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JUNE 2008

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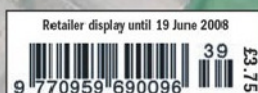
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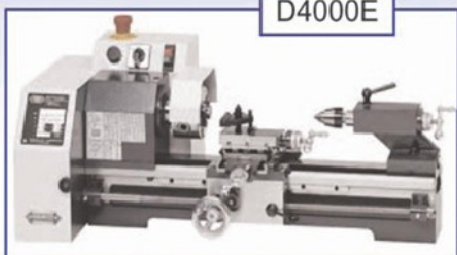
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Turning a steam engine connecting rod using a
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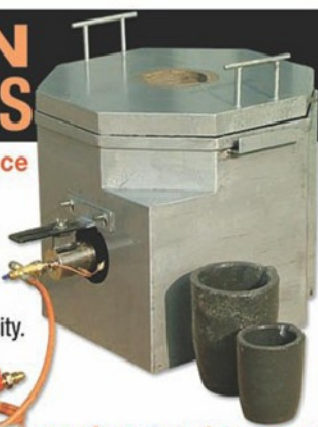
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Ballscrew Size (Dia./Pitch)	12mm x 4mm	20mm x 4mm
X axis Motor	1.35Nm	4Nm
Y axis Motor	1.35Nm	4Nm
Z axis Motor	2.2Nm	6Nm
Throat	140mm	190mm
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Positional Accuracy	0.01mm	0.01mm
Spindle Taper	MT2	R8
Spindle Motor	500w Brushless DC	1000w Brushless DC
Spindle Speed	250-7000rpm	200-3500rpm
Max. Spindle Motor Torque	1.8Nm @ 1500RPM	5.5Nm @ 1500RPM
Power Requirement	230v AC 50Hz	230v AC 50Hz
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F1	1/8 - 3/16 - 1/4 - 5/16 - 3/8	16.00
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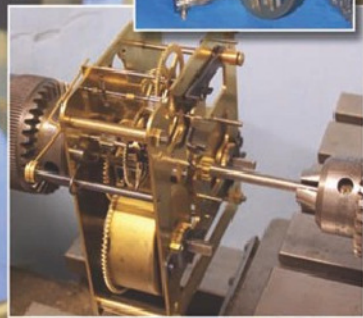
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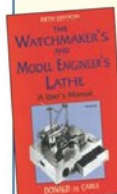


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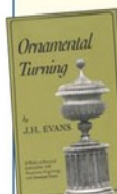
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David Clark

ON THE EDITOR'S BENCH

We are nearly into June now and the Harrogate Show is behind us. I am writing this in late April before visiting the show. Hopefully I met plenty of you, the readers', you may have bent my ear with article suggestions or comments on the magazine. It depends on the response I got this year as to whether or not I go next year. That does not mean I did not enjoy the show, it means that if plenty of readers spoke to me and useful ideas etc. were received, it was worthwhile going. Living in Scotland now, it is about 475 miles to Harrogate and there are the hotel (bed and breakfast) expenses to consider as well as the approximately 1000 mile round trip. Yes, I can claim expenses back but it all comes out of the magazines budget. The more profitable the magazine is, the more I can increase the contributors' payments (every January, I hope) and the better the articles should be. I will do a short 2 page report on Harrogate in the next issue.

Myford - thinking out of the box

It may seem as if the Myford Series 7 is taking over the magazine. This is not the case, and if you check back over the last 15 or so issues since I took over as editor, the Myford has hardly been touched on. I look on MEW as an ideas magazine, although some readers will build a project exactly as described, the benefit of MEW is that you can take one or two of its published designs and combine or modify them to suit your own needs.

A typical example is Tony Jeffree's article on converting the Myford to CNC control. He has written a useful article on a cross feed power unit that is just as suitable as an add-on to a standard Myford lathe as it is to the CNC version. If you combine this article with the 'More Power To Your Elbow Article' by David Haythornthwaite in MEW issue 119, you will probably end up with a useful power cross feed with electronic control on your Myford.

I say probably because I have not tested it yet but it instantly sprang to mind when seeing Tony's article. Why does it have to be a Myford? You could probably use the same basic design to motorise any lathe. Perhaps limit switches could be added to stop the cross slide at the end of its travel, maybe even an adjustable stop rod to cut the feed off? How about automatic

withdrawal when screwcutting? The carriage triggers a micro switch and the cross slide instantly winds out. It should not be too difficult to figure out.

Subscriptions

Because I work about 6 weeks in advance of publication date, I tend to get out of sync with the magazine. This happened again with issue 138. In Ed's Bench, issue 138, I mentioned subscriptions and the benefits of subscribing. I get reasonably regular figures for both newsagents' sales and subscription numbers and was pleased to see that although newsagents' sales were down by about 100 copies, subscriptions were up by almost the same amount. I thought 'great'; readers' are reading Ed's Bench and taking note. Then a little later, I checked the on sale date for issue 138 and realised that it would not have had any impact yet because the issue had only been on sale for a couple of days. It will be interesting to see the next set of figures to see if subscriptions have gone up again.

Back numbers

As editor, I get 15 copies of MEW for various purposes. I usually use 5 or 6 copies, it has been a lot more at times, and I was contacted by customer services to see if I had any spares. I parcelled up all the issues from 129 backwards and sent them off. When they are gone, they are gone. Due to great demand, customer services have run out of a lot of the recent back issues, they have sold out completely. We even called on the services of Dave Fenner, as he still received his editors' copies, to fill a hole in the in house copies. We preserve one of each copy for reference and for supplying photocopies. Fortunately, we now have a full set of back issues to call on. I do have a set as well

but it is a pain to scan copies when they are fully bound rather than just in binders.

In the Workshop

It has been very quiet in the workshop this month. I am still very busy with other things to get out there. There are two changes to the workshop this month, I have purchased from a reader (he phoned me up) a Clarkson Cutter Grinder and I also had a short holiday in Poole and travelled via The Toolbox in Colyton, Devon. While talking in general and about the new CNC series in particular, David, (yes, another one) the owner mentioned he had an old Boxford CNC lathe in the back workshop. A quick look and a deal was done at a very good price. It was a Boxford 125TCL and was originally intended to work from a BBC B computer. It is in a reasonable condition and is destined to be converted to MACH 3. How long this will take is anyone's guess but at a cost of £83, it can stand in the workshop for a while. I have found conversion information on the internet and it looks a reasonably straightforward job. Time will tell. Perhaps it might form the basis of a CNC turning series in the future. (Or maybe a reader would like to write one?)

Articles

I have noticed that we are tending towards short series of articles rather than the stand alone article traditionally published in MEW. This is not too much of a problem now we are publishing monthly but perhaps some readers would like to write some shorter articles for publication. I do have a few that I hope to fit in soon especially now Harold Hall has concluded the Metalworking series. Harold is still actively writing. I have received 2 new articles this month from him as well as an updated one to take into account new legislation.

Dates for your diary

Please email david.clark@magicalia.com if you would like your event listed here. Please let me know at least 2 months in advance.

The Merstham Model Steam Show is on the 17th & 18th May 2008. This is an excellent day out with all the main narrow gauge railway traders attending.

The date of the Guildford Model Engineering Society 2008 Model Steam Rally and Exhibition has been changed to the 12th and 13th of July. Don't forget your Wellington boots.

Bristol Model Engineering and Hobbies Exhibition will be at the Thornbury Leisure Centre on the 15th 16th and 17th August. I got totally lost trying to find this event last year even with the help of an online map printout. I was so annoyed that after the show, I went out and bought a Sat Nav.

Warco are holding their open day on the 12th & 14th September 2008.

The Official Model Engineer Exhibition is on the 19th - 21st September 2008 at Ascot racecourse. I shall be there manning the Magicalia stand for the 3 days.

THE METALWORKERS WORKSHOP 13

Presses

Except maybe for a shaping machine, a press is probably the least likely major machine to be found in the average home workshop. What then are the reasons for owning or not owning one?

Purpose

The extent to which a press will be needed will depend on the workshop's activity but it is likely that all workshops will find one useful for the occasional task. In many cases this would be a task that would be much more difficult when attempted by other means. Also, an important feature of using a press is that when set up, the intended task can be performed in a matter of seconds. It is therefore highly efficient when it comes to making batches of components.

Bending

Probably top of the list of possible uses is to bend strip and sheet materials, a task that it does with ease providing the item is being made using a bending quality material.

Punching holes

Another frequent use is to punch holes. This is a particularly useful alternative to drilling large holes in thin sheet as this is far from easy. For example, a 15mm diameter hole in a 0.5mm thick workpiece is almost impossible with a drill but relatively easy with a press.

Another advantage of using the press to punch holes is that part holes can be made enabling slots to be made by repeating operations at say $\frac{1}{4}$ of the hole diameter along the sheet. To ensure the slot is straight, a fence would be set up against which the workpiece would be slid. **Photo 1** shows an example, but unfortunately the guide fence cannot be seen in this as it is hidden under the stripper plate. This principle can also be extended to make large rectangular and round holes.

Cropping

Of less use, but worth considering if batch production of parts made from strip material is necessary, is to equip the press with a mini guillotine for cropping parts to length. With an end stop set, making a batch of parts all the same length will be very time efficient.

Do bear in mind that punching holes and cropping parts to length is not just an operation to be carried out on metal as other materials can also be worked on, typically card, leather or plastic.

Force fitting and removing

Whilst a vice can be used for force fitting one part into another, this will frequently not be possible where the component is large. A press will in this case be the ideal tool for such an operation.

Press types

Unlike in industry where presses will often be large and powered, those in the

Harold Hall concludes the series with a look at presses, shaping machines and Welders.



Photo 1. By repeat punching at about $\frac{1}{4}$ of the hole's diameter, slots can easily be produced (right of picture) using a fly press.

home workshop will usually be small and hand operated.

Fly press

These are made in a range of sizes with that seen in **photo 2** being one of the smaller ones having a throat depth of 120mm and height of 200mm. This is a much used, perhaps even abused, version of this form of press that was salvaged from an industrial background.

In terms of the pressure provided (tonnage), it can be seen from the photograph that the ram is operated via a coarse thread rotated by means of a handle. In use, the handle is rotated quickly so that the energy stored in the ball, seen on the end of the arm, provides the power required when the punch contacts the workpiece. Herein lies the scope for abuse as the pressure available will depend on the rate at which the handle is let fly, (hence the name of the press, I think). However, the press in the photograph has a nominal rating of 3 tons giving it the ability for example to punch a 15mm hole through 1.5mm thick steel sheet.

The coarse thread that operates the ram is a square thread but its outer diameter may have a fine thread on which an adjustable down feed stop can be set if provided, **photo 3**. This can be set to ensure the punch only just enters the die, or when carrying out bending operations, to set the angle of the bend being made. Fly presses are very robust machines and even one that has been much neglected should be more than adequate for home workshop use.

Arbor presses

These, **photo 4** are primarily intended for assembly work, typically light duty riveting or press fitting one part into another, etc., and are made in a range of sizes,



Photo 2. A much used small fly press of 3 tons nominal size.



Photo 3. A fine pitch thread is usually provided on the outer diameter to provide the fine adjustment for a down feed stop.

commonly sizes 0 to size 3 but larger are also available. Their nominal tonnage ratings are 0.5, 1, 2 and 3 tons. However, some tests carried out on the one in the photograph (size 0, 0.5 tons) showed that with a larger diameter and longer handle fitted 1 ton is achievable and without noticeable stress to the press. Arbor presses are widely available and at the smaller sizes, economically priced.

Whilst designed for assembly duties,



with a little attention they can carry out much that a fly press can, albeit at a much lighter load. The most likely problem will be the fit of the ram. Readers will, I am sure, appreciate that when punching holes the clearance between the punch and the die will be quite small and if there is clearance between the ram and the press body allowing the end of the punch to wander then the punch and die may foul each other causing premature wear.

The press in the photograph originally only had a gib strip on the front face of the ram allowing the end of the punch to move left to right. A second gib strip had to be added as the four screws in the photograph make evident. This is a simple improvement but some arbor presses are now being advertised as having two gibs fitted.

Toggle presses

These use a toggle mechanism to provide the down pressure but due to the characteristics of the toggle action, near maximum tonnage is only available at the point the three pivots approach being in line. This makes them less useful in the home workshop and in any case they are not that easy to locate but second hand is your main option.

Hydraulic presses

I mention these for completeness as their uses are very limited, pressing a shaft into or out of a gear for example. They are commonly available and can easily achieve tonnage's greater than those with the other presses mentioned. Their construction does not lend itself to fitting accessories for punching holes. Bending workpiece's would, I think, be achievable.

Accessories

As with other machines, the press is capable of very little without some additional items. Consider first the task of punching holes where a punch and die of the required size will be necessary. Unfortunately, what at first appears to be an easy operation is not without its limitations. Top of the list is that having punched the hole, the workpiece will be firmly gripping the punch and some method of extricating it must be provided. For this to be achieved a stripper plate is necessary, that in **Sk. 1** being typical.

Other provisions provided by this setup are a locating fence and an end stop to control the position of the hole relative to the workpiece's edge and end. Also, to limit the physical size of each punch and die, holders are provided rather than fitting them directly into the ram and the



Photo 4. A 1/2 ton arbor press.

die onto the press bed. The holder for the die is frequently called a bolster.

When working with thin material, it will often be the case that holes are required to be made in relatively large sheets. Because of this, the stripper plate as illustrated in **Sk. 1** becomes impracticable and a stripper mounted off the upper framework of the press is used. **Photo 5** shows an example that also includes an added support table for larger workpiece's.

Photo 6 shows a range of items necessary that provide these facilities on the fly press whilst **photo 7** shows a similar range of equipment, but smaller, for use on the arbor press. The items shown for use on the fly press are available commercially but the smaller assembly for use on the arbor press will have to be shop made.

Punches and dies

These will of course be required for every hole size and would appear as a result to be an expensive requirement. Fortunately however, for many readers there is a surprise outcome to this situation, that is punches and dies do not have to be made from hardened steel, normal mild steel being more than adequate for anything other than mass production. One hundred holes plus can easily be made with unhardened mild steel punches and dies and when blunt and producing poor holes they can easily have the ends faced



Photo 5. An overhead stripper assembly makes it possible to punch holes in large sheets. The set up also includes an auxiliary table for supporting larger workpiece's.

on the lathe to give them a new lease of life. I suspect however that there may be a problem with non hard punches and dies if attempting to punch a small hole in a relatively thick workpiece as the punch may collapse, say 4mm diameter into 3mm thick.

Another advantage is that soft punches and dies if made for a one off job can be remachined for other diameters at a later time. With rather more care, shapes other than round can also be made.

There is an added complication to this situation. That is, in theory, the clearance between punch and die is dependant on the thickness of the material being punched. The difference in their diameters being approximately equal to 0.1 times the material thickness though generally, this value is not critical.

To limit the number of blanks held in the die so as to minimise the force required to push them through, the rear should be either tapered, **Sk. 2a** or opened up with a slightly larger drill, **Sk. 2b**.

Photo 1 showed a fly press set up for punching holes with **photo 8** showing a similar setup on an arbor press.

Bending

Using a press for bending either strip or plate is an easier operation than punching holes as it requires simpler equipment. Typically, **Sk. 3** shows how a V form punch and die can be used to create a bend. Unfortunately, whilst the equipment is simple the process is not without its complications. Most important is that when the punch is raised, the angle will spring back a little. If therefore the angle of both the punch and die is 90deg., the resulting bend will be a few degrees less.

Reducing the angle of the punch only will help but the extent to which this is done can only be determined by trial and error. Because of this an alternative approach has to be used, at least in the home workshop. In any case, machining an internal V with an angle of less than 90deg. is not straight forward.

Sketch 4 shows a simpler method that will enable the variations mentioned above to be compensated for by varying the amount by which the punch enters the die. This, I believe, is called air bending for obvious reasons and is perfectly adequate for small quantity work likely to surface in the home workshop. **Photo 9** is an example of this method and close examination of the picture will show that

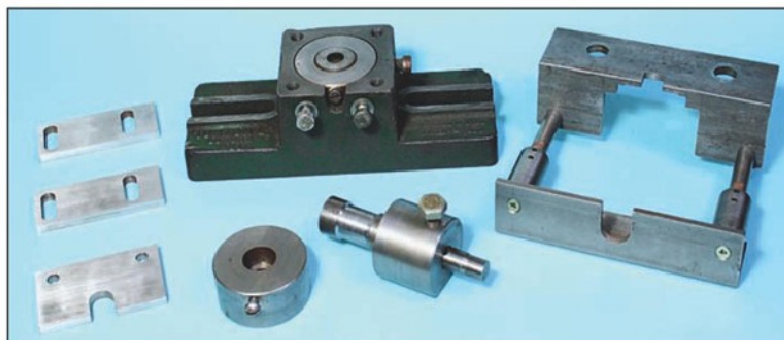
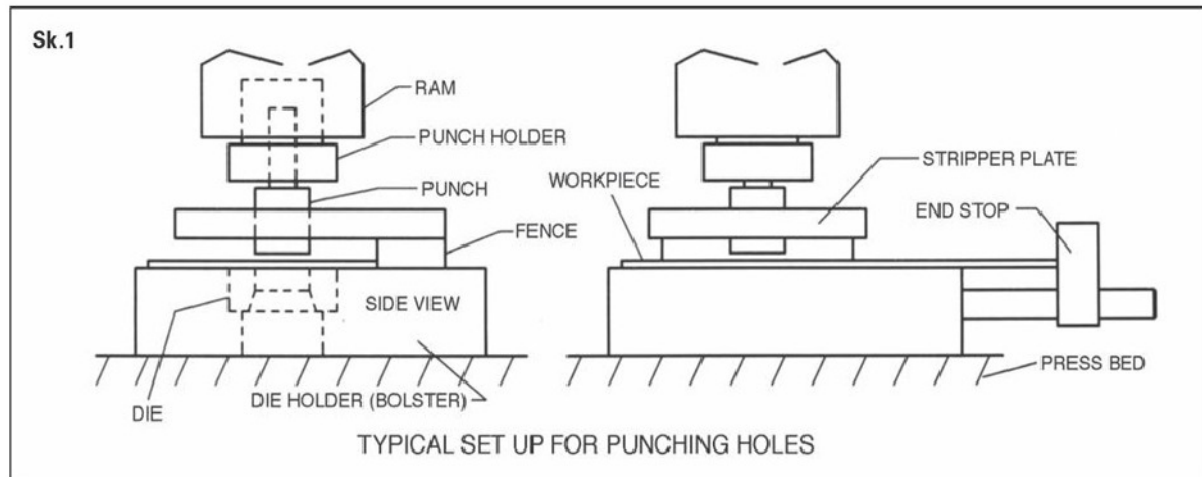


Photo 6. A set of typical parts for use on a fly press when punching holes.



neither the punch nor the die is machined with a V formation.

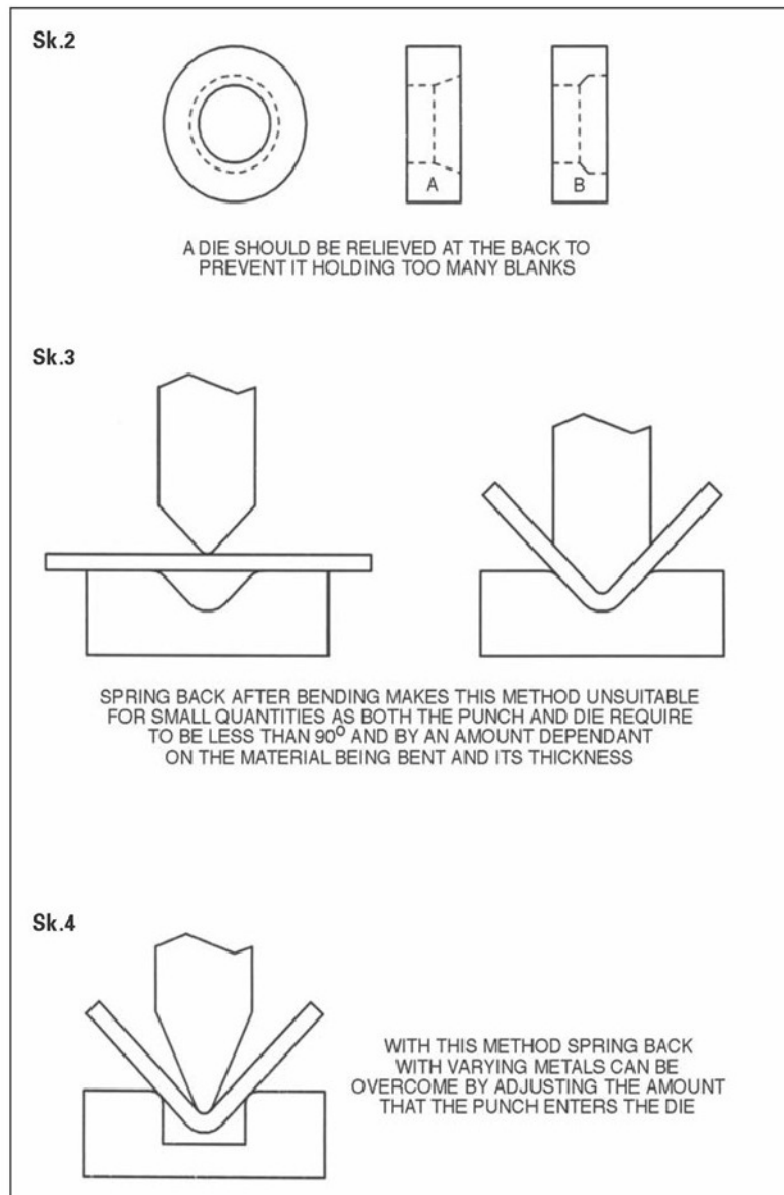
Photo 10 shows some typical equipment used for bending on the fly press on which it can be seen that the wide die is equipped with a fence for setting the

position of the bend relative to the part's edge. This could also be seen in **photo 9**.

The narrower punch and die also shown illustrates a vital requirement, that is, thicker materials will require a wider die and a larger radius on the punch. **Photo 11**



Photo 7. Accessories for an arbor press for use when punching holes.



shows this being used and also illustrates that for a one off bend, or just a few, there is no need to fix the die. It can also be seen that the die has been made with a V of much less than 90deg.

Note that the more common strip steel specifications are not ideal for bending unless annealed; because of this, bending quality steel would be a better option.

Installation

Installing a fly press in the workshop calls for a very robust bench, which must itself be firmly anchored either to the workshop floor or wall. Another requirement is that the handle must be able to be rotated fully through 360deg. As a result, even a small fly press will take up much more space than its base would imply. Even so, the bench space on either side can be used for other things whilst the press is not in use, even leaving them there providing it does not restrict the handle's movement. Whilst an arbor press requires much less space and is not quite so demanding with regard to the rigidity of its mounting, it still needs to be very secure.

Need For?

Whilst I feel every workshop would find a use for a fly press at some time, this may not be sufficient to warrant providing the space that one requires. Do give much thought regarding the situation before deciding to work without one.

Sheet metal machines

Guillotines and press brakes in an industrial workshop enable a speed and quality of work to be achieved that has been almost impossible in the home workshop. This is quite different to the situation with lathes and milling machines where what is done in the home workshop compares favourably with



Photo 8. An arbor press set up for punching holes. See workpiece on the right.

similar processes in the industrial world. However, the 3 in 1 universal sheet metal machines, **photo 12** that have become available in recent years have gone some way to narrowing the gap, albeit at a much smaller size. The three devices contained within these are a guillotine, a press brake and a three roll bender and are available with widths of between 300mm and 1000mm.

Reference to suppliers specifications for these show figures for shearing sheet steel of between 0.6mm and 1mm for what appears to be essentially the same machine. If therefore your requirement is to shear the thicker material then do discuss this in detail with the supplier to be sure that this can be done without the machine complaining. If your requirement is within the machines range then they are certainly worth considering as the alternative methods of cutting and bending sheet materials are far less satisfactory. With softer materials, aluminium for example, thicker material could be sheared, say 1.5mm for a machine quoted as suitable for 1mm when cutting steel.

The quoted figures for bending also vary but are sometimes quoted the same as the



Photo 9. Using a fly press for bending sheet steel.

shearing capability and sometimes rather more. For my part I would consider that they could bend thicker material than they could shear especially if making a bend of less than the full width of the machine. In this respect 1.5mm on a machine quoted as shearing 1mm would seem very likely. Do though check with the supplier.

The upper bending V is supplied in sections of varying widths enabling them to be set up in suitable widths for bending boxes.

The upper part of the machine is a three roll bender. This will enable sheet, or thin bar material, that has become slightly curved in storage to be straightened. More importantly, as there is no real alternative method, they can be used to produce curved items and cylinders from sheet materials and thin strip.

As an alternative to the above, **photo 13** shows four items for cutting sheet metal. These are a jig saw, a nibbler and pencut attachments for use with a power drill, and a small guillotine. With regard to which one, for me the jig saw is the one to choose. This is because it can be used to cut a wide range of materials and with thicker cuts in the softer materials, plastic and timber for example. It can also follow curves. Even when used to cut steel, a thickness of 3mm should be practical with a reasonably powerful saw. On the downside, it will be slow and difficult to keep to a straight line.

The nibbler and Pencut power tool attachments will be limited to around 1mm thick, whilst the small guillotine will have limited use being only suitable for very thin materials, 0.5mm maximum I would suggest but much larger



Photo 10. Accessories to enable bending of sheet and strip materials using a fly press.

versions are available.

Alternative methods for bending compared to those available in the 3 in 1 machine are available but they either have a similar capacity or if capable of bending thicker materials are much larger and or expensive. Of course if you can limit the width to around 200mm, then a fly press would be worth considering. If you have a need for a more substantial bender, do arm yourself with a range of catalogues so that you can compare what is available.

Welding

Welding is quite unlike most other activities in the workshop in that it is a skill, rather than knowledge that has to be acquired. I for one, despite considering that I know all the essentials, still find welding very difficult to master. In my defence, infrequent use of the process has not helped, and I suspect that this will be the situation for many other workshop owners. This is without doubt a case where practice makes perfect.

Electric welding equipment

There are two main types of electric welders but both work using the same basic principle, an electric current passes from the welding torch into the workpiece creating an arc that melts both halves of the item being welded. Additionally, extra metal is deposited by the torch to further improve the bond. However, beyond this there are some major differences.

Arc welders

These were for many years the only method available and are still worth considering where the initial cost of the equipment needs to be kept down, especially if eventual use is likely to be low.

These use flux coated welding rods to establish the arc and need replacing as the rod burns down to its end. Typically each rod will produce a few metres of weld.

MIG welders (Metal Inert Gas)

With these the rod is replaced by a roll of wire that is fed through a pipe to the torch avoiding the need to stop to replace rods frequently. Also fed down the tube is a



Photo 11. Bending strip material on the fly press.



Photo 12. The Warco 3 in 1 sheet metal machine is available in 4 widths from 305mm up to 1000mm.

gas that surrounds the weld being made so as to avoid oxidation taking place. This process is considered easier than arc welding. Even if this is the case, I am still unfortunately some way from mastering the process. MIG welding is also preferable to arc welding where welding thin sheets are concerned. This makes it a good choice for carrying out repairs to car bodywork.

In addition to the welder itself there are a number of other items required. In the absolutely essential category there is a face mask with a suitable darkened glass visor. One that starts clear but darkens instantaneously as soon as the arc is struck is available and makes the process somewhat easier. Also essential are some leather gauntlets and ideally a leather apron; failing that, use some heavy duty overalls that will not catch fire as a result of the occasion spark contacting them.

If you feel that welding will be a frequent requirement or one where second best will not do, then try to find a local technical college that runs a welding course that you can attend. Failing that, at least get some help from a knowledgeable exponent of the art, or at the very least, get a good book on the subject and a large pile of scrap metal to practice on.

Shaping machines

I am concluding this series by discussing a machine that was once much more common than the milling machine but today is almost non-existent in the home workshop, this machine being a shaper. It was during the first half of the twentieth century that the shaper was frequently to be found in the home workshop but during this time it was invariably a hand-operated machine. This limited the tasks undertaken to quite small ones but no doubt this was largely in keeping with the size of the projects undertaken at the time.

I had anticipated that the shaper had largely disappeared from the industrial scene also but a search on the Internet showed that new machines are still being made. These are very large and completely outside the range appropriate to the readers of this magazine. Because of this, should the reader decide that a shaper would be a



Photo 13. Four methods of cutting sheet materials, jig saw, power cut and nibbler attachments for use with a power tool, and a small guillotine.

useful acquisition then a second hand version is the only option. I suspect that even these are becoming less easy to find though small machines are still advertised occasionally by the suppliers of used machines advertising in Model Engineers' Workshop.

Photo 14 shows a typical early belt driven shaper but if something does not look quite right it is because it is a model rather than a full size machine. I have included this because it occurs to me that the reader may still be unsure as to the direction the workshop is to take and what better than to make the first project a model of an early machine tool such as this, ref. 1.

For the reader who is not conversant with the shaper's operation, its single point cutter works with a reciprocating motion, cutting on the forward stroke but raised on its return. At the end of the cycle the workpiece is moved over slightly and a further cut taken. Both the length of the stroke and the amount that the workpiece

moves between cuts can be set to suit the part being machined.

What then are the advantages of a powered shaper?

1. They use the same tools as used on the lathe so are much easier to maintain than milling cutters and, particularly important, when machining castings the tool can be a simple tungsten carbide tipped tool that can be obtained very cheaply and easily sharpened when blunt.
2. The surface finish produced is far superior to that achieved using a milling machine, especially if working with a less than sharp milling cutter. A temptation that is easy to succumb to as milling cutters are so difficult to sharpen.
3. With the length of stroke and width of cut having been set, the shaper can be left to complete the machining of the part's surface of its own accord. Wait of course till a few passes of the tool have been completed to check that all is well. I am not suggesting that the operator need not be present but could undertake some other minor workshop activity, sweeping the floor for example.

If both the finance and space are available then I believe there are good reasons for owning a shaper in many workshops, not in place of, but in addition to, a milling machine. I for one would certainly have one if I had the space.

A final comment

Having now completed the series, I would not like readers to think that my workshop faithfully follows all my recommendations; it does not. It has been written as a result of the lessons I have learnt on the way, some of which I have taken note of, carrying out the necessary changes, whilst for some that was just not possible. Typically, how I wish I had made a larger workshop so that there would be space for a shaping machine.

References

1 Shaping Machine, Set of Castings. From Stuart Models Braye Road, Vale, Guernsey, UK GY3 5XA. Tel. 01481 242041.

www.stuartmodels.com



Photo 14. A model of an early belt driven shaping machine.

The C3 Mini Lathe ⑦

The toolpost powered spindle drive

Back in the late 1970's, when first setting out in hobby engineering, the two machines in my own shop were an incomplete and cobbled together Herbert drill and a Myford ML7 lathe. A little later, one of the lots on offer at a club "bring and buy" sale during 1979 was a kit of parts for a toolpost grinding/milling attachment, designed for use on the Myford. After this device was built, it saw a good deal of use until a milling machine was acquired and even afterwards proved its worth on small work more easily handled in the lathe.

As can be seen from **photo 1**, this device is pretty robust and features an on board sewing machine motor and several speeds selected via a multi pulley arrangement. It can be moved by a limited amount vertically before clamping up on the pillar. Note that it may be rotated around the toolpost bolt, but has no provision for angular adjustment in the vertical plane. Prior to the availability of small electric motors, amateur toolpost devices would frequently be belt driven from an overhead shaft. Such arrangements are still favoured by many, in particular those using classical ornamental turning equipment within that branch of the hobby.

In the intervening years, new products like the various ranges of mini tools have become available, such as that offered by Arc Euro Trade. These frequently also feature an optional flexi drive and dental style hand piece, which enables the motor unit to be mounted remotely from the tool. This concept was used most effectively by Ralph Sparrow in his tool grinding arrangement described in MEW issues 117 and 118. In that instance, the tool spindle was located in a nylon clamp. Because the cutting forces are of a low order, such a material provides more than adequate rigidity. He also made the point that when a conventional grinding wheel is used, it produces much abrasive grit debris, whereas, a diamond disc produces mainly dust from the work, and this is potentially less damaging to the machine.

My thinking here is to emulate some of the attributes of the earlier toolpost device by means of a simple bracket holding the hand piece so that it may then be used for light drilling, grinding or cutting operations on work held in the chuck.



Photo 2. Mini tool and flexi drive from Aldi.

Dave Fenner introduces three easily made accessories to further extend the versatility of this machine.

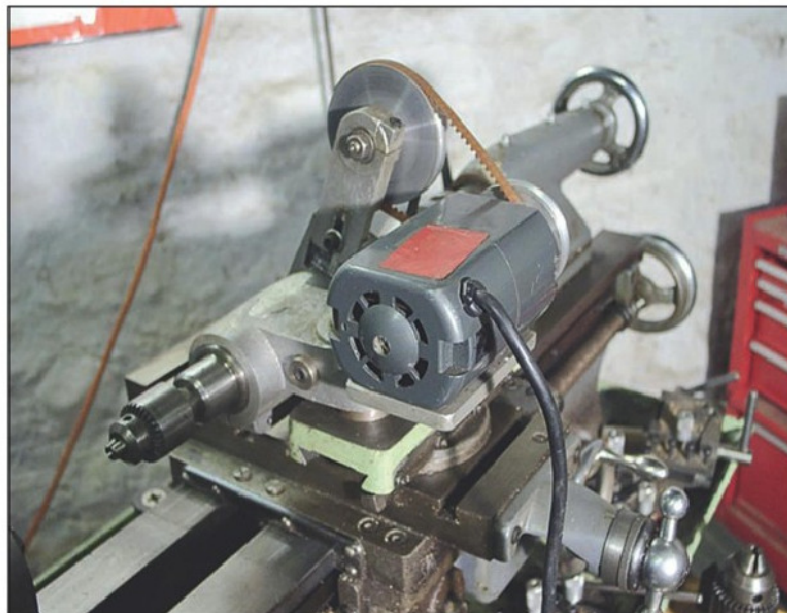


Photo 1. Milling attachment for a Myford.

