No.161

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MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

MARCH 2010

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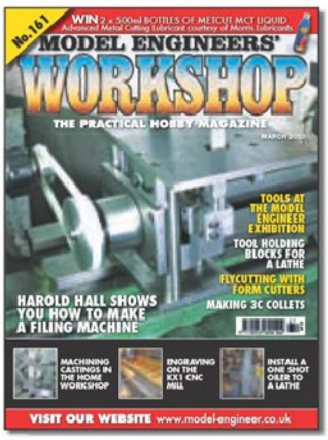
Contents

ON THE COVER

A homemade filing machine. See article on page 12. Photo by Harold Hall



SUBSCRIPTION GIFT!
HEADBAND MAGNIFIER

Please see page 10 for our latest subscription offer. This is a headband magnifier with four different lenses and it is ideal for small work in the workshop or maybe even for reading Model Engineers' Workshop!

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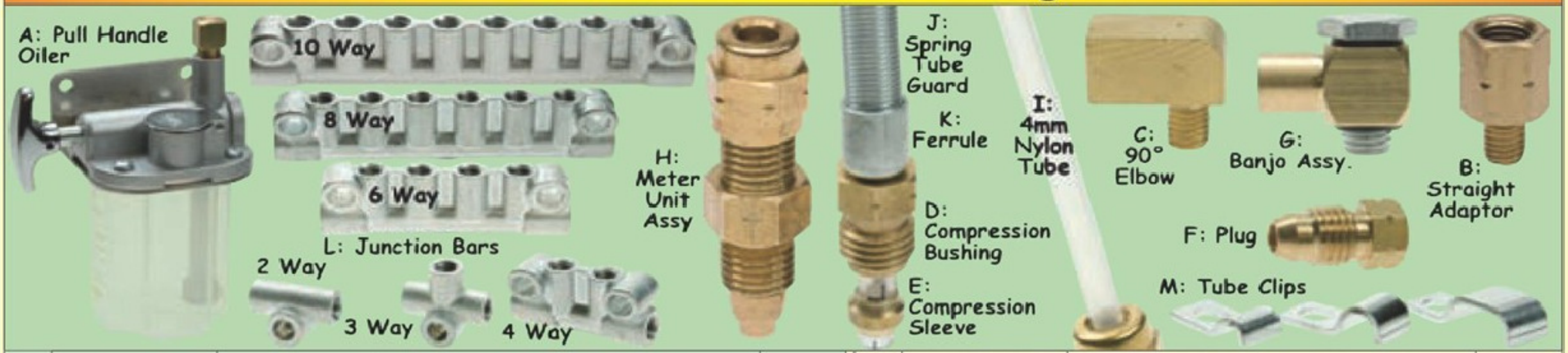
One Shot Lubricator Fittings



A	084-025-00001	Pull Handle Oiler - 180ml reservoir - 3ml/shot with 90° Hose Adaptor M8x1.0 (F)*	£23.95
B	084-025-00200	Straight Hose Adaptor - M6x1.0 (M) - M8x1.0 (F)	£1.00
C	084-025-00250	90° Elbow Hose Adaptor - M6x1.0 (M) - M8x1 (F)	£1.25
D	084-025-00300	4mm Compression Bushing - M8x1.0 (M) - Pack of 6	£3.00
E	084-025-00350	4mm Compression Sleeve (Olive) - Pack of 6	£1.00
F	084-025-00400	Plug - M8x1.0 (M)	£1.00
G	084-025-00500	Banjo Assembly - M8x1.0 (F) - M8x1.0 Banjo Bolt	£2.75
H	084-025-00099	AJB00 Meter Unit Assembly - M8x1.0 (M) (smallest)	£2.95
	084-025-00100	AJB0 Meter Unit Assembly - M8x1.0 (M)	£2.95
	084-025-00101	AJB1 Meter Unit Assembly - M8x1.0 (M)	£2.95
	084-025-00102	AJB2 Meter Unit Assembly - M8x1.0 (M) (largest)	£2.95
I	084-025-00700	4x0.75mm Nylon Tube - Per Metre	£1.00
J	084-025-00750	Spring Tube Guard for 4mm tube - 6 Metre length	£12.00

K	084-025-00760	Ferrule for spring ends - Pack of 6	£2.00
L	084-025-00602	Junction Bar 2 Way - M8x1.0 (F)	£2.95
	084-025-00603	Junction Bar 3 Way - M8x1.0 (F)	£3.25
	084-025-00604	Junction Bar 4 Way Single - M8x1.0 (F)	£3.75
	084-025-00606	Junction Bar 6 Way Single - M8x1.0 (F)	£4.95
	084-025-00608	Junction Bar 8 Way Single - M8x1.0 (F)	£6.95
	084-025-00610	Junction Bar 10 Way Single - M8x1.0 (F)	£8.95
M	084-025-00770	4mm Tubing Clip (1 Tube) - Pack of 4	£1.00
	084-025-00780	4mm Tubing Clip (2 Tubes) - Pack of 4	£1.00
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	084-025-00800	6mm Tubing Clip (1 Tube) - Pack of 4	£1.00
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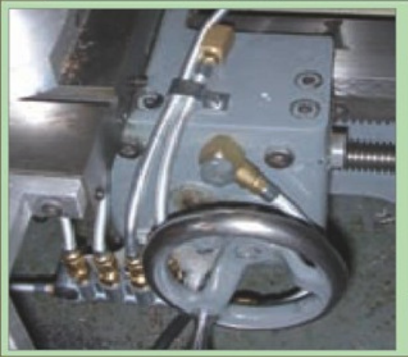
* Requires compression bushing & sleeve - (F) = Female - (M) = Male



See Tony Jeffrey's article in this issue on adding a One Shot Lubrication System to a Myford ML7.

To save customers having to state each and every part number for this project, we have created a new product code which covers all the parts and quantities mentioned in the bill of materials.

084-025-10000 One Shot Lubrication Parts for Myford ML7 **£160.00**

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CODE	JAW WIDTH	PRICE
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XC216	4"	£39.10
XC217	5"	£48.90

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MAP744	6 x 5 x $4^1/_2$	£28.95

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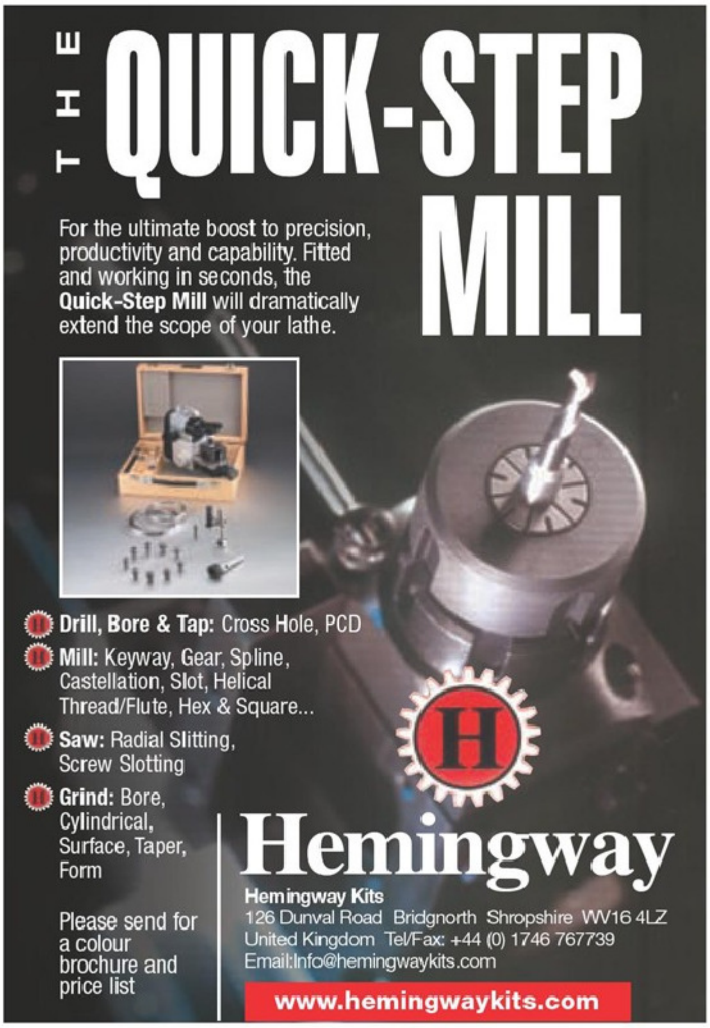
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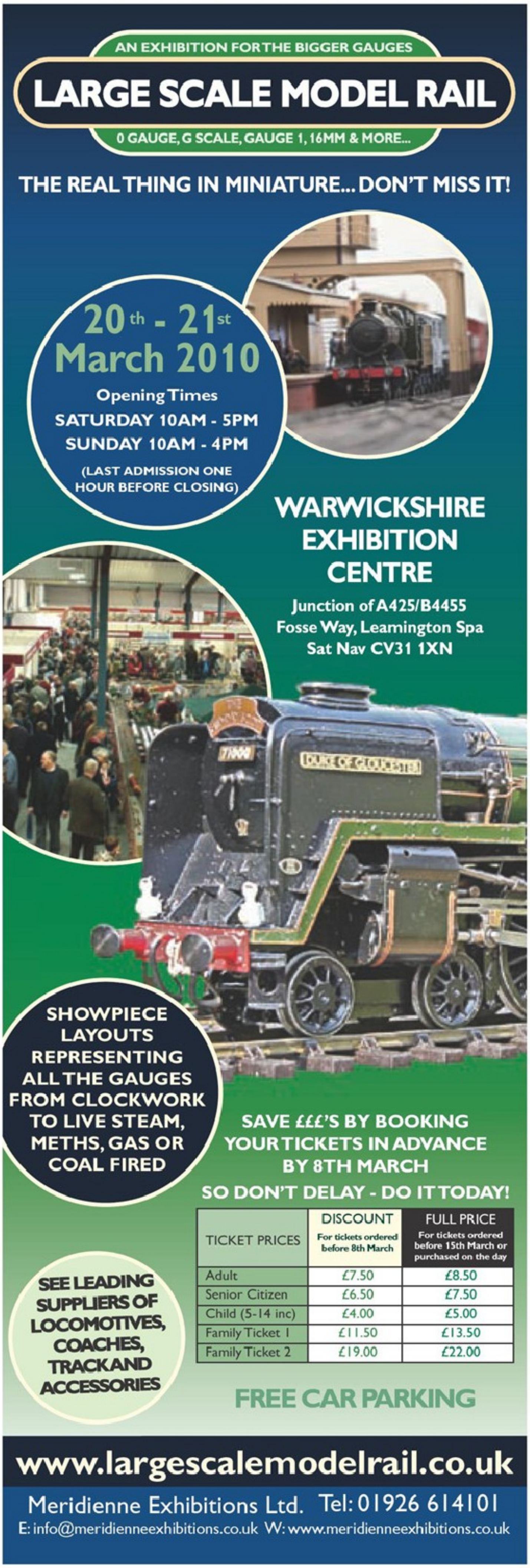
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ON THE EDITOR'S BENCH

David Clark

On the web

The web site is very active at the moment, membership is rising fast. Forums are very active and plenty of photos are being posted to the gallery. Free Adverts on the website, both for sale and wanted are also starting to increase. I have noticed membership increases each time a magazine hits the doorsteps.

We shall soon be offering a Digital version of Model Engineer back issues. There should be no teething problems with the Model Engineer Digital Editions as we have sorted out most of the minor problems with the MEW Digital Editions.

Myford Open Day

The Myford Spring Show is on Thursday 15th April from 9am to 5pm, Friday 16th April 9am to 5pm and Saturday 17th April 9am to 3pm. I am hoping to be there for all 3 days. I really enjoyed last year's Spring show. I spent too much as well. Malcolm Towsend, who has worked at Myford for many years, is retiring soon after the show and I am sure you will join me in thanking him for the service he has provided to model engineers over the years.

The SMEE have a stand as usual and also, this time, Erewash Valley and Nottingham Model Engineering Society will be attending. Kirjeng M.E Services will be supplying a wide range of cutting tools and Kirk and Sandra Burwell will be bringing a selection of their Hemingway Kits.

Myford staff will be on hand to demonstrate maintenance on a Myford lathe. Subjects covered will include changing the belt drive and adjusting the spindle bearings and the saddle and slides to get the best from your Myford.

Myford employees will be demonstrating milling and Myford Electrician Ian Mills will be there to discuss Myford related electrical queries. I hope to see you there. Why not see if your club can organise a coach trip to visit. Entry is free and the whole event is very enjoyable. Oh, I nearly forgot, Doreen Paviour will be selling bar ends. These are the remains of the material used in the production of Myford lathes. This is always a popular feature and although the metal sells fast, there is usually enough to go round.

Gremlins

Most of the gremlins have gone although as I write this, incoming email is not working. There appears to be a problem with the office email server. I can however, send emails as they don't go through the office server. Until the email stopped working, I don't think I realised how much time it takes up and how much I rely on it. It also makes simple tasks difficult because I have to dig out a phone number and phone someone to ask a simple question. Then, on this occasion, I had written the phone number down incorrectly and found I was a digit short.

Still, these things are sent to try us.

In the workshop

I don't know about you, but I have not been out in the workshop much recently. I had decided to do some work over Christmas but it has been too cold. Not that I mind the cold that much, I am more worried about the machines going rusty if I switch the heat on in the workshop. I have a dehumidifier running permanently during the winter period. There did not appear to be much water in the air until mid December. Certainly the dehumidifier in the brick workshop did not take in much water. The one in the wooden workshop was virtually empty as well. Since the snow melted, the dehumidifiers have been very busy and have to be emptied every 3 days or so.

More storage

I have put up one of the little multi drawer cabinets and also mounted a TV wall bracket above the lathe tailstock to take the quick change toolposts and spanners. I also purchased a toolbox and stand as I am short of storage space and also wanted to move the surface plate off the main workbench so I could fit a bench vice.

Although the toolbox is reasonably strong, the base front panel is quite weak as regards thickness. I think the paint is probably thicker than the metal. However, the basic framework is adequate to support the surface plate and I gained a couple of drawers and a large storage section with a fold down flap. The storage section should be ideal for storing inspection equipment. I have removed the castors fitted to the cabinet as they made the cabinet rock and have also added a chipboard top to the base unit to spread the load of the surface plate.

Before Christmas I ordered a few bits of tooling to make life easier. I now have a decent set of small clamps for the mill and can tackle almost any job that is thrown at me. The lathe is almost fully equipped now. I also purchased a range of wobblers of different types intending to do an article on them and then received a comprehensive article about them a few days later in the post.

At last, I am getting more organised, at least the brick workshop is. I find that if I go out into the workshop and can start work immediately without having to step over a pile of boxes filled with tools, I am much more likely to produce some useful work. Although rust is not a major problem the odd little mark does appear especially on recently machined surfaces. I went on to EBay a few weeks back and bought some Silica Gel sachets. They are widely available on EBay in various packet sizes. A lot of tools are now stored in the Myford lathe stand in some of the 'Really Useful' range of plastic boxes together with a pack of Silica Gel.

Workshop Special

I have started thinking about the next Workshop Special. This will be a look at basic tools and machining in the home workshop. It will include several useful projects and although some will be based on the ML7, they should be capable of being adapted to other lathes. I know some readers don't like articles based on Myford lathes as they don't have one but most projects are capable of being modified to suit other lathes. A case in point in this issue is the one shot oiler article. This is based on the Myford ML7 lathe but the principle and the components are capable of being used on any lathe or milling machine.

Projects included

Many designs for tool grinding rests have been produced in the past and they all probably work very effectively. However, I have designed one of my own that is capable of sharpening lathe tools accurately. It will be simple to make and do basic lathe tool sharpening accurately and quickly. I may include an attachment to sharpen end mills and slot drills on the cutting face if time is available.

A couple of years ago, I published designs for a carriage stop for the Myford lathe. This was successful but only had one (adjustable) stop position. With the addition of a few bits of bar and some more stop rods, this stop is now much more versatile and can easily be adapted to any lathe.

Also useful will be a cross slide stop and/or indicator holder. I am designing this at the moment and it looks like being a useful piece of equipment on the lathe.

An indicator set to lathe centre height is very useful for clocking work true in the four jaw chuck and a simple attachment for this is planned. Finally, a long while back I started to make a rear parting of tool holder. This I hope to complete soon and drawings will be included in the Workshop Special. There may be other little projects included if there is sufficient room and time to do them.

The Special is not on sale until the 19th of July so I have time to write it all and now I have told you what will be included, I have no alternative now but to go out into the workshop and get on with it.

1. The completed filing machine.

HOW TO MAKE A FILING MACHINE

Harold Hall makes a useful machine

My involvement with filing machines is very limited and dates back some 57 years. At the age of 15, I went to work for an electrical control gear company but as in those days such companies made many of their components there was a very large machine shop. As a result, my apprenticeship started with me working on the capstan lathes, moving on to the milling machines and then to the press department. I must have made a good impression as after 18 months I was asked if I would like to work in the Jig, Tool and Production Methods office, and stayed there for 3½ years prior to doing my national service. As a result it was not much of an electrically related apprenticeship but I was very happy with the situation.

There were just three of us in the office, the manager, one chap designing the multi stage press tools for the more complex items and myself doing the simpler press tools, also drilling, welding and assembly jigs, etc. I tell you this because it was in the tool room that a filing machine existed and it was used extensively for producing the very shallow angle at the rear of each press tool die so as to provide clearance for the part being ejected out at the rear, also being used on the front of the die when this was of a complex shape that could not be easily made by other means. This use is no doubt why such machines are often called die filing machines. However, my involvement was just watching as some of my press tools were being made so I did not get any hands on experience.

OVERVIEW

Following the publication of a filing machine on the front cover of issue 155 the editor made it known that an article describing the design and manufacture of one would be ideal for the magazine. Having had a very successful period completing some major non metalworking tasks, time for the workshop was obviously going to be available and as this would be during the winter period it would fit in nicely. I therefore suggested to him that I could now produce a few more articles and a filing machine (**photo 1**) could be one of them and as no other offer had been forthcoming it was agreed that I should take on the task.

Having mentioned the photograph of the finished machine readers will appreciate that there is a limit to the number of photographs that can be published in the magazine even for something this complex, this especially as the article demands a large number of pictures of the parts being made and assembled. In view of this I have decided to publish a range of photographs of the machine, taken from various angles, on my web site (**ref 1**). The articles in the magazine are however, complete on their own, the Internet photos being a useful but not essential reference.

The basics

With so little experience to work on I needed to establish the basics before going on to design a machine that would fill the bill, and started by browsing the Internet for information. Having found a few photographs of industrial machines there was one that included a collection of files although these were quite large and appeared to have a round end rather than the pointed tang of a conventional file. This obviously made it easier to provide a secure and accurate mounting for them. The files therefore seemed the next place to continue my investigations.

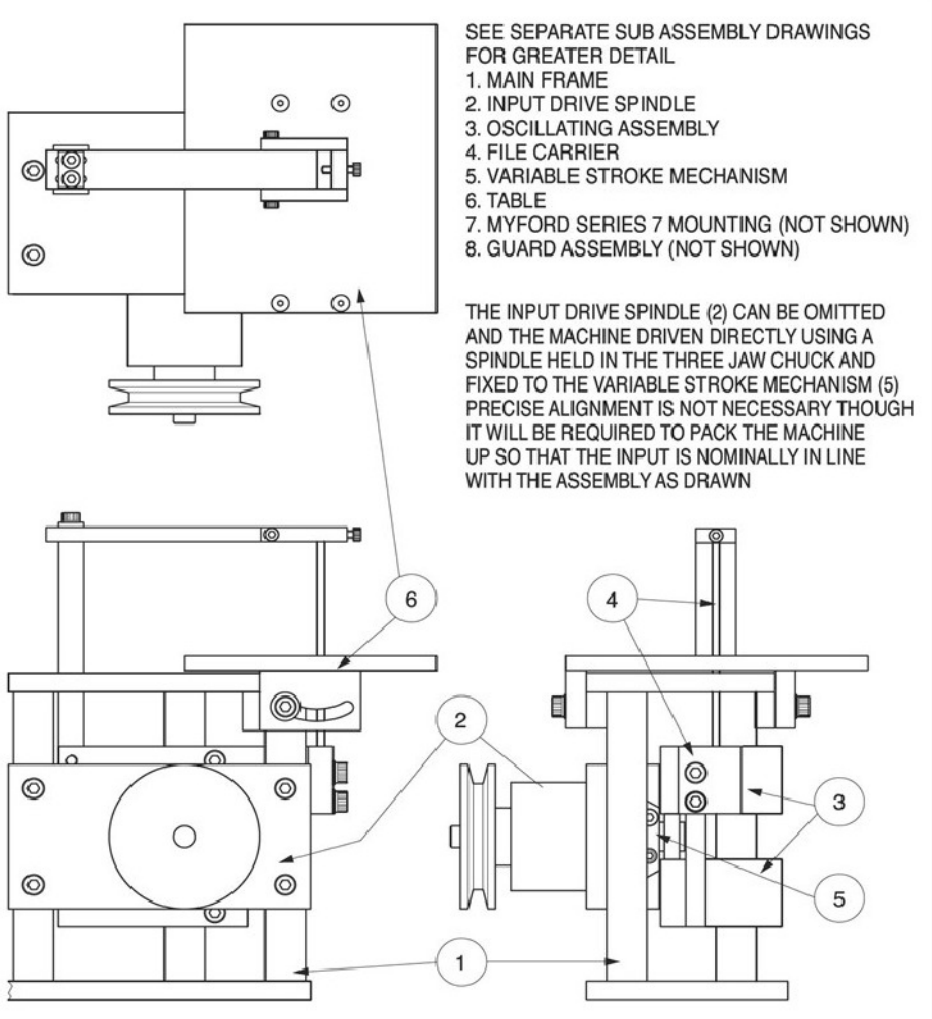
My very large industrial tool supply catalogue seemed the logical place as I expected to find them there, but none were listed, with a similar result when searching the web. Apart from just one American company that had files specifically named as being for use on a filing machine but by their dimensions appeared to be no more than needle files, there may though be an answer to this but more about this later. I did subsequently find one other file manufacturer, again in America, who listed filing machine files but no details were given as to their cost or where they could be purchased. I anticipate that due to limited demand they would be quit expensive.

I also found a forum on the web where the subject was being discussed and the approach being taken by some was to modify standard files. Whilst the end result was no doubt very satisfactory I did not feel I wanted to take this approach and decided to attempt to use standard files as purchased. However, eventually I had to accept the modified file approach as being the only satisfactory one.

Most of the filling machines that I found illustrated on the web held the file solely on its lower end making it possible to thread the workpiece over the file and then enabling it to be easily removed for inspection as the work progressed. As I considered this to be a very worthwhile feature I decided that the machine must make this possible. Even so, this may limit the rate at which material can be removed as the file may flex if too much pressure is placed onto it and being able to be mounted on one or both ends seemed an essential feature to aim for.

It also occurred to me that, if using the tang as a single ended method, it would be cutting on the up stroke. That seemed contrary to normal practice as typically bandsaws and jigsaws, etc. all pull the work towards the worktable. It did though make me wonder if those files mentioned earlier were in fact needle files but with their cut reversed. I decided therefore that I would have to use standard files but to remove the tang and endeavour to mount them so that they cut on the down stroke, choosing 100mm long files for the purpose.

With what appeared to be a relatively crude method of mounting the file, I was concerned that the file face may not be parallel with the file's movement. This would mean that the workpiece would have to move backwards and forwards, albeit minutely, to keep in contact with the file at each stroke, a situation that would be far from ideal. Some adjustment would therefore have to be provided so that the file's face was parallel with its movement. With a file having parallel sides, setting the edges parallel was also important so adjustment in this direction was deemed also to be necessary.



FILING MACHINE
BASIC ASSEMBLY

Speed in terms of strokes per minute (SPM) would have to be decided and as I could find no data regarding this I had to come up with what I considered to be a logical starting value. Making an estimation as to the rate I would use if filing manually, a speed of between 200 and 300 strokes per minute appeared to be a good starting point. However, file speed would depend on length of stroke as obviously if the stroke length were doubled for the same SPM then the file linear speed would double. I decided therefore that to provide the facility to change both SPM and stroke length would be worthwhile, aiming at mean values of 250 SPM and 25mm stroke length. I did though eventually find the design I had produced worked well at speeds considerably in advance of this value; more about that later.

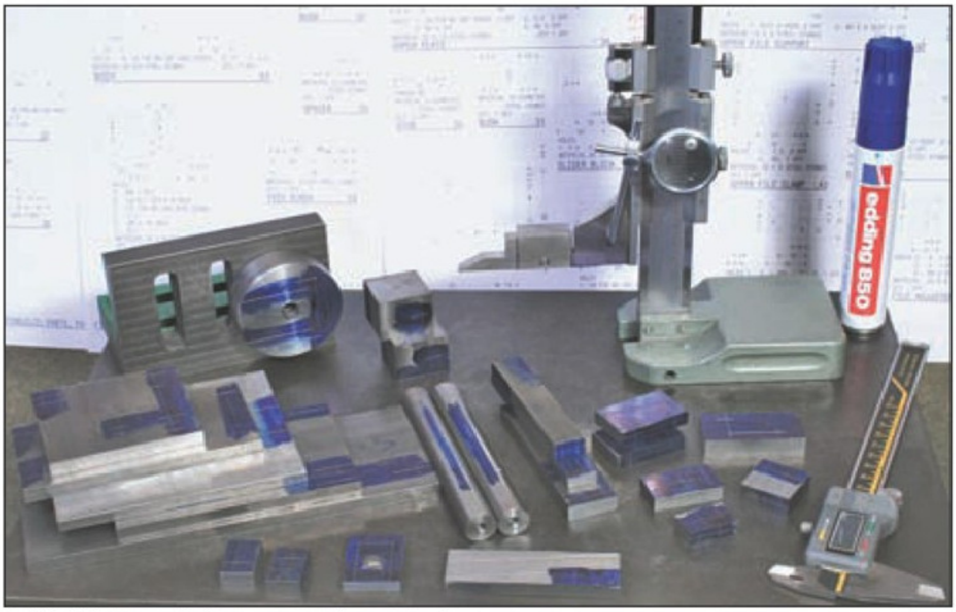
The drive

Next, the method of driving the machine had to be decided and I chose for it to be mounted on the lathe's bed, taking its drive from the lathe itself using a belt and pulley arrangement, the main advantage of this being that a range of low speeds was available making it easy to experiment to find the best value for the work in hand. I could have chosen to line up the input spindle with the lathe's spindle and connect them using a flexible coupling but felt that this would prevent me being able to choose the input drive position as that would be best for the design I eventually established. With the design principles established I could perhaps revert to a direct drive if it was found beneficial.

Another benefit of the belt drive arrangement would be that it could be driven from an electric motor should the user wish. This I thought at the time would need a motor with gearbox as getting the reduction using just a single belt would be impractical due to the ratio required. However, as I said above, the machine worked at speeds higher than I had anticipated but even so a large reduction ratio would still be required and this was only available with a single belt if a large pulley were acceptable on the filing machine itself.

The basic design

With the design criteria established this was translated into a working design but being complex it is difficult to get all the detail into a single assembly drawing and I have therefore produced a basic assembly drawing plus additional sub-assembly drawings for specific sections of the machine. These are listed on the basic drawing. With there being so many parts to be published over many pages I have, so as to make it easy for the reader



2. Marking out all the parts at the same time.

to associate a part with the sub assembly in which it is being used, numbered them typically, 31, 32 33, etc. for assembly 3. Before I proceed with the sub assemblies some further background information is appropriate.

Materials

In the appendix (**ref 2**) I have listed the suppliers for the materials that I have used but of course there are others should the reader wish to purchase them elsewhere. I do know though that readers frequently find it difficult to obtain the metric materials I list in my designs and can recommend the supplier I have used as they list a very wide range of metric sizes, typically listing 233 metric steel flats in 070M20 (EN3B). Also, as they advertise in MEW they are geared up for supplying in small quantities.

For the files, I chose Swiss made Vallorbe files. Unfortunately though, I could not find one supplier who listed all the file shapes I wanted in the 100mm length so I have therefore given the two suppliers that I used (**ref 3**).

Ball races are widely available but I have included the supplier I used who lists a vast range (**ref 4**). Editors Note, I have also added Arc Euro Trade as bearing suppliers as they always check bearing sizes and specifications for me and give me international standard bearing codes. This means that you should be able to use these codes to purchase bearings worldwide.

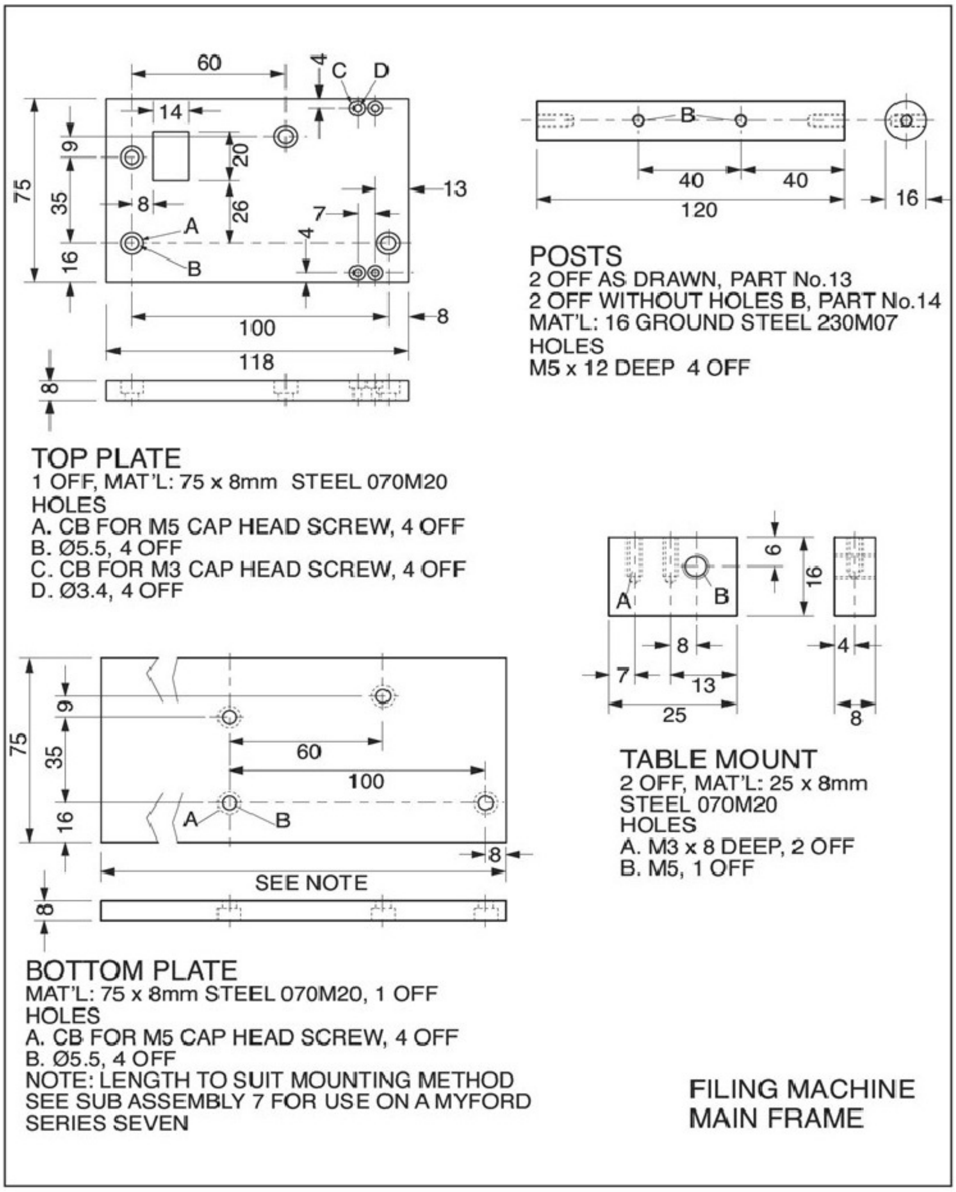
Brief notes

Where I call for holes to be counterbored for socket head cap screws I have not quoted a diameter or depth. My reasoning for this is that readers counterbores are likely to vary in size as I can find no quoted standard diameters, the depth should be just larger than the thread diameter, typically 6.2mm for an M6 thread. I have though quoted a clearance size hole that lines up with the pin diameter on the counterbores that I have but as these may also vary the reader should check with those he or she has just in case they are different.

I will be detailing the manufacturing method, where required, a part at a time for simplicity but the reader making the machine will find it very beneficial to organise the manufacture so that similar operations are carried out together. Typically, **photo 2** shows that I marked

3. The Main Frame Assembly.

out all the flat components at the same time having similarly cut and machined them all to size previously. I then drilled them using one drill size at a time to avoid the need to keep changing the drill in the drilling machine and similarly the taps in my tapping stand. Except where holes need some special consideration I will not make any reference to them being made, similarly with cutting materials to size.



To reduce the large amount of offcuts of steel that I have, I have machined many of the smaller parts from larger cross sections rather than purchase material to size. The photographs may therefore show machining marks where a normal drawn bar finish would be expected.

