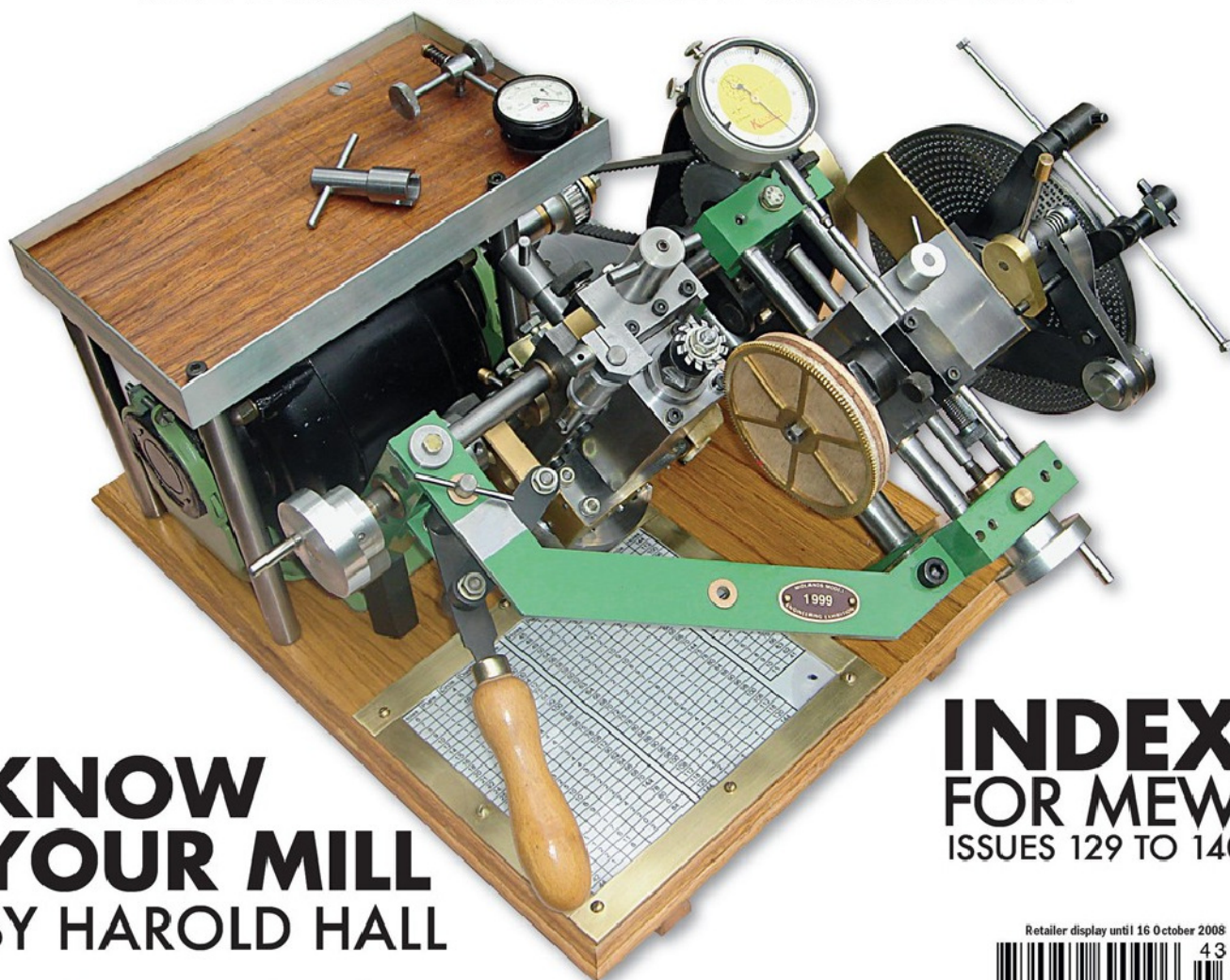


No.143

OCTOBER 2008

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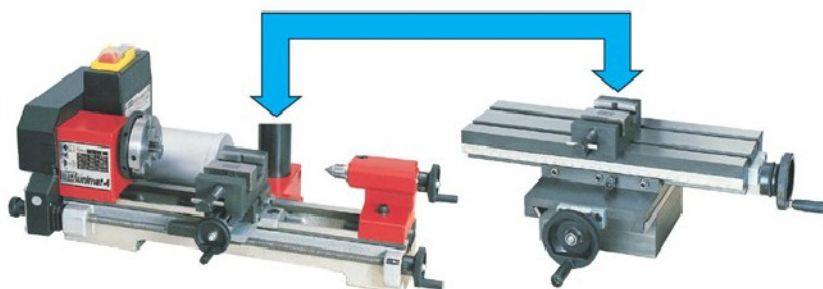
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Model Engineers' Workshop is published for \$6x per year by MyHobbyStore Ltd c/o EWA Magazines, 205 US Highway 22, Green Brook, NJ 08812. www.ewamags.com. Periodicals paid at Dunellen, NJ. Postmaster please send address correction changes to Model Engineers' Workshop Magazine c/o EWA at the address above.



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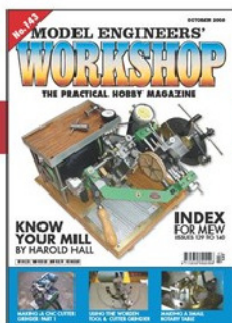
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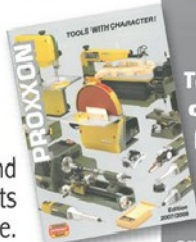
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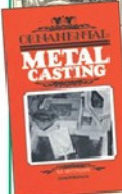
Dave Gingery's gas fired crucible furnace, above, whilst a superb design of which a fair few have been made, only melts small amounts of cast iron. NOW you can melt very much larger quantities, thanks to Steve Chastain who has written this brilliant book, highly recommended by Dave himself. The 10" diameter, 7' high cupola Steve describes in detail here will melt 330 pounds of iron per hour in its standard version, or 660 pounds per hour in the supercharged (or blown) version! This is really a very good book; the design is explained clearly - as is the maths behind it, so you can vary the size if you want. This is information you won't find anywhere else in such concise form, and if you build your own cupola, you can save a fortune on buying castings. We are not sure what your neighbours are going to say when you fire up this brute, but that is your problem. 124 page paperback, crammed with drawings, photos, tables and all you need to know.



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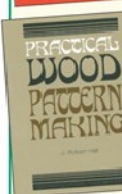
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All change for the better

As part of a successful expansion program there is a new name for the company which publishes Model Engineers' Workshop. Since September 1st we have been known as MyHobbyStore Ltd.

The change of name emphasises that the company is no longer just a magazine publisher and now has three significant parts to it - magazines, events and our rapidly expanding website, myhobbystore.com. There has been no change of ownership and the familiar team of Editors, publishers and commercial support are still here providing the magazine you enjoy so much.

We continue to expand our vision for serving our hobbyist audiences in as many ways as possible - visit us on the web, yes, Model Engineers' Workshop will have one, combined with Model Engineer.

Take the opportunity for a face-to-face meeting during the coming year as our new 'My HobbyStore' mobile shop visits exhibitions and events around the UK. We will have a huge range of books on board and also a range of our most popular Model Engineering plans at specially reduced show prices. It may be too late to fit the shop out for the Model Engineer Exhibition but MyHobbyStore will still be in attendance.

Contacting the editor

I am away from Tuesday 16th of September until Tuesday 23rd September for the Model Engineer Exhibition.

12 or 13 issues per year?

We shall shortly be doing the budget and printing schedule for 2009. Shall we leave it at 12 issues a year or should we increase it to 13 issues printed every fourth week? Let me know what you think? I have plenty of quality articles in hand so an increase in frequency would not be a problem, in fact it would help to reduce the number of articles in hand, which I am sure would please the contributors, particularly the ones that have asked me when their articles will appear.

Dividing article

I have received an email about Jim Whetren's dividing article in last month's issue. The correspondent pointed out that Jim's method was approximate only and might mislead newcomers.

Jim did what worked for him but for anyone who requires an exact approach, the correct pitch of worms for many different sizes of gears is detailed in the

ON THE EDITOR'S BENCH

Workshop Practice book No 17, Gears And Gear Cutting by Ivan Law, page 88. Also shown is the correct method of determining change wheels to cut the pitch. This book is available from www.myhobbystore.com

New model engineering club in Scotland

I have received the following from Peter Fittock in Caithness. He would like to start a Model Engineering club in the North East of Scotland.

"I am trying to start a Model Engineering Club in Caithness and Sutherland with the ultimate ambition of having a loco track running around the boating lake in Thurso. So far I have had two replies, but there must be other enthusiasts in the area.

I would like to ask people in Caithness and Sutherland to contact me if they have any interest in getting a club up and running, not only to run loco's, but anyone with an interest in Model engineering.

Contact info is Peter Fittock: - Mobile No. 07733 267904 or e-mail aestus57@googlemail.com

Purchasing from advertisers

When you purchase from an advertiser please try to use a credit card rather than a debit card. If anything goes wrong you can claim money back from the credit card company. I am not aware of any problems with current advertisers in MEW however in these difficult times it is wise to be forearmed. The same goes for prices. If buying something mail order, get a price before paying for the item and ensure you are aware of the postage costs. If you are ordering from a catalogue, check the prices are current. Raw material costs are going through the roof and what is the correct price this week may be out of date by next week.

Model Engineers' Workshop Special

The 'Workshop Special' should be available in W.H.Smiths by the time you read this. I hope you will all go out and buy a copy, it is sure to become a collector's item. It is a very good read as well. The section on Cherry Hill is very interesting especially if you have followed her models over the years in Model Engineer as I have. Although a 'Setting Up A Workshop' magazine, I have included a few pages of pictures of Cherry's models. See opposite page for ordering details.

A world first?

This issue sees the first part of a construction series on making a CNC cutter grinder. I doubt this has been done in any hobby engineering magazine in the

past. Although the basic machine is only designed to regrind the helical flutes of milling cutters, I am sure some of you will figure out how to grind end faces on it. If you do, write in and tell us how you did it. A separate grinding head mounted on the opposite side to the side grinding spindle springs to mind. It will also be interesting to see if anyone tries running it with Mach3.

In the workshop

There has been lots of activity in the brick workshop this month. I have painted the walls and floors, fitted a small consumer unit and a ring main. I have installed lighting, lots of it. Photography in the workshop has always been dependent on the weather for two reasons; one, I need the door open to let sufficient light in and two; if the sky is overcast it is still insufficient light to take photos. I have installed 5 halogen security lights. I changed the bulbs from the standard 500 watt to 300 watt. Not all lights will be on at once but two together will illuminate both sides of a machine and reduce shadow as well. I have Dave Fenner to thank for the idea of using halogen lamps. He uses a portable version in his workshop.

I have fitted the Tom Senior mill with proper machine feet similar to the ones I used on the Myford in the Practical Engineer article a few issues ago but they are slightly heavier duty. I have purchased a TV wall mount to mount the digital readout console and the three phase inverter controller on. Fitting these will be done after the exhibition.

All the workshop equipment is stowed in the cupboard and in the Myford lathe stand. It is amazing what you can stack inside a Myford industrial stand. Pictures of the workshop will be included in the ME/ MEW Workshop Special on sale mid September.

Lathe coolant

I now have a Warco coolant tank (see trade counter this issue) and some neat cutting oil to fit to the Myford lathe. This will be the subject of a future article and will include the manufacture of a simple base to bolt onto the cross slide to support the flexible pipe rather than the usual magnetic stand that attracts all that steel swarf.

Evening classes

Scarborough and District Model Engineering group have vacancies. The group are based at Yorkshire Coast College where they hire the workshop out. They meet Tuesday evenings 7-9 and this year 2 members are unable to attend so we have two vacancies which we need to fill otherwise the course fee becomes prohibitive. Anyone wishing to join the group can obtain details from Ted Fletcher on 01723 362537 or email g4egb@yahoo.co.uk

KNOW YOUR MILL

Harold Hall looks at milling machine accuracy

I will briefly introduce this article by stating that I am not one to say, this is how it should or should not be done but to introduce some facets of the milling operation that are probably rarely considered.

It was when commencing to use the lathe mounted milling head that I had made, MEW issue 127 page 16, that I finally decided that it was about time I investigated an aspect of the milling operation that had been on my mind for a number of years. This was the effect of the milling machine vertical spindle not being exactly perpendicular to the traverse of the machine table.

Permitted Errors

I think that many workshop owners tend to overlook that even quality machine tools are made with permitted errors. For example, the precision three jaw chuck will not be expected to hold the workpiece exactly concentric but should have less error than the run of the mill chucks that most of us use. It would be easy to assume that the lathe's cross slide will be exactly at right angles to the bed but this is not so and an error, within limits, has to be allowed. In this case, rather than having a plus and minus error, an error is permitted just one way, albeit very small. The permitted error is such that a surface faced on the lathe can be very marginally concave, but not convex. This ensures that two mating flanges will come together at the outer diameter, rather than in the middle, as this is considered

best practice. If such errors were not permitted then our machine tools would be astronomically expensive. Where then is this leading us to?

Well, in the case of the milling machine spindle, an error from the perpendicular is just one such a permitted error. It was when becoming involved in metalworking at the time I became editor of MEW that I gained the impression from reading an item from a reputable author that the permitted error was, rather like the lathe's cross slide, just one way and decided at the time that I would like to investigate the reasoning for this and its effect on the machining operation.

Now, having referred to the appropriate British Standards regarding the accuracy of milling machines, I find that an error is permitted both ways, that is, left and right. It may be that the information conveyed above was the authors own considered opinion, a situation that I will elaborate on through this article and to which I basically agree. With regard to the error viewed from the side, the error is only permitted one way and this also will be discussed in more detail later.

Adjustable head milling machines

Although the level of the error is in the hands of the user, in some workshops the machine is of the type that is fitted with a head that can tilt as in **photo 1**. This is a situation where greater errors than those found on fixed head machines can easily occur. The content of this article is



Photo 1. A typical milling machine with a tilting head.

therefore of considerable importance to readers with such machines.

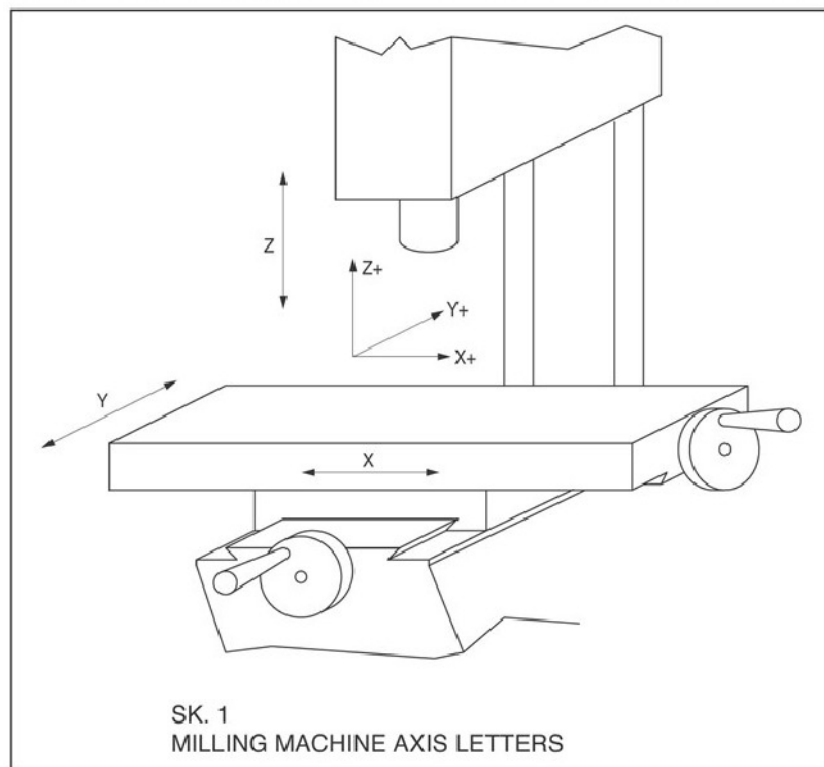
Another factor is of course that the spindle should ideally be perpendicular to both the X and Y axis. For the reader who is not conversant with this terminology **Sk. 1** should make this clear. Beyond that, the three axes are allocated positive and negative directions but using these will for most overcomplicate the issue and so I will refer to left and right and towards and away throughout the article.

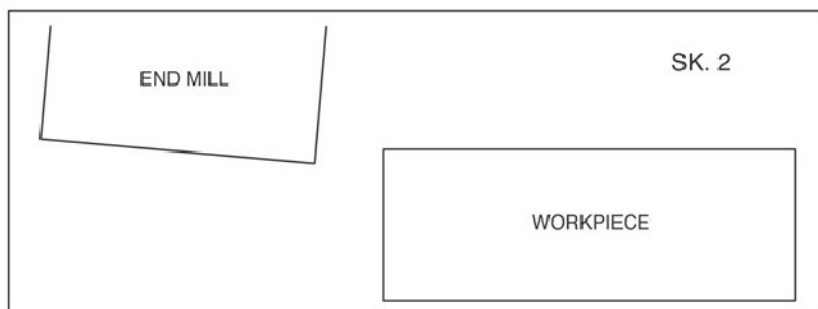
Returning to the spindle there will be errors as viewed from the front and from the side but for this article we will consider primarily that from the front. Where an error exists from the side, the considerations will be the same.

The theory

Before going into the level of the permitted error, let's consider the theory. It is though much easier to visualise the effects if they are magnified beyond what will occur in practice. **Sk. 2** shows an end mill that is not at 90deg. to the workpiece. What then if the workpiece is traversed to the left? In this case, **Sk. 3** shows that the cutter will produce a concave surface. However, if we consider the workpiece approaching from the left and feeding to the right, the cutter will still produce the same result, **Sk. 4** but there the similarity ceases. Closer examination of the two sketches shows that in **Sk. 3** the cutter is cutting on its outer diameter whilst in **Sk. 4** it is cutting on its end, a way in which the cutter is not intended to be used.

Having therefore decided that an error in the orientation of the spindle is inevitable, does this mean that machining should always be carried out in the direction that gives the result shown in **Sk. 3**? If there are no factors that prevent an operation being carried out in the preferred direction then it should be used; some work pieces will though make this impractical. Consider the part in **Sk. 5** that requires the two recesses to be exactly parallel and the depth of one precisely the correct depth in relation to the other. If the part had to be turned end

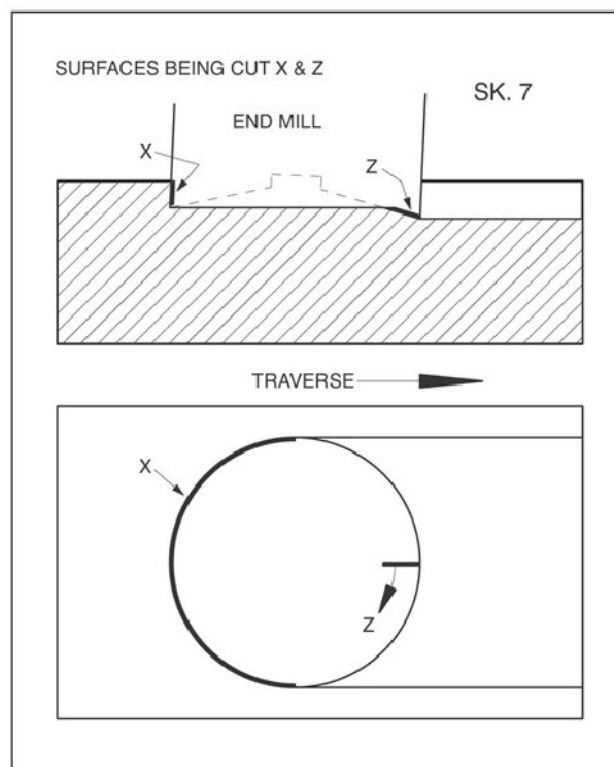
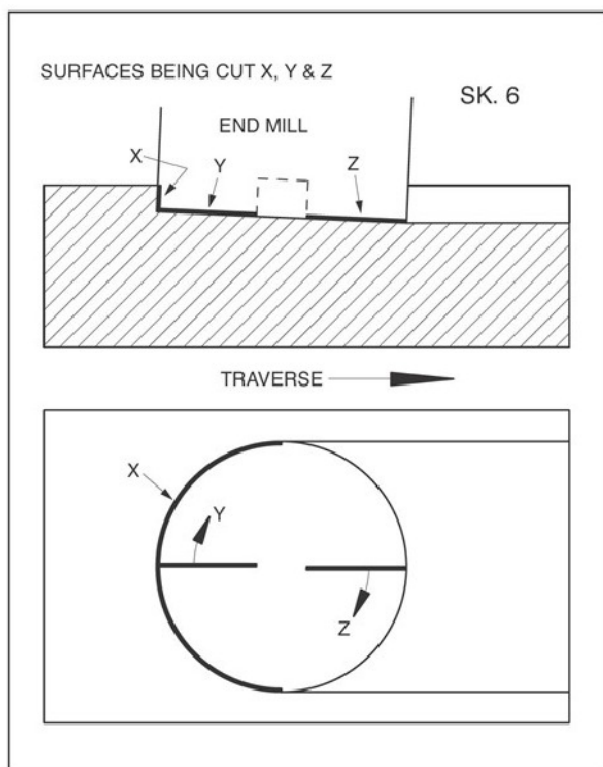
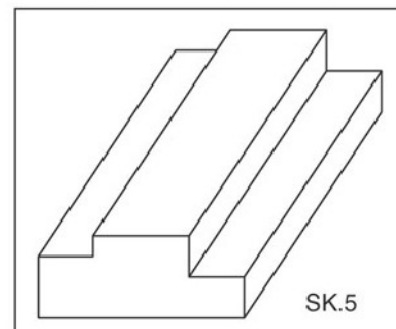
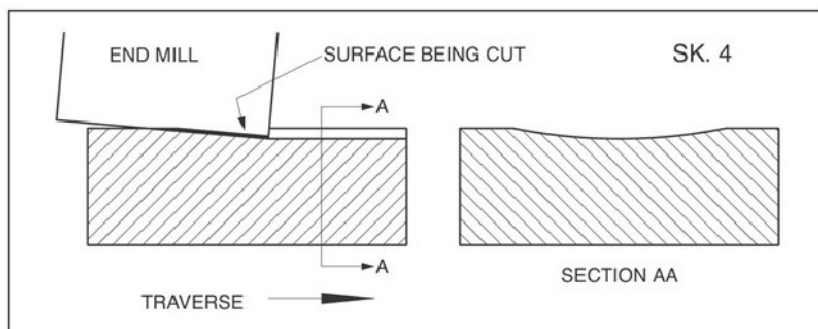
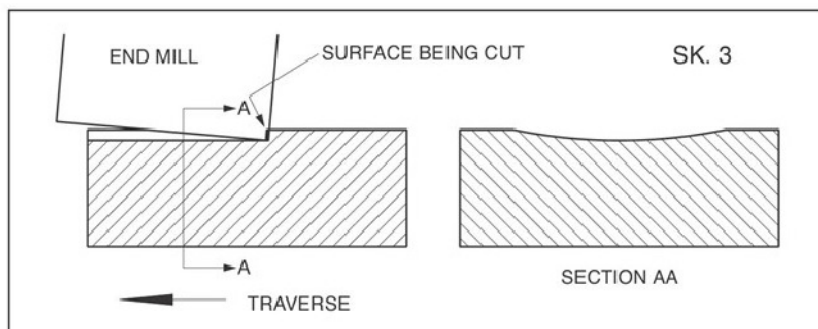




on end to machine the second side these requirements would be more difficult to satisfy. Because of this we have to accept that machining in both directions is a necessity. However, this does not eliminate the fact that there may be a preferred direction.

Returning to the situation in **Sk. 4**, in this case, anyone who has attempted to machine a workpiece in this way with a substantial error in the spindle's orientation will without doubt have been aware that the traverse of the worktable requires considerably more effort than normal. This is not an acceptable way of using a milling machine with a tilting head. It could of course be used to machine a sloping surface with the workpiece being traversed towards and away rather than left and right. It is though a feature provided mainly for drilling.

Having established above the basic difference between traversing left to right and right to left, how does this effect machining even when the error is much less than in the illustration. Well, let us consider a common operation of skimming a very small amount from a surface just to improve its appearance, say 0.1 to 0.2mm. **Sk. 6** shows that the cutter



as sharpened will cut on its outer diameter (x) but also on its end cutting edges at (y) and (z).

If we were to put a value on the depth of cut per tooth on the end cutting edges, it would be found that this would be minute and require a razor sharp edge for this to be possible. Actually, it would just rub the surface until after a number of revolutions the depth of cut was sufficient for the cutter to get under the surface.

End mill end cutting edges

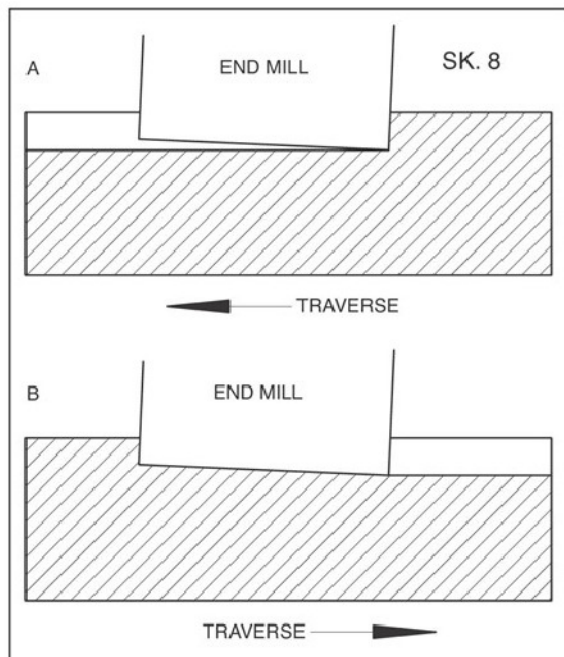
This now leads nicely I think, into a subject that has raised questions in the magazine on occasions, that is, should the end of an end mill be sharpened flat or with a minute concave form.

Sk. 6 showed how with a flat cutter, each tooth will be called upon to remove a very thin slither whilst Sk. 7 shows that with the cutter having a concave end, the situation is quite different taking relatively narrower but deeper cuts per tooth. This shows that the concave end enables the cutter to cope with errors in the spindle vertical position much easier and is therefore absolutely essential.

Back cutting

With that situation having been understood and conformed to, it would appear that milling can take place equally well in both directions. Certainly the increase in the load on the leadscrew will be infinitesimal. Reference to Sk. 8 though, shows clearly that in one direction (A) the cutter only cuts on its outer diameter (preferred) whilst in the other direction (B) it cuts both on its outer diameter and its trailing tip, back cutting I think is the term for this. This understanding has now brought us to a situation where if we know the direction of lean of the machine spindle and if an option is available, then choosing the direction where back cutting is eliminated is to be preferred.

There is also another factor to be considered, that is the direction of movement with increasing numbers on the leadscrew micrometer dials. Machines mostly apply the same configuration, which is the numbers increase with clockwise rotation of the hand wheel resulting in the table moving away from the operator. Whilst this seems to be predominantly the standard, I have machines in my workshop that work differently; most confusing! Another feature on my mill/drill table is that the leadscrew runs in bearings at both ends but with a thrust race at one end only. A result of this is that when taking a relatively heavy cut the table traverses much easier one way than the other, the easiest being with increasing numbers on the leadscrew dials. No doubt superior machines will have thrust races both ways. Even so, increasing numbers and the position of the thrust race on my machine at least, still



appear to dictate that the table moving to the left is the preferred direction.

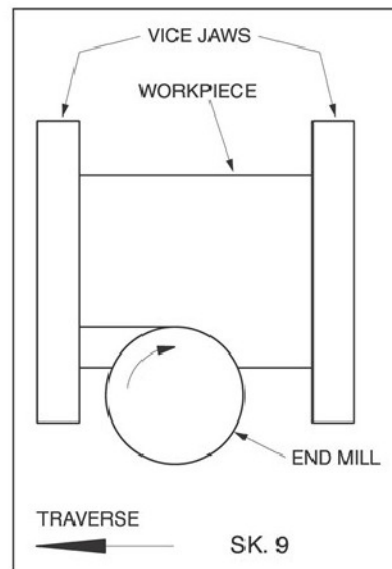
Having chosen movement to the left as being preferred, the orientation of the cutter spindle should ideally be in accordance with Sk. 8A rather than Sk. 8B. This I believe was where the knowledgeable contributor based his suggestion, rather than what the standards (if any in those days) had to say regarding the situation.

Unfortunately, for most vertical milling machine owners, you are faced with whatever situation you find you have. That is of course unless you are prepared to make adjustments to the machine in some way. In the case of the typical mill/drill, shims between the column base casting and the machine base is one possibility.