Alternatively, with the facility for vertical angle adjustment, it might be employed, along the lines suggested by Ralph Sparrow, to sharpen end mills and drills, which would be accommodated in the spindle chuck. I had intended to use the mini tool supplied by Arc, but due to the popularity of the package, it was unfortunately out of stock when this project was being planned. As it happened, the local Aldi supermarket had just the thing at a bargain price, **photo 2** together with a pack of accessories, **photo 3** so work progressed using this kit as a basis. No doubt there will be detail differences between mini tool hand pieces, so my suggestion is to review the concept, examine the equipment to hand, then modify to suit.

Construction

The bracket

The requirement is simply to create an angle bracket which will allow the hand piece to be raised, lowered, and adjusted

for angular position. I have chosen to achieve this by means of two parts, the base and the slotted upright, both being made from aluminium. Many other arrangements are possible probably determined by whatever you happen to have in your raw material store (aka the scrap box).

Bracket base

A suitable piece of aluminium flat bar 9.5mm thick was cut to the rectangular shape as shown in **fig. 1**. The single 10mm dia hole was then drilled, followed by the three pairs at 2.5mm dia., which were tapped M3. Initially just one pair of M3 holes were provided on the end face, **photo 4** however, once set up on the machine, it was clear that adding alternative mounting positions for the slotted upright would improve the versatility of the device.

Bracket upright

The material chosen here is 1in. by 3/16in. aluminium flat, cut to a length of about 102mm as shown in **fig. 2**. The two M3 holes are drilled at 18mm pitch to match the base. It will depend on your equipment how you chose to deal with this. For the enthusiast with a fairly basic tool kit, it may be advantageous to produce this part first and then spot through on to the sides of the base.

One beneficial modification would be to use countersunk screws, in which case the 4mm step in the tool holder might be omitted.

My preferred method for cutting the 5mm slot employed a 3/16in. dia FC3 "throwaway" cutter. These cutters can be used as slot drills, i.e. they can be driven

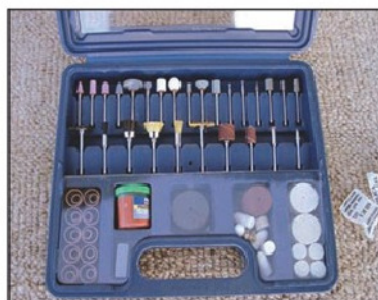


Photo 3. The matching accessories pack.

in just as a drill, so step one was to rough out the slot by a sort of chain drilling technique, stepping across about 1.5mm between cuts. The cutter may then be set to about half depth and run down the length of the slot. This is then repeated at full depth. The work is then moved sideways a little over 0.1mm and a cut taken to widen the slot. The final cut on the other face is taken at a depth to give the required 5mm width.

Note that when working along the slot you should ensure that the direction of

feed opposes the rotation of the cutter. If this is not the case, then "climb milling" results. Where backlash exists in the feed screw, it is possible for the work to be drawn into the cutter with adverse results. The completed upright is illustrated in **photo 5**.

Tool holder

This item was actually made twice. Mark 1 was a simple rectangular block but interference with the heads of the two M3 screws limited downwards movement,

so the redesigned Mark 2 is shown in **fig. 3**. The modifications are the M5 screwed rod which serves the dual purposes of retaining the holder and clamping the tool and the 4mm step. Together they avoid the movement problem and permit the tool to be set lower down with reference to the slot.

Unlike Ralph Sparrow, I did not have a suitable piece of nylon, so settled on a chunk of 30mm thick MDF. This was cut to a rectangular shape, then drilled through $\frac{1}{8}$ in. (tool location), then 5mm and 3mm in for the clamping studs. The 4mm step was then sawn out, after which the piece was cut in two by sawing diametrically across the $\frac{1}{8}$ in. hole. The sides of the location position were then opened out slightly by filing to improve the fit on the hand piece body.

Araldite was then employed to fix the M5 and M3 screwed rods in place, which had been cut to lengths of 55mm and 40mm respectively giving the result shown in **photo 6**.

The thumb nut and toolpost nut

For the Mark 1 tool holder, two aluminium thumbnuts were made as shown in **photo 7** and detailed in **fig. 4**. For the Mark 2, only one nut is used, but we now work with two standard M5 nuts and washers. The thumb nut is a straightforward turning job and needs little comment. Eagle eyed readers may deduce that the tool post nut shown is actually made from $\frac{1}{8}$ in. AF hex bar, however **fig. 5** specifies 17mm AF as this size will fit a spanner which is already present in the Mini Lathe toolkit. Again a regular turning job, note though that the nut, **photo 8** is counterbored 10mm dia to reduce the amount of thread engagement to expedite the fitting to, and removal from, the machine.

Using the attachment

Photo 9 shows the hand piece and bracket mounted on the topslide, with the Mini tool power unit located on its pendant. By using a thin grinding disc and a slow main spindle speed, it becomes possible to cut grooves in, or even part off hard material. If power is disconnected from the lathe and the headstock dividing unit fitted, then it becomes a straightforward matter to drill small holes on a pitch circle.

Because the hand piece is mounted on the topslide, three movement axes are available: axial, using the leadscrew handwheel; transverse, by means of the cross slide and angular, determined by the topslide setting. Thus if the topslide is set to move at 59 degrees to the lathe axis, then it is possible to touch up the edges of standard drills at 118 deg. **Photo 10** shows this exercise in progress where the tool is fitted with a thin grinding disc and is being used to lick the edges of a $\frac{1}{8}$ in. drill. **Photo 11** gives a view of the assembled bracketry off the machine.

The saw table attachment

If you care to examine the range of accessories which used to be offered by Myford for their Seven series lathes, you will come across a saw table and arbor intended to accept a 5in. dia. metal cutting slitting saw. I understand that it is no longer available, principally due to the changes in Health and Safety requirements. My proposal here adopts

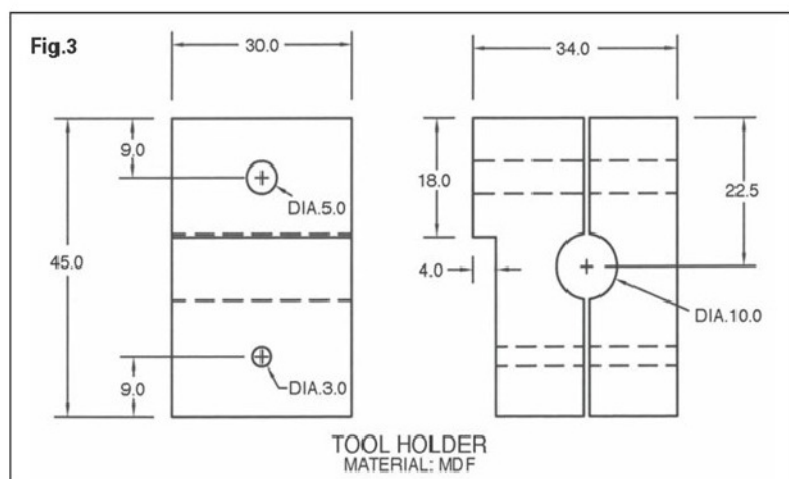
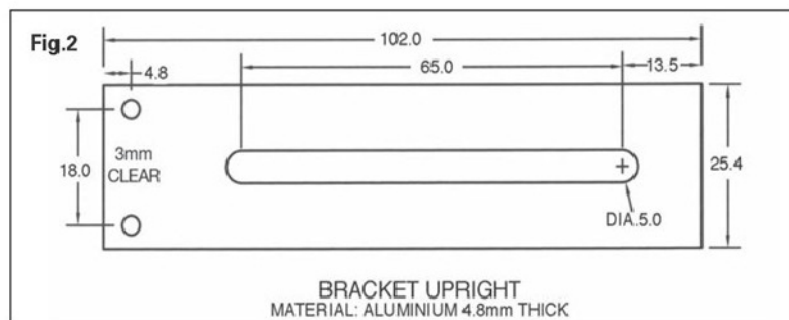
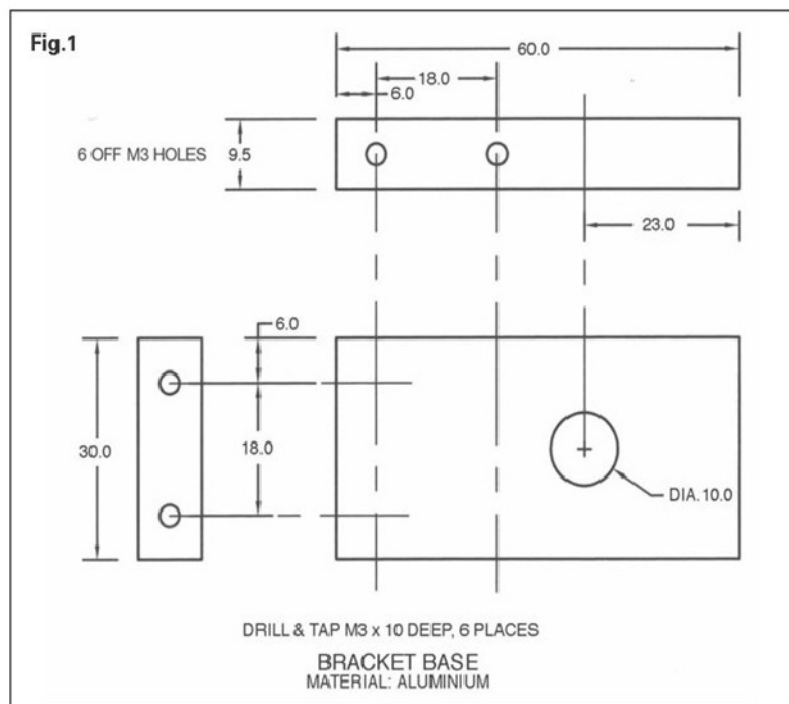




Photo 4. The base at this stage has one pair of mounting holes.



Photo 5. The completed upright.

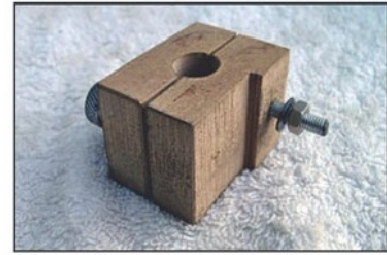


Photo 6. MDF tool holder with screwed rods glued in place.



Photo 7. A pair of aluminium thumbnuts.



Photo 8. The toolpost nut.

the concept of the Myford device, but uses one of the 115mm dia. diamond discs which have become available in recent years at ever decreasing prices. These are available in various forms with either a segmented or continuous periphery. The latter is used here, as it is thought that the lack of "teeth" would bring safety considerations broadly into line with those for abrasive discs. Nevertheless we are still setting up an unguarded rotating tool, which will warrant a common sense approach to its use. This table is locked in a horizontal position and hence may be used for cutting and grinding at 90degrees.

Just six components are needed, two from a length of 25mm BMS bar for the arbor, two pieces of 50 x 50 x 5mm steel angle for the mounting brackets, and two pieces of 6mm aluminium plate for the table top. No great precision is needed, except to ensure that the mounting matches the topside retaining disc, the mounted height clears the top of the arbor, and the 4mm parallel slot between the table top plates is maintained. The diamond disc used here features a bore diameter of 22.2mm, and a thickness of approximately 1mm at the bore and 1.5mm at the periphery. Others were found to be slightly thicker, hence the 4mm slot.

Arbor (1) fig. 6

A length of 25mm BMS was set up with the fixed steady as shown in **photo 12** then faced to 94mm, centred, and the 22.2mm dia. location spigot formed. It was then drilled and tapped M6 for the retaining screw. The spigot was made rather longer than the thickness of the disc to ensure satisfactory location. This would then entail a mating counterbore in the clamp disc.

This simple arrangement worked well because the three jaw chuck is new and pretty accurate, hence in use the arbor rotates truly with very little swash at the disc periphery. If your chuck is not accurate, then consider other options, which may include; working with the four jaw chuck and setting accurately on

centre; turning the arbor between centres with a reduced location diameter to match a collet chuck; or starting with a No 3 Morse taper arbor and drawbar, then adding an extension retained by Loctite.

A further variation would employ a longer arbor, supported at the right hand end by the tailstock. In this case, the disc would be held in place by a suitable fine thread nut. (Tracy Tools list 20 and 22mm diameter by 1 and 1.5mm pitch taps.) Note that the diamond disc used here was obtained as part of a budget set from the Aldi supermarket. Similar discs are available from Arc Euro Trade and other suppliers. The Arc discs are 100mm diameter and 20mm bore, so if using one of these, size the arbor spigot accordingly.

Clamp disc fig. 7

A thin cheese of the same bar was sawn off then faced on both sides to 6mm. It was then drilled 6mm and counterbored to a little over 22.2mm diameter and a depth of 1.5mm. The arbor components with diamond disc are shown in **photo 13**.

Base bracket fig. 8

When the topside is removed by unscrewing the two M6 retaining screws, the lower retaining disc is revealed. It is this part that will be used to secure both the saw table assembly and the grinding rest, which follows. The lower disc carries two M6 tapped holes and a protruding peg 8mm in diameter, these features

being spaced on my machine at 16mm centres. Cut a length of 50 x 50 x 5mm steel angle to a length of 65mm and drill the 8mm and 6.35 mm location holes. Check for fit on the machine. If there is a bit of interference, just open up the 6.35 holes a little to gain extra clearance. It is possible that thinner section angle would give adequate rigidity. However, opting for a thickness of 5mm gives enough meat to give reasonable tapped threads thus avoiding the need for separate fiddly nuts. Note that for fixing the base in place, the original topside Allen screws can be used, however, a couple of washers will be needed on each to accommodate the difference in thickness. Experience in use suggests that if a couple of hex headed screws are used, then spanner access at final setting will be easier.

Table bracket fig. 9

This is also made from another length of the same steel angle, this time 144mm long. Let us deal first with the two holes on the vertical face. Positions are detailed on the drawings, however it will be quite adequate to clamp these two bracket parts together ensuring that the top and bottom faces are parallel; that the spacing gives clearance over the arbor; and then to drill through 5mm at two approximately correct positions. The holes in the base bracket are then tapped M6 and those in the table bracket opened up to 6mm. **Photo 14** illustrates these two brackets.

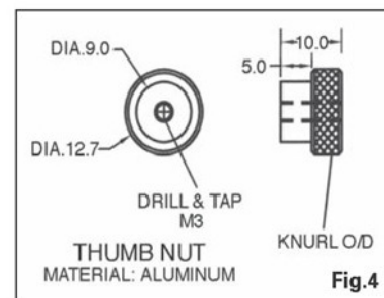
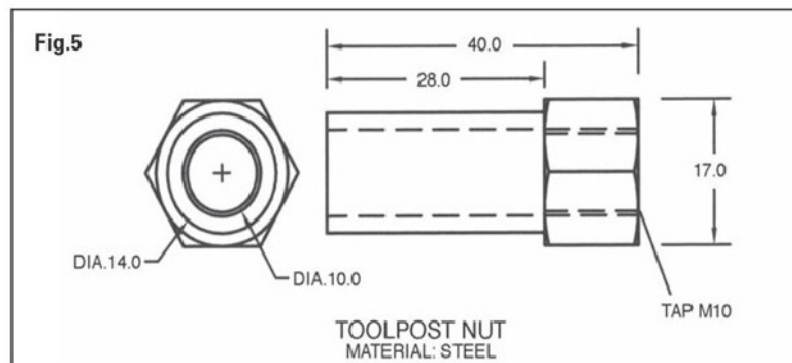


Fig.4



TOOLPOST NUT
MATERIAL: STEEL

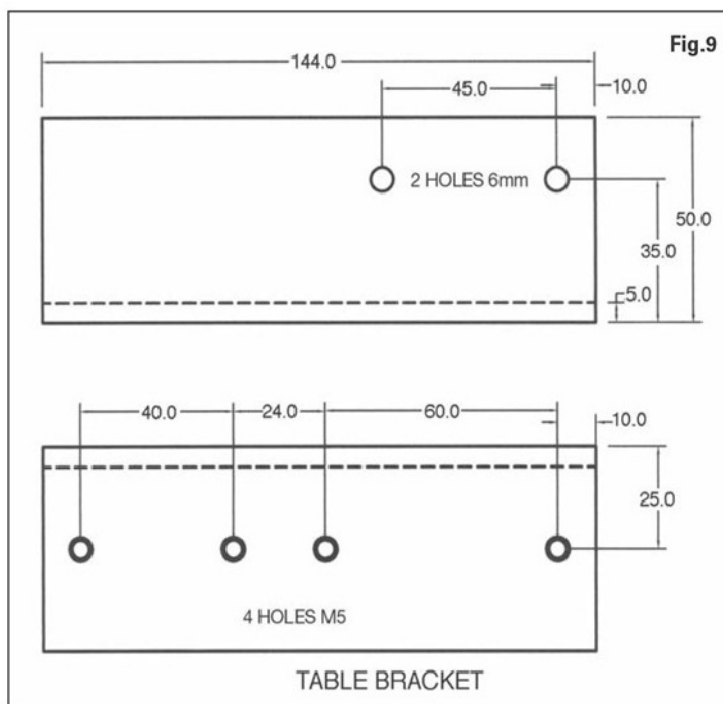
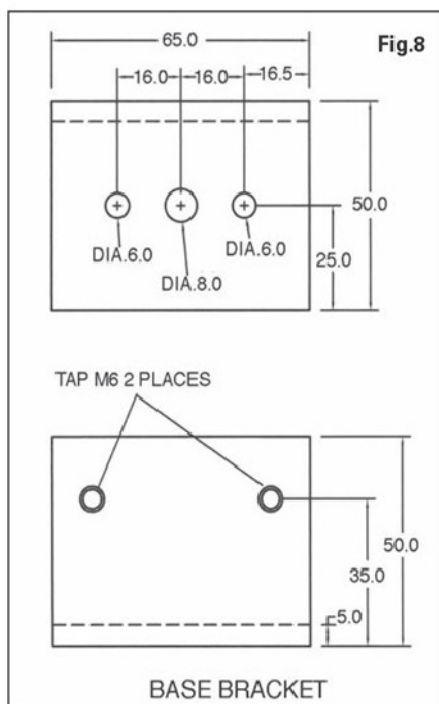
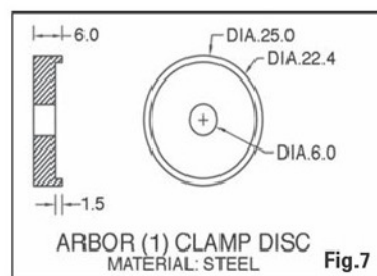
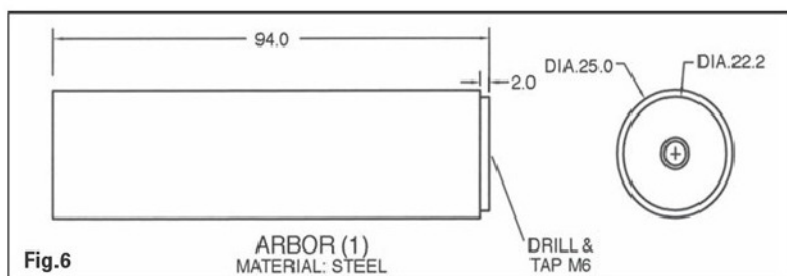


Table top plates fig. 10 and photo 15

A similar philosophy may be applied to these parts. Hole positions for the screws attaching the top plates to the angle are detailed, but as long as the plates are located at about 90degrees to the angle and a 4mm parallel gap is obtained, the actual screw positions are not important. Thus you may choose to clamp together and drill through prior to tapping the steel M5 and opening up and countersinking the aluminium. My box of M5 countersunk screws contained some socket head and some slotted head. It was noted that the slotted type carried a significant burr on the underside of the head from the (final)

slotting operation. This would need to be removed before fitting. The assembled saw table may be seen fitted to the machine in **photo 16**.

The grinding rest

The general concept here is similar to that for the saw table, but the top plate is a single piece (although offered as two versions) and includes provision for setting at an angle. The arrangement has been kept as simple as possible and hence lacks refinements such as a built in graduated protractor. After setting up for use with the cheapo diamond disc, it occurred that the arrangement might also

be used with one of the more expensive diamond wheels and a second arbor was duly turned up to accommodate this.

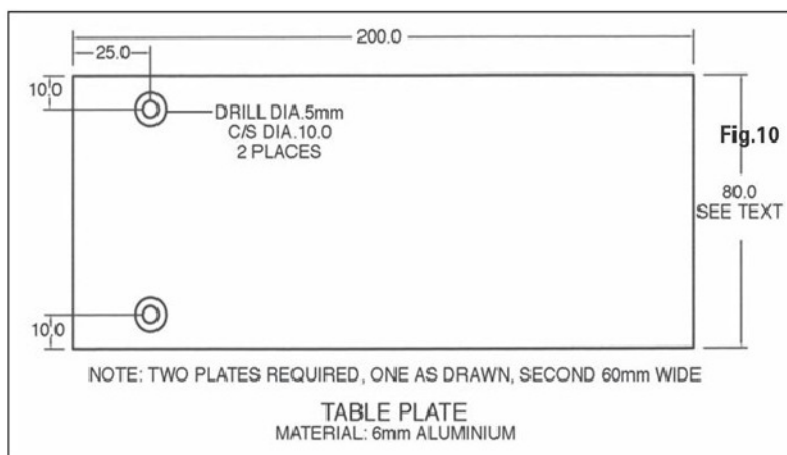
Brackets figs. 11 and 12

These are made as before from short lengths of 50 x 50 x 5mm steel angle, however this time we do not need to go over the arbor, so the mounted height has been reduced and to allow for angular adjustment, the shape in elevation has been made triangular with rounded corners.

After cutting to length, drilling and sawing roughly to shape, work proceeded with a file. A turned button held in place by an M6 screw, **photo 17** served as a guide to get a reasonable looking radius. **Photo 18** shows the work clamped in the vice using a piece of 1/2in. thick flat to grip the work in a way that would improve rigidity and reduce vibration. The completed brackets are shown in **photo 19**.

Rest plates (tops) figs. 13 and 14

Again each is made from a rectangle of 6mm aluminium plate, squared off, then drilled and countersunk for the M5 retaining screws. One is a simple square, each side being 85mm long. The second has a cut out which allows the surface to project to the rear of the wheel edge. This allows work such as lathe tools to be supported as shown in **photo 20**. The underside of the edge close to



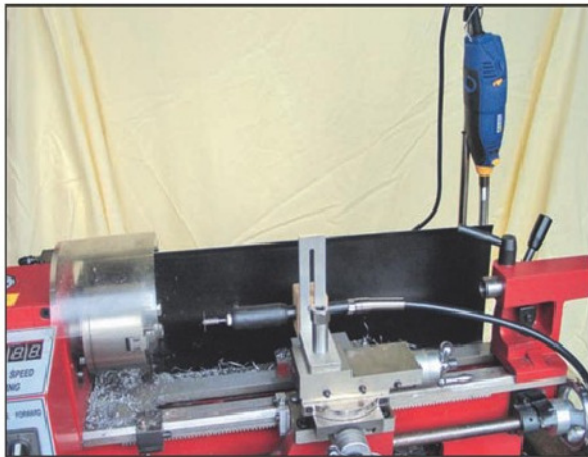


Photo 9. Hand piece, flexi drive and power unit mounted.

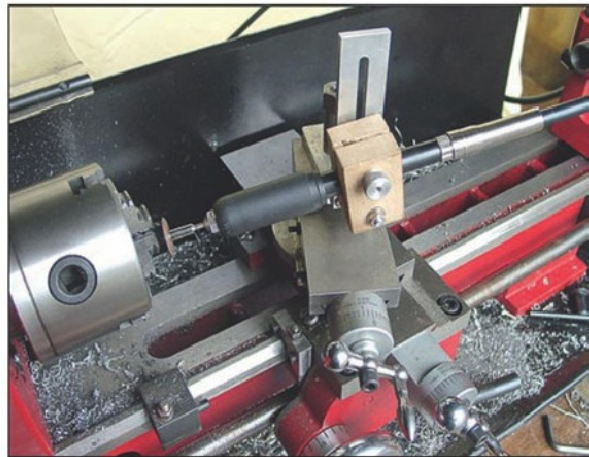


Photo 10. Touching up a 1/8 in. drill.

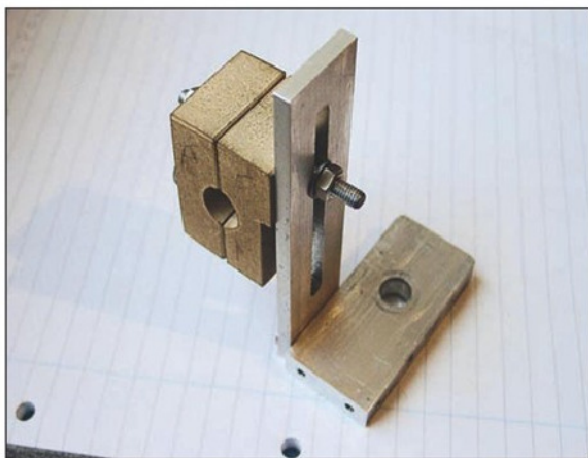


Photo 11. The hardware removed from the machine.

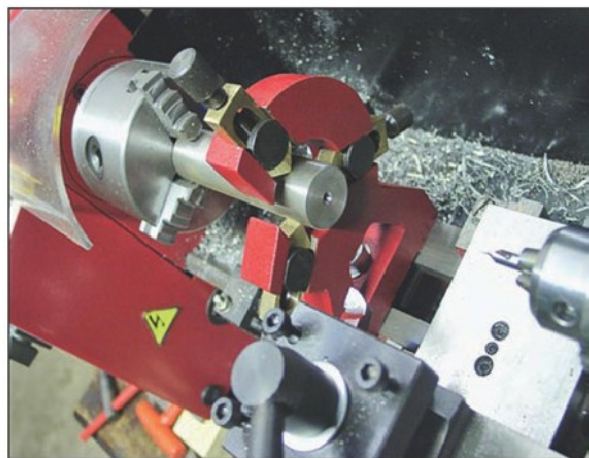


Photo 12. Bar supported by fixed steady

the surface of the disc/wheel has been heavily chamfered (about 3mm) so that the rest top face can be moved that bit nearer the abrasive surface.

Arbor (2) fig. 15

My diamond cup wheel (obtained some time ago from Eternal Tools) has a bore of 1/2 in. and a location thickness in excess of 3/8 in. It was therefore decided to use a spigot of about this length working with a plain clamp disc, as depicted in the drawing. This wheel can be seen mounted on its arbor, set up with the cut away rest top in **photo 21**. Similar wheels may be obtained from Arc and others. The range supplied by Arc covers a variety of shapes, and diameters both external and internal. Working from their list, my suggestion would be to opt for either the 10 or 20mm bore, adopt as

a personal standard, and machine the arbor to suit.

Added embellishments

These projects have been presented in a basic and simple format in the hope that this will encourage the less experienced to extend the versatility of their machines. In the case of the saw table, it would be straightforward to add a clamp on adjustable fence, and for the grinding rest, to add guide and clamping details to hold work at predetermined angles. In this arrangement, angle setting is accomplished by means of a protractor held against the disc or wheel and the rest top. Reference was made earlier to the articles by Ralph Sparrow. The device he described included a graduated angle setting facility. Clearly adding such a feature would expedite the setup process.

Comments after initial applications

The cheap diamond disc proved a little on the coarse side for producing a good tool edge on carbide (although probably better than a green grit wheel). Nevertheless, it offers a useful approach for roughing to shape. Changing to the "Eternal" cup wheel, it became very easy to create a sharp edge with accurately determined clearance angles.

When working on a left hand tool, if the disc is fitted, then the rear face can be brought into play. Obviously this is not possible with the cup wheel, and this prompted the thought of an extended rest top projecting to the rear of the lathe, and having a rectangular cut out to accommodate the wheel. This would then allow left handed tools to be supported to the rear of the lathe axis. It was noted



Photo 13. Arbor components with diamond disc.



Photo 14. A view of the two brackets.



Photo 15. Two table top plates.



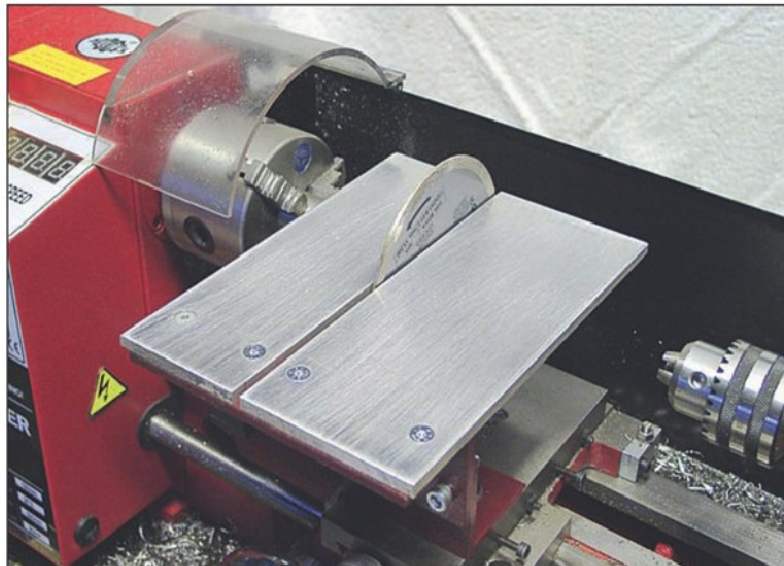
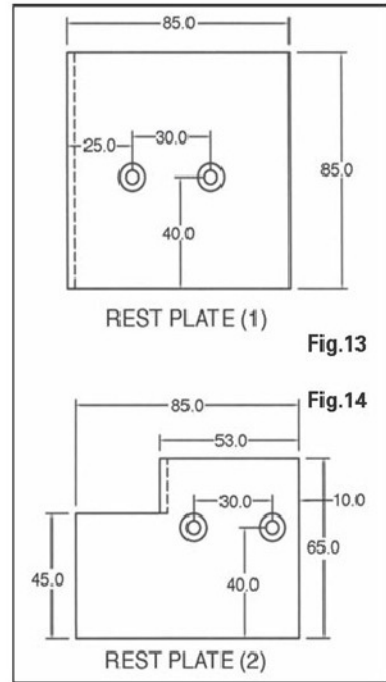
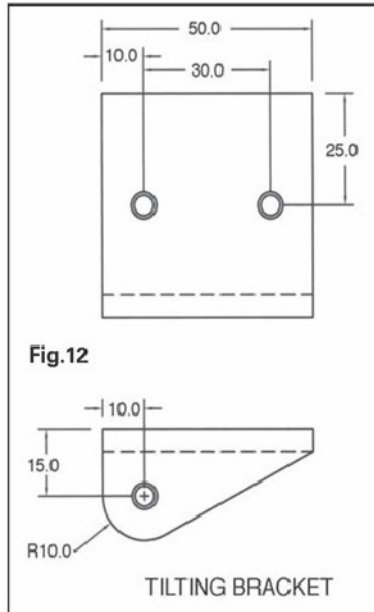
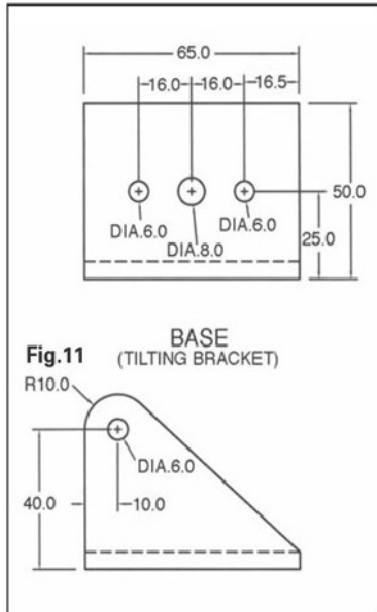


Photo 16. The saw Table assembled on the Mini Lathe.

earlier that the grinding debris emanating from a diamond disc or wheel is very much less than from a conventional grinding wheel. However, the dust, particularly from carbide (and HSS) tools, will be very hard and hence potentially abrasive. It is therefore worth introducing some form of guard to keep dust off the bed ways. This might be a modified version of the bed protector outlined

earlier in the series, or just a piece of stiff card cut to shape. A piece of rag is not recommended as this can be caught and wound in by the rotating parts. When these gadgets were first considered, the aims were fairly limited, but included attempting to give the novice an easy approach to tool sharpening. Having enjoyed initial "playtime" sessions with the kit, it occurs



Photo 19. The two completed brackets.



Photo 20. The cut away top supports the work behind the disc face.



Photo 17. A turned button is used as a filing guide.



Photo 18. Clamping method to reduce vibration.

that with extra items such as fences, guides, and clamps one could undertake some very effective grinding work. The Mini-Lathe is never going to double up as a "Quorn" tool and cutter grinder, but for much of what we want to do, in terms of basic tool shaping and sharpening, this simplistic avenue may be worth more than a second thought.



Photo 21. A diamond cup wheel now in place of the disc.

CONVERTING A MYFORD ML7 TO CNC Part ②

Introduction

In part 1 of this series of articles, published in MEW issue 138, I described modifications to the ML-7 leadscrew thrust bearings and the installation of a stepper motor to drive the Myford leadscrew. In this second article, I will describe modifications to install a stepper motor to drive the cross slide feed screw.

