No.303

THE MAGAZINE FOR HOBBY ENGINEERS, MAKERS AND MODELLERS

MODEL ENGINEERS' WORKSHOP

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MAY 2021

ROTARY TABLE ISSUE

INSIDE

- Angle Grinder Improvements
- A Workholding Challenge
- Introducing the Lathe
- Mandrel Handle for a Warco Lathe
- Lantern Chuck Drawings
- 3D CAD and Print in action

And much more!

Adapting a rotary table for electronic indexing and hobbing

Fitting end stops to your Rotary Table

COVER STORY

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On the Editor's Bench

When Will Engineering Clubs Meet Again?

I've been scouring the internet for clear guidance of when hobby-related clubs may be able to meet again. There is lots of information for sports and leisure, but it sems the sort of activities that we enjoy don't fall under this classification of 'leisure'. As for 'community groups' it seems that 'support groups' can have meetings of up to fifteen people, but I can't find any clear rules or advice for typical hobby-based groups.

Numbers of people who can meet outdoors able to meet outside are still small. In Wales, for example, six people can meet from no more than two households, but in England six people from different places can meet, which might allow the resumption of some small scale activities – such as essential maintenance on club facilities to prepare for re-opening. Please do check your local rules, as things are changing all the time, even if only in small steps.

But although it seems that the vaccination programme (I had my first jab in early March) is starting to have a significant effect across the UK, I'm afraid it does seem a long haul before we can expect to be meeting in large groups. Let's hope it's before the end of the summer!

A New Workshop in Sight

My move has happened, but it seems there are things like a new kitchen and bathroom to contemplate before I can start on a new workshop. That doesn't stop me from making plans, I have an unheated garage about fourteen by seventeen feet to work with. That's bigger than my old workshop that was eight by sixteen, even though I have to keep some storage space for my dad's collection of large model warships! The photo shows my father testing out the hull of his 1:48 Warspite.

At the moment, my thought is to divide the space in two to give a heated workshop on one side and storage on the other. That would give me the maximum amount of wall along which I could place benches, storage and machinery and limit the amount of space that needs to be kept warm in winter. The first job will be some roof repairs, followed by dry lining. I will also need to arrange a higher capacity electricity supply to allow things like welding, and no doubt a hundred and one other little jobs along the way. One thing for sure, this time I will go for a painted or vinyl floor, not carpet!


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20 Fitting Stops to a Rotary Table
For working with accurate angles these adjustable stops from Keith Beaumont are a great accessory for a rotary table.

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Eric Clark concludes his useful advice to owners of these popular machines.

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David Rendle has designed a neat solution for manually turning a Warco WM250V that can be adapted for other similar lathes.

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Roger Vane continues his detailed description of an electronic edge finder, with instructions so you can make your own.

50 3D CAD and 3D Printing Helps Fix a Car
David Jupp uses Alibre Design and his 3D printer to create some jigs to help with cleaning his cars injectors.

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Geometer gives advice on the selection and use of files in the hobby engineering workshop.

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A beginner's guide to the most essential of tools in the precision metalworking workshop.

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Des Bromilow had to figure out how to hold an unusually shaped casting as part of a vintage motorcycle restoration.

See page 48 for details.

Coming up...

in our next issue

In our next issue we feature a clutch for an Emco Lathe from Graham Meek, as well as a depth stop for a Myford ML10 and a bandsaw blade repair jig – and much more besides!.

Regulars

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A bumper selection of readers sale and wanted ads.

ON THE COVER

This month's issue features three complementary articles on the subject of rotary tables. Our cover shows Pete Worden's 'Concentrica' tool being used with a dial indicator to centre a rotary table on his milling machine.

HOME FEATURES WORKSHOP EVENTS FORUMS ALBUMS

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THIS MONTH'S BONUS CONTENT

Log on to the website for extra 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.

LED Tubes in the workshop
Share your experiences of replacing fluorescent tubes with LED lighting.

Source of 2 inch balls for water pump
Some interesting suggestions for replacing wooden balls in a vintage pump.

Photogrammetry
Bearing in kind David Jupp's article this month, it's interesting to speculate how 3D scanning and photogrammetry might aid our hobby in the future?

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.

CLASSIFIEDS EXTRA SUBSCRIBE ARCHIVE SUPPLIERS

A Stepper Driven Rotary Table With Hobbing Capability

Joseph Noci describes another beautifully executed project.

I have never had the need to cut gears in any of my projects and my Emco rotary table in manual guise has always served me well. However, after an exercise developing an ELS system for lathes, together with a few MEW forum members, one of said members 'conned' me into developing an electronic hobber, **photo 1**. I did not intend to build the mechanics for this, but as this development exercise was taking place between folk seperated by many thousands of kilometers, I did need some sort of test bed. So, my Emco rotary table was used to do the job. During the process I also made some chuck attachments to make it easier to align a workpiece for mimimum runout, and made the drive electronics do a whole lot more besides just hobbing.

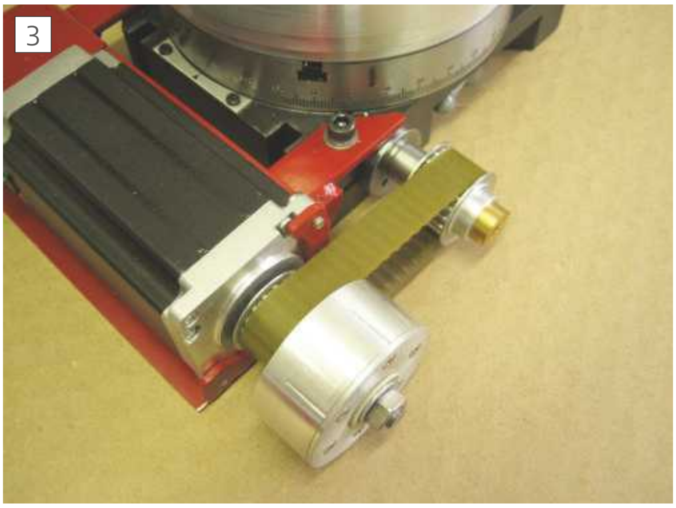
The stock rotary table was modified by fitting a drive pulley to the Worm shaft, and fitting a stepper motor with similar pulley and drive belt, **photo 2**.

1

Power supply upper left, controller lower left, Spindle encoder, for hobbing, lower right, and the rotary table.

2

Worm Shaft and Pully



Stepper motor with drive pulley, belt and Rattle Damper

The Rattle Damper construction.

In addition, a 'rattle damper' was fitted to the stepper drive shaft, to overcome lost steps during acceleration through the lower RPM settings. This is especially critical during hobbing, notably so when cutting low tooth count gears, coincident with keeping the spindle speed, or cutter RPM, as high as is required for correct cutting and good finish. The hobbing process is often interupted to check progress, clean the teeth, etc, and when the hobb is spun up again, the gear blank must keep pace, in sync with the gear pitch and hob speed. Since the hob is driven by a powerful spindle motor, it normally achieves terminal RPM quickly, in the order of hundreds of millisends at the most. This requires the stepper to accelerate fast and to maintain sync with the Hob, without losing steps on the way.

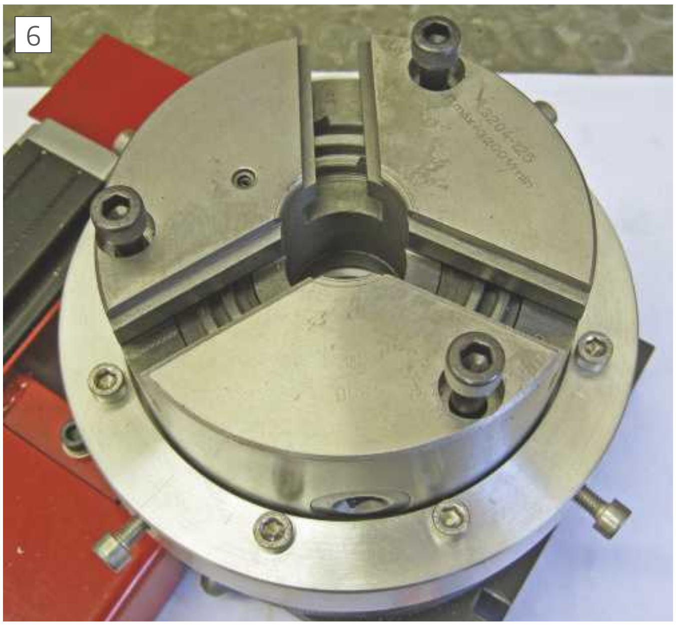
As an example – A 10 tooth Mod 0.8 gear being cut with a Hob spinning at 400rpm.

This gives a blank diameter of 8mm and a blank rpm of 40rpm

Assume a 40:1 worm ratio in the rotary table, and a 1:1 ratio between stepper and worm drive.

This gives a stepper rpm of 1600rpm - very high for a stepper, and it would need to accelerate from 0 to 1600rp,

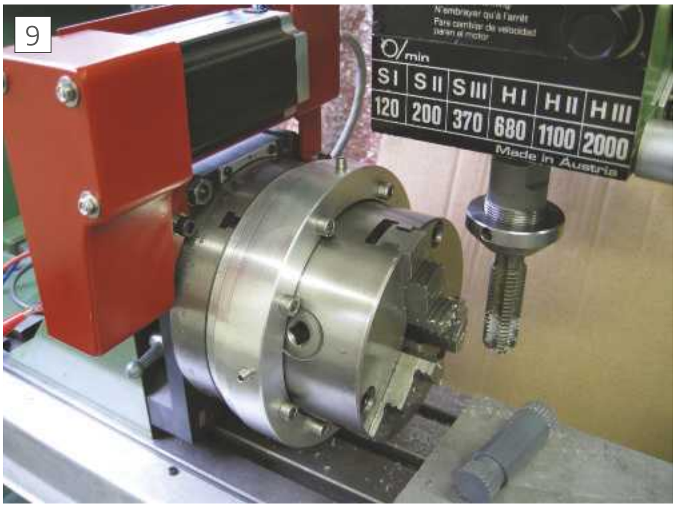
Disc and ring arrangment



Closer detail of ring, disc and chuck fitment

Optical encoder.

Encoder fitted for the job.



Rotary Table assembly fitted to milling table

Since the hob is driven by a powerful spindle motor, it normally achieves terminal RPM quickly, in the order of hundreds of millisends at the most.

Quick hobbing test, using a ¾ WW tap as hob!

A not too shabby 'gear'.

in the few 100 millisecinds that the hob takes to reach speed.

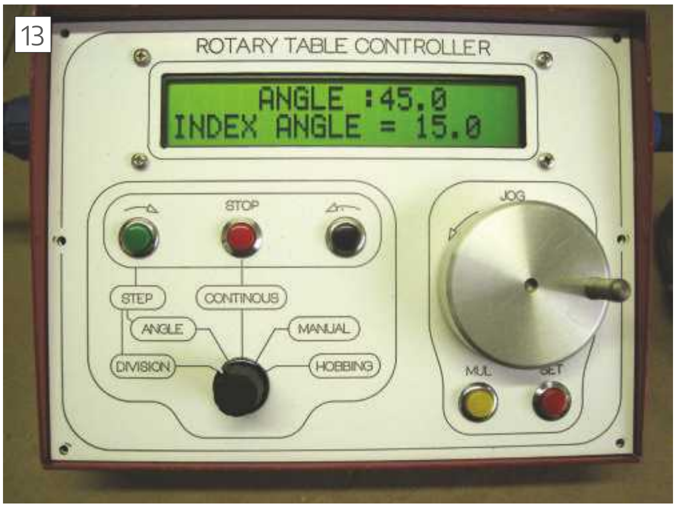
A further example - for a 50 tooth mod 0.8 gear, the blank is 40mm diameter and it spins at 8rpm for a Hob at 400rpm. In this case, for the same table and stepper gearing, the stepper spins at 320rpm - much easier to achieve.

The key with small diameter gears being cut is to drive the stepper with the highest voltage possible to achieve best acceleration and top end RPM, if pushing the Hob speeds up. The Rattle damper as fitted was the difference between the 10 tooth gear only being possible with the Hob running at 100rpm, versus the hob running at 500rpm with the damper, **photos 3** and **4**. A very worth while addition.

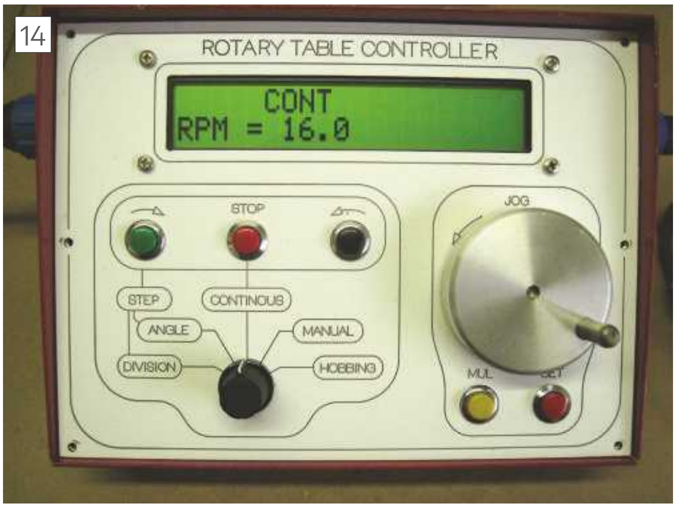
To complete the main mechanical construction, a sort of 'Set-Tru' arrangment was manufactured, permitting adjustment of the 3 jaw chuck on the rotary table in order to minimize runout of the in-jaw workpiece.

This consists of a disc bolted to the rotary table surface, onto which the chuck is bolted via chuck face-side bolts, and an outer ring then bolted to the periphery of the same disc, with hex screws through the ring periphery impinging on the chuck periphery, **photo 5**.

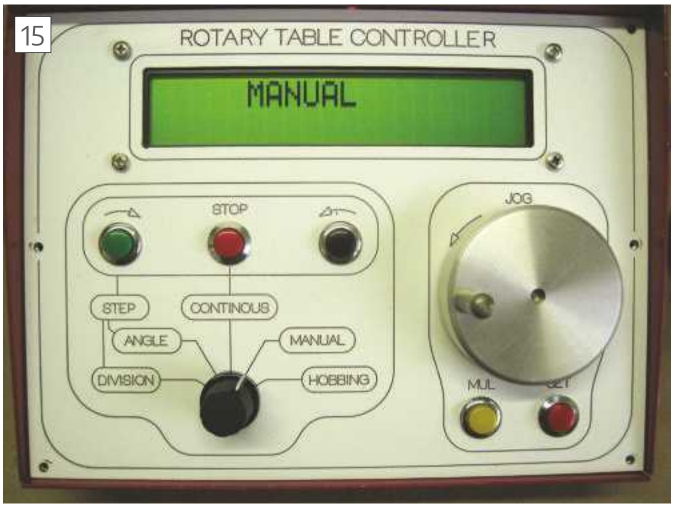
Division Mode



Angle Mode



Continuous mode.



Manual mode.

Hobbing mode

Looseing the chuck hold down bolts a touch then allows the 4 side screws to adjust the chuck as one would a 4-jaw chuck. When done the chuck bolts are tightened up, **photo 6**.

Since hobbing requires synchronisation of gear blank rotation to Hob rotation, an encoder disc is required, attached to the hobbing spindle, and feeding rotation positional information to the controller, **photos 7** and **8**. The pulses from the encoder are then processed by a tailored Bresenhams algorithm, which ensures the two run in sync, by generating stepper run pulses directly in proportion to the encoder pulses, at a rate required by the relationship between number of teeth being cut, hob pitch/mod and therefore blank diameter, and hob rpm.

The optical encoder was designed as a 'strap on' unit, since I would perform any hobbing in the vertical mill, and did not wish to have the encoder or 'hobber' as a permanent part of the mill.

The finish is poor, but that's the hob's fault, **photos 9**, **10** and **11**.

The Controller unit has a number of features - It allows gear cutting as a hobber, but also allows various modes of indexing, by set angle increments, or by dividing a circle into N segments and also allows continous rotation, so that corners can be milled round, such as, perhaps the ends of con-rods, etc.

Display lower line shows number of segment to divide a circle into. Upper line shows current segment indexed to, **photo 12**.

All desired angles, division and counts are set by pressing the RED set button, and rotation the jog wheel to increment/decrement the count.

Then pressing the GREEN button will initiate the selected function, clockwise, and the BLACK button, anti-clock.

In photo 13 the upper line is current angle moved to, lower line is the angle step size. In the mode in photo 14 the jog wheel selects the desired rpm the chuck should rotate at, from 0.1rpm to 40rpm.

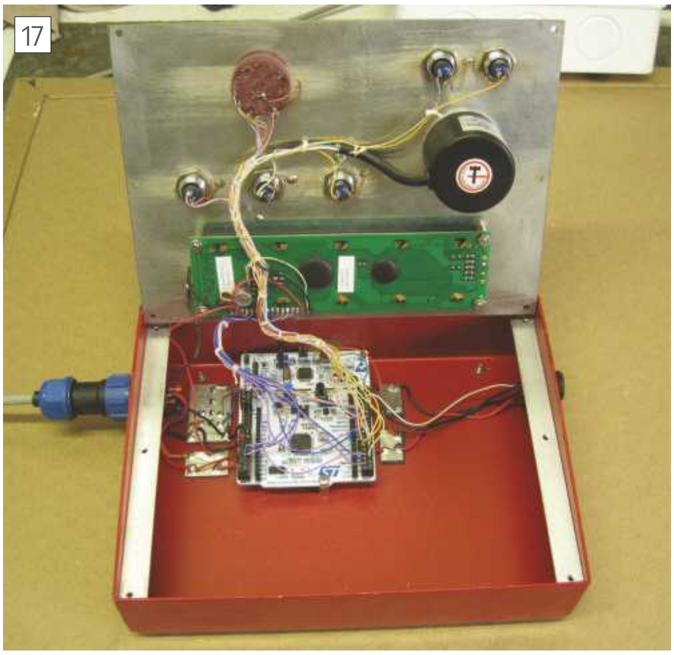
The chuck rotates with the jog wheel in manual mode, **photo 15**.

Finally, in hobbing mode the encoder is slewed to the chuck rotation, according to the selected tooth count, **photo 16**.

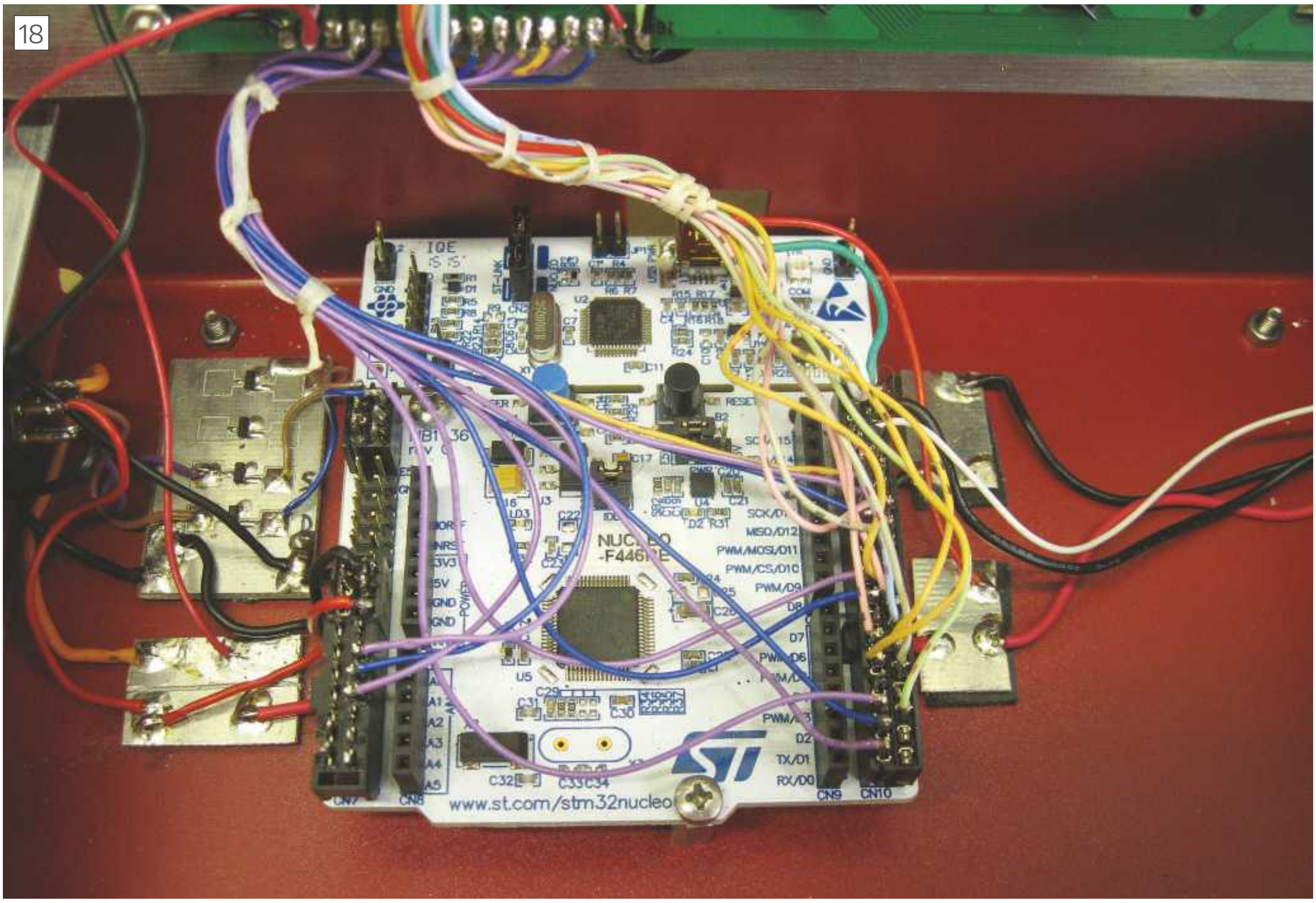
Wiring is not my favourite task, so the internals could be neater, **photos 17** and **18**.

I have not used the unit for hobbing, but the forum fellows who built up the Hobber function using this system have, and report it works well!

As for the rest of the indexing functions on this unit, I use them regularly and now wonder why I waited so long to upgrade the table! ■



Internals of the controller



The microprocessor module, a NUCLEO - STM processor - sort of an Arduino on steroids.

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Astronomical Clock

Adrian Garner describes his astronomical clock, which shows both mean time and sidereal time.

Nene Valley

John Arrowsmith takes a trip to Wansford station near Peterborough to find a 5 inch gauge miniature railway being built alongside the full-sized Nene Valley line.

Information

Graham Astbury looks at several ways to track down that piece of elusive but vital information.

Cylinders

Graham Langer follows the design of the cylinders for the A1 Steam Locomotive Trust's new-build Gresley Class P2 *Prince of Wales*.

Content may be subject to change.

Readers' Tips

CHESTER MACHINE TOOLS

Flexible Swarf Screens

TIP OF THE MONTH WINNER!

This month our lucky winner of £30 in Chester gift vouchers is Rob Edwards from Kenilworth who has a suggestion for simple swarf screens which we are sure would even find approval at the Ambassador's parties...

These are my simple prototype flexible swarf screens which may be an idea worth passing on to readers.

They consist of the two halves of the clear base of Ferrero Rocher box and four magnet cupboard latches which can be cheaply obtained from a Pound shop and four 6BA screws and nuts.

In other words simple and cheap!

They work extremely well are very stable and a perfect addition to the mill, they can be positioned as required and simply removed to make adjustments to work piece and tools etc. with the added bonus of helping to keep machine and bench clean.

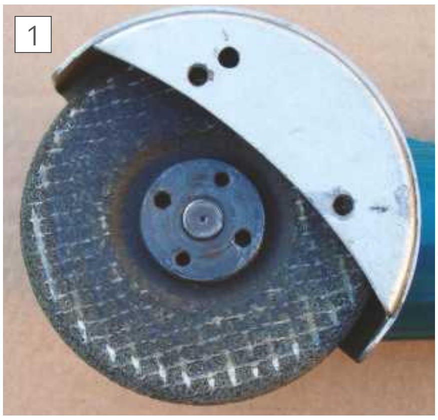
I apologise if something similar is available commercially but can honestly say I've not seen anything like them. On a safety note they are great for swarf catching, but if true safety screens are needed, they would require refining with the use of clear acrylic or polycarbonate sheet which should be more resilient.

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!

