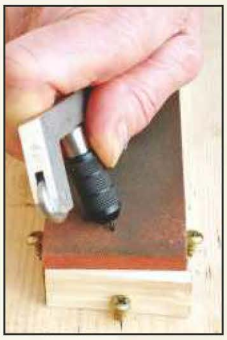
No.251

3D DELUXE: DISCOVERING DREMEL'S NEW 3D40 PRINTER

MODEL ENGINEERS' WORKSHOP

Join the conversation about this issue: www.model-engineer.co.uk

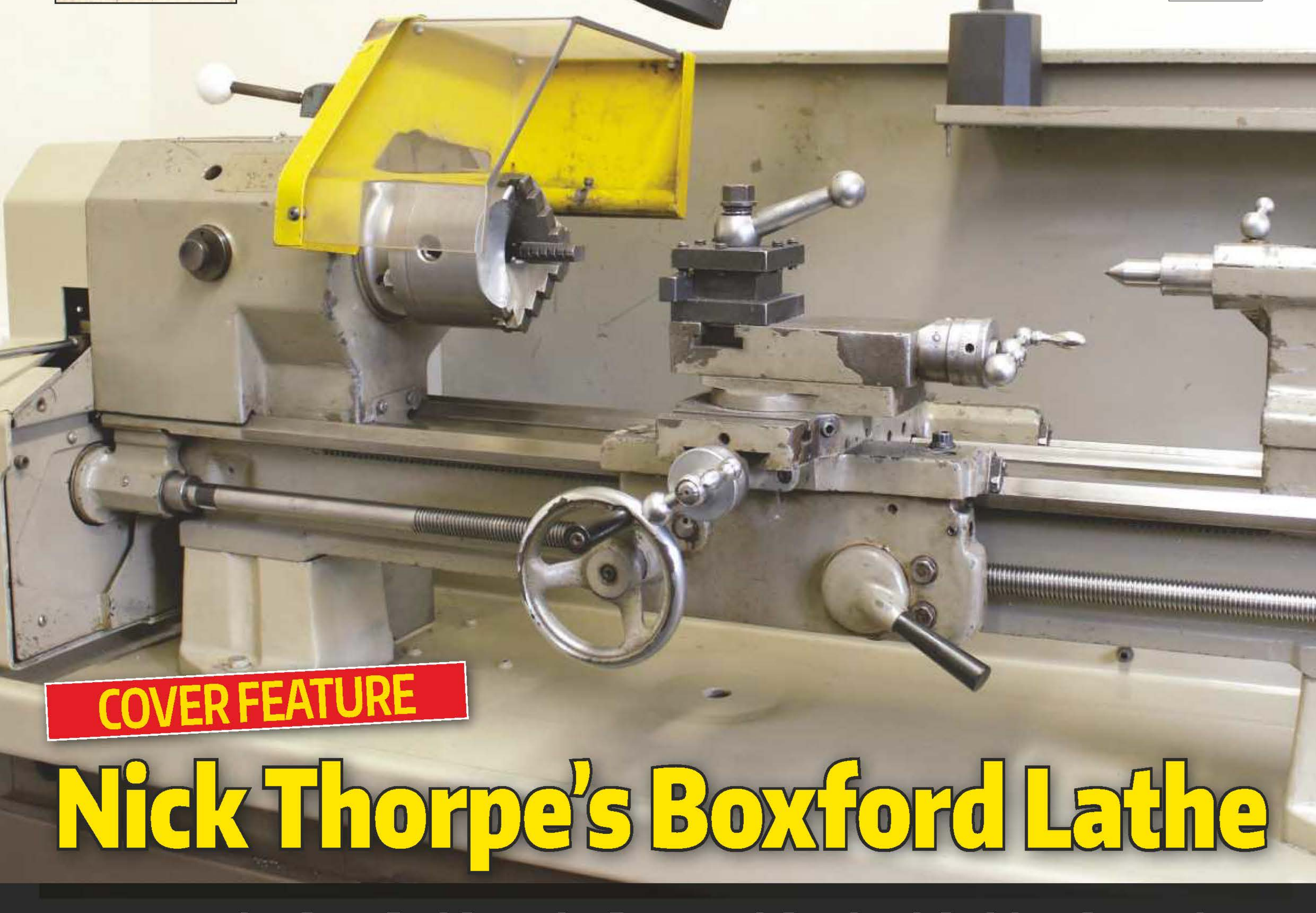
FEBRUARY 2017



Make a Wishbone Sharpener for small drills

£4.50

mytimemedia ENGINEERING GROUP



COVER FEATURE

Nick Thorpe's Boxford Lathe

MEW: YOUR INDISPENSABLE WORKSHOP COMPANION!


PRO
MACHINE
TOOLS LIMITED
Tel: +44(0)1780 740956
Fax: +44(0)1780 740957
emco
1885 WABECO 1885
CERIANI
TE CO
GOLmatic
Maschinenbau
EMCO
Hobbymaschinen
PROXXON
swiss tec
Since 1865
Precision European made machine tools for the discerning engineer!
Wabeco CNC Mill
CC-F1410
2 year warranty
• Table – 500 x 200mm
• Z axis – 280mm • Speed – 140-3000 rpm • Power – 1.4 KW
Wabeco Lathe
D6000
• Centres – 600mm
• Centre Height – 135mm
• Speed – 30-2300 rpm
• Power – 1.4 KW
5 year warranty
TECO
Mill
VF400
• Table – 450 x 160mm
• Z axis – 320mm
• Speed – 365-1800 rpm
• Power – 250 W
Ceriani Lathe David 203
• Centres – 500mm • Centre Height – 200mm
• Speed – 100-1800 rpm • Power – 0.75 HP
Wabeco
Mill
F1210
• Table – 500 x 150mm
• Z axis – 280mm
• Speed – 140-3000 rpm
• Power – 1.4 KW
5 year warranty
Ceriani
Mill
David
403
• Table – 420 x 160mm
• Z axis – 300mm
• Speed – 100-3000 rpm
• Power – 1.5 KW
ACCESSORIES
Lathe Chucks, Drill Chucks, Tipped Tools, Boring Bars, QCTP, HSS Tools, End Mills, Slot Drills, Machine Vices, Clamping Sets, Slitting Saws, Arbors, Boring Heads, Radius Mills, DROs, Rotary Table, CNC fits, Collet Chucks, Collet Sets, Flanges, Face Mills, Shell Mills and Much More...
Wabeco
CNC Lathe CC-D6000
• Centre Distance – 600mm
• Centre Height – 135mm
• Speed – 30–2300 rpm
• NCCAD • Power – 1.4 KW
2 year warranty
TECO Lathe MD 200
• Centres – 300mm
• Centre Height – 52mm
• Speed – 250-2000 rpm
• Power – 250 W
MORE MACHINES AND ACCESSORIES ON LINE
Our machines suit the discerning hobbyist as well as blue chip industry
We regularly ship worldwide
Please contact us for stock levels and more technical detail
All of our prices can be found on our web site:
www.emcomachinetools.co.uk
PRO Machine Tools Ltd.
17 Station Road Business Park, Barnack, Stamford, Lincolnshire PE9 3DW
tel: 01780 740956 • fax: 01780 740957
email: sales@emcomachinetools.co.uk

MODEL ENGINEERS' WORKSHOP

Published by MyTimeMedia Ltd.
Suite 25, Eden House, Enterprise Way,
Edenbridge, Kent TN8 6HF
+44 (0)1689 869840
www.model-engineer.co.uk

SUBSCRIPTIONS
UK - New, Renewals & Enquiries
Tel: 0344 243 9023
Email: help@me.secureorder.co.uk
USA & CANADA - New, Renewals & Enquiries
Tel: (001)-866-647-9191
REST OF WORLD - New, Renewals & Enquiries
Tel: +44 1604 828 748
Email: help@me.secureorder.co.uk

CURRENT AND BACK ISSUES
Tel: 01733 688964
Website: www.mags-uk.com

MODEL ENGINEERING PLANS
Contact: www.myhobbystore.co.uk/contact
Website: www.myhobbystore.co.uk/me-plans

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: Robin Gray

ADVERTISING
Senior Account Manager: Duncan Armstrong
Email: duncan.armstrong@mytimemedia.com
Tel: 01689 869855

MARKETING & SUBSCRIPTIONS
Subscription Manager: Louisa Coleman

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

mytimemedia
print & digital media publishers

Model Engineers' Workshop, ISSN 0959-6909, is published monthly with an additional issue in August by MYTIMEMEDIA Ltd, Enterprise House, Enterprise Way, Edenbridge, Kent TN8 6HF, UK. The US annual subscription price is 52.95GBP (equivalent to approximately 88USD). Airfreight and mailing in the USA by agent named Air Business Ltd, c/o Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA. Periodicals postage paid at Jamaica NY 11431. US Postmaster: Send address changes to Model Engineers' Workshop, Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA. Subscription records are maintained at dsb.net 3 Queensbridge, The Lakes, Northampton, NN4 7BF. Air Business Ltd is acting as our mailing agent.

On the Editor's Bench

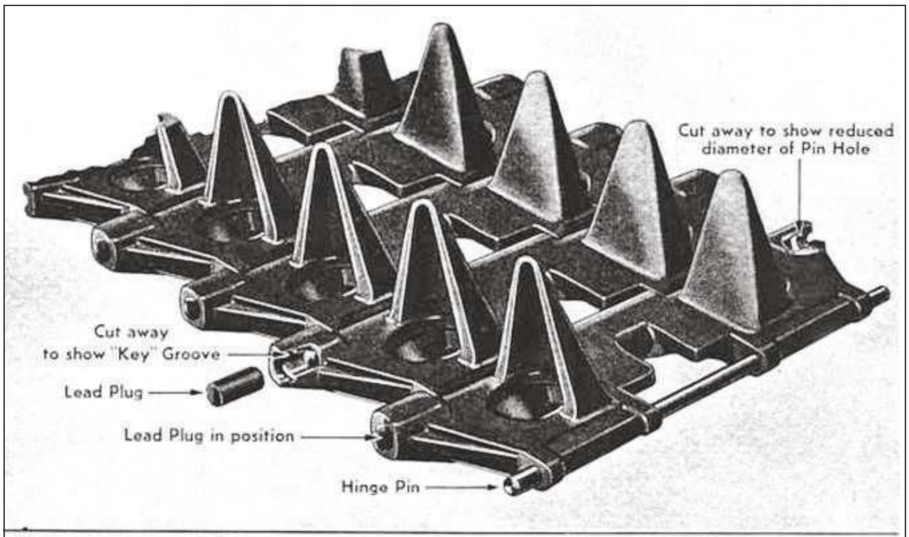


Fig. D 1. Details of Tracks

On My Bench

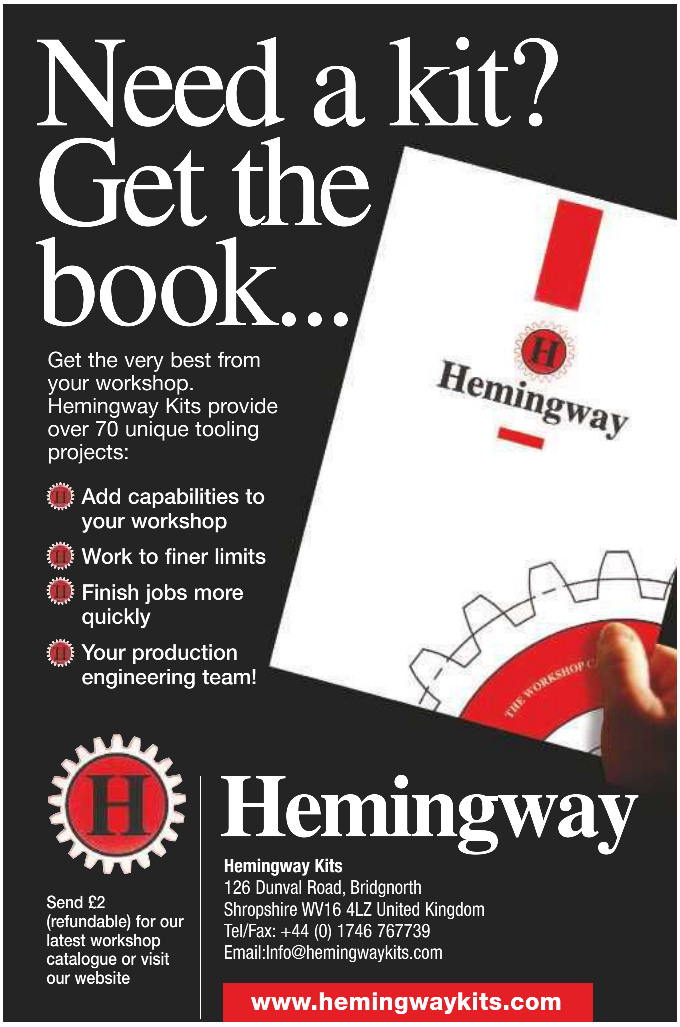
I'm sure that a proportion of readers will still be very sceptical about 3D printers, not least because, they can be perceived as 'de-skilling' their hobby. However, unlike some other CNC machines, they aren't really doing something we can do in our workshops in any other way – producing complex shapes in plastic.

For a long time one of the models I have always wanted to build is a large-scale Vickers Light Tank Mk. VIb. The biggest barrier to such a model is making the tracks; each link is a small but complex part that would take several setups and many machining operations to make! The ideal solution would be lost wax casting, the original links are cast, but there are 187 links on each track, so I can't see that's feasible. An ideal solution might be injection moulding, but the challenge of making the machine and the die blocks for a one job is off-putting. This is a task where 3D printing comes into its own.

When I was given the opportunity to use a Dremel 3D40 3D printer on review for a month, making those tracks was my first thought! A basic link design was easy, a realistic one more challenging, and in the end I had to print and glue on a separate 'strake' to each link. A big advantage was that the hole for the linking wire was printed in so assembling the track was just threading in a piece of stainless steel wire and securing it with a drop of cyanoacrylate.

Common sense should have left the project there, but 3D printing is addictive! In a month I can't design and build an entire tank, but I have used the opportunity to make an array of other parts. I Can think of no better way to test the printer than such a challenge! While these would have been practical to make in a traditional way, it's been fascinating discovering the capabilities and limitations of 3D printed objects. It has also been rewarding to see how printed objects and engineered parts can be made to work together.

It's also got me wondering how feasible it would be to 3D print (almost) the entire tank – but for that I will need my own printer...



Need a kit? Get the book...
Get the very best from your workshop. Hemingway Kits provide over 70 unique tooling projects:
Add capabilities to your workshop
Work to finer limits
Finish jobs more quickly
Your production engineering team!
Hemingway
Send £2 (refundable) for our latest workshop catalogue or visit our website
Hemingway Kits
126 Dunval Road, Bridgnorth
Shropshire WV16 4LZ United Kingdom
Tel/Fax: +44 (0) 1746 767739
Email:Info@hemingwaykits.com
www.hemingwaykits.com

AMADEAL Ltd.
www.amadeal.co.uk
See our vast range of mini-lathes, bench lathes, milling, grinding and boring machines, both manual and CNC.
For professional or hobby purposes
All machines we sell are fully guaranteed, and we aim to give product support that is second to none
We stock all kinds of spare parts for all of the machines that we carry. If you require parts and they're not listed on the website, drop us a line or email us and we might be able to help you.
(Between 8am-8pm)
(Between 11-4pm)
Tel: (+44) 0208 558 4615 or 07887 945717 or (+44) 0208 558 9055
Unit 20 The Sidings, Hainault Road, Leytonstone, London E11 1HD
Monday - Friday (11am-4pm) or at other times by calling for prior arrangement.

Call 01454 324546
FREE Shipping
25 yrs Experience
Online Discounts
Massive Selection
Any tap, any die
Any where
No jack of all trades, not us
Visit us online: www.avontapdie.co.uk
It's what we do. It's all we do. Isn't it time you chose a specialist? Any tap, tap set, tapping drill, die, die nut -any where -and when you need it. We've been doing this for more than 25 years, supplying the world with vital taps, dies and cutting & threading tools of the highest quality. No job is ever too big nor too small, every order for us is just as important -it's our reputation at stake as well as your deadline.
AVON

gandmtools
Just a small selection from our current stock
Buy online now at: www.gandmtools.co.uk
Fobco 7/8 Pillar Drilling Machine, Rack Op Table, 2 MT Spindle, 3ph, £650.00 plus vat.
Colchester Bantam 1600 Lathe, Tooled, VGC, 3ph, £1750.00 plus vat.
Tom Senior M1 Vertical/ Horizontal Milling Machine, Vice, VGC, £1850.00 plus vat.
• Telephone enquiries welcome on any item of stock. • We hold thousands of items not listed above.
• All items are subject to availability. • All prices are subject to carriage and VAT @ 20%. • We can deliver to all parts of the UK and deliver worldwide. • Over 7,000 square feet of tools, machines and workshop equipment.
Opening times: 9am -1pm & 2pm – 5pm Monday to Friday. Closed Saturdays, except by appointment.
telephone: 01903 892 510 • www.gandmtools.co.uk • e-mail: sales@gandmtools.co.uk
G and M Tools, The Mill, Mill Lane Ashington, West Sussex RH20 3BX

Contents

Coming up...

in the March issue

Once you have enjoyed this issue, look out for the next, packed full of more tools and techniques!

Regulars

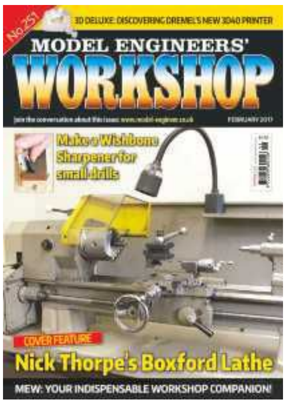
3 ON THE EDITOR'S BENCH
Some background to those 3D Printing experiments!

55 READERS' TIPS
This month a lathe swarf guard and quick (but not dirty) stepped pulleys.

62 SCRIBE A LINE
What's in the MEW postbag this month?

Due to having very few reader adverts this month, after a bumper crop in the last issue, we are holding reader's ads over to the March issue. If you need the form, it can be downloaded from the MEW preview page on our website. Click the picture of this issue, then scroll to the bottom of the preview page.

ON THE COVER »»
This month's cover shows Nick Thorpe's rather splendid Boxford CUD lathe. Less popular than a Myford, but with a 4" centre height, excellent quality and with plenty of machines about, a lathe well worth considering if you want a second-hand British machine.



HOME FEATURES WORKSHOP EVENTS FORUMS ALBUMS

Visit our Website

www.model-engineer.co.uk

Why not follow us on Twitter: twitter.com/ModelEngineers

You can also visit our website for extra content and join in our online forum

Jorg Hugel's Drill Grinding Geometry Spreadsheet
This sought-after spreadsheet and its explanatory document have now been uploaded to the Model Engineer website at: http://www.model-engineer.co.uk/hugel

Hot topics on the forum include:

- **The Workshop progress Thread 2017**
- **What did you do today?**

The forum's two most popular subjects return for the New Year, tell us about your engineering triumphs – or just what you have been up to lately.

- **Motorcycle general Discussion**

It's amazing how many MEW readers restore old bikes!

- **Alternatives to PC-based CNC controllers**

People are starting to make progress with these interesting new bits of kit.

CLASSIFIEDS EXTRA SUBSCRIBE ARCHIVE SUPPLIERS

A Quick-Change Rear Toolpost

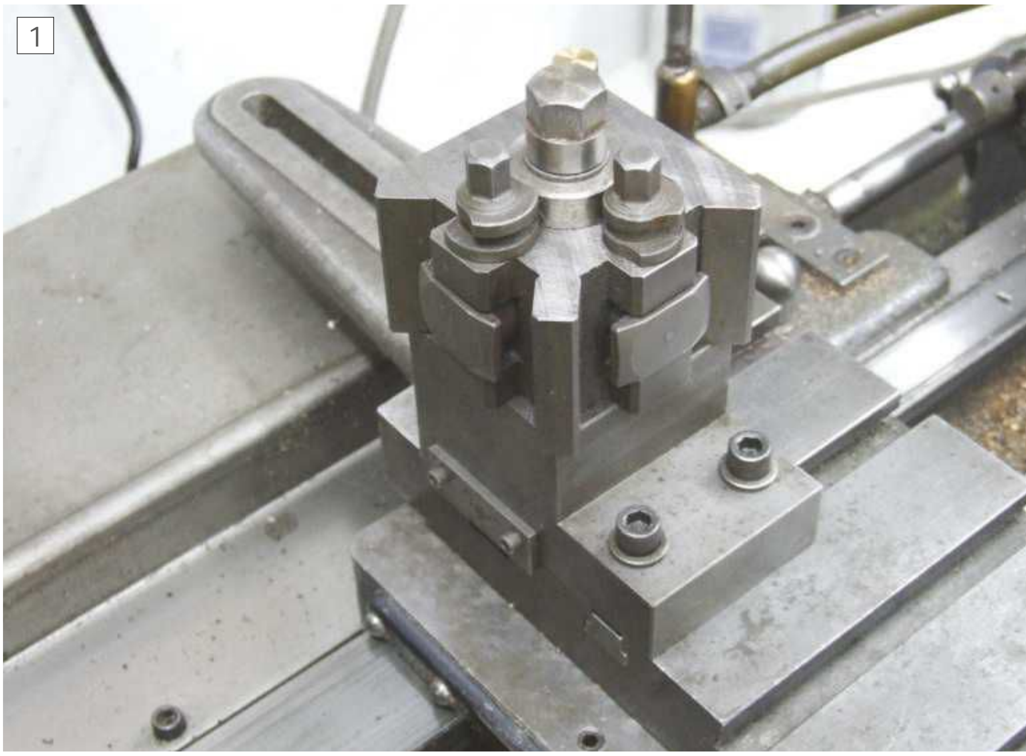
Roger Vane describes a useful addition for Myford Series 7 lathes fitted with a long cross-slide, although the principles could easily be applied to lathes with a large tee-slotted cross-slide.

This design was conceived at around the time when the original Myford company introduced a rear quick change toolpost and special parting toolholders (fitted with blades). I found the concept very interesting, but I also wanted the ability to use tools in the 'boring position', which was something that the Myford system did not offer.

To achieve my goal, I bought a standard quick-change toolpost set from one of our suppliers and then the special parting holders and blades from Myford. This course of action added another four standard holders to my growing collection.

All I had to do then was design and make the mounting block and associated hardware. The finished result is shown in **photo 1**.

This arrangement brings all of the benefits associated with the standard front mounted quick change toolpost, such as 'quick' change-over of tools, easy height adjustment and (as long as you have enough holders) the benefit of not having to change tools over as you would with a 4-way toolpost. In fact, tools or the whole toolpost can be easily removed when not in use.



1

Toolpost fitted to rear of Myford long cross slide

2

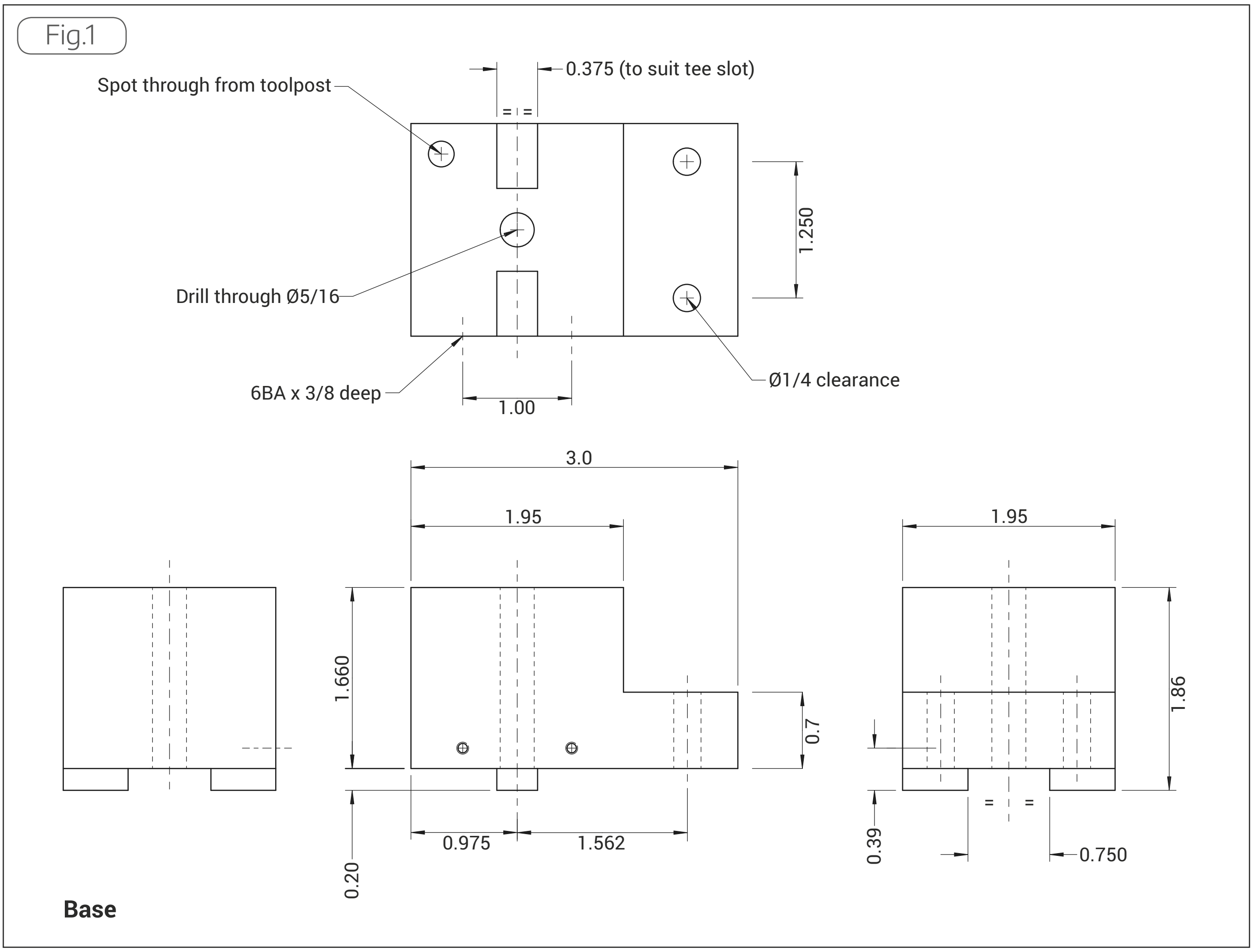
The Myford holders as purchased - only the one on the left is currently shown on the Myford website

When I made my toolpost, Myford sold two distinctly different toolholders and blades, and although the new Myford still sell the system it is only the larger of the two (on the left-hand side of **photo 2**) that appears to be available now.

Although this toolpost has been designed for the Myford Series 7 lathes, the concept could easily be applied to other lathes, possibly with the Myford size tool-block and parting toolholder, or alternatively using a toolpost more in keeping with the size of the lathe. Whichever option is taken, the base and associated components would need to be sized accordingly.

As I made this toolpost more years ago, that I wish to admit to, I'm afraid that there are no genuine 'in-process' photographs, although there are some posed photographs and the descriptions should help, and there is nothing particularly complicated about it anyway.

Apart from the base, the only other items required are a couple of tee-nuts and the



central column components. The individual component parts are shown in **photo 3**.

You will notice that I have specified imperial fixings - this is only because I have good stocks of BSF and BA fixings. It would be easy to substitute metric fixings - M6 for 1/4" BSF and M3 for 6BA as long as the related tapping and clearance holes are sized to suit. On the central column M8 could easily be substituted for 5/16" BSF.

Please note that parting toolholders with blades specifically designed for the front toolpost cannot be used in this toolpost unless you can safely run your lathe in reverse (as they will be 'upside down' when fitted in the rear toolpost).


3

The component parts

Making the base (Figure 1)

Before we start making the various parts a brief description of the toolpost may be helpful. The tool-block is mounted on a base through which passes a central column. The base has a tenon machined into it which is a close fit in the rearmost tee-slot. The central column both locates the toolpost and clamps the whole assembly to the cross-slide by means of a tee-nut at the bottom. There is also a separate tee-nut at the front of the base which acts in the adjacent tee-slot to make the whole assembly more secure.

Additionally, there is a stop plate, the purpose of which is to locate the back toolpost against the edge of the cross-slide to ensure repeatability should it have to be removed.

I made my base from a short piece of square Meehanite bar, which in my experience is very easy to machine, although you will get a bit grubby. I've always understood that Meehanite bar is cast slightly oversize in section to allow the nominal size quoted to be achieved with all surfaces machined. Obviously, this requires care as it is all too easy to remove too much material in an attempt to clean-up

The underside of the base, with the tenon formed and the holes partially drilled (posed photo). The 3/4" diameter slot drill is removing the tenon from around the hole for the central spindle

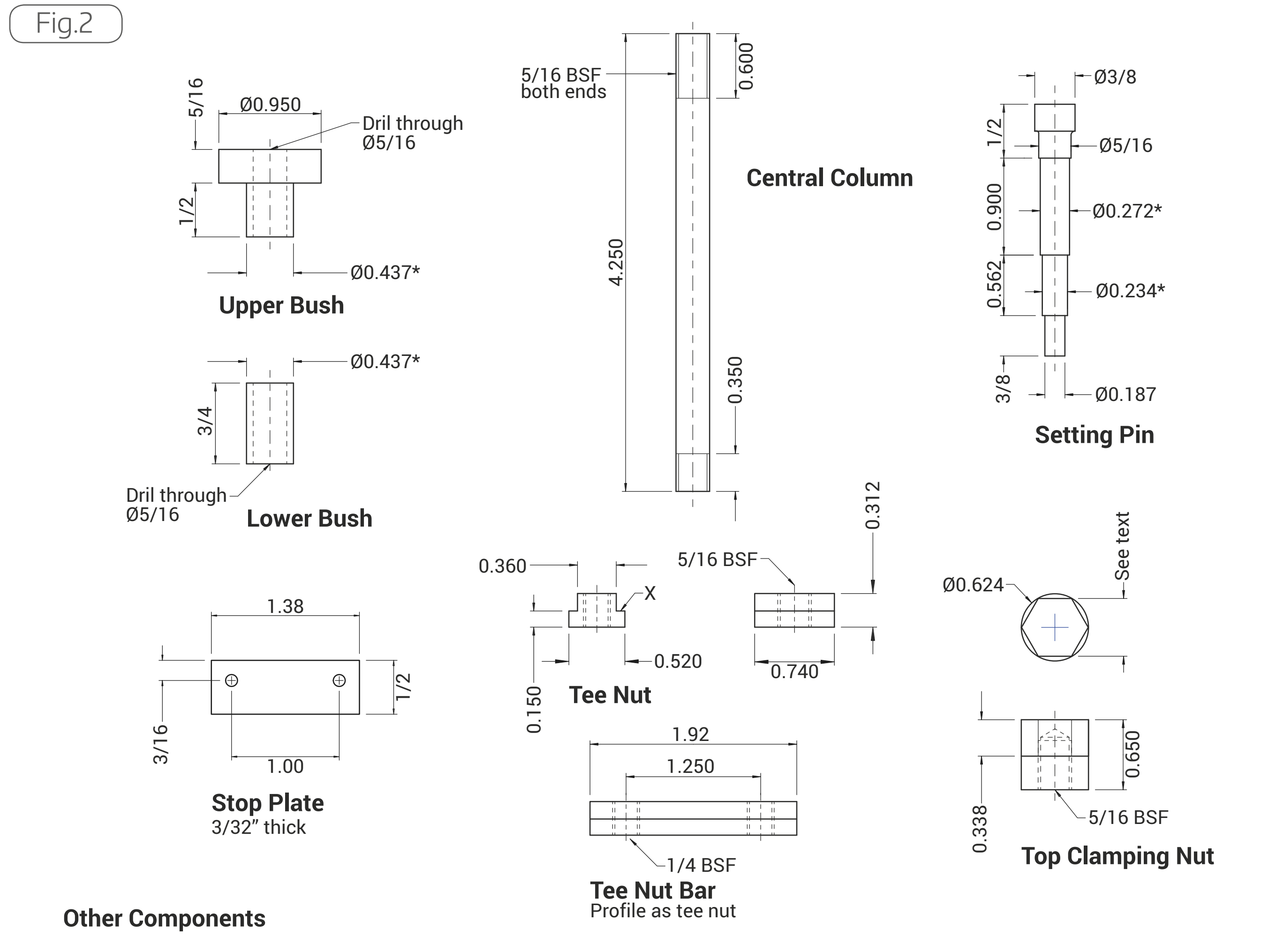
Finish drilling the through hole for the column (posed photo)

and then finish with an undersized blank. It is best to discuss this with your chosen supplier, who will be able to advise. With this particular job if you do machine the bar slightly undersize it is of little consequence. I see that both 50mm and 55mm square are available from one of our suppliers (Ref 1), and one of these two sizes should be ideal for our base. Of course, if you don't wish to use Meehanite there is always the option of machining or fabricating from steel bar.