THE SUB ASSEMBLIES
The main frame assembly (1)

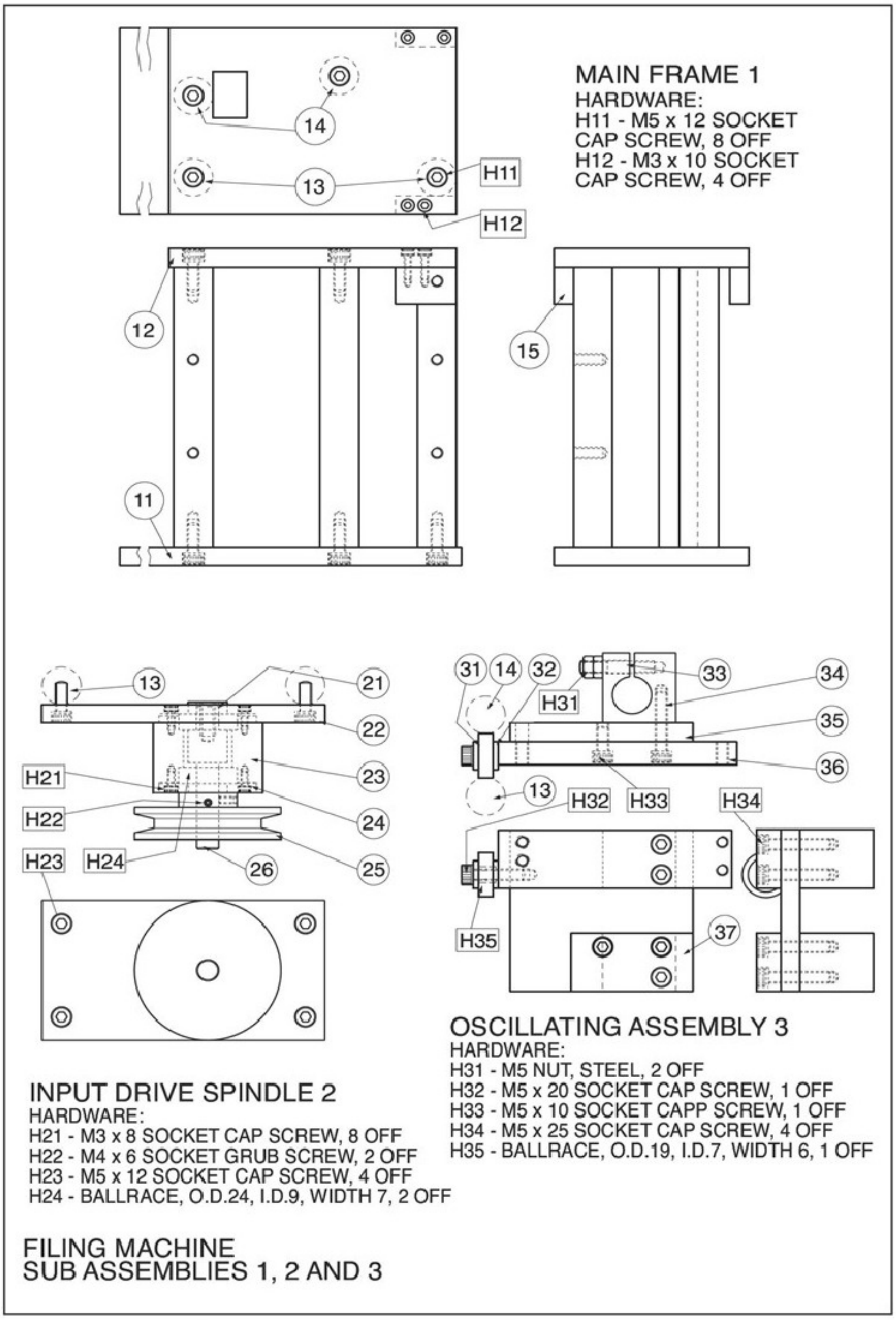
This is a simple assembly as can be seen by (**photo 3**) with only a few areas needing special attention.

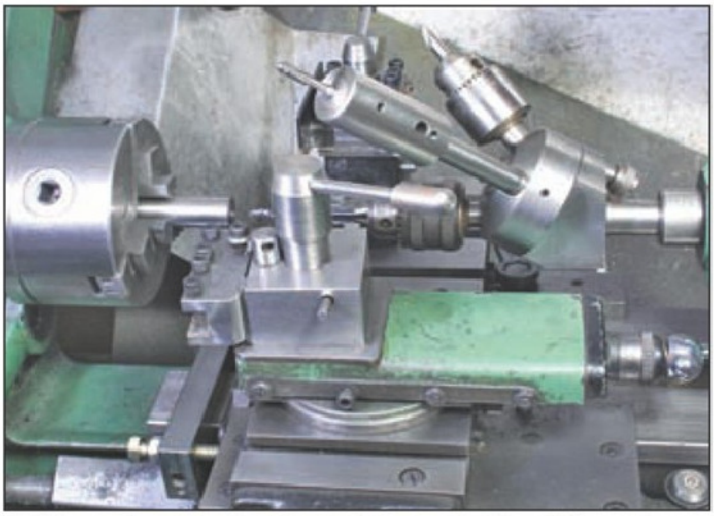
The posts (13 and 14)

The first essential feature is that, whilst their length is not critical, all four posts should be the same, say within +/- 0.03mm. To do this, set up a backstop in your lathe bore and drill, tap and face the end of the first post. Reverse the post in the chuck ensuring that it is now firmly against the backstop, also fit a saddle stop and with the saddle firmly against this. Again drill, tap and very lightly face the end of the bar using the top slide to establish the part's length, DO NOT now move either the saddle or the top slide. Remove the post and measure its length to determine how much more requires to be removed, return to the chuck, again against the backstop, and using the top slide set on the amount to be removed and face to the final length. It is essential that the top slide is now left in that position for the remaining three posts. I find it difficult not to instinctively adjust the top slide so, if you are like me, place a flag of masking tap on its handle as a reminder not to do so.

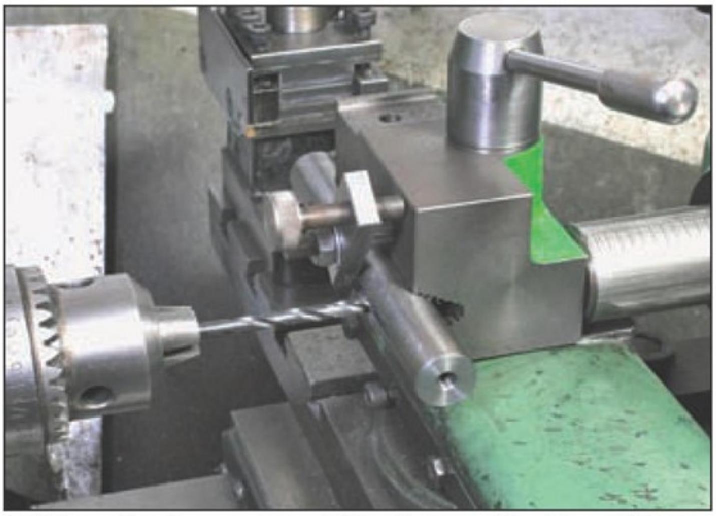
Fit the second post and with the saddle away from the saddle stop, face, drill and tap the first end, then, with the part reversed in the chuck and the saddle now against the saddle stop, the second end is faced, drilled and tapped ensuring, as a result, that it is the same length as the first. **Photograph 4** shows that I used a three way tailstock turret to avoid continually changing the centre drill, drill and tap and also that I used the auto feed mechanism from my controlled feed tapping stand (**ref 5**). This makes tapping, even in the lathe, delightfully simple. Repeat for the remaining two posts.

The difference between posts 13 and 14 is that 13 has two radially drilled and tapped holes bringing up the age old





4. Using a three way turret speeds up production of the posts.



5. Using a Hemingway cross drilling jig to position the radial holes in the posts.

6. An alternative cross drilling method to that shown in photograph 5.

problem(?) of cross drilling a hole accurately. However, added in this case is the need to drill a second hole radially in line with the first hole. First though, scribe a line at 40mm from the end of the post to indicate the position of the first hole. **Photograph 5** shows that I used the Hemingway cross drilling jig (**ref 6**) to drill and tap the post with the second hole accurately positioned by just feeding the cross slide by 40mm. However, the jig did not position the workpiece suitably to make possible the 40mm traverse required but as can be seen in the photograph this was overcome by turning the top slide through 90deg. and using this to initially feed the jig nearer the rear of the lathe. The 40mm could then be achieved using the cross slide. Incidentally, I again used the auto feed mechanism mounted in the drill chuck when tapping the radial holes in the post.

The reader may question why I have made the radial holes blind as this adds to the complication. If though the assembly drawings are studied it will be found that a ball race runs up and down between the two left hand posts, passing one of the holes if it were made as a through hole. I had overlooked this point and made mine with through holes and had not detected any problem when I ran it the first time. However, when it had been run in on the lathe for a couple of minutes it could then be turned easily by hand and doing this it I did notice a knock as the ball race passed the hole and thought that possibly localised wear may occur and decided therefore to put a plug in the rear of the offending hole and shaped this to match the post's shape. When I eventually ran the machine again I felt confident that it was running quieter than it did originally.

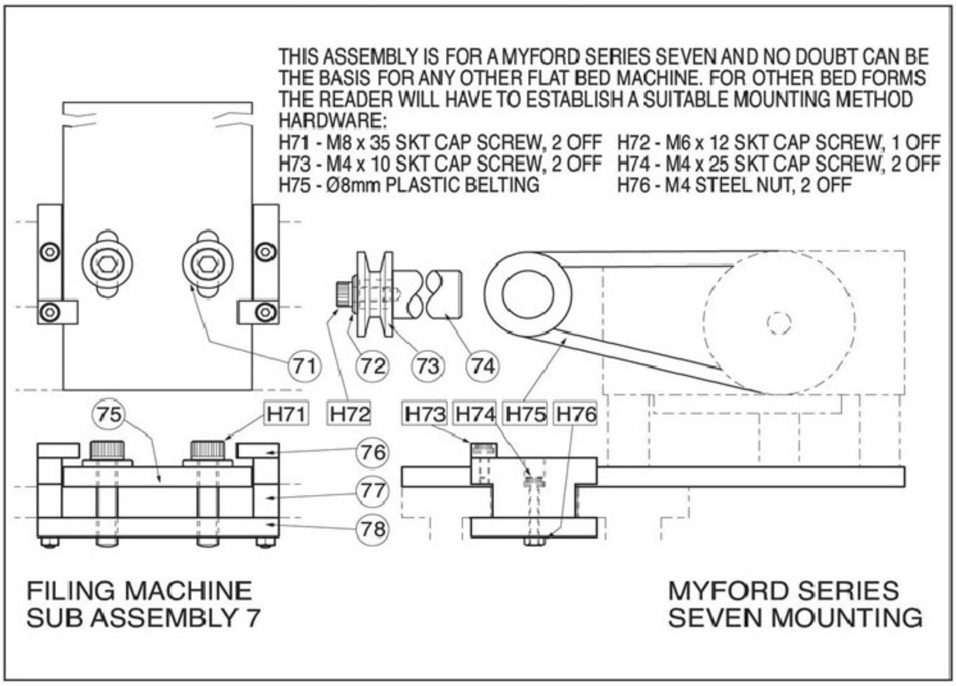
As many readers will not have the Hemingway jig, or similar, the following will be almost as easy. Set a fence on the milling machine table with its edge in line with the cross travel, using an engineers square from the table front edge to do this will be sufficiently accurate. Now choose the centre drill that you are going to use, 8mm diameter or preferably bigger, and use this lengthwise as a spacer to set a second fence parallel to the first. With the centre drill now in the drill chuck adjust the table traverse so that the drill passes centrally between the two fences and lock the table traverse in this position. With that done the post can be clamped in place as can be seen in **photo 6** and the holes drilled and tapped using the table cross traverse to set up their positions.

Bottom Plate (11) and Top Plate (12)

These are simple items with normal workshop tolerances being more than adequate with just one exception. The 19mm diameter ball race moves up and down between the two posts mounted at the 35mm centres dimension and whilst the clearance in the holes will permit a small amount of adjustment these two holes need a little more care in positioning them. Also, to ensure that the four posts all stand upright it would be a good idea to use the top plate as a template for drilling the holes in the bottom plate.

Lathe mounting plate

The bottom plate as drawn does not detail how the machine will fit to the lathe driving it as obviously this will vary considerably depending on the lathe it is to be used. See though the Myford mounting assembly (**7**) for a method of mounting it to a series seven lathe. The reader will have to determine the best approach for other lathes though the published method will probably be a starting point for the method to adopt. The mounting drawing does not include the holes for the machine guard; these will be detailed later in the series. To be continued...



■ MEW RESOURCE BOX

Ref 1.
Website: www.homews.co.uk/page9.html and clicking on the link "further projects".

Ref 2. Materials
Raw Material:
M-Machine, Unit 6 Forge Way,
Cleveland Trading Estate,
Darlington, Co Durham, DL1 2PJ.
Tel. 01325 381300.
E-mail: **sales@m-machine.co.uk**
Website: www.m-machine-metals.co.uk

Ref 3. Files
MSC J&L Industrial Supply
7 Pacific Avenue,
Wednesbury,
West Midlands WS10 7WP
Tel. 0800 663355.
E-mail: **sales@mscjlindustrial.co.uk**
Website: www.mscjlindustrial.co.uk

Axminster Power Tool Centre Ltd.
Weycroft Avenue,
Axminster, Devon
Tel: 0800 371822
Website: www.axminster.co.uk

Ref 4. Ball Races
Three ball races are required,
2 off id 9mm x od 24mm x width 7mm - 609-zz and 1 off id 7mm x od 19mm x width 6mm - 607-zz.
Arc Euro Trade
10 Archdale Street, Syston,
Leicester LE7 1NA
Tel: 0116 2695693
Website: www.arceurotrade.co.uk

Simply Bearings Ltd.
386 St Helens Road, Leigh,
Lancashire WN7 3PQ
Tel: 0845 6783336
Website: http://simplybearings.co.uk

Ref 5. Tapping Stand, MEW issue 105 page 12

Ref 6. The Lathe Only Workshop (6)
Cross Drilling Jig. MEW issue 113, page 12. Supplier:
Hemingway Kits,
126 Dunval Road, Bridgenorth,
Shropshire WV16 4LZ
Tel: 01746 767739
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Website: www.hemingwaykits.com

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- Metric/inch conversion.
- Digital measurements without batteries.
- Storage case.

Part no	Range	WAS	SALE
ME-CAL-SOL-150	0-150mm/6"	~~£34.95~~	£27.96

Depth Gauges...

- Digital depth gauge with internal step measuring hook*.
  *not present on ME-DEPTH-500.
- 100mm base size.

Part no	Range	WAS	SALE
ME-DEPTH-150	2-150mm/6"	~~£29.95~~	£23.96
ME-DEPTH-300	2-300mm/12"	~~£39.95~~	£31.96
ME-DEPTH-500	0-500mm/20"	~~£110.95~~	£88.76

Quill Clamp DTI Holder...

- Fits to most machines.
- 42mm to 54mm clamping range.

Part no	WAS	SALE
MT-QU-CLAMP	~~£9.95~~	£7.96

Cutter Tool Trays...

- Store milling cutters, drill bits, taps, solder tips etc..
- 102mm (4") wide, 215mm (8 1/2") long & 22mm (7/8") high
- Tough plastic.

5 trays for £5.00
12 trays for £10.00
25 trays for £20.00

£1.25 EACH *cutters/drill bits not included.

Left Handed Caliper...

- Left handed with the jaws opening to the left.
- Metric/imperial conversion.
- Comfortable left handed lathe work measurement.
- Storage case.

Part no	Range	WAS	SALE
ME-CAL-LH-150	0-150mm/6"	~~£29.99~~	£23.95

Magnetic Stand...

- Vee base and ground side face.
- Rigid locking mechanism.
- Fine screw adjustment.
- Dovetail & ring clamp indicator fixing.

Part no	WAS	SALE
MT-MG-BASE	~~£29.95~~	£23.95

Digital Angle Finder 200mm...

- Lock arm at any angle through 360 degrees.
- Absolute & relative display.
- Large LCD display.
- 200mm arm length.
- Spirit level bubble on top face.
- Aluminium body & stainless Arm.
- 0.05 degree resolution.

Part no	Range	WAS	SALE
ME-AN-MEAS	0-360°	~~£36.95~~	£29.56

Digital Indicator...

- Large easy to read LCD.
- mm / Inch.
- Set Zero at any position.

Part no	Range	WAS	SALE
ME-DI-IND-10	0-10mm / 3/8"	~~£39.95~~	£31.96
ME-DI-IND-30	0-30mm / 1 3/16"	~~£52.95~~	£42.35
ME-DI-IND-50	0-50mm/ 2"	~~£64.95~~	£51.96

Dial Test Indicator- Imperial DTI...

- Automatic reversal.
- Dovetail mounted spigot, with dovetails on 3 sides.
- 1/4" and 3/8"mm diameter spigot
- 30mm dial diameter.

Part no	WAS	SALE
ME-IM-DIAL-DTI	~~£29.95~~	£23.96

Z Axis Dial Tool Setting Gauge...

- Accurate tool height setting.
- Magnetic base.
- Built in height calibration.
- Precision tool height setting to 50mm.

Part no	WAS	SALE
MT-ED-Z-DIAL	~~£82.95~~	£66.36

Vertical Digital Scales...

- mm / Inch.
- Set Zero at any position.
- Mounting bracket supplied.
- Data output.

Part no	Travel	WAS	SALE
ME-VT100	100mm/4"	~~£32.95~~	£26.36
ME-VT150	150mm/6"	~~£34.95~~	£27.96
ME-VT200	200mm/8"	~~£39.95~~	£31.96
ME-VT300	300mm/12"	~~£54.95~~	£46.36
ME-VT400	400mm/16"	~~£64.95~~	£53.57

Digital Angle Gauge...

- Digital angle/inclinometer.
- Zero calibration function.
- 0.1 degree resolution.
- Magnetic base.
- Compact size (51x51mm).

Part no	Range	WAS	SALE
WR300-KIT	+/-180°	~~£28.95~~	£22.50

External Digital Micrometers...

- Large LCD Display.
- Tolerance function - user defined under or over tolerance.
- Metric/imperial display.

Part no	Range	WAS	SALE
ME-DI-MIC-0-25	0-25mm/1"	~~£39.95~~	£31.96
ME-DI-MIC-25-50	25-50mm/1-2"	~~£52.95~~	£42.35
ME-DI-MIC-50-75	50-75mm/2-3"	~~£62.95~~	£50.36
ME-DI-MIC-75-100	75-100mm/3-4"	~~£75.95~~	£60.75

Imperial Caliper with Fractions...

- Imperial calipers with fractions 1/16, 1/2 etc..
- Displays decimal inches and fractions simultaneously

Part no	Range	WAS	SALE
WR100	0-150mm/6"	~~£32.95~~	£26.36

Co-ax Centering indicator...

- Simple method of centering a workpiece or assembly.
- Dial face remains stationary.
- Can be used horizontal or vertical.
- Internal or external setting.

ONLY £67.96
Part No. ME-DIAL-CENT

Horizontal Digital Scales...

- mm / Inch.
- Set Zero at any position.
- Mounting bracket supplied.
- Data output.

Part no	Travel	WAS	SALE
ME-HZ100	100mm/4"	~~£24.95~~	£21.55
ME-HZ200	200mm/8"	~~£32.95~~	£26.36
ME-HZ300	300mm/12"	~~£41.95~~	£33.56
ME-HZ400	400mm/16"	~~£54.95~~	£43.95
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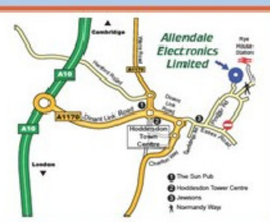

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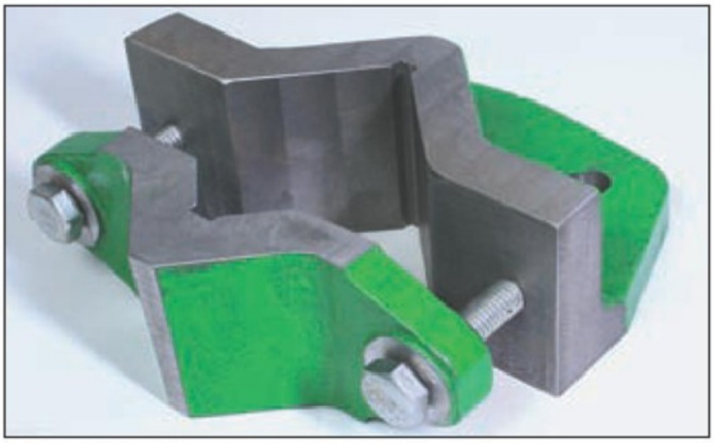
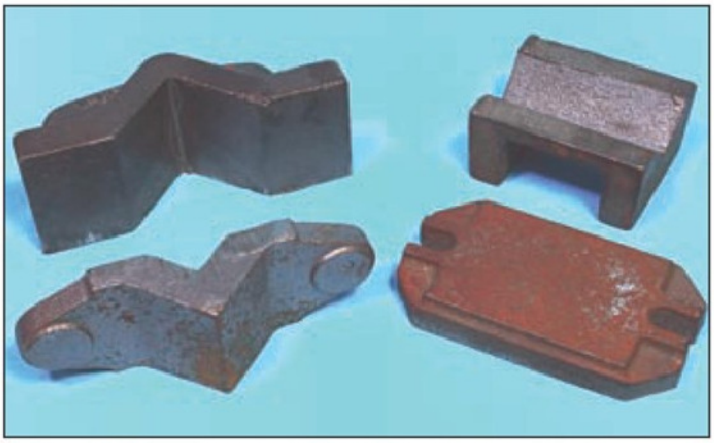


1. The finished Keats angle plate.



2. The castings as supplied, both for the Keats angle plate and the Vee angle plate.

HOW TO MACHINE CASTINGS

Harold Hall make a Keats Vee angle plate

■ OVERVIEW

A reader of the magazine commented to the editor that, as a novice metalworker, he found it difficult to decide which face to work on first when confronted with a casting to machine. At the time he was considering the Keats Angle Plate (**photo 1**) shown in "The College Engineering Supply" catalogue, (**ref 1**). The purpose of his letter was to suggest that an article explaining where to start would be helpful to him and no doubt many others.

Having agreed to provide the article it would be good to be able to say, "mount the casting in a manner so that you can first machine the surface that ----", but of course, it is not that simple. The very nature of a casting is that its shape is likely to be in most cases quite different from any other casting the workshop owner is likely to be called upon to machine, the Keats Angle Plate being a good example.

The reader having mentioned this item makes it an obvious choice to use as a subject so as to come up with some pointers for this and other castings needing to be machined.

So as to provide other examples, in the next issue I have chosen the Small Vee Angle Plate also from "The College Engineering Supply". Both items are intended to perform similar functions though the Vee angle plate is more adaptable and will work more readily with smaller workpieces.

I intend therefore, in addition to detailing the setups for machining these, also to explain their purpose and the pluses and minuses of each design. The castings as received are shown in **photo 2**, with those for the Keats on the left and the two for the Vee angle plate on the right. In both cases the hardware required has to be provided by the workshop owner.

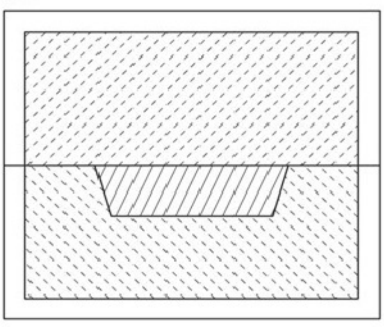
The nature of a casting

I do not confess to being knowledgeable regarding the finer details of casting metal objects but in this article we are considering plain iron castings that are almost exclusively produced in a sand mould. In very basic terms the mould is made in two parts that can be separated so as to enable the pattern to be removed when, after reassembling, the molten iron can then be poured in to produce the required shape.

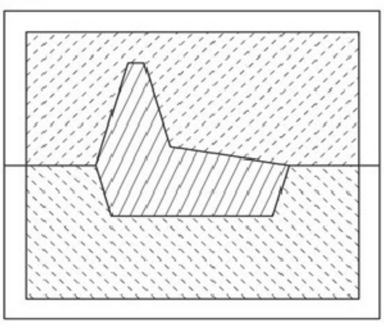
Sk.1 shows a very simple example of a rectangular section component being cast. I state rectangular, but I think all readers will understand that the sides have to be tapered so as to enable the pattern to be removed without damaging the sand cavity prior to the iron being poured. Because of this the casting has two parallel faces and the remaining faces are tapered and non parallel. The two parallel faces would be relatively easy to secure in a vice, depending on size of course, and other methods such as using an angle plate would also be quite easy, the tapered faces would though present a problem. The Vee block casting in photo 2 (rear right) has similarities to this simple example.

Castings do though come in a very wide range of shapes and sizes and many will not be able to be mounted so easily as the above explanation. **Sk.2** shows another example and from this it will be seen that in this case no two faces are parallel and as a result, mounting it in a vice will be much more of a problem though not necessarily impossible. It is because of these variations that make it impossible to give an all embracing answer to the reader's question. I will though explain for each of the four castings, how I come to the decisions I do, both with regard to the face to machine first and the sequence for the remaining faces. Of course, many castings will not have an obvious first face and some workshop owners will choose one whilst others will choose another.

Sk. 1



Sk. 2



The first task

First, one must study the casting carefully noting which faces are parallel and which are not and which faces have to be machined as often many are left in their as cast state.

Having spent time considering the situation the aim at this stage would normally be to choose the most secure method of holding the casting whilst presenting the first surface for machining. The choice though should also take into consideration whether or not the surface machined first will make subsequent stages easier to mount. Therefore, where a number of choices for the first surface would appear equally acceptable the decision must be made on the basis of the next operation. Planning ahead is an essential feature when machining a casting!

Also included in the considerations is that one should attempt to chose a method that presents the larger surfaces in a manner that enables them to be machined equally over their full surface. If this is not done then as more will need to be removed on one edge than the other the increased amount of metal removed may make it impossible to work to the dimensions given. This I feel is best understood by reference to **Sk. 3**. In this, "**A**" shows the casting as supplied and which needs to be surfaced on the two outer faces to make them at 90deg. to one another. With the short face mounted vertically, as at "**B**", much more has to be removed compared to the longer face being mounted vertically, "**C**". Having first machined the casting as at "**C**" it can then be mounted as shown at "**B**" and machined equally over the larger surface.

Fortunately, the pattern maker will have chosen in most cases to make the taper on the shortest sides, see **Sk. 4A**, so as to reduce the depth of the pattern in the mould and minimising the amount of metal that will have to be removed at the machining stage if made as per **Sk. 4B**. Another benefit of this is that it reduces the amount of iron used thereby reducing the cost of the casting as a result.

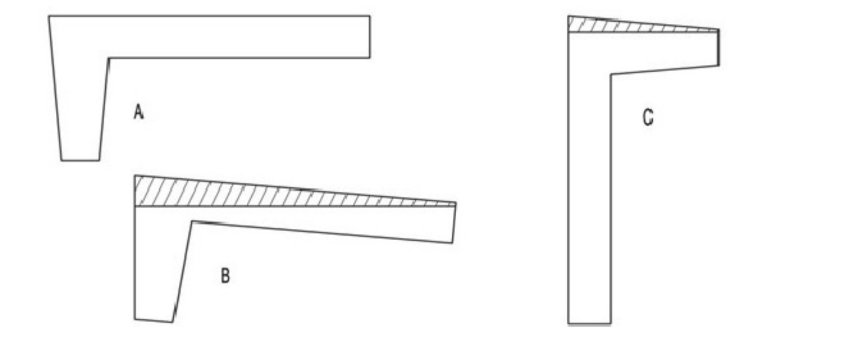
With castings that conform to the above, one of the shorter faces is very likely to be the one to machine first. That is certainly the case with three out of the four castings being machined in this article. I should add here that the angles shown in the sketches are, for clarity, more than those normally present on the casting, which is usually between one and two degrees per face.

Machining cast iron

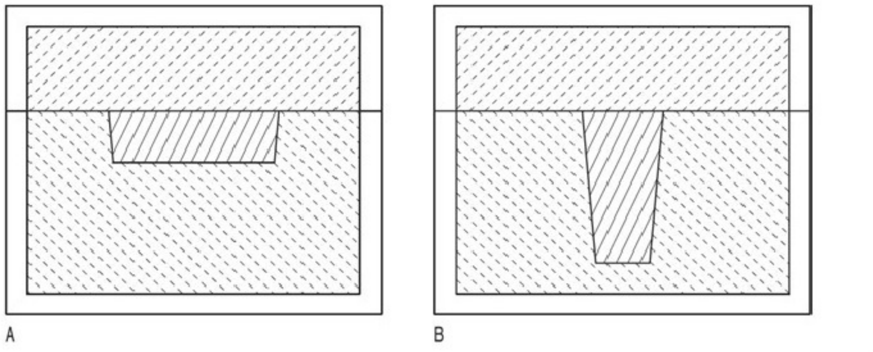
The subject of machining cast iron has been covered frequently in the magazine and therefore a very detailed explanation is probably not appropriate. However, as the article is mainly aimed at the workshop owner new to metalworking I will briefly cover the most important points.

1) The surface of iron castings can frequently possess hard spots that will rapidly blunt high speed steel tooling.
2) Because of the hard spots, if possible use carbide tipped tools for initially machining the casting's surfaces.
3) If the surface starts to take on a glazed appearance, this is because the depth of cut is not sufficient to get below the hard skin.
4) This can either be because the casting surface has a shallow hollow or that it has been mounted on the machine with the surface being machined sloping down very slightly.
5) In this case, return to the start, deepen the cut, and recommence to machine the surface.
6) If you do not have a tipped tool, reserve an old HSS cutter for the task, keeping your sharp cutters for more appropriate tasks.
7) If you have to use a HSS cutter, grind a chamfer, about 1 to 2mm deep, around the edge of the casting so that the cutter does not have to break through the hard surface.
8) Whilst less important, the chamfer is also worthwhile if using a tipped tool.
9) After the hard surface has been removed, iron castings machine easily. A sharp HSS cutter can then be employed to machine to the size required and/or to achieve a better finish.
10) As a result of the surfaces having been machined, the internal stresses within the casting may have changed resulting in the casting distorting. This can happen between the individual stages of it being machined or while in storage after it has been completed.
11) Machined castings are therefore best left for a few days (preferably more if time permits) and then finally machined to size, see point 9 above.

Sk. 3



Sk. 4



THE KEATS ANGLE PLATE
The main casting

This conforms very closely to that shown in Sk. 3 with the two faces of the larger web being essentially parallel and the shorter web tapered on each face clearly indicating which way the casting was produced in the mould.

The drawings provided by College show it being machined on the two outer main faces plus the two faces of the Vee. Additionally, two parallel slots have to be fully machined as they are not cast in. However, I chose to change the centres of the parallel slots to 60mm from the 70mm shown on the drawing as they would then line up with the slots on the "Quick-Set faceplate from Hemingway Kits that I made and was featured in the magazine (**ref 2**).

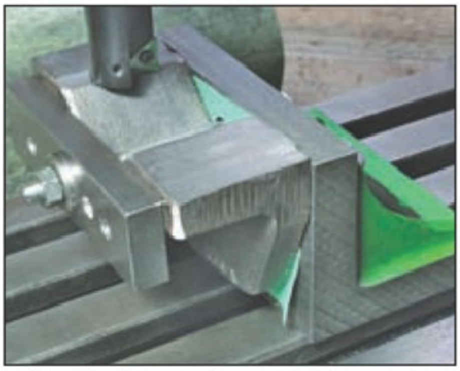
Surprisingly, the drawing does not call for the top of the web opposite the main face to be machined but as it may be used as a location for the workpiece in a few cases, I consider that it should be. The ends of the shorter web are also tapered in view of the way the item was cast but are not shown as machined on the drawings. However, just possibly, the ends may be useful as reference faces or a means of locating it if stood on its side so I decided to machine these also. It would also provide a challenge getting the Vee central to the two ends that would add to the depth of this article.

Having considered the points that I have already discussed, it was obvious that the casting should be located off its larger face whilst the shorter one is machined. However, it was first necessary to remove any localised high points (pin head size or a little bigger) and being very few I removed these using a file and with that done the face was checked against a surface plate and I found it adequately flat for the next task.

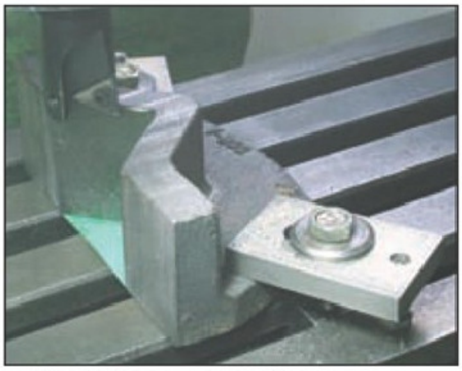
Should you find it necessary, any high points should be removed either with an old file or by localised grinding. If the latter, do take care not to remove so much that you remove material below the level to which you will ultimately wish to machine it.

Perfection will not of course be possible so a piece of thin hard card between the casting and the mounting surface will compensate for minor errors. However, do not be fooled into thinking that the situation is better than it is as often the casting will fall away towards its edge. Because of this do ensure that any bar clamps are applying their force well in from the perimeter of the casting.

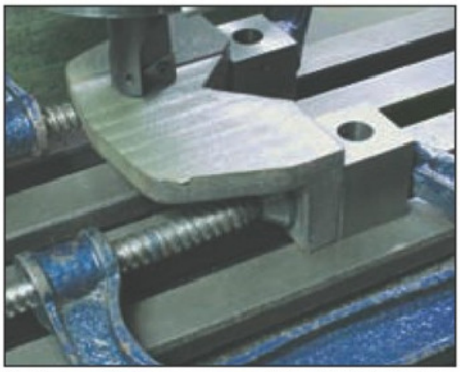
With those precautions having been taken note of, I machined the two faces as shown in **photo 3**, having set them reasonably level so that they were machined equally. Regular readers of my articles will possibly be aware of my statements that relying on a single clamp is to be avoided if possible and that one too many is much better than one too few. In this case though, the compact nature of the assembly made it acceptable, do note though that the machining forces are towards the angle plate, not away or across. I did consider that some workshop owners would not



3. The first faces to be machined are those on either side of the Vee.



4. Machining the second face.



5. The main face was machined with that in photo 3 against the square posts and that in photo 4 firmly against the machine table.

6. The cutter used in the previous photographs had insufficient reach to machine the Vee so my boring head was used instead.

have an angle plate large enough to permit more clamps to be employed so decided that I would like to illustrate a method within the bounds of what would likely be available in some cases.

It may seem obvious that the next face should be the large main face but I decided that the top of the web should now be tackled, the reason being that it was very likely that the main face and the top of the web would only be nominally parallel, so by machining the web first the two surfaces were trued up with the minimum of metal removed (**photo 4**).

Next, I chose to mount the casting onto two square posts to machine the main face (**photo 5**). To do this the surface machined in the last operation was placed firmly on the machine table ensuring that the larger face now being machined was parallel with the top of the web already machined. It is worth considering that posts such as these can find many uses on the milling machine so are worth making.

You will see that I have used a form of clamp that I rarely use but their pivoted end piece makes them ideal for dealing with the slightly sloping surface of the casting. Again note that the cutting forces are towards the posts. Whilst the casting is set up in this way it would appear an obvious time to make the two slots mentioned earlier, but as they need to be equally spaced about the Vee, which was not yet machined, and being super cautious, I delayed the process just in case the Vee did not end up in the position I anticipated.

The next task was to machine the two faces of the Vee being, I thought, relatively easy other than to measure the result during the machining operation. Unfortunately though, I had overlooked the fact that the projection of the cutter from the milling spindle was insufficient to avoid the top edge of the casting fouling the underside of the milling spindle. I could have used an old high speed steel end mill in the cutter chuck, which would have given me the necessary clearance and would anticipate that this would be the method chosen by most.

Having machined the surfaces at either end of the Vee about to be made the cutter would not be breaking through a hard skin so I did not anticipate too much of a problem with this method.

In an endeavour to stay with tungsten cutters, I decided, as an experiment, to try using my boring head for the purpose and even though the cut was intermittent, the arrangement worked quite well providing the depth of cut was kept to a reasonable value; 0.3mm I seem to remember.