As I said in Part 1, the intent with this particular conversion was to make it possible to retain the option of manual operation of the lathe so that, for simple jobs, the lathe can be used without the need to use the CNC control, and also so that the lathe can be returned to original specification very easily if the owner decides that is desirable for any reason. The one casualty in this part of the conversion was the graduated dial on the cross slide, which I modified from its original form. However, this is not an expensive item to purchase as a spare from Myford, so having to buy an extra dial to restore the lathe to its original condition didn't seem like too much of a compromise. Alternatively, as the dial is basically just a slice of steel bar, marked with 100 graduations and having a $\frac{1}{4}$ in. axial threaded hole, making this part for the purposes of the conversion wouldn't be terribly hard if so desired.

Design decisions

As with the leadscrew conversion in Part 1, it is desirable to properly control end float in the cross-slide feed screw, and also to reduce the frictional load seen by the motor when driving it. In order to achieve this, I used the cross-slide bearing conversion kit sold by Arc Eurotrade. This

Tony Jeffree continues with the cross slide

consists of a pair of roller thrust bearings, part number NTA411, and a tiny ball race, part number R168, mounted in a bearing housing machined from $\frac{3}{8}$ in. aluminium plate. This particular conversion turns out to be extremely worthwhile even for a manual lathe; the difference in the cross-slide operation is enormous. Adjusting the bearing for zero end float is very simple and the reduction in bearing friction vastly improves the "feel" of the cross slide feed.

In order to provide a support for the stepper motor drive to the cross slide, the conversion involves a bearing and motor mount bracket that replaces the standard Myford component. The bracket allows the stepper motor to be mounted below the feed screw and for drive to be achieved using a toothed "timing" belt and a pair of pulleys and retains the ability to use the conventional ball handle to operate the screw.

The top slide is still available for full manual operation in this conversion; alternatively, the top slide could be removed and the tool-post mounted on a raising block to restore the correct tool height – the advantage of going this route is that the setup will be somewhat stiffer. Editor's note: See page 31 in this issue.

As with the leadscrew conversion, I used a NEMA 23 frame stepper to drive the cross-slide feedscrew. However, in this case I chose a smaller motor – an Astrosyn 140 oz-in motor (these are the same motors that I used in my Taig lathe CNC conversion – MEW issues 120 and 121). I used a 2:1 reduction drive between the motor and the cross-slide feedscrew,

again using "timing belt" pulleys supplied by RS Components, but 2.5mm pitch, 6mm wide in this case.

The cross-slide requires significantly less torque to drive than the main leadscrew – partly because the frictional and inertial load seen by the motor is smaller, and partly because most of the cutting load will be on the leadscrew. In fact, just to see how small a motor it is possible to use, I tried using a NEMA 17 frame motor, rated at 36 Ncm torque (Arc Eurotrade part number 160-010-00100) with this setup, and found that it was capable of making surprisingly heavy cuts. However, for more reliable use, it is as well to have a bit more headroom than these small motors give you.

Constructional details

The overall arrangement of the combined motor mount and bearing housing can be seen in fig. 1. All of the components were fabricated from aluminium stock, but steel would be suitable also. The original Myford bearing plate is replaced by the top plate, fig. 2. The front plate, fig. 3 attaches to the top plate with a pair of M4 cap head screws and has pockets machined on either side to act as housings for the thrust bearings, and a through bore to carry the central ball race. The motor bracket is made from $\frac{1}{4}$ in. aluminium angle and attaches to the base of the front plate, fig. 4.

Machining of the top plate is pretty self-explanatory from the detail given in fig. 2. I used a length of 2in. X $\frac{1}{2}$ in. bar stock as the starting point. Photo 1 shows

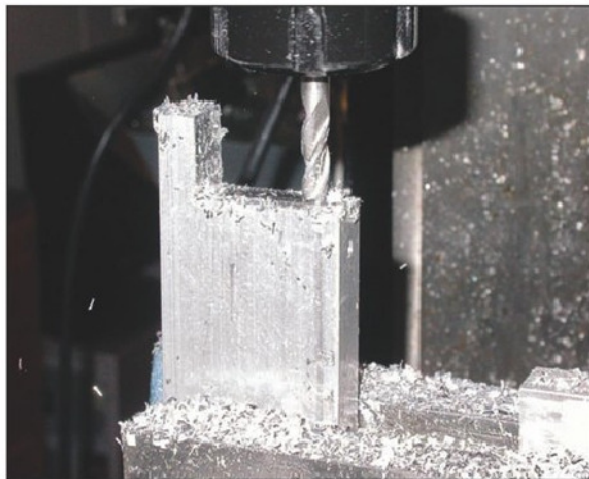


Photo 1. Machining the top plate.

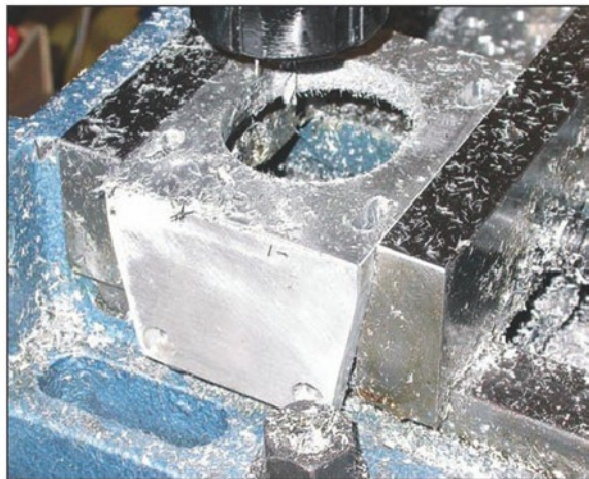


Photo 2. Machining the motor bracket on the CNC mill.



Photo 3. Removing the flange from the large pulley.



Photo 4. Shortening the pulley boss.



Photo 5. Remove the boss from the lathe dial.

machining in progress for one of the mounting lugs. The only comment needed here is that the counterbored holes that take the original Myford $\frac{3}{16}$ in. cap head screws are intentionally placed $\frac{1}{16}$ in. below the centre line so that the top surface of the top plate ends up pretty much where the original Myford bracket did. As all of the other critical dimensions, such as the placing of the bearings and the motor are referenced from the locations of these holes, it is important to maintain accuracy here.

The front plate, **fig. 3** is also fairly straightforward and was machined from 2in. X $\frac{3}{16}$ in. aluminium bar. The deeper bearing recess is on the face of the plate that faces the lathe operator. The depth of this is critical to ensure that the graduated dial will act as a bearing cover for the front thrust race and still have a couple of thou of running clearance between it and the front plate. The rear recess is less critical, and could in fact be bored a little deeper in order to give more protection to the rear thrust race. If you were feeling energetic, it wouldn't be hard to add a bearing cover for the rear bearing if so desired.

The motor bracket, **fig. 4** started life as a 2.25in. length of 3in. X 3in. X $\frac{1}{4}$ in. aluminium angle. The vertical arm stays as 2.25in. wide and the shorter horizontal arm is tapered to 2in. wide to match the width of the front plate. Apart from that, there is nothing terribly complicated about its construction. In my case, I was able to use my CNC-converted X3 mill to make short work of machining out the various holes and cutting the taper. The final stages of machining can be seen in **photo 2**.

The other items that need to be machined are the two pulleys and the

graduated dial. The smaller (14 tooth) pulley simply needs to be bored out to accept the $\frac{1}{8}$ in. diameter motor shaft and the plain boss is drilled and tapped for a suitable set screw (I happened to have a 4BA screw to hand; the size is not critical).

The larger (28 tooth) pulley is a little more complex. First, it is mounted in the lathe chuck, held by the plain boss. If like me you have a three-jaw chuck that will hold concentricity, then use that; otherwise, hold it in the four-jaw chuck and clock it in for concentricity. The bore is then drilled and tapped $\frac{1}{8}$ in. BSF to match the threads on the end of the cross-slide feed screw. Next, the last millimetre or so is machined off so that the flange is completely removed, but the toothed part of the pulley is not reduced in length at all – see **photo 3**. Finally, the pulley is reversed in the chuck, using suitable protective pads to avoid the teeth being bruised (I used a strip of thin aluminium sheet wrapped around the pulley) and the plain boss is shortened so that the overall length of the pulley after machining is 11mm, see **photo 4**. Finally, file a pair of flats on the plain boss to aid with tightening later on.

The graduated dial is the final component to modify. As you need the cross slide to be operable in order to do this, what I did was to borrow the dial from the top slide and modified that one. The dials on my lathe are the more modern cylindrical ones; if your lathe has the older tapering dials, you will need to obtain one of the new ones to modify, or you could make your own of course. The modification is simply to machine off the boss with the flats, as shown in **photo 5**. This reduces the length of the dial to approximately 8mm, so the numbers just remain intact. The combined length of the dial and the pulley should be a little more than the original dial and the machined face of the dial will double as a retaining flange for the belt, as seen in **photo 6**.

Assembly

The new bearings and mounting arrangements can now be assembled. First, remove the cross-slide crank handle and graduated dial and remove the bearing bracket. The top bracket is then fitted in place of the original bearing bracket using the original cap screws, noting that the bracket must be mounted the right way up as discussed earlier.

Next, fit one of the thrust bearings to the end of the feed screw and fit the small ball race to the bore in the front plate. Note that this should be a slip fit in the bore. As the bearing is so small, there would be a significant risk of distorting the bearing if the fit is too tight. The front plate can now be fitted over the end of the leadscrew and screwed to the top plate with a pair of M4 cap head screws. I filed a notch at the top of the front plate to act as a witness mark for the graduated dial, as can be seen in **photo 7**.

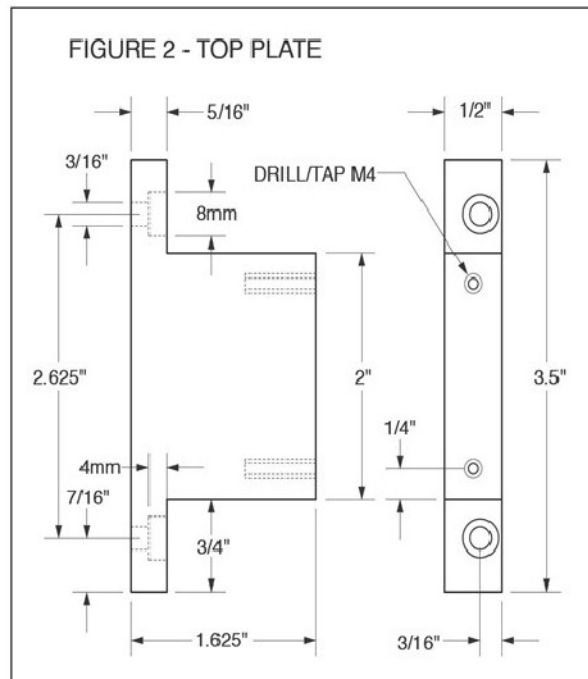
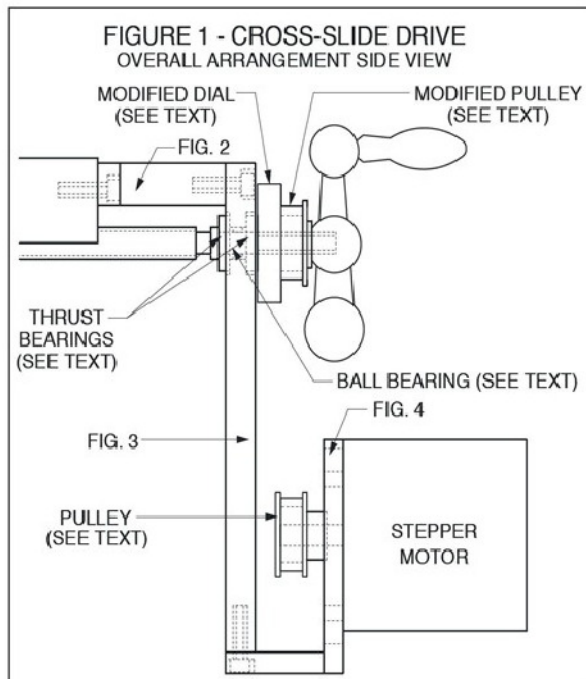
The second thrust bearing is then fitted to the front housing. The modified graduated dial can be threaded onto the feed screw. I used a small drop of Loctite thread locker on the screw, taking care not to contaminate the thrust bearings. The dial should be adjusted so that there is absolutely no play in the bearings but not so tight that the bearings tighten up or run rough. The pulley is then threaded on to lock against the dial, again using thread locker. Finally, yet more thread locker and the crank handle is tightened in place.

The motor bracket is then added to the bottom of the front plate, held in place with two more M4 cap screws. File a flat on the motor shaft and mount the small pulley on the shaft with the pulley boss towards the motor; the motor can then be offered up to the mounting bracket to check the alignment of the pulleys.

The simplest way to do this is to fit the drive belt and crank the handle to see where the belt rides on the bottom pulley; slide the pulley on the shaft so that the belt will tend to ride in the centre of both pulleys and tighten the set screw once the right position is found. The motor can then



Photo 6. The front of the dial will act as a new pulley flange.



be fitted permanently using M5 cap screws and Nylock locknuts. Slide the motor down in the mounting slots to tighten the belt appropriately. The completed assembly can be seen in **photos 8 & 9**.

If all is well, the cross slide should still be operable by means of the crank handle. The stepper motor will give a slightly "notchy" feel, but it should still be easy to operate by hand. The cross-slide drive is now ready for use as soon as the thread locker compound has been given time to cure.

Cross slide drive performance

As with the leadscrew drive, I did some initial testing using one of my DivisionMaster controllers. In this case, I wasn't too bothered about what traverse speeds I could obtain. I had gone through this exercise before with the leadscrew and having also seen a much smaller NEMA 17 frame motor achieve

quite heavy facing cuts, as mentioned earlier, I was confident that the motor I was using would be more than adequate for the cross-slide drive. I was much more interested in the way the setup performed from the point of view of repeatability and backlash.

Using the DivisionMaster set for a 720:1 worm ratio allowed me to read the display in inches, as described in Part 1. I set up a dial indicator with its probe bearing against one of the jaws of the chuck, as shown in **photo 10**, to give me an accurate indication of how the cross-slide was moving. Making repeated moves back and forth showed that there was almost exactly 1 thou of backlash in the system, which would be accounted for by play in the feed screw/nut, which is perfectly usable. On repeated moves, any inaccuracy in the final position, when approached from the same direction (i.e., move 1in. in, note the dial reading, move 1in. out, then 1in. back in, and compare

readings) was below the resolution of the dial indicator I was using. So far, so good.

Using a similar setup to test repeatability and backlash on the leadscrew, with the dial indicator rotated to align with the spindle axis (see **photo 11**) was a different story – I measured of the order of 10 thou of backlash and error in the final position on repeated moves was of the order of half a thou. This told me that it was time to adjust the clasp nuts. After adjusting the three gib strip adjusting screws (on the left hand vertical edge of the saddle) for fairly stiff operation of the operating lever play between the clasp nuts and the leadscrew, and adjusting the depth screw underneath the bottom half nut to allow maximum engagement of the nuts, the repeatability was as good as the cross-slide and the backlash was down to about two thou. I would guess that treating the lathe to a new leadscrew and clasp nuts would improve the situation even more. However, the measured performance

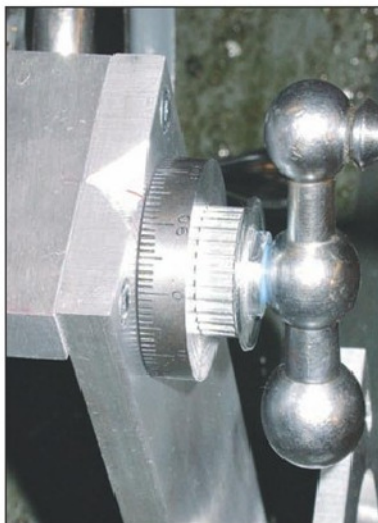


Photo 7. File a notch for the zero mark.



Photo 8. The completed cross slide assembly.



Photo 9. Tighten the belt by moving the motor in the slots.

FIGURE 3 - FRONT PLATE

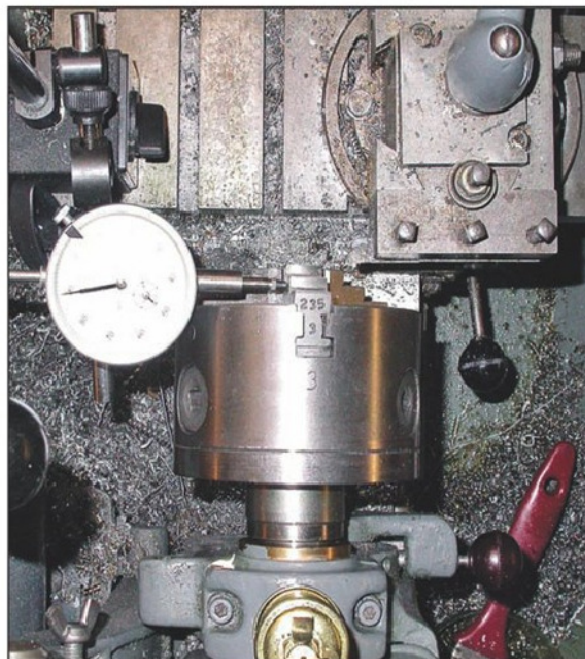
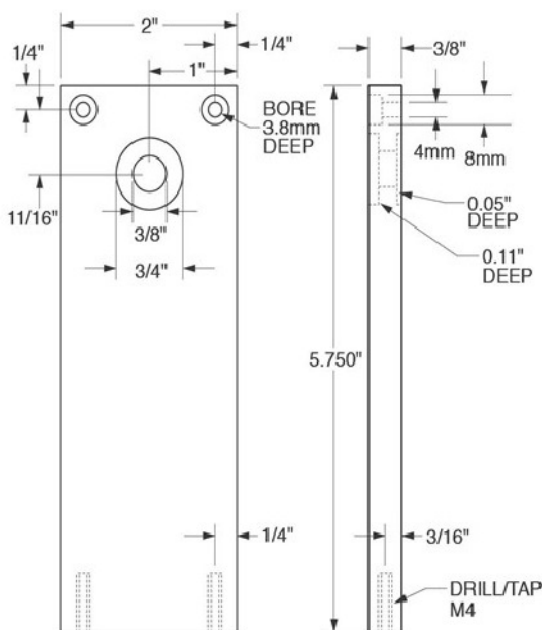


Photo 10. Checking cross slide backlash.

FIGURE 4 - MOTOR BRACKET

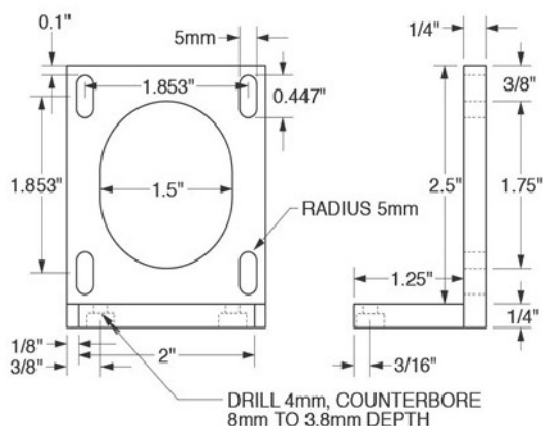


Photo 11. Checking for leadscrew backlash.

seems to indicate that the lathe will be usable in its current form.

If you happen to have a DivisionMaster controller to hand, or even better, two of them, the conversion so far can now be used either completely manually or using power feeds on either or both axes. Obviously, using DivisionMaster controllers is rather less convenient and much less versatile than having a fully fledged CNC control, but if your primary objective was to fit a power feed, then you would get that, with the added bonus of being able to define precise moves of either.

Next time...

That completes the mechanical aspects of the conversion for the cross-slide. In part 3, I will describe the construction and installation of the drive circuitry and the use of Mach 3 as a CNC control

Suppliers and other contact details:

Astrosyn International Technology PLC, The Old Courthouse, New Road Avenue, Chatham, Kent, ME4 4QJ, UK. Tel: 01634 815175 Website: <http://www.astrosyn.com>

Arc Eurotrade Ltd, 10 Archdale Street, Syston, Leicester, LE7 1NA, UK.

Tel: 0116 269 5693

Website: <http://www.arceurotrade.co.uk>

RS Components.

Tel: 01536 201201

Website: <http://rswww.com/>

DivisionMaster controllers are supplied by L.S. Caine Electronic Services, 25 Smallbrook Road, Broadway, Worcs, WR12 7EP.

Tel: 01386-852122

Website: www.medw.co.uk

PARTS LIST

Description	Specification	Quantity	Supplier	Part number
Cross slide pulley	2.5mm pitch, 6mm wide, 28 teeth	1	RS	744-520
Cross slide motor pulley	2.5mm pitch, 6mm wide, 14 teeth	1	RS	744-4911
Cross slide toothed belt	2.5mm pitch, 6mm wide, 230mm long	1	RS	474-5066
Stepper motor	NEMA 23, 3A/phase, 98Ncm (140 oz-in)	1	Astrosyn	AC570764525I
Bearings	Myford ML7 Cross Slide Bearings Set	1	Arc Eurotrade	MYFML7CSBS

THE PRACTICAL ENGINEER 3

Three useful accessories

Last month, we levelled up the lathe and checked it for truth. I have had an email about this article asking what to do if the lathe turns out of true. The three Myford lathes I have set up have always been true when set up as suggested but in case your lathe needs adjusting, I will detail how to do it.

Firstly, set up the lathe as suggested last month. If the lathe won't turn true it is probably because the bed is twisted so we need to twist it back to correct it by adjusting the raising block nuts at the tailstock end. If the test piece is larger at the tailstock end, you will need to higher the adjusting nut at the front position. If the test piece is larger at the headstock end, you will need to higher the nut at the rear position. I have not had reason to adjust this so instructions are taken from the Myford Series 7 Manual available from www.myhobbystore.com. You will also need to realign the tailstock after aligning the bed.

Myford series 7 bed stop

First up this month, I am giving details of a bed stop for the Myford 7 series lathe. This bolts onto the front of the lathe using the gearbox mounting screw holes, **photo 1**. The rod is clamped by the locking handle at one end and acts as a dead stop on the carriage at the other end, **photo 2**. The blocks and clamp are shown in **photo 3**. The construction of the two main components is quite straightforward and nothing is particularly critical although you should try to get the two mounting holes reasonably accurate. The counterbores should be sized to suit the screws used. I would recommend using Allen cap screws.

The two holes that mount the gearbox are usually $\frac{1}{4}$ in.BSF so I spent a few hours tidying up the storage shed and found the bag of screws, great, I can put the stop

back on the lathe (it was removed to avoid damage in transit). Unfortunately, my Myford is quite a new model and Myford in their wisdom had changed the mounting screws to M6. Rather than spend any more hours in the shed, I drove to the nearest DIY store and bought a packet of M6 machine screws which have been used temporarily to bolt the stop on to illustrate this article. I will replace them with M6 when I find the box full.

The support block

First, make the 102mm long block, **fig. 1**. The length is unimportant; I just measured my one and used that to make the drawing. Centre drill all four holes and drill the centre pair M6 through. Drill through the two outer holes, 6mm or $\frac{1}{4}$ in. depending on your Allen screw size then counterbore to suit the screw head. If you don't have a counterbore, drill the hole out to full diameter a couple of mm deep then flat bottom the drill and finish to depth. Please use a drill vice clamped down so the work does not spin. Alternatively, leave the holes clearance size and use longer screws. Try the block on the lathe

and hopefully it will fit. If the holes are slightly out, just open them up a bit until the block can be screwed to the lathe.

The main block

After reaming the 8mm ($\frac{5}{16}$ in.) hole in the main block, check the location against the lathe to check for clearance. Although the dimensions worked out ok for my ML7R, there have been a number of variations to the size of the lathe back gear handle and you may have to lower the stop slightly so the rod clears the handle. As designed, the support block should be in the middle of the main block, **fig. 2**. If you need to lower the height of the stop rod, mark out the main block and drill to suit, otherwise drill so the main block is in the centre.

The counterbores may cut slightly into the stop bar hole but just take them lower past the rod diameter until the screw head is clear when the bar is fitted. The M6 tapped hole for the clamp screw should be drilled 5mm through and then drilled 6mm clearance as far as the slot and then just taken slightly past the slot to square the edge of the tapped hole up. Finally, tap M6 through.

Fig.1

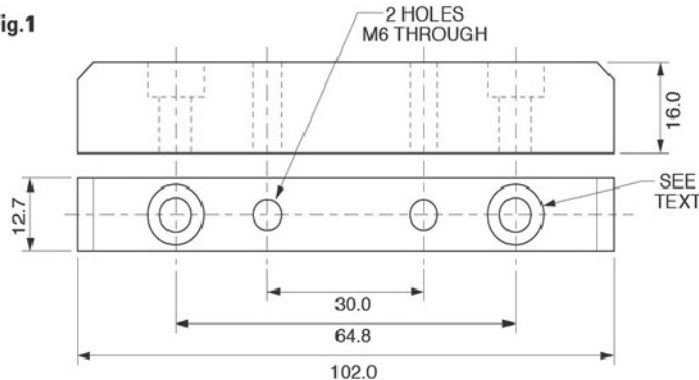


Photo 1. The finished stop fitted to the Myford.



Photo 2. The stop rod position.

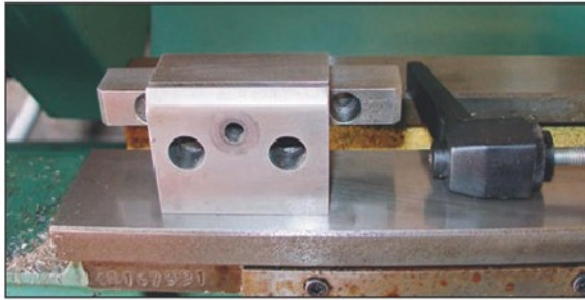


Photo 3. The stop components.

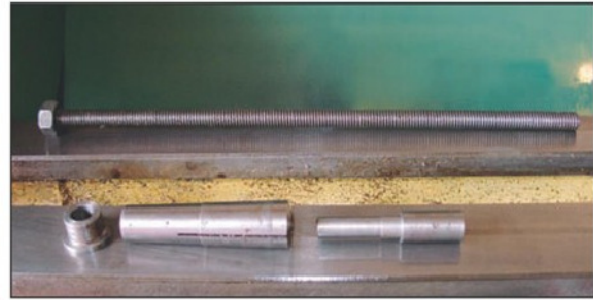


Photo 4. Parts for the simple back stop.

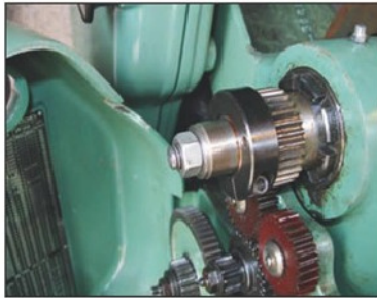


Photo 5. The top hat bush fits into the mandrel end.



Photo 6. The back stop fitted in the collet.



Photo 7. The carriage lock.

I milled the slot in the vertical mill using a slitting saw but it would be acceptable to use a hacksaw but you use two blades in the hacksaw as this will cut a wider slot. The plastic handle is a standard M6 male threaded handle. The one I used is a large one. If a handle is not available, a bolt could be used instead.

A simple chuck back stop

Next, I will describe a simple chuck back stop. This stop is so simple that it does not even warrant a drawing. The components of the stop are shown in **photo 4**. The basis is a cheap two Morse taper collet readily available from many of the suppliers advertising in MEW. These collets are available in imperial and metric sizes. As long as the drawbar thread is metric any size will do. I have used an 8mm collet with an 8mm threaded hole in the end.

You need a length of 8mm studding and an 8mm nut. The only part you need to make is the top hat adapter. This is turned to fit the mandrel hole leaving a raised portion at the end and drilled through to take the studding. **Photo 4** should give enough information to

enable you to make it. **Photo 5** shows the top hat fitted to the back of the headstock and in **photo 6**, the stop at the front of the mandrel before fitting the chuck. The bar in the collet can be turned to suit the job in hand and the length can be varied to suit the thickness of the work in the chuck.

A carriage lock

The final item is a replacement carriage lock, **photo 7**. This is also simple to make. Again there is a top hat bush. This is turned to fit the hole in the carriage and drilled about 6.2mm for clearance on a 6mm thread. Leave the outside diameter about the same size as the diameter of the plastic locking handle.

The eccentric nut can be copied from the original. From memory it is $\frac{1}{16}$ in. diameter but check from your example. The quickest way to make it would be to spot through the original nut onto the new one and then drill and tap it M6. The plastic handle is a small M6 one but check that you get one with a long enough thread length. The plastic handle is serrated and spring loaded so you can pull it up, turn it to the position



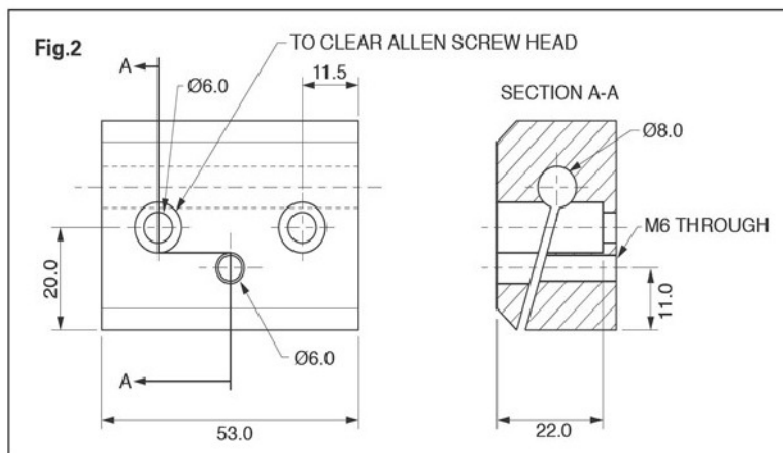
Photo 8. The three parts of the carriage lock.

required and drop it back down. This simple accessory means never having to look for the carriage locking spanner in the swarf again.

Using the three items.

Put a piece of bar into the chuck against the back stop, bring the tool up to the front of the bar and lock the carriage. Using the top slide, put on a cut sufficient to clean up the end of the bar and face the end. Turn the bar round in the chuck and bring the tool almost up to the front of the bar. Bring the stop bar up against the carriage and lock in position. Clean the end of the bar up using the top slide to put the cut on. Remove the bar from the chuck and measure it. Work out how much you need to remove to take the bar to length, put the bar back into the chuck, put the cut on with the top slide and face to length. Assuming you now want to turn say, a $\frac{3}{8}$ in. long spigot on the end of the bar, turn the topslide handle along .375 and you can then turn the spigot by traversing the carriage backwards and forwards to the stop.

This is a very useful technique for one off's but really comes into its own when you have a lot of identical parts to make. Face them all at one end then reset to face the second end and finally turn all the spigots. Once you have made these three simple items, you will wonder how you ever managed without them. Next month, I will show you how to fit a chuck to a back plate using only the lathe.



CNC MILLING WITH MACH 3

Part ②

An introduction to CNC – the basics

Last month, we learnt how to set a datum in the X & Y planes using G54. I have had an email about this saying that most readers would find it easier to just set the machine coordinates and the G54 to Zero. This is especially true when the machine does not have homing switches. I have played around with the machine and offer a method that the reader can use to set Zero easily. If you have homing switches, I would still recommend you get to grips with the G54 coordinate system but more on that later.

Switch the machine on and go to the first MACH 3 screen, 'Program Run', see MEW issue 138, page 36, fig. 1. Press the red reset button, fig. 1. The message "Press Reset Emergency Mode Active" should clear. If not, check that any emergency stop buttons on the mill are in the released positions and that the machine is not sitting on a limit switch.



Fig. 1

Check the Machine Coord's button underneath the digital display, fig. 2. The outside should not be red. If it is, click it



Fig. 2

Zeroing the machine

Press the Zero X, Y and Z buttons, do not use the 'ref all home' button. The readouts should all be set to Zero, +0.0000

To start the mill spindle, type 600 into the lower speed box on the program run screen and press enter. The spindle will only start when you click on the spindle start icon or press F5. To stop the spindle you do a repeat of the same command.

First reference the Y axis. Jog to the edge of the work or vise until the edge finder clicks out. You can jog by pressing

the tab key on the PC keyboard. The jogging tool fly out will appear on the right of the screen, fig. 3. To remove the jogging fly out, press tab again. At this point, click in the Y axis DRO box and type in the radius of the edge finder. If the edge finder is in front of the work enter the edge finder radius as a negative value, see fig. 4 and press enter to have it accept this value. If the edge finder is at the rear of the work, enter a plus figure.

Next reference the X axis, again jog to the edge of the work until the edge finder

clicks out and again enter the radius of the edge finder in the X axis DRO box. If the edge finder is to the left of the work/vise then this value needs to be negative.

Next raise the Z axis using the page up button so that the distance between the top of the work/vise and the bottom of the spindle is greater than the distance from the bottom of the longest tool to the bottom of the spindle, i.e. you need clearance between the bottom of the longest tool and the work. A decent figure here is 30mm as this will clear most clamps etc. This is known as the clearance plane. We now Zero Z at this point with the Z Zero button on the readout.

If you have a spare tool holder, I suggest you put a bit of bar longer than the longest tool in it and use this together with a block of metal say about 30mm thick to set the Zero. Then if you need to reset, all you have to do to set the Z is to bring this bar back down onto the setting block and you can Zero the machine Z so avoiding the need to set all the tool heights again.