In the following description, I have used a 5/16" diameter central column so the 7/16" diameter hole in the toolpost will need bushing - an alternative would be to use 7/16" diameter bar, but this would need to be reduced in diameter at the bottom to fit through the narrow part of the tee-slot. It's really a case of 'swings and roundabouts'.

So, now to work on the base. Square up and machine to size - a nice milling job and nothing particularly critical here. The block can then be marked out the underside for the tenon and the holes for the tee-nut screws. It is worth making the tenon as good a fit as possible, so first we have to measure our tee-slot width. In my opinion,

Fig.2



The bushing fitted into the toolpost

digital callipers are totally inadequate for this purpose and using slip gauges is much to be preferred. However, not everyone has a set of slip gauges, so one simple approach would be to use a piece of stock rectangular material (3/8" thick in our case) which will be almost certainly be slightly undersize and therefore a loose in the slot. Now we can bring the feeler gauges or shim stock into use - probably a couple of thou are sufficient.

The tenon and holes for the tee-nut screws can now be machined on the bottom of the base. The holes for the central column and the tee-nut screws should be correctly spaced to match the tee-slots (1.562" in the case of the Myford). Also, the central hole should be a close fit for the column without binding. It would be inadvisable to drill the holes right through the block at this stage to avoid the risk of drilling into the vice. In fact, the holes for the front tee-nuts only need to be drilled around 1" deep as we still have to machine the front step.

As mentioned above, the tenon width should be machined for a close fit in the tee-slots and central to the hole for the column - it is also advantageous for the cut-out in the tenon to be central to the column hole as this will make fitting the tee-nut easier - see posed **photo 4**.

The base can now be turned upside down in the vice and front step machined - nothing too critical here in terms of dimensions.

The fixing holes for the stop plate can be drilled and tapped in the position shown - this will allow the toolpost assembly to be removed, and then replaced in the same position.

The only outstanding operation on the base is to complete the drilling of the 5/16" diameter hole for the central column - this can be done using a standard bench drill with the base being held in a drilling vice where the drill can pass into the central slot as it breaks through, **photo 5**.

Making all other parts **(Figure 2)**

As mentioned above, I decided to make the central column from 5/16" diameter material, so let's make a start with this part. It's simply a piece of good quality 5/16" diameter mild steel rod threaded at both ends 5/16"BSF and really doesn't need any further explanation. The tee-nut fitted to the end is slightly shorter than the length of gap that it is designed to fit into. This will stop the tee-nut rotating 'out of alignment' and making it difficult to fit the toolpost to the cross-slide of the lathe. I will say a few words about making tee-nuts in due course.

I made the upper and lower bushes a light press fit into the toolpost, just to retain them so that they didn't fall out. The lower bush is shown in position in **photo 6**. The shoulder on the upper bush will need to be sized to avoid interrupting the cam movement of the clamping units - the dimension given worked satisfactorily on my toolpost.

Next comes the top clamping nut - I made this 'shouldered' and blind, just for appearance sake. It is easy to make using an indexing head - just machine the 6 sides of the hexagon to match the spanner you intend to use. Once the flats have been machined you can cut the nut off from the parent metal and mount in the 3-jaw chuck, holding by the newly formed hexagon. Now you can face off, drill and tap. That's it - job done. You will see from photo 3 that I used a standard washer under the nut.

The only other turned part is the location pin which is designed to act in a reference position to maintain squareness and to resist the possibility of the toolpost rotating under cutting forces. You will need to check your own toolpost for the dimensions - mine has a reduced diameter at the bottom of the hole in the toolpost. This item is made from steel - I added a brass top - fitted with Loctite - just to be different and also to help find it when lost. If you need to move any tool into an angular position,

Finish machining the shoulders on a tee-nut to the same 'depth' on each side - example only

Before removing the tee-nut from the vice it is best to tap the thread for the stud so that it is square to the working face - example only simply remove the pin and lock the toolpost at the desired angle. However, before we can fit the pin we must accurately align the toolpost on the base (see 'setting the toolpost' below).

The stop plate is very simple with just a couple of clearance holes for the 6BA screws which attach it to the base. Mine was made from a short length of 1/2" x 3/32" steel strip.

A note about tee-nuts

The method we use to mill the profile of tee-nuts is important to their clamping securely, so I'm including a few notes here which may help those readers who haven't made them before. It is important that the faces which contact the underside of the tee-slot profile (X in the drawing) are machined equally in the same plane to provide 100% contact. This will ensure maximum clamping force and eliminate the risk of distorting our rather weak tee-slots.

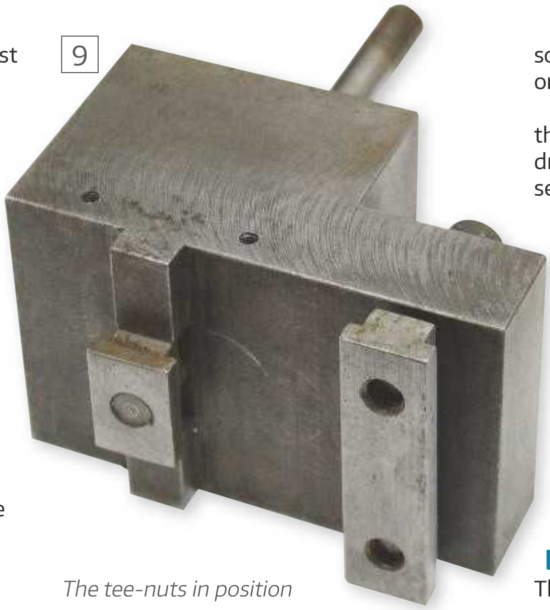
Our Myford sized tee-nuts start off as 5/8 x 5/16" bright mild steel strip, which is reduced down in width to 0.520". Ideally, with bright mild steel equal amounts of material should be removed from each side to avoid distortion, but with our short tee-nuts I doubt that this would be a problem.

It is preferable that the tee-nut is machined entirely (shoulders and threaded holes) without removing it from the vice. This can be accomplished by either supporting the material on a parallel or recesses in the vice jaws if available. With this method both shoulders can be milled by approaching the material from both the front and rear directions, ensuring that the final cuts are taken without changing the depth setting on your mill. The holes can then be drilled and tapped with the appropriate thread. Using this method, the shoulders should be in the same plane and the threads should be square to the shoulders. All that is now required is to deburr the tee-nut ready for use. **Photographs 7** and **8** show machining the shoulders and tapping for the stud (or screw) on a sample tee-nut (please note that as I already had the tee-nut for this job, I chose to machine a different design to illustrate the process).

One final word about using tee-nuts - on the smaller lathes (or milling machines) it is quite easy to break open the tee-slot by 'jacking' the tee-nut upwards if the screw protrudes through the nut and contacts the base of the tee-slot - I understand that the Myford tee-slot can be particularly prone to such damage.

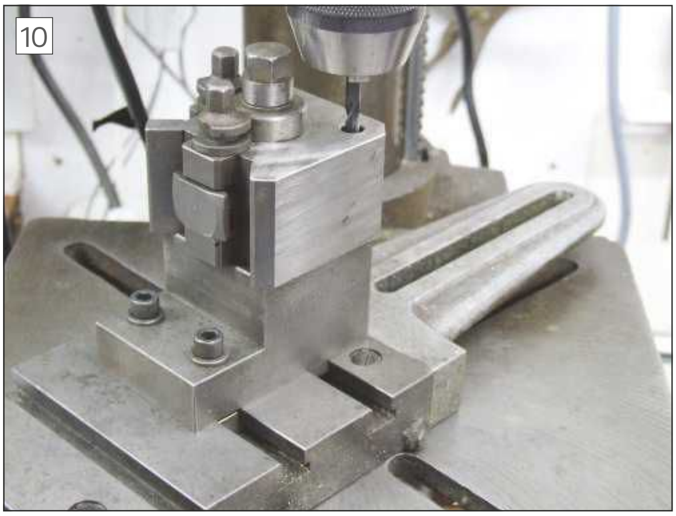
The base assembly, complete with tee-nuts is shown in **photo 9**.

9



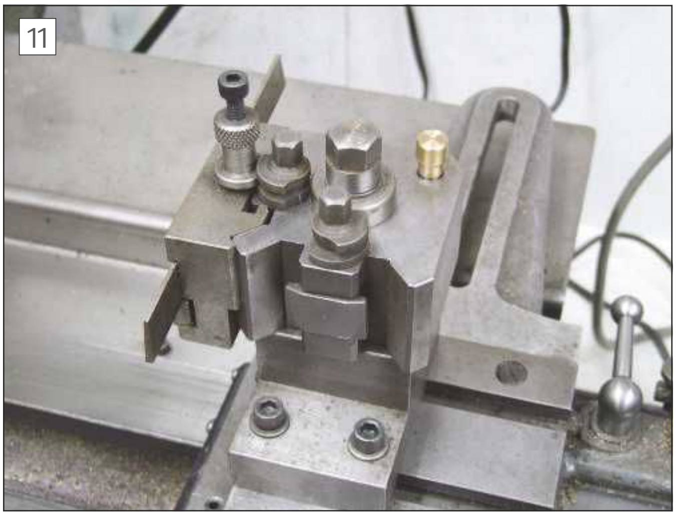
The tee-nuts in position

10



Drilling for the setting pin (posed photo)

11



The Myford parting toolholder fitted to the toolpost

Setting the toolpost

All that remains now is to align the toolpost on the base so that the hole for the locating pin can be drilled. The aim here is to be able to set the parting tool at exactly right angles to the lathe bed axis.

This was a fairly simple operation on the Myford. I fitted a toolholder onto the toolpost and then clocked it true to the cross-slide movement (ie: square to the lathe bed), tightening the nut when I was confident that the setting was correct. There is only one chance of getting the hole in the correct place, so the old saying 'measure twice and cut once' applies in this situation.

The whole cross-slide assembly can then be removed and placed on the bench drill, **photo 10**, to drill into the base for the setting pin.

For those people with larger lathes (and hence cross-slides) may find this approach difficult due to size and weight of the parts involved. An alternative method would be to make a temporary special 'nut' to fit on the end of the column - such a nut would be an easy fit in the narrow part of the tee-slot and would have no 'shoulders'. In this way, the toolpost and base can still be clamped together, but easily removed from the cross-slide for drilling.

Ready for use

That's it - the back toolpost is now ready for use. **Photograph 11** shows the larger of the two Myford parting toolholders in position, while **photo 12** shows a homemade chamfer tool.

References.

Ref 1 Square Meehanite bar is available from M-Machine in both 50mm and 55mm sizes, and Noggin End in 50mm.

12

A chamfer tool set in a standard toolholder

Counterweight for a Seig SX2P Mill

Phil Dawes takes a balanced approach to milling with this popular machine.

Late last year I realised a long-standing ambition to own a milling machine and finally decided to purchase a Seig SX2P Milling/ Drilling machine from Arc Eurotrade. I based my decision on three features of the machine. The first was that the motor was of the latest brushless type which have high torque at low speed and was belt drive. The second was the relatively large size of the table and the third was that it didn't have a tilting column which I considered a weak design feature reducing its rigidity and having limited use.

The machine arrived promptly and I unpacked and set it up on a purpose-built cabinet. Prior to ordering, I had read and watched all the information on various websites in which other users described their experiences when using the machine and the various modifications they had made to enhance the usefulness or solve the limitations of its design or construction.

One of a number of problems highlighted and discussed at length on various websites and published articles, is known as 'head wilt' whereby a torsion spring intended to counter the weight of the head has a rapidly diminishing effect as the head is raised by the rack and pinion feed handle This means that the only way to prevent the head from sliding back down the column under its own weight, is to tighten the gib strips and rely on the increased friction so generated. Sadly however, this means that as the head is lowered the combined effect of increasing force from the torsion spring and the gib friction makes the head difficult to move smoothly and is not helped by a fair amount of backlash between the rack and pinion.

Chain terminal on mill head

The fine head control wheel was also very stiff and I actually fitted it with capstan handles to make it easier to turn. I experienced this undesirable effect soon after starting to use the machine and found it difficult to drill small diameter holes as there was no 'feel' at the feed handle.

I found a number of solutions on the web that other users had employed to improve this situation and a company in USA (Little Machine Shop) actually sell an expensive conversion kit which replaces the torsion spring with a gas strut fitted inside the mill column to counteract the head weight. Although this is obviously a big improvement on the inadequate torsion spring arrangement, the force generated by the strut is still non-linear. I subsequently found out that the increased footprint size of the new brushless motor precluded the use of this conversion on my machine.

Other solutions seen involved the use of cables and counter weights or lever arrangements. It was one of these solutions which prompted me to try the simple counterweight method of reacting the head weight and had the advantage that it would be truly linear i.e. the reaction force would remain the same regardless of the head position. My two criteria were to make as little modifications to the mill as possible and to be relatively inexpensive in case it wasn't a success!

Basic Arrangement

The basic arrangement is shown from the rear of the machine in **photo1**. It consists of a cycle chain attached to the top of the head which then runs over two cycle sprockets held in a bracket mounted on the top of the mill column. The chain then runs down the back of the mill, through a hole in the top of the cabinet and is fixed to an open fronted counterweight box.

Chain to Head Attachment

As I didn't want to drill more holes in the mill than necessary I decided to utilise the two rear bolts which hold the motor mounting plate to the plastic drive belt housing. The housing has M6 brass thread

Mill counterweight from the rear

inserts moulded in and seemed quite strong enough to support the loads involved. These bolts are actually fitted through slotted holes in the mounting plate to allow belt adjustment, but as the belt is toothed I didn't anticipate too much adjustment would be needed.

I cut a four inch length of ¾ x 3/8" BMS, marked the centre on the 3/4" face and drilled and tapped M12 through. I then drilled M6 clearance holes 25 mm either side of centre to align with the holes in the motor mounting plate and belt housing.

I chucked a length of 1/2" diameter BMS, turned a 3/8" length down and threaded it M12. I parted off a further 1/2" length and screwed it tightly into the beam with a dab of Loctite. I then set it up in the mill and machined an eye to fit between the cycle chain side plates, securing it with an M3 nut and bolt, as shown in **photo 2**. Two longer M6 caphead bolts were required to attach the beam to the head.

Sprocket components

Sprockets

Two fixed wheel cycle sprockets and a matching 3/32" chain were purchased from 'Single Speed Components' for the sum of £13 post free (usual disclaimer). The number of teeth was not important for the design but I chose 18 teeth to make it easy to hold them in a 3-jaw chuck. The sprockets turned out to be around 3" diameter. Each sprocket was set up in the chuck and the internal thread machined away to leave a smooth bore.

Flanged bushes were machined from light alloy to be a good fit in the sprocket bores and secured with Loctite. Each bush was then bored 10mm diameter for clearance and a recess machined to accept a 22mm x 7mm x 8mm bore 'skate bearing'. Care was taken to ensure that the sprocket teeth were in line with the centre of the bearing to avoid side loading. Concentricity of the assembly was not important as the sprockets only make about one revolution during full head travel. The object of using bearings was only to reduce friction.

Sprocket Brackets

These were cut and formed from 3mm aluminium alloy sheet using a cardboard template to determine the correct spacing of the sprocket axles. It was considered important to position the front sprocket such that the chain pulled the head up parallel to the column and in line with the centre of the slide ways. The rear sprocket was positioned so that the chain would avoid the electronics box attached to the column and pass down through a hole bored in in the top of the cabinet.

Assembly

The sprockets were mounted on axles made from lengths of 8mm diameter steel rod cross drilled for split pins. The brackets were connected together using two M6 bolts/nuts with suitable width spacers to provide working clearance for the sprockets. The components are shown in **photo 3**.

Each bracket was bolted to the top of the column using two M6 bolts screwed into holes drilled and tapped into the casting. A hand-held power drill was used and care was needed to avoid the drill encroaching on the large casting radius inside the column, as this would have thrown the drill off centre. A special extended tap holder was made to thread the holes.

It was found that the plastic stop screwed to the column to limit the upward head travel fouled the chain so it was removed and a new stop incorporated into the right-hand bracket. The complete assembly fitted to the mill is shown in **photo 4**.

Weight Box

This was made from 12mm plywood glued and screwed together in the form of an open fronted box. It was attached to the chain with an M3 nut/bolt and two L brackets bolted to the top of the box and initially it just hung from the chain. However, it was found to rattle against the cabinet when taking intermittent cuts so was constrained with a simple guide system allowing it to slide up and down smoothly. The length of the chain was adjusted so that the box didn't touch either the top or bottom of the cabinet during full head travel.

The weight consisted of layers of lead sheet (cut from the flashing removed from an old conservatory roof) thus allowing close adjustment of the load necessary to balance the head.

The correct weight was determined by first disconnecting the torsion spring with the head at its maximum height, i.e. minimum torsion spring force. The head was then lowered to its minimum position and its gib screws slackened. Weight was then added to the box until the head could be easily wound up and down by the feed handle but remained in any position. The gib screws were then carefully adjusted to provide minimum slack in the head without binding. It was found that a mass of about 14.5 kilos (measured crudely on a bathroom scale) was necessary to balance the head but subsequently an extra 2 kilos were added to provide an upward bias to the head to give a suitable feel when drilling.

Conclusion

I have found that this modification has greatly improved the ease of use of the mill as a precision drilling machine and as an exercise I was easily able to drill a 1mm diameter hole through 3/8" mild steel. The fine head control wheel also turns far more smoothly although I now always use the head lock when milling. The only disadvantage envisaged (though not yet experienced) is if drilling thin material with a large diameter drill the slack in the rack and pinion may allow the drill to 'grab'. I have read that some users have packed out the back of the rack with steel shim to reduce the clearance with the pinion so this may be a project for the future! ■

Bracket installed

It's model engineering, Jim. But not as we know it!

Our MEW Editor, Neil Wyatt had never used a 3D printer before reviewing a Dremel 3D40 Idea Builder over the holiday period – Part 1.

The Dremel 3D40 printer, boxed up

This brief series will be a bit different from the usual fare in MEW for several reasons. First of all, it's about 3D printing and that in itself is still a little-visited topic in these pages., secondly it's a going to be a bit of a mixture: part review, part 'this is what I learned about 3D printing', and part tutorial.

The practical experience of using a 3D printer has totally transformed my perspective on the capabilities and usefulness of this new technology. It may not be everyone's cup of tea, but I can see 3D printers becoming as commonplace in the workshop as any other machine.

The Dremel 3D40 Idea Builder

The Dremel 3D40 is aimed at both the home and educational markets – there are dedicated educational packages available that include lesson plans, this means robustness, reliability and ease of use are important as well as the quality of the final product. Like most 3D printers it is a 'fused filament' design and the basic principle is no more complex than squirting out a narrow bead of hot plastic to build up a three-dimensional object in layers.

The printer arrived in a large and heavy box. Inside the plain outer carton was the

2

Recyclable papier maché packing protects the printer well

display box, **photo 1**. Opening this, **photo 2**, revealed the manual and what turned out to be the build plate – toughened glass sheet in a plastic carrier, together with a few sheets of build tape, of which more anon! Inside the very robust egg-carton style packing, **photo 3**, a rather tricky lift produced the printer itself, **photo 4**, much larger than I had expected, roughly 500mm wide and 400 deep and tall. Unwrapping was something of a mission, especially as I had to keep it intact for returning the machine, but eventually I extracted several bags of accessories and bits, **photo 5**. These included what looked like a posh wallpaper scraper that I later discovered was a ‘special removal tool’, of which more later...

The machine itself, **photo 6**, looks very different from the familiar reprap machine. It has contemporary styling, fully enclosed with a colour touch screen on the front of the base. The screen, **photo 7**, is reasonably large and uses easily read fonts.

Naturally I went straight for the ‘quick start guide’, this showed me how to feed the filament. I had imagined this was rather difficult, but actually it was very easy, the

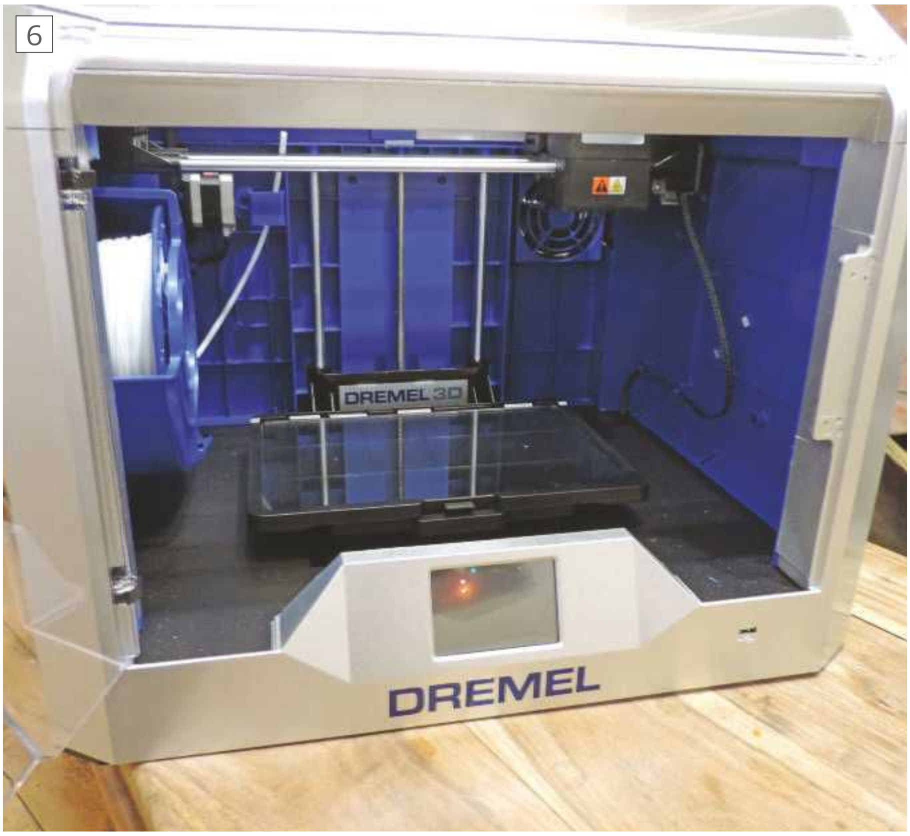
3

Even with packing, the printer virtually fills the box

4

The printer is very securely wrapped!

Various accessories – a reel of PLA, build tape, manuals, 'special removal tool', USB lead and three different mains leads.



The machine out of the box, but without build tape applied

The colour screen is very legible

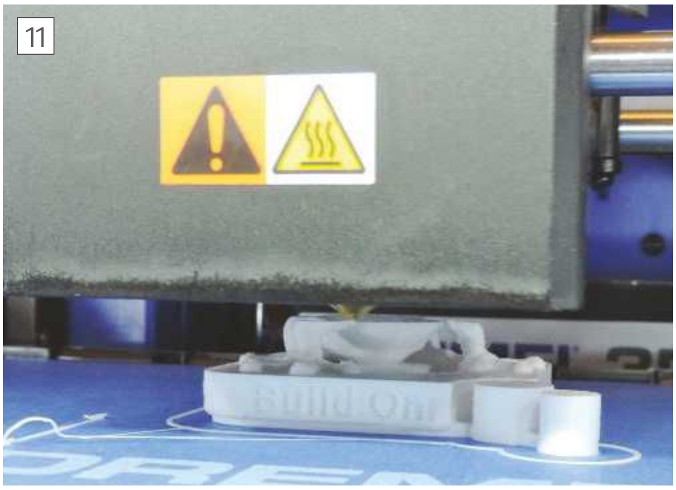
filament is well behaved (it doesn't try and jump off the reel) and the screen guides you through each step with pictures. The filament reel is totally enclosed, but this does limit you to 500-gram reels, **photo 8**. I attached a sheet of build tape to the build platform and then attach this to a sub platform on the machine, **photo 9**.

Once I had plugged in the printer, I had to level the platform This is a semi-automated process where a probe takes three readings, two of which are over adjustment screws, and the screen tells you which way to turn the screw and when you have got it right. I

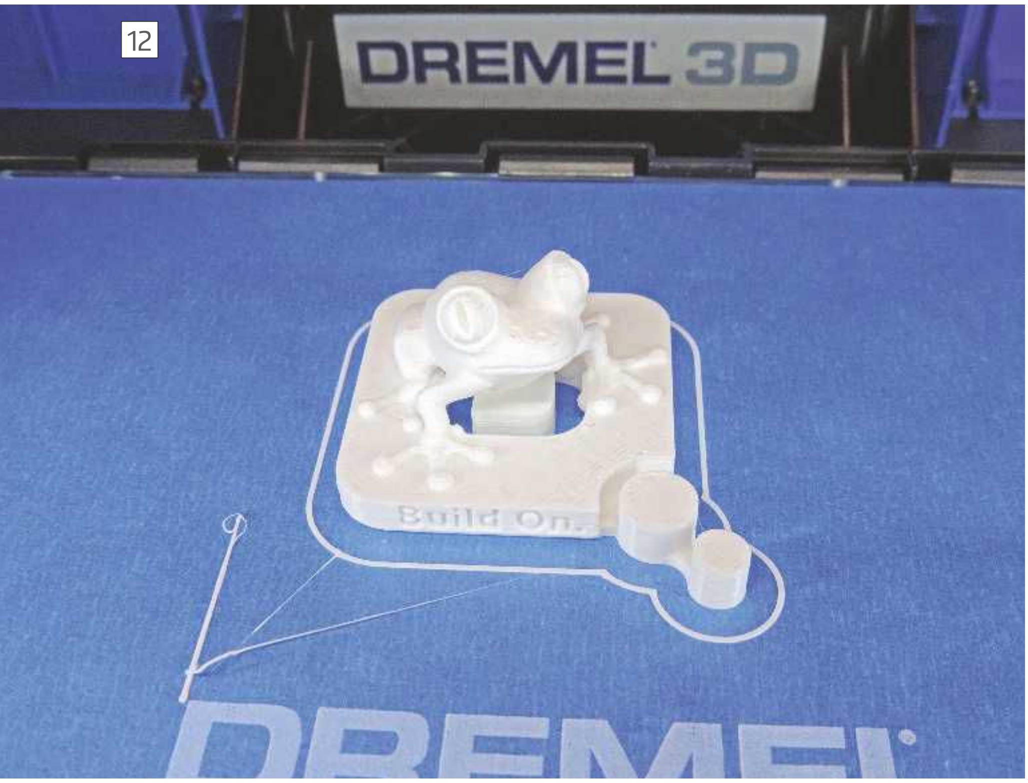
Dremel's 500-gram reels of PLA fit into the side of the machine, behind a twist off cover

The printer warms up, note that a sheet of build tape has been applied

The printer starts up- by drawing a 'skirt' around the part, then building the part up in layers. The loose material at bottom left is some I should have removed from the extruder after I set up the printer



Unfortunately, the large build head of the Dremel makes it hard to see progress with smaller models



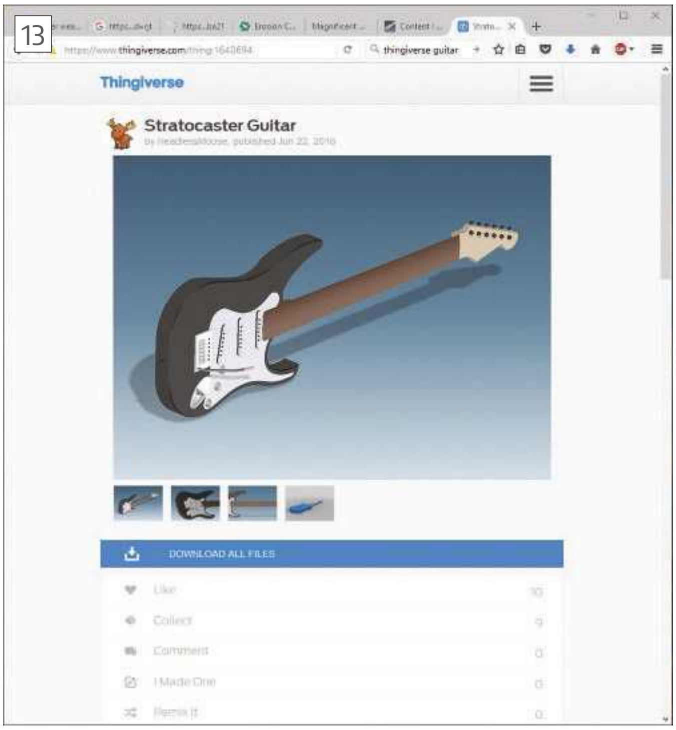
First test out of the box: Al the Frog on the Idea Builder logo

found that for the first dozen prints I had to make small adjustments after every print. Once the machine had 'settled in' though, I found I could even remove the platform (see later!) and after replacing it the level check would normally not require any more screw twiddling.

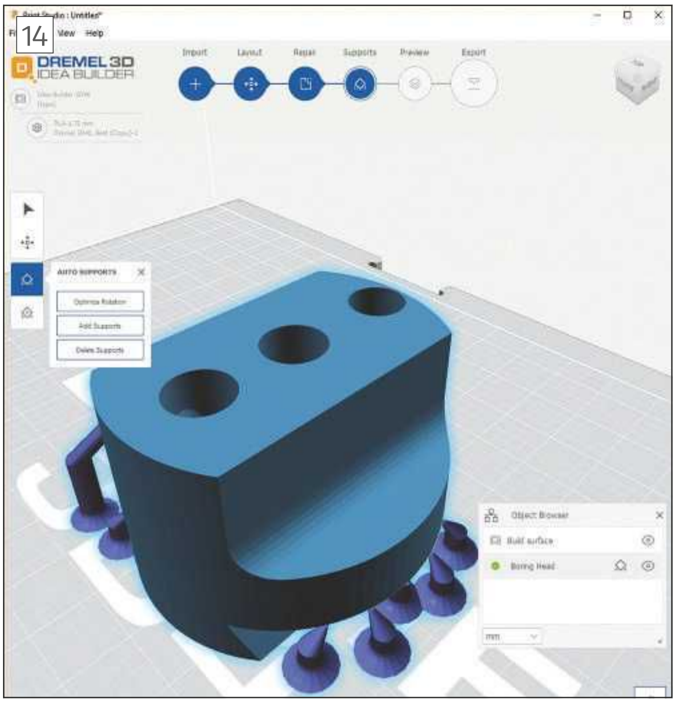
A test print was as simple as selecting 'build', choosing an on-board sample and pressing start! The machine warmed up, cleared the nozzle, drew an outline 'skirt', then proceeded to make a rainforest frog ('Al') sitting on top of Dremel's Idea Builder logo, **photos 10, 11** and **12**. If you look closely at photo 11, you will see that the base of the object was filled with an open 'honeycomb' rather than being solid. The quality of the print was excellent, as good as anything I had seen produced by a 3D printer before.