When I purchased my mill/drill I had to dismantle it to enable me initially to transport it and ultimately to install it as it was too heavy to remain intact. I found that there were a lot of copper pieces between the column base casting and the base of the machine. These were probably 1 to 2 mm thick, I could only assume that these allowed some adjustment if the nuts on one side were tightened more than the other. I did not like this and they were left out when the machine was reassembled. In any case, I could not remember which pieces went where, having dismantled the machine quickly at the supplier's. It was because of this that I checked the spindle in relation to the table at the time and decided that it was acceptable without them. I do hope that this approach is not being used on later mill/drills but see no reason why a very thin shim cannot be used to provide the accuracy required.

Workshop owners who have one of the milling machines with a tilting head will have a ready way of setting the spindle to the required position. If though it is calibrated for setting the head to varying angles, photo 2 under no circumstance use solely the zero mark for setting this position, this will not be sufficiently accurate; see later comments.

With movement of the worktable from right to left having been chosen as the



preferred method, are there any other considerations requiring some thought? Well not strictly relating to the machine but being at least of theoretical importance is the way round that the vice is placed onto the machine table. With the workpiece moving right to left it will have to pass the rear of the cutter and the direction of the cutter's rotation will be placing a load on the right hand jaw, see Sk. 10. Now it is often said that the machining force should be placed on the fixed jaw of the vice. However, rather like milling vices often being overly robust for use on a vertical mill, probably due to them having been designed with horizontal milling in mind, the suggestion that milling should be towards the fixed jaw has similarly originated from their horizontal use. Still, I must say that with no overriding consideration it is probably a principle worth adopting. I must confess though that being right handed I instinctively position my vice handle on the right with the fixed jaw therefore being on the left, the wrong side for the principle suggested above.

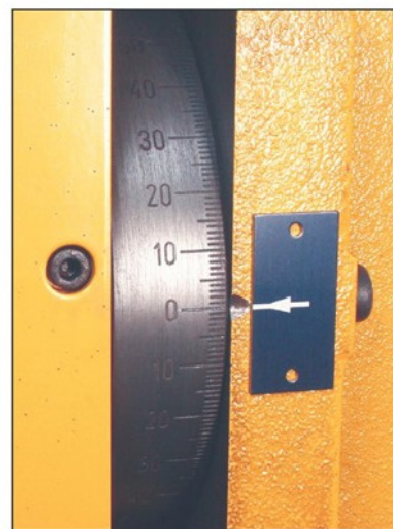
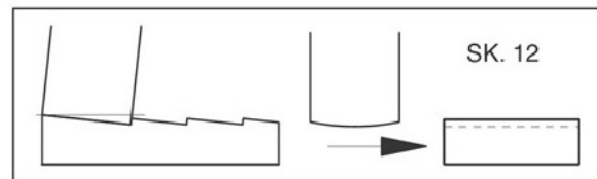
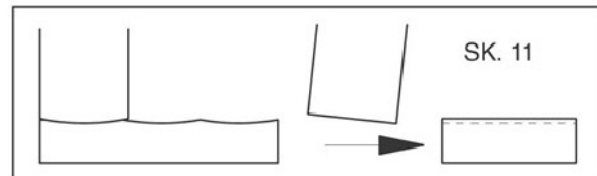
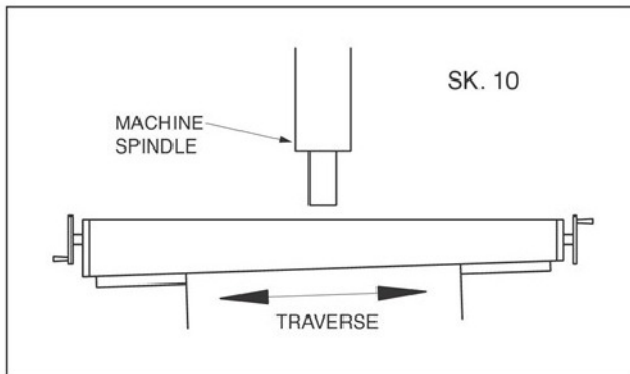


Photo 2. The calibrations for setting the tilting head angle, though this would not be accurate enough to return it to the zero position.



What the standards say

What then is the mathematical extent of the situation? Well British Standards give us some values for the permitted error of the spindle in relation to the table's surface. **Photo 3** shows the set up for testing the requirements which are that there should be no more than 0.025mm variation in the dial indicator reading over a distance of 300mm. This is with the dial indicator set at 150mm from the machine spindle and the spindle rotated through 180deg. The error can be either way, that is with the table higher on the left or higher on the right but for my suggested preference, higher on the right would be the situation to aim at. The tests should be carried out with all three axes locked. To express another way, the angle of the spindle to the table should be less than 90deg. on the right and more than 90deg. on the left.

To quantify the effect at the end mill, the above maximum error would cause one edge of a 10mm diameter cutter to be 0.0008mm deep compared to the other. Whilst this is very little, its main effect would be in the quality of the surface finish if fed in the wrong direction; this is most important when the work entails light cuts to provide a good finish.

When the test is carried out in the back to front direction, the same level of error is acceptable but only in one direction, that is, the front of the table is high, meaning the table to spindle angle in front of the spindle is less than 90deg. I can only assume that it is considered that with some operations, typically heavy duty drilling, that the downward pressure required has the effect of lifting the head resulting in the error reducing.

Having quantified the error permitted, the reader should now appreciate how the slight concave nature of the end mill will ensure that any cutting that does take place on its trailing edge will be very small, **Sk. 7** rather than along the length of the cutting edge, **Sk. 6**.

Traverse accuracy

Unfortunately, the above tests do not tell the full story, the reason being they do not take into account the possibility that the workpiece may not be travelling exactly parallel to the table's surface. **Sk. 10** shows that even though the spindle is at right angles to the machine table, the workpiece can still approach at an angle if there is an error between the table's surface and the dovetail slides on which it moves. **Photo 4** shows the method of testing this requirement with the permitted error levels being the same as

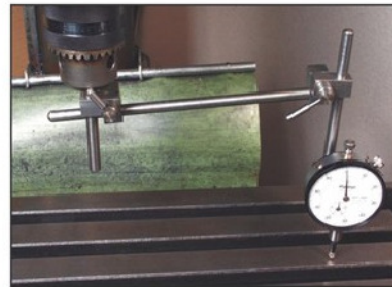


Photo 3. The set up for checking the accuracy of the 90deg. angle between the spindle and the table's surface. The spindle is rotated 180deg. and the difference in the reading noted. This should be no more than 0.025mm over a distance of 300mm.

those above, that is 0.025mm in 300mm, left to right and back to front. In this case the down feed and the traverse not being used should be locked. Unfortunately, this is a condition that the machine user would find difficult to improve should the error be excessive.

If the reader is attempting to achieve a condition that conforms to that I suggest as being the preferred, then the effect of both errors must be considered collectively as it is really the angle between the spindle and the traverse direction that is important.

The British Standards

For the values above I referred to the following British Standards.

BS 4656-3:1971 Specification for the Accuracy of Machine Tools and Methods of Tests. Milling machine, knee and column type, horizontal or vertical spindle.

BS 4656-4:1971 Specification for the Accuracy of Machine Tools and Methods of Tests. Milling machine, bed type, horizontal or vertical spindle.

Whilst primarily aimed at large industrial machines, 4656-4 would be comparable to the mill/drill form of construction and BS 4656-3 typically turret mills. However, both specifications give the same values for the tests mentioned. They do of course cover many other conditions, flatness of the table for example.

Access to British Standards has improved considerably over recent years and it is likely that most local libraries having computers for public use will have access to the standards. Readers outside the UK can view standards ISO 1701 and



Photo 4. Checking if the table's surface is parallel with the dovetails on which it moves. Again the error should be no more than 0.025mm over 300mm.

ISO 1984. Whilst there are minor differences I do believe they have the same values as those given above.

Setting your milling machine tilting head

I have already suggested that shims can be used to set the head of a fixed head machine but the process with a tilting head will be very much more difficult. The problem is that one is trying to set the head within a very narrow band. To quantify this, 0.025 in 300 amounts to a maximum angle of 0.005deg.

Loosening the head, moving it manually and then re-tightening it will be very much a case of trial and error, probably with a lot of trial and a lot of error. My method, which is far from foolproof but does make it possible to make small adjustments relatively easily is seen in **photo 5**. In this the head is fitted with a centre and a plate placed onto the machine table having a drilled centre in it. The head, which must be quite close to the required angle, is lowered into the drilled centre and the plate fixed in place. The dial assembly can then be rotated through 180deg. to establish the error. With the head loosened, the table can now be traversed by a very small amount to rotate the head and the

head fixed again in that position then the setting can be checked once more. Do not expect to arrive at the required setting at the first attempt, or second or third but it should be quicker than the unaided trial and error method.

The design of the tilting head feature varies considerably from machine to machine and some just may be easier to reset to the all important position for milling operations. If your machine permits, it may be possible to drill, ream and fit a locating dowel but if this is entering into a blind hole then do remember to drill and tap the end of the dowel so that it can be jacked out when it is required to set the head at an angle. Without such a provision I would be reluctant to move the head once set and find some other way of carrying out the task in hand. Its use for milling will be very limited with drilling being the more likely task to use the feature. For drilling operations it should not be that difficult to find an alternative method.

A few related thoughts.

Above I have illustrated an end mill cutting over its full width but this is only acceptable with a small overlap and for very shallow finishing cuts. The surface will though be made up of a series of furrows as is illustrated by Sk. 11. As the amount is very small this situation is more of a theoretical interest in most cases than of actual importance. Even so, it is worth considering that the effect is greater with larger cutters. For example, do be aware of the condition if you are attempting to finish a block of cast iron to make a surface plate using a large fly cutter. Having said that full width cuts are acceptable, it is still preferable, even for finishing, to use a larger cutter and use only around $\frac{1}{3}$ of its width as described below.

If therefore using the full width of the cutter is limited to shallow cuts only, what is acceptable for heavier cuts? A frequently quoted figure is a maximum depth equal to the cutter's diameter but at a maximum width of $\frac{1}{4}$ of the cutter's diameter. Such a depth is beyond what most home workshop mills will be happy with and a depth of $\frac{1}{8}$ the cutter's diameter would seem to be more practical. It is worth bearing in mind that only the depth determines the torque demand on the machine, the width sets the duration of the cut and therefore the power required.

Personally, I frequently exceed the $\frac{1}{4}$ width figure but not by that much, probably $\frac{1}{3}$, that is 4mm with a 12mm cutter. Readers who have approached $\frac{1}{2}$ the cutter's diameter, or past this value, will have found that the load on the leadscrew, and therefore the cutter,



Photo 5. A set up that enables small adjustments to the angle of the tilting head to be made using the table traverse.

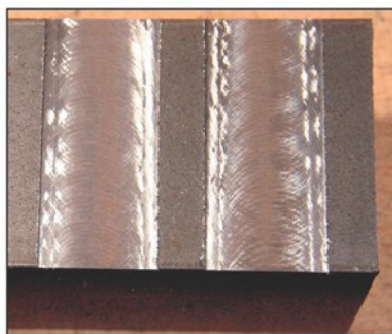


Photo 6. A test piece machined with a sharp cutter. On the right the trailing edge of the cutter was lowest and back cutting has occurred, on the left the leading edge of the cutter was lowest.

increases appreciably. If you want the theory, mine that is, then this is because as the cut passes the centre line of the cutter, the cutting edge and the traverse are travelling at 90deg. to one another; this is theoretically impossible and deflection of the cutter or cutter spindle must therefore occur.

Some readers may be saying what happens when a slot is being cut? Well of course, in this situation there is no option, but reducing the feed rate will probably be necessary.

What however if the error in the machine spindle is across the line of the workpiece's traverse? In this case the surface produced will be a shallow saw tooth as Sk. 12 shows. As with the furrows produced when the error is in line, this will rarely be a problem but again, the larger the cutter being used, the more likely that the result may be unacceptable.

Also take note that when machining a surface, both edges of the cutter should pass the edge of the workpiece as you may end up with a raised edge if the trailing edge of the cutter requires machining the workpiece at the edge. This can easily be seen on the left hand edge of Sk. 12.

When surfacing, do use a sharp cutter especially if there is no option and back cutting has to be allowed. Alternatively, using a blunt cutter will certainly make the effect of the trailing edge more apparent resulting in a poor finish.

Test Pieces

Having explained the theory and double checked my machines, I decided to machine a test piece. Photo 6 shows a test piece that has been machined both ways using a 14mm cutter and at a depth of 0.2mm. The difference is very noticeable on the test piece and also when the photograph is displayed on my computer. On the right, the direction is where the trailing edge is lowest and back cutting has taken place. When machined in the opposite direction with the trailing edge highest, seen on the left, back cutting is almost absent and the finish is improved. However, having been machined with a very sharp cutter, both surfaces would be acceptable in many cases.

Photo 7 shows the same tests being carried out using a 20mm end mill that is very blunt. Evidence of back cutting is very apparent on the right hand cut but also confirms my earlier comments that a

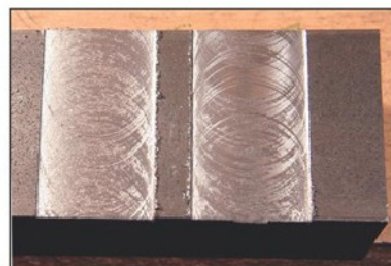


Photo 7. The same test using a blunt cutter.

blunt cutter will not cut at every turn but only when the depth is sufficient for the cutter to get below the surface. This is seen by the back cut circles as they occur randomly. Whilst the left hand test is appreciably better it is still poor; a case for keeping your cutters sharp. The test piece was 230M07 (En1A) steel and the cutters were running at about 500 rpm.

A final thought

I realise that the content of this article does not set hard and fast rules for using your milling machine, only some factors that should be born in mind when carrying out milling operations. For many dare I say, its content will be new ground in terms of their knowledge regarding the machine's use? Do though go further than just reading the article but also get out the dial indicator and test where your machine stands in terms of its accuracy and make a record of these. Then, by observing the results you achieve whilst considering how your machine is set up, your understanding of the milling operation will be increased.

Having encouraged you to check your own machine it occurs to me that I have no experience as to how close our home workshop machines come to the standards laid down. Realising that these are predominantly budget machines, perhaps it would be expecting rather a lot for them to conform fully. However, they should come close and perhaps some readers who carry out the tests could send in a short letter regarding their findings. Even if you do not want to implicate the supplier by name the results would still be interesting. Having removed the pile of shims from my machine, as mentioned earlier, I found my machine was within the quoted requirement in the left/right direction and only just outside in the other two. Why were those pieces of copper there I wonder?

I will close finally where I almost began, that is with the comments of the magazine contributor. Having stated that any error should be with the angle between the table and the spindle being less on the right of the spindle with the leading edge of the cutter low when the workpiece is being traversed right to left, I now believe that the advice given was not that the angle could be 90deg. or less, but that it should be less than 90deg. ensuring as a result that the leading edge of the cutter is definitely lower than the trailing edge, thereby minimising the effect of back cutting. This would seem eminently sensible but it does mean that where a good finish is required then machining should always be undertaken by traversing right to left. ■

THE C3 MINI LATHE 11

Dave Fenner adds a sensitive lever feed tailstock

Being a small size machine, it is to be expected that the threads of the various leadscrews will be relatively fine. The 1.5mm pitch of the tailstock screw gives on the one hand, fine control of depth but on the other, many turns of the handle are needed for any significant depth. Also, when working with very small drills, it can be helpful to be able to feed by a more sensitive means. Myford offer an excellent accessory to give this sensitivity and their device is shown in **photo 1**. It fits into the MT2 tailstock taper and thus can be used in conjunction with the regular screw feed. For drilling small sized holes it can be a real boon. A lever feed also makes life so much easier if a small hole is to be drilled to relatively great depth as it can so easily be "pecked" to clear the swarf.

The device offered here has been made as simple as possible and is installed in place of the existing handwheel. The existing barrel and screw are left in place, thus catering for taper ejection and giving a fine depth limit adjustment. Manufacture of the gadget is straightforward with little need for precision. Close tolerances are

not mandatory but it is necessary to make matching pairs of parts and to make the aluminium anchor plate match the lathe. The dimensions given on the drawings are metric, however, the raw material was very much old imperial, hence the somewhat odd figures which result.

Anchor plate (Fig. 1)

The material used here was $\frac{3}{8}$ in. aluminium. Feel free to use steel, but I find aluminium to be easier to work and more importantly had some suitable offcuts. The work is first cut roughly to size then squared up and trimmed in the lathe using the four jaw chuck. The three holes in line, (two 4mm counterbored and one 10mm) then need to be set out accurately so that the plate can be bolted on to the rear of the tailstock casting and the main screw can pass through it. How you achieve this will depend entirely on the kit at your disposal, it can be done on a mill with a DRO or on the Mini-Lathe using the milling attachments described in an earlier article or by removing the relevant part from the lathe, clamping to the plate, sighting to a scribed line and



Photo 1. Sensitive drilling attachment as supplied by Myford.



Photo 2. Anchor plate.

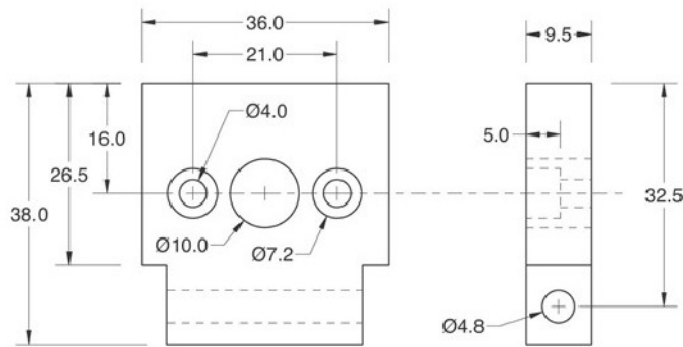


Fig. 1

ANCHOR PLATE
ALUMINIUM

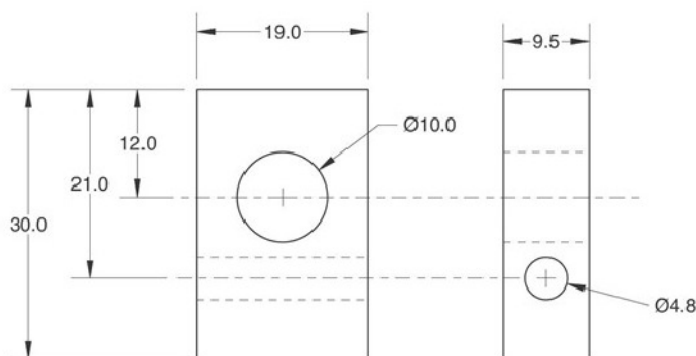


Fig. 2

PRESSURE BLOCK
ALUMINIUM

spotting through with 4mm and 10mm drills respectively.

Counterbores should be ideally cut with flat bottoms, however, for low stressed applications, I frequently cheat and simply drill down with a suitable jobber drill.

The next step was to cut the two step features and again this may be a cut and file operation or carefully milled to size. It then remains to drill the $\frac{3}{8}$ in dia. hole for the pivot pin. The completed part is shown in **photo 2**.

Pressure Block (Fig. 2 and photo 3)

This time a short piece of $\frac{3}{8}$ in. x $\frac{3}{8}$ in. aluminium flat bar was cut then squared to size in the lathe. Two holes are then needed, one at 10mm dia. the second $\frac{3}{8}$ in. dia. It may be found beneficial to file a few thous off the width to ensue free movement between the handle arms.



Photo 3. Pressure block.

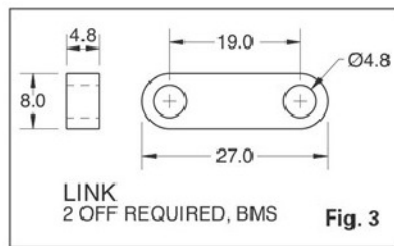


Photo 4. Links and pivot pins.

Links (Fig. 3 and photo 4)

Two links are needed, and these were made from $\frac{3}{16}$ in. x $\frac{3}{16}$ in. rectangular bright mild steel flats. The essential feature is that the centre distance of the two holes is equal in both cases and the quick and dirty solution is to cut roughly to size, drill one hole in each, pass a pin through both, clamp together and drill the two second holes in a single operation. After this, the ends may be tidied up by filing/finishing to a radius.

Handle Arms (Fig. 4 and photo 5)

The philosophy here mirrors that for the links. The actual hole position is not critical but the two parts should have identical hole spacing.

Lever Block (Fig. 5 and photo 6)

If you are relying on the "spot through" technique, then mark the positions of the two M3 holes using a 3mm drill through one of the arms. Then drill through 2.5mm dia and tap M3 in two places from each side. Next drill and tap the 2BA position for the lever. Note I used 2BA as I did not have an M5 die to hand for the lever. This hole should also be counterbored $\frac{3}{16}$ in. diameter to a depth of some 2mm to clear the thread runout on the lever.

Lever (Fig. 6)

Nothing dramatic here, just a length of 8mm BMS bar, cut to length, faced, turned down and threaded 2BA, then radiused at the outer end for comfort and appearance.

Knob (Fig. 7 and photo 7)

This part basically fits in place of the tailstock handwheel, taking the "pull back" force from the pressure block. Mine was turned from a convenient piece of brass hex and then cross drilled and tapped to take an M3 set screw for clamping.

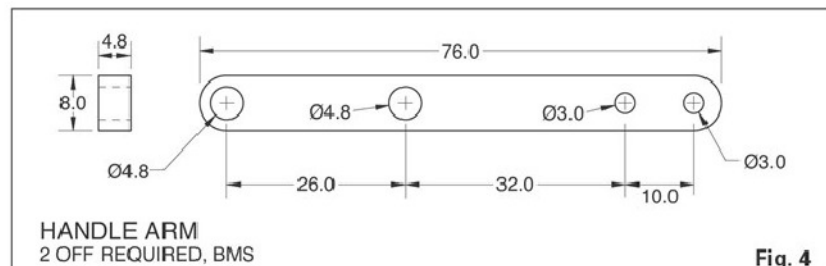


Photo 5. Handle arms.

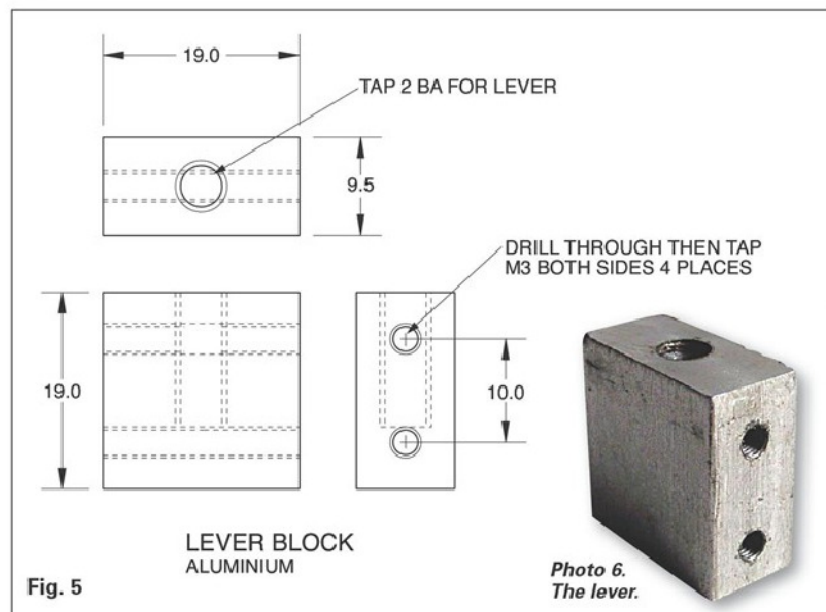


Fig. 5

Photo 6. The lever.

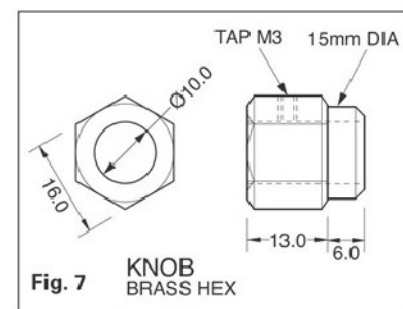
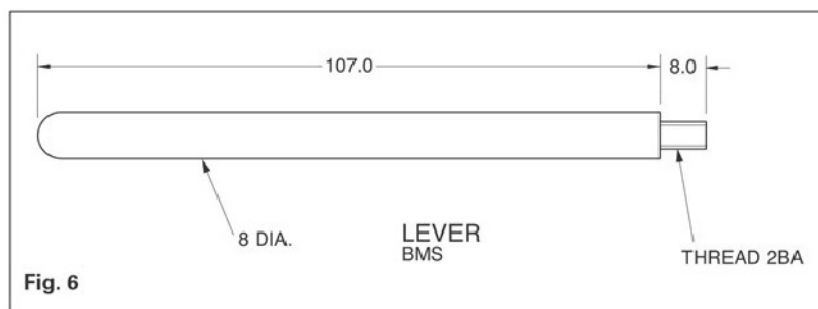


Fig. 7

KNOB BRASS HEX



Photo 7. Knob showing position for grub screw.

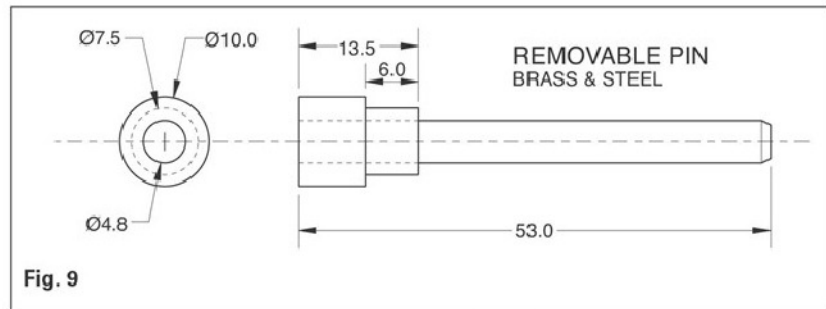


Fig. 9

Pivot pins (Fig. 8 and photo 8)

Two are required made from $\frac{3}{16}$ in. dia BMS. I have chosen to retain these two pins by 3.2mm ($\frac{1}{8}$ in.) E clips. To achieve a neat fit, first measure the thickness of the E clips, mine were 0.5mm. The cumulative thickness of the components (links, arms, block) is 1.5in or 38.1mm so the ideal positioning of the two grooves will be such that the inner faces of the clips are just over 38.1mm apart and hence the measurement between the outer faces of the grooves will be just over 39.1mm. The grooves may be cut with the inverted part off tool described in an earlier article. Ideally a blade should be ground to produce a groove just wider than the clips, but it is quite possible to use something wider. Before proceeding, measure the width of the part off blade; in my case this was 1.6mm and the settings that follow are based on this blade width.

The rods were first faced to 41.9mm length. One was then located but not gripped in the three jaw chuck, with say 7mm protruding. The tool was then brought close to the work and the half nuts closed. The saddle was then moved using the leadscrew handwheel to contact the work then push it back until a



Photo 9. Removable pin.

zero mark came round on the wheel. The chuck was then tightened and the cross slide and tool retracted clear of the work. The leadscrew handwheel was then employed to move the tool 3mm closer to the chuck. The lathe was then started (in reverse) and the tool moved in to touch. The DRO handwheel could then be zeroed, and the groove cut accurately to depth of 0.032in taking the root diameter to $\frac{1}{16}$ in for the E clip. This procedure was

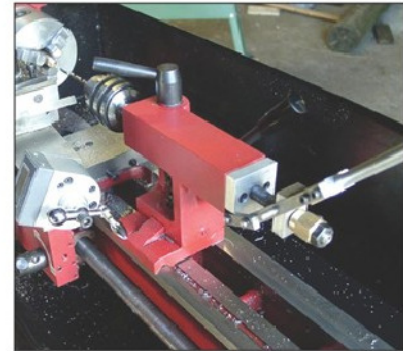


Photo 10. Device fitted to Mini Lathe

then repeated for the second end, and then the second pin.

An alternative approach to setting the groove position is to first grip the work then bring the tool in close to the diameter of the work then manoeuvre along so that the outer edge of the tool is level with the end of the work (as checked with a magnifying glass). Then move the tool along just the 1.4mm to bring the groove edge to the desired location.

Removable pin (Fig. 9 and photo 9)

It is necessary that one pin be removable in order to access the screws to mount the device on the lathe. This pin is a simple 53mm length of $\frac{3}{16}$ in. BMS rod fitted with a turned brass head 13mm long retained by Loctite. The end of the pin has been lightly chamfered to facilitate fitting. If the device were to be used in more of a production setting, then I would recommend some means of keeping the pin in place. This might take the form of a cross drilling with an R clip, or perhaps a short thread with nut. For my occasional use, this embellishment has not been needed.

