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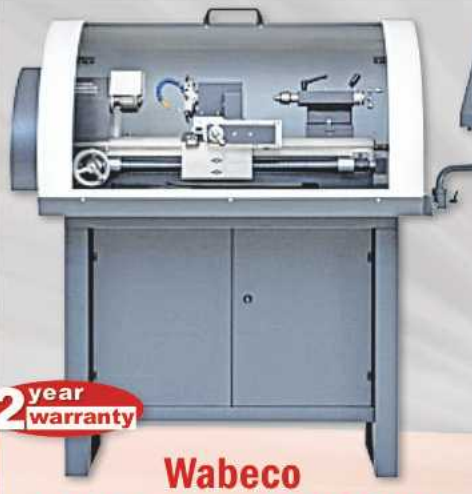

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EDITORIAL
Editor: Neil Wyatt
Tel: +44 (0)1689 869 912
Email: neil.wyatt@mytimemedia.com

PRODUCTION
Designer: Andrew Tompkins
Illustrator: Grahame Chambers
Retouching: Andrew Tompkins
Ad Production: Andrew Tompkins

ADVERTISING
Business Development Manager: David Holden
Email: david.holden@mytimemedia.com
Tel: +44 (0) 7718 64 86 89

MARKETING & SUBSCRIPTIONS
Subscription Manager: Kate Hall

MANAGEMENT
Group Advertising Manager: Rhona Bolger
Email: rhona.bolger@mytimemedia.com
Chief Executive: Owen Davies

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On the Editor's Bench

Alibre Atom3D is here!

As promised, this issue contains the first instalment of our tutorial series for Alibre Atom3D, together with instructions on how to access your free six-month licence for Atom3D. I'd like to thank Max Freeman and Wes Davis from Alibre in Texas and John Minto from Mintronics, their UK distributor, for all their help and support in setting up this great opportunity for readers. I'd also like to than Rob Footit who is writing the tutorials for offering a few simple words of advice which have helped me make some of my own 'masterpieces'.

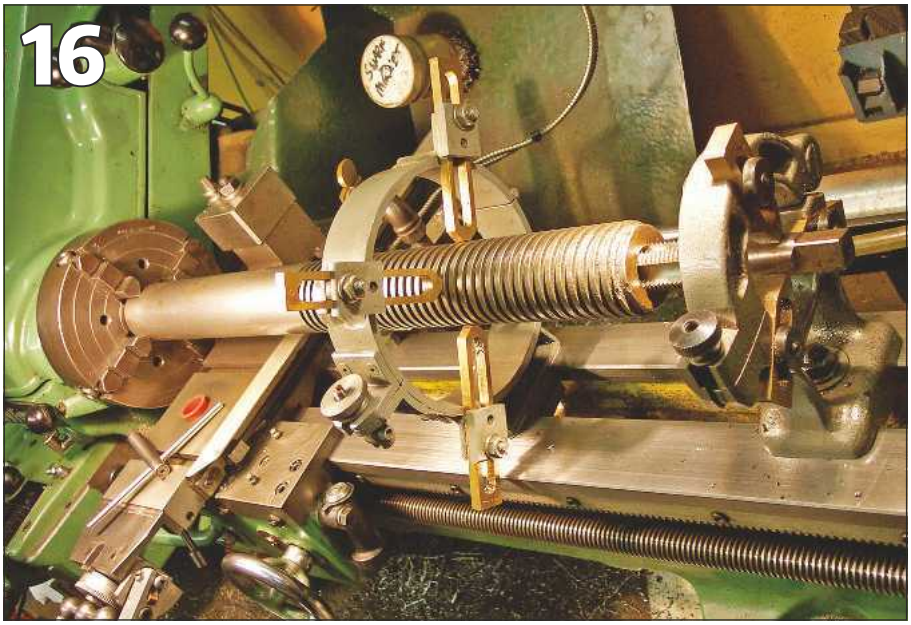
Although more intuitive and with a 'cleaner' interface than many CAD programs, it's still to be expected that some readers may need some extra advice. A thread dedicated to Alibre Atom3D has been set up on the forum at **www.model-engineer.co.uk**. We already have several experienced Alibre users on the forum and I can provide a beginner's perspective, so if you do have any questions please head over to the forum and ask away!

Anodising and Sulphuric Acid

I had a call a few days ago from a reader who was worried about the new regulations around sulphuric acid. In short, if you want to purchase or keep concentrated acid you will need to purchase a licence through an involved process, not unlike applying for a gun licence. As there are very few reasons to have concentrated sulphuric acid other than convenience, my suggestion was and is to dilute any stock you have to below 15% and the regulations will no longer apply to it. And remember, always add acid to the water! As for obtaining future supplies at 15% I imagine a market for the diluted product will emerge. It may also be feasible for clubs to get a licenced member to buy in concentrated acid and supply the diluted product to members.

As for me, the reason I need concentrated sulphuric is for anodising, the photo shows my shop-made telescope, all in anodised aluminium. I prefer to use gentler commercial descaling products like sulphamic acid for pickling brazed items.

Contents

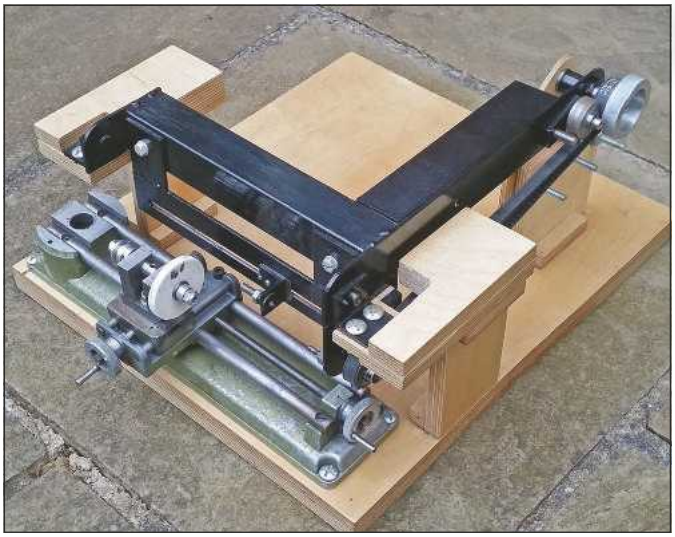


See page 52 for details.

Coming up...

in our next issue

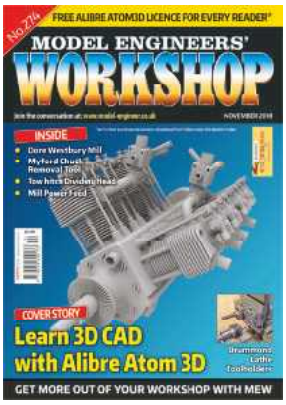
In our December issue, number 275, look out for Alex du Pre's Cam Grinder capable of making complex camshafts for IC engines.



Regulars

ON THE COVER

This month's cover shows a four-stoke V8 aero engine modelled using Alibre Atom3D. To find out how you can start on the road to producing a similar result see page 46.



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THIS MONTH'S BONUS CONTENT

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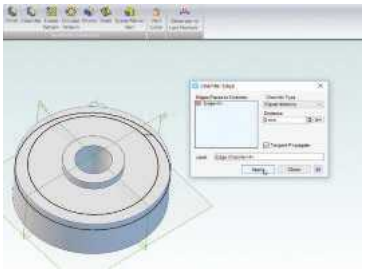
Visit our website to access extra downloads, tutorials, examples and links to help you get the most out of your free Alibre Atom3D Licence: **www.model-engineer.co.uk/alibreatom3d**



Any questions? If you have any questions about our Alibre Atom3D, Lathework for Beginners or Milling for Beginners series, or you would like to suggest ideas or topics for future instalments, head over to www.model-engineer.co.uk where there are Forum Topics specially to support the series.

Where are you? Come and join one of the busiest and friendliest model engineering forums on the web at **www.model-engineer.co.uk?**

The Workshop Progress Thread
- Share your workshop triumphs and tragedies!

New Mill Starter Tooling
- Have you just got a milling machine? This thread will help you decide what is the best tooling to get you off to a good start.

Hemingway Hacksaw
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Norman Tool Holders for Drummond M Type Lathe.

Geoff Walker returns with more ideas for users of vintage machine tools.

The standard Norman tool holder for a Drummond M type lathe is a simple design first introduced by Drummond Brothers nearly 100 years ago. The basic holder shown in **photo 1** is a hardened steel block with a 1 1/4" diameter location hole and a square broached hole which holds tool bits or accessories. The holder is clamped to a stud on the top slide and the tool is adjusted for height by raising or lowering the holder on the stud.

The design of the original basic holder is now outdated and therefore not entirely suitable to holding plain high-speed steel tool bits, parting blades and boring bars.

The design of the original basic holder is now outdated and therefore not entirely suitable to holding plain high-speed steel tool bits, parting blades and boring bars.

1

The standard Drummond tool holder with two home made variants.

Despite this the holding method is still popular with m type users. It is not difficult to make similar additional basic holders or variants which can be set up with different tools. Changing holders can be done quickly and by adding a height adjustment screw you can have instant centre height setting of the tool. The only real drawback is that there is no angular indexing facility which is useful when making rapid tool changes for repetitive work.

This article is about two variants which I have designed and which I find very useful. With a break in project work and time to spare I decided to make a bespoke holder for 1/2" parting blades and a holder for round section boring bars. The latter will hold bars from 1/8" up to 1/2". The holders can be seen in **photos 2** and **3**. All the machining was done on my M type lathe with the milling operations being done using a vertical slide.

The parting tool holder was long overdue. The arrangement I used for many years using the basic holder had an excessive overhang and was far from satisfactory. I wanted a holder with an integrated blade which would bring the tip of the blade much closer to the leading edge of the holder. Photograph 2 Shows the original holder and the new one with the integrated blade.

The boring bar holder uses home made and commercial 1 MT (Morse taper) collets. The home-made collets are for larger round boring bars 1/4" to. 1/2" and the commercial 1 MT collets for smaller and shorter round

2

The old and new parting tool holders.

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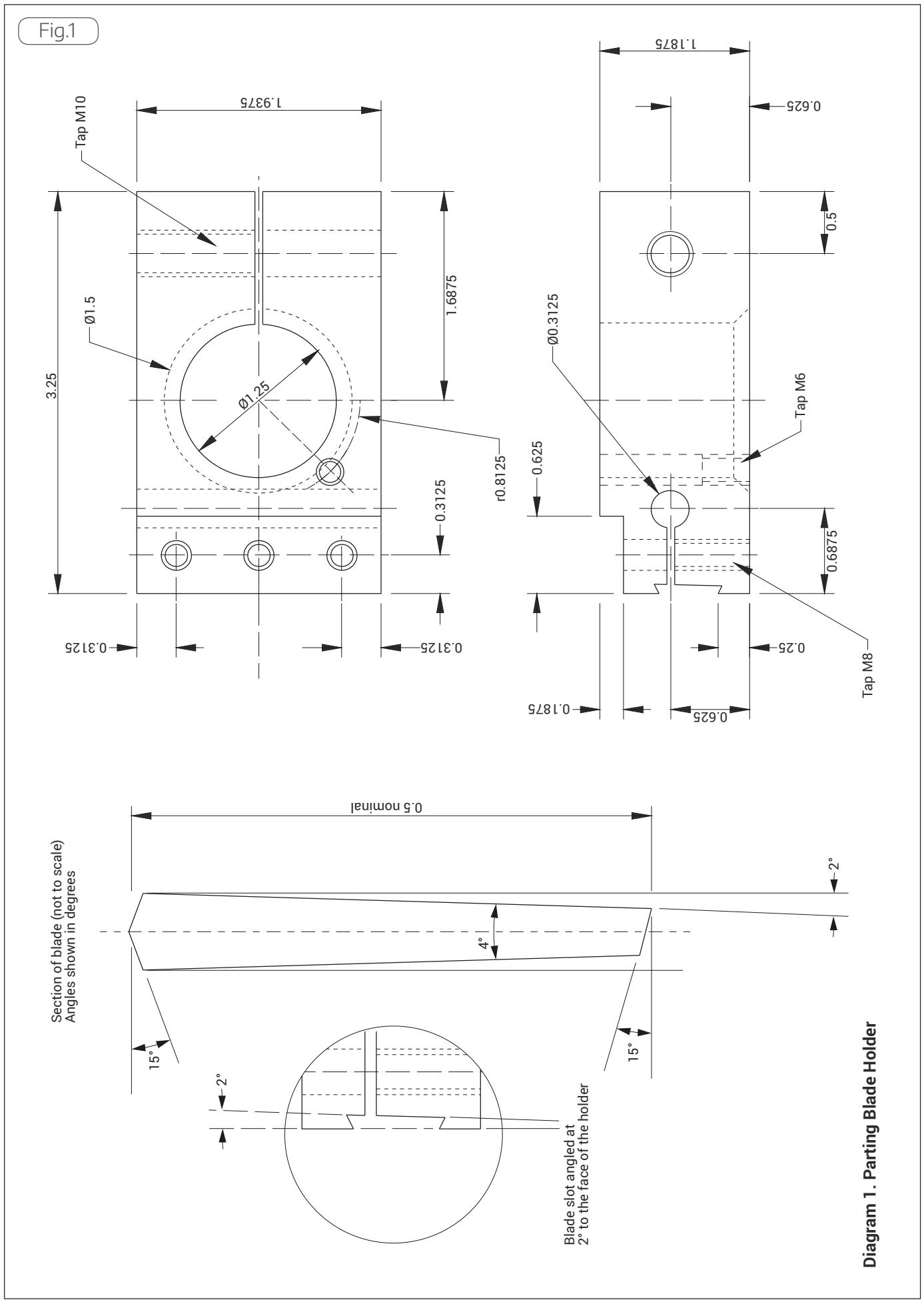


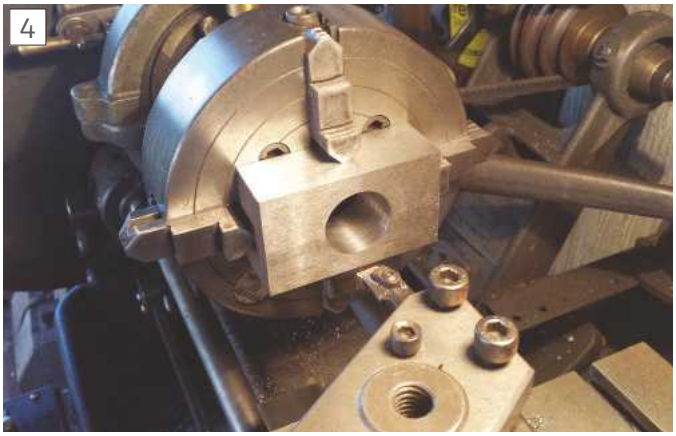
Diagram 1. Parting Blade Holder

section tool steel bars. The holder with the collets, M.T. sleeves and some boring bars is shown in photo 3. The tool steel boring bars shown in the photo are sheet metal perforation punches. In use hundreds of these are lined up military style in a long tool block. This assembly with a matching die block is then loaded into a 250 ton automatic press and with the machine running large sheets of metal are then perforated at a rapid speed. After prolonged use the punches wear, become unfit for purpose and are classed as scrap. To the home machinist they are anything but scrap and will have numerous uses, in this case as small boring bars.

Both holders are made from a nominal 2" x. 1 1/4" Section mild steel bar or metric equivalent. Figures 1 to 3 give all the sizes for the holders plus the collets for the boring bars. The dimensions are as I made them, but they are flexible and can be adjusted a little if necessary.


3

The new boring bar holder and accessories.


4

Boring the hole for the top slide stud.

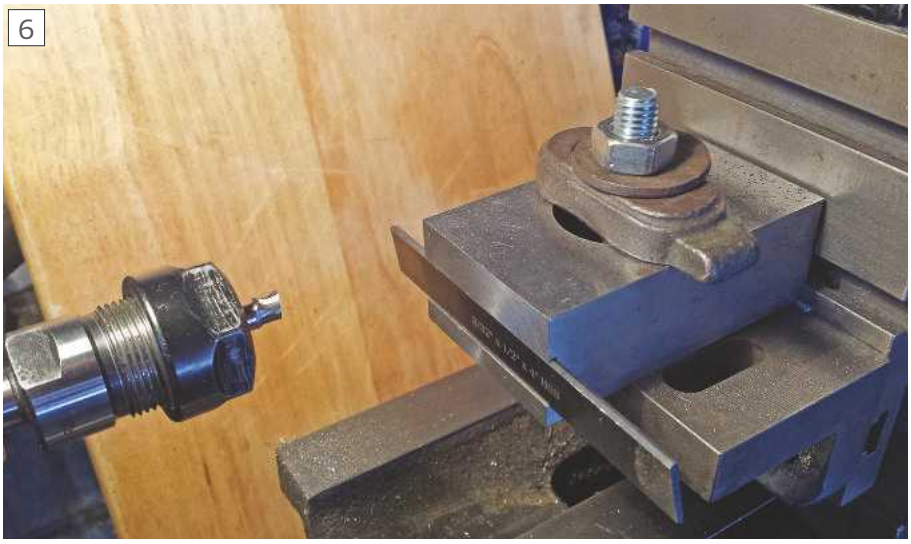

5

Milling the slot for the parting blade.

The holders have common machining operations which need little explanation, the threaded holes for the screws and clamp bolt, the height adjustment screw, the shoulder for the screw heads and the bored hole for the tool post stud. These involve drilling/milling/lathe operations the latter using a 4 jaw Chuck as shown in photo 4. The hole in the boring bar holder is offset to move the leading edge closer to the end of the top slide. The slit for the clamp bolts was cut by hand with a hacksaw as the depth was outside my machining capacity. For the shoulder on each holder I used a hacksaw to remove the bulk of the metal just leaving light milling cuts with the holder clamped to the vertical slide.

Photograph 5 shows the parting holder clamped to an angle plate to mill and fly cut the slot for the blade. A small round packing piece is tilting the holder at an angle of 2 degrees. This is so the inside of the slot will be angled inwards at 2 degrees, as shown in **fig. 1**. The blades I use have side clearance angles of 2 degrees so with the holder in a horizontal working position the blade will be set vertically on its centre line. **Figure 1** shows a cross section of the 1/2" blade I used. The included angle of 4 degrees was determined by taking measurements and using simple trigonometry to calculate the angle. For the top and base angles, I used a small bevel gauge and a protractor. The diameter of the round packing piece in the photo was also determined by simple trigonometry, the width of the angle plate x the tangent of the angle (2 degrees) gave a value of approximately 0.080". I would imagine that most new 1/2" blades would have similar angles but it is wise to check before proceeding.

Using a small end mill and making light cuts I removed the bulk of the metal ensuring that the slot was deep enough to accept the blade. Careful judgement is needed to leave enough metal top and bottom to make the vee cuts. The vee cuts were made with a small fly cutter


6

The fly cutter for the slot and the parting blade in place.

which can be seen in photo 6. The cutter is piece of round HSS ground to a D shape and then on one edge to the angle required for the vees. Adequate clearance needs to be ground on the back, and the opposite edge. There is some trial and error involved as the cutter was ground off hand using the bevel gauge to judge the angle as precisely as I could. With the cutter held in a collet chuck it was now a matter of patience and just "nicking away" top and bottom with light cuts until the blade is a close sliding fit in the slot as shown in **photo 6**. In fig. 1 the only sizes given are the starting point a 1/4" up from the base and the and the inside angle of 2 degrees. The slit through the slot to the 5/16" hole was cut with a 3" x 1/16" wide slitting saw mounted on a 1 M.T. arbour. I don't have a photo of this but the set up for the boring bar holder in **photo 10** is similar.

The boring bar holder presented some problems but thankfully I overcame these with some modifications during the making process. Having an increasing number of round boring bars, I wanted a versatile holder which would hold a wide range of short and long lengths and of different diameters.

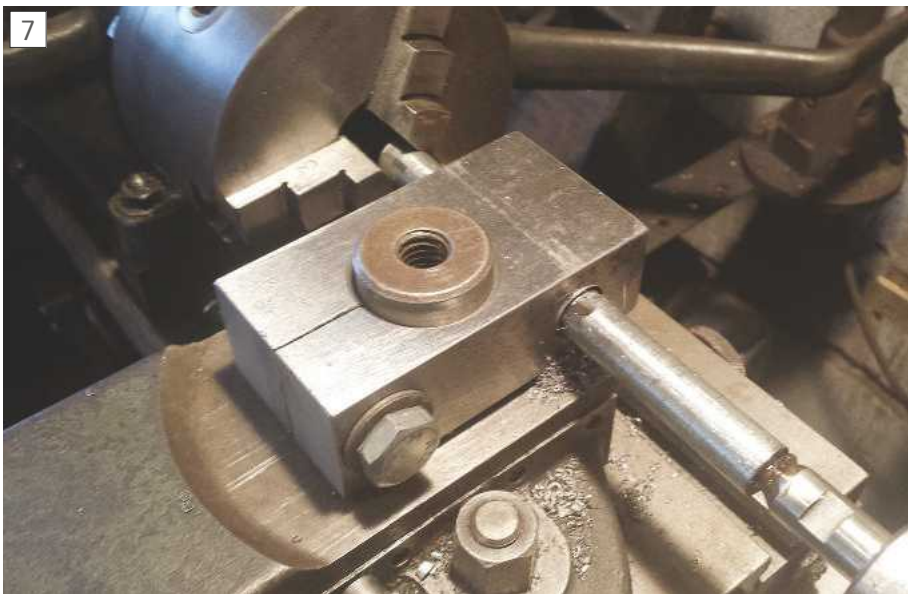
The 5/8" hole in fig. 2 was pre-drilled to 1/2"diameter with a pedestal drilling machine. With the stud hole bored to size and the clamp bolt in place the holder was locked squarely on the top slide tool post stud with the centre of the 1/2" hole positioned as accurately as possible on the centre line of the lathe. A 3/8" diameter boring bar was then held in a 3 jaw Chuck, passed through the hole and supported by a tailstock centre. The hole was enlarged with small successive cuts to a nominal 5/8" diameter as shown in **photo 7**.

The collets are simple plain turning exercises and just need to be a close sliding fit in the 5/8" hole. To save on material I turned them end to end and used the parting tool holder to separate them, as shown in **photo 8**. I had no particular reason for using brass I just had plenty of 3/4" diameter in stock.

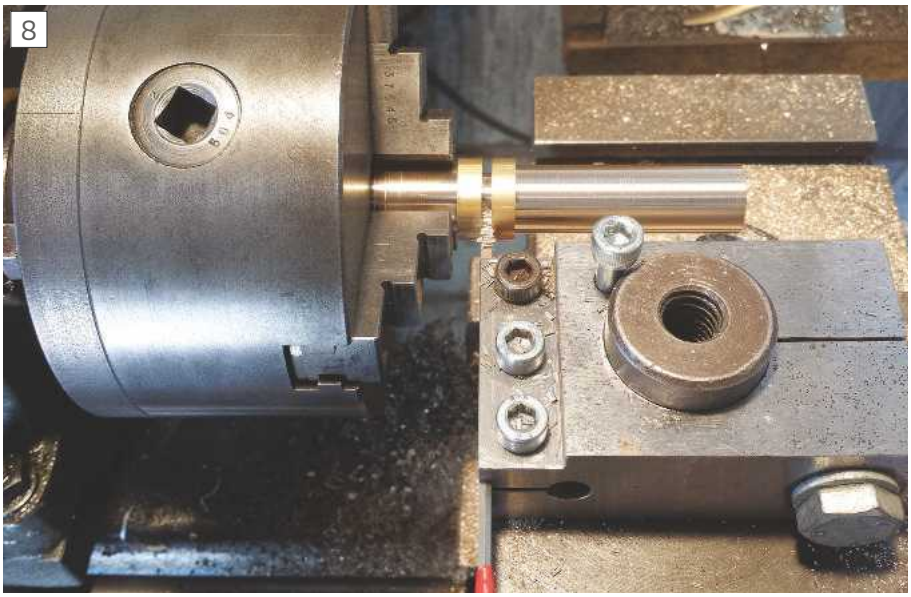
The slit in each collet was made using the set up in **photo 9**. The slit in the tool holder was done first and then without altering the setting each collet was slit in turn using the tool holder as a jig. The small 3/32" stud above the 5/8" hole was used to locate each collet using the curved groove in the flange. This stopped it rotating and a small g cramp secured each collet lengthwise while the slit was cut

The brass sleeve in the holder in photo 3 is turned to the same external dimensions as the collets but instead of a plain and slit parallel bore it has a No. 1 M.T. This is to accept the 1 M.T. collets and the collet chuck. A small Allen screw and washer are used to draw and close the collets.

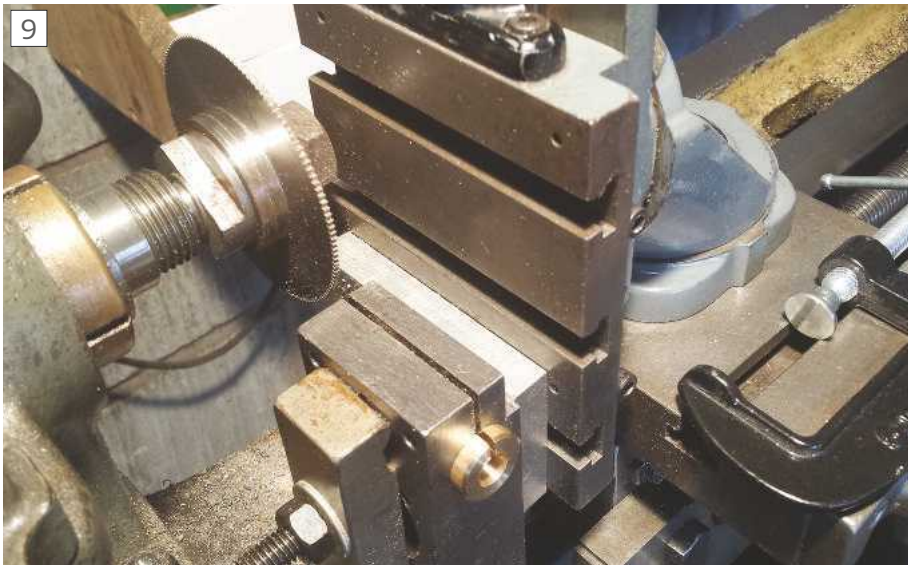
With the slit cut in the holder and the collets and the three 6 mm holding screws in place it was time to test clamping efficiency. This is where the



Boring the collet hole in the boring bar holder.



Parting the collets with the new parting holder.



Cutting the slits in the collets.