I must admit, I was astounded, the whole process was not really any more involved than setting up an inkjet printer in the days when you had to align the heads. I was also impressed by how quiet the machine is, it does hum away to itself and it has a fan on the back, but mostly it is no noisier than my laserjet printer.

Naturally, I wanted to do something useful with the machine, so my next step



Thingiverse is full of free printable objects to download



An object that may be familiar to MEW readers imported into Autodesk Print Studio

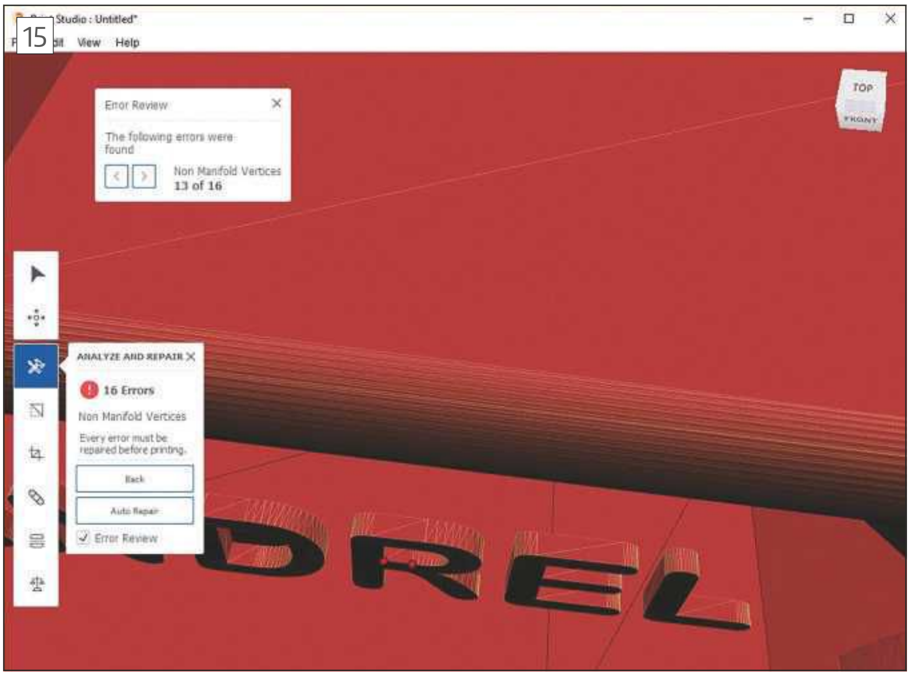
was to see if I could find a customisable object on the Dremel website. I found a customisable dog tag, into which I could type three short lines of text and download as an STL file. There are many other websites offering objects for free or paid download, such as Thingiverse, **photo 13**.

Dremel supply two programs for working with STL, OBJ and other 3D files to prepare them for printing. The one I made most use of was Autodesk Print Studio, mainly because the other one, 3D Builder seemed rather simplistic. Revisiting 3D builder, I can see it is actually rather capable and has a few features that print Studio lacks, such as basic 3D design functionality.

Using Print Studio was simple enough, I selected the 3D40 printer and 'dragged and dropped' the dog tag on to the program screen. You then get six buttons across the top of the screen, **photo 14**, and a 3D image of your object on a large picture of the build plate. I later discovered that some objects will appear huge or just an inconvenient size. It's easy to switch between inches, millimetres and centimetres and you can also scale your object at import time.

Once you have imported all the objects you want to print (you can have more than one at a time) you move to 'layout'. The scaling options remain, but you can also arrange and rotate your objects. There are also options like 'lay flat' and 'move to build surface'. Lay flat should settle your object if it isn't already in good contact with the build plate but oddly it sometimes chooses to angle the object on a narrow facet rather than a broad base!

Repair is the next stage Usually you will get a green tick with 'no problems' but sometimes there will be errors, such as the object 'floating' above the build plate or worse – holes and 'non-manifold vertices',



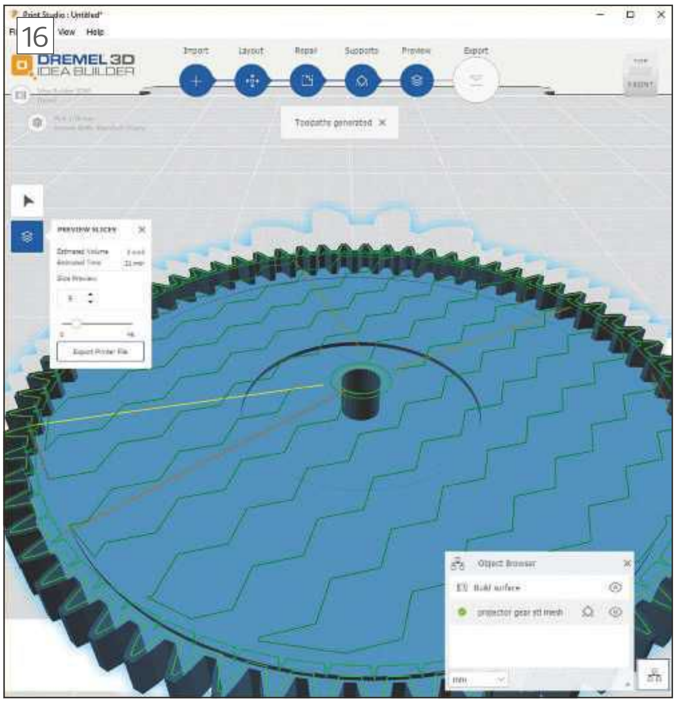
Errors in a 3D model highlighted by Print Studio

these are highlighted by dots in **photo 15**. No - I don't understand non-manifold vertices either, even after reading the Wikipedia article on them. Basically, these are things that confuse the printer, and fortunately they can usually be cured with a single click. If repair fails, you have to edit your object (which can be tricky!), or use another repair tool. I found that Microsoft's website at tools3d.azurewebsites.net/ allows you to upload and repair files that Print Studio couldn't. Although the 'repaired' file was in a new format Print Studio accepts it OK, typically finding new errors that it fixes easily. The repair screen also allows you to 'slice' an object, useful if you have something without a flat base that you would prefer to print as two halves.

Once repaired we move onto supports. If you skip this step they are added automatically, if needed, but you can also add them manually, or edit out unwanted ones, refer back to photo 14.

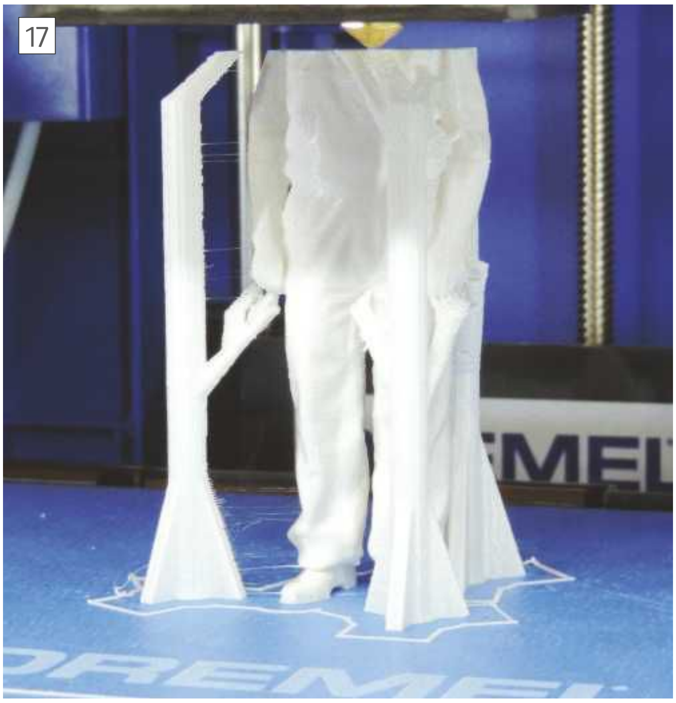
The next step is 'preview' which is literally just that, you can step through the build seeing how the layers will be built up – this is a good point to spot errors, such as poor contact with the build plate (you can go back and use slice to remove any unwanted protrusions) or parts of the model with no support. **Photograph 16** shows a

16



Previewing the stages of a print

17



Printing a driver figure from ARD Digital's file

layer of a small gear that I printed off for a forum member. Preview also gives you an estimate of build time, which tends to be rather pessimistic.

Swapping the USB key to the printer – the socket on the front is a bit exposed – and it's easy to select your file from the build menu and away you go! Watching the object build is strangely addictive, as you start to notice all sorts of subtleties - the thickness of the layers is produced by the end of the nozzle 'smearing' the filament, for example.

Now this 'workflow' sounds very simple, and left me thinking that it wasn't very 'customisable'. It was only after several days that I noticed some text near top left in a faint grey that announced 'PLA 1.75mm, Dremel 3D40, Standard'. Clicking on this came up with a dialogue that gave me three presets: best, standard and draft. It also gave me access to five basic settings, layer height from 0.1 to 0.3 mm, number of perimeters (how many solid layers around the outside of your shape), sparse infill pattern and density (rectilinear grid or honeycomb) and enable raft. The raft is a thin, peelable, base printed under the object which improves adhesion, particularly useful for tall, thin objects.

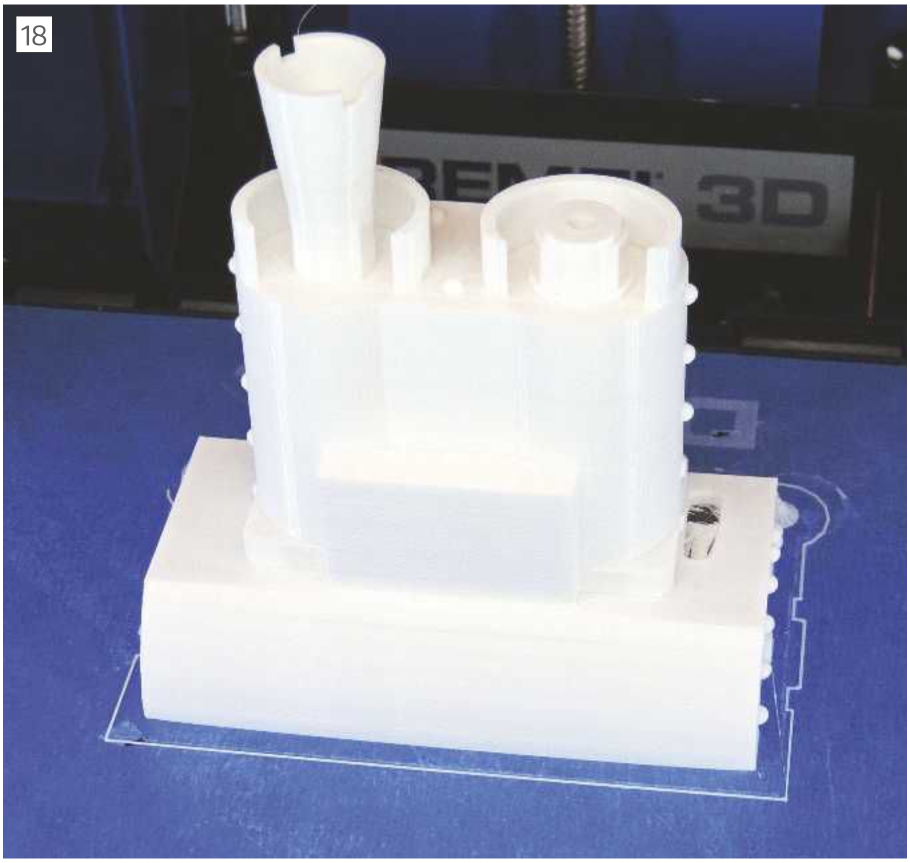
There are also 'advanced' settings, suffice to say there are twelve groups with from three to twenty settings. I won't go into these at all, aside from saying I found that making the supports a bit smaller was helpful for smaller objects.

In l the last issue we featured ARD Digital's 3D printed figures for 16mm railway enthusiasts. They kindly sent me an OBJ file for one of their engine driver figures, which I was able to enlarge to suit my loco, Southam. The tall, thin figure benefited from plenty of support. **Photograph 17** shows the print in progress. If you ae interested in these figures, visit their website at designscanprint3d.bigcartel.com to see more examples of these very reasonably priced prints.

I think that the use of excellent defaults for the built-in settings is one reason why the Dremel 3D40 really is a 'plug and play' device without the long trail and error setup which most kit built machines require.

Next time, I will look in more detail at the capabilities of the Dremel 3D40, tackling some large and complex objects. I will highlight some of the lessons I have learned about the practicalities of 3D printing, with some examples of objects, such as that in **photo 18**, that I have designed and printed myself. ■

18



A test print of the mantlet and twin machine guns for a 1:6 scale Vickers Light Tank

An Improved Tool Height Indicator

Warren Jacobs in Australia describes his dial reading tool height gauge.

Having made a new quick change tool post recently, I looked at my old tool height gauge; a fixed position bar on a stand and when the tool tip touches the underside then it is on centre.

I thought it looked a bit primitive, so I decided to make a new gauge with some sort of dial to show when centered, (I like direct reading indications) so back to eBay and have a look in the measuring section of metalwork to see what is available.

Lots of dial devices were displayed, but I did not want a micrometer type as they are too sensitive, but one that caught my eye was a leather thickness gauge, **photo 1**, which also shows where it was modified. It had a large dial, calibrated in 0.1mm steps, a 20mm total movement, was on a nice shaped frame and best of all only cost $5.50 post free. There was, however, a long plunger protruding from the top which was puzzling to see how it worked; to measure, did it move up or down, but for $5.50 it looked interesting, so get it anyway.

Since I purchased my gauge there is now a bigger variety of similar ones available. The unit arrived, then I discovered that to measure anything you had to press the spring-loaded plunger down on to the object and it returned up when you let go.

I would have preferred it the other way round, so now what to do. Not wanting to open up the dial and perhaps breaking it, I thought a suitable spring placed on the outside of the plunger in the down position, would equalize and make the movement half way. In the all sort spring box, I found one that was just the right fit with light compression which held the plunger position halfway, **photos 2** and **3**. To hold the spring on the plunger, the original pointed tip was unscrewed and a flat face tip, slightly larger than plunger diameter was turned from brass and screwed on

The gauge as supplied.

Now it was worth while to press on and complete the project. The following description should suit any lathe with a centre height similar to a Myford, say three to four inches.

The idea was of course to make the dial read zero at centre height of the lathe and to do this the frame of the indicator has to be cut and lengthened, and the base of the stand must grip the cross slide against the plunger spring tension when measuring.

To find this new height, set a flat top test bar in the tool holder, at exact centre height and measure from the cross-slide surface to the bar top.

Lock the dial plunger then cut the frame at the point indicated on photo 1, hold the frame and mill the end for a half lap join about 12.mm long. The extension piece of aluminium bar can be milled down to the size of the frame and about 45mm long, then half lap one end to suit the frame shape. Place the two half laps together

The spring.

And fitted.

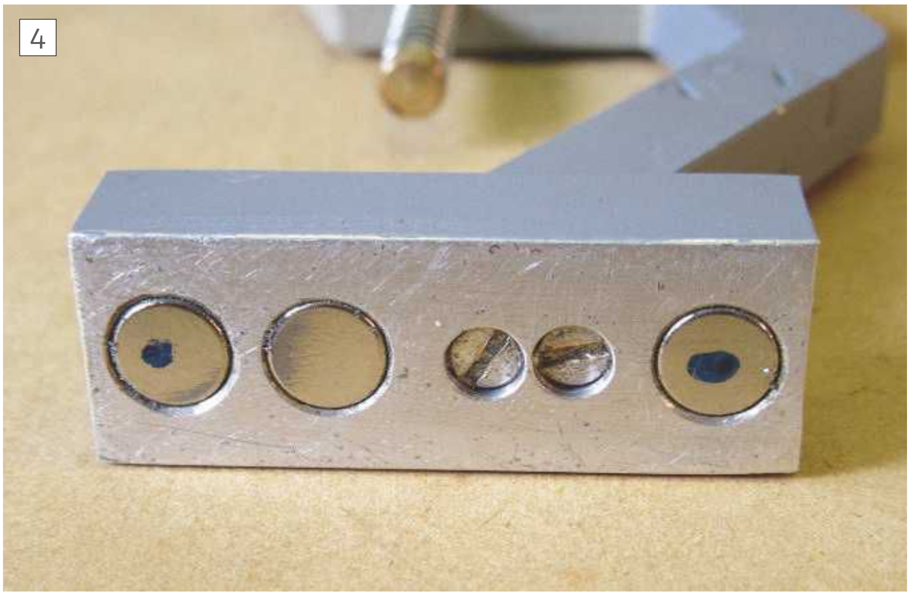
and drill and tap for the securing 8BA countersunk screws, and then temporarily join together.

Leave this part for a while, next job is the base. This is made of aluminium bar 15 x 10 x 42mm long and to hold it down firmly to the cross slide, I bought a packet of 20 Neodymium magnets from E-Bay, 7mm diameter x 3mm high for $2 post free, only three magnets are needed. The base is drilled as shown in fig 1, but make the holes slightly larger and deeper than the magnets, the two smaller holes are to fix the frame to the base but make sure the counter sunk screw heads will be clear of the base surface.

After drilling the holes take a light cut across this face to ensure that the base sits flat on the slide with no rocking, or rub gently on emery cloth on a flat surface, in a figure eight pattern.

To find the new height of the frame, raise the dial plunger to read zero and lock, measure down from the plunger tip, the dimension you got from centre height, minus the base thickness and scribe a line across the frame at right angles to the plunger, cut here and drill and tap 8BA into this end, for securing to the base. For ease of adjusting the frame later, perhaps cut the frame a little longer than the scribed mark.

4



The base, showing the magnets.

Temporarily screw the frame to the base, hold the base firmly on the lathe slide, check that the dial outer ring has the zero at the top centre and see if the dial reads zero when the plunger is placed on the test centre tool height bar.

If the reading is under zero, you can either take a little metal off the top of the base, or reduce the length of the frame, if the reading is over zero your frame is too short so either a new frame piece is needed or perhaps a shim between base and frame may help, or if the reading is one or two divisions either side of zero, you may prefer to rotate the outer dial rim to zero, this will only move a few divisions either way, so you have to be close.

All being well, now to fix the parts together permanently. The magnets for the base have to be selected by marking one face of each with a marker pen to indicate an attracting pole. Use a fourth magnet to determine these pole faces, two marked faces down and one marked face up, this will ensure that the base has a good magnetic grip on the cross slide. Smear a little epoxy glue around the sides of each magnet, push them into the base holes as indicated in **photo 4**, then place the base, magnets down, on a flat steel plate, clamp the base firmly down and allow to harden. The magnets will pull themselves down flat to the plate while the epoxy is wet. Don't use loctite to glue the magnets in; it's a lot thinner, if any flows down between the base and the magnets, the lot will stick to the steel plate. Assemble the frame to the base with the 8BA x 12mm screws and loctite, and the half lap join with its screws and loctite between. I put in a small 1.6mm roll pin for extra rigidity. After everything is dry, there should be no movement in any part of the frame; otherwise your centre reading will vary when in use.

Do a test now, place the indicator on the cross slide, hold the plunger up and rotate the test bar set to exact centre height so the bar is under the tip then lower the plunger, you will be surprised how strong those magnets are, the dial should read zero, or rotate the dial slightly to read zero, this is now set, **photo 5**.

Every time you use the indicator you can be assured the tool is within 0.1mm of centre and that is good enough for me. ■

5

The indicator on the lathe.

Further modifications to a bench grinder

Michael Cox revisits the subject of a recent article for some further fettling.

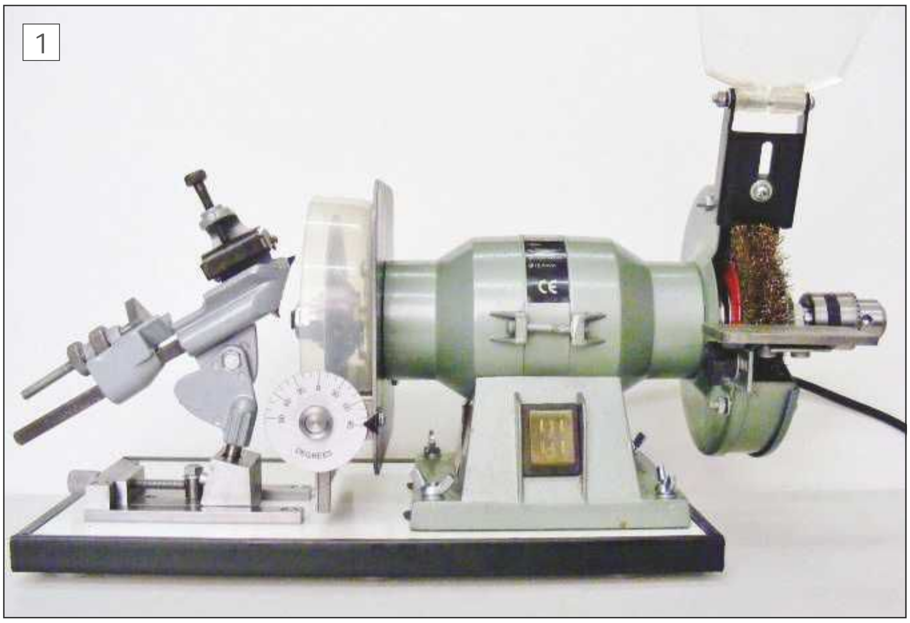
In issue 247 of MEW I described some modifications to an old bench grinder so that I could use a cheap diamond disc, purchased from Aldi, to grind carbide tooling.

Very shortly after completing the diamond disc conversion I realised that the broad face of the diamond disc would be perfect for sharpening twist drill bits using my Potts/Picador/Reliance clone drill sharpening jig.

Having resurrected the grinder from under the bench and converted one side for diamond disc grinding and drill sharpening I wondered whether I could use the other end of the grinder for something useful. I decided that a wire brush would be quite useful for de-rusting and burnishing small parts. I also noted that certain high end bench grinders could be fitted with a chuck on the end of the spindle to allow the use of a polishing mop or a flexible drive shaft.

Photograph 1 shows the completed grinder after the modifications. On the left-hand side is the diamond grinding disc and the drill sharpening jig. On the right-hand side is the wire brush and the drill chuck. The diamond disc and table arrangement are exactly the same as described in the previous article but a guard, made from a cut down polythene food container, has been added as well as a graduated disc to indicate the table inclination. The polythene guard is not there to protect in case the disc shatters, but just to minimise flying particles that are ejected during grinding.

1



The modified grinder

Drill sharpening jig

I have a drill sharpening jig, **photo 2**, that is based on the Potts/Picador/Reliance jig. Mine is a cheap clone that is readily available from many outlets. It has a number of defects which have been discussed many times in the pages of this magazine (and on the ME Forum). However, after modifying the base to have forward inclination of 15 degrees from the vertical, as shown in **photo 3**, I find that it works very well.

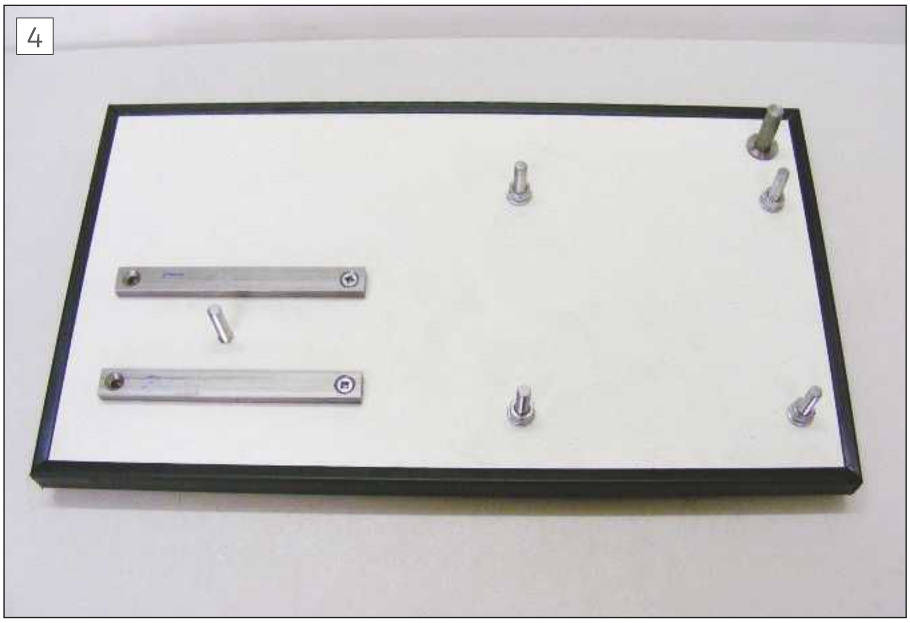
However, it has not been used a great deal! In order to use it I have to remove the guards from my 150mm bench grinder and then bolt the sharpening jig to the bench near to it. Then I have to run the grinder, unguarded, and grind on the side of the wheel which is against all the advice for safe use of grinding wheels. Armed with suitable eye protection, stout gloves and standing out of the line of the grinding wheel I can

2

The drill grinding jig

3

The drill grinding jig with the base modified



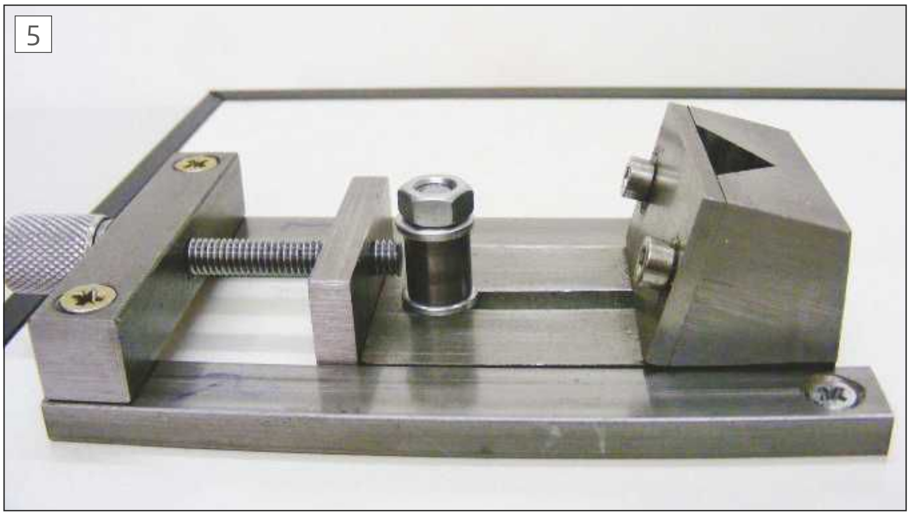
The base board

then use the jig taking very small cuts. This method is time consuming to set up and potentially hazardous in operation.

I quickly realised that the diamond disc grinder would be ideal for use with the drill sharpening jig. The grinding rest folds down allowing easy access to disc. The disc being made of steel is not likely shatter. I made a quick lash up of grinder and jig on a piece of old timber and it worked very well. On the basis of this I designed and built the base board shown in **photo 4**. This shows the four bolts for mounting the grinder on the right-hand side. The 8mm pillar at the top is a parking post for a drill chuck, see later. The two bars on the left-hand side are guides for the base of the sharpening jig. Between the two bars is the bolt that secures the jig base to base board.

The base board is just a piece of melamine laminated chipboard. Four 6mm holes were drilled to match the pattern of the screw holes in the base of the grinder. Four M6 bolts with square anti-rotation shoulders were inserted in these holes and drawn in using a washer and nut. The grinder just slips over these bolts and is held down with M6 nuts. The sharpening jig base was attached using similar bolt.

The jig base has also been modified to provide a screw feed to advance the jig in a controlled way. The arrangement for doing this is shown in **photo 5**. A vertical plate has been attached to the base of the jig using two M3 screws. This plate has been drilled and tapped M6 12mm up from the base board. The feed screw and associated components are shown in **photo 6**. The 12mm square bar is 62mm long and drilled out 4mm diameter 12mm from the base board when sitting on top of the of the guide bars. The feed screw is a 52mm length of M6 threaded rod that was turned down for a length of 25mm to make a free fit in the 4mm hole in the square bar. The last 13mm of the 4mm section was threaded M4. The knurled aluminium adjuster knob was made by knurling a piece of 12mm aluminium for a length of 15mm. It was chamfered at the end and drilled through 3.3mm for a length of 16mm and tapped M4. It was then parted off at 15mm.

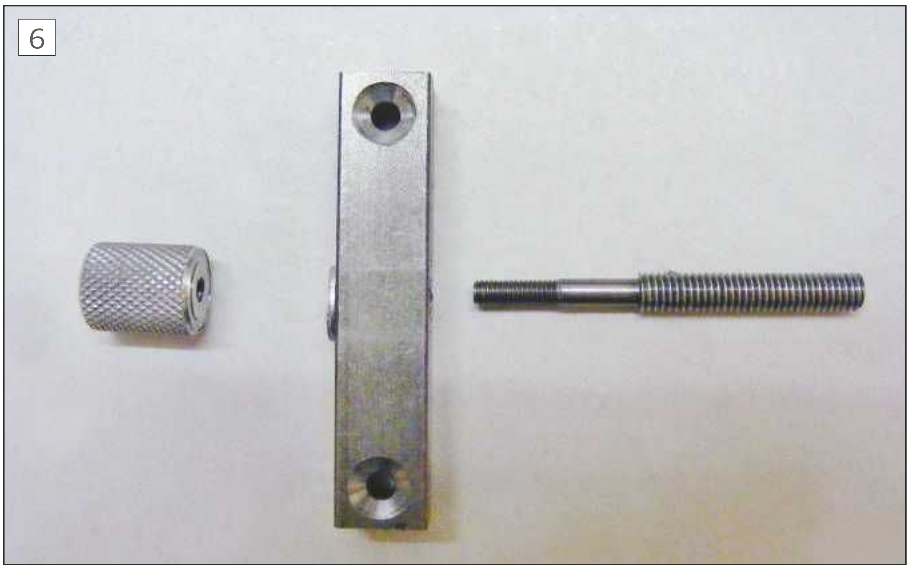


The base advance mechanism

The 4mm diameter end of the feed screw was passed through the 4mm hole in the square bar. The knurled knob was screwed on the threaded end protruding from the square bar until there was little longitudinal play but the feed screw rotated freely. The adjuster was locked in place with an M4 grub screw. The M6 threaded end of the feed screw was then screwed into the vertical plate at the end of the jig base. and the square bar secured through the guide bars using woodscrews.

Note the collar around the securing bolt in the centre of Photo 5. This is to raise the nut up so that it can be tightened without the spanner constantly hitting the end of the feed screw.

Photograph 7 shows the arrangement for drill sharpening. Note that the grinding rest is folded down and that it does not interfere with the sharpening jig. This is very quick to set up and much safer than the arrangement I have used previously for sharpening drills. The diamond disc gives good results on all the drills I have



The feed screw components

7

This shows the grinder set up for drill sharpening

8

The connector nut, chuck and wire brush

tried, including masonry drills. One added advantage is that the diamond disc creates no sparks when grinding steel. If the drill sharpening jig is removed from the base the then the grinding rest can be raised and used as normal.

The other half.