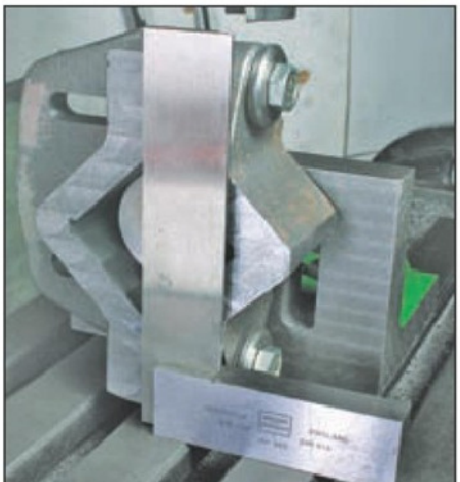
7. Using a slot drill to produce the fixing slots. The round bar gives a reference point for positioning them relative to the Vee.

I marked the two machined faces with marking blue and scribed machine-to lines to define the width of the Vee. This being a distance of 60mm, I positioned it to be an equal distance from each end of the casting, nominally 30mm. I mounted the casting on the angle plate setting the faces to 45deg, doing this away from the milling machine on the surface plate as the larger surface makes it easier to use the protractor from my combination square. Having done that it was transferred to the milling machine table and the Vee made using the boring head as mentioned above (**photo 6**). When machining these faces one can stop just short of contacting the other as a groove is machined in the bottom of the Vee that will remove any unmachined surface.

The casting was next tilted the other way and the second surface machined. In this case the machining forces were away from the angle plate, which is not ideal, but this was difficult to avoid and with the light cut being taken there was no problem. With the angle plate still on the machine table the casting was moved to the horizontal position and the groove in the bottom of the Vee was made.

Having finished the Vee I was now able to machine the two fixing slots ensuring that they were equally spaced about it. To do this I clamped a piece of round material in the Vee which gave me a reference point for setting the position of the slots. Again using the square posts, **photo 7** shows the set up with the first slot already machined.

This now leaves the ends of the web. They need a rather special setup to ensure that the Vee is central to a fair degree of accuracy. The casting was positioned on a round post fixed to an angle plate and set vertically as shown in **photo 8** and then machined. Next I rotated the casting through 180deg. setting it vertically once more and machined the second end using the same down feed setting as for the first (**photo 9**). These operations could not though be carried out at this stage as they needed the clamp and its fixings to be completed.



8. Setting the casting vertical for machining the ends.

The clamp

This is a casting with no obvious best sequence for machining it and I am sure some would tackle it differently. The parallel faces are those of the raised bosses with the sides of the Vee being tapered and narrowest at the point. Having removed any major roughness on the sides, I chose to hold this in the vice but used some copper shims to help compensate for the taper and any localised raised portions. With the vice just lightly closed, I used a soft hammer to encourage the casting to take up a horizontal position, checking this using the protractor from my combination set. Incidentally, the clamp is a malleable iron casting and machines quite differently from the main casting.

As my milling machine has not been set up accurately to have a level table, I first placed the protractor on the table and adjusted it to read zero. With that done I then used it to position the casting thereby compensating for any error with the machine table, of course precision is not a requirement. The vice was then fully tightened and in view of the limited amount of machining necessary I was happy to machine the two bosses using this setup (**photo 10**).

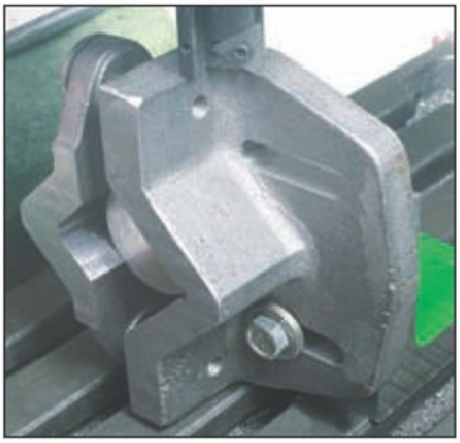
It is worth noting that security can in many cases be increased by a shim of soft copper, about 1mm thick, that will, under pressure, conform to the minor irregularities of the casting, improving the grip appreciably. This is especially beneficial if working as in this example.

I then turned the casting over and again mounted it in the vice but this time used a parallel to support it ensuring the two ends would machine to the same thickness. When the Keats angle plate is in use for small diameter workpieces, the clamp is inverted with pressure being applied by the top of the Vee, to avoid this being a sharp edge, a 3mm wide flat is made, which was also machined whilst the casting was still held in the vice.

Next I mounted the casting onto the square posts, seen previously, and machined the first side. The casting was then turned over and this time, making sure the already machined side was in contact with the machine table, the second side was also machined (**photo 11**). This ensured that the two sides were parallel.

The two sides of the Vee and the groove in its base were the next to be machined using a similar method as used for the main casting. However, the absence of a flange made it a little more difficult to clamp securely, **Photograph 12** shows the setup I used. In this, I have again used one of the posts, which I set accurately at 45deg. on the angle plate before mounting it on the machine table. The part was then first clamped to the post thereby easily setting it at the required angle with the bar clamp finally being added.

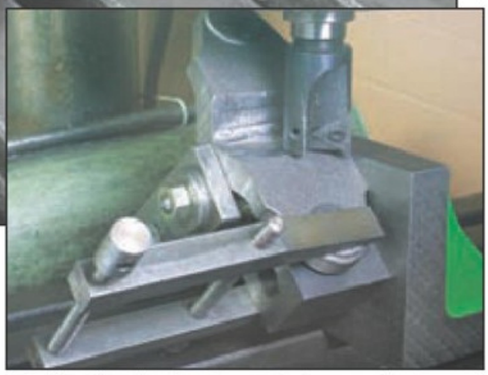
I have not mentioned the tapped holes in the main casting or the plain holes in the clamp but produced these at this late stage. Some workshop owners would I am sure have drilled them earlier and used them to fix the castings to the angle plate rather than using the methods I have illustrated. If you have a large enough angle plate then it is certainly a method worth considering providing the slots in the plate are suitably spaced.



9. The second end being machined having been set up in a similar manner to that in photo 8.

10. Facing the fixing lugs on the clamp

11. The square posts again being used whilst the sides of the clamp are being machined.



12. The Vee in the clamp being made.

The clamp now being finished, I was able to machine the ends of the main casting as was explained earlier and illustrated in photos 7 and 8. You may though understandably consider this an unnecessary feature and chose to bypass this operation.

Having done that, there just remained for the edges to be lightly chamfered and the non machined surfaces painted and we have the finished item (photo 1), that is unless I eventually choose to re-machine some of the faces as explained below.

At the time of writing this article, I have not checked to see if there has been any movement within the casting as a result of the machining as this is best undertaken after a time delay of at least a few weeks. The only area that is important is that the two surfaces of the Vee are at 90deg. to the main face, a situation that I will check using an engineer's square. If I find an error in excess of what I feel is reasonable, I will set up a cylindrical square on the milling machine table and clamp the Keats to this using its own clamp and with that done, lightly re-surface just the main face.

In the next issue I will describe how to machine the Vee angle plate castings. ■

■ MEW RESOURCE BOX

Ref 1.
Keats Angle Plate castings, Ref 558.
Small Vee Angle Plate, Ref. 580.
(Required for part 2)
The College Engineering Supply,
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Wolverhampton WV8 1EJ
Tel. 08451 662184
Website: **www.college engineering.co.uk**

Ref 2.
Quick-Set Face and Angle Plate,
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FITTING A ONE-SHOT LUBRICATION SYSTEM TO A MYFORD ML7 LATHE

Tony Jeffree makes his lathe easy to lubricate

■ OVERVIEW

One of the deeply frustrating aspects of owning a Myford ML-7 is its lubrication system, if it deserves to be called that. The drip oilers are a pain to adjust, and half of the time, they are totally useless because you forget to turn them on at the start of a session; the other half of the time, you forget to turn them off when you have finished, so the next time you want to use the lathe, the oilers have emptied their contents uselessly, via the head bearings, into the drip tray.

The original glass dome oilers did at least let you see what the drip rate was; however, I had fitted my lathe with the modern oilers that Myford currently sell as replacements, and these manage to run the oil down the sides of the sight tube without giving any visible drip. And of course, then there are the oil-nipples-from-hell and the appalling and utterly useless little toy oil gun that was issued as standard equipment with the lathe. The more modern oil guns that Myford now sell are a vast improvement, but it is still nothing short of a black art to persuade the gun to form a seal with the nipple that is good enough to prevent a high pressure jet of oil squirting you in the eye when you push the plunger. So, it was with considerable interest that I read in the Arc Euro Trade catalogue that they now stock a range of parts that will allow you to design and install a "one-shot" oiling system (**photo 1**).

System components

Photograph 2 shows the heart of the system, which is an oil reservoir with a built-in manually operated pump. You pull back the spring-loaded plunger and release the handle; the spring then forces a measured quantity (3ml) of oil out of the reservoir and into the pipework that you have attached to it. The tank holds 180ml of oil, so there are approximately 60 shots per tank.

Photograph 3 shows the main components of the system. On the top row is a straight hose adapter and a 90-degree elbow adapter. These have a male M6X1 thread that screws into an oiling point on the machine, and a female M8X1 thread that is designed to accept a compression bushing and a compression sleeve or olive (right hand column in the photo) so that you can insert 4mm Nylon tube into the fitting and get a good seal.

To the left of the middle row is a "banjo" assembly; this does a similar job to the 90deg. elbow connector, but is useful for use in awkward positions where there isn't room to "swing" the 90deg. elbow as you screw it in. The banjo bolt is M8X1, and is sealed top and bottom with O-rings.

In the middle of the photo is one of the metering unit assemblies. Alan at Arc Euro Trade showed me one that he had hacksawn in half to show the internal structure. Built into the device are a small filter plate, an accurately machined metering orifice, and a spring-loaded non-return valve. This latter point gives you a clue that these units fit only one way round - you can just see the arrow on the flat at the left of the unit, indicating that flow direction starts at the pointy end and exits through the screw on cap. This cap hides a compression sleeve, so the 4mm Nylon tube can be attached to the outflow end of the metering unit. The metering units come in four sizes; the flow rate increases by a factor of two when you go from one size to the next largest size in the range.

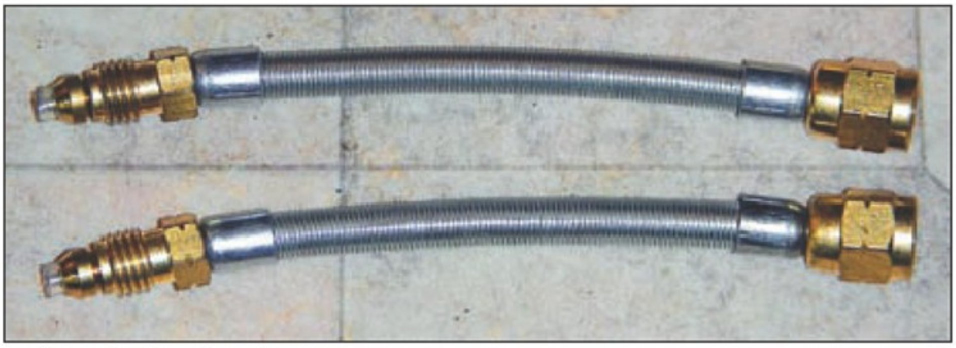
At the bottom of the photo is a 6-way manifold. The six ports in the manifold are threaded M8X1 to accept either the pointy end of a metering unit, or a compression bushing and its compression sleeve. Naturally, one of the ports will be used for the inflow of oil from the pump; the remaining ports can be used to feed individual oiling points, or to feed another manifold. The manifolds come in a variety of sizes, from 2-port manifolds to 10-ports. I can already hear the question being asked - why have a 2-port manifold? The answer is simple - the metering units should be kept as near to the oiling point as practically possible, so if there is a long run of pipe from the nearest manifold to the oiling point, then you place a 2-port manifold near the oiling point and screw the metering unit into that. A short stub of tube can then run from the business end of the metering unit to a straight or 90 degree adapter at the oiling point.

Not shown in the photo are the ranges of tubing clips that are designed either to clip the bare 4mm tubing, or to clip the tubing after it has been sheathed in the 6mm spring tube guard that protects the Nylon tube in places where it may be vulnerable. There are also metal ferrule ends available to make a neat job of the tube guard. **Photograph 4** shows a couple of pipe assemblies made up with compression

1. Most of the lubrication system can be seen in this photo.

2. The oil reservoir with pull handle.

3. Lots of different connectors are available.



4. A couple of made up hoses.

Table 1	
Type of bearing	**Oil requirement (cc/hour - measurements in inches)**
Plain bearing or drive screw	0.15 X bearing shaft diameter X bearing length
Gear	0.3 X gear pitch diameter X gear face width
Slideways (flat)	0.04 X [length of moving member + travel] X width
Slideways (cylindrical)	0.15 X diameter X [length of moving member + travel]
Ball or roller bearing	0.1 X bearing shaft diameter X number of rows of balls or rollers

sleeves at one end to fit an oiling point adapter, and metering unit caps at the other end to fit the business end of a metering unit.

As the compression olives grip tightly onto the plastic tube, you will appreciate that there are ample opportunities when using this system to forget to put all the right bits in place before tightening down the olives, with the result that you have to dismantle, cut off the ends of the tubes, and start again. There is also a point of technique that is worth noting here - when the tube goes around corners, the length of spring guard tube that is required decreases slightly. I found that the best approach was to make up tube assemblies with the tube held straight, and temporarily fit the caps or compression sleeves to a socket in a manifold or to a metering unit to partially compress the olive at each end before attempting to fit the tube in its final position.

Because the larger manifolds only have even numbers of ports, and because it is inevitable that the number of ports you actually need won't match, the system also includes a blanking plug that looks rather like the compression bushing but with a pointy end and no through hole that can be used to block off unused ports in manifolds. However, if like me you forgot to order one, it is possible to improvise by using a compression bushing and olive with a short length of Nylon tube that you have filled either with hot melt glue from a glue gun or with a short stub of suitable diameter rod.

Designing a system

The first decision is which bits of the lathe you want to lubricate. On my lathe, I decided that I would attempt to use the system with as many of the oil points as I could manage. So, my list of points to lubricate was as follows:

- Two headstock bearings.
- Two countershaft bearings.
- Two leadscrew bearings.
- Two saddle oiling points.
- One oiling point on the front of the saddle (this feeds the rack and pinion and associated gears).
- Two oiling points that I would have to create at the front of the saddle to feed oil into the cross slide dovetails.

It should be intuitively obvious that all oiling points are not created equal; the headstock bearings probably need more oil than the others, closely followed by the saddle and cross slide bearings, followed pretty much by the rest. However, it is possible to apply rather more objective analysis to the problem in order to choose the right size of metering unit to place at each oiling point, as discussed later.

It might be tempting to save money by sharing a metering unit between two oiling points, for example feeding the output of a metering unit to a 3 way manifold, and then feeding the remaining two ports of the manifold to each of the oiling points; however, this is best avoided unless the resistance to oil flow seen at both oiling points is identical. If it isn't then the consequence is that one of the oiling points will get more oil than the other, which would rather defeat the object of installing the system in the first place. So, for this installation, I chose to use individual metering units for each of the eleven oiling points listed above.

Determining the size of metering units for each oiling point is a multi-step process. The first step is to work out what volume of oil, in cubic centimetres per hour, the bearing associated with the oiling point should receive. There is a formula associated with each different bearing type that allows this to be calculated, as shown in **table 1**.

Using these formulae, I arrived at the following, based on not terribly precise measurements taken from my ML7:

- Headstock: Large bearing is 1.25in. diam X 2in., so oil requirement per bearing = 0.15 X 1.25 X 2 = 0.375 cc/hour. In reality the left hand bearing is smaller, but I chose to treat them as the same.
- Leadscrew: 0.625in. diam X 2in. (1.25in. for the shorter bearing at the tailstock end), so oil requirement per large bearing = 0.15 X 0.625 X 2 = 0.19 cc/hour and oil requirement per small bearing = 0.15 X 0.625 X 1.25 = 0.12 cc/hour.
- Saddle slide: Oil requirement per large bearing = 0.04 X 1.75 X 15 = 1.0 cc/hour, and oil requirement per small bearing = 0.04 X 1.25 X 12 = 0.6 cc/hour.
- Cross slide: Oil requirement per bearing = 0.04 X 1.25 X 12 = 0.6 cc/hour.
- Countershaft: Oil requirement per bearing = 0.15 X 0.75 X 1.75 = 0.2 cc/hour.

I didn't attempt to calculate the requirement for the rack and pinion gears - I figured that if it got the same as the lowest requirement in the system then it would be getting more than it was getting before!

With a bit of rounding here and there, this resulted in the spreadsheet below.

This requires a little explanation. The "nominal volume requirement" is in cc/hour, derived from the calculations shown above. So, using these formulae, the system nominally needs about 4.5 cc/hour to be delivered in total, proportioned as shown in the second column of the table.

The "flow rate" column simply assigns relative flow rates to each lubrication point, based on the size of the metering unit that will be used at each point. Hence, the smallest size of metering unit is assigned to the leadscrew bearings, the

Oil point	Nominal volume requirement	Flow rate	Volume per shot	Metering unit size
Headstock 1	0.4	4	0.571428571	AJB2
Headstock 2	0.4	4	0.571428571	AJB2
Saddle 1	1	2	0.285714286	AJB1
Saddle 2	0.6	2	0.285714286	AJB1
Cross-slide 1	0.6	2	0.285714286	AJB1
Cross-slide 2	0.6	2	0.285714286	AJB1
Leadscrew 1	0.19	1	0.142857143	AJB0
Leadscrew 2	0.12	1	0.142857143	AJB0
Countershaft 1	0.2	1	0.142857143	AJB0
Countershaft 2	0.2	1	0.142857143	AJB0
Pinion gears	0.2	1	0.142857143	AJB0
Total	**4.51**	**21**	**3**	

5. The reservoir is mounted on the belt guard.

countershaft bearings, and the pinion gears; the next larger size of metering unit (twice the flow rate of the smallest) to the saddle and cross-slide, and the next larger size to the two headstock bearings. You will note that this doesn't actually follow the relative sizes of the calculated flow requirements, as these suggest that the slideways should get more oil than the headstock bearings; my rationale here was that I suspect that the slideway lubrication rates are calculated on the assumption that the slideways are in constant reciprocal movement, which might be true of a machining centre but not true of a hobby lathe. So I decided to give the headstock bearings more oil than the slideways.

Add up the flow rate column entries and you get a total of 21 "units of flow"; i.e., the smallest metering unit will deliver $\frac{1}{21}$th of the total volume (3cc/shot), the mid sized ones $\frac{2}{21}$ths of the total volume, and the large sized ones $\frac{4}{21}$ths of the total volume. The "volume per shot" column then shows how much of the 3cc shot will be delivered to each point. This shows that if you give one shot per hour, then the headstock bearings get about the right volume, but the remaining points a little less than the theoretical requirement. However, as under normal circumstances,

6. The three way connector on the back of the lathe bed.

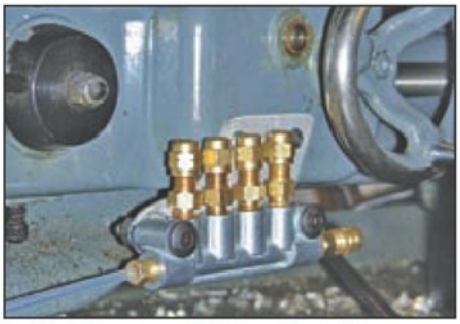
you would leave the drip oilers running continuously, and maybe give the other lube points a squirt once in a while, it is probably a reasonable balance. Clearly, you could choose to vary the arrangement by choosing different metering units to the ones I used.

The final column shows which metering units I selected in order to meet the requirement. I decided to go for the largest ones that Arc sells (AJB2) for the headstock bearings and work down from there; if I had started with AJB1 for the headstock and worked down to AJB00 for the smallest, then the only difference in performance would be that the time taken to deliver a shot of oil would double. With the units chosen, the shot gets delivered over approx. 30 seconds.

Assembling the circuit

The circuit was designed around three manifolds; one 8-way manifold, located close to the pull handle oiler (**photo 5**), which serves the headstock, countershaft, and leadscrew bearings, a 3-way manifold, mounted on the back of the bed (**photo 6**), that allows a Tee-take off point to be located in the pipe that feeds the tailstock end leadscrew bearing, and a 6-way manifold attached to the front plate of the saddle (**photo 7**) that serves the slideway oiling points (4off) and the pinion gear oiling point.

The first step was to attach the pull handle oiler and the 8-way manifold to the pulley guard at the left hand end of the lathe, as shown in photo 5; I used screws and nuts that I had to hand for this. In order for this to work properly, you need to reverse the position of the mounting plate on the oiler; simply remove the four screws that screw down through the top



7. Multi-way manifold on the lathe carriage.

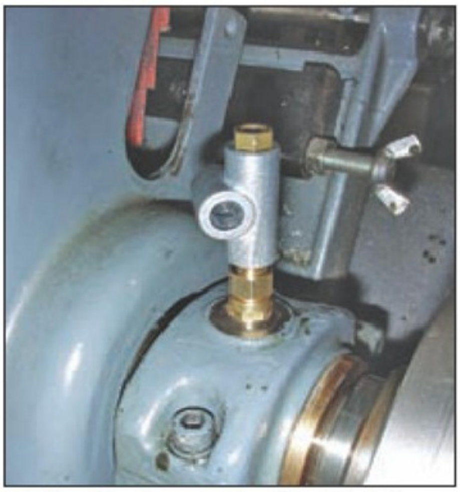
plate of the oiler into the mounting plate, spin the mounting plate through 180 degrees so that the mounting holes are on the right of the oiler handle instead of the left, and re-assemble with the four screws.

The plumbing work can now start. The first connection is from the output of the oiler to the top end port on the manifold. This is straightforward enough; you start by fitting a compression bushing and an olive over the end of a length of Nylon tube, insert them into the output port of the oiler, and screw the bushing home with sufficient turns to compress the olive so that it both grips the tube and seals the joint. You then cut the tube to length so that it will fit all the way into the port on the manifold, cut a length of the spring tube to the right length so that it will allow for two ferrules plus a compression bushing and an olive to be fitted and still allow about 2mm of Nylon tube to protrude through the olive, fit the ferrules, bushing and olive in place, and screw the bushing into the manifold port.

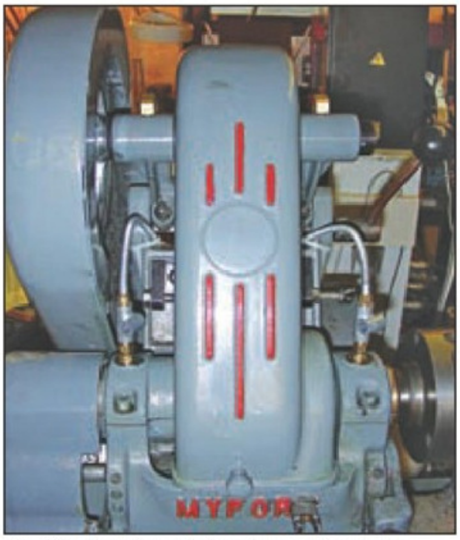
It is now a matter of working your way down the remaining ports, and connecting them up as required (photo1). The second port feeds the left hand countershaft bearing (looking from the operator's side); to do this, I used a two-port manifold, mounted onto the countershaft bracket by means of a socket head screw into a tapped hole in the bracket. The tube from the 8-way manifold feeds into the bottom of the 2-port manifold, with a compression bushing and olive as before; the metering unit screws into the top end of the 2-port manifold (pointy end first) and a short length of tube from the outflow cap of the metering unit connects to the 90-degree elbow that is screwed into the countershaft oiling point. There are two ways that the

8. Turning and threading the connector.

9. Unmodified (left) and modified (right) connectors.



10. Headstock connector fitted to lathe.

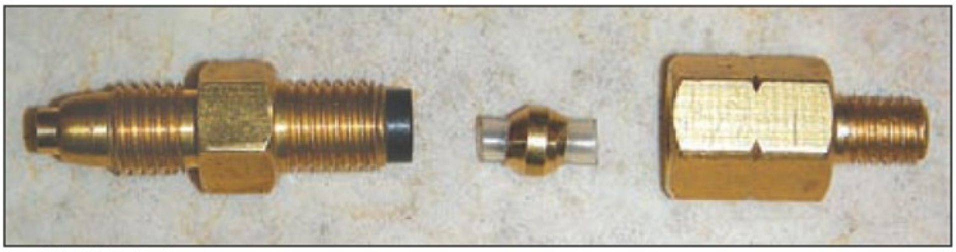


11. The headstock has been piped up.

12. Banjo connector to leadscrew bearing.

13. The split bush.

14. Modified banjo bolts.



15. Modified adaptors.

elbow can be fitted here. The first is to disassemble the countershaft, remove the standard oil nipple, drill and tap the nipple hole M6X1 to suit the thread on the elbow joint; the second is to modify the thread on the elbow joint to fit the standard oil nipple thread. I chose the second approach; the elbow joint can be gripped in the 4-jaw chuck so that the threaded end is on-axis, and the thread is then turned down and threaded 2BA to fit the nipple hole (**photo 8**). If you go that route, then you may as well modify all four of the 90-degree elbows to 2BA threads at the same time, as they are all used to replace existing 2BA threaded nipples.

The next port in the 8-way manifold feeds the left hand headstock bearing (looking from the operator's side). Having removed the standard drip oilers, you are presented with a ⅛ BSP threaded hole in the bearing cap. It turns out that of you turn down the hex portion of the screw cap on a metering unit, there is just enough meat left to take a ⅛ BSP thread. **Photograph 9** shows the "before and after"; the original metering unit on the left, and one with a modified cap on the right. The pointy end of the metering unit is screwed into another 2-port manifold, and then the whole assembly can be screwed into the bearing cap (**photo 10**). It is then a matter of fitting the Nylon tube, spring tube, compression bushings and olives as before; the tubing fits neatly through the gaps in the countershaft hinge assembly, and is held in place using cable ties (**photo 11**).

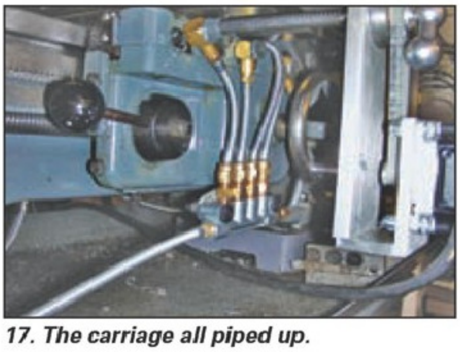
The next two ports on the 8-way manifold feed the right hand countershaft bearing and headstock bearing; the assembly is simply a repeat of the left hand ones. I fitted a couple of two-tube clamps to these four tube assemblies to keep things neat and tidy (photo 1). The next port isn't used; ideally you would use a blanking plug (part number 084-025-00400) to blank this off, but a perfectly workable alternative is to find a short length of rod (plastic or metal) that is a close fit for one of the compression olives, and fit that in place using one of the standard compression bushes.

The penultimate port feeds the leadscrew bearing at the changewheel/gearbox end of the leadscrew. **Photograph 12** shows the assembly that is required there; a "banjo" assembly screws into the oiling point, the metering unit screws into the banjo assembly, then a 2-port manifold attached to the pointy end of the metering unit, and then the tube feeds back to the 8-port manifold. Again, you have a choice with the banjo as to whether you will drill and tap the leadscrew bearing to take the banjo's M8X1 thread, or whether to modify the banjo thread to 2BA. I chose the latter approach; you need to make a split collet like the one shown in **photo 13** to allow you to hold the banjo screw in the 3-jaw chuck. **Photograph 14** shows "before and after" shots of the banjo screws. Fitting the metering unit to the banjo assembly is a bit of a cheat, and is probably not what was intended, but it works; basically you remove the cap of the metering unit, cut a length of Nylon tube that is just a tad longer than a compression olive, and then screw the metering unit, tube and olive into the port of the banjo assembly, tightening to make the seal. **Photograph 15** shows the same general idea but with one of the straight adaptors instead of a banjo unit. Two more banjo units will need modification to 2BA if you choose to go that route - one for the tailstock end leadscrew bearing, and one for the pinion gear oiling point on the saddle.

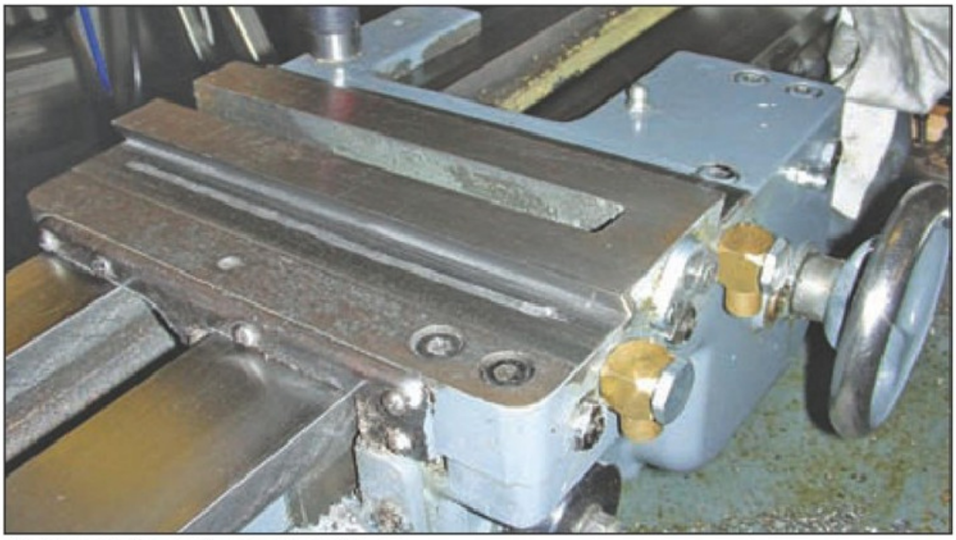
The final port on the 8-port manifold feeds a tube across to the 3-port manifold; this is mounted on the back of the bed (photo 6). This acts as a Tee-splitter. One branch (the straight through branch) feeds the tailstock end leadscrew bearing (**photo 16**) and is simply a repeat of the left hand leadscrew bearing assembly. The other branch feeds across to the front of the apron and into the left-most port of the 6-way manifold (**photo 17**). This manifold was attached to the front of the apron, below the cross slide feed screw, using a piece of aluminium plate from the scrap box. The tube from the 3-way manifold obviously has to be long enough that it will allow the saddle to traverse the entire length of the bed without snagging.

The remaining 5 ports of the 6-way manifold are all reasonably close to their points of delivery, so I chose to screw the metering units directly into the manifold,

16. Tailstock end leadscrew bearing banjo.

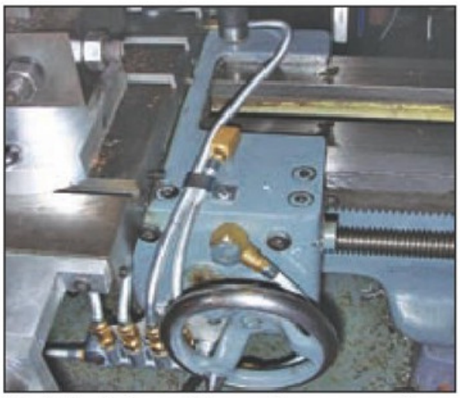


17. The carriage all piped up.



18. Two of the carriage connections.

19. Another connection, this time on top of the carriage.



20. A final view of the carriage connections.

which makes the plumbing a bit simpler as you don't need to mess around with any more 2-port manifolds. The left-most pair of ports feed into banjo assemblies that feed the cross slide bearing surfaces. There aren't any convenient oiling points for these, so this is the first case where the only way to fix the problem is to make an irrevocable change to the machine. First, remove the cross slide assembly so that you have access to the front of the apron. Now drill horizontally into the top member of the cross slide with a 4mm drill, directly below the bearing surface and in the direction of travel of the slide, to a depth of about an inch. The hole should start about ½in. down from the top surface so that the banjo doesn't interfere with the slideway, as seen in **photo 18**. Drill down from the bearing surface so that the hole connects with the horizontal hole. The horizontal hole needs to be opened out for tapping M8X1 to take the banjo screw, and I also made an oil groove in the bearing surface (as can be seen in the photo) to allow the oil to flow pretty much the full length of the bearing surface. This is easy enough to do with a Dremel-style drill fitted with a small mounted grinding wheel; I just made a straight(ish) groove, but you could of course zig-zag it, or do it a lot neater by putting the saddle on the mill. Obviously the procedure is repeated for the second bearing surface. Once the banjo assemblies are in place, pipework is installed to connect to them from the two left-most metering units.

The next two ports carry the metering units for the saddle slideways. These terminate in 90 degree elbows, modified to 2BA thread as described above (**photo 19**). Again, the tubing is installed as described before, and a cable clip holds the tubes reasonably tidy (**photo 20**). The clip is held by a self-tapper screwed into a hole drilled in the top of the saddle casting. For the tube that feeds the rear of the saddle, I left a reasonable loop of "spare" so that the tailstock can still be brought close to the saddle without trapping the tube against the cross slide. The final right-most port of the 6-way manifold feeds the pinion gear lubrication point behind the saddle handwheel, via the last remaining modified banjo assembly.

Testing and final comments

Fill the oil reservoir with your favourite Myford lubrication oil, pull back the plunger, and release. You will need to do this several times to drive all of the air out of the system and fill the pipework with oil, but before too long the plunger action will slow down as the spring meets more resistance, and oil should start to ooze out of the various bearings. Check all of the compression joints to make sure that they are not leaking; if they are, tighten them down and check again.

The system seems to work very well for me; the only downside seems to be that spare oil from the countershaft tends to fly about, leaving the tell-tale black stripe down the left shoulder, but if I get too irritated by that it is probably fixable with the installation of a simple spray guard. All in all, for the relatively small amount of effort involved, it is a worthwhile addition to the machine, and gives you peace of mind that all of the parts that need lubricating are getting their proper dose.