Fig.2

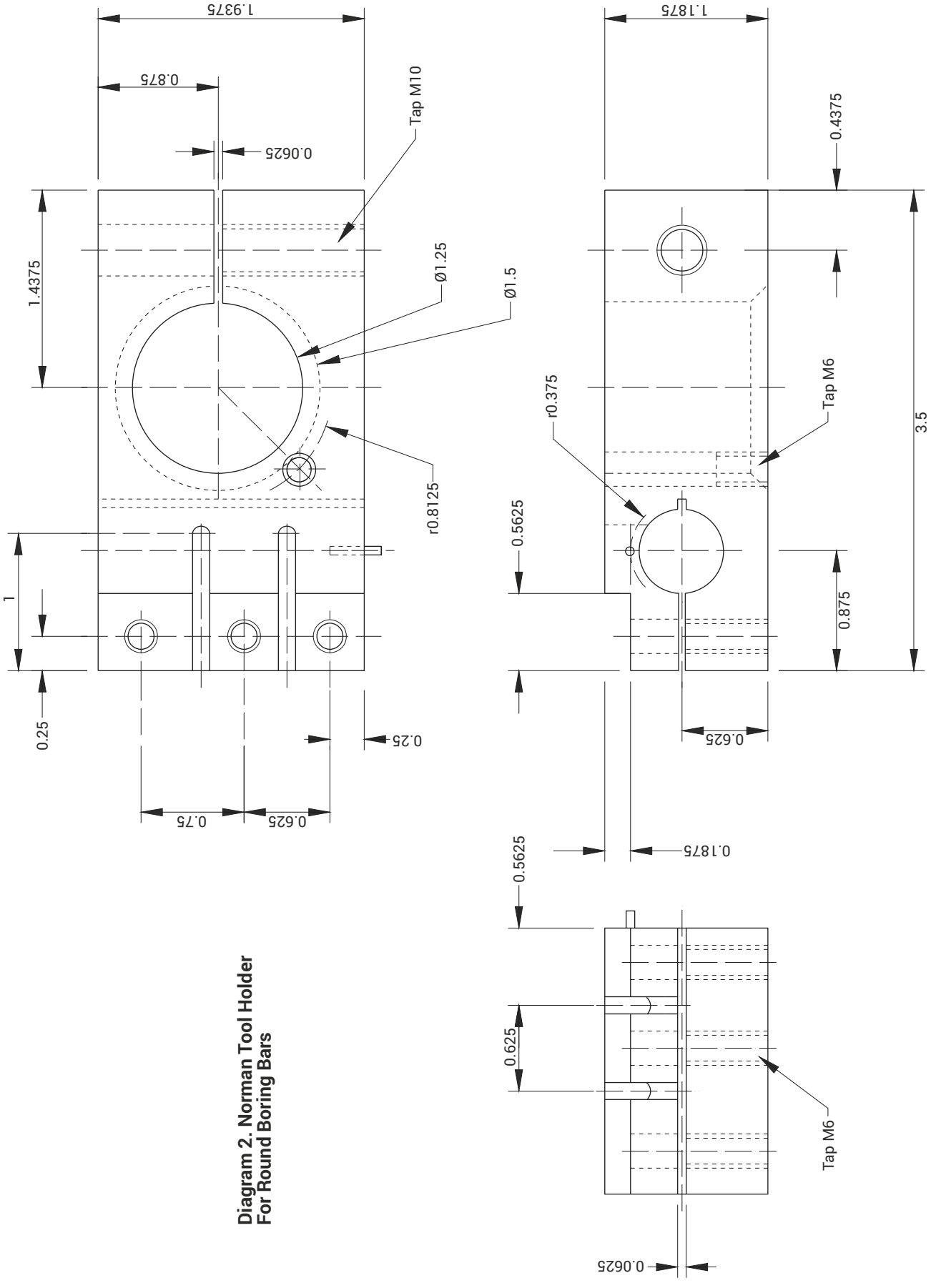
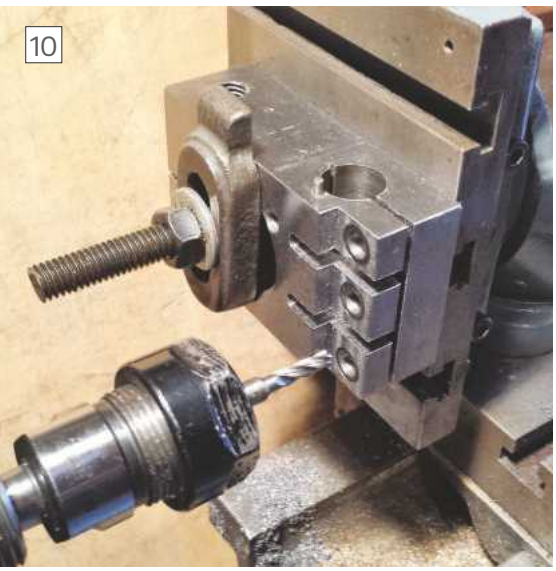


Diagram 2. Norman Tool Holder For Round Boring Bars



Milling the lateral slots in the boring bar holder.

problems started. It needed a lot of effort to tighten and close the collets to lock each boring bar securely. When tightening or releasing it was necessary to adjust each screw a little at a time as fully tightening or releasing one put a lot of additional strain on the others

Naturally this was unsatisfactory, and a remedy was needed. After some thought I decided some flexibility was required and decided to cut two lateral slots above the slit in the holder, as shown in fig. 2. This was a case of "divide and conquer" as with the upper part of the holder now in three sections this meant that each screw was clamping independently on the collet. To further ease the load on the screws and improve clamping efficiency I opted to split the collets into three sections, cutting across at two points as shown in **fig. 3**. **Photograph 10** shows the milling set up for the two slots. The additional cross slits in the collets were made using a junior hacksaw.

Both holders are in regular use and have certainly been worth the time and effort it took to make them.

The parting tool holder has three blades all ground at different rake angles. It really is a joy to use, blade changing is quick and simple and with well ground and honed surfaces I get a really efficient cutting action on a wide range of popular metals. I also like the fact that I can part work very close to the jaws of the chuck. To avoid an unfortunate accident, I always cover and highlight the rear edge of the blade with red insulation tape.

The boring bar holder may seem to some to be a little "over designed". That would be fair comment, there are easier ways to hold round boring bars. It's real value to me has been the use of the MT sleeve and collets to hold mini diameter bars. **Photograph 11** shows the holder using an MT.. collet to bore the air inlet taper on a small carburettor. The collet chuck is great for short stubby bars and when I need a little extra reach over the end of the top slide.

I actually have a more home-made collets than shown in the photos, each one set up with a bar ready for use. Centre height setting is easy and by rotating the bar I can make minor adjustments to rake and clearance angles.

As a footnote I have become aware the there are some non-Drummond lathe users who are modifying their top slide to accept a Norman style tool post. Very easy to do, all you need is a long collar around the existing stud which can then be secured in place with a nut and washer. Converting for a Norman tool post? Interesting but easy to understand if you use the system on a regular basis, as I do. ■

Fig.3

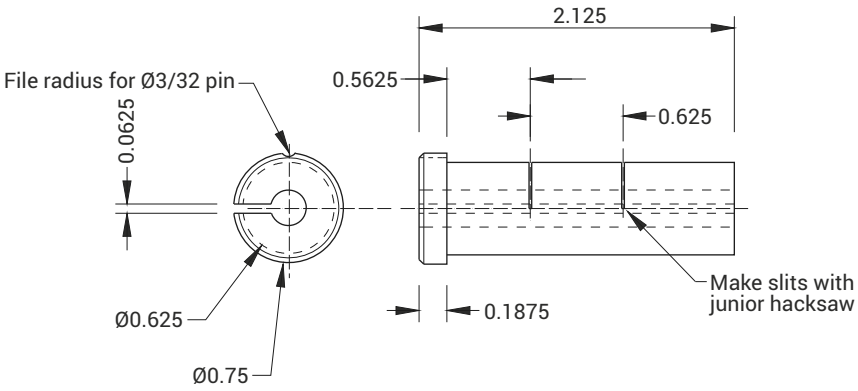
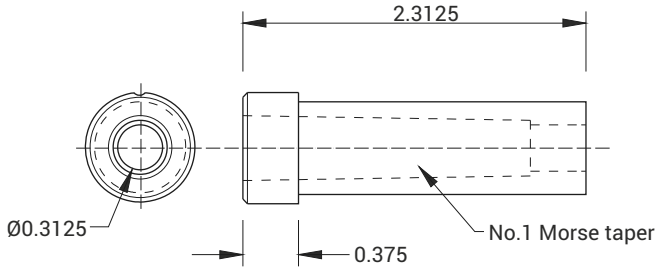
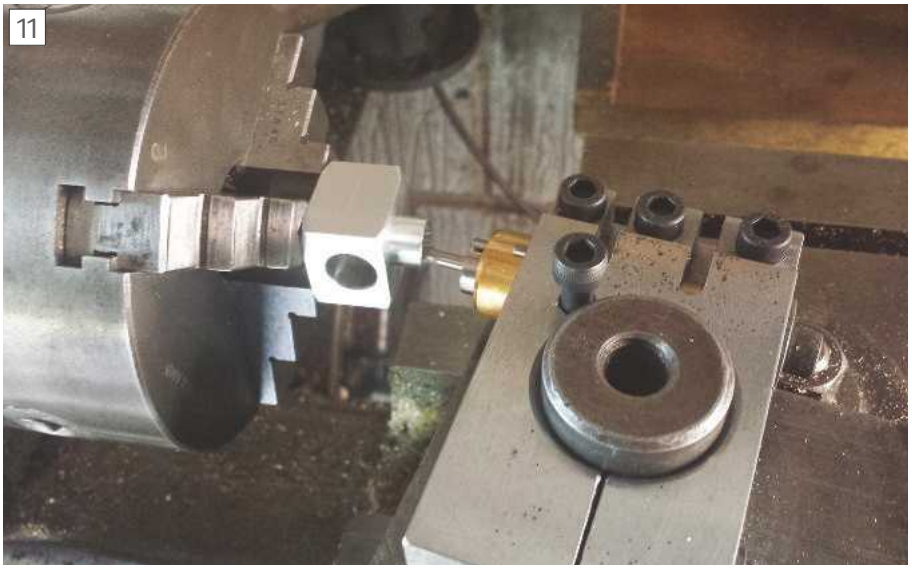


Diagram 3. Home Made Collets Bore to Size Required



Morse Taper Sleeve



Boring the air intake taper on a small carburettor.

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ACTUAL MODEL SHOWN

CHURCHILL CROCODILE

1/6TH METAL MODEL FOR RC, WITH WORKING FLAMETHROWER

CHURCHILL MK VII TANK

The Churchill was introduced to counter German tank superiority. However, shortage of materials, suitable engines and larger calibre anti-tank guns rendered the early marks a shadow of what the vehicle was destined to become. An entirely new version of the Churchill finally emerged, with 150mm of frontal armour.

Designated the Churchill VII it was used as the basis for the development of the ultimate flamethrower tank. This was named the "Crocodile". All production Mk VII's had a rectangular hatch in the hull floor for the mounting of the flame equipment so that they could be readily converted from gun tanks to Crocodiles.

In WWII Crocodiles were used in North Western Europe and in Italy. They later served in Korea. A Crocodile is easily identified as the fuel for the flamethrower was contained in an armoured trailer towed behind the tank. In Crocodile form the Churchill retained its 75mm gun. The flame projector replaced the hull machine gun.

"As an award winning professional model maker, I am proud to have been involved in the design, development and testing of this superb 1/6th scale model. The Churchill Crocodile presented some unique challenges, but the end result is magnificent."

Mike Pavie

SUMMARY SPECIFICATION

- 1/6th scale
- Cast track links
- Gun Recoil
- Motion pack option
- Flame thrower option
- Coil spring suspension
- Aluminium and brass construction
- Fully detailed
- Gun Elevation/ depression
- Opening hatches
- Delivered assembled and painted
- Weight of gun tank approx 120kg
- Length: 2,100mm
- Width: 575mm
- Height: 457mm

THE 1/6TH SCALE MODEL

The model is available as a Mk VII gun tank and as a fully fledged Churchill Crocodile with trailer **and working flamethrower!** The model is constructed in aluminium and brass **and is supplied fully assembled and painted**.

OVER 2 METRES IN LENGTH

The gun tank has an overall length of 1,240mm. The Churchill Crocodile is 2,100mm including the trailer. The flamethrower is mounted in the front of the hull which leaves the trailer space available for additional batteries to provide excellent run time. The motion pack includes 2 x Parvalux main drive motors, auxiliary motors for turret turn, recoil and elevation, 4QD speed controllers.

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Brian Wood's **Dore Westbury Mk II Miller**

Brian Wood recounts the story of his adaptations to this classic home-build machine.

I commissioned my mill about 20 years ago after a four-year build; much of the work was done on the old Myford ML4 lathe I inherited after my father died. I finished it on the ML7 that replaced it.

Some minor additions to the specification were built in at the time, things like a shroud to cover the fine down feed worm and a friction grip drum fitted on the left hand side of the down feed shaft marked up in 0.100 inch steps to keep count of turns of the fine down feed. In practice that has not been found useful. There were some other small improvements of a similar nature.

A number of more significant modifications have been made to this useful and versatile machine; they are described in this article and might be of interest to other owners.

Introduction and background

Before we get to those, perhaps a little history is in order. When I bought the kit of parts from Model Engineering Services (long since disbanded) I had hoped to buy the model that came with the larger table. That was no longer available so I had to settle for the size I have which is 412 mm x 144 mm.

The kit itself was complete in every respect with all the materials included; bar stock was in generous lengths, some of which is still to hand today. The large scale work had already been done, recognising that buyers would not be able to tackle that work themselves. All the various sizes of bolts were present, circlips, bearings and 'O' rings were included. Everything came very carefully packed in a number of very strong wooden packing cases that would have stood up to delivery by air drop!

The well illustrated build notes that accompanied the complete set of full size drawings were also very well written and bound in a proper folder with plenty of additional advice and guidance for successful assembly. It was in fact a master class study in how such kits should be supplied.

One salutary comment in the notes that I took to heart with this being my first major construction was to avoid the temptation to made things to over precise degrees of fit and clearance and keep a sense of

Mill as it is at present

proportion about the job. One builder had written in to complain that his machine had seized on commissioning.

It was gently explained to him by Ivan Law that using all the facilities and dimensional standards of the fully equipped tool room which was available to him at work, as this builder had done, was not what the machine had been designed for and it was not therefore surprising for this to have happened.

Photograph 1 is a view of the machine as it is at present. The swarf tray was shop made from galvanised sheet steel and the whole machine base sits on raising 'blocks' made from sections of 100x50 mm welded box section steel with a 6 mm wall section. These adjustable height machine mountings are identical to those I made for the Myford lathe, shown here in **photos 2** and **3**.

The spindle nose end options that were available at the time included a 3 Morse taper socket. I considered this gave more flexibility in use than duplicating the Myford nose with a 2 Morse socket. That configuration is readily achieved when needed with a dummy Myford nose adapter fitted into an open ended 3-2 Morse taper sleeve.

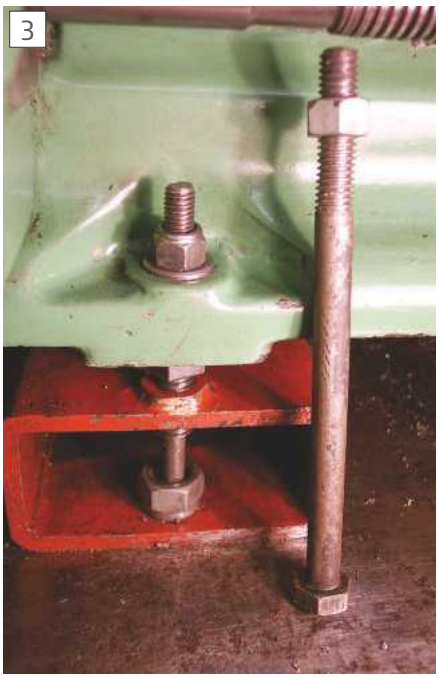
A short 3MT plug with a centre hole already formed in it was supplied so that the quill shaft drive tube could be accurately aligned down the central axis, via a steady at the joint, for joining those components together.

It has since found use as the taper fitting for a direct fitting low profile holder for a co-axial indicator, shown here in **photo 4**

At this fairly early stage of building up the equipment inventory in my workshop, I very soon discovered the law involving the expression Tx [T to the power of x] where x is a variable term; it applied right from the start on this construction..

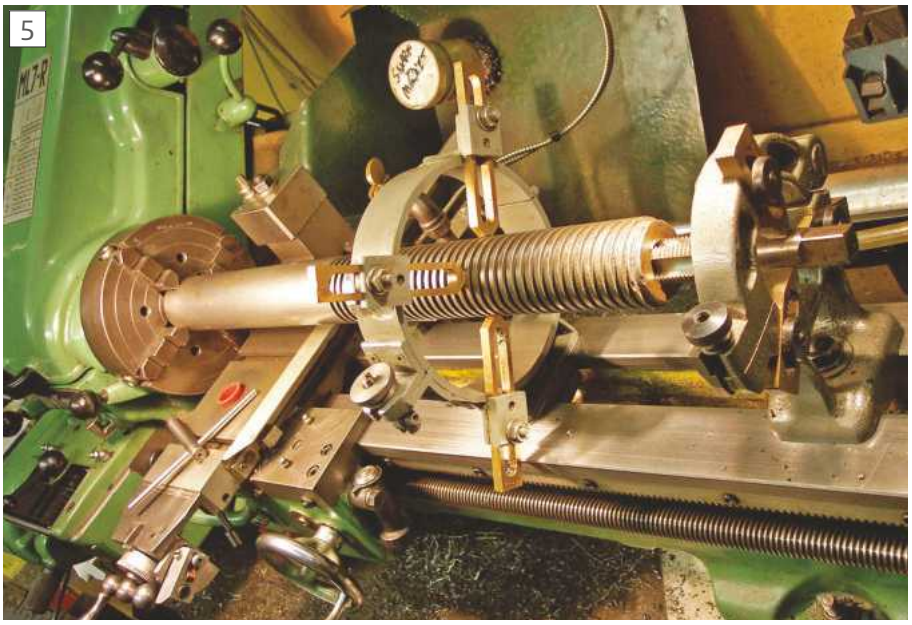
In this expression the term T stands for

Machine mount as normally set



Lock nut released and similar long bolt shown

Low profile 3 MT mounting



Barrel centred on lathe

Task and the function 'x' is a multiplier which can have values up to at least 4 and maybe more depending on the complexity of the job.

Some of you may already be familiar with this stumbling block to progress where your construction might be helped perhaps with a jig to support or align parts, but to build the jig needs tooling that you don't actually have, some of which has to be made, but to do that a special widget part number ***** is needed and so on and so on.

As a small example of this law, and happily coincident with the start of this construction, I was taught how to gas weld by a good friend so that I could rebuild the chassis on our old Landrover.

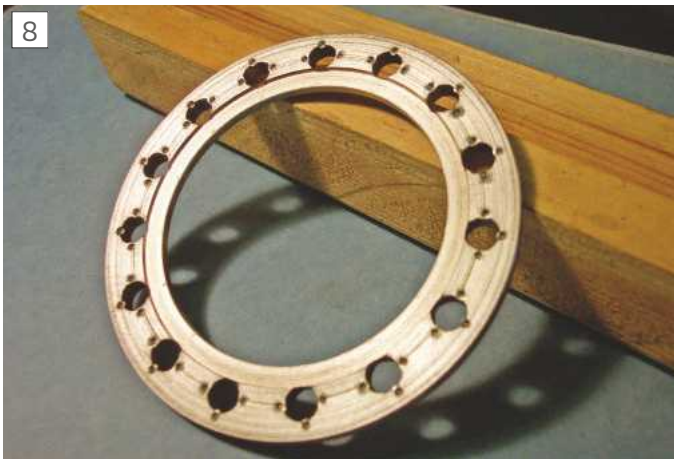
That newly acquired skill was put to good effect to make, amongst many other useful things, a large capacity four armed steady for the lathe.

The normal Myford size was too small to hold the thick-walled tube

›

Added height raising slabs

Teeth sheared off wood saw



Carrier before populating with balls

Bearing complete

of the embryo quill into which the bearing pockets for the spindle were to be machined. The build notes suggested using a simple wooden support with a well greased central hole, but I wanted a more permanent and versatile accessory.

Many and various were these hurdles to be overcome, all of which required solutions that have since gone on to provide invaluable bits of tooling to help move work forward on other projects.

That big steady for example was used on a recent salvage job to support a large tailstock barrel and cut a 7/8 inch Whitworth thread into the end of the barrel.

When it was mounted in the lathe chuck, the barrel was not far off the length of my lathe bed and the arrangement shown in **photo 5** using two steadies worked very well.

The more significant modifications

1. Adding extra throat clearance

I built this in during construction to increase the throat height for the machine. It seemed rather silly to me to have usable length for the main column poking through the support casting into the space under the mill base when it could be put to work above and still provide a secure mounting. After all, it was contributing nothing in fresh air.

Photograph 6 shows two additional spacing slabs, each one inch thick made from cast iron tractor weights that I added to the base of the column support where it is bolted down to the base.

Even then in 1994 it was hard work finding the appropriate size of longer Whitworth bolts to replace those supplied in the kit; they were eventually found at a nearby agricultural supply company. As the picture shows, I marked the stack right through so that the orientation was maintained if any shimming was needed.

On final assembly when I was testing the tramming of the machine, there was a forward lean of the head by 0.002 inches at 3.5 inches radius from the spindle centre. I had bought a pack of the very useful colour coded plastic shim material from Radio Spares (Stock number 770-816) and it was not difficult to remove the two front bolts, leaving the rear bolts slack and tilt the whole machine backwards on the column to create a gap at the front of the machine base and slide in a shim.

The alignment was then rechecked after tightening down the bolts. It took a shim of 0.003 inches to correct the lean to my satisfaction. It no doubt needs checking again now.

2. Powered lift to the column

The mill was used unchanged in this form for some 9 years before I finally tired of cranking the column up and down with a short bar in the capstan to accommodate the varied heights of different work. I also wanted to reduce the quite significant frictional loading on the underside of the capstan.

There were two distinct stages I had planned for this work, starting with the reduction of friction, but an unwelcome discovery as the work proceeded when it was fully committed forced a very necessary third stage before it could be completed.

That will also be described in some detail, together with a work around, as it might be indicative of a hidden generic design weakness waiting to be discovered on machines belonging to other owners. **Section c** covers this part of the work

a) Making a thrust bearing

Looking at the cost of thrust bearings in these sizes made me wince so I decided to make one from scratch. I had a supply of ¼ inch diameter balls; all that was needed was a carrier to contain them and two hardened flat washers to run them on.

The perfect material for the washers came from the blade of a blunt hard point wood saw.

The high carbon blades on these saws as sold in tempered condition can be cut with a hacksaw but it is fairly hard work and expensive on hacksaw blades. I considered that level of hardness would be quite sufficient for the low speed and

10

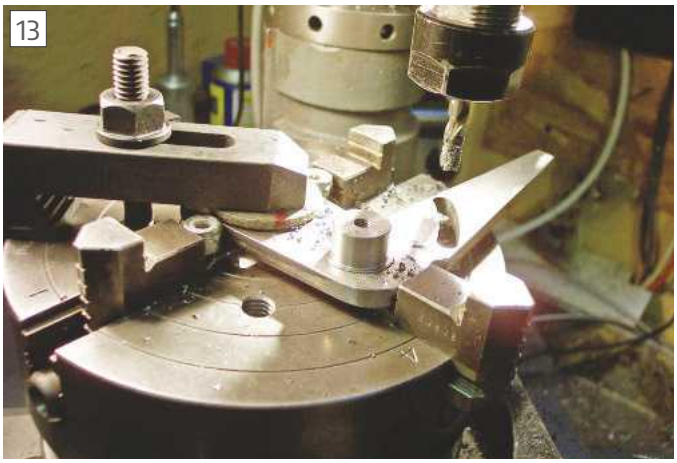
Good quality Japanese motor


11

Power lift to Myford VMF mill Photo courtesy of Alec Payne


12

Gear centre being trepanned out


13

Carrier for swing away idler gear

intermittent duty expected of this bearing.

Photograph 7 shows an old saw with the induction hardened teeth sheared off, the remaining saw blade has not deformed at all in the process. The material sheared very cleanly with minimal effort.

Two sections were then sheared off and roughly shaped to 8 sides with the shear. They were held in a 4 jaw chuck to trepan out the centre with carbide tooling. The job was then transferred to a 3 jaw chuck with the jaws expanded into the new centre hole to machine the O/D down to match that of the capstan.

A steel carrier of about 3/16 inch thickness was drilled through at 6.5 mm diameter in a ring of holes to contain 15 balls of ¼ inch diameter on a PCD of 75 mm to match the radial centre of the capstan. The mill was used for this work with the job indexed round in 15 steps of 24 degrees between each hole. The holes were centre punched at the edges on one side to just swell the edges, filled with balls and centre punched on the other side in the same manner to trap the balls.

I had made a prototype in aluminium which I would have preferred to use, but I found it was difficult to control the degree of deformation needed in the softer material to secure the balls without overdoing it and preventing them from rotating freely.

Photograph 8 shows the carrier before it was populated with balls and **photo 9** shows the completed bearing. The aim of a low profile bearing of about 8 mm in thickness was achieved.

b) Fitting a suitable motor

A friend of mine had found one, a nicely made Japanese single phase reversible geared head motor from Motors Direct, that he used to power the knee control on his Myford VMF mill.

The bare motor is shown in **photo 10**. His installation on the VMF mill is very neat; it is shown here in **photo 11**.

It worked very well on the Myford mill, my friend described the winding up action of the knee especially as fairly heavy work, look at the leverage available on the handle, so on the basis of his experience I bought one for this job. The output speed of these motors is approximately 60 rpm.

Coupled directly to the capstan that would give a lift rate of ¾ inches per second; ie one turn of the capstan per second acting on the ¾ inch helical pitch of the column.

I considered that would be much too demanding of the 25W output power of the motor and a greater degree of geared reduction was required.

A search in my useful parts boxes found a war surplus 96 tooth 20 DP aluminium alloy gear which meshed nicely with a spare 30T Myford gear to bring the rotational speed of the capstan down to about 3 seconds per revolution, which in turn of course reduced the lift rate to a value of ¼ inch per second, a much more satisfactory value.

The 96-tooth gear would easily contain the capstan with room to spare and **photo 12** shows the centre trepanned out to clear the column diameter. It was then bolted to the underside of the capstan with four countersunk screws.

The two gears were linked together by an idler gear, also of 30 teeth as that suited the geometry, on a swing away carrier shown in final manufacture here in **photo 13**. The idler gear will be mounted on the upstand and held in place under a washer and screw. The motor was supported on a sturdy welded up and braced bracket that bolted down at one of the column support bolt positions.

I am though getting just a little ahead of myself here. It was first necessary to support the weight of the milling head on a Dexion slotted angle frame so that the column support could be taken right out to release the capstan to do this work on it.

●To be continued

Four Gadgets

Nigel W.J. Taylor's article describing four simple workshop tools was cut short last month, here's the balance of account.

Components of the low-profile slitting saw holder

The collar of the Low Profile Slitting Saw Arbour, **photo 7**, is bored out to 5/8 inch with a stepped diameter. The smaller end is a close fit over the thread. I choose to use a ½ inch UNF nut, partly because I liked the finer pitch compared to using M12 and also to try screwcutting an 'imperial' (American) thread on a metric lathe. The shank is 10mm diameter, to suit an ER16 collet. Photograph 5 under the hacksaw blade parting off tool holder shows the arbour in use. When I made the arbour, I slightly undercut the 'corner' by mistake, so I have to use a spacer when using very thin saws. However, my arbour design meant I could clamp the 12mm square piece directly to the mill table to cut the slit in it.

Quick-tighten Saddle Stop Lock

The saddle stop lock on my lathe (Warco 290V) had to be tightened in place using a spanner on two bolts. I decided this needed improvement. I used the quick-release wheel lock from a scrapped bicycle to make a quick-tighten saddle stop lock.

Photographs 8 and **9** should be self-explanatory. Care was needed to avoid the micro-adjuster bolt on the lock when drilling the hole for the actuating rod (5mm diameter in my case). The rod goes from the handle on the top, which sits on a stainless steel penny washer, through the two pieces of the bed lock, then through a piece of 10mm diameter bar which acts as a washer. A nylock nut provides the means of adjusting the lock. ■

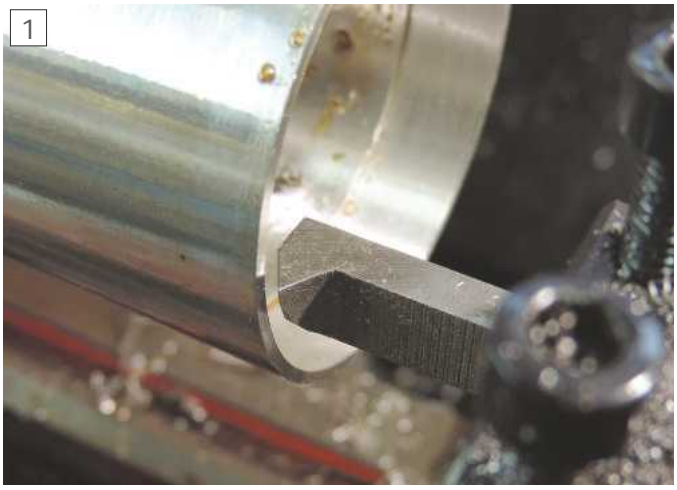
The cycle wheel lock used as a saddle stop lock

Another view showing the fixing underneath the saddle stop block

Lathework for Beginners

PART 8 – SCREWCUTTING AND MORE

This ongoing series will build into a complete guide to using an engineering lathe. This month Neil Wyatt returns to screw cutting and covers a few other miscellaneous items.