Bench grinders are supplied mounted with a grinding wheel on both sides of the motor. All the modifications described above were made on the left-hand side of the bench grinder. I already have a 150mm bench grinder which can cope with all my grinding needs on HSS lathe tooling so I do not need a grinding wheel on the other side of the modified grinder. I began to think what other facilities might be added to the right-hand side.

I have the usual brutal type of twist knot wire brushes that are used in an angle grinder but nothing that is more gentle and I thought that one of the softer wire brushes mounted on the grinder might be quite useful for de-rusting and burnishing.

Looking around at some of the upmarket bench grinders some had an accessory kit for adding a drill chuck to the end of the grinder shaft. that could be used to power a flexible shaft or hold a polishing mop. This seems like it would be a worthwhile addition.

I ordered a 125mm wire brush off of ebay. This was branded Silverline and it was the type with soft bristles. It was supplied with adaptors for shaft sizes of 1/2" and 5/8". I already had a 0-10mm drill chuck with a 3/8" x 24 tpi internal thread. The right-hand side of the grinder had a M12 right hand thread nut to clamp the grinding wheel to the shaft and I had some 40mm long M12 connector nuts. These three components are all shown in **photo 8**.

Using these components all that was necessary was to make two washers to go either side of the wire brush and shorten

9

The guard after drilling the hole for the chuck.

the connector nut to a sensible length and screw this on the shaft to fix the wire brush in place. I could then make an adaptor with an M12 thread at one end and a 3/8" x 24 tpi UNF thread at the other to connect the drill chuck to the M12 connector nut.

The guarding on the right-hand side was dismantled. With the guarding off the old grinding wheel was removed. The centre of the right-hand guard cover was marked and centre punched. The cover was clamped with g clamps to the drill press table and a hole 28mm in diameter was drilled using a step drill, **photo 9**. This hole was to allow the chuck to protrude.

The connector nut was chucked in the lathe and faced off square.

The centre hole of two 30mm diameter penny washers were drilled out to 12.5mm. These were place either side of the wire brush and this was slid onto the shaft. The connector nut was then screwed down hard on the shaft to retain the wire brush. The guarding was then re-assembled onto the grinder. The end of the connector nut protruded though the hole in the guard cover. A standard 19mm spanner was used to mark the length of connector nut that needed to protrude from the guard. The connector nut was undone and shortened to the marked length using the band saw. Finally, the nut was chucked in the lathe and the cut end faced square. The shortened nut was screwed back on the shaft and tightened down. Using callipers as a depth gauge the distance from the end of the nut to the

10

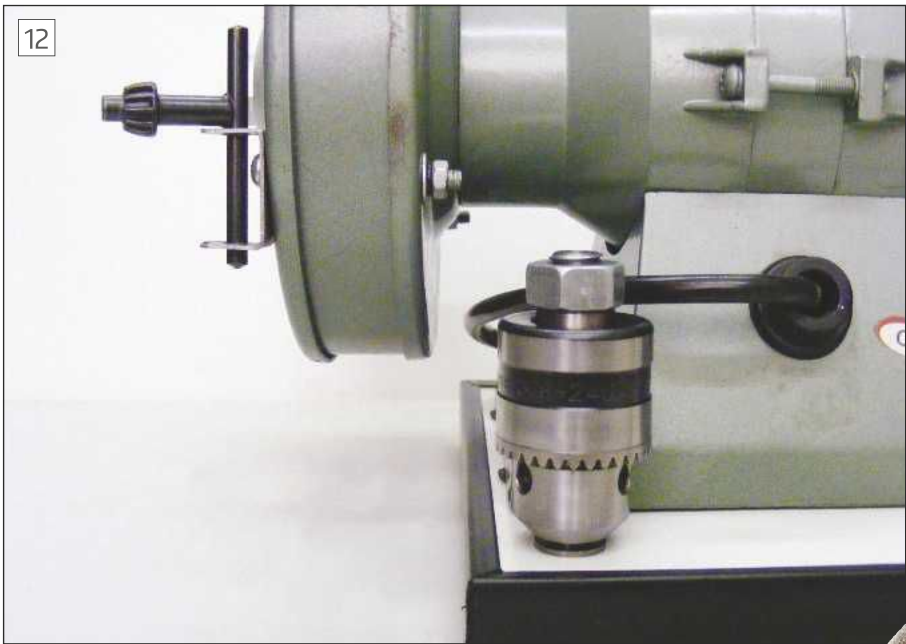
The chuck, threaded adaptor and shortened connector nut beginning of the shaft was measured to determine the length of thread required for the drill chuck adaptor.

A piece of 1/2" steel round was chucked in the lathe and the end faced. This was turned down to 3/8" for a length of 16mm. From the shoulder it was then turned down to 12mm for a length of 13mm. Using a parting tool run out grooves were formed at the shoulder and at the end of the 12mm section. Using a 60-degree threading tool the 3/8" section was threaded 24 tpi and the 12mm section was threaded M12. In both cases the threading was continued until the 3/8" section would just screw onto the chuck and the 12mm section would just screw into the connector nut. To ensure concentricity it is important that all turning and threading are carried out without removing the bar from the chuck. Finally, the threaded piece was parted off from the bar at the second run out groove. The extended nut, the threaded adaptor and the chuck are shown in **photo 10**.

The threaded piece was screwed into the chuck. It was gripped by the 12mm section in aluminium vice jaws and tightened down hard. The chuck was screwed into the connector nut.


11

The right hand side of the grinder after modification


12

The chuck parked on its storage pillar

Photograph 11 shows the completed modifications to the right hand side of the grinder. Fast turning wire brushes can eject wire bristles with considerable velocity and have enough momentum to penetrate clothing, eyes and skin. Always wear eye protection and stout gloves when using them.

I do not have room in my small workshop to leave this grinder out all the time and I keep it in a deep draw under the bench. It will only fit in the drawer if I remove the drill chuck. In order to keep the grinder and chuck together the chuck stows onto the 8mm pillar at the back of the grinder. **Photograph 12** shows the chuck parked on the pillar.

Conclusion

This project started with the simple aim of being able to grind some brazed carbide tooling. It finished by providing facilities for grinding carbide, safely sharpening twist drills, wire brushing, polishing and being able to power a flexible drive. It cost almost nothing since only salvaged machines and parts were used.

Note on sourcing diamond grinding discs.

The problem with Aldi special buys is they are only available for a short period of time whilst the offer is on. You can never be certain when or if the offer will be repeated.

I have searched for similar discs to the Aldi disc on the internet and I have not found an identical article. However, I have found a company called AIM-Tools that sell a number of different types of diamond discs. I have purchased a 115mm diameter disc from them which is very similar to the Aldi disc, **Photo 13**. This disc does not have a depressed centre so I have had to modify the arbour to use it. The disc is double sided and can be used for cutting as well as grinding. The diamond grains are similar in size to the Aldi disc. Tests indicate that it works just as well.

The website for AIM-tools is http://stores.ebay.co.uk/AIM-Tools ■


13

The disc from AIM-tools

Universal screw modification fixture

John Ashton describes a useful device to simplify the holding of screws for machining – Part 2

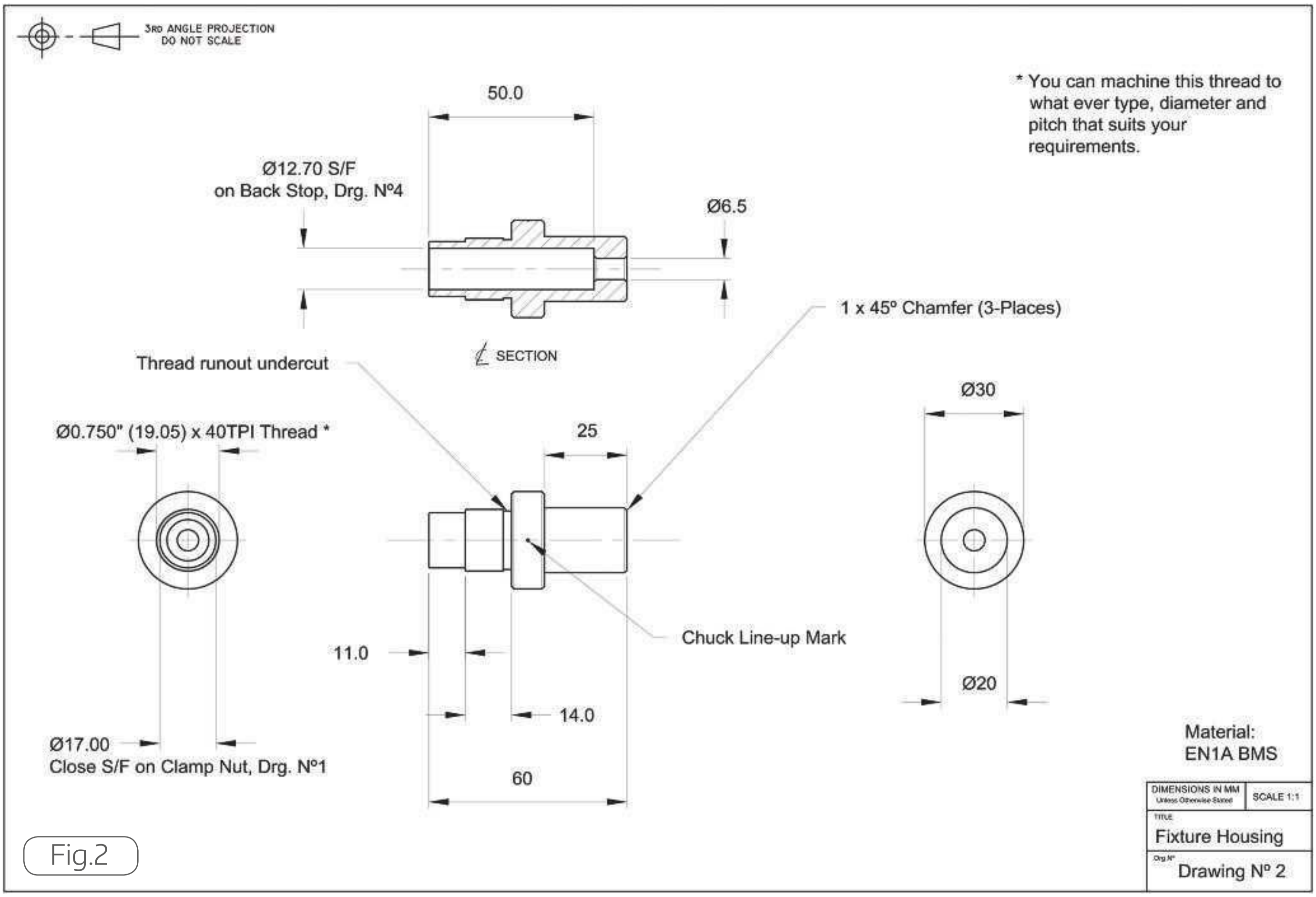


Fig.2

Note! If you are going to screw-cut the thread and the thread form you decide to use has a crest radius then you will need to machine your bore size slightly larger to eliminate the crest radius, unless you decide to chase the thread afterwards, but I think this is taking the refinement of the fit beyond practical necessity, if the fit of the mating threads feels right it usually is. Also, remember to machine an undercut at the bottom of the counterbore, as shown in fig. 1.

This is as far as you want to go with the machining of the clamp nut at the moment, see **photo 11**, as you are going to use it as a gauge for machining the fixture housing. The machining of the opposite face of the clamp nut will not be finalised until the machining of the fixture housing is complete.

Fixture housing, fig. 2

Depending on your available equipment you can machine from bar stock and part off or cut off a billet. Position your bar stock or billet such that you have enough protruding from the chuck to machine the mounting spigot and shoulder diameters. The first step is to face off and machine the shoulder diameter to size, 30mm diameter by 40mm. Next machine the mounting spigot diameter to size, 20mm diameter by 25mm lg. Next mark the shoulder diameter in line with the chuck line-up marks, see **photo 12**. It is important to mark the line-up position to minimize any possible eccentricity of the fixture each time you position it in the chuck. If you are machining from bar stock, move the bar stock out enough for parting off to length plus a couple of millimetres, then part off, if machining a billet turn it around in the chuck. Position the mounting spigot in the chuck ensuring you line up the line-up

11

Nut at this intermediate stage

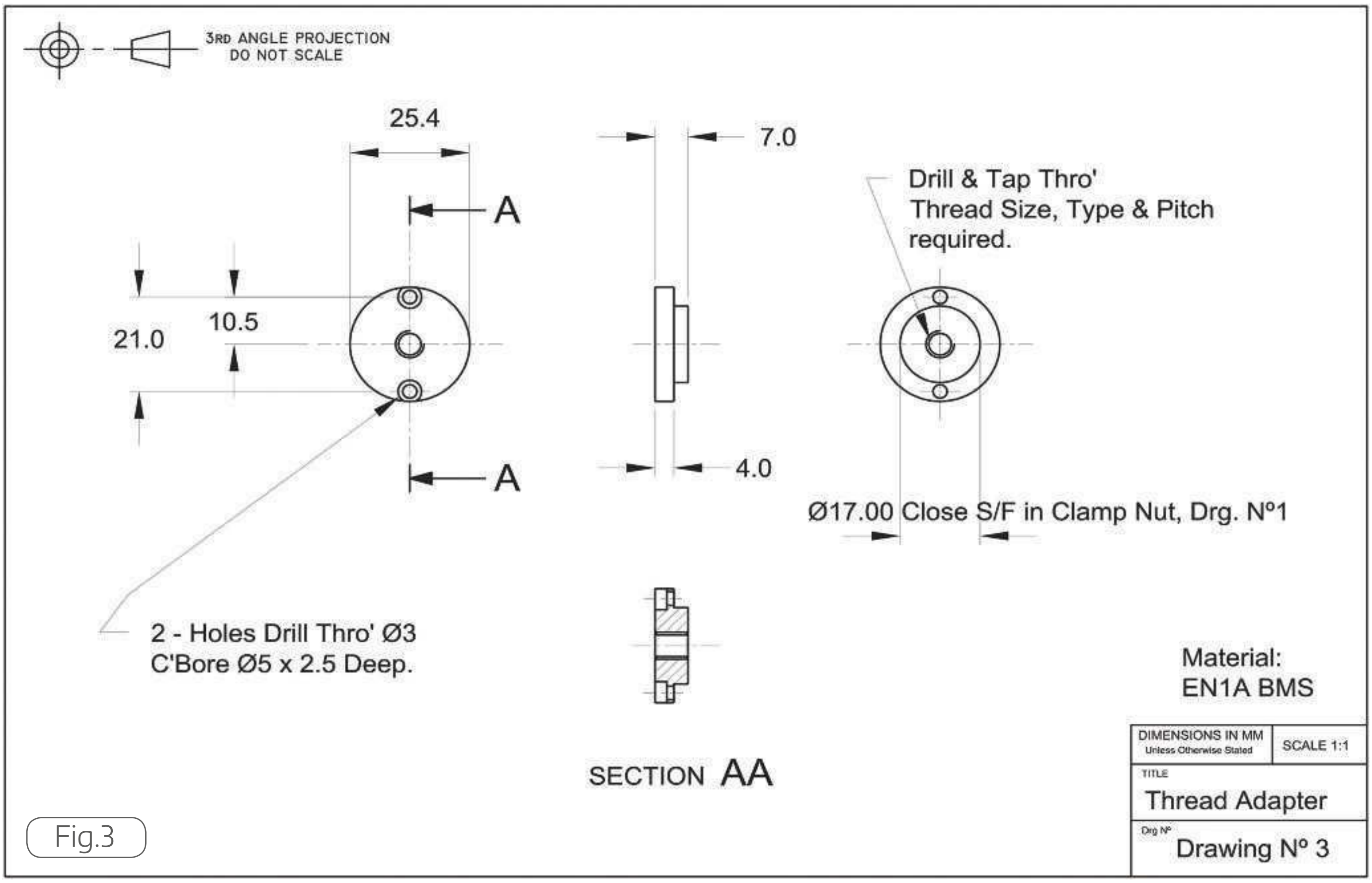
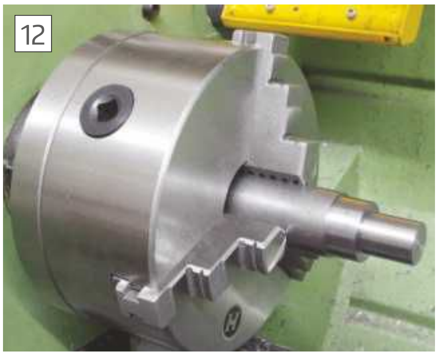


Fig.3



12 *Note the centre pop for alignement*

13 *Housing mounted in a collet chuck*

14 *Threading the housing*

marks. You are now ready to complete the machining of the fixture housing, reference **fig. 2**. Cutting large diameter threads with a die can be problematic when you require concentric accuracy so I decided to thread cut the ¾ inch by 40 tpi thread. First, I machined the outside diameter of the thread and undercut for thread run out. Next I machined the 17mm locating diameter for the clamp nut, using the partly machined clamp nut as a gauge to obtain a close slide fit. I completed the machining by drilling through 6.5mm, and then machined

15 *Assembled with the nut*

16 *Drilling tapping size for the Thread Adaptor mounting holes*

17 *Tapping the Thread Adaptor mounting holes*

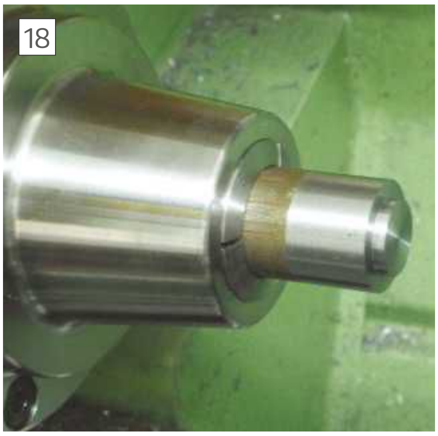
the flat-bottomed counterbore, for the back stop, 12.7mm by 50 long, **photo 13**. Finally, I cut the thread, again using the partly machined clamp nut as a thread gauge to achieve a close fit thread, see **photo 14**. Do not remove the completed fixture housing from the chuck just yet.

Completing the clamp nut

Before removing the fixture housing from the chuck, screw the clamp nut fully home onto the fixture housing and face off and chamfer to length, **photo 15**, this is to ensure the face of the clamp nut is perpendicular to the fixture housing centreline, now you can remove the fixture housing from the chuck. The next step is to machine the thread adaptor retaining screw threads, two 6BA or M3 x 12mm deep pitched at 21mm, equally spaced about the centreline across the corners of the hexagon, so that the screw heads don't protrude outside the clamp nut. I machined them using a set up on my milling machine, **photos 16** and **17**, alternatively you could machine a thread adaptor first and use it as a drill jig to spot through to the clamp nut.

Thread adaptor

Machine the adaptor, **fig. 3**, from bar stock. First face off and machine the outside diameter 20mm, then machine the location diameter 17mm, a close fit in the clamp nut, 3mm deep, **photo 18**, part off the blank to 8mm or 9mm in length. Next position the location diameter in the chuck and face off to 7mm in length, **photo 19**. Next machine the mounting holes and counterbores. Using the same mill set-up as the clamp nut, machine the two mounting holes 3mm and counterbore 5 x 3mm deep, pitched at 21mm equally spaced about the centreline, to match the clamp nut, **photos 20, 21** and **22**. Alternatively mark out and centre

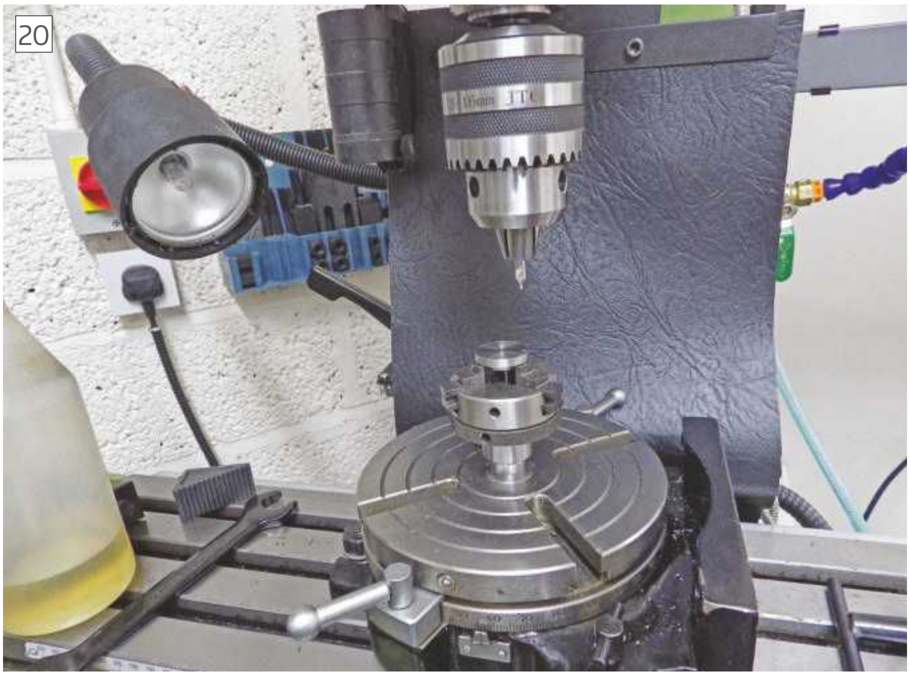


18

Early stage in machining the adaptor

19

Adaptor reversed and faced off



20

Centring the Thread Adaptor mounting holes

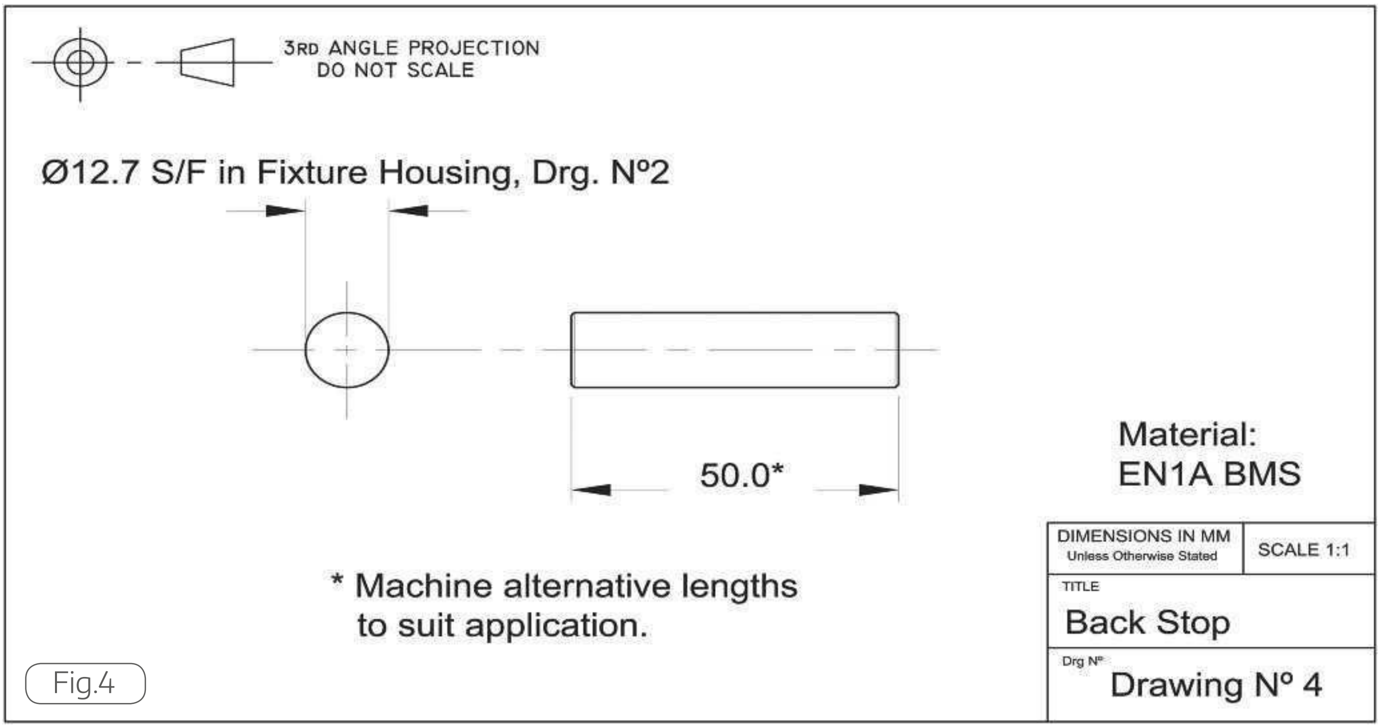


Fig.4


Drilling the Thread Adaptor mounting holes


Counterboring the Thread Adaptor mounting holes


A stack of Thread Adaptor blanks

pop the mounting hole positions then drill and counterbore on a pedestal drill. If you prefer you can leave out the counterbores, if you don't mind the mounting screw heads standing proud of the face of the thread adaptor. While your set up, it's a good idea to machine a few spare blanks, **photo 23**.

The final step is to machine the desired thread type and size. First assemble the fixture housing, clamp nut and thread adaptor in the lathe chuck, ensuring you line up the line-up mark on the fixture housing with the line-up mark on the chuck, **photo 24**. Then centre drill, drill and tap through the desired thread type and size, see **photos 25, 26** and **27**. Remember to drill the core diameter not the tapping size, to maintain as close a fit as possible. Once again, my tapping head adaptor came in useful, photo 27, be careful with very small diameter threads to ensure that the tap does not bind too much, you do not want to end up with a broken tap.

Note! If the thread length happens to be shorter than the thickness of the thread adaptor, then you will need to carry out a further operation to counterbore the thread adaptor face to reduce the thread length. Alternatively, you can counterbore the back face of the adaptor which would be machined when machining the outside and location diameters, this may also require a modified back stop.

Back stop

The Back stop is shown in fig. 4. Depending on what the final diameter of the back stop bore in your fixture housing is you can either part off or cut off from standard diameter bar stock or machine from larger to be a sliding fit. I did not bother to take any photographs for machining such a simple component.

Assembly and Use

Photograph 28 shows the component parts laid out ready for assembly. First position the fixture housing into the lathe chuck, remembering to line up the line up marks (photo 24). Next position the appropriate back stop, if required, into the fixture housing, then, screw the clamp nut onto the fixture housing. Depending on what modification you are intending to carry out, either screw the item to be modified into the front or back of the thread adaptor then secure the thread adaptor to the clamp nut with the two mounting screws, then tighten the clamp nut and your ready to go, enjoy your 'trouble free' screw modifications. ■


Lining up the line-up marks


Machining the centre for accurately positioning the desired thread core size drill


Machining the core size of the desired thread


Tapping the desired thread

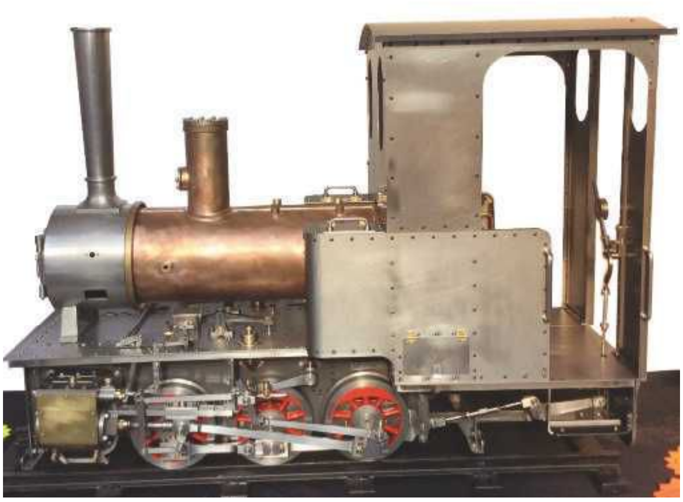

Component parts of a standard Universal Screw Modification Fixture ready for assembly

POLLY Model Engineering Limited

Manufacturers of the famous POLLY kit-build 5" locomotives
Suppliers of drawings, castings, materials, parts, accessories, tools and books to the model engineering hobby.

Choose from the wide variety available and build a POLLY LOCO using the most basic workshop tools. Move on to more advanced projects as your workshop develops. Whether your interests are stationary engines, fine scale standard gauge locos, or narrow gauge, whatever your requirement, there is so much available from POLLY, from nuts and bolts to complete loco kits.

7 ¼" gauge GWR Collett Goods Doncaster 2016



7 ¼" Narrow Gauge Koppel 0-6-0 under development based on Ken Swan Design.






Polly Model Engineering Limited

Atlas Mills, Birchwood Avenue, Long Eaton
NOTTINGHAM, ENGLAND, NG10 3ND
Tel: +44 115 9736700 Fax: +44 115 9727251 email: sales@pollymodelengineering.co.uk

www.pollymodelengineering.co.uk

Variable Frequency Drives for a Milling Machine and Lathe

Adding an inverter or 'variable frequency drive' is a popular way to increase the flexibility of many machine tools. Laurie Leonard describes his experiences.

VFD unit and three phase socket

I purchased the Tom Senior M1 mill second hand with a three-phase drive but the seller "threw in" a single-phase motor. Initially I built a phase converter, ref 1, utilising capacitors but the three-phase motor got very hot and did not run up to speed properly. I therefore adapted the drive mount and fitted the single-phase motor and used the machine on many jobs but decided that an upgrade was in order and to fit a Variable Frequency Drive (VFD), going back to a three-phase motor. Discussing the project with a potential supplier, ref 2, it was suggested that if I fitted a similar rated motor to my lathe, Myford ML7, then I could use the same VFD to drive both without the need to change any of the VFD drive settings when swapping it from one motor to the other. The 1HP motor needed for the mill was larger than that needed for the lathe but I decided to go with it. The following covers some of the practicalities I encountered in the job and the way I got around them.

Control Panel mounted for use on the mill

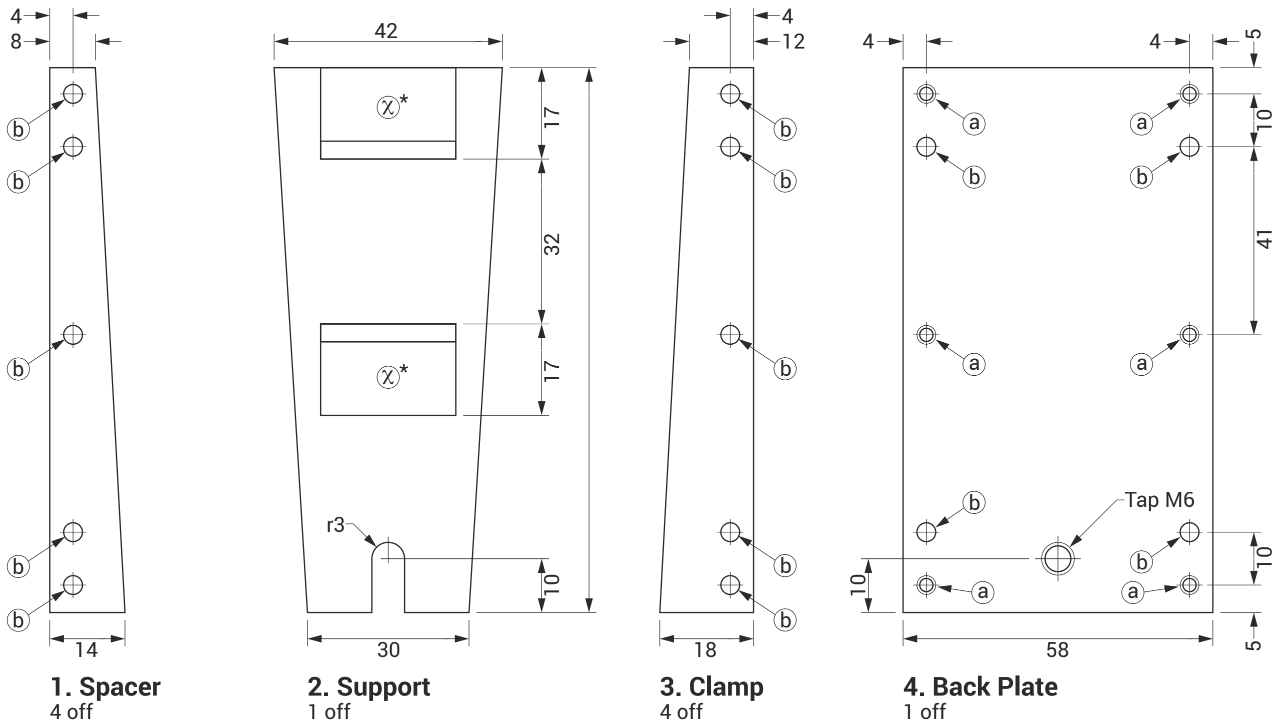
Control Panel mounted for use on the lathe

General Aspects of the VFD

As the VFD unit was to be shared between the lathe and mill it needed to be mounted on a plate with a three-phase socket to enable it to be moved from one machine to the other. Each of the motors was fitted with a three-phase plug to engage with the VFD socket. A panel was needed to accommodate the VFD unit and the three-phase socket, **photo 1**. The support literature for the VFD stated that this needed to be fireproof as the unit got hot so a sheet of 1.5 mm mild steel was used. The literature also gave the size of air gaps required around the unit for cooling air flow. As the mounting position for the unit for both the lathe and mill was to be under a shelf this determined the size of the panel above the unit. To ensure cooling and protect potential flammable materials in the vicinity of the panel it was suspended with cup hooks locating in hole drilled in the panel.