Assembly and use

The existing handwheel and nut are removed, followed by the leadscrew bearing and the leadscrew. The anchor plate sub assembly, **photo 9** is then fitted carrying the links and lever assembly and the leadscrew refitted. The pressure plate is fitted over the leadscrew and the removable pin fitted. The knob is then added, along with the original handwheel retaining nut, these being set to allow free rotation of the screw. **Photos 9 and 10** show the device in an unfinished state (links and arms are rough sawn to length) and in the latter picture, it is being used to drill the add-on head for the removable pin.

In operation, rotation of the knob will allow fine adjustment of the max depth, and also permit extraction of Morse taper fittings. ■

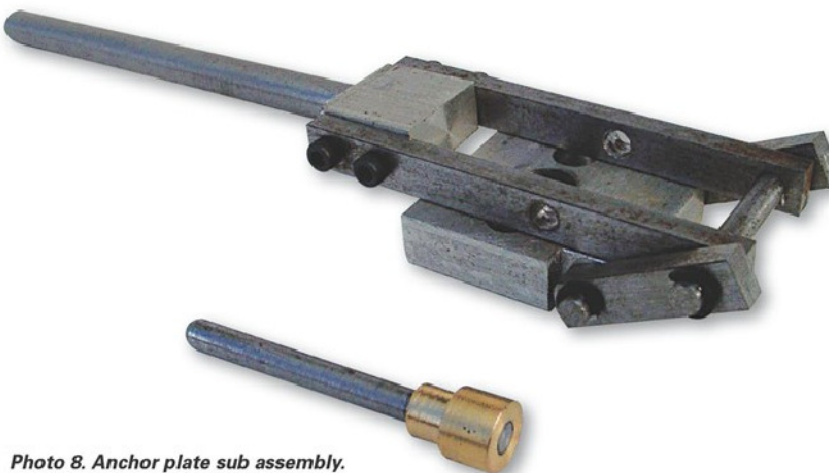


Photo 8. Anchor plate sub assembly.

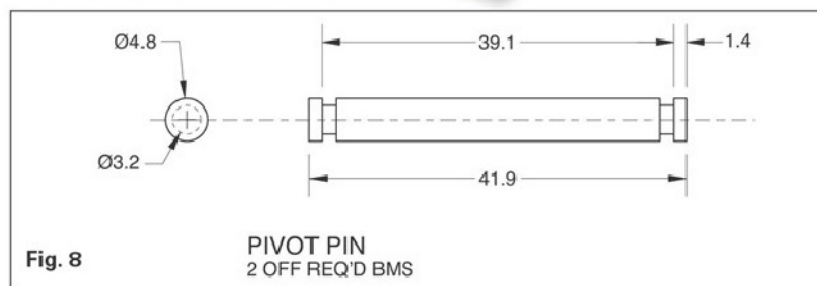


Fig. 8

RETROFITTING THE DENFORD ORAC CNC LATHE 2

Dave Fenner fits the new Interface Board

For me, as a non expert where electronics is concerned, the means by which the speed sensor might be persuaded to connect to the inverter and give it the industry standard 0 - 10 volts signal to specify a spindle speed posed a problem, which I raised with John Curtis. I was aware that he had assisted another club member to set up a small CNC lathe with Mach3 and he had kindly agreed to have a look at the Orac. This earlier application had not involved computer control of the spindle speed but it proved possible to utilise elements of the earlier work and add in circuitry for spindle control. The result was the interface board shown in photo 10.

Power is 12 volts DC taken from the original Orac regulator board and connection to the computer is via a standard 25 way printer cable. Input wiring provision is made for speed pulse train, emergency stop and a single limit switch input. (At this stage I believed the machine had only a Z limit, but see below.) Outputs go to the stepper drivers (step, direction and enable) for each axis and to the inverter to enable operation and set the spindle speed.

John suggested that the wiring to the drivers should be kept short, so the easy answer was to mount it on an MDF sub chassis attached to the aluminium stepper driver chassis as shown in photo 11. Compared with photo 3 (last issue), this view also underlines the contrast in stepper drive packaging between the old and the new.

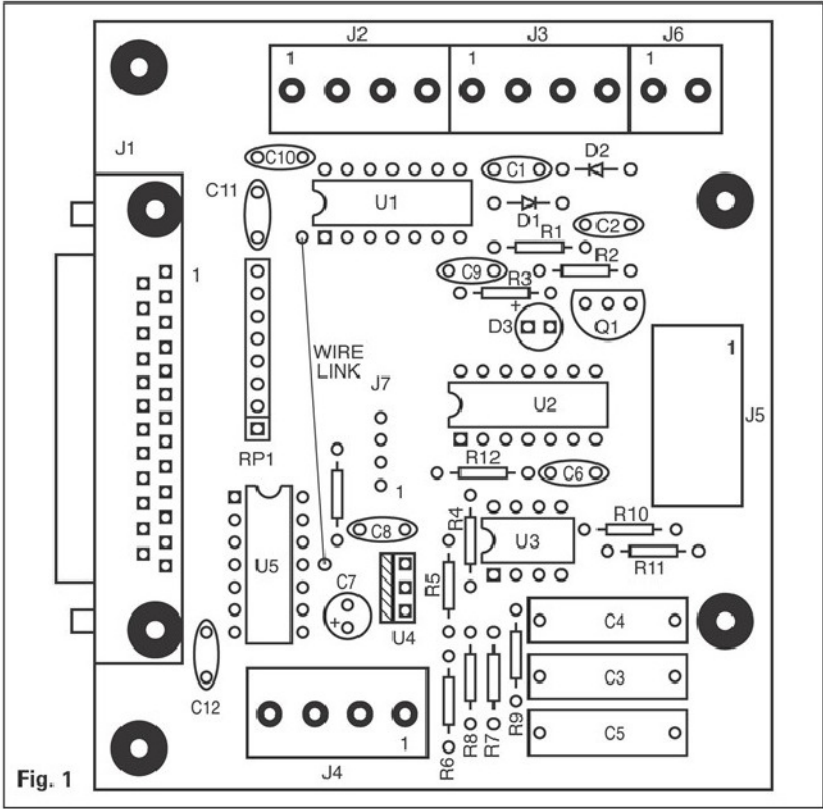


Fig. 1

There are now a fair number of interface boards available commercially from various suppliers, ranging in cost from just a few to well over a hundred pounds. Details are given here of the board designed by John, (now modified to

include the added capacitors for interference suppression) so that the home electronics enthusiast may etch and construct his own board. Fig. 1 gives the component layout and Fig. 2 the mask for etching and Fig. 3 the circuit diagram. For

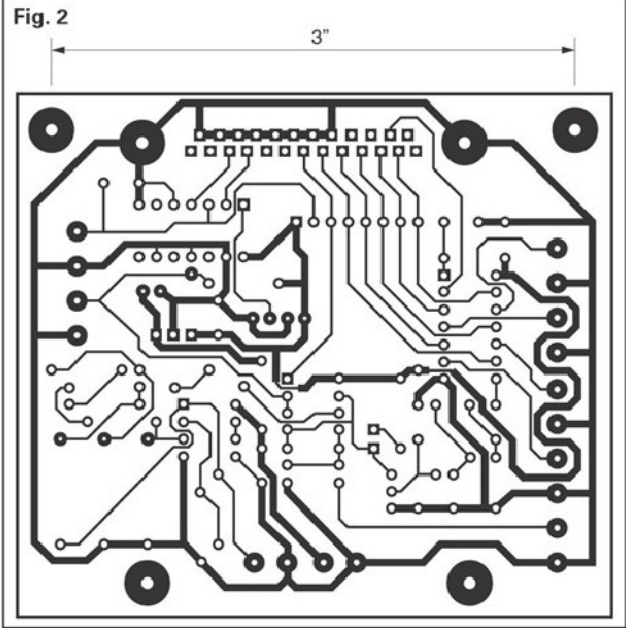


Fig. 2

Bill Of Materials

QTY PART-REFS VALUE

Resistors

3	R1,R2,	
	R13	4k7
1	R3	1k0
1	R4	100k
1	R5	2k0
1	R6	51k
1	R7	2k4
1	R8	20k
1	R9	5k1
2	R10,R11	360k
1	R12	47R

Capacitors

7	C1,C6,	
	C8-C12	100nF
1	C2	22nF
3	C3-C5	2u2F
1	C7	100uF 35vW

QTY PART-REFS VALUE

Integrated Circuits

2	U1,U5	74HCT04
1	U2	74HC27
1	U3	LM258
1	U4	7805

Transistors

1	Q1	2N3904
---	----	--------

Diodes

2	D1,D2	1N4148
1	D3	LED

Miscellaneous

2	J1, J5	
1	J2	Z-Axis Stepper
1	J3	X-Axis Stepper
1	J4	Switches
1	J6	Stepper Drives
1	J7	Spindle Sensor
1	RP1	10k

Table 1

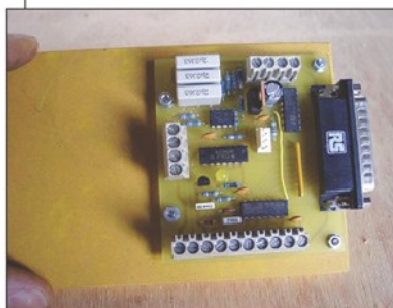
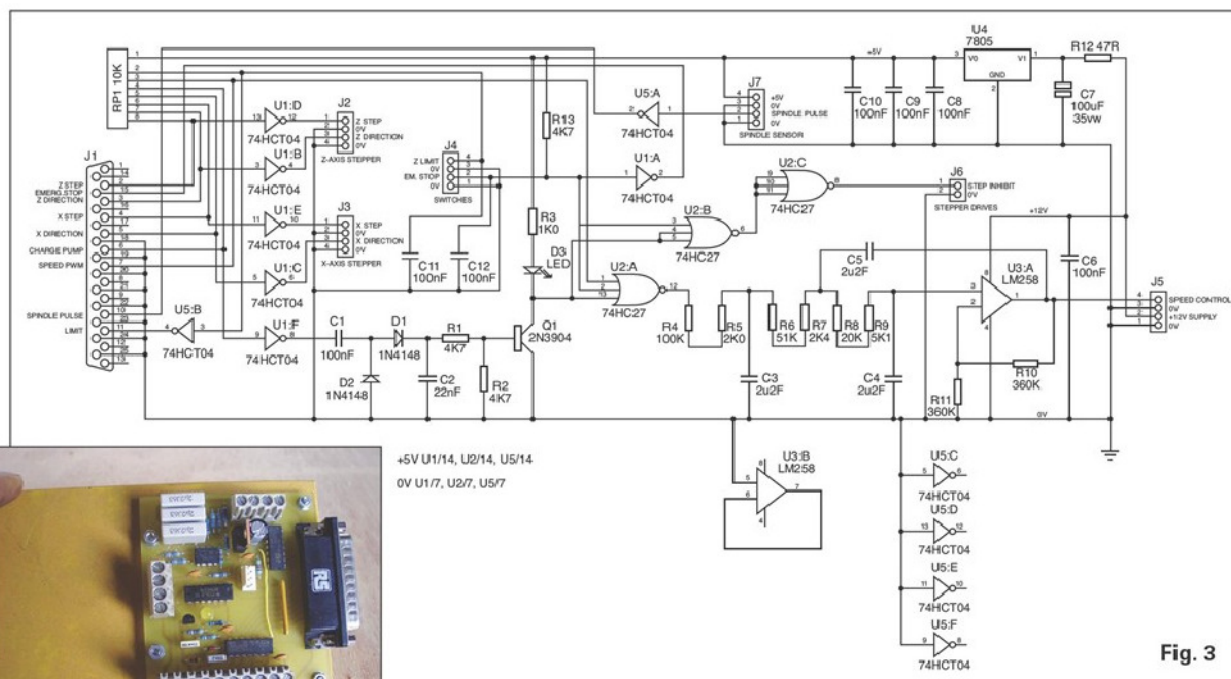


Photo 10. Plan view of interface board.



Photo 11. Sub assembly of interface and Arc stepper drivers.

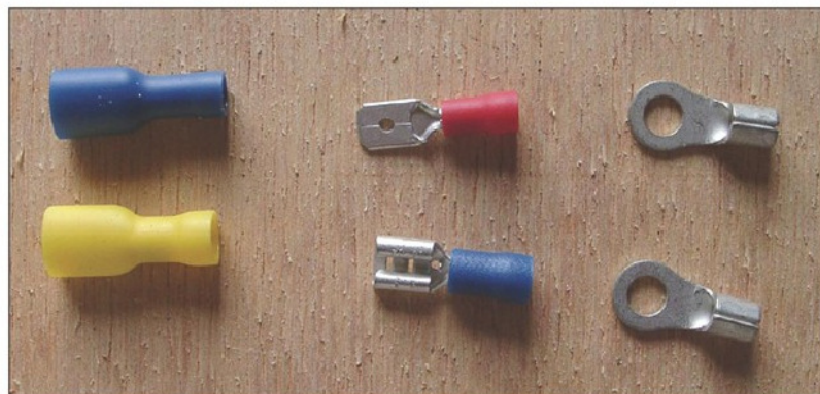


Photo 12. A selection of insulated and non insulated terminals and connectors.

those not wishing to make a pcb, it should be possible to rework the circuit diagram into an arrangement for strip board. The component list is given in Table 1.

General notes on wiring/refitting

The original Denford wiring harness and connection arrangements were made to a good standard. The motor supply cables are screened as are some of the other interconnections. However the computer and electronic arrangements related to the early 1980's and over the intervening years, there has been a trend to lower operating currents which can lead to greater sensitivity to interference. When the new set up was first tested, it became plain that I had not taken on board John's advice on the use of "twisted pairs" to avoid signal interference. Both the limit switch and emergency stop wiring caused erroneous signals and were therefore bridged for initial checks.

It seems that twisted pairs can be less affected by interference than screened cable so efforts were made to employ this arrangement wherever appropriate. John's

system for creating a twisted pair evoked memories of winding up rubber powered model aircraft. The two lengths of wire are set parallel then knotted together at each end. One end is then held in a vice, while the other is gripped in the chuck of a good old fashioned hand drill. With a bit of tension applied, it is then easy to quickly add an even twist along the length by winding the drill. A quick tensile jerk before release will help reduce the tendency to unwind.

The original main motor cable was a screened three phase and earth but unfortunately it proved just a bit short for the revised installation. A new cable was made up using appropriate flex, then adding a woven wire screen spiraled from a larger cable, which could be reduced in diameter by stretching the length. At each end, a wire was soldered to the screen and connected to earth.

For connections carrying significant power, my preferred arrangement is to use crimped terminals.

These are typically available as pre-insulated or non insulated, in a variety of shapes and sizes. So there will

be male/female blades, male/female bullets, ring terminals etc. For those who may not be familiar with these, photo 12 shows a selection of sizes and types of pre-insulated and non insulated connectors. Different insulation colours relate to wire cross section (and current capacity). Red 0.65 - 1 sq mm; Blue 1.5 - 2.5 sq mm; Yellow 3 - 6 sq mm.

Photo 13 illustrates a selection of crimping pliers, ranging from basic to the more



Photo 13. Crimping pliers for connectors.

advanced. That on the left is a budget multi-purpose tool; centre is for non-insulated, and right for pre-insulated. The better quality item on the right features a ratchet system, which effectively forces you to complete the crushing action before release, thus ensuring the quality of the connection. Some of these connectors and application tools are readily available from Halfords, but I have found that Vehicle Wiring Products offer a wider variety and run an excellent mail order service at rather more attractive prices.

Limit switches

I had cheerfully accepted that the machine was equipped with only a Z axis limit switch, however, whilst idly thumbing through the parts manual, I chanced upon the page which showed both X and Z limit switches. A quick bit of dismantling demonstrated that indeed there once had been a second micro switch for X, presumably removed by some previous owner. The actuation method is a rod with two notches which allow the switch to operate near the extremes of travel. My electrical scrap box yielded a suitable roller operated micro switch, which then needed a small mounting block. When making fiddly small parts, it is often convenient to keep the component attached to a larger chunk of metal until an advanced stage of manufacture. In this instance, I drilled the various positions, **photo 14** before cutting away the parts.

In spite of what I thought was careful measurement of relative positions, once assembled the switch needed to be moved about 2mm towards the front of the machine. The quick and dirty solution was to elongate the mounting holes by filing and add an outer cover plate beneath the screw heads so that the assembly became a bit like the "rattle plate" arrangements used for car door locks. **Photo 15** shows the two switches mounted to their carrier and **photo 16** shows the sub assembly in place on the machine.



Photo 14. Drilling/milling operations were completed before sawing off the small parts.

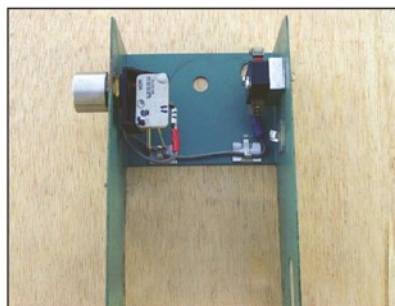


Photo 15. Inside view of switch carrier showing two limit switches.

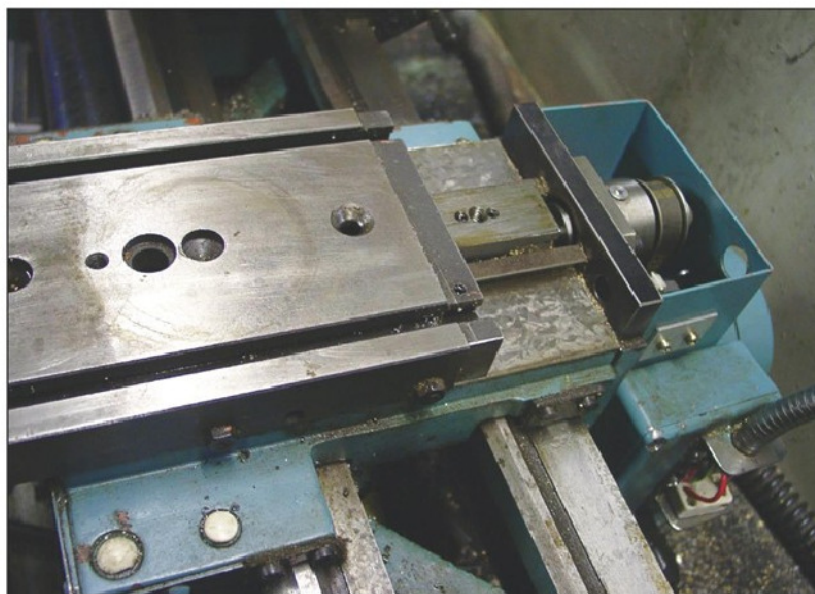


Photo 16. Switches mounted on lathe, note actuating rod is not fitted.

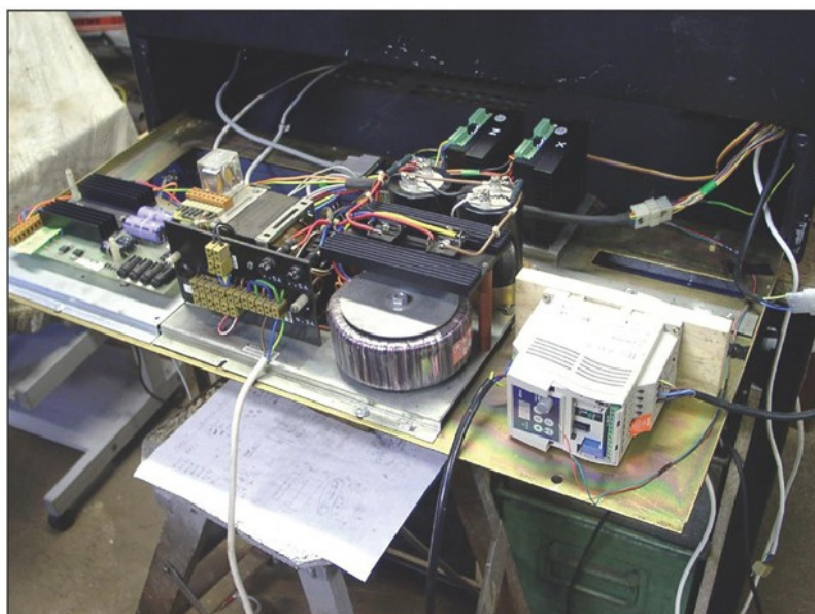


Photo 17. New inverter and stepper drives with temporary wiring.

Software/hardware setup

I had previously looked through the Mach 3 manual (downloaded as a 130 page PDF file), worked through much of the set up arrangements and played with the computer as a desktop simulation. The new drivers have micro stepping capability so I chose to use this to improve the resolution. The Orac has ball screws of 5mm pitch on both axes, driven by 12:30 tooth pulleys on the Z axis and 12:15 on the X. Selecting a microstep figure of 16 for Z would give 800 steps per mm of tool movement which in old money would be roughly 0.0001in on diameter per step. A microstep selection of 8 for Z would give the same component length resolution.

Initial testing

Due to spurious signals causing shutdown, the E stop and limit switch terminals were each temporarily bridged

by short loops of wire. At the first trials, the X axis behaved perfectly; however, Z seemed not to respond to commands. It later transpired that in removing and replacing the driver connectors, one or more of the microstep selector switches had been moved. The saddle had in fact been moving, but so slowly as to be thought stationary.

Further intermittent difficulties were experienced with signal interference, on both the E stop and limit switch lines, for which the solution was to connect a 0.1microfarad capacitor across each at the board terminals. Later, it was also found that interference could occur when the (mainly Perspex) original front panel was closed. A new cover was made from MDF and this cured the problem. **Photo 17** gives a view of the chassis with new inverter, stepper drivers etc in position fitted with some temporary wiring.

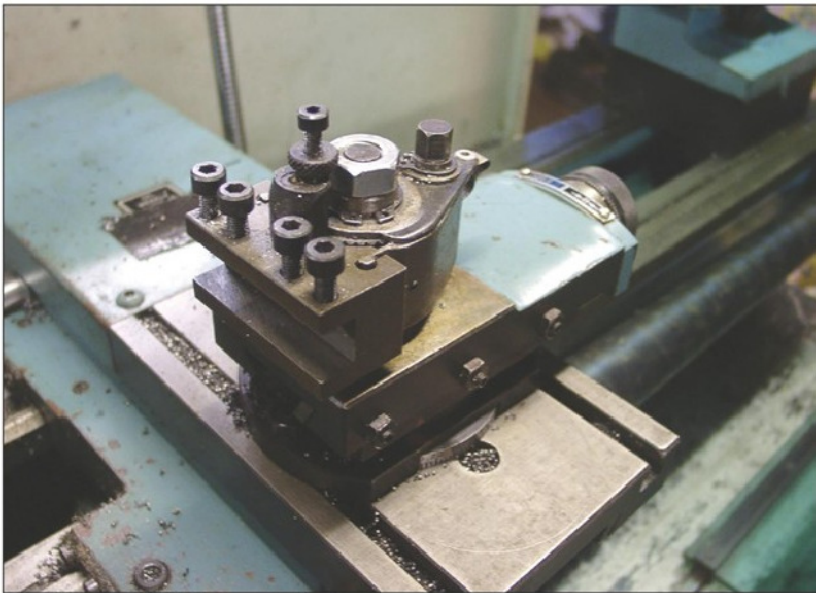


Photo 18. Hahn & Kolb type toolpost.

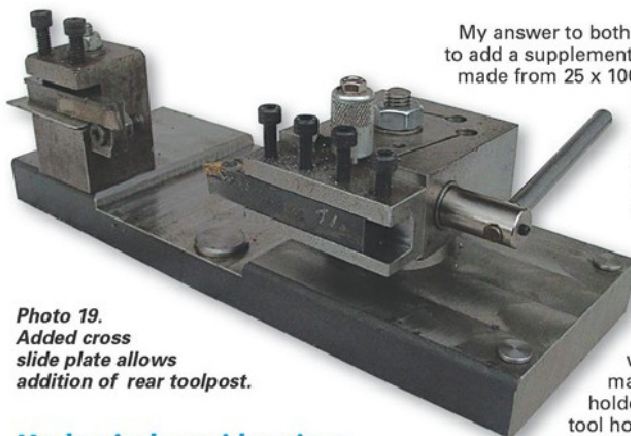


Photo 19. Added cross slide plate allows addition of rear toolpost.

My answer to both of these points was to add a supplementary cross slide plate made from 25 x 100 mm steel flat, which can be seen, fitted to the lathe, in **photo 19**. This carries two home made toolposts. At the rear, a simple item to take a part off tool and at the front, a copy of a quick change tool post already proved on the Myford 7 and for which I had earlier made a number of tool holders, **photo 20**. This tool holder arrangement was described in MEW Issue 127.

Mechanical considerations

In its original form, the Orac is fitted with an excellent quality Hahn & Kolb quick change tool holder mounted on a top slide. These are shown in **photo 18**. When I acquired the machine, it had just one tool holder. I believe this pattern is expensive and certainly I have not come across used examples at shows. Additionally, the cross slide is relatively short, and therefore lacks the space to fit a rear toolpost for parting off.

In use

At the time of writing, I am just beginning to explore the possibilities of the Mach3 software. It clearly represents a massive technological advance over the original Orac system and indeed over the Ahha system used on the Matchmaker mill. This is particularly the case in terms of the "Wizards" for creating part programs and the real time display of tool movement.

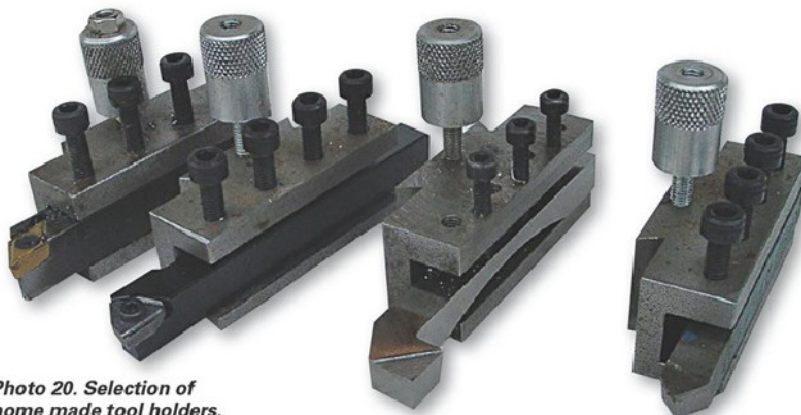


Photo 20. Selection of home made tool holders.



Photo 21. Wheel set showing tyre profile.

For the present, the power supply, inverter, stepper drives and interface board are all housed within the original enclosure beneath the lathe. The computer, monitor and keyboard are sited on a typical computer workstation parked to the right of the tailstock and the lathe as a whole is perched on the stand built for the Myford and described in MEW issues 133 and 134. The result is that the lathe is several inches too high and the keyboard too remote for comfortable use. You do need to be able to look closely at the tool while operating the jog functions and the immediate solution here has been to add a USB number key pad giving a secondary set of arrow controls, which could be held in a comfortable position for viewing.

During a recent conversation with John Stevenson, he mentioned undertaking a similar exercise on an Orac. However, as he plans a production oriented application, a coolant system will be necessary. Mounting the electrics and electronics below the lathe, would not be such a good idea, and he plans to remove the machine from the existing base and construct a completely new enclosure/guard arrangement, taking all of the power and control systems well out of the way of possible liquid ingress.

On mine, the first serious job undertaken was to profile a set of four wheels for a 7 1/4 in. gauge driving trolley. Initially, a part program was constructed by assembling four sub routines generated by the Mach3 wizards, (taper, fillet radius, taper and flange radius), however I opted to take dimensions from a CAD drawing then write to suit. There is certainly something deeply satisfying about watching the final pass working along the tapers and sweeping around the radii. An assembled wheel set is shown in **photo 21**, which illustrates the profile produced. ■

Suppliers

Vehicle Wiring Products Ltd

Tel: 0115 930 5454

They supply an extensive range of cables, connectors, tools and equipment mainly aimed at vehicle use.

Arc Euro Trade

Tel: 0116 2605805

www.arceurotrade.co.uk

Stepper Drivers, stepper motors, bearings, tooling and machinery.

RoutOut CNC

Tel: 01269 841 230

Stepper drives, CNC software, breakout board etc.

MAKING A CNC CUTTER GRINDER

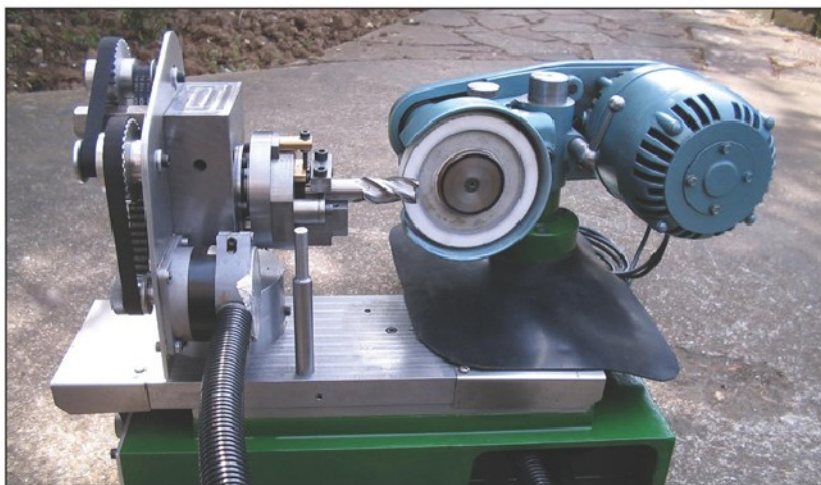


Photo 1. The finished cutter grinder.