The complete bill of materials is shown in the following table. ■

■ MEW RESOURCE BOX

Arc Euro Trade, 10 Archdale Street, Syston, Leicester LE7 1NA
Tel: 0116 2695693
Website: www.arceurotrade.co.uk

Editors Note: "To save customers having to state each and every part number for this project, ARC have created a new product code which covers all the part numbers and quantity mentioned in the bill of materials. The code is: 084-025-10000 – One Shot lubrication parts for Myford ML7"

Arc part number	Quantity	Description
084-025-00001	1	Pull handle oiler
084-025-00250	4	90 degree elbow hose adapter
084-025-00500	5	Banjo assembly
084-025-00606	1	Junction bar 6-way
084-025-00608	1	Junction bar 8-way
084-025-00602	6	Junction bar 2-way
084-025-00603	1	Junction bar 3-way
084-025-00100	5	AJB0 meter unit
084-025-00101	4	AJB1 meter unit
084-025-00102	2	AJB2 meter unit
084-025-00700	6	metres 4mm Nylon tube
084-025-00750	6	metres Spring Tube Guard for 4mm Nylon tube
084-025-00760	5	packs Ferrules for Spring Tube ends - pack of 6
084-025-00300	5	packs 4mm compression bushings - pack of 6
084-025-00350	6	packs 4mm compression sleeve (olives) - pack of packs 6
084-025-00800	1	packs 6mm tubing clip (1 tube) - pack of 4
084-025-00810	1	packs 6mm tubing clip (2 tubes) - pack of 4
084-025-00400	1	Blanking plug

CNC MILLING - ENGRAVING ON THE SIEG KX1 CNC MILL

Mick Knights makes a Roll of Honour

■ OVERVIEW

In the last issue, MEW issue 160, I described the birth pains and the eventual running of a few trial routines on my KX1 CNC mill. I have since discovered that the manual supplied with my machine only covered the basics. My manual stopped at section 9:11. The full MACH3 manual can be downloaded at www.Machsupport.com and has a further five sections, plus an index and is intended for the more advanced user. This follow on article deals with the engraving of a brass plate (**photo 1**).

Recently, I downloaded the free trial version of Cut2D. I've now purchased the full licence for the Cut2D CAM software and I'm currently somewhere near the bottom of that particular learning curve, but enjoying the experience none the less.

Even if you aren't actively thinking about buying a CAM (computer aided manufacture) package, its well worth downloading the Cut2D trial, from the Vectric web site, as there are some examples that the home machinist can take through the tool path generation stages and by selecting the control currently in use, from the post processor list, you can create a G code part program, that will run on your own machine.

1. The finished plate.

The Loco Wheel is an excellent example and will demonstrate the capabilities of your CNC machine, with a program, that the average hobby machinist, my self included, would be hard pressed to produce (**fig 1**).

The support engineers at Vectric are very helpful, both before and after the purchase of the product. The package also has basic drawing capabilities, which compliment the wizards in MACH3. Until such time as I opt for a full CAD/CAM programming capability, these tools are doing everything I've asked of them, thus far.

The project I want to discuss is really just a bit of fun, but is all useful experience and tests the machine at the extremities of its travel.

For a few years now, some of my friends and I have been involved in an annual pumpkin growing contest, the weigh in of which is held at our local pub. The contest isn't a matter of life and death, in my experience it's far more serious than that. Some Saturday afternoons, when the history of the contest is discussed, previous champions have been known to forget the correct order of winners. So we decided to produce a Roll of Honour, which, when displayed in the pub, would help to settle all arguments.

In my previous piece about the KX1, I mentioned the free to use text wizard in MACH3 and while useful, the text writer in Cut2D is a far more powerful tool.

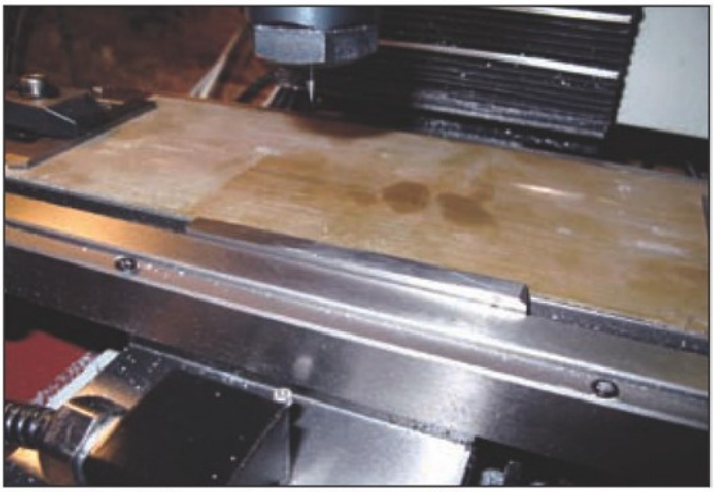
As I have a quantity of four inch wide, by 0.1in. thick brass plate in my bottomless scrap box, I used a piece twelve inches long, to produce a decent size plaque.

The start point was to create a rectangle of the above dimensions in the "Create Vectors" section of Cut2D with the centre of the plate being X0 Y0.

Next the "Draw Text" section was opened and the, "Text Alignment" from the left, option chosen. To choose the height of the characters entails trying different heights of text to see if they fit the width restrictions of the rectangle. By using the longest line of text, as a test line, it was found that 6mm height characters fitted the space evenly.

There is a text display box in the top left hand corner of the screen, so the text being created is shown in this box prior to applying it to the main screen. Once happy with the text layout, simply apply the text to the main screen. At this stage the text appears vertically, but will need to be finally machined along the length of the X axis on the milling machine. All that is required to achieve this is to rotate the text on the screen through ninety degrees (**fig 2**).

The tool path tab is then opened and the "Mill Pocket" option selected. A cut depth of 0.25mm and a safe Z working plane of 6.0mm was then applied after which an engraving tool was chosen from the tool library. No further options are required to complete the program. Finally, the "Calculate Tool Path" tab is clicked (**fig 3**). The tool paths are then applied to the main screen. Once happy with the tool paths, as they appear on the screen, simply choose the control to be used from the list of post processors. In this case MACH3 and click the save tool paths tab (**figs 4 and 5**) The G code part program is then saved to a folder of your choosing, or downloaded directly to the machine.



2. Aligning the brass plate with the machine.

3. Setting the engraving tool.

Setting the brass plate directly onto the machine table will mean that the Z axis will be working on the very extremes of its travel. Before committing to this, the operator must be happy in their own mind to use the machine in this condition. The alternative would be to make a sub plate, to raise the workpiece a further 25mm or so. But as any sub plate would need to be the size of the actual machine table, this would entail a lot of extra work and so I will leave that project for another day.

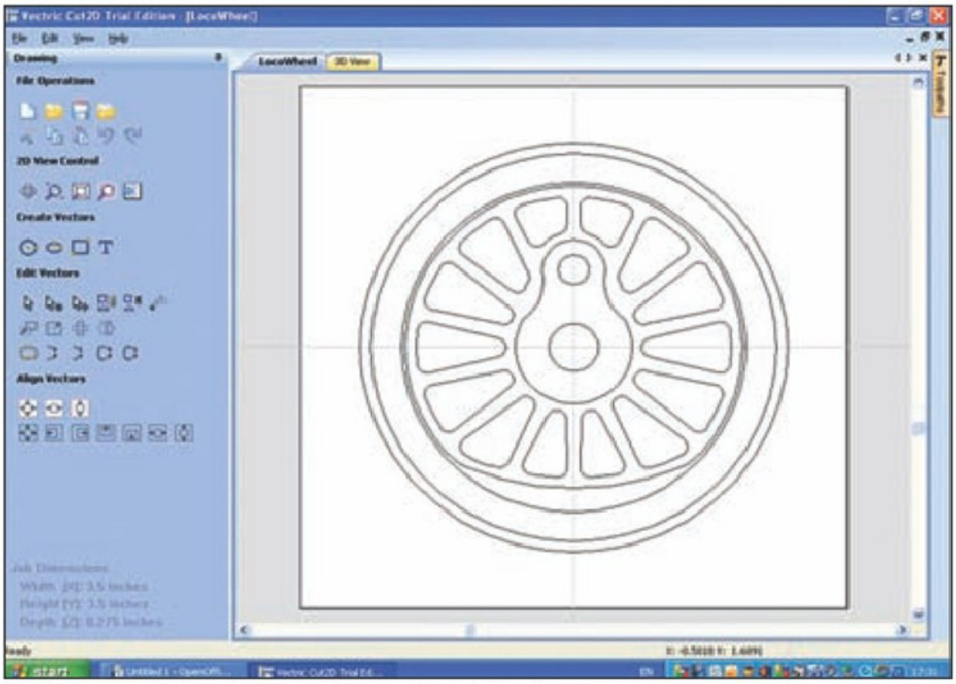


Fig 1. Tool paths for the loco wheel in the trial software.

The brass plate is located against a removable tenon block, located in the table tenon slot (**photo 2**). With a pencil, mark the position, in from the top edge, where the centre of the block of text will start. The machine table needs to positioned (by eye) centrally to the spindle. The plate can then be clamped to the machine table, with the pencilled line beneath the engraving tool. To spread the clamping pressure, use a suitable plate beneath the actual clamps.

The Y zero position needs to be 6mm in from the outside edge of the plate. When the program was loaded, a soft limit warning was displayed, which meant the program would probably be stopped by the soft limits at some stage of the machining. The best way to find out where this would occur, is to dry run the program until the limit concerned, is reached. The final X0 Y0 position will need to be adjusted, after the soft limit concerned is identified. When the program is on dry run, the Z axis has to be raised clear of the workpiece.

In this case the text program runs from an anchor point in the centre of the block of text. When the end of the text was reached in the X- quadrant, without the soft limits tripping, the adjustment would obviously be required in the X- quadrant. I recorded the X- travel as 110.0mm When the dry run reached X+95.0 the limits tripped, so using the incremental jog, the table was moved 15mm back into the X-

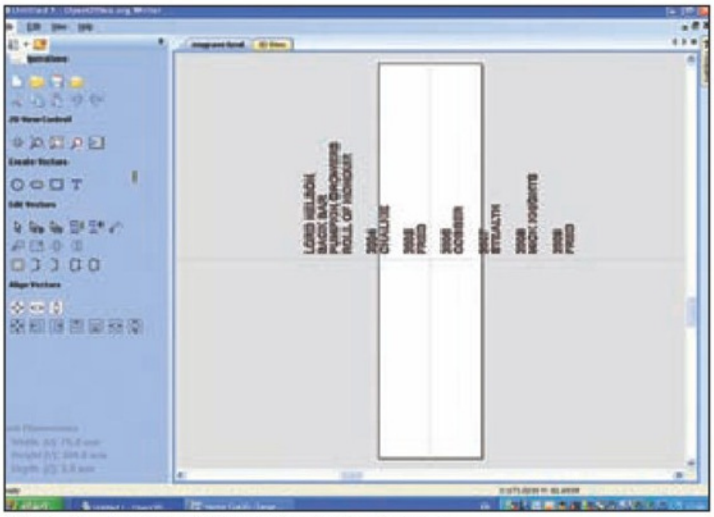


Fig 2. Text rotated through ninety degrees.

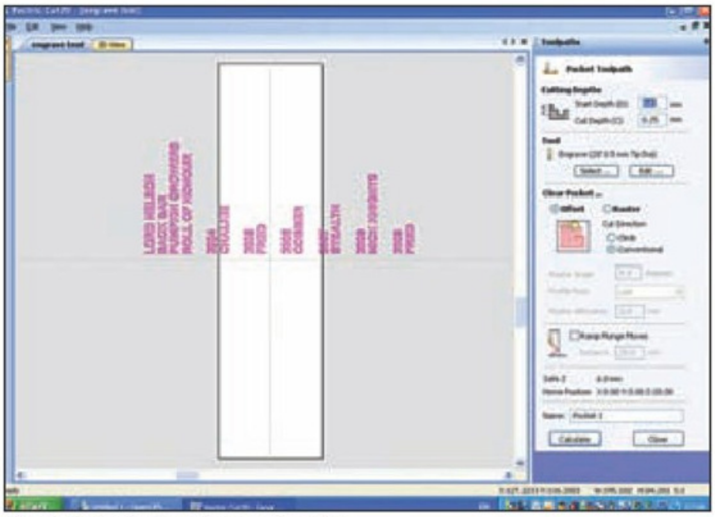


Fig 3. Calculating the tool paths.

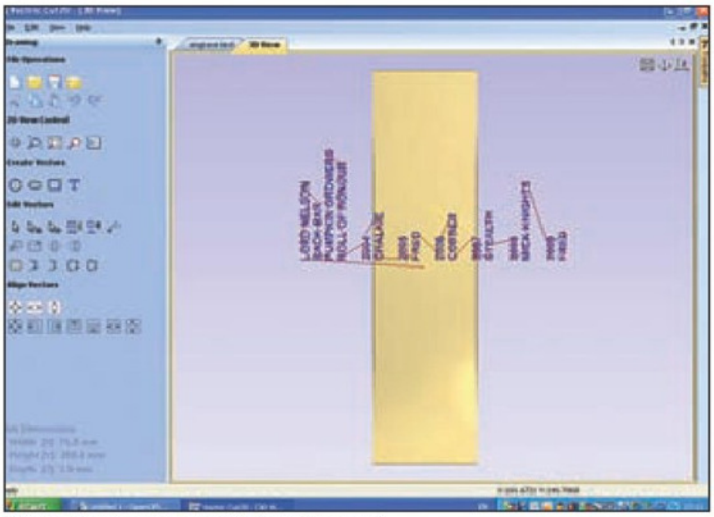


Fig 4. Tool paths applied and saved.

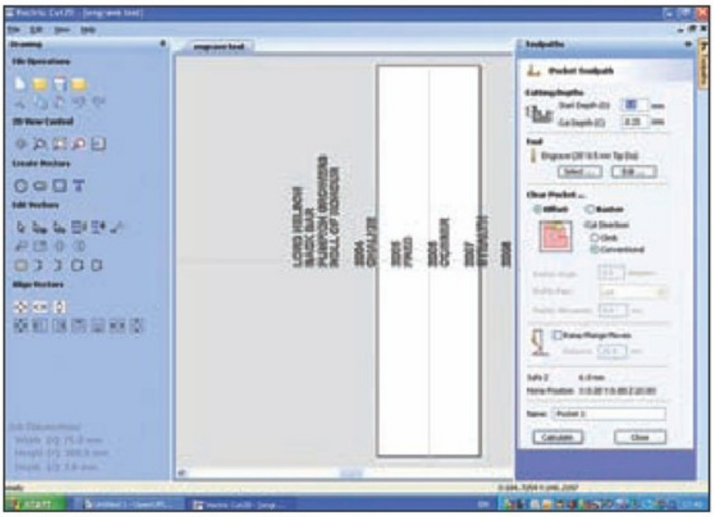


Fig 5. The open tool path tab.

4. Starting to engrave.

quadrant and at that position, the X axis was re-zeroed.

To double check, the program was run dry again and this time no soft limit warning appeared and the program ran without any problems.

Now to set the tool and offsets. As the engraving tool is virtually a point (it does have a 0.2 flat) it could easily be damaged, so can't really be set in the normal way of jogging down in increments and checking the distance between tool and workpiece with a feeler gauge in case the point became trapped against the job, and was chipped.

As I've mentioned before, the Z axis will have to be working at the extreme limits of its travel. Again, the operator must be happy with this situation. To set the Z parameters, I gently jogged the Z axis down, until the stepper motor note

5. The final pass.

changed, at this point the Z was zeroed. The Z was then jogged back to a value of +10.0 and zeroed again. With the engraving tool loosely held in the collet chuck, the Z was jogged down to -Z 8.0 The engraving tool was released and allowed to sit on the face of the plate and the chuck gently tightened by hand, to just grip the engraving tool. The tool length offset was then set at this point. The 2.0mm difference between the two Z points previously obtained will be used to fine adjust the cutting depth of the engraving tool as it's unlikely to cut over the entire area of the plate on the first pass (**photo 3**). The engraving tool was fully tightened when the collet chuck was clear of the work face.

A couple of edits need to be applied to the G code program. The post processor selected a speed of 12,000rpm and as my machine only has a top speed of 7,000 a speed of 6750rpm was substituted. As the feed rates programmed are in, "Feed per Minute" mode (G94) these values would have also been set to cut at a speed of 12,000 rpm. So these feed values need to be reduced by around a third. If the cutting seems too fast when actually machining, they can, of course, be reduced further by the feed override control.

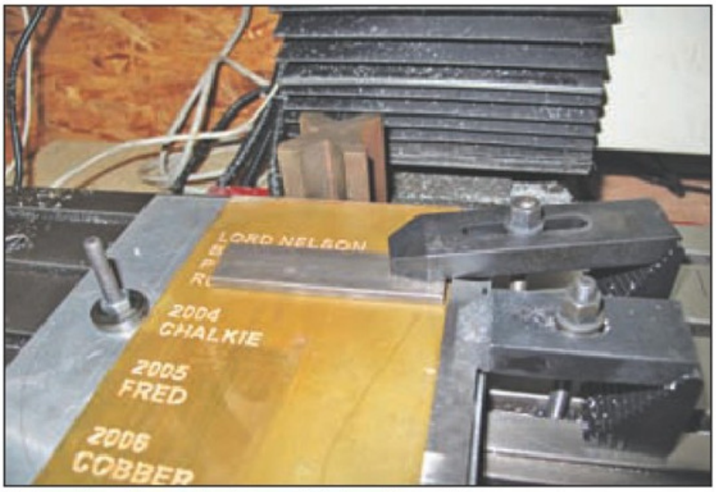
The first run of the program produced some engraving across the whole of the plate. The depth of cut was increased by jogging the Z to -0.2 and re-zeroing. The engraving started to become visible with this depth of cut (**photo 4**). After two further passes the engraving was complete.

To aid the machining process, a little cutting fluid was applied during the engraving (**photo 5**). The casual observer might be forgiven for thinking that the 2008 winner was a particularly fine specimen!

To finish the plaque off, 15mm radii were machined on all four corners. The plate was supported on a piece of spare aluminium and was located in the X axis with a parallel clamped to the fixture and in the Y axis with a hand held Vee block (**photos 6** and **7**).

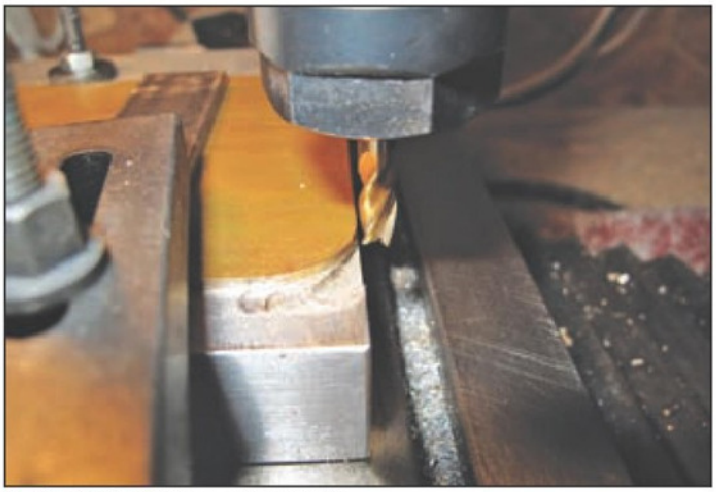
Absolute zero was set using a wiggler (**photo 8**). Once established, both the X and Y axes were jogged to -15mm and re-zeroed, as the centre point for the radius. Each corner was cut at this position (**photo 9**). The finishing touch was to buff the plate with Scotch Bright (photo 1). This completed another successful application for this versatile little machine. ■

6. Lining up a straight edge prior to cutting the corner rads.



7. Loading the plate for machining the rads.

8. Establishing absolute zero.



9. Machining 15mm corner rads.

Belt drive and chain drive components.

FIRST STEPS IN 3D DESIGN 9

Linton Wedlock models belt drives and chain drives

■ OVERVIEW

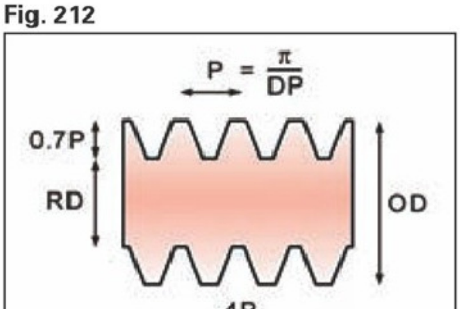
Linton covers worms and their matching worm wheels followed by belt and chain drives.

Modelling a worm

Before starting the main subject of this article, I'll describe a couple of gear models which couldn't be fitted in part eight. These are a 20 DP worm and a matching worm wheel. For these two objects, the calculations, grid squares and Object Info Panel values will be in inches.

Worms can be built with the same technique that was used for the Leadscrew described in part four; that is combining a core cylinder with a spiral thread produced with the [Lathe] tool. First, here are some proportions for a worm as recommended in ref 1 (given last month):

Fig. 212

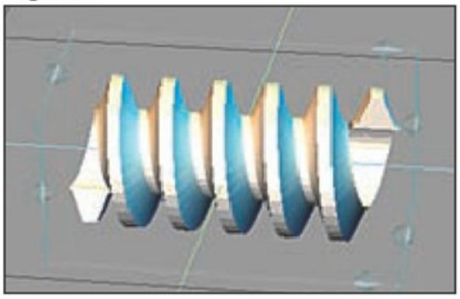


The pitch, P, of the worm thread is 3.142 / 20, or 0.157 inches. This matches the circular pitch of a 20 DP worm wheel. Choosing an outside diameter, OD, of 0.5 inches gives a root diameter, RD, of 2.80 inches (= OD - 1.4 x P = 0.5 - 1.4 x 0.157). This will be the diameter of the core cylinder, and its length will be 0.6 inches (roughly four times P). Begin the modelling in trueSpace with [**Reset View**], set the cylinder **Longitude to 36** (one face per 10°), and [**Cylinder: ZL0/XR90/XS0.28/YS0.28/ZS0.6**]

The position of the teeth on the cylinder can be found by calculation, but this won't be necessary if the modelling is done in the following way: Load a copy of the 20 DP 2D **rack tooth** shape that was created last month, then place it centrally on one side of the cylinder with [**XL0.14/ZR-90**] (the X location is half the cylinder diameter). Select the upper face of the shape with [**Point Edit: Faces**], then right-and-left click [**Lathe**]. Set **Helix:-0.157** (= the tooth pitch, P), and **Rotation:270**. Make **Angle:1000**, and **Segments:100.** The exact value of the angle here is not important, as long as the end of the lathed tooth will extend fully beyond the end of the cylinder. The Segments value is one-tenth of the Angle, giving one segment per 10°. Drag the Radius adjustment point on the Lathe tool guide-lines (as shown in part six) until it is at the centre of the cylinder (at the World Centre); zoom in close in a Top View in Wireframe mode to do this accurately. The Radius value should now be 0.17. Click [**Lathe**] to create half of the worm's thread.

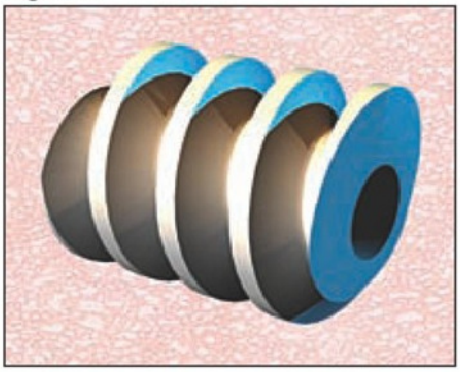
Adjust the viewpoint to see the underside of the original starting tooth shape, and pick the face with [**Point Edit: Faces**]. Right-and-left click [**Lathe**] again. This tool's previous settings have been remembered, but for the Radius and Helix values this is only to a precision of two decimal places, so retype **Helix:-0.157,** and move the lathe's Radius control point back to the World Centre with the mouse. Click [**Lathe**] and [**Object Tool**] to complete the thread.

Fig. 213



Select the core cylinder, and [**Copy: XS1/YS1**]. Use [**Object Intersection**] with this new cylinder and the worm thread to cut the latter down to the same length as the core cylinder. Select the cylinder once more, and **Subtract** this object: [**Copy: XS0.188/YS0.188**] (= 3/16 inch diameter) to make a bore. [**Object Union**] the cylinder and worm thread together to give:

Fig. 214



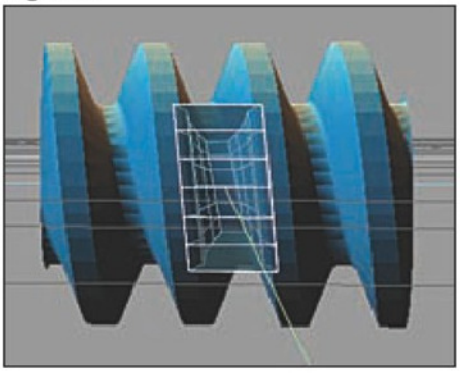
A matching worm wheel

Creating virtual models of complex objects can be a great way of gaining a better understanding their geometry. This was true for the next example - a worm wheel, which I had never modelled before. The construction steps shown here seem to make a visually credible model, although I can't say if the method of making the wheel is the best possible. The particular example demonstrated is a 60 tooth, 20 DP wheel which matches the previously created worm.

Keeping the worm as created, [**Reset View**], and load a copy of the 20 DP 'average' tooth shape that was created last month. Orient the object with [**ZR-90**], and move it to the correct position in respect to the worm with [**XL-0.203**]. This value is half the worm's outside diameter minus 0.3 multiplied by the worm's thread pitch (= OD / 2 - 0.3 x P = 0.5 / 2 - 0.3 x 0.157). This position is where the pitch circles of the worm and wheel are coincident. If you zoom into a top view, the tooth can be seen to fit closely in the worm, but there is a very small overlap because the tooth profiles are approximates only.

To make a single tooth for the wheel, select the top face of the tooth shape with [**Point Edit: Faces**], and use the [**Lathe**] tool with these values: **Segments:3**, **Angle:30**, **Rotation:90**, and **Helix:-0.157** (= P). Move the Lathe Radius control point to the World Centre with the mouse, then click [**Lathe**]. Repeat this procedure for the lower side of the starting tooth face (including resetting the Helix and Radius), then click [**Object Tool**] to produce a tooth like this (drawn in Transparent Outline mode):

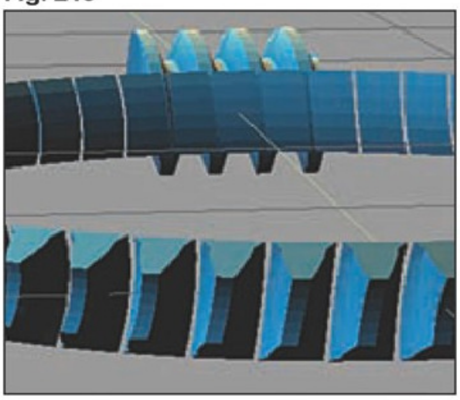
Fig. 215



The two Lathe operations have created the tooth so that it wraps around the worm axis by 60°; 30° above and below the worm's centre line, and with the same pitch as the worm.

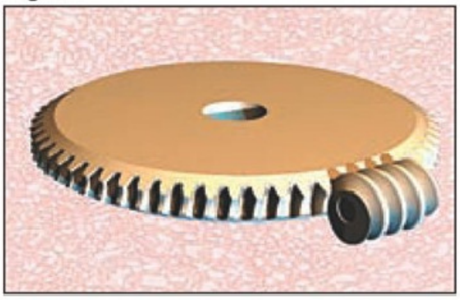
With the tricky part complete, all that has to be done now is to copy the tooth with a radial array, and then make the gear's centre. Right-and-left click [**Create Radial Array of Objects**], and click once in the workspace. For a 60 tooth wheel, set # **Segments:60**, **Center X:-1.703**, and **Center Y:0**. This X value is made up of the original Axes position of the 2D tooth shape (-0.203) minus half the pitch diameter of the 60 tooth wheel (PD = 60 / DP = 3 inches).

Fig. 216



With cylinder **Longitude:60**, add [**Cylinder**] and [**XL-1.703/ZL0/XS2.884/YS2.884/ZS0.1**] This object has the root diameter of the gear (RD = (60+2) / DP - 2 x 2.157 / DP). Select the top face of the disc with [**Point Edit: Faces**], adjust the view to look at the underside of the disc and select this second face also (Control Key down). Right-and-Left click [**Sweep**], and set **Z:0.08** in the Sweep/Tip Panel and type [**XS2.954/YS2.954**] (these values were found by examining a zoomed-in Front View). Right-and-left click [**Bevel**], set **Bevel:0.1** and **Angle:60** (matches the angle of the side of the tooth). Click [**Object Tool**], then [**Object Union**] the wheel centre and teeth together, and add a bore if you like.

Fig. 217

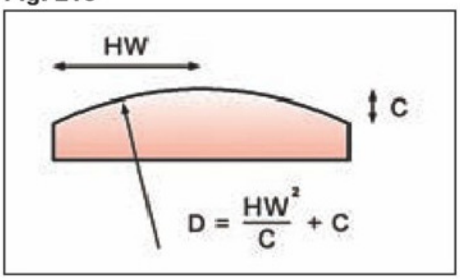


A flat belt pulley

Vee belts and pulleys have been covered in previous articles, so I'll stick to other types of belt drive in this part. The first example will be a flat belt pulley. Although these are not used so frequently now, the modelling will demonstrate some techniques which have not been covered before. Also, the modelling of the pulley's spokes may also be useful as an alternative way of creating a flywheel to that which was shown in part six.

The models in the rest of the article will be created at a scale of one grid square equals one centimetre, but I couldn't find a metric specification for the crowning of flat belt pulleys. For imperial pulleys, one recommendation is for 3/16 inches of crowning per foot of the pulley width. This corresponds roughly to a 0.5mm camber for the 30mm wide pulley which will be created in this example. This amount, though, is barely noticeable on a model, so I'll use an exaggerated crowning value of 2mm in this demonstration. The first step is to find the diameter of a circle which corresponds to the required camber. This can be found either with a quick CAD drawing or with this equation:

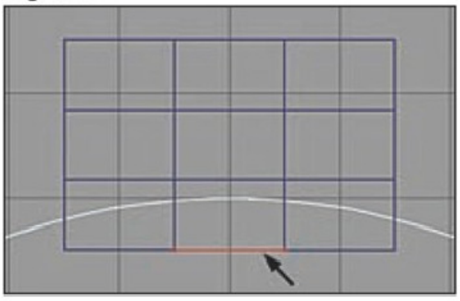
Fig. 218



D is the diameter, C the amount of camber, and HW is half the width of the pulley. In the present example, D equals 15 squared, divided by 2, then add 2, which is 114.5mm. (For a 0.5mm camber on the same width, D would be 450.5mm). Choose a large cylinder **longitude** value (80 is a good number here) which is many times greater than the number of faces required across the pulley's outer rim width. It's probably easiest to estimate this, although it can be found with a drawing or calculation. Add: [**Cylinder: YL5.725/ZL0/XS11.45/YS11.45**] - XS and YS are the diameter just calculated, and YL is half the diameter.

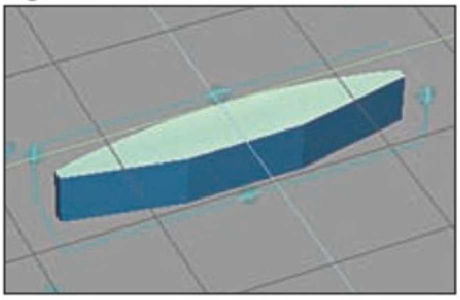
The cylinder will now be intersected with a modified plane, creating a 2D shape for the pulley rim. Right-click [**Plane**], set the **Resolution** value in the Plane Panel to 3, then add a [**Plane: YL-0.7/XS3**]. With [**Point Edit: Edges**], pick this edge:

Fig. 219



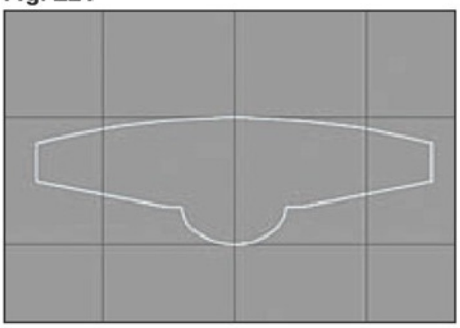
Type [**YL0.5**], [**Object Intersection**], and click the cylinder. Select the new 2D shape with [**Point Edit: Faces**], then [**Sweep**], and [**Object Tool**] (if the extrusion was downwards, type [**ZL0.5**]).

Fig. 220



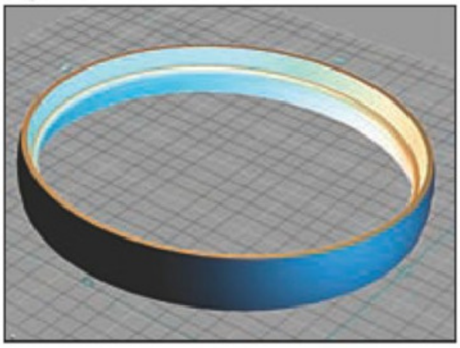
Add a [**Cylinder**] with **Longitude:20**, and [**YL0.5/ZL0.25/XS0.8/YS0.6/ZS0.5**]. [**Object Union**] the two objects together, select the combined object's top face, and click [**Separate Selected Part of Object**] (in the Point Edit Panel, this tool was used to create the lapping plate in part 5). Delete the solid object to leave this 2D shape:

Fig. 221



Type [**ZL0**], move the object axis to the outer edge of the rim with [**Axis**], [**Normalize Location**], [**Axis**], then reposition the shape with [**YL-10**]. Use the [**Lathe**] tool with **Segments:60**, **Angle:360**, **Rotation:90** (Helix:0), and move the Lathe Radius bar to the World Centre (zoom in close for accuracy). Click **[Lathe]**, **[Object Tool]**, **[Axis]**, **[Normalize Rotation]**, and **[Axis]**, then **[YR90]** to complete the pulley's rim:

Fig. 222

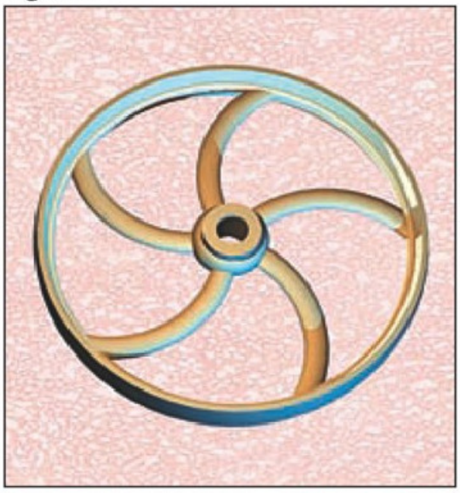


Hub and spokes

[Reset View] and add three Cylinders:
[ZL0/XS3.0/YS3.0/ZS3.0]
[ZL0/XS1.5/YS1.5/ZS3.0]
[XL1.4/YL-1/ZL0/XR90/XS1.2/YS1.6]
Subtract the second cylinder from the first to make a bore, then select the nearest end face of the third cylinder. Click **[Separate Selected Part of Object]**, then delete the original cylinder. Pick the new 2D ellipse, then **[Copy: XR0/YR90/XS0.6/YS1]**.
Use the **[Lathe]** tool with **Segments:12**, **Angle:90**, **Radius:6.04**, and **Rotation:90**. Copy the spoke with **[Create Radial Array of Objects]**, setting # **Segments:5 or 6**, **Center X:0**, and **Center Y:0**.