The control box also had to re-locateable

Fig.1



Notes:

1. Ⓧ* Denotes angle iron pieces to support control box arm
2. Mat'l: 1.5mm mild steel

Holes:

ⓐ Tap M3

ⓑ Ø3mm

Quick Release Bracket

4

Mounting Bracket and shaped Support Plate

and mounted in each position in an ergonomic way. A support arm was made from box section steel terminated in a quick release bracket which was designed as in **fig. 1**. This provides a sturdy mounting, it has to withstand the pressure of the buttons being pressed, but is easily disengaged so it can be relocated on the other machine.

Photographs 2 and **3** show the panel and control box mounted for use with the mill and lathe respectively.

Photograph 4 shows one of the mounting brackets and the shaped support

5

Component Parts for one Mounting Bracket and the Support Plate

Set up for drilling rivet holes

One side of mounting bracket riveted up

Bracket mounted on milling machine

Bracket mounted for the lathe

Control box arm

plate before it was fixed to the control box arm. The component parts for one bracket and the support plate are shown in **photo 5**. As the support plate has to be a good fit in each bracket, a reasonable degree of accuracy is needed in manufacture of the items. **Photograph 6** shows the set up for drilling the rivet holes in one set of side parts. The paper was inserted to that the support plate would slide in behind the front members without too much binding but minimal slop. **Photograph 7** shows one side riveted up. The support plate was used to position the other side members and the drilling and riveting process was repeated. The completed brackets are shown in **photos 8** and **9** mounted for their respective machines. In use the support plate carrying the control box on its arm, photo 10, drops into the "v" of the bracket and is clamped by tightening the red knob which secures the arm/control box and provides a stable arrangement. The arm is held in two angle iron brackets, photo 11. The holes in the brackets are a good fit for the connecting rod which is only threaded enough for the nuts so that the holes in the brackets and arm pivot on plain rod reducing the likelihood of slop and arm droop. Nyloc nuts are used which are tightened to provide for tight frictional movement.

Attention is now centred on the electrical connections. Instructions were provided and the supplier was happy to answer questions but it goes without saying that any work of this kind should only be undertaken by those with sufficient knowledge and skill and if there is any

Arm supports

Control box cable support glands

Screen braid prepared for sleeving and connection to earth

Screen and earth connected to earth

doubt about competence then the services of a professional should be engaged.

The drives were provided with motor and control cables but all connections had to be made. The wiring for the VF unit just connects into the unit's terminal strips. I

Use of heat shrink sleeving

Original mill mounting studs

was not happy with this as I felt that some method of securing the sheaths of the cables involved was required so I made a simple steel bracket and provided cable glands to grip the multicore, mains inlet and VF output cables. The three glands are mounted in line and can be seen in **photo 12**.

Three core (one core for each of the

New mounting studs

Box section to provide mounting for new motor

inverter phases) plus earth screened cable was supplied. The screening helps to reduce the transmission of interference from the system. The screen is in the form of a "braid" over the cores. It is usual practice to earth one end of the screen (one end only to prevent the introduction of a circulating current path via the earth system). **Photograph 13** shows the screen carefully unbraided and twisted to make a wire. The motor end of the cable was chosen to earth the screen and the two connections to the earth pin can be seen in **photo 14**.

Heat shrink sleeving was used at the end of the sheath to trap the end of the screen. This can be seen in **photo 15** which shows the connections at the plug end of the motor cable.

The Mill Motor

Installing the motors on the individual machines threw up machine specific problems. The original motor was mounted on top the milling machine using adjustable studs, photo 16. These were in a bad way being a motley collection including

19

Unbored sleeve being parted from the excess stock

20

Grooving the sleeve on the lathe to take the key

fabricated ones where the threads were not concentric. A new set was made using bolts to match the threads in the machine casting and metric stud bar, not ideal, **photo 17** . Lengths of steel box section were used to bridge the studs and provide a base for new holes on the new motor's footprint, **photo 18**. Note the spacers inside the box section to prevent it being crushed when nuts were tightened down.

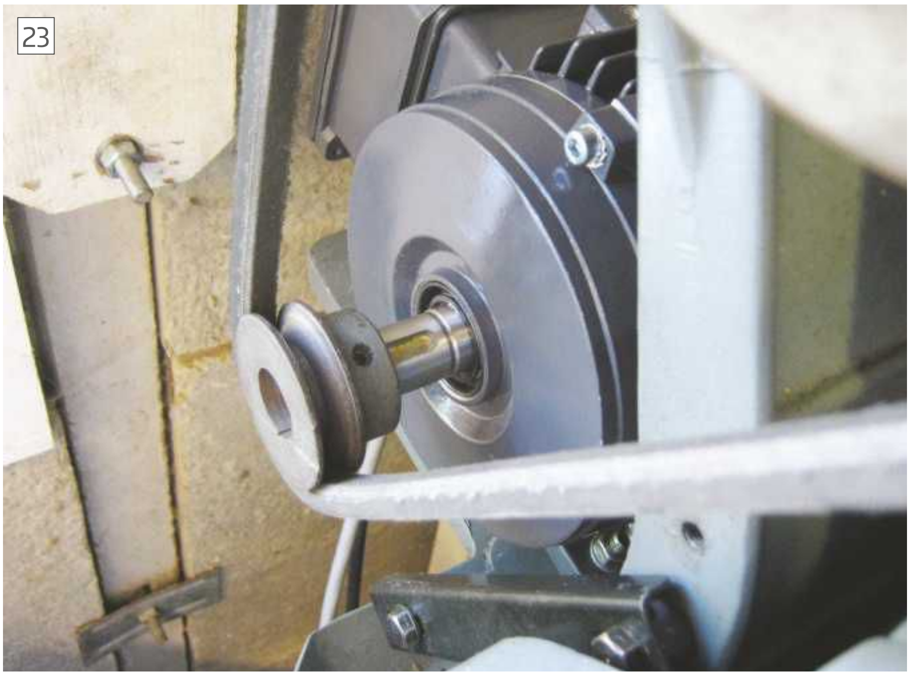
The new motor shaft was measured as 19mm whereas the pulley from the old set up had a bore of 0.943 inches. It was decided to make a sleeve for the larger hole in the pulley. The old pulley drove via a screw into the keyway on the motor shaft. Weighing up the different dimensions the sleeve was designed with a flange, square in this case as that was what stock was available, that was bolted onto the pulley. **Photograph 19** shows the as yet unbored sleeve being removed from the excess stock with power hacksaw and indicates the size of the material involved.

21

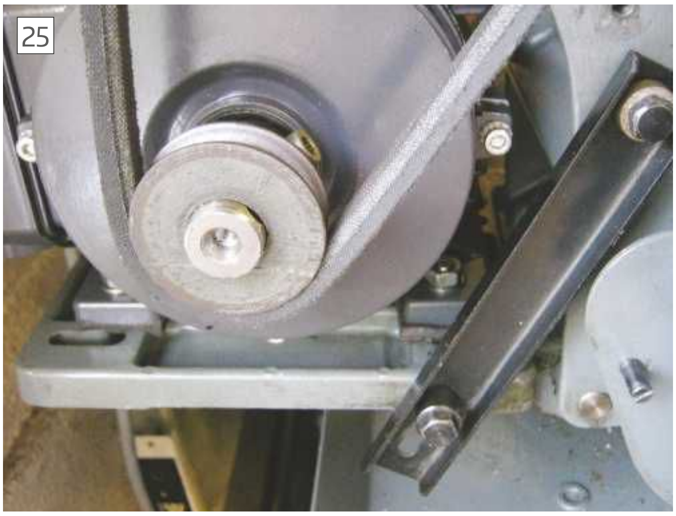
Sleeve in place on the motor shaft with key inserted in keyway

22


Drilling the sleeve flange for bolting onto the pulley

23

New motor mounted on the lathe motor platform

Extending the lathe motor support platform slots



New motor mounted on the inverted platform

The sleeve was grooved to take the drive key. As the mill was in pieces this was done on the lathe, **photo 20**. **Photograph 21** shows the sleeve in place on the motor shaft with the key in place. The key corners just protruded above the sleeve circumference although not sufficiently to provide any level of drive, hence the flange bolted to the pulley. They needed to be rounded off to allow the sleeve to enter the pulley bore. Drilling of the sleeve flange was accomplished on the drill press, **photo 22**, with the aid of a rotary table.

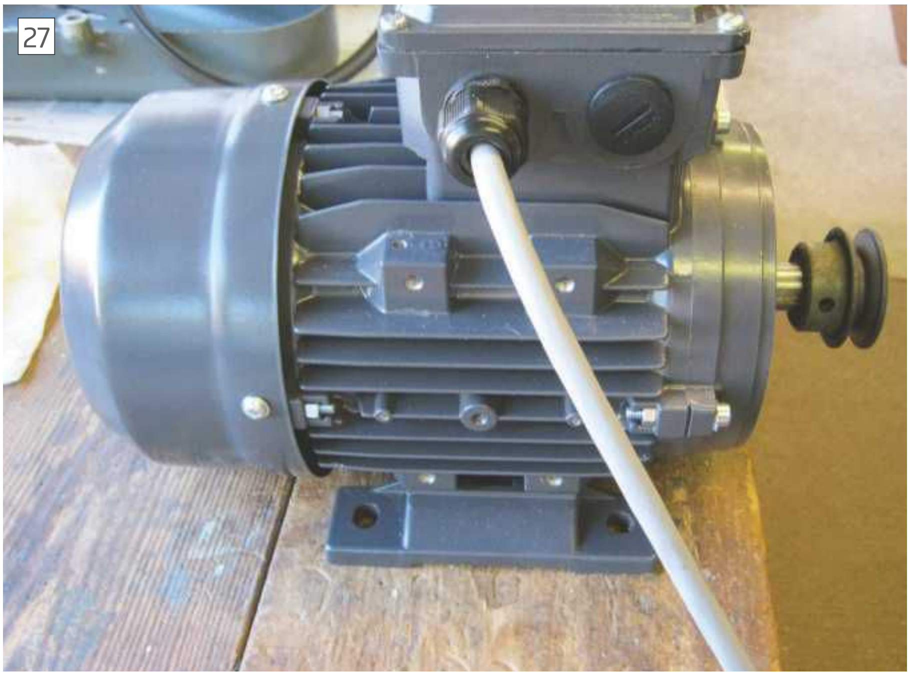
The Myford Lathe

Whilst this was a little more straightforward it had its problems. **Photograph 23** shows the new motor mounted on the support platform utilising the existing mounting holes with the pulley aligned to the lathe drive. It can be seen that the pulley is barely on the shaft and the overhang is excessive. This was solved by inverting the support plate and extending the mounting slots, **photo 24** and remounting the plate, **photo 25**. The pulley is now well on the shaft but must buy a new belt of the right cross-section! Ideally the pulley should have had a keyway machined in it and I gave some thought to buying a keyway cutting jig or set of broaches but resorted to a screw locating in the keyway and leaving the resolution of this as a future project.

The old motors

Conclusion

The conversions have been successful. The motors removed, **photo 26** being replaced with two similar motors as in **photo 27**. As someone with a hearing disability one of the outstanding features of the new drive, especially on the lathe is the quietness of the system. The lathe is almost silent removing the urge to shut the motor down at the earliest opportunity.



A replacement three phase motor

References

1 Electric Motors in the Home Workshop, Jim Cox, Workshop Practice Series 24.

2 Power Capacitors Limited. www.powercapacitors.co.uk ■

On the Wire NEWS from the World of Hobby Engineering

SMEE Training Courses

SMEE's unique training courses start in February 2017 over three Saturdays with the 'Part One' course (Basic Training). This discusses the setting up of a workshop, what equipment is desirable and the basics of how to use machines and hand tools. There's also advice on good suppliers - saving many participants a lot of money. Each day session consists of lectures, discussion and sometimes demonstrations. All are held at the Society's base in South London with its meeting room, library and workshop over three Saturdays. Previous participants have come from as far as Yorkshire, Oxford and Manchester.

The second course, over six sessions, covers construction of a small oscillating steam engine and boiler, T.D. Walshaw's celebrated "Polly" model. It uses a variety of metal working techniques demonstrated on the course. After each session delegates make parts in their own workshops in time for the next session.

Roger Backhouse comments: "I took the 'Polly' course four years ago and I wish I'd taken it years before - it would have saved me making a lot of mistakes!"

These courses are open to all but other SMEE courses including milling and the practical tool grinding course are for members only.

Course organiser Allen Berman says ."These courses are very popular as they demonstrate basic metal work techniques now rarely taught in schools. They aren't 'hands on' courses but many participants have been inspired to enjoy model engineering and making metal components".

Allen knows the courses will benefit model engineers but also others interested in aspects of metal working and engineering. As a keen motorcycle restorer himself he knows the courses will help anyone restoring a classic bike. The photos show a BSA Tiger Cub Allen's restored and a Norton Dominator restored by Howard Caroline who enjoyed last year's courses.

BSA Tiger Cub

Norton Dominator

Measuring Density in the Home ~~Workshop~~ Kitchen

Eureka! Roderick Jenkins demonstrates the benefits of a classical education.

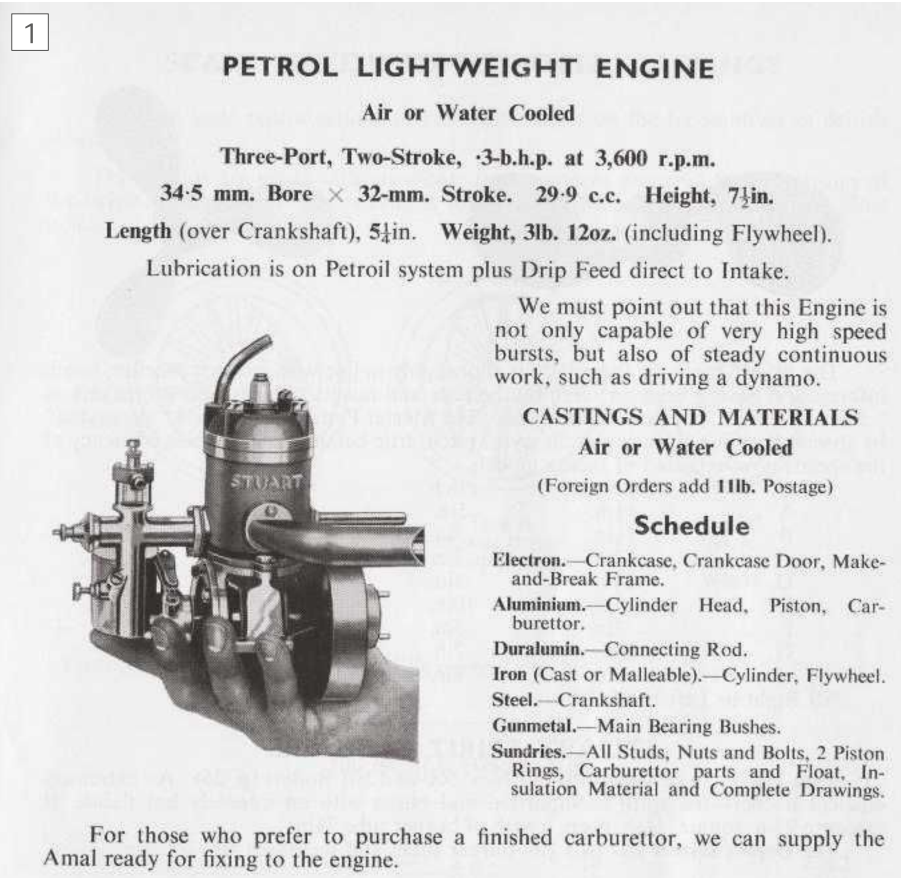
I'm sure many of you, like me, are inclined to gather "useful" material from various sources. Identifying these materials can be somewhat troublesome but one aid that will give a hint is the density of the material. Density, as you will remember, is "Mass per unit Volume" so it is simply calculated by dividing the weight of the object by its volume. My rather elderly and pre S.I. Tables of Physical and Chemical Constants gives the figures in megagrams per cubic metre which, rather more conveniently, is the same as grams per cubic centimetre (g/cc). Another way of thinking about density is using the concept of Specific Gravity, where the material is compared to water which is considered to have a density of 1. However, fortunately for those of us using a metric system, 1 cc of water weighs 1 gram so S.G. or g/cc are one and the same.

The densities of some typical home workshop materials in g/cc are shown in the table:

The figures given for the alloys and polymers are only approximate since the density depends on the actual composition and, sadly, brass and bronze are too close and variable to differentiate; as are the various steels including stainless.

My interest in measuring density was recently piqued by the fortunate acquisition, through the ME/MEW forum, of some castings for a Stuart Turner Lightweight petrol engine with both the air cooled and water cooled cylinders and heads. For some reason this engine has always fascinated me, an engine designed to do a job of work – not a model. Adverts for it had been regular in The Model Engineer since the 1930s. It was still in the Stuart Turner catalogue in 1971, **photo 1**. What is most fascinating about this engine is the fact that two of the castings are described as being made of "Electron", a magnesium alloy that is more usually spelt with a 'K' rather than a 'C'. I have no idea of the age of my castings but I wondered if, in later years, Stuart Turner continued to produce these in Elektron or did they move to a more easily cast aluminium? Compared with the weight of the cast iron cylinder, the weight saving of magnesium

1



PETROL LIGHTWEIGHT ENGINE

Air or Water Cooled

Three-Port, Two-Stroke, ·3-b.h.p. at 3,600 r.p.m.

34·5 mm. Bore × 32-mm. Stroke. 29·9 c.c. Height, 7½in.

Length (over Crankshaft), 5¼in. Weight, 3lb. 12oz. (including Flywheel).

Lubrication is on Petroil system plus Drip Feed direct to Intake.

We must point out that this Engine is not only capable of very high speed bursts, but also of steady continuous work, such as driving a dynamo.

CASTINGS AND MATERIALS

Air or Water Cooled

(Foreign Orders add 11lb. Postage)

Schedule

Electron.—Crankcase, Crankcase Door, Make-and-Break Frame.

Aluminium.—Cylinder Head, Piston, Carburettor.

Duralumin.—Connecting Rod.

Iron (Cast or Malleable).—Cylinder, Flywheel.

Steel.—Crankshaft.

Gunmetal.—Main Bearing Bushes.

Sundries.—All Studs, Nuts and Bolts, 2 Piston Rings, Carburettor parts and Float, Insulation Material and Complete Drawings.

For those who prefer to purchase a finished carburettor, we can supply the Amal ready for fixing to the engine.

The Stuart Turner Lightweight engine from a 1971 catalogue.

Aluminium Alloy	2.8	Lead	11.3	Silver	10.5
Beech wood	0.75	Lignum Vitae	1.3	Stainless Steel	7.8
Brass	8.4	Magnesium Alloy	1.8	Steel	7.8
Bronze	8.5	Mazak	6.7	Tin	7.3
Cast Iron	7.1	Nylon	1.15	Tungsten	19.6
Copper	8.9	Polyethylene	0.95	Tungsten Carbide	14.5
Gold	19.3	PTFE	2.3	Zinc	7.1

over aluminium would be minimal. Looking at the density table, there is a significant enough difference in the densities of aluminium and magnesium alloys to determine which is which.

Density, as I stated above, is simply the weight divided by the volume. Weight is easy to determine using a pair of digital kitchen scales but volume is trickier. A rectangular section or round bar is easy, just multiply the cross-sectional area by the length. The castings are rather more

Light alloy components

irregular, **photo 2**. Fortunately, that Ancient Grecian streaker comes to our rescue. Archimedes' principle states that when a body is immersed in a fluid, it experiences an apparent loss in weight which is equal to the weight of the fluid displaced by the immersed body. An extension to this law is that if we weigh the casting dry, then weigh it suspended in water, the wet weight is the weight of the water displaced. We know that one gram of water occupies a space of one cc so the weight in grams is equal to the volume in cubic centimetres. I weighed the crank case casting dry, **photo 3**. I then chose a bowl of water that was big enough to immerse the whole of the casting without it touching the bottom. The balance was tared, that is reset to zero with the bowl of water in place. I suspended the casting from a length of cotton thread and dunked it in the water, taking care to shake it about a bit to get rid of any adherent air bubbles and making sure that it was fully immersed but not touching the bottom, **photo 4**. I then noted the weight and repeated the procedure for the two other castings. The results were as follows, simply dividing the wet weight into the dry weight to get the density:

Weighing the crankcase dry

4

Weighing the crankcase wet

5

The unknown solder

	Weight dry	Weight wet	density g/cc
Crank case	154	86	1.8
Cylinder head	113	43	2.6
Crank case door	70	38	1.8

The conclusion is pretty clear: The crank case and crank case door are magnesium and the cylinder head is aluminium.

Since I had the kit to hand, I took the opportunity to investigate another item that has had me puzzled for some time. I have a bar of solder but don't know the composition. I suspect it is either 60/40 tin/lead for normal soldering or 40/60 tin/lead as used for wiped joints. I went through the density process of weighing dry, **photo 5**, and then wet. The density worked out at 8.8 g/cc. Knowing the respective densities of lead and tin, we can work out the respective proportions of these metals from the following equation:

Fraction of lead = (Density of Solder – Density of Tin) divided by (Density of Lead – Density of Tin)

Fraction of lead = (8.8-7.3) / (11.3-7.3) = 0.4. So, 40% lead and the remaining 60% is tin. That's normal tinman's solder and very useful. ■

Large Model Aero Engine Casting and Pattern Making Techniques

In his second article on this topic, Stephen Wessel addresses complex patterns

In my first article (MEW 250) I wrote about the casting of a complex crankcase for a V8 engine using the traditional method of pattern and sand. I described how patterns are often better made from PVC rather than wood and that some lateral thinking may be required to work out how the patterns are to be removed from a sand mould. In fact, I went so far as to "think outside the box" quite literally by asking for one section of a pattern to be withdrawn through the side of a mould box.

This time I will examine another method for dealing with complex patterns that have undercuts, reverse tapers and other awkward features that render them impossible to remove from a rigid mould. Such patterns may be just too complex to consider multipart construction as in my earlier example, or too large for investment casting. This latter topic I shall address in a final article.

Rubber Plaster Moulding or RPM

This technique replaces sand with plaster while the patterns will be of rubber, usually an RTV silicone rubber. The plaster is not the familiar Plaster of Paris but a much weaker, more porous material. Relative to sand it is a poor conductor of heat, which means the metal will cool more slowly and have time to fill thin sections. It is only suited to aluminium alloys and certain other non-ferrous metals.

The principle is this: the rubber pattern is placed in the mould box along with the necessary sprue and riser sleeves and liquid plaster poured over it. After setting, the pattern can be removed by flexing it around awkward angles, re-entrants and so on. Cores are made in the same way. The complete mould is then cured in an oven to dry it out completely, metal being poured while it is still warm. The surface finish of the casting will be much smoother than anything obtained with sand and, from the modeller's point of view, probably need no further work. It will though need heat treatment as mentioned last time.

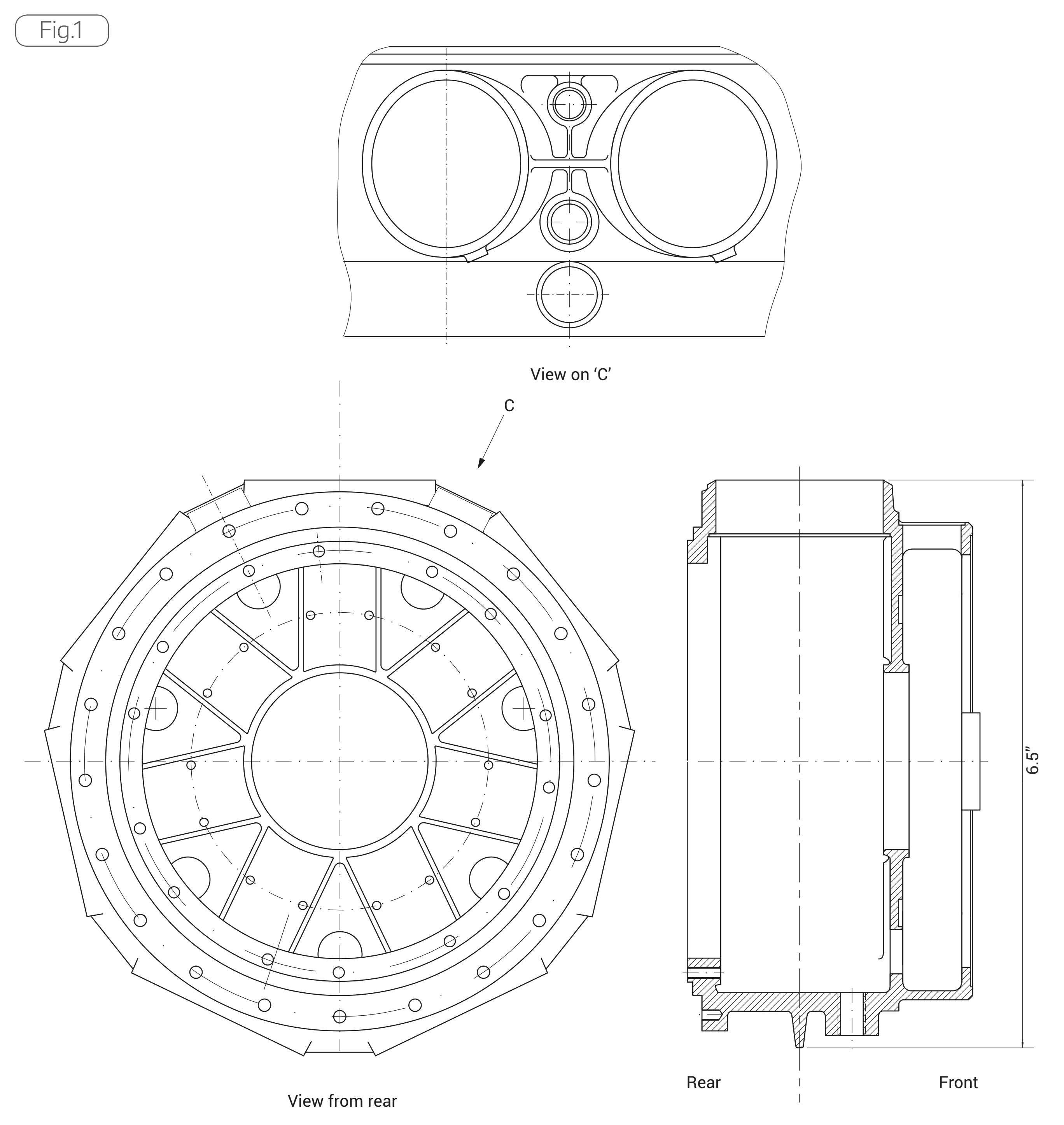
From the designer's standpoint, the method is perfect: he can reduce draft angles to zero in most cases, introduce any number of bosses, ribs or hollow areas without worry and also reduce machining allowances. The elephant in the room however is of course the pattern! How is it to be made? That is the subject of this article.

Patterns

I shall use as an example the crankcase for my 1/3 scale Armstrong Siddeley Lynx radial engine. This has already been the subject of several articles written for our hobby magazines, one of which covered the casting work in some detail a few years ago. But as I am so frequently questioned about this aspect of the build there seems no

The Lynx crankcase casting viewed from front.

The crankcase from rear. Notice the various stiffening ribs.



Crankcase Casting

harm in repeating some of the story.

Having mentioned that patterns for this type of work will be of rubber we now need to go back a few steps. To make a complex rubber pattern obviously some kind of mould is necessary while the starting point will almost certainly be a master made of wood or, you've guessed it, PVC. So, compared with the traditional route I described before, we now have two additional stages, namely the rubber mould taken from the master (the negative) and the positive pattern that will be taken from it to be used in the foundry. A lot more work therefore and some expenditure too, for silicone rubber is not cheap. One has to weigh it up: making the master pattern should be easier while the finished casting should be excellent, few if any blow holes and a smooth finish.

The Lynx engine needed three large castings to form the body: a central crankcase, a front cover plate and a fan box, all about 6" across. The original builders in 1925 of course didn't have this rubber and would have used the traditional wood/sand approach. Their patterns must have been fearsomely intricate, comprising many removable sections like some Chinese puzzle. Their work in the aero engine business of the period must have been a sublime example of the pattern maker's art; yet while similarly skilled furniture makers may have become well known as artist craftsmen, the pattern- maker was sadly forgotten as technology moved relentlessly onwards, though I suspect that early engine designers were completely in hock to what those unsung heroes in the pattern shop and on foundry floor deemed possible.

Photographs 1 and **2**. and **fig. 1** show the main crankcase casting, giving some idea of its complexity both inside and out. There is a thin, heavily ribbed, central dividing wall that supports one of the main bearings. Also visible are the cylinder sockets and various bosses. To reduce weight (the aero engineer can think of little else!) material around studs becomes a mere local thickening in an otherwise thin section. Castings with a core such as this obviously need to be made in a split mould so the core can be placed. In this case I chose a parting line, or rather plane, to cut through the centre line of the sockets, **photos 4** and **5.** The core would also start life as a plastic pattern in two sections meeting at the dividing wall. From each master pattern I would make a rubber mould. The core moulds would go directly to the foundry for plaster casting while the exterior moulds would be used to make the rubber positives, also required by the foundry. This all sounds complicated but **figs 2** and **3** show the complete sequence. The object drawn here is much simplified and can be considered as a round hollow thing with projections.

The other two cast components making up the engine body.

Main pattern on left, core pattern on right. Both are in two sections needing radial registration.

Core showing the registration button

Photograph 3 shows the other two components that form the engine body and were cast in the same way.

Materials

I have already covered the advantages of using PVC in place of timber, especially for patterns that are essentially round. Rubber however needs further elaboration.