Photo 2. View from rear showing timing belt pulleys.

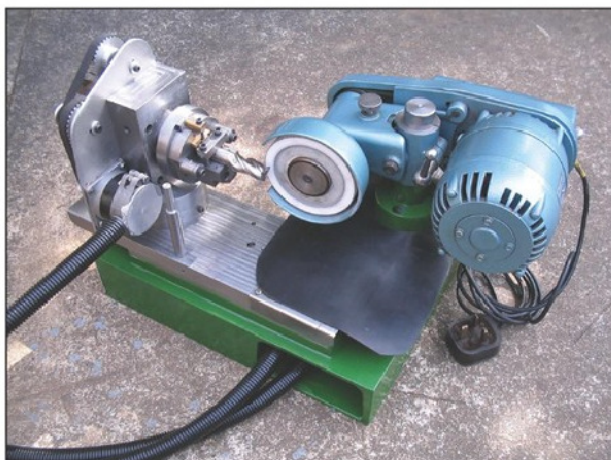


Photo 3. Sharpening the sides of a helical flute.

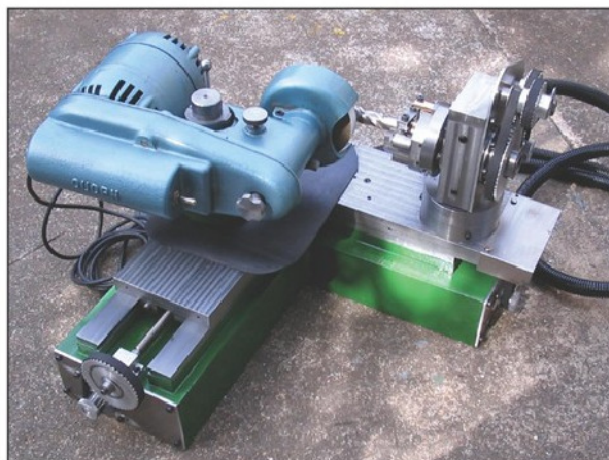


Photo 4. A better view of the Quorn grinding head.

John Pace introduces his machine and makes a start with the base

Background

Some twenty years ago I built a Quorn cutter grinder; it has been one of the most useful pieces of workshop equipment I have ever made. I bought a copy of Prof. Chaddock's book on the Quorn. It is a valuable reference for any workshop even if you do not own a Quorn. In the book a description is given on sharpening milling cutters. The end mill teeth are easy to sharpen but the fluted edges are a more difficult operation. I made a set of guide hobs as described in the book and although successful, in some sizes the pitch does not match the pitch of the cutter. The solution is to grind the cutting edge and the flute and from that point the cutter will always match the hob. This point is made in the book.

The guide hobs only cover the sizes from about $\frac{3}{32}$ to about $\frac{3}{8}$ inch. Sizes of cutters above $\frac{3}{8}$ inch are sharpened using a guide finger in the flute. I have never successfully mastered this skill and have always found the results unsatisfactory. I find that now the situation is even worse as inevitable deteriorating eyesight makes setting up difficult. The finely engraved divisions on my Quorn, which were easily visible when I made it, are now nearly invisible.

I know from the many articles that have appeared in MEW over the years that many people have produced successful solutions and produced excellent results. I for my part have now turned to an alternative approach.

CNC machining

In recent years, I have developed a new interest in CNC machining having converted my Dore Westbury mill to full CNC use and Myford super 7 and Warco A2f mill to part CNC use. All of the machines use Richard Bartlett's excellent Compucut system, Ref. 1. It occurred to

me that CNC would be the ideal solution to guide any cutter during cutter grinding operations. Photos 1 to 4 give a good view around the machine.

A brief description of the machine

I should make it clear at the start that this machine in no way replaces the function of a Quorn or other similar cutter grinding machine. Its only function is to grind the fluted cutting edges. However, it may well be used to grind other useful things such as camshafts and have designed the machine with this in mind.

This small CNC machine uses 3 axes for operation. The base made from steel channel forms an 'L' shape; the X axis table carries the cutter work head. The work head has a rotary action and is driven by the Y axis. To hold the cutters, I had intended to use ER 25 size collets and the nut from my collet chuck. This gives a range of cutter sizes from about 3mm to 16mm shank size, but I encountered some errors during the testing of the machine and had to turn to an alternative system but more of this later on.

The grinding head is on the other slideway and is driven by the Z axis. I used the head from my Quorn grinder but I have dimensioned the machine to enable the use of a cheap bench grinder, with some modifications, from Wickes of about 5 inch centre height. Any similar unit from another source would do. The three stepper motors I used are very low power and only have a phase amperage of about ½ amp and are frame size 23. Suitable and more powerful 2.5 amp motors are sold by Arc Euro Trade, usual disclaimer. These motors drive standard 12 mm dia 1.75 mm pitch stainless steel leadscrews via toothed belts. The toothed belt drive resolves the screw in X axis to 1mm pitch = 0.005 mm per motor step and in Z axis to 0.5 mm pitch = .0025mm per step. The Y axis is driven by a series of toothed belts, one rev = 7200 motor steps, one motor step = 1/20th of 1 deg. I chose these numbers to keep the ratio of X to Y steps to about 4 to 1 and 1 to 4 when sharpening cutters in the range from 3mm dia to ¾in. dia. cutters.

The machine is essentially dimensionless, has no leadscrew dials or indicators and relies entirely on Compucut units. From this point onwards, all of the references regarding the operation of the machine using CNC refer to Compucut. I do not have any working knowledge of other systems and what facilities they provide. There is no need to know the pitch or lead of any cutter as this information is compiled directly from the machine and written into a template program.

Machine construction

The base

Photo 5 shows some of the main parts of the base and tables. I started by making the base frame first. The basic frame is made from two sections of steel channel as in the drawings, Fig. 1 & Fig. 2. It is best to ensure that they are cut square and the motor mounting plate holes drilled before welding.

The plates for the X and Z motors, Fig 3 can be made at the same time spotting the holes into the channel. Leave the motor mounting positions for the time being.

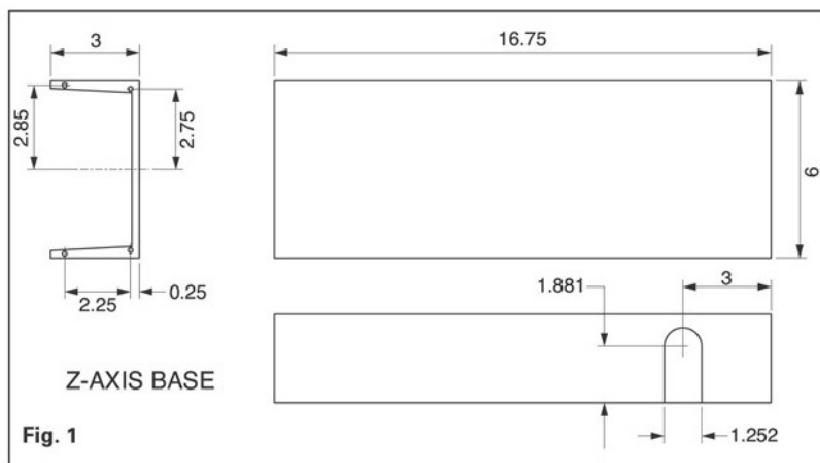


Fig. 1

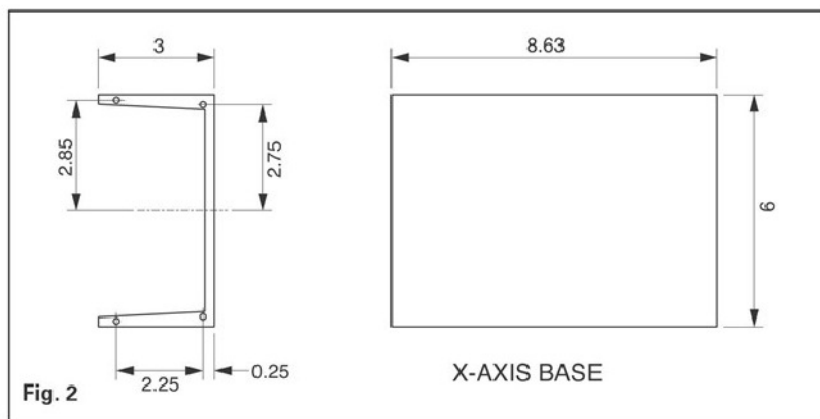


Fig. 2

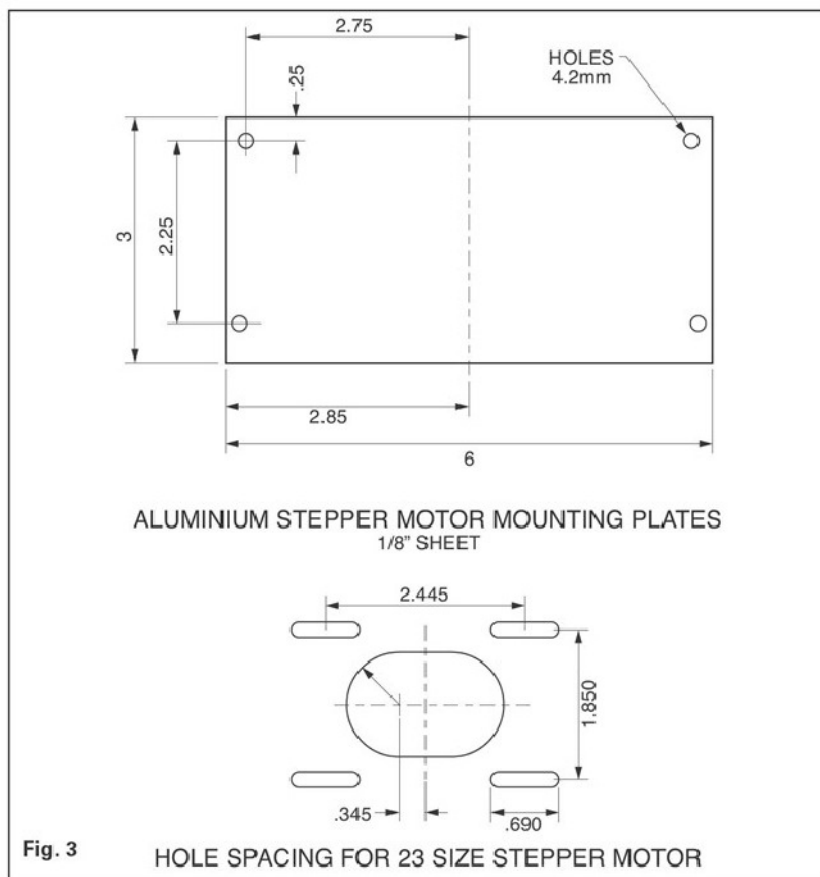


Fig. 3

HOLE SPACING FOR 23 SIZE STEPPER MOTOR

Weld the two parts together as per **Fig. 4** making every effort to avoid distortion and try to keep flat. **Photos 6, 7 & 8** show the development of the base assembly. Cut and weld in the bridge pieces on the undersides. Next, drill holes in the underside bridge pieces to suit bolting down to the milling table, **Fig. 5**. Despite my best effort in this I still had some distortion and had to mill the top and bottom of the frame level, **photos 9 & 10**. There is not much material to play with so take off a minimum amount. Drill slideway mounting bolt holes and prepare some mild steel bars as per **Fig. 6**. Fix the slide bars to the base, **photo 11** with some cap head screws. I glued mine on with some Loctite as well and let it set. The base is now just like a casting and just needs final machining of the slideways, **photo 12**. The section is shown in **Fig. 7**. Both slideways are the same; make sure the frame is not distorted when bolting down to the milling table. Machine the dovetails and the tops of the slides at the same setting. ■

Next month, we continue by making the machine slides.



Photo 5. The main components.



Photo 6. Two base channels welded together.



Photo 7. Underside of the fabrication showing cut out between.



Photo 8. Brackets have been added.

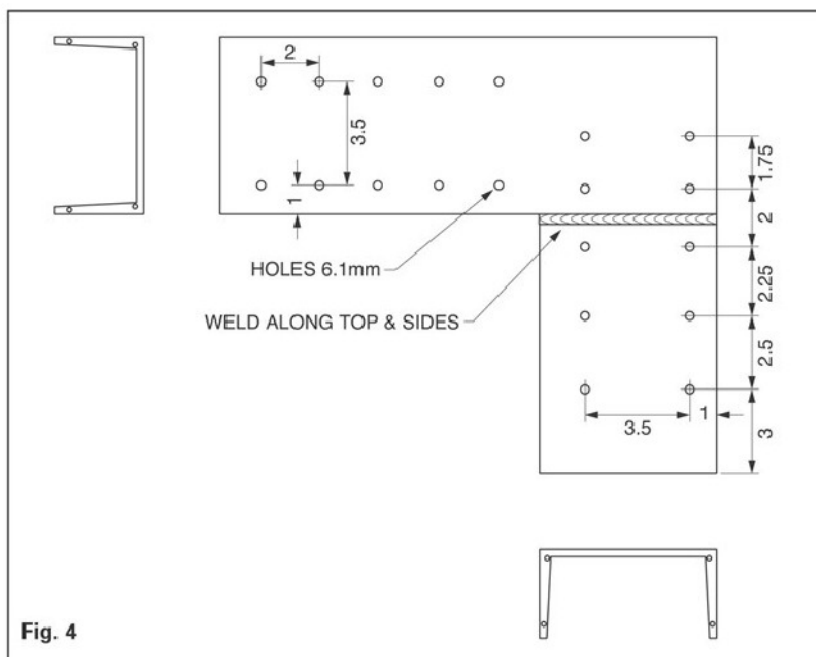


Fig. 4

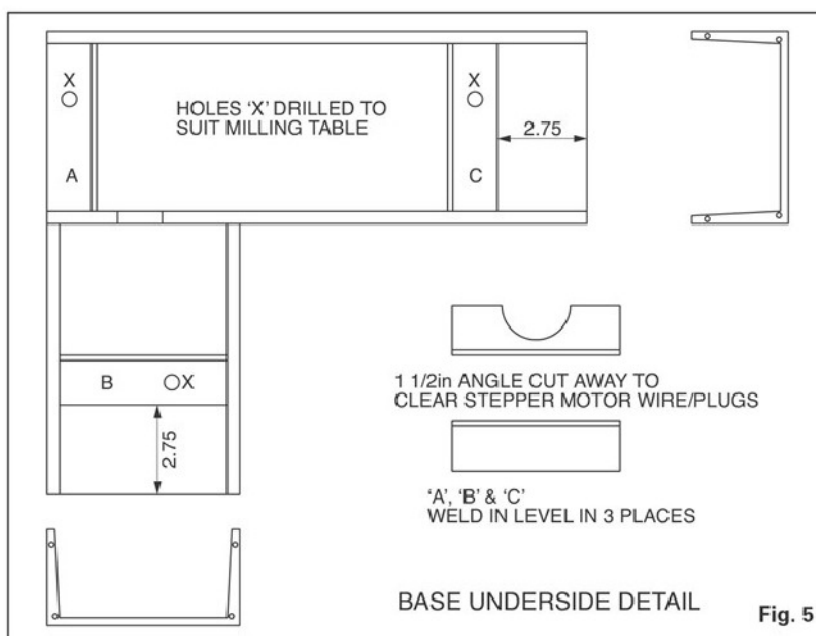


Fig. 5

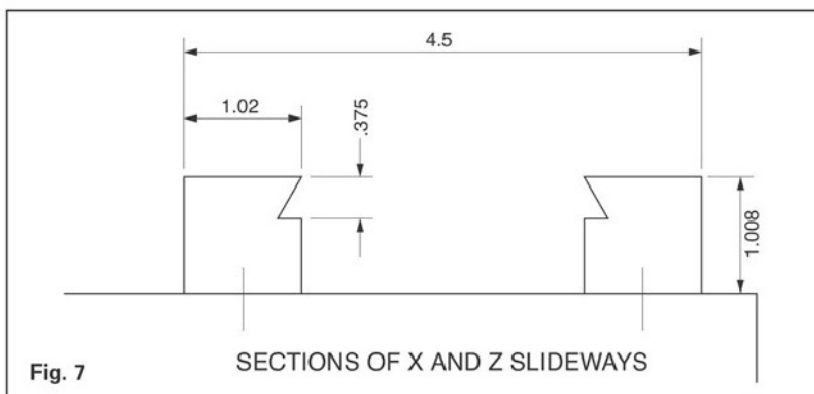
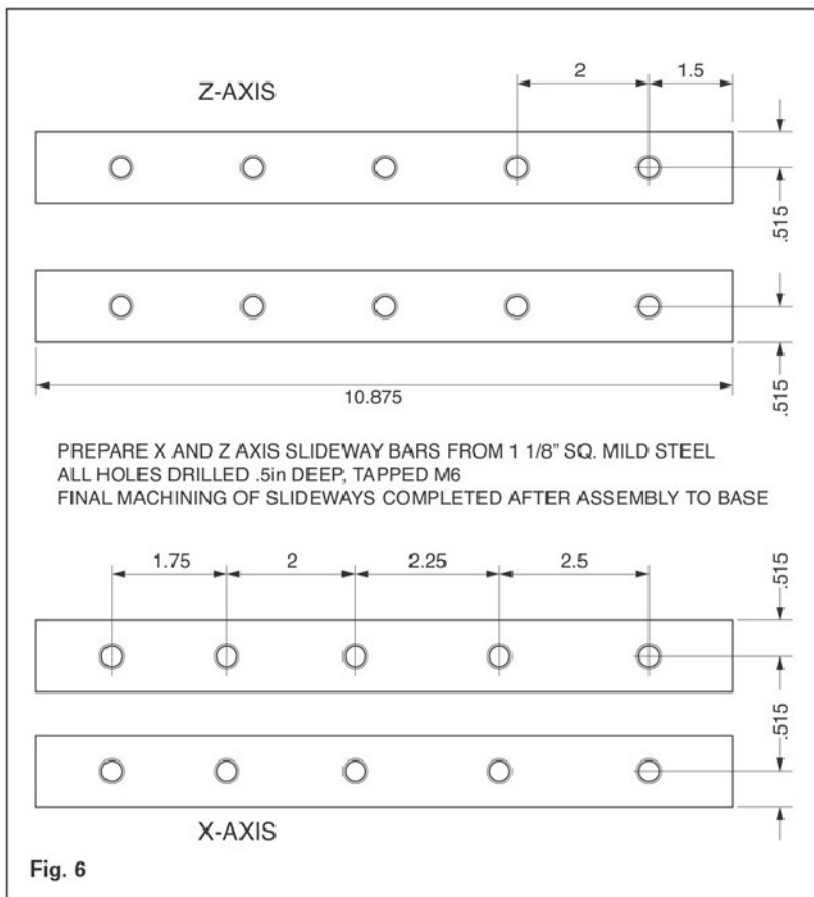


Photo 9. Machining the underside.



Photo 10. Machining the top surface.



Photo 11. Fitting the blanks for the dovetails.



Photo 12. Machining the dovetails.

MAKING A SMALL ROTARY TABLE

Dyson Watkins goes round in a circle

This rotary table, **photo 1** started off as a temporary tool to use on the milling machine in the absence of a rotary table with a worm drive. Its purpose was simply to provide a means of adding radiused ends to items without the expenditure of a great deal of energy from pushing a hacksaw followed by filing. It is really something of a lash-up, being made to suit the sizes of scraps of material available from my scrap boxes and the table itself is perhaps a little small, being just three inches in diameter. Having made it however, it has turned out to be very useful and quickly set up, being held in the machine vice. The sizes are readily changeable to suit ones own circumstances so the principles of making and use are possibly of some interest.

Base plate (Fig. 1)

I decided to make this part first of all. It was set up on the mill and clamped down on parallels to square up the ends and mill the plate to size. This is not hard and fast and because my length of plate happened to be 4in. wide, it was machined to 4in. square.

Locate the centres and drill three holes, one at the centre, and two others 1½in. on either side, all using a 6.8mm drill. Remove from the mill and mount it in the lathe four-jaw chuck using parallels between the face of the chuck body and the back of the plate, clocking up using the centre hole of the three holes drilled previously.

Remember to remove the parallels after the plate has been set up as they will probably fly out with disastrous consequences if left in place. Drill out as

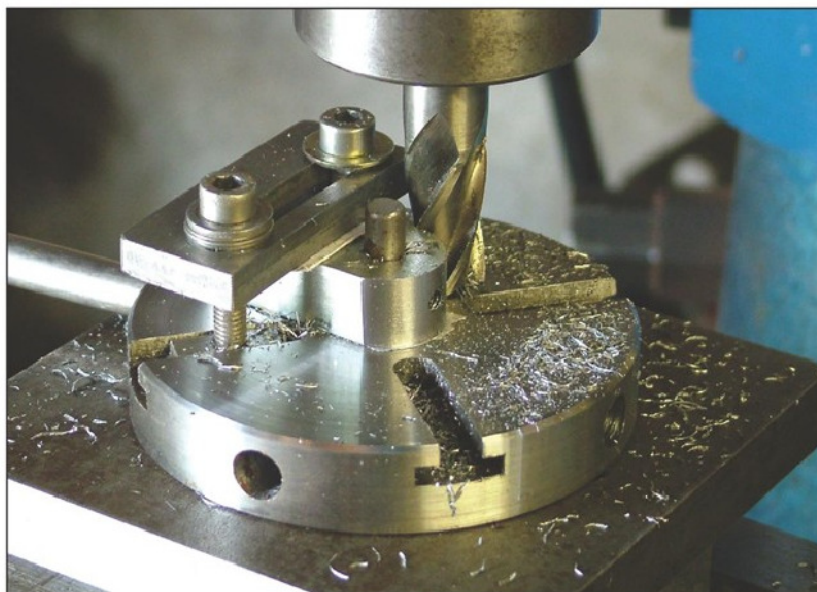
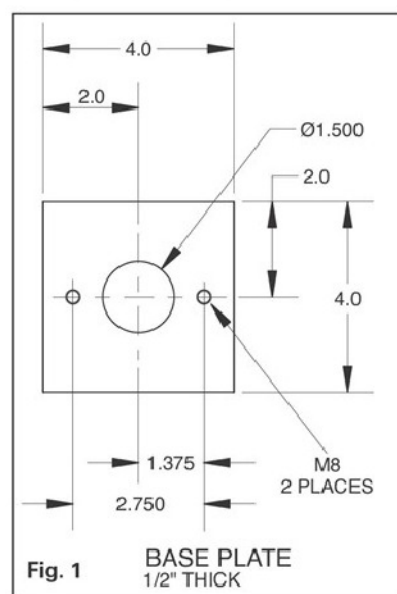


Photo 1. The finished rotary table in use.

much waste as possible followed by boring to 1½in. final diameter. Chamfer the edges of the bore on both sides of the plate, **photo 2**. A chamfer of 0.020in. x 45deg. will be sufficient. Finally, drill and tap the holes for the M8 screws.

The disk (Fig. 2)

Turn this from 2in. diameter bar. A length of ¾in. is fine. Centre drill and drill through 10mm diameter. Face the end, chamfer, clean off the outside diameter and part off. Clean up the other face if necessary.

The table (Fig. 3)

I would have preferred to make this 4in. diameter but the largest diameter bar available was 3in. so it was made that size. The material was quite hard and I was forced to use a carbide turning tool to rough it out. It could well have started life as a hydraulic piston rod on some earth moving machine and when it was given to me, both ends had been flame cut and had to be sawn off a good 5in. or so away from the ends as the metal was so hard that my machine hacksaw simply skidded over it. A length of 1½in. was eventually sawn off and faced off in the three-jaw chuck. Mild

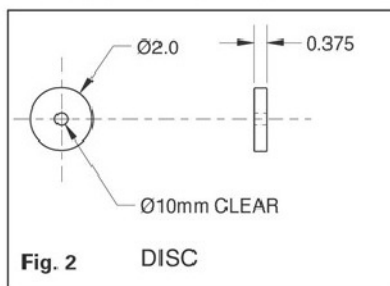


Photo 2. Boring the baseplate.

steel should present no difficulties at all. The 1½in. diameter spigot is turned next. Use the bore previously made as a gauge to obtain the close sliding fit required. Turn the length of the spigot slightly longer than the thickness of the base plate, say 0.010in. or so initially. The final amount to remove was determined by setting up a dial indicator on a magnetic base mounted on the cross slide and traversing it across the end of the spigot on to the adjacent plate surface. The difference in readings will give the amount to remove (less the couple of tenths needed for clearance).

Centre drill the end face followed by drilling the tapping hole for M10 with an 8.5mm drill. The tap can be started by holding the shank in the tailstock to ensure that it goes through squarely. After the hole has been tapped through and before removing the table from the chuck, the base plate can be mounted on the spigot and the disk bolted into place in order to check the clearances. Clean the base plate before assembly. If all is well, dismantle the parts and reverse the table in the chuck holding on the spigot.

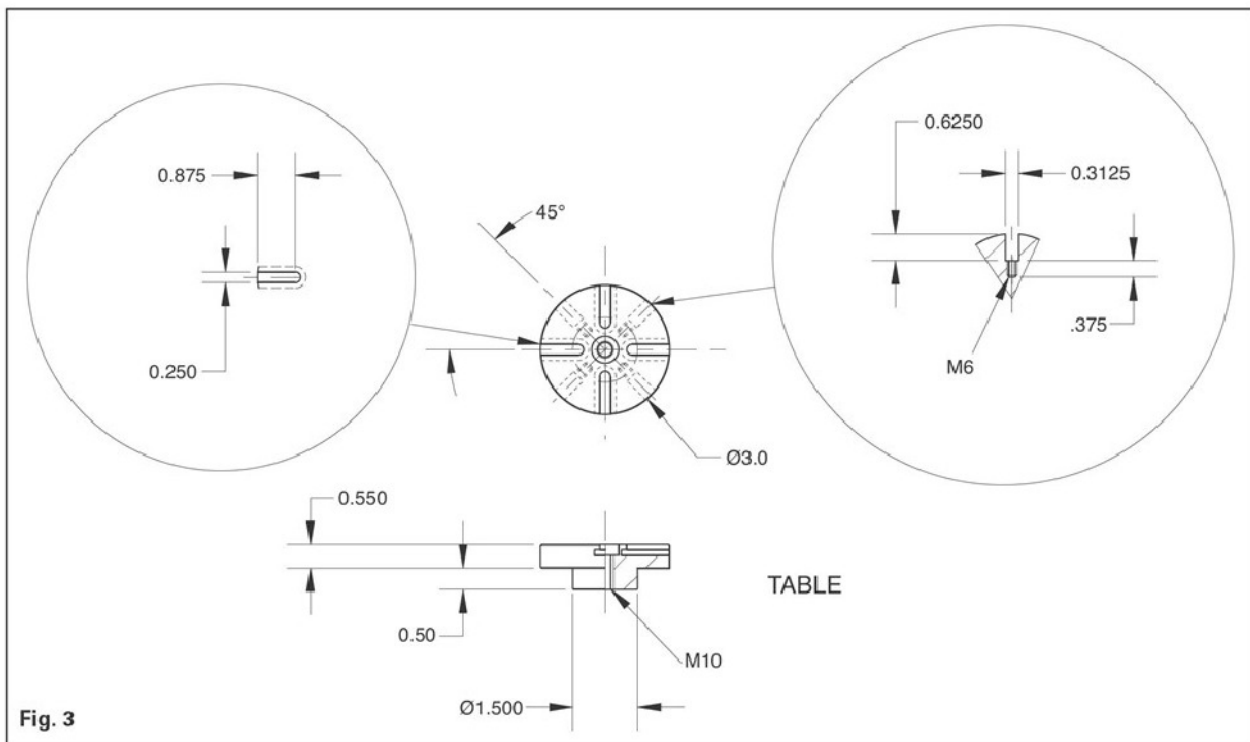


Fig. 3

If your three-jaw chuck is at all suspect use the four-jaw chuck to ensure concentricity.

Clean up the outside diameter and follow up by facing the top. Next bore the recess that houses the insert to 0.625in. diameter by 0.25in. deep to a shoulder. The insert when made is faced so that its top face is flush with that of the table.

The insert (Fig. 4)

This part can be made now and is a quick job to make. Turn and face to fit the recess and drill/ream to 0.25in. diameter through. The fit in the recess should be an easy sliding fit without play. Its purpose is to provide location and support for the spigots, which will need to be made for locating the various components that need the application of a radius.

