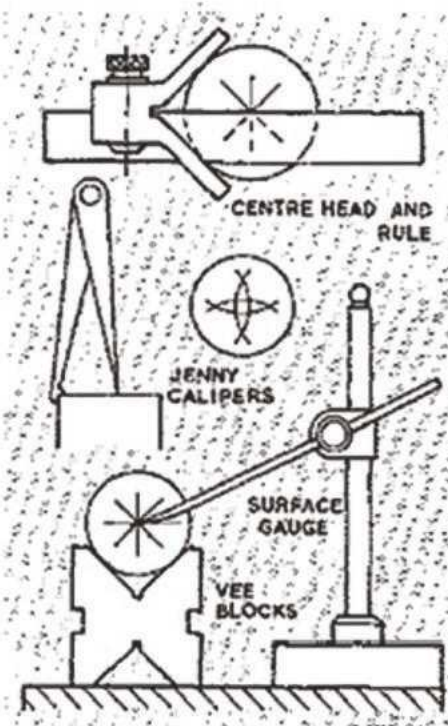
The centre head has two arms disposed at right-angles and the blade of the square, or rule, fits in centrally and is clamped by means of a groove. The edge of the blade passes centrally across the shaft. Thus, the tool has only to be held firmly and moved round the shaft for several intersecting lines to be scribed.

Jenny calipers have a leg with a scriber point and the other with a small step to rest on the edge of the shaft. The leg with the step is held firmly at one spot while the scriber leg is swung in an arc slightly beyond the actual centre of the shaft. This being done at four positions round the circumference, a tiny square is formed in the centre of which the centre punch dot can be placed.

Surface gauge method

The surface gauge and vee blocks, normally used on a surface plate, can be employed on any flat surface like the bed of a machine. The shaft is rotated in the vee blocks for several lines to be scribed horizontally. These need not pass across the centre. If the scriber pointer is a little above or below, a small boxed in area is formed--centrally in which lies the shaft centre.

The following method is as good as any. Scribe a horizontal line, turn the shaft through 180 deg. (approx.), scribe a second line; turn the shaft



A number of methods of marking on metals. The details are explained in the text

through 90 deg. (approx.), scribe a third line, turn the shaft through 180 deg. (approx.), scribe a fourth line.

To mark a square or hexagon on a shaft, using vee blocks and surface gauge, its centre should first be found, lightly centrepunched and a horizontal line scribed through it. In marking a square, an engineer's square is employed for the vertical centre line; for a hexagon, a 60 deg. square or a combination square is used--first one way, then reversed, so producing two sloping lines.

In this and subsequent work, vee blocks having horizontal grooves are advantageous, taking clamps to hold the shaft firmly.

Marking the flats

To mark the flats, it is necessary to know the height H for the scriber pointer to be set above or below centre.

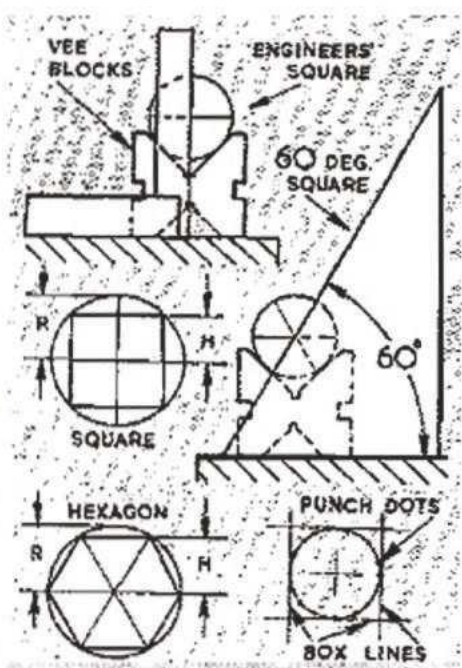
This is calculated from the diameter of the shaft and its radius R . For a square, R is multiplied by 0.707, for a hexagon by 0.866.

This dimension H is obtained on an engineer's steel rule with dividers. Then one leg of the dividers is placed in the shaft centre, and highest and lowest positions marked to one or other of which the surface gauge pointer is adjusted.