There are, broadly speaking, two kinds of synthetic rubber suitable for accurate mould making, namely polyurethane and silicone. Both use a base to which a catalyst is added for curing. Silicone rubber subdivides into the "Condensation curing" type and the "Addition curing" type. Polyurethane rubber is a lot cheaper, has extremely low shrinkage, and pours easily. But it is also an extremely good adhesive! A very reliable release agent is needed. Without that you might as well say goodbye to your pattern and bury it in concrete. I learned this the hard way later on.

Condensation cure silicone is all right but shrinks quite a lot on curing. It is generally more pourable than the Addition cure types but has much less tear strength. This is an important property for removing the pattern. It is slightly cheaper. I had forgotten to allow for any mould shrinkage on my patterns so had no choice but to use the more expensive Addition cure, whose shrinkage is negligible. I was lucky enough to be given a free sample by one of the larger suppliers to try out.

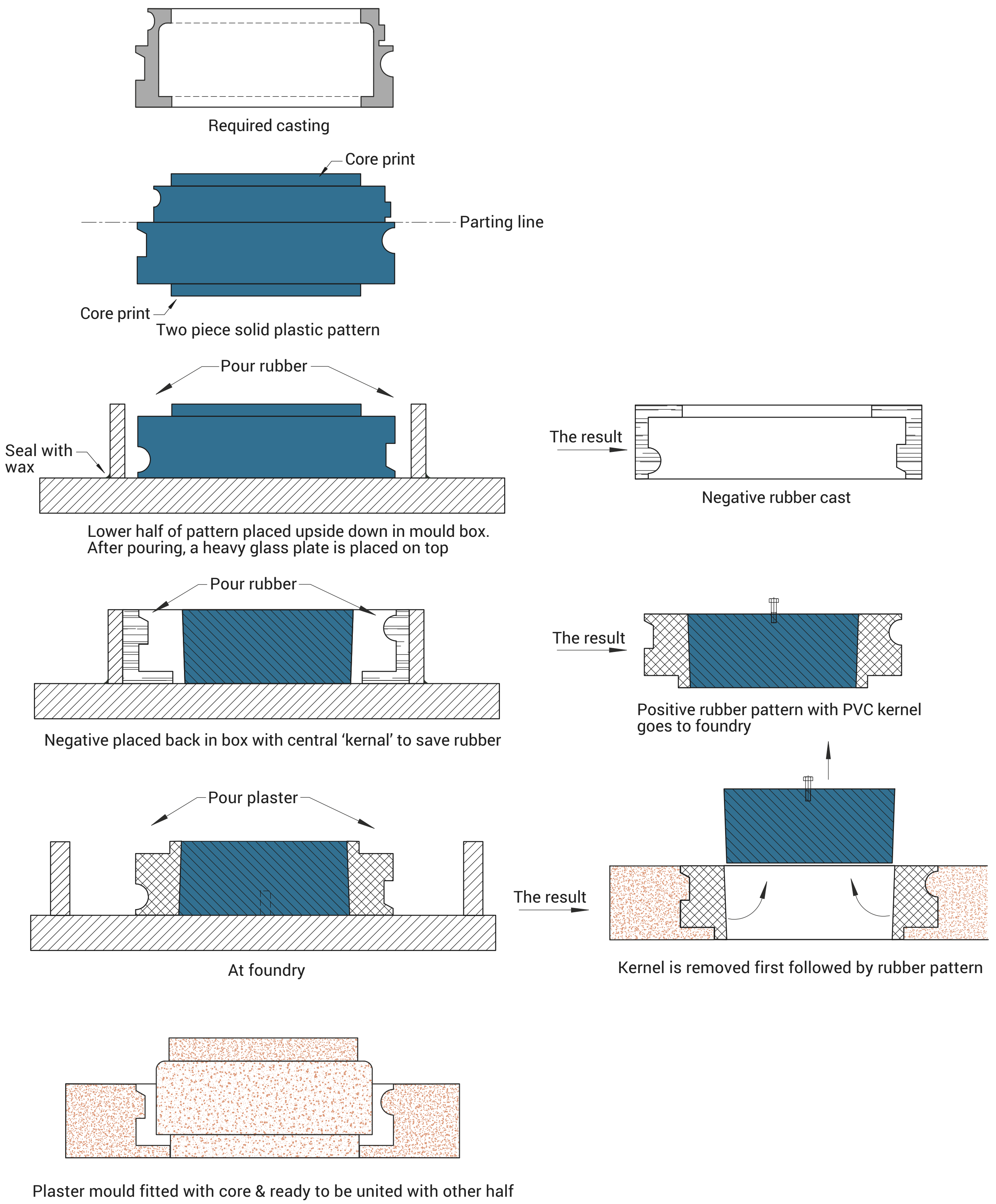
Manufacturers of addition cure silicones warn of a number of inhibiting substances that prevent the platinum catalyst working properly. Many of these are common chemicals and include certain unspecified sorts of paint, cyanoacrylate adhesives like Superglue, sulphur, latex and many solvents. The lists are not exhaustive, being constantly updated according to customer reports and misfortunes. There is a host of different formulas for silicone rubber offering a huge range of properties and there are many different suppliers; naturally the inhibitors vary in their effect, often having none. But you won't really know for sure unless experiments are carried out.

Mould boxes

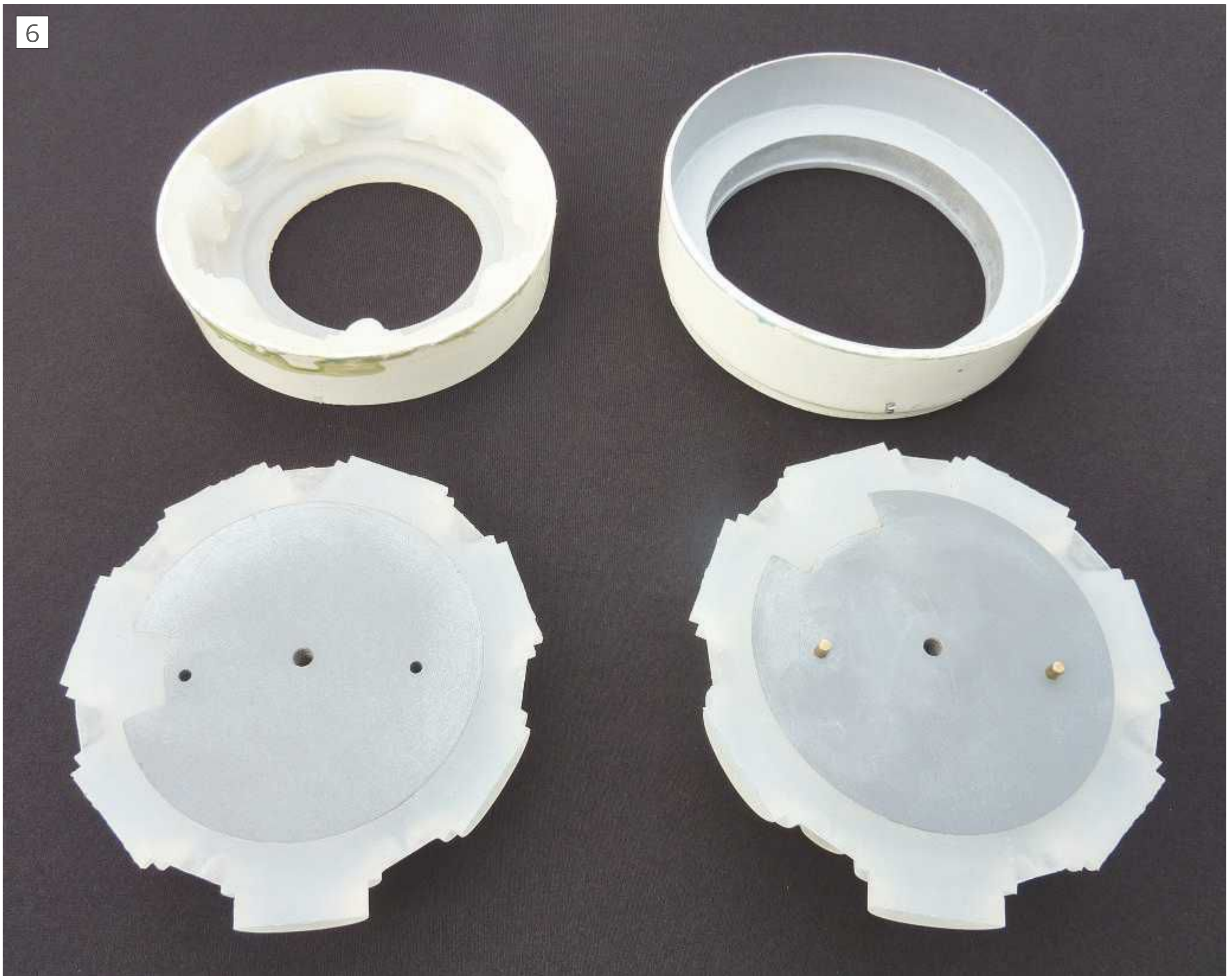
As the rubber is so expensive it is essential to use the minimum you can get away with. The boxes should ideally be roughly of the same shape as the pattern and only a little larger all round. This is not always feasible, square boxes generally being easier to make. I used 12mm PVC plate for the square ones and various bits of PVC drainpipe or old cake tins and the like for round ones. Consideration has to be given to how the rubber will be poured in. These rubbers tend to be very viscous, much like treacle. They flow very slowly but given enough time will fill every crevice and undercut on the pattern. You never think they will but they do. Pot life is variable according to make; some will start curing after only 20 minutes which may not be long enough to allow complete fill. Others provide a couple of hours or more. All of them must be degassed thoroughly before pouring and preferably again once the mould box is nearly filled.

There is a standard method, which many

Fig.2



The Moulding Sequence

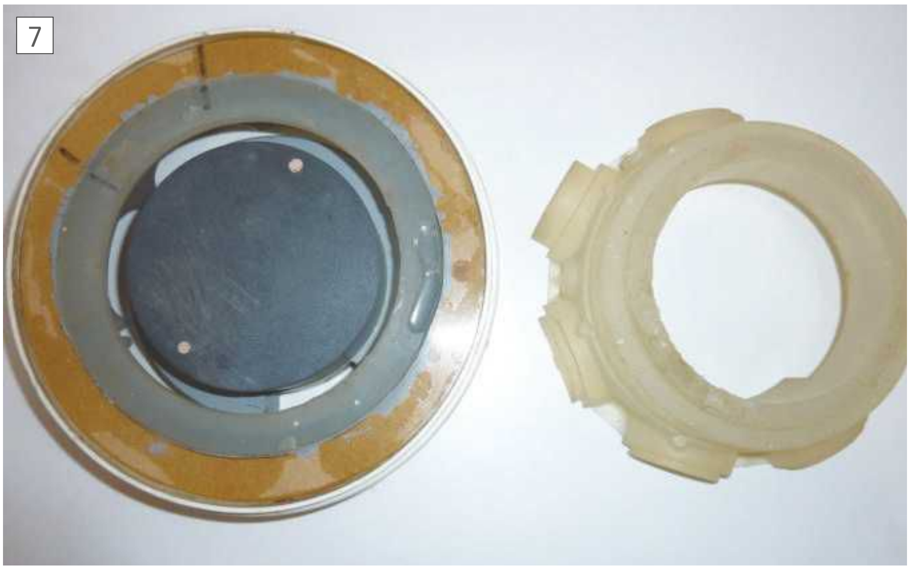


Top: Modified cake tins used as a mould boxes. Below: the two rubber positives complete with kernels

artists use for saving rubber; I didn't try it as it seemed like more work and required two more materials, namely modelling clay and Plaster of Paris. The clay is used to build a shield around the pattern up to about 1/2'' all around. Plaster is poured around it. When set, the pattern is removed, the clay peeled off and discarded. The pattern is reinstalled inside the plaster cavity. Rubber is introduced into the space once occupied by clay. The plaster block is lifted away from the rubber which can then be peeled off the pattern. Finally, the thin rubber is reunited with its plaster backup, location being easy due to the irregular shape of the original clay shield.

My workbench was already messy enough without bringing in any more sticky substances. So, to save on rubber I designed my boxes judiciously. I also measured their volume with the pattern in place, using water, so that the exact amount of rubber would be mixed with absolute minimum wastage.

There are two vital pieces of equipment needed at this point. One is a good vacuum pump that will pull a 95-99% vacuum. The inlet of an ordinary compressor probably won't do this. The other is an accurate weighing machine, measuring to 0.1gm. Such things are not cheap but I have found both to be invaluable additions to my shop for all sorts of other uses. Of course, you also need a vacuum chamber big enough to hold your largest mould box with plenty of room to spare. I made use of a large pressure cooker from the kitchen. I gave it a new lid from 1'' thick clear Perspex, placing this directly on the cooker's own sealing ring. The lid was drilled for various pipe fittings and the vacuum gauge. It worked



Producing a positive

perfectly and proved big enough for all my mould boxes. It was also used for the wax injection process (to be described in the next article). Having a transparent lid was vital for obvious reasons.

The master external pattern was made in two halves registered together with a single central stud of 1" brass tubing. I got hold of some large chunks of PVC up to 5" diameter from an online supplier and with little difficulty turned them quickly into the patterns illustrated in photos. Superglue was used to join the various bits, Milliput for the fillets and paint to bring the colours together as before. Great care was taken to produce truly flat faces at the split line. Any inaccuracy here would lead to excessive flash on the casting and possible ovality of the cylinder sockets. When finished, one half of the pattern was turned upside down on to a truly flat piece of 20mm PVC plate. It was checked for good contact all around the edge. A metal shrinkage allowance of 1.2% was allowed as advised by the foundry. Rubber shrinkage would be negligible. If successful, the other half would be done in the same way.

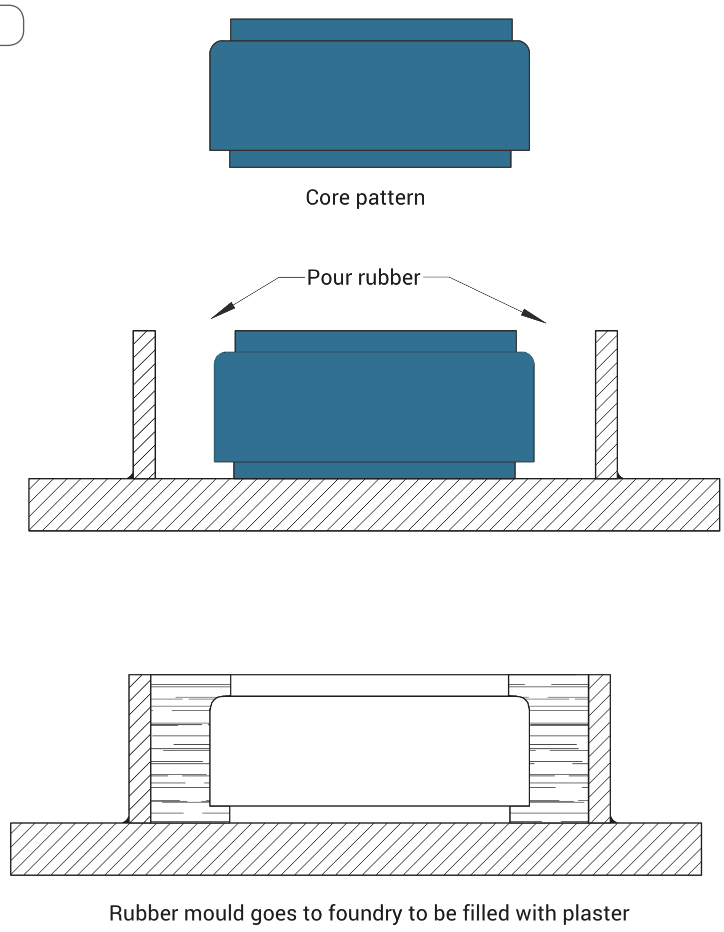
Milliput

Milliput is a marvellous filler for this application. I made a couple of simple ball ended tools for smoothing it into fillets of different radii. These were stainless balls fitted to a 3/32 steel stem. The filler is plastered firmly but roughly into place for several inches of length; then by wetting the tool you can push it hard down into a fillet shape, smoothing as you go. It is a messy business and you need plenty of rags to hand. Wetted cotton buds will wipe off the excess, much of which can be reused. After complete cure it can be sanded if necessary. See Part 1 of this article about painting the pattern.

I found a suitable kitchen cake tin and placed it over the pattern. It allowed an approximate 1" gap all round for the rubber.

It was now necessary to measure the quantity of rubber that would be needed. The lower edge of the bowl was first sealed to the board using wax; candle wax does nicely for this. The bowl is filled with water which is then tipped into a measuring jug. A simple calculation using the manufacturer's figure for specific gravity gives the required weight of rubber in grams. The upper part of **photo 6** shows the modified cake tins and the resulting rubber castings – the "negatives". **Photograph 7** shows one of the tins with a negative reinstalled being used to make the final rubber positive, which should be exactly equivalent to the original plastic pattern, **photo 8**. Notice the solid PVC "kernel". This was needed both to save a large amount of rubber and ease its

Fig.3



Producing A Plaster Core

8

A finished positive ready for the foundry. The kernels have a taper to make withdrawal easy and saved about £40 in total!

Easy to get it out

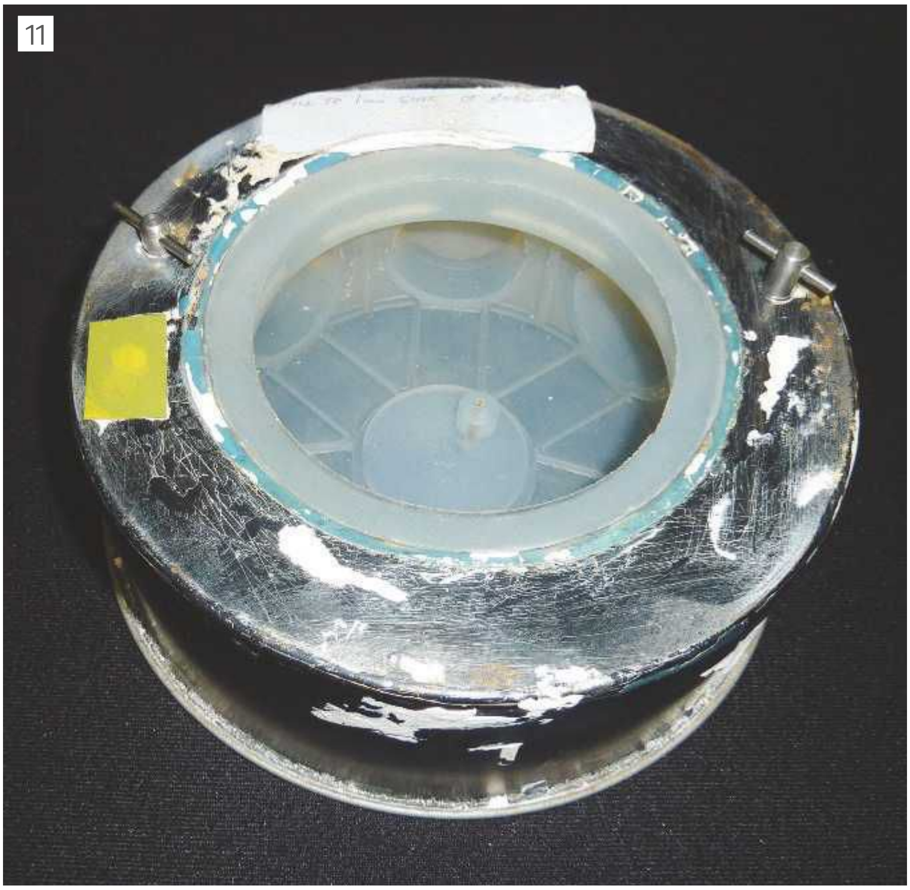
Rubber core moulds

removal from the plaster; the M10 bolt at its centre served as a vital handle for this purpose. **Photo 9** gives an idea of the flexibility of this rubber once the kernel is taken out.

Pouring Rubber

The two components must be mixed very thoroughly following maker's instructions.

When about 75% vacuum is attained, the rubber begins to foam upwards and, if the container is too small, will bubble over the sides. I found all sorts of useful plastic containers lurking in kitchen cupboards. At about 95% it all suddenly collapses again. This is the point when the vacuum can be released. All remaining bubbles will disappear and the rubber can be poured. However, if there are undercuts on the pattern, air will be trapped by the rising level of liquid. So when the pattern is covered, a further quick degas is applied. More foam, so the mould box may need a temporary upward extension around it to catch escaping rubber.



Another cake tin as presented to the foundry. The two pins register both rubber parts and tin in their correct radial positions.

Cores

Photograph 10 shows the core moulds. There are three moulds to make two cores. The two on the left are assembled together in another modified cake tin, **photo 11,** while the smaller one on the right is the crankcase front core. The two cores have to register correctly both with each other and the main plaster mould. Reference to photos 4 & 5 will reveal that No 1 cylinder socket leaves a slightly longer core print than the others, so the final plaster core is turned until it fits.

Registration of the various patterns both with each other, their respective cores and their mould boxes is very important. Rubber being so flexible can take up a distorted shape if it is taken out of its mould box and then put back in a different position. The box itself probably won't be truly circular. Cores must be easily removable from moulds, then correctly oriented before positioning inside the main plaster mould. In my case the foundry would be doing this job so the process needed to be absolutely foolproof. Needless to say, cores must fit their various prints perfectly leaving nothing for the founder to wonder about.

That concludes this description of Rubber Plaster Moulding. I realise however I have said little about the plaster itself. I managed to get a sample sack of it from a major supplier and found it quite unlike ordinary builders' plaster or Plaster of Paris. The mixing water plays little part in the cure chemistry so the resulting solid is achieved mainly by evaporation; it has very little strength so must be handled delicately. Unlike common plasters however it has excellent porosity and ability to stand thermal shock. Plaster of Paris should never be used for metal casting for these reasons, despite the temptation.

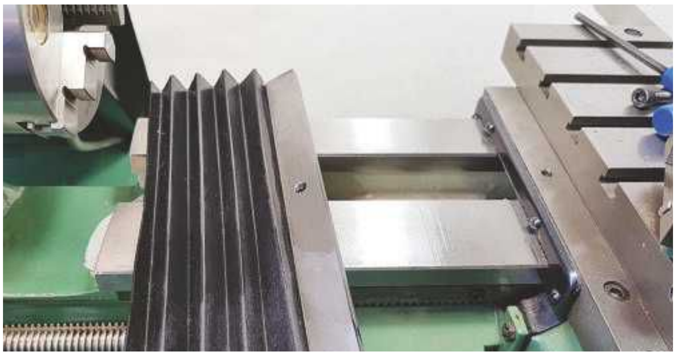
In the final article I shall cover the investment casting process, often known as "lost wax". I made use of this for the smaller more intricate parts of the Lynx engine. It was so difficult at times that I nearly abandoned the whole project! ■

Readers' Tips

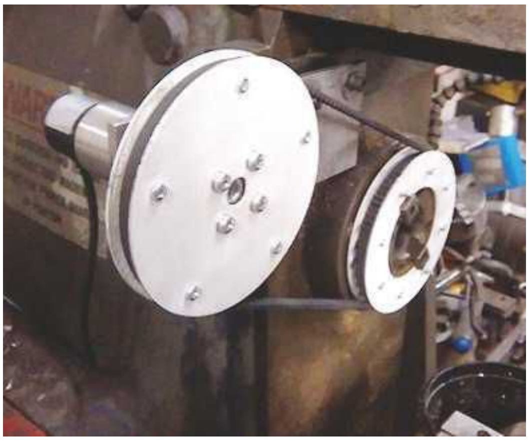
CHESTER MACHINE TOOLS

Extending Swarf Guard

TIP OF THE MONTH WINNER!




Our winning tip from Peter Smith uses two pieces of mill swarf guard on the lathe, he wins this month's Chester Vouchers!
Peter offers no lengthy description, he just says: "I most respectfully submit the following for your "Readers Tips" section in Model Engineers Workshop. I hope that I haven't plagiarized someone else's idea? But I don't think I have seen it published elsewhere."



Let the Computer do the Hard Work!

Our runner up tip is from ME forum stalwart, John Stevenson, he wins a headband magnifier!

What do you do if you want two 80 tooth HTD5 pulleys over a weekend and no one is open or even stock them as standard ?

You 3D print the pulleys and cut the cheek plates out on your laser cutter.

Jobs a good un.

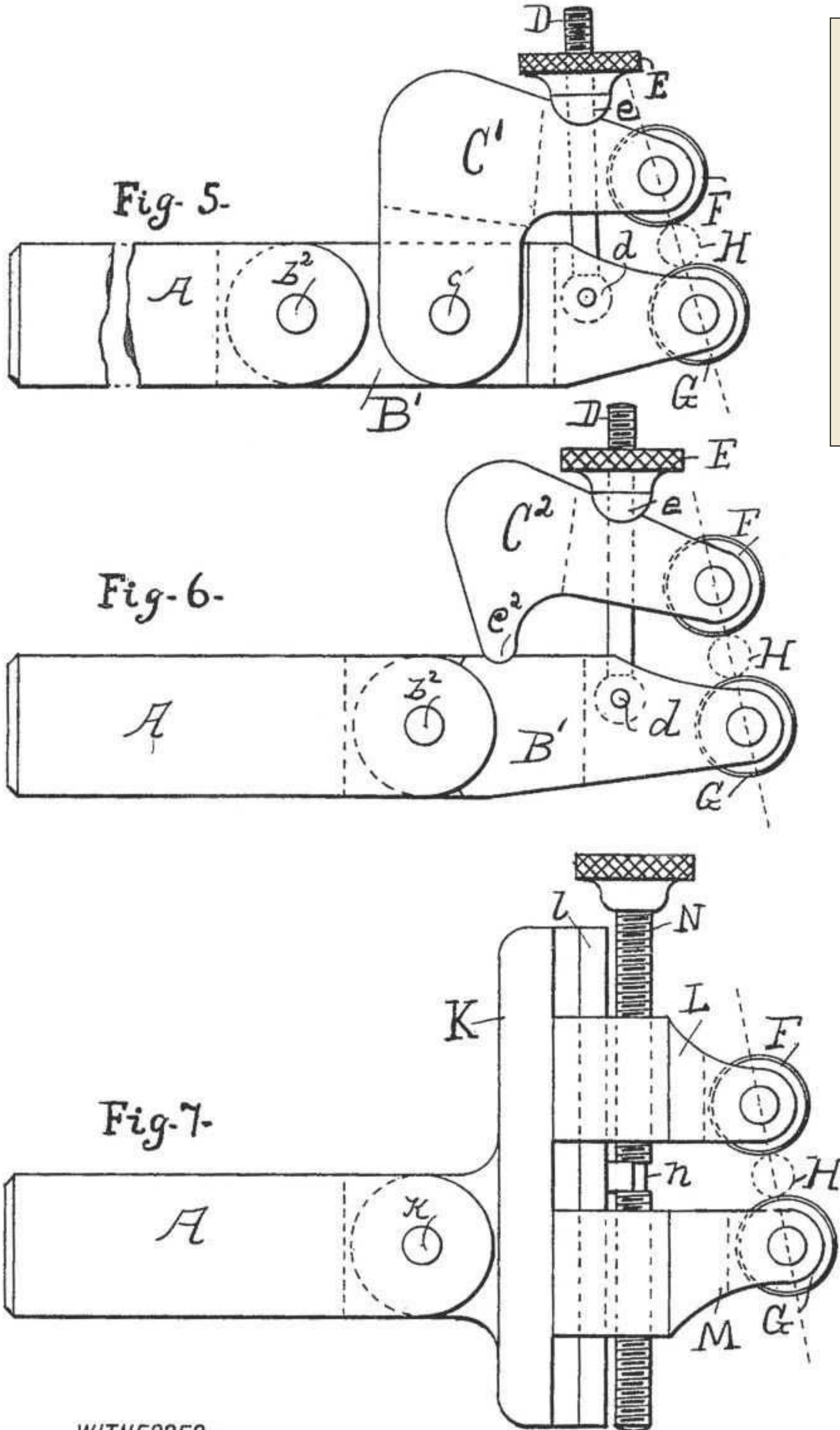
We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'. Email your workshop tips to **neil.wyatt@mytimemedia.com** marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 400 words and a picture or drawing.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

Please note that the first prize of Chester Vouchers is only available to UK readers. Other prizes are at the discretion of the Editor.

No. 632,358. Patented Sept. 5, 1899.

T. H. MILLER.
NURLING TOOL.
(Application filed Mar. 21, 1898.)

(No Model.) 2 Sheets—Sheet 2.



WITNESSES:
Henry V. Brown.
Bernard J. Beck

INVENTOR
Theodore H. Miller.
BY
D. Walter Brown
his ATTORNEY.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

The Original Scissor Knurling Tool

Following a discussion of knurling on the Model Engineer forum, I tracked down what appears to be the original patent for the balanced 'scissors' type of lathe-held knurling device. It was patented (in the United States) on September 5 1899 by T. H. Miller (apt name!) The attached page from the patent shows some of the arrangements he envisaged, and you can see he pretty much got the device right first time!

Two New Chucks for An Old Myford Lathe

Mike Haughton fits and tests some new accessories for his machine.

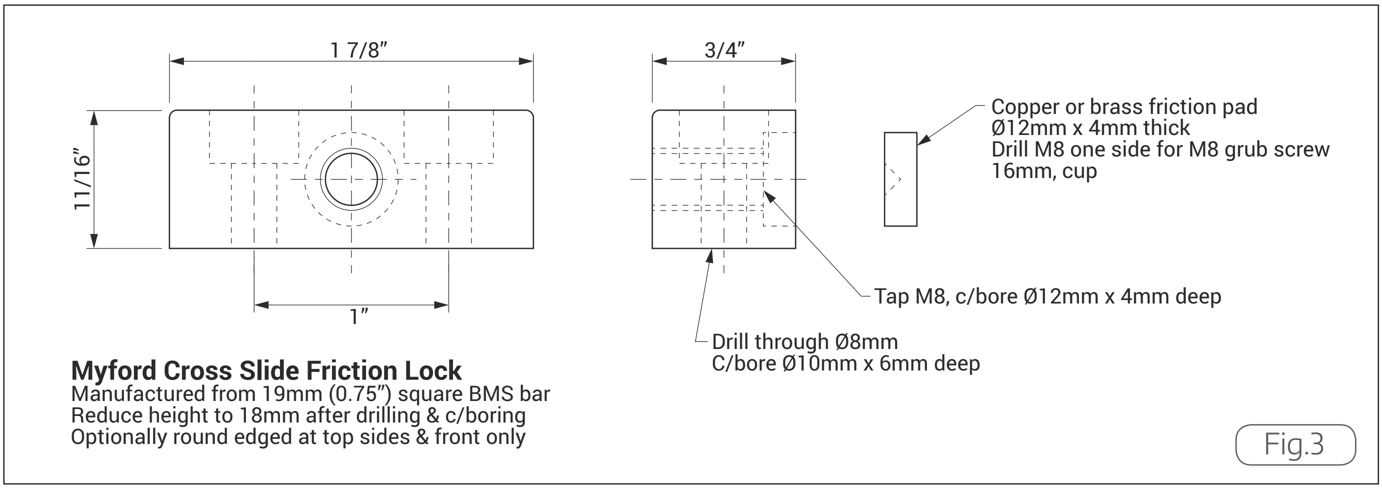


Fig.3

To measure the radial and axial run out with a ring gave me all sorts of problems finding a suitable test piece. Rings turned from thick walled pipe had poor surface finish and I had no way of grinding them on either lathe. Eventually I found a 75mm diameter bearing outer race and used that as a test piece. Measurements G and I came out about 0.030mm and were not tap adjustable provided the ring was properly seated against the chuck jaws. Measurements F and H were tap adjustable and came down to about 0.025mm.