Milling 'T' Slots

The most suitable 'T' slot cutter to hand gave a width of 0.510in. with a slot depth of 0.125in. This size was suitable for a bolt diameter of 5mm. To provide some clearance for the bolts, the 'leg' of the 'T' was machined using a 1/4in. diameter slot drill. The four jaw chuck from the Myford was used as a fixture

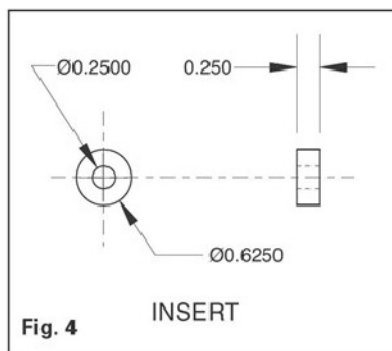


Fig. 4



Photo 3. Clocking the top of the rotary table true.



Photo 4. Milling the slots.

and set up so that a clear cutting path was maintained in between the chuck jaws. The chuck was clamped to the bed of the milling machine and clocked up on centre, **photo 3**. At this point I generally reset the machine dials to zero so that the centre position is quickly referred to if required. Now using a 1/4in. diameter slot drill, mill each slot down to its full length and depth. Change the cutter to the 'T' slot cutter and to find the depth, simply lower the cutter until one of its teeth rests gently on the bottom of the slot. Back the cutter away from the slot before switching it on. Mill each slot in turn, **photo 4**.

Tommy bar holes

Set up the work in the vice. I used a small 45deg. setsquare off the top of the vice jaw lining it up with the edge of one of the slots, **photo 5**. To locate the position for drilling the hole I used a wobbler off the edge. Centre drill and drill 5mm diameter to 7/16in. deep, **photo 6**. Open the hole out to 5/16in. diameter for a depth of 5/16in. Repeat for each hole and then tap the inner hole M6. This completes the table.

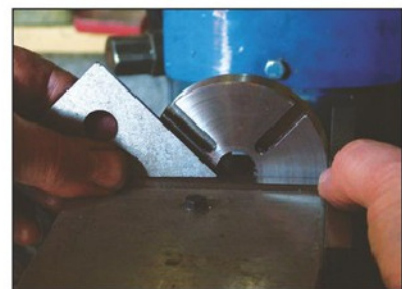


Photo 5. Setting up for the tommy bar holes.



Photo 6. Drilling the tommy bar holes.

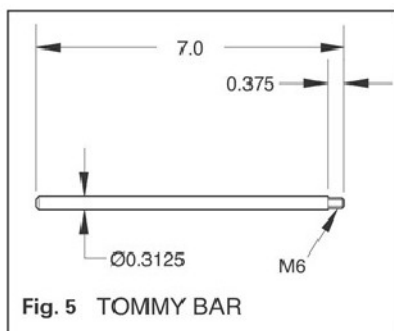


Fig. 5 TOMMY BAR

Tommy bar (Fig. 5)

Turn this from a length of $\frac{5}{16}$ in. diameter steel. Turn and thread one end M6 for a length of $\frac{3}{8}$ in. Turn a chamfer on the other end for comfort. An overall length of 7in. will be fine.

Mounting support (Fig. 6)

A length of bright mild steel bar 1in. square by 4in. long is required. Clean to length in the mill and set up on parallels in the vice with just over $\frac{1}{2}$ in. accessible above the vice jaws. Mill away the clearance recess to $2\frac{1}{2}$ in. long. Locate the centre of the bar with the wobbler. Centre

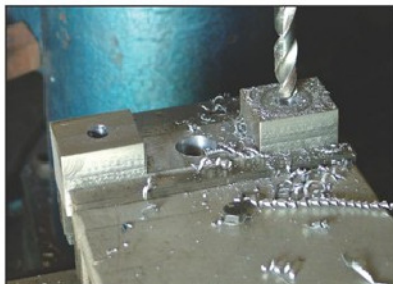


Photo 7. Drilling the mounting support.



Photo 8. Counterboring the mount.

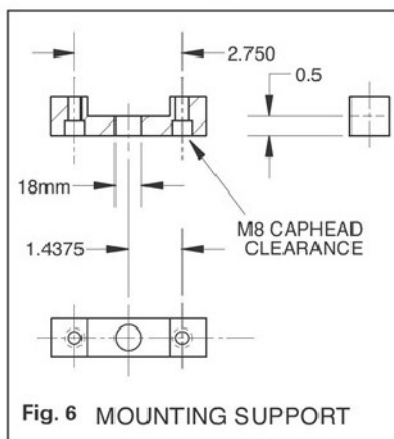


Fig. 6 MOUNTING SUPPORT

drill and drill through to $\frac{1}{16}$ in. diameter. The remaining two holes are $2\frac{1}{4}$ in. apart and are clearance size for M8 cap screws, photo 7. These are counterbored after inverting the workpiece to enable the screw heads to sit slightly sub flush, photo 8. Lightly chamfer all edges and assemble.

'T' nuts (Fig. 7)

These can be made from $\frac{1}{8}$ in. x $\frac{1}{4}$ in. bright mild strip but I used a couple of slices cut from the edge of a piece of plate. Set the strip on edge on a parallel and mill the corner away along the full length. Clean off any burrs and invert. Repeat as for the first cut. Drill and tap the M5 holes and saw into lengths, photo 9.

Clamp (Fig. 8)

I decided on a single strap clamp; this would be suitable for most work, but due to the variety of work likely to find its way onto this piece of tooling it is probable that other clamping arrangements will be required from time to time. The clamp as shown was deliberately made having a narrow front edge with a wider edge at the back. The reason for this is that cutter space is limited on such a small table and consequently there is a limit to the diameter of end mill that can be used. The rear edge is wider to retain as much strength as practicable to avoid bowing, photo 10.

Setting up and use

The tool is simply clamped in the machine vice with a thin parallel temporarily inserted beneath to set the clearance necessary for the disc. The table is centred by either clocking the hole in the insert, or by gripping a length of $\frac{1}{4}$ in. diameter material in the $\frac{1}{4}$ in. collet and adjusting position until the hole is in line. Clamp both axes. Now using a spigot matching the $\frac{1}{4}$ in. hole in the insert on one end



Photo 9. Making the tee nuts.

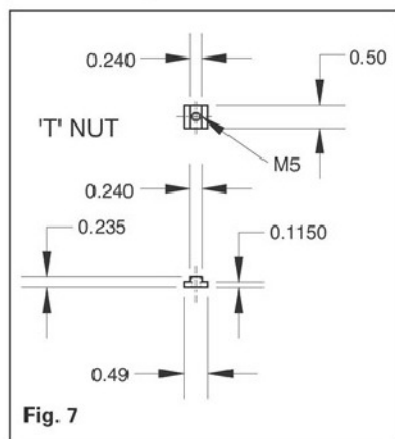


Fig. 7

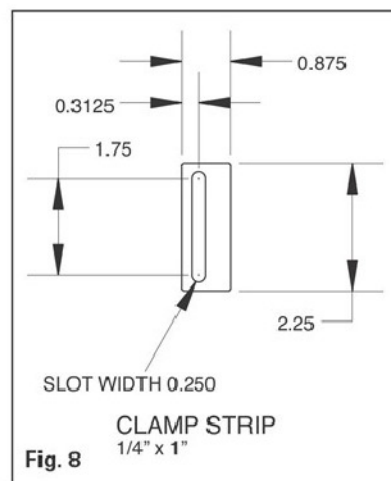


Fig. 8

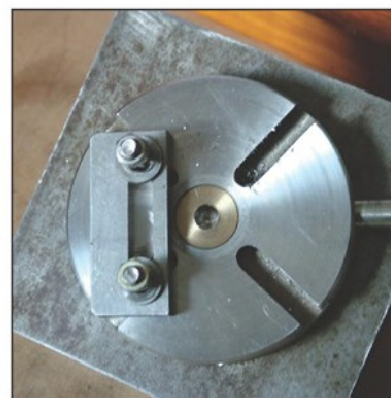


Photo 10. The strap clamp in use.

and the other end turned to fit the hole in the part, clamp the work in position. The spigot locates the work on centre and can be left in position to provide additional security. Photo 11 shows a link being set up. The work is raised above the table using a scrap of aluminium foil reclaimed from a container used previously for a food item. This is 0.005in. thick and allows the cutter to reach the bottom of the work without marking the table. A piece of paper, or thin card should be interposed between the clamp and work to provide extra security in clamping. The paper achieves this by increasing the contact area in between, thereby reducing the likelihood of slipping. During use it is advisable to avoid 'climb' milling thus avoiding the possibility of the cutter grabbing the work. The use of sharp cutters also reduces loading on the work and increases safety, which when all is said and done, is paramount. Enjoy. ■



Photo 11. Setting up a link for milling.

A CHAIN DRILLING JIG

Howard Jennings spends an afternoon in the Workshop

When you are down in the workshop for a few hours with no particular job on the go and looking to make a useful addition to your tool box, this tool fits the bill nicely. This jig can be made in an afternoon tailored to your needs. I have found myself picking it up for all sorts of jobs beyond what I originally made it for.

Difficult Beginnings

This jig started out as a solution to a nasty little DIY problem. I had to remove a section of rotted hardwood window frame in a conservatory I was repairing for a relative. The frame section had two double glazed panels on either side in toughened glass. The slightest 'touch' with a metal tool and the whole pane would shatter into tiny pieces. I also needed to get the joint face square to fit the repair wood section. I designed this jig to chain drill through the wooden frame leaving a face I could easily dress square. The jig also enabled me to control accurately exactly where the cutting tool was relative to the glass panes. With some bits of aluminium sheet slid in to protect the glass edges and final careful sawing and file work the job was done, glass intact.

Jig description

So on to the jig itself, the jig is made of some material I had to hand, a piece of $\frac{1}{2}$ in. x 1in. x 3in. welded to a piece of $\frac{3}{4}$ in. x $\frac{1}{4}$ in. x 4 $\frac{1}{2}$ in. mild steel. A similar result could be machined from solid or the block could have been silver soldered/ brazed to a wider steel strip that formed the whole base. **Photo 1** is an attempt to show the hole centre relationships without a drawing; from the left the first and third countersunk holes are on the centre line of the chain drilled holes. Similarly, from the left the second and fourth countersunk holes are on the centreline half way between the holes. The chain drill hole size is not hard and fast, I have used $\frac{1}{4}$ in. diameter holes. I find it is a convenient size for this sort of job. The hole spacing for the 'chain drilling' set of holes is the drill diameter plus half the drill diameter. So in my case the hole spacing works out to be $\frac{1}{4}$ in. + $\frac{1}{8}$ in. = $\frac{3}{8}$ in. I think there are endless variations on this depending on what the jig is generally used for. Tightening up the spacing for instance will reduce the dressing work on the slot produced, see later photos.

Using the Jig

Stage one is to screw the jig down, **photo 2** the countersunk holes were made for 4mm wood screws. Note the position of the wood screws in this picture. Stage two is to drill through leaving out the hole nearest the camera, **photo 3**. **Photo 4** shows the result of the drillings thus far. Stage three is shown in **photo 5**; now the jig is screwed down again but this time with the other pair of countersunk holes in the jig. Note you are using the screw holes in the wood originally made



Photo 1. The drilling jig.



Photo 2. Screwing the jig down.



Photo 3. Drilling the first holes.



Photo 4. The first row of holes.



Photo 5. Screwing down using the offset holes.



Photo 6. The second row of holes are drilled between the first holes.

for the first stage. This repositions the 'chain drill' holes so that they are on top of the wood between the holes first drilled. Stage four is to drill through again. The result is shown in **photo 6**; there is now a chain drilled slot ready for file/chisel saw etc. I hope you can see that although this is a short jig, it is possible to 'step it' along using the countersunk holes and a straight edge.

What happens with metal?

Just in case some of you were thinking that you have picked up a wood working/DIY magazine this month, we now go back to the workshop. When I mentioned this jig to the Editor, he was interested but tacked on the question "will it work with metal?" I said yes even though I had not tried it. My reasoning was if it will work with hard wood it's not too big a stretch to aluminium. Later I thought well just how far can I push it. Most MEW readers I reasoned will be more interested in steels. At least I could try it and report a heroic failure if it all goes wrong.

Just to live dangerously and really push it, I decided to screw the jig to steel plate using some self tapping screws I have. I found the piece of 6mm hot rolled plate while I was looking for something a bit thinner. Well 'in for a penny in for a pound', I would give it a try. I clamped the jig down just as the procedure for the wood using the self tappers, **photo 7**. The main difference in approach here was to use a workshop pillar drill to drill the holes through. For the wood I used a hand held 24volt battery drill. For a site job drilling through steel away from the workshop, where use of a mains power drill was not possible, I might use such a power tool knowing I might need one or two recharges to finish the job. In **photo 8**, the jig is repositioned as before. As I started to drill through between the first set of holes I was apprehensive; I quite expected to hear the ominous crack of a breaking drill. **Photo 9** shows the result, success! I was astonished; as you can see a chain drilled slot has been produced ready for further work with a file. I was expecting some drama from the drill as it started to cut but there was no jamming or even suggestion of jamming.

Points for use with metal

One or two points arose during this trial; firstly the self tappers worked, but only just! Either use better quality ones designed for thick material or better still tap a suitable thread (M4 in my case) and use proper countersunk machine screws. I think clamping would work. Making the plate base bigger would help enormously. It might be possible to reset the jig between drilling stages by eye but I think using blue marker pen in the countersunk holes produced in my jig to mark position etc would be very convenient. Of course clamping will make presenting the job to the pillar drill that bit more inconvenient. For metal more dimensions need to be known to site the jig accurately. The best time to note these is whilst it is being made.

Hardening

My jig was made from mild steel from what was to hand; I never expected to use the jig more than once. For regular use I might consider hardening it. I think with regular use on steels particularly with hand held power drills hardening

would be worth it to maintain accuracy and increase its life. If you have a piece of steel suitable for hardening and it is big enough for this job then it may have found its destiny in this jig. For my jig I am likely to case harden it. I am fortunate to have a multi fuel stove in my workshop. For this job I will wait for winter. I have had success with the method I am about to describe. Firstly I rub pencil 'lead' (really graphite pure carbon) all over the areas I want the case. This will mean exposing as much of the pencil core as needed to get down the holes and carefully rubbing all around the holes. Next I will pack the jig in a container, say a used food tin if I spot something that I can fit it in and it can be closed up. I then pack around with 'Kasenit' type powder. I also am not above using crushed barbecue charcoal particularly if I have saved some from summer barbecues that has been at temperature and 'gassed off'. This is good for reducing the amount of 'Kasenit' type powder needed. Theoretically it should work alone but I haven't tried it.

Once the job is packed up in a steel container that won't spill out its contents, it goes into the coal fire running red hot for as long as I can, it needs to be a cold day! After this soaking at temperature, I pull it out of the fire, get the job out of the can and quench in cold water whilst it is still red hot. Don't even think about doing this without gloves, eye protection and tongs; I even wear safety shoes. Alternatively, leave it to cool down in the ashes, pull the job out when the fire is cold, reheat with a propane or butane torch and quench. I have found this produces an 'even' very hard case which has some corrosion resistance.

Final points

I don't believe for one minute this jig is an original idea, however, as the Editor said "I haven't heard of any thing like it before". I made the jig shown just over a year ago and the potential uses are still being explored. Clearly chain drilling a large square hole in plate would be a possibility. It can cut down milling time if used with care for producing slots especially for smaller machine tools. ■



Photo 7. The first position on the steel plate.

Photo 8. The second position on the steel plate.



Photo 9. The finish drilled slot.

INDEX FOR ISSUES 129 TO 140 OF MEW

The information contained in this index supplements that published in issue 129 and brings the information up to issue 140. A computer based index is also available for those with suitable equipment to run the software.

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Model Engineers' Workshop Publication Dates

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Model Engineers Workshop Computerised Index

The computer index is available from CAHW. It is supplied in DOS format on two floppy disks with a full manual. Facilities are included to VIEW, SEARCH, SORT, EDIT, UPDATE and PRINT. Cost is £10 for full version and £6 for update; non-UK orders should add £2 carriage. CAHW are at 43 Waller Drive, Banbury, Oxon. OX16 9NS

CONVERTING A MYFORD ML7 TO CNC 5

Tony Jeffree Looks at adding a pendant control

There is just one further addition that will make using the lathe easier and that is to add a "pendant" control. The cheapest and simplest way to achieve this is to fit a Shuttle Xpress device; this is a device that was designed to make video editing and similar tasks easier on a PC, but it lends itself well to CNC. Two versions are shown in **photo 16**; the one on the right is the standard version and the one on the left, while mechanically and electrically identical, has been personalized by Tormach for use with their milling systems. The device has an inner wheel that rotates indefinitely in either direction; it has a click detent and in operation as a pendant, a single click of the inner wheel causes Mach3 to drive the currently selected axis by whatever the current jog increment is. Clockwise "clicks" cause the axis position to increase; anticlockwise "clicks" cause the axis position to decrease.

The outer ring is spring loaded to a central position, but can be wound anticlockwise or clockwise by a quarter of a turn or so in either direction. This ring gives progressive velocity control of the current axis; a small clockwise twist of the ring causes the axis to move slowly in the + direction, and if the twist is increased, the axis accelerates to a faster speed. Similarly, turn it anticlockwise and the axis will go the other way.

There are five buttons that can be configured for a bewildering array of functions; the Tormach device is clearly marked with the intent that the first 4 buttons (counting from the left and going clockwise) are used for axis selection and the fifth button selects the jog increment size; however, on a lathe with 2 axes, the choices would be different. I chose to set



Photo 16. The two different shuttles.

the first 2 buttons to select X and Z, the third and fourth to give rapid + and - axis moves and the fifth to change the jog increment. There is also a Shuttle Pro that has many more buttons; however, I felt that this would offer more confusion than clarity, so opted for the Xpress version.

In use, this device makes for quick and easy positioning of the axes and the "velocity" control with the outer ring is great for quick-and-dirty manual operation of the lathe - the slowest speed gives a very fine feed. The easiest way to reference the work before you start a CNC machining operation is to face off the end of the work to give you the Z=0 position, then take a skim cut and measure the diameter to give the X diameter (this is why it is worth choosing "Diameter" in Turn Options); doing this with the Shuttle control is very quick and convenient.

Shuttle Xpress setup

To get the Shuttle Xpress working, you first need to load the Mach3 "plug in". This can be downloaded from the

Downloads area of the Mach3 support website; scroll down until you find the "ShuttlePRO" section (the same plug in works for all versions of the Shuttle). On your Mach3 system, with Mach3 running, place the plug in file in any convenient directory and double click on it; the file will then be automatically renamed as a DLL and placed in the C:/Mach3/Plugins directory. Exit Mach3 and restart it to ensure that the plug in is properly recognized by Mach3 and then plug the Shuttle into a convenient USB socket.

The plug in needs to be configured; select Config, then Config Plug ins from the drop-down menu, and a window appears as in **photo 17**. Make sure that the Enabled box next to the Shuttle Pro entry is ticked, and then click the CONFIG button next to the entry, which will bring up the shuttle configuration screen as in **photo 18**. This is laid out to look like the Shuttle Pro; for the Xpress, only the buttons in the second arc from the top are functional. As can be seen in the photo, these are set to make the first two buttons select X and Z

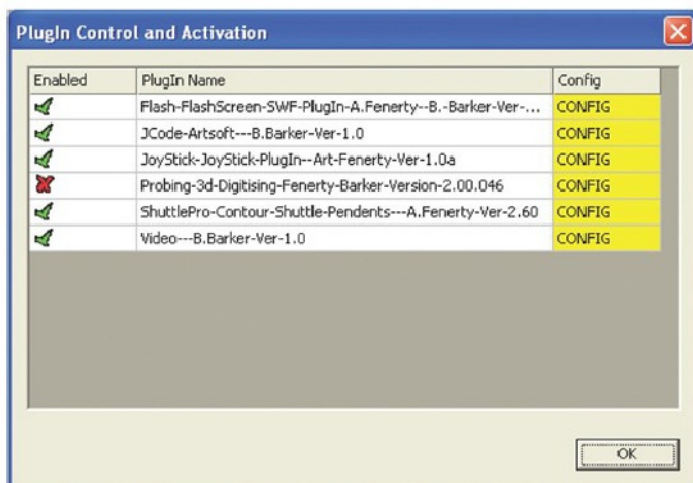


Photo 17. Configuring the plug in for the shuttle.

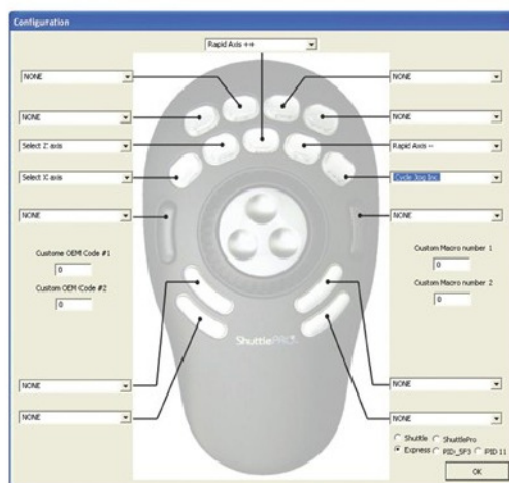


Photo 18. The shuttle configuration screen.

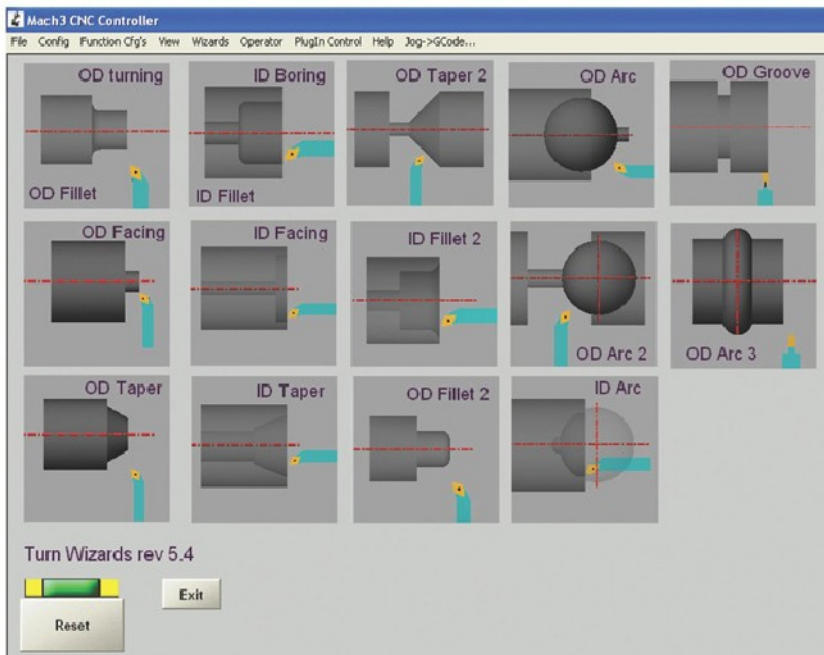


Photo 19. Turning operations are easy with wizards.

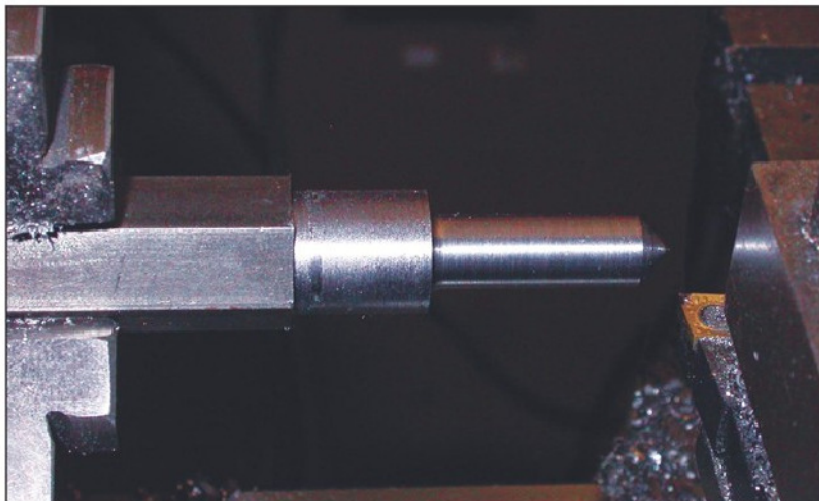


Photo 20. A part programmed with a wizard being turned.

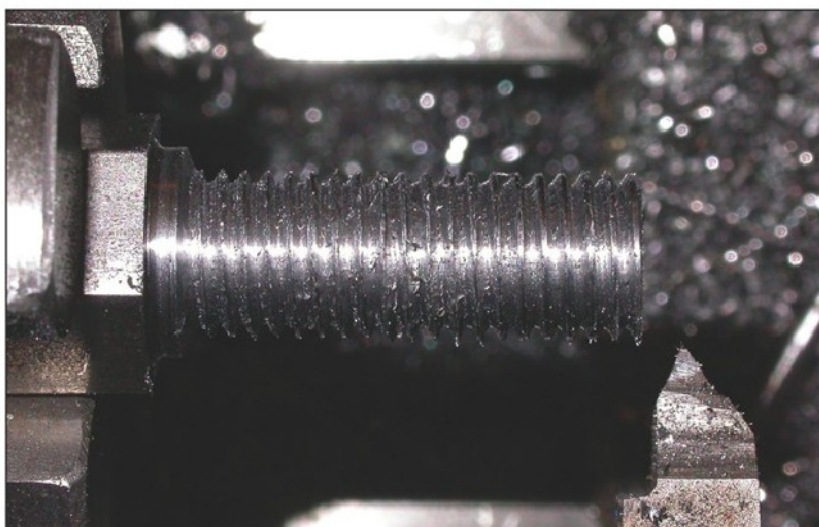


Photo 21. A thread also programmed with a wizard.

axes, the third and fourth give rapid + and - moves, and the fifth cycles the jog increments. In the bottom right hand corner, you must make sure that the right radio button is checked to select Express or Pro, depending on which one you choose. Click "OK", and the shuttle should then be operational. I attached a disc magnet to the back of mine so that I can hang it on the front of the lathe cabinet when it is not in use.

An alternative hand control device is a joystick; as I mentioned earlier, the keyboard that I chose to use has a mini joystick built in and it can operate either as a joystick or a mouse. If you want to experiment with this, there is yet another plug in for that, which needs to be loaded and enabled in a similar manner to the Shuttle. In use, the joystick gives progressive velocity control of the axis movements, rather like the outer ring of the shuttle; however, one interesting difference is that if you move the joystick diagonally, both axes move, which can be useful.

Using the lathe

I don't plan to say a great deal about this, principally as it is very early days for me, so I am not in a very different position from anyone else coming at Mach3 for the first time and trying to make sense of it. The best advice I can give here is to make full use of the documentation and videos that are available on the Mach3 support website to help you to get familiar with the operation of the system.

However, I will offer a little taster of what it can do by way of a couple of my first two attempts at using the "Wizards"; there are two sets of lathe wizards, one for simple threading, and the other for turning. **Photo 19** shows the wide range of simple turning operations, internal and external, that can be performed using the turning wizards. The first example, shown in **photo 20**, was cut in three stages. First, I used the Shuttle to face off the end of the hex bar, and to turn off the flats. Having "referenced" the part by using the facing cut to set Z to zero and the finished diameter to set the X position DRO, I used the OD Fillet wizard to plain turn to a shoulder, with a small radiused fillet in the corner. I then used the OD Taper to put on a 45 degree point at the end. For the taper cut, I was a bit too aggressive with the cutting depth and speed, so it isn't as neat as it could be, but it illustrates the "point". The wizards present you with a simple screen with boxes for the desired starting and ending positions of the axes, radiuses, angles, etc.; you literally fill in the boxes, then the wizard generates the corresponding "G"-code to cut the part and posts the "G" code in the "Auto" screen in Mach3. If you wish to do so, you can save these G code programs for later use if the operation is one that will be repeated and you can even combine fragments of code from successive wizards to make more complex programs.

The second example is a threading wizard example; the finished article (a length of $\frac{3}{8}$ in. X 20 TPI thread) can be seen in **photo 21** and the corresponding Wizard screen that generated it is shown in **photo 22**. The wizard will tell you whether, at the chosen spindle speed (500 RPM in this case) and the chosen screw pitch (20 TPI in this case), the speed required of the Z axis

is above the maximum speed that the control can achieve and ask you to reduce the speed if need be. 500 RPM proved to be OK, so I ran the G-code generated by the wizard, as shown on the screen in **photo 23**. As I haven't set up the system to directly control spindle speed (although this is a definite possibility for a future enhancement), I had to adjust the speed manually to near enough 500 RPM, using the displayed value in the "STrue" DRO, before running the program. The resultant thread wasn't as clean as I would have liked, partly because I used a rather deep cut on each pass and partly because the threading tool wasn't the sharpest it could have been; however, the example again demonstrates the potential of the system.