To then Zero X and Y we press the GOTOZ button, then the ref all home button then Zero X,Y and Z again so all the DRO's read Zero, fig. 5. This now sets the machine coordinate and work coordinate points at the same position as your work Zero. The important thing is that both sets of coordinates are set to Zero. You can check this by clicking on the machine coordinate button. It will alternate between machine Zero and coordinate Zero. If they are not the same, repeat the previous section until they are.

Setting the tool height offsets

Change to the Offsets screen, fig. 6. (Note the red X & Y lettering has been added for ease of use. This is a simple modification to the screen. If you would like this modification, email me and I will send you the Jpeg and simple instructions for installing it.) Fit the tool to be used into the machine noting the tool number you are using or what the program needs. Click in the number box where it says tool, enter the tool number and press enter to save it, then enter the diameter and again press enter to save.

Jog the tool down using the page down key until it just touches the work. A time honoured method here is to use a sheet of cigarette paper under the tool until it just traps it. At this point, click the set tool offset button. Note - ensure the gauge block box is set to Zero.

This then enters the value in the tool table. If you now click the Tool offsets option to on (the surround turns green) the Z readout will show Zero. Click the machine coordinates button and you will



Fig. 3

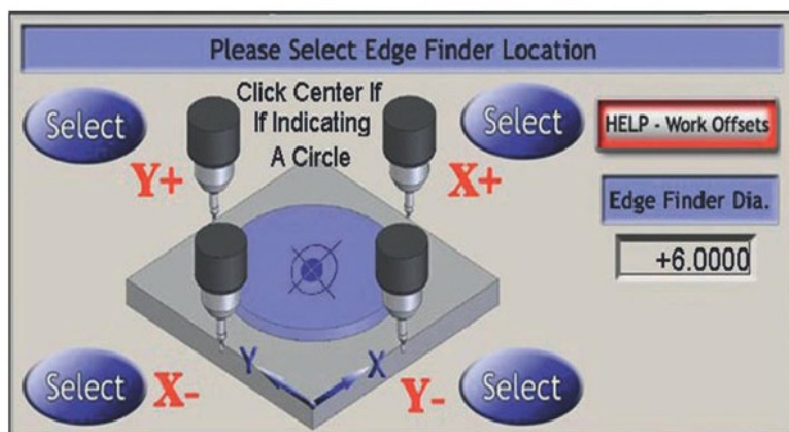


Fig. 4

see that the Z reads the same as the tool offset. Click the machine coordinates button again so it is no longer red. If you now click the Tool offsets button again to turn it off, The Z display changes to the actual Z position.

Go to the Program run screen and click the GOTOZ button and the tool will raise to the preset Z clearance plane. Repeat for all the other tools you are using in the program.

At this point, all the work and tool offsets have been set. Go to the offsets screen and save the tool offsets. This table will load when you next switch the machine on. All work offsets in the work offset table should be set to Zero. Before finishing the machining session, change to tool 0, (no offset) and press the GOTO Z button. Next time you switch the machine on, Zero it where it is and you should not have to wobble the component in or set

the tool heights again.

That concludes this section on setting Zeros and tool heights without using the G54.

Tool height setting with G54

Last month, we set the X & Y positions with G54. Before setting the tool heights, we need to set the Z height. We need a dummy tool to do this, put the tool into the spindle and bring it down to the top of the job. If possible, make the dummy tool longer than any of the tools used on the job. Make sure that no tool offsets are active by changing to Tool 0 on the offset screen. Click on the Set Z button after checking that gauge block is set to Zero. This will put the current spindle position into G54. All tools will be offset from this point.

Put tool 1 into the spindle and take it down to touch the top of the job. Change

the tool No display to tool 1 and click the Set Tool Offset button. Enter tool diameter if required and press return. Tool 1 is now set. Repeat for the remaining tools. If you ever need to reset a tool, perhaps due to breakage, just change the tool No to 0, put the dummy tool into the spindle, bring it down to the top of the job and Zero the Z display. (The Machine Coord's button should not be red.) Change to the new tool and set the tool number to the replacement tool. Bring this tool down to the top of the job and click Set Tool Offset. The replacement tool is now set. You should now know how to set Zero and set the tool heights using the two different methods.

Finally, a correction to part one. In the section about G codes – straight linear moves, at the end of the article, the text was incorrect for MACH3. It is only correct for standard Fanuc G Codes. MACH3 travels the path marked Blue = G1 travel in MEW issue 138, page 38, Fig. 6, whether it is travelling in G0 or G1 mode.

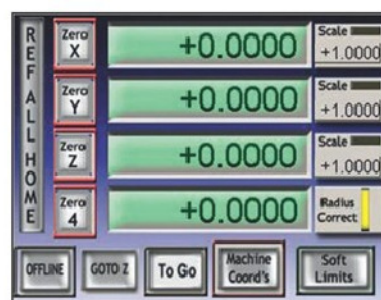


Fig. 5

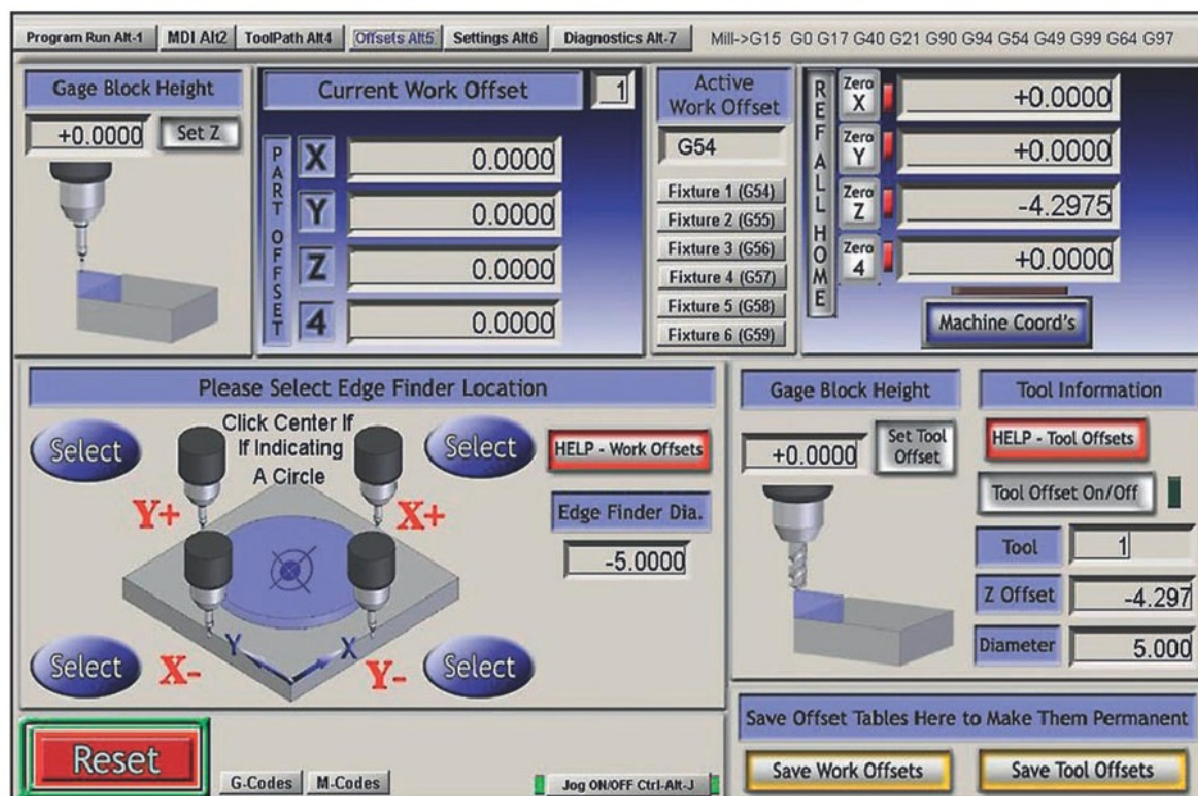


Fig. 6

MYFORDS RULE – BUT NOT ALWAYS!

Background

My first foray into home machining was the purchase of a Cowells 90 ME lathe. It soon became apparent that, like my first SLR camera, to use it effectively additional kit was needed; flash gun, lenses, skylight filters etc.

In the case of the lathe, Cowells offered a good range of accessories, some of which were bought over time as finances allowed. At this time I started reading books on lathe use by such as Sparey, Mason etc. and subscribed to Model Engineer.

Having a means of machining metal, many of the much needed tooling items and accessories could be home produced at a great cost saving, and also to gain machining experience. Most of the designs in the books and magazine were based on the use of a Myford lathe, which has become almost standard equipment for home workshops.

Additional machines followed in the form of a Hobbymat mill/drill, **photo 1** and a Drummond B type flat bed lathe (1912-21), **photo 2**. I purchased another Drummond, a type 1 (1908), **photo 3** intending to sell it on after a good sort out, **photo 4**. Both Drummonds were originally foot powered.

Following the sale of the Drummond lathes, a Myford was still financially out of reach, but on an annual visit to Axminster Power Tools in the town of that name, I saw that they had a Prazimat DLZ lathe from the same East German manufacturer as the Hobbymat. This was just affordable, so an order was placed.

Having made many items of tooling for this lathe over the past several years or so, I thought I would explore the possibilities of making a Myford specific item, adapted where necessary for my machine. The chosen accessory was the Versatile Dividing Head from the George Thomas stable. What follows is the making of this tool, with changes to the design and the method of making found to be necessary or desirable.

The kit

The full kit of materials (metal only) was obtained from Hemingway Kits of Bridgnorth. The drawings and working methods were taken from George Thomas's book; Workshop Techniques. Already having the book, the first thing was to scan and print out all the drawings for use in the workshop and to, as much as possible, convert all the imperial fraction and decimal measurements to metric, as this is what I use with my metric machines.

The major stumbling block with the dividing head is the centre height above

Jim Whetren builds the 'George Thomas' Versatile Dividing Head

the cross slide; it is designed to suit the Myford 7 series lathes at 2 1/4in. (52.5mm), which falls short of the Prazimat height of 60mm. A packing plate of 7.5mm would make up this shortfall, so that was the place to start.

Packing Plate

When looking for suitable material, I found a second hand piece of 1/4in. aluminium plate in the corner which was large enough to provide a packer for both the head and tailstock. A check on the body casting revealed that after machining the base, there would be enough meat to allow this piece of material to be used, **fig.1**.

The machining of the castings and other parts is covered in the book, so I will only describe my deviations and additions. Following completion of the packing plate, the body casting was machined and a 6mm hole drilled and reamed in the centre of the base to allow the fitting of a locating pin enabling rotation on the packer to change the orientation of the head on the lathe if necessary, and to pick up the mill's T slots.

The packer was press fitted with a pin and located square on the base of the casting. The mounting holes were spotted through the packer onto the base and the base drilled clearance for 2BA socket cap screws. The position of the

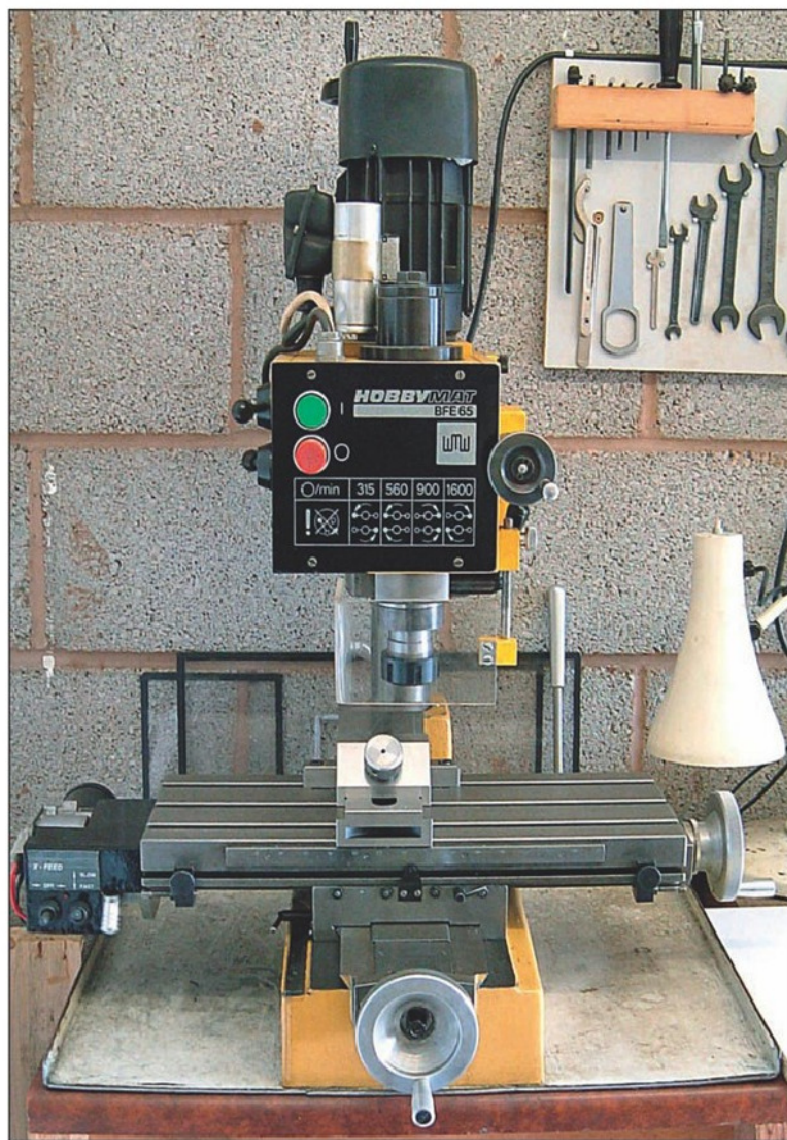


Photo 1. The Hobbymat mill.

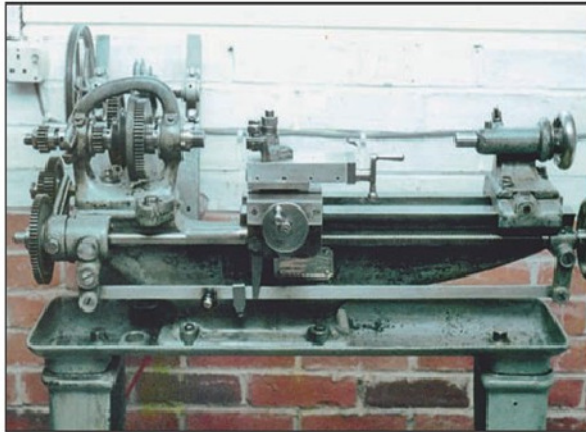


Photo 2. A Drummond 'b' type flatbed.

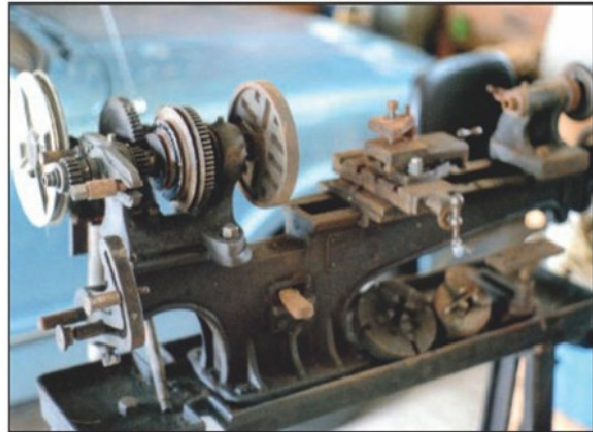


Photo 3. A Drummond type 1.

screws in the base allow just enough clearance from the tailstock boss to spot-face the casting from above with a suitable twist drill having a pilot ground to locate in the clearance holes.

The completed assembly was mounted on the lathe cross slide with the rear facing the headstock for boring the spindle hole, and machining the banjo boss at one setting.

Boring and machining the boss

Two between centres boring bars were made from $\frac{1}{2}$ in. and $\frac{3}{4}$ in. bar 200mm long with the tool bit set at 30deg., the axial centre of which is 80mm from one end. Not as elaborate as George's but the angle does allow for easier tool measuring.

A piece of bar was fitted into the cored hole and the hole aligned with the lathe bed. With the cotter piece fitted, the small bar was used to open up the bore to accept the larger bar, and this was used to bring the bore to size. I drove the bar with a three jaw chuck as my mandrel is not easily fitted with a catch plate and drive pin. If the job must be centre mounted at both ends, I use a device held in the chuck which centres the work and also provides the drive, **photo 5**.

A small boring head was held in the

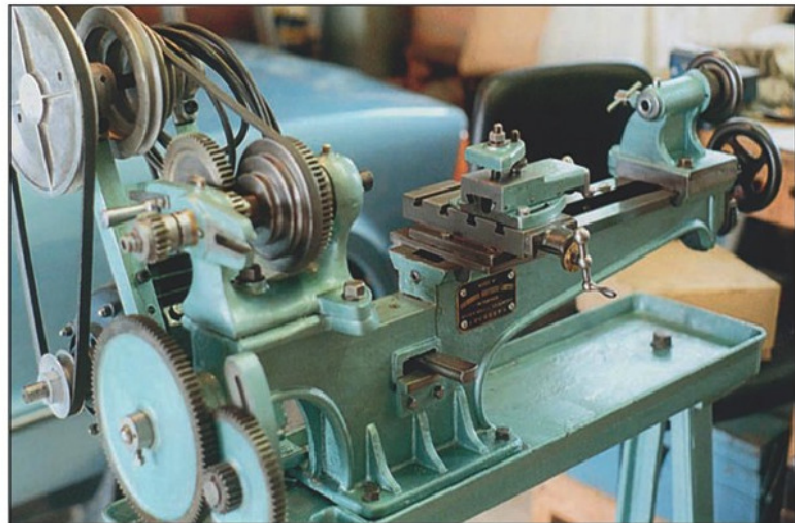


Photo 4. The Drummond type 1 renovated.

chuck, and fitted with a boring tool made from a broken end-mill mounted the wrong way round. The lathe was run in reverse to machine the banjo boss to size. (One advantage of the mandrel mounting system, don't try this on a Myford.)

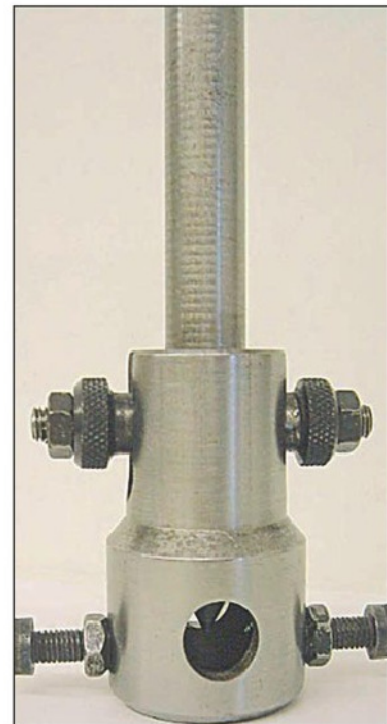
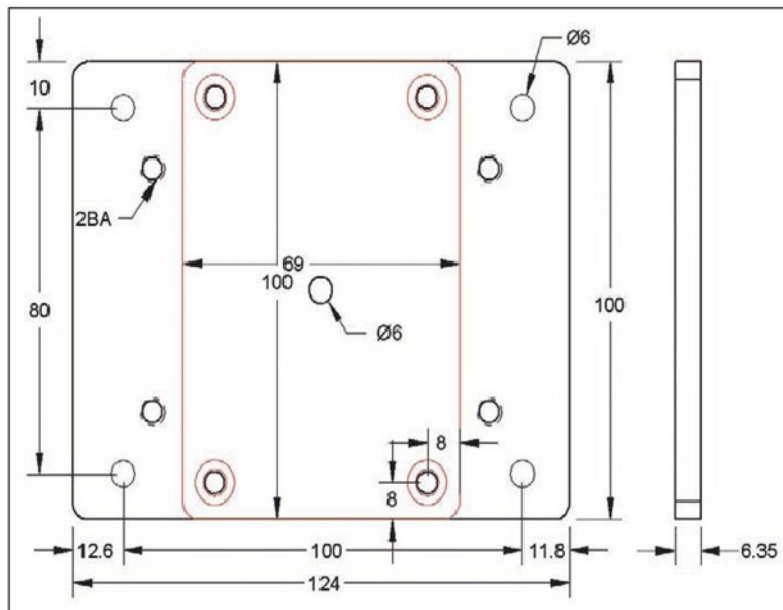


Photo 5. The centering drive attachment.

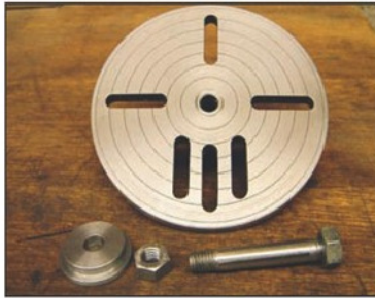


Photo 6. The simple faceplate used for drilling the plates.

The Spindle

The mandrel nose of this lathe has a short taper and bayonet ring (TGUDIN 55021) to mount chucks etc. which is very quick, as the three locking nuts have only to receive a quarter turn to release the ring and remove the item. It was not feasible to allow a chuck to be fitted to the dividing head, so the spindle would be made to accept ER32 collets as I use these on the lathe, and collet to collet work swapping should retain concentricity.

The spindle material was held in a 6in. four-jaw chuck set running true. A spigot was machined as in fig. 2. This was to accept the piece of 40mm x 27mm material bored to a press fit on the spigot.

The spindle was drilled through with a 5mm long series drill and then opened up with larger drills to 18mm. My next size is 20mm, so I bored the hole to 19mm dia.

The material for the collet nose was cut, with a machining allowance, then faced and bored to 19mm. It was then opened up 10mm deep to a tight fit on the spigot. The two pieces were drawn together with M10 studding, large washers and nuts.

The piece was returned to the chuck and set running true on the OD of the spindle. The 1.5mm thread was cut to a good fit on a collet closing nut, and the end taper bored 8deg. to accept a collet, with about 2mm below the extracting groove exposed. A good test is to fit a 7-6mm collet, and ensure that it will grip 6mm dia. material.

The rest of the spindle machining is by the book but with 1mm pitch threads.

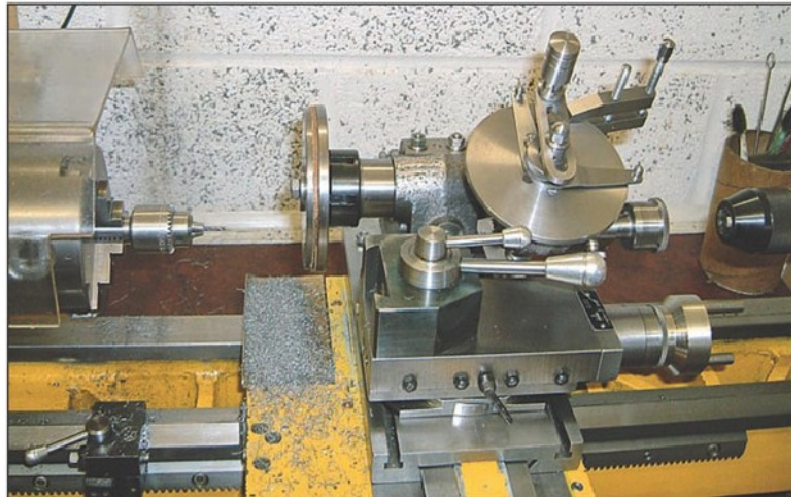


Photo 7. The faceplate held in the dividing head.

Tailstock cotters

These are $\frac{1}{8}$ in. dia. machined from $\frac{1}{2}$ in. material to allow forming the small locating flanges. I had no material of this size, so used $\frac{1}{2}$ in. dia. drilled and tapped right through. When they were inserted in place to bore the $\frac{1}{8}$ in. and $\frac{1}{4}$ in. holes, what would have been the flange was provided by a short cap screw and washer and the piece locked with another cap screw and thick washer with $\frac{1}{8}$ in. clearance. After separating with a parting tool, the appropriate cotter piece was drilled clearance for the locking screw. This method was also used for the micro drum cotter.

Worms

When the worm was fully inserted into a collet, no run-out could be detected at the end of the shaft. After a facing cut to remove the pip, a small No.2 centre was made to support the shaft with a running centre with the worm held in a collet. Both worm shafts were machined successfully in this way.

Division plates

Each plate blank was held in the outside jaws of the three jaw chuck and drilled and tapped

M6. This thread was used to fasten the blank onto a threaded mandrel held in the inside jaws with the blank pressed against the jaw ends. This allowed the first side to be faced and chamfered, followed by the other side and a clean up pass over the outside edge.

With the drilling ring and plug jig made, the plates were again held in the outside jaws to bore the plates to a close push fit on the jig's plug piece. They were then fitted with the jig which was threaded M6 in the plug portion to allow the jig to be clamped to the plate with an M6 screw and large washer allowing the plate to be rotated under the drill keeping station with the ring. The assembly was clamped to the table for each operation with a quick release clamp made from an old Mole wrench.

Drilling the many many holes

With my modified spindle nose, the recommended plate drilling method was

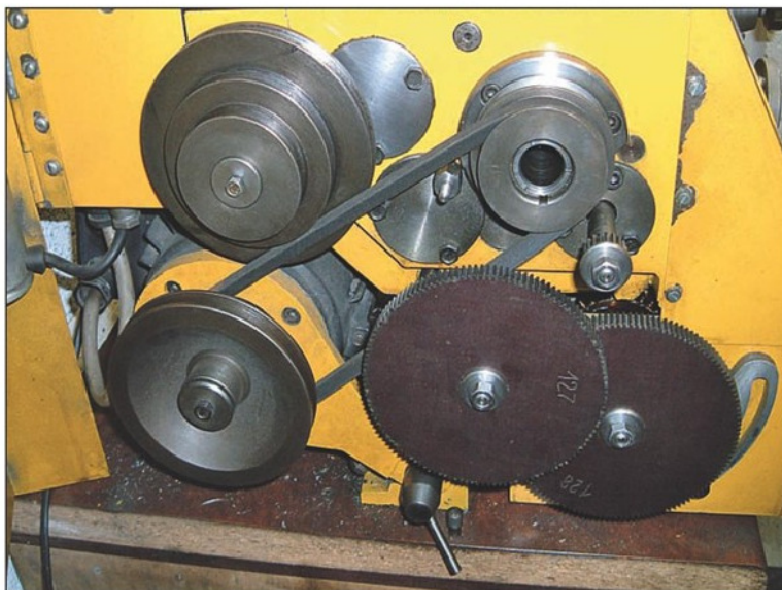


Photo 8. Using the additional speeds.



Photo 9. A cover is placed over the normal start position.



Photo 10. The temporary indexing hole is in the scrap metal that is clamped to the plate.

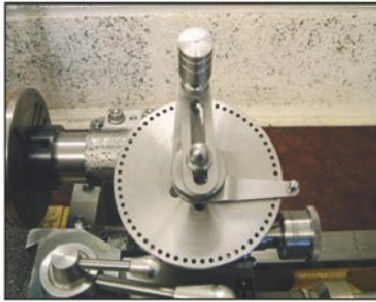


Photo 11. The first plate is used to make the other plates.



Photo 12. A magnifier was used to read the drum index.

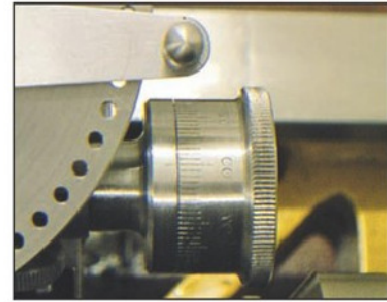


Photo 13. A view through the magnifier.

out of the window so another means of holding had to be found. I had a small faceplate mounted on a 19mm arbor for holding in the chuck should a small item need mounting on an angle plate for machining. The arbor has a $\frac{1}{8}$ in. reamed hole for mounting and setup purposes, so a piece of rod was threaded M8 at both ends and a flanged bush made to fit the plates, **photo 6**. The two extra slots allow for better fastening and positioning of a small angle plate.

The plate blank was attached to the faceplate, with a disc of hardboard sandwiched in between, and held in the spindle with a 19mm collet, **photo 7**. I followed George's advice and tested the stub drill in the drilling machine. It would not start on a smooth surface and when started in a centre punch mark, drilled oversize. Close examination showed the faces were of different lengths, and one had a negative cutting angle. Following a regrind it started on a flat face producing equal curls of swarf and cut size.

The lathe came with an accessory two step pulley for fitting to the end of the mandrel together with a longer belt providing direct drive for additional speeds of 1250 and 2000 RPM, **photo 8**. The drill was run at 1250 RPM, with a cover placed over the normal start button as in direct drive, the motor runs the opposite way. Thus I avoided the force of habit starting as normal and wondering why the drill has suddenly stopped

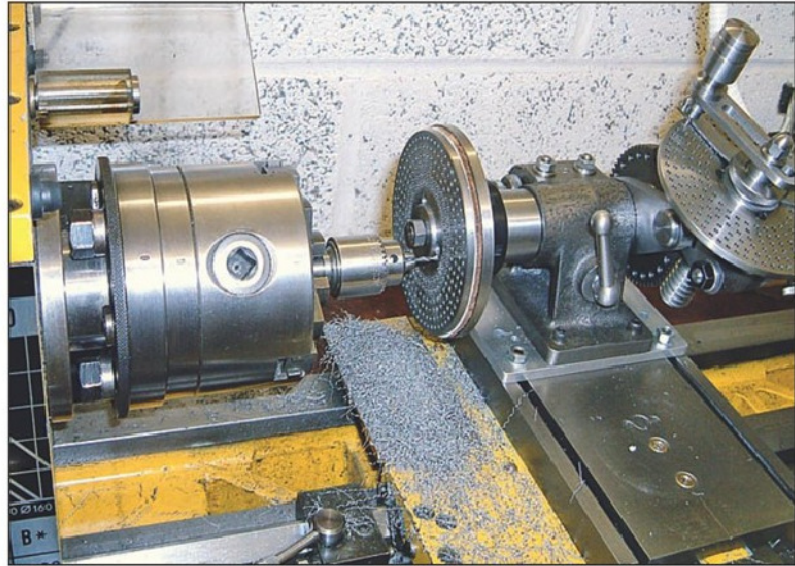


Photo 14. Drilling the holes.

cutting, **photo 9**.

I have a Jacobs1B stainless steel drill chuck of US manufacture, which is mounted on a $\frac{1}{8}$ in. arbor for holding small items in the Worden. This was used to hold the stub drill.

The first 60 hole circle was drilled using the recommended temporary 'hole' in a



Photo 15. Check the holes by going to the first hole.



Photo 16. The homemade faceplate used to bore the banjo plates and sector fingers.

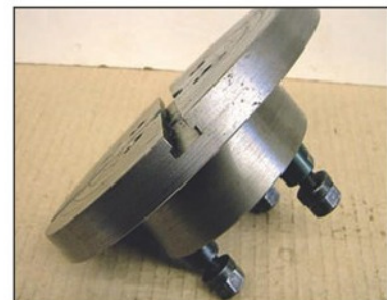


Photo 17. The faceplate has T slots milled in it.



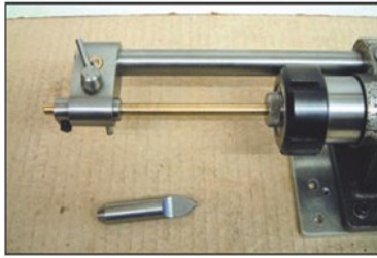


Photo 18. The tailstock when extended.

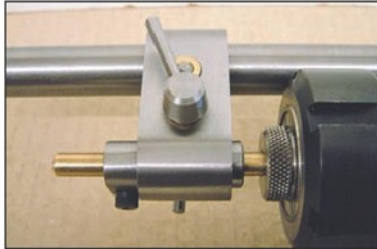


Photo 19. The tailstock when close to the headstock.

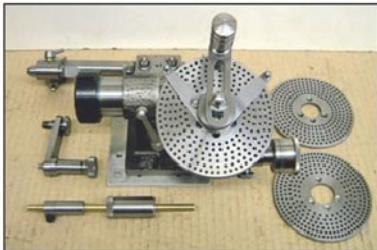
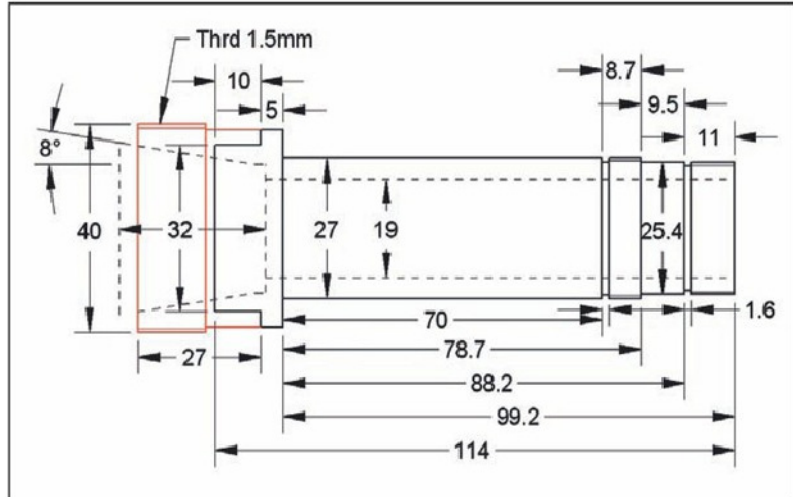


Photo 20. The finished head and accessories.

small piece of scrap metal, **photo 10**. This plate was then mounted on the dividing head to produce the other plates, **photo 11**. As the next phase requires the setting of the Micro Drum, the sequences were printed out to allow ticking off each stage to hopefully avoid getting lost and



making a mistake.

Also to assist in reading the drum markings, I put my daylight lamp's redundant magnifier to use, **photo 12**, and **photo 13** is the actual view through the magnifier.