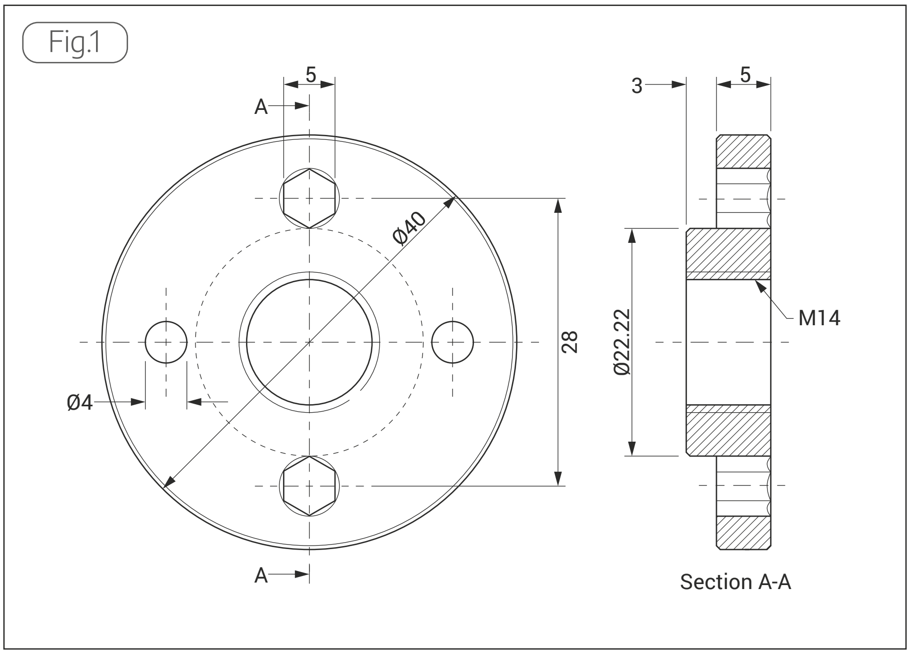
Please note that the first prize of Chester Vouchers is only available to UK readers. You can make multiple entries, but we reserve the right not to award repeat prizes to the same person in order to encourage new entrants. All prizes are at the discretion of the Editor.

Improvements for Your Angle Grinder

Angle grinders are something of a blunt instrument compared to most of our engineering tools, but they have their uses. Jacques Maurel offers some tips for getting the most out of one.

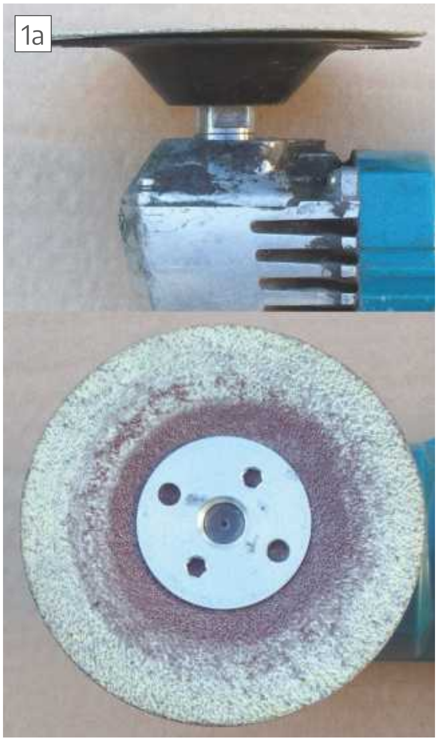


Standard peg nut for disc fixing.



Clamping Nut Driving Without a Peg Wrench:

Very often the peg wrench is hidden somewhere in the workshop and sometimes lost. It is worth being able to drive the nut with a standard



Nut with two 5mm hex holes.

Set up ready for rotary broaching.

Be careful as the nut is made of hardened steel that must be annealed before machining.

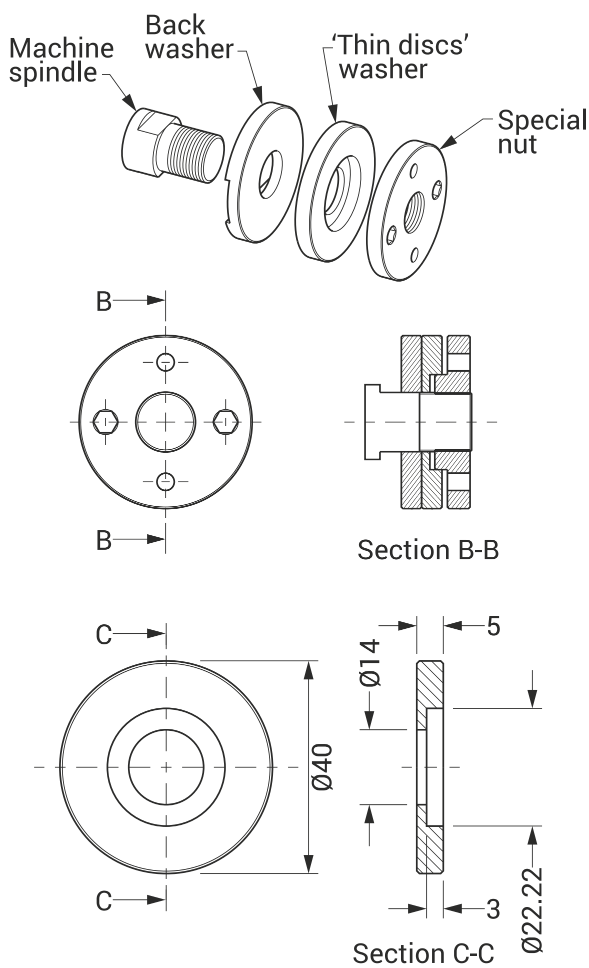

1c

Nut in recessed disc.

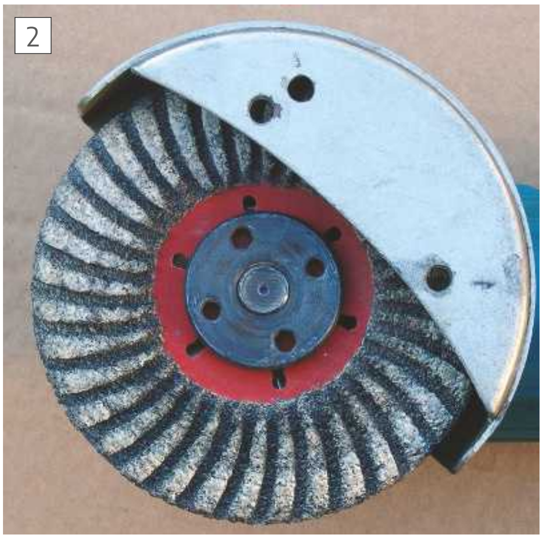
wrench. I've made 5 mm hex holes on the nut (see **fig. 1** and **photo 1)**, to be used with a 5mm hex wrench, one would be sufficient but two are made for balancing. These holes can be made by punching (see ME issue N°4310) or by rotary broaching on a drill press. Be careful as the nut is made of hardened steel that must be annealed before machining.

Photograph 1a shows a sanding disc adaptor plate set on the angle grinder spindle, the back of the locking nut is conical, **photo 1b** shows the set up to allow rotary broaching with the drill press: a piece of 14mm diameter threaded rod and a standard hex nut are used. The sanding disc adaptor is locked between the two nuts, and the hex nut tightened in the machine vice. **Photo 1c** shows a non woven sanding disc set on the grinder, it was impossible for the peg wrench to reach the nut, but easy with the hex wrench.

Fig.2



Thin Discs Washer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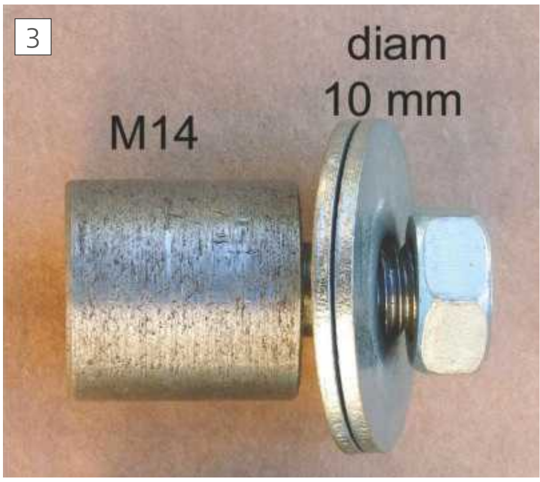
Wood working disc with 2mm washer.


3

10mm adaptor.

Using Thin Discs:

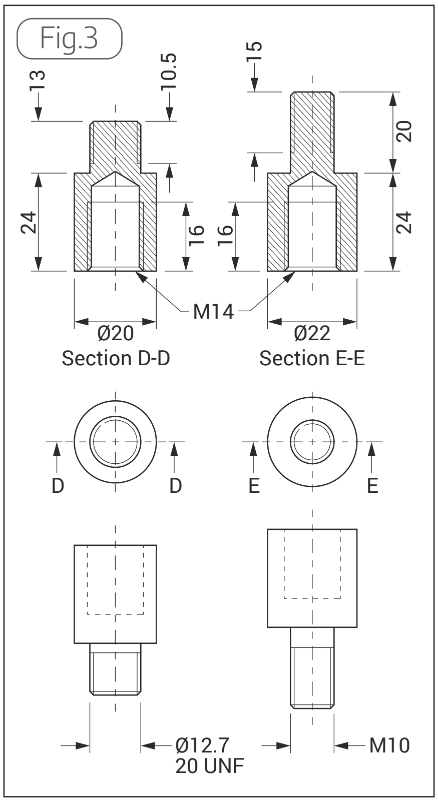
The usual grinding discs are 6.35mm thick (¼") and cutting discs 3.18mm thick (⅛"), these discs are centered on a shoulder carried by the cylindrical clamping nut. The bore diameter is 22.22 mm (⅞"). A 3mm shoulder is convenient for these disc thicknesses. If we want to use very thin discs – 1.6; 1.2; 1mm – It's worth using a special washer to lodge the 3 mm shoulder in, see **fig. 2** and **photo 2** showing a 2mm thick (for the clamped part) heavy duty wood grinding disc.

Using 10mm bore diameter wheels:

Wire brushes with 10mm or 13mm (½") are frequent, so an adaptor from M14 to 10mm diameter (and an adaptor ring from 10 to 13mm diameters) is a boon for the grinder, see **fig. 3**, **photo 3** top and **photo 4**.

Setting A Drill Chuck on The Grinder Spindle:

This allows you to use the grinder as an angled drill in awkward spaces. For this, it's necessary to machine a M14 thread in place of the ½"UNF one, this is possible for the 13 mm capacity key chucks as there is sufficient stuff in the chuck body. Turn a piece of steel rod set in the lathe chuck to 12mm diameter, 25mm long, and tighten your key chuck on. Bore the back hole to 12mm diameter, 21mm long and machine a 14mm diameter recess, 3.5mm long. Tap the hole to M14, **photo 5**.



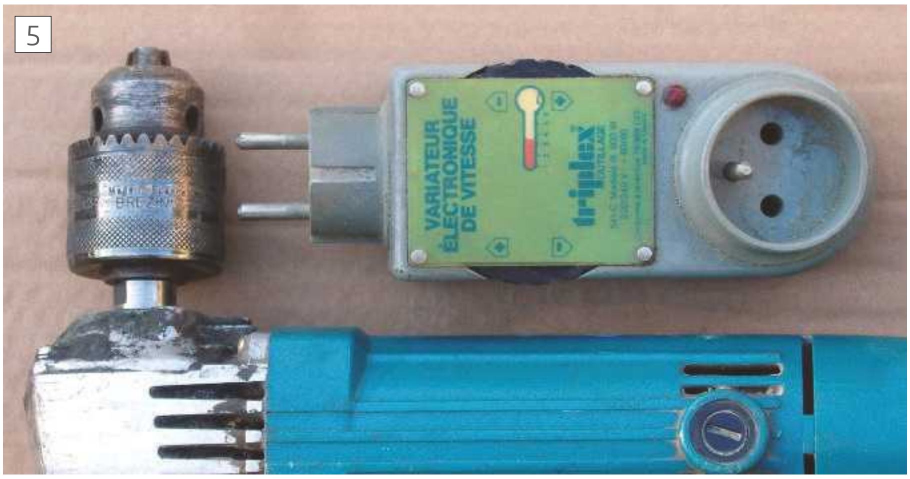
10mm adaptor fitted.

Note: there is some interference between the M14 and the ½"UNF threads but the result is satisfactory. Best results can be obtained from chucks having a ⅜"UNF thread, or old Black & Decker ones having a male thread.

This chuck can be used to carry wire brushes with tang, and also to drive drills in narrow places, be careful as the spindle speed is very high (12500 rpm for the small grinders) so it's necessary to use a variable transformer or an electronic device (shown in **photo 5**) as "dimmer" to avoid burning out the drills.

If you want to fit a 10mm capacity key chuck, it's necessary to make an adaptor from M14 to ½"UNF (see fig. 3 bottom, **photos 6** and **7**) as there is not enough stuff to machine a M14 bore in the chuck body.

Finally, always remember to wear appropriate personal protective equipment (PPE) such as eye protection and gloves when using an angle grinder. ■



Drill chuck fitted to grinder, also speed controller.

Adaptor for smaller drill chucks.

10mm capacity chuck fitted.

On the Wire NEWS from the World of Hobby Engineering

£875,000 boost for London Transport Museum

London Transport Museum has received an £875,000 boost for its future from the Government's £1.57 billion Culture Recovery Fund to aid its recovery after losing £7 million during the pandemic.

London Transport Museum, the world's leading museum of urban transport, is among more than 2,700 recipients to benefit from the latest round of awards. More than £300 million has been awarded to thousands of cultural organisations across the country, including London Transport Museum, in the latest round of support from the Culture Recovery Fund.

Over £800 million in grants and loans has already been awarded to support almost 3,800 cinemas, performance venues, museums, heritage sites and other cultural organisations dealing with the immediate challenges of the coronavirus pandemic.

When the pandemic forced London Transport Museum to close its doors in March 2020, the popular venue took a major financial hit. Although over 40% of the Museum's visitors returned when it reopened in September, reduced ticket sales, shop sales and venue hire income left it facing a total income shortfall of almost £7 million before emergency support.

In October, the Museum was one of 35 organisations to receive a grant in the first round of the Culture Recovery Fund. This vital £1.75 million lifeline has kept the Museum in operation throughout the winter.

This new grant of £875,000 administered by Arts Council England, will get London Transport Museum's long-term recovery off the starting blocks and enable it to reopen with confidence when restrictions lift on 17 May 2021.

Visitors to the Museum can look forward to refreshed galleries and exploring the award-winning Hidden London exhibition in the Global Gallery, now extended due to popular demand. A new series of After Dark events will also be on offer, with opportunities for people to show off their transport trivia knowledge and get creative.

To be the first to know about event dates and ticket releases, sign up to the Museum's e-newsletter by visiting **www.ltmuseum.co.uk**.

Customers' Dream Workshops

Machine Mart are on the lookout for dream workshops packed with tools, big or large, messy or immaculate!

The first video in the new series from Machine Mart is now live with dedicated Clarke enthusiast Ant showing off his impressive workshop and collection of products. To watch, please visit: www.machinemart.co.uk/dream-workshops/

Do you have a garage or workshop you'd like to show off? Have an interesting story you think they would love to hear? Machine Mart would love to hear from you and could be doing a video on you very soon!

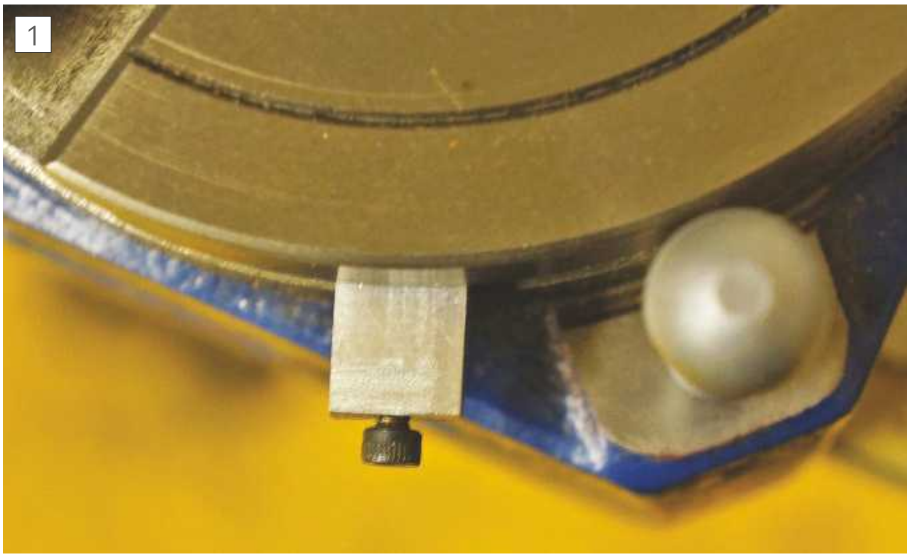
If interested, get in touch with Machine Mart via social media every Wednesday using #WorkshopWednesday or on email at **socialmedia@machinemart.co.uk**

Also, the latest Machine Mart catalogue went live on 5th April!

Fitting Adjustable Stops to a Rotary Table

Keith Beaumont explains a useful improvement suitable for two popular makes of rotary table.

My main interest within our hobby is the making or re-furbishment of model I/C engines. One component that I always start with some trepidation is the con-rod, especially if it is for the smaller engines, around 1cc in size. I have always used a rotary table, plus home made fixtures to machine these and achieving an accurate "dog bone" shape is usually a buttock clenching time. The one made for my latest engine is only 0.093"wide at the small end! I have read about various other ways of machining this item without using a rotary table, but they all involve the fingers providing the movement and being too near the cutter for my liking. What is needed is a means of being able to machine a radius from one stopped position to another opposite stop.



Prototype stop in aluminium alloy.

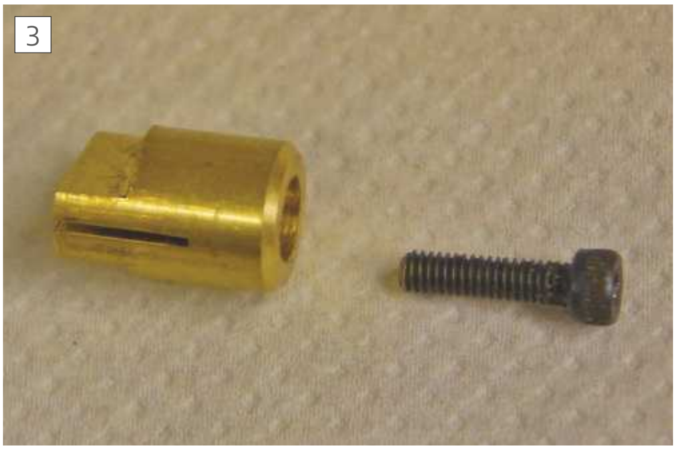
I have dreamed up several ways of achieving this, all involving drilling and threading holes in the table somewhere. All were discarded as being too complicated to make, or to set up. It then occurred to me that it might be possible to use the radial channel around the table that the table locks clamp into, by making an expandable block to fit in this channel. Expansion being created by the same means as the method I use for an internal lap. This is drilled through, tapped with a tapered second cut tap and slit so the action of screwing in a matching screw expands it when the screw runs into the tapered thread. A test piece was rapidly made in aluminium and found to work well enough to continue development using this method, **photo 1**. I did not get it right first time, but I think it worth describing the various steps I went through to the final version.

My table is the Vertex HV4. This uses two clamps to lock the table if required and it immediately became obvious that they would impede rotation if left in place. Fortunately, they are easily removed and in removing them I realised that I could screw one of the handles into the threaded hole in the casting for the lock, to create a fixed stop for the adjustable stop to abut against, **photo 2**.

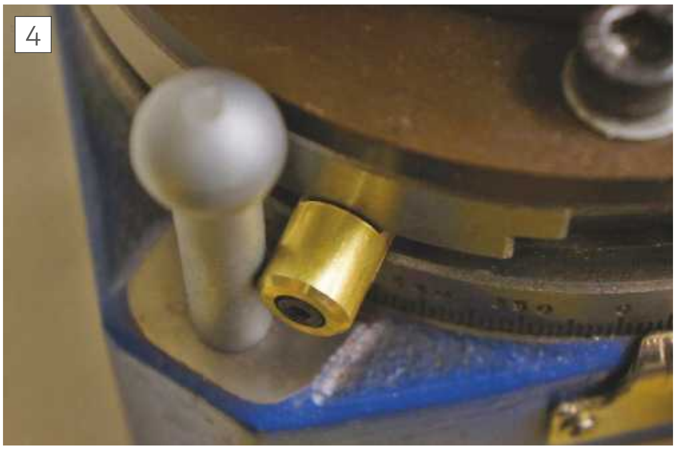
Having now a clear 360 degrees, I rotated the test piece, only to find it would collide with the casting at the bottom flange where the gap is narrow. This narrow space then dictated the depth of any part that I will make, which I decided would be ½".

For the next stage I decided to use 3/8" diameter brass, milling a tenon

Handle repurposed as a removable stop.



Mk 1 stop in brass.



Mk 1 against the stop.

Uneven gap allowing slight movement.

to be a push fit in the channel. This was then drilled, counterbored for a 4BA cap head and tapped with a 4BA second cut tap until the nose of the tap was just protruding from the hole. The tenon was then slit horizontally with a 0.025" slitting saw to twice the depth of the tenon. **Photograph 3** shows the finished item. This was repeated to make stop number 2. Both fitted into the channel and expanded to a firm grip using 4 BA cap head screws that were carefully adjusted to length to sit in the counterbore and achieve a tight fit. **Photograph 4** shows one fitted to the side of the fixed stop.

At this point I thought I had achieved what I had set out to do, but subsequent testing of winding the stop into the fixed pillar several times showed no radial movement, but it was pivoting slightly, as shown by the uneven gap of the tenon, **photograph 5**. I put this down to the fact that the space restriction forcing the cap head to be counter bored, was using the extreme end of the thread only, plus the nose of the tenon was square and therefore only touching the rear face of the channel in the centre. Result, a pivot point.

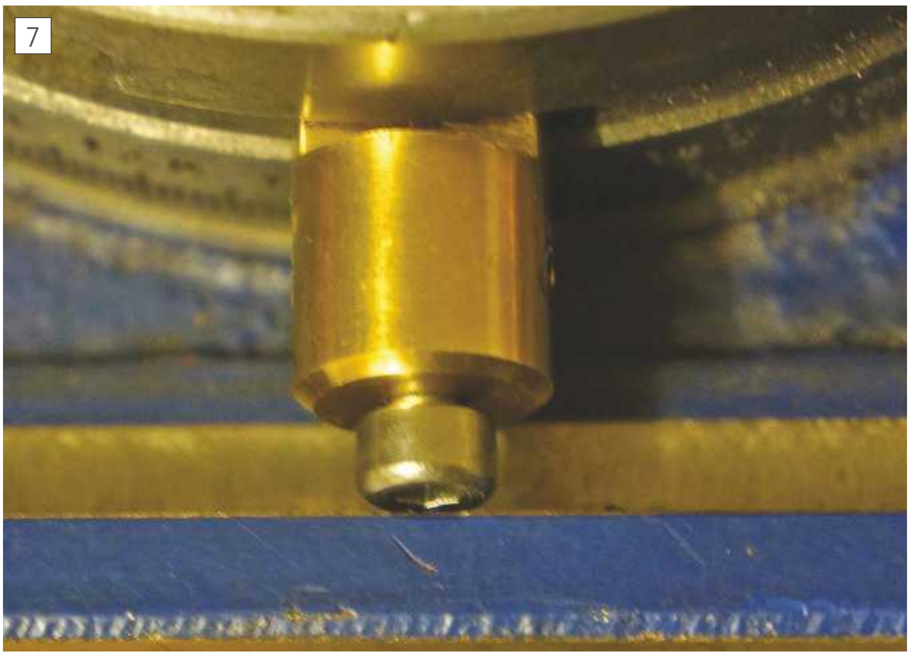
Another version was then made, this time using ½" diameter brass. This was drilled and tapped using a 4mm second cut thread this time. The tenon was made 0.002" thicker than the channel and the nose face was hollowed by milling with a ½"diameter cutter for 0.050" to leave a shoulder each side of about 1⁄16", **photo 6**. This gave enough clearance for the nose to contact the inner face of the channel without any rocking movement. The tenon was again slit with the 0.025" saw for twice the depth of the tenon. This piece was then a tight push fit into the channel and a 4mm cap head screw tightened into its thread. Testing this by winding into the stop several times, harder than I would

Hollow-nose tenon.

when machining, showed no movement at all.

This set up clearly would not pass the narrow gap at the flange, so I decided to mill this back to ¼ inch thickness to allow space for the cap head to pass OK. This version of the Vertex table and its Soba clone have slots to fit clamps in either side when used in the horizontal position, but when set up vertically only the back has a pocket. To fit a clamp onto the front was always a problem of where to put it and I had listed milling it back to make more room as a "job to do", I have also made two low profile clamps to match, so all now OK...

The 4mm cap head was then adjusted for length by trial and error until the head had about another full turn to seat when maximum tightness was achieved. A test rotation to see if it passed the newly machined flange showed it did, **photo 7**. I thought it a good idea at this stage to round off the nose of this



Mk 2 stop fitted.

thread and to put a slight lead on the first few threads to maximise the fit when tightening.