Ready to start an internal thread

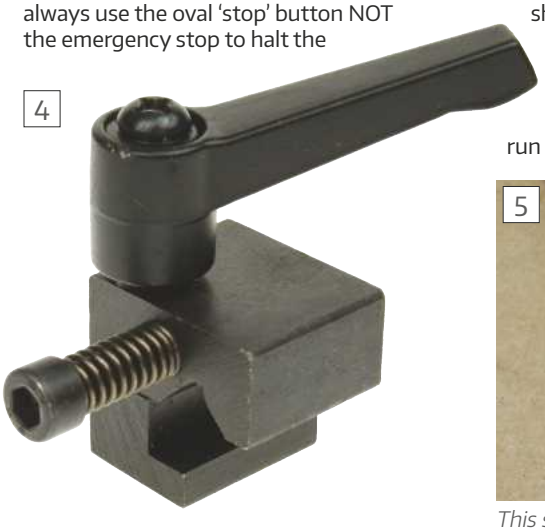
The handwheel dial on the SC4 reads to 0.5mm, but you can easily stop the lathe within 0.1mm.

Internal threads

Last time, I promised to look at cutting internal threads, **photo 1**. The principle of cutting an internal thread is identical to that for cutting an external one – you set the correct gearing for the leadscrew and make multiple passes with a suitable tool. The devil is in the detail as there are three extra challenges: Most obviously, you can't see what's happening inside the work. Secondly the tool has to be overhung, making it less rigid, and finally there is the problem of reduced clearance below the tip of the cutting tool.

Just as with boring a hole to depth, working blind inside a hole requires some sort of aid to ensure you get a consistent depth. If your lathe has an accurate dial on the carriage handwheel, like the SC4, you can set this and work to a consistent depth, **photo 2**. I've found it easy to stop the SC4 accurately in this way. Just a reminder, always use the oval 'stop' button NOT the emergency stop to halt the lathe in normal circumstances. If you don't have such a facility, an alternative is to use a marker pen or a wrap of insulation tape around the shank of the tool as a depth marker. The problems with this are that oily swarf easily rubs off 'permanent' marker and can even cause tape to move. The third option is to use a bed stop, **photo 3** shows my shop made one for the mini lathe and **photo 4** is a ready-made mini lathe stop, I don't think there is one available for the SC4 yet. Bear in mind the 'stop' is a marker – don't run the carriage into it, this will just push

A simple shop-made bed stop.

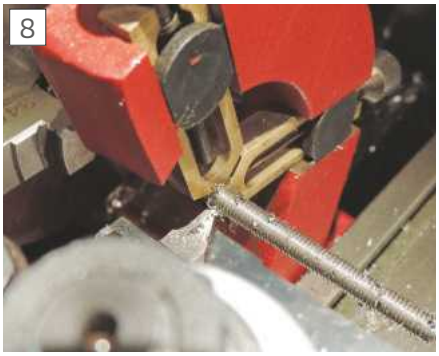


The equivalent commercial item.

This stock HSS threading tool has had extra clearance ground below its tip.

A 3/8" (~10mm) shank boring bar with a 1/8" (3.2mm) inserted tool ground for cutting a fine thread up to an internal shoulder.

Using a steady to support a long workpiece for threading.



Taking a second cut, the steady happily works on the top of the emerging thread.

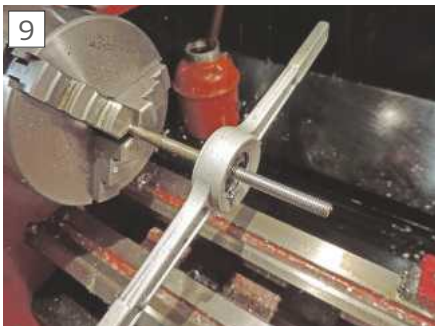
it a long (which is why they should never be rigidly fixed in place). Stop short and advance the last bit by hand.

To address overhang you want the biggest, most rigid tool possible but the bigger the tool the more likely you are to have interference between the cutter and the work. As with boring tools the answer is often to grind away surplus material at the tool tip, **photo 5**. For fine threads in large items, a large shank boring tool that can hold a suitable small-section cutting insert can work well **photo 6**.

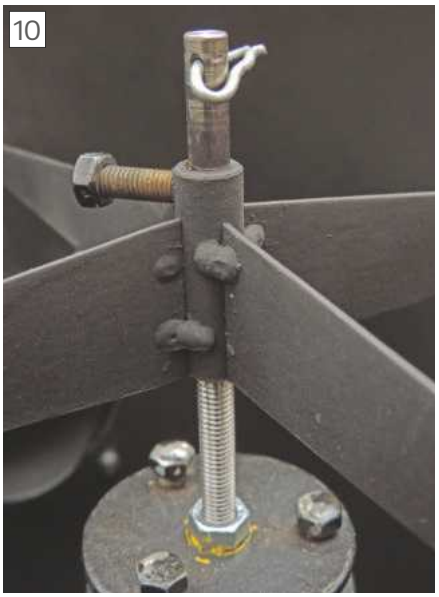
A technique for internal threads that is preferred by some turners is to reverse the lathe's direction and use an inverted tool (or to set a tool against the back of the hole) to cut the thread. This results in the tool travelling out of the work and is much less stressful when working up to an internal shoulder. This does require a threading tool whose tip faces the opposite way to normal.

Screwcutting a long thread

Sometimes you may need to produce a long, thin thread. This might be a leadscrew for a machine, or it may just be to allow a long range of adjustment. In my case, after modifying a telescope I needed a longer support for its secondary mirror. This required about 60mm of M6 thread on a stainless-steel bar. Hand cutting such a long thread in stainless is both a tough job for the die which is also more likely to wander and give a 'drunken' thread over such a distance. The combination of the overhang and the relatively tough material posed a challenge for cutting it on the lathe. The solution is to make use of a travelling steady ('follow rest'), photo 7, which removes any drama from the screwcutting operation. The tool should be set slightly after the steady, photo 8. I didn't quite cut the thread to full depth with my single-point HSS tool, instead I removed the steady and ran an M6 die along the thread, **photo 9**. Because there was already a thread to follow the cutting forces were low, so I just guided the die by hand while the lathe turned slowly under power, I also reversed the die off the same way. The end result was a perfect replacement for the original, **photo 10**.



The thread was finished by running a die along the thread.



The finished part fitted to the telescope.

Using a Pump Centre

In the last instalment I mentioned using a sprung 'pump' centre to guide a tap, but I think it's worth giving a few more details as this such a convenient approach. **Photograph 11** shows a freshly drilled 5mm hole, ready for tapping M6. If this was steel, not an oddment of aluminium alloy, I would probably use a slightly larger hole. To tap the hole with the pump centre you need a tap wrench with a conical centre hole in the end of the Handle – most tap wrenches are made this way. As you can see the nose of the tap is inserted in the hole and the tailstock (or tailstock barrel) brought up to compress the pump centre, **photo 12**, holding everything in alignment. I've applied a bit of cutting fluid to the tap.

You can now tap the hole in several ways – you can obviously rotate either the tap or lathe by hand, but you can also tap the hole under power if your lathe has a quick stop function. On the Arc SC4-500 I set the speed to the minimum (100 rpm) and held one 'arm' of the tap wrench. I then started the lathe and stopped it when the tap was at depth, photo c.

With very small taps it is probably wiser to tap by hand, also if you are tapping a blind hole the 'feel' of tapping by hand will help avoid breakages. With very large taps be aware that the tap will feed very rapidly, and the torque on the tap wrench may be more than you can comfortably control, so return to hand power for larger taps. The wheel-shaped spindle handle featured in MEW 272 is an idea aid to doing this.

Cross Drilling Rods and Tubes

Last weekend, I had a little task to make a reasonably accurately centred 'window' in a tube. There are various ways of doing this, one of which would be setting up in the milling machine, centring carefully, drilling and boring. If you don't have a milling machine an alternative approach is to use a 4-jaw chuck to hold the work, **photo 14**. You'll notice I have had to remove the chuck guard to allow it to swing the offset, long tube. On the SC4 this is just a case of unscrewing the mounting stud, the position sensing switch is arranged so that this will not stop the machine operating. Obviously, use extra care and remember to refit the guard once you have completed an outsize job.

Centring was an easy task for me as I have the benefit of a self-centring 4-jaw chuck and no extreme accuracy was needed. You can hold round or square work in this way with an independent 4-jaw chuck as well, but be prepared for some patient fiddling to get it centred.

I bored the hole using the carbide insert boring bar which is rapidly becoming my 'weapon of choice'; for this sort of work. Note how the bar is mounted higher than a normal tool, with the tip angled down to be at centre height, **photo 15**. The round holder body has flats to get the tip at the

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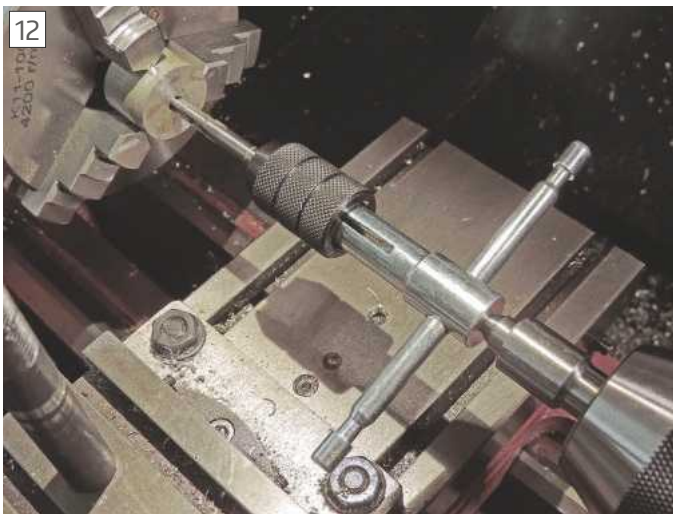
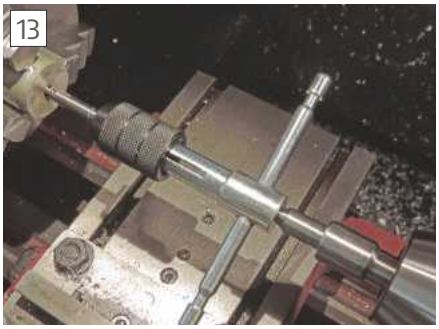
Hole prepared to tap M6.

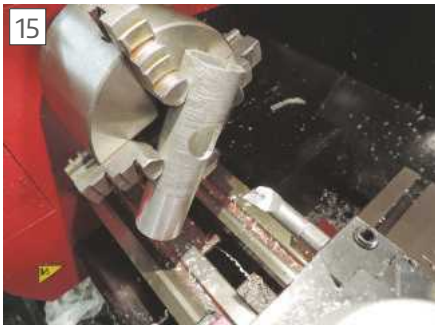


Set up to start tapping with the pump centre compressed.



Tapping complete, note how the pump centre has extended.

Using a 4-jaw chuck to hold a tube centred across the axis of the lathe.



The boring tool has an angled tip which needs to be set at centre height for best results.

correct angle, which minimises the size of the required starting hole. This, unfinished, job is making a 'cheshire eyepiece' out of a piece of well-worn bicycle seat tube but the laser collimator in **photo 16** was made in exactly the same way.

Preventing Rust

I'm fortunate that my workshop is dry and well insulated, so that I have few problems with rust, however I'm well aware that many readers are not as fortunate. The self-centring 4-jaw is the sort of tooling that doesn't get a great deal of use in many workshops, although I know some lathe users prefer them to a 3-jaw. Incidentally. **photo 17** shows the SC4's spindle flange, I wanted to illustrate the pattern of six fixing holes, the one at the top is common to chucks that use either three or four fixings. The SC4 has a bit more room behind the flange than some lathes, this means that screws or studs and nuts can be used to attach chucks. Screws are a touch easier to use for those who don't like fiddling with nuts. They should be done up firmly, but not overtightened.

Before returning the chuck to its shelf, I treated it with MetalGuard Ultra, a special anti-rust treatment. This comes in a small tin, **photo 18**, but a little goes a long way. It is claimed to provide up to two years' protection from rust, by forming a 2-micron film which means you can use it on precision tools, such as micrometers, and don't need to remove it before using them again. You can apply it using a brush or spray, but I find the most convenient method to is to use a kitchen towel (I have a dispenser in the workshop). I wiped the chuck down first, then rubbed MetalGuard into all the exposed surfaces. As you can see, **photo 19**, the treatment is effectively invisible and is therefore also suitable for protecting bright surfaces on models. If, like me, completing a model takes you years, not months, it's also a way of keeping finished parts looking fresh.

Filing in the Lathe

I'm going to break with some 120 years of tradition for model engineering magazines and discuss filing in the lathe! Usually any mention of this subject is studiously avoided or hedged around with a crop of caveats. In fact filing work in the lathe can be done safely, and is certainly safer than using loose strips of emery cloth, a practice that results in many industrial injuries as fingers get pulled into moving machinery.

This laser collimator was made with the same technique, but with an independent 4-jaw chuck.

The SC4 spindle flange, note the fixing bolts with low-profile heads.

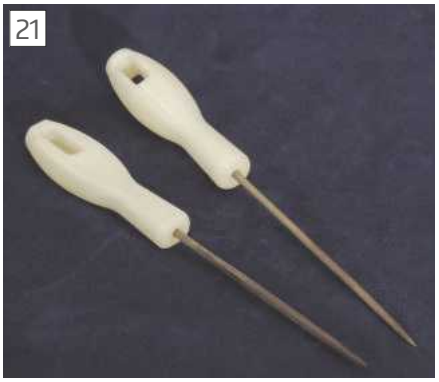
MetalGuard Ultra is an anti-rust coating that can prevent corrosion on all metals.

The 4-jaw chuck treated with MetalGuard.

Large, comfortable handles are essential for safe use of lathe files.

As well as a clear view of the work and suitable care it is essential that any file use with a lathe has a secure and well-fitting handle. If a file is stuck by a moving jaw or otherwise pushed backwards a bare tang can be pushed through the palm of your hand or even into your wrist with potentially awful consequences. A nice large, well fitting handle like that in **photo 20** is ideal. For small 'needle' files I use handles like those on **photo 21**, I really don't trust the very small handles sometimes provided with these files to give adequate protection or control of the file.

Observe obvious precautions –make sure the chuck guard is in place and make sure you keep the file and things like sleeves and fingers well away from the chuck. Always avoid using a file close to the chuck jaws as contact can damage chuck, file and yourself. Eye protection is even more strongly advised than normal. To use the file, it can help to gently hold the far end of the file with your left hand to improve control. Don't leave the file still at any time as this may create a soft or blunt spot on the file. Gently apply forward strokes and don't rush, letting the machine do the work. For a straight chamfer, hold the file at a fixed angle and for a gentle curve twist it sideways as you move it forwards.



For small files I retro-fit them with decent sized handles – these are 3D printed.

Although you can potentially use any file the use of a proper lathe file will give better results. The Tome Feteira lathe file in **photo 22** shows the single, rather steep, cut of a lathe file. This pattern is chosen to be much less likely to grab. It also requires constant, gentle, pressure away from the chuck to keep it in place. This means that if it loses contact with the work you have a natural tendency to push it away from the chuck. With its handle the lathe file is about 400mm long, has two 'safe' edges, **photo 23**, and feels a little heavier than most files. I find it much easier to control than an ordinary file for even relatively delicate work.

Finally, let me return to emery tape. A lot of people use this to put a good finish on turned parts without realising just how nasty the results of it catching on the work or chuck can be. The HSE off some really good practical advice which in short is to use emery tape glued to a wooden backing. It can then either be used like a lathe file, levered against the work using a support. I strongly recommend the HSE's guides to safe working practice, far from being 'nanny state' they are full of practical and sensible approaches to safe working.

Next time, I will look at ball turning. ■

Arc Euro Trade

The various accessories featured in this series including pump centres, metalcote, Tome Feteira files and various cutting tools as well as the featured Arc SC4-500 lathe are available from Arc Euro Trade, as are both Brian Wood and Martin Cleeve's books on screwcutting.

A proper lathe file.

A close up of the file's cut showing a 'safe' edge.

Scribe a line

YOUR CHANCE TO TALK TO US!

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

Choosing a Lathe

Dear Neil, thanks for your interesting series "Lathework for Beginners". I am sure you will realise that some of those beginners have yet to purchase their first lathe and will use the information and tips they glean from your series to firm up their shopping list of 'desirable features and accessories' to look for before laying their cash on the counter.

One of those features is the presence of a leadscrew protector. Now who could argue against that?

Typically, they fall into one of three types:

(i) the telescoping, helicoil type,

(ii) the telescoping, straight tube type,

(iii) the 'overhanging' ledge type under which the leadscrew 'shelters' in a deep channel.

So, let's make sure that's on our shopping list, right?

The problem is that in some circumstances it interferes with the normal operation of the lathe for example, holding a workpiece via a spindle mounted dead-centre or even a short-nose collar Chuck and then attempting to machine right up close to the spindle nose and discovering (usually too late!) that saddle movement is obstructed by the leadscrew protector. I have a friend who regularly faced this issue with his machine so in a fit of frustration he ripped it off - which rather defeats the purpose of having a leadscrew protector fitted in the first place! Oh well, back to the drudge task of picking swarf out of the leadscrew thread crevices...

Likewise, similar clearance issues may arise at the tailstock end with interference with the threading dial indicator and of course the 'classic' - limited approach of the tailstock due to the installation of a cross-slide DRO transducer rail, usually requiring an overhanging extension piece... not good!

These are examples of wrongly thought-out bad design but are not true of every machine but the newby lathe purchaser needs to be aware of these issues. It's a shame that this is a little late for inclusion in the earlier episodes of your series but perhaps you may like to include a future section specifically devoted to clearance/interference issues arising from machine design or else comment more extensively in SaL in reply to this letter.

Andre Rousseau, Papakura, New Zealand

One problem with lathes is that 'one man's meat is another man's poison' and what is the right choice will depend on everything from the space and budget you have through what you want to achieve with the machine and your personal preferences! I will be writing a separate article to summarise my impressions of using the Arc SC4-500 for the series, which will cover some of these issues. It's no secret that I have been very impressed by the machine, although I have one or two modifications in mind. – Neil.

Differential Dividing

Dear Neil, a fascinating article by John Olsen – I may have a go at this. However, from earlier efforts of mine, let him know that a compound train for 'pi' that will easily fit his quadrant is 25 x 50/51 x 77 = 3.1416:1 (all easily cut gears). I made that set of gears for the job of cutting some DP helixes many, many years ago and they still hang on the board behind the lathe gathering dust beside the lathe gears.

For imperial lathes, those gears inserted instead of the standard train to the gearbox and the gear box set to the appropriate threads per inch, the cut produces the DP pitch. i.e. with those gears inserted and box set to 16 tpi, pitch produced is 16DP. The gear train is run 'step up' when used in a lathe. I presume that with rather more 'sweat of the brow' expended the same will apply for Metric pitches.

Peter King, New Zealand

Curious Machine

Dear Neil, would any readers be able to identify this tool? It's made of cast iron and steel with a brass nameplate.

Terry Durham

I'm afraid your photos were a bit battered by their journey through the 'snail mail', we'll do our best to reproduce them. For clarity, the nameplate appears to say: "Aug. Brehmer's (British) Succ. Ltd. 12 City Road London E.C.1 Manufactured in Germany". The machine appears to do something involving a large spool of wire – perhaps it was for making beaded edges on sheet metal? - Neil.

Holding drills in the chuck correctly

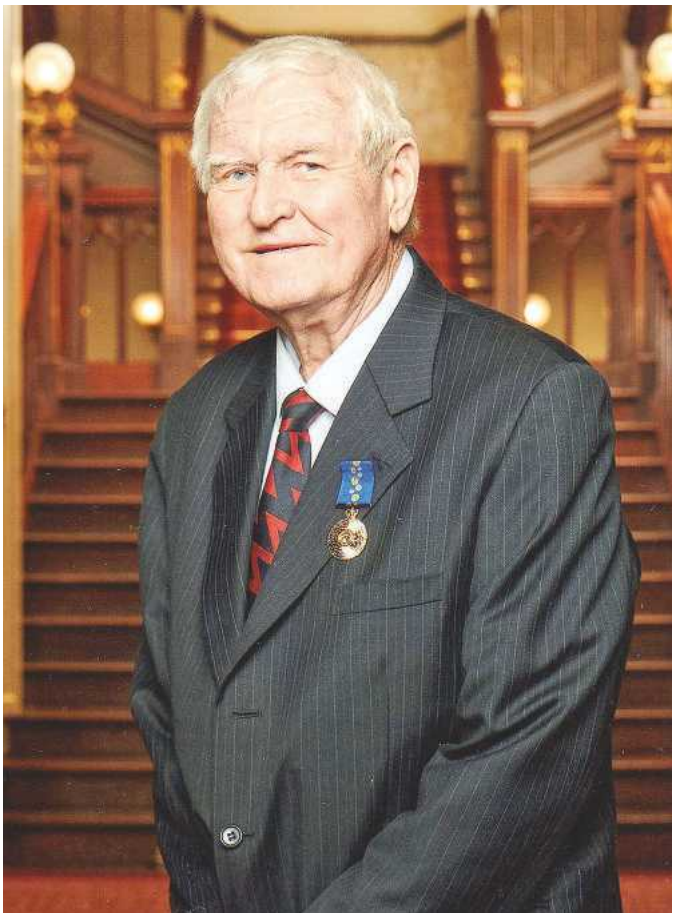
Dear Neil, probably a lot of engineers know this, but I know an awful lot that don't, it really irritates me when I see someone putting a drill in a chuck and placing it too far inside, nobody's taught me this but, when I fit a drill in a chuck, I only put it in 1/2" maximum, as I've always found that putting it too far in reduces the gripping force, i.e. if only fitted a little way in the jaws will 'sprag' out preventing further damage to drill/drill chuck with the drill pushing back, also if drill fully inserted what happens on auto feed?

This has stood me in good stead for the last forty years.

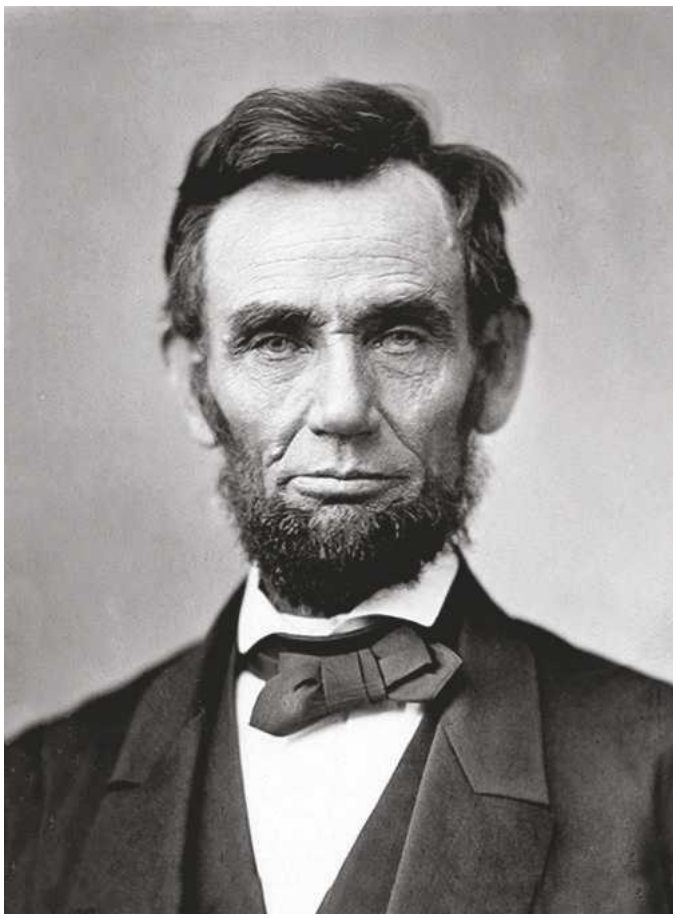
Andrew Lengert, Wolverhampton

I suspect you may have sparked a controversy there, Andrew. What do other readers think? Or do you have any similar pet hates? Neil

Barry Glover



Not a letter, but a press clipping in my inbox from Australian Model Engineering, Model Engineer's counterpart down under. I'd like to add my congratulations to Barry Glover who was awarded the Order of Australia in the Queen's Birthday Honours List. Barry was president of the Australian Association of Live Steamers for 26 years and is a founder and live member of the Illawarra Live Steamers Club. As well as his model engineering credentials Barry has been a State Councillor and has a long list of service to local community organisations.



Tips

Dear Neil, I have subscribed to MEW for a good few years now and the one constant that runs throughout its pages is the immense pride that contributors take in the projects they describe for our benefit. A case in point is the excellent article by Pete Barker in MEW 273 who has taken the trouble to hand fettle his dividing head 'casting' before bringing it to a stunning painted finish.

Why then would you award this month's £30 Chester gift voucher to something that looks like a pig's breakfast? With due respect to Richard Gibson it left me feeling quite poorly!

Peter Cole, by email

I have to agree that last month's tip wasn't the prettiest thing ever featured in MEW, but we judge tips by how useful they are not on their good looks. That means they are often makeshift solutions rather than exhibition pieces. The tip was praised for it's usefulness on our web forum and someone else grumped about the pictures of the VDH. It all goes to prove what Abe Lincoln said "You can please some of the people all of the time, you can please all of the people some of the time, but you can't please all of the people all of the time"! – Neil

Abrafiles – A Thank You

Dear Neil, I picked up my August copy of Model Engineers Workshop yesterday and noted the advice listed in scribe a line re round hacksaw blades, great feedback, good stuff, thanks!

I can now continue with getting my hands dirty

Richard Cains, Australia

Differential Dividing

John Olsen makes an attachment to allow dividing awkward primes.

Table 4 Parts list

Part no	Description	Material	Quantity	Comments
1	Bevel Gear mounting plate	Steel plate 9mm	1	
2	Gear, 40 teeth, 20 DP	Steel or cast iron	2	FCMS or cast iron bar
3	Gear, 40 teeth, 20 DP	Steel or cast iron	2	FCMS or cast iron bar
4	Bevel gears	steel	2	See text
5	Spacer	BMS 50mm	1	
6	Input shaft extension	BMS 21mm	1	
7	Arm Retainer	BMS 28mm	1	
8	Bevel gear pin	BMS	1	
9	Bevel gear block	BMS	1	
10	Bevel gear shaft	BMS 5/8 inch	1	
11	Shaft end washer	Brass	1	
12	Back plate	BMS 12mm	1	
13	Boss	BMS 50mm	2	
14	Change wheel pin	BMS	2	Or use Myford items
15	Change wheel bush	BMS	2	Or use Myford items
16	Main shaft	BMS 5/8 inch	1	
17	Main shaft end boss	BMS	1	
18	Quadrant	BMS Steel 10mm	1	
19	Stud for main shaft	Steel M8 by 105 mm	1	Screw rod
20	Nut for bevel pin	Steel M8	1	
21	Washer for bevel pin	Steel M8	1	
22	Bevel plate cap screws	Steel M5 by 10mm	3	Use original Vertex screws
23	Dividing plate mounting screws	Steel M5 by 45mm	3	Cap screws
24	Dividing arm screw	Steel M6 by 75mm	1	Cap screw
25	Washer for dividing arm	Steel M6	1	
26	Grub screws for arm collar	Steel M5 by 5mm	2	
27	Grub screws for bevel block	Steel M5 by 5mm	2	
28	Screw for bevel gear shaft	Steel M5 by 10mm	1	Hex head
29	Screws for back plate bosses	Steel M5 by 15mm	4	Hex head
30	Back plate mounting screws	Steel M5 by 15mm	4	Hex head or cap
31	Bronze bushes for bosses	Bronze	2	
32	Quadrant mounting screws	Steel M5 by 15mm	2	Hex head
33	Quadrant gear pin nuts	Steel M8	2	
34	Quadrant gear pin washer	Steel M8	2	
35	Keys for change wheels	Steel	4	1/8 key steel or gauge plate
36	Collars for change wheels	Steel	2	Or use Myford items
37	Grub screws for change wheels	Steel M5 by 5mm	2	Or use Myford items
38	Screw for change wheels	Steel M5 by 10	2	Or use Myford items
39	Washer for change wheels	Steel M5 bore by 19mm	2	Or use Myford items

A list of parts is provided in **table 4**, and the text will refer to the numbers. The choice of screw heads is important, as some must be cap screws, while others can be better accessed during assembly with a spanner, **photo 6**. For screws to fit existing holes in the Vertex, metric is needed, at least on my example. For other screws, feel free to substitute your favourites, for instance 2BA for M5, and 5/16 inch for M8.