There then followed much drilling and curly swarf until the last hole was drilled, **photo 14**. It was reassuring when the plate was moved to the starting position each time, that the drill entered the first hole in the row, **photo 15**.

Boring

The large holes in the banjo arm and the sector fingers were bored while clamped to a home made faceplate, **photo 16**. This was made from three MS discs screwed together with socket cap screws. Unfortunately, being HT steel, the ends still show. Different width slots were milled in the top two discs to form T slots, **photo 17**. Having quite a bit of mass, it is quite forgiving regarding the balancing of the clamping arrangements.

Micro Adjuster

The adjuster sleeve was made up with

two pieces of material to save time and waste. The micro drum was threaded right through with a corresponding length of thread on the worm shaft. The drum was fully tightened, then slightly backed off and the sunken lock-nut fully tightened. It turns freely with no end play.

The Verdict

I am pleased with the result and more than satisfied that the tailstock alignment rod entered in all positions, **photos 18 & 19**. It may seem odd to use brass for the rod, but a piece of silver steel would not enter although four different reamers were tested in the holes. A steel rod was too slack, but the brass rod was a smooth sliding fit so it was used.

The parts completed so far are shown in **photo 20**, with the final item being the milling tailstock. With the head rotated on the packing plate, it was tried in its more usual location on the milling machine, the outer T slots being at the same 100mm centres as the lathe, **photo 21**. Should it be found necessary to have more clearance, then the packer could be rotated and the alternative mounting holes used moving the head back about 50mm.

The basic head is shown in **photo 22**. The dividing head certainly works. I have used it to index some 800 odd holes, so it could be considered to be 'Run In'. It just remains to finally fettle the castings and apply a coat of paint, which can wait until the better weather.

The main Myford tooling restriction with my lathe is the T slot spacing, but if I can pluck up the courage to drill and tap my boring table, I may consider the GHT indexing rear tool post?

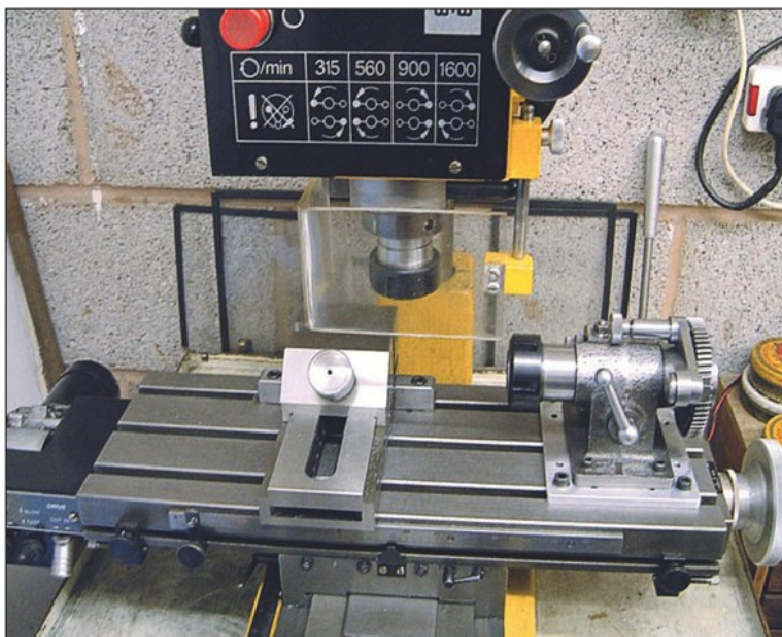


Photo 21. The attachment can also be used on the mill.

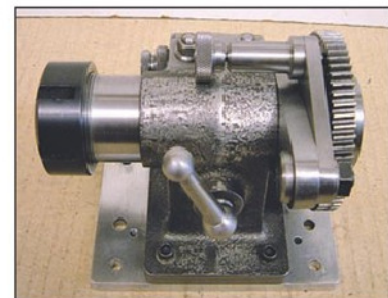


Photo 22. The attachment can also be used as a basic indexer.

GRINDINGWHEEL SELECTION, SAFETY AND DRESSING

Part ①

Michel Christiaens starts by looking at the different types of grinding wheels

Although grinding has been with us for a very long while and we all use it from time to time, it still seems, in many respects, somewhat of a black art. This is mainly because we are used to working with geometrically well defined cutting edges. That is exactly what we do not have with grinding and grinding stones. The grains of the abrasive material are of totally undefined form and hence the cutting action is different from what we are used to seeing when turning, milling, sawing and so on. Fig. 1 shows an abrasive grain in action and fig. 2 shows a possible form of a cutting grain. We will see later on that there are many more factors and their interaction that make it difficult to choose the right kind of

grinding wheel and to use it correctly.

Anatomy of a grinding wheel

A grinding wheel is a combination of an abrasive grain, the bond that holds all the grains together and the pores in between. In fig. 3 you can see a schematic of this situation. Each and every grain forms a cutting edge and the pores serve as the spaces to evacuate the chips. Although the grains generally have very unfavourable negative angles, they can nevertheless cut even the hardest materials.

It is obvious that blunt grinding grains cannot be sharpened. They should break out of their bond thus giving room to new and sharp grains that take over the cutting. So, ideally, the grains should break out just before they get too blunt to cut and

not before that. There the nature of the bond plays a very important role.

The following factors are involved in choosing the right grinding wheel for the job in hand:

- the kind of abrasive;
- the size of the grain;
- the hardness of the bond;
- the structure (porosity) of the grinding wheel;
- the kind of bond.

The abrasive

Natural abrasives like sand and emery have been largely superseded by artificially made ones.

There are three main sorts of abrasives used in grinding stones: aluminium oxide, silicon carbide and diamond.

Aluminium oxide

Aluminium oxide, also called corundum is produced by fusing the soft, clay-like mineral bauxite in special electric furnaces. After cooling, the mass is crushed. This seems simple enough but in fact it is not. After all, the cutting ability of the grinding wheel depends largely on the shape of the particles of which it is composed. Fig. 4 shows, in a schematic manner, the difference between good (left) and badly (right) shaped grains. There are mainly two qualities of aluminium oxide usually called corundum and white corundum. The latter is a more refined form and it contains more pure aluminium oxide which makes it more friable presenting thus more acute cutting edges. This abrasive is used primarily to grind material of high tensile strength. As we will see later, it is designated with A or WA.

Fig.1

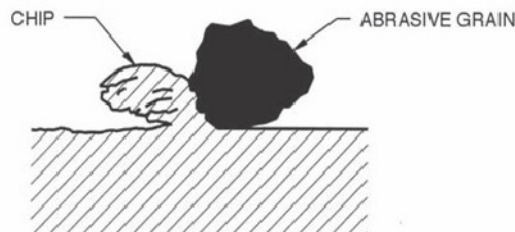
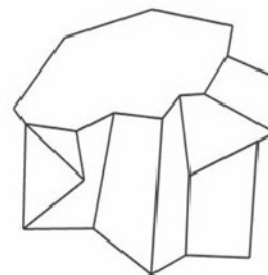


Photo 1. Various types of grinding wheels.

Fig.2



Silicon carbide

Silicon carbide is made by the chemical interaction in an electric furnace of, among other constituents, high carbon coke and silica sand. It is still harder than aluminium oxide. It is used for lower strength materials and is designated by C. In this category, the well-known "green wheels" find a place, although there are grinding wheels of silicon carbide that are black as well...

Diamond

Diamond is harder and more expensive than the previous materials. Natural and synthetic diamond is used in grinding wheels. It can be used on very hard and/or abrasive materials such as ceramics, cemented carbides, glass and, not to forget, the tungsten carbide of various cutters. **Photo 2** shows a diamond wheel on a tool grinder.

There is still another material that more recently took its place on the grinding

scene: boron nitride, also called Borazon. It is sometimes referred to as "super abrasive". This material is very hard, very expensive and it is used on hardened tool steels and on aerospace alloys.

The size of the cutting grain

To refer to the size of the abrasive particles the terms "grit" and "grain" are used. To designate the grit a number is used. This number originates from the selection process used after the abrasive is crushed. The mass of crushed abrasive is passed through a range of sieves each having a definite number of meshes to the linear inch (see **fig. 5**).

The grains are numbered according to the sieves through which they have passed. So a grain with, for instance, the number 46 will have passed through the sieve with 46 meshes to the linear inch, but will not go through the sieve with 54 meshes anymore. We will see later what the standard numbers are.

The hardness of the bond

Also called the "grade" of the wheel. It is a measure for the hardness of a grinding stone. Mind you, this hardness is not equal to the hardness of the abrasive grain! The hardness of a grinding wheel only varies with the tenacity with which the bond holds the abrasive grit together. That way, a grinding wheel can be made of hard abrasive material and yet be a very soft wheel! **Fig. 6** shows three grinding stones. All of them use the same abrasive, the same size of the grit, the same distance between the grits and the same sort of bonding material. Yet the range of hardness goes from soft to very hard. To complicate matters still more, not only the nature of the bond determines the hardness but also the way the wheel itself is used.

Before you loose track completely, there is rule of thumb that can be used. We can

Table 1 - Wheel Specifications

Mark	ABRASIVE A	GRAIN SIZE 46	GRADE K	STRUCTURE 5	BOND V
Aluminium oxyde (Alundum, Bauxilite, Corundum)	A	Coarse 8 10 12	Very Soft D E F	Closed 0 1 2	V = Vitrified B = Resinoid R = Rubber E = Shellac S = Silicate
White aluminum oxyde	WA	14 16	G Soft	3 4	
Siliciumcarbide (Carborundum, Unirundum)	C	20 24 Medium 30 36 46 54 60 Fine 80 100 120 150 180 Very Fine 220 240 280 320 400	H I J K Medium L M N O Hard P Q R S Very Hard T U V W	Normal 5 6 7 8 9 Open 10	

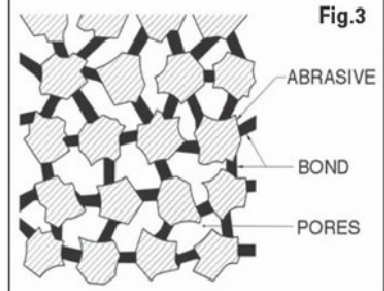


Fig.4

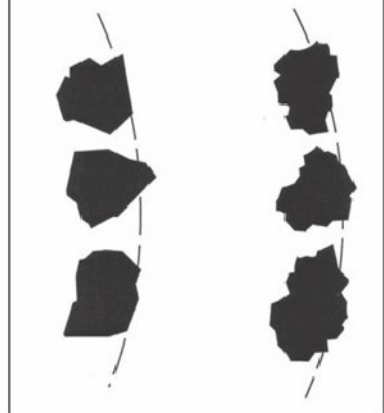


Fig.5

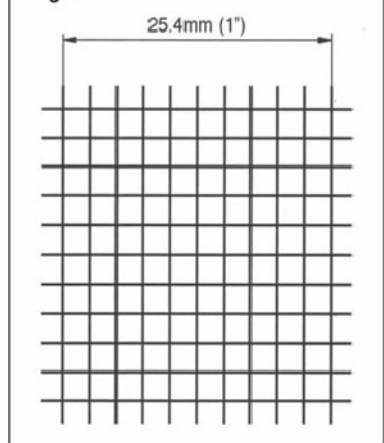


Table 2 - General Grinding

MATERIAL	ABRASIVE	CYLINDRICAL EXTERIOR		CYLINDRICAL INTERIOR		SURFACING	
		Grain	Grade	Grain	Grade	Grain	Grade
STEEL	A	46-60	M	46-80	J-M	24-46	K
HARDENED STEEL	WA	46-60	K-L	46-80	H-L	30-46	I-J
CAST IRON	C	46-60	I-J	36-80	H-K	30-46	I-J
BRASS	C	36-50	I-J			20-36	I-J
ALUMINIUM	C	36-50	I			20-36	I

Table 3 - Tool Grinding General

MATERIAL	ABRASIVE	STRAIGHT WHEEL		FLARING CUP		DISH	
		Grain	Grade	Grain	Grade	Grain	Grade
TOOL STEEL	A	60-80	M	60-80	M	46	K
HSS	A	46-60	K	46-80	K	46	H
TUNGSTEN CARBIDE	C	54-80	K	54-80	K	46	H



Photo 2. A diamond wheel on a tool grinder.

say that the harder the material to grind, the softer the grinding stone must be. This seems a contradiction but it is easily explained: in a hard material the cutting grains get blunt quite fast. If the bond is too strong those blunt particles just rub the material and do not cut anymore. When the grains are released earlier, fresh cutting edges are presented and the grinding wheel keeps on cutting well. A too hard wheel will "glaze" and get a shiny aspect on its grinding faces.

The hardness of a grinding wheel cannot be defined precisely. Whatever designation, it is always part of a range that is given. The effective hardness is not only defined by the way the grinding stone is built-up, it also depends, as I have said already, on the way the stone is used. It would lead us too far to loose ourselves in this technologic maze.

The structure

By "the structure of the wheel" is meant the spacing of the grains or the porosity (see fig. 1). It is an important factor because the pores are the spaces where the abraded material finds a place until the particles get thrown out. Too little porosity and the grinding wheel is soon loaded with chips and does not cut anymore. The range of porosity goes from "dense" (0) to "open" (10) and a "normal" structure gets the number 5. Dense grinding wheels are hardly ever used.

Wheels with an open structure have distinct advantages. The grain and hardness being equal, the open structure cuts faster and cooler. So with an open structure, a finer grain can be chosen resulting in a smoother surface to the work. The little chips are slung out of the grinding stone easily and the bigger pores have a more substantial ventilating action as well. A disadvantage is that wheels with an open structure wear away sooner so they are not so good for grinding profiles, for instance.

Generally speaking, a grinding wheel with an open structure is preferable when:

- much heat is generated that can bring about burns on the surface of the work;
- there is a tendency for the grinding wheel to clog. For instance, when soft material is ground.

The bond

The bond not only holds the cutting grains but determines several other properties of the grinding wheel as well. The strength of the bond determines for instance, how much RPM can be used before the grinding wheel disintegrates and the parts are thrown all around, causing death and destruction. The bond must resist the



Photo 3. A typical grinding wheel. Note the maximum speed rating.

cooling fluid that is eventually used and it determines the usable thickness and the elasticity of the wheel. There are several kinds of bonds in use.

Vitrified

The majority of wheels (more than 80%) are made by this process. All the wheels in photo 1 except one, are of this kind. The abrasive, together with the correct proportion of clay is pressed in moulds and then the wheels are submitted to temperatures of 1400 to 1600 degrees centigrade (2550 to 2900 F). These grinding wheels are designated with "V". Vitrified grinding wheels resist cutting fluids very well. They are quite strong and cut well. Because the bond is not flexible at all, it is not used for thin wheels.

Silicate

Silicate bonded wheels give excellent results due to their milder cutting action when used for knife grinding and certain surfacing operations on hardened steel. They behave somewhat like the sandstones of old age. The abrasive is bonded with silicate of soda and some other materials. After being moulded, the wheels are submitted to a temperature of approximately 200 degrees centigrade (390F). The silicate bond is given an "S" as designation.

Shellac

Shellac is designated by "E". It is an extremely elastic and strong bond so it is



Photo 4. A large grinding wheel, 400mm diameter X 50mm wide X 127mm bore.

suitable for very thin wheels. These can be used to cut off hardened steel, damaged taps, reamers and the like. The shellac has a polishing action too. The grinding wheel cuts very cool and leaves a high lustrous surface.

Resinoid

The "B" it gets in the designation stems from "Bakelite", a thermo hardening synthetic resin. This bond has a high tensile strength so the wheels can be used at very high RPM. They are not elastic, though. Resinoid bonded wheels are used for cutting off metal bars, tubes etc. as well as for deburring cast iron and forged work pieces. In photo 1, the very thin wheel on the front right is of resinoid bond. It smells of burnt bakelite when used to cut off milling cutters, for instance!

Rubber

Rubber bonded wheels consist of raw rubber and abrasive. The rubber is vulcanised at approximately 150 C (300F). This type of wheel is particularly successful on operations requiring a very thin wheel. They can take side forces without breaking. Designation: "R".

Marking grinding wheels

For clarity as well as to avoid mistakes in wheel selection, a standard designation of wheel specifications is used. But! Apart from the minimum markings the international standards want us to use,

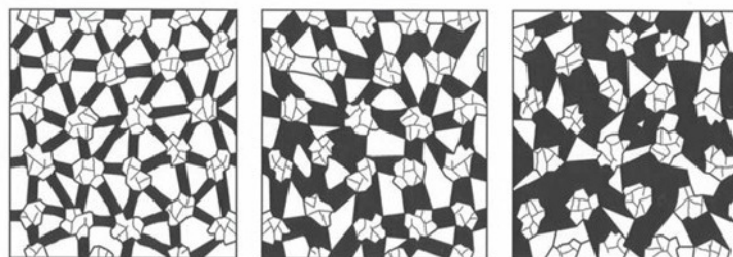


Fig. 6 SOFT HARD VERY HARD

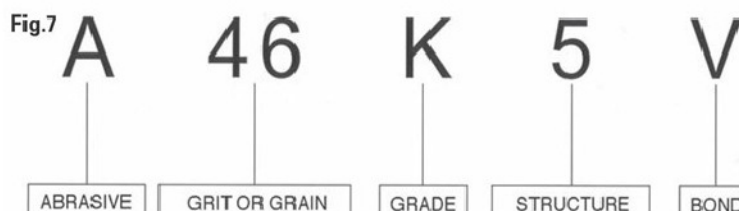




Photo 5. A wheel that does not appear if it has been well looked after.

a manufacturer can add a prefix to the designation of the abrasive to specify certain special kinds and there can be a suffix specific for the manufacturer's records. But all in all the marking is as you can see in fig. 7

The explanation of what every symbol means and what choices you have, can be seen in Table 1.

Photos 3, 4 & 5 depict actual markings as found on the blotters of some grinding wheels. The marking for the structure is often omitted, as can be seen.

When ordering a specific grinding wheel, you should provide at least the following data:

- wheel specifications (as seen in fig. 7 and Table 1);
- wheel shape and face (see fig. 8 and Photos 1 & 6). They show the shapes we are most likely to use in the home workshop;
- dimensions. At the least the diameter, thickness and hole size, but preferably what is given in fig. 8.

The way diamond wheels are marked is slightly different. It is shown in fig. 9.

Difficult choice

If you ploughed through the text above, you must certainly ask yourself by now: "OK, now how do I choose the right grinding wheel for the work I have to do?" Well... good question and hard to give a good answer. You must be convinced by now that choosing a grinding wheel is quite complicated. Moreover the way we use our grinding wheels is seldom to any standard and as you may have learned: the way you use a wheel can influence its behaviour. Nevertheless I will try to be of service. Take into account, though, that these recommendations are not written in stone (!). Most are very much "middle of the road". For the biggest part the use of grinding stones in the home workshop boils down to sharpening cutting tools so there will be some emphasis on that aspect. See Tables 2, 3 & 4.

Next month we look at grinding wheel safety and dressing the wheel.

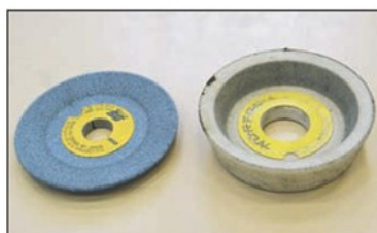
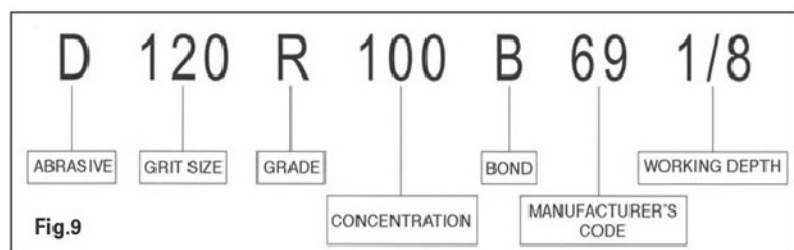
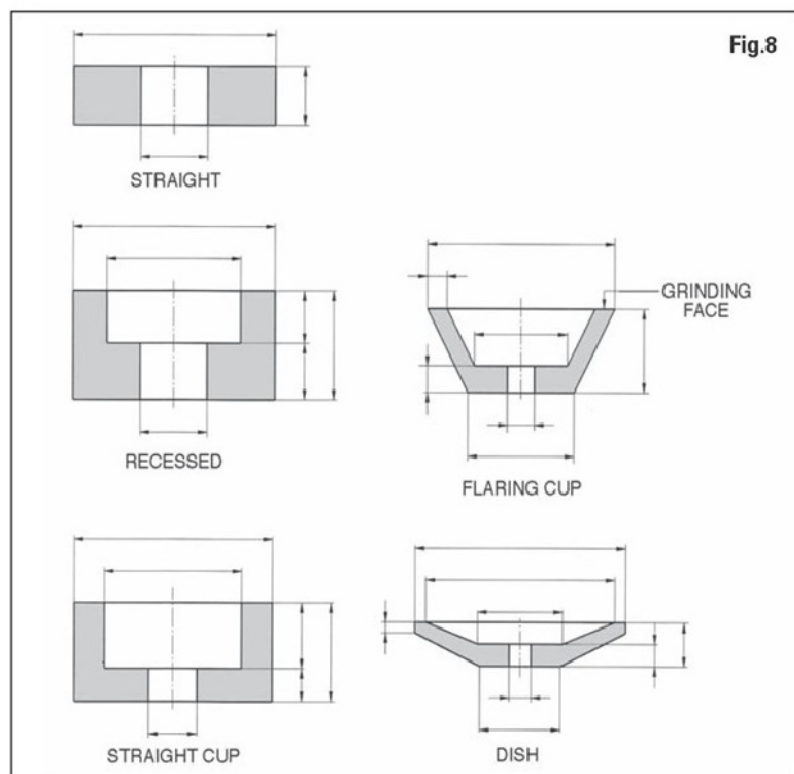


Photo 6. A dish and a flared cup grinding wheel.

**Table 4
WORK**

	BEST SELECT	APPROX GRITS AND GRADES	
BROACHES Sharpening	WA 60 K V	46-80	K - M
CHISELS			
Woodworking	A 46 M V	46-60	M - N
Engineers'	A 30 P V	30-46	O - P
CUTTERS			
Cup wheel	WA 46 K V	36-60	J - M
Dish wheel	WA 60 K V	46-80	K - M
DRILLS			
Sharpening offhand	A 46 M V	36-60	K - N
Sharpening machine	A 46 L V	36-46	K - M
Point thinning	A 50 N V	46-60	M - N
KNIVES			
Sharpening	A 60 P V	60-100	O - P
Pocket (offhand)	A 80 P V	70-100	O - P
Table (steel and stainless)	A 60 N B		
Lawn mower	A 60 P V	60	N - P
PLANE IRONS			
Cup wheels	A 36 K S	36-46	J - K
Straight wheels	A 46 J V	36-46	I - K
REAMERS			
Backing-off	A 46 K V	46-60	J - M
Cylindrical	WA 46 M V	46-60	K - M
SCISSORS	A 80 P V	80-120	O - P
TAPS	A 60 N V	60-80	M - O
TOOLS Lathe and planer offhand			
Up to 8 in. wheel	A 46 N V		
Up to 12 in. wheel	A 36 O V		
TUNGSTEN CARBIDE			
Offhand (roughing)	C 46 L V		
Offhand (finishing)	C 100 I V		



INSERT TOOLS

part 4

Mike Houghton looks at ISO milling inserts

In parts 1, 2 and 3 we dealt with cutting materials, the ISO classification of work piece materials, inserts grades and shapes and lathe tool holders. In this part we discuss ISO Milling tools. Some favourite insert systems and their sources are described.

This article is about manually operated milling machines of a size likely to be found in a home workshop. Operations that demand CNC milling machine control are not covered. E.g. thread milling, circle milling, helical milling and pocketing.

The focus of this article is more on face milling, shoulder milling, end or slot milling, dovetail cutting and spot facing. Typical insert tooling for milling may look like diagrams 1, 2 or 3.

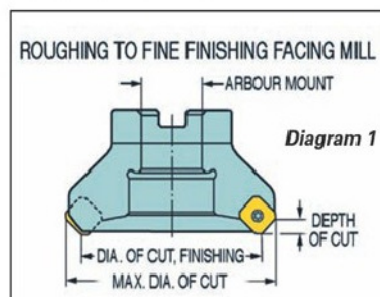


Diagram 1

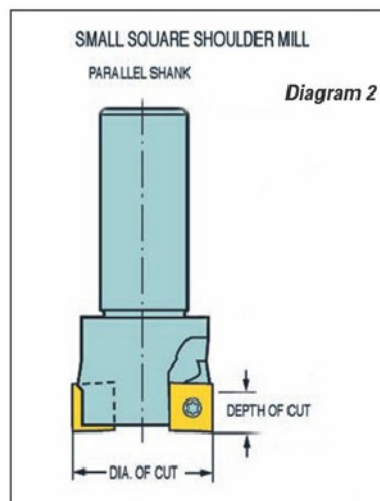


Diagram 2

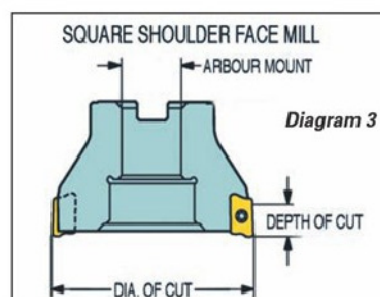


Diagram 3

Milling

Turning on a lathe is usually used to generate round surfaces with a single cutting edge tool and is a fairly simple cutting process. Provided the workpiece surface speed and the tool feed per revolution are constant, the chip thickness will be constant.

The cutting process during milling is considerably more complex; often milling cutters have more than one cutting edge on a single tool and the edges enter and leave the cutting zone in such a way that the cuttings produced vary in thickness.

Consider diagram 4; a simplified view of a face mill looking down the machine spindle.

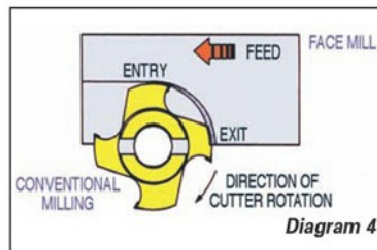


Diagram 4

In conventional, sometimes called up-cut-milling, the cutter rotation pushes against the feed of the workpiece. The cutting edges enter the workpiece at close to zero thickness and exit the work at a maximum chip thickness. This conventional cutting process has disadvantages and advantages. At the cutter entry point, see diagram 4, the cutter slides along the surface of the workpiece until sufficient pressure is created and it can dig in and start cutting chips. This sliding process creates heat and hardens some work pieces, notably stainless steels, titanium and high nickel alloys. The next cutting edge to enter the entry point will have to cut through this hardened material and this hardening will shorten the life of the cutting edges.

Conventional milling is also undesirable where chips can become welded to the cutter and get carried around to the next cutting position. Diagram 5 shows climb or down-cut-milling with the same cutter style.

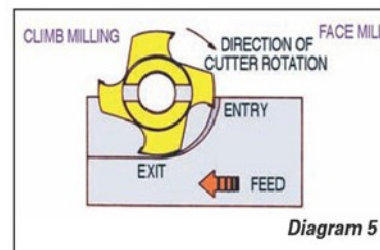


Diagram 5

In climb milling the cutting edges enter the workpiece at maximum chip thickness and exit at close to zero. Industrially, with powerful machines and stable workpiece clamping, climb milling is preferred over conventional because it causes less heat to go into the workpiece and probably uses less feed drive power. However, if the surface marked as the entry point in diagram 5 has a hard scale, the cutter edges will last longer if conventional or up milling is used because the cutter lifts the scale from below. Hard scale might be on the surface as the result of flame cutting or sand casting.

Many home workshop mills are lightly built or worn and their users will reject up-cut-milling because the impact at the entry point pulls the work into the cutter and shortens its life; it may even jam or chip the cutter. The machine vibrates, the cutting process is noisy and the resulting surface finish is poor. Sometimes it helps to cut the feed per cutting tooth, reduce the tip cutting speed, adjust the jibs on your machine, lock any axis that isn't required to move and even partly lock the moving axis to provide additional frictional resistance. If you have backlash adjustment on your machine's leadscrew, adjust backlash out as much as you can.

Milling cutter geometry, rake

Earlier, in turning, we looked at positive and negative inserts and the effect of the tool holder insert seat angle (rake). The insert clearance or relief angle is described in the ISO system. So called "Negative" inserts have ISO N relief or clearance angle of 0deg. Positive inserts have relief angles greater than 0deg. See table 1.

Table 1

Insert clearance or relief angle

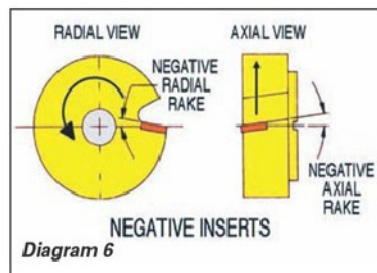
ISO Symbol	Relief Angle	ISO Symbol	Relief Angle
A	3°	F	25°
B	5°	G	30°
C	7°	N	0°
D	15°	P	11° or 10°
E	20°		



When considering milling tool holders there are two axes, radial and axial. **Diagram 6** shows two views, radial and axial, of a face mill with negative axial and negative radial insert rake. The insert shown fitted is also negative.

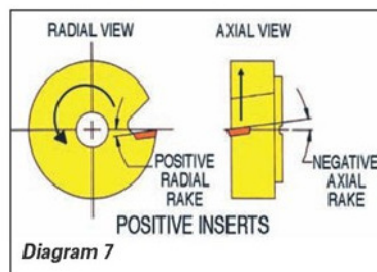
Negative inserts are generally said to be the strongest and resist impact better than "sharper" positive inserts. Some work piece materials cut much better with positive inserts however.

The double negative rake configuration shown in **diagram 6** is good for hard workpiece materials, hardened steels and cast irons. However, it isn't so good for long chipping softer materials, such as low carbon steels, as the chips can be crushed and welded against the cutting edge. My diagram only shows one cutting tooth for simplicity. Multiple teeth in contact with the workpiece give a smoother cutting action.



Obviously there are several possible combinations of tool holder negative or positive radial and axial rakes and each has its advantages and disadvantages. I will not detail them all.

Diagram 7 shows two views of a common geometry for steels and cast irons utilising a negative axial and positive radial rake used with a positive insert.



Double positive rake tooling and positive inserts are favoured for aluminium alloys with a low silicon content.

Looking at several insert milling tools in my collection shows most have a neutral radial rake. Those designed to take negative inserts have negative axial rake to prevent rubbing and those intended to use positive inserts tend to have a neutral or positive axial rake. More on these aspects later.

Milling Cutter positioning (Face milling)

Milling inserts are subjected to a shock loading every time they enter and to a lesser extent when they leave a cut. This is particularly true of climb milling, **diagram 5**. The shock loading on the cutting tooth can cause machine vibration and may shorten the life of the cutter insert depending on the angle that the cutter hits the surface to be cut. See the entry and exit points in **diagrams 4 & 5**.

For these reasons, it is good practice for 25% to 33% of the cutter diameter to overhang the workpiece as this produces a negative angle of entry of the cutter edge. Should the workpiece be more than 75% of the width of the cutter diameter, overlapping passes are desirable.

Entering angle

Photo 1 shows three small (25mm) end mills / small face mills with triangular, square and round inserts. The entering angle for each of these is 90deg. for the triangle, 45deg. for the square and variable, depending on the depth of cut for the round insert. The 90 degree cutter generates mostly radial forces and very little axial pressure. I have attempted to show this in **diagram 8**. Well, really it's a photograph that I have drawn on using Photoshop Elements **ref. 1**. The red arrows represent the radial force horizontally and the axial force vertically. The length of the line represents the relative size of the forces.



Photo 1. Three small end mills.

The 90 degree entering angle insert is useful for thin walled components as the downward axial pressure is low and of course it produces a 90 degree form. With indexable end mills, tolerances and cutter deflection will contribute to a deviation from a true 90 degree shoulder.

For the 45 degree entering angle square insert, the radial and axial forces would be equal and is usually reckoned to be the first choice for general purpose use. Decreasing the entering angle reduces the chip thickness for a given feed rate. Round insert cutters give the strongest cutting edge with the possibility of multiple small indexes, which is more economical than most other shapes.



Diagram 8

Face mill tilt angle

There is a lot of discussion on internet groups about "trammig the head" of vertical mills. E.g. see **ref. 2**. The object of this trammig exercise is to set the spindle truly vertical to the machine table. However, in face milling there is some merit, even on a small sized mill, in setting the spindle tilt angle slightly off vertical and leading with the lower insert. **Diagram 9** shows an exaggerated spindle tilt. The advantage is that the trailing insert cannot rub on the machined surface and this will eliminate back cutting or re-cutting, both detrimental to the surface finish and insert life. The downside of this mode of operation is a slight curvature of the flat surface that results and the necessity to only mill in one direction.

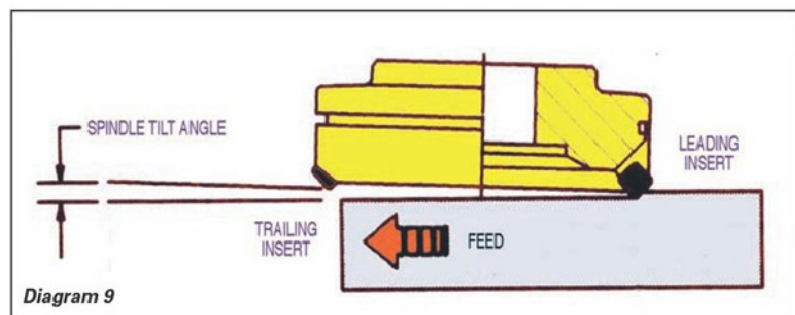


Diagram 9

ISO Nomenclature

In an earlier part of this series of articles I described the application of the ISO nomenclature to tooling and inserts for turning.