Mach3 forums

As I have already mentioned, there is a lot of useful material to be found on the Mach3 Support website; there is also an online technical forum that is part of the website, where Mach3 users can post questions, offer advice, and so on. There is also a Yahoo discussion group dedicated to Mach issues; this can be found at <http://groups.yahoo.com/group/mach1mach2cnc/>. The people that are responsible for ongoing development of the Mach3 software and related products are members of these forums, as are many knowledgeable users of the Mach3 system; if this article fails to answer any questions you have about Mach3 (and I'm sure it will!), then these make for an excellent starting point. You will find that the inhabitants of these forums are friendly and helpful.

A potential short cut

Configuring Mach 3 is a fairly straightforward but time consuming process, especially if you are doing it for the first time, so some may decide, after reading this article that a short-cut is in order. It is possible to buy pre-configured Mach3 systems - the so-called "MACH-in-a-box" - from Lester Caine's Model Engineers Digital Workshop. This is a boxed PC system, with Mach3 pre-loaded and configured, ready to run. To date, I believe Lester has been aiming these systems at milling machine installations; however, I will let him have a copy of the XML configuration file I have used in this project so that he can supply pre-configured systems set up with the appropriate parameters for the hardware configuration I have described here. As mentioned at the end of Part 3, I will also email copies of the XML file to anyone that wants it; email me on tony@jeffree.co.uk if you want a copy. Even if you plan to install the software yourself and tinker with the configuration parameters, starting off from a "known" configuration can be very helpful.

While I am happy to answer email questions about this series of articles as best I can, please bear in mind that I am still very much a novice as far as Mach3 is concerned and I am certainly not the best source for advice on the finer points of Mach3 configuration or operation, so please be prepared for answers of the form "I don't know - try the Mach3 forums".

Closing words

There are only two things I regret about choosing to use Mach 3 for this project; the first is that I didn't start using Mach3 sooner and the second is that it now

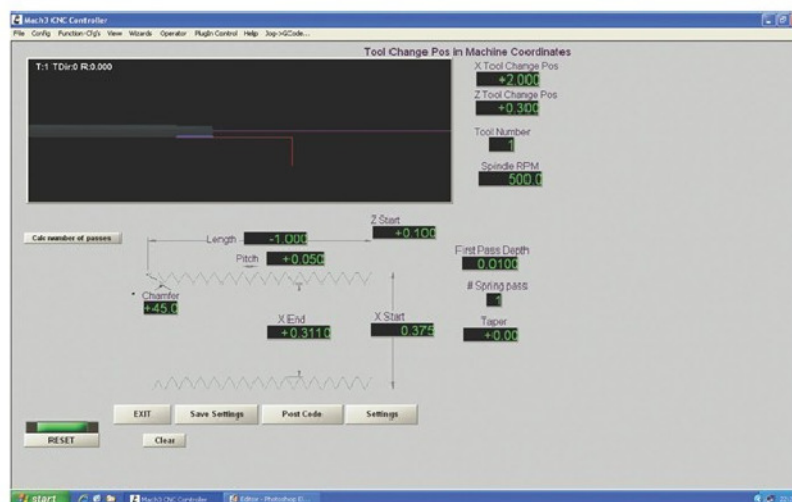


Photo 22. The wizard screen that generated the thread shown in photo 21.

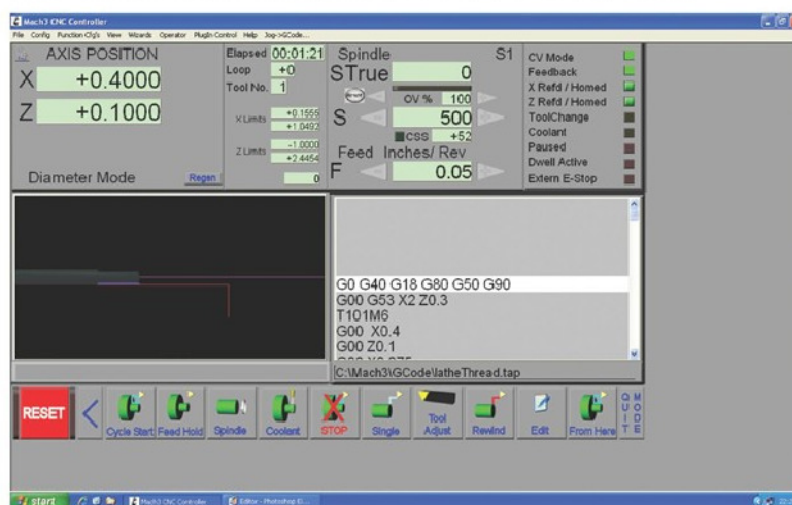


Photo 23. The thread wizard while running.

means I will want to go back to my two previous mill conversions and upgrade them to use Mach3 as well. It isn't as easy a system to get to grips with as DeskCNC; however, it is far more flexible in the ways it can be used, has good support for lathe operation and even without the addition of a "proper" CAM front-end, such as Dolphin Partmaster or Vectric's Cut2D or VCarve, the in-built wizards offer most of what you need for run-of-the-mill (or should it be run-of-the-lathe?) CNC turning operations. The combination of the Mach3 capability and the Shuttle Pro for manual override makes the machine very usable and the fact that you can turn off the hardware and still use the lathe as a manual machine is great for those occasions when what you are doing just doesn't need the sophistication of CNC control.

Finally, I'd like to say a thank you to John Stevenson for the advice he has provided over the course of this project (and yes John, I have lost count of how many beers I owe you!). He convinced me that Mach3 was the only way to go for a lathe conversion and discussing various aspects of the conversion with him has been very helpful in clarifying how best to do the job. ■

Suppliers and other useful links:

1. The MAC support website: <http://www.machsupport.com>
2. Ebayer's website: <http://www.ebayer.com/>
3. Contour Design for Shuttle Xpress: <http://www.contourdesign.com/shuttlepro/shuttlexpress.htm>
4. Tormach's website: <http://www.tormach.com/>
5. DivisionMaster controllers, RevMaster sensor boards, and "MACH-in-a-box" systems are supplied by Model Engineers Digital Workshop, L.S. Caine Electronic Services, 25 Smallbrook Road, Broadway, Worcs, WR12 7EP. Tel: 01386-852122 Website: <http://www.medw.co.uk>
6. Yahoo discussion group for Mach users: <http://groups.yahoo.com/group/mach1mach2cnc/>
7. Vectric CAM software is available from Vectric Ltd, Unit 3 Dunstall Court, Astwood Lane, Feckenham, Worcestershire, B96 6QH, United Kingdom. Tel: 01527 460 459. Website: <http://www.vectric.com/>
8. Dolphin Partmaster software is available from Dolphin CadCam Ltd., 7 South Dean Road, Kilmarnock, KA3 7RE Tel: 01563 543989 Website: <http://www.dolphin-systems.co.uk/>

HIGH SPEED DRILLING AND ENGRAVING ON A CNC MILL

By Anonymous.*

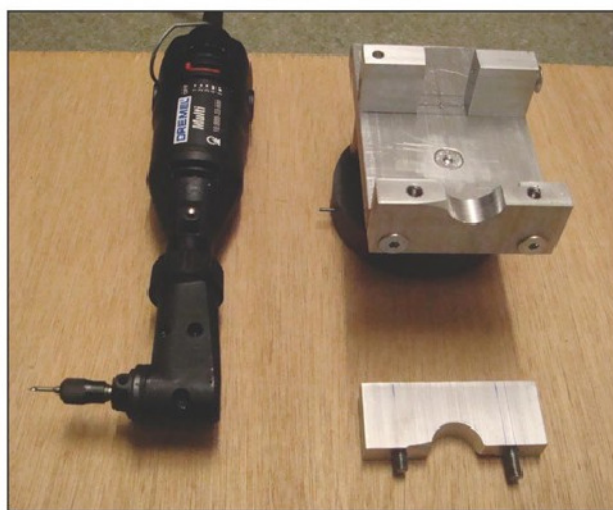
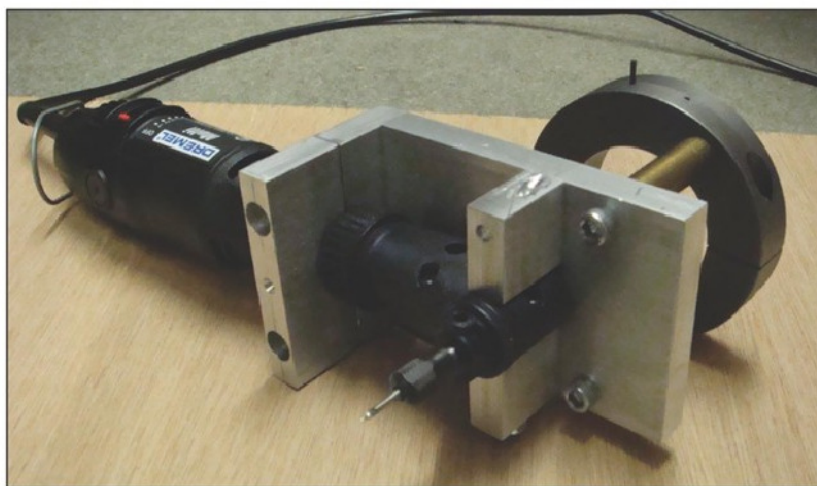
The photographs show the arrangement that I now use for engraving and drilling on my CNC mill. After many previous attempts and reading of other arrangements in MEW, I find this one works extremely well and is easy to produce. It is also easy to setup. It only requires the tightening of one clamp bolt to fix the assembly to the mill. Also, when I want to use the Dremel for other jobs there are only three screws to remove it from the assembly.

The Dremel gives me a variable speed up to 34,000 RPM and the Dremel Right Angle Attachment makes it possible to mount it easily on a mill.

The Dremel is held on a plate, in a split clamp, at the join between the Dremel and its attachment. The attachment itself is located between two blocks which are fixed to the plate for alignment and stiffness.

Three columns join the plate on which the Dremel is clamped to a split clamp ring. This split ring is bored accurately to fit the end of the mill "quill housing", which is the cylindrical part that moves up and down inside the "mill head". NB, the accuracy is required to avoid damaging the bearing inside the quill housing. The columns are made long enough to provide a gap between the end of the quill and the plate. I give no dimensions since mine are particular to my mill and the materials I had to hand.

Note also that I have converted the quill feed for CNC by using a stepper motor with a worm and wheel. This is preferable to driving the mill head with a stepper motor since milling and engraving are best done with the head clamped to the column. The quill has enough vertical movement for all the CNC machining that I do. I use a simple DC motor driving the column lead screw for quick positioning of the mill head. ■



*The fee for this article has been donated to REMAP.

USING THE WORDEN TOOL & CUTTER GRINDER

Jim Whetren shows how to use this versatile tool

In July 2007 an article appeared in MEW issue 127, in which I described my experiences 'Living with the Worden'. Although the grinder and various alterations and attachments I had made were described, I did not describe how they were actually used.

What follows is an attempt to address this situation. Although most of the items described are fairly self evident in their construction and use, it may be of benefit to a new user of the machine, or someone new to sharpening tools, to have some hints on how to obtain a satisfactory result with this grinder, Ref. 1.

Lathe Tools

This will probably be the most frequent use of the grinder and is the most straightforward of the various operations with the tool in its standard form.

To grind the side clearance, the table is lifted to the clearance angle, say 6 deg. and the workslide is rotated to the required cutting angle. The tool bit is mounted in the square holder and the end presented to the left side of the grinding wheel, photo 1. The right hand table stop is set to limit the travel to the length of the ground area.

It will depend on personal preference, but I consider that the wheel rotating anticlockwise to be normal and therefore wired the switch for this to be the forward position. Whatever is chosen, the object is to have the wheel direction go downwards towards the table.

The table assembly is slid forward to bring the tool just clear of the wheel and locked. The feed is applied in small increments of 0.001in. with the work slide feedscrew. Pre 2006, this only applied a pushing action. Since that date the arrangement has been changed to allow controlled feed in both directions and subsequent accessories were produced to this method. There is an accessory kit to convert earlier builds to this method, Ref. 1.

The tool is passed across the face of the wheel until the required area is ground, photo 2. As can be seen, the standard taper cup wheel produces an excellent finish requiring the minimum of honing. Also shown are the captive spacers fitted to the bottom and rear of the standard 1/2in. square tool holder to better accommodate my normal 3/8in. lathe tools.

The tool is turned around to present the top to the right hand side of the wheel to grind the top rake. This angle will be dependant on the material to be turned and various angles are quoted from 0deg. for brass to 60deg. for plastic. This means each tool is ground to the appropriate angle for the material to be turned. (Engineers ignore this next bit) I have ground this tool to an angle of 25deg. and would use it for whatever was held in the chuck. I am not advocating poor practice, but this is purely what I, as a non engineer, do.

The workslide is set from 0deg. for a turning tool to about 6deg. if it is intended to also take facing cuts towards the centre

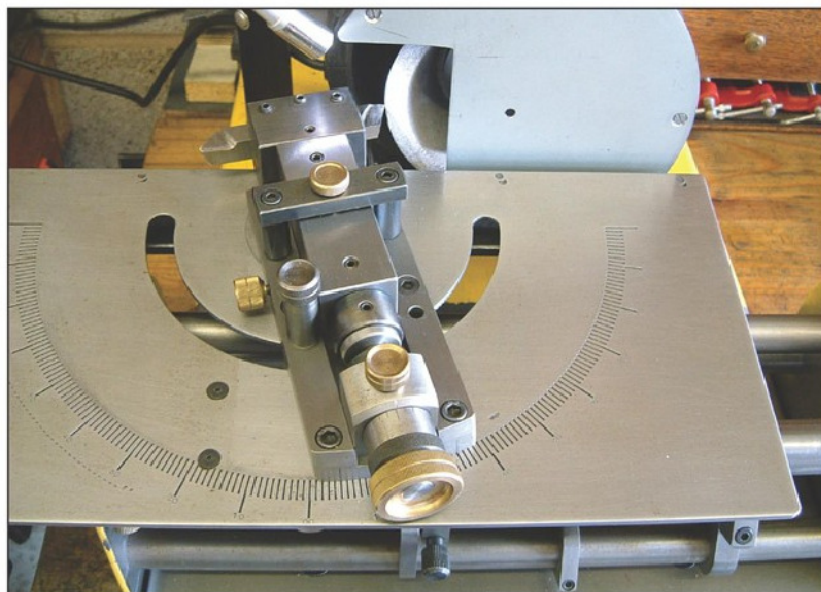


Photo 1. Grinding the side clearance.

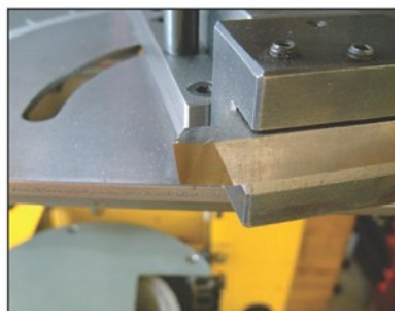


Photo 2. The good finish obtained with the standard wheel.

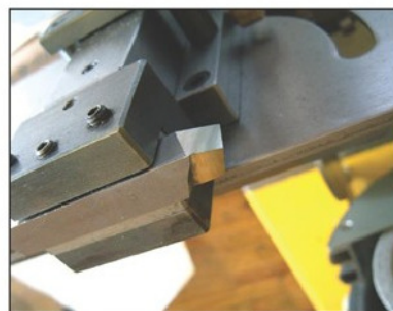


Photo 4. The angled base of the tool face caused by the position above the wheel centre.

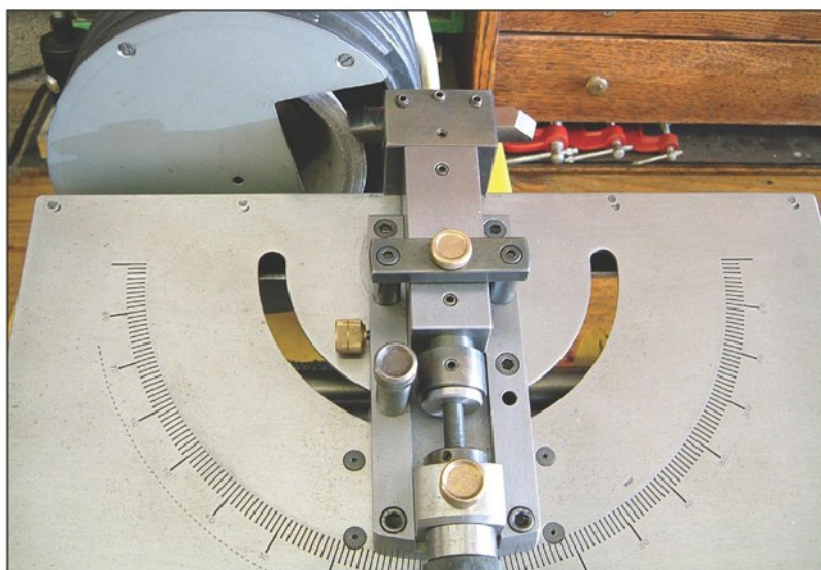


Photo 3. Grinding the top rake.

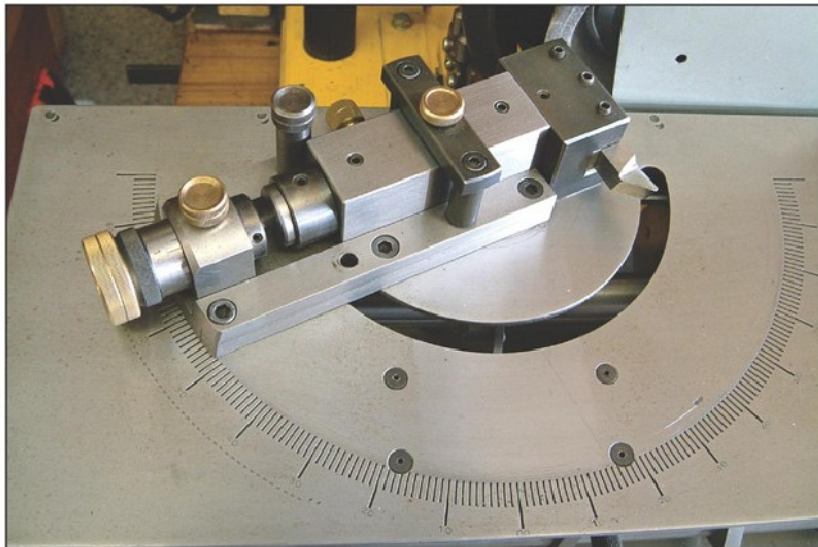


Photo 5. Grinding the front clearance.

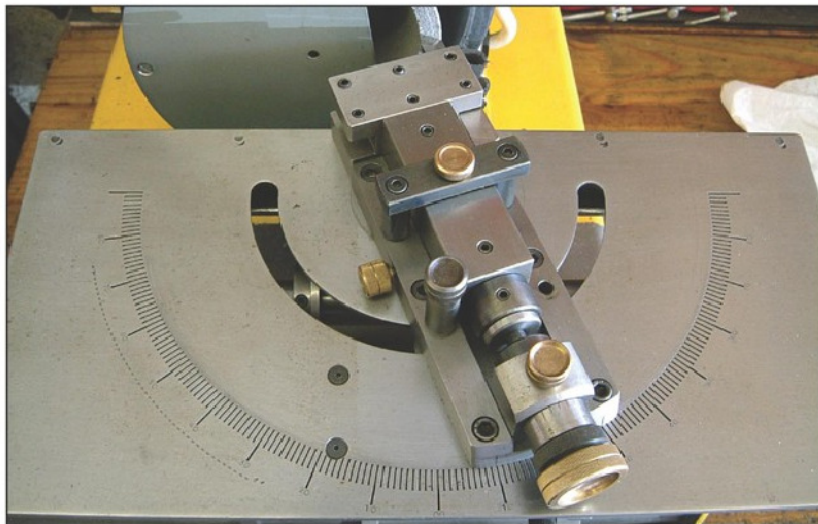


Photo 6. Alternative square tool holder allowing more effective use of the in-feed.



Photo 7. Finished tool awaiting the honing of the tip radius.

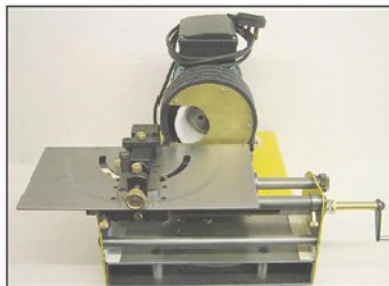


Photo 8. Feedscrew traverse kit.

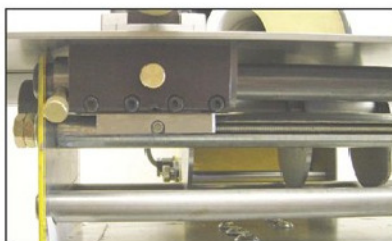


Photo 9. Method of feedscrew engagement.

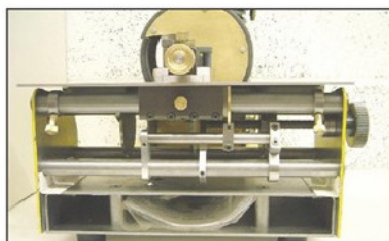


Photo 10. Feedscrew method described in MEW.

of the work, **photo 3**. This time the grinder is run in reverse and cuts taken as before to finish this face, **photo 4**.

For the front clearance, the table is moved back to the left of the wheel and the table set to 6deg. In this case the tool had a front angle of 25deg. and the workslide was so set, **photo 5**. With angles much less than this the angle to the wheel is so acute that the feedscrew becomes less effective and at 0deg. doesn't work at all. To overcome this, I made a new wider square holder, with slots carried down both sides to allow use of the feedscrew, **photo 6**. The tool bit ready for honing the tip radius is shown in **photo 7**.

While performing these operations, the table is slid from side to side. This is made much easier if there is a means of traversing the table with a feedscrew. Such an item is available, **Ref. 1** and I had the opportunity to build one and try it out, **photos 8 & 9**. Although this was effective, I had already made such an arrangement as described in the February 2007 MEW issue 122, **photo 10**.

Screw Cutting Tools

This is certainly an occasion where the ability to set known and precise angles is required. As I use round toolbits for both external and internal threads, I will describe sharpening this type of tool. The principles would be the same for a square tool but using a different holder.

The Worden has an adaptor for holding various round items using suitable reducing sleeves, **photo 11**. I have made a longer adaptor to gain more clearance, **photo 12**. Here the screw-cutting tool is still in its holder for a touch up.

The working method is the same as for the lathe tool; the respective sides being ground on the appropriate side of the flank angle. The table is raised a couple of degrees to give some side clearance. When the top is ground, a small amount of rake angle will assist in feeding the tool into the work. With an inserted round internal tool this top grinding should be continued towards the tool centre to allow more clearance in a small bore, as will a facet at the bottom; as in a boring tool.

Slot Drills

Again the round adaptor with a sleeve is used and the slot drill set with its cutting edges parallel to the table with the shorter face towards the right edge of the grinding wheel, **photo 13**. The work slide is set 1deg. to the right to provide a concave cutting edge and the table raised 5deg. to provide the clearance. The left stop is set to allow the wheel to fully pass the shorter cutting face.

After a grinding pass with the feedscrew zeroed, the tool is examined and if not too worn, the edge should clean up. If more passes are needed note the collar reading on the final pass.

The tool block is rotated 180deg. in the work slide and the collar reset to zero. If one pass was sufficient on the first edge, then when the stop is reached, it is released and the work advanced until this edge is fully ground. If further cuts are required, then the stop is locked at this position and further cuts taken to the stop until the previous collar reading is reached, **photo 14**. After a while, the primary face becomes too wide needing

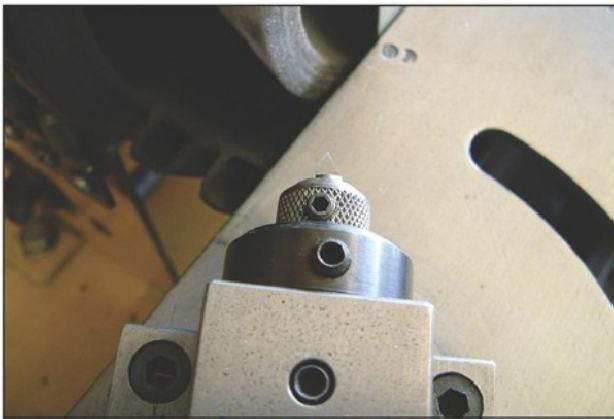


Photo 11. Method of holding round tooling.

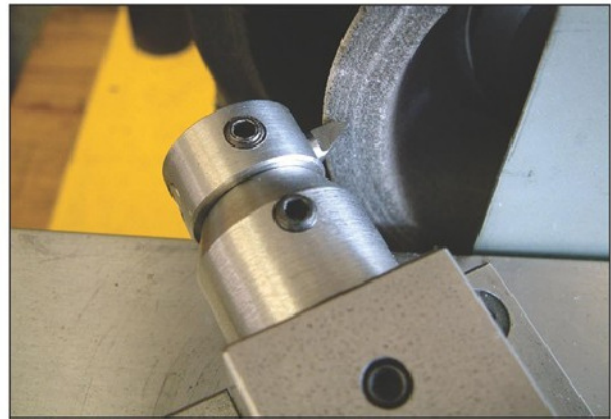


Photo 12. Extended round adaptor allowing better access showing tool still in its holder.

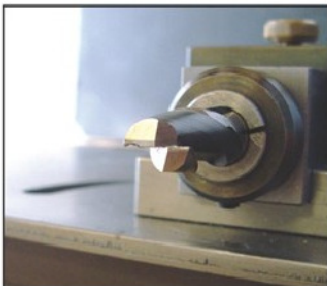


Photo 13. Slot drill set up for grinding the primary angle.

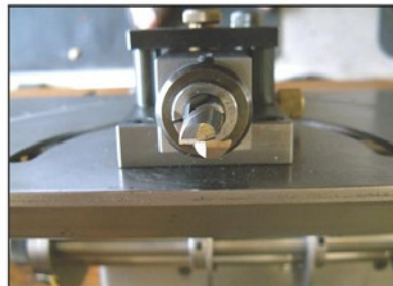


Photo 14. The re-sharpened slot drill.



Photo 15. Examples of the drill grinding angle range.



Photo 16. A re-sharpened centre drill.



Photo 17. The first lip set for grinding.



Photo 18. In position to start the grinding.

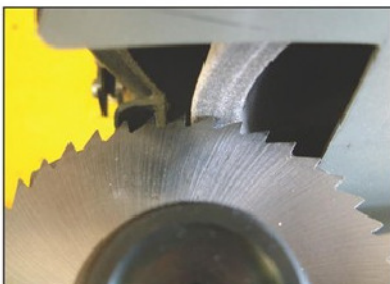


Photo 20. The tooth tip set on the centreline of the jig.



Photo 19. A commercial drill jig is easily fitted to the Worden.

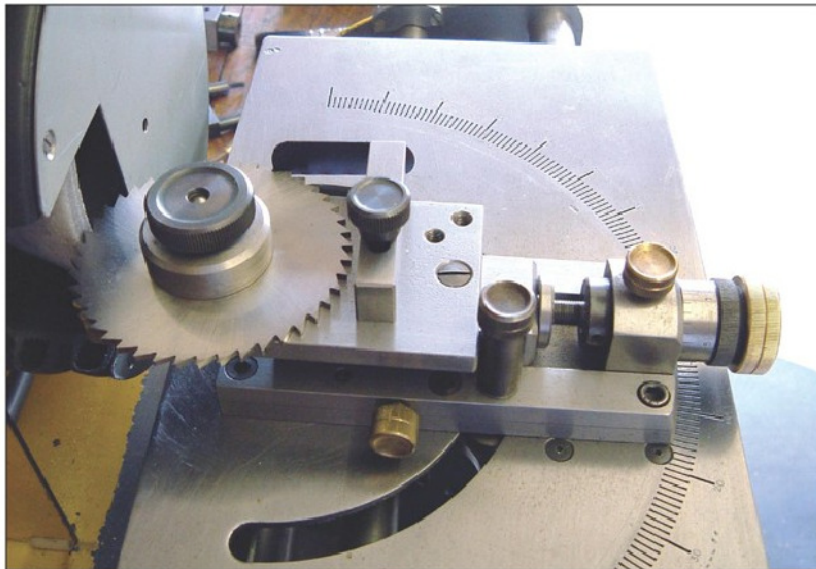


Photo 21. Index finger, table stop and angle set for grinding.



Photo 26. The holder automatically presents the diamond in the optimum position.



Photo 27. Plastic film used to keep the dust at bay.

the secondary angle to be reground at an angle of 10 to 12 degrees using the same procedures as for the primary faces.