Looking at the chuck accuracy supplied on the manufacturers data sheet that came with the chuck indicates C and D=0.040mm, E=0.060mm, G and I = 0.040mm; H and F = 0.075mm. Assuming that these are maximum figures and the sheet doesn't say, nor does it quote a standard, the supplied chuck does quite well, on my old Myford, if you are willing to tap adjust the radial run out.

Looking at other chuck European manufacturers' accuracy data, Bison-Bial, (Polish); Zentra (Germany); TOS Svitavy (Czech Republic) and Pratt Burnerd (UK, but most smaller chucks were made for them by TOS I'm told) confirms that most offer at least 2 ranges of manual scroll chucks, "precision" and "super precision" that appear to be compliant with DIN standards 6386 I or 6386 II. For a 125mm dia. chuck radial run out E is 0.04mm (I) or 0.075mm (II). My general rule of thumb is that the radial run out for a SC chuck of 80 to 125mm should be expected to be about 0.003" maximum or 0.075mm.

125mm chuck mounted on 6 inch rotary table

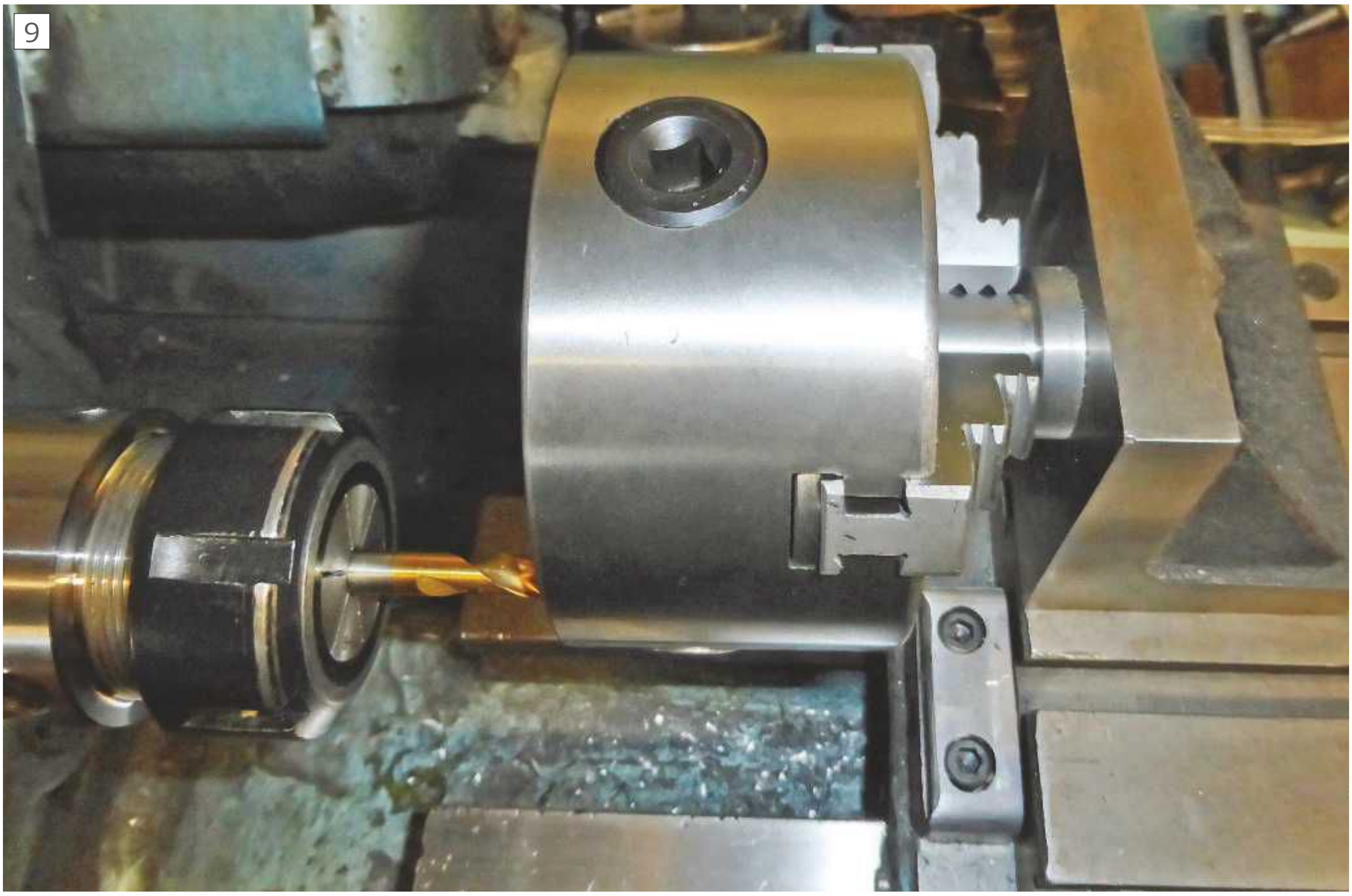
A lot has been written about grinding chuck jaws to regain concentricity and I know a couple of folks who have done this with success to the internal gripping surfaces of external jaws. In my opinion this course of action should only be attempted if the jaws on your chuck are "bell mouthed" such that you can get the thinnest feeler gauge between the jaw and a gripped round test piece. If soft jaws are available for your chuck machining could these be a better solution? I surmise that "bell mouthed" chuck jaws are produced by repeated gripping of thin/short work pieces.

Mounting on a rotary table

Because the new HBM 4jaw chuck has 4 mounting holes close to its outer edge I found that I could mount it directly on my 6" Soba HV rotary table, without any backplate, which saves valuable height. The supplied M8 bolts were too long and I reduced some new Allen HT headed bolts from 65mm to 57mm long simply by gripping them in an ER32 collet chuck, making a vee groove with a carbide tool and parting off in the vee, again with a carbide tool. The M8 tee nuts are a standard accessory for this table. **Photograph 8** shows the set up. A 2MT drill in the table socket has been used as a centering pin; I intend to improve on this at a later date as its difficult to remove after use.

Burnerd and other 3-jaw chucks, no backplate

My Super 7 came with a Burnerd 30M 110mm diameter 3-jaw chuck marked "Made in England", so I suspect it was standard issue with the lathe in 1960, serial number 103066. There is no back plate, it's integral with the body, and that gives



Spotting chuck backplate

a smaller overhang, but no possibility for tap adjustment. Having cleaned the chuck's external surfaces, I measured the radial run out C=0.020mm and axial D=0.045mm. The 20mm test piece gave E=0.055mm and the 3/8" test piece 0.060mm run out. With the bearing ring and outside jaws gave F=110 microns and G=65 microns, without a smooth transition from minimum to maximum, in fact a reversal at one point. With inside jaws H and I a similar result was obtained. Clearly a well used and worn chuck! The reversal may be due to damage to the chuck scroll. This style of chuck is really difficult to disassemble to clean out the inside.

A 110mm diameter 3-jaw chuck with integral back plate also came with the Super 7 carrying no maker's mark. The chuck body measured C=0.035mm and D= 0.035mm but the inside jaws gave E= 0.180mm and 0.250mm run out on the 3/8" and 20mm test pieces respectively, very badly worn, un-adjustable and no good for accurate work.

Back Plate Chucks with "problems"

I present these to illustrate how some seemingly inaccurate chucks can be recovered. These all come from my "heritage or legacy collection".

Case 1 a used HBM 3-jaw 100mm chuck on a commercial backplate attached with rear Allen bolts that had a body with a radial run out of 0.050mm and remained so even after tap adjusting. The chuck backplate was re-skimmed axially and radially and the step spigot eased on the Myford spindle to give C and D =0.005mm. With the chuck re-attached the 3/8" and 20mm test pieces with inside jaws adjusted from 0.0100mm to 0.015mm and 0.170mm down to 0.015mm. Other ring results were similarly improved.

Case 2 a TOS 100mm 3-jaw chuck fitted to what appeared to be a re-used cast Iron backplate with several sets of bolt holes in the back. Run out results were really poor and it was found that the 3 bolt holes were not equally spaced and not on exactly the same pitch diameter so tap adjusting just didn't work. It was decided to drill 3 new bolt holes. To get them right I adopted a

2MT Marlco collet chuck

method suggested by a friend which works well and is worth passing on.

Photograph 9 shows the setup, note the cross slide lock is mounted on 2 x¼" BSF holes normally used to mount a travelling steady. They were blocked with rubbish and had to be cleaned out with a spiral tap.

A small angle plate 89mm wide x 77mm high x 64mm deep with at least 1 vertical slot, is mounted on the cross slide with a machined boss mounted at centre height in one of the angle plate vertical slots. The chuck inside jaws grip the boss and the cross slide moved back until a tapping size drill bit in a collet will just enter one of the chuck bolt holes without deflection. The backplate is added to the chuck recess and the drill used to spot the position of one bolt hole. This hole is drilled through on the bench drill and the backplate fitted to the chuck body with one bolt through one of the other 2 holes in the chuck body. The next bolt hole is spotted and the process repeated. I find this method works well and have used it several times since. Figure 4 shows the boss dimensions that I used.

Having remounted the backplate correctly on its new holes all measurements were dramatically improved with all test pieces. This a quality chuck.

Case 3 A 100mm machined cast Iron back plate that had never been used was found to be extremely tight on the Myford spindle, even after screwing in a tapered 8-sided oak peg that I use to remove swarf from chucks and face plate threads. I bought a 1.125" x12 tpi carbon steel second tap from Chronos to clean out the thread. The tap, supplied was UNF, wrong thread angle, 60° but it cleaned the thread out and gave a good fit on the spindle. The backplate was reused and gave accurate results.

Case 4 A 100mm 3-jaw chuck refused to adjust by the tapping method. It was found that M6 cap head bolts were fitted through 6mm holes in the backplate. Running a 7mm drill through the 3 mounting holes allowed the chuck to be tap adjusted and an "inaccurate chuck" saved.

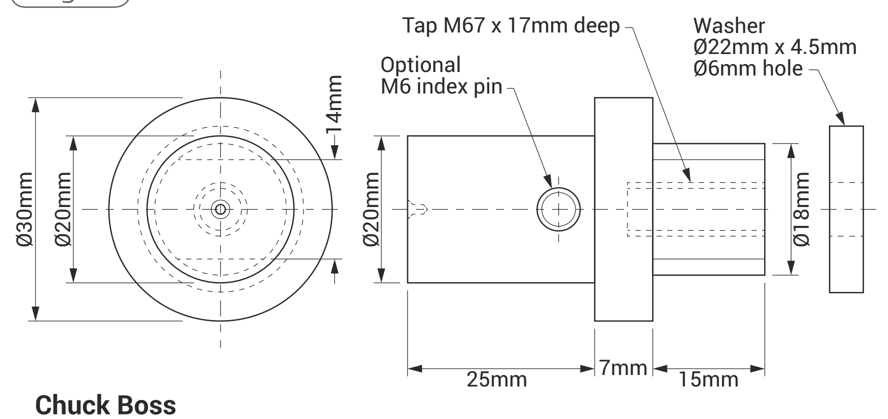
HBM ER32 Collet Chuck

I must admit that I used this chuck, photo 2, for a lot of small components long before I got around to measuring its accuracy. I found it extremely useful. I have a full range metric and some imperial ER32 collets, up to 20mm, mostly from Arc Euro Trade. Although some of my ER32 collets have seen quite a lot of use on the mill, Chester lathe and some fixtures, they seem to keep their accuracy well and most will achieve run outs of 0.015mm, 0.0006". Most suppliers don't quote accuracy figures for their collets but quality ER 32 spring collets can achieve a TIR of 0.010 mm or 0.0004".

The HBM collet chuck didn't come with a tommy bar or a collet nut "c" spanner. So the first simple job was to turn a short 8mm bar from BMS.

The chuck body screwed right up to

Fig.4



Chuck Boss

the Myford spindle shoulder but had a comparatively slack fit on the 1.25" x 12 tpi thread. I measured the ER32 chuck body as if it were a spindle nose. The radial run out of the body was 0.020mm, the axial faces at the step behind the thread 0.006mm and the front face 0.006mm (similar to A in drawing one). Pretty good I thought. The taper measured a run out of 0.025mm, which was worse than I expected.

Fitting a 20mm collet and the standard 20m test piece gave run outs of 0.050mm with a repeatability of 0.010mm. Changing to another 20mm collet gave much the same result. However, changing the closing nut, I have 5 of these, gave between 0.040 and 0.060 mm depending which nut I used. I conclude that the ER32 collet body would benefit from the 8-degree taper being reground since the same collets and test piece do achieve 0.015 mm run out in other collet bodies. If I can improve the run out by grinding I shall report back. I have no idea if this is a "typical" result for this style of collet chuck since no accuracy standard is disclosed.

A Marlco 2MT collet chuck.

Photograph 10 shows a 2MT boxed set with collets and were probably made in the 1960's. Earlier boxed sets were housed in wooden boxes, I have a 3MT set from the 1940's /50's that use the same collet style in a wooden box.

Although marked Marlco these items are also sub-marked CC (Crawford Collets). Marlco never made collets, as far as I know. The collets are a style that originated with Alfred Herbert, Coventry and were extensively used on "manual" automatics. The collets are marked 2820.

Both chucks have threaded shanks for a drawbar and were probably intended for milling.

The Myford 2 MT in the spindle was carefully cleaned, a 2MT finishing reamer gently turned in the socket, the collet chuck fitted and the run out of collet taper measured about 0.0005", 0.013mm. As the collet set only goes to ¾" the 3/8" HSS test bar was used and gave a 0.040mm run out with no reversing. A second 3/8" collet gave 0.065mm on the same test piece. Marlco Collets sets with 2 or 3 MT shanks appear to command very high prices on the Auction Websites, I wonder why?

To Tap or not to Tap?

Tapping chuck bodies to improve run out isn't to everybody's taste, it's a bit brutal. Those with adjustable back plates can feel superior here. (Griptru, Easyset, Setrite etc.) but you can always use soft jaws or a good quality 4-jaw independent chuck and get as good result. Chucks like the Easy-Set use 3 tapped holes in the chuck body to push the chuck body about on the backplate. This doesn't look easy to achieve so I have looked at ways of adjusting the chuck mounting on a backplate by boring and tapping 3 holes through the backplate close to the step that fits the chuck recess. My optional index pin in **fig. 4** was used to space the holes around my backplate. My idea was to fit screws with eccentric ends to push the chuck body about. If you have managed this successfully perhaps you could share your experiences with myself and the readers?

Conclusions

This exercise has produced a few eye openers for me. I encourage you to critically measure and compare the performance accuracy of your chucks; you could be in for a few surprises! You should consider equipping yourself with accurate dial and finger clocks with micron resolution as they can quickly show up accuracy problems in new and used machinery. Needless to say, a bit of skill and practice are required but the end result will be worth it. Happy measuring.

I give a big vote in favour of both the 4-jaw SC chuck and the ER32 collet chuck and would buy them again despite shortcomings revealed by my testing.

If you have any comments on this article, you may send them to Scribe a line or the author is happy be contacted by email at mikehaughton@btinternet.com

MODEL ENGINEERS' WORKSHOP SUBSCRIPTION ORDER FORM

DIRECT DEBIT SUBSCRIPTIONS (UK ONLY)

Yes, I would like to subscribe to *Model Engineers' Workshop*

☐ Print + Digital: £13.50 every 3 months

☐ Print Subscription: £11.25 every 3 months

YOUR DETAILS MUST BE COMPLETED

Mr/Mrs/Miss/Ms....................Initial ....Surname ....

Address ....

....

Postcode .... Country ....

Tel .... Mobile....................................

Email .... D.O.B ....

I WOULD LIKE TO SEND A GIFT TO:

Mr/Mrs/Miss/Ms....................Initial ....Surname ....

Address ....

....

Postcode .... Country ....

INSTRUCTIONS TO YOUR BANK/BUILDING SOCIETY

Originator's reference 422562 DIRECT Debit

Name of bank...

Address of bank ....

....

....Postcode ....

Account holder ....

Signature.. Date ....

Sort code ☐☐ ☐☐ ☐☐ Account number ☐☐☐☐☐☐☐☐

Instructions to your bank or building society: Please pay MyTimeMedia Ltd. Direct Debits from the account detailed in this instruction subject to the safeguards assured by the Direct Debit Guarantee. I understand that this instruction may remain with MyTimeMedia Ltd and if so, details will be passed electronically to my bank/building society.

Reference Number (official use only) ☐☐☐☐☐☐☐☐☐

Please note that banks and building societies may not accept Direct Debit instructions from some types of account.

CARD PAYMENTS & OVERSEAS

Yes, I would like to subscribe to *Model Engineers' Workshop*, *for 1 year* (13 issues) with a one-off payment

UK ONLY:

☐ Print + Digital: £56.99

☐ Print: £47.99

EUROPE & ROW:

☐ EU Print + Digital: £64.95

☐ EU Print: £55.95

☐ ROW Print + Digital: £64.95

☐ ROW Print: £55.95

PAYMENT DETAILS

☐ Postal Order/Cheque ☐ Visa/MasterCard ☐ Maestro

Please make cheques payable to MyTimeMedia Ltd and write code V1050 on the back

Cardholder's name...

Card no: (Maestro)

Valid from.............................. Expiry date.................... Maestro issue no...................

Signature.. Date...........................

TERMS & CONDITIONS: Offer ends 24th February 2017. MyTimeMedia Ltd & Model Engineers' Workshop may contact you with information about our other products and services. If you DO NOT wish to be contacted by MyTimeMedia Ltd & Model Engineers' Workshop please tick here: ❑ Email ❑ Post ❑ Phone. If you DO NOT wish to be contacted by carefully chosen 3rd parties, please tick here: ❑ Post ❑ Phone. If you wish to be contacted by email by carefully chosen 3rd parties, please tick here: ❑ Email

POST THIS FORM TO: MODEL ENGINEERS' WORKSHOP SUBSCRIPTIONS, MYTIMEMEDIA LTD, 3 QUEENSBRIDGE, THE LAKES, NORTHAMPTON NN4 7BF

Please visit **www.mytimemedia.co.uk/terms** for full terms & conditions

CODE V1050

HURRY OFFER CLOSES 24th FEBRUARY 2017

PRINT + DIGITAL SUBSCRIPTION

- 13 Issues ***delivered to your door***
- ***Great Savings*** on the shop price
- ***Download*** each new issue to your device
- A ***75% discount*** on your Digital Subscription
- Access your subscription on ***multiple devices***
- Access to the ***Online Archive*** dating back to Summer 1990

PRINT SUBSCRIPTION

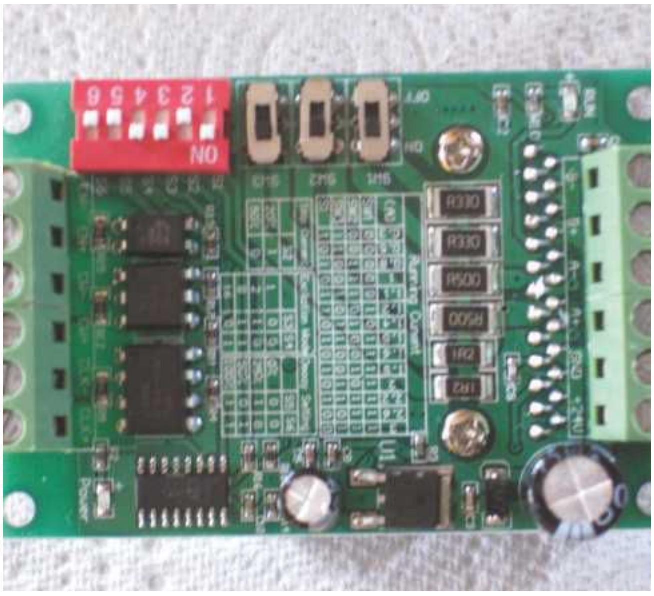
- ***13*** Issues ***delivered to your door***
- ***Great Savings*** on the shop price
- Save up ***to 23% off the shop price***

SUBSCRIBE TODAY

Scribe a line

YOUR CHANCE TO TALK TO US!

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



Arduino Project Update

Dear Neil,

In MEW of January 2017 , Scribe a line, there is a remark about the part number of the Toshiba Driver board. I experienced another minor issue on this subject. When I tried to compile the sketch I received a fault message saying:

C:\Program Files (x86)\Arduino\libraries\LiquidCrystal\I2CIO.cpp:35:26: fatal error: ../Wire/Wire.h: No such file or directory

#include <../Wire/Wire.h>

After including this line the program worked perfectly. (from the menu choose: Sketch --> Include sketch and pick: Wire)

It might be possible that this message has to do with a somewhat older Arduino board or the version of the initial software (1.6.5).

Bernhard van der Steen, Netherlands

OMT Optical Table

Dear Neil, May I please ask, via Scribe a line, if anyone can help with information about my OMT 10 inch No. 2 Optical Rotary Table.

This is a splendid piece of kit (probably pre-1960) which I have owned and used for about 25 years. When I first bought it, the internal scale appeared to carry a coating of small droplets of oil; however, this did not interfere with reading the scale and there were no problems in use. The same scale now appears to carry a rather coarser coating of droplets which obscure the scale to some extent. At first I thought that it was oil due to over enthusiastic lubrication by a previous owner but I am now considering that it may be condensation and, as a test, it is now installed in the sitting room to see if it will dry out – so far no change.

If possible, I wish to access the "works" and possibly clean the scale (with a great deal of care). Removing a rectangular cover plate underneath the table simply shows that the inside is pretty well filled with the "works" . Under the table casting are a number of deeply counterbored allen screws which are tempting but, whilst some of the screws may hold the device together, others may be retaining vital bits of precision tackle in position internally – and disaster may lie in wait.

I would really appreciate any and all assistance – Scribe a line correspondents do seem to be familiar with all sorts of things so, here's hoping.

Malcolm Leafe, by email

Happy New Year

Dear Neil,

I'm sure you receive hundreds of letters of support for your efforts as editor of Model Engineers' Workshop and I'd like to add mine to that list.

Putting a publication together as frequently as you do with a balance of articles to satisfy a diverse range of model engineering interests, is I imagine, a real challenge and you consistently manage to accomplish this and I look forward to every issue.

A very good new year to you, family and co-workers at Model Engineers' Workshop

Paul Zeusche, USA

Thanks Paul, and thanks also to the many other readers and contributors to MEW who have sent us their best wishes for 2017. The very best wishes of all at MyTimeMedia go to you all – Neil.

We would love to hear your comments, questions and feedback about MEW

Write to The Editor, Neil Wyatt, Model Engineers' Workshop, MyTimeMedia Ltd., Suite 25, Eden House, Enterprise Way, Edenbridge, Kent TN8 6HF. Alternatively, email: neil.wyatt@mytimemedia.com

Mtroniks
electronics innovation

25 years of know how

DCi-75 (inc. Handset)
Brushed Loco speed controller
FROM £119.99
Available as 12V, 24V or 48V
100% Waterproof!
True traction control!
Forwards & Reverse

DCi-120 (inc. Handset)
Brushed Loco speed controller
FROM £199.99
Available as 12V, 24V or 48V
100% Waterproof!
True traction control!
Forwards & Reverse

DCi-250 (inc. Handset)
Brushed Loco speed controller
FROM £314.99
Available as 12V, 24V or 48V
100% Waterproof!
True traction control!
Forwards & Reverse

digiSound602
Real sound, 2 x 50W module
£199.99
Available sounds:
Class 08, Class 20
Class 31, Class 37
Class 40, Class 42
Class 50, Class 55
Class 66, Class 67
Generic Perkins

Special offer!!
Order any digiSound602 sound module at the same time as the DCi-120 Loco controller and get the sound module for half price!!

Loco Handset
Full control of direction, speed and sound
£44.99
For use with any DCi controller

Please feel free to call us for advice or to discuss your requirements!
01943 461482

24 Month Warranty on all Mtroniks electronic products

Mtroniks Loco products are available direct from Mtroniks, either over the phone or through our website

High quality speed controls designed and manufactured since 1987 in the UK

Mtroniks
electronics innovation

41A Ilkley Road, Otley, LS21 3LP, UK
Tel: +44(0)1943 461482 Fax: +44(0)1943 468335

www.mtroniks.net
enquiries@mtroniks.net
www.facebook.com/MtroniksLtd
Twitter : @mtroniksteam

The Wishbone Sharpener Revisited

Jacques Maurel

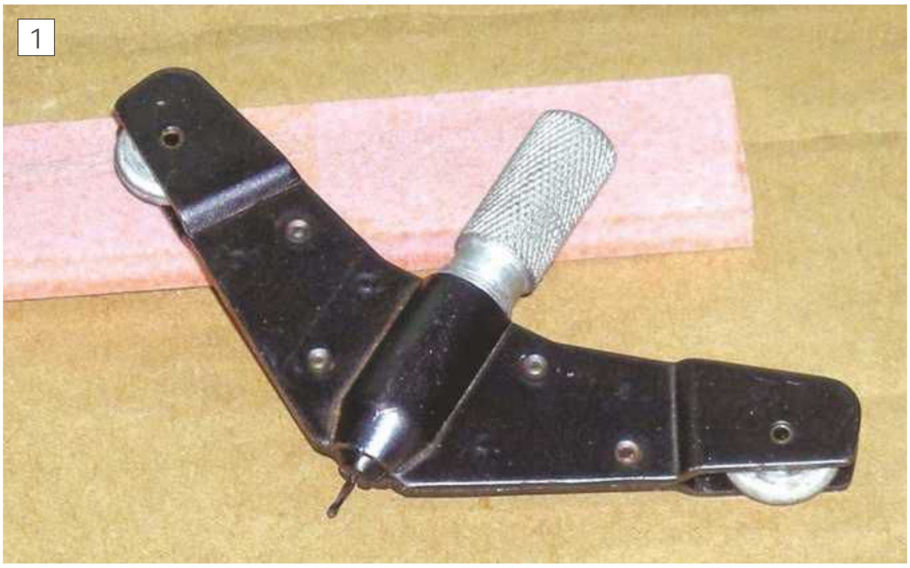
This device, **photo 1**, is very useful for sharpening small drills (diameters of 3mm and less). It was thoroughly described by Mr Trevor Marlow in issue 97 of MEW where he proposed his own solution (and other variations have appeared in our magazines over the years – Ed.)

It seems that this attachment is still not commercially available.

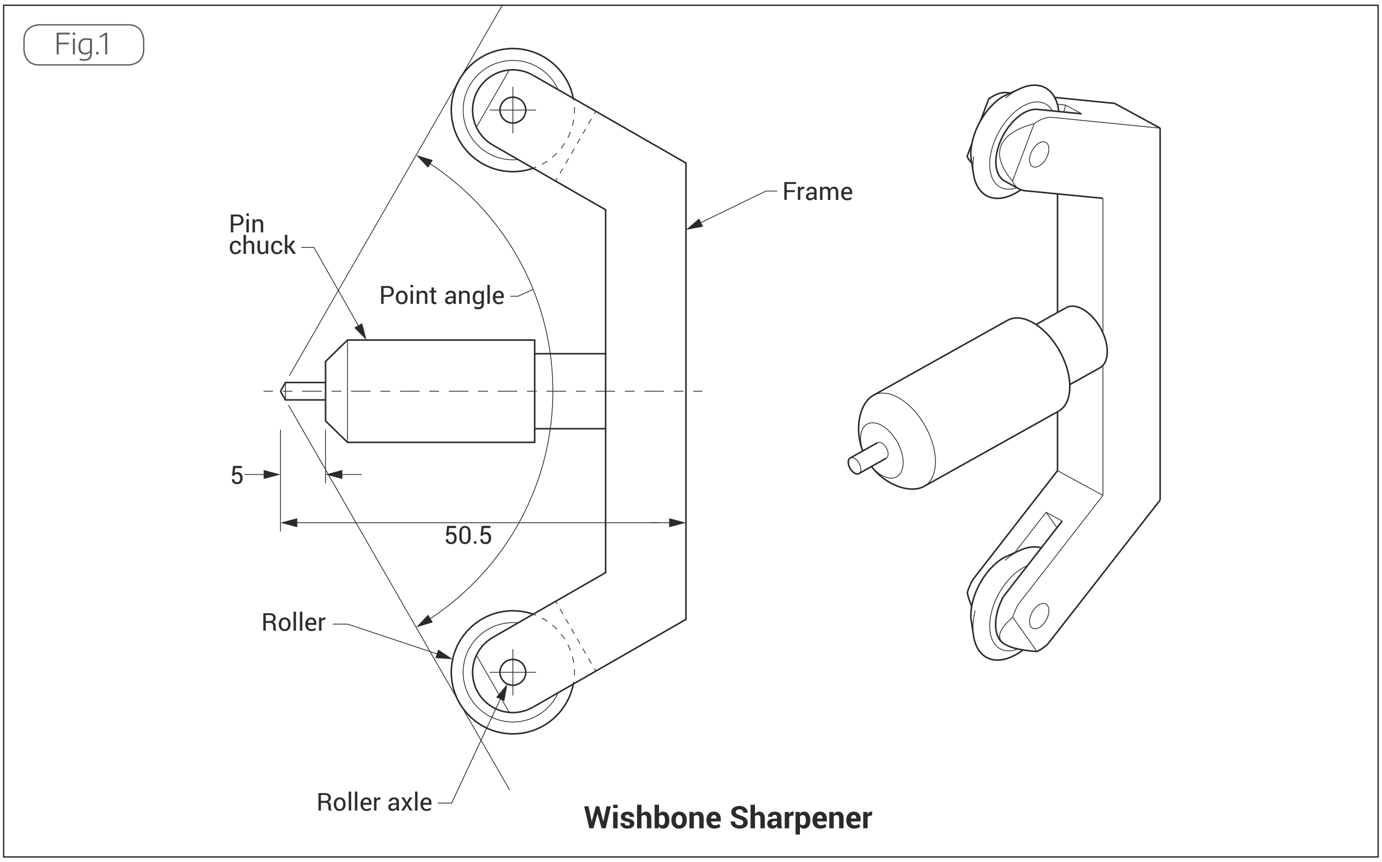
I propose here another solution being not better not worse, simply made in another fashion that can be of some interest for the model engineer.