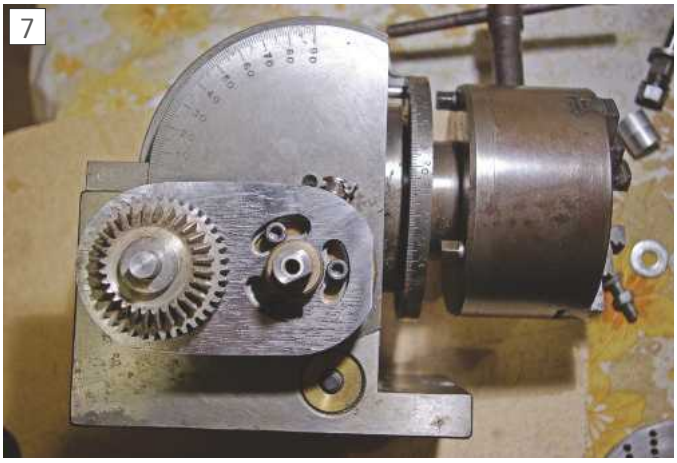
We will start from the input shaft end, mainly because that is where I started. When we remove the dividing detent and the dividing plate from the Vertex, we find a bronze carrier for the worm shaft which can be adjusted when the three screws are loosened. It has three screw holes for the dividing plate. We make the bevel gear mounting plate (**photo 7**, fig. 1) to attach to this bronze carrier by means of the three screw holes normally used to attach the dividing plate. Now, as the dividing head gets adjusted over time, the position of

these three screw holes will vary. So in order to be able to keep our bevel gears aligned, we provide curved slots for the bevel gear plate to adjust over a small range. This is similar to the existing arrangement of curved slots on the carrier. Since I have a rotary table as well as the dividing head I did not have to reassemble my dividing head to cut these. This adjustment is used to allow the gears to align when the bronze carrier has been adjusted and also to allow for the probable inaccuracy of the height of the bevel gear shaft on the backing plate, **photo 8**. The position of the slots should allow a good range of adjustment around the horizontal when the worm carrier is adjusted for the best mesh of the worm. The most critical dimensions for this part is that the hole centres should be the correct distance for the two forty tooth gears to mesh correctly, and the larger hole should be a good fit on the boss on the worm carrier. By this I mean that it goes on and off freely but does not have excessive clearance.

Next out is a 40-tooth gear, fig. 2. The pair are 20 DP gears and apart from the diameter of the centre hole they are exactly similar to a Myford change wheel, which may be used by boring the hole. Do not use up all your wheels from the lathe for this project, you may need them later. I made my own, but they are readily obtainable. The one on the input shaft requires three holes drilled and tapped to match the spacer. To over bore a gear that already has the teeth cut, set it up in the four-jaw chuck and use the indicator on the existing bore. This gear attaches to the spacer, **fig. 4**. The spacer has several important functions, although it is a simple part. It moves the dividing plate out to a point where it clears the bevel gear assembly. Because the plate has to move out, the input shaft needs to be longer. Rather than pull the head to bits and make a new shaft, I made an extension (fig. 5) that attaches to the existing shaft by means of a long screw. The extension is made a good running fit in the spacer so that the spacer helps to maintain the alignment. The long screw that holds it together also holds the dividing arm onto the extension shaft. Note that the gear, the spacer, and the dividing plates are all a good free running fit on both the shaft extension and the boss on the end of the worm carrier so these parts must all be made with holes matching the existing boss. Mine is 20.8mm diameter but check yours before cutting metal. The holes will of course need to be a little larger to allow free running. The three holes in the spacer and in the gear should be marked out from a Vertex dividing plate. The flats on the end of the input shaft extension, **fig. 6**, should be a nice fit in the slot in the Vertex dividing arm. Their length should be such that the washer bears on the dividing arm when the unit is assembled, so the arm is retained in place. The recess on the inside end of the extension piece must not be too deep and should be a good fit on the Vertex shaft. The bottom of this recess must bear on the end of the Vertex input shaft, so should be bored to a square end inside. There should be clearance between the extension and the Vertex worm carrier.

Left to right above are the 40 tooth gear, the spacer, the input shaft extension, and the collar to retain the dividing arms. The three plated Allen screws fasten the dividing plate and spacer to the gear. Collars for the change wheels to the left below with two keys. M5 fasteners for assembly.

At the other end of the bevel gear plate is **fig. 7,** the pin for the bevel gear, fig. 3. In my case, the bevel gear had a boss on the back. I adjusted the length of this boss to allow me to press fit it into the 40-tooth gear. Actually, there may be some Loctite in there. But anyway, the shortening of the boss leaves a recess for the shoulder on the pin so when the pin is attached to the bevel plate the two gears can freely turn on it, while of course being locked to each other. Incidentally I have allowed steel to run on steel in several places in this device as the speeds and loads are such that this is perfectly acceptable. If you are using the Davall gears I would suggest proceeding as follows. The boss on the Davall gear is deeper than we need. It is specified as 12mm. The 40-tooth gear is only 9.5 mm thick so we need to turn that much off the boss. We also need to make provision for the flange on the pin. I would suggest mounting the gear on a stub arbor, using high strength Loctite. The stub should be short enough to allow turning the boss



The bevel gear plate posed next to the bronze worm carrier where it mounts on the three M5 screw holes

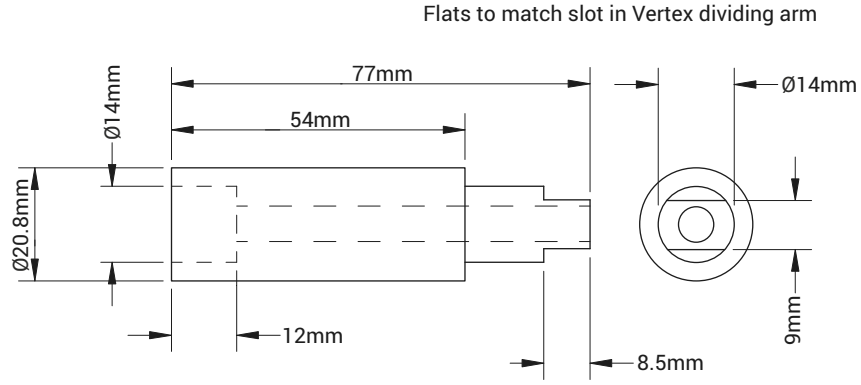
Bevel shaft with bevel block attached above. Bevel plate with bevel gear and forty tooth gear on pin below.

down to length and to allow counter-boring it as shown in the scrap diagram to accommodate the flange on the mounting pin. Turn the stub mandrel then fit the gear to it without removing the mandrel from the lathe, to maintain concentricity.

Rather than turn the outside of the boss down, I would bore the 40-tooth gear out to match the boss size. When opening out an existing hole in a gear like this I prefer not to try to mount it in a chuck. Instead I would mount it on a faceplate and use a dial gauge to set up the existing bore to run true. I have done this with quite a few gears, especially while I was making the Machin gearbox for my Myford. (This is the kit that is available from Hemingways, usual disclaimer applies.) I had a large number of suitable gears, the same pitch as required, but thicker than needed and with smaller bores. It is a bit annoying setting up a wheel to run true to the bore when it already has a key-way but is preferable to breaking teeth by holding them in a chuck, or to finding that the finished gear is not quite running true.

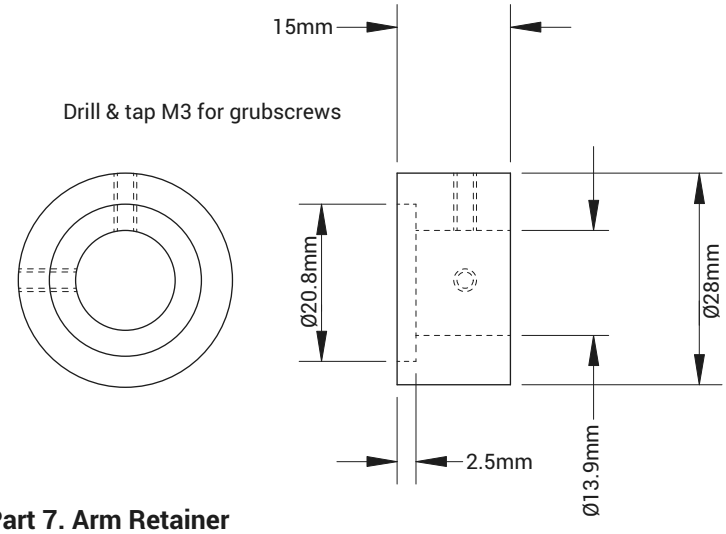
On the other end of the pin is a block (**fig. 8**) which maintains the alignment of the two bevel gears. The size of this block is likely to have to change depending on the size of your bevel gears. My gears allow just over 8mm of the pin to engage in the block without fouling the other bevel gear shaft, which goes right through. This is adequate, but I would not want it to be too much less, since we want the two grub screws in the block to engage on the pin. My gears have a shallow boss on the inside that I could have reduced if required. You may need to look at your gears and see how big a block can be accommodated. Just to add to my fun, the two gears had slightly different boss height. If you have bought two identical gears you should be able to make these two dimensions the same, the exact value depending on the gears. I have shown the dimensions that should suit the Davall gears, but be aware that I have not tried

Fig.6



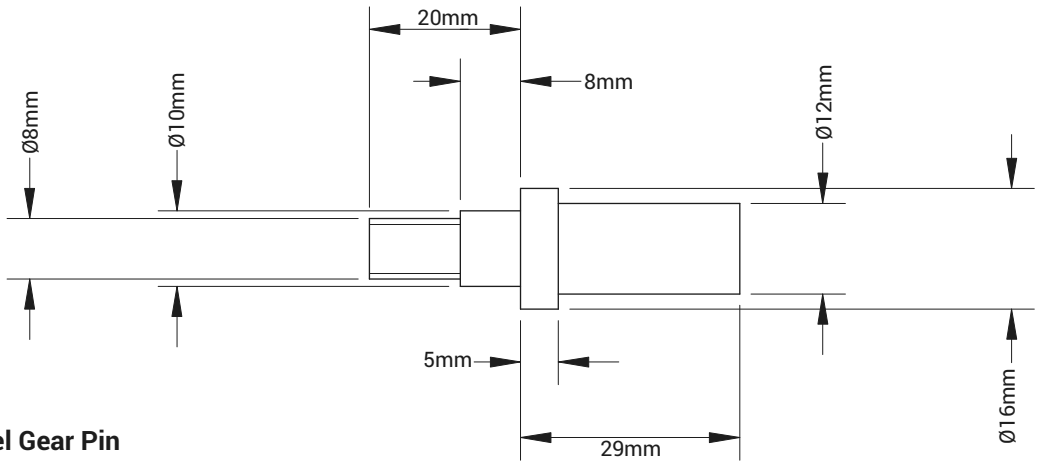
Part 6. Input Shaft Extension

Fig.7



Part 7. Arm Retainer

Fig.8

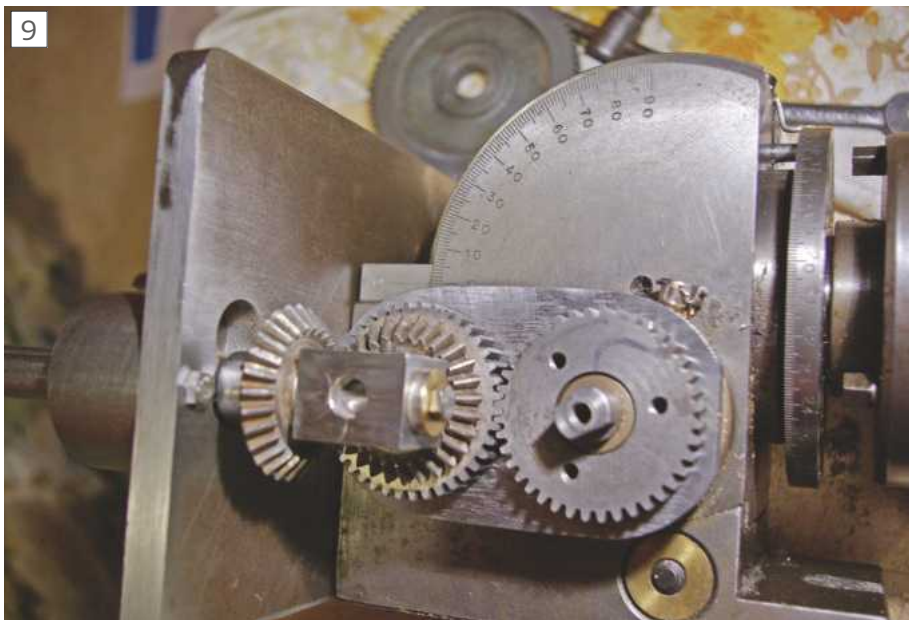


Part 8. Bevel Gear Pin
Mat'l: Steel
Change the Ø12mm dimension as needed for your bevel gear
Thread end M8

these, so some tweaking may be needed. When the two gears and shafts are tried on the block, the gears should run freely but without excessive backlash, **photo 9**. As well as the different bosses, one of my gears had a metric bore while the other appears to be Imperial. Makes me wonder about what they came out of! You can adjust the shaft size where the gear fits to suit the bore of your gears too.

The second bevel gear shaft (**fig. 9**) should be made from a piece of 5/8 inch bright mild steel shaft, not metric material since the Myford change wheels should fit on it. The end is reduced to fit your bevel gear and the block. Again, I have shown the sizes that would suit the Davall gears. A thick washer (**fig. 10**) is attached to the end of the shaft with a small cap screw to retain the block on the shaft. This should have minimal end float while allowing free rotation.

That brings us to the back plate, **fig. 11**. This attaches to the Vertex by means of the four holes that have to be drilled and tapped into the base of the dividing head. I don't really like drilling holes in expensive items like this, so I took special care to make sure that I got them in the right places. First thing to do will be to check your Vertex since they may have made changes in the thirty years or so since my father purchased mine. Machine the plate and the holes for the shafts and the fixing screws for the bosses. Drill the four holes for the attaching screws to tapping size, not clearance size. Make sure the Vertex head is set to the exact horizontal position and fit the main shaft extension. Make sure that it is aligned, so that there is no wobble when the dividing head is rotated. Fit the main shaft boss, see fig. 17 later, to the backing plate and slide it onto the shaft. Now it should be possible to line up the plate in the correct position and then spot though the holes. Drill and tap them, screw the plate into place and check that the main shaft can rotate freely without binding. You can disengage the worm for this check. One final thing to check after you have this located properly is that the back plate should not extend below the Vertex. This is so that when you put the dividing head on a milling table, it is resting on its own base and not held up by the back plate at one end. If necessary, skim enough off the bottom edge of the back plate to ensure clearance.

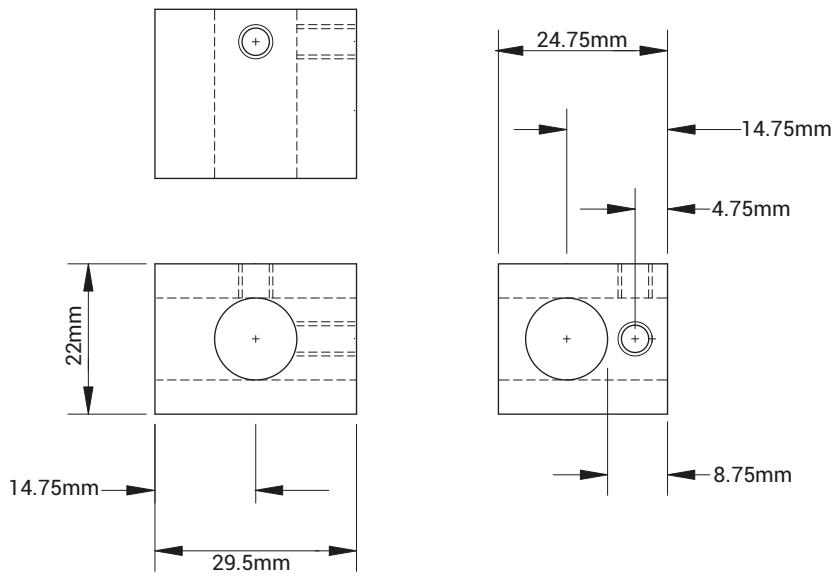


Bevel plate attached. Screws should not be fully tightened yet.

The recess in the back plate allows us to get at the back hold down bolt for the dividing head, so we can take the whole circus off the milling table without dismantling it. The back plate carries two turned bosses (**fig. 12**, make 2) which are used to hold the quadrant, part 31 (Fig. 18, **photo 10**). Mine are nicely bushed with bronze bushes, photo 11, since I happened to have some and since this provides a register for the quadrant. You could just make the hole in the quadrant to fit the shaft. I have only made one quadrant, which is all that you are likely to need for differential dividing. For helical milling another may be required to go on the end of the mill lead screw.

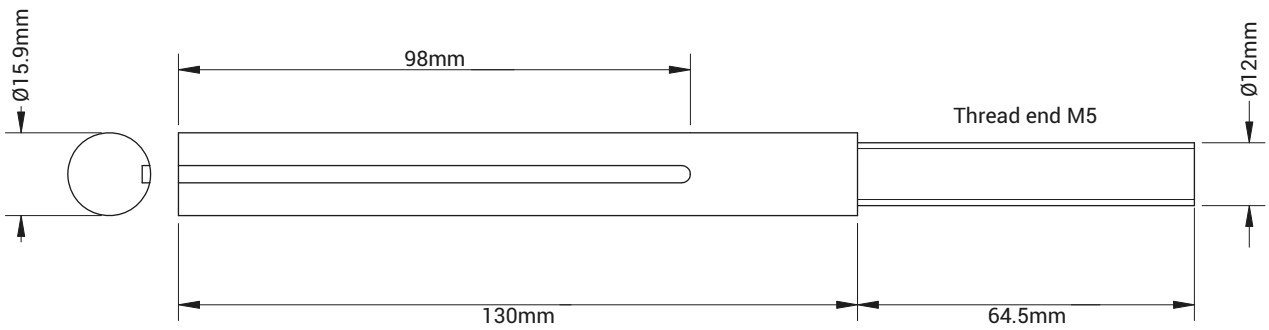
My quadrant takes standard (Imperial) Myford gear pins, but I have shown a metric version (**figs 13, 14**) which is similar to the Myford one, for those who do not possess Myford lathes. One difference is that with the Myford one, you will probably need to put a couple of washers on to bring the gear position into line with the gear by the quadrant. The curved slots I have specified for the quadrant where it attaches to the boss should match the Myford ones, at least they do for my ML7, and without too much trouble you could use a Myford quadrant, if you happen to have one. The main difference is the Myford one needs a recess in the boss, rather than the bush sticking out. The location of the holes for the screws that I have shown may not be a perfect match, but the slots in my Myford one are cast in and so are pretty wide. However, I preferred not to have to tear down the quadrant on the lathe every time I wanted to set this device up, so made a separate one. There are plenty of holes shown for the studs, so you should be able to put the quadrant on wherever it is needed. You can also put it on either boss. The idea is to be versatile, since we don't know what hare-brained ideas we may come up with in future.

Fig.9



Part 9. Bevel Gear Block
Shaft holes to match bore of bevel gear
Grubscrew holes tap M5
Modify dimensions to suit gears

Fig.10



Part 10. Bevel Gear Shaft
Shaft is 5/8" to suit Myford change wheels

This dimension should be checked on the job to take the shaft through the bevel block without excessive end float

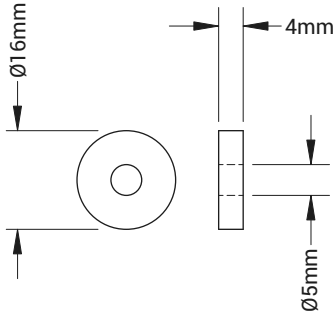
The top boss on the backing plate aligns with the main shaft of the dividing head as described earlier. The alignment of the other shaft is slightly less critical, since the vertical position of the bevel gear can be adjusted slightly at the input shaft end. A look at the backing plate reminds me that I did get this hole out of position by a large margin on the first try. As I recall, I subtracted an amount that I should have added, or vice versa. To allow adjusting the horizontal location, I provided a small movement by slotting the holes. I have allowed 3 mm here. The basic idea is that the height of the holes can be obtained by putting the Vertex on a surface plate and measuring.

The distance from one side of the Vertex can also be measured to give the position of the holes in the horizontal dimension. While I have given the dimensions that I have measured from my plate, I cannot guarantee that this will fit on your Vertex. However, given that the vertical height can be adjusted on the bevel gear side, and the horizontal position can be adjusted on the backing plate, it should be possible to align it all correctly. These alignments only affect the free rotation of the shafts, they will not affect the accuracy of dividing unless they prevent things turning properly. An order of assembly is described later. This should be followed to get things set up correctly.

The next parts are the two pieces for the main shaft extension assembly. These are shown in **figs 15** and **16**. They could be turned in one piece if you wish, but it is easier to use a piece of 5/8 in. stock for the gear shaft. Mild steel would be fine, ground stock would be ideal. I believe I used some silver steel, which is overkill, but does have a nice accurate ground finish. The boss on the shaft must fit your spindle so please check the size. Note that making the boss as a separate item means turning an item with a register on one end that must be concentric with a boss on the other, so care is needed with this. A stub mandrel would be a good idea for turning this part.

On assembly the stud engages with the draw thread on the centre. The Vertex centre does not come tapped with a thread for a draw bar. If you need to drill and tap a hole on yours, first grind the end enough to go through the hardening. Once through the case, the material should be quite machineable. It does seem odd that they provide a drive dog that clamps onto the nose of the centre, but do not provide any way of preventing the centre from turning. I am one who can testify that this is not a good idea. The screw on chuck or faceplate is also not a good idea for a dividing head. I am still thinking about ways of locking this in place more securely. Incidentally I have had to machine other taper items to provide either tapped holes for draw-bars or plain holes to allow a draw-bar to pass through and have generally found that apart from the hardened surface, the material is quite machineable. This is useful when you have a taper adapter with a tang and need to pass a draw-bar through it.

Fig.11



Part 11. Washer For Bevel Shaft End
Mat'l: Brass

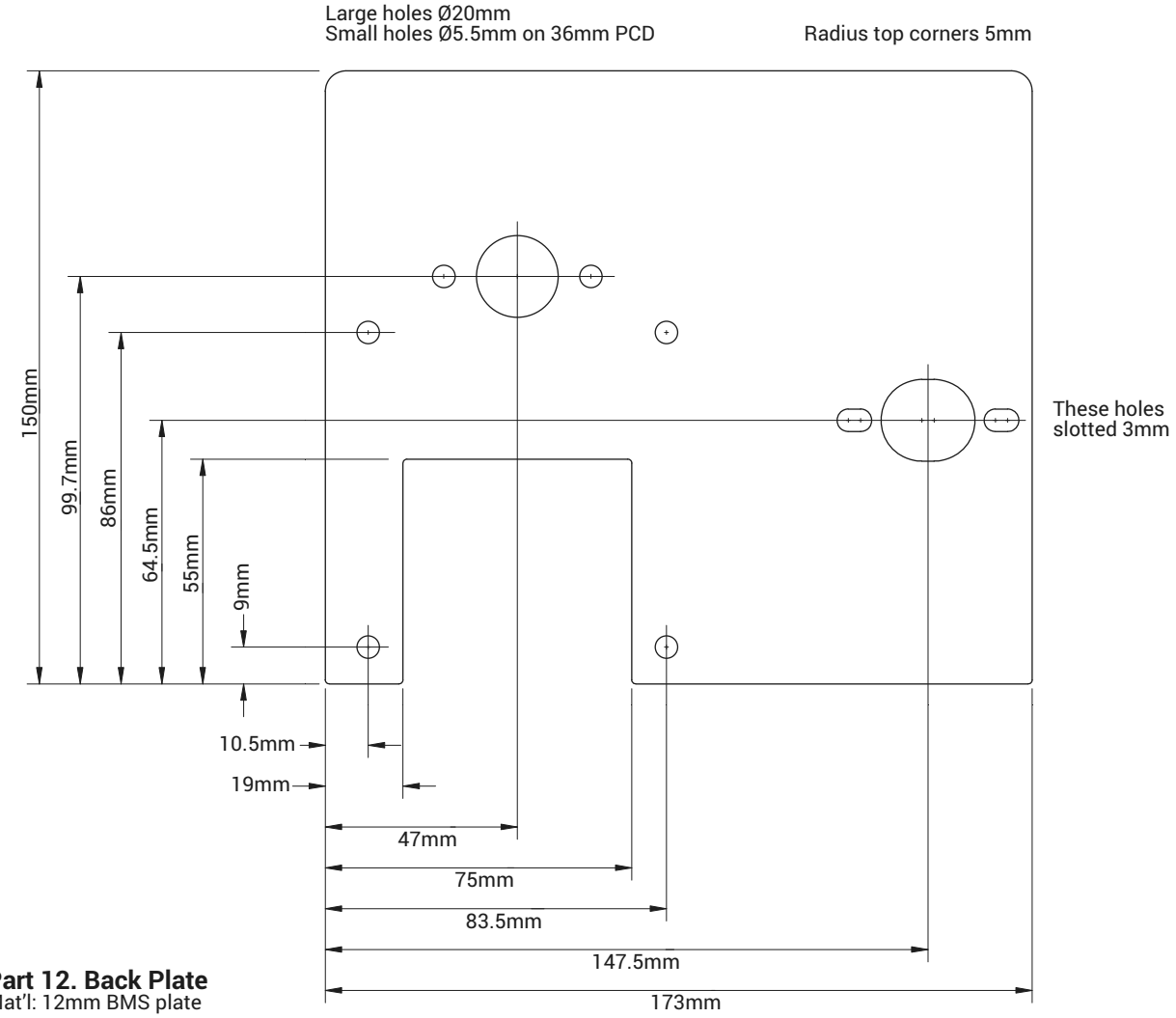
My Vertex is quite an early one, so later ones may vary, particularly those with Morse taper spindles. The remaining parts are fasteners, collars to retain the change wheels in place, and keys and should need no discussion.

Assembly

On assembly, check first that your Vertex worm is correctly adjusted to the wheel. This is done with the three screws on the bronze worm carrier. When they are loosened, the worm carrier may be

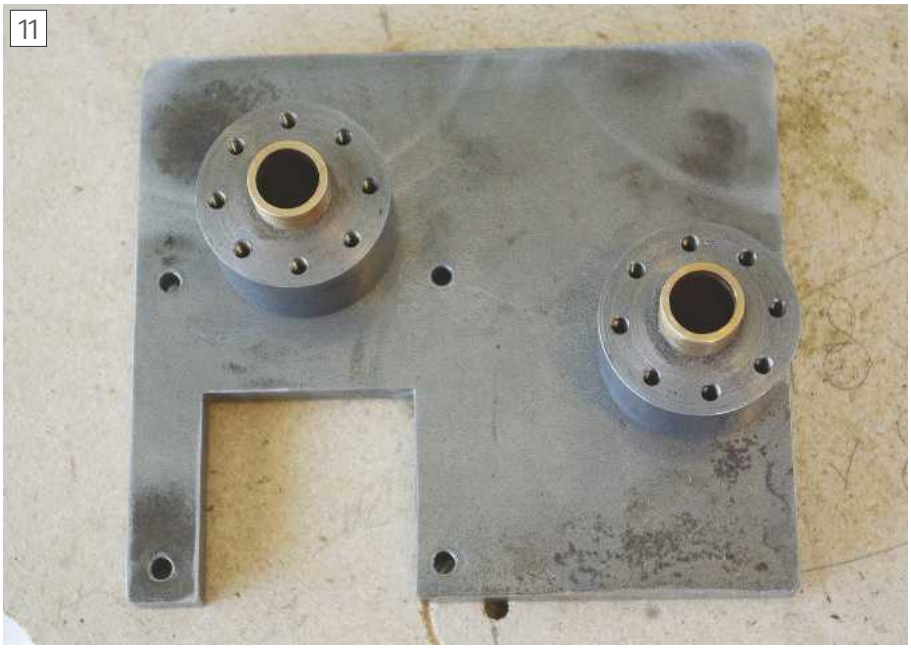
Change wheel quadrant with a pin fitted in the slot.