End Mills

As these usually have four cutting edges, the procedure is as for the slot drill but rotating the tool block 90deg. each time. However, when it comes to regrounding the secondary clearance, the lack of height adjustment becomes apparent. As the table is raised, the work moves further up the periphery of the wheel, **photo 3** resulting in the wheel cutting more at the lower edge of the tool, **photo 4**. In the case of an end mill this means the wheel hits the lower tooth before the upper tooth is fully ground. In this case, the tool is brought up to the stationary wheel and rotated to the left, ensuring the upper face can be ground, whilst still leaving a small gap in front of the lower tooth end and the tool clamped in this position.

Twist Drills

There is an attachment available to grind these with four facets, **Ref. 1**. The jig can be set at any point angle so it is possible to apply this system to a drill for flat bottoming up to a countersink, **photo 15**. Also, the back stop is reversible to allow the adjuster rod to act as a stop for very short drills, including centre drills, **photo 16**.

The jig is set to the point angle, 59deg. and fitted to the workslide. The drill is mounted in the jig with the lower flute lip against the stop pin and moved in or out to bring the upper cutting lip vertical, **photo 17** and clamped in place, the back stop being brought up to the drill and locked. The workslide is rotated left 10deg.

The table assembly is moved forward to bring the top lip almost touching the wheel and the feedscrew collar zeroed, **photo 18**. A pass is made and the result examined. This

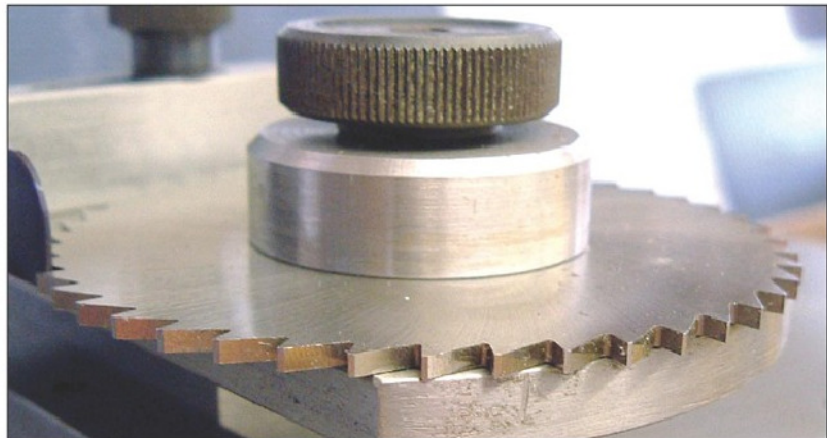


Photo 22. The sharpened slitting saw.

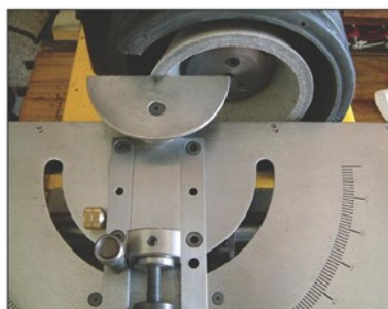


Photo 23. The radius attachment set at the initial position touching the wheel.



Photo 24. Ensuring that the tool remains on the vertical centreline as it is swung.

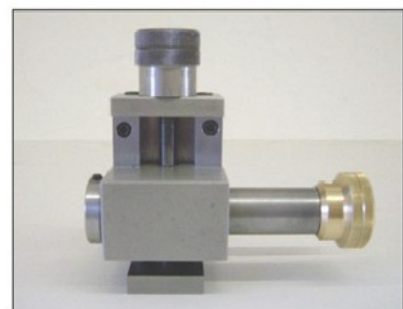


Photo 28. The radial attachment with height adjustment.



Photo 29. Small (Cowells) collets used for tool holding.



Photo 25. The finished radius on the tip.



Photo 30. Selection of punches with inserted HSS points.

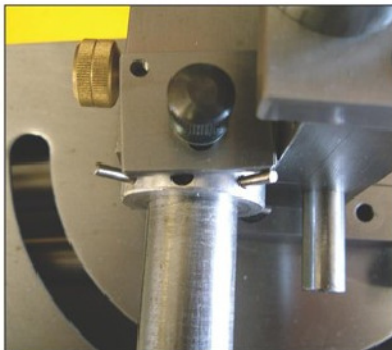


Photo 32. Exaggerated cam plate position showing setup considerations.



Photo 33. Angle set for the initial cut.

facet should be about 2mm wide. When this is achieved, the collar reading is noted and returned to zero. The table is lifted to allow the drill to be rotated and clamped with the flute against the stop pin. Cuts are taken to the previous collar reading

With the workslide now set to 30deg. the procedure is repeated for the secondary clearance, stopping when this facet is at the centre of the chisel edge. The drill is rotated and the other facet completed. If all has gone well, there should be a shallow point in the centre of the chisel edge where the two facets meet. If necessary, a further light cut is taken at the primary angle on the side needed to achieve this.

The Worden base has a tapped bushing to allow the popular swing type of drill grinder to be readily mounted after removing the table assembly, **photo 19**. This shows an alternative base for the jig; the hole provided uses the standard base mounting position.



Photo 31. A tap held in a collet for sharpening.



Photo 34. The first pass should only touch the rear of the threads.

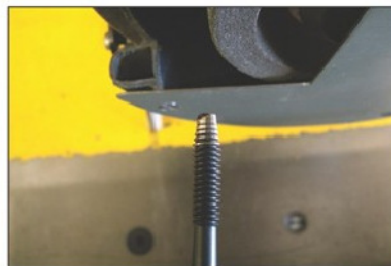


Photo 35. The sharpened tap with back off clearance.

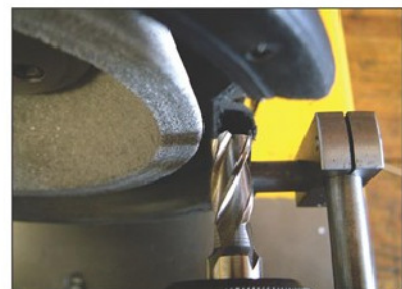


Photo 36. Ensuring that the tooth completes its pass along the wheel.

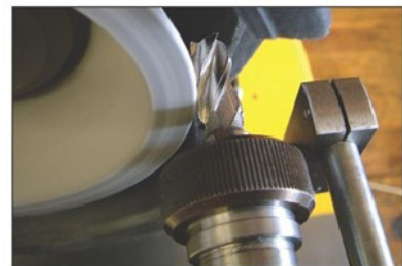


Photo 37. The end mill is drawn backwards against the tooth rest finger.

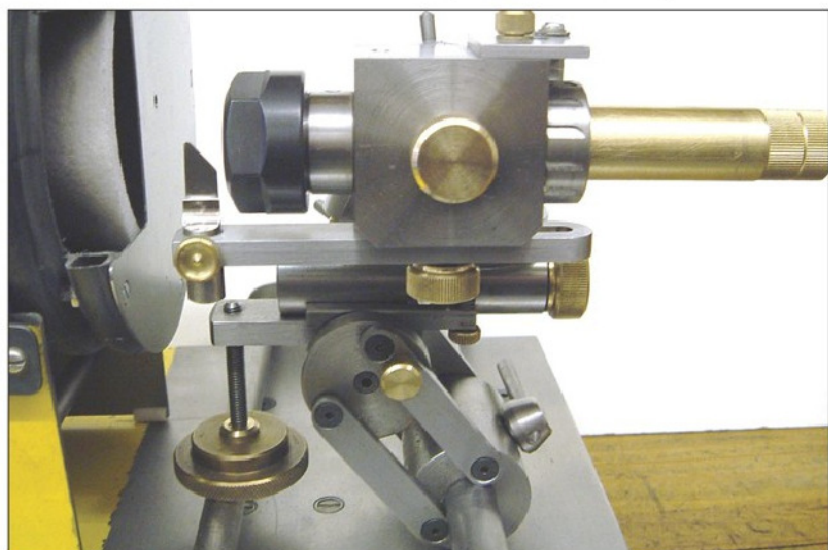


Photo 38. An attempt to gain some height adjustment and provide extra facilities.

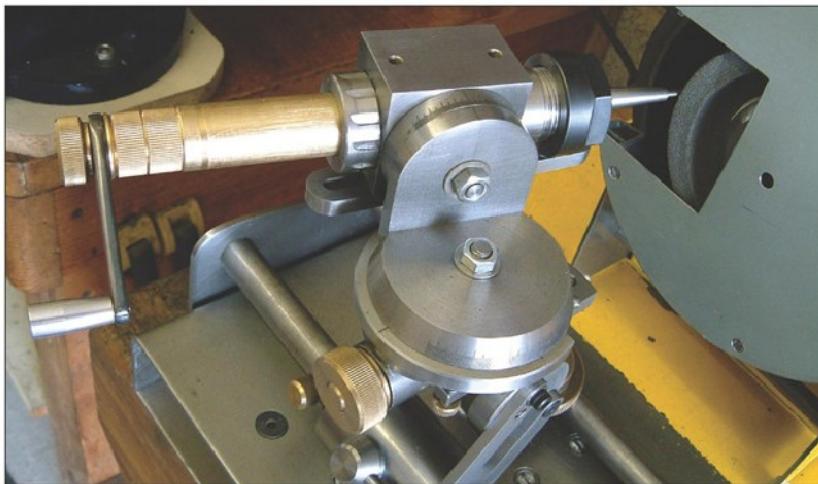


Photo 39. The addition of a handle speeds up radial grinding.



Photo 40. A half centre produced from $\frac{1}{2}$ dia. HSS (should wear well).



Photo 41. Preparing to make a tool from HSS as alternative to Silver Steel heat treated.

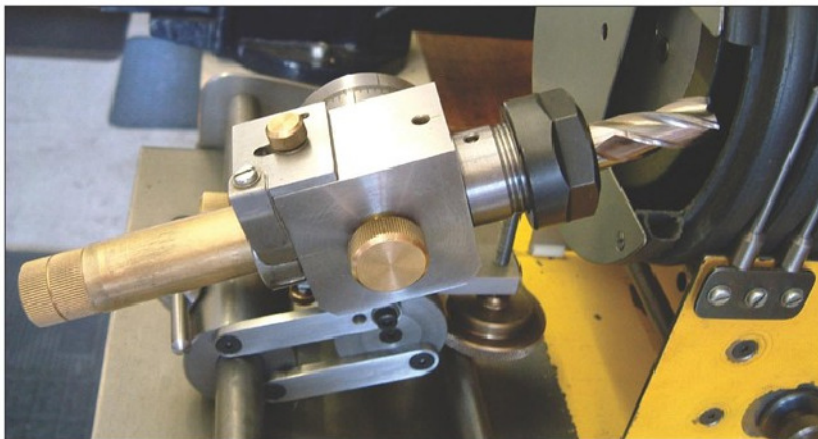


Photo 42. The work head lowered.

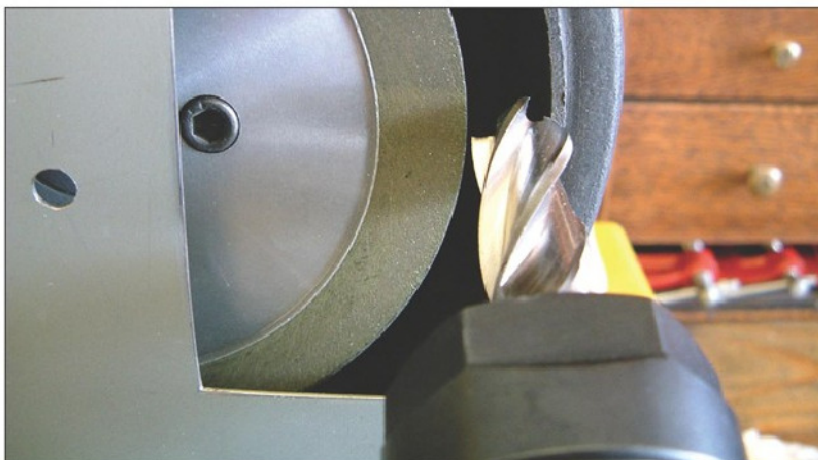


Photo 43. Keeping the tooth tip on the centreline of the wheel.

Slitting Saws

A slitting saw grinding attachment, Ref. 1 allows the tips of slitting saw teeth to be re-ground to restore their sharp edge.

The attachment is fitted on to the workslide and an appropriate boss to suit the bore of the saw is fitted and adjusted along the top plate to bring the teeth just beyond the end of the plate for maximum support, with the end of the tooth on the centreline of the plate, photo 20 and secured with the nut and collar. The index finger is fitted to engage a suitable tooth, photo 21.

The work slide is set to the left 5deg. and the right table stop set to prevent contact with the preceding tooth. A pass is taken and if the tooth cleans up, the blade is indexed to the next tooth and the process repeated for the rest of the teeth. The end result can be seen in photo 22. This jig will accommodate blades from 2in. to 4in. diameter.

Radius Grinding

A radius grinding attachment, Ref. 1 will enable a known radius to be ground on the tip of a pointed tool or on the corner of a square ended tool.

With the jig fitted to the workslide and the table lifted to the front clearance angle, the radius table is brought up to touch the stationary grinding wheel and the feedscrew collar zeroed, photo 23. To allow access, it was necessary to remove the front cover of the wheel guard.

The jig is now withdrawn with the feedscrew by the required radius. The tool holder is fitted with the tool free to be pushed in contact with the wheel. The tool is swung from side to side to ensure the point to be ground remains in a constant vertical position against the wheel, photo 24. The holder can be moved to achieve this by slackening its securing screw and rotating it slightly. When satisfied, grinding is commenced by traversing the tool holder around the radius table whilst maintaining a forward pressure until the radius formed reaches either side of its desired position, photo 25.

Wheel Dressing

After all of this tool grinding, the wheel is probably in need of re-dressing. If the wheel takes on a dark grey appearance as work proceeds, this is due to the wheel grain being clogged with debris and losing its effectiveness, causing overheating of the work-piece. If this is done as soon as the grey appearance is seen, then a couple of passes of half a thou' will usually restore the wheel to a white appearance and work can proceed.

I use a single point diamond dresser fitted into a holder with the hole drilled at a compound angle to present the diamond to the wheel at the left hand side, trailing the direction of traverse and the rotation of the wheel, photo 26. It is held in the tool block with the table horizontal and the placing of the mounting spigot puts the dresser on the horizontal centre line of the wheel. All grinding operations produce abrasive dust but nothing more so than wheel dressing. In order to contain this highly abrasive material as much as possible, I use an acetate sheet with a hole a close fit on the dresser, pushed onto the end of the dresser and in contact with the front of the wheel guard, photo 27. If care is taken when setting the initial position of

the dresser, it doesn't really matter if the tool can't be seen.

Radial Grinding

Having made an accessory for radial grinding with a means of height adjustment, **photos 28 & 29** as described in the July 2007 article, more items can be ground easily with the Worden.

At the basic end, an accurate point on marking punches and scribing points can be obtained, **photo 30**. These were made from pieces of HSS fitted into a MS body and were ground at 20deg, 30deg. and 118deg. included angles before being pushed into their holders.

Tap Sharpening

Although I have seen this operation described using a disc wheel run along the flutes of a tap, to my non engineer mind, the wear takes place on the lead angle of the tap, as this is the main bit which does the cutting. After the first full depth thread has been formed, the remaining threads only have to feed the tap forward and provide guidance.

My Jig-boring former neighbour once gave me a tin of spiral point taps, which I presumed he used in his work and when their efficiency was reduced, he used a new one. These are excellent for tapping through holes in the lathe, as they push the chips forward; therefore they don't need to be backed off every couple of turns or so.

I have selected an M6 tap which had seen better days and the angle suggested it was a second cut; 8deg. extending for 4-5 threads. A taper being 4deg. for 8-10 threads and a bottoming (which I thought was called a plug) being 23deg. for 2 threads.

These taps have a shank diameter the same as the nominal size, so a collet is used to mount the tap in the spindle, **photo 31**. The wheel used could be a disc wheel or, as I did, use a shallow cup wheel which can be used on either the side or face.

The cam plate is fitted and tilted to allow one of the four index pins to still be in contact at the right hand side when the next pin makes contact to form the stop, shown exaggerated in **photo 32**. The tap is rotated to just clear the trailing end and the collet tightened, **photo 33**. The actual tilt of the cam plate is only 1deg, which allows the spindle to travel forward about 0.4mm.

With the index pin at the start of the cam and the work slide set to the taper angle, the spindle is rotated clockwise maintaining contact with the cam plate until hitting the stop. This first pass should only have ground the rear of the thread, **photo 34**. With one stop missed, the next thread is ground and a small in-feed applied with the feedscrew, repeating until the front of the thread is ground. This should result in a uniform curved surface extending across the tread area, **photo 35**.

Although the photo doesn't show it, the threads are ground progressively deeper from front to back, providing the back-off. With the normal four flute taps all index pins are used and with a three flute tap, the alternative 3 pin index ring is used.

End Mill Side Teeth

With the attachment spindle free to rotate and move in and out, it is now possible to touch up the side teeth of milling cutters. In normal circumstances, the tooth rest

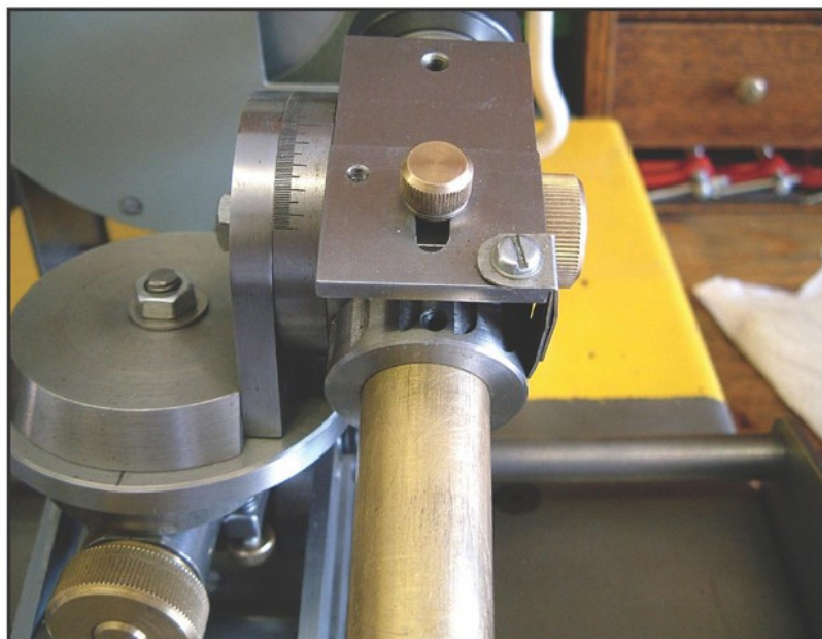
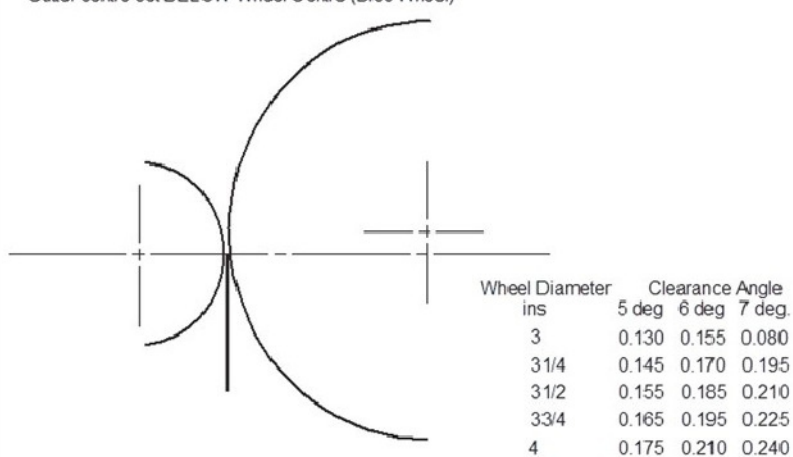


Photo 44. The 12 station index collar and spring stop.

Cutter centre set BELOW Wheel Centre (Disc Wheel)



Cutter centre set ABOVE Wheel Centre (Cup Wheel)

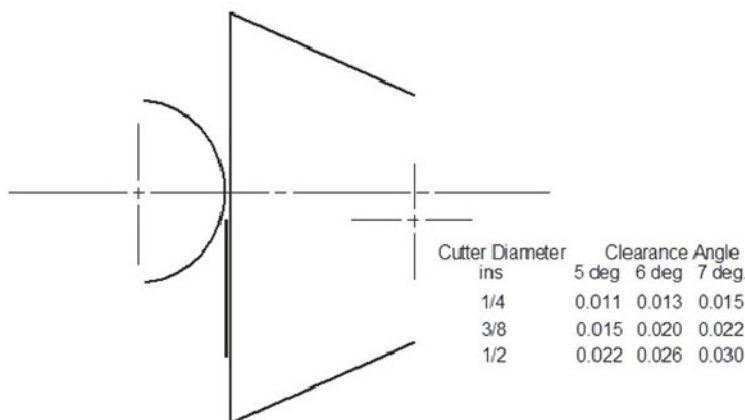


Fig. 1

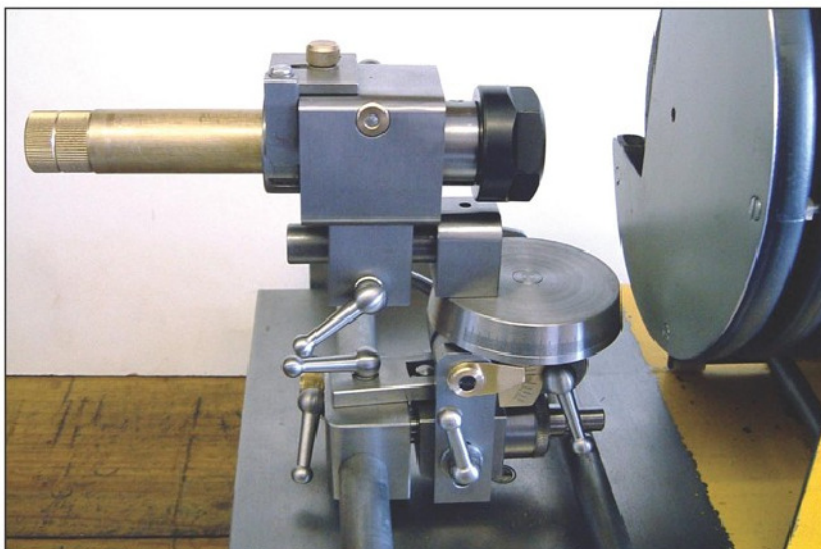


Photo 45. The experimenting continues (or I just got the sack).

is set under the tooth to be cut, at the left hand side of the wheel. Due to space restrictions, the tooth opposite is used at the right hand side.

The clearance angle is set according to type of wheel used using the dimensions outlined in **Fig. 1** and the cutter brought up to the wheel with the end of the tooth just clear, **photo 36**.

Starting at the rear of the tooth with the opposite tooth against the tooth rest, the cutter is drawn backwards keeping contact with the rest. By pulling straight back the cutter should maintain contact. Once the technique is mastered, a small amount of cut is applied with the feedscrew and the

first side sharpened, **photo 37**. The table is lifted clear to set up the next tooth and the grinding repeated for the rest of the teeth.

Gaining Some Height Adjustment

Having found it desirable to be able to adjust the height of the grinding wheel, I took the easier option of adjusting the tool height. I experimented with an alternative work-head, **photo 38** a description of which appeared in MEW December 2007, issue 132.

This uses an ER20 collet system for work holding and can accept up to 13mm diameter. The addition of a turning handle made radial grinding much easier, **photo**

39 and enabled the easy production of tools 'turned' from HSS, **photos 40 & 41**.

The ability to lower the work-head now allows the secondary clearance to be ground on an end mill at the wheel's centreline, clear of other teeth, **photos 42 & 43**.

The spindle is fitted with a 12 position index ring, engaging with a spring blade fitted to the cam plate, **photo 44**. A feedscrew applies the cut and the tool is wiped across the wheel controlled by two stops.

The Future?

Having found this work holding system to have been a success, a Mk. 2 version is now under development in an attempt to improve the overall appearance and address any limitation found with the earlier effort, **photo 45**.

The Worden Tool & Cutter Grinder Kit is complete and reasonably priced. It is a worthwhile acquisition and can be recommended. It is easily completed with modest workshop equipment.

It serves its function well, but as with most workshop kit, the users are always looking for ways to do more things with it, or do them in a different way. (I offer the usual disclaimer, although three items were designed by me.)

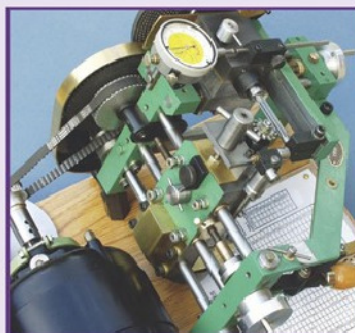
References

Ref. 1: Hemingway Kits, 126 Dunval Road, Bridgnorth, Shropshire WV16 4LZ
Tel. 01746 767739
www.hemingwaykits.com

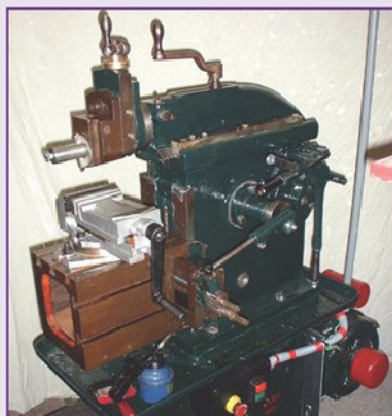
Worden Mk 3 Tool & Cutter Grinder HK 1300
Work slide Upgrade HK 1300W
Feedscrew Traverse Kit HK 1315
4 facet Drill Grinding Jig (Mk2) HK 1310
Slitting Saw Grinding Attachment HK 1306
Radius Grinding Kit HK 1312

IN OUR NEXT ISSUE

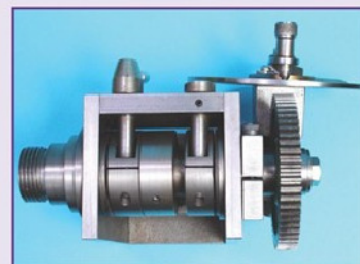
Coming up in issue 144, on sale 17th October 2008



CHARLES WOODWARD
DESCRIBES HIS PINION MILL.



RENOVATING A SHAPER.



CUTTING METRIC THREADS WITH
AN IMPERIAL LEAD SCREW.

(Contents may be subject to change)

DON'T MISS THIS GREAT ISSUE – see page 9 and subscribe today

TRADE COUNTER



Warco coolant system

Warco have advised us that their coolant systems are back in stock. They supply a small system, ideal for the home workshop, which is ok to use with neat cutting oil as well as water based soluble coolant. It comprises a small blow moulded tank with a small pump mounted on to it. The system is controlled by a small on/ off switch that can be screw mounted to the machine tool or a nearby wall. It includes a suitable coolant pipe together with a magnetic base and a lever operated valve.

Also available is neat cutting oil called Neatcut. This is a refined mineral oil with additives to improve the lubricating and cutting properties. It is suitable for ferrous and non ferrous metals. The benefits of neat cutting oil are that it is much less likely that the machine tool will go rusty like it would if soluble oil was used. The system can of course be used with water based soluble oils.



Metal cased verniers from Warco

Warco have supplied us with samples of two of their new metal cased verniers. The first is the 8858a Fractional metal cased vernier at £32.00. This is a nice caliper and has a heavy quality feel to it. It also shows fractions when set to the imperial range. This is useful when using some of the older drawings drawn using fractions. This vernier avoids the need to convert dimensions.



The second is the 8147 Waterproof caliper at £43.00. This is again a metal cased vernier although it does not have the fraction facility. As this is a waterproof vernier, I had to try it out. I filled a glass dish with water, switched the vernier on and put it into the water. I left it in for about 5 minutes then took it out and switched it back on (it switches off when not in use) and put it back into the water. It continued to work perfectly. I took it out, gave it a shake and slide the head backwards and forwards. Still no problems, it still worked perfectly. This is a quality vernier and is a pleasure to use. It is thoroughly recommended as is the fractional version. Contact Warco, Tel: 01428 682929 www.warco.co.uk

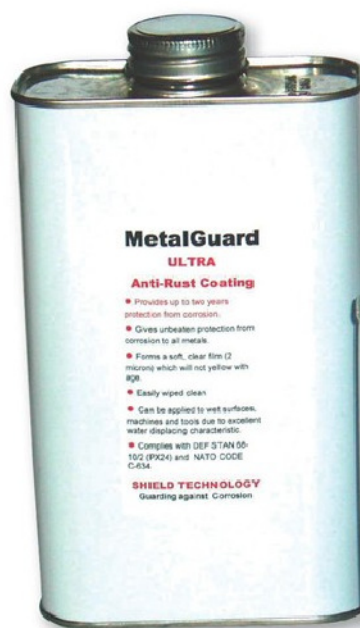


SAVE MONEY, SUBSCRIBE TODAY (see page 9 for details).