My practice when rotary milling has been to first insert a piece of silver steel the same diameter as the cutter to be used and with a fine finish on its end, in the collet and use this to find the finish line, then note the angle figure and mill to this point. I always gave about .020" space for a finishing cut. I will still use this method to locate the finish line when positioning the initial position of the stops, but I thought the stop should have a means of fine adjustment built in.. This was achieved by drilling and tapping for a 6BA cap head at 90 degrees to the body, **photo 8**. To position this correctly on the centre line of the fixed stop I put a dab of Engineers Blue on the fixed stop and rotated to make contact. This left a spot of blue on the movable stop for me to centre punch prior to drilling and tapping. To make this a firm thread, I laid it in a vee block, put a 3⁄16" diameter piece of steel across the hole and gave it a tap with a hammer. This distorted the first few threads enough to make it a firm screw action. I also rounded the nose and filed a lead on the first threads.

8

Mk3 – modified with an adjusting screw.

Also the cap head face was skimmed off to ensure a smooth contact when checking with a micrometer. The method will now be to set up the movable stops with a stub mandrel as before, leaving about 0.020" from the finish line. Mill to these positions. Check the item dimension then adjust the cap heads, checking with a micrometer to reset the stops to the finished size.

The finished and fitted stops are shown in **photo 9**. In use I found it a good idea to gently tap the stops firmly into the channel with a soft hammer to make sure they were in as far as possible.

The making and using of these fairly simple items has increased the versatility of my Rotary Table considerably, without any permanent modification, other than reducing the flange thickness, but this was something that needed doing for general use anyway.

9

Finished stops fitted to the table.

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 3

Also the fuse will not offer any protection to the operator who needs to stop the machine quickly in the event of a mechanical emergency or from a machine starting automatically after a power failure.

The Dewhurst switch is susceptible to contact burning as its action is operator controlled and unless it is operated with a fast "snap" action arcing will occur eventually causing a high resistance connection that will cause overheating and burning of the contacts.

When my Super 7 would not start and just buzzed and vibrated I found that the contacts in the Dewhurst switch so badly burned that two of them had welded together **photo 13**.

If this happens the two unused contacts (4 & 8 on used for three phase motors) in the Dewhurst switch can be cannibalised to replace any badly burned ones. Otherwise, there internet sources who have a limited supply of new contacts.

It is recommended to fit a proper motor starter, matched to the motor specification, between the supply and the Dewhurst switch as this will enable the Dewhurst to be used only to change the direction of motor rotation before starting the motor with the starter, thus preventing any burning of is contacts. It will also protect the motor and provide a "no volt release" facility that will prevent the motor self-starting following a power outage. It is also easy to fit a variety of normally closed switches into its latching circuit e.g. emergency stops, interlocks and limit switches. **Photograph 14** shows a typical installation.


13

Overheated contacts from a faulty Dewhurst switch.

Headstock Adjustment

If you have no previous experience of the Super 7 headstock, please do not just dive in thinking that it will be easy to adjust it without fully understanding the design considerations involved, as you are likely to do more harm than good. Before attempting to adjust or dismantle the headstock it is essential to study the relevant pages in the Myford handbook as the bearing arrangements are specific to this lathe and to no others in its class.

This section is specific to the Myford Super 7 and ML7R but not the earlier ML7 which has an entirely different headstock design. The following notes are no substitute for reading and thoroughly understanding the precise instructions given on pages 24 – 26 of the Myford handbook. They are just produced to explain the methodology of the bearing adjustment sequence.

Once correctly adjusted the Super 7 headstock should not need any regular adjustment or maintenance other than lubrication. Probably the most likely need to disturb the headstock is when the drive belt from the countershaft needs replacing. Even this can be avoided by fitting a link belt in place of the normal V belt. Some people who have made such a change report that the lathe runs more smoothly afterwards.

Signs of the headstock requiring attention are:

•Spindle slowing down or even stalling during drilling from the tailstock. This is usually caused by the spindle having undesirable end float which allows the load from the drilling operation to force the spindle backwards into the front taper bearing bush causing excessive friction. The spindle must always have zero end float.
• Noisy rear bearings which can be a sign of wear, poor adjustment or over enthusiastic pumping of oil into it (the latter which normally occurs at high spindle speeds is only a temporary problem which resolves itself once the excess oil drains away).
• Rattles that could be due to a loose drive pulley or back gear – also worn or missing woodruff keys.
• Poor results when turning due to poorly adjusted bearings.
• When the lubrication wick needs changing.

Myford designers put a lot of careful thought into the design of the Super 7 headstock bearings born out of experience with previous models and the Model M inherited from Drummond during WW2.

The front bearing consists of a precision ground taper on the spindle running in a large tapered bronze bush, needing only a VERY small clearance between them.

The front taper bearing takes the side thrust from the turning operations, also the spindle remains at the designed centre height at all times. This rear bearing setup provides the adjustment facility to eliminate all end float in the spindle and takes the end loading when boring, drilling and so forth.

The rear bearings consist of a matched pair of angular contact ball bearings mounted back on the spindle with a spacer between them. The spacer has a cut away section to allow oil to reach the bearings – this must be located at the top. It is vital that the adjusting collar is rotated to preload these bearings and to secure them to the spindle, after which the collar can be secured in position by tightening the screw that closes the gap in the collar.

The following notes are just a brief summary of the steps to be taken when adjusting the headstock. Study the full instructions in the handbook before starting.

To set up the bearings properly first adjust the rear pair of bearings to preload them as described on page 26 of the handbook. It is important to make adjustments in the correct order.

Move the spindle forwards to make it free of the front bearing bush by turning the rear bearing locking rings.

Adjust the essential pre-load on the pair of rear bearings and then lock the adjusting collar to the spindle.

Move the spindle backwards until it contacts the tapered bronze bush and will not rotate giving a "no-clearance" condition.

Move the spindle forwards from the no-clearance position by rotating the rear bearing locking ring by 15° (about ¼" rotation of the rim of the back locking ring. which should allow the spindle to rotate freely without any end-float.

This provides the preliminary setting that may require further fine tuning. I find it advantageous to tap lightly the spindle at both ends using a hide or plastic mallet to ensure nothing has "pitched", then repeating the final adjustment of the front bearing.

I also find it advantageous to fit the catch plate onto the spindle during the whole adjustment process as it provides an easy means of rotating the spindle by hand and it can be grasped to detect unwanted end float. It will also protect the head stock thread and register. A

Example of an improved Dewhurst switch installation.

Suitable C spanners for headstock adjustment.

dial gauge mounted on a magnetic base located on the lathe bed is very useful here.

Early Super 7 models have a large cast-in oil reservoir, with a sight glass, at the front bearing which failed to control oil loss. Later models have the wick feed lubricator with a low level Adams oil filler that very effectively lubricates the bearing without unwanted oil loss. As mentioned above a correctly adjusted spindle with lubrication wick feed will not consume much oil at the front bearing.

Useful tools for adjusting the headstock bearings are:

- 5⁄32" Allen key – for adjusting and securing the collar at the left hand end of the spindle to ensure preloading of the rear bearings.
- Two thin C spanners with a maximum thickness of 5mm, you can get away with one but using two makes the job easier. New Myford part number A2128.
- Feeler gauges to set the 0.005" end float between the stepped pulley and the bull gear.
- Small hide or plastic mallet for tapping the spindle to "seat" the rear bearings.

C spanners are sized by the diameter of the ring they are to be used with. For our application 2" will be OK, photo 15. I bought various sized C spanners from car boot sales over the years and the small one with a hexagon hole in one end is particularly suitable being thin and a good fit on the Myford bearing adjusting rings. It is really designed for tightening bicycle bottom bracket bearings and only cost 20 pence!

Headstock drive belt change

There are two options:

The simplest is using link belting which does not involve interfering with either the headstock or counter shaft. It is easy to fit a link belt in place of the original "V" belt – just cut through to old belt and fit the link belt according to the instruction provided by the manufacturer. This is simple and worthwhile modification praised by many who have done it finding the lathe runs more smoothly. The only downside appears to be that link belts cost a lot more than V belts.

Alternatively, using a new traditional V belt, however this entails removing the spindle and partially dismantling the clutch counter shaft. Before embarking on changing the headstock drive V belt it is essential to read the relevant section in the handbook - page 35. After completing the belt change it is necessary to carefully adjust the headstock bearings as detailed above. The correct V belt is A 29½ or its metric equivalent A870A. Note that imperial and metric V belts are measured differently.

Chuck stuck on the spindle

When buying a used Myford lathe, if you are unlucky the chuck could be stuck on the spindle making it impossible to remove by gentle means. It will then be necessary to consider a bit of intelligently applied force. When viewing a potential purchase get the vendor to demonstrate the removal of the chuck, this will also allow close examination of the spindle nose to detect any signs of abuse or neglect. A stuck chuck is more likely to be a problem on a lathe that shows other signs of general carelessness or abuse.

Whatever you do, do not be tempted to lock the spindle by partially engaging the back gears. This is likely to result in breaking teeth off the brittle cast iron gears as well as still having a stuck chuck.

The Super 7 has a spindle lock bolt located on the left-hand end of the headstock consisting of a sliding bolt locating in a purpose located hole in the step pulley. This only locks the spindle via the drive key between the spindle and the drive arrangement so treat it with respect.

Methods to try to release a stuck chuck (all with power turned off) are:

Put the spindle drive belt on the lowest speed position and engage the clutch; this will apply the maximum "drag" to the spindle. Tighten a suitable length of hard wood between the chuck jaws and give the end of it a sharp blow with a mallet. Several attempts may be required.

If this fails to release the chuck repeat the operation with the spindle lock properly engaged. Remember to disengage the spindle lock before running the lathe again.

There are other "last resort" methods described on the internet but before attempting any of them please consider what damage they may cause to other lathe components. Always try "soft" methods first.

When fitting any chuck always put a generous coating of anti-seize compound on the spindle register faces and nose thread. Prevention is better than cure. Suitable compounds are Rocol J166 (now called Rocol Anti-Seize Compound) or copper containing anti-seize products sold by motor factors for application to noisy disc brake components. **Photograph 16** shows typical anti-seize products.

16

Typical anti-seize compounds.

Conclusions

On acquiring a Super 7 please get yourself a handbook before attempting any adjustments or using the lathe for screw cutting especially if it has a quick change gear box.

Always take your time when setting up a job of making any repairs even if you are familiar with other lathes – the Super 7 has some quirky features!

Be careful of accepting any advice from others who may be unfamiliar with the Super 7.

Good luck and enjoy many years of pleasure from your Super7.

I thank my longsuffering wife Susan for her patience whilst checking and rechecking the several draft copies of this article and for her valuable contributions towards improving my style and presentation. ■

In our Next Issue

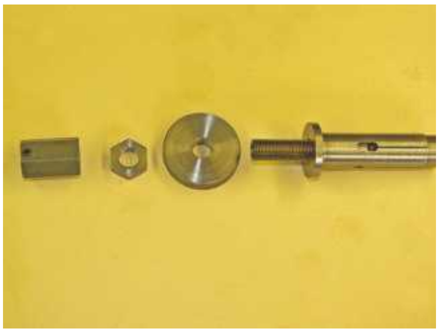
Coming up in issue 304

On Sale 21st May 2021

Content may be subject to change

Look out for MEW 304, your April issue, which brings you more fascinating workshop builds:

Graham Meek adapts his screwcutting clutch for the Emco Maximat.



Peter Hodkinson details an adjustable backstop for the ML10 lathe.

Will Doggett makes a bandsaw blade repair station.

DON'T MISS THIS GREAT ISSUE - SEE PAGE 48 FOR OUR LATEST SUBSCRIPTION OFFER

Scribe a line

YOUR CHANCE TO TALK TO US!

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

Offset Tailstock Device

Dear Neil, I am really enjoying the April 21 edition of MEW thank you. Terry Gorin's version of Michael Cox's tailstock offset caught my eye. I made one for my 9x20 lathe some time ago with a couple of modifications. When I bored the hole for the tail stock in the rear fixed plate, I had the adjustable front plate bolted to it so I could continue the hole 5mm into it as well. When I mount it for use I make sure that the tail stock goes completely through the rear plate and into the front plate. This way I know that the front plate is in alignment with the tailstock center. To use it I then slide it away from the tail stock until the front plate is free and clamp it with the cotter pin. Instead of a dead centre I have mounted a roller bearing instead and use a steel ball as a live centre. I left the ends flat instead of rounding them to give plenty of area to use a dial indicator when measuring the off set.

Robert Walker, by email

Keyway Cutter

Dear Neil, would you or any of your well informed readers be able to tell me where I can get the information about the key way cutter as in photo. Keep up the good work in model engineer's workshop.

Barry Barnett, by email

The casting looks like one produced by College Engineering Services, if memory serves me right. Perhaps a reader can provide confirmation or a picture of a completed item – Neil.

Mastic Sealants

Dear Neil, I wonder if I could impose on your time a little and I hope you have an answer. I have got to the point with the 2" scale Ransomes light tractor that I took over last year through Model Engineer could now have it's cylinder block mounted on the boiler and would need sealing, particularly as it's fixing screws penetrate the boiler tube. My only knowledge in this area is years out of date, oiled paper for Stuart kits and Hermetite for motor bikes and I would be grateful to know current practice.

Peter Hamm, by email

What do readers suggest? Personally I'd use the time-honoured Boss White as used by LBSC, a non-setting mastic that works at steam temperatures and pressures - Neil.

Chuck Changing Board

To change a chuck I put a length of rod in the tailstock and into the chuck, close the chuck jaws until they are not quite gripping the rod and then just unscrew it. To refit just reverse the process.

Ellis Boardman, by email

Thanks for the idea, Ellis, the board (see MEW 302) is useful for particularly large and heavy chucks.

Mystery Lathe

Dear Neil
I was interested to see the tailstock of the unidentified lathe on page 64 of issue 302. Unfortunately the headstock is not clear in the picture, but it reminded very much of a lathe which I inherited from my late uncle some 65 years ago. The following may shed some light on it.

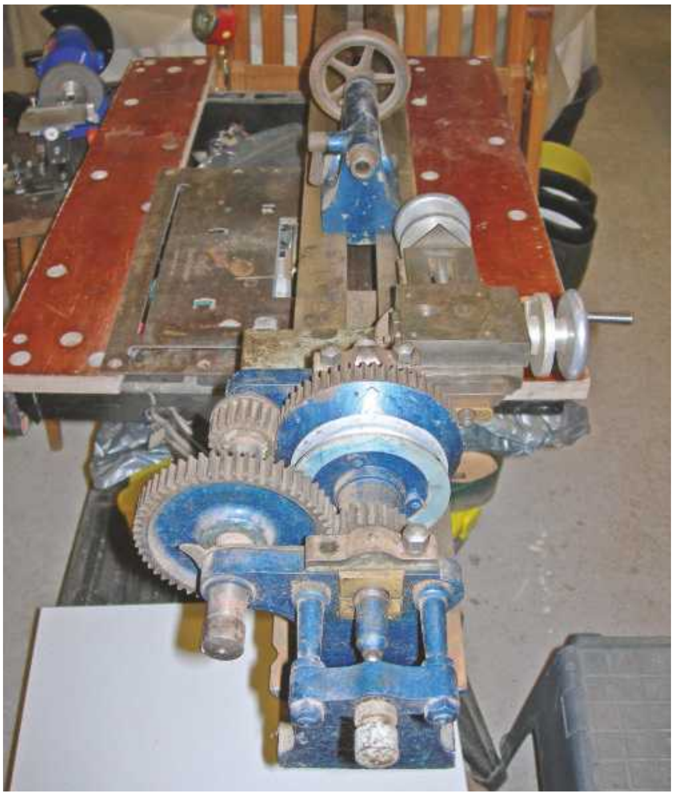
The centre height is $3\frac{5}{16}$ inches and the bed is a plain beam $48\frac{1}{4}$ inches long giving at least 30 inches between centres if the head and tail stocks are moved to the ends. The beam is $4\frac{1}{4}$ inches wide with bevels suitable to locate a saddle, but, as with your example, there is no saddle. The bed carries no markings whatsoever and I discovered the manufacturer only on dismantling the headstock and finding “T Taylor. Chester St Hulme Manchester” on the casting under the smaller gear (the one with the flange). The headstock also has the number 122 in the casting under the large gear while the tailstock similarly has 123.

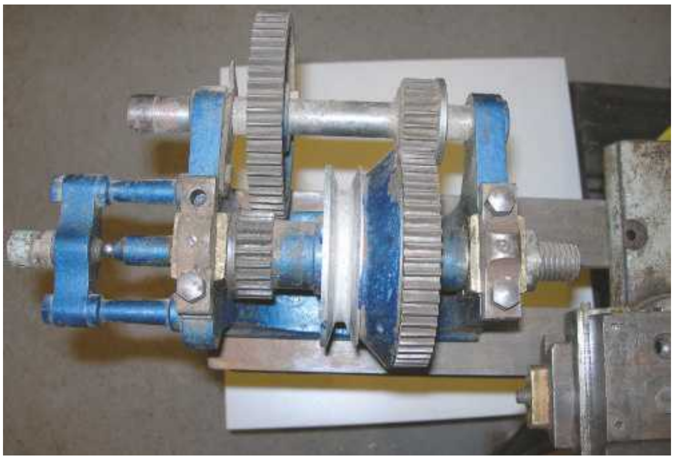
The headstock bearings are plain split brass(?) blocks with parallel bores of $\frac{3}{4}$ inch at the chuck end and $\frac{11}{16}$ at the remote end. End thrust is taken by a single ball and adjusting screw.

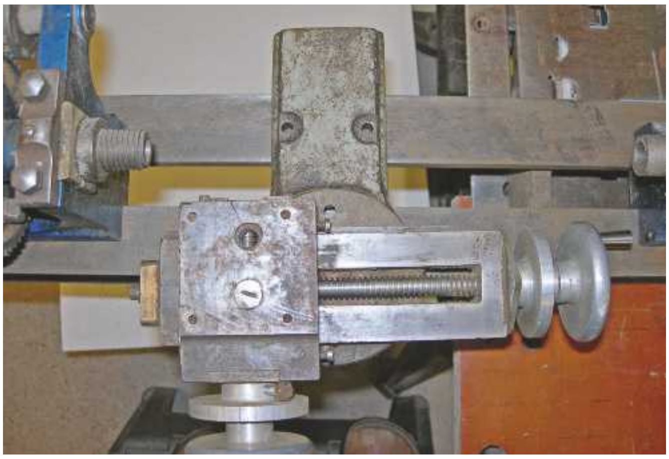
The cross slide has a movement of $1\frac{1}{2}$ inches before the feed screw becomes disengaged and the longitudinal movement is about $3\frac{1}{2}$ inches. The top of the cross slide is only $\frac{3}{16}$ inch below centre height, leaving little room for a tool and holder. The spindles have $\frac{5}{16}$ inch square ends (the aluminium dials and wheels were added later).

The bed has two $\frac{1}{2}$ inch Whitworth holes on the underside at each end and I can remember (as a small boy) the lathe mounted on A-shaped legs at each end with a shaft running the full length and carrying a large diameter flywheel which drove the headstock through a round leather belt. I think there was a three step pulley with semicircular grooves (the aluminium one in the photograph is a later modification). Unfortunately, these parts were scrapped when I acquired the lathe.

John Nelson, by email

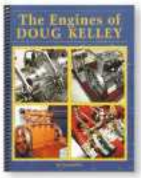






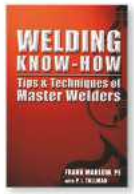
THE VERY BEST OF SPRINGTIME READING!

The Engines of Doug Kelley • £28.49



From the 'The Home Shop Machinist' come full drawings and building instructions for four IC engine models from Doug Kelley. All are scale models and are: *The Snow*, a Tandem, Double-Acting Engine, the Two Cylinder *Nash*, the *Bruce Macbeth* 4-cylinder upright, and the horizontal two cylinder *Titan* 50 HP engine. All have a cylinder bore of around 1" and other than flywheels are designed to be fabricated. The presentation of the designs and drawings is impeccable; dimesions are in decimal inches. They are not designs for beginners - as it says in the Introduction, building any of them 'will challenge your machining prowess', but you will end up with a very attractive model. 116 pages, full drawings and numerous colour photographs of parts, machining set-ups, and prototypes. Spiral Bound.

Welding Know-How • Marlow • £44.70



We have offered a number of welding books - all good in their different ways, but here is a book which covers every aspect of soldering, brazing, welding and cutting by electrical, gas and combined means. Illustrated with line drawings (500 of them!), rather than photographs, the wall to wall information is put across very clearly. OK - it isn't cheap, but all the information you will need is here; if you buy just one book on joining metal, this is the one! 544 pages. Paperback.

The Stonemason A History of Building Britain • Ziminski • £23.55

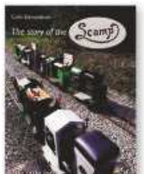
A stonemason's story of the building of Britain: part archaeological, part history and part deeply personal insight into an ancient craft. Andrew Ziminski has worked on many of Britain's greatest monuments; neolithic monoliths to Roman baths and temples, from the tower of Salisbury Cathedral to the engine houses, mills and aqueducts of the Industrial Revolution and beyond, this is his personal history of how Britain was built - from the inside out. Not a tutorial on working stone, although, more or less incidentally, you will pick-up quite a lot on the tools and how they are used. Enjoyable, informative, well written, frequently amusing and strongly recommended. 316 pages. No illustrations other than drawings at the start of each chapter. Hardbound.

Building the Maltese Falcon

Shelley • EXTRA SPECIAL PRICE! £ 9.69

The Maltese Falcon is a 260cc Flat Four, Side Valve engine which turns a (scale) 34" x 18" propeller at 2500 rpm, measures 8" in length and depth, and 13" across the heads. Essentially designed to be built from solid, but certain parts, notably a magneto kit, and standard Honda pistons can be used if you want. This engine can be built by any competent model engineer and, with modifications to the cooling arrangements you could use it to power non-flying items. You get the drawing set of 11 sheets, reduced to fit A3 format, and 36 A4 pages of notes, hints and tips on building the engine, plus many photos of parts and set-ups; this isn't a 'normal' construction manual, but good solid information helping you to build a jaw dropping 'model' I.C. engine! Wirebound with card covers.

The story of the "Scamp" - the little loco with a big heart • Edmondson • £ 8.69



The "Scamp" is a 7 1/4" gauge ride-on, narrow gauge outline i/c locomotive, based on a 'Lister' industrial locomotive. Usually built as a petrol-electric, around 100 have been built so far. It is a small locomotive, which can be easily partially disassembled to fit in most car boots, and kits of laser-cut or machined parts are available to expedite construction. In this very good value book, "Scamp's" designer tells of the design's development, there is a chapter on how to build one (but no plans) and much more. 42 A4 format pages, full of colour photographs, and much to enjoy.

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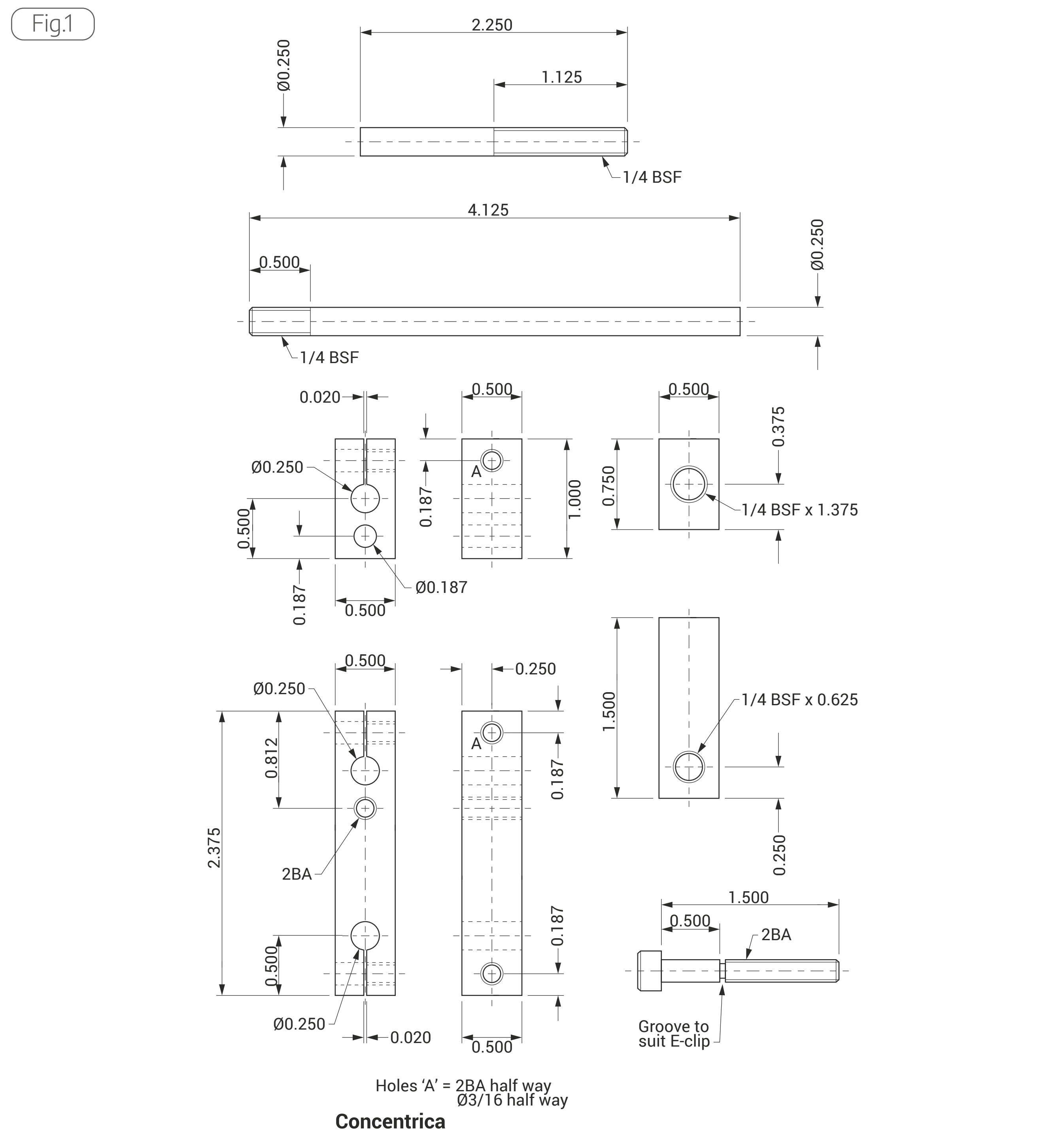
Concentrica

This little device from Pete Worden offers an easy route to centring a rotary table on a milling machine.