Fig.12



Part 12. Back Plate
Mat'l: 12mm BMS plate

11



Back plate with bosses fitted. The main shaft boss remains fixed but the bevel shaft boss needs to allow for adjusting the mesh on assembly.

rotated to bring the worm into or out of engagement. This adjustment is not accessible while the differential dividing attachment is in use or for that matter normally when a dividing plate covers it, but rarely needs adjustment. However, it would be annoying to find that it needed adjustment part way through a large job.

The sequence described below is intended to allow all the gears to be aligned and meshed properly. It can be hard to get at some of the screws once the whole device is assembled.

●To be continued

Unfortunately, due to the complex nature of the material in this article, it has not always been possible to co-ordinate text and figures. We apologise for this and hope that it does not affect your enjoyment of John's piece.

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Readers' Tips

CHESTER MACHINE TOOLS

Tool shims

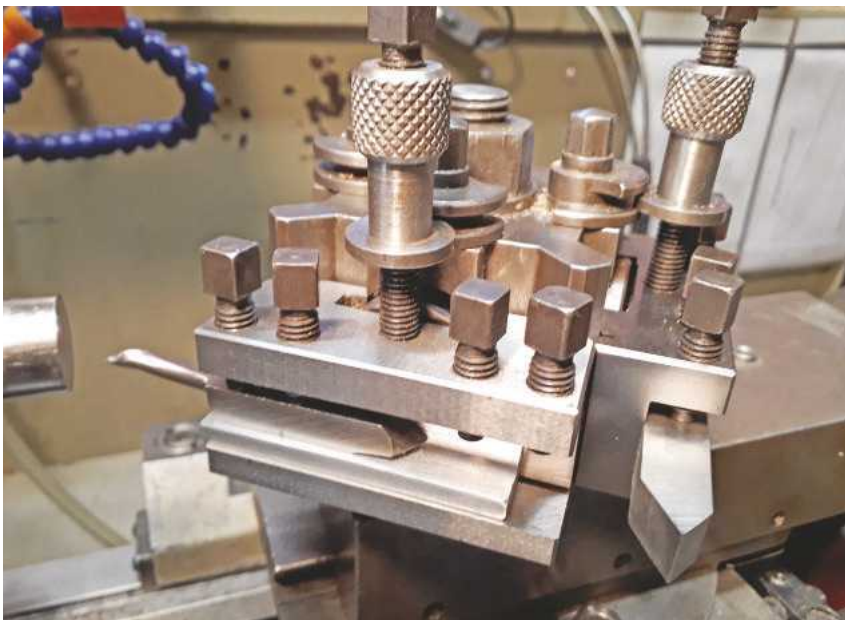
TIP OF THE MONTH WINNER!

This month our lucky winner of £30 in Chester gift vouchers is Chris Gill; he's independently come up with a good old tip, but it's new to this feature and I'm sure it will be useful to readers!

I don't know if this is an old idea that I just reinvented or whether it qualifies for the strange ideas page in MEW?

Some time before I bought my lathe I inherited a tobacco tin full of small lathe tools and they've proved quite useful. As they, and tools I've bought or made since, are all different sizes it's annoying having to adjust the tool-holder each time I swap tools (which is quite often if I'm experimenting).

To overcome the problem I made a set of L-shaped aluminium packing pieces shown in the picture. The thickness at the bottom should be the difference between the "normal" tool (12mm in my case) and the smaller one, say 8mm, giving a thickness of 4mm. The width of the upright will typically be half that in order to centre the tool under the screws, 2mm in this case. Now I only need to tweak the tool height.



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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.

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Credits

This index is compiled by Barry Chamberlain. Sadly supplies of Barry's computerised version CAHW are now sold out. For information of alternative computer searchable indexes please visit: www.model-engineer.co.uk/news/article/indexes-to-model-engineers-workshop/19778

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Keyed drill chuck B16 1 – 13mm
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NEW

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Selection of metric and imperial thread cutting through gear box. No more change gear selection. Only one 127T change gear necessary to switch from metric to imperial. This feature not usually found on smaller lathes.

Compact gear head lathe
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Saddle controlled forward and reverse
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lathe tools 12mm
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SPECIFICATION

Centre height	140mm
Maximum swing	280mm
Swing over cross slide	158mm
Distance between centres	600mm
Bed width	150mm
Longitudinal travel	560mm
Spindle taper	4MT
Spindle bore	26mm
Maximum tool size	12mm
Range of spindle speeds rpm (12)	45 - 2000
Range of metric threads	0.25 – 5.0mm
Range of imperial threads	4 – 96 tpi
Tailstock taper	2MT
Tailstock quill travel	60mm
Top slide travel	65mm
Cross slide travel	130mm
Headstock bearings	Taper roller
Compound slide swivel	360°
Chuck mounting	Flange
Motor	1.1kw
Power supply	240v

Dimensions L x W x H to end of handle grips
1260 x 580 x 600mm Weight..... 160kg

£2,150 including VAT and UK mainland delivery

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WARCO

On the Wire NEWS from the World of Hobby Engineering

Roy Darlington

Roy Darlington passed away peacefully at the beginning of October at the age of 96, following a short illness. Roy was a mainstay of the Stirling Engine Society and a member of the SMEE. Many readers will know his book, with Keith Strong, *Stirling and Hot Air Engines: Designing and Building Experimental Model Stirling Engines*, which featured his unique hot-air engine powered 'Moon Buggy' on the front.

I had the privilege of meeting Roy a few times on the Stirling Engine Society stand at exhibitions. Anyone else who met him will agree he was a wonderful chap whose enthusiasm and ingenuity were reflected by the range of his models. A celebration of Roy's life was held in Worthing on Tuesday 16th October.

Bristol Model Engineering and Model Making Exhibition

Having only recently attended the 2018 exhibition, we were sad to hear the Bristol Society of Model and Experimental Engineers has decided not to stage an exhibition in 2019. They do not however, see this as the end of the line for the Bristol Model Engineering Exhibition as they are looking at alternative venues and approaches to see an event return in 2020, a return that will build on their success over the past 17 years.

The Bristol Society of Model & Experimental Engineers faces considerable challenges in 2019 both with the exhibition and with other society affairs. In respect of the exhibition, it is evident that the model engineering environment is undergoing increasing change. They see changing demographics having an effect on many exhibitions, including theirs, with increased costs, reduced visitor numbers and the growth in internet-based purchasing being used by consumers; all these changes contribute to uncertainty around what might be the best exhibition format. In addition to those challenges BSMEE, as a society, need to focus on some big issues the currently face.

The club wishes to thank all Traders, Clubs & Societies and individual Exhibitors for all your support in the past and they will be in contact as soon as they have any news on a new event in which they hope you will want to be part.

The SX3.5DZP Mill

Arc Euro Trade have announced the arrival of the new SIEG, the SX3.5DZP mill. Out of the seven SX3.5 models available from SIEG, the SX3.5DZP is the most feature rich model at the top of the range. Arc claim the machine has 'more than just bling' and the machine is pretty impressively 'tricked out'. They state:

S is for Super. Powerful, 1000w Brushless DC Motor with Direct Belt Drive.

D is for Display. Linear magnetic encoders are built-in to all 3 axes and the 3-axis display is built-in to the head.

Z is for Z-axis auto lift. The Z-axis handwheel has been abolished on this machine. Instead, a geared motor at the top of the column moves the head up and down at the push of a button.

P is for Power Feed. Let the X-axis power feed take the strain.

The machine is available at the introductory price of £2251.00 (Including VAT) from **www.arceurotrade.co.uk** where you will also find that the prices of many of their other lathes and mills have been drastically reduced.

A Myford chuck removal tool

The broken back gear

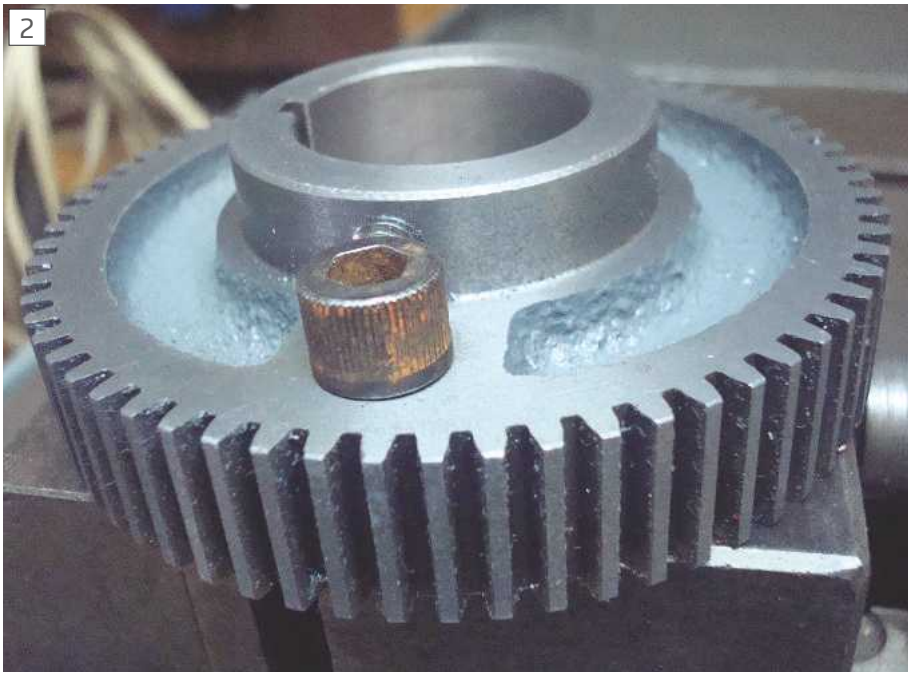
Craig Webb offers a simple device that can save Myford owners from making an expensive mistake

In 1962, my Grandfather purchased a second hand Myford ML7 lathe for my father and uncle, they were 14 at the time.

On close inspection, it was found that some of the teeth on the larger back gear on the spindle were missing. This was replaced with a new gear. My uncle still has and uses this lathe.

Last year I purchased another second hand ML7 and found that the same back gear also had a few teeth missing, **photo 1**. It was thought that this damage was possibly caused by engaging the back gear to remove a chuck that had been over torqued onto the spindle.

So, to overcome this problem in

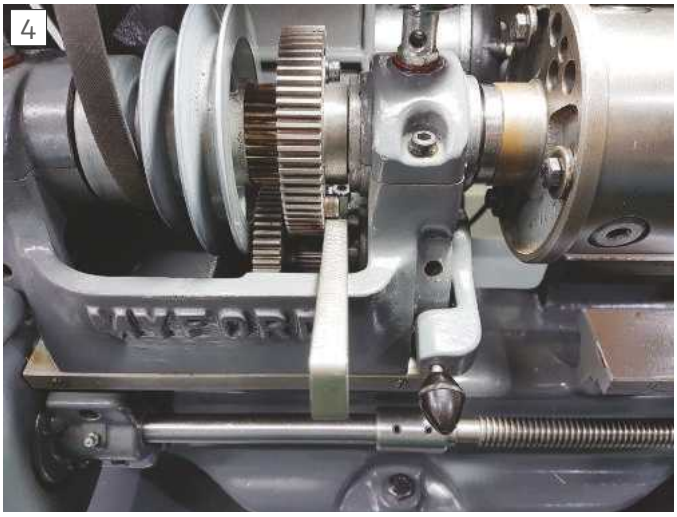


The cap screw in place, you could use M8 instead of 5/16" UNC.

3

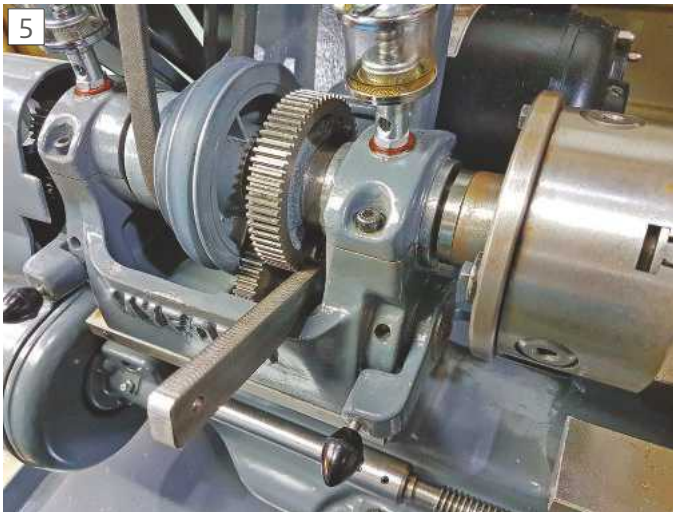
The locking bar tool.

4



The tool fitted to the lathe.

5



Another view of the tool in action.

the future, could a tool be made up to lock the spindle before attempting to remove the chuck?

Before installing the replacement gear, the face of the gear was drilled and tapped 5/16 UNC and a cap screw installed, **photo 2** and fig. 1. A tool was then made which when installed allowed the cap screw to butt up against it, saving having to engage the back gear to remove the chuck.

The tool was made from mild steel plate 10mm thick with an overall length of 140mm, **photo 3**. the profile was marked out, cut on a band saw and filed to suit.

Photographs 4 and **5** show the tool in position.

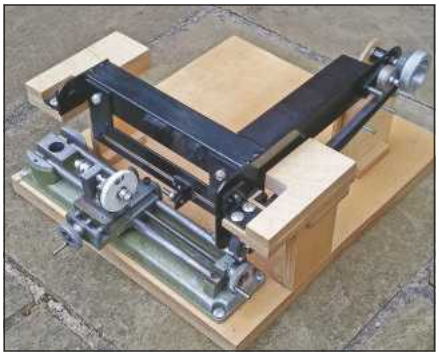
I'm not sure if this problem has ever been covered in the Model Engineers Workshop before, but it may be of some interest to others who may have encountered the same problem in the past. ■

In our Next Issue

Coming up in issue 275
On Sale 30th November 2018

Content may be subject to change

The December issue, number 275, of Model Engineers' Workshop will feature:



We commence **Alex duPre**'s Cam Grinder, a three-part series with full plans for this useful tool for makers of mode IC engines.

Roger Vane makes a special cutter.

Alan Wood offers an unusual approach for using printed circuit boards as a construction material.

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Alibre Atom3D

To accompany the free six-month license available to every MEW reader, Robert Footitt starts a tutorial series to introduce you to working with Alibre Atom3D. For extra information on the series including files to support the tutorials, other examples and links to useful resources visit www.model-engineer.co.uk/alibreatom3d

The MEW Boring head, recreated in Alibre Atom3D and rendered. The free version of SimLab composer can be used to render your own AA3D images.

What is Alibre Atom3D?

Alibre Atom3D is a parametric CAD system. This is the same type of software used widely by designers and engineers across a multitude of industry sectors. Alibre Atom3D has been specially designed with hobbyists and those new to 3D design in mind. The focus is on keeping it simple- AA3D provides all the tools users need to create parts suitable for CNC machining and 3D Printing. AA3D is supplied as a perpetual, stand alone licence (upgrade options will be available but are entirely optional). The software and all files created are stored locally- there are no hidden costs such as rental of cloud-based storage space.

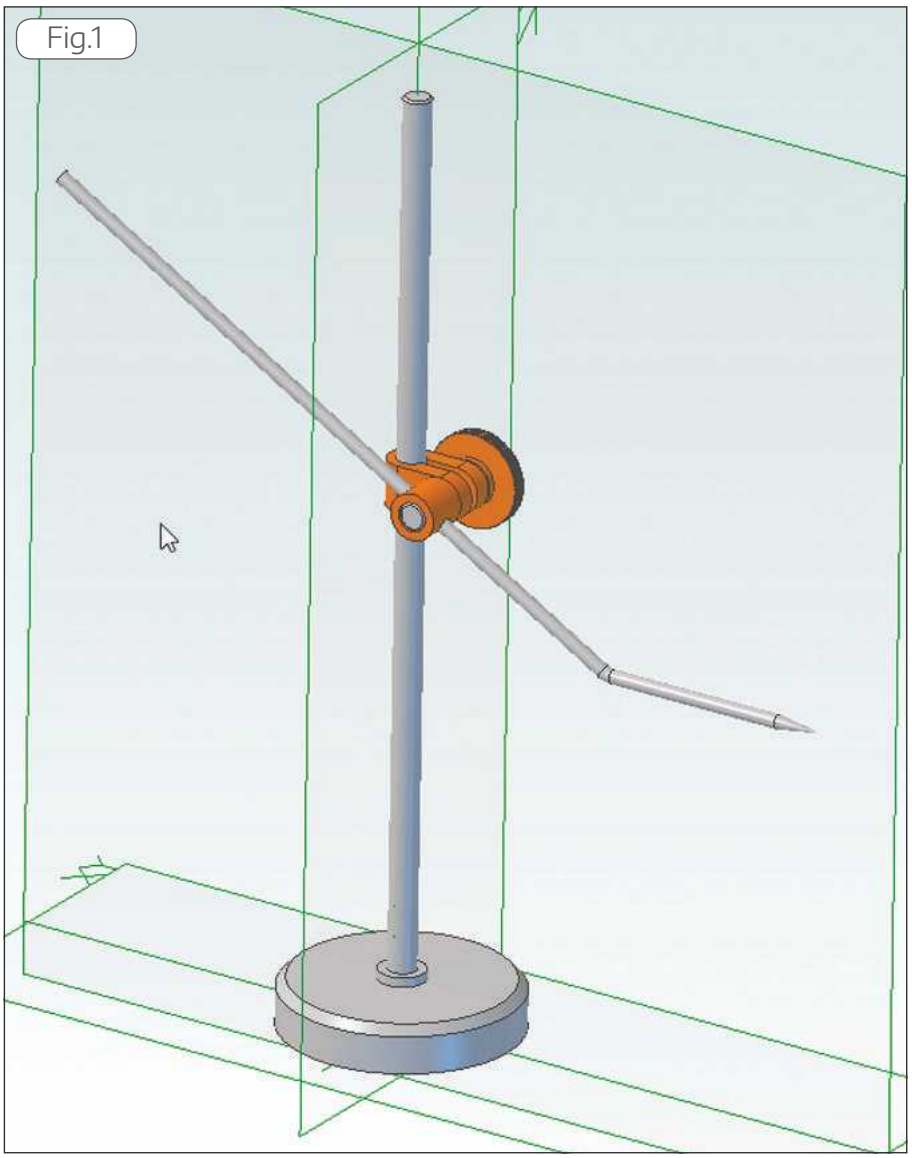
What is Parametric CAD?

For anyone unfamiliar with the term, the easiest way to think of parametric is 'parameter driven', when you perform an action it gets stored as feature within the model. At any point during the design process you can go back and modify these features and the part will update accordingly. Drawings of parts remain linked to the parent part file- realise you need to change the size of the part after producing the drawing? No problem, modify the part then open the drawing back up and all the views and dimensions will update automatically.

How to get Alibre Atom3D:

In order to give Model Engineers Workshop readers plenty of time with the software Alibre are offering a 6 month free licence

1. Go to www.alibre.com/MEW
2. Enter your email address and press the sign up button
3. Check your email in the next few



minutes for a download link and a licence key

4. Download and install the software, then on first run input the supplied licence key to activate the extended trial.

Hardware requirements:

Alibre Atom3D will run on most modern computers without issue, below are the minimum hardware requirements:

- Windows 7, 8 or 10 (64 bit versions only)
- 4gb ram
- Direct X 9 compatible graphics card (integrated graphics are fine for light work although a dedicated graphics board is recommended)
- Internet access

Tutorial 1

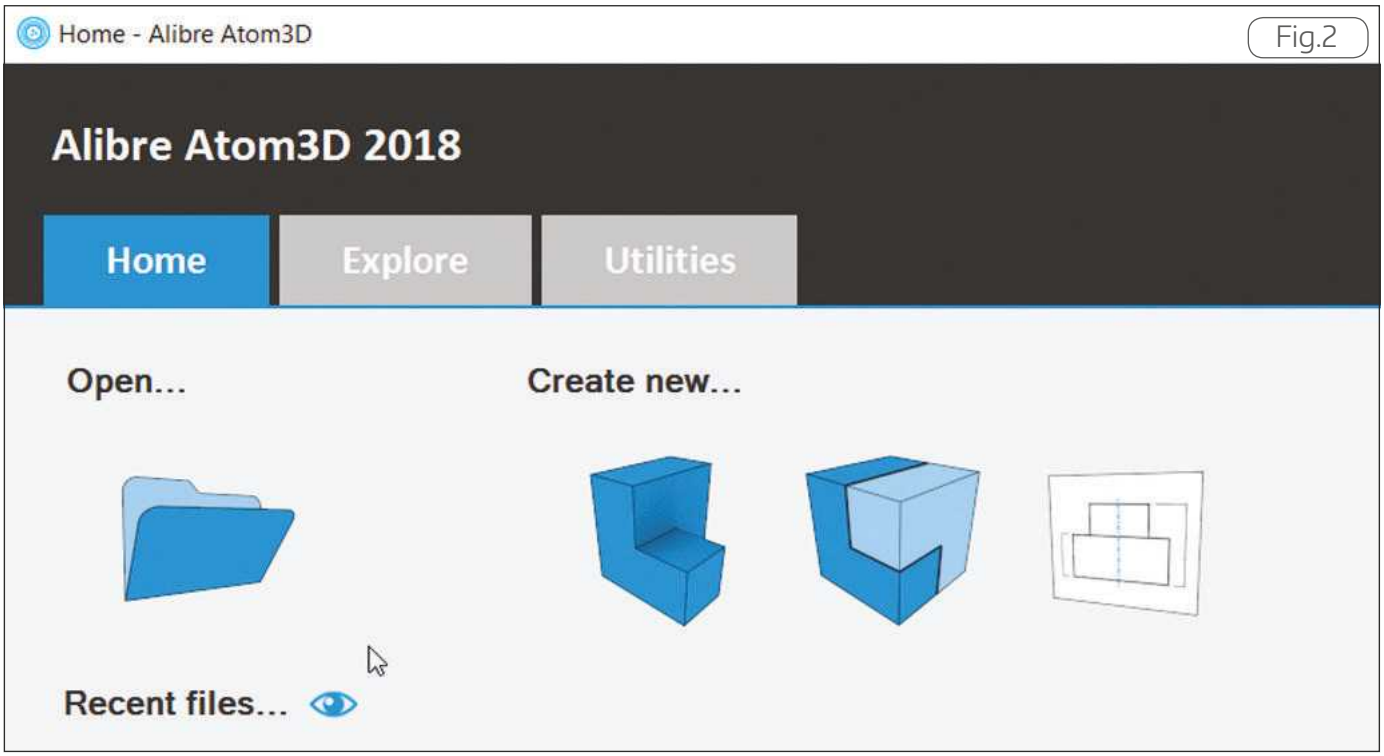
In this series of articles, we will go through the creation of a 'Mini Gauge' as shown in **fig. 1** (many thanks to Neil Wyatt for the design).

In part 1 we will focus on producing the base component.

Alibre Atom3D offers two separate modes, "Parts" and "Assemblies", **fig. 2**. As a rule of thumb, anything that is cut from a single piece of material (or built as a single component in the case of 3D printing) should be modelled using the Part workspace. If something is comprised of multiple pieces (even if these are subsequently welded together), then you would create the constituent components as separate parts and then combine them together using the Assembly workspace. If you produce your model in a way that mimics how it would actually be manufactured, you shouldn't go far wrong.

Create the base component:

From the Alibre Atom3D home window, open a new part workspace by clicking on



the blue part icon, **fig. 3**.

Figure 4 shows the part workspace. This is broken into 3 sections:

A: The main ribbon

B: The design explorer – all created features are listed here

C: The main window

Basic controls:

- Rotate view, hold left and right mouse buttons and drag
- Zoom in / out- scroll the mouse wheel (note the program zooms to / from the mouse cursor).
- Pan – press down the mouse wheel and drag
- Left click to select items
- Right click to bring up shortcut menus

To create the basic shape for the base component we first need a sketch. Sketches must exist on flat faces or reference planes, as this is a new model we can use one of the provided reference planes. Select the 'XY' plane by left clicking on the edge of the plane in the main window. Then click on the 'Activate 2D Sketch' button on the ribbon, **fig. 5**, to enter sketch mode.

Sketches in AA3D must be both sized, and positioned in relation to the software co-ordinate system. AA3D provides an origin point to position to when starting a new part.

Click on the 'Circle' command under the 'sketch figures' section of the ribbon. Click on the origin point provided in the centre of the main window and move the mouse away from the origin. This will create a circle, **fig. 6**.