In marking, a line is carried across the end of the shaft and along the side(s) as required. Then the shaft is unclamped, and for a square turned through 90 deg., as checked by the engineer's square, re-clamped, and another flat and side line scribed--this being done for all four. For a hexagon, the procedure is similar, but either the engineer's square or the 60 deg. square can be used for the settings.

At the finish, the side lines act as guides when filing the square or hexagon in the vice.

Castings and parts can be marked off with the surface gauge, finding the centres, boxing them in with or scribing circles with dividers, then placing centre punch dots for reference when the holes are bored. @



A Wind-Powered Scarecrow



Tony Jeffree describes a light-hearted project that involved some improvisational engineering.

It has been a long while since my last contribution to this august publication; in April 2014 we upped sticks and moved from the suburbs of Manchester to a remote and windy location on the Isle of Mull, and my workshop still hasn't fully recovered from the upheaval. I do have my ML7 back in action, at least in manual form, so that is a step in the right direction; hopefully, normal service will be resumed before too long, but I said that 5 years ago and there's still a way to go. On the positive side, I do have a usable and large shed that has been pressed into service for some woodworking projects, and more recently, to construct this project. I must admit, it isn't exactly normal fare for MEW, but it has its amusing engineering aspects, and the end result has been entertaining, not only for me but also for the many visitors to the island that pass by on their travels.

The origin of the project lies in the annual Ross of Mull Gala Fortnight, which was revived a few years ago; the general idea is that the two weeks leading up to the annual Bunessan agricultural show are packed with interesting and varied activities in the local area, and the culmination of the Gala fortnight is the Bunessan show itself and the dance/ceilidh in the evening. One of the Gala events is a scarecrow trail that extends the full length of the Ross of Mull – a distance of around 20 miles and takes in 3 village communities and various scattered hamlets. The creativity involved in the many and varied creations is fantastic, and new ideas seem to pop up every year. We have entered into the spirit of the competition since it started; last year, Nessie was to be seen peering at the passers by from our pond, and in a previous year we had a huge 6-foot



A nasty case of glue gear.

diameter spider crawling up the fence. All great fun, but of course, with every year, the stakes get higher, and the inventions need to keep pace with the ever-increasing quality of entry.

A skeleton of an idea

This year I decided that I wanted to create something that moved – not just a static display, but something that

had some kind of animation, and as the west coast of Scotland is notoriously windy, using wind power to drive the animation seemed like the simplest way to go. Wind power implies using some kind of wind turbine; it seemed to me that the simplest starting point would be to turn a bicycle wheel into the turbine by adding blades to the wheel. The idea developed from there – why

not turn both wheels of the bicycle into turbines, so the bicycle would appear to be riding all by itself? The chain drive could be employed to allow the rear wheel to drive the pedals, which would be visually even more appealing. Of course, having created a bike that pedals all by itself, why not seat a figure on the bike to make it look as if the figure is actually doing the pedalling? This was beginning to sound like a plan. The final stroke of creativity was to use a skeleton as the figure on the bike. Probably best not to use a real skeleton, as that might lead to awkward questions from the local “plod”, but I felt sure that I could find a suitable plastic one. It turns out that for not very much at all, you can buy a plastic skeleton of approximately adult human size on Ebay (other on-line sellers are available!), and one duly arrived in our mailbox a few days later. For a while, he sat at the head of our dining table while I figured out the other details of how it was all going to work but looking at the way the skeleton was made and articulated, it was clear from the outset that there would be some re-engineering needed to make the skeleton work nicely as an impromptu cyclist. But more of that later. The other major ingredient for the project was a suitable bicycle; an advert on our local “buy and sell” page almost immediately resulted in the offer of a rather sad looking mountain bike. Its chain was in very poor condition (rectified for a fiver) and the Shimano gear changers were shot, but apart from that, the major components that I needed were in good condition.

Modifications to the bike

There were plenty of components that were not needed for this project – I didn’t plan to change gears, so the front and rear Shimano gear changers were



Wheel with 9 vanes.