I've often had the need to set up something on a milling machine, like a rotary table for instance, so that its axis is concentric with the machine spindle axis. In the past I've just clamped a clock (DTI – dial test indicator) in the machine for this purpose but the problem with that is half the time the dial of the clock can't be seen when the spindle is rotated because it is facing the wrong way. One solution is to use a mirror but then there's the problem of working out which way the needle on the dial is going. What is needed is something

1

Concentrica in Action

that will show the dial face all the way round. This gadget is designed to do just that **photo 1**, though I don't think it is anything new, somebody somewhere must have thought of the idea before, but it could make an easy project for a beginner **fig. 1**.

To use the gadget the first thing to do is locate the target object to be as near to concentric with the axis of the machine spindle as is possible by eye. Then, referring to **fig. 2**, hold the vertical shaft of the gadget in the machine, by whatever means. Clamp the clock in the clock block, as shown, with the stylus pointing downwards. Slacken the two clamps on the adjuster block and clock block and slide them along the radial bar until the stylus of the clock is almost touching the target. Tighten the clamp on the adjuster block and turn the adjuster screw to move the clock so the stylus meets the target to move the needle on the dial about halfway round and lock the clock block on the radial bar by tightening the clamp.

Rotate the machine spindle, by hand of course, and watch the needle on the dial, then move the target using the X and Y movements of the machine table as appropriate until the dial needle remains in one position as the machine spindle is rotated, **fig. 3**.

It may be necessary to move the clock slightly one way or the other as the target becomes more concentric. ■

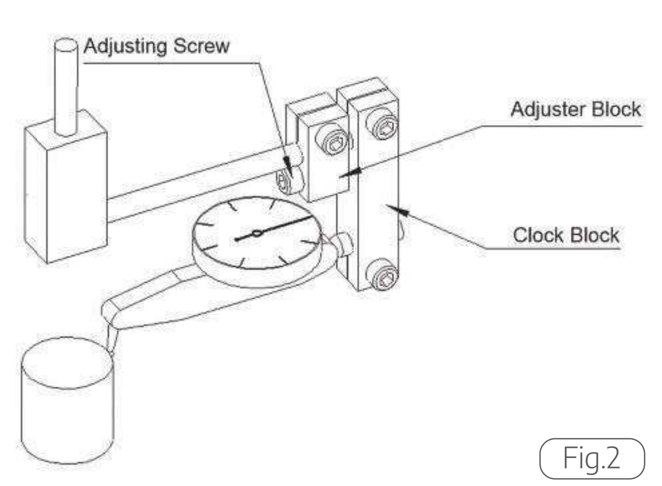


Fig.2

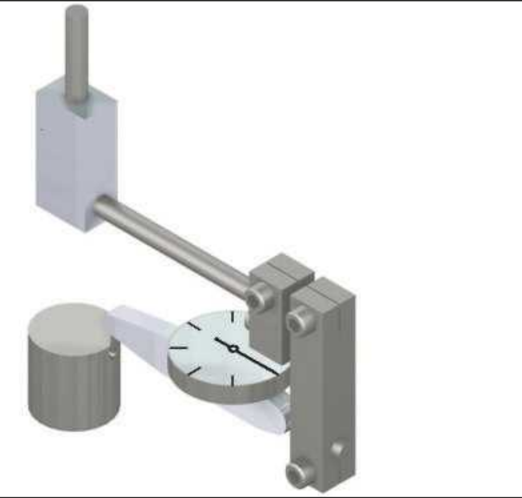


Fig.3

Model Engineers’ Workshop Data Book

MODEL ENGINEERS'WORKSHOP DATA BOOK

DRILL SIZES METRIC	DRILL SIZES INCH	DRILL SIZES NO./LETTER	DECIMAL SIZES METRIC	DECIMAL SIZES INCH
		28	3.569	0.1405
	9/64		3.572	0.1406
3.60			3.600	0.1417
		27	3.658	0.1440
3.70			3.700	0.1457
		26	3.734	0.1470
3.75			3.750	0.1476
		25	3.797	0.1495
3.80			3.800	0.1496
		24	3.861	0.1520
3.90			3.900	0.1535
		23	3.912	0.1540
	5/32		3.969	0.1563
		22	3.988	0.1570
4.00			4.000	0.1575
		21	4.039	0.1590
		20	4.089	0.1610
4.10			4.100	0.1614
4.20			4.200	0.1654
		19	4.216	0.1660
4.25			4.250	0.1673
4.30			4.300	0.1693
		18	4.305	0.1695
	11/64		4.366	0.1719
		17	4.394	0.1730
4.40			4.400	0.1732
		16	4.496	0.1770
4.50			4.500	0.1772
		15	4.572	0.1800
4.60			4.600	0.1811
		14	4.623	0.1820
		13	4.699	0.1850
4.75			4.750	0.1870
	3/16		4.762	0.1875

MODEL ENGINEERS'WORKSHOP DATA BOOK

DRILL SIZES METRIC	DRILL SIZES INCH	DRILL SIZES NO./LETTER	DECIMAL SIZES METRIC	DECIMAL SIZES INCH
		D	6.248	0.2460
6.25			6.250	0.2461
6.30			6.300	0.2480
	1/4	E	6.350	0.2500
6.40			6.400	0.2520
6.50			6.500	0.2559
		F	6.528	0.2570
6.60			6.600	0.2598
		G	6.629	0.2610
6.70			6.700	0.2638
	17/64		6.747	0.2656
6.75			6.750	0.2657
		H	6.756	0.2660
6.80			6.800	0.2677
6.90			6.900	0.2717
		I	6.909	0.2720
7.00			7.000	0.2756
		J	7.036	0.2770
7.10			7.100	0.2795
		K	7.137	0.2810
	9/32		7.144	0.2813
7.20			7.200	0.2835
7.25			7.250	0.2854
7.30			7.300	0.2874
		L	7.366	0.2900
7.40			7.400	0.2913
		M	7.493	0.2950
7.50			7.500	0.2953
	19/64		7.541	0.2969
7.60			7.600	0.2992
		N	7.671	0.3020
7.70			7.700	0.3031
7.75			7.750	0.3051
7.80			7.800	0.3071

DRILL SIZES			DECIMAL SIZES	
METRIC	INCH	NO./ LETTER	METRIC	INCH
7.90			7.900	0.3110
	5/16		7.938	0.3125
8.00			8.000	0.3150
		O	8.026	0.3160
8.10			8.100	0.3189
8.20			8.200	0.3228
		P	8.204	0.3230
8.25			8.250	0.3248
8.30			8.300	0.3268
	21/64		8.334	0.3281
8.40			8.400	0.3307
		Q	8.433	0.3320
8.50			8.500	0.3346
8.60			8.600	0.3386
		R	8.611	0.3390
8.70			8.700	0.3425
	11/32		8.731	0.3438
8.75			8.750	0.3445
8.80			8.800	0.3465
		S	8.839	0.3480
8.90			8.900	0.3504
9.00			9.000	0.3543
		T	9.093	0.3580
9.10			9.100	0.3583
	23/64		9.128	0.3594
9.20			9.200	0.3622
9.25			9.250	0.3642
9.30			9.300	0.3661
		U	9.347	0.3680
9.40			9.400	0.3701
9.50			9.500	0.3740
	3/8		9.525	0.3750
		V	9.576	0.3770
9.60			9.600	0.3780

DRILL SIZES			DECIMAL SIZES	
METRIC	INCH	NO./ LETTER	METRIC	INCH
4.80		12	4.800	0.1890
		11	4.851	0.1910
4.90			4.900	0.1929
		10	4.915	0.1935
		9	4.978	0.1960
5.00			5.000	0.1969
		8	5.055	0.1990
5.10			5.100	0.2008
		7	5.105	0.2010
	13/64		5.159	0.2031
		6	5.182	0.2040
5.20			5.200	0.2047
		5	5.220	0.2055
5.25			5.250	0.2067
5.30			5.300	0.2087
		4	5.309	0.2090
5.40			5.400	0.2126
		3	5.410	0.2130
5.50			5.500	0.2165
	7/32		5.556	0.2188
5.60			5.600	0.2205
		2	5.613	0.2210
5.70			5.700	0.2244
5.75			5.750	0.2264
		1	5.791	0.2280
5.80			5.800	0.2283
5.90			5.900	0.2323
		A	5.944	0.2340
	15/64		5.953	0.2344
6.00			6.000	0.2362
		B	6.045	0.2380
6.10			6.100	0.2402
		C	6.147	0.2420
6.20			6.200	0.2441

MODEL ENGINEERS'WORKSHOP DATA BOOK

DRILL SIZES			DECIMAL SIZES	
METRIC	INCH	NO./ LETTER	METRIC	INCH
9.70			9.700	0.3819
9.75			9.750	0.3839
9.80			9.800	0.3858
		W	9.804	0.3860
9.90			9.900	0.3898
	25/64		9.922	0.3906
10.00			10.000	0.3937
		X	10.084	0.3970
10.10			10.100	0.3976
10.20			10.200	0.4016
10.25			10.250	0.4035
		Y	10.262	0.4040
10.30			10.300	0.4055
	13/32		10.319	0.4063
10.40			10.400	0.4094
		Z	10.490	0.4130
10.50			10.500	0.4134
10.60			10.600	0.4173
10.70			10.700	0.4213
	27/64		10.716	0.4219
10.75			10.750	0.4232
10.80			10.800	0.4252
10.90			10.900	0.4291
11.00			11.000	0.4331
11.10			11.100	0.4370
	7/16		11.112	0.4375
11.20			11.200	0.4409
11.25			11.250	0.4429
11.30			11.300	0.4449
11.40			11.400	0.4488
11.50			11.500	0.4528
	29/64		11.509	0.4531
11.60			11.600	0.4567
11.70			11.700	0.4606

MODEL ENGINEERS'WORKSHOP DATA BOOK

DRILL SIZES			DECIMAL SIZES	
METRIC	INCH	NO./ LETTER	METRIC	INCH
	9/16		14.287	0.5625
14.50			14.500	0.5709
	37/64		14.684	0.5781
14.75			14.750	0.5807
15.00			15.000	0.5906
	19/32		15.081	0.5938
15.25			15.250	0.6004
	39/64		15.478	0.6094
15.50			15.500	0.6102
15.75			15.750	0.6201
	5/8		15.875	0.6250
16.00			16.000	0.6299
16.25			16.250	0.6398
	41/64		16.272	0.6406
16.50			16.500	0.6496
	21/32		16.669	0.6563
16.75			16.750	0.6594
17.00			17.000	0.6693
	43/64		17.066	0.6719
17.25			17.250	0.6791
	11/16		17.462	0.6875
17.50			17.500	0.6890
17.75			17.750	0.6988
	45/64		17.859	0.7031
18.00			18.000	0.7087
18.25			18.250	0.7185
	23/32		18.256	0.7188
18.50			18.500	0.7283
	47/64		18.653	0.7344
18.75			18.750	0.7382
19.00			19.000	0.7480
	3/4		19.050	0.7500
19.25			19.250	0.7579
	49.64		19.447	0.7656

MODEL ENGINEERS'WORKSHOP DATA BOOK

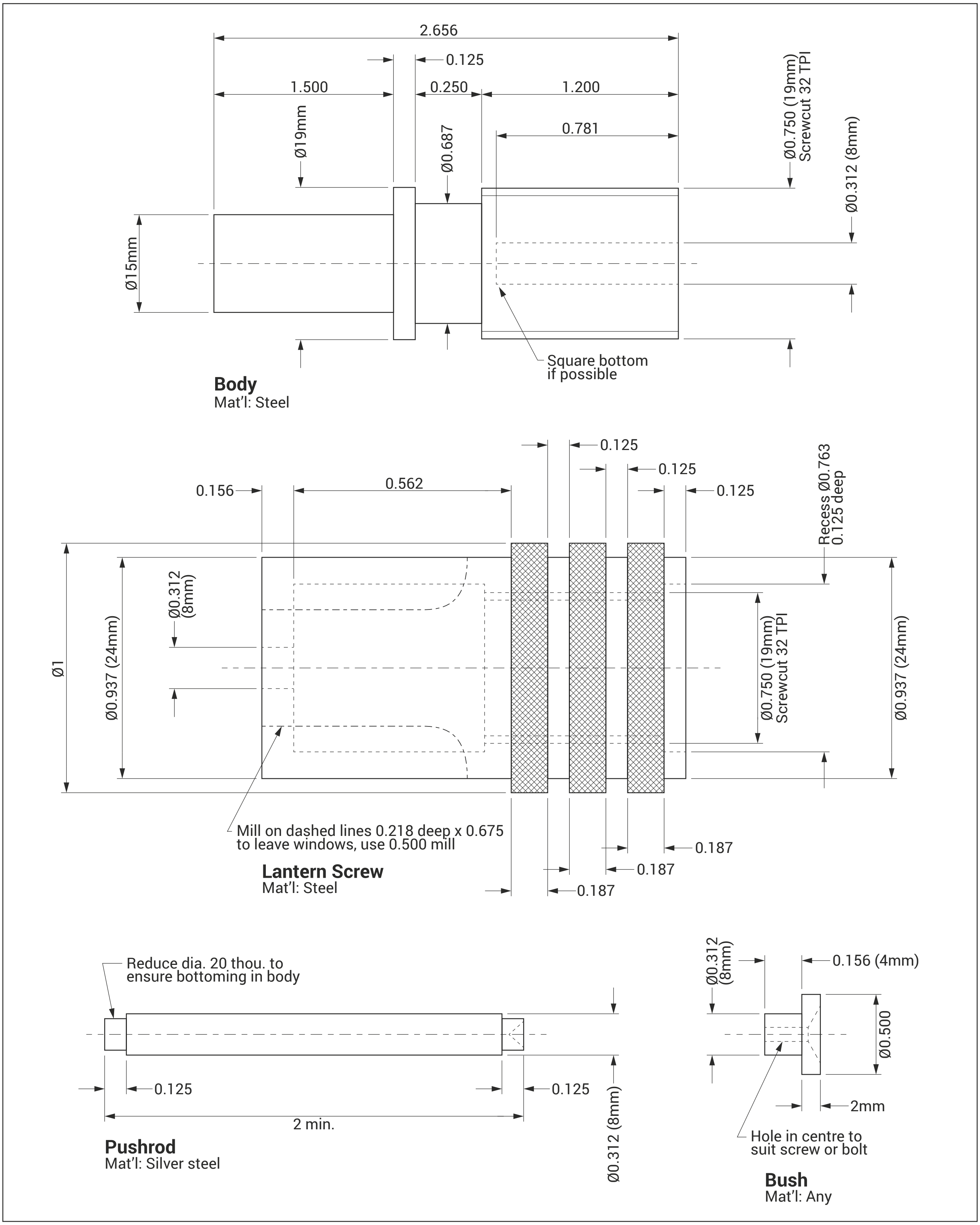
DRILL SIZES METRIC	DRILL SIZES INCH	DRILL SIZES NO./LETTER	DECIMAL SIZES METRIC	DECIMAL SIZES INCH
19.50			19.500	0.7677
19.75			19.750	0.7776
	25/32		19.844	0.7813
20.00			20.000	0.7874
	51/64		20.241	0.7969
20.25			20.250	0.7972
20.50			20.500	0.8071
	13/16		20.637	0.8125
20.75			20.750	0.8169
21.00			21.000	0.8268
	53/64		21.034	0.8281
21.25			21.250	0.8366
	27/32		21.431	0.8438
21.50			21.500	0.8465
21.75			21.750	0.8563
	55/64		21.828	0.8594
22.00			22.000	0.8661
	7/8		22.225	0.8750
22.25			22.250	0.8760
22.50			22.500	0.8858
	57/64		22.622	0.8906
22.75			22.750	0.8957
23.00			23.000	0.9055
	29/32		23.019	0.9063
23.25			23.250	0.9154
	59/64		23.416	0.9219
23.50			23.500	0.9252
23.75			23.750	0.9350
	15/16		23.813	0.9375
24.00			24.000	0.9449
	61/64		24.209	0.9531
24.25			24.250	0.9547
24.50			24.500	0.9646
	31/32		24.606	0.9688

MODEL ENGINEERS'WORKSHOP DATA BOOK

DRILL SIZES METRIC	DRILL SIZES INCH	DRILL SIZES NO./LETTER	DECIMAL SIZES METRIC	DECIMAL SIZES INCH
11.75			11.750	0.4626
11.80			11.800	0.4646
11.90			11.900	0.4685
	15/32		11.906	0.4688
12.00			12.000	0.4724
12.10			12.100	0.4764
12.20			12.200	0.4803
12.25			12.250	0.4823
12.30			12.300	0.4843
	31/64		12.303	0.4844
12.40			12.400	0.4882
12.50			12.500	0.4921
12.60			12.600	0.4961
12.70	1/2		12.700	0.5000
12.75			12.750	0.5020
12.80			12.800	0.5039
12.90			12.900	0.5079
13.00			13.000	0.5118
	33/64		13.097	0.5156
13.10			13.100	0.5157
13.20			13.200	0.5197
13.25			13.250	0.5217
13.30			13.300	0.5236
13.40			13.400	0.5276
	17/32		13.494	0.5313
13.50			13.500	0.5315
13.60			13.600	0.5354
13.70			13.700	0.5394
13.75			13.750	0.5413
13.80			13.800	0.5433
	35/64		13.891	0.5469
13.90			13.900	0.5472
14.00			14.000	0.5512
14.25			14.250	0.5610

Bernard Towers Lantern Chuck

Bernard Tower's design, featured in MEW 301, did not feature any drawings, although Bernard offered to make them available. A veritable tsunami of requests from readers followed, so by popular request, here they are. It would be nice to see some photos or readers' completed chucks.



The Rendle Mandrel Handle

1

WARCO WM250V lathe with headstock end-casing removed.

2

Completed mandrel handle bolted to the main drive pulley.

3

Completed mandrel handle.

David Rendle makes a useful mandrel handle for a WARCO lathe that can be adapted for similar machines.

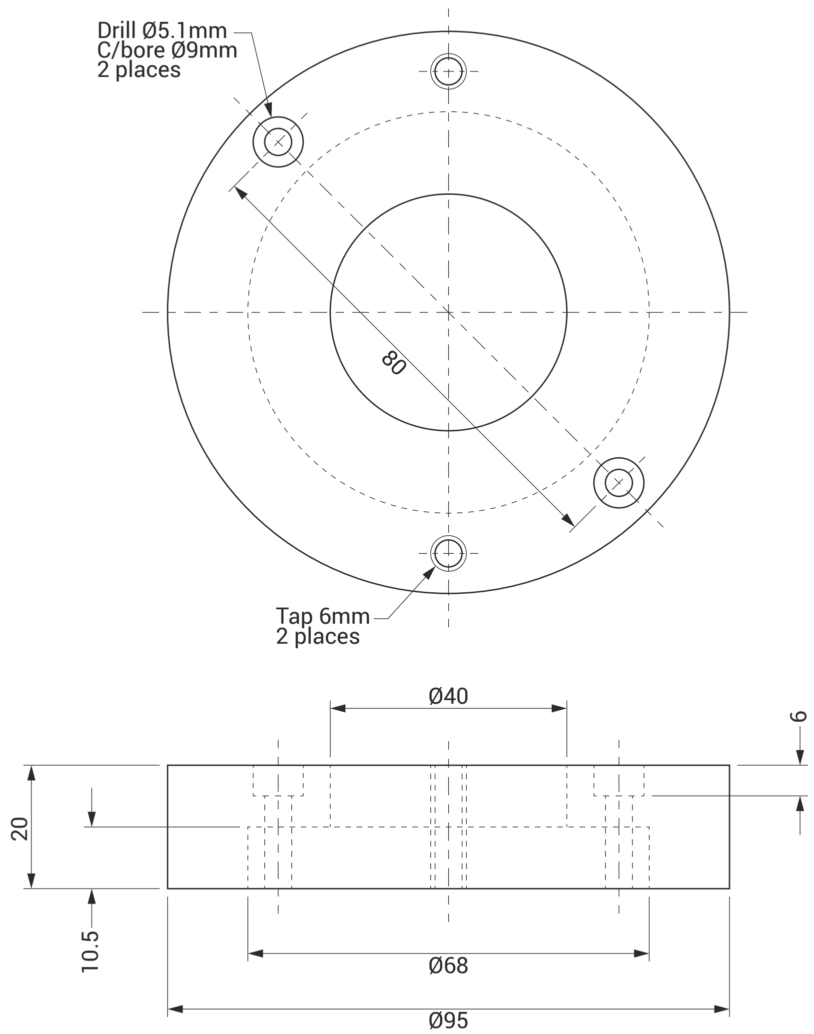
Most screw cutting operations I undertake are on relatively short lengths of bar, ending usually against a shoulder. Powered screw cutting under these conditions can be a bit of a challenge and the obvious alternative is to rotate the headstock mandrel by hand, and I have done this in the past, not very satisfactorily, by gripping the chuck. The aim of this short article is to describe the design and fabrication of a mandrel handle, specifically for manual screw cutting operations.

My lathe is a nine-year-old WARCO WM250V and **photo 1** is of the lathe with its headstock end-casing removed, showing the drive pulleys, belt and gear train. The end of the hollow mandrel can be seen protruding from the centre of the large pulley, and surrounding the mandrel is a black slotted nut (seen more clearly in photo 6) which is used to correct end play in the main spindle bearings. The mandrel handle has been designed to fit over this black slotted nut and the end of the hollow mandrel and is bolted to the main drive pulley, **photo 2**.

An important safety feature of the lathe is the use of micro switches on this end-casing and on the (yellow) chuck guard such that if either casing or guard is removed, power to the motor is disabled. In addition, fortuitously, the completed mandrel handle is too big for the end casing to be replaced with the handle accidentally enclosed within it.