Type in '25' and press enter to size the circle. The circle will be coloured in grey to indicate that there are no remaining degrees of freedom and a dialogue at the bottom of the main window should read

Fig.3

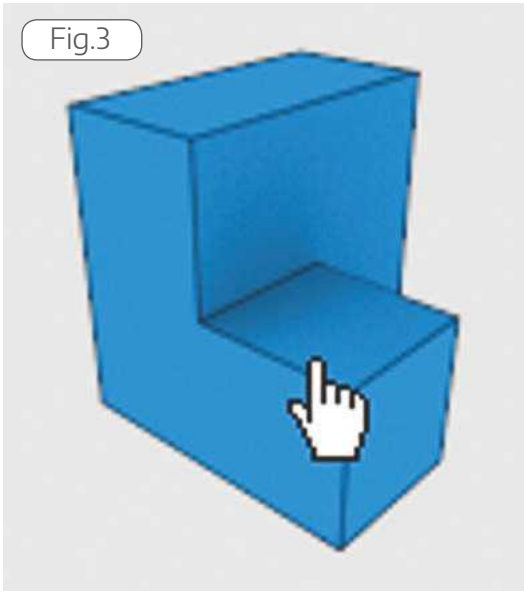


Fig.4

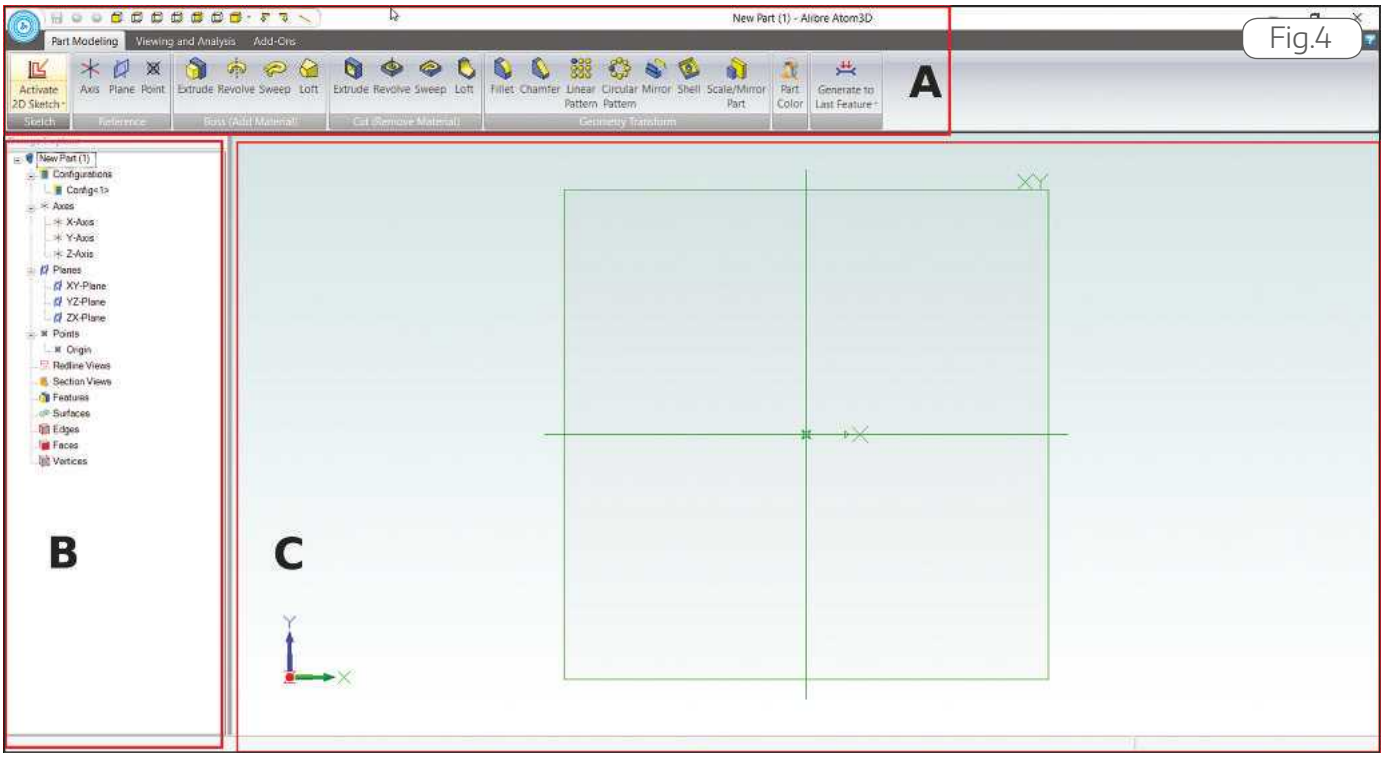
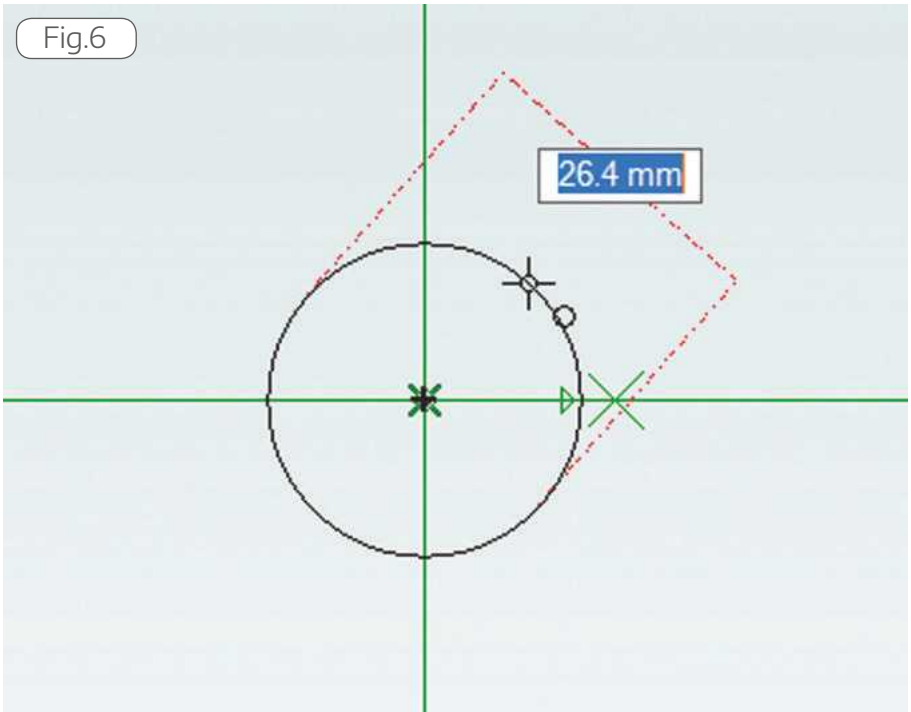


Fig.5

Fig.6



Sketches in AA3D must be both sized, and positioned in relation to the software co-ordinate system. AA3D provides an origin point to position to when starting a new part.

'fully defined'.

Click the green tick 'deactivate sketch' button top left to exit sketch mode.

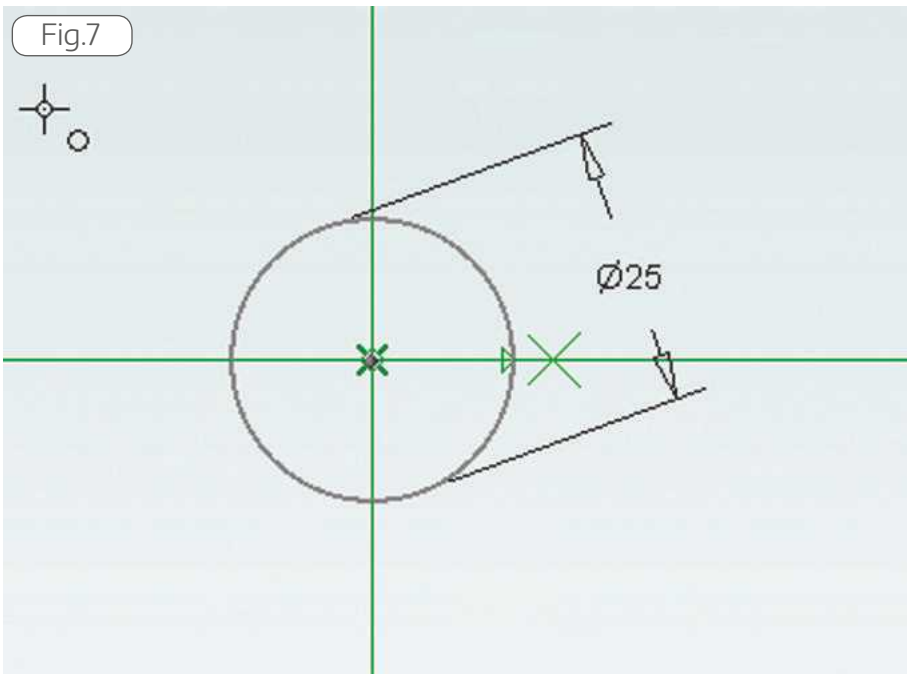
Select the sketch in the main window by left clicking on the edge of the circle, then click on the 'Extrude' button located in the 'Boss (add material)' section of the main ribbon, **fig 8**.

Set the depth to 10, then click OK, **fig. 9**.

This will create a 3D part- drag whilst holding down left and right mouse buttons in the main window to rotate and inspect the part. You can move the part around the window by holding down the mouse wheel and dragging.

Note that a feature named "Extrusion<1>" is now listed in the design explorer.

We can now create the support collar on the top surface of the base. Left click on the top face of the part in the main window- this will highlight it blue, **fig. 10**.



Next click on 'activate 2D sketch' to start a new sketch on this face.

Create a circle (again starting on the origin point) 10mm in diameter, **fig. 11**.

Come out of the sketch mode, then use the extrude (add material) function to create the collar. Set the depth to 2mm.

This will add a second feature named "Extrusion<2>" to the design explorer.

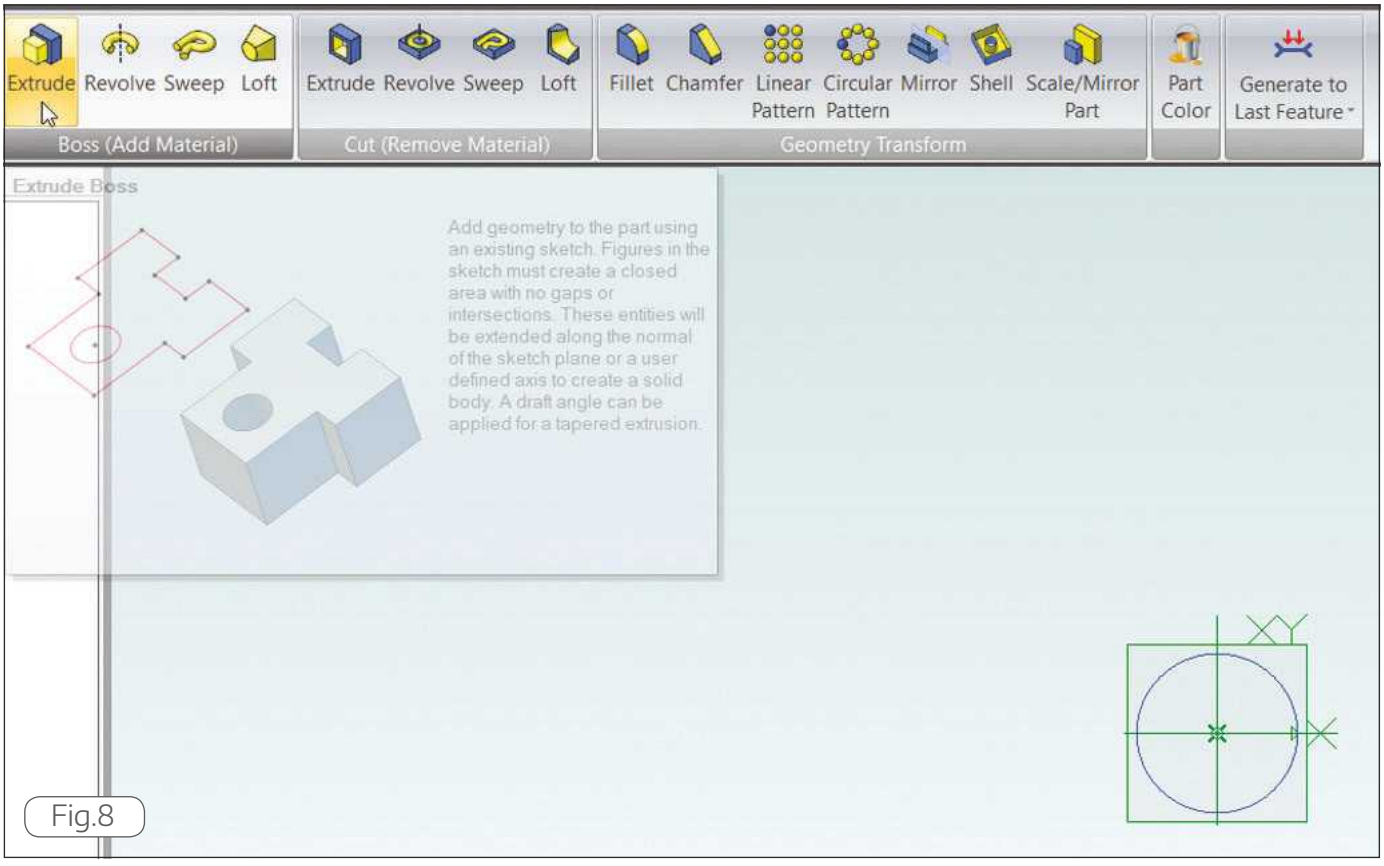
Select the face on top of the second extrusion and start a new sketch. Draw a circle 6mm diameter starting on the origin point and exit sketch mode.

With the new sketch selected, click on the 'Extrude' button located in the 'Cut (Remove Material)' section of the ribbon as shown **fig. 12**.

Set the Type to 'Through ALL' and input '2' into the Draft angle box. Uncheck the 'Outward' option (the value in Draft Angle will change to '-2' upon doing this) and click OK, **fig 13**.

This will create a tapered hole that runs through the entire part.

In the main window, select the upper edge of the base shape (be careful to



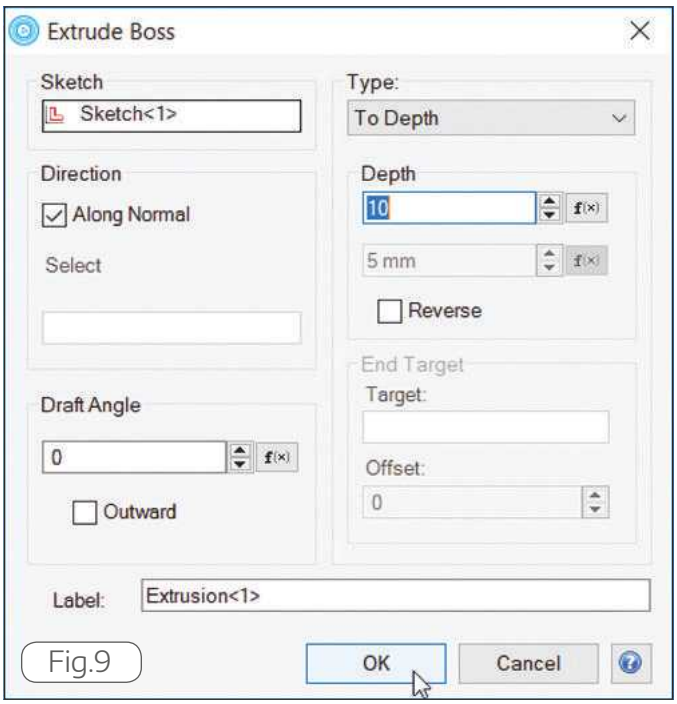


Fig.9

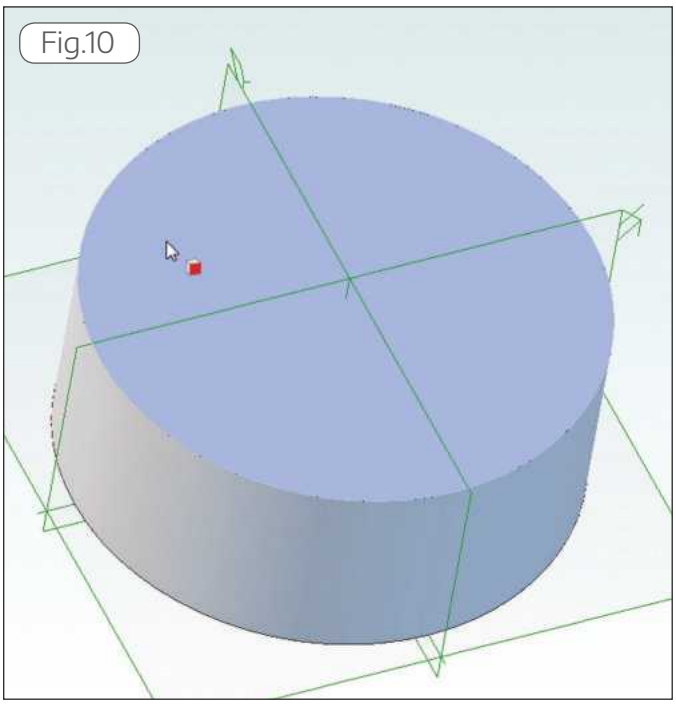


Fig.10

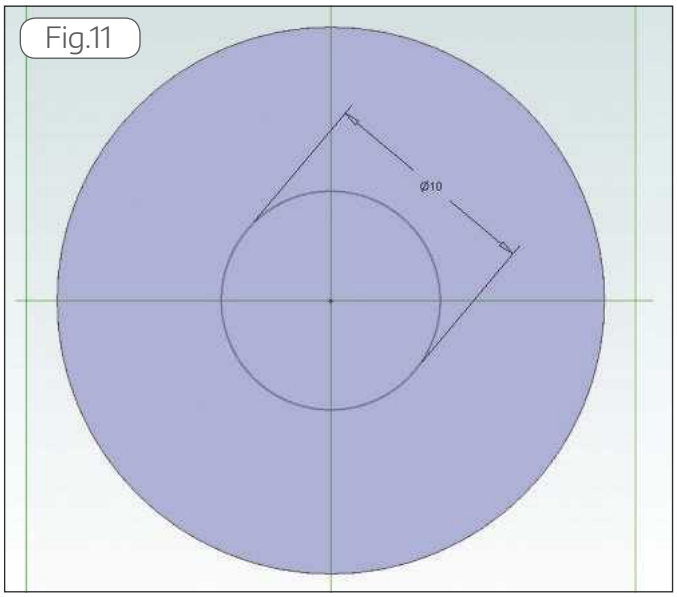


Fig.11

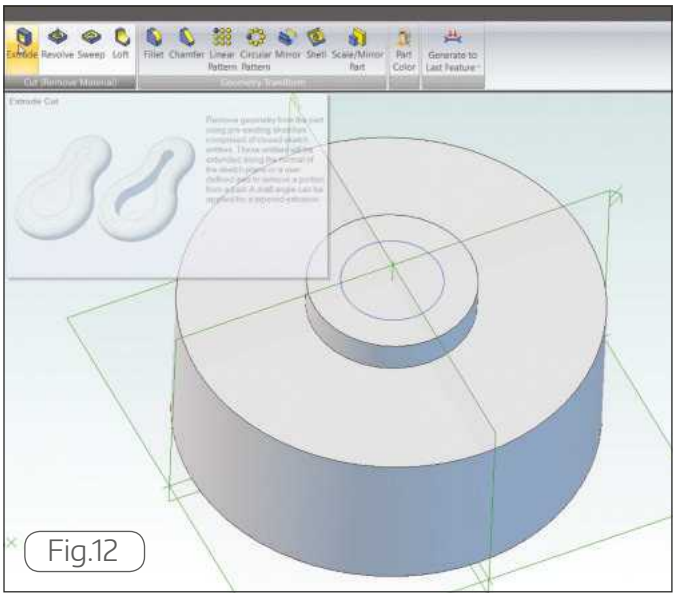


Fig.12

get the edge rather than a face), then click on the 'Chamfer' tool located in the 'Geometry Transform' section of the ribbon.

Set the size to 2mm then click Apply, **fig 14**.

Now click the 'Close' button to exit the Chamfer tool.

Figure 15 shows the finished base component.

Click on the AA3D roundel (top left) and then choose 'Save' to save the part, **fig. 16**.

Choose a location you will be able to find easily on your machine (for example create a folder on the desktop called 'Alibre Atom3D Tutorial' and save into that), as you will need to locate the part in the next tutorial.

Summary:

In this introduction we have covered the fundamentals of the interface, the basics of sketches and how to create a simple part. In next month article we will cover some more in depth sketching and part modelling tools and an introduction to the Assembly workspace. In the meantime I suggest you download Alibre Atom3D, explore some of the examples available at **www.modelengineer.co.uk/AlibreAtom3d** and experiment with creating some parts of your own.

References:

Further information and useful details:
www.model-engineer.co.uk/alibreatom3d

Online discussion forum:
www.model-engineer.co.uk/forums/

Sign up for your free six-month licence:
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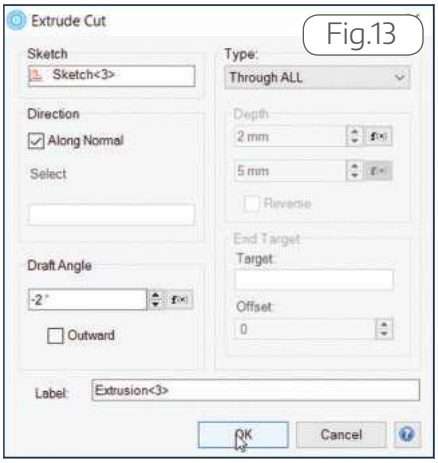


Fig.13

Fig.14

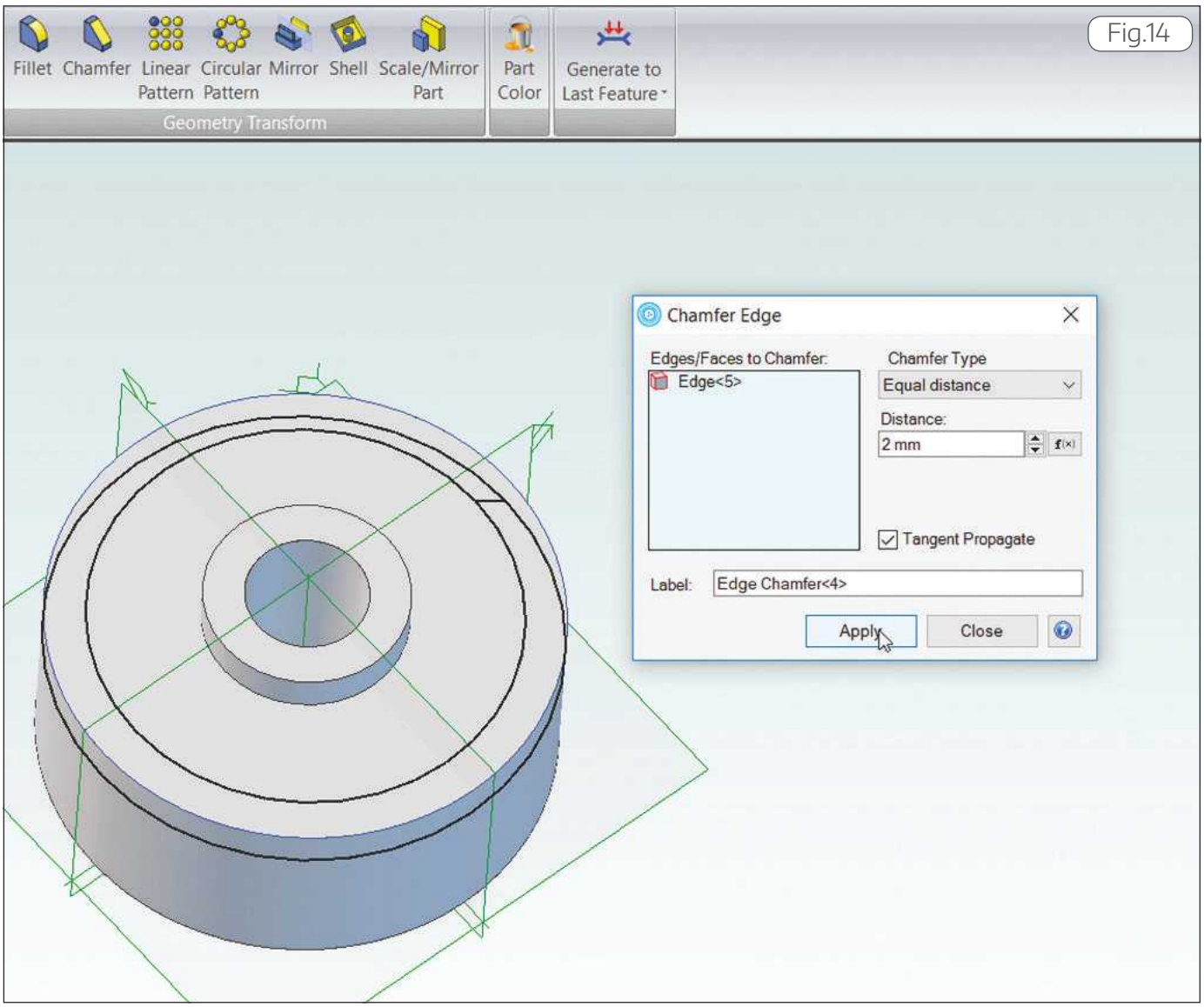


Fig.15

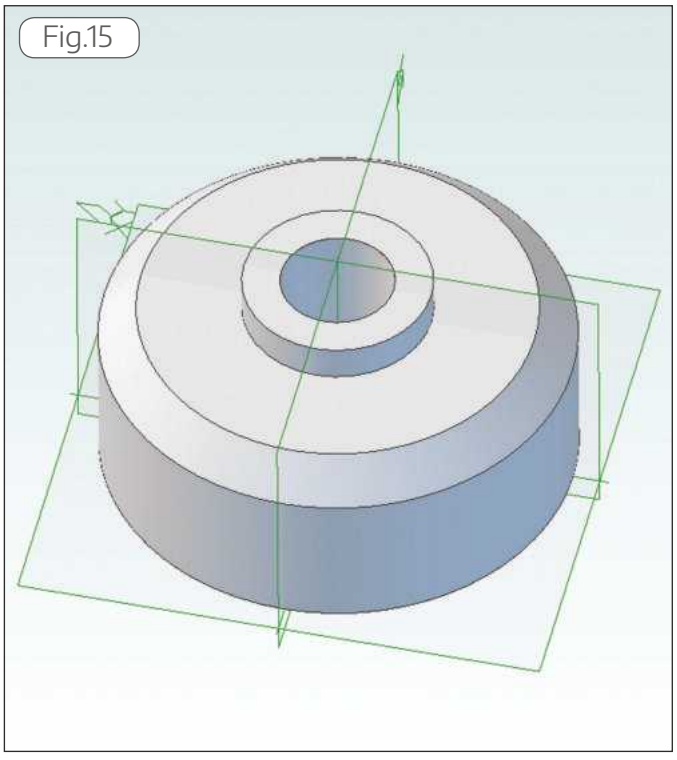
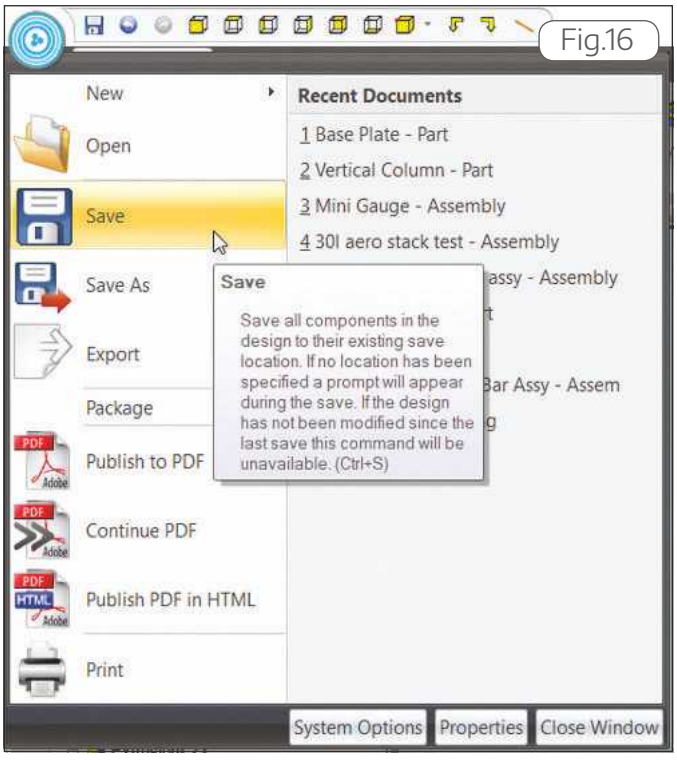


Fig.16



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Persevere – Fitting Power Feed to a Small Mill

Stephen J. Roberts, a retired professional engineer, describes some ideas that have helped him keep active in the workshop

When I disposed of my large lathe and in particular my large geared head GEM500 milling machine due to old age, of me not the machines, I did not realize how spoilt I had been! I have reached the stage in life where I have to use a walker for inside and a wheelchair for outside, but I am not complaining as I am now in my mid eighties. I look at each day as a bonus. I did retain my G4000 (9"x12") small lathe and it was not long before I found that I did need a small milling machine because although I have milled on the lathe, it is as you know a compromise. You may well be wondering how I manage to not only get from machine to machine but to handle the accessories. Well I use roller chairs to get about the workshop and I had the foresight some years ago to install a small high-speed overhead bridge crane. I remember well when I could lift a 10" rotary table complete with chuck from the floor to the mill table. Not any more even though the accessories are much smaller and weigh a lot less, I am not to proud to utilize the crane and on some occasions plead for assistance! After my recent aneurism, I was warned not to lift anything heavier than a milk carton, see **photo 1** as an example of how I accomplish this to follow the rules.

I remember well meeting a ninety-year-old gentleman professional woodturner who had had a linear roller chair installed on rails parallel to his huge long bed wood lathe where he turned those big front porch posts for the very large houses. Never give up is what I am trying to communicate to you.