Milling tool holders

None of the milling insert holders that I use show any standardised marking system. Each manufacturer seems to use their own part codes. E.g. the economy end mills shown in **photo 1** are simply etched or laser marked 90° XML 1"; 45° XML 1"; RXML1". Another example I have is marked "R8 EM Ø32", a marking which indicates the shank type, end mill cutting and the cutting diameter.

So if you can determine the manufacturer of a tool holder, look up his tool markings on the "web"; you should find most manufacturers have extensive on-line catalogues. If the tool holder is unmarked you will have to do a bit of measuring and intelligent guesswork to determine the insert type and size. A milling tool holder will normally only accept one insert shape and size but you can often ring the changes on the insert by the selection of clearance (relief) angle, the insert nose radius and the edge preparation and of course the carbide grade and coating.

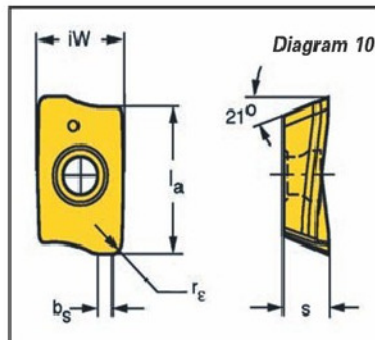
Milling inserts

The news here is better. Many milling inserts follow the ISO nomenclature described earlier in parts 2 and 3. However, there are some manufacturer specific insert shape additions that are not described by ISO so caution is needed when you buy new milling insert tool holders. Check that an ISO insert nomenclature is available for inserts that fit the holder or you might get stuck with a costly insert replacement problem. ISO inserts shapes are described in **Table 2**.

Table 2 Milling Insert Shape

ISO Symbol	Shape	Nose Angle
A	Parallelogram	85°
B	Parallelogram	82°
C	Diamond	80°
D	Diamond	55°
E	Diamond	75°
F	Diamond	50°
H	Hexagon	120°
K	Parallelogram	55°
L	Rectangle	90°
M	Parallelogram	86°
O	Octagon	135°
P	Pentagon	108°
R	Round	
S	Square	90°
T	Triangle	60°
V	Diamond	35°
W	Trigon	80°

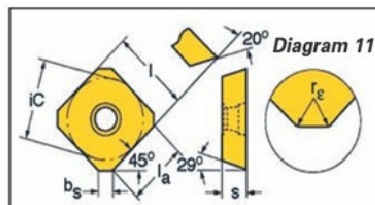
A number of insert shapes used for turning are less suitable for milling, especially the D,E,F,K and V ISO shapes, because of their relative lack of strength. Common ISO milling insert shapes that don't find much use in turning are shown here. **Diagram 10** is a Sandvik R390 insert which is non ISO but similar, but not necessarily interchangeable, ISO shapes might be ADKT, ADCT, APKT and the BAAP series types. Notice the curvature



of the long cutting edge. **Diagram 11** is a Sandvik R245 insert, again non ISO but similar to some square and octagonal positive inserts.

Inserts intended for milling operations often have edge preparations that are very different from the corresponding insert prepared for turning. Wiper inserts are common and do seem to give better surface finish even on light home machinery. Rather than just provide a round nose to the insert, the wiper modification provides a flat area that wipes away ridges made by the passage of the previous cutting edge through the work piece. On a 22TPKN insert this might, for example, be 1.2 to 1.4 mm wide. The wiper width should exceed the feed per insert for the best effect.

On large industrial sized face mills, it's quite common to have separate wiper inserts that protrude slightly below and trail behind the other cutters to achieve mirror like finishes without resorting to grinding after milling. As you might expect, in the real world, milling of engine cylinder heads and cylinder blocks is carried out on a massive scale by dedicated multi-insert face mills.



My favourite milling insert systems

Well that's all for the theory, what about the practice in a home workshop? The following are my experiences using inserted tooling. Most of my milling is now done on a Chester UK 6in.x26in. vertical mill, **ref. 3**, but previously I owned a Dore-Westbury. Before that, I did all my milling on a Myford ML7 lathe. The Chester UK 6x26 has a power feed on one axis and an R8 spindle. It has a spindle speed of 200 to 2300 rpm in 9 steps, but with a large gap between 610 and 1070rpm.

HSS tooling used on the mill soon needs re-sharpening and you really need a cutter grinder and a bit of skill to re-sharpen end mills and slot drills. I find brazed carbide milling cutters are useful and stay sharp much longer than HSS especially if you machine tough or abrasive materials. They have the advantage of fairly simple insert shapes that can often be brought back to something close to their original sharpness with the careful use of a fine diamond file.

Face milling cast iron

Please see article 3 for a description of problems with the tough skin on cast iron. Tasks that I often seem to get with cast iron components are to produce large flat surfaces, square shoulders, dovetails and spot facing.

Photo 2 shows a four insert R8 shank face mill from Arceurotrade (they call it an end mill), **ref. 4** being used to take a series of overlapping first cuts along an iron casting. The speed I used was 200rpm. Since the cutter is 63.5mm diameter that's roughly a tip speed of 40metres per minute. The feed per tooth is less than 0.2mm and the depth of cut around 1.5 mm to get under the skin. This particular casting wasn't very flat as cast. Subsequent cuts were made at 300rpm and a much smaller depth of cut. It is normally recommended that a face mill should be wider than the casting being faced. In this case overlapping passes had to be used as this is the largest diameter mill I have available.



Photo 2. Face milling Cast Iron.

Arceurotrade don't know the ISO specification of the inserts supplied with this tool. They import replacement inserts from the tool manufacturer in China. I have been replacing these inserts as they wear out with TPKN 22 04 PD R from Sandvik in their grade H13A (K20). This is an uncoated insert with an 11deg. positive edge and wiper edge for right hand cutting. The Arceurotrade and Sandvik Coromant (**ref. 5**) inserts behave similarly for me; somebody kindly presented me with a full box of the Sandvik inserts. I also have a box from Widia (**ref. 6**) with the same ISO code and they behave similarly. A close up examination of this insert, **diagram 12**, shows the main features. The wiper sections, marked R and L are to indicate the differences between right and left hand cutting.

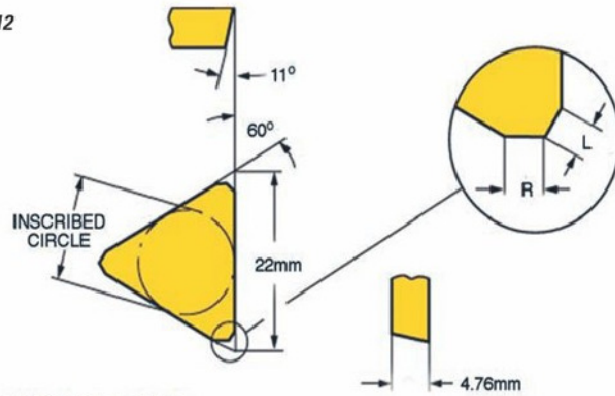
In my Dore-Westbury days I would have attempted to single point flycut a surface like this with HSS and spend a lot of time re-sharpening the cutter and complaining about the surface finish!

I find that this face mill also gives good results, with the same inserts, on low carbon steel plate and aluminium alloy like 6082 (HE30).

Low carbon steel plate, supplied as hot rolled black plate, can cause problems because its surface contains mill scale (abrasive) and there are usually many



Diagram 12



small surface defects resulting from the hot rolling process. I find that tilting the spindle slightly, say 0.05mm (0.002in.) and leading with the lower insert tip gives a better surface finish and less "pick up". Of course on my mill I can only easily adjust the tilt left to right, not front to back as you might on a real mill like a Bridgeport. I find a feeler gauge is OK for setting the tilt angle.

Milling hardened steel

This is something you might want to avoid with HSS tools! I have found that it is often desirable to reduce the shank height of lathe tools, especially insert types so they fit my Chester UK Craftsman 300mm x 570mm lathe. I don't have a quick change toolpost (Dickinson type) which normally brings the luxury of micro adjustment of the tool tip height. The insert lathe tools supplied with this lathe averaged about 1.27mm (0.050in.) above centre height. This above centre height mounting of the cutting tip is sufficient to cause havoc with

the surface finish of smaller diameters, especially those turned between centres. I have also successfully reduced the shank heights of insert tooling intended for larger lathes using this method.

Normally insert lathe tool shanks are made of toughened steel. If you come across some of the new solid carbide shank tools don't try this! Carbide is easily detected by its very high density. **Photo 3** shows a nominal 16mm square lathe tool being milled down to reduce its height. Apparently I left an insert in the lathe tool when I did this, naughty!

I got a mirror like finish using the end mill shown in **photo 3**. The end mill was run at 1070 rpm, a depth of cut of no more than 0.25mm (0.010in.) and a slow feed rate. As I hope you can see in the photograph the cuttings turned from light brown to dark blue as the depth of cut or the feed rate was increased. These end mills come from Chronos, ref. 7.

This inexpensive set of three holders was bought following a recommendation from Dave Fenner. I originally used them with an R8 collet but I find I get better results when they are held in an ER32 collet as shown in the photo. The inserts for this set have the ISO codes TNMA 16 03 08:

RNMA 09 03 00 and SNMA 09 03 08. No edge details are given and none can be seen under magnification. These inserts are negative and can be used on both sides, which makes them particularly cost effective. The holder has a negative axial rake and a neutral radial one. Using photography and the Photoshop Elements software I estimate the insert negative rake to be about 7 degrees. See **diagram 13**. These angles are important should you wish to have a go at making your own milling tool holders.

Dovetail cutting

60deg. dovetail cutting in cast iron is a task that seems to come up fairly regularly in my workshop. If you study commercial dovetails on machine tools they will often



Photo 3. Milling a hardened lathe tool holder.

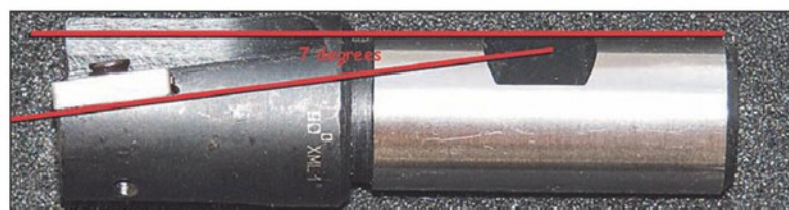


Diagram 13

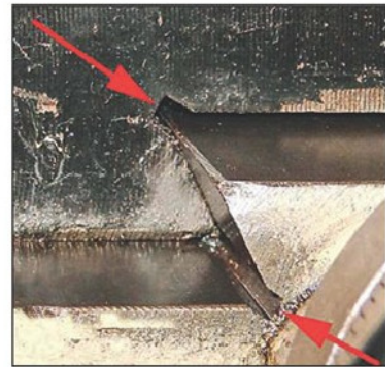


Photo 4. Detail of a commercial dovetail.

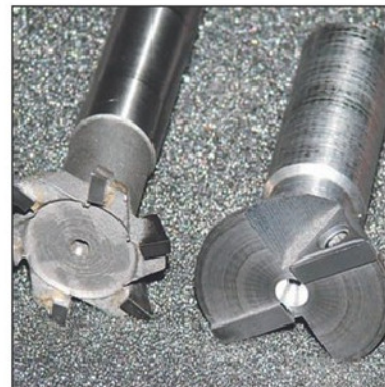


Photo 5. Dovetail cutters.

be cut with a square relief at the bottom of both the "outside" and "inside" dovetail parts. See **photo 4** of the cross slide on my lathe, where the square relief's have been cut at approx 30deg.

This feature doesn't appear in most home workshop projects; it's clearly there to protect the point of the dovetail cutter from rapid wear but is difficult to accomplish without a slot mill working at an angle. If you start milling dovetails in cast iron, even with the outer skin already removed, the wear rate on the tips of these very expensive cutters is fast. For some time I have successfully used a brazed carbide 60deg. dovetail cutter from ArcEuro, ref. 4. The problem with this cutter is its lack of cutter depth which means that I have to take two cuts at different depths to generate the final dovetail. To counter this I have made some tool holders from EN8, ref. 8, for triangular insert 60deg. cutters. See **photo 5** which shows both cutters together for comparison.

These home made dovetail cutters work quite well if run at 600rpm with a low depth of cut and low feed rate. The two inserts shown in the photographs came from J&L Industrial and are TCMT 16T304. These are not really intended as milling inserts, I normally use them in a lathe boring bar, but they were pressed into service as I already had them in stock.

Spot facing

Castings often require spot facing to produce a flat area around a bore that can act as a seat for a bolt head, a washer or a thrust area for a spindle. In smaller sizes an end mill can work although the seat will probably not be absolutely flat as end mills are normally sharpened with a 1 to



Photo 6. A spot facing tool.

5deg. angle across the front face of the teeth. I made a simple insert spot facing tool shown in **photo 6**. I used the insert and screw "borrowed" from the square insert SNMA 090308 shown in **photo 1**. This particular example isn't centre cutting but works well around a pre bored hole in cast iron. The secret to making these simple insert milling tools is the correct position and angle of the insert seat. If there is any interest, I can write up the manufacture of these home made end mills.

Power consumption

I often hear those who are very negative about inserted carbide tooling stating, as a fact, that their lathe or mill does not have sufficient power to run carbide inserts.

Photo 7 shows a power meter that I use to give an almost instantaneous read out of power consumption in watts of my machines. The supplier is Maplin, **ref. 9**. My Chester 6x26 single phase belt driven mill has a motor plate rating of 1.5HP or 1119 watts. Running the four insert face mill shown in **photo 2** gave a total power consumption of 485 watts at 200rpm. However, from that one has to subtract 95 watts for the power feed and the low voltage machine light, leaving 390watts



Photo 7. Power meter.

consumed by the motor whilst face milling cast iron. This set me wondering about power consumption of the mill motor cutting air compared to cast iron. The following table of power consumption cutting air, with no machine light and no power feed gave a set of results that surprised me. The numbers in the table are after the initial starting surge, which is too fast for the meter to accurately register. I waited for the reading to stabilise before recording it, around 30 seconds.

Mill Power consumption cutting air, no light, no power feed

Belt Position	Spindle R.P.M.	Watts
D1	200	315
C1	300	314
D2	430	373
A1	610	375
B2	1070	510
C3	1120	583
A2	1330	504
B3	1850	745
A3	2300	950

As you can see, surprisingly my cast iron cutting exercise only added 75 watts to the total consumption. My measurements show that as the mill speed increases the losses in the two belt transmission rise rapidly and at the top speed there isn't a lot of power left for machining! Glancing at the power meter as I carry out various milling operations doesn't really confirm that insert tooling imposes any excessive power demand, provided you avoid the highest spindle speeds. In fact I have difficulty seeing a difference in power consumption between insert and non insert tooling at the same rpm. Commercially, of course, high spindle speeds are essential for high productivity (high metal removal rates) and high spindle power is then essential.

The most energy intensive operations on my mill and lathe appear to be drilling and opening out holes by drilling. I'd be interested to hear if other readers have tried measuring the power consumption of their mills or lathes.

Coolant and Lubricants, Yes, No or maybe?

Because carbide tooling is not degraded at temperatures that would rapidly soften and dull HSS tooling, I find that dry machining with uncoated carbide inserts is usually perfectly satisfactory and less messy. I usually start off cutting dry to see what happens; if the surface finish isn't great and I can't improve it by changing the conditions, I will then try a metalworking lubricant.

Remember that an intermittent supply of water based coolant or lubricant may actually shorten the life of the insert because sudden temperature change of the insert can cause micro cracking and lead to premature failure, so dribbling fluid on with a brush may actually be counter productive. Some workpiece materials prone to long chipping or edge build up benefit from lubrication. Unfortunately some insert coatings are not as thermally stable as carbide itself so adopt a suck it and see approach.

Sources of inserts and tooling

There must be literally thousands of permutations of insert size, shape, materials, coating, edge preparation etc so that stockholding must be a major headache for any supplier. I'm sure that major manufacturers would be unwilling to supply individual inserts to small users.

Many of the home workshop suppliers in the UK only stock very limited ranges of replacement inserts for tooling they sell and often don't display the complete ISO codes of inserts they supply, but they will usually supply single inserts. I have found that I can also buy single inserts on line from J&L Industrial **ref. 10**. Following a change of ownership, J&L now offer a wider range of insert suppliers and the on-line discounts can be quite good(25%+).

Ebay always has a large selection of inserts on offer at discount prices; just search for "inserts", but care is needed to ensure that the full ISO description is given. As I noted in an earlier part, inserts often don't have comprehensive marking so getting an original unopened box is critical. Remember that inserts on Ebay probably come from stores and warehouse clearances and are likely to be slow moving stock or trials that didn't work out. Ebay sales of insert tooling tend to be in sizes to large for our machines.

Conclusions

Insert tooling looks expensive and complex but can give exceptional results, even on home workshop machines especially on difficult to work materials if you make the effort to understand its peculiarities. I find that I am turning more and more to inserts and solid carbide tooling. OK, so I don't use a small lathe or mill by "our" standards but small scale tooling is now available and is worth a try.

Study of the professional / production tooling catalogues from the major manufacturers show a wealth of new developments that must eventually filter down to our types of machines. I might mention indexable drilling systems, copy milling cutters used in die making and the parting, grooving and profiling lathe inserts.

Please feel free to add your comments and experiences, good or bad, with insert tooling to Scribe a Line or mikehaughton@btinternet.com

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- Ref. 10: <http://www.jlindustrial.co.uk>

REBUILDING THE SUPER SEVEN LA

By "Richmond"

You may remember from last month's issue that the house was burgled, so I will say here and now that I haven't had the amount of time needed in the workshop to finish everything. Dealing with the insurance company, the police, and a partner who doesn't really like to be alone in the house takes up valuable time, especially when time is limited anyway. The items still to be completed are the final fitting of the coolant system and the lighting. All works as it should, I just haven't had time to finish fit them. I am indebted to Harry for giving up his time this month to help me. Without his assistance only half the work would have been completed.

Stripping the small bits

The first job was to strip all the small assemblies that needed re-spraying. My small collection of parts bins came in handy here, and each was labelled appropriately with the name of the assembly it contained. The parts were masked then primed and sprayed with the top coat. **Photo 1** shows the results.

I wasn't very happy with some of the results on the larger items such as the belt cover, and the gearbox, **photo 2** so a rub down session ensued, followed by yet more spraying. The changewheel cover still needs more work. In fact I think I have rubbed down and sprayed that item four times now. It will have to do for now. At least until the lathe is finished and tested, then I will spend some more time on it prior to the Harrogate Show.

Reassembling the headstock

Assembling the headstock was one of those jobs I dreaded. Whilst Myford owners will say adjusting the bearings is easy, it is not something I have done before, so it was put off until the last moment. The headstock was assembled and cleaned, **photo 3**. Note the paint on the bronze bearing that crept under the masking tape. This was cleaned off with turpentine substitute and a scourer – yet more time spent cleaning



Photo 1. Small parts after spraying.

Background:

Last month we covered the preparation and spraying of the lathe, the selection of the DRO, as well as some of the pitfalls when purchasing some of the parts needed to complete the project. This final instalment will cover the re-assembly and alignment, as well as the installation of the inverter, the power cross feed, and the DRO.

instead of building!

The headstock was assembled to the bed. Remembering back to my day at Myford, Darren told me that the base must be totally clean with a flat underside. It wasn't. So, guess what, more cleaning off surplus paint! I didn't want to start the alignment process with paint or grit hampering the fit of mating surfaces. The screws were fitted and torqued down evenly after ensuring that it was seated correctly against the rear shear. This is done by tightening the grub screws in the front shear until no movement is felt.

The tailstock

After a break for tea, the tailstock was then assembled after yet more cleaning of surplus paint and fitted to the bed. At this point it is worth mentioning that any setting up of the headstock or tailstock must be done on the bed when it is on a flat surface, and NOT under tension, i.e. undo any bed clamping bolts you have in place, and just "nip" them past finger tight.

Being an eager soul I went straight to the test procedure, so out came the 2MT test bar and the DTL. Shock, horror, both the headstock and tailstock were pointing downward towards the bed. After some head scratching it dawned on me that I hadn't set up the bearings in the

headstock, I was going to have to do the dreaded job sooner than I thought. The light bulb in my head came on when I was adjusting the test bar in the headstock; there was visible play in the spindle.

Fig. 1 shows a simplified cross section of the headstock. The adjustment procedure I used, and subsequently verified with Myford, is as follows:

1. Loosen the Split collar and the 2 'C' nuts A and B.
2. Holding the bull wheel or pulley, tighten the Split Collar by hand. N.B. There should be a visible scribed line marked on the spindle which should line up with the split in the collar when new. It is likely there might be some small movement due to wear.
3. Tighten nut B carefully with a 'C' spanner until the spindle has become stiff with a jerky motion, but can still be moved by hand.
4. Tighten nut A fully, and hit home gently with a soft faced hammer. The spindle should now turn smoothly yet freely, but still be very slightly stiff.

Whilst sounding complicated, in actual fact it takes only two or three minutes to do. The difference it made to the headstock test was dramatic. From pointing down by 3 thou over the 8 inch test bar, it was now totally parallel with the bed, **photos 4 & 5**. The eagle eyed



Photo 2. Gearbox, change wheel cover, and belt guard after spraying.

THE MYFORD LATHE Part ③

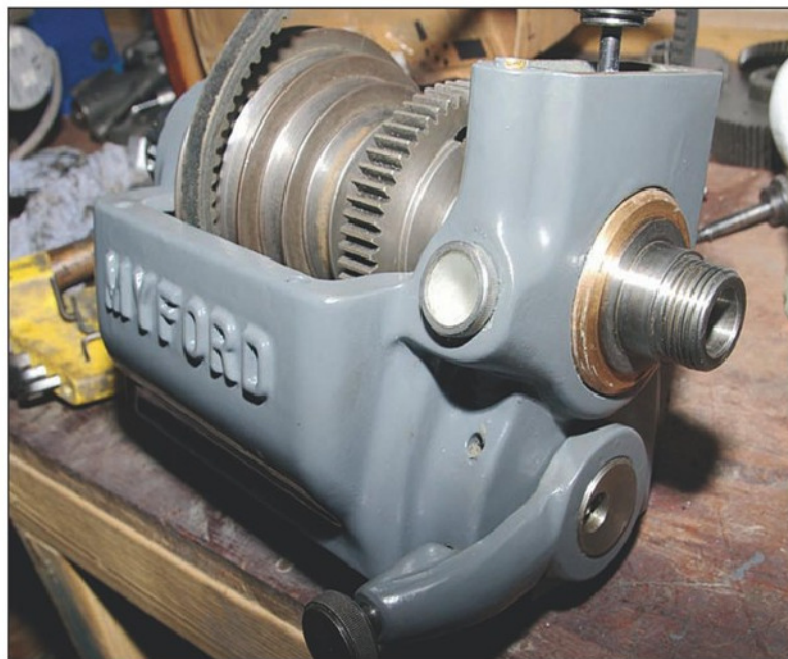


Photo 3. Headstock assembled, prior to bearing adjustment.

amongst you will notice that the saddle and cross slide have been fitted. This was done to enable the DTI base to move slowly and not disturb the arm whilst traversing the test bar. It also helps to see if any error is linear along the length. Also, I don't have an "elephant's foot" on the DTI, but it does have a ball bearing base, which was freshly oiled and checked. N.B. the test procedure was explained in part 1 of this

article, MEW Issue 137.

The headstock horizontal alignment was also checked. Some small adjustment was made and I now have 0.0008in. vertically, and 0.001in. in the horizontal plane over the 8 inch test bar.

Unforeseen wear

Having had several lathes, and more than a little experience of drilling small holes via the tailstock, I know how important

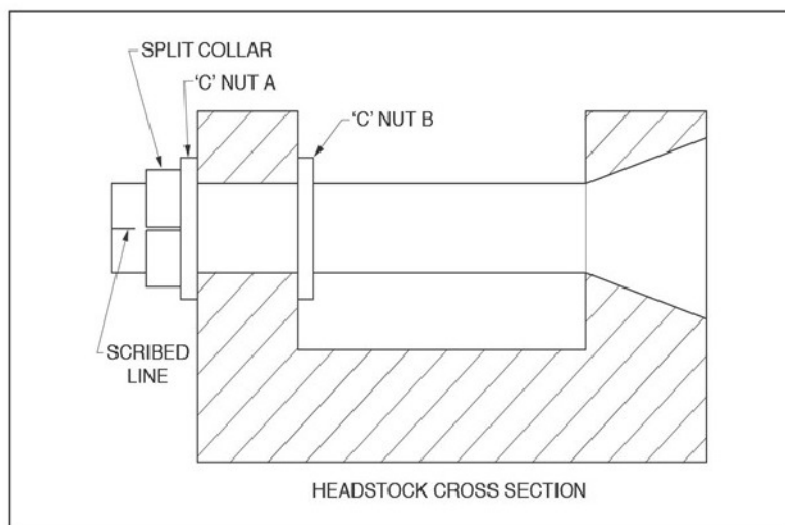


Fig 1 - Simplified Headstock cross section.



Photo 4. DTI Reading at Headstock.



Photo 5. DTI Reading at end of test bar.

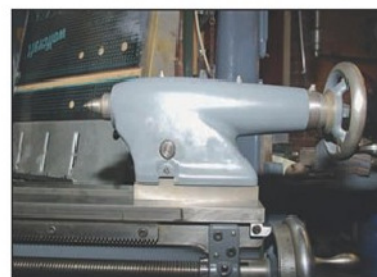


Photo 6. Tailstock with new slipper block.

tailstock alignment can be. This one proved to be a " *&^%\$"! The slipper block was cleaned and cleaned again. All traces of scrapes, marks, and paint were removed from the castings. The barrel was removed and checked, the clamping mechanisms checked. I could not get it to line up with the headstock. It dipped by well over 10 thou in 8in. and it was linear as well! In the end I shimmed up the front edge of the main casting by 4 thou. It just about came level. Using a bit of math, 4 thou over the 5in. length of the base, plus 7 thou over the 8in. test bar translated into 12 thou over 13in. The only conclusion I could reach was that the slipper block must have a slope along its length due to 50 years of use.

The Myford open days

Luckily, Myford had their open days recently, which Harry and I attended. Having previously spoken to Malcolm at Myford about the problem, the tailstock was given to Darren upon arrival who fitted a new slipper block for me. Incidentally, Myford fitters have a range of slipper blocks which vary in thickness (up to 5 thou over size) to cater for this and other tailstock alignment issues, **photo 6**.

As is usual on Myford Open Days, there were VAT free offers, and I spent my pocket money for the next month or two. I needed a new backplate for the 4 jaw, as well as a new 3 jaw chuck, and other sundries. Besides the lines of new and second hand machinery, there were

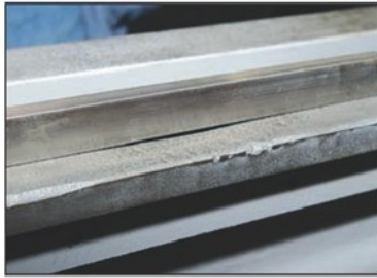


Photo 7. An excessively worn Super 7 bed.

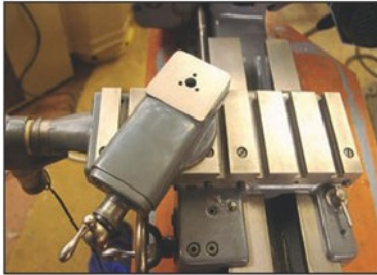


Photo 8. New cross and top slide in place.

displays by the SMEE, as well as turning and milling demonstrations.

DAG Brown was demonstrating some precise turning methods, and Ivan Law was there showing his prototype cylindrical grinder. It used Prof D H Chaddock's original prototype Quorn head, and Ivan told me he needed to redesign the head as a result of a lack of power from the motor, as well as a lack of rigidity due to the cutting forces involved. We had a pleasant, long, and eventful chat, and hopefully, I will be able to visit Ivan later in the year and see what he gets up to in his workshop.

Unwarranted optimism

One source of amusement during the day was a Super 7 bed that had been returned to Myford for regrinding, **photo 7**. Note the flat bar above the divot in the bed, the

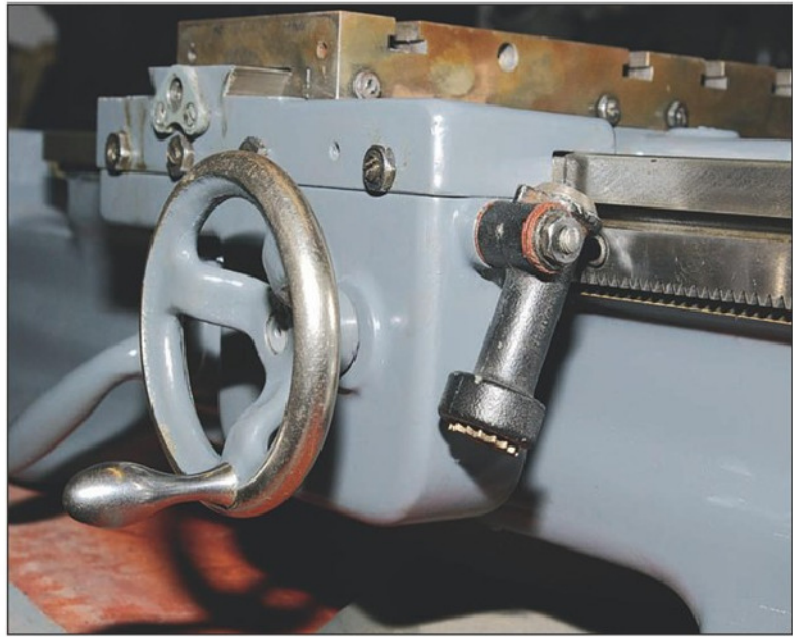


Photo 9. The rack and apron.

depth of which is about 100 thou. As well as the main divot, there were numerous pock marks probably due to rust, as well as chips out of the edges of the shears. Myford are good, but not even they could recover this one!

Since the last instalment of this series, I have thought long and hard about the condition of the cross and top slides, and despite the vast improvements due to the welding and surface grinding, I decided to obtain new ones. The top slide was sprayed and the parts were fitted, **photo 8**.

Excessive backlash

Another interesting point arose when moving the re-assembled saddle and apron along the bed via the apron hand wheel. Some excessive backlash had crept in. When the bed was reground at Myford Darren refitted the rack, apron and saddle, and there

was no backlash evident. It then occurred to me that he nipped the rack mounting bolts just tight **photo 9**, and using a soft faced hammer tapped it down towards the apron, traversing the saddle as he went to make sure that the play was negated at regular intervals. The apron was then run along the bed to ensure free running and the bolts were then tightened fully. I repeated this exercise and hey presto, no backlash.

The gearbox, motor and clutch

Now we had some of the main parts assembled it was time to mount the gearbox, motor and clutch assemblies. Firstly the gearbox was re-assembled, and then mounted onto the lathe, but without the top cover. A DTI base was mounted onto the cross slide, with the pointer resting on top of the machined portion of the gearbox casting. The saddle was then traversed along the bed to determine the parallelism of the gearbox to the bed. This was adjusted and the bolts tightened fully in place.

The cover, gear lever and new gear selector plate were then attached, **photo 10**. Note that the new design of selector plate bends over the front of the gearbox and as such, one of the holes doesn't quite line up. This will need to be drilled and riveted. Note to self: Create a snag list!

When cleaning the leadscrew, Harry noticed some rounding of the threads, and whilst I couldn't remember any play when I first bought the lathe, we swapped it for a spare one. This was mounted without effort. The only thing to remember here is that whilst we don't want any end float, tightening the handwheel excessively induces additional and unwanted friction. (Editors note: see MEW issue 138, Converting A Myford To CNC for fitting thrust bearings to the leadscrew.)

Next came the mounting of the motor, and the other thing I was dreading, the notorious pre 1958 clutch. Whilst Harry built up the clutch assembly on the bench, I mounted the motor, and belt guards, **photo 11**. (Editors note: Under no circumstances dismantle a post 1958 Myford clutch. Some versions can eject

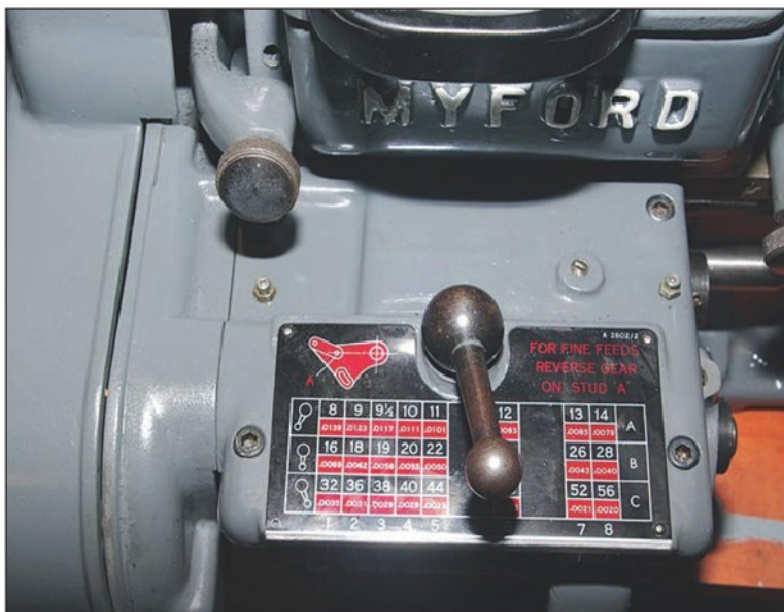


Photo 10 –Finished gearbox with new selector plate.

the centre push bar at a dangerous velocity. Return to Myford for servicing.) Yes, I know a new belt is needed, another thing for the snag list. Myford offer motors ranging from 1/2hp single phase to 1hp 3 phase and whilst I didn't buy one from their range, I opted to take the middle ground and chose a 3/4hp 3 phase ABB motor sourced from Ebay controlled by a new IMO Jaguar VXSM inverter. The original 5/16in. bore in the motor pulley was bored out to 19mm to suit the new motor and a new keyway was cut.