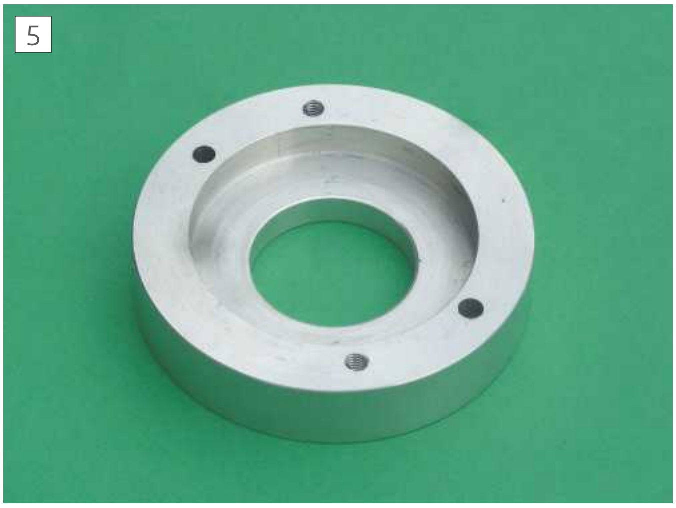
The device consists of three parts: a hub, a crank and a chrome M6 tapered revolving handle. The hub and

Fig.1



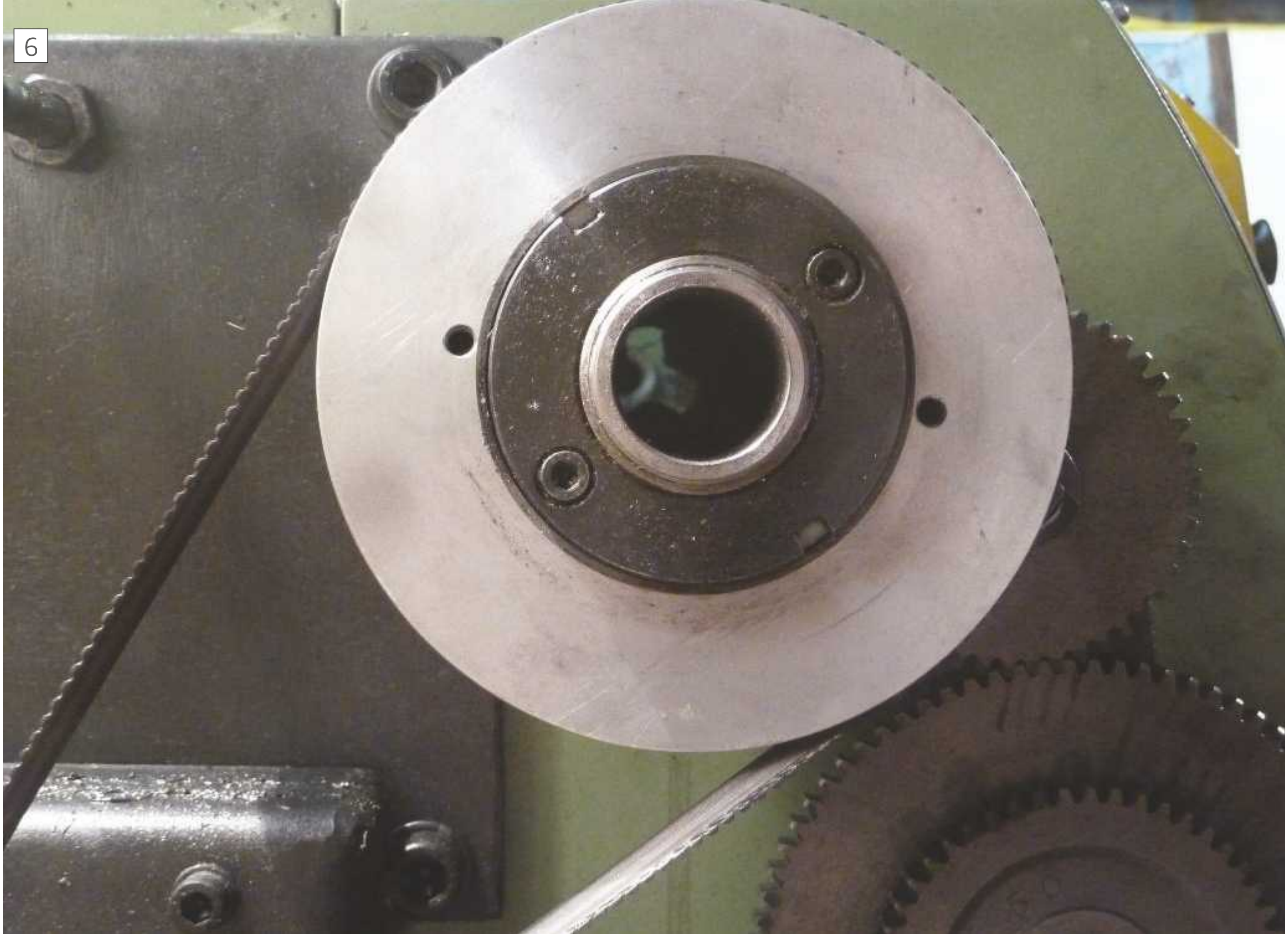
Mandrel Handle Hub

Exterior of the machined hub.



Interior of the machined hub.

6



M5 tapped holes in the main drive pulley.

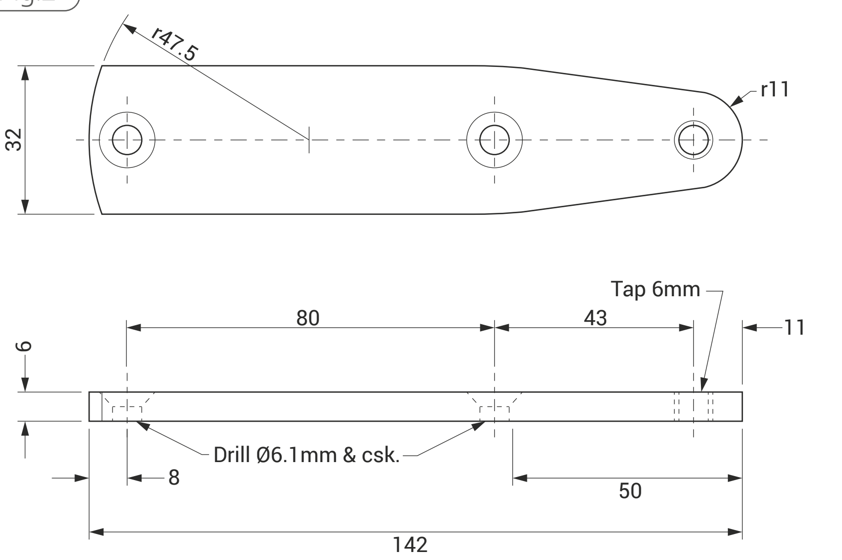
crank are made of aluminium and the revolving handle was purchased from Arc Euro Trade. **Photograph 3** shows the completed mandrel handle prior to bolting to the lathe, and **photos 4** and **5** show the exterior and interior of the hub respectively.

The hub was machined from a billet of aluminium 20mm thick and 95mm in diameter. It was mounted in the three jaw chuck, faced and bored to dimensions, **fig. 1**, to yield an easy fit over the slotted nut and mandrel of the lathe. Two diametrically opposed pilot holes 4.2mm diameter (M5 tapping size) were drilled in the hub, 80mm apart, then the hub was held against the main pulley and these holes were used to spot through to the pulley which was then drilled to a depth of 13mm and the blind holes tapped M5, **photo 6**. The pilot holes in the hub were enlarged to 5.1mm and counterbored 9mm diameter to accommodate 5mm hexagon cap screws (see photo 4). Two further holes, again diametrically opposed, of 5mm diameter were drilled 80mm apart in the hub and tapped 6mm (photos 4 and 5), enabling the crank to be fixed to the hub with 6mm countersunk screws.

The crank, **fig. 2**, was marked out and sawn from 6mm thick aluminium plate, then shaped and filed. Holes spaced 80mm apart for the 6mm screws were drilled 6.1mm and then countersunk. The hole for the tapered revolving handle was drilled 5mm and tapped 6mm. After the hub had been machined and the crank screwed in place, the combination was mounted on a rotary table and, using a vertical mill, any overhanging part of the crank big end milled carefully until its radius merged with that of the hub (47.5mm). The crank small end was treated similarly but milled to a radius of 11mm.

The attachment has proved a most useful and well used addition to my collection of lathe accessories. ■

Fig.2



Mandrel Handle Crank

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 - Part 2

Initially, I remembered that I had a ‘Helping Hands’ unit hidden away under the workshop bench, so decided to give it a try. I found it to be a most awkward device to adjust, and finally gave up in sheer frustration. I now know why I’d hidden it away under the bench and was pleased to return it there once I had made the new fixture.

The design finally adopted consists of two holders, one for the LED and the other for the resistor. The holder for the LED has a recess to locate the LED - this is machined in with a 5mm ball-nose cutter to a depth of 0.27”. The holder for the resistor has a $\frac{3}{32}$” diameter through hole, and the resistor is held gently in position with an 8BA screw (see later photo of the fixture in use).

The material used was $\frac{5}{16}$” diameter aluminium alloy for the bodies and $\frac{3}{16}$” diameter mild steel for the columns, mainly because I had these to hand. Any other suitable combination of materials would be ok.

The two holders are fitted into holes in a simple steel block (not drawn) - the holes should be $\frac{7}{8}$” apart. The size of this block is unimportant, but it should be fairly heavy to provide stability during the soldering operation.

The holder for drilling and tapping the probe ball.

2.4 Battery holder for testing LEDs

I felt it advisable to test the LED / resistor combination after soldering just to check that it still functioned ok and hadn’t been damaged during the soldering operation. After all, there was no point in building a faulty LED into the cartridge, with all of the work involved in making and assembling components. It is just a simplified version of the battery case as used in the cartridge, and it’s use will be described when we assemble the cartridge. The holder uses the same end cap as used in the cartridge.

2.5 Guide for LED assembly

This is a simple guide to locate the LED in relation to the cartridge body while the adhesive used to bond the two together is setting. This can be made from an odd end of acetal or aluminium - the only important dimension is the form of the seat for the LED which should be made with a 5mm ball-nose cutter. The slot is to accommodate the wire which runs alongside the LED base - nothing special here.

2.6 Holder for the end cap

This is simply a short end of rod with recesses in both ends, and is used for locating the smaller diameter of the brass end cap so that the countersink can be formed, and locating the larger diameter of the brass end cap when it is glued into the acrylic tube.

The diameter of the rod is unimportant, and the holes are formed to provide for a slight clearance for the

A simple backstop.

end cap. Length to suit your method of holding.

2.7 Holder for drilling and tapping the ball

Ideally made using a collet to maintain concentricity, the holder is straightforward to make with the ball clamped in the seating formed by a No.4 centre drill. In use the nut is tightened to secure the ball in the seating, **photo 10**.

2.8 Backstop - will come in handy

This is a simple backstop made from a readily available blank end arbor, as sold by a number of our suppliers, and it forms part of my general workshop tool collection, rather than being a dedicated tool for this project (so it doesn't appear on the drawing). Various lengths of screw provide for a range of length settings. This item is shown in **photo 11**, and it is used on this project to stop fragile components from sliding into the mandrel due to insufficient grip in the chuck.

Of course, any other form of backstop that you may have could be used for this purpose.

Making the cartridge body parts

This applies to both fixed and moveable styles. The cartridge is shown on the general arrangement drawing, and detailed in **fig. 3**. There are more details about the wiring later on in this article.

The cartridge body consists of four parts which require turning, and the white acetal parts will need to be skimmed down to 0.394" (10mm) diameter during manufacture if the material is oversize. As clearances in the main steel body are tight any machining deviations from size should be downwards (this comment applies to the battery case end cap and the cartridge body). In fact, it is preferable that the finished diameter should be less than the acrylic tube as we will need to hold the finished cartridge in a collet to skim the end cap and it is preferable to hold on the tube itself.

I aimed to make the cartridge body a good fit in the acrylic tube to maintain good alignment of the finished cartridge, and also to prevent adhesive from finding it's way into the tube and causing optical defects. Too tight though, and there is always the risk of damaging the acrylic tube on assembly. In particular, initially the fit of the cartridge body in the acrylic tube was too tight and the acrylic showed signs of crazing and cracking. Please be aware that this may not appear for several days as stresses are relieved. This is also a problem with holding too tightly in a 3-jaw chuck, so it is worth using a collet if you have one available.

One point worth noting is that I experienced a small amount of 'spring-back' of the acetal material which affected clearances, so it seems that sharp tools and small final cuts may be required to overcome any problems. So please beware. When making the cartridge components, the following methods worked for me.

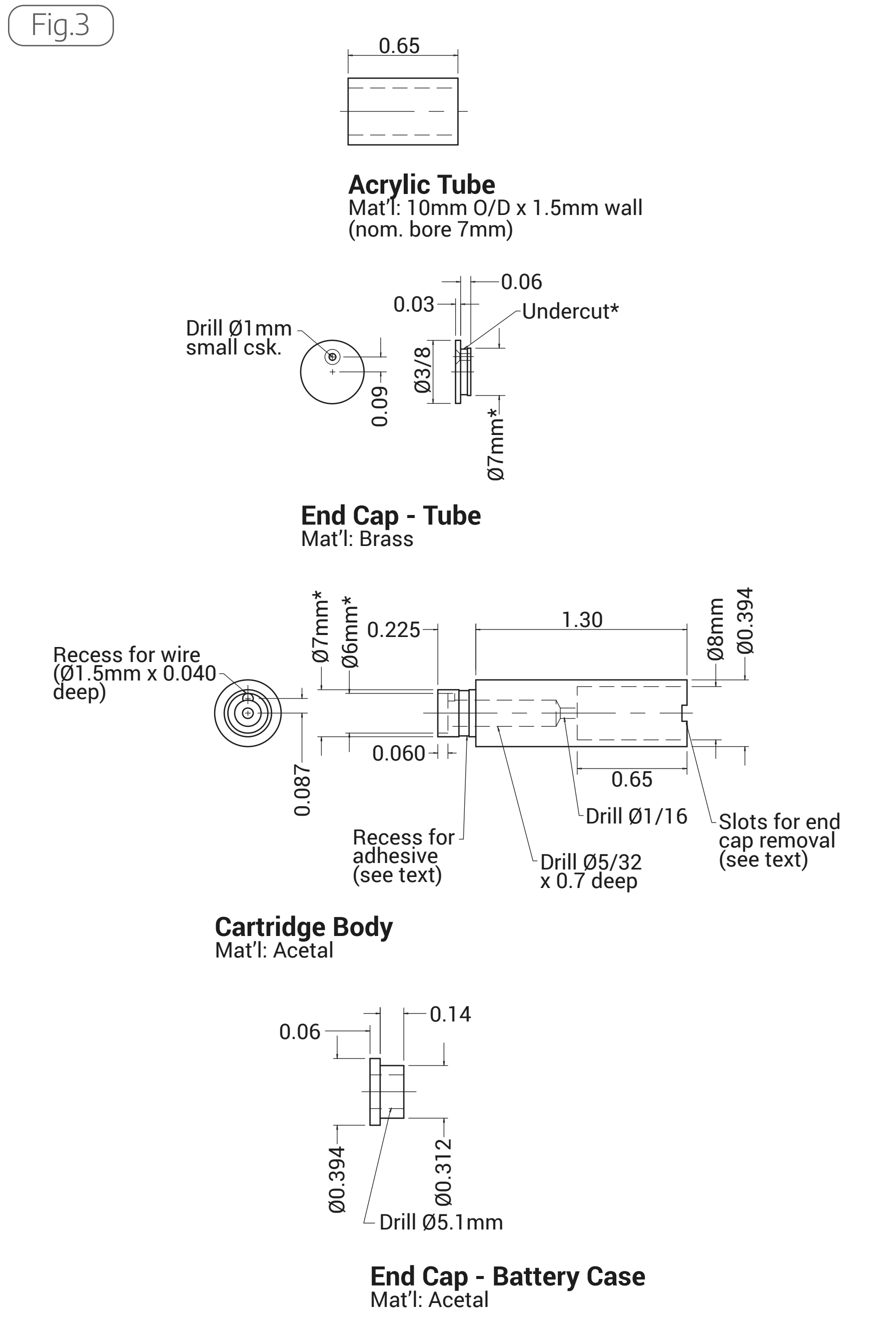


Fig.3 Turned Components For Cartridge
*see note in text for dimensions marked *

3.1 Acrylic tube

The first part to turn should be the acrylic tube, as it can then be used for gauging the cartridge body and brass end cap. The tube used is stock 10mm x 7mm bore (nominal). The bore of my particular sample was 7.37mm (0.290") so I made the end cap and cartridge body spigot dimensions to suit.

I found that the kindest method of producing this tube was firstly to gently face off in the lathe (using a collet - hand tight only) and then cut-off slightly over-length using a junior hacksaw. Given my previous experience

Positioning the milling spindle using the centre finder.

Drilling the 1.0mm diameter hole in the brass rod.

with machining the acrylic tube I felt that using a junior hacksaw would be safer than using a parting tool. Then, again holding in the collet and using the backstop, I faced the sawn end to the correct length.

3.2 End cap - tube

I used a piece of ⅜" diameter brass rod to make this. The operation sequence that I used was firstly to face the end (to clean-up) and then reduce the diameter to fit into the acrylic tube. Next, form the undercut - this is included to hold sufficient adhesive to ensure a good bond - I made mine around 5 thou deep. The full diameter land acts as a location and should stop any adhesive from seeping into the tube. The face of the end cap can also be polished at this stage to provide a reflective surface.

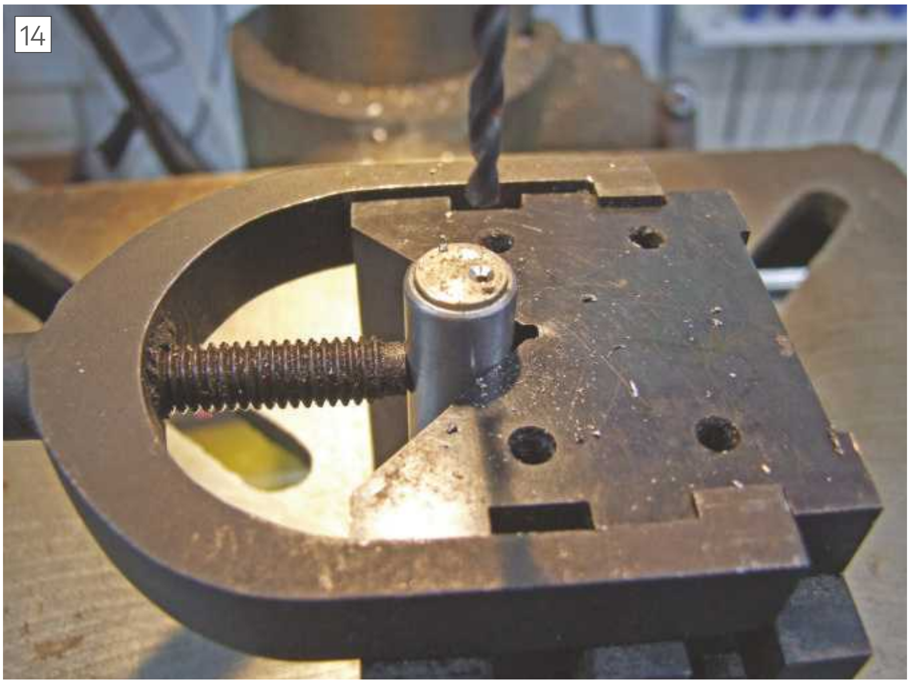
To drill the 1.0mm diameter hole I first needed to establish the centre of a ⅜" blank, and then offset it by 0.090" to drill the hole. I found the easiest method was to use the milling machine, with the material held in a vee-block clamped in the milling vice. To locate the centre of the blank I used another length of ⅜" diameter material which had been centre-drilled, and then located this under the milling spindle using a centre finder. **Photograph 12** shows the situation before moving into the 'centre position' - the bottom disc is offset to the main spindle and milling table needs to be moved so that there is no discernible offset (the fingers are sensitive enough to feel any offset). Once this alignment has been completed the position holds good for any material of the same diameter as the test piece - then just zero the dials or DRO. The milling table was then moved 0.090" away from this position, the centred blank replaced with the brass and the 1.0mm hole drilled, **photo 13**. If this hole is drilled fairly deeply then the material can be parted-off to produce a number of end cap blanks. Before parting off it is worth breaking the edge of the hole you have just drilled to provide a lead-in for the cathode wire when it comes to assembly - simply hold a small drill in a pin vice and twiddle it between your fingers.

One final little job is to put a countersink in the 'parted-off' face to feed in the solder, **photo 14**. I used a 1/8" diameter drill for this. I found that the easiest way to hold this was to drill a hole in the end of an odd length of round bar (as in fig. 2.6) and then lay the end cap in it - the force exerted when drilling is perfectly adequate to keep the end cap captive. This hole will need to be pre-tinned before the end cap is glued into the acrylic tube, and this will be covered as part of the cartridge assembly description (section 4.4).

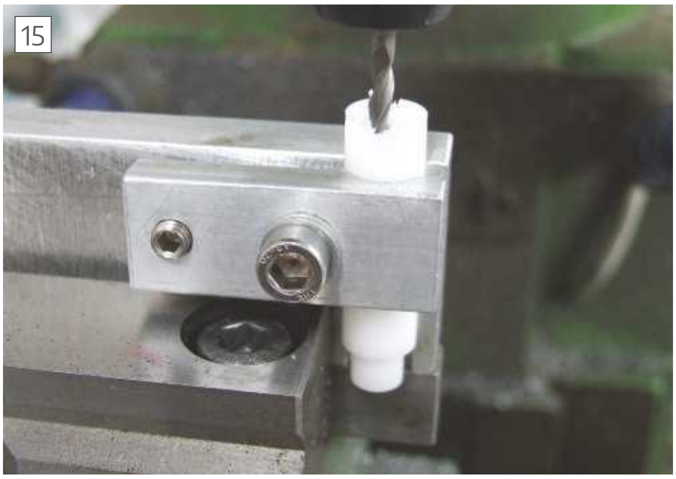
3.3 Cartridge body

The cartridge body combines the battery case and LED base which were separate items with the first two versions of cartridge.

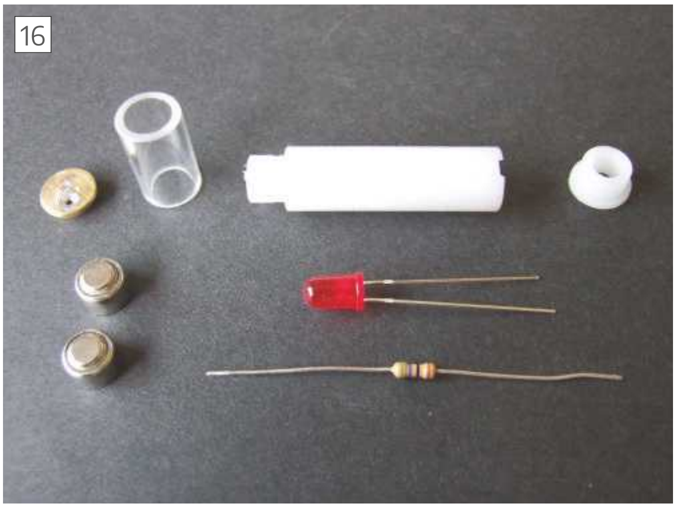
Starting at the acrylic tube end (LHS on the drawing), the spigot should be turned to be a snug (but not tight) fit inside the tube as this should avoid the risk of adhesive seeping into the acrylic tube. The diameter should be reduced slightly where shown to allow for the adhesive. The $\frac{1}{16}$" and $\frac{5}{32}$" diameter holes are drilled next, followed by the $\frac{1}{16}$" deep seating for the LED (using a 6mm slot drill). This counterbore is very slightly larger in diameter than the base of the LED, which again has



Forming the recess in the end cap for the solder.



Milling the slots in the end of the cartridge body - they will be useful when prising out the battery end cap. Note the parallel being used as an end stop.



Component parts for the cartridge.

the advantage of somewhere for the adhesive to go.

The cartridge body can now be parted-off to length and turned round in the lathe to machine the recess which houses the batteries. The batteries chosen for this project are SR48, which are quoted as being 5.4mm high x 7.9mm diameter. I found that the samples tested were all below the 7.9mm specified diameter, so I was confident in using an 8mm slot drill to form the battery compartment. Anyone deciding to make these edge finders should check their battery diameters. However, please also check that the batteries fit easily, as I found that the bore was likely to cut undersize with this material, particularly if the cutter has previously been used on other materials such as steel. It is also worth holding the cartridge body in a collet if you have one suitable, as once the bores are machined the wall thickness is down to 1mm, so care is required. I also found that I needed to use a backstop in order to stop the cartridge body from being pushed away by the tool.