Attachment of outer end.

removed (although the rear one was re-fitted later), and the front and rear brakes, reflectors, drinks bottle mount, and so on were unceremoniously unscrewed and/or attacked with an angle grinder. One of the pedals had badly rusted bearings, and this had to be dismantled and cleaned to get it running freely. The steering needed to be locked solid for my purposes, and this was achieved by the simple expedient of tightening up the steering head’s

bearing adjuster so the bearing simply wouldn’t turn any more. The final mod to the bike was to fix the rear sprocket cluster – the idea was that the rear turbine would drive the pedals, so the operation of the free wheel would have prevented this from working. My initial attempt at fixing the gears was to loop cable ties through holes in the largest sprocket and around the spokes, but this proved to be too fragile, and the problem was finally fixed with liberal application of hot melt glue between the hub and the largest sprocket, **photo 1**. Initially, my assumption was that the rear gear changer would merely add

frictional drag and would therefore best be removed, so I shortened the replacement chain so that it was just long enough to go round the smallest rear sprocket and the largest chainwheel – this gave the best ratio for the wheel driving the pedals.

The turbines

Turning bicycle wheels into crude turbines is a simple matter. Looking at the way the spokes are arranged, there are 36 spokes on a standard wheel, with a repeated pattern every 4 spokes, so using 3, 6, or 9 turbine blades sounded like the right way to go. The blades themselves are rectangular strips of thin aluminium sheet, 60mm X 240mm, which are attached to the spokes using cable ties – one tie in the centre of the short edge at the wheel rim, two ties at the hub end of each of the long sides. The end result on the front wheel is shown in **photo 2**, and the fixing arrangement at either end of the blade can be seen in **photos 3** and **4**. Initially, I only fitted 3 blades to the wheels, but soon found that there wasn’t enough “oomph” to get the wheel spinning in a gentle breeze, so I decided that 9 blades was the right number. **Photograph 5**



Fixings at hub end.

shows the rear wheel with blades in place. The single fixing at the rim end allows the blade to be twisted to give an appropriate pitch, once the hub ends of the blades are attached to the right spokes. It is easier to see from the photos how this works than to attempt to explain it in words!

Pivoting the bike

It will be obvious from the design of the turbines that they both need to face into the wind in order for them to work correctly, so the bike needs to run at 90 degrees to the direction of the wind for this to work. This implies two things; firstly, the bike needs to be free to rotate to follow the wind direction, and secondly, it needs a "sail" of some kind to keep the turbines facing into the wind. The sail obviously needs to stick out of the side of the bike for this all to work; with the particular handedness I chose for the turbine blades, the sail has to stick out of the left-hand-side of the bike.

I thought long and hard about how to pivot the bike. The requirement is that the bike should be free to turn, and



Rear wheel with vanes.

ideally the pivot point should be roughly mid-way between the two turbines. My initial thoughts were to use ball bearing races, and I ordered some roller skate bearings from Amazon to play around with, but I rapidly concluded that it was worth trying the simplest possible approach – stick the bike on a unipivot. If it didn't work, I could always overcomplicate things later.

A rummage through my stock rack came up with a suitable length of 12mm

steel rod to make the pivot; a quick bit of turning and polishing in the lathe produced a smooth rounded end to act as the thrust bearing surface, and the rod was in turn mounted in the end of a spare 4" X 4" X 5' timber fence post by drilling it axially to the depth of the spade drill bit I had to hand – about 5" deep I would guess. The fence post was temporarily driven into the ground near the shed for testing purposes and the rod fitted into it, making sure all was nicely vertical. Mounting the bike on the pivot was very simple, as can be seen in **photo 6**; I worked out where the balance point of the bike was by



Simple pivot.

lifting the bike by the top tube, marked the top tube at the balance point, and dropped a vertical to the bottom tube. A few minutes work with one of those nice conical drills and I had holes top and bottom of the bottom tube that allowed the pivot rod a good clearance fit, and a clearance hole through the underside of the top tube. Mounting the bike on the pivot, suitably greased, showed that this arrangement was going to work well – very little force was needed to cause the bike to rotate, and it was held nicely in a running position.