The clutch lived up to its reputation. I think Harry built and stripped it three times on the bench and another twice when fitting it to the lathe. We now know it's workings inside out. It also brought about a debate as to whether to allow clutch slippage or belt slippage when under excessive load. We opted for belt slippage on the basis that whilst either one produces a stalled mandrel, a slipping clutch which cannot now be bought as a spare is therefore irreplaceable, whereas belts cost less than £10.

In my last article, I mentioned that I had a spare countershaft pulley in case the original one with the welded section didn't come up to scratch. Well, we couldn't use the spare because the central hub was not wide enough to take up the end float in the countershaft without fouling the belt housing. Also, it wasn't a double pulley, so I would have lost some flexibility in gearing so I opted for the original, **photo 12** and to date it has proved more than adequate.

At this point the lathe was starting to look finished. However, I still had to mount it onto the stand, level it, fit the DRO and the inverter, do the wiring, fit the coolant pump, the power cross feed system, and write this article. Whoever wrote the 80/20 rule certainly was right. Twenty percent of the work does take 80% of the time.

Reuniting the lathe with the stand

The stand had been placed in its new home in the workshop and the drip tray levelled for a few weeks, so we wheeled over my temporary bench, an old yet sturdy TV stand that had been the home

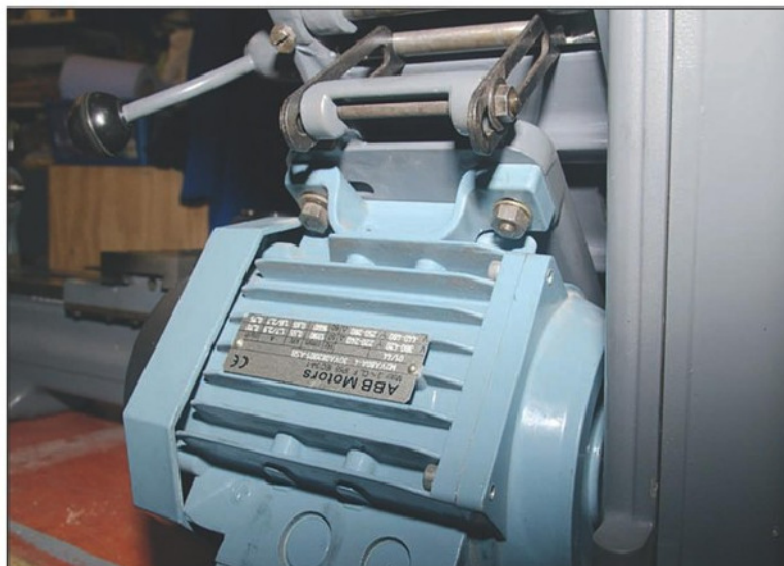


Photo 11. 3 Phase motor is in place.

for the lathe for the past two weeks. To save too much lifting, we chocked up the lathe until it was within half an inch or so of the level of the raising blocks. The mounting points on the raising blocks were checked for height, they were all set at 1.000" above the blocks. Hopefully, this would mean an easier time in levelling the lathe once mounted, and provide a good starting point for the fine tuning of the lathe. The lathe was more or less slid across into place with little effort, and then loosely bolted down, **photo 13**.

The Editor has written a piece in MEW Issue 138, The Practical Engineer about lathe levelling and fine tuning so I won't repeat it here. All I will say is take the time to do it; it does make all the difference in performance.

Testing the lathe under power

Essentially, the lathe was complete, so it was oiled, the inverter was temporarily connected, and it breathed again. We left it running at various speeds for 15 minutes



Photo 12. Motor pulley and belt.

or so, and then checked for any warm bearings, oil leaks, and loose bolts etc. The only problem we found was that the clutch appeared to slip, so it was adjusted, and we then ran the lathe at low speed for another 15 minutes traversing the saddle up and down the bed under power to bed in the gearbox and leadscrew assemblies. After another run round with the Allen keys and spanner, we called it a night.

The electrical installation

Early the next day, I decided to tackle the electrical installation. Given that I planned to use coolant on the lathe, I decided to use "SY" rated cable for the motor to inverter connection, **photo 14**. This is a sheathed multi-core cable covered in wire braid, and then enclosed in a further plastic outer coat. At only £3 or so per metre for 4 core 2.5mm², it is flexible, moisture and abrasion resistant, and is used extensively in industry. Cable glands were used to avoid cable stresses and moisture ingress into the stand. N.B. the mains cable will be replaced with "SY" cable once the local electrical wholesaler has it in stock. Another one for the ever growing snag list.

My plan was to mount the inverter inside the top of the stand tucked away to the left of the drawer, with a control panel mounted on the front face. **Photo 15** shows the bottom of the inverter mounted on its RFI filter, tucked up in the stand. My apologies for the poor shot but I couldn't get the camera any closer.

The plastic control box was mounted to the left of the drawer, **photo 16** and 2 x



Photo 13. Mounted on the stand, the lathe is starting to look the part.



Photo 14. Motor and Mains cable Glands.

20mm holes drilled, one to cater for the mains cables, and the other for the low voltage control cables for the inverter. Rubber grommets were also fitted to avoid cable chaffing. It is a good idea where possible to run mains and low voltage cables separately to avoid interference.

Initially, I had decided to use an Emergency Power Off push button switch, but subsequently, after reading the inverter manual and coupled with my own workshop practices, I decided against it. In industry it is standard practice, and I think a legal requirement on machinery, as well as "no volt" switchgear. However, the main power switch for the lathe was to be mounted on the same panel as the inverter controls, and its position will be second nature to me because I use the same layout on all the control panels on my workshop equipment. I have also positioned it so that it would be difficult to switch on accidentally. Further, the inverter has a function such that if the power fails it will NOT automatically switch on when power is returned. This is my solution, and not the only way of achieving this. If you fancy using an inverter, but are in doubt about electrical matters please seek the advice of a professional.

On to the DRO

You will remember that I decided to purchase the Sino SDS6-3V from Jade Products (Rugby) Ltd. I chose this console because of the advanced functions, the ability to use metric and imperial units in the advanced functions, and the segmented error compensation function.



Photo 16. Lathe and inverter control panel.

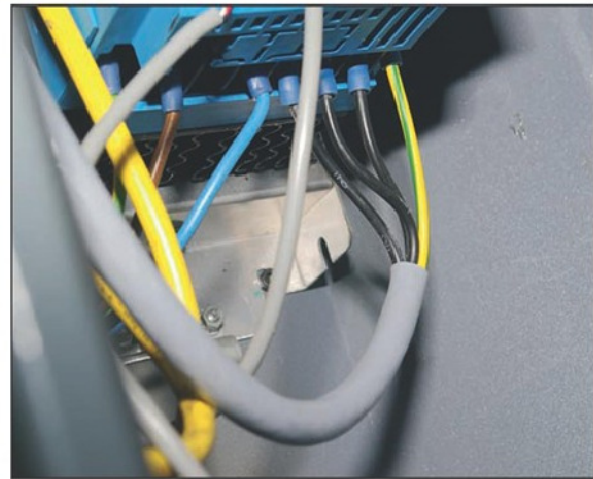


Photo 15. Inverter mounted in cabinet.

Further, the console is multifunction, in that it caters for lathe, mill, EDM and grinding functions, and could be swapped between machines equipped with the reading heads. It was the right price for me, and the whole system including the reading heads was backed by a 3 year warranty, which is not something that everybody offers.

Fitting the DRO

How it should be done has been in the back of my mind for some time. I have scoured the web and seen the various pictures showing how others have done it. Some good suggestions came to mind but I thought that there were good and bad points to each method.

My constraints were as follows:

- I wanted to fit the carriage (Z0 axis) scale so that it would not impede the fitting of a taper turning unit.
- The cross slide (X axis) scale should not impede the tailstock, saddle lock, the fitting of the travelling steady, or reduce the lathe centre height.
- The topslide (Z1 axis) should be able to fit without impeding the cross slide

or tailstock, or decrease the lathe centre height.

So, I decided to fit the Z0 axis scale on the front of the bed under the saddle, and I used the lathe feet as a datum. After all, the lathe bed had just been reground and the feet had to be parallel to the bed. Also, even though the scale is protected by a cover from moisture and dirt ingress, it is further protected by being under the saddle. The scale was mounted on a length of 30 x 30 x 3mm aluminium angle which was relieved to fit around the bed mountings. This was then bolted to the bed of the lathe after marking the relative end positions i.e. so that the scale did not run out of travel at one end or the other. The actual reading head was coupled to the saddle via one of the supplied brackets, **photo 17**. When I get some spare time this will be modified to tidy up the aesthetics.

Given my time constraints on this article, I have fitted the X axis scale, **photo 18** but it does break one of my constraints because it does impede the travelling steady. However, I did manage to keep it 0.1in. clear of the motor, **photo 19**. For the

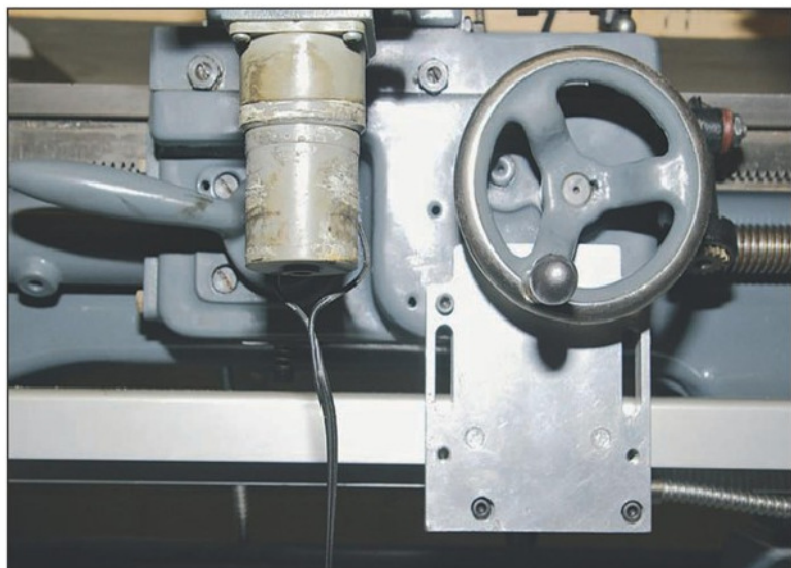


Photo 17. Y axis SINO reading head mounting.

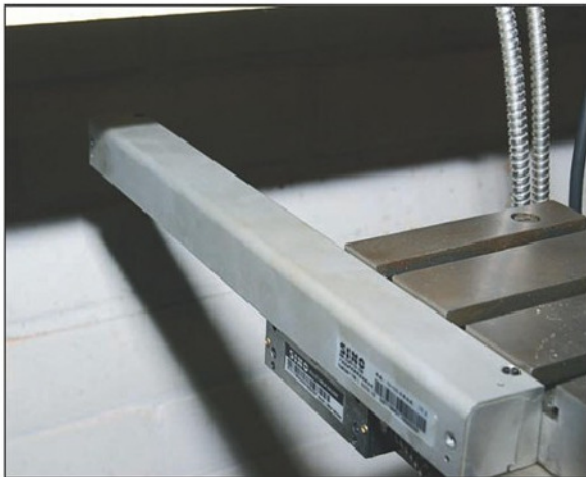


Photo 18. X axis SINO reading head mounting.



Photo 19. X axis SINO reading head clearance against motor.

life of me I could not see a way of fitting a scale to the topline tidily, so I rang John Devonport (Jade Products) to seek some advice. I originally chose the slim line KA-500 scales due to space constraints, knowing that they were the smallest scale available at that time. But subsequently, I have realised that a tidier installation could have been effected by the just newly released smaller KA-200 scales. Two of these have been ordered (for the cross and top slides) and are on the way to me now, with the KA-500's being returned to Jade. Hopefully, they will have been fitted in time for the Harrogate exhibition.

A minor problem

Mounting the console on the lathe also posed a problem. I had ordered two brackets, one for use on the lathe and one for the mill, but I couldn't make either one fit to the lathe without fabricating some form of adaptor plate in time for the article deadline. In the end, the hammer drill made an appearance, and so the console bracket is mounted on the wall, **photo 20**. Again, I have now worked out a way of mounting the console, and it has been added to the snag list.

Setting up the console took less than 2 minutes. Many of the default setup settings can be used. In fact, I only had to change the console from Mill to Lathe mode, with the axis definitions and directions already set, and I was done. Inputting the segmented error compensation (SEC) values for the scales took some 15 minutes, but it only has to be done once per scale, and is a quite straightforward procedure. If however, you are considering using the console on multiple machines, you would be better NOT using the SEC because the console might be setup for a scale that has an error in one direction, where on another machine the scale might have the error in the opposite direction. The accuracy of the standard scale is on average better than 5µm or 0.005mm (0.0002" in.), so in everyday usage any error is minimal. If you really do need the accuracy the other alternative is to purchase the higher accuracy scales (1µm and 0.5µm).

Power cross feed

Photo 21 shows the coolant and power cross feed control panel. The coolant pump is controlled by the switch on the left of

the panel. Further, it is setup so that the coolant pump can only work when the master switch in the other panel is on. In the end I decided that because this is a feature project that I should abandon the "cheap" coolant system idea suggested in MEW Issue 137 and I have sourced a standard coolant pump and fittings. I won't go into detail here about the installation because it is "old hat" and very simple.

In the last issue I asked if anyone had any knowledge of DC motor speed control circuits suitable for the power cross feed. I have had some responses, and I thank those people concerned. I did manage to source a DC motor speed control from Quasar Electronics which is suitable for 6 – 16v DC motors, and at 3A output it is ample for the job at hand. The 12v DC comes from a power pack mounted in the top right of the lathe stand, and the directional control of the motor is via a three position double pole switch (in-off-out) in the centre of the panel, with speed controlled by the knob on the right. When setting up for the first time with a new motor, the only thing required is to adjust another potentiometer on the speed

control PCB for the minimum speed required. Stupidly, when connecting the new cable to the power feed motor I broke one of the small solder tags which means sourcing a replacement motor. Luckily, one of the correspondents from last month's issue has informed me that the motor is available from RS Components. I have yet to find it in the catalogue, but I will persevere.

Nearly done

Photo 24 shows the lathe in its current state. Overall, I am very pleased with the outcome. Having taken some test cuts on some 25mm FCMS the lathe appears to be accurate and quiet, with good speed control. The low range torque in back gear means some heavy cuts could be taken. The DRO is accurate and stable, with no temperature drift, something I have seen a fair amount of in the past. In terms of cost SWMBO would not be pleased, but this has become a labour of love.

If you are embarking on a restoration similar to this, let me offer you some advice. Pick your subject carefully, go and see it, write down the list of faults, write



Photo 20. The SDS6-3V Console mounted on the wall.



Photo 21. Coolant and power cross feed control panel.

down any potential faults, write down your extras and any sundries. Go away and find out all the costs including the potential costs and the extra's then add 25% to it, and you might be somewhere near. Only then decide whether to proceed. I can say personally that I found that the reward is excellent. I have a lathe that will outlast me, it is in almost perfect condition, I have learned a great deal, and gained a good friend. He knows who he is, but I will say it again, "Thanks Harry!"

I have a snag list of about 20 minor things that need sorting prior to the Harrogate show. Hopefully, I will have seen some of you there.

Comments and constructive criticism are welcome at: Richmond@richmond.dkaro.co.uk



Photo 22. Accessories shelf.

Resource List:

Myford Ltd - Wilmot Lane,
Chilwell Road, Beeston,
Nottingham, NG9 1ER.
Tel: +44(0)1159 254222

www.myford.com

Jade Products (Rugby) Ltd - 43 Long
Hassocks, Rugby, CV23 0JS.

Tel: +44(0)1788 573056

www.digital-caliper.co.uk

Westoby's Paints www.westoby.co.uk

Quasar Electronics www.quasarelectronics.com

RS Components <http://rswww.com>



Photo 23. G H Thomas rear toolpost mounted and ready for use.

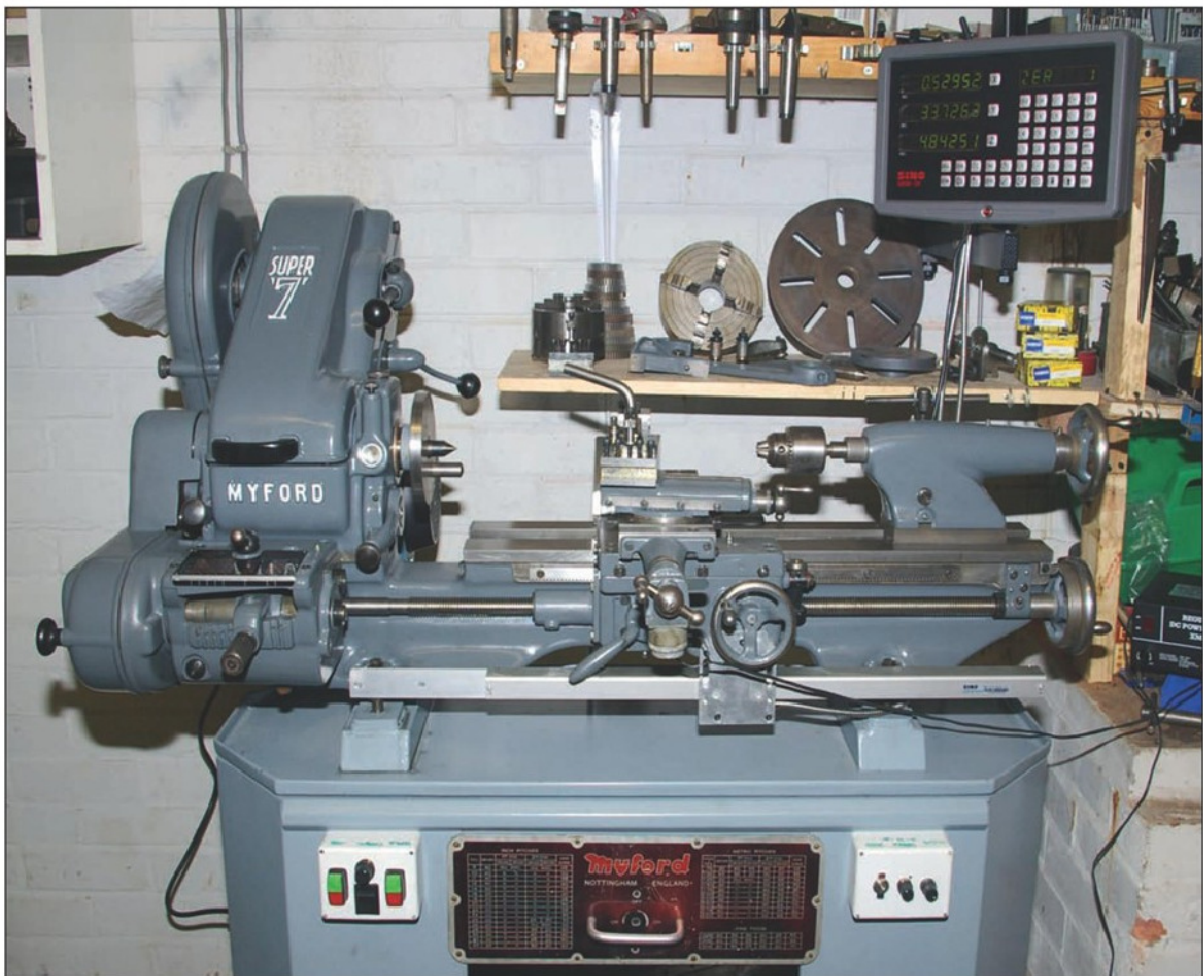


Photo 24. The finished lathe.

LOCATING PLUGS

Sometimes it's the laughably simple things which turn out to be surprisingly useful. Who would have thought a simple set of plugs could be one of the most frequently used tools in the workshop? Here's a set of locating plugs you can make very quickly, and which will save you lots and lots of time in setting up work.

Basic plugs

The basic requirement is for each plug to have a standard diameter and length of shaft, and to have a good finish on the head. The plugs shown in **photo 1** have a 6mm diameter shaft, 15mm long, and their heads have a range of diameters, from 3mm to 32mm or more.

Because the plugs have the same diameter of shaft (say 6mm or $\frac{1}{4}$ in.) they will all fit in one standard size of hole. Larger holes can hold a suitable adaptor, so the plugs can be used on the staking tool or the centre of a rotary table or various jigs. That way, the plugs will be versatile. The heads might be more or less the same thickness, but that's not particularly important.

Some applications

The swinging link on the rotary table, in **photo 2**, is located by an 8mm plug which is in a central hole in the table. The table itself has a 2MT centre hole, so there's a short 2MT sleeve with a 6mm plain hole in the centre of the table. My smaller rotary table has just a 6mm hole in the centre of the solid table.

Cross-drilling

Photo 3 shows a plug held in the drill chuck. That plug should be the same diameter as the work to be cross-drilled. The jaws of the vice are closed gently around the plug and then the vice is clamped to the table. If the workpiece is held in the vice, its centreline will lie

Marcus Bowman looks at a useful workshop accessory



Photo 1. A set of plugs.

directly under the centre of the chuck.

If you want to drill a hole a specific distance from the edges of a rectangular plate, put a plug of that radius in the chuck, then clamp two stops at right angles, located so that they are both touching the plug. When you replace the plug with a drill, the centre of the drill will be offset from each stop by the same amount (the radius of the plug). That saves marking out.

Sometimes, the end of a plate might need to be radiused in the mill, but it doesn't have an obvious location point for a plug. In that case, it's often worth drilling

and reaming a hole just for the purpose of location. **Photo 4** shows the mounting plate for a stepper motor and the small hole created simply to allow the plate to be located on the rotary table. There were two identical plates, so it was easy enough to get identical results. The plates were milled on the rotary table before the CNC mill was fully operational, otherwise it could have been done without the rotary table, but that's another story.

On the faceplate or in the 4 jaw chuck, it's sometimes useful to be able to line up on an existing hole in a workpiece. Simply hold the appropriate size of plug in the tailstock chuck and adjust the position of the work until the plug slides easily into the hole.

Turning the plugs

The plugs can be made from small offcuts and odd ends of bars, as they are required. Some of mine were made that way. But there came a day when I realised it would be more efficient to make a range of sizes so that I had them to hand. The trouble is that if you don't have the right size of plug handy, you tend to make do with a temporary setup but never quite get around to making the plug. If you have most of the common sizes to hand, your setups can be more efficient and more secure.

For preference, and an easy life, I used leaded free cutting mild steel (230M07 leaded) which gives a mirror-like finish, despite my questionable turning skills. EN1A will do almost as well, if you have that to hand.

It's a toss up whether you will get the best results from a high speed steel tool, or a tipped tool. A polished HSS tool will always give a first class finish if you use neat cutting oil, provided the tool has a tiny radius at the tip. Polish the front, side, and top faces with an oilstone then an Arkansas stone, and watch for build-up on

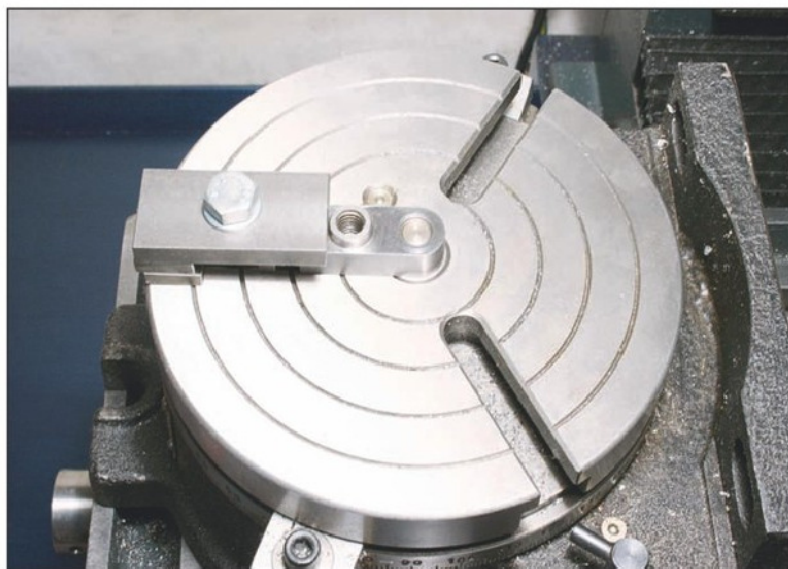


Photo 2. Locating a workpiece on a rotary table.

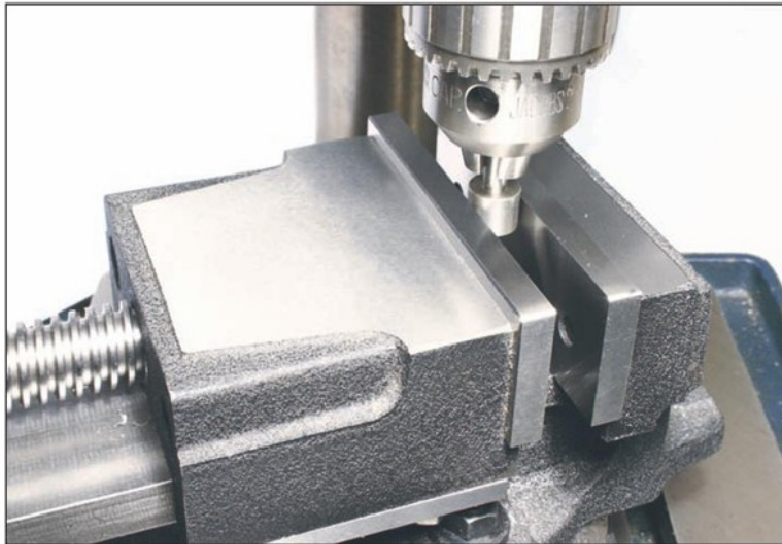


Photo 3. Aligning the drill vice for cross drilling.

the top face especially if you are using high speeds or heavy cuts.

Photo 5 shows two of my most used HSS tools; one with a tiny radius at the tip, and the other with a very generous curve.

A different way of tackling the job is to use tipped tools and **photo 6** also shows two equivalent tipped tools. The more angular tool has a small radius at the cutting edge, while the tip of other tool is a much larger radius.

The tipped tools are used at a much higher speed, and cut dry, of course. In either case, the shaft of the plug is finished using the tool with the tiny tip and the edge and front face of the head of the plug is finished using a tool with a larger radius at the tip.

I tend to use the angular tipped tool for the shaft and the widely curved HSS tool for the heads, because the shafts need a good finish, but the heads should have the best finish you can manage, and the HSS tool seems to do that.

The underside of the heads should be undercut, as shown by the arrow in **photo 6**, so that the plug sits down if it's inserted into a holder. A radius of any size between the shaft and the head of the plug will tend to hold the plug a little above the shaft locating hole, unless you put a suitable radius at the top of the hole. This is not a great worry with small diameter heads, but it does look a bit unstable and unsightly when the plug has a large head.

The angular tipped tool in **photo 5** has a swept back side face and will give a slight undercut, provided it is used with care. It can easily dig in and start to chatter because it can get trapped if it finds itself cutting on the front and side faces. As an alternative, you could use a graver to just

shave a delicate undercut from the plug head, **photo 7**.

The larger plugs

The larger diameter plugs are more easily made with a separate shaft. That way, we won't have to turn off lots of material to make the shaft. Over 22mm or so it's worth using a short piece of 6mm silver steel as a shaft. Turn the head on its own, and while it's still in the chuck, centre drill, drill, then ream the 6mm hole.

I used a so-called hand reamer. The name is misleading, because although they were once used by hand, they are normally held in a chuck, nowadays and the name only has historical significance. The taper on a hand reamer is gentle and quite long, so you'll want to make sure you can poke it right through the work so that it cuts its full diameter.

For a 6mm reamer, drill the hole 5.9 or 5.8mm before reaming. Best results seem to come from a slow speed, frequent backing out and copious amounts of neat cutting oil.

Loctite the shaft into the head. You may be surprised how slack the fit of the shaft in the hole can be. That's because of the tolerances at work. Below 25mm diameter, good quality silver steel has a tolerance of $+0/-0.010$ mm, so the largest a 6mm shaft can be is 6.010mm.

A decent 6mm reamer should be made to a DIN standard tolerance of H7 or the more generous old British H8. Assuming the tighter H7 tolerance, the reamer diameter will be between 6.002 and 6.008mm. The sloppiest fit will be when the silver steel is 5.990mm and the reamed hole is 6.008mm, a difference of 0.018mm, while the tightest will be when the shaft is

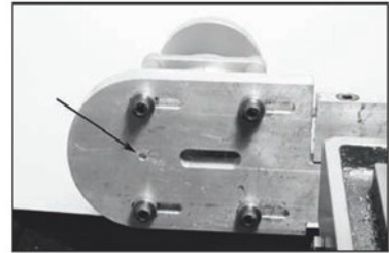


Photo 4. Location hole for a plug.

6.000mm and the reamed hole is 6.002mm. Either way, there will always be a clearance.

That makes this kind of fit an ideal candidate for securing with Loctite or similar adhesive, **photo 8**. Loctite 603 will cope with an oily surface, but it's wiser to clean the surfaces first. I use a cleaner/degreaser from the local gun shop, which is very effective, but it's highly poisonous and needs to be handled with care, **photo 9**.

Interestingly, Loctite is an anaerobic adhesive so it requires air to be excluded to cure. A narrow gap will help the adhesive grab relatively quickly, while a wider gap will result in a delay before the adhesive begins to set. In this case, even the worst case sloppy fit is still on the tight side compared to the gaps that the adhesive will cope with because Loctite 603 can still set when the gap is 0.25mm, although the initial setting time is measured in hours rather than seconds.

After the initial grab, allow up to 72 hours for the adhesive to set to full strength, not that the plugs will be subjected to the kind of loads that would come anywhere near the limits of the strength of this adhesive, which is considerable. This is, after all, an industrial strength adhesive.

The easiest way to ensure the shaft is aligned properly in the head is to hold the shaft in the tailstock drill chuck and insert it into the head while that is held in the lathe chuck, **photo 10**. You might want to check the shaft is flush with the top of the head or that it protrudes just a tiny amount. Leave to set. Once set, face the plug head, thereby making the end of the shaft flush with the plug head. It's not essential, but it does make the job look smart.

As you finish each plug, stamp its size on the end face, so that you don't end up with a box of assorted sizes

A tip

Up to about 22mm, turn the larger headed plugs first. That way, you won't be too embarrassed if you turn the head a little too small. The next size down will still be within striking distance. Never happens in



Photo 5. Tool shapes.



Photo 6. Solid plugs need an undercut.



Photo 7. A watchmakers graver.



Photo 8. Loctite 603 adhesive.



Photo 9. Birchwood Casey degreaser.

my workshop...

You will want to be realistic here. What's important is that the head is never larger than its nominal size. A tad under is fine and you can define the technical term "tad" to suit your own standards. A few tenths of a millimetre should be close enough for most work, but don't beat yourself up over it.

Where you end up with a plug just a whisker too large, it can be difficult to just shave a smidgeon off without taking too much. That's the point at which you might appreciate a pivot file, **photo 11**. The file end is perhaps a bit coarse for the kind of finish we want here, but the burnishing end can work magic. Use some spit as a lubricant, and take care. This is a hand held tool, so keep cuffs and clothing well clear, watch out for the chuck jaws, and keep the tool firmly under control. The pivot file is particularly useful on the shafts, because the edges are swept back at less than 90 degrees and can reach into

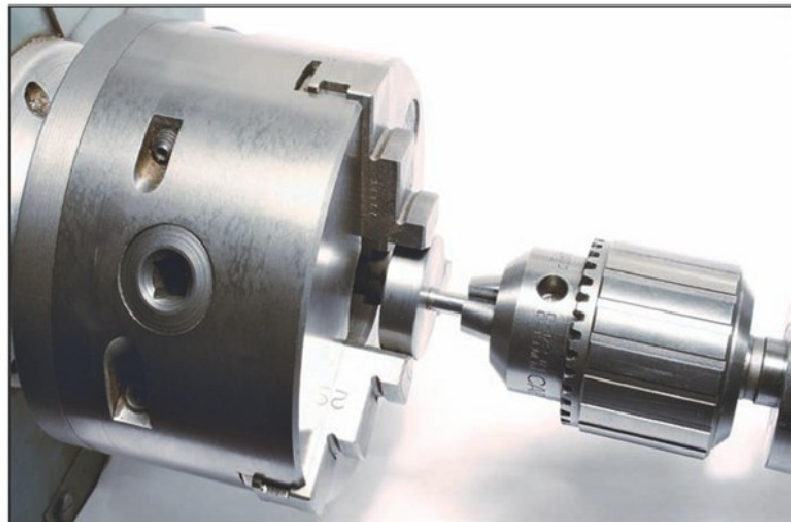


Photo 10. Aligning the head.

the corners. If you haven't used this kind of tool before, you'll want to practice on something else first.

Storage

I keep my smaller plugs in a block of teak I happened upon. You can use almost any common wood, the denser the better, but do avoid oak because it attacks steel.

Drill the shaft holes 0.1 or 0.2mm larger than the diameter of the shafts. The holes for the plugs which have head diameters less than 6mm can be drilled to a constant depth, leaving the heads protruding fully so that you can get them out easily. In a close-grained wood, an ordinary jobber



Photo 11. The pivot file.

drill will cut a neat hole if the speed is high enough. Varnish the block if you have time, and put a generous spot of oil in each hole to protect the shafts.