This part has a couple of additional features which need to be added at this

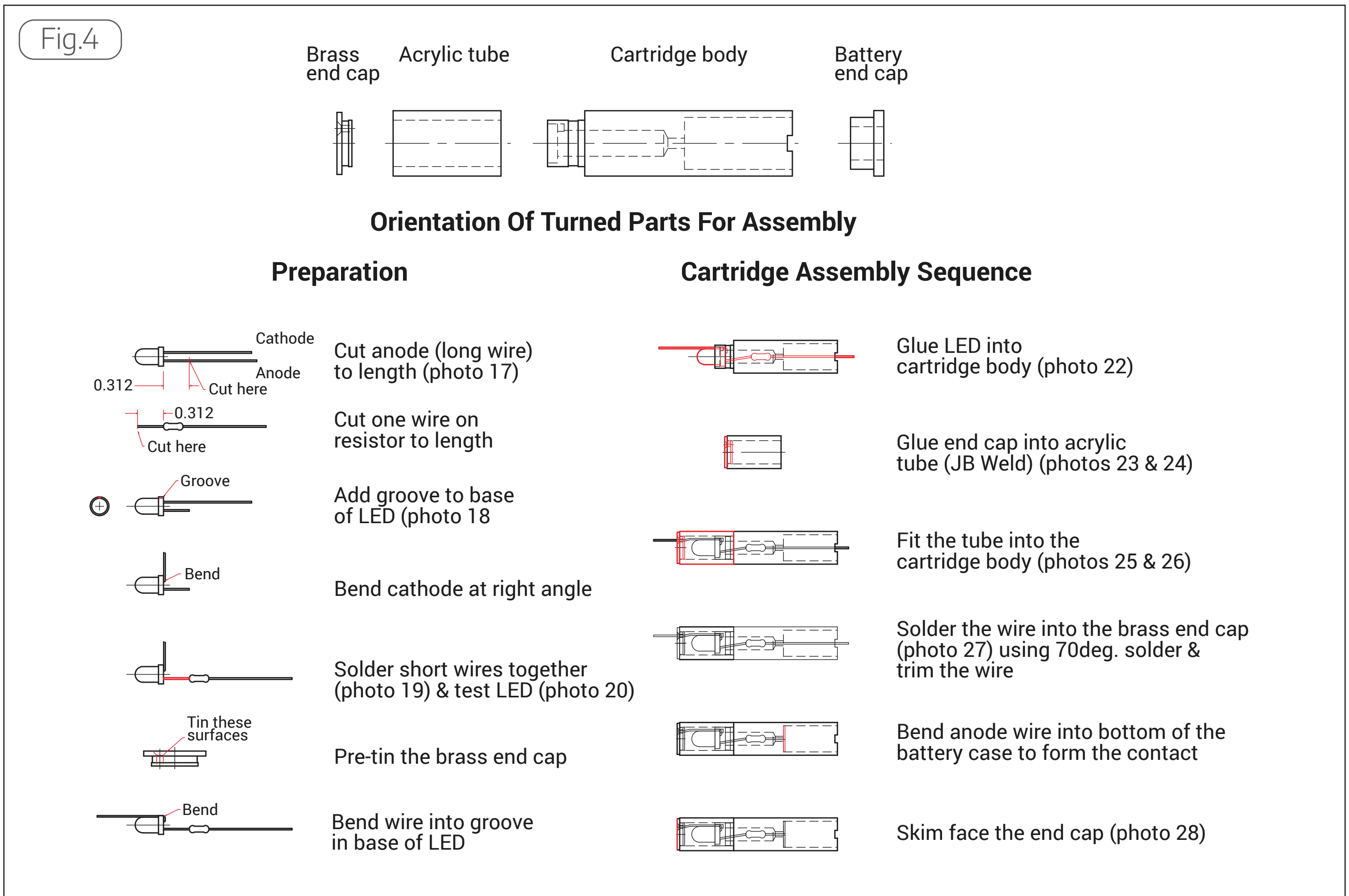
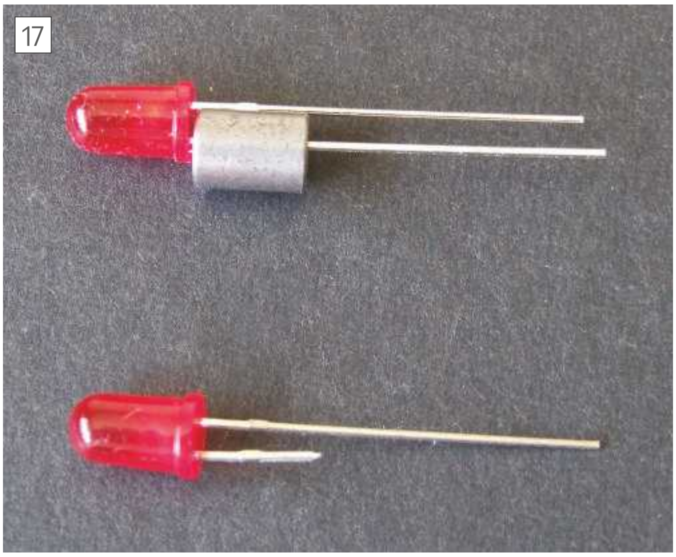
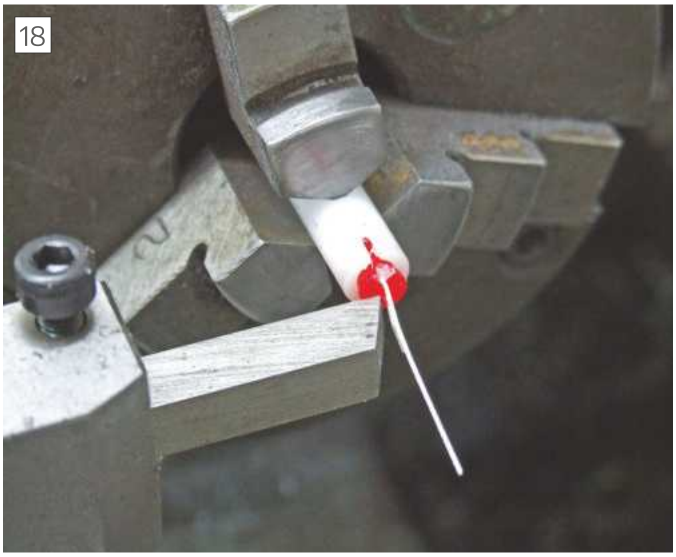


Fig.4 Assembly Sequence For Cartridge
Each operation or new component added shown in red



Cutting the LED wire using the gauge to determine the correct length.



Holding the LED to form a groove in the base. This groove will allow the cathode wire to pass into the acrylic tube.

stage. Firstly, there are two small slots in the battery end of the body which can be used when prising off the end cap - I decided to use the tube vice in the mill to produce these slots, as shown in **photo 15**, although they could easily be filed. In this set-up the parallel acted as an end stop making repetition easy. Size is not critical and is probably best matched to the available screwdrivers. Secondly, as the wire from the LED which runs to the brass end cap is bent under the base of the LED, a recess will be needed to accommodate the wire. I made a plunge cut with a 1.5mm 3-flute cutter to a depth of around .040" as this would allow for any curvature of the wire as it exited the LED body. Making this slot would also be a simple job for the Dremel and a burr.

3.5 End cap – battery holder

This is used to stop the batteries from falling out of the cartridge if it is tipped upside-down and should be a good fit in the battery case. It has a 5.1mm diameter hole to clear the contact spring and needs no further description. The complete set of components for the cartridge is shown in **photo 16**.

Cartridge assembly

The cartridge assembly sequence is shown on the drawing **fig. 4**, and described below but first, a few thoughts about adhesives and soldering.

Adhesives

With the first two versions of the cartridge I used a medium viscosity superglue, and all went reasonably well until the operation when I fitted the LED base (with the LED) into the acrylic tube. Disaster struck - too much superglue and it went everywhere. The major problem was that it seeped into and filled the slot in the acrylic tube. It also stiffened the cathode wire, making it impossible to bed it into the slot. That batch of cartridges went into the bin, so beware.

Another problem that I found when using superglue was that it is very easy to stick fingers and components together if too much adhesive is applied, leaving marks on the surfaces (and the fingers!). My initial thoughts were to use masking tape to mask-up both the LED and the acrylic tube to avoid finger marks. In practice this didn't work out too well as the superglue tended to seep under the masking tape, making removal very difficult and time consuming.

Following on from these bad experiences I decided to abandon the use of superglue. The assembly process now uses just Araldite for all of the 'plastic' parts, and I found that this was far more controllable than the superglue. To glue the brass end cap into the acrylic tube though, I had concerns regarding the use of Araldite in a potentially higher temperature environment. Apparently, Araldite starts to soften at around 60 - 70 degrees C, which is around the melting point of the white metal solder. I used a different approach with this joint and found a JB Weld two-part epoxy product which can withstand temperatures of up to 290 degrees C (550 degrees F) once fully cured (at which stage the acrylic tube would be long-gone). The only downside with using this product is that it takes up to 24 hours to fully cure, although as I had already spent several years developing this project, I didn't regard it as a huge problem.

The only issue that I had with the JB Weld (and potentially with the Araldite) was one of ambient temperature, where the adhesive 'flowed' rather more than I would have liked. As I chose the hottest day of the year to date then maybe I should have expected that. Any surplus was soon wiped away with a meths-dampened paper towel. The next applications took place under cooler conditions without any problems.

Soldering

Soldering the wire into the brass end cap was my main area of concern regarding heat damage to the tube and found out that acrylic begins to soften at around 100 degrees C, and eventually melts at around 230 degrees C, so if I could keep the temperature well below that during soldering then I should hopefully be OK.

I looked at the typical melting temperature of soft solder and found it to be over 200 degrees C, so obviously that was a non-starter. I knew that railway modellers who build white metal kits have to use solder with a much lower melting temperature, so I managed to find 'solder' with a melting point of around 70 degrees. The advice given is that it is unsuitable for soldering to brass as the joint would be weak, although this can be overcome by pre-tinning the brass. I wasn't looking for a particularly strong joint anyway, but it had to have good electrical contact - more of this later during the assembly stage (sections 4.4 and 4.7).

As a heat source I experimented with a 60W soldering iron and also 100W and 175W solder guns - all did the job satisfactorily, with the only difference being speed.

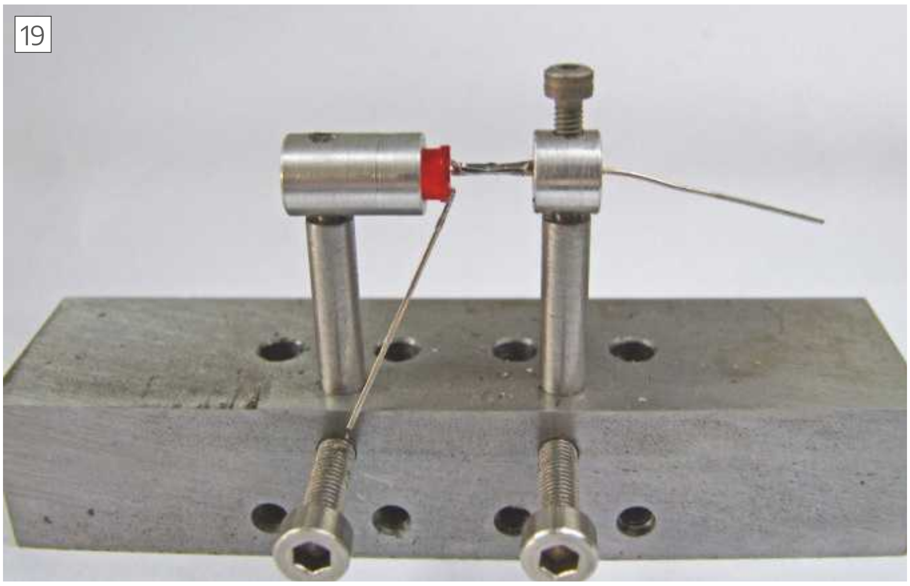
4.1 Prepare the LED and resistor

A certain amount of preparation is required to the LED and resistor before construction proper can take place. The wires which will be soldered together need to be shortened. The anode wire is the longer of the two wires from the LED, and needs to be reduced in length to 5⁄16" maximum, as is the case with one of the resistor wires. If you've made the gauge (fig. 2.2) then now is the time to use it - just pass it over the wire and snip - job done, **photo 17**.

The LED itself also needs to be modified - the wire to the probe end of the cartridge runs within the cartridge itself and is 'wedged' between the LED and the inner surface of the acrylic tube. The flanged base of the LED will become a barrier and needs to have a groove added to allow the wire to pass between the LED and it's seating in the cartridge body (adjacent to what is now the longest wire, if that makes sense). This is easily accomplished with a small burr held in the Dremel. I found the easiest way to hold the LED for this operation was to use the LED assembly guide (fig. 2.5) in the lathe chuck, and then a piece of square material held in the toolpost can be used to secure the LED in position (**photo 18**). It is also worth breaking the corner where the groove runs out onto the base end of the LED to ease the bend in the wire. One final task was to bend the (now) longer wire at right angles to the base of the LED - I found it easiest to use the flat blade of a screwdriver to do this.

4.2 Solder the LED to the resistor

Preparation completed, we can now solder the LED and resistor wires together. This is where the soldering fixture (fig. 2.3) comes into play.



The LED/resistor soldering fixture in use.

Fit the LED into the socket and then pass the resistor though the hole in its holder and use the screw to gently hold it in position. **Photograph 19** shows the LED and resistor after soldering.

For soldering the resistor and LED wires together I used standard cored solder, suitable for electrical applications. I was rather nervous about this operation due to the potential for damaging the LED due to too much heat being applied. Available data suggested that for soldering the LED the maximum temperature should not exceed 260°C for a maximum of 5 seconds, so I had a fighting chance. I'd bought plenty of LEDs and resistors so I could afford to lose a few in getting the process right, although I'm pleased to report that there were no failures.

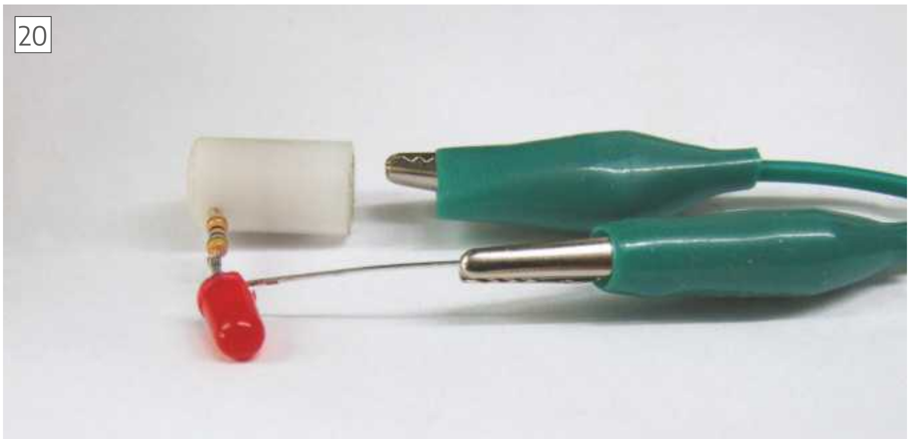
I had intended to use a very thin wire to tie the LED and resistor wires together for soldering, but somehow it got mislaid and the soldering was completed without it. The lesson here is put things somewhere safe and then remember where that is.

The big question though was had I overheated the LED, and would it still function? This is where the battery holder shown in fig. 2.4 was used. Simply fit the resistor wire through the 1⁄16" diameter hole in the battery holder and then add the two batteries (with the positive '+' face downwards against the wire). The other wire from the LED is then connected back to the negative '-' side of the batteries using the lead shown, and if all is well the LED will light up. The general idea is shown in **photo 20**. Once you are satisfied that the LED is ok, then the cartridge itself can be assembled.

4.3 Pre-tin the brass end cap

The end cap must be prepared by pre-tinning the hole for the cathode wire and the low melting point solder. This is done before the end cap is fitted into the acrylic tube as higher melting point solder is used here and the high temperature would damage the acrylic, and possibly the adhesive bond. The aim here is to coat the recess rather than fill it.

I found that the best way of achieving this was to partially fill the hole with a 'core' of smaller diameter wire, and then remove it leaving the hole coated in solder. I used a short length of stainless steel wire for this. If the hole is too large around the LED wire at stage 4.7 (below) then the white metal solder is liable to flow down it and into the space around the LED.



The arrangement for testing the LED.

●To be continued

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3D CAD and 3D Printing Helps Fix a Car

David Jupp uses new technologies to tackle an interesting problem.

Though this article describes the use of 3D CAD and 3D printing to help tackle a particular problem, the manufacturing steps could equally have been undertaken by more traditional methods. I used 3D printing because I have a printer, and it could be left to produce the parts whilst I was doing other things. The techniques used could be applied to produce simple fixtures or non-critical adapters for other purposes.

Based upon symptoms that I'd noticed my car exhibiting, backed up by a stored OBDII diagnostic code that I retrieved, I thought it possible that at least one fuel injector was not shutting off tightly.

I searched on-line for information on 'leaking' or 'faulty' fuel injectors – what I found suggested that most 'faults' are the result of carbon accumulation in the injector, and that these can be resolved by ultrasonic cleaning, and the replacement of seals and filter elements. Having the injectors overhauled would be much cheaper than replacing them, though it would require sending the injectors away and being without use of the car for several days. As I wasn't entirely convinced of my diagnosis, I was reluctant to be without the car and to incur the cost of overhaul.

Further internet research revealed details of how injectors are cleaned, and also that 'repair kits' (seals/filters) are available inexpensively from on-line retailers. As I have a small ultrasonic bath, I began to think perhaps I could tackle this myself. I needed to work out how to operate the injector electrically during cleaning, and how to forward and back flush the injector after cleaning.

Devices are available that can 'pulse' the injector, and these aren't horribly expensive – but spending cash on something which might never be used again seemed silly when I had a small 'intelligent relay' device surplus from a work project which would be easy enough to program. In extremis I could have resorted to a simple push button switch, for initial trials.

To avoid the symptoms getting worse, and perhaps to make some improvement, I added a bottle of 'injector cleaner' into the car fuel tank whilst I planned my next move.

I had to find out the make/model of fuel injector, not easy when they are installed. Internet to the rescue again – a multi-manufacturer, on-line car parts catalogue with exploded diagrams allowed me to identify the part and gave both Ford part number, and a Bosch part number. Searching in turn on the Bosch part number revealed the injector to be from the EV14 family and implied a standard length body (but see later for a sting in the tail). I was able to locate a data sheet from Bosch Motorsport and a drawing showing full mounting dimensions. Additionally 3D STEP file models of several variants of the injector were available for free download! **Figure 1** shows imported STEP models of EV14 Standard body, with normal and extended tip options. These STEP models provide the shape and size of the exterior of the injector, but no internal details.

On the EV14 fuel injector, the fuel flow rate and spray pattern are both

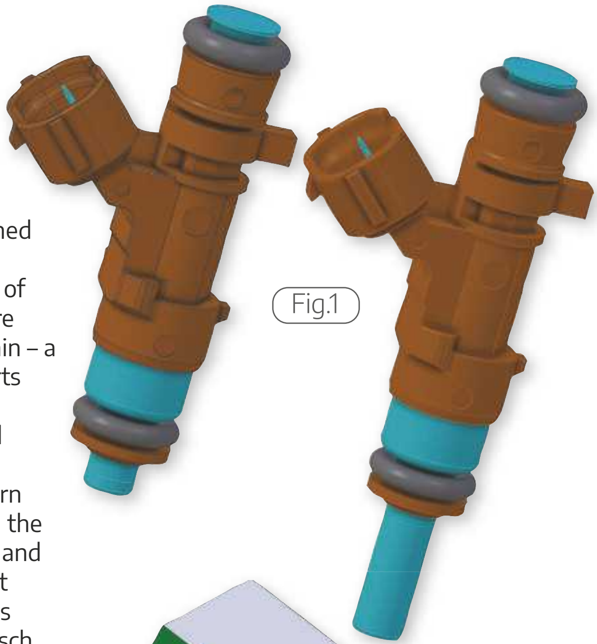


Fig.1

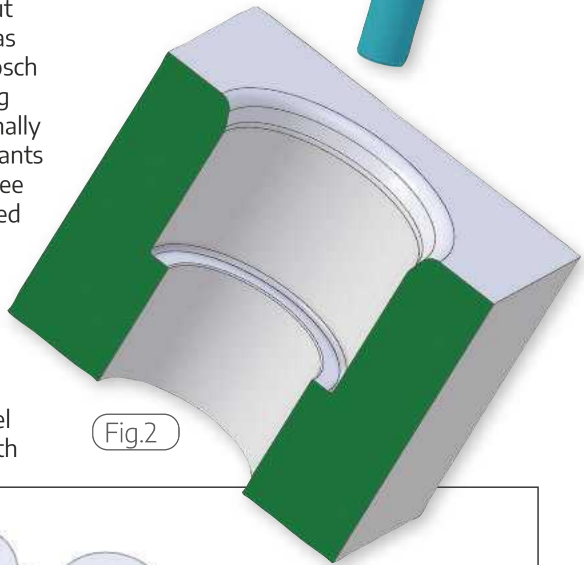
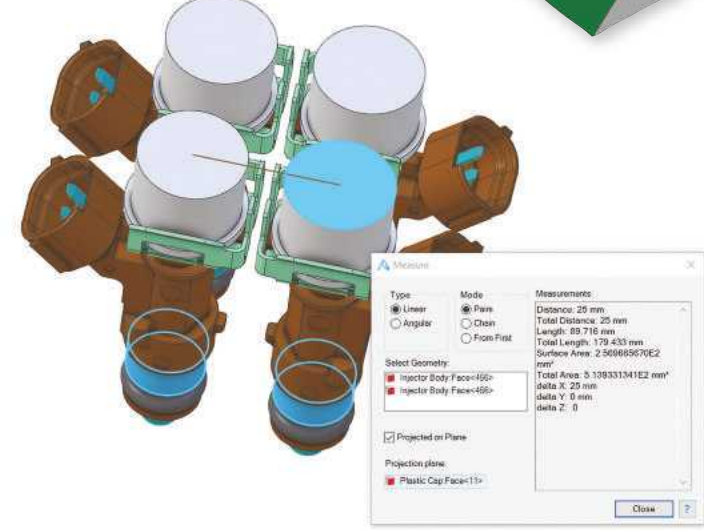


Fig.2

Fig.3



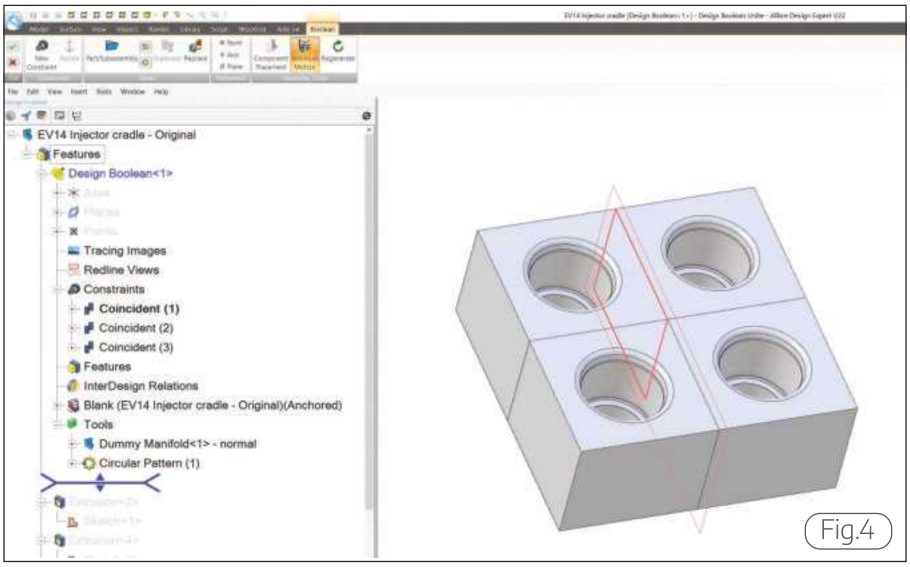


Fig.4

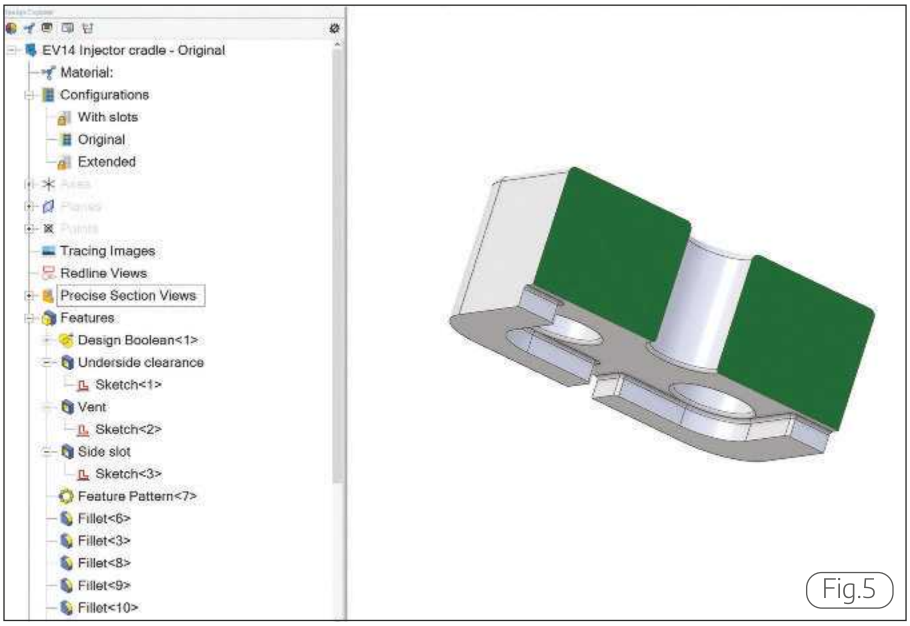


Fig.5

determined by precision holes in the circular end face of the injector; part of the cleaning process requires the injector to be held vertically in the cleaning bath, so that the end face is towards the ultrasound source. After checking the size of the cleaning bath I set about designing a simple fixture to hold four injectors in the required orientation.

The first step was to design a very simple block which replicated the dimensions of the mounting detail given in the Bosch drawing, **fig. 2**. It wouldn't have been difficult to have created this totally from scratch – but as the dimensions were available, I used them.

Next, I imported the 3D STEP model of the injector into my Alibre Design CAD system and arranged four injectors in an assembly, to allow me to judge what spacing would avoid clashing, whilst keeping the whole arrangement compact, **fig. 3**.

Having arrived at a spacing, I combined four of my previous simple blocks into one (Boolean unite), added a recess in the underside, a 'vent' hole in the centre, and notches in the base to allow cleaning fluid in and out. This build-up of features is shown in **figs 4** and **5**.

Having designed the part, I processed it through Cura slicing software and set it to print. I used the second finest of the slicing profiles in Cura – I wanted the part to come out fairly accurately and to have a reasonable finish, so that injectors could be inserted without difficulty. The O ring seals would tolerate a less than perfect surface finish as only very modest pressure would be used to flush through.