The sail

As mentioned earlier, the bike needs a sail to keep its turbines facing into the wind. This seemed like a tricky problem – how to make a sail that was large enough and light enough to be mounted



7

MK.1 sail.

on the bike - and the initial solution was more complex and ultimately much less satisfactory than it needed to be, **photo 7**. We had some collapsible "tent poles" that were surplus to requirements - basically, several sections of carbon fibre tube held end to end with ferrules and bungee cord down the middle - and I pressed some of these into service for Sail Mk 1. The tent poles were formed into a rough open-ended triangle and attached to the seat post of the bike using U-bolts and hose clips (the remnants of this fixing arrangement can be seen in **photo 8**) and covered in thick polyethene sheet. The sheet was folded over at the edges, sewn in place with copper wire, and further sealed with hot melt glue and duct tape. The tent poles were a bit too flexible, and the sail had a tendency to twist so it was not vertical, so a bamboo cane was added, attached below the bottom mounting at the seat post and at the top outer corner of the sail, to counter the twist (this can just about be seen in photo 7). With a sail in place, I could test that the bike



Attachment point.

tape broke it clean off at the mounting points, so Sail Mk 2 came into being. By this time, knowing that the demise of Sail Mk 1 was only a matter of time, I had already planned how Mk 2 would work, so it was a matter of a couple of hours to bring it to fruition. The finished sail is shown in **photo 9**; it was fashioned from a length of 25mm diameter electrical conduit pipe and a triangle of aluminium. The triangle is fitted into a slot in the end of the pipe, fixed with more hot-melt glue and M5 bolts. The bike end has a length of M10 threaded rod fitted, held in place with yet more hot melt glue, with a Jubilee clip added to crimp the tube firmly onto the glue bung after it had cooled and set. The free end of the M10 rod fits through a hole drilled all the way through the top tube of the frame just next to the pivot, and held with M10 nuts; the detail of this can be seen in **photo 10**.

Skeleton engineering

The plastic skeleton is a pretty crude thing, made from thin hollow plastic mouldings, and the articulation of the shoulder, elbow, hip, knee, and ankle joints relied on lengths of thick galvanised iron wire shoved unceremoniously through the various bones. In order to get the cycling motion to look at all realistic, I needed the hip and knee joints to work nicely, and the remaining joints would need to be fused solid so that the skeleton would sit nicely and not flap around in the breeze. The hip and knee joints would also need to stand up to lots of use as the finished scarecrow would be in place for many weeks. So, the first stage was to re-engineer his hips and knees. On a visit to B&Q while travelling on the mainland, I acquired some M6 threaded rod and plenty of matching washers and Nylock nuts, plus a couple of lengths of light steel tubing that was a good clearance fit for the threaded rod.



MK. 2 sail.

did actually work, and you can see this stage of the construction in a YouTube video at: tinyurl.com/18tz2x9x. You can see in the video that there is a length of bamboo cane protruding from the bicycle seat; this actually protrudes down through the seat and into the seat

tube and is used as an anchor for the skeleton.

The Mk 1 sail lasted for a few months - from the end of June to the end of September 2019 - before the relentless battering of the elements and the deterioration of the glue on the duct



More elegant attachment for the MK. 2 sail.



Hip replacement?

12



The leg bone's connected to the thigh bone...

The hip joints were dealt with first; I drilled through the pelvis, from one hip socket to the other, using a drill slightly larger than the OD of the steel tubing, and fixed a length of tubing through these holes with hot melt glue. This tube was long enough that it protruded a good 60-70mm beyond the rather narrow pelvis of the skeleton, so that the legs, when fitted, would drop nicely perpendicular to the pedals. I reinforced the joint between the tube and the skeleton with washers that fitted over the steel tube. A length of the threaded rod was fitted through the pelvis to check everything was straight and level. Two shorter lengths of the tubing were inserted through the heads of the two femurs, again fixed in place with hot melt glue and reinforced with large washers. Care was taken at this stage to ensure that the angle of the short tubes was such that the femur could hang vertically when fitted onto the threaded rod. The threaded rod was then cut to length, and the hip joints assembled, as can be seen in **photo 11**. I used an M6 washer between the nuts and the leg tubes, and 2 washers between the leg tubes and the pelvis tube. The Nylock nuts were tightened so that there was plenty of play between the leg tubes and the pelvis tube, to ensure that the joints would move freely.

The knee joints used a similar strategy – short lengths of tube through the top of the tibia and through the bottom end of the femur, with washers to separate the tubes and a length of threaded rod through all three tubes. In this case, I didn't bother with nuts to hold the rod in position, just lots of hot melt glue. As before, attention was paid to the alignment of the bones so that the lower leg and foot would fall nicely onto the pedal. The result can be seen in **photo 12**.