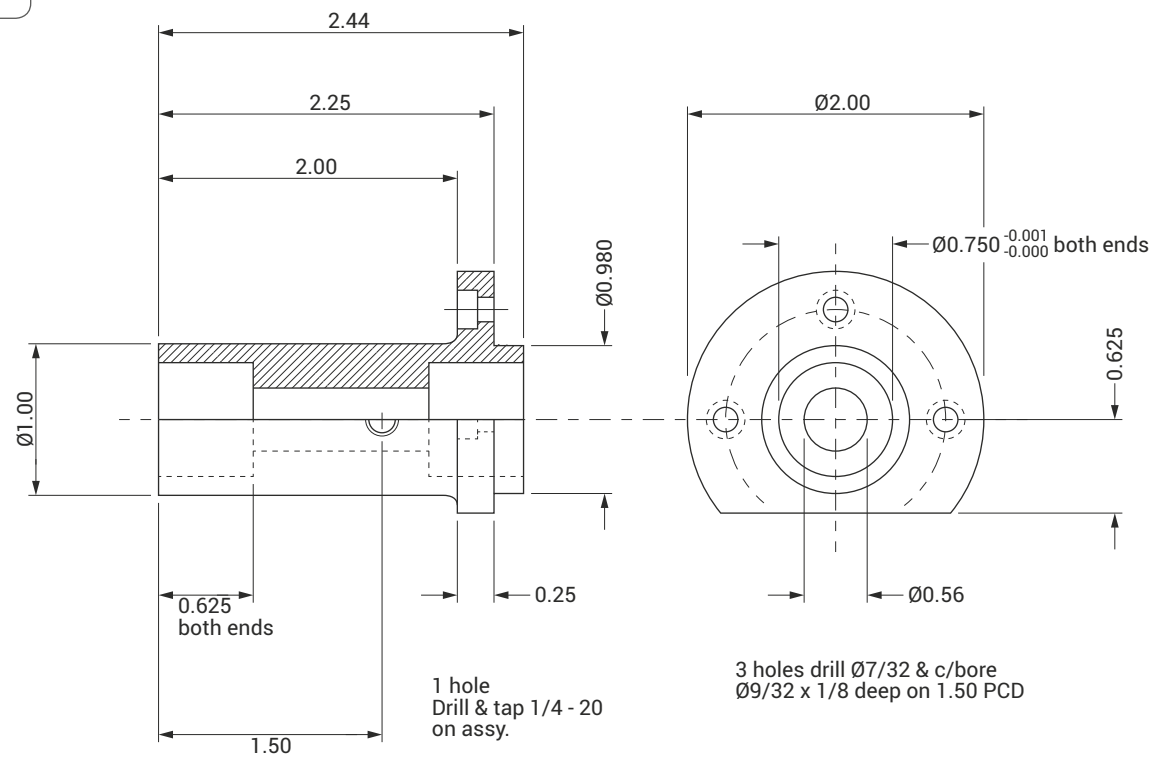
Using a sling to support a power drill

Now for the reason for the lengthy preamble, the small milling machine I purchased is a SIEG SX3 which has become very popular and for a small machine has very respectable capabilities. No, I no longer cut blue chips!

Assembling a long bed to the mill

The power feed arrives

Fig.1



1. Cantilever Support

Milling off excess material from the adaptor casting

Trial assembly of feed unit

The machine as delivered from the factory has a standard short to me, working table which I was aware of. After the usual machine cleanup, getting the services to the machine organized and positioning in my workshop I noticed that the dealer was offering from the factory a much longer table at a very reasonable price, so I opted for one and **photo 2** shows it being assembled to the mill.

It was when the long table was installed and I had three accessories on it, the angle table at the right-hand end, the machine vise in the middle and the dividing head at the left-hand end I realized although it was excellent from all aspects except the time consumed to traverse end to end by hand was excessive (and tiring). I decided that I needed a power feed like I had installed on the departed big machine and so the evaluation began. I did not particularly like the power feeds that were supposedly designed for these machines and they were for the right end of the table which I did not want as I did not want to lose the hand wheel and graduation dial at that end. The big mill I had installed an "Align" left hand unit and I decided on one of these well manufactured units from China. A few emails back and forth to the distributor and a left-hand unit was procured. This was a bit of a risk as these are designed for the big mill tables but I had sort of lost patience trying to source the perfect unit, if there is such a thing.

Two weeks later the familiar unit arrived. **Photograph 3** shows the packaging before opening. I had anticipated not a straight forward fit up but on first look I saw there would be more problems than I expected. The double casting that is designed to attach to the machine table by clamping to the table end coolant well and the thick traverse screw bearing block. The casting projections for this purpose much to my surprise were not spaced wide enough to go over the machine table components, I first thought this small mill must have thicker components and elements than the big mill. It was partly true but looking at an old picture of the big mill it did not have an end bearing block as the bearing support was an integral part of the table casting. My problem was rectified by clamping the assembled casting to the mill table and milling of the excess material as shown in **photo 4**. I assembled the power feed unit to the casting and turned it over for inspection as per **photo 5** together with **photo 6** and it began to dawn on me this unit was not completely the same as used on the big mill in that the lead screw gear supplied would be on a large overhang that would not be acceptable to me.

On the big mill, everything mated together close up to the table end and thus the lead screw. On with the thinking cap and open up the AutoCAD and start designing a solution. That in itself was a minor problem as although I had for some twenty years been conversant with the program designing steel plant machinery

The feed pinion is just visible near the wire emerging from the unit

On with the thinking cap and open up the AutoCAD and start designing a solution.

and overhead cranes, I retired at eighty and found I had to re learn the program after the five year lay off. The main thing was to support the unacceptable overhang and provide an end bearing to support the mating gear, Reference to **fig. 1** will show you how I achieved this by machining a cantilever plain bearing support that bolts up simply to the thick lead screw table end bearing block. First, I thought I would incorporate deep groove bearings but this is a slow running application and does not run continuously thus I elected to use plain bronze bearings.

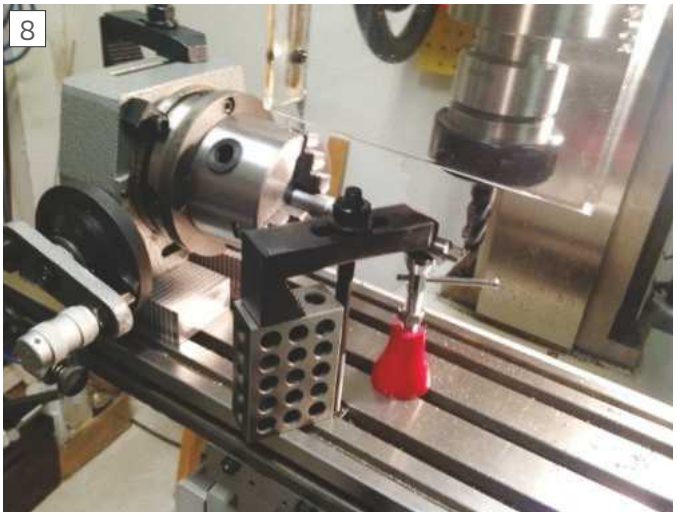
For the bearing bushes, I acquired a brass bar as no bronze was available at my supplier. I happened to mention this to a friend East of me on Lake Ontario who makes parts for the medical profession and robotic devise mechanisms on a voluntary basis on his CNC mill. He dug in his material bin and sure enough found me ¾" diameter bronze bar which he sent express delivery. We often exchange items and it serves us well. Other machinists are useful to keep in contact with as they can be very helpful and you in turn can help someone who is struggling to find a solution to a problem.

If you look at photo 6 carefully just below where the cable comes out you will see the drive pinion buried deeply, the milling machine thick end bearing plate is loosely positioned to get some idea of how much the second casting can be displaced to get near gear mesh. From this it was determined the set of tapped holes lining up with the elongated slot were not sufficient and two sets more were made.

Photograph 7 shows the required extra tapped holes being made.

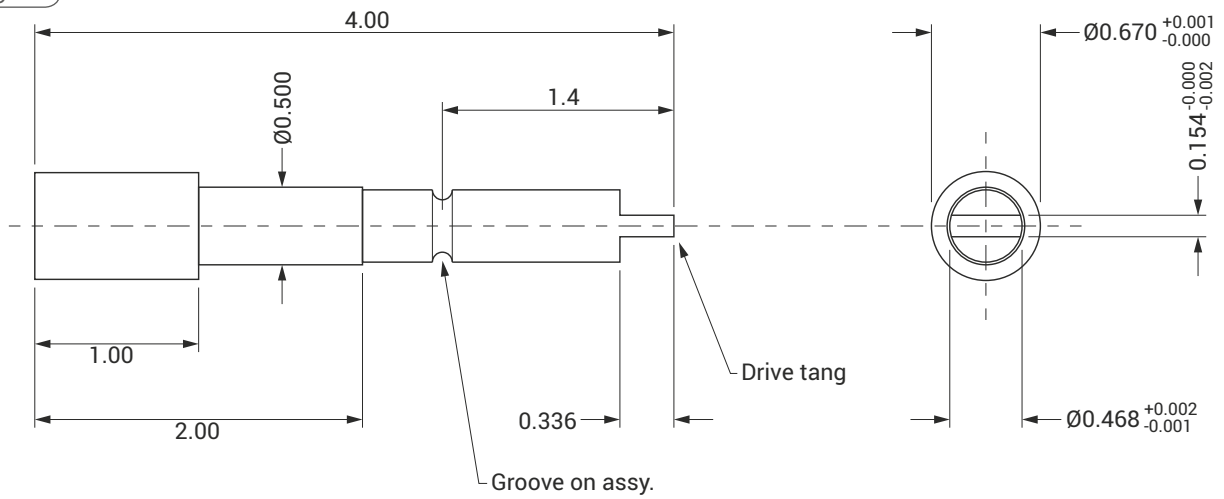
The first item I made was the spindle shaft shown in the detail drawing shown on Figure No 1, nothing to complicated straight forward turning followed by a bit of milling to produce the driving tang. My dividing head is small so the gear end of the spindle would not fit into the back recess of the chuck, so the overhang had to be supported as shown in photo 7. If you the reader have a larger dividing head the gear

Tapping the extra holes



Supporting the spindle to allow milling the outboard end

Fig.2



2. Gear Spindle

end of the spindle will enter the recess of your chuck behind the chuck jaws and make life easier for you in that you will not need the outboard support and you could mill the tang in the vertical position if you so wish. **Photograph 8** shows the outboard support in place and the cuts taking place.

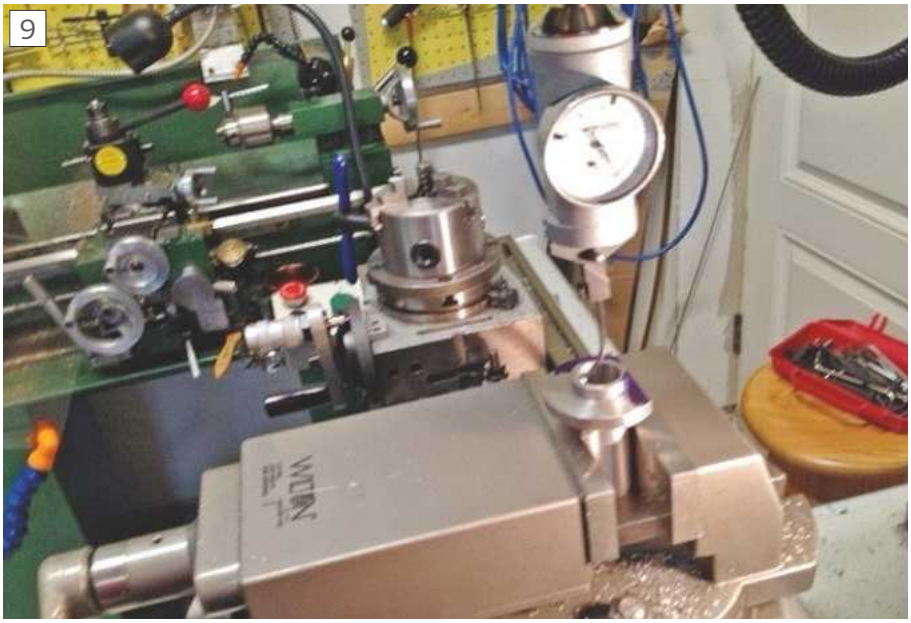
Now came the more complicated part the cantilever support. I had bought a length of 2" diameter steel bar but my friendly supplier in his wisdom thought he was doing me a favor, gave me a bar end far exceeding what I required in length at the same price. Now I used to have a large horizontal band saw but that went with the large machines so now I have what is called a "portablade" band saw on a small stand hand operated. It's a bit of a pain as it needs you to provide some of the work! One has to press in the dead man safety button which has a strong spring on mine and at the same time pull the switch in to run it and also at the same time pull the blade down into the material being cut. Talk about multi tasking, I will one day mechanize it. My energy for hand sawing is not what it was so this "portablade" is definitely more acceptable. I used cold rolled steel so no real need to use a dial indicator for the first operations.

The turning was again relatively straight forward and **photo 9** shows the bore being located in preparation for the drilling of the three mounting holes. After the ¼-20 tapped hole was located by partial assembly and completed, I gave thought to blackening this component using the fluid method but it goes underneath the main assembly and never seen, so I elected not to do it. The complete components are shown in **photo 10**.

With all the machined parts completed the parts were "dry assembled" to ensure that the fit up was reasonable as shown in photo 10 and I was satisfied to proceed.

Next it was a dry assembly onto the

9



Locating the bore

10

Drive components

power unit itself. This was a bit more fiddly for as you can see in **photo 11** the unit pinion is buried deep down. This made it difficult to get a piece of paper or plastic shims between the gear and pinion which is the way I space gears using different thicknesses of paper as I see fit. Anyway, I achieved it and thought I had adjusted the variables and re engineered the settings to ensure a problem free live assembly. Not to be! It was not one variable working against another as is the case on many occasions, but this was a simple blunder on my part relating to a measurement. This I did not discover until the "Live Assembly", not a disaster but certainly as set back I had not reckoned on.

The end of the spindle had to be machined back 1/8" to clear the unit gear housing, this prevented interference and allowed the gears to mesh.

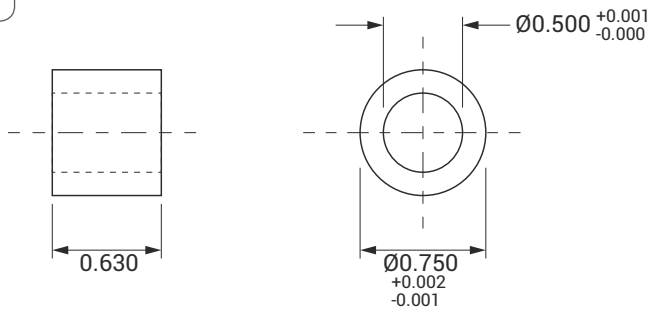
Photograph 11 also shows the limit switch that is actuated from either side by the table dogs.

The next items to be made were the bushes. The gear side bush is easy as simple turning and a standard ½" reamer sees the job done. The table side bush is a bit more difficult as unless you have a 12mm reamer you will have to resort to what I did and that is fine bore it.

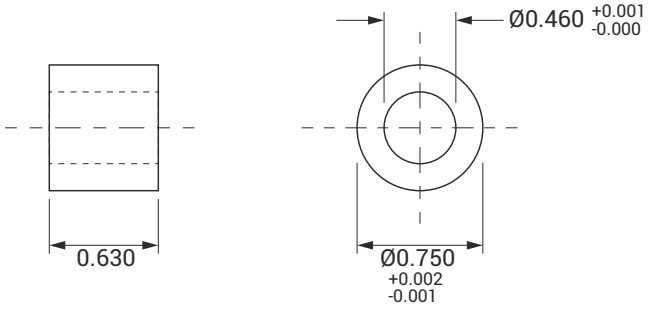
The moment came where the final assembly is presented to the machine and fitted up into position as shown in **photo 12**, a check is made of the gear mesh which was found to be to the writer's satisfaction.

The next thing that was undertaken was to decide on the location of the linear movement restricting groove in the spindle which was duly located by using a slim black marker through the previously tapped hole in the cantilever bearing support and machined into the spindle.

Fig.3



3. Gear Side Bush

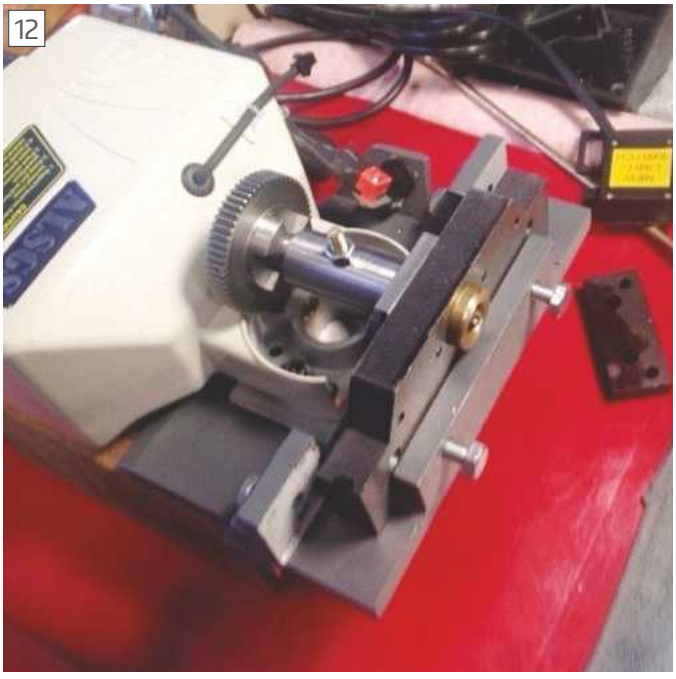


4. Table Side Bush

The required brass screw became a bone of contention in that the dozen brass hexagon headed 1/4 bolts I ordered did not show up in time and the nuts never did show up. So, I took a piece of ¼-20 brass threaded rod I had in stock, sawed off 1" length, turned a 60-degree cone on one end and cut a slot in the other end. I used a steel nut as it is not in touch with revolving part. Everything was re assembled and the power plugged in and the switch activated and the pleasant "buzzzz" resulted and the table was off and running. Now some of you eagle eyed readers may have wondered what the underneath wires were for. Well the two wires are firmly cleated together with a locking device provided by the manufacturer and this provides rapid traverse. I tried this, and the table took off like a rocket so I will have to be careful using this feature. The unit manufacturer provides nicely made table limit switch and stops and you will see in some of the

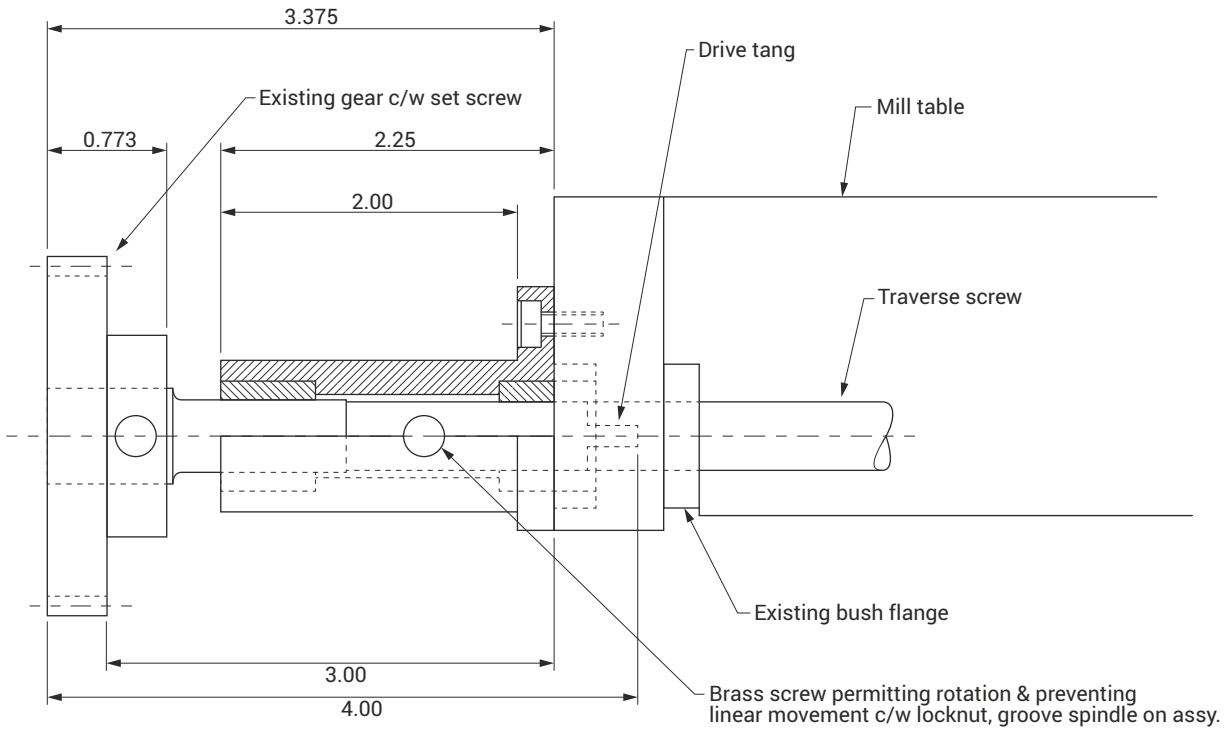

11

Test assembly of the drive


12

Offering the drive up to the machine

Fig.4



photographs these stops attached to the table that are designed to be moved at will. I have not yet fitted the limit switch as its mounting bracket is too big and interferes with the dividing head indexing plate so I will have to modify the mounting bracket.

Photograph 13 shows the side view of the installed assembly and you will see the displacement of the two castings that enables the gear mesh to be achieved. photo 13, the tang on the spindle simply slides into a corresponding slot on the leadscrew thus providing the required driving motion.

Photograph 14 shows the underside of the assembly mated up into place and connected to the leadscrew

Photograph 15 shows what all the huff and puff was about. This completed the project and all the objectives were met to my satisfaction. I may give thought to a power feed on the vertical "Z" axis but it's not a project that I want to undertake at this stage. This upgrade has certainly made life easier to get the accessories on the table out in the open either side from under the mill head so that I can get the crane slings on to them.

If any of you have questions, please do not hesitate to contact me at **sr888@cogeco.ca** ■

Side view of the installed assembly

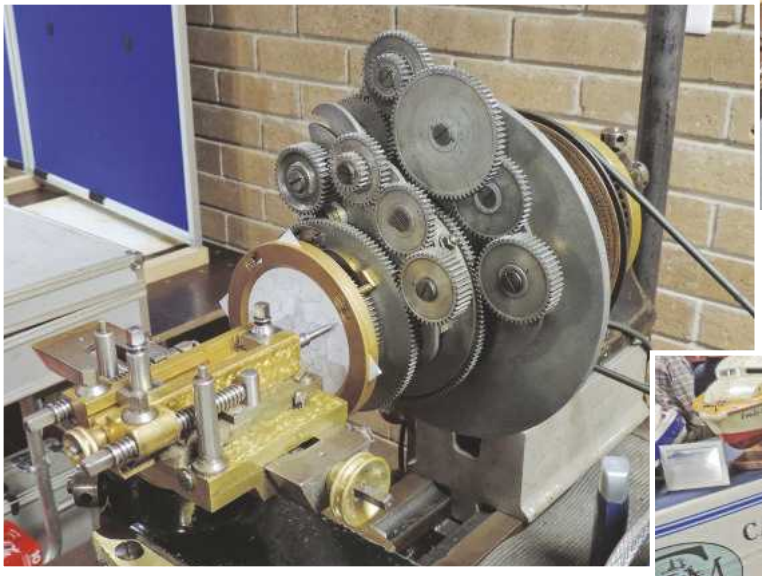
The connection to the leadscrew

Everything finished!

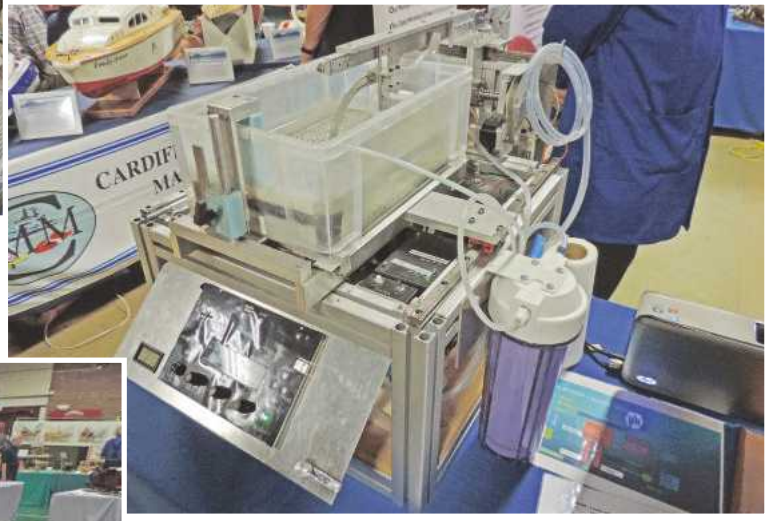
Tools at Bristol

Following the news that the Bristol show won't be taking place in 2019 – see On The Wire for details – here are some photos of tooling at this year's exhibition which cover nearly 200 years of engineering.

Maurice Turnbull exhibited several of his wonderful models of Victorian machine tools. This model is Archibald Milnes' nut cutting machine of 1840. Early milling cutters often had very large numbers of teeth compared to modern ones.

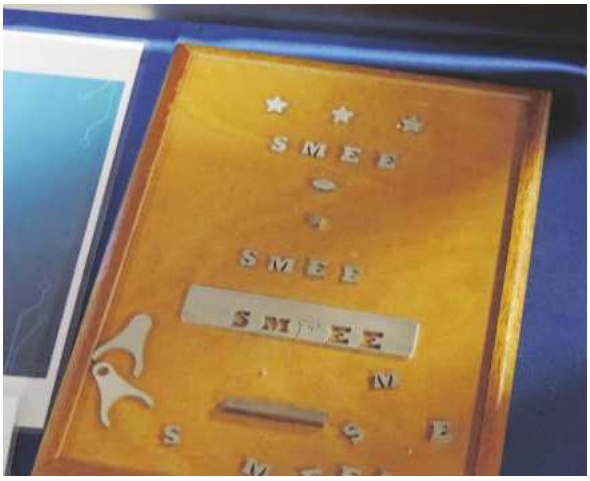


This wonderful machine was being demonstrated on the Society of Ornamental Turner's stand. The craftsmanship involved in making these old machines with their remarkable complexity is outstanding.



Brian Neale exhibited this CNC wire eroder on the SMEE stand. It was built by Alan Martin and Mike Kapp with input from several other members of the SMEE's Digital Group, essentially as a 'proof of concept. We hope to feature an article about the machine in MEW in the future.

The bodywork of this Bullied shunter by Rob Speare was entirely 3D printed on the machine behind it. The wheels are patterns, not intended to be used on the track.



Some examples of the delicate work produced by the wire eroder, the stars are roughly the size of a penny.

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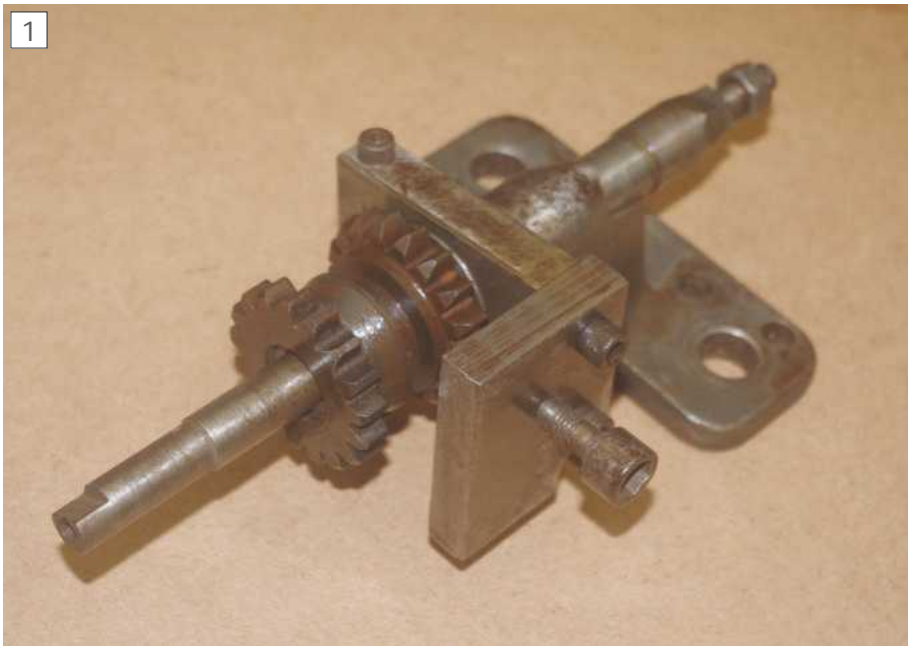
A Direct Indexing Head from a Scrap Towing Hitch

Terry Cleife makes a long-lived tool from an unusual starting point.