As soon as I had printed the part, I realised that I hadn't made sufficient provision to avoid air entrapment around the injector tips. A revised Mk2 design (**fig. 6**) was produced with added communicating slots between each injector socket, and the central vent.

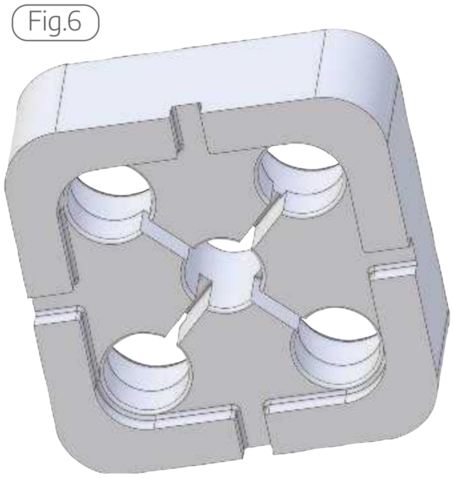
Next my attention turned to making 'end caps' to fit the injector and facilitate flushing. For the fuel supply end, I started from the plastic cap dimensions in the mounting details drawing. I decided to try using a syringe to force fluid through the injector – so the end cap would need to incorporate a suitable female taper to accept the Luer slip fitting on the end of a syringe. To find the dimensions of such a taper I resorted to searching British Standards via the on-line eLibrary services of a local public library. BS EN ISO 80369-7 turned out to contain the information required, and though printing copies of the standard is not supported via the eLibrary, the dimensions were simple enough to just note down.

Armed with the details of the female Luer fitting, in CAD I added extra material to the end of the 'cap' and then cut the profile for the taper. I placed the taper hole 'on axis' as it would allow 3D printing of the part without added supports – if I had been machining the part from solid, I may have considered placing the female taper radially instead.

Because the part was small, and to get best possible finish for the Luer taper (no soft seal this time), I altered STL export settings from CAD to give a smoother surface finish, and I used the finest slicing profile for printing of the part. **Photograph 1** shows the printed cap attached to a syringe salvaged from an inkjet printer re-fill kit.

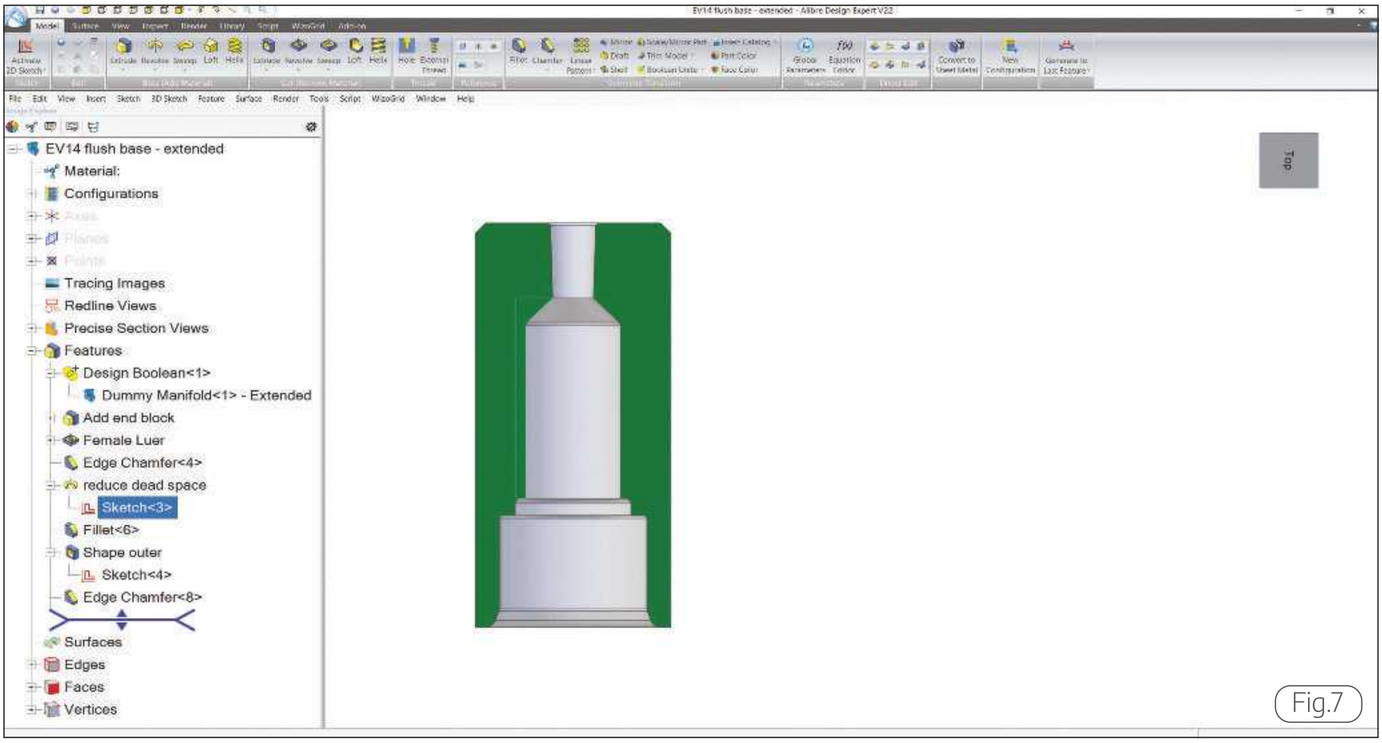
Whilst the fuel supply end cap was printing, I worked on the design of the cap for the engine end of the injector (to be used in reverse flushing). I started from the simple block design previously mentioned, that I had used when first designing the fixture to hold the injectors. Sufficient material was added

Fig.6



to the end to accommodate the female Luer connection, and the taper was 'cut'. Placing this part and an injector model together revealed significant dead space around the injector tip. A little 'in-place editing' of the part with the injector still visible made short work of eliminating much of the dead space. **Figure 7** indicates the build-up of this design (though a later version is actually shown). The resulting design was exported, sliced and printed using

Syringe with 3D printed cap attached.



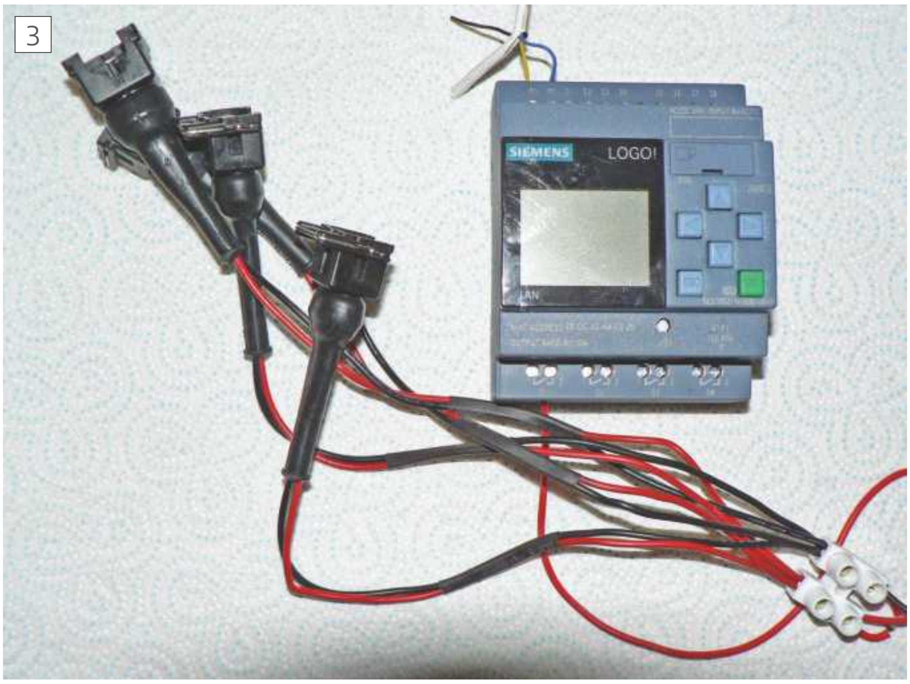
Reverse flushing cap attached to injector.

the same settings as for the first end cap. **Photograph 2** shows the reverse flushing cap with an injector in place.

Not being keen on using crocodile clips or similar to connect to the injector operating coil which would be in a metal ultrasound bath, I purchased 4 connectors from a fuel injection systems specialist. I made up a simple loom from the intelligent relay to the injectors, including a quench diode to prevent arcing damage to the relay contacts, **photo 3**. I programmed a pulsing signal which could be latched in operation, and also a 'hold down for on' signal, both triggered from button on the front of the module. The intelligent relay wasn't a cost effective item for this task, except that I already had it. A relay or solid state switch driven from an Arduino or similar device would be more economical.

After removing the fuel injectors from the car, they were connected to the pulsing system and submerged in the ultrasonic bath in a solution of degreasing detergent.

3



Setup for cycling the injectors.

It soon became apparent that the injectors were not quite the same dimensions as the STEP model that I had worked with – initially I thought that they were the 'extended tip' version, which I also had a STEP file of (it is a standard option on the injector family but wasn't indicated clearly for the part number that I had). However, I then found that the injector tip was of slightly larger diameter than that in the STEP model. At this stage I looked more closely at the injectors, and found they were not a Bosch part at all, but a DEKA unit! Sometime later, checking the part number from the injector body with a specialist supplier of injector seals revealed that the particular DEKA part is based upon a Bosch injector body design – so it seems reasonable that both might fit the car. In the short term I had to progress the cleaning, and return the injectors to the car.

Another small re-design in CAD of both the injector holding cradle, and the cap for reverse flushing made adjustments to allow for the extended and fatter injector tip. Luckily such adjustments only involve altering a few dimensions, and re-exporting to STL for printing. The final design of support cradle is shown in **fig. 8**, and with injectors in place in **photo 4**.

Pushing an injector into the cap for forward flushing was quite difficult, removing it again even more so. The dimensions of the fuel supply cap which I had copied were intended to ensure the O-ring seal withstood the nominal 3.8 bar from the fuel pump – I was only using a syringe to gently flush the injector, so didn't need so much squeeze on the seal.

4

Injectors in support cradle.

The cap was eased using a hand held 14mm end mill, which made it much easier to flush the remaining injectors. The injector cradle, and the reverse flushing cap didn't suffer the same problem, as the diameter indicated for the hole in the engine head/manifold is rather larger than for the fuel supply connection.

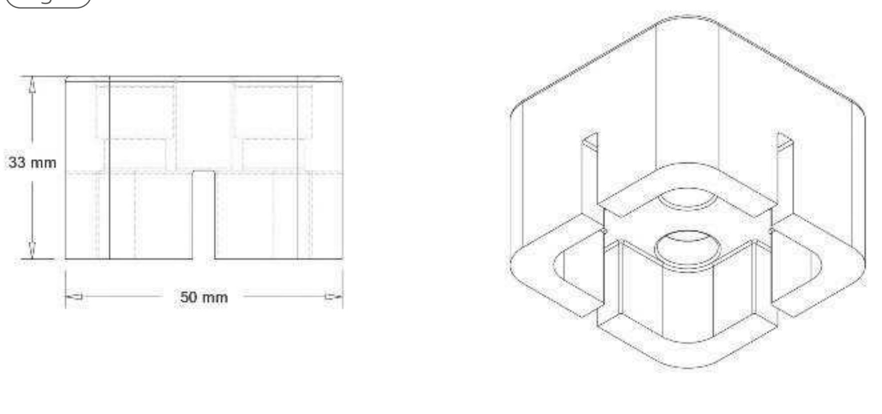
After the initial submersion clean, the injectors were set vertically in the cradle and placed in the ultrasonic bath to ensure maximum ultrasound energy reached their tips – electrical pulsing was again applied during cleaning. This was followed up by forward and reverse flushing, a rinse through with clean water to remove the detergent, and a flush through with Automatic Transmission Fluid to displace the water and leave some lubrication in place. Excess ATF was blown through gently.

The injectors were re-fitted to the car, and I'm pleased to report that the symptoms noticed are much less severe. I now have the correct service kit for the injectors, and I'll repeat the process when the weather warmer.

Though the project was successful, things could have gone better! Checking the part number directly from the injectors would have reduced the amount of work to be done – both in avoiding 'on-the fly' re-design, also the reverse flushing cap would not have been needed as the DEKA injectors have replaceable filters, whilst the EV14 has moulded in, non-replaceable ones. Ironically, I haven't been able to find dimensional data for the DEKA injector. Without having the Bosch data, I would have been forced to measure directly from a removed injector, and from its mounting hole in the cylinder head. I wouldn't have been able to do any of the pre-preparation ahead of dismantling the car.

The main point of my story is that 3D printing can be useful to produce one off fixtures or adaptors, and that the combination of 3D CAD and 3D printing allows rapid adjustment of such items to adapt to the unexpected. ■

Fig.8



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 of 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.

Selection and use of files

GEOMETER indicates which file to use for a specific task and gives a few hints on their maintenance

THE PROCESSES OF marking-off, drilling and sawing, described in previous articles, often precede filing operations. To save time and effort surplus material should, so far as possible, be reduced to a minimum in these previous operations.

An attempt should be made when sawing metal to keep a distance of 1/32 in. to 1/16 in. If the metal is thick make sure that the saw does not bend or run. After sawing it is a question of choosing and using files.

File sections

The diagrams show the more common file sections, choice of which is often settled by the physical limitations of the work. To elongate a drilled hole, for example, a round file, A, would be used, while to square it, a square-section file, *B*, would be used. The corners then might be finished with a three-cornered (three-square) file, C-this type has sharper corners.

Flat surfaces and outside curves can be produced with the ordinary flat or rectangular-section file, *D*. Normally, this has one smooth edge to run against shoulders without damaging them. A round-edged or joint file, *E*, will produce a radius against a flat surface, though it can be used for general filing.

For use on flat surfaces

A half-round or D-section file, *F*, may be used for flat surfaces or to produce internal curves when they are of large radii. A knife file, G, will go into sharp corners or between segments-such as those of commutators of dynamos or automobile starter motors.

A file may be single-cut, *H*, or double-cut, Z, depending upon whether it has one or two series of grooves forming teeth. Freer and more rapid cutting is obtained from double-cut files, although the finish tends to be poorer than that produced by single-cut varieties.

Terms rough (or coarse), second-cut, smooth, and dead-smooth indicate broadly pitches of teeth. A rough tile may be 20 t.p.i., a second-cut about 40-, a smooth about 60-, a dead-smooth 100- or more.

The general principle is to use the coarser files for the softer materials and roughing out, and the finer ones for harder materials and finishing. Another fairly common practice, is to use new files for brass or hard alloys, then to use them on to mild steels.

The right length

For general use when choosing the length-when it is not already settled by the size, a blade length of 12 in. maximum for a large file, and 5 in. minimum for a small one will be the most economical. A long, coarse file will not necessarily remove metal quicker than a shorter and finer one, since important factors are the comfortable swing of the arms and the pressure which can be applied. On the other hand, a very short file, even on small work, can be restrictive.

It is always wise to fit a handle to the file, gripping this with one hand and holding the tip of the blade with the other. For cavities or holes, the file will have to be used with two hands on the handle.

Avoiding scratches

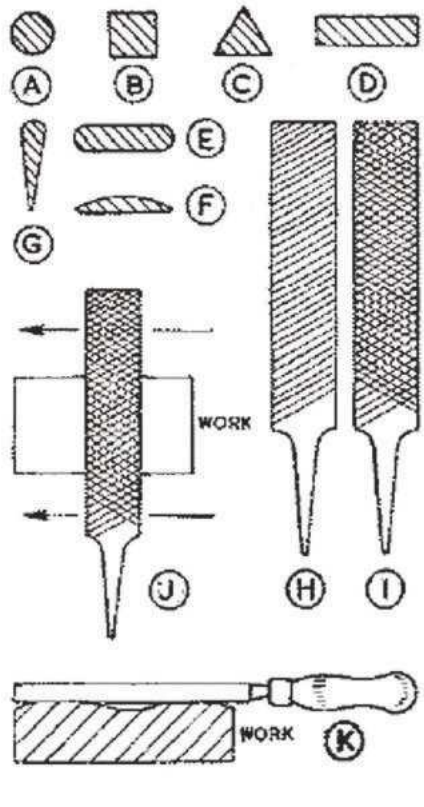
All metals tend to clog the teeth of files, the softer ones more than the harder. These include aluminium, iron, certain mild steels and, of course, lead and solder. For these, a coarse pitch of tooth should be chosen and light pressure applied to the file. Chalk may be applied to the file to reduce clogging; once pieces have started to adhere in the teeth, work should be stopped and the file cleaned otherwise the surface will be scratched and scored.

A wire brush or " file carding " can be used to clean out adhering fragments, though a spiked instrument such as a sharpened piece of rod is necessary for stubborn pieces deeply embedded.

When working on line surfaces, even on tool steels, it is important to keep the file clean as the work approaches completion, otherwise scratches will appear on the finished article. The file is best cleaned with a piece of brass or mild steel about 1/2 in. to 3/4 in. wide sharpened to a chisel edge; this is pushed into the teeth and moved diagonally across the file, clearing fragmented metal before it. This is the only practicable method of cleaning smooth and dead-smooth files.

Draw filing-as illustrated in J-holding the file flat on the work and drawing with both hands can be employed to finish substantial flat surfaces. Flat pieces on which a straight edge is required should be filed from the end, at the finish, *K*; very small components can often be rubbed on the file to produce a better final flat surface.

Sections of the most common files and an illustration of draw-filing



Introducing Metal Turning Lathes

The heart of almost every metalworking workshop is a lathe. In its simplest form, a lathe is a device that rotates a piece of work, allowing a fixed, single-point cutter to shape it with shaving cuts. In practice the lathe is the most flexible of all machine tools and with the right accessories or modifications it can carry out almost any machining task. The downside, of course, is that it may require considerable ingenuity or extra equipment to do so, and it may not be as effective as using a purpose built machine.

But this supreme flexibility is what makes a lathe the obvious first choice of machine around which to build your workshop. So how do you decide what sort of machine you need?

Choosing a lathe

There are two main considerations to take into account when you buy a lathe - how large do you need and should you buy new or second hand?

A lathe with a centre height of 3½" (80mm) has long been a popular choice for model engineering, but if you want to tackle larger projects, such as 7¼" gauge locomotives or skimming brake disks you will probably want to look at something a bit bigger. On the other hand, if your interests are in small components, such as for clock making or space is at a premium, you may want a machine you can literally pick up and put in a cupboard.

Probably most popular choice of 3½" centre height lathe for the beginner is a so-called '**mini-lathes**', although this description can be applied to many smaller machines it is generally used to refer to machines produced chiefly by Chinese manufacturers SEIG and Real Bull and evolved from the same original Russian design. With a centre height of 3½ inches (90mm) and between centres distances from just 260mm to 400mm they have a capacity comparable to popular model engineering lathes of the past and have the advantage of variable speed as standard.

These machines have been sold around the world in huge numbers and by providing an affordable but able machine have enabled many thousands of people to enter the model engineering hobby – including the author. While some of the original machines had notoriously unreliable electrics and a number of 'rough edges', the sheer number produced has given suppliers the clout to demand ongoing improvements and new design features. Depending on the specification the cost of a mini lathe ranges from around £400 to £800, making them a good choice for the beginner on a budget.

These machines are available from many suppliers including Warco, Chester Machine Tools, Arc Euro Trade and Axminster, each with a slightly different specification. The **SEIG Super X3** mini-lathe is an example of a well-specified mini-lathe with a long bed, quick-release tailstock and brushless motor.

A slightly smaller alternative to the mini-lathe, an option is the Proxxon **PD400**, rather unusually it is made

Big or small? - The Warco WM280V is one of the larger bench lathes in the hobby market.

largely of aluminium alloys with a die-cast zinc cross slide, but it is capable of very accurate work. If you are looking for a more robust machine, The **DB7VS** (90mm centre height) and **DB8VS** (100mm) from Chester are machines with similar and slightly greater capacity to mini lathes, but rather more but more heavily built - the DB8VS has a 750-watt motor, for example. They are machines worth considering by those who want a compact machine but who expect to carry out heavier tasks more regularly.

Smaller Lathes

There are some lathes, well under a 90mm (3½ inch) centre height that although very small, are capable of excellent work within their capabilities. Popular examples of these include the Cowells lathe, the American Sherline lathe and the TAIG/PEATOL lathe and the Proxxon PD250/E. All there of these are known for their quality of construction, and are worthy of consideration if you have very limited space or are only interested in small scale projects.

Other 'micro' lathes include the SEIG C0, which though a useful machine is limited mainly by its lack of screwcutting capability and small; capacity, and the Unimat 1. The Unimat 1 is an unusual machine, being modular in design allowing it to be used as various types of tool, including a milling and sanding machines. It comes in both plastic and extruded aluminium versions, naturally the latter is capable of more serious work but it is really restricted to light duties such as making detail parts for small-gauge model railways or ship modelling. Be cautious of cheap imported copies of the Unimat 1, these are not of the same quality.

Myford Lathes

Any article introducing lathes for hobby engineering has to mention the Myford '7-series' lathes. The **ML7**, introduced after the second World War was deliberately designed to meet the needs of Model Engineers. Though with a centre height of 3½", a gap bed (a cut-out near the headstock) allows it to be used for larger work which made them popular with garages and small engineering shops. It was remarkably successful, and with its successors, including the **Super 7**, pretty much defined the model engineering lathe in the second half of the 20th century. Today, Myford lathes are only made in relatively small numbers and are very much top-of the range British machines with a price tag to match, the ultimate evolution of these lathes, the Myford **Connoisseur** has a price tag of over £9,000 including VAT. The large numbers of ML7 and S7 lathes produced, however, mean that second hand machines are readily available.


Myford Connoisseur

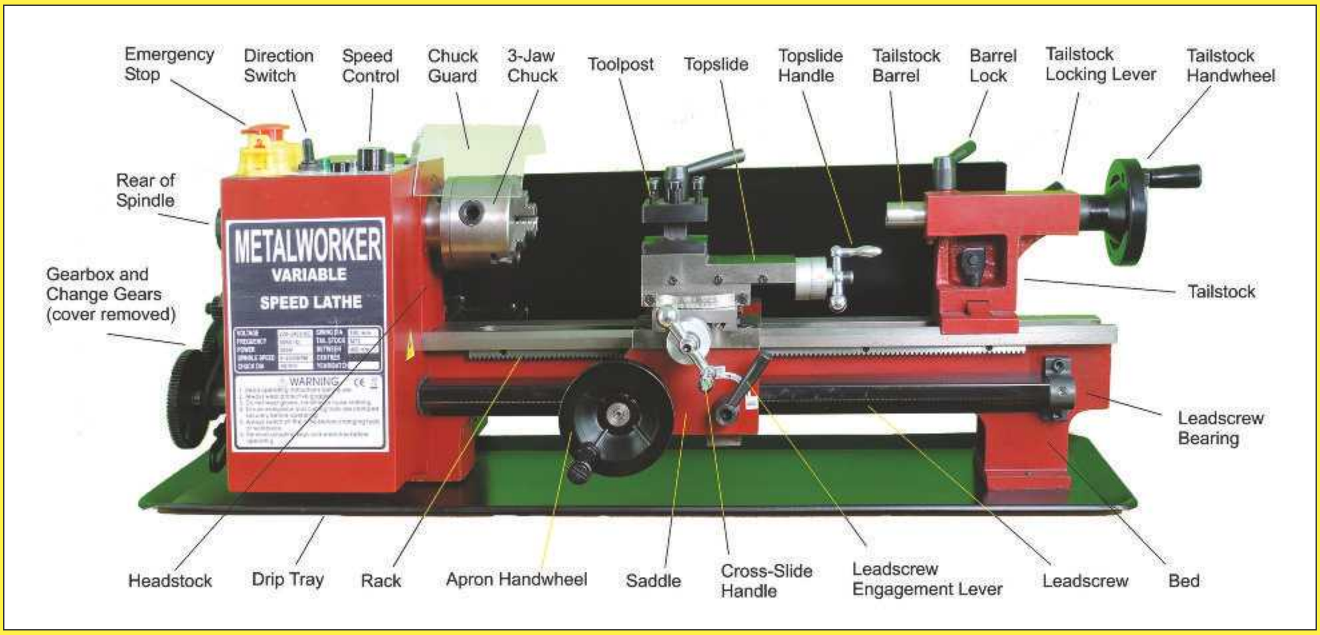
The Chester DB8VS variable speed lathe.

Larger Lathes

If you want to tackle bigger projects, then you might consider something like the Warco WM280V this sizeable machine has a centre height of 140mm (5½") and is 700mm (27" between centres). A robust and accurate machine, it comes with a comprehensive set of accessories including 3 and 4-jaw chucks and both fixed and travelling steadies.