Mounting the skeleton

At this point, the skeleton was ready

13



Seating arrangements.

to be mounted onto the bike and fixed in its final riding position. One of the problems with using a scrap bike for this project appeared at this point – the skeleton's stature was a little bit too short for him to both sit nicely on the saddle and also have his feet on the pedals, and corrosion between the seat post and the down tube of the frame meant that adjustment of the saddle height wasn't an option. So, the skeleton was modified slightly by removing part of its coccyx, which allowed it to "sit" on the very tip of the saddle.

The bamboo cane through the saddle served as an anchoring point; a length of nylon cord round the end of the cane and around the backbone, plus more

14



Right hand...

cord through the pelvis and around the back of the seat locked the skeleton in this rather uncomfortable position, **photo 13**. More hot melt glue fused the shoulder and elbow joints, and more cord attached the hands to the handlebars, **photos 14** and **15**.

Finally, the ankle joints were fused so that the lower leg bones were perpendicular to the feet, and the feet attached to the pedals with string and glue, **photo 16**.

A touch of oil on the various moving joints, and the whole contraption mounted in its final position next to the road, and the scarecrow took its first flight, see photo 17 and also a YouTube video clip at tinyurl.com/277o38sz.

15



...left hand.



Teething troubles

One source of irritation with the way that this contraption works has been getting the chain drive to work reliably. As can be seen in the second video, the chain isn't quite tight; the frame was designed for use with a derailleur gear change unit, so any slack in the chain would normally be taken up by that, and the rear forks provide no adjustment for chain tension. As a consequence, I found that one of two things happened on a regular basis; either the chain would change up to the next largest sprocket on the rear cluster, and then be too tight for the wheel to rotate, or the chain would come off altogether and jam up. Most of the time this wasn't a problem, but in high winds, the flapping up and down of the chain was sufficient to encourage misbehaviour. Close examination of what was going on led me to conclude that there was poor alignment between the smallest sprocket and the largest chainwheel, so the solution seemed to be to re-instate the rear derailleur unit so that it could guide the chain properly onto the sprocket.

I tried re-fitting the derailleur in a relatively normal configuration – with the chain passing around the two idler sprockets on the unit – but the friction generated by this combination was just too great for the mechanism to work properly. A partial solution was to remove one of the idler wheels altogether and just use the one remaining idler; this reduced the frictional load considerably, but the force of the return spring on the derailleur unit was sufficient for the idler still to cause too much drag. A crude, but effective, solution to this was to attach a second spring between the derailleur and the rear fork to reduce the tension provided by the derailleur – see **photo 17**. As can be seen in the photo, the short chain means that the Shimano unit is in a rather unconventional position now, but



Derailleur as chain tensioner.

the main thing is that it seems to work – I have had no further problems with the chain since making this change, which was about a month ago at the time of writing. The final state of the scarecrow (at least until something else breaks!) can be seen in **photo 18** and in the Youtube video at tinyurl.com/g76fhxh8.

All in all, it has been a very satisfying

project, although maybe not the usual fare for MEW. It has been a definite “hit” as far as visitors to the island are concerned; we get large numbers of coaches and cars full of visitors passing us, and we regularly spot them stopping so their passengers can take photos of the unusual “wildlife”. Of course, now I need to start thinking about what I will build for next year! ■



Beware the Ghost Rider!

Scribe a line

Continued from page 29

Investment Casting

Dear Neil, I found your article on investment castings from 3D prints very interesting - especially since I have been walking the same path and recently finished a long article touching on the same subject. It actually started out as an article about lost wax casting which I have been doing as a sculptor for years and was published in Home Shop Machinist magazine last year (four issues - May to Dec).

Like you, my approach was to simplify the process to show how it can be done with minimal equipment, so that a worker can get started without a lot of expenditure.

In the sculpture field, we made much larger castings than would be practical for 3D printing. We used a home made investment mix and lost wax instead of lost plastic, but the process is basically the same.