Here is a tried and tested project that I made from scrap about fifteen years ago at zero cost. A large number of special nuts had to be made that were not available commercially and my horizontal mill did not have a satisfactory means of holding the work to mill the hexagon flats. It appeared unlikely that the process would ever be repeated, therefore it did not seem economic to rush out and buy an expensive commercial dividing head or rotary table. A rummage in the scrap bin produced an old caravan ball hitch, a reverse gear from a

> A rummage in the scrap bin produced an old caravan ball hitch, a reverse gear from a Leyland Mini and some odd bits of bright steel plate.



The finished dividing head

A scrap tow hitch

The dismantled dividing head

Leyland Mini and some odd bits of bright steel plate. It all had distinct possibilities to cobble together a direct indexing device, especially considering that the chosen gear had 18 straight cut teeth which are easily divided by 6, giving the required milling position for a hexagon flat at every third tooth space.

What follows is not a detailed build manual, merely a basic design concept which can be adapted to individual requirements. It is backed up by a largely self explanatory set of photos. The most likely use will be to mill hexagons and gears by direct indexing, this latter facility being further refined by adding a worm and wheel drive to the spindle. Having done so it would then be equipped for making any gear or dividing plate.

Clearly there will not be many who carry round a mini reverse gear in their pocket but a good option would be to use a 30 tooth lathe change wheel or in fact any gear according to the job in hand. It should be easily detachable from the spindle but here lies an opportunity to make a bespoke index wheel. Simple V notches is all that will be required, made with a fly cutter rather than using a sophisticated tooth form and 6 notches will suffice for milling hexagons by locking a 30-tooth wheel at every fifth tooth space.

The finished index device is a little rough round the edges after fifteen years of use because it proved to be rather more versatile than the single use at first envisaged. Apart from milling nuts and bolt heads it was used to make a replacement gear for a modern car's electric window winder by removing the 18 tooth indexing gear and fitting the worn window gear in it's place, then simply indexing round using the (still evident) tooth spaces, **photo 1**.

Ball hitches are immensely strong and machine easily, as well as having two handy mounting holes and plenty of metal to drill additional holes. The first step would be to cut off the 50mm ball and it would be surprising if a use could not be found for this also. Leave the supporting neck as long as possible. A scrap hitch is

Ball hitches are immensely strong and machine easily, as well as having two handy mounting holes and plenty of metal to drill additional holes.


4


5


6

A firm push fit by hand of the spindle into the main body will ensure accurate chatter-free operation, as will a tight fit of the index screw in the bracket.

shown in **photo 2**.

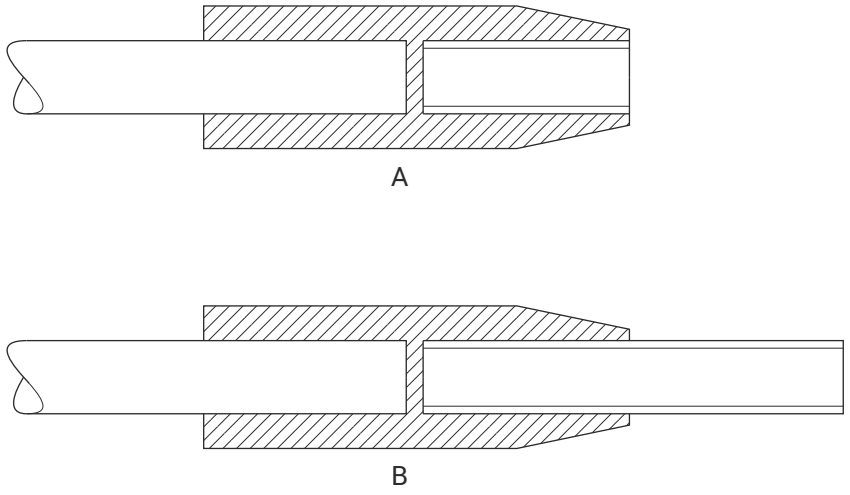
Only five parts plus screws make up the most basic version of this dividing head. Silver steel for the spindle would be appropriate but some easily obtained scrap shafting from car suspension telescopic dampers could be used. These struts leak in service and therefore fail the MOT long before any detectable wear is evident on the hard chrome plating. They make excellent shafts for all sorts of applications and are typically of 12 mm diameter. I never use "mild steel", whatever that is, for any kind of shaft. The main body can accommodate a maximum shaft diameter of about 14 mm. Warning - telescopic dampers contain oil which might be under pressure so always saw through the top of the outer tube held in a vertical position to release the pressure and wear a face shield, **photo 3**.

An example of the work needed on the main body is shown in **photos 4** and **5**.

A word here on the construction details. A firm push fit by hand of the spindle into the main body will ensure accurate chatter free operation, as will a tight fit of the index screw in the bracket. This can be achieved by using a first or second tap that has not passed through the whole of the taper. The diameter of the spindle could match the hole in the chosen index gear up to about 14mm or the hole in the gear could be temporarily sleeved to fit the spindle as in **photo 6**.

Finally, some thought must be given to the arrangement for work holding. The cutting forces on the work piece need to be addressed and the preferred option would be for thrust to be taken by a selection of either integral sleeve/shaft assemblies or removable sleeves tightly secured to a plain spindle. The sleeve in each case would butt against an annular flat around the spindle hole. Each sleeve would incorporate a bespoke mounting for the work in hand which might for example require a flange or spigot or a female thread (**fig. 1 A**). A male thread could be achieved by inserting a screwed stud (**fig. 1 B**). ■

Fig.1



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Mike's WORKSHOP

A Lever Feed Tailstock for The Mini-Lathe

Mike Cox fleshes out the details of a useful Mini-Lathe mod first introduced on the forum by John Stevenson - Part 2.

Fig.8

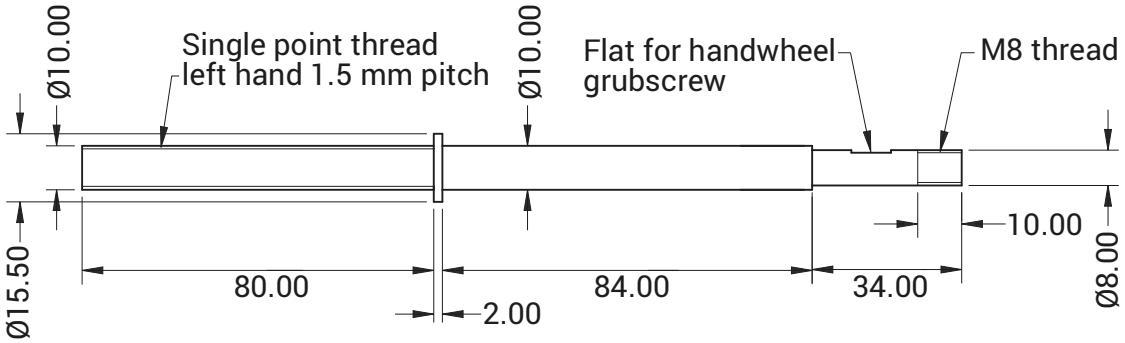

Fig 8. The Feedscrew

The feed screw

The feed screw is shown in **fig. 8**. This could have been turned from a length of 16mm mild steel round bar. However, I dislike purchasing a piece of 16mm bar and then turning more than half of it into swarf. I fabricated the feed screw from two lengths of 10mm bar and a small slice from a 16mm bar, **photo 8**. A length of 10mm bar was chucked in the lathe with about 30mm protruding. This was faced and centre drilled. The end was turned down to 6mm for a length of 25mm and the tip was turned down to 5mm for a length of 10mm. The tip was then threaded M5. The protrusion from the chuck was then increased to 120mm and the end of the bar supported in the tailstock. A moving steady was set up to support the bar. The bar was then left hand threaded with a pitch of 1.5mm for a length of 85mm from the shoulder. It was parted off 80mm from the shoulder.

Another piece of 10mm bar was chucked in the lathe. The end was faced and centre drilled. This was drilled out 4.3mm for a depth of 30mm and then counterbored 6mm to a depth of 15mm. This was tapped M5 to the full depth. The bar was parted of to a length of 118mm. The bar was turned around in the chuck.

8

The leadscrew parts.

The end was faced and turned down to 8mm for a length of 34mm. The end was threaded M8 for a length of 10mm using the tailstock dieholder. A small flat was milled 6mm wide at 18mm from the end of the bar, **photo 9**. This is for the tailstock hand wheel grub screw to grip on to.

The final part of the feed screw is the small disc to make the flange in the middle. This was made from 16mm mild steel bar. This was chucked in the lathe and the end faced and centre drilled. It was then drill out 6mm for a depth of 6mm. and then a disc 2mm wide was parted from the end of the bar.

Prior to assembly of the feed screw all parts were cleaned in white spirit and then lighter fluid. The feed screw was assembled by placing the flange disc on the end of the screw section. Both side of the disc and the parts leading to the screwed section were smeared with

Loctite. A little Loctite was also placed in the tapped hole of the other female part of the leadscrew and the two parts were then screwed together. One end was clamped in the lathe chuck and the other in the tailstock chuck to ensure alignment whilst the Loctite set. Excess loctite was removed from the out side of the parts with a soft tissue. Once set, I normally leave overnight, the assembly was removed from the lathe and then re-chucked by the spindle end and both sides of the flange were lightly faced and the periphery turned down to 15.5mm diameter. The finished feed screw is shown in **photo 10**.

The lever components.

Figure 9 shows the lever components. These were all made from 4 x 14mm hot rolled strip cut to length and drilled out as indicated. The ends of the strips were rounded by making a 14mm diameter washer with a 6mm hole. This was fixed to the end of the bars using a M6 screw and nut. The washer was then used as a guide to remove material with a hacksaw and file to give a smooth rounded profile. The sections of the lever system were joined together using 6mm socket head screws and nyloc nuts with washers under the socket head, between the two parts that meet, and under the nyloc nut. **Photograph 11** shows the completed lever system. The handle was sleeved with a short piece of 1/2" garden hose, which is a good fit over the 4 x 14mm lever, to provide a comfortable grip. The HoZelock yellow hose is quite a good match of the standard Clarke yellow of my mini-lathe!

One end of the lever system attaches to the block and the other end, the handle end, attaches to a collar that is fixed to the auxiliary sleeve. Thus moving the

The HoZelock yellow hose is quite a good match of the standard Clarke yellow of my mini-lathe!

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The end of the feedscrew.

10

The finished feedscrew

Fig.9

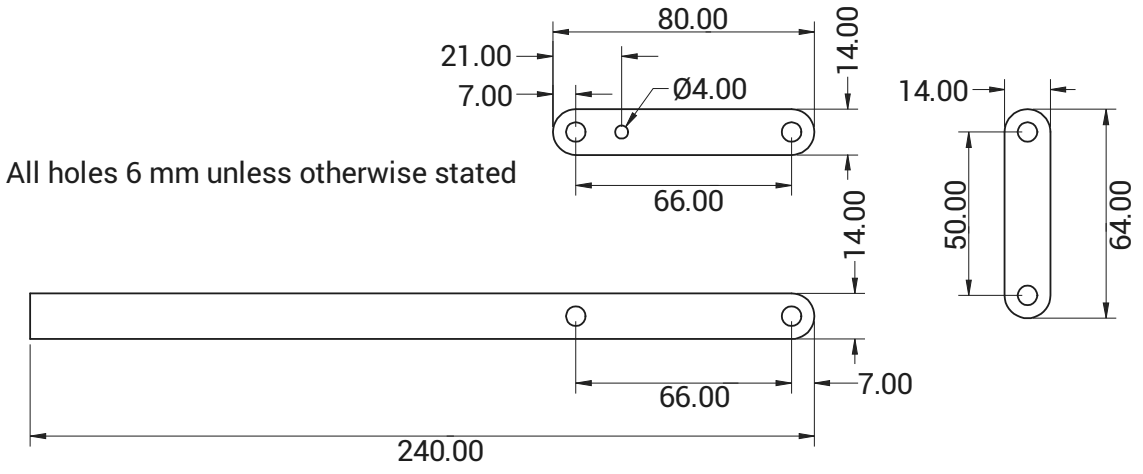
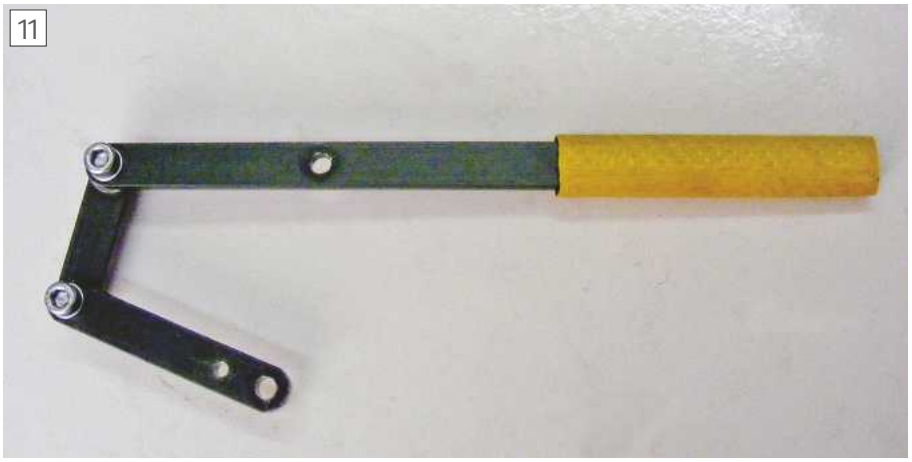


Fig 9. The Lever Components

Material 4 x 14mm hot rolled steel strip

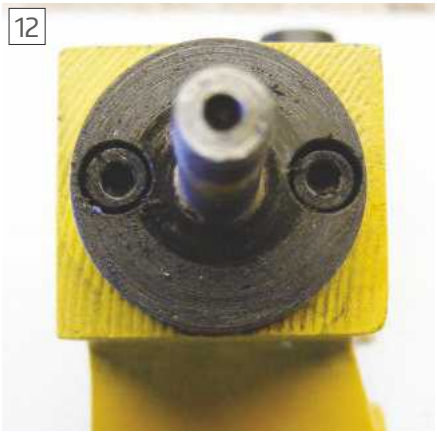


The lever system.

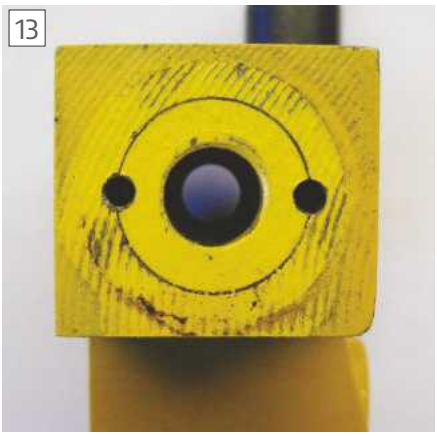
handle slides the auxiliary sleeve in and out of the block. The attachment collar, **fig. 10**, was made from a length of 38mm round steel. This was faced drilled and bored to a sliding fit on the auxiliary sleeve to a depth of 14mm. It was parted off to give a collar 12.7mm wide. Two holes were drilled and tapped as shown.

Also shown in fig. 10 is the special screw used to attach the lever to the collar. This was made from a short length of 10mm hexagon bar.

Drilling the tailstock.



The end of the tailstock after removing the handwheel.



The end of the tailstock after removing the end cap.

Assembly.

The first step was to dismantle the standard tailstock. First the handle was removed by undoing the nut in the hand wheel. The grub screw in the collar of the hand wheel was then removed. The handle was pulled off. Once the handle was out of the way the end cap of the tailstock is revealed, **photo 12**. The two screws were undone and the end cap removed to show the end plug, **photo 13**. The feed screw was then unscrewed. The anti-rotation screw under the front of the tailstock barrel was undone and the MT2 sleeve removed. The end plug was removed by inserting a suitable drift into the tailstock barrel and tapping it out.

The block was attached to the tailstock barrel. To do this the auxiliary sleeve is pushed into the block with most of the sleeve protruding from the back of the block. It was locked in place using the clamping screw. The protruding part was slid into the tailstock and the block lined up square with the edges of the tailstock barrel casting and held using toolmakers clamps and packing. This assembly was clamped in the drill press vice and the counterbored 4.5mm holes in the block were spotted through onto the tailstock casting with a 4.5mm drill. The drill was only used to mark the hole position. The block and auxiliary

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This project was very satisfying because it works very well unlike my previous attempts to construct a lever feed arrangement.

sleeve were removed from the tailstock casting. The marked positions were then drilled out on the drill press using a 3mm drill to a depth of 15mm, **photo 14**. These holes were then enlarged to 3.3mm and tapped M4. After cleaning out the blind holes carefully the block was attached to the tailstock using 30mm M4 socket head screws, **photo 15**.

The MT2 sleeve was replaced in the barrel and the anti-rotation screw adjusted so that the sleeve could slide freely but not rotate. The feed screw was assembled into the auxiliary sleeve using some grease to lubricate the bushes. The flange on the feed screw should fit into the recessed end of the auxiliary sleeve. This assembly was passed through the block and the feed screw was screwed into the MT2 sleeve. The groove in the auxiliary sleeve was turned to the back of the block and a M5 screw with the tip sharpened to a blunt point was screwed into the back of the block to engage with the groove. The auxiliary sleeve was pulled out as far as it will go and the collar slid on. The lever system was next fastened to the block using a M5 and M4 screws. The other end of the lever system was attached to the collar using the special screw. The hand wheel was fixed to the end of the feed screw shaft using a M4 grub screw and an M8 nut. The MT2 sleeve was next set so that the end was just inside the tailstock barrel and the auxiliary sleeve was extended as far as possible outside the block. The sleeve was then pushed forwards into the block as far as it will go. This corresponds to the maximum extension of the tailstock and the collar was then slid along the auxiliary sleeve until it was adjacent to the block. The collar was then fixed to the auxiliary sleeve using an M4 screw through the back of the collar into the groove. The lever feed action was now tested. Moving the lever handle back and forth should move the MT2 sleeve in and out of the tailstock.

Some years ago, I added a graduated collar to the feed screw hand wheel. With the new arrangement there was no fiducial mark for the collar. An addition collar was made, with a fiducial mark scribed on, that fitted on the end of the auxiliary sleeve, **photo 16**. If used with a standard factory supplied handwheel then the additional collar is un-necessary.

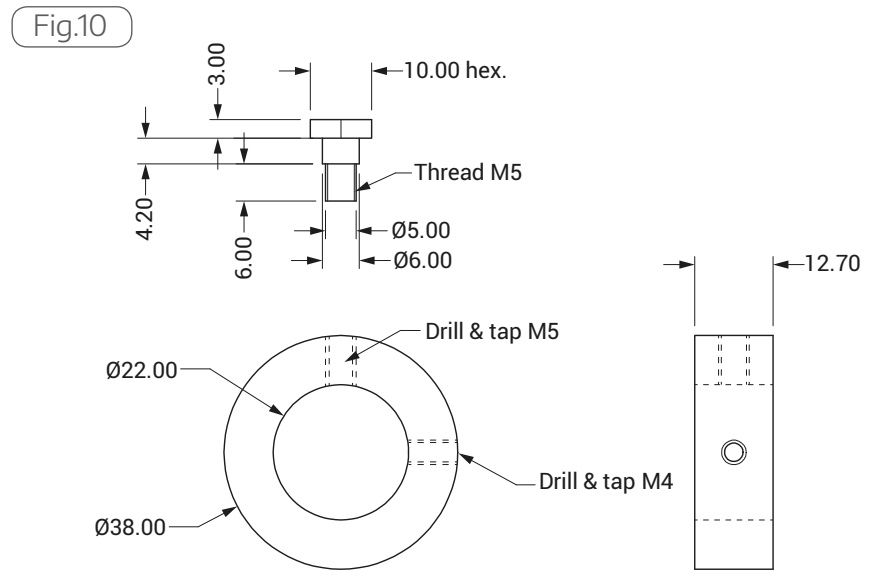
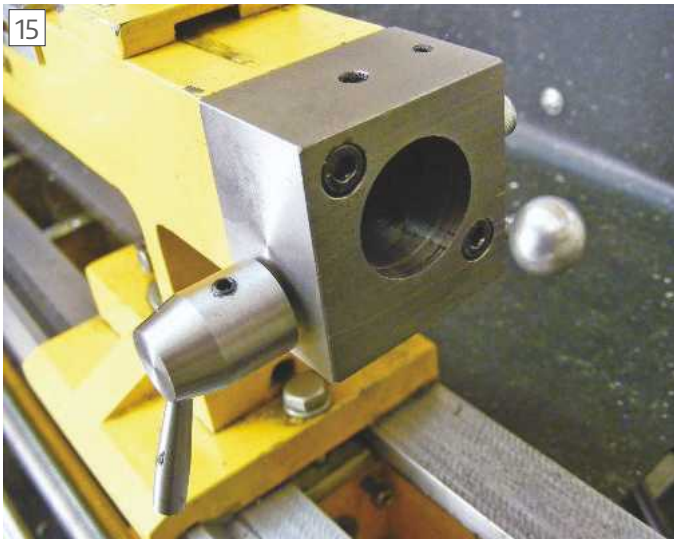


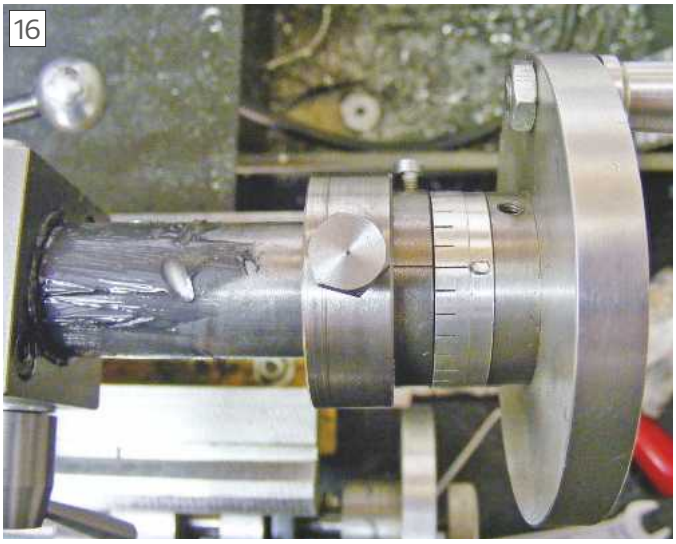
Fig 10. The Lever Attachment Collar

Conclusion.

This project was very satisfying because it works very well unlike my previous attempts to construct a lever feed arrangement. The ability to change instantly from lever feed to screw feed at the turn of the locking screw is very convenient. The modification come into its own for any situation where peck drilling is necessary in order to clear the flutes of the drill such as when drilling deep holes. It is also very convenient for operation such as reaming and tapping. For tapping the locking screw is released so that the sleeve can slide freely and the tip of the tap is started in the hole using pressure on the lever. Once started the tap will self feed but be kept perfectly aligned. ■



The block bolted to the tailstock.



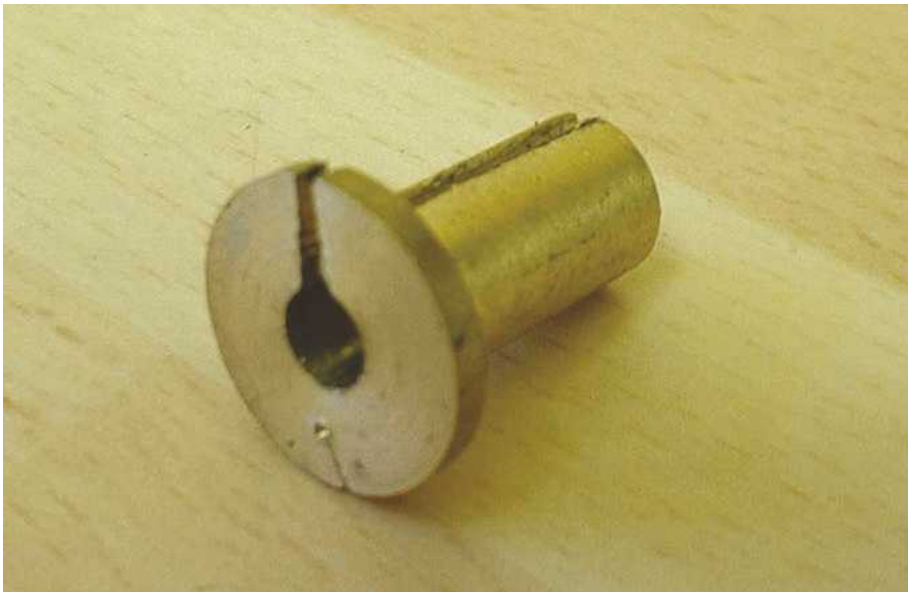
The extra collar with the fiducial mark.

Split Bushes and Mandrels

Stub Mandrel keeps things in line

A myth of the modern workshop is that of the inherent inaccuracy of the three-jaw chuck. Only the best can be relied upon and overtighten such a device just once and it is ruined forever, we are warned! I chucked a six-inch piece of silver steel in the three-jaw chuck that came with my inexpensive far-eastern lathe the other day. Testing along its length with a dial gauge, it was still no more than a thou or so off centre a good four inches from the chuck. Others have reported similar results. Admittedly, I only carried out this check at one diameter but my experience in resetting work does suggest that even this inexpensive chuck has a good level of basic accuracy. This is after several years of use and abuse, so check your own you may be surprised. My one warning is do make sure the chuck is cleaned and lubricated – I find most inaccuracy comes from bits of swarf, not poor manufacture. Incidentally, the late George Thomas performed similar tests on several drill chucks, and he too was surprised at their accuracy.

Even so, at times you may want to be absolutely sure that work is held truly concentrically. The simple way of achieving this is a split bush, **photo 1**, bored in situ to a good fit on the work, but drilled and reamed if the bore is small. A 'top hat' shape is convenient, as it can be positively located against the chuck jaws. If the slit is made opposite to jaw number 1 you can have a sporting chance of locating it accurately again in the future.



A simple split bush

Most scrap can be used to make such a bush, but brass is a good material, being easy to work accurately and to a good finish, while having a degree of 'springiness'.

For hollow work, then a mandrel that fits inside the work is needed instead. You can knock them up by repurposing odd bits of scrap, as in **photo 2**. Turned in place such a mandrel will be 100% accurate. If you turn such mandrels from offcuts of hexagon material (marked for number 1 jaw) they can be re-used for less critical applications.

This can be turned to a tight fit, relieved to give a slight taper at the outside end. This is the most accurate solution, but the danger is always there that the work will skid and be scored on its bore. A threaded end for a nut and washer, or a screw and washer, can be used to hold most work secure. Another alternative when you need to be able to turn the whole face of the work is to thread the mandrel undersize for a large screw (just use the tip of a taper tap), then split it with a neat sawcut; once fitted inside the work it can be expanded by fitting a suitable screw. ■

A basic screwed mandrel, use it and recycle it!

My one warning is do make sure the chuck is cleaned and lubricated - I find most inaccuracy comes from bits of swarf, not poor manufacture.

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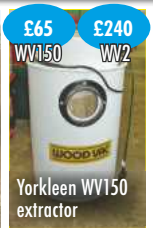

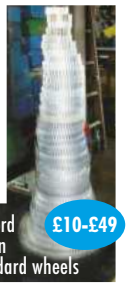

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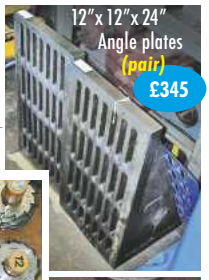

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