Select the original 2D ellipse, then use the **[Lathe]** tool with **Segments:40**, **Angle:360**, **Radius:1.4**, and **Rotation:180**. **[Object Union]** the pulley's hub to the other objects to finish.

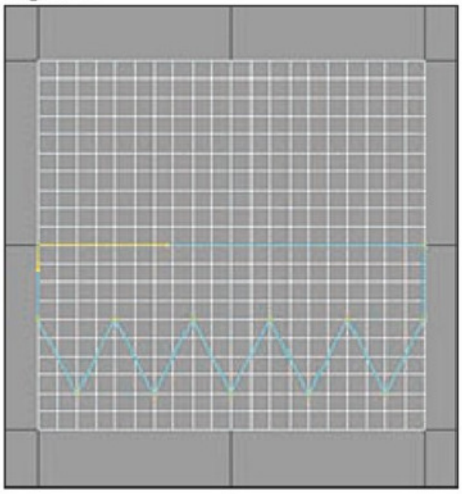
Fig. 223



A poly-V belt and pulley

Using a Top View in Wireframe Mode, right-and-left click **[Toggle Grid Mode]**, and set both X and Y resolutions in the Grid Panel to 0.1. A 2D cross-section shape of a poly-V belt will now be created with a Polyline, but first a grid object will be made to use as a snapping point guide. Right-click **[Plane]**, set **Resolution:20**, and add a **[Plane]**. This object has points spaced every 0.1 grid squares (one millimetre) - the same value as set for the snapping resolution. Draw this closed 2D poly-V shape with the **[Add Polyline]** tool:

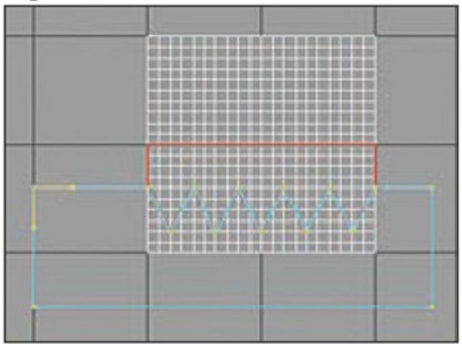
Fig. 224



This simplified shape does not represent any specific poly-V belt, but the vertices could be edited to make it match a real example. Alternatively, you could draw the shape in a CAD program and then import it into trueSpace; this is one of the subjects covered in next month's article.

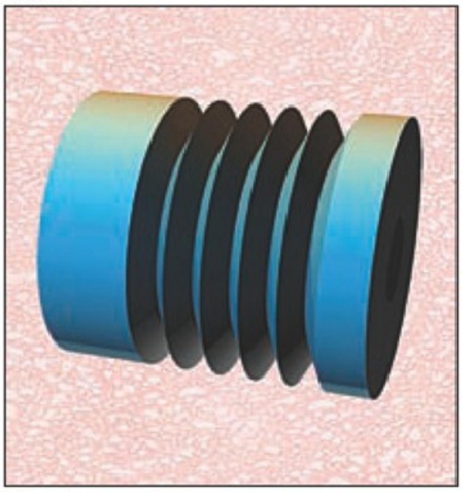
Add a second **Polyline** for a half cross-section of a matching pulley; the one shown next has an allowance for a bore of the pulley:

Fig. 225



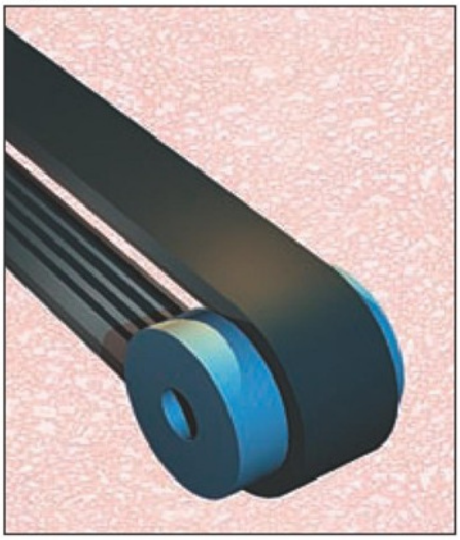
If you like, this shape could be saved and later reused for pulleys with different diameters. Make the pulley with the **[Lathe]** tool set to an Angle of 360°, and the Radius adjusted with the mouse. Make a note of the Radius Control Point position; the same location will be used for the belt.

Fig. 226



Select the 2D belt section and make a 180° **Lathe** extrusion around the pulley. Don't click **[Object Tool]**, but immediately add a straight extrusion with the **[Sweep]** tool (say 30cm long). Add another 180° **Lathe** extrusion (the radius Control point will need a small amount of resetting with the mouse) and another **[Sweep]** section to arrive back at the starting point. (The belt and pulley have been reoriented in the next diagram).

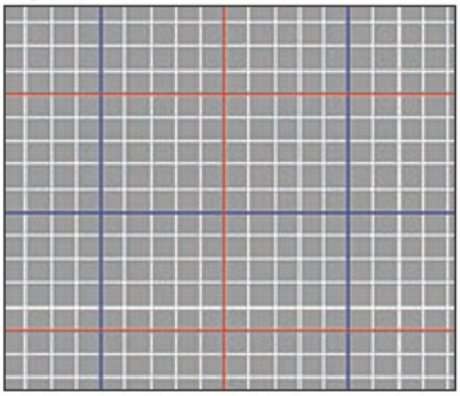
Fig. 227



Using guide grids

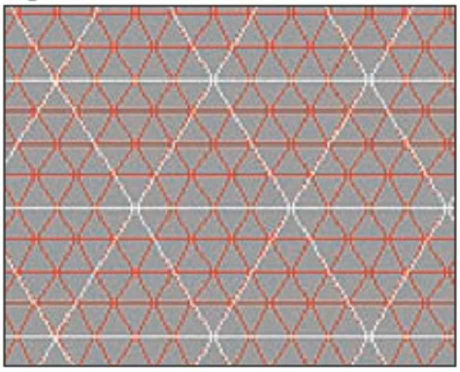
Because trueSpace has an unchanging grid, it can be worthwhile making up a collection of guide grids (like the one used in the previous example), and guide objects (as was used to make the spiral spring in part four). Although it's not possible to snap to the vertices in these guide objects (except indirectly when the squares in a rectangular grid match the trueSpace snapping values), they are still very useful in some situations, especially as they can have any location, rotation, or scaling. An example of a rectangular grid (in close-up) is:

Fig. 228



This is made up of three separate planes, all with X and Y sizes of 10, but with different resolutions (10, 20 and 100). Each plane was put in a different layer, each with a contrasting wireframe colour, and the three objects grouped together. The grouping order is chosen to prevent the higher resolution plane obscuring the others. Here is another grid example made up from equilateral triangles:

Fig. 229



Timing pulley

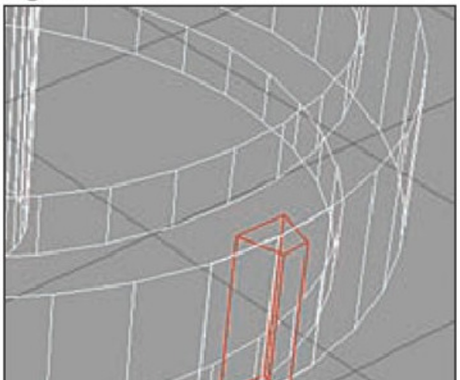
The techniques used to construct belts and those used for gears can be combined when making timing belt drive models. The next example shows the construction of two 40 tooth, 2.5mm pitch timing pulleys with a 330 mm long, 6 mm wide, 132 tooth belt. The model is an accurate representation of real components, although there is a little simplification.

Start with a pulley centre by adding these three objects:
[**Cylinder: XS2.99/YS2.99/ZS0.6**]
[**Cylinder: XS2.6/YS2.6/ZS1**]
[**Cylinder: XS0.6/YS0.6**]

Union the first two cylinders, and **Subtract** the third. This object has the root diameter of the pulley.

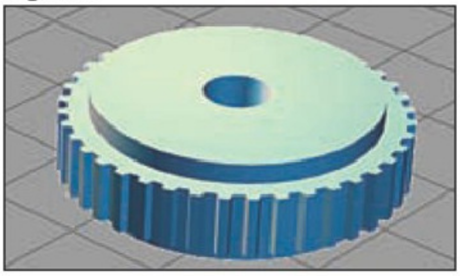
Make a tooth with:
[**Cube:XS0.177/YS0.139/ZS0.6**]
Select the nearest right-hand face, and reduce its width with [**XS0.09**].This 40 tooth shape could now be saved as used as an 'average' tooth for other pulleys. Position the tooth with [**YL1.495**] - the pulley centre's radius.

Fig. 230



Make a **40 segment Radial Array** with the tooth, and **Union** it to the pulley.

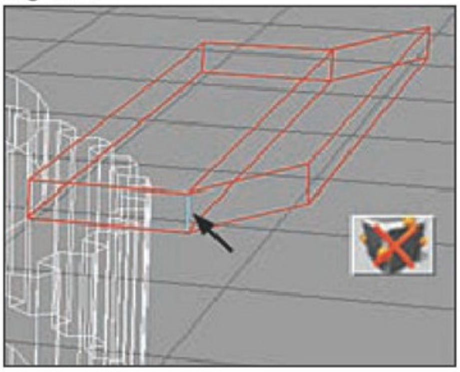
Fig. 231



For the flange, start with:
[**Cube:XL-1/YL1.5/ZL1.35/YS0.4/ZS0.1**]

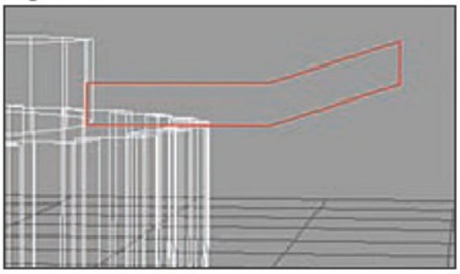
Select the long thin outer face of the cuboid, [**Sweep**], and [**YL1.984/ZL1.45**]. Select the edge indicated in the next diagram (with [**Point Edit: Edges**]):

Fig. 232



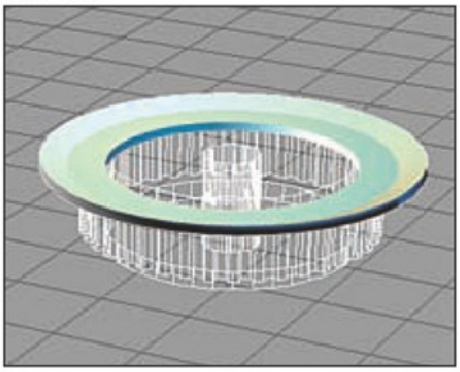
The edge divides the flat end face of this object into two parts, but will now be removed by introducing a new trueSpace function: click [**Erase Vertices**] from the Point Edit Panel (its icon is shown in the diagram above). Incidentally, the Erase vertices tool is a useful function which works with vertices, edges, and faces - you may like to experiment with it later on a sphere. Select the now single end face of the object, click [**Separate Selected Part of Object**], then erase the original object to leave a kinked, but flat, 2D shape.

Fig. 233



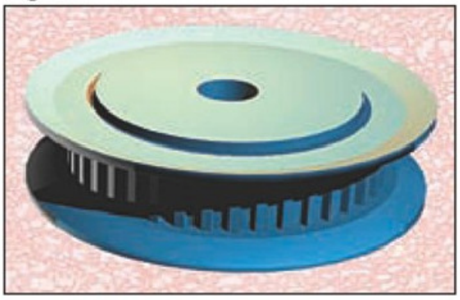
Select this shape and make a 360° extrusion with the **Lathe** tool with **Rotation:180**, and putting the Radius Control Point at the pulley's centre with the mouse (zoom in close in a Left View - the Radius value should be 1.66).

Fig. 234



Make the second flange with [**Copy**], [**Axes**], [**Normalize Rotation**], [**ZL1**], [**Axes**], and [**XR180**]. Select the pulley centre and **Glue** it to the two flanges to give:

Fig. 235

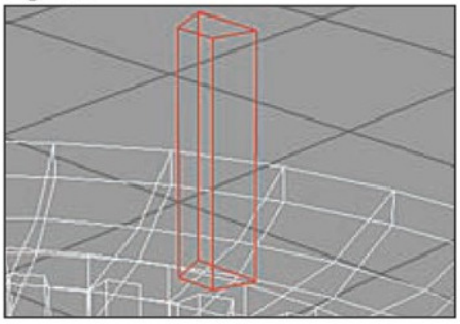


Timing belt

For the first step, rotate the pulley with [**ZR4.5**], which aligns it with the teeth which will be made for the belt. A 40 tooth pulley with a tooth pitch of 2.5mm has a pitch circle circumference of 100mm. For a 330mm long belt around two such pulleys, this gives a pulley separation of 115mm, so, with the pulley selected, click [**Copy**], and [**YL11.5**].

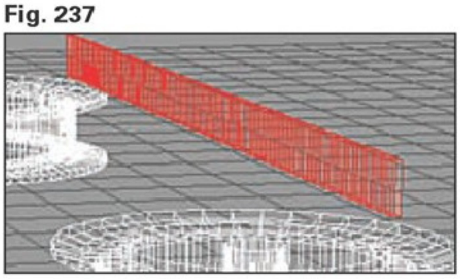
The teeth for the belt will be made first, and to make the steps clear, the modelling will be done above the pulleys. Add [**Cube: ZL2**], then [**Axes**], [**XL-1**], [**Axes**]. Resize the object with [**XS0.097/YS0.17/ZS0.6**]. The Z size is the belt width, in this example it's 6mm. Select the innermost face of the tooth (nearest the pulley's centre), and reduce the face width with [**XS0.1**].

Fig. 236



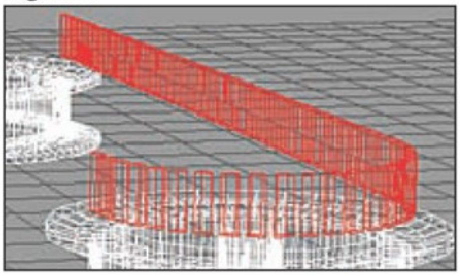
(This object could be saved for making other belts). Move the tooth into position on the Pitch Radius of the current pulley (= 100mm / 2p) with [**XL-1.592**] - in a top view the tooth can be seen to fit between the pulley's teeth. The other belt teeth will be created with two Grid Arrays and two Radial Arrays. Turn on **Grid Snapping**, then with the tooth selected, right-and-left click [**Create Grid Array of Objects**]. Click and drag the mouse in the workspace near the second pulley, making the grid array control parallel to the Y axis. Release the mouse button, and click it once more. In the Grid Array Option Panel, type # **X Items:46** and **X Space:0.25** (46 x 2.5mm = 115mm); the last tooth in the array should be just one short of reaching the perimeter of the second pulley.

Fig. 237



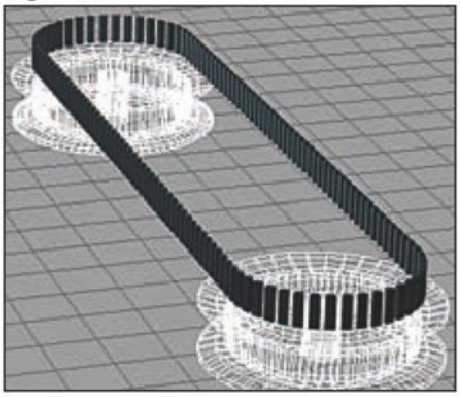
Press the Down Arrow keyboard key to select the first tooth in the array. [**Copy: YL11.5**], then make a **Radial Array** with these values: # **Segments:20**, **Angle:-180**, **Center X:0**, and **Center Y:11.5**.

Fig. 238



Press [**Convert an Array to a Group of Objects**], press the Down Arrow key, then select the last tooth in the radial array and [**Unglue**]. Starting with this single tooth, repeat the above procedure, making identical **Grid** and **Radial Arrays** to arrive back at the starting tooth position. Finish by converting the three remaining arrays into ordinary groups.

Fig. 239



For the outer part of the belt, start with a [**Cube: ZL2**], and:
[**XL-1.596/YL5.75/XS0.06/YS11.5/ZS0.6**]

These values were found from belt specification and a little arithmetic. Select either end face of the cube and **Lathe** it through a 180° angle, setting the Radius Control Point with the mouse to the centre of the pulley (Radius should be 1.59). Follow this with a **Sweep** of length **11.5**, and finish with another 180° **Lathe** extrusion, ending back at the other end of the original cuboid. **Glue** this object to the four teeth groups, and lower it to its final position with [**ZL1**].

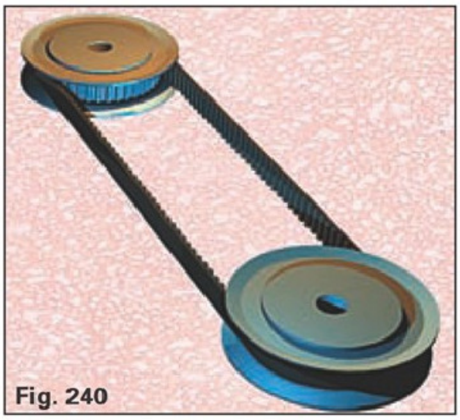
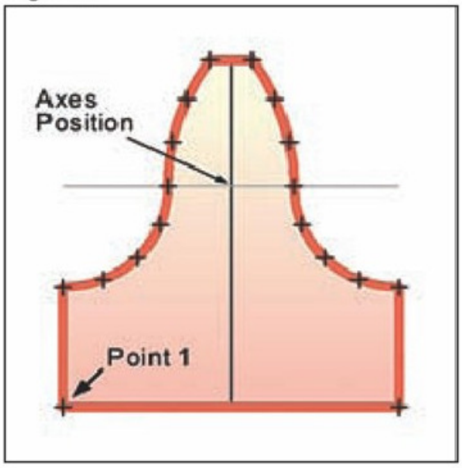


Fig. 240

Modelling a sprocket

Sprockets share some of the same features as gears and can therefore be modelled in the same way. The next diagram shows a sprocket tooth profile, with 18 points which will be used as an approximation of the shape:

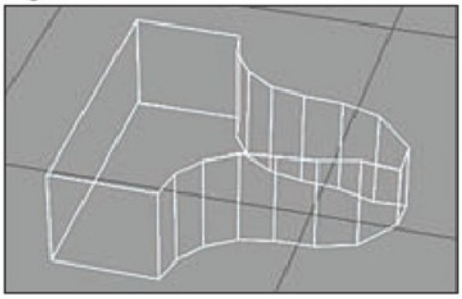
Fig. 241



To make the 2D shape, follow the method shown last month for creating a 2D gear tooth shape. **Table 1** shows the X and Y locations of the points beginning with point 1 in the diagram above, and working clockwise.

Save this 2D tooth shape, which is for a 8mm pitch chain, then extrude it with the **Sweep** tool and make it 0.3cm thick. Optionally, some chamfering can be given to the tooth tip by picking its end face and typing [**YL0.25**]. (this will make the top and bottom tooth faces non-planar, but it doesn't seem to cause any problems).

Fig. 242



To make a sprocket, the position of the tooth is found in this way: first, find half of the angle between the sprocket teeth, HA, - for N teeth this is 360° divided by 2N. The example shown here will be a 20 tooth sprocket, which makes HA = 9°. Next, divide the chain pitch (0.8 centimetres in this case) by two, then divide this value by the tangent of HA, for this example this is 0.4 divided by tan 9°, or 2.526. This is the position of the tooth in the negative Y axis direction, so type [**YL-2.526**].

Make a **20 Segment Radial Array** with the tooth, with **zero Center X and Y values**. Add a [**Cylinder**] and [**ZL0.15/XS4.6/YS4.6/ZS0.3**], then make a hub and a bore subtraction object with two more **Cylinders**. Pick the first cylinder, **Union** the hub, **Subtract** the bore cylinder, and **Glue** this combined object to the teeth (object union won't work - or not without several more convoluted steps).

Fig. 243

A sprocket chain

Without including too much detail, a chain can be modelled in this way: Set the cylinder **Longitude to 12**, then **Union** the first of these next three objects with the other two:
[**Cylinder: XR90/XS0.7/YS0.7**]
[**Copy: XL-0.8**]
[**Cube: XL-0.4/XS0.8/ZS0.7**]
Turn the object into a side plate with:
[**YL0.3/ZL0/ZS0.1**]

Make three more copies: [**Copy: YL-0.3**], [**Copy: XL-0.8/YL-0.2**], and [**Copy: 0.2**].

Make a 5mm diameter roller:
[**Cylinder: ZL0/XR90/XS0.5/YS0.5/ZS0.6**]
And a pin:
[**Copy: XS0.25/YS0.25/ZS0.8**]

Copy both of these cylinders, giving them [**XL-0.8**]. **Union** the first roller, pin and two side plates together (shown in blue below), then make a second **unioned object** (in red) from the other four objects. Pick the first object and **glue** this to the second:

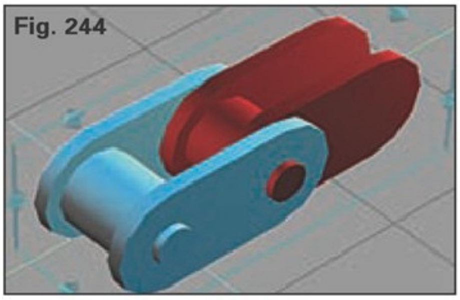


Fig. 244

A full chain can be made in the same way as the pulley timing belt was. When creating radial arrays around the sprockets, though, an additional step is required with a rotation of the two links in the group. Here's the first stage of making a chain that wraps around the 20 tooth sprocket:

First, select the sprocket, and type [**ZL0/ZR9**] - this nine degree rotation aligns a sprocket hole with the Y axis. Rotate and move the two-link object with [**XR0/YL-2.557**]. This Y location value is found in the same way as the position of the tooth was when making the sprocket, except that the sine of HA is used instead of the tangent (= 0.4 / sin 9°). This centres the first chain link pin on the pitch circle of the sprocket. The first roller in the link object should now be aligned between two of the sprocket's teeth:

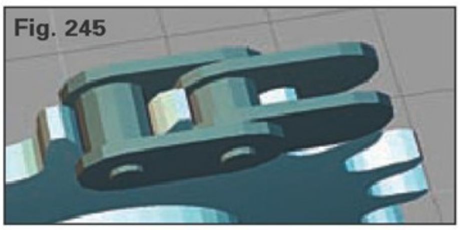


Fig. 245

Rotate the links with [**ZR9**], which is half the angle between the sprocket teeth. Press the Down Arrow and Right Arrow keys to select the second link, and rotate this around the sprocket by a additional 18° with [**ZR27**] (one-and-a-half times the sprocket teeth angle).

Point	XL	YL	Point	XL	YL
1	0.400	0.550	10	- 0.050	- 0.316
2	0.400	0.250	11	- 0.105	- 0.218
3	0.304	0.231	12	- 0.139	- 0.112
4	0.223	0.177	13	- 0.150	0.000
5	0.169	0.096	14	- 0.169	0.096
6	0.150	0.000	15	- 0.223	0.177
7	0.139	- 0.112	16	- 0.304	0.231
8	0.105	- 0.218	17	- 0.400	0.250
9	0.050	- 0.316	18	- 0.400	0.550

Table 1. Sprocket tooth point coordinates.

Press the Up Arrow key, and make a **Five Segment Radial Array**, with **zero Center X and Y** values and **Angle:-180.** Convert the array to an ordinary group, Press the Down Arrow key, and select the last two-link object in the group, then [**Unglue**]. Reselect this object and straighten it with [**ZR180**]. Press the Down Arrow and Right Arrow keys and type [**ZR180**] again to straighten the second link. Press the Up Arrow key to finish.

With these links now at a tangent to the sprocket's pitch circle, a straight length of chain can be added with a **Grid Array**. Follow this with two similar Radial and Grid Arrays to get back to the chain's starting point.

Next month: The concluding part of this series will look at some miscellaneous topics, including using other programs to help with the modelling in trueSpace.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• Distance spindle to table 290mm
available in metric or imperial
£410.00
WMT 500
The Ultimate Combination Machine
• Centre height: 150mm
• Distance between centres: 500mm
• Power cross feed
• Imperial/metric threadcutting
• Thread dial indicator
• Fine feed handle and calibrated dial for accurate milling
• Machine can be used immediately using standard accessories supplied
£1,250.00
WMT240 VARIABLE SPEED LATHE
• Metric or imperial leadscrews and dials
• Centre height: 105mm
• Distance between centres: 400mm
• Tailstock quill: 2MT
• Range of spindle speeds: 50 - 2,200 rpm
• Supplied with 3 / 4 jaw chucks, fixed and travelling steadies, faceplate
• Precision spindle on taper roller bearings
• Metric/Imperial threadcutting
• Individual accuracy test report
£780.00
Including free of charge drill chuck, arbor, live centre and 5 piece lathe tool set.
WM16 VARIABLE SPEED MILLING MACHINE
• Table size: 700 x 180mm
• Maximum drilling capacity: 16mm
• Cross travel 175 mm
• Range of spindle speeds: 50 - 2,250 rpm
• Motor 600w
• Locks to head, column and slideways
• Digital rev. counter
• Captive, self ejecting draw bar
• Digital depth gauge
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New DIGITAL SCALE
Digital scale. Inch, metric and fractions. Magnetic counter.
575mm alloy scale, easily cut to suit specific requirements.
£65.00
New
New POLISHER GRINDER
£50.00
including VAT and UK mainland delivery.
DI-3 BACK PLATE
• 160mm. Will suit Myford, Harrison and Colchester lathes.
£45.00
ER-25 COLLET CHUCK
• To suit ML7. Internal thread for minimum overhang.
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ML7 BACK PLATE
• 100mm £12.50 + £3.50 P&P 125mm £13.00 + £3.50 P&P
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3 MORSE TAPER TO 3C COLLET ADAPTER

Richard Gordon puts his ORAC CNC lathe to work

1. The Orac CNC lathe.

OVERVIEW

Recently, I had the good fortune to be able to buy an ORAC CNC lathe for a reasonable sum on EBay. I had used one at school in the 80s and knew they were good machines. For those not familiar, it is based on the Emco Compact 8 lathe, to which Denford fitted ball screws and added an early CNC system. I converted it to MACH3 using the same drive electronics I had developed for a mill. As you can see in **photo 1**, it's not quite finished yet. To exercise the machine and fulfil a workshop need, I designed this 3 Morse Taper to 3C collet adapter system. It will hold stock from 1.5mm to 12.7mm diameter and is a very good match for the ORAC lathe or similar.

Two or three Morse Taper collets are readily available but seem inconvenient as they are not self-releasing. ER collets are a challenge to fit to the ORAC due to the very specific spindle nose mounting system the Emco Compact 8 and ORAC uses. Also, the ORAC saddle cannot get particularly close to the spindle without setting the topslide to considerable overhang. The design shown here has quite a long body to help with this situation compared to the few Morse Taper to 3C adapters available commercially.

3 Morse Taper to 3C Collet System Design

I chose 3C sized collets as they fit well within a MT3 spindle nose taper and use a draw tube to close. They also self release and will hold and allow 1/2in. bar to pass right through. They also make use of a pin in the adapter and a slot in the collet to prevent rotation. However, I decided to omit this feature as reading forums on the Internet, it seemed to be more trouble than it is worth. I did not plan to harden or grind any feature, including the collets, so I've made use of EN16T steel, which is available in the hardened state, but is still machinable.

CNC turning has many advantages, one being that it can turn perfect tapers with no set up time so this collet system is a highly suitable project for CNC. However, you can make it with a standard lathe and I've included normal drawings for your use. Another benefit of CNC is that making 10 or 15 collets is no problem; doing this by hand can be a little tedious.

I've had experience of making collets for a topslide milling spindle, leaving both the spindle and the collet soft and after 15 years of quite hard use, they are still working well. In this application, for home use, using EN16T as-is will also work well if you keep everything clean in use. If a collet does start to show signs of wear, you can easily make a new one.

Commercial 3C collets are available and I found RotaGrip had some so if you don't mind paying for them, you can go that route. However, the RotaGrip versions would not pass ½in. bar through and work out quite expensive if you need more than a few. So, why not have a go at making them yourself?

Drawing 1 shows the layout. Note the 32mm overhang from the spindle and the resulting position of the draw tube threads within the adapter. The draw tube handle uses a needle roller thrust bearing which is thinner than a ball thrust race and considerably cheaper. The draw tube length clears the rear cover and places the handle at a convenient position. If you are making this for another type of lathe then you may need to adjust these dimensions to suit.

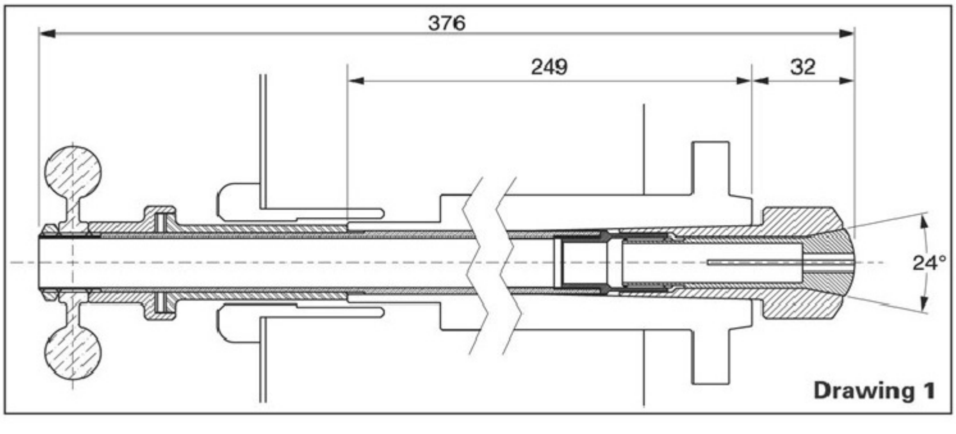
CNC Machine Setup

There are a few points about the CNC setup that you need to consider before getting started.

First I am using MACH3 Version "R3.042.027". Make sure you are using this or a later version as earlier versions had threading problems that have now mostly been fixed.

Second, and this is VERY IMPORTANT, I am working in DIAMETER mode. You must set your machine to this way of working if you want to use the G-Code in this article unaltered. You can check this setting at menu "Config" > "Ports & Pins" > "Turn Options" tab. The benefit of this is what you see in the MACH3 screen X axis digital read out (DRO) is the workpiece diameter. Later, when we get to setting up the machine, you will note that when you measure the work with callipers or a micrometer, you can just enter this reading into the DRO. It also makes converting drawings to G-Code easier. Also, one further setting in the "Turn Options" tab, I did not check the "Reversed Arc's in Front Post" option. You may need to experiment with this to get the arcs to move in the correct direction - see later.

Third, in the menu "Config" > "General Config..." set "Exact Stop", Distance Mode "Absolute" and IJ Mode "Absolute". This



Drawing 1

is less critical as we can set this by G-Code as you will see later. I'm also assuming your native units are Metric, but I don't think that is an issue as long as "metric" is selected in the G-Code (G21).

Fourth, I've tried to keep the G-Code as simple and understandable as possible. You may know a quicker way of achieving the same result with more complex G-Code features. If so, please go ahead and modify the code and let us know how you got on. Also, I have not used the MACH3 Wizards (except for one simple part). These are great tools but we want to know exactly what is going on and to help with the learning of G-Code. For those who know industrial G-Code but have not used MACH3Turn, you will find quite a lot of functionality missing. For example, no working nose radius compensation or roughing out facilities as yet... These are in development and it's not a big problem for home use.

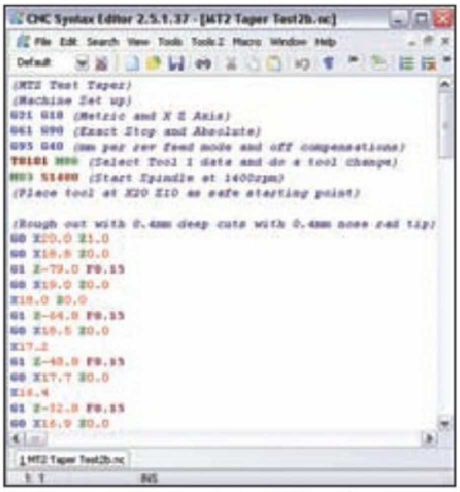
Fifth, safety. There seems to be a dislike by some readers of mentioning safety in these pages. For manual machines, this is understandable, you know what is going on and take appropriate action if things don't go quite to plan. With CNC it's very different. A CNC lathe presents significant dangers to the operator. It can take considerably faster and deeper cuts and produce prodigious quantities of razor sharp swarf, it can crash the tool into the work, the chuck and the tailstock and can move very quickly - probably more quickly than you to the stop button! So I urge you to take the following precautions with your machine:

- wear appropriate eye protection
- have and use appropriate guards and check the stop button works and is to hand
- do not start a cycle cutting until you know exactly what it is going to do - we'll look at how later
- make sure the tooling is up to the job and the cutting depth, feed rate and spindle speed are appropriate for your machine and the material
- know that it will not try to travel outside safe working boundaries, particularly towards the chuck and tailstock and...
- again, wear appropriate eye protection!

Sixth, I'm assuming you have set your machine up correctly but it is VITAL the stepper motors are not "missing" steps. You can read the MACH3 manual about this. Make sure your maximum axis speed setting is well below the speed at which it starts to loose steps. Also, eliminate free play, backlash and looseness as much as you can. You also need a working spindle index feedback system and enable menu "Config" > "Ports & Pins" > "Spindle Settings" tab "Use Spindle Feedback in Sync Modes" to be able to cut threads. Also, generally it's advised just to use one notch in the spindle disk, rather than four or more. I use one with no problems so far. If you've got four notches working successfully then leave well alone. It all seems a bit daunting to the beginner but it all becomes clear as you work through the examples.

G-Code Generation and CAD

To help you enter G-Code as painlessly as possible, it is convenient to use a G-Code editor. These colour the code as you enter it and you can see if you have entered a real G-Code and are using the appropriate syntax. It won't tell you if the coordinates are right or wrong, but it helps



2. A screen dump of the CNC editor software.

you with the housekeeping. It also makes it much easier to read. I use a free version available here:

www.cnc-syntax-editor.com/download/

If you scroll down, you will see the free "exe" version. **Photo 2** shows it in use. After entering the code, I use the MACH3 screen to check that the paths are as expected.

Next, it will make your CNC life a whole lot easier if you use 2D CAD. There are a good number of free 2D CAD packages around and the ones I've tried work surprisingly well. I use "progeCAD 2008 Standard", which, although tricky to install and get working for some reason, has the functions you need for simple CNC G-Code work and is very similar to AutoCAD, i.e, it is easy to use. You may need to search for other options if this is not available when you read this.

You can find it here: www.progecad.co.uk/Downloads/ scroll down to find the file. It comes with very good help as well.