A very large lathe, by hobby standards, is the Italian-made Ceriani 203 David from Pro Machine Tools, which has a 'Norton gearbox' to allow the cutting of metric and imperial threads without the need to swap change gears. With a centre height of 200mm (8 inches) plus a gap bed and 500mm (20 inches) between centres it is capable of some of the largest tasks to be expected in a home workshop.

The Ceriani David Norton 203



Anatomy of a Lathe

A lathe is built on a rigid **BED,** on the left had end is mounted the **HEADSTOCK** which contains a precision **SPINDLE**. On modern lathes the spindle is driven by a built in motor, but on older machines the motor is often separate, driving the spindle via a long belt. Some very old machines used treadle drive.

The front of the spindle usually has a thread or a flange used for accessories such as 3-jaw and 4-jaw **CHUCKS** – rotary vices used for holding work or a **FACEPLATE** - a flat disc to which work can be attached for machining. The spindle usually has a through bore for long work, and the front of this is normally tapered to accept collets, chucks or other accessories fitted with a matching tapered shank.

Opposed to the headstock is the **TAILSTOCK** which can be moved back and forth along the bed. This can be used to support the work by means of centres, or to hold tooling such as drills and reamers.

Between the two, the saddle or **CARRIAGE** is used to move tooling left and right past the work, usually by turning a handle on the **APRON**. Thread cutting lathes have a **LEADSCREW** geared to the spindle that moves the carriage under power, a level of the apron is used to engage the feed. This arrangement can also be used to apply fine cuts, but in either case care must be taken to ensure the tool is not driven into the chuck.

On top of the carriage is the **CROSS-SLIDE**, used to advance tools into or across the work. Many lathes have a further, rotatable **TOP-SLIDE** or **COMPOUND-SLIDE** which allows finer adjustment of the tool position than the carriage and the cutting of simple tapers.

Finally, on top of all these slides you will find some form of toolholder. Typically, a **FOUR-WAY-TOOLPOST** is supplied with most lathes.

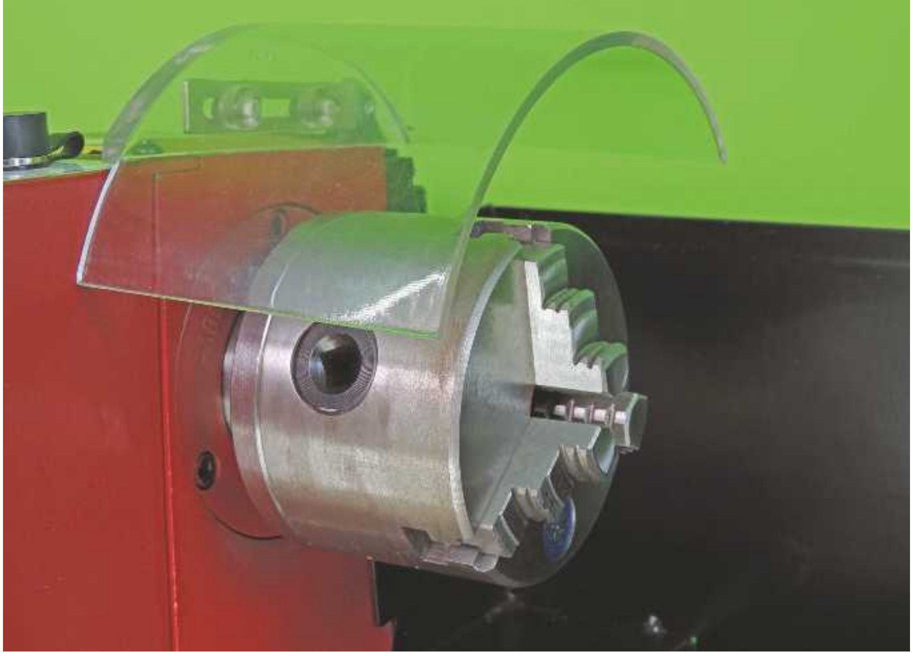
New or Second Hand?

The obvious benefits of buying new are that you get an unworn machine, normally with a decent guarantee period and backed up by ready availability of spares and accessories and good customer service. Second hand machines offer less certainty – there is no doubt that many older lathes were made to exceptionally high standards and you can probably afford a much bigger machine second hand – but you need to inspect it carefully to be sure it really is a bargain.

Buying second hand is an appealing choice for those who would like to own a classic British made machine; as well as Myford, popular choices include the Boxford AUD, BUD and CUD lathes, South Bend lathes and the Colchester Student, all often available as ex-college or school machines. With around a 4 inch (100mm) centre height these are slightly larger than the many hobby machines. Other machines no longer made that have their own followings include the Drummond/Myford M-Type and the tiny but well engineered Unimat SL. Naturally many more modern lathes appear second-hand, usually the larger ones. The second hand market is a fairly brisk one so decide the machine you want, then look for a good example within your budget, rather than just going for the first machine you can afford.

Second hand lathes should be approached with some care. Just like second hand cars you may be lucky and get a barely used machine in pristine condition for a knock-down price, but it is also possible to end up with a clapped-out machine that has been 'prettied up' and needing major work. Naturally, most machines are somewhere in between and it pays to take along a more experienced friend if you are not confident of your ability to detect faults. Always ask to see (and hear) the machine running and if at all possible it is good to see it actually cutting metal.

If you buy from an established second hand machine dealer you can be more confident that the machine has been looked over and is in generally good condition and get the opportunity to inspect it in a showroom situation, but expect to pay a premium to reflect the overheads of running such a business. The alternative is a private sale – classified ads in Model Engineer and Model Engineers' Workshop or on www.model-engineer.co.uk are a good place to start your search. It's possible to get bargains on internet auction sites – but also to be ripped off, especially as some names can start a 'feeding frenzy' where a machine ends up selling for far more



A three jaw chuck

Workholding

There are four main ways of holding work in the lathe. The earliest approach was 'between centres' where a conical centre hole in each end of the work is used so it can be supported by cones centres inserted into the spindle and tailstock. A device called a driving dog has to be used to ensure the work rotates, which means the work has to be switched end for end in order to be turned all over. Ideally use a rotating centre in the tailstock, if a plain centre is used, it is essential to ensure it is well lubricated and not pushed too tightly into the work.

These days, most lathes are supplied with a 3-jaw self-centring chuck. In essence this is a rotating vice, but be aware of its limitations, although described as self-centring even the most expensive chucks are unlikely to hold work perfectly central. The easiest way around this issue is to turn all the concentric surfaces on the work in one go.

The other common chuck is the 4-jaw independent chuck. Its individually adjusted jaws are suitable for holding irregular objects, and using a dial indicator in the toolpost to check alignment, it is possible to get round work running almost perfectly concentrically without too much fiddling about.

A collet chuck, which can also do service holding milling cutters, is one way of holding round work very accurately, although the need for many collets to suit each size can be inconvenient. The various ranges of ER series collets are popular because,

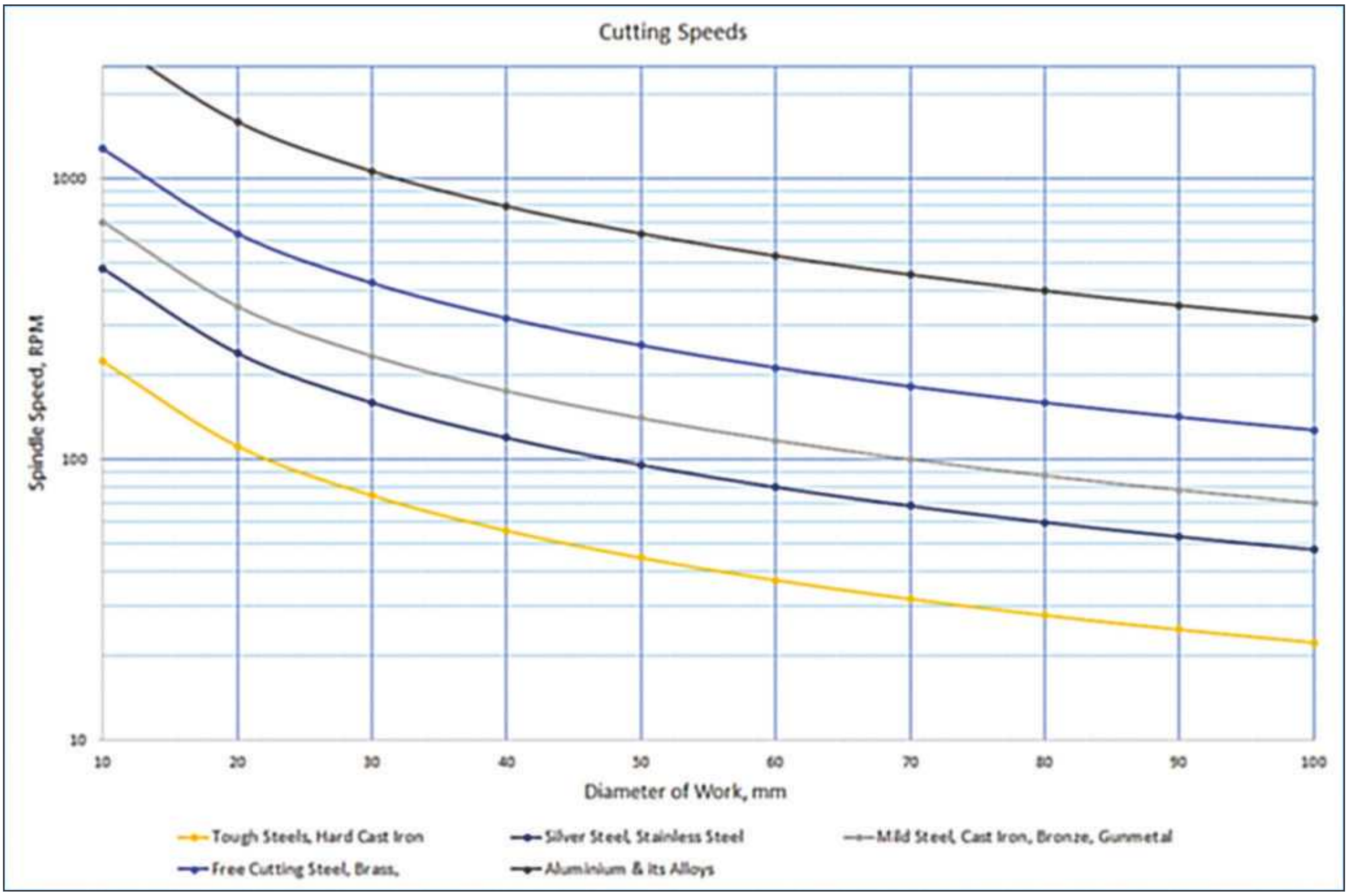
than its true value. It really is worth trying to view any machine first hand before making your buying decision.

Using a Lathe

The principle of using a lathe is simple – the work is attached to the lathe spindle and rotated and a suitable tool is moved to take a cut from the work. This brief introduction cannot train you to use your lathe safely – read your manual, get one of the many excellent books available of lathe work. There are also many helpful videos on the web, but be aware that there are also some that show really bad practice! Probably the best way to learn lathe work is to attend an evening course, but these are becoming scarce. An alternative is to join your local model engineering club and you can also seek advice on through online forums such as **www.model-engineer.co.uk**

A set of HSS turning tools from Arc Euro Trade

The Diamond Tool Holder



Cutting speed chart

unusually, each collet can grip over a range (typically 1mm) of sizes.

Finally, the other time-served method of holding work is to screw it to a large round faceplate. This takes a degree of care to ensure the work is very securely held and that the weight is balanced to avoid vibration, but the advantage is that it is generally possible to mount on the faceplate work it would be impossible to hold in any other way.

Basic techniques

Before you start, you will need some basic turning tools. Two popular types are high speed steel (HSS) and tipped tooling. HSS tools are made from solid, very hard metal and ground into different shapes. Tipped tools comprise a shank with a socket into which a special shaped tips made from materials such as tungsten carbide are fitted.

Whilst carbide tipped tooling is becoming increasingly popular in the hobby workshop, it requires some experience to get the best results and avoid chipping the tips. Most beginners find that a set of HSS tooling is more forgiving and easier to learn with, not least because it redoes not require the lathe to be run at high speed. HSS is also considerably cheaper and most tools can be resharpened fairly easily using a bench grinder.

One other type of tool should be mentioned here, tangential toolholders are used with short HSS toolbits. Sharpening these tools is very simple and users report excellent results. A popular tangential toolholder is the Diamond, from Eccentric Engineering.

Basic turning tools include the ubiquitous knife tool and the 'roughing tool' with an angled cutting edge. For your first trial, a good idea is to start with a round bar of aluminium or mild steel held in the three-jaw chuck. The tool should be fixed in the toolpost so that its cutting edge is on the centre height of the lathe, this may mean you need to pack it up a bit – little shims cut from aluminium drinks cans are ideal for this.

Once the work is securely fixed to the spindle the lathe and you have checked that all feeds are disengaged the machine is set running at an appropriate speed. The chart indicates typical speeds for high-speed steel tools, carbide tools can be used at two or three times these speeds, but please treat the graph as a rough guide – the best results will depend on your machine, the nature of your tooling and your own technique so be prepared to experiment. Before switching on, check that the work is held securely, there are no clashes where the work or tool could crash into other parts of the machine, that guards are in place and that any chuck keys are removed.

Turning

The tool is moved along the length of the work using the carriage handwheel, leadscrew handle or power feed, if it is available. A mistake that beginners often make is to only take very light cuts. This rapidly wears tools and even small lathes are capable of quite reasonable cuts. If using power feed, be very careful not to let it feed the tool into chuck jaws! For small lathes good depth of cut for early practice is 0.25mm (0.010"), experience will teach you when you can take deeper cuts, and you may need to take smaller ones to bring a part exactly to size.

Facing

For facing the tool moves across the face of the work using the cross-slide, making flat surfaces. Many ordinary turning tools have angles that allow them to be used for facing as well, but it is also possible to get tools designed for this purpose. Facing is generally a fairly stress-free activity, but make sure the saddle is held securely in place by engaging it with the leadscrew (after making sure the leadscrew is NOT set up to rotate first!) and do not wind the tool too fast, or it will leave a spiral mark on the work instead of a smooth finish. Few hobby lathes have power cross-feed, but if you do have this use it to get the best results.

Parting and Grooving

Here the tool is fed into the work using a narrow tool to create a groove or completely cutting off the workpiece, which is parting off. Many beginners struggle with parting off, because the need for the tool to be quite robust means it takes a wide chip and imposes heavier loads on the machine. Combine this with having to use an overhung tool at the bottom of a narrow groove and it is easy to see why it can cause problems. Some people resort to using a rear toolpost with an upside-down tool, but most lathe owners find that, if the machine is well set up the secret to easy parting off is a sharp tool dead on centre height and fed in with confidence -if the tool 'howls' it is rubbing and is probably either blunt or not being fed in firmly enough. Changing speed (up or down) can also help, as can applying a little neat cutting oil into the cut using a brush.

Boring

The fourth of the basic lathe operations is boring or the making of holes. Typically, holes are started by drilling using a drill chuck held in the tailstock. If a drilled or reamed finish is suitable for the work being done, then everything is simple. For larger holes, when an unusual size of special finish or very accurate concentricity is needed then the hole should be finished by boring. Boring tools are fairly simple in concept – a cutting edge on the end of an overhung bar which is used to remove material cutting towards the operator. Always use the largest boring bar you can fit in the hole, as smaller boring bars are liable to vibrate or chatter, causing a poor finish. If you get problems with chatter, try varying the speed of the lathe slightly.

Because long boring bars can deflect, it is usual to take three or four cuts at the final setting, or before measuring progress, to 'work the spring out of the tool'. It can be quite surprising how much metal these repeat cuts can remove.

Particular care must be taken when boring blind holes, in these cases you should use a tool capable of making a cut on its end. To finish the hole neatly, on the final pass the tool can be used to 'face' the bottom of the hole.

Self Act and Screwcutting

If the lathe has change gears or a screwcutting gearbox these can invariably be used to provide a slow, steady feed along the work making it easy to take well-finished cuts without having to feed the cutter by hand. They can also be set for a more rapid feed that creates a spiral cut along the work, this enables you to produce your own screw threads.

In order to cut accurate screw threads, you need a tool shaped to match the profile of the thread you are cutting and to set the gear ratio between the spindle and the leadscrew correctly. You will need to consult your manual or charts on the lathe to see what threads it can cut and how it needs to be set up. To cut metric threads on an imperial lathe or vice-versa you may need to buy a special additional 'translation' gear.

Taper Turning

Most lathes have a compound slide or top-slide that can be angled to allow the turning of tapers. Some but not all lathes have machined surfaces that aid accurate setting of the angle of the top-slide – if your lathe has a graduated scale of degrees these are rarely very accurate so treat it as a rough guide only. Naturally their length is limited by the travel of the slide, unless you are very careful with resetting it. It is possible to buy or make taper turning attachments that move the cross slide back and forth as the saddle moves along the bed, these can make very long accurate tapers and even tapered screw threads.

If you need to make a taper and bore a matching hole for it to fit in, it is wise to do so 'at the same setting', that is to do both operations without readjusting the angle of the top slide. This way the exact angle becomes unimportant, but the two parts should fit each other perfectly. ■

Changewheels for screwcutting on a mini lathe

The gearbox of a Ceriani lathe

A Workholding Challenge

Des Bromilow tackles an awkward part during the restoration of a vintage motorcycle.

In the process of fabricating a replacement fuel tank mounting lug (for a 1914 motorcycle - which contains three of these castings inside the fuel tank) the issue of holding the semi-finished brass casting, **photo 1**, to allow two blind tapped holes to be positioned and created was met, **photo 2**.

A short scrap of SHS (steel hollow section) was selected and an oversized hole was drilled in one of the sides. Care was taken to ensure that the side chosen did not contain the internal welded seam, so the internal wall was flat and at ninety degrees to the next wall.

In one of the adjacent walls an oversized slot was cut to ensure that none of the corner curve was left to prevent contact with the flat internal of the side containing the oversized hole, **photo 3**. This allowed the casting to be placed with the flat surface against the internal wall, and padded jaw vice-grips were used to clamp the casting in place, **photo 4**. The oversized hole allowed the marked-out surface of the casting to be viewed easily and its position to be adjusted under the drill press, photo 5.

Drilling and tapping was then a simple exercise. The castings are then soldered in place as the fuel tank is recreated with fresh sheet metal. ■

1

The casting.

2

Tapped holes on the underside.

3

Simple jig from steel section.

Casting clamped in place.

Drilling in progress.

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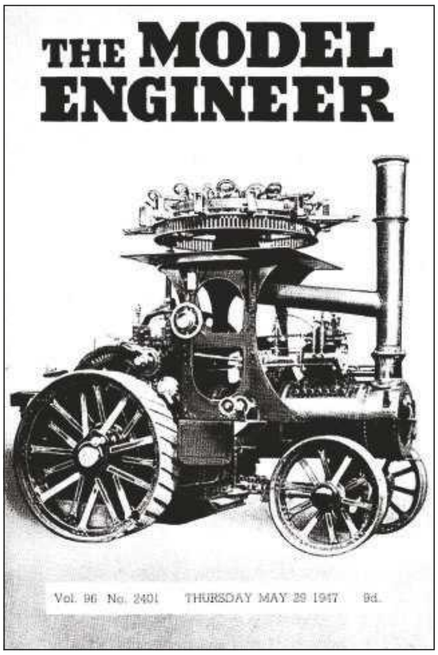
■ Corbet XL7 shaper, £250. Clarkson Mk1 tool and cutter grinder, 240V, £290. Jones and Shipman 360° vice, 4" wide jaws, £90.
T. 01159 872211. Nottingham.

■ American Paterson 4 ½" v-bed lathe, 3-jaw, 4-jaw, tailstock chucks. 3 face plates, fixed steady, full set change wheels, 4-way toolpost, power cross feed. £295.
T. 0161 330 5112. Manchester.

■ Wartime era Myford 4 centre lathe, 3 ½" x 18" cantilever bed, bench top motorised, clean, £300, no offers. Heavy. May swap for W.H.Y.
T. 01429 281741. Hartlepool.

■ George Adams GA lathe, several mandrels, accessories, 4-jaw £250. Change gears suit Myford, 20T-75T £15. All ONO plus carriage.
T. 01752 788862. Plymouth.

■ Chester Mercury Mill s/ph, p/head, v/speed, 240 x 820mm table size, on stand. £650 ONO. Elliot 10M shaper s/



ph. £325. Both machines in excellent condition.
T. 01766 540521. Blaenau Ffestiniog.

Models

■ Stuart Turner N. 10V good runner £260. **T. 01625 262197. Macclesfield**.

■ 3½"G Tich, Walschaerts valve gear, Large Boiler. Has been completely restored. Hydraulic test valid until July 2024 steam test valid until September 2021. Runs Superb. Many Extras, can email photos. £1200 ovno.
T. 07798 737850. Maldon.

Parts and Materials

■ Motion brackets for Super Simplex 5" gauge. Laser cut, unmachined £10. Stuart Turner N. 10V good runner £260. 12" square surface plate with cover, £45. Needle roller bearings, 16 – ID, 22 – OD, new, various lengths and seals. Plus postage for above.
T. 01625 262197. Macclesfield.

■ Heilan Lassie loco and tender chassis, all wheels, half machined and fitted, tender tank, £60 ONO plus carriage.
T. 01752 788862. Plymouth.

■ Dividing Head. GHT VDH kit of castings and gears by Hemingway. This is the reduced weight export kit, includes castings, gears, worms, division plate blanks but not common fasteners and materials. Can email details.
T. +61 411 105811. Balaclava, Australia.

Magazines, Books and Plans

■ Eight bound volumes of Model Engineer and Amateur Electrician covering Jan 1901 to June 1905. Jan to June1904 missing, facsimile copies of originals. Perfect condition £40 to charity. Includes 100 loose MEs 1955 to 1988. **T. 01527 879974. Bromsgrove**

Wanted

■ For Myford ML4, Change wheels for use with 8tpi leadscrew. Teeth numbers 20, 25,30, 35, 40 (x2), 45, 60 (x2), 55, 60, 65, 70, 75 and 80.
T. 01732 361673. Tonbridge.

■ Full set of drawings for Tidy Twin 100cc OHC inline petrol engine, believed to be published late 90s-early 2000s.
T. 01622 683368. Maidstone.

MODEL ENGINEERS' WORKSHOP CLASSIFIED

HOME AND WORKSHOP MACHINERY

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tel: 0208 300 9070 - evenings 01959 532199
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email: sales@homeandworkshop.co.uk
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RotoCAMM MDX-40A CNC Router £2000


Check out our eBay store to view our large amount of stock!


Stanier precision vice 55mm jaw New / New Zealand £195


Myford Super 7, ML7R, ML7 Ml10 Speed 10 Change wheels Genuine £10 - £37


Denford Tom Senior


Boxford CUD MK111 lathe £1350


MEDDINGS MB4 £645


Bridgeport milling machine 42" x 9" (metric) £3750


Centec 2A V/H mill quill head + height block £1950


Boxford 260 VMC mill less software £1495


MYFORD SUPER 7B £3250


Union 12'' Grinder £625


Harrison Graduate wood lathe 240V £1375


Morgan Rushworth BP50 / 16 50" x 16G box and pan folder £1750 Complete with fingers


DP / MOD gear cutters £20 each, please enquire for availability


Ajax UP Universal Mill £1750


Denbigh No 6 Fly press £345


Smart and Brown Model L second operation lathe £750


Carpenters bench £750


MYFORD SUPER 7B 3 1/2" x 31", gearbox, clutch, power cross feed £3750


Colchester Master 1500 revs, Clutch, 6 1/2 "x36" lathe £3450

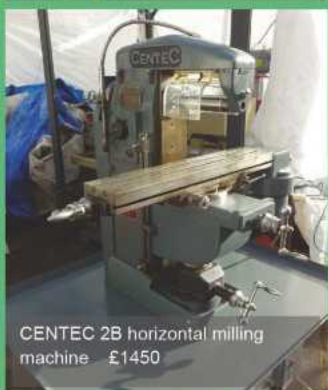

COLCHESTER STUDENT ROUND HEAD Hydraulic copying attachment and TRUGRIP collet chuck £2950


MYFORD SUPER 7B 3 1/2" x 31", gearbox, clutch, power cross feed £3250


Rolls 48" x 3" 16g (slip roll) £1400


Selection of pillar drills just arrived!


Edgwick centre lathe 7 1/2" x 44" 240 volts £1400


CENTEC 2B horizontal milling machine £1450


Tripus 240v switch £90


Myford rifle / bridge felts 5 for just £20

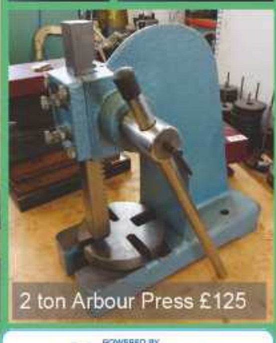

Neat cut and soluble cutting oils £10 each


Large Vee Blocks 12" bar £425


Union centres 7.5'' x 24'' £425


Pipe centre 4MT 4-8'' £245


Colchester Mascot VS2000 fixed steady £575


2 ton Arbour Press £125

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