These little plugs are a relaxing exercise, but you will be surprised at how many applications they have. A decent set can be knocked out in no time at all, and they look the part sitting next to the lathe, drill or mill. 

IN OUR NEXT ISSUE

Coming up in Issue 140 will be



Learn how to fit a back plate to a lathe chuck.



Make a versatile lathe stop - easily adaptable to many makes of lathe.



Harold Hall shows you how to make and use simple drill jigs.

ISSUE ON SALE 20 JUNE 2008

(Contents may be subject to change)

Scribe a Line

Please send your letters to Scribe A Line (or Readers' Tips), The Editor Model Engineers' Workshop, Magicalia Publishing Ltd., Berwick House, 8-10 Knoll Rise, Orpington, Kent, BR6 0EL or e-mail to david.clark@magicalia.com and you will have the chance to win a book. Please remember to include your name and address with the letter and also in the email. I normally answer letters where necessary but a lot just get put in a letter tray (after reading them) ready to insert in Scribe A Line so please be patient. Emails are normally answered very quickly although please allow at least 12 hours for reply. I have a copy of a book from the Workshop Practice range to give to the writer of the best letter (the editors decision is final) and also another book for the best readers' tip in each issue. If you would like to purchase a copy of any book in the Workshop Practice series, please e-mail customer.services@magicalia.com for prices or visit www.myhobbystore.com to order online.

Michael Gilligan receives a bonus book by way of saying thank you for subscribing. This was a one off, don't all write in at once. Phil Mason receives a Workshop Practice book for his email and David White receives one for his excellent tip on the C3 lathe accessories.

Star Letter

Subscription offers

First ... congratulations on another excellent issue. Your CNC series is off to a good start, as is Tony Jeffree's. Your editorial note about Subscriptions caused me both delight and irritation. I was delighted to see what an honourable position that you are taking on subscription "offers" ... and [of course] am irritated to have missed out. When I renewed my subscription [and changed from pre-payment to Direct Debit], I was infuriated to find that there were several better offers available to new subscribers. I came close to cancelling my subscription and then starting afresh ... but in the end was pragmatic and simply renewed. [You will recall that, despite this, we nearly missed issue 135; although the situation was saved by your personal intervention.]

This is a sensitive area for many of us ... The Nationwide Building Society's TV advert "Brand New Customers Only" says it all.

I am sure that your present stance will be greatly appreciated.

Michael Gilligan by email

Stop press

I have just received permission to print extracts from the Clarkson Autolock handbook. It is too late for this issue but it will appear in issue 140. I have decided to print the information in the two centre pages of MEW so that you can photocopy it and hang it up in the workshop.

Electrical braking

A question for all you Electrical Gurus out there. I have Chinese lathe, marketed here as AL320G. It has a 150mm chuck, the 4 jaw is bigger again; it is belt driven by a 1 hp cap start motor. I can live with having to stop and start the motor, but waiting for the chuck to stop spinning is a bit tedious.

I have experimented with injecting 12v d.c. to stop the motor, and it works fine (I used a similar motor, sitting on the bench).

Does anyone know of any adverse reactions-motor life, shock to the gear train? I have been told the braking effect is savage enough to snap shafts when used on large fans for example, but that it can be modified using light globes in series. I am an electrician, and do understand the potential for outright disaster.

A mechanical clutch/brake arrangement would be nice, but I can't come up with a mod. that would be economical, in either an engineering or monetary sense. The realization that buying another, more appropriate lathe would be cheaper has come too late! Many thanks.

Nigel Norton by email

Does anyone speak Chinese scales?

A few years ago I fitted a 3 axis glass scale D.R.O. system to my Super Lux milling machine. This was a great success and worked perfectly until about a month ago when one axis failed. As this axis was moved only the least significant digit on the read out flickered 0 or 5, the other numbers remained constant. The glass scale itself was proved to be O.K. by substituting the sensor from one of the other axes, so the fault is in the sensor electronics. The scale is a KNUTH DIGIDATA model IV. And is common to the different lengths of linear scale units. In the sensor there is a small printed circuit board containing an LM339N (four voltage comparators) DIL I.C. along with other components.

Rather than go to the expense of replacing the whole scale, I wish to remake this circuit and repair the one I have. This would reassure me regarding similar problems arising in the future. Can any reader supply information and/or a circuit diagram for this unit?

Garth Shepherd g_n_shepherd@sky.com or contact the Editor.

Setting datum's for MACH3

Having been through the exercise of modifying my X1 mill for CNC and using Mach3 and Dolphin CAD/CAM software I have found that the industrial practice of homing the machine on switch on and

Star Letter

The C3 lathe from Arc Euro Trade

I read with interest the letter by DJ Harris and your response in the

May edition, and in particular the comments on the factory spec. (i.e. unprepared) C3 lathe from Arc Euro Trade. I bought this lathe from Arc because of the exceptionally low price (about £260 at the time) compared with some of the mainstream suppliers who wanted more like £400. Having researched the topic fairly well on the internet, I accepted that I would need to do some work on the machine prior to using it. Your article by David Fenner was enormously valuable (and in fact introduced me to your excellent magazine). I did however get the impression that David must've got an easy one, however! I had to do the following additional work to my lathe:

- Remove 2mm of material from the curved change-wheel holder so it would fit over the screws correctly.
- Shift both pillow blocks for the leadscrew vertically – on delivery it was not parallel to the ways by a significant amount and would cause seizure on power-feed.
- Drill out the detent holes for the forward/reverse lever.
- Modify the tailstock so that the locking screw was accessible from the top – my tailstock centre was off-axis by 0.2mm on delivery and it was virtually impossible to align it without doing this mod.
- Slacken off the motor drive-belt to stop squeaking at 300/600 rpm.

There were times during this process when I started to lose heart and question my decision to purchase an unprepared machine (although the ARC staff were very helpful when I called them on certain issues). However, now that it's all done, I have a machine which runs like a dream and in which I have confidence. Moreover, I have learned an enormous amount about the lathe and how to maintain it in the future. I would recommend the unprepared machine to anyone with a modicum of skill and confidence (and a lot of spare time) who wants to get to know their machine properly.

Phil Mason – Bristol

using offsets from a known position is not really readily adaptable to the home workshop and the way I, and I suspect many model engineers work.

When using CAD/CAM the drawn part usually has a drawing datum and a CNC datum, both of which can be anywhere on the drawing but more usually located at a convenient edge point or points on the part being drawn. They both need not be in the same position but I find it mostly convenient if they are and locating them where I know it will benefit the ease of set up on the mill table. With Dolphin CAD these datum's can be moved at any time so they may not always reside in the same place during the development of a drawing.

Having now got the datum's, it then remains to align the work on the mill table so that the work can be cut out within the material extremities. With the CNC datum known in respect of the material blank extremities the mill quill can be centred over the CNC datum and the X and Y coordinates set to zero and the part cut without reference to home position or offsets. Likewise the Z zero is set by using the uppermost face of the material as the zero reference point.

Whilst it is fully appreciated that some operations will need a more complicated set up, the foregoing in the main will account for the large majority of the home workshop use of CNC where parts are being machined from a blank.

As I am not a CNC machinist and totally self taught, I offer the thoughts of a beginner!

Alan Marshall by email

The editor replies: I have listened and have incorporated Alan's suggestion into this month's CNC article.

Free CAD package

For anyone interested in obtaining a 2D drafting program check out this site: www.solidedge.com/free2d

It is what it says on the package. Totally free! It is a bit of a pain to go through the subscription form to obtain the download, but well worth the effort.

Danny Rearden by email

Alternative CAD

Commenting about David Haythornthwaite's article on using CAD for a stepper motor hand control wiring diagram, an ordinary paint program is useful for coloured wiring diagrams such as for a motorbike. I drew mine with A2 as the paper size in the computer, zooming to screen size for rough laying out and up to A2 for fiddly bits and lettering. It is perfectly clear in A4 and is now a laminated workshop aid.

Colin Porter - Blackpool

The Practical Engineer - Lathe alignment

I've just received the May edition of your excellent magazine and as usual have spent the last 24 hours reading it from cover to cover - it's like a good book you are so disappointed when you finish it.

Anyway the reason for email is that referring to The Practical Engineer article, I was wondering what the corrective action would need to be if the micrometer readings of the test bar had been different. For example what would one need to do if

Best Tip

An alternative vertical slide for the C3 lathe

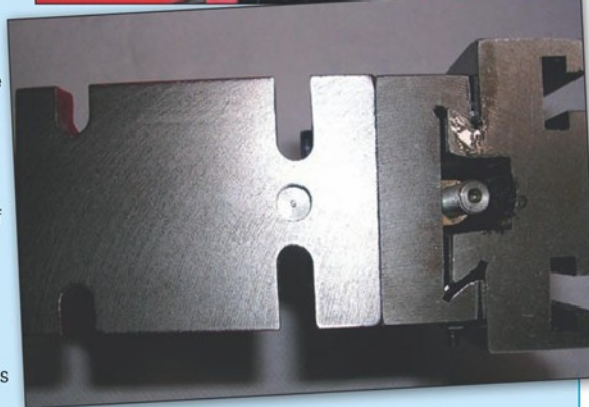
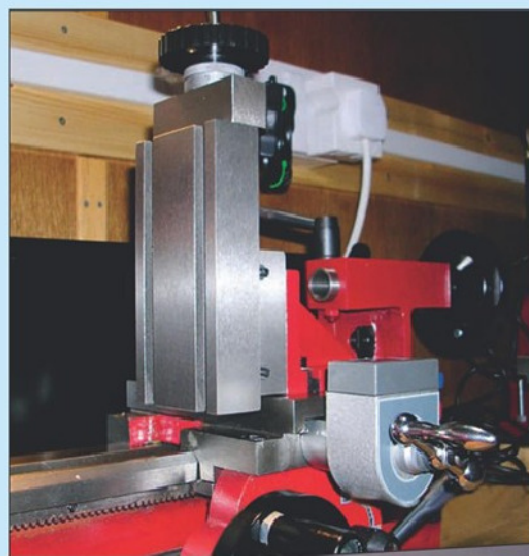
It has occurred to me that others may be interested in a couple of tips for using the Sieg C3 Mini lathe. The first tip concerns the milling slide for the C3 Mini lathe, which has featured in Dave Fenner's recent articles. I must admit that I am not too keen on this because it has no T slots but rather an oversized tool holder style clamp which moves up and down on the dovetails. This is not a particularly flexible arrangement and greatly restricts the work holding possibilities. On the other hand, the milling slide for the smaller Sieg C1 lathe does have T slots on the slide and oddly enough is pretty much identical in size to the C3 slide. I examined pictures of the C1 milling slide to see if it looked possible to mount it on the C3 Mini lathe. I convinced myself there was a fair chance that it was possible and duly ordered a C1 milling slide, at half the price of the C3 variant!

The C1 milling slide sits on the C3 cross slide in place of the compound in the same way as the C3 milling slide. In order for the C3 lathe to accommodate the C1 milling slide, the two mounting slots nearest to the slide proper must be extended inwards to accommodate the 1.25in. spacing between the mounting holes on the lathe cross slide and an 8mm hole drilled 5mm deep at the midpoint between the slots to accept the mounting stud on the cross slide. Straightforward operations if you have access to a milling machine but a bit tedious otherwise.

The C1 milling slides, like the 50mm quick vices, are available from a number of sources. They are designed to fit directly onto the C1 cross slide.

Secondly, although not advertised as such, the economy QCT1 quick change toolpost and QCT4 quick change toolpost starter set from Chronos can be used on the C3 without modification. Although the mounting hole purports to be $\frac{3}{16}$ in. it is in fact 10mm and so no boring out is required. The tool holders slip easily into the toolpost. I replaced the cap screw, which is tightened to lock the tool holder in place, with an indexable handle. Sieg's own economy quick change toolpost is a little more inconvenient in use because the moving male dovetail tends to rotate a little as an attempt is made to insert the tool holder into the toolpost. This makes tool holder insertion a fiddly two handed job unless you modify the toolpost to prevent the rotation.

David White by email



the head stock reading of the test bar was greater than that at the tail stock end and vice versa (photos 12 and 13 page 35) assuming all the setting up to this point had proceeded satisfactorily as per the article?

Jim Macintosh - Bedfordshire

The editor replies: I have addressed this at the start of the current Practical Engineer article. If any one else has thoughts on this, feel free to write to Scribe a Line.

Brushless outrunner motors and castings versus fabrications

I thought the article on these motors was excellent and it is on my list to have a go at some time. We had a graduate student at college who did his thesis on these motors with a view to making a simple ESC, we failed miserably. It would start up but appeared to get to a rev limit beyond which it would not go. It is in the feedback from the motor which tells the electronics

where the rotor is. In the early days there was a separate magnet and Hall effect chip which did this, but no longer.

The price of these controllers is tumbling fast so I cannot see any point in making ones own from discrete components. Most of the clever work is done by a PIC anyway, so unless you are conversant with programming these units it is a non starter. The servo driver is a different matter and a number of designs for these have been published. RS printed a circuit diagram on their data sheet 232-2425 and Ken Ginn shows one in his book Electronic Projects for Model Boats which was published by Argus. It is basically two 555's producing a pulse every 20 milli sec of width varying from 1 to 2 milli seconds. Inwood Models (usual disclaimer) show testers for £17 so it is barely worth making one. Just as an aside the motor in your DVD drive is the same type of brushless motor and they have been used very successfully to power small planes!

On the issue of castings it is getting much more difficult to find small foundries prepared to do this work. I believe we have to ask the question: Does it have to be a casting? Wheels are probably going to have to be cast but stretchers, motion brackets, horn blocks etc. can all be fabrications. With a little thought as to how the parts can be self jiggling, by using tabs and slots, a bracket, which was once a casting can be made very quickly. There is a lot less cleaning up to do, it will be square and there are no hard spots to cut away. On the actual locomotive many of these parts would have been fabrications anyway.

I am enjoying the different articles and technology now appearing in MEW, keep it up David you are doing a good job.

Malcolm High by email

Keeping chuck threads clean

I was interested to see John Slater's method in the December issue. Another method which I have used successfully for several years is to bolt two toothbrushes back to back. Most supermarkets sell straight handled toothbrushes which are suitable.

On both my Myford series 7 and my elderly Zyto lathes these, screwed through the threads, work very well. If there is a tendency for a lot of grease and oil around the thread, I have found that moistening them in white spirit will remove this, and once the bristles get dirty I wash them off in a drop of white spirit, which gets any small particles out of the bristles.

I have another method, which is a false nose turned up for the Zyto, (thread is 7/8in. BSW), I filed a couple of nicks in the lead-in on the screw. This is excellent at removing muck. I really must get round to making the same up for the Myford.

Ted Jolliffe Clapham, Beds

Workshop layout

In response to Charles Waterton's request for help in the layout of his workshop - here is how I have tackled this problem in the past. First, I draw up the space available. Then I draw each machine to scale, with felt tip pen, on coloured transparent plastic film after which I then draw the outline of the space required to operate/ access the machine. These drawings were then cut out so that you have a piece of material with the machine on it and a coloured transparent

outline. These are then juggled around the available area until a possible solution was found. The object of the use of the transparent material, is that whilst obviously two machines cannot use the same space, in the layout, the working areas can overlap, that is, assuming that only one person is using the various machines.

I then used a bit of Blu tack to stick each piece into place and then photocopied the trial layout. Repeating this process then gives one the opportunity to come up with a number of possible options, which can be thought over until a final optimal solution is arrived at.

Incidentally, I found in industry that, although it is tempting to place machine tools square to, or parallel to walls, placing them at an angle, say 30 degrees, facilitates access behind them for cleaning and adjustment.

Chris Pattison Auckland by email

Setting the spin indexer true

Reading the article on modifications made to a spin indexer last Month prompted me to write in with my mod. I machined the base side faces parallel to the indexers axis so that it could be set up on the mill with the minimum of set up time.

I fitted a 1in. 5C collet to it and held a length of ground stock protruding from either end which was supported in raised vee blocks. The base underside was fixed to a bolted down angle plate using G clamps. The base side face was then machined. The same set up was used for milling the opposite face.

To set up the indexer parallel with the milling table, I have two machined blocks that fit tightly in the tee slots. The indexers newly machined side face is butted up against these blocks and the indexer is clamped down to the table.

John Roberts by email

Mounting vices on milling machines

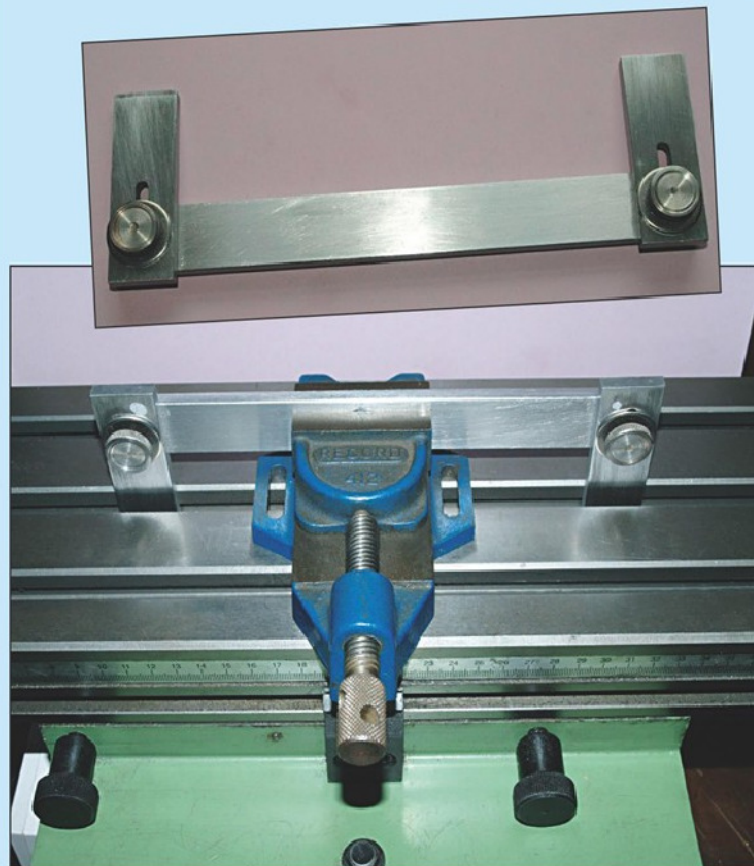
Harold Hall (Metal Workers Workshop, Part 11) describes setting up a vice using a square from the front edge of the machine table. However, many vices do not have a straight machined edge to set to, and I am sure there are other methods.

I have used a very simple method which I read about around 1994, but hands up - I can not remember the source. The essential is that the vice jaws are set parallel to the table T-slots.

If a robust steel flat (mine is 1 x 1/4 x 9in.) is provided with two short, vertical extensions set at right angles at each end to form a short armed U, it can be held in the vice jaws so that the arms fall into the T-slots of the table. Thus with the arms held against either edge of the T-slot, the vice may easily be clamped up true. Again my own has slotted arms to accommodate vices of differing heights. "Clocking" the result shows a quite acceptable accuracy for my working.

The purists/experts may have ideas about this method - I would be pleased to hear what they think. As one with no engineering training, I have found it reliable for many years now.

Dr. Bruce Foster by email



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DIGITAL INVERTERS

Basic 220 Volts input - 220 Volts output

These small and compact basic 220 Volt output inverters allow you to run a DUAL VOLTAGE motor from a single phase supply, they come in sizes from ¼ HP up to 3 HP (0.18kW up to 2.2kW) and offer SOFT START, SPEED, ELECTRONIC BRAKING and JOG functions via the low voltage remote control terminals, they are perfect for fitting into workshop machines, it is often possible to connect the remote START/STOP and FORWARD/REVERSE to the machines existing controls as long as they are of the maintained type (IE not push button).

- ¼ HP (0.18kW) £77.50
- ½ HP (0.37kW) £94.95
- 1 HP (0.75kW) £134.95
- 2 HP (1.5kW) £189.95
- 3 HP (2.2kW) £239.95



We also offer ADVANCED INVERTERS in the same size range as above, these offer all the functions of the basic inverters BUT they drive the motor using a method known as torque vector modulation, this can only be used on single motor applications such as a lathe spindle and offer super smooth speed control over the full range and also full power even at very low RPM, in addition to this advanced inverters also offer extra functions like 3 wire START/STOP control so they can interface to a machines existing pushbutton control, removable display panels, built in PLC logic and advanced communication are just some of the extra functions these units offer, please contact us for more information and prices on this range. Prices start at £149.95



Basic 220 Volts input - 415 Volts output

These basic 415 Volts output inverters come in 3 sizes from 1HP up to 3HP and they offer all the functions of the 220 Volt output version BUT the fact they offer 415 Volts output means they can be used with motors that are NOT DUAL VOLTAGE, this would often be the case on older motors or on DUAL SPEED motors.

- 1 HP (0.75kW) £274.95
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All of the inverters above are available as IP-65 units for applications where dirt/dust or fluid ingress may be a problem, these units have a built in mains power ON/OFF switch, FORWARD/STOP/REVERSE selector and a SPEED CONTROL as well as a digital display and programming pad, please ring our sales office for pricing on any of these units.



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We offer a range of high quality aluminium 3 phase motors in sizes ranging from 90 Watts (¼ HP) up to 2200 Watts (3 HP), the 90 W motor being one that's small enough to hold in the palm of your hand with a 9mm shaft that's perfect for fitting to bench top lathes etc. Prices start at £39.95



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HOME AND WORKSHOP MACHINERY

Genuine Used Machines & Tooling

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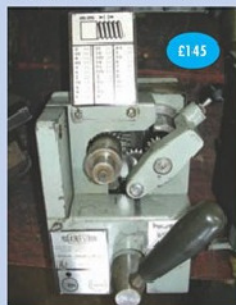
Opening Times: Monday-Friday 9am-5.30pm - Saturday Morning 9am-1pm
10 minutes from M25 - Junction 3 and South Circular - A205



Meddings, Fobco & Startrite bench drills



Elliot '00' Omnimill, one of the best ones yet!! vertical and horizontal



Ainjest / Colchester Student attachment, metric and imperial available



Denbigh No.6 flypress + stand



Boxford drilling (pedestal) machines



Startrite 18.5-5 240 volts bandsaw, 18" throat / 5 speed / non ferrous



Myford ML10, 3 1/4" x 13" lathe



Cowell's miniature lathe



Boxford CUD 5" centre height precision lathe



Myford Super 7B 3 1/2" x 19" power cross feed + indust. stand



Crompton/Tyco NEW motor for ML7/Super 7



GHA Alexandra engraving grinder + collets



SIP 39" high, 16 speed, 2MT 5/8", rack table NEW



JUST IN!!
Harrison M250 5" x 30 lathe

Myford/Boxford Accessories

Myford dividing head £395
Boxford dividing head £895
Myford vertical slide £100 - £245
Boxford vertical slide £345 - £425
Myford 6" 4 jaw chuck £90 - £140
Boxford 6" 4 jaw chuck £85 - £125
Myford collets boxed £275
Boxford collets + draw bar £175
Myford fixed steady £90
Myford travelling steady £40
Myford 9" faceplate £45
+++ loads more



Harrison pedestal grinder



Myford 1AS vertical milling machine / R8 taper



Brierley drill point grinder + wheels and followers



Raglan 5" lathe + gearbox and variable speed



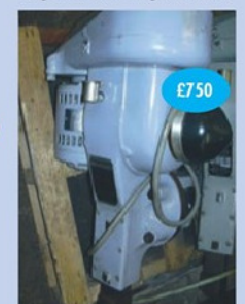
Boxford 1130 5 1/2" x 30" + stand



Colchester Student, gearbox + gap



Eagle Model 3 + magnetic chuck



Bridgeport slotting head



Milling/Drilling ground X-Y table

Also:

Myford Super 7B lathes with power cross feed; selection of seven

- Myford Fixed steady £90
- Myford travelling steady £40
- Colchester Bantam travelling steady £45
- Baty 0-1" (calibration certificate) NEW £30
- Baty 0-25mm (calibration certificate) New £30
- Micrometer 11"-12" M & W £55
- Micrometer 12"-18" M & W £120
- CEJ metric slips (as new) £245
- Engineers flat's £125 each
- Harrison (lathe) jig boring table £175
- Boxford (lathe) jig boring table £145
- Burnerd 3 jaw chuck for Graduate wood lathe £70
- Meddings EMG tool grinder £475
- Marlow vertical mill (3MT) £950
- Viceroy vertical mill (30INT) from £495
- Super Brown cut-off-saw £345
- Pedrazzoli Aluminium cut-off-saw £345
- Viceroy sharpedge 10" wheel £150
- Clarke Strongarm 1 ton (fold up) crane £125
- Epco 1 ton quality engine crane £245
- Clarke profile router 145 £175
- RJH Gerbil 2020 vacuum plastic cutting mch. £275
- Clarke 812V vacuum forming machine £345
- Draper WTL 100 wood lathe £100
- Multico K3 mortiser £475
- Startrite 145 sawbench £395
- Startrite 275 sawbench + sliding table £1950
- Startrite TA1250 sawbench + bells & whistles £2250
- Startrite 14-S-5 bandsaw £595
- Black & Decker radial saw £345
- Minor finisher 4" wide/ bench type £145
- Jones and Shipman No.2 arbor press £175
- Hearths (small pedestal model) £70
- Flamefast DS220 hearth £245
- Crompton 240 volt Myford motors NEW £155
- G & C 2hp 240 volts 1420 revs £120 each
- Brook 3hp 240 volts 2850 revs motor £120
- Denford CNC Microrouter £625
- Hulton Universal 12 Universal press £425
- Boxford PD4 2MT pedestal drills £245 - £295
- Burnerd 10" D14 Harrison M300 4 jaw £245
- Triumph fixed steady (round head)
- Colchester Triumph £175



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DISTANCE NO PROBLEM!

DEFINITELY WORTH A VISIT

ALL PRICES EXCLUSIVE OF VAT

Just a small selection of our current stock photographed!



Boxford STS 1020 lathe



Huntun Universal 12 / 12" throat press



'LO' Colchester drive/catch plates



Edwards 18" circle cutter



'LOO' face plate + we have loads more from Myford to Colchester Mascot



Myford Super 7B's with gearbox and power cross feed



RJH buffing machine 3000 revs



Myford MA99E collet chuck collets



Gabro 24" folder



EME (Elliot) swivel tilt vice



Gear involute cutters 'More just in'



More broaches metric and imperial



Q and S 6" power hacksaw + coolant



Colchester Chipmaster lathe



Boxford dividing head complete



Clarkson 40INT collet chuck + collets (we have 2MT-5MT and 30INT to 50INT in stock!!)



Burnerd Boxford 4jaw chuck (more variations available)



Myford ML7R 3 1/2" x 19" + clutch & stand



EMG tool grinder



Dickson toolposts to suit Colchester Mascot (others available)



Almost silent running 8 bar compressor



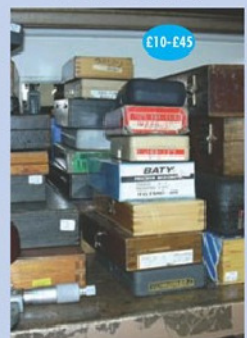
Crown Windley magnetic sine table MSPM44



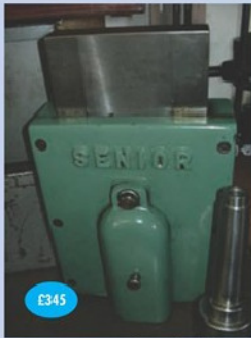
Flamefast double sized hearth + guns



Clarkson Mk1 tool and cutter grinder



Micrometers in (most sizes and makes)



Tom Senior slotting head



Harrison L5 travelling steady (LSA, L6, Student, Master also)



Boxford 'Little Giant' toolpost grinder



Mitutoyo 150mm - 300mm micrometer set as new



Van Norman 944 boring bar + tools



Denford Viceroy buffer's



Eclipse angle plates



Burnerd 'LO', D13 & D14 collet chucks



Myford dividing head complete with two plates as new



RJH vertical finisher + built in extractor

Please call
0208 300 9070
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or request our list

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SAWS



LATHES



MILLS



DRILLS

Chester Machine Tools

DB8VS



£699

Features
Digital Spindle Speed Readout • Hardened and Ground Vee Bedways • Offset Tailstock • Variable Spindle Speed • Metric & Imperial Thread Cutting • Longitudinal Power Feed • Cast Iron Construction

Distance between Centres 400mm
Swing 210mm
Motor 750w

Shown with optional stand

H110 BANDSAW



Special Offer

£149

Features
Max Cutting Capacity @ 90°
Round 110mm Square 100x150mm
Max Cutting Capacity @ 45°
Round 100mm Square 85 x 65mm
Blade Speed 52m/min
Motor 2400w
Power 1640 x 0.65 x 13mm
Blade Size 965 x 410 x 500mm
Packing Size 84N-SAW-H110
Stock Code

626 MILL



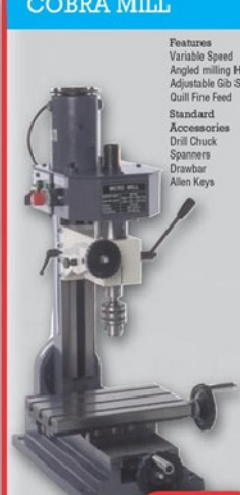
£1450

Features
1.5HP Motor • Metric or Imperial Machines • MT3 or R8 Spindle Taper • Head Swivels 90 degrees • Head Tilts 45 degrees • One Shot Lubrication System

Standard Accessories
Machine Work light • Central Lubrication System • Machine Stand • Table Guard • Drawbar • Manual & Parts list

Face Mill Capacity 75mm
Table Size 156x745mm
Motor 1.5hp

COBRA MILL



£319

Features
Variable Speed
Angled milling Head
Adjustable Gib Strips
Quill Fine Feed

Standard Accessories
Drill Chuck
Spanners
Drawbar
Allen Keys

Specifications
End Mill Capacity 10mm
Table 145 x 40mm
Speeds Variable 100-2000rpm
Spindle Taper MT2
Weight 25kgs
Size 480 x 380 x 680mm

CHAMPION 16 V MILLING MACHINE



£575

Features
Variable Spindle Speed • Dovetail Column • Digital Quill Depth Readout • Column Guideways Covers • Tilting Head • Large Table Size • Wide Spindle Speed Range

Standard Accessories
Drill Chuck • Drill Chuck Arbor • Chuck Guard • Drawbar • Manual & Parts List

Face Mill Capacity 50mm
Table Size 500x140mm
Motor 600w

Shown with optional stand

12" Multiformer



£164.50

Bending Capacity (Mild Steel) 1mm
Shearing Thickness (Mild Steel) 0.6mm
Max Bending Length 305mm
Rolling Thickness 1mm
Weight 45kgs

DB10VS LATHE



£949

• Digital Speed Readout
• T Slotted Crossslide
• Variable Speed

Supplied with full range of accessories:- 3 & 4 Jaw Chucks, Face Plate, Steadies, Machine Tray, Lathe Tools, Thread Cutting Gears

Distance between centres 550mm
Swing over bed 250mm
Spindle Bore 26mm
Speed Range 50-2500rpm
Motor 1200w
Net Weight 120kgs

DB7VS LATHE



£475

Supplied With Variable Speed
Digital Speed Readout
Hardened & Ground Bedways
Metric & Imperial Thread Cutting

Distance between centres 300mm
Swing 180mm
Spindle Bore 21mm
Motor 700w
Net Weight 55kgs

Supplied with full range of accessories:- 3 & 4 Jaw Chucks, Face Plate, Steadies, Lathe Tools, Change Gears, Machine Tray

COBRA LATHE



Special Offer

£199

Supplied With 80mm 3 Jaw Chuck • Lathe Tools, Steel Centre • Change Gears • Variable Speed • Splash Guard

Centre Height 70mm
Centres 250mm
Motor 150hp
Weight 30Kgs

CRAFTSMAN LATHE



£1549

• Powered Crossfeed
• Left/Right hand thread cutting
• Large spindle Bore
• Independent Powered Feed and Leadscrew
• Supplied with:- 3 and 4 jaw Chucks, Face Plate, Steadies, Machine Stand, Splash Guard, Thread Cutting Dial

Distance between Centres 570mm
Swing over bed 300mm
Spindle Bore 36mm
Motor 1.5hp
Net Weight 390kgs

CENTURION MACHINE CENTRE



£1299

Specification
Centre Height 210mm
Centre Distance 500mm
Spindle Bore 28mm
Drilling Capacity 25mm
End Mill Capacity 28mm
Size 1570 x 480 x 955mm
Weight 250kgs
Motor 3/4hp

Features
Powered Crossfeed • 2 Motors • 28mm Spindle Bore • Large Milling Table • Taper Roller Bearings

Standard Accessories
3-Jaw Chuck • Drill Chuck • Steel Centres • Change Gears • Lathe Tools • Vice

CHAMP 20V



£779

• Variable Speed
• Digital Quill Readout
• Dovetail Column

• Supplied with Keyless Drill Chuck & Arbor

Face Mill Capacity 63mm
Table Size 700x180mm
Spindle Taper MT2
Motor 1hp

D13 DRILL



Special Offer

£49

• Cast Iron Construction
• Supplied with Keyless Drill Chuck & Arbor
• 1/4 hp Motor

Drilling Capacity 13mm
Chuck Size 1 - 13mm
Speeds 600 - 2500 rpm
Net Weight 17Kgs

All prices include VAT. Delivery Free to UK mainland – excluding certain Scottish postcodes. Prices valid for duration of this issue only.



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