Using 2D CAD will help you follow some of the examples given in this article. It is also invaluable in the calculation of nose tip radius compensation as you will see.

Before we move on, just a few points on G-Code. Please read the "MACH3Turn_1.84.pdf" file from the www.Machsupport.com website if you have not already done so.

Some G-Codes are "Modal". This means once you set the G-Code, it stays active until you cancel it or change it. G1, F, S and G0 for example stay set. You do not have to enter them again unless you want to change from that function. Be sure you are familiar with the basic G-Codes as shown in the documentation. If you have no experience at all, then take a look here: www.welsoft.co.uk/machlathe/index.htm

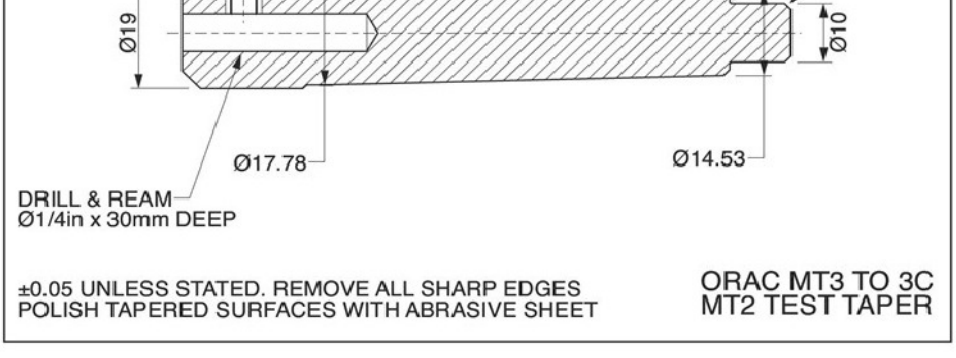
The writers have put a lot of relevant examples and tips together for CNC turning, most of which are compatible with MACH3Turn.

Finally, the use of tipped tools is very convenient, mainly because they have a known and accurate tip radius so you can compensate for this correctly and end up with a workpiece of exact dimensions, particularly on profiles and tapers. However, using tipped tools is not an absolute requirement. They do require quite aggressive feeds and don't like light cuts, so you may find if you want to use HSS tooling, with the G-Code given here, you will probably need to re-program the paths with lighter cuts and approximately half the feed rates.

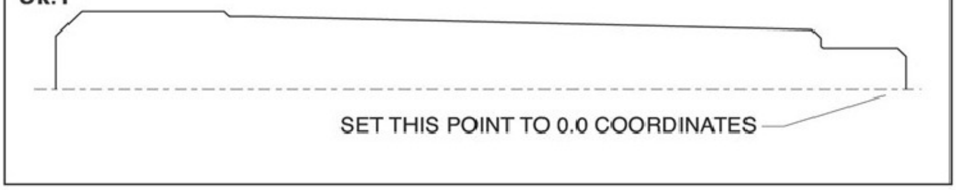
MT2 Test Taper

Before we start on the collet, let's quickly make a MT2 test taper! If this comes out correctly then you know that your machine is working correctly and that you understand the process. Also, you don't really want to be making mistakes with EN16T - it's not so cheap to come by. I found this a useful exercise as I found a number of accuracy issues with my ORAC, requiring me to re-set the headstock to the bed and the tailstock when the taper came out wrong first time. Using a test bar I found the headstock was canted over towards the tool by over 0.25mm at 300mm from the chuck. Perhaps it had suffered a crash at some point. Releasing the headstock bolts and pushing the chuck in the opposite direction and re-tightening sorted that out perfectly.

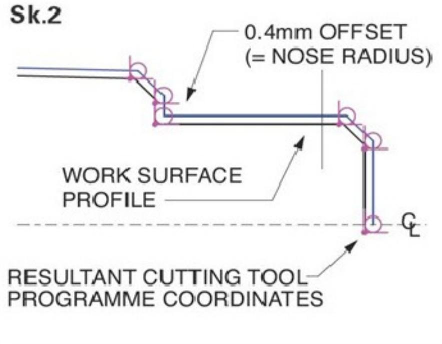
I'll cover this MT2 taper exercise in quite a lot of detail to get started. **Drawing 2** shows the part but we only need to be concerned with the profile as shown in **Sk. 1**. This is the starting point for our G-Code. If you draw this in CAD from the drawing, construct it or move it such that the right



Sk.1



Sk.2



hand end face is at X = 0 and the part centre line is at Y = 0. (By the way, do not use “PLines”, just use normal “lines” in your 2D CAD system.) Now you will start to see a slight confusion with CAD. It's normal for CAD to be set up as X-Y, however the lathe is Z-X where Z is the work axis with +ve away from the headstock and X is the diameter with +ve away from the work piece centre. It is possible to change the drawing axis in CAD but I don't usually bother. Just remember CAD X is CNC Z and twice CAD Y is CNC øX...

As mentioned before, the turning tool will have a tip radius. With insert tooling, this radius is known (I use 0.4mm throughout) so we have to compensate for this as the G-Code is written for the “effective cutting point” - see section 9 of the MACH3Turn documentation. (Remember this compensation is not yet functioning in MACH3 - hence we have to do it for ourselves.)

The process for setting up the cutting tool is to face the material and set the Z position as 0.0mm in the Z axis DRO. Then turn a diameter, measure it and enter that dimension in the X axis DRO (remember we are in Diameter Mode). So MACH3 now knows the tip position, but what about cutting a 45deg. taper? The workpiece would come out larger than planned over the taper because the tip radius means the cutting face is actually further from the work than MACH3 thinks. To compensate for this, we need to workout the effective cutting surface of the tip and programme the G-Code coordinates so that the tip radius follows the real workpiece surface. Using CAD, this is actually quite easy to do. **Sk. 2** shows this process starting at the end of the profile.

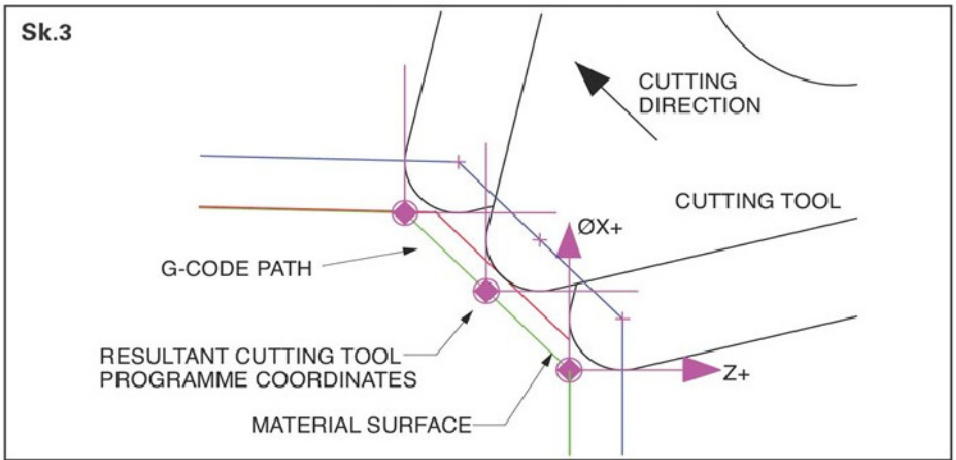
First, using the “offset” tool in CAD, draw an offset from the profile equal to the nose tip radius, 0.4mm. This is the blue line. You will also see that the 0.4mm radius at the root of the 10mm diameter does not appear as a blue line, this is because this is exactly equal to the nose radius of the tool, so does not need any radius moves to be created. It's made by the tip itself. Now, draw a circle, 0.4mm radius, at each and every endpoint of the blue lines using the “snap to endpoint” function in CAD. Don't try and do this by eye! Now draw lines from the “quadrant nodes” of the circles. These are the extreme points of the circle on the X and Y axis as you can see in Sk. 2. I've drawn these in magenta and also added a small blob where they cross. These are the ***resultant cutting tool programme coordinates*** that we need for our G-Code, sometimes called the “effective cutting points”, which doesn't really make sense as they are not actually the point at which cutting takes place! Anyway, if you look at **Sk. 3** you can see the effect this makes on the taper.

The blue line is the 0.4mm offset and you can see that the centre of the nose tip radius follows this line. You can also see the “resultant cutting tool programme coordinates” that make up the green line which is the G-Code path. Finally, you can see the red line which is the resultant surface of the material on the taper, which is the profile we started with. Once you try this a few times and watch the lathe cut parts, it will become much clearer.

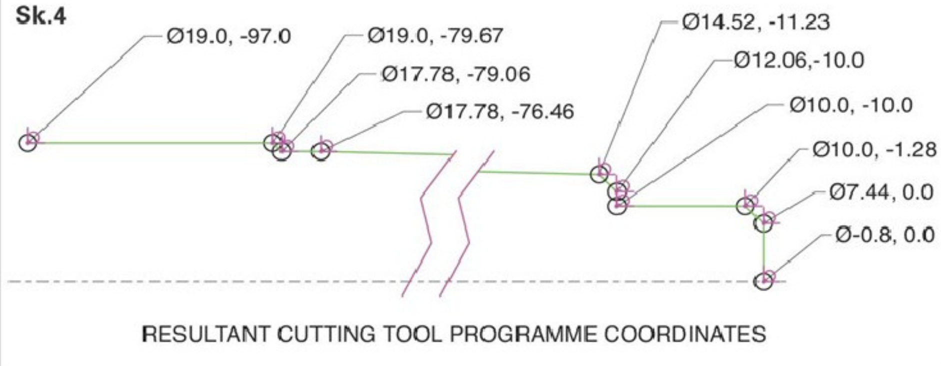
In **Sk. 4**, I've noted the coordinates for the *resultant cutting tool programme coordinates* and these make up the end points of the green lines, which are the programmed path. You can see I've multiplied the CAD Y coordinate by 2 to get the diameter and the CAD X coordinate becomes the Z axis position.

However, this is only half the story. We can't usually cut the profile in one cut from the bar. **Sk. 5** shows how to work out the roughing coordinates and actually its quite easy if you start from the final cutting path profile as this already has the tip radius compensation built in. Remembering tips with this nose radius don't like less than a 0.1mm cut, “offset” the final profile by 0.1mm and then again at 0.3mm. Then, I've offset or drawn horizontal lines at 0.4mm spacing, which intersect with the outermost profile. This will give a stepped roughing. These extend out to the stock, which is shown dotted. You need to think about how to arrange these lines at the chamfers and where the taper ends so as to not leave any material over 0.4mm thick. Then each and every end point of these green lines is the coordinates for the final G-Code. It looks a lot, but as most are straight, they are actually very quick to enter. ■

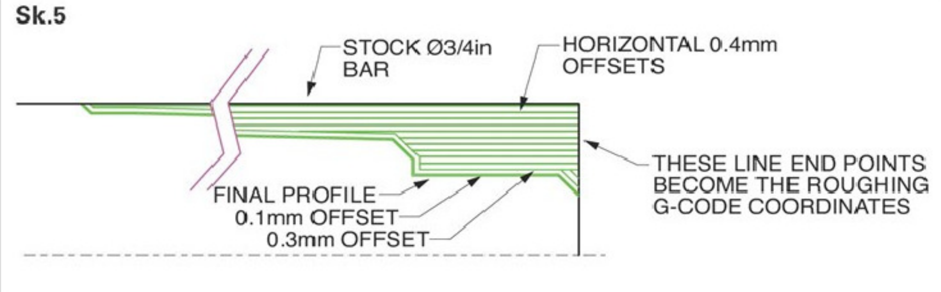
Sk.3

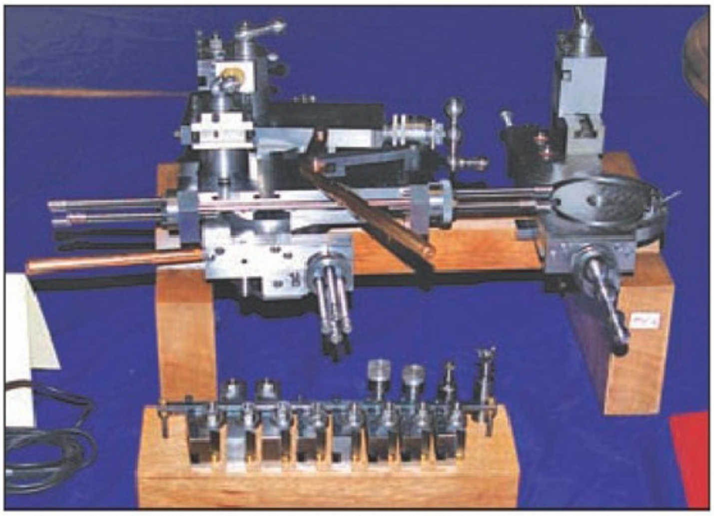


Sk.4



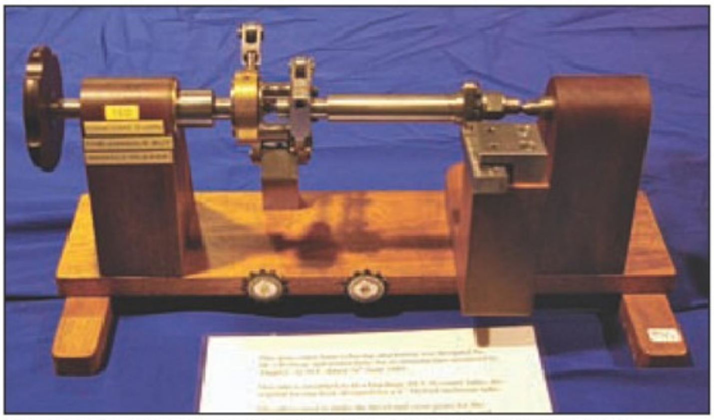
Sk.5



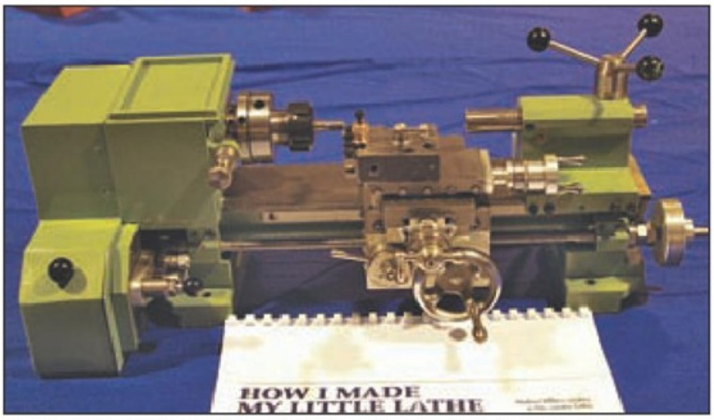


1. Neil Read's Pultra accessories which gained a silver medal and the Bowyer-Lowe Challenge Cup.

2. Highly Commended cam grinding jig from Mike Sayers.



3. Also Highly Commended was the cutter relieving device also made by Mike Sayers.



4. The 2in. lathe designed and built by Hubert Elffers won a bronze medal.

WORKSHOP EQUIPMENT

At the 2009 MODEL ENGINEER EXHIBITION

1907-2009

Dave Fenner visits Sandown Park

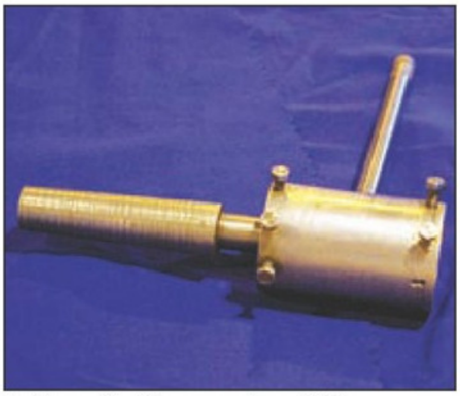
> **OVERVIEW**
>
> This year the Model Engineer Exhibition returned to Sandown Park to the delight of exhibitors and visitors alike. My impression was that compared to last year at Ascot, significant advances had been made on all fronts, notably entries, quality and quantity of models on display, trade support, club support, and visitor numbers. The entry list had a truly international flavour, with models and equipment being brought from far away places such as Italy, Germany, and Switzerland. I hope that the following few words and pictures will convey a flavour of the workshop equipment that was on view.

Competition

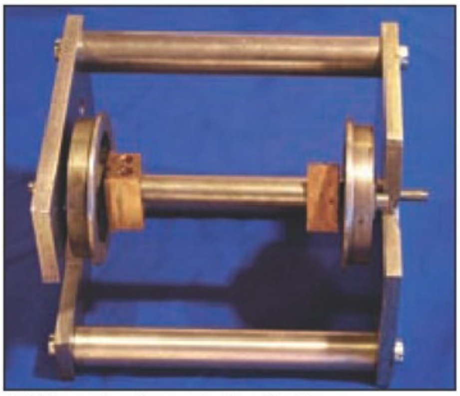
It was a great delight to meet up again with Neil Read and his charming wife Linda. Some readers will recall that Neil used to be the Technical Editor for sister magazine Model Engineer, until choosing to retire. He clearly now enjoys rather more free time for the workshop and had brought along a set of accessories designed and made for his Pultra lathe (**photo 1**). Former MEW editor and judge Geoff. Sheppard, who owns a similar machine, was clearly impressed and tried hard but unsuccessfully to cajole Neil into producing a second set. The design and finish of the devices came in for very positive comment, and Neil was awarded a silver medal and the Bowyer-Lowe Challenge Cup.

In the lower exhibition hall, on the I/C engine stand, Mike Sayers was exhibiting and demonstrating his superb one third scale Bentley engine, which was awarded the Duke of Edinburgh trophy. In the course of building the engine, Mike had found that he needed to construct various items of equipment. Two of these were entered into the competition class. In order to produce accurate cam forms, he had created a cam grinding jig (**photo 2**), which used a full size master copy to generate the one third scale cams for the model. The jig was awarded a "Highly Commended" by the judges.

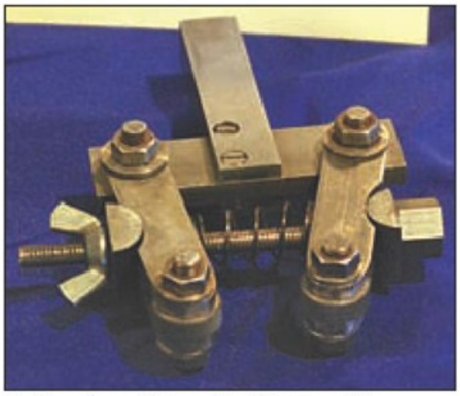
In making the model, numerous bevel and crossed gears were needed, and Mike had chosen to make, rather than buy the various gear cutters. His second entry was a gear cutter relieving attachment (**photo 3**). The original design is attributed to a Mr.J. Rodway, and its construction was



5. Roger Backhouse entered this tailstock die holder.

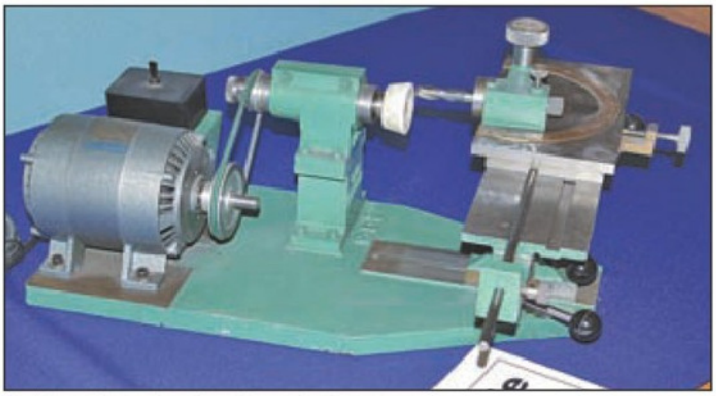


6. The wheel quartering jig from Roger Backhouse.



7. Also from Roger Backhouse, this straddle type knurling tool.

8. Joerg Hugel's Spark Maker - the identity detail engraved on the die is just visible.



9. Kennet tool and cutter grinder - Ivan Law.

described by "Duplex" in Model Engineer in 1949. Whereas the original had been intended for use on a 4in. Myford toolroom lathe, this version was tailored to fit a Hardinge HLV-H machine. It also won a "Highly Commended"

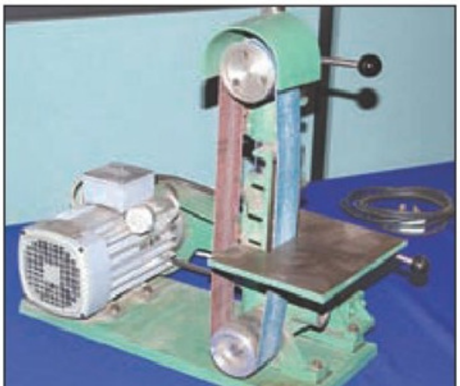
Back in issue 155 of MEW there appeared an article by Hubert Elffers describing a very capable looking 2in. centre height lathe which he had built. The lathe (**photo 4**) has been designed with a number of useful built in features such as basic headstock indexing, quick change tooling, leadscrew handwheel and rack and pinion tailstock. Hubert received a bronze medal for his work.

Roger Backhouse perhaps better known to Model Engineer readers for his accounts of visits to museums and other interesting places, had brought along three items of home constructed tooling, a tailstock die holder, a wheel quartering jig, and a knurling tool (**photos 5, 6** and **7**). While he did not gain specific recognition from the judges, Roger is to be commended for entering his work. My personal view is that we should see more of the less exotic tooling items entered, perhaps with evidence of application/ effectiveness, and with due allowance for loss of pristine appearance with use. Examples of less complicated items of tooling on display should encourage more newcomers to the hobby. *(Roger was aware that the finish was not up to scratch for exhibition purposes but kindly entered them, for which I thank him, following a request for more tooling from me, Editor.)*

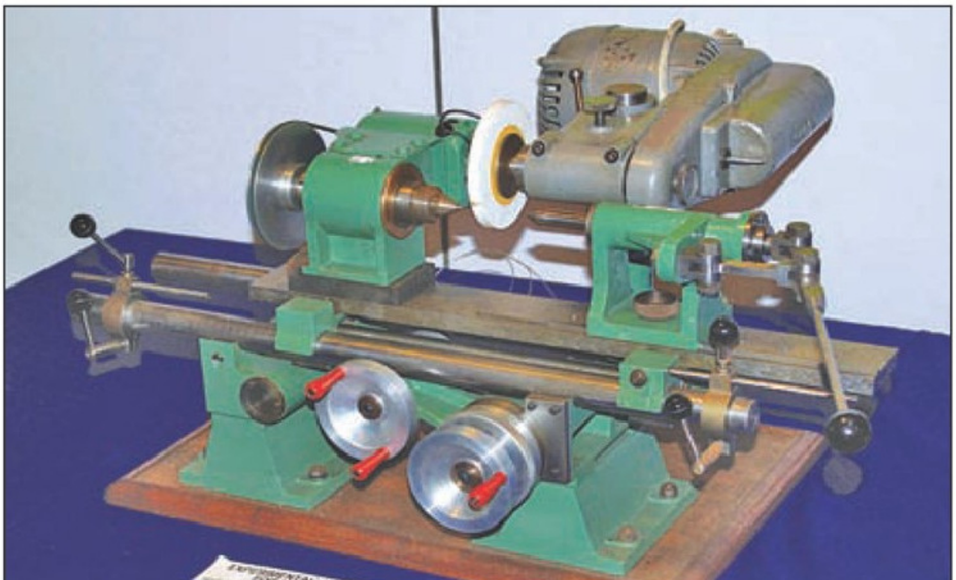
Prof. Joerg Hugel had made the journey from Zurich and in addition to an expensive display of optical and measurement equipment located on the SMEE stand, had also entered his electrical spark marking tool in the competition category. This device (**photo 8**) works on a solenoid principle such that as the needle touches the work, current flows, and it is withdrawn slightly creating a spark. It can thus be used to spark engrave conductive materials and comes into its own where the work is hardened. Examples of engraved work showed that when fitted to a CNC mill, very professional results can be achieved. A Commended certificate was awarded.

Judges Work

In a departure from tradition, the judges had been invited to show examples of their own work, creating a superlative

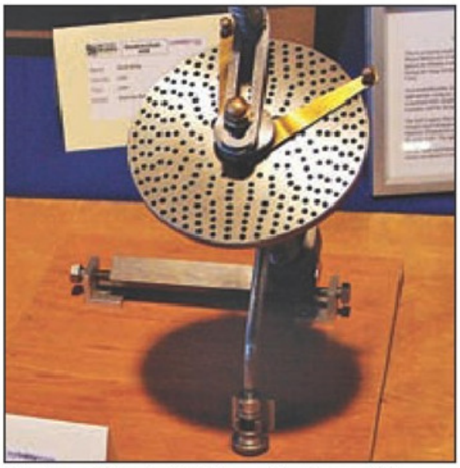


10. Abrasive belt sander - Ivan Law.

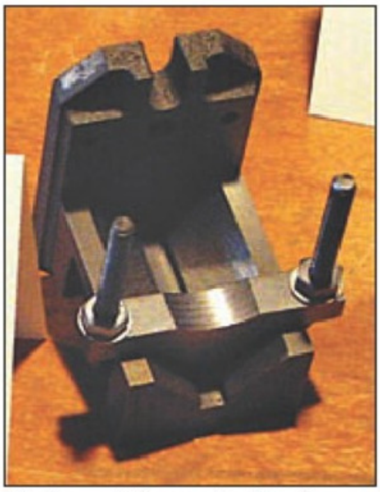


11. Also from Ivan Law this experimental cylindrical grinder.

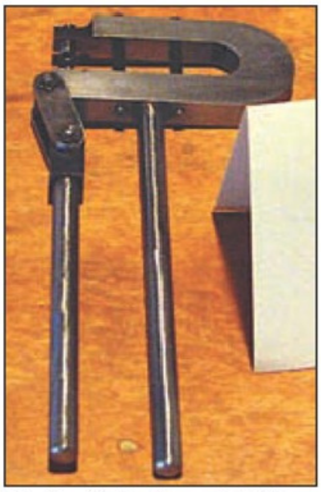
12. George Thomas designed versatile dividing head - Geoff Sheppard.



13. Headstock dividing attachment for Myford - Geoff Sheppard.

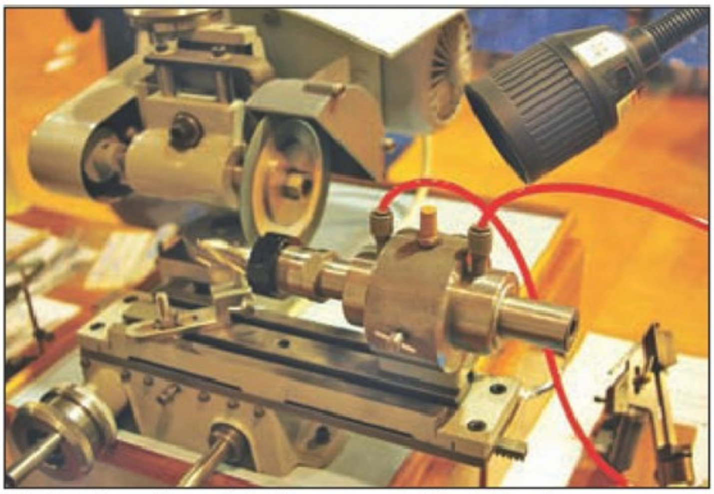


14. A small Vee angle plate from Geoff Sheppard.

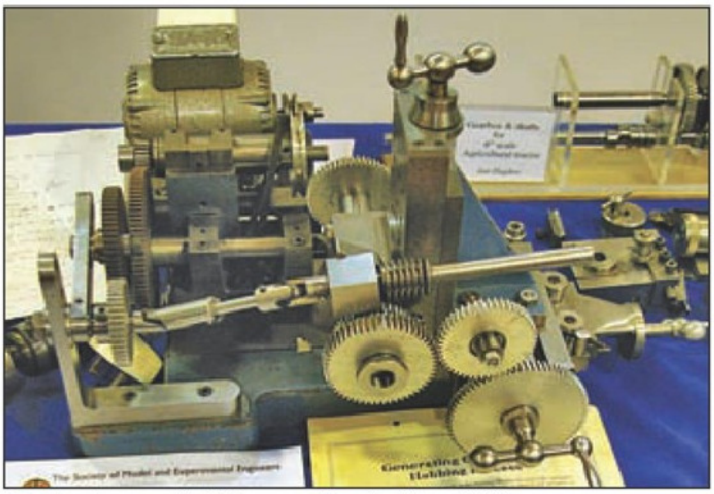


15. Geoff also brought this hand rivet press -

16. - plus 5in. lathe steady and rotary table.



17. Grinder with work holder supported in air bearings.



18. Jacobs gear hobbing machine by Tony Phillips

display which more than filled the initially allotted space. In terms of workshop equipment, Ivan Law had brought three machines, a Kennet tool and cutter grinder, (**photo 9**), an abrasive belt sander, (**photo 10**) and an experimental cylindrical grinder (**photo 11**). Geoff. Sheppard had assembled a considerable array of accessories including a GHT versatile dividing head, (**photo 12**), a Myford headstock dividing attachment, (**photo 13**), a small vee angle plate, (**photo 14**), a hand rivet press, (**photo 15**), a 5in. lathe steady and a rotary table, (**photo 16**).

Club stands

The show assembled by SMEE really had to be seen to be believed and is a massive credit to their membership in general, and to Stuart Walker in particular. Lectures had been organised in two rooms on topics as diverse as "Modern Adhesives and Paints", Making Your Own Spark Erosion Machine", and "Sharpening Lathe Tools That Really Cut". One of the SMEE stands was set up for a series of demonstrations such as "Making small steam injectors", Soft soldering techniques" and "Tool grinding using air bearings". Relating to this last topic, **photo 17** shows the grinder fitted with the air bearing support for the work. If you have tried to sharpen the flutes of an end mill, you will probably be aware of how sensitive the operation can be if the bearing is at all sticky. Using air as a support medium offers an excellent solution.

There really was a superb selection of conventional items, such as the Jacobs hobbing machine (**photo 18**), shown by Tony Phillips, but some of the more unusual exhibits which caught my eye were the centering microscope by John Florentin, (**photo 19**) and the developments in spark erosion machines achieved by Alan Wragg and Mike Kapp.

19. John Florentin's centering microscope. The spring and weight are to establish the focal position.

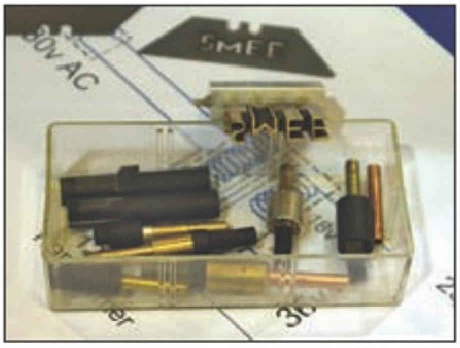
By introducing some clever control electronics, they have managed to reduce the tool wear rate by some 95 per cent. As a demonstration, holes were being cut in Stanley knife blades. **Photograph 20** shows the spark erosion machine, and **photo 21** some of the tooling used (brass and carbon). Prof. Joerg Hugel had arranged an extensive display of metrology equipment, particularly aimed at inspecting drill lips. In addition to accessories for use with digital callipers, he also employed a camera (**photo 22**) linked to a laptop which showed the drill point against a calibrated graticule (**photo 23**).

Ickenham Society had once again laid claim to their exclusive site, tucked away at the end of the ground floor. Here workshop items included a Lathe Mandrel Backstop for a Colchester Student by Peter Pardington, (**photo 24**) and a Grinding Rest made to a Harold Hall design by

20. Spark erosion machine with electronic control of downfeed and waveform.

Graham Hutchinson, (**photo 25**). Guilford member, Clive Lawrence clearly takes his clockmaking seriously and showed his wheel cutting engine (**photo 26**) built to an Elliot Isaacs design published in "Clockmaker" in 1990.

I spied a nice set of bending rolls (**photo 27**) made to the timeless GHT design, on the Staines Society stand, but



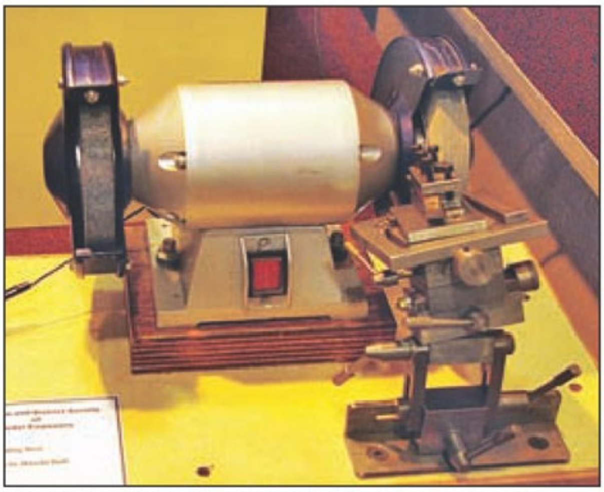
21. Work and tooling for the spark eroder.

22. Camera aimed at drill point.

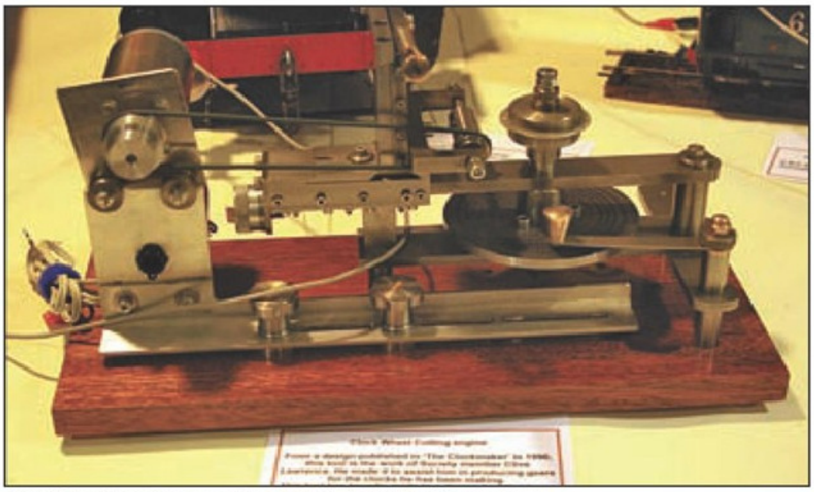
unfortunately am not able to credit the builder. In addition to their models on display, Reading Society also had an extensive array of workshop kit to view. Taking just one or two examples, **photo 28** illustrates the Worden grinder from Nigel Penfold, while **photos 29** and **30** show a Vee block and machine jack produced by Mike Perry.