The new concept

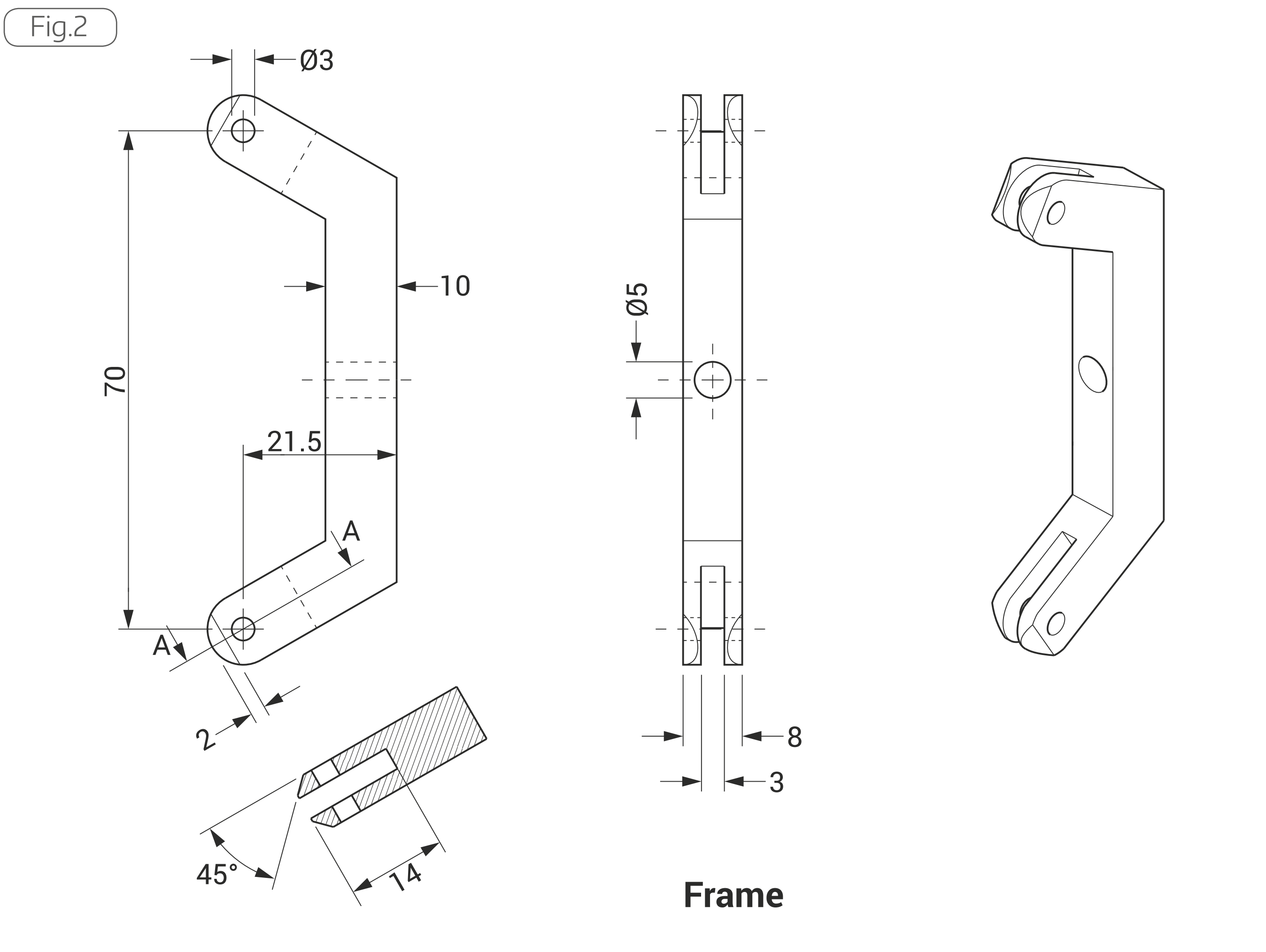
This attachment, shown in photo 1 and **fig.**



Trevor Marlow's wishbone design



Jacques Maurel's new design



1, is made from a low-price pin chuck, **photo 3**, providing an easy way for holding the drills, three 'collets' are given to hold from 0 to 3 mm drills.

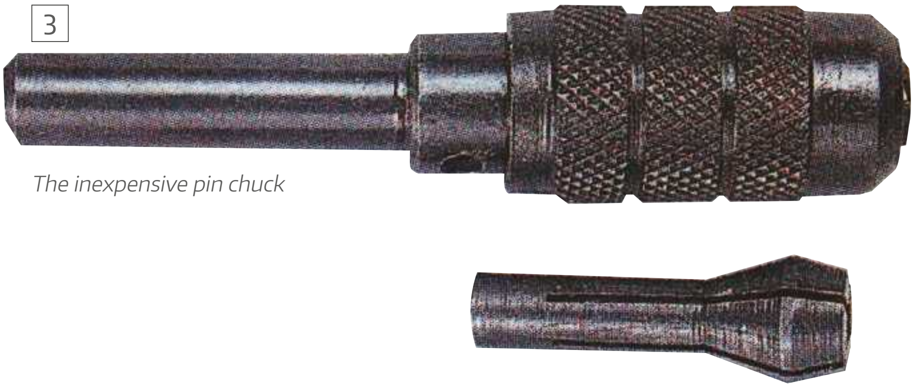
Machining

Pin chuck body This must be drilled through 3mm. The shank needs to be shortened to 10mm and 5mm diameter.

Frame (**fig. 2**) Sawn from 8mm Dural plate. The roller's grooves are machined with a slitting saw on a milling machine.

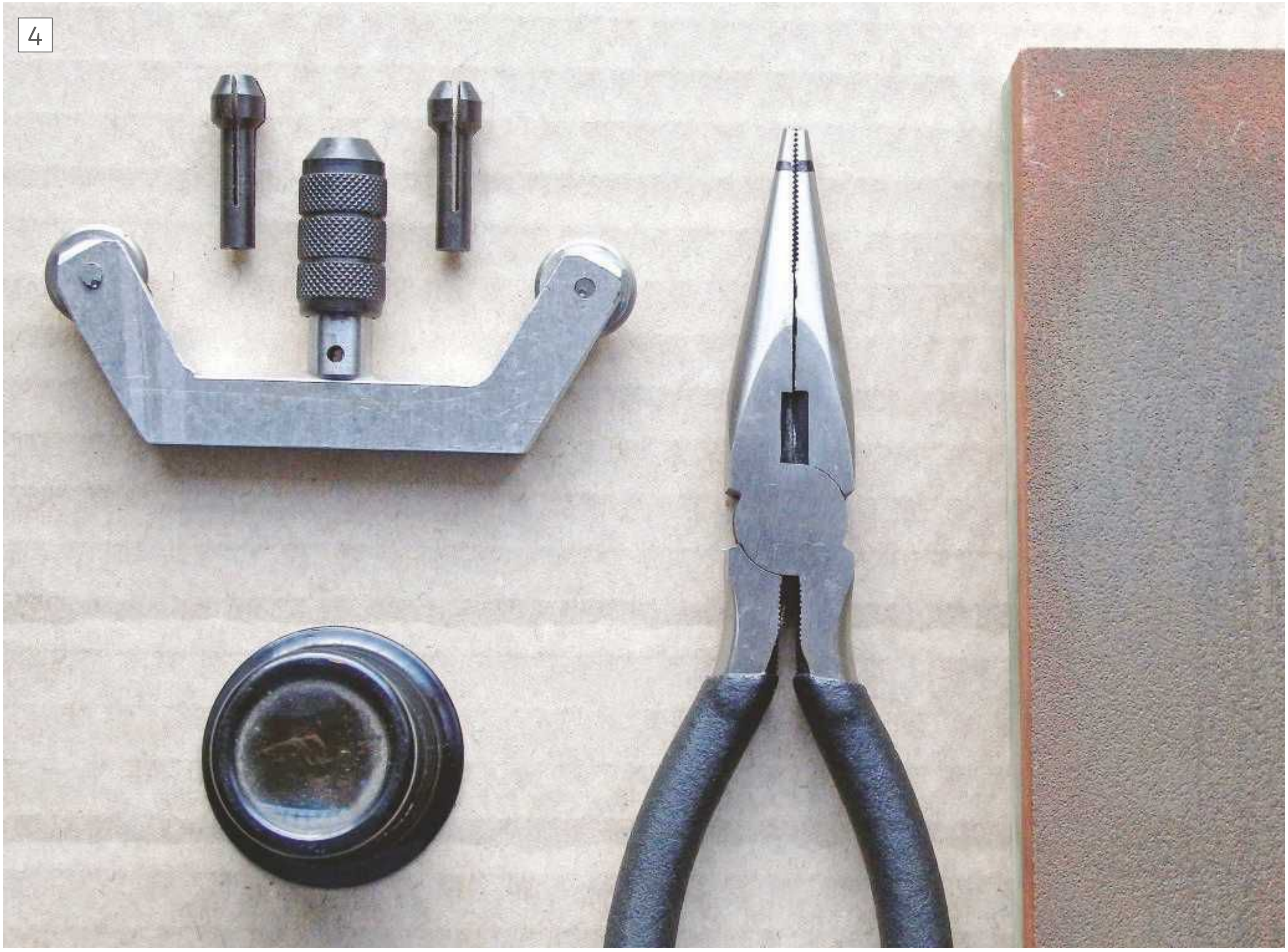
Rollers (**fig. 3**) Turned from free cutting mild steel, the rim being chamfered and

3



The inexpensive pin chuck

4



Items required for drill sharpening

5

Carefully adjusting the drill

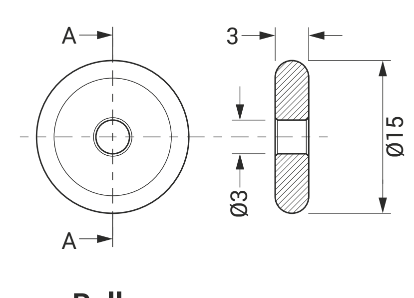
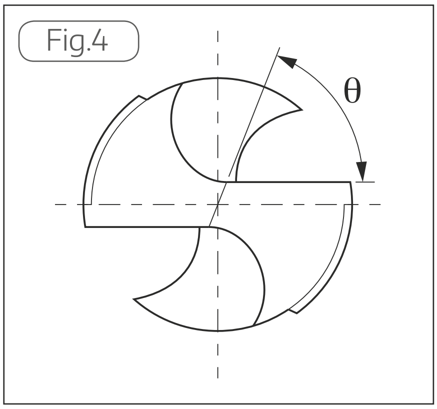


Fig.3

Start off at roughly a 30-degree angle...

...and finish nearer 15 degrees



then rounded by careful filing in the lathe. (Always take great care and make sure to use a file with a well-fitting handle).

Roller axles made from 3mm diameter, 8mm long silver steel.

Setting

The pin chuck body must be stuck in the frame with epoxy glue. A punch dot struck on the roller axle's ends will stop them drifting axially.

Using the attachment

A 1.5mm drill is used as an example. **Photograph 4** shows some of the tools involved.

1 – Tighten the frame in the bench vice.
2 – Chose the right collet and gently tighten the drill in the chuck.
3 – Use the fine-nose pliers, **photo 5**, for

- Setting the right drill protrusion (5mm, black mark) to get the right point angle right.
- Aligning the drill (cutting edges parallel with the frame plane).
- during the tightening of the chuck cap.

4 – Start the sharpening stroke on the slip stone farthest from you, **photo 6**, the frame tilted to the right about 30° and pull the frame toward you while tilting the frame from 30° to about 15° at the stroke end, **photo 7**.

Don't use a pushing movement for the frame as there will be a "digging in the stone" tendency for the drill which must always be trailing behind the roller.

Give the same number of strokes for each lip and check the result with a magnifying glass.

The cutting edges must be of equal length and fully sharpened, the chisel edge inclination θ, fig. 4, between 45° and 60°. Correct the angles if necessary.

For θ=45° the clearance angle is about 26°; for θ= 60° the clearance angle is about 16° - see my article using 3D CAD to explain drill sharpening in MEW issue 245.

The stone bracket

It's worth making a rear rest, shown in **photo 7**, having the same thickness as the stone, for the roller to go on to at the stroke end, and so get a longer stroke. ■

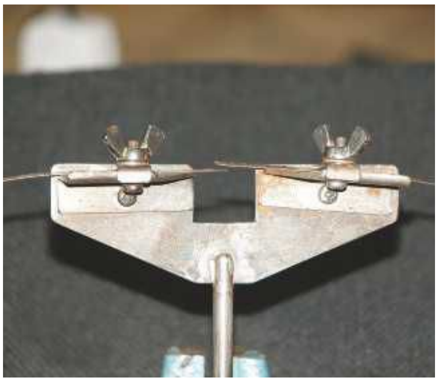
In our Next Issue

Coming up in issue 252
On Sale 27th February 2017

In the next packed issue of Model Engineers' Workshop:

Alan Hearsum builds a Drummond Lathe from spares

A Mill Indexing fixture from **Thor Hansen**



Gary Wooding looks at the repair of bandsaw blades

1 *1978 Boxford CUD lathe*

One Man and his Lathe

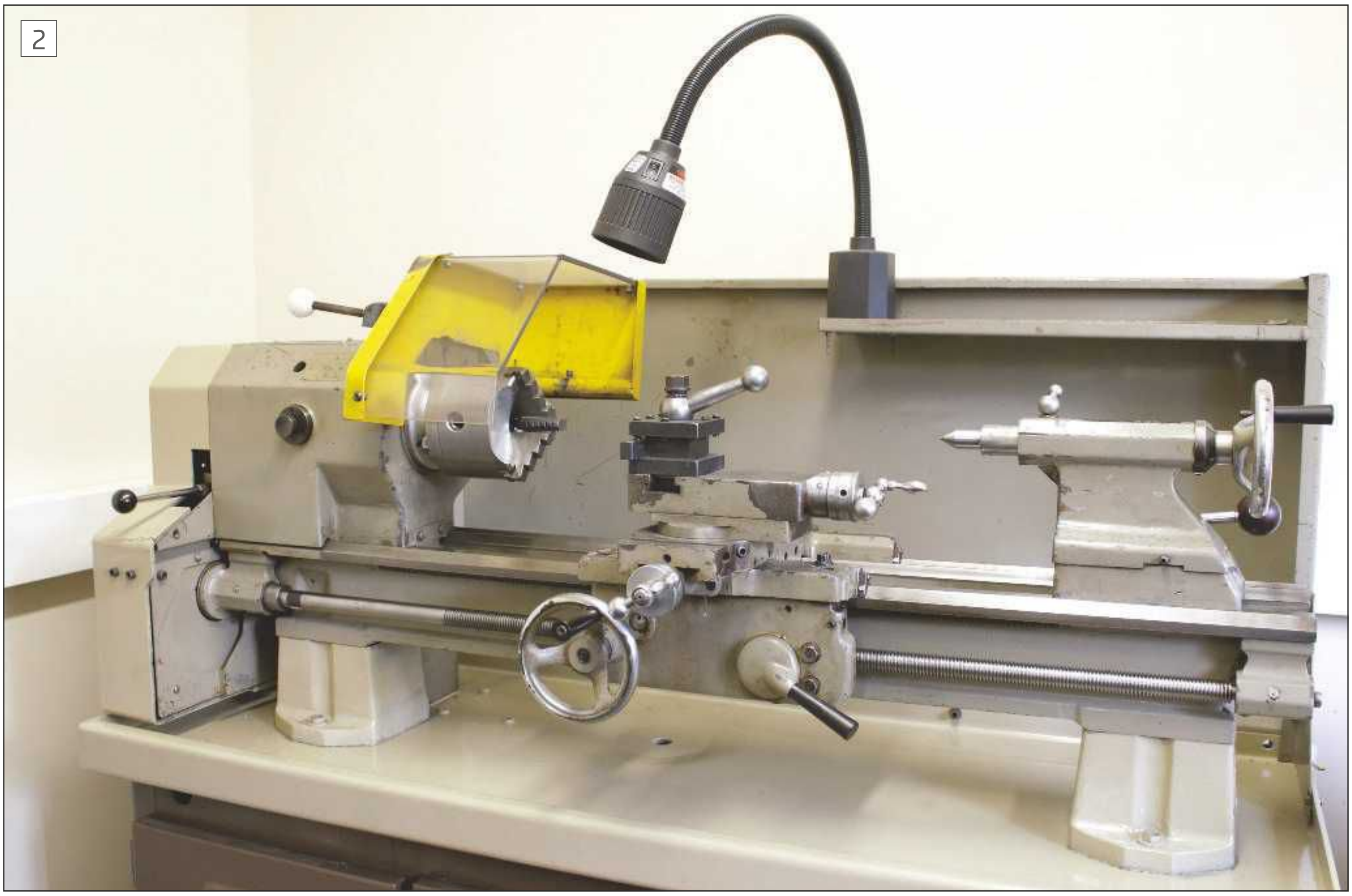
Nick Thorpe and his Boxford CUD

My lathe, **photo 1,** is a 1978 Boxford Mark III CUD that I bought in 2014 for £600 from a dealer in Sussex. About that time my school boy interest in small scale engineering had been rekindled and I initially considered buying a small Chinese hobby lathe to make a clock. My own industrial experience of electronically controlled motors coupled with a desire to keep things simple led me to concentrate my research to traditional belt driven lathes. There are a few new Chinese lathes that are belt driven but I turned my attention to used British products such as Myford and Boxford. I could have also looked at Harrison and Colchester to name just a few. Working on the theory that you can make small things on a big lathe but not big things on a small lathe, I eventually chose a Boxford as they can cope with fairly large work and tend to offer good value for money compared to a Myford. They are also very robust, relatively compact and are fairly easy to find.

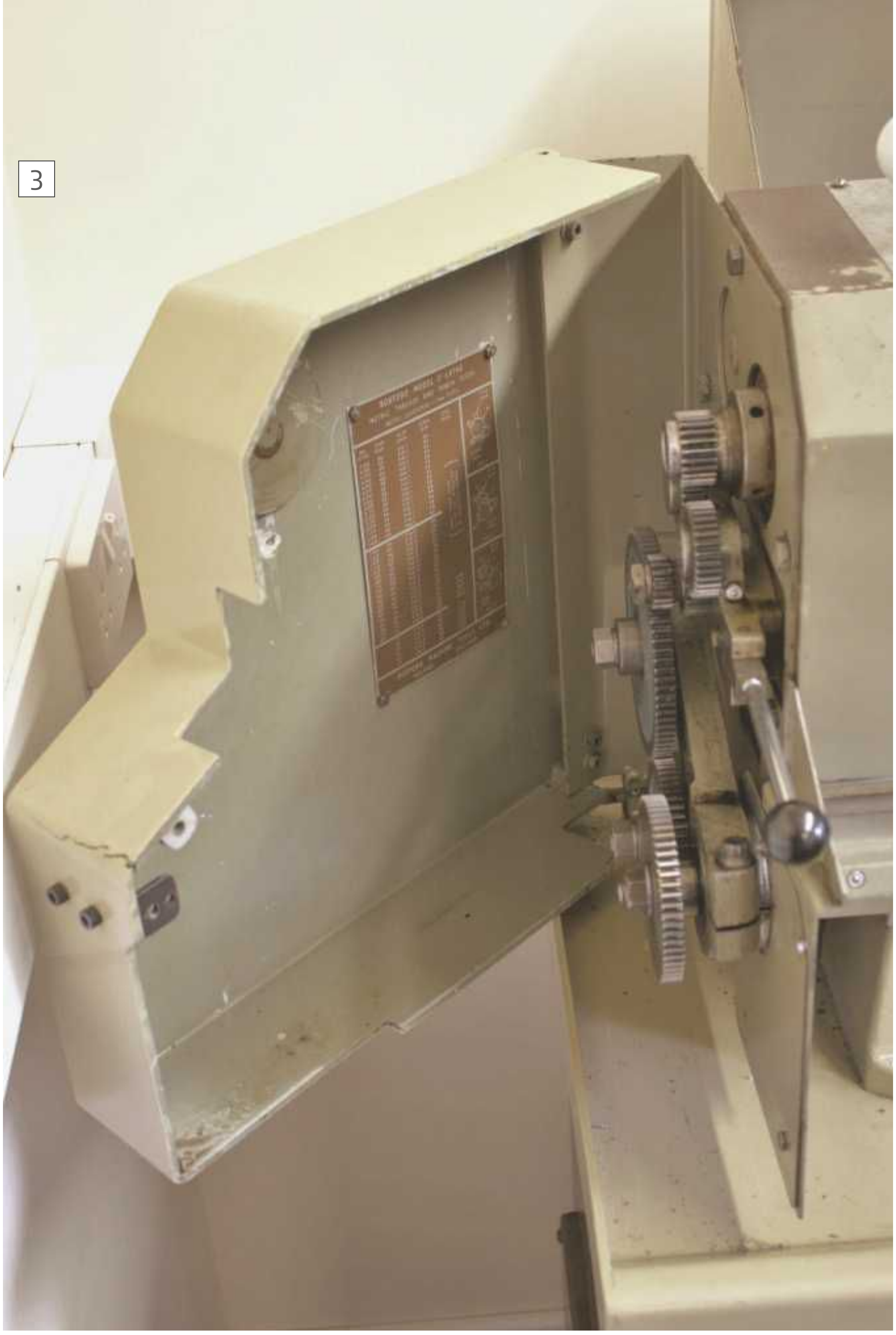
Background

The history of the Boxford lathe is covered extensively at lathes.co.uk, which is Tony Griffith's invaluable machine tool resource. Boxford's model types were primarily the A, B and C, and were available in metric or imperial configuration. The A and B have powered longitudinal and cross slides and the A also has a screw cutting gearbox. The C, **photo 2**, just has a powered longitudinal feed. There is a T, also known as the Technical, and this has completely manual longitudinal and cross slide feeds and no gear box, **photo 3** . The T's are relatively inexpensive but I feel that a powered longitudinal feed is a must for finish and ease of operation. My CUD has a useful centre height of 5" (127 mm) and a distance between centres 28" (710 mm). Shorter models have 22" (560 mm) between centres. Earlier Boxford models had a 4.5" centre height. The 'UD' suffix shows that the motor is an 'underdrive' and sits underneath the lathe in a solid purpose built steel stand. Another variant has the motor behind the headstock but these can be quite deep and take up valuable space, unlike the UDs which are a maximum of 53" (1350 mm) long for the 28" centres model and a very useful 22.5" (570 mm) deep, including the splash-back. One important thing to remember about these lathes is that they were designed for use in schools and might be too low for the average adult. I am 6' 2" tall (1.87 m) and raised mine by 4" (100 mm), which is a perfect height for me.

2



Top view of the lathe



Change gear cover open to show gears

Tom Senior mill

Buying

This was the hard part as I had no experience of lathes. The lathes.co.uk Website has an excellent section about buying a lathe and the obvious advice from most quarters is to take someone knowledgeable along with you. Sadly, I didn't know anyone with experience at that time and had to rely on my limited knowledge and perceived credibility of the vendor. I eventually decided that if there were any problems a Boxford could be resold, possibly at a slight loss, but that was a risk I was prepared to take. From my own experience in buying an Elliott pillar drill, a Tom Senior mill, **photo 4**, and the Boxford I would suggest the following criteria: In the first instance the cosmetic condition of the machine is not that important. My ex-school Boxford was quite tatty and the tray was through to bare metal in many places. Some little darlings had engraved their names on the change wheel cover. The important thing was a complete absence of major dents on the bed and no rust. The bed was clean and oiled and it seemed that the important parts had been oiled and greased during its life. I personally would steer clear of a pristine example that has been stripped and repainted unless this has been done by a specialist. The motor needs to be seen working and all variations of speed etc. should ideally be tested. Leaving the motor running for ten minutes or so will allow you to check for weird noises, especially from the headstock where the main bearings are housed.

Delivery

One major consideration is removal and delivery of the lathe which is very top heavy and weighs in at 560 pounds (254 kilos). This is where a Myford wins hands down as it is said to be a two-man lift. It is possible to break the Boxford down into its major 'manageable' components but I felt uncomfortable doing this at the dealer's premises. I ended up hiring a van with a tail lift. He dealer craned the lathe onto the van with an extra strong pallet that I had found and my colleague and I moved it at the other end with a borrowed pallet truck. The biggest problem is that they are top heavy and can easily fall over. Another alternative is to contact Steve Cox at Landy Lift who covers the country with a flatbed Transit with rear mounted crane, which is ideal for narrow drives.

I later broke the lathe down to move it into my workshop which is a fairly straight forward job when undertaken in one's own time and space. The main drive belt will have to be cut, the tailstock and carriage removed and two nuts loosened under the headstock which can then be slid off. I removed the bed from the metal stand as I was going to paint the tray. The bed and headstock are very heavy and I just about managed them on my own. I left the motor in the stand and while this was a heavy old lump I was able to manoeuvre it with a sack trolley.

Power

The Boxfords come with single or three phase motors. For those who don't know, single phase motors are the sort that we usually have in our homes and have one neutral conductor and one line (live) conductor. Three phase motors tend to be used in more industrial locations and for simplicity imagine that they are fed by one neutral conductor and three line (live) conductors. The three line conductors allow more electrical power to be delivered to the motor thereby providing more torque and smoother running. Most homes only have single phase power available but fortunately this can be converted to three phase using a box of tricks called a Variable Frequency Drive (VFD). The great advantage of a VFD is that it offers full control of the motor, not only allowing soft starts and reverse, but also the ability to adjust the speed from a few revolutions a minute up to full speed - and

New control panel

without power loss. There are other ways of converting from single to three phase but this is probably the easiest and most convenient. Some motors will work with VFDs and others won't. I chose an IMO Jaguar that came with five years' warranty from Transwave and it cost about £180. I also bought a pendant that provided the all-important switching and speed control for the motor. Installation of the VFD is fairly straight forward if you are experienced with electrical work, if not it is well within the capabilities of a qualified domestic electrician. My installation is shown in **photos 5** and **6**. The Boxfords have a safety interlock circuit that runs through various switches such as the motor cupboard door. The IMO Jaguar VFD has a useful safety function whereby it will not work if a continuous circuit is not evident across two low voltage terminals and I wired the Boxford interlock cabling to this point. As soon as an interlock is opened the VFD gently stops the motor and it will not restart until the switch is closed and the start button depressed. I wired the emergency off button into the same circuit and it works perfectly. Check out the Yahoo Boxford Group for more information about this subject.

Today

I am currently building a 5" gauge Sweet Pea narrow gauge locomotive and the Boxford is now being put to good use as I work on the chassis turning cast iron wheels and boring axle boxes. On the Yahoo Boxford Group site is a copy of the original factory QA test for a similar lathe and after checking all the measurements I could the Boxford is well within the manufacturer's original specification - not bad for 38 years old. ■

References:

Paint: Nearest match to Boxford beige on my lathe, but not perfect is Harrison Lathe Beige from Paragon Paints, who also sell other Boxford colours: paragonpaints.co.uk

Three phase conversion: Transwave Convertors +44 (0)121 708 4522 or Ebay

Yahoo Boxford Group - just Google it.

lathes.co.uk - an invaluable resource about machine tools, also has a good buy & sell section

Model Engineer Website, For Sale section: model-engineer.co.uk

Control panel wiring & VFD (blue box)

All advertisements will be inserted in the first available issue. There are no reimbursement for cancellations. All advertisement must be pre-paid. The Business Advertisements (Disclosure) Order 1977 - Requires all advertisements by people who sell goods in the course of business to make that fact clear. Consequently all trade ads in *Model Engineers' Workshop* carry this 'T' symbol

MODEL ENGINEERS' WORKSHOP CLASSIFIED

MODEL ENGINEERS' WORKSHOP CLASSIFIED

HOME AND WORKSHOP MACHINERY
Genuine Used Machines & Tooling
144 Maidstone Road, Foots Cray, Sidcup, Kent DA14 5HS
Tel: 0208 300 9070 - Evenings: 01959 532199 - Fax: 0208 309 6311
www.homeandworkshop.co.uk • sales@homeandworkshop.co.uk
Opening Times: Monday-Friday 9am-5.30pm • Saturday Morning 9am-1pm
10 minutes from M25 - Junction 3 and South Circular - A205
£3250
very nice example
Holbrook 8B toolroom lathe 240V
£3450
Weiler lathe + collets... lovely!
Tom Senior 'V' (large table)
£2450 240 volts
See 'To Clear' section
240 volts
Colchester Bantam lathe
Lots of aluminium - just in!
Tapmatic 50 TC/DC 2MT tap holder
£145
MYFORD Super 7B
Beautiful!
£3950
Ferranti Inspection bench
£2250
Myford super 7B lathe
£5750 Immaculate!
£3950
Myford Super 7B + Sino DRO & Tesla
£875
Eagle Model 3 surface grinder
£845
Edwards 40" 14g/16g geared rolls
from £75
Faceplates various
Wadkin 10" AGS saw bench
240 volts
£1475
Just arrived!
£15 each
DP/MOD gears
New
Myford nose and chuck type collets
£30 each
Trolley wheels (heavy duty) sets of 4
£40
Rolsan Reelers 40" powered rolls
£2250
£425
Viceroy 240V 16" grinder
Baileigh AP5; 5Ton press
£475
£65 each
Trolleys Various!
£375
£625
Edwards 40" guillotine
Rapidor Major hacksaw
Kerry 240V lathe...
...see 'To Clear' list in Web Site
Fobco drill 240V
£375
£3450
BCA MK111 + lots of tooling
WD-40
from £10
Tap/ Die holders
£20 each
Harrison 140 lathe
£1650
Prince 6075 grinder
£12000
£1850
BRL mower grinding machine
Choice £1725
Jones and Shipman 540 grinder
£5750
Colchester Triumph lathe
£425
J & S arbor press 8"x 15½" height
Myford non standard wheels
£10-£49
£1725
Boxford MK111 CUD 5"x 28" long bed
£425
Hofmann 10" rotary table
MYFORD GENUINE PARTS
Running out fast!
Purchased from Nottingham
Check the web site for full list!
£525
RJH late buffing machine
Bridgeport Series 1 2HP mill
£4250
Various!
0-16"/ 300mm Micrometers
£125
New 18"x 6" ground compound table
Steel EN3B (mild steel)
£7 each
various!
Angle plates + surface plates
Special 5 for £20
Myford ML7/ Super 7 Rifle/ Bridge bed felts
£90
Tripus (German) on/off switch
£425
Boxford Little Giant toolpost grinder
New
Myford coolant
£345
NOW ARRIVED!
• Harrison M300 lathes
• Startrite 18-S-10 metal bandsaw
• Surface tables
• Warco surface grinder + more!
PLEASE PHONE 0208 300 9070 TO CHECK AVAILABILITY OR TO OBTAIN OUR LIST
DISTANCE NO PROBLEM! • DEFINITELY WORTH A VISIT • ALL PRICES EXCLUSIVE OF VAT
Just a small selection of our current stock photographed!
We are currently seeking late 'Myford Super 7B' & 'Super 7 large bore' model lathes!
SHIPPING WORLDWIDE
New even easier to use Web site!
SWITCH
MasterCard
DELTA
VISA

CHESTER
Machine tools
Orderline: 01244 531631
Visit us at the Manchester Model Engineering Exhibition
MMEX
Saturday 18th February 2017 - Sunday 19th February 2017
@ Queen Elizabeth Hall, Oldham OL1 1QJ
DB7VS Lathe
300mm Between Centres
180mm Swing Over Bed
£768.90
Stand Included
Craftsman Lathe
570mm Between Centres
300mm Swing Over Bed
£2,359.50
D13 Drilling Machine
13mm Drilling Capacity
0.25kW Motor
600-2500rpm Spindle Speed
£99.00
Champion 20V Mill
360mm Spindle to Table
700x180mm Table Size
MT2 Spindle Taper
£955.91
626 Turret Mill
20mm Millling Capacity
660x152mm Table Size
R8 or MT3 Spindle Taper
£1,686.30
H80 Band Saw
Horizontal Band Saw
85x85mm Rectangle Capacity @ 90°
90mm Round Capacity @ 90°
0.4kW Motor
£173.81
NEW
Conquest Super Lathe with DIGITAL SPEED READOUT
325mm Between Centres
180mm Swing Over Bed
£495.00
NEW
Conquest Superior Lathe with BRUSHLESS MOTOR
325mm Between Centres
180mm Swing Over Bed
£682.00
Conquest Super Mill
270mm Spindle to Table
100-2500rpm Spindle Speed
460x120mm Table Size
£575.29
Champion 16V Mill
360mm Spindle to Table
700x180mm Table Size
MT2 Spindle Taper
£713.89
DB10 Lathe
Closed Gearbox
550mm Between Centres
MT3 Spindle Taper
100-2000rpm Speed Range
£1,175.89
DON'T FORGET OUR ONLINE TOOLING SHOP
www.chesterhobbystore.com
sales@chesterhobbystore.com
All prices include VAT but exclude delivery
Chester Machine Tools, Clwyd Close
Hawarden Industrial Park, Hawarden
Chester, CH5 3PZ