For an investment mix, we used grog (brick dust - which is surprisingly expensive) or very fine sand as refractory material with plaster as a binder (mixed about 2/3 to 1/3). Plaster alone is not really suitable for larger castings (by "larger", I mean about the size of a full size bust) because it is prone to cracking. After the first few casts we would crush the burnt out investment into a very fine powder and use that as the refractory part of the mix (very cheap!). We would also line the inside of the investment mold with a ring of chicken wire as a reinforcement and bury the mold in sand as protection in case the mold split open while casting.

One thing we have found absolutely crucial is venting. You touched on this in your article but for pieces that are larger than the sprues and runners that feed them it is critical. Air cannot be expected to vent out of the same runner that metal is flowing down and separate vents must be provided everywhere. Not doing so will result in gas pockets in the casting, and in my experience, this is the single most common cause of failed castings.

Burnout was always the most critical part of the process and took place in a dedicated furnace. Most of my fellow sculptors used an electric ceramics kiln as a furnace but I could not make such an expensive piece of equipment a prerequisite for a home shop worker so I designed a propane fired kiln using a trash bin lined with homemade refractory and fired with repurposed Bar-B-Que burners. The refractory mix was 4 or 5 parts perlite

mixed with 1 part clay (recipe from Mike Cox's website) and the resulting furnace proved reliable, efficient and safe. It could also melt both aluminum and bronze if the gas pressure was boosted to about 2 psi. It could hold a #8 crucible which is 8 lbs of aluminum or 24 lbs of bronze.

Although most sculptors use an excessively long and slow burnout schedule, we found that usually considerable heat could be applied fairly quickly. The refractory is sufficiently porous that cracking due to steam pressure is not actually a problem and the temperature in the mold interior will self-limit until all the free water is evaporated. Getting rid of the bound water is, of course, more difficult, but must be done. The technical literature recommends holding the mold at 800°F for at least 2 to 3 hours but also cautions that temperatures above 1300° will cause the plaster to deteriorate and weaken, which is not a good thing to have happen to a container you are about to fill with molten metal.

It is difficult to determine when the burnout is finished and most sculptors rely on smell as much as any measurement. The mold is taken to a dull red heat and held at that temperature if possible. A sulfur smell indicates that it is too hot and the plaster is starting to break down. A finished mold will smell "clean" like hot pottery and will look clean inside. Sometimes a bit of persistent grey ash can be tolerated but never any black residue.

We also found there was little to be gained by trying to keep the mold hot for pouring. Bronze pours at 2200+ degrees and it would be almost impossible to maintain the mold at anything over 3 or 400 degrees. There is not enough difference in the metal/mold temperature differential (1800° for a "hot" mold, 2100° for an ambient temperature mold) to materially affect the pour.

Like you, we found that extracting the casting from the mold was not easy as it could not be dissolved, and the easiest way was to smash it off. There is one art foundry near here that uses a pressure washer but that is only practical for large items.

Congratulations on a timely and excellent article. I'm sure 3D to metal will be one of the "up and coming" trends in Model Engineering.

Ted Hansen, Canada

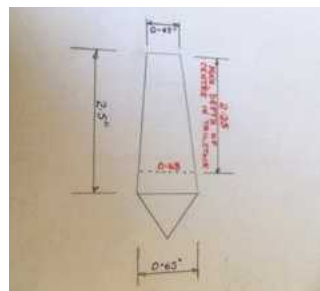
Strange Taper

Attached are a couple of photos. The lathe was originally my fathers and treadle operated, it is quite old. I am hopefully going to restore it properly. I have tried quite hard to identify it, there are no name plates etc. and I have drawn a blank.

I hope someone can help identify the taper. Thanks for any help you can give.

Dave Martin, by email

I think the taper may be a 'special' as it is roughly twice as steep as the usual Morse, Brown & Sharp and Jarno tapers. Can any readers help or shed light on his lathe? - Neil



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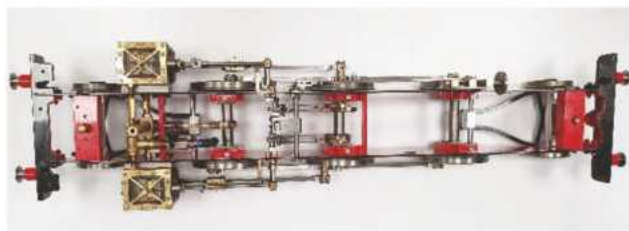
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