23. Magnified view of drill point on computer screen.

24. Peter Pardington's mandrel backstop for a Colchester Student.

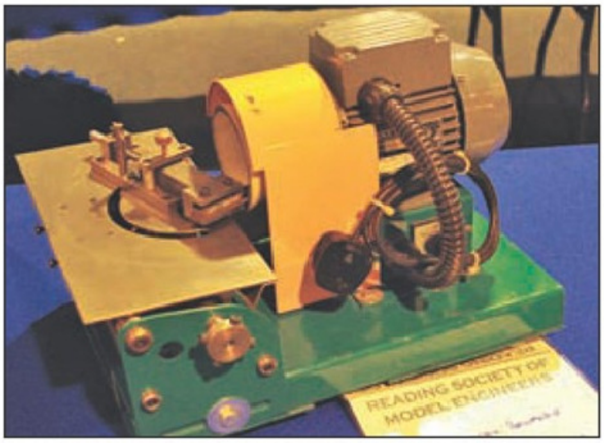


25. Graham Hutchinson made this grinding rest to a design by former MEW editor Harold Hall.

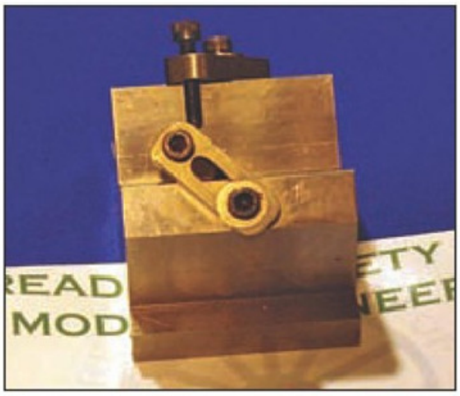


26. Wheel cutting engine made by Clive Lawrence.

27. **_Bending rolls to the George Thomas design on view at the Staines society stand._**

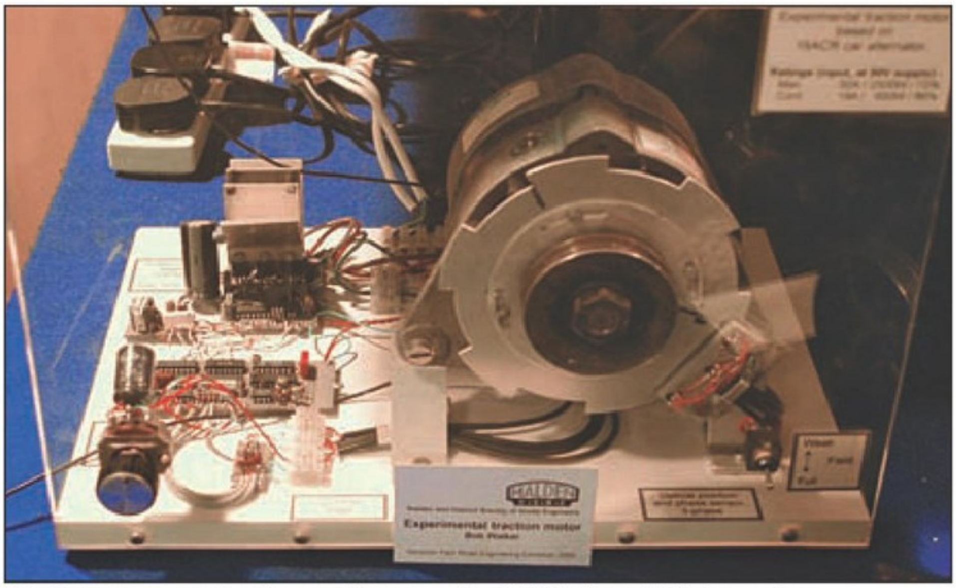


28. **_Nigel Penfold showed his Worden grinder._**



29. **_Two items from Mike Perry, a Vee block -_**

30. **_- and a machine jack._**



31. **_Alternator converted to traction motor by Bob Walker of Malden society._**

The final item I am going to mention is not a piece of workshop kit, but a car alternator converted by Bob Walker of Malden Society, to operate as a three phase traction motor (**photo 31**). In the past, I have considered trying to use one of the mass produced brushless motors with controller (which are supplied for model aircraft) as motive power for a machine spindle drive. From the discussion with Bob Walker, it seems that this approach would be OK as long as the starting torque requirement is low. His alternator conversion includes angular position sensing and thus delivers very high starting torque. And yes, I did ask if he would write it up for publication, but he feels that the project is still very much at the experimental stage. ■

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MACHINING TOOL BLOCKS AND A REAR TOOLPOST FOR THE MYFORD SERIES 7 LATHE 2

Mick Knights adds a tool holding system to his new Myford lathe

The billet was machined square in the usual way (**photos 25** and **26**). To ensure that the parting blade is always positioned square to the head stock, a tenon needs to be machined to fit snugly into the Tee slots of the cross slide. The exact width of the Tee slot is determined by using drill shanks or stock diameter rods, until one fits snugly (**photo 27**). The Tee slots should be checked for any bruising or burrs, which might impede fitting the machined tenon. Machining the tenon is quite straightforward. Any machining process will benefit from a roughing operation, prior to finishing with a sharp end mill, but it's a good idea to leave a couple of thou for final bench fitting, as the tee slot can sometimes be slightly tapered (**photos 28** and **29**),

The tee slot centre distances need to be measured, as the clamping slots will be machined to line up with the rear cross slide tenon (**photo 30**). These slots are machined 10mm wide by 20mm deep. Two slots are machined 12mm wide by 20mm deep in the vertical sides to accommodate the clamping nuts and a modified spanner (**photo 31**).

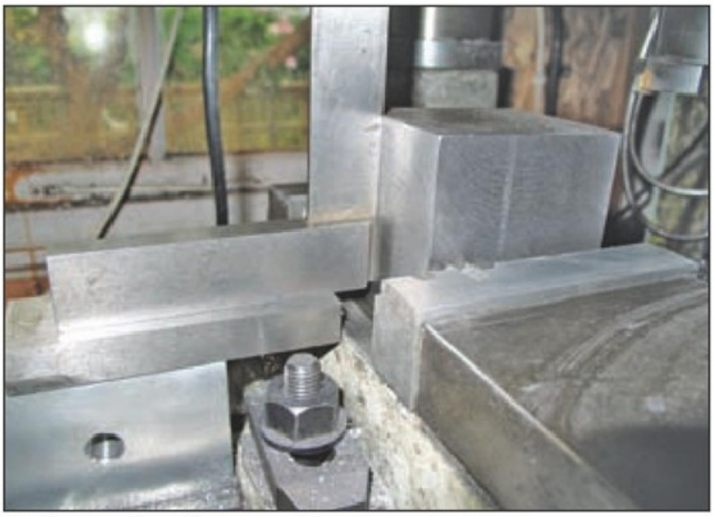
A special Tee nut now needs to be produced to hold the studs which will secure the block to the cross slide. This is produced from a piece of nine 9⁄16in. square mild steel bar, machining equal amounts from each side, till the 3⁄8in. wide tenon is achieved (**photo 32**).

Positions for the studs are centred to correspond with the centres of the previously machined clamping slots (**photo 33**). (These will of course depend on the size of billet being used.) Finally

■ OVERVIEW

Last issue we looked at tool holders for the Myford lathe. This time we look at machining a rear tool mounting block. As the billet of cast steel I had selected to use for the rear tool post, was of a reasonable size, which spanned two tee slots on the cross slide, I decided to produce a multi-purpose tool mounting block, which would accommodate a variety of tool holders, providing extra versatility. Besides the parting tool, these applications wouldn't be in daily use, but would be a handy piece of kit to have for any eventualities.

25. Machining the billet square.



26. Setting the billet to machine the ends square.

27. Sizing Tee slot with a drill blank.

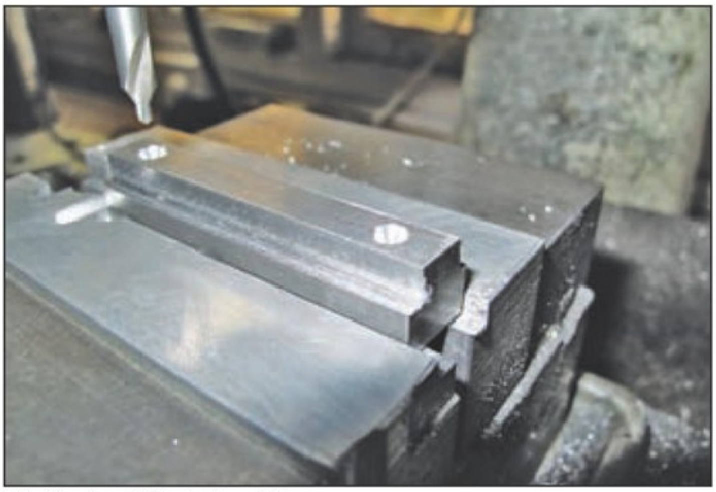
28. Roughing out the tenon.

29. Finish machine, leaving a couple of thou for final fitting on the bench.

30. Slots need to line up with the rear tenon.

31. Slots to accommodate clamping nuts.

32. Machine equal amounts from each face to suit the cross slide tenon.



33. Centre drill stud positions.

machine the Tee nut to size to suit the Tee in the cross slide (**photo 34**). Final bench fitting may be required to achieve a snug, but easily removable fit.

As the studs will only be held in a comparatively small section of Tee nut, they need to be secured, to prevent them turning out of the nut when the tool block is tightened down. They can be secured with a little thread lock, but I prefer the mechanical method of peening over the ends of the studs into a countersunk recess in the bottom face of the Tee nut, using the ball of a light ball pein hammer. Employing this method ensures the fitting is permanent (**photos 35**, **36** and **37**).

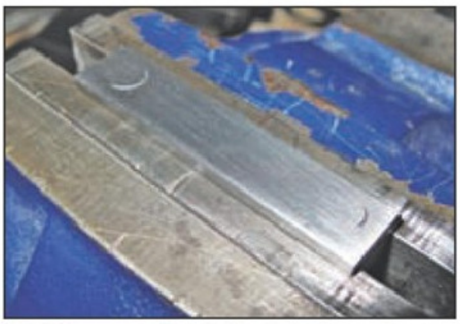
Parting off tool

The first tool holder to be fixed to the tool block is a parting tool. This will be positioned upside down, so it can be used while turning in the conventional right hand rotation. I've had the parting tool I'm using for a good few years. The shank thickness was reduced to fit the tool carousal of a CNC lathe quite a while ago. These tool holders are made from extremely tough high tensile steel. Great care should be taken when modifying any feature of a high tensile tool body. When machining with any conventional HSS cutter, speeds need to be reduced by around two thirds. Solid tungsten or a coated end mill is the preferred option as HSS will very quickly become blunt. Coolant is definitely required when drilling. If the machine doesn't have its own coolant system, then coolant can be delivered by using a hand held oil can and at the very least, a Tic N coated drill should be used. Constant pressure should be applied to the drill

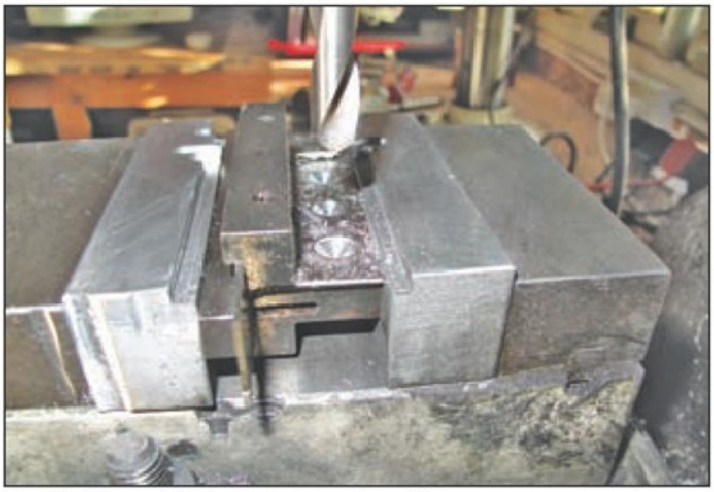
34. Machine Tee to size.

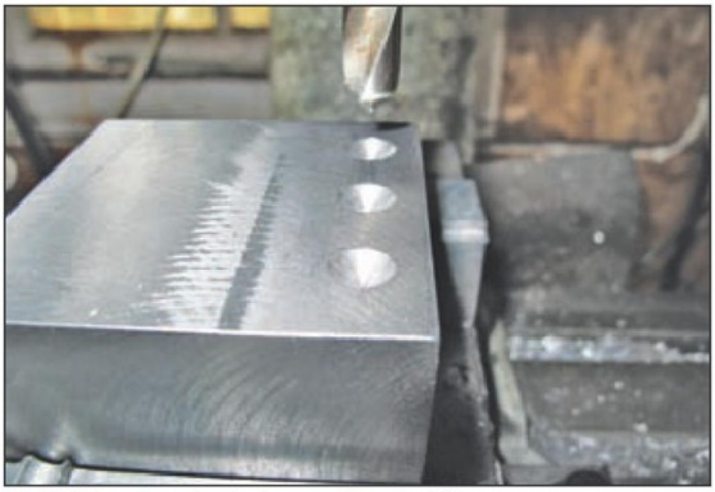
35. Studs protruding from tee nut.

36. Peening over the studs with light ball pain hammer



37. File peened ends flush to tee nut.


38. Pitching out hole centres on the mill.


39. Drilling clamping holes on a bench drill.


40. Drilling the holes to finished size in the bench drill.


41. Determining the stock removal to achieve centre height, using feeler gauges.


42. Checking the final centre height.


43. Rough machining the tool base.


44. Transferring clamping hole centre position.

during the entire drilling operation, only releasing the pressure at the point of break through, as light pressure will only cause the tool to rub and overheat, which causes the drill to burn out. Marking out the clamping hole centres and centre popping is not really advised in this case, as due to the toughness of the material, alignment of the drilled holes can't be guaranteed.

Pitching out on the mill, with the tool held securely in the machine vice, is the best method (**photo 38**). This will ensure the clearance holes will line up with the M10 holes pitched out in the tool block, (**photo 39**). The tool holder can then be transferred to a bench drill for final drilling (**photo 40**).

The height of the tool block now needs to be reduced in order to achieve the parting tool's centre height. This is determined with the distance piece used for setting the compound slide tool holders, along with a set of feeler gauges. The tool block needs to be securely clamped down to the cross slide at this stage, so a true working situation can be simulated (**photo 41**). The block can then be machined to the required height (**photo 42**).

Tool block back support

The tool blocks produced for use on the compound slide will need a fair amount of stock removing from the tool block (**photo 43**), so that when mounted, they will sit at centre height. The initial amount of stock to be removed is determined by holding the tool holder on the tool block and measuring the distance between the tool tip and the distance piece, using the depth probe of a digital vernier (photo 21 last issue). To measure the amount of stock removal to achieve final height, the boring bar mounting block needs to be clamped down to the rear tool block to achieve a true working situation. The components are clamped together using a toolmaker's clamp. The assembly is held in a drill vice and the centre transferred by using a $\frac{7}{16}$in. drill (**photo 44**). Any reader, who has taken the time to read any of my previously published discussions, will be aware that I seldom throw anything away that might be of possible use at a later

45. Assessing tool centre height.

46. Tool at centre height.

47. Centring tool post position.

48. Quick change tool post in position.

49. Facing a brass disc.

50. Trepanning the centre out.

51. Facing a brass disk.

date. Scratching through my collection of socket head screws turned up a 7⁄16in. Whitworth cap screw, with the ideal length for clamping through the 0.437in. reamed hole in the tool holder. The tool block was drilled and tapped 7⁄16in. Whit at the centre produced by the spot through.

With the tool blocks clamped down, the final amount of stock to be removed can be measured with the distance piece and feeler gauges (**photo 45**). A final check on centre height is carried out and the distance piece should just pass beneath the tool tip (**photo 46**). If the distance piece won't pass beneath, then the tool is set below centre. This situation can be rectified with shim placed between the parting tool and the block.

Quick change mounting

The final embellishment to the tool block is to drill and tap a fixing and locating hole, which will enable the quick change toolpost, from the compound slide, to be mounted to the tool block. This is by no means essential, but as mounting the tool post shouldn't take too long, it might as well be done at this stage, as it could conceivably be useful at some future date. To achieve this the rear tool block needs to turned through 180 degrees, so that the machined tenon now locates in the rear Tee slot of the cross slide and the Tee nut now fits in the tenon previously used as location. The quick change tool post needs to positioned in such a way as to allow all the quick change tool holders to clear the front face of the tool block. This is to achieve centre height, when using tools ground from different size tool steel, as with its conventional use, mounted on the compound slide. The clamping and locating bore in the tool post is positioned centrally from its two plain ground sides, so determining the position to drill and tap the clamping hole in the tool block, is a simple process. To ensure accurate positioning, the centre is pitched out on the mill (**photo 47**). The hole is tapped M10 and an adaptor sleeve turned 16mm O/D to suit the central bore of the tool post, then drilled through 10mm to clear the clamping cap screw (**photo 48**). To prove the new system, a few simple turning tasks were carried out (**photos 49, 50** and **51**). The facing and trepanning operations were a great success.

With the tool block repositioned back in its every day working position, the parting blade was clamped down, ready for use (**photos 52** and **53**).

The tool block can quickly be adapted to mount the boring bar blocks produced for the compound slide by un-clamping the three M10 cap head screws securing the parting blade, time well spent.

Left hand turning

As previously, I briefly touched on left hand turning, while proving a trepanning and facing operation so it might be an idea to explore this subject further.

52. Parting tool block ready for tool.

53. Parting blade in position.

54. Trepanned ring and centre with its web.

What would prompt a turner to reconfigure a set up to left hand cutting? Well, quite simply, tool chatter and vibration. If you have had the misfortune to have introduced chatter into a turned surface, be it O/D or I/D, you will no doubt know how difficult it is to rectify. Over the years I have seen many attempts to minimise this effect occurring in the first place. In one method I witnessed, a turner had wrapped a large quantity of string around an overhanging boring bar, in an attempt to absorb the vibration. As I remember, without a great deal of success. Problems are more likely to occur when turning shafts, or deep bores, where work is only supported with a back centre, or where a travelling steady is not appropriate or unavailable. In these circumstances, resonance can occur between the tool and the workpiece.

On smaller workpieces there are several ways to overcome chatter. The bravest and most effective method is to increase the speed and feed. This is a method best suited to an industrial environment, where feed knock off, triggered by a bed stop is available. The thinking over the past ten years or so is for rapid speed and feed coupled with light depth cuts, as the most efficient method of metal removal. This is best employed on CNC units, but I have successfully used it on centre lathes. In the past of course, low speed and deep cuts was considered to be the best approach.

The time honoured method of overcoming the problem vibration marks on a turned surface, is to drop the speed and apply a deeper depth of cut, to get directly under the surface chatter (this chatter is sometimes referred to as mackereling, as the effect produced resembles the markings on a mackerel's skin). Both of these methods work and have merit. Experience will tell you in which situations chatter is most likely to occur, so the machinist can take avoiding action.

To understand this phenomenon, first you have to be aware of exactly what you are asking the tool and lathe to do. The best shape to grind a centre lathe tool, for it to cut efficiently, without undue resistance, is the V form. This form is used to its best effect on through bore and facing tools, as it produces a shearing action (**fig 3**). This can be seen in photo 50 where a brass disc is being faced, with the tool mounted in left hand orientation. Of course, this method of tool grinding is only suitable for a limited number of applications as the majority of turning operations require machining to a shoulder, where front clearance needs to be incorporated. The front clearances in **fig 4** have been exaggerated in order to demonstrate the cutting action and the amount of resistance the tool is creating against the workpiece.

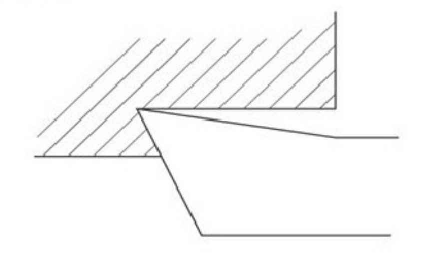
Although the tool appears to be cutting efficiently, the effect is for the tool to want to dig into the material. As the pressure on the tool is in a downward direction, it is supported against this force by the rigidity of the compound and cross slides (**fig 5**). This illustration is also exaggerated, purely to emphasise the forces at work.

If a tool is unduly overhanging the toolpost, or a boring bar is extended to machine a deep bore, then the support offered by the lathe's construction is compromised and the tool will actually start to dig in. This is what, in the vast majority of instances, will cause the vibration to occur as the tool battles against the downward force of the workpiece and being forced up by machine rigidity.

If we now consider what the pressures and forces are going to be on a left hand or upside down tool mounting, it begins to become obvious why the tool reacts in a different manner. There is no rigidity above the tool, other than what is offered by the tool holder itself. Therefore the tool, in essence, is being pushed away from the workpiece, which will greatly reduce the tendency for it to dig into the material (**fig 6**). Although this explanation is quite simplistic and I feel sure some might take issue with it, it is hoped that the reader might now have a better understanding of the cause and effect and of a route out of trouble.

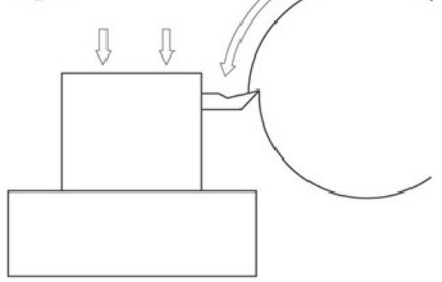
Trepanning is the one operation that I feel should always be performed with the tool in left hand mode. The tendency for the tool to dip and dig into the material is greater when plunging directly into the face of a turned component. Ideally this operation should be carried out by machining in from one face, to halfway distance, then turning the job around in the chuck, and machine in to half distance from the other face. Enough material should be left on the web holding the centre billet in place, to allow it to be gently knocked out with a hammer, when the operation is complete. The web only needs to be a couple of thou thick. Machining straight through and allowing the centre to fall out while the lathe is still running, is, in my experience the cause of most tool breakages (**photo 55**). ■

Fig. 4



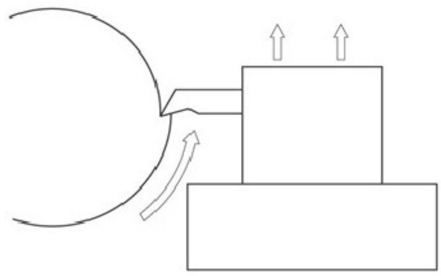
Front clearance angle undercutting the material in its path.

Fig. 5



Illustrates the forces during conventional right hand cutting.

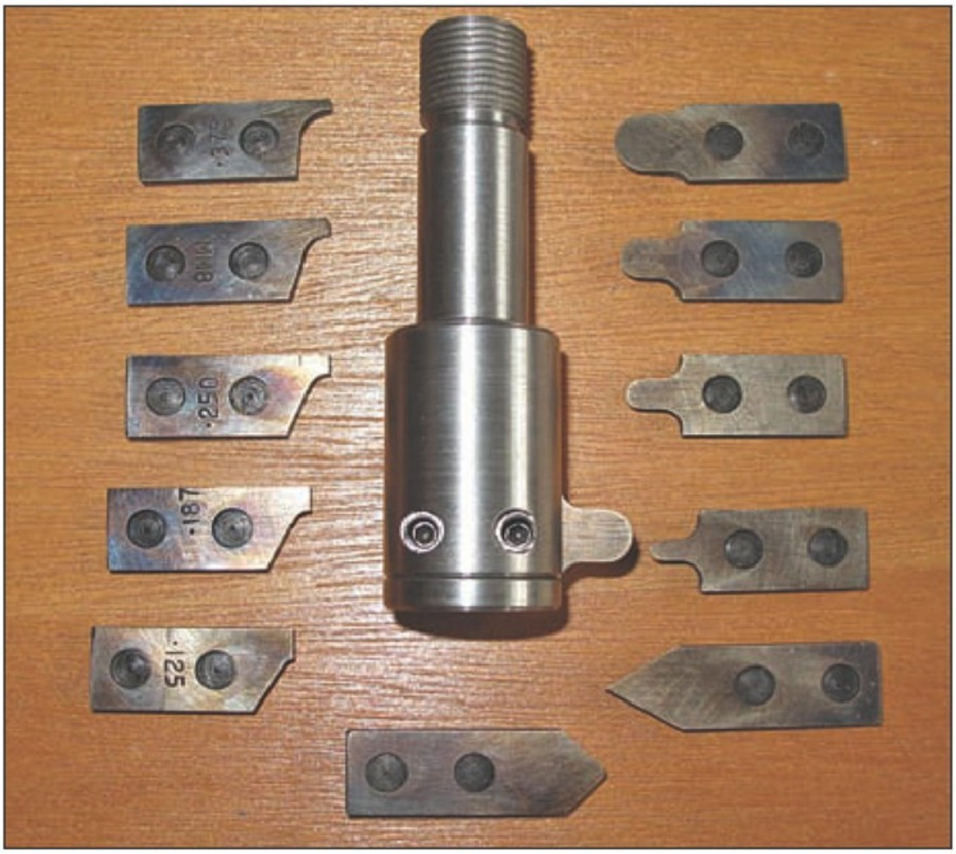
Fig. 6

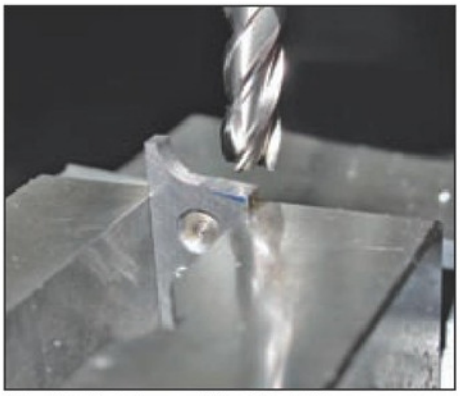


Shows a tool in left hand mode and the forces tending to push it off the workpiece.

FLY CUTTING OF RADIAL FORMS 2

Mick Knights looks at advanced Flycutting





30. The finish machined 0.187in. radius cutter.

31. Cutter blank sitting in fixture location and resting against recessed back stop.

32. Cutting the right hand flank.

■ OVERVIEW

From time to time, the home machinist will have the need to generate radial forms, both concave and convex, onto workpieces. The quick and inexpensive solution is single point fly cutting. This is the second part of the article first published in MEW 157.

Touch the milling cutter on the highest point of the inclined blank, zero the read outs or mechanical dials, then carefully remove 0.207in. to the centre line (**photo 30**). The process needs to be repeated on the remaining cutters. This completes the concave cutter machining operations.

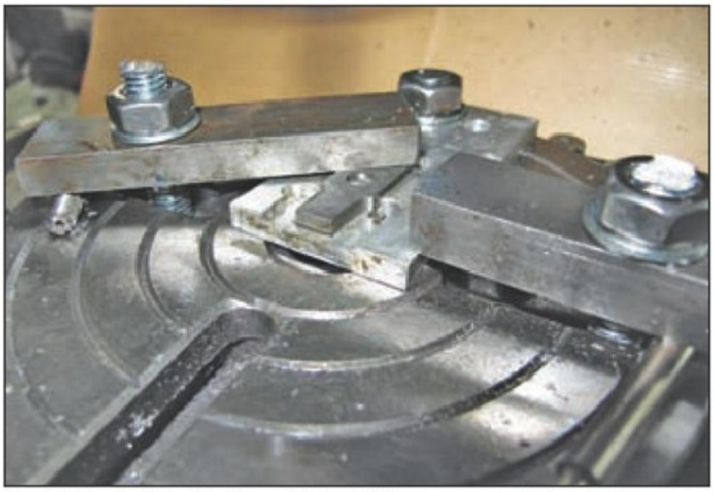
Milling the convex radius

Rather than spend a lot of time and effort in making a dedicated milling fixture for generating the radii, a simple, use once and discard fixture, machined in position on the rotary table, is the easiest and most accurate option.

With the rotary table set at zero and the clamps locked, set the rotary table square to the machine table. With the machine spindle zeroed to the table centre, all machine slides should be zeroed. This milling operation could be a bit tricky if the machine doesn't have digital read outs, as cutting on both sides of the centre line is required, and backlash might prove to be a problem. If this is the case, then the backlash could be taken out against a dial indicator at each change of direction, but this is not an ideal situation. A complete DRO system is probably unjustifiable in the home workshop, but a couple of digital vernier read outs are well worth the investment, as they transform the average mill into a machine capable of very accurate pitching out and machining. Even a cheap digital vernier calliper can be adapted for the purpose.

Any convenient piece of aluminium, as long as it can be easily clamped, can be used for the fixture. The edge of the fixture needs to be slightly over the centreline of the table to support the cutter while milling. With the clamps locked and ensuring the table is still set at zero, with a 6mm diameter or similar size end mill, machine a locating register 0.500in. wide equally about the centre line. Also mill a relief in the register, an inch and a quarter from the centre, to act as a back stop for the blank (**photo 31**).

To generate the 0.187in. radius, the flanks need first to be machined to 0.375in. equal about the centre line. Using a 6mm (0.236in. dia.) milling cutter, the first roughing cut needs to be positioned at: 0.310in. (0.118in. + 0.187in. + 0.005in. final machining allowance) to the right of the blank, with the blank facing the operator (**photo 32**). This is because the rotary table being used would only rotate on the worm screw in a counter clockwise direction so the radial generating needs to start at the zero position on the right hand side. To aid the milling operation, a little cutting paste should be applied with a brush during machining. The cut needs to be taken a further 0.125in. past the centre line on the Y axis, so the machining extends up to the body of the tool holder. The milling cutter is then withdrawn using the Z axis (quill) and repositioned at the front of the fly cutter, but at 0.310in. to the left hand side. The previous machining operation is repeated (**photo 33**). The machined section can then be measured. The measurement obtained was actually 0.383in. so with the slide now set at 0.306in. the left flank was cut to final size. The milling cutter was reset at 0.306in. on the right flank, but this time after machining 0.125in. past the

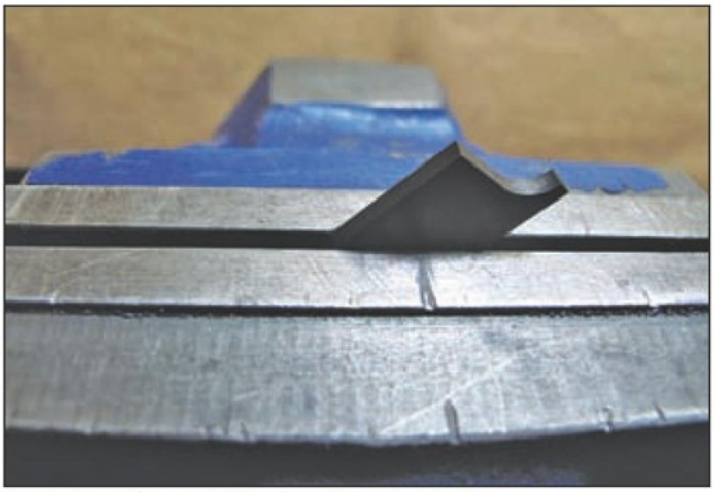


33. Cutter before final machining. Clamp removed for clarity.

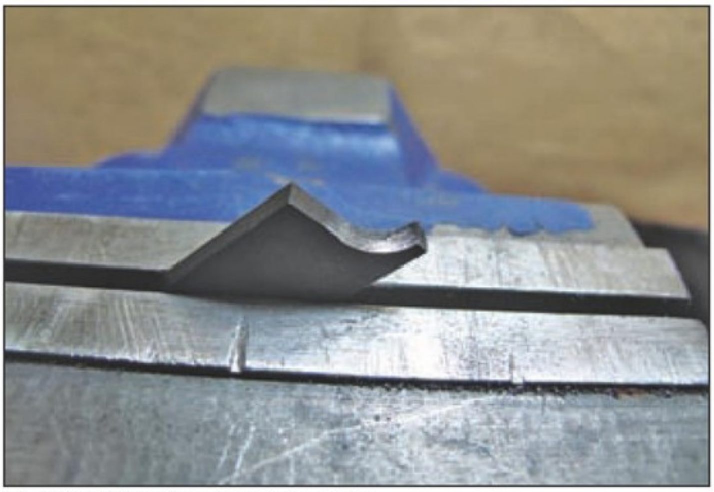
34. Finished 0.187in. fly cutter.

35. Grinding the relief angles.

36. Another view of grinding the relief angles.



37. Before diamond filing the clearance angles.



38. After filing the clearance angles.

centre line, the milling cutter was returned to zero on the Y axis. The table clamps were released and the table rotated through 180 degrees (**photo 34**).

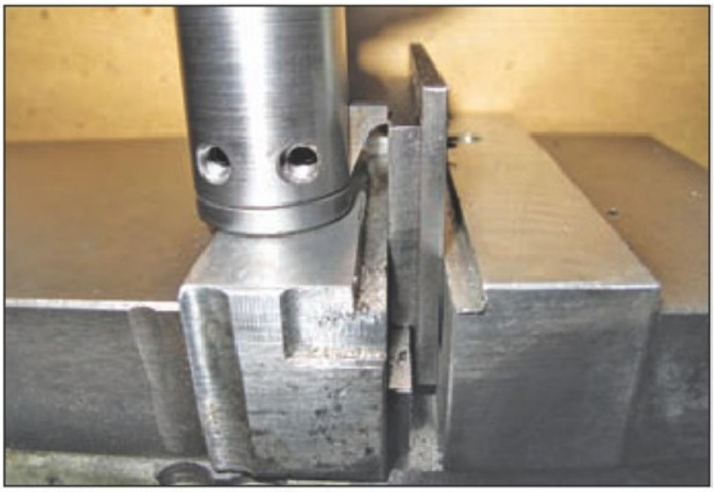
The 0.187in. rad cutter machining is now complete. The process now needs to be repeated on the remaining cutter blanks. To fully utilise the machine set up, two chamfering tools where also produced, one at 60 degrees and the other at 45 degrees.

Now all that needs to be tackled is the hardening and tempering. Gauge plate is an oil hardening steel. In these days of ecological awareness it's probably not a good idea to recommend the traditional method of quenching in whale oil. It's quite alright to use a bog standard, own brand, motor oil, as long as it's not too thin.

The cutters need to be placed on a fire brick and heated to a bright cherry red. Holding the cutter in a pair of pliers, quickly plunge vertically into the oil and quench in a circular motion for about thirty seconds. Once all the cutters have been hardened they should be tempered straight away. The cutting faces need to be cleaned back to natural colour. This is to have a clear view of the colours running up the blank when tempering. The fly cutter can be lent against a fire brick and a gentle flame played around the square end of the cutter. When the metal starts to take on a darker colour, the heat should be removed, so the colours can slowly run towards the cutting face. When the cutting face takes on a light straw colour, the tool should be quickly quenched in the oil. The hardness can be tested by passing a file across an unimportant section of the cutter. No file marks should occur as a result.

The clearance angles now need to be ground, but in the case of the concave cutters, diamond filed. A set of perfectly good diamond files can be bought these days for only a few pounds, so no workshop should really be without a set.

The ideal type of wheel for this grinding operation would be a medium grit white



39. Setting the fly cutter, Y axis

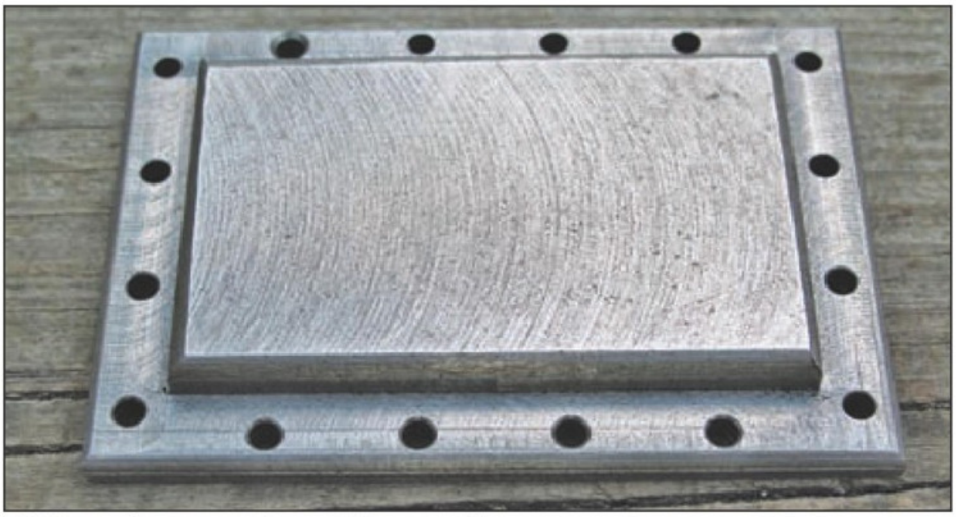
40. Machining the radius.

wheel. I'm lucky enough to have an old lapping wheel, which I've set up on an offhand grinder, so this appears in the photographic illustrations.

The grinder support should be inclined at 6 to 8 degrees, with the minimum gap between support and wheel. The relief should be carefully ground until only the slightest witness remains (**photos 35** and **36**). If the operator intends to cut the radial form deeper than the centre line, then the parallel sides of the cutter should also have a ground clearance angle.

The concave cutters need to be clamped in a bench vice and with the diamond file (preferable a fish back section) held at a slight angle, the clearance is then draw filed, with a riffling action. Time and care needs to be taken, as the clearance has to be filed right up to the cutting face on the cutters with the parallel reamed holes. The smaller diameters should be filed, to only leave about 0.010in. of the primary clearance angle remaining (**photos 37** and **38**).

All that is needed now is to prove the cutters by actually removing metal. The concave cutters should be the only ones that might require a little remedial attention. If there is not quite enough back clearance, the cutter may rub. It's a simple matter to take the cutter out and file off a little more clearance. With the cutters being located by the grub screws and spot faces, they will relocate back in the tool holder, virtually in the same position. Setting these cutters is quite straightforward. As the concave cutters are a precise radius, the face can be gently touched by hand against the workpiece and read outs or dials zeroed, **photo 39.** With the cutter raised clear, advance 0.010in. towards the workpiece, it can now be gently lowered with the spindle running. When the cutter comes into contact with the top edge of the workpiece, the read outs, or dials on the Z axis can then also be zeroed. Set the fly cutter to a depth of 0.125in. Mill in suitable increments till 0.125in. is reached on the Y axis. Always leave about 0.005in. for a final cut. Coolant should be used if available, if not then cutting paste will help ease the cutting operation and improve surface finish. The component being machined was cast steel, so a relatively slow speed of 300 rpm was used (**photo 40**). With use, the operator will be able to determine the best speeds to suit their particular machine and set ups.



41. Steam chest cover plate with fly cut radii.

The finished component is a steam chest cover plate, with 0.125in. radii on the upstanding area and 0.062 radii around the edge (**photo 41**).

Two more cutters were proved at this time, a concave cutter, plus the 45 degree chamfering cutter (**photos 42** and **43**). The actual fly cutter profiles are limited only by your imagination and all sorts of profiles can be created. ■

42. Proving 0.187in. diameter cutter.

43. Proving the 45degree cutter.

SCRIBE A LINE

Mandrel nose gauge

I read with interest Harold Hall's article on machining a mandrel nose gauge. This could be usefully carried out on a Morse taper shank. The resultant lump of metal could then be used for mounting the chuck in the dividing head. A further advantage would be the mandrel nose will be exposed for comparison while machining.

There have been several designs published for sheet metal rolls. The usefulness of these could be improved by extending the non drive ends through the bearings. The extended shafts can then be fitted with short interchangeable grooved rolls to facilitate rolling angles, flats on edge and rods. This facility is often incorporated on larger plate rolls.

Dave Pearson, Australia.

Painting aluminium

Brad Amos should clean & de-grease the surface, spray with an 'etching primer', follow with a suitable undercoat and add 1 or 2 top coats. When purchasing the paint it is necessary to tell the salesman what metal it is going on and get etch primer, undercoat and top coat that is compatible. Until recently I had a Land-rover that I had sprayed with Acrylic paint 25 years ago using the above procedure. It has been out in all weathers for that period and the paint is still sticking to it! (It has not faded either).

Peter King, New Zealand.

Victoria milling machine

I have a Victoria universal milling m/c which was my fathers. He bought it from a school in London in the 1960s. Although it is old it is very sturdy and shows no sign of wear. I have just added a DRO from Allendale Electronics Ltd and am very pleased with the system. I have tried to locate a manual without success. The only time I have seen a similar machine is in the Aug/Sept 2002 issue of MEW.

This was a 3in. model by Mr Malcolm Leafe which was awarded the Chester Shield at the Harrogate M.E. Exhibition. I was hoping through MEW if I could get in contact with Mr Leafe to find out more about this m/c.

Alan Holley, Maidstone.

If Malcolm is reading this or any reader can help with a manual, please contact me, Editor.

Fighting the rust fairy

I read the comments in Scribe a Line concerning Workshop heating with some interest. My own experiences in fighting rust derive from living in an environment in which the humidity in my basement workshop is typically between 70 to 80 percent (and 80 degrees F) for the months of July and August. Although I have an active exhaust system for venting the damp air in my basement, which is more effective and less costly to run than a dehumidifier, the painful reality of high humidity persists.

I have found that the best way to fight rust is with a light coat of mineral machine slideway oil AND storing my tools with a low wattage heat source. My machine tools are covered with semi-permeable covers and each tool has a small heating rod (called Golden Rod here in the US and often used in gun cases and on boats). I also have a Golden Rod in my tool chests. The heaters serve to elevate the temperature to the point where condensation does not take place, and subsequently avoids the risk of rust.

On the other hand, WD40 is just about the worst thing that can be used as a rust inhibitor. I believe that the WD in WD40 stands for water displacer (or something along those lines) and the 40 is trial 40. It is meant as a water displacer, and will also dissolve and remove any protective oil from your tools; it leaves behind no protective barrier.

Mike Ambrosino, USA.

Quality service

At last year's ME show in Harrogate I purchased a re-settable micro dial from Myford for my ML7R from the Myford stand. When I tried to fit it I found that a previous owner had made a mod to the cross slide screw and mounting. I contacted Myford and spoke to a gentleman called Malcolm. After a discussion he suggested that I send it to him and he would sort it out, which I did on Tuesday. On Thursday I received the assembly back with everything in working order. I would just like to put on record my thanks to Myford and in particularly to Malcolm.

Now for a tip, if you have difficulty in cleaning out the fine turnings, brass etc, from the chuck and don't have time to strip it, try using one of the auto industry carburettor or brake dust cleaning sprays. The pressure shifts the turnings and they dry very quickly. They can be obtained from any auto parts shop. Caution should be exercised as some of these sprays are highly inflammable so take care and use all the usual precautions.

Ken Deighton, by email.

Electric clutches

I have been following with interest the items regarding electric clutches for lathes.

My questions are, 1. How do they work? 2. Are they 'on' or 'off', or can you 'slip' them to inch a job round? Can some kind person explain?

Ian Strickland, by email.

Bandsaw run out

In MEW issue No 155, John Nelson was asking about bandsaw run out. Whilst I'm not an expert here are my comments. Firstly the problem is probably caused by the nut that pushes the material through the bandsaw. A bandsaw is not a precision machine, think of it as a powered hacksaw for metal or a powered hand saw for wood. I have 2 bandsaws, 1 for metal and 1 for wood.

Metal first, after all this is a metalworking magazine. My bandsaw is of the horizontal/vertical type as sold by my various companies including Machine Mart, Chester and Axminster. I use this to cut everything from ¼in. mild steel to 3in. stainless steel and have used the bandsaw for about 25 years. Run out on this machine is usually caused by the blade being worn or not set true. A worn blade is easy to rectify, simply fit a new blade but don't just buy a cheap replacement; search for a saw blade specialist and pay a little bit more for a decent blade. Setting the blade to run true is not a difficult matter with this type of bandsaw; it just needs to be done carefully. On my bandsaw the guides are on loose dovetails which can be twisted slightly to correct the blade tracking, think of it as twisting a hacksaw frame to keep the cut running true.

The only other adjustment that needs to be undertaken is the blade tension. Here I tend to slightly over tension the blade, as reference to the manufacturer's instructions, but I do release the tension when the bandsaw is not in use. It soon becomes habit to check and adjust the blade tension before use and release afterwards.

The manufacturer's instructions for tension are based on the poor quality bands supplied as original equipment.

Wood cutting next. I have a small 2 wheel Ryobi bandsaw that I have been using to ripsaw 2in. Iroko and 2in. Americal White Oak, both up to 5ft lengths. Again make sure that the blade is in good condition. If the blade is worn it will never cut true or tension properly. Again, I over tension to use the bandsaw, and then release the tension afterwards. The first thing I did with this bandsaw was to put the fence into a drawer and forget it. Draw your line on the wood and cut to the waste side as you would with a hand saw, then plane and finally sand the cut edge. Finally do not try and push the material to quickly, let the machine do the job. Just remember, if this was a lathe or miller you would be thinking of speed, depth of cut and tool feed so try to relate these to the bandsaw.

Les Pitt, by email.

Turners smock

I can endorse Ken Willson's recommendation for wearing a turner's smock. I have always done this, probably as I branched out into metalwork from woodwork and already had three of them. One was navy blue which I thought was a good engineering colour and would improve my work.

I had to make the sideways move as my "no-longer-made" woodworking machinery was wearing out, and spares were unavailable, so it was make-it-yourself time.

My preferred supplier for the smocks is Lovell Workwear, of Cardiff, www.lovellworkwear.com who attends major woodworking shows. They have a range of colours, and more importantly, different materials, light and heavy cotton, polycotton, etc. They also do good heavy cotton aprons which are great for a quick turn.

Phil Robinson

YOUR CHANCE TO TALK TO US!
Drop us a line and share your advice, questions and opinions with other readers.

Boring opportunity

I believe that I may have spotted a gap in the vast amount of engineering knowledge published in Model Engineer and Model Engineers Workshop.

I have recently acquired a small boring head (a present) and have a few jobs lined up to use it in a 4in. Chester lathe and a medium sized bench mill/drill.

I have checked through all my copies of ME and MEW for some basic knowledge regarding the USE of a boring head in a lathe and bench miller. I have found many articles giving great details of MAKING boring heads, but very few basic details of the use of such a tool.

I would like to know more about setting up the tool, cutting speeds, feed rates etc. pretty basic stuff really.

Perhaps one of your pool of experts could write an article on the subject.

Bob Middleton, by email.

Tailstock cross drilling

In reply to H Lord's request in M.E.W. 160 for a past article on a tailstock cross drilling device, he would find it easier to make a toolpost equivalent, whether for directly clamping onto his cross slide or holding in his four way toolpost.

Mine is a piece of mild steel approx ¾ x ½ x 3in. long, thus making it about ½in. longer on either side than the width of my four way toolpost. It was made by clamping into the toolpost with a shade standing proud, butting up to the lathe jaws to ensure it was parallel before tightening the toolpost itself, then using a ⅜in. centre drill up to its shoulder depth to drill holes at 9mm centres and then subtracting 4.5mm from the last hole and working back along the bar at 9mm intervals again to remove the webs leaving a rippled result. Use a HSS countersink tool to smooth the outcome and the job is done other than marking the top surface to check it's the right way up when using it if there's only a little difference between the upper and lower portions. The extra length allows small G clamps at one or both ends to hold the work whilst drilling.

This system has the advantage that it can be used at skew angles, and enabled me to drill a fly cutter at 45 degrees for the tool and at the reverse 45 degrees for the clamp screw.

Colin Porter, Blackpool.

Engineering courses

I have just received the latest Axminster catalogue and noticed that they have added engineering courses to their already successful woodworking courses. If you do not know about this you could have a look at www.axminsterskillcentre.co.uk and may feel it worthwhile giving them a mention, if you have not already done so. The courses are for two days and are in Devon so it would only suit a limited number of people but a mention may encourage others, such as Warco, to do the same but perhaps they already do and I am not aware of it.

The woodworking suppliers have for years provided a wide range of courses, some residential and lasting for at least a week, and I have always felt metalworking suppliers should do the same.

Harold Hall, Berkhampsted.

Condensation

During winter in the southern hemisphere I also having condensation issues, with of all things my TIG welder. It only gets used once every few weeks and during that time I suspect that air (having a similar density to argon) is migrating up the gas line. Once there the normal daily temperature cycles mean that moisture can condense out of the air into the gas line. When the welder is next used the moisture is picked up by the dry gas and manifests itself as weld porosity.

To try and reduce this problem I made up a cap from some polyethylene bar stock to suit the end of the TIG torch (around 17mm diameter in my case), complete with sealing O ring (which also helps retain the cap on the torch end). As the rest of the gas system always stays connected, this seems to seal the gas line well enough that the porosity issue is much reduced - I won't say gone, just in case. It is removed prior to a welding session and replaced at the end once the torch has cooled.

Michael Green, Australia.

Slideway oil

I would be interested in reader's opinions on the use of slideway oil on machine slides. I am currently using it on my machines and think that it is a vast improvement on 'normal' oil which needs to be reapplied far more often in comparison. However, I have heard that some machinists won't use it on their machines for the reason that as well as sticking to the ways, they feel that it will also keep metal particles in suspension and so promotes wear. I should also confess that as I don't want to keep a minimum of 6 x 20 litre drums of different oils in my workshop, I also use it for general lubrication on machines (although not enclosed gear boxes). Does the nature of this oil mean that I am allowing particles to stick to leadscrews, bearings, change gears, ways and slides rather than (presumably) flushing them out/off? If we have any Tribologists out there, can they explain whether this type of oil will hold particles in suspension in a harmful way? Should this type of oil only really be used on large machines with protected ways and oil filters?

Michael Green, Australia.

A letter from the editor

I am running short of Scribe a Line letters. If you have any questions you think other readers might know the answer to, please get in touch. Perhaps you want to share a useful tip? When writing or emailing, please send general area of the country you are in. Other readers like to know where you are based. Also, please include a phone number. If I have a query or a response, it is much easier and cheaper to pick up the phone than to write to you.

Photographs should be reasonably high resolution or they will be unsuitable for publication.

Also, articles are still welcome. If you would like guidelines, please email me at david.clark@myhobbystore.com Guidelines have recently been updated and are available free of charge.

Finally, note our new address, I note some people are still sending to the old address and although they will reach me eventually, the correct address will speed up response.

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WRITE TO US!

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CONVERT YOUR ANGLE GRINDER INTO A COMPACT DRILL FOR RESTRICTED ACCESS

Dyson Watkins makes a useful modification to an angle grinder

1. The finished drill ready for use.

■ OVERVIEW

A problem cropped up recently while preparing our loft for installing insulation. It was my intention to lay a floor in the attic space above the insulation, and in readiness for this event I decided to tidy up the wiring that had been run above the joists. A number of cables needed to be installed through holes in the joists low enough to avoid the possibility of damage from a stray nail. I was aware of the availability of 90deg. drill adaptors, which were as expensive as a drill. The cheaper versions were liable to failure from temperature softening of the bevel gear casing that was made in a thermoplastic material. The decision was made, to make an adaptor for mounting a drill chuck directly onto the spindle, in place of the usual disk (**photo 1**).

I wanted the adaptor to be easily assembled and vice versa, so the parts to be joined were duly measured up. I noticed that although the two threads were generally M14 x 2mm on the grinder spindle, and 0.5in. x 20tpi on the chuck, some differences were in evidence. Screwcutting required both Metric and Imperial systems with my Myford being an Imperial version equipped with a gearbox. The M14 internal thread, being the more awkward, was tackled first of all.

I did all of the turning in the three jaw chuck, which being a 'Griptru' version, was very accurate. A light cleaning up skim was taken off the outside diameter, and the end was faced square. The end was centre drilled and then drilled to depth using an 11.5mm drill. The hole was then opened out to 11.7mm diameter and the internal undercut added in readiness for a run-out for the screwcutting tool.

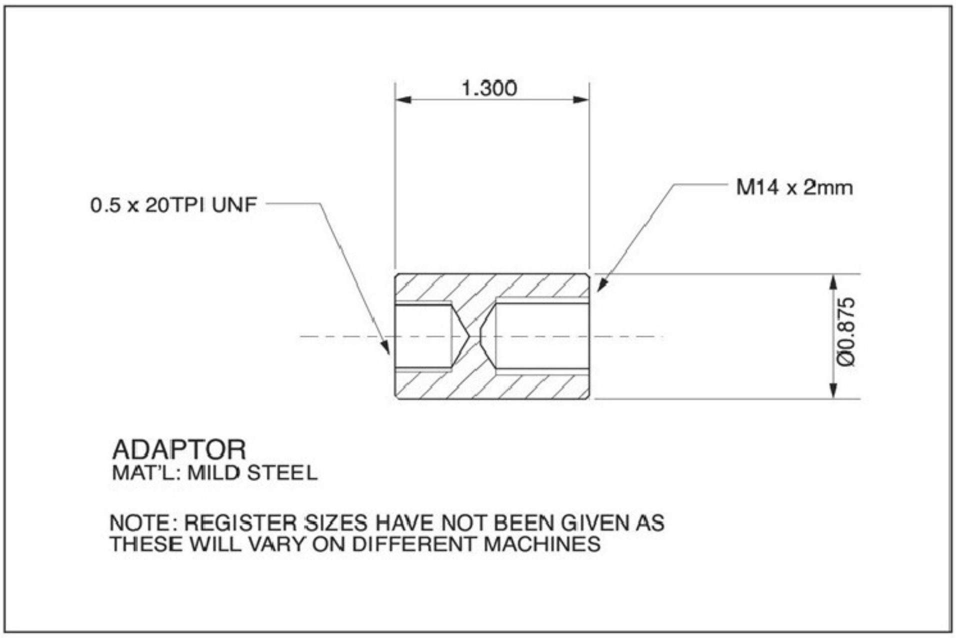
Screwcutting metric threads on my machine necessitates the keeping of the leadscrew nuts in permanent engagement, so the clutch had to be disengaged at the instant the tool entered the undercut. If you don't have spindle reverse available, then the saddle has to be returned to its start position by winding the spindle backwards by hand in readiness for the next cut, (after retracting the tool).

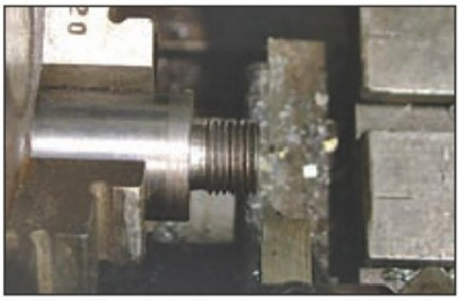
There are some variations in the design details of some grinders. Some have a register while others don't so check the details beforehand

The chuck end is a straightforward 20tpi UNF thread, and most chucks have a register in the outer end. It is worth checking the diameter of the register. The two chucks available to me varied by about 0.005in. on the diameter. Engagement on the Myford for even pitches is straightforward; the half-nuts can be engaged at any numbered position on the screwcutting dial and disengaged at the end of each cut (**photo 2**). Afterwards, clean off the crests of the thread by holding a fine file on the o/d while the work is turning, followed by some fine emery tape.

In order to ease assembly, spanner flats are milled on the sides (**photo 3**). In my case a convenient size was 19mm A/F. The work was held in a 3-jaw chuck mounted on a rotary table. The assembled adaptor is as shown in photo 1.

The working length is considerably shorter than a normal drill and awkward drilling jobs are much simplified. ■





2. Checking the adaptor external thread.

3. Milling spanner flats on the adaptor.

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■ Model Engineers' Workshop, Summer 1990, Autumn 1990, June/ July 1991, Oct/Nov 1991, Feb/ March 1992, Apr/May 1992, June/ July 1992, Nos 14, 15, 16, 19. 27, 33, 34, 52, £3 each. **T. 01493 668358 Great Yarmouth.**

■ Model Engineers Workshop Nos 13 to 80 (68 consecutive editions) plus eight earlier editions, buyer collects, £130 ONO. **T. 020 84679296 Bromley.**

■ EIM magazines, Vol 1 no 1 to Vol 10 No 2 also Model Mechanics, Vol 1 No1 to Vol 2 No 2, all in good condition, Also various volumes of Practical Engineering and Model Engineer. Best offers? **T. 01455 636951 Leicestershire.**

■ Model Engineer and exhibition extras from 1966. **T. 01525 377547 Leighton Buzzard.**

Books & magazines wanted

■ Operating manual for BCA universal jig boring and milling machine MK1 or MK2 with three slot rotary table. **T. 01373 832681 Wiltshire.**

■ Little John lathe, copy of fitting instructions to fit gearbox and also copy of screwcutting label from gearbox top. **T. 01392 466079 Exeter.**

Miscellaneous offered

■ Anvil, 50 CM long, 23.5 tall, 9cm wide, 18cm wide base, OK condition, £120. **T. 01744 612119 St Helens.**

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CONVERTERS MADE IN BRITAIN SINCE 1984; 3-YEAR WARRANTY ON ALL CONVERTER PRODUCTS; BS EN 9001:2008 QUALITY ASSURED MANUFACTURING ENVIRONMENT; CE MARKED PRODUCTS COMPLIANT WITH EMC REGULATIONS, THE LOW VOLTAGE DIRECTIVE and BS EN ISO 61000-3-2:2006.

Myford

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MYFORD SPRING SHOW
Thursday 15th April
to
Saturday 17th April 2010
To find out more contact Malcolm

0115 925 4222

Website: www.myford.com
Email: sales@myford.com

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The UK's most advanced phase converters with a unique 3 year guarantee. Never beaten on price.

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Fax: 01344 303 312
Mob. 07952 717960
www.boost-energy.com
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BOOST HAS BEEN MANUFACTURING HIGH QUALITY PHASE CONVERTERS IN THE UK SINCE 1957

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Model Engineer Requires Myford lathe

- Any condition
- Any size

Required to complete steam engine build
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Cowells Small Machine Tool Ltd.

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www.cowells.com

Manufactures of high precision screwcutting lathes, 8mm horological collet lathes and milling machines, plus comprehensive accessory range.
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THINKING OF SELLING YOUR LATHE MILL OR COMPLETE WORKSHOP?

and want it handled in a quick, professional no fuss manner? Contact David Anchell, Quillstar (Nottingham).

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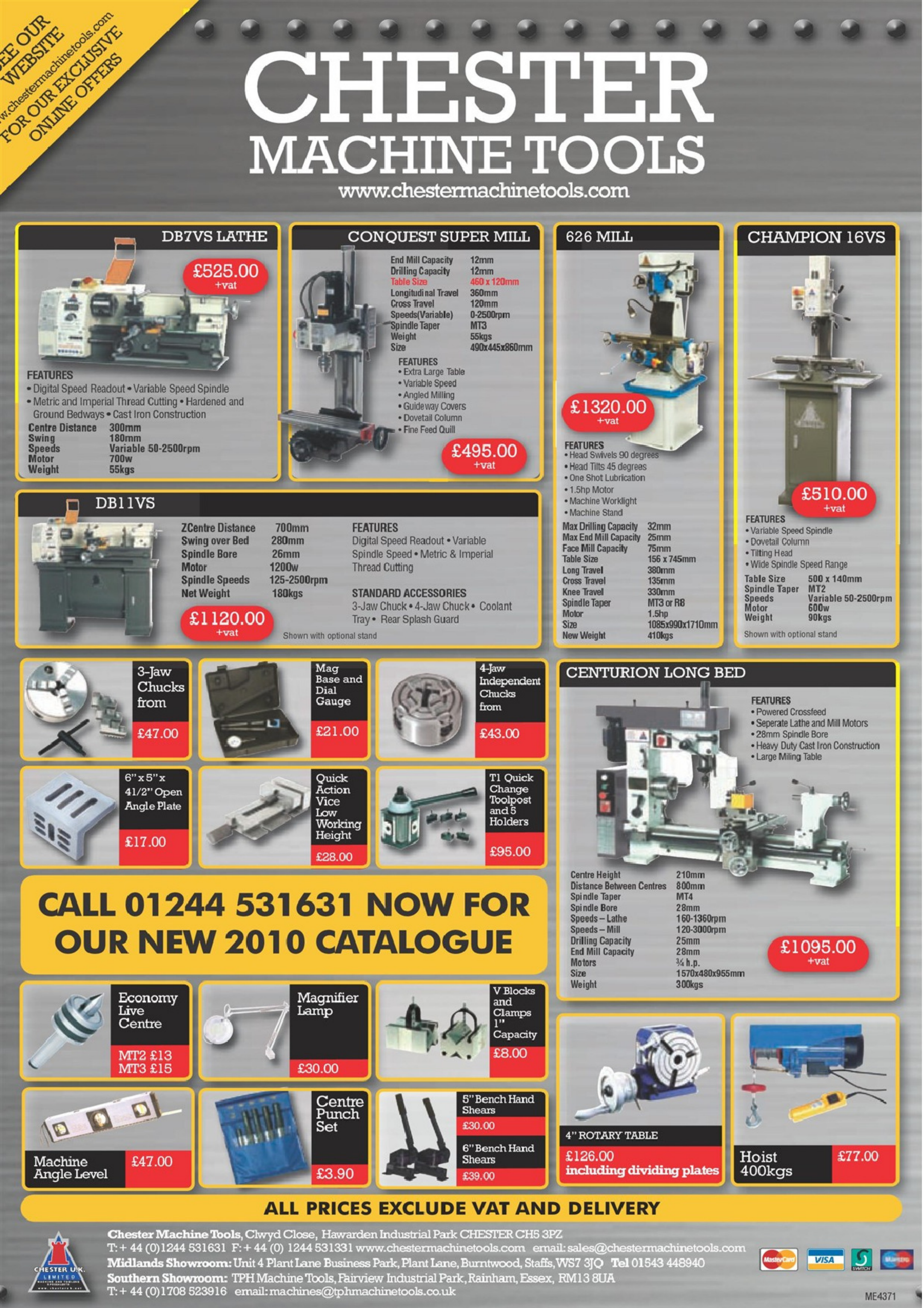
MODEL ENGINEERS' WORKSHOP CLASSIFIED


HOME AND WORKSHOP MACHINERY
Genuine Used Machines & Tooling
144 Maidstone Road, Foots Cray, Sidcup, Kent DA14 5HS
Telephone: 0208 300 9070 - Evenings: 01959 532199 - Facsimile: 0208 309 6311
www.homeandworkshop.co.uk • stevehwm@btopenworld.com
Opening Times: Monday-Friday 9am-5.30pm - Saturday Morning 9am-1pm
10 minutes from M25 - Junction 3 and South Circular - A205
very nice condition
£1125
Alexander 3A (3 dimension engrave
£675
RJH 4" vertical belt linisher (240volts)
£2950
Harrison M250 5" x 30 lathe
£1250
Denford Viceroy lathe
£950
Colchester Chipmaster lathe
NEW £125
Milling/Drilling ground X-Y table
£975
Viceroy drill grinder
• Harrison M300 lathes
• Colchester Master 2500 lathes
• Colchester Chipmaster lathes
• Colchester Bantam lathe
• Semco (Bridgeport size) mills
• Fobco pedestal drills • Sets of rolls
Tote bins 18" x 12" £7 each
• Adcock & Shipley 2E vertical heads, slotting heads £625 / £495 / £625
• J & S balance + bottom base only £80
• Startrite 352 bandsaw £975
• Marlco keyway broaches just in!
• Harrison L5/L5A/140/L6 T/steadies
• Eclipse De-magnetiser £80
• Hofmann dividing head + gears £625
• Clarkson Autolock chucks Selection
• Colchester Triumph 2000 fixed steady £245
• Harrison M300 Ainjest attachment £345
• Axminster bandsaws, morticer, sanders, Scheppach planer, Startrite sawbench
£725
Lorch LLK 2.5" x 10" lathe
£1250
Boxford AUD Mk11 5" centre height + gearbox
£625
Adcock and Shipley 1ES vertical knuckle head
Q & S QDM 32mm pedestal drill
£1425
£145
Eclipse Cat.927 4" cased magnetic chuck
£140
Harrison 11" lathe + gearbox, pcf & gap
£950
Harrison L5 lathe + pcf & gap
£1200
Harrison 11" lathe + pcf & gap
£2950
Elliot '00' vertical milling machine. Very nice example.
£950
Tom Senior Major milling machine
Colchester Student 1800 geared / gap bed lathe
£2950
Ka (Germany) toolro power hacks 150 x 170
£745
£24
5 kilo anvil
Boxford Mk11 BUD lathe
£875
NEW (old stock) drilling machines, better quality!
£125
Boxford Mk111 5" lathe
£1400
£1250
Wadkin panel saw
£425
RJH Swordfish fretsaw + extractor
£2950
Colchester Triumph 2000 + gap & taper turning
< Harrison/ Colchester etc D14 tooling
Harrison M300 > (2500rev) 6" x 24"
£2950
Meddings pedestal drill / 2MT
£375
£164.50
Crompton/Tyco NEW motor for ML7/Super 7
£2400
Myford Super 7 Sigma lathe
£2450
Excel 1440E lathe + chucks, steadies (1997)
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 have wood lathes, saw benches, bandsaws, morticers and Record vices etc - large selection!


We have thousands of lathe tools, milling cutters, drill bits, centre drills, consumables and odd items all here in our workshop ready for you!!
£425
Abwood tool grinder
£575
Pedestal 12" guillotine + spare blade
£70
Eclipse de-magnetiser
£40 & £50 each
Keyway broaches 7/16" 18mm
£625
Startrite EF1 geared head drilling machine
£1650
Myford ML8 lathe + accessories and turning tools
£425
£175
10" x 10" high swivel tilt rotary table
As NEW!
£140
Crompton Parkinson Foot Mounted 2HP 240V / single phase 1400 revs as new.
12" x 12" x 12" angle plate
£90
£1650
SPS Minibar
Chesterman 18" height gauge (cased)
£145
£245
70mm capstan attachment
Ace Minor (240 VOLT) 4" horizontal linisher
£245
36" x 24" surface table
£245
£245
Denford Viceroy buffer's
Harrison 140 + gearbox just arrived!
£1650
£1250
Colchester Student lathe
Grobet / Vallorbe Swiss files
£3 each
£3 each
Eclipse scribers
4 jaw chucks!!
Newall 6" - 12" quality micrometer
£75
Eclipse angle plates
From £20
£275
Norton No.3S flypress
very nice press!!
£125
Verdict metric lighthouse (made in Switzerland) Imp. available
£4.50 each
Eclipse 300mm / 12" x 1" x .050" machine hacksaw blades
Jones and Shipman (10" daylight) arbor press
£145
£245
RJH Trimtool grinder (diamond wheel)
Verdict sine bar (choice)
£40
£425
RJH buffer/ grinder
Eclipse 9" magnetic chuck
£145
Q&S 6" Sawmaster
£625
Tom Senior M1 vertical
Only £950
£245
Myford Multi stop
As NEW!
£70
Acvocke 4" lever cam operated machine vice
Myford Super 7 lathe + power cross feed & stand
£2250
Axminster morticer
£495
£625
Norton 6DB deep throat + handle and balls
Colchester Student 6" fixed steady
£145
£245
Colchester Triumph 2000 fixed steady
£495
Axminster linisher/ disc sander
As NEW!
£345
Harrison Imperial M300 Ainjest attachment + bar
>>>>> We are still OPEN SATURDAY MORNINGS dedicated to the model engineer >>>>>



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FOR OUR EXCLUSIVE ONLINE OFFERS
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DB7VS LATHE
£525.00 +vat
FEATURES
• Digital Speed Readout • Variable Speed Spindle
• Metric and Imperial Thread Cutting • Hardened and Ground Bedways • Cast Iron Construction
Centre Distance 300mm
Swing 180mm
Speeds Variable 50-2500rpm
Motor 700w
Weight 55kgs
CONQUEST SUPER MILL
End Mill Capacity 12mm
Drilling Capacity 12mm
Table Size 460 x 120mm
Longitudinal Travel 360mm
Cross Travel 120mm
Speeds(Variable) 0-2500rpm
Spindle Taper MT3
Weight 55kgs
Size 490x445x860mm
FEATURES
• Extra Large Table
• Variable Speed
• Angled Milling
• Guideway Covers
• Dovetail Column
• Fine Feed Quill
£495.00 +vat
626 MILL
£1320.00 +vat
FEATURES
• Head Swivels 90 degrees
• Head Tilts 45 degrees
• One Shot Lubrication
• 1.5hp Motor
• Machine Worklight
• Machine Stand
Max Drilling Capacity 32mm
Max End Mill Capacity 25mm
Face Mill Capacity 75mm
Table Size 156 x 745mm
Long Travel 380mm
Cross Travel 135mm
Knee Travel 330mm
Spindle Taper MT3 or R8
Motor 1.5hp
Size 1085x990x1710mm
New Weight 410kgs
CHAMPION 16VS
£510.00 +vat
FEATURES
• Variable Speed Spindle
• Dovetail Column
• Tilting Head
• Wide Spindle Speed Range
Table Size 500 x 140mm
Spindle Taper MT2
Speeds Variable 50-2500rpm
Motor 600w
Weight 90kgs
Shown with optional stand
DB11VS
ZCentre Distance 700mm
Swing over Bed 280mm
Spindle Bore 26mm
Motor 1200w
Spindle Speeds 125-2500rpm
Net Weight 180kgs
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Digital Speed Readout • Variable Spindle Speed • Metric & Imperial Thread Cutting
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• Heavy Duty Cast Iron Construction
• Large Miling Table
Centre Height 210mm
Distance Between Centres 800mm
Spindle Taper MT4
Spindle Bore 28mm
Speeds – Lathe 160-1360rpm
Speeds – Mill 120-3000rpm
Drilling Capacity 25mm
End Mill Capacity 28mm
Motors ¾ h.p.
Size 1570x480x955mm
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6" x 5" x 41/2" Open Angle Plate £17.00
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