Toolcare Products

Arc Euro Trade are now stocking ToolCare Products from Shield Technology.

The majority of tooling found in a typical workshop will be made from steel and iron. Unless protected from the effects of damp and humidity, corrosion can be a problem. Shield has designed a range of products specifically to prevent corrosion of valuable tooling. There are eight products, each designed for a specific application.



MetalGuard Ultra is a high spec thin film coating which leaves a 2 micron clear film which will not yellow with age. It contains both ferrous metal and yellow metal corrosion inhibitors. Supplied as a liquid in either 250ml or 1 litre cans it can be applied by brush, spray or dipping. Under typical workshop conditions it can be expected to provide protection for up to two years. It does not contain silicone. Arc Euro Trade use MetalGuard Ultra to protect their specially prepared machine tools.



GreaseXtra is made from a high quality gelled mineral oil with the addition of corrosion inhibitors. It has a melting point of approx. 200 Deg C. and is particularly difficult to emulsify. Typical applications include the lubrication and protection of live steam models. GreaseXtra does not contain silicone.

ProtecTool wax polish is the latest corrosion inhibitor to be added to the range. Designed specifically for the woodworker it is rapidly finding new uses by metalworkers and model engineers. ProtecTool wax is unique. It is a soft paste blend of microcrystalline waxes and corrosion inhibitors. Apply with a soft cloth, allow to dry for a few minutes and then buff. In addition to protecting tools such as hand planes and saws, and machine tables it reduces friction dramatically. ProtecTool wax is supplied in 250g pots



ToolGuard VCI is a vapour phase inhibitor for protecting tooling stored in drawers and toolboxes and manufacturers packaging. The VCI chemical is absorbed into a felt pad inside a 35mm dia. lidded plastic pot. On removal of the lid, the VCI chemical permeates the enclosed volume forming a monomolecular protective layer on every surface; be it steel, iron, wood, plastic etc. Because it is a vapour, it will find its way into every nook and cranny. ToolGuard VCI works at up to 100% RH and is effective for 12 months in a volume of 2 cubic feet. Because it does not lower the level of humidity like silica gel, it will not distort any delicate pieces of a model made from wood - which 'moves' with changes in humidity. ToolGuard VCI is available singly, in packs of three or boxes of ten.

Please note that unless otherwise stated, trade counter items have not necessarily been tested. We give news of products and services which have been brought to our attention and we consider may be of interest to our readers.



Two products have been designed to aid the tool sharpening process.

HoneRite Gold is a universal additive for grinding, honing and lapping that makes water non-corrosive. It is supplied as a concentrate and is added to water, protecting both the machine and anything in the vicinity that may get splashed. It is highly recommended for use with all makes of powered water stone grinder. It can also be used with Japanese water stones. HoneRite Gold is available in 250ml tins, which make a total of 6 litres of honing/grinding fluid.



HoneRite #1 is a dual action ultra low viscosity honing and lapping fluid for use with diamond plate sharpening systems and traditional oil-stones. It has the added benefit of containing powerful corrosion inhibitors so that once a tool has been sharpened it may be protected by applying some of the fluid. HoneRite #1 can also be used to revive old clogged oil stones by soaking the stone and scrubbing with an old brush to remove debris from the pores of the stone. HoneRite #1 is supplied in a 250ml tin.

The products listed above and opposite are all designed to help prevent corrosion. In some cases, parts or tools will already be rusty and what is needed is an effective rust removing solution. Restore Rust Remover and Restore Pre-Clean address this problem.



Restore Pre-Clean is a powerful water-based degreasing concentrate which should be used to prepare parts for derusting with Restore Rust Remover. It is non-toxic and biodegradable. It will remove oil, grease and grime from all metal surfaces and is harmless to plastics, rubbers and copper based alloys. It should not be used to clean aluminium alloys. Included in the formulation is a powerful corrosion inhibitor to prevent flash rusting. Restore Pre-Clean is extremely economical, making up to 10 litres of degreasing fluid. If a stainless steel container is used, the solution may be heated and the cleaning action accelerated. Restore Pre-Clean is supplied in 500ml bottles.



Restore Rust Remover

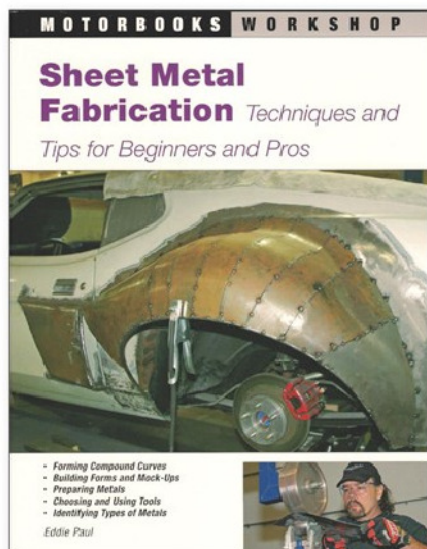
is a water-based, non-acidic, non-toxic, biodegradable derusting concentrate.

The contents of the 500ml bottle, when mixed with plain tap water make 10 litres of fluid (approx 2 gallons). Because it does not contain any acids, only the rust is removed, leaving good metal undamaged. (Products that contain phosphoric acid will remove both the rust and a certain amount of good metal which may not be desirable). Because of the absence of acids, there is no danger of flash rusting occurring when parts are removed from the bath. In fact, parts will remain rust free without further protection for a considerable period allowing plenty of time for painting, chemically blackening, or plating. Alternatively, to give longer protection in the 'bare', cleaned state, they may be protected with MetalGuard Ultra, GreaseXtra or ToolGuard VCI. The derusting solution may be used over and over again until the solution becomes blackened and the reaction time becomes excessively slow. Because the residue is completely biodegradable the spent solution may be flushed down the drain without harm to the environment. Litre for litre, Restore Rust Remover is the most economical product of its kind currently available. Restore Rust Remover is supplied in 500ml bottles.

Please see the Arc Euro Trade advert in this issue for pricing.
Arc Euro Trade Tel: 0116 269 5693 www.arceurotrade.co.uk

The full range of products are also available from Warco
Tel: 01428 682929 www.warco.co.uk

FIRESIDE READING



Sheet Metal Fabrication

This book starts with chapter 1, a guide to metal fundamentals. Sheet metal qualities, types of aluminium alloys, types of steel, metal thickness, metal shrinking: how to shrink metal and why, how to stretch metal, annealing sheet steel and annealing sheet aluminium are all covered in detail.

Chapter 2 covers pattern making with paper, cardboard, plastic and wood. This chapter is very comprehensive and is in the form of photographs and captions, in fact, almost all the chapters in the book are in this format.

Hammer forming is covered in chapter 3 including making a wooden plug (former) to form the sheet metal over.

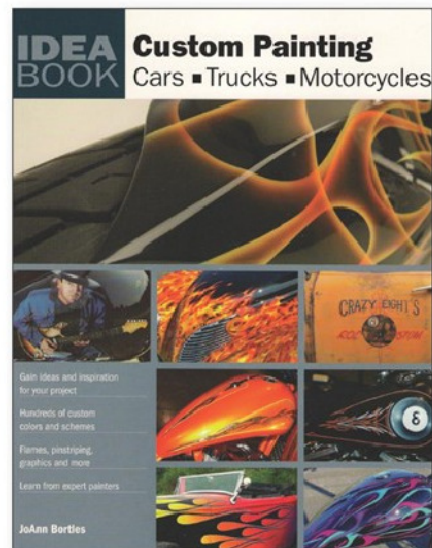
Chapter 4 covers the main metalworking tools required and how to use them. Chapter 5 has 3 pages about the benefits of CNC mills for machining metal parts for those so inclined.

Chapter 6 shows you how to cut, bend and shape parts. It includes details of some machines and concludes with how to fabricate a firewall.

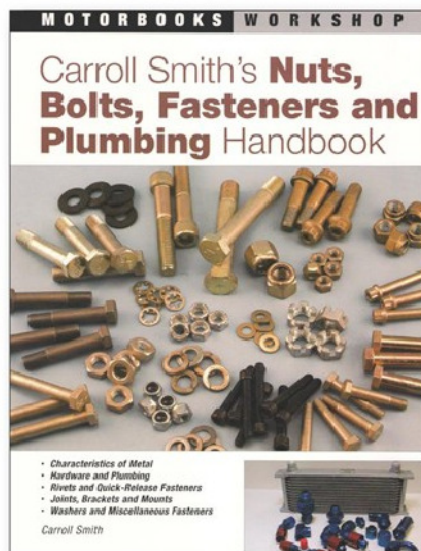
Chapter 7 covers metal finishing including leading seams. Chapter 8 is all about metal treatment more commonly known as rust removal. Chapter 9 covers tube bending and how to fabricate a complete roll cage. Chapter 10 is all about sheet metal projects and shows how to fabricate various bits of metal found on a car. Finally, chapter 11 gives an insight into further training materials.

Custom Painting Cars ■ Trucks ■ Motorcycles

This is an ideas book. It has 160 full colour pages with photos of many different paint schemes for cars, bikes and trucks. It is a complete guide to picking a colour coordinated scheme for your transport. Numerous graphics are pictured and all the different types of flames are shown. If you are short of ideas to paint your custom vehicle, you are sure to find a solution within these packed pages.



Carroll Smith's Nuts, Bolts, Fasteners and Plumbing Handbook



Again, this is a very comprehensive book with 224 pages and is packed with lots of black and white photos and diagrams. The book starts with a discussion of metals, stresses and fatigue. Different types of fasteners are shown and their uses discussed. Wire locking of bolts is shown and also charts of high quality bolts are printed inside. There is a very comprehensive section on the plumbing of brakes etc. including details of various adaptors.

All three Motorbooks are available from Grantham Book Services,
Isaac Way, Alma Park Ind. Estate, Grantham, NG31 9SD. Tel: 01476 541000

Please mention Model Engineers' Workshop when replying to advertisers'.



Radio Control Car Manual

This book is about Radio Control Cars. It is hardback format with 176 pages.

Chapter 1 covers the history of radio control cars since the early 1970's when the first 1/8th scale nitro models appeared. Chapter 2 covers radio control versus remote control, race or recreational use, on or off road, what scale and ready to run versus kit built.

Chapter 3 is a complete guide to building a radio control car kit. It covers selection of the correct tools, special tools and power tools followed by assembly techniques. There are building tips and a discussion of a basic setup. Fitting and gluing on tyres are covered in detail.

Starting the car is next followed by fitting the radio control gear. Painting and finishing the body is covered in detail from preparing the body through the masking, painting and finishing stages.

Car maintenance is covered in chapter 4. This covers minor maintenance, cleaning and preparing a car for use. Chapter 5 is all about performance enhancements. This is more about battery powered vehicles rather than petrol power enhancements.

Chapter 6 is about driving the car. Different types of radio controllers are shown and then driving techniques are explained. Mastering jumps looks a useful section as is the section on problem solving. Chapter 7 is all about racing. It covers the basics and looks at the different classes available. Chapter 8, the final chapter describes setting out a racecourse and the book ends with a glossary of technical terms.

The book is available price £17.99 from Haynes Publishing, Sparkford, Nr Yeovil, BA22 7JJ.
Tel: 01963 442030
www.haynes.co.uk

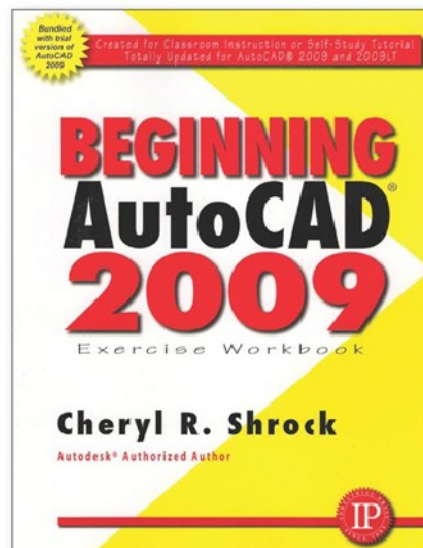
Beginning AutoCAD 2009 Exercise Workbook

This large format book has several hundred pages. I am not sure how many as it is numbered in sections. It comprises a comprehensive selection of exercises designed to teach you the basics of AutoCAD. It comes with a 30 day trial of AutoCAD 2009 so you can start learning straight away.

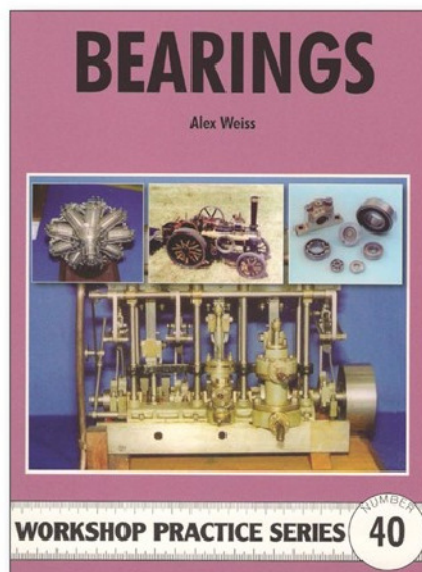
This book is available from Transatlantic Publishers Group Ltd. Box 242, 235 Earls Court Road, London SW5 9FE.

Tel: 020 73732515

www.transatlanticpublishers.com



Workshop Practice series No. 40 Bearings by Alex Weiss



Ixpect most readers use bearings in one form or another. This book from Alex Weiss describes the diverse range of bearings found in many different models and items made in the home workshop. It covers choice of bearing materials, the type of bearing to use in specific applications; it highlights the differences in homemade and purchased bearings and looks at the correct use and care of bearings. It also covers clock making and machine maintenance and other full size applications.

It is available price £6.95 + £2.25 postage from www.myhobbystore.com or Tel: 0844 8488822

SCRIBE A LINE

Back articles referred to

I started subscribing to MEW at issue number 133 and I thoroughly enjoy it. There is however one aspect which I find frustrating. Usually in every issue there are at least a couple of articles with statements such as: "as I explained in Issue 120," or "see the article in Issue xyz".

One can't keep buying back numbers, if they are indeed available at all. I realise that you cannot keep repeating articles but perhaps when a reference like this is made and the previous article is important to the understanding of the present issue, the previous article could be put on the website with a link to it in the references at the end of the article, or even bracketed in the main text.

Tony Reid by email

The Editor replies: *At the moment we still don't have a web site. It has been built but is not going live yet. Hopefully it will be launched very soon. I have had a play on it and it is very professionally designed.*

Boxford CNC

I was very interested to read of your experience with your TCL125. I bought an HMC165 last year and tried to get information via several routes but failed, so it now sits at the back of the garage buried under other part finished projects!

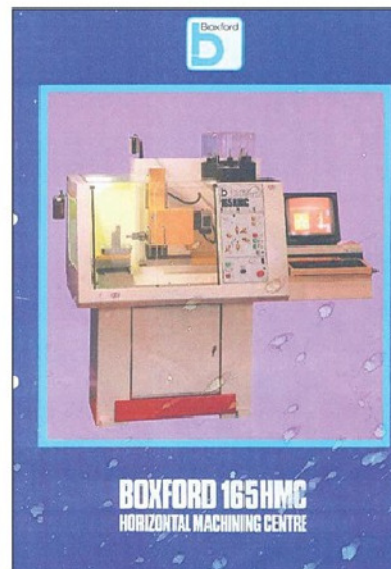
It was working in manual mode. I'm told that many of the boards and circuitry are common to many of the small Boxford CNC machines so I would appreciate any assistance you could give to track down information on the interface.

I've been advised by several contacts that the best route would be to throw out all the electronics and start again with new parts but I'm loathe to do that yet. The HMC is a Horizontal Machining Centre with 3 axes of movement for the cutting head and an indexing turntable for mounting the work piece. It can handle a 165mm cube.

I attach scanned copies of a poor copy of a publicity leaflet. My machine lacks the computer, but the ribbon cable and plug are still connected. It appears to have had some of the safety interlock switches and wiring removed; everything else seems to work in manual mode.

Robert Tompkins by email

The Editor replies: *This appears to be a very rare beast indeed. This is the first I have heard of it. We are talking to Boxford about releasing some information on the condition that we print a disclaimer that Boxford will not support the home hobby user as they are committed to educational establishments. This does not apply to spare parts which are readily available for*



all previous Boxford machines, manual and CNC. I did not realise that Boxford still make manual lathes. A factory visit and article is being arranged.

Waterproof keyboards

I notice a reader has posted a tip to save the expensive keyboard in the workshop from being damaged by liquids etc. I've been using two Mini Silicon Keyboards for about a year now.

They are resistant to coolant, WD-40 and oil. That's the list of stuff I've spilt on them so far and they are easy to clean with a brush as there is no chance of swarf getting under the keys.

There are quite a few sellers on eBay and some PC suppliers also stock them though at a price considerably higher than the eBay versions. Search for Silicon Keyboard.

Alistair Grant by email

Dimensioning consistency

Firstly, as a relative newcomer to this magazine, may I say how informative & helpful I find it? As a "forty something" rekindling a schoolboy enjoyment of all things mechanical, I find the mix of articles highly enjoyable & useful. As a schoolboy I was, in my opinion, lucky enough to go to a technical grammar school complete with drawing offices & a machine shop. It is this experience & training in my youth that prompt this letter.

It concerns mixing metric & imperial measures in drawings & articles. I have just read, in issue 142, the article on the adjustable dial indicator bracket. At first read I knew something was odd & then it occurred to me - the sketches appear to show imperial dimensioning for general sizing & then reference metric drill & tap sizes.

Such duality exists within the text also. I quote from the end of the article "The cross rods are two lengths of 1/4 in silver

Newbie's to the hobby

This is a quick thank you letter for producing an exceptionally fine magazine. I stumbled on Model Engineers' Workshop a few months ago while researching my first micro-lathe purchase. As a complete newbie to miniature engineering I had very little idea where to start in finding solid information to support any kind of informed purchase. These days there is the internet, of course, but nothing beats a great magazine for timely information. I have purchased the last six issues (133-138) and thoroughly enjoyed them all.

I am a scale plastic modeller who was looking for a micro-lathe to make small turned parts to add to my models. I had modest means, modest skills and no idea what I was doing. In short a disaster waiting to happen.

While the articles contained in MEW deal mainly with equipment that is larger than I would require I have found that many of your articles explain processes and procedures which are very relevant to my needs. I think many of your more experienced readers would be surprised how much information needs to be absorbed before you can just do a simple turning. This is magnified many fold when, as I am, the reader is alone without a mentor to answer the basic questions.

Your authors have a clear, friendly and encouraging style which I find positive and inspiring. The series on the Sieg C-3 was of particular help though without a

doubt the C-3 was far too large for my needs, budget and shop space.

The series laid out the basics in an understandable way and allowed me to better gauge what I needed. After reading and rereading my first few issues I felt able to take the plunge and purchase a small Sieg C-0 (clone). Tiny and not very accurate the C-0 may be but I have had hours of fun slowly learning how to get some decent results.

With the purchase of a lathe, I could now put to use some of the ideas I'd read of in MEW. Some of the articles might not be all that applicable to my needs but it is surprising what you can find out paying attention to them. To be sure I may never need the information on how to run a CNC mill. But I now know how to clock a vice on a mill. Truth be told I didn't even know that it needed to be done in the first place but now it makes perfect sense. Who knows, a micro mill may be in my future yet? So be of good cheer. Folks, even newbies like me in the depths of darkest Australia, are reading and enjoying the fruits of your hard work. Keep up the fine efforts and be assured that all of your labours are very much appreciated. The gift of knowledge and encouragement are very precious ones.

I very gratefully thank you and your team very much for your marvellous efforts.

Daniel Cooper Australia by email

Star Letter

YOUR CHANCE TO TALK TO US!

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

Compliments from down under

G'day David
I've been a reader of M.E.W for a few years now and just want to say that I was a bit worried when Dave Fenner decided to hand over the magazine to a new editor.

These worries have well and truly subsided and have now turned to excitement as the magazine is looking better than ever! I have also noticed that like all magazines you have got a few people who wish to constantly complain about various things in the magazine (like content, front cover etc).

These people need to understand that M.E.W is a fairly unique magazine as it focuses on the part of model engineering that is often overlooked and that is being able to make the tools and equipment needed to make models etc. More importantly, it passes on tips and hints to others who are only beginning in this hobby or are looking to advance their current skills to a new level in many different fields.

I don't know about the U.K or U.S.A but here in Australia we get M.E.W, M.E. & Australian M.E. but as far as I'm concerned M.E.W is the only one that every page has something of interest!

I am particularly looking forward to the

C.N.C stories that you are doing as I have never used that system. I also hope that Harold Hall keeps writing for a while as we still have a lot we can learn from him but the short stories are also very good as you can get the whole picture in one issue and not 3 or 4.

As for those who want to complain, tell them to find another magazine that is even half as good as M.E.W and I think they will get the picture!

The only thing I could have wished for is that M.E.W was around when I was at high school as I would be far more knowledgeable for it!

Keep up the good work David, thank you.

Ian Bertenshaw by email from Australia

The Editor replies: Thank you for your kind comments Ian. I know people sometimes complain but thankfully this is rare. I try to make MEW as good as I can and please most of the people most of the time. I have seen all the major Model Engineering magazines and feel that MEW is probably the best of them all. At the end of the day, we are running a commercial magazine and as editor, although readers' come first, I still have to make a profit or the magazine ceases to exist.

steel about 95mm long....". If I had done that in an engineering drawing class I would have been kicked (literally) out of the room!

Don't get me wrong I am guilty of the same, having grown up learning imperial & then metric measures, I still "convert back" with many things if they are to have any meaning, but such duality in articles is bad practice & can lead to serious errors. I have no problem with metric or imperial measures (we did our engineering drawing mock "O" levels in imperial & actual exams in metric!) but any article should be consistent in the dimensions & terms whichever system is used.

Nigel Crompton by email

The Editor replies: The original article used NC American threads unlikely to be unavailable in the UK. The tapping size given was 2.5mm so I changed the threads to M3. The cross holes were reamed .250, which is a 1/4in. Lengths of the cross rods were not given in the original article so I measured them from the drawing (yes I know not to do this but it was not a

critical dimension) and put a metric length in without thinking as I work mainly in metric. Fortunately both imperial and metric dimensions appear on most rules so readers did not get confused.

Chinese scales

While being of no practical use to Mr Shepherd, Scribe a Line issue 139, the principals behind these scales may be of interest. I worked on DRO and CNC machines in the 70's. The scale at that time consisted of a glass strip chrome plated on one side then etched to leave a line and space one half a thou. wide like a comb. The reader head consisted of a small glass window (Diffraction grating) etched to match the scale. While both the scale and the grating were aligned vertically the optical effect was to generate horizontal bars almost 2mm wide which moved either up or down as the grating moved left or right (a similar effect to Moire fringes).

Two LEDs shone through the window and the Bars were picked up by two photo diodes. The movement generated two square wave signals 90 Degrees out of

phase. 7400 logic chips detected the change of state of these waves (leading and trailing edge of each wave) generating a series of four spikes each cycle. Further logic detected the sequence of these spikes i.e. what order they occurred thus telling the following counter what direction the reader head was moving.

With one of the LEDs out, the sequence for detecting the direction is lost and the counter detects the count but cannot progress.

Unfortunately the LEDs are infra red and cannot be seen without a special filter.

While in the 70's these LEDs were replaceable, I doubt if they are now given the state of miniaturisation these days. Note a DRO should be regularly tested against a Dial Indicator zero for repeatability, full travel out and back.

Doug N.S.W. by email

Pinnacle problem

May I first of all say MEW has and continues to give me plenty of ideas and satisfaction ever since its inception? I missed the first two editions and EBay eventually supplied them 'At A Premium!' so I have the full set to date.

My reason for this letter is a Request for Help thus. I have a Pinnacle PDM20 Mill/drill which has developed chatter in the spindle area which I think is due to play with the taper bearings, they may need nipping up. Can any reader give me any help with the procedure? My primary worry is the spindle return spring, how to release and how many turns to preload when reassembling? Also how much do I tighten the spindle nuts?

A further question, does any reader know of a small quantity supplier of 8mm or 10mm high quality ply, to sort with 7 or 9 fully glued layers. Just one 8x4ft sheet is my need. I have been looking to make a clock not too dissimilar to the one young Thomas Barnes made. I don't fancy MDF too much, it's a bit soft. All credit to Thomas for getting it to work.

Peter Wilton by email

Picador Parts

For anyone who, like me, wishes to purchase (occasionally) their pulleys or hand wheels and are having difficulty in purchasing them, the company appears to have been taken over by a another called "ABCpolishing" and the Picador products are now available online from the website: www.abcpolishing.co.uk

Usual disclaimer and thanks for a great magazine.

John Davidge by email

WRITE TO US!

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

Write to the Editor, David Clark, Model Engineers' Workshop, MyHobbyStore Ltd., Berwick House, 8-10 Knoll Rise, Orpington, Kent BR6 0EL. Alternatively email: david.clark@myhobbystore.com

THE STAR LETTER OF THE MONTH WINS A WORKSHOP PRACTICE BOOK

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Cheap Chinese machines

In response to Jim Fitzpatrick (Scribe a line August 2008) regarding whether to choose an expensive used lathe of industrial pedigree or settle for an inferior new machine of oriental origin, I can only relay my own pleasant experience. My first lathe was a BV20 type of Chinese origin which I outgrew as my business needed a more substantial unit.

Like Jim, I also started to look at used machines, most of which had seen intense production and some of which had ostensibly been "refurbished" - still bearing scars and bed damage etc. I was very keen on a lathe of Swiss origin, but it was devoid of its steadies and 4 jaw

chuck, plus one or two change wheels for thread cutting etc. When I mentioned that for less money I could buy a complete Taiwanese lathe complete with steadies, change wheels and a four-jaw chuck, the salesman told me that it all depended on whether I wanted a Rolls Royce or a bicycle!

Well, for a 25% saving, I settled for the 'bicycle' which, 6 years on, has served me faithfully and profitably. The saving I made also helped buy the extras (quick change tool post etc.) which really make lathe work a pleasure.

If you go the "bicycle" route, choose from a reputable buyer who can back their brand. I doubt you'll regret it.

Manny Kay, South Africa by email

very good quality tool. I have taken the ME Workshop since issue No. 1 and the ME since 1950 but this really put a smile on my face.

Once again I thank you for your speedy response.

John Hamlyn from Slough by email

The Editor replies: John did not receive his free set of callipers so I arranged for them to be sent to him. Sometimes our subscriptions company makes an error. They are a third party company handling subscriptions for many different companies including MyHobbyStore (formerly Magicalia) and inevitably there will be the occasional hiccup. If you have a subscription problem and are getting annoyed or frustrated, talk to me by email or phone. I will try to sort it for you.

Warco lathe

A couple of issues back a letter appeared comparing our BH-600 to the Chester Craftsman. The editor mentioned a review of the Chester lathe, no mention of ours. Just thought that the readers should be referred to a previous article in MEW, back in 2003.

Lindsey Brinded - Warco

The Editor replies: I believe this was published in issue 87 although the author is not given and I have just discovered the yearly index has been removed from my volume of the magazine. If a reader wants a copy of this review or a review of any other Warco lathe, I am sure Warco would oblige.

CNC milling

I have just received the August issue of MEW and would like to congratulate you on the improvements you have made to MEW. This is no mean achievement with the diversity of readers' interests and experience. I always find it "a good read" with a good mix of articles.

I have an EMCO CNC mill which I have rebuilt with new stepper motors, "Routout CNC" drivers and Mach 3 software and have been delighted with the result.

Referring to the article CNC milling with Mach 3, I think it may be useful to point out the availability of Wizards in Mach 3. Although I realise you are developing the principle G codes required for the drilling of holes on a PCD you can achieve the same result with minimum effort by using the Wizard "circular bolt pattern" by Brian Barker. This comes with Mach 3 software as standard.

With no previous use of this wizard the G code can be created in just a couple of minutes with the option of controlling all the required variables. This may be of interest to readers who may initially be put off by the programming aspects of CNC milling.

Perhaps an article covering the Wizards could be included in your CNC series?

Geoff Josey by email

The Editor replies: I did try the wizard but for some reason it did not work. Wizards will be discussed in a future instalment. CNC is proving very popular. I get quite a few positive letters and emails, also the CNC book reviewed a few issues back sold over 50 copies including two to New Zealand.

Subscription gift sorted

Just to let you know that you are working well, as this morning in the post came the promised gift of the Digital Callipers. The wait was well worth it as they are great.

Nice large figures on the reading scale, very appropriate for the older Model Engineer like me, everything has a solid feel about it and in a nice box, what more could one wish for.

Very many thanks for your help David I am delighted with them. You should spread the good news to all the readers about the great gift and the pleasing comments that you have received from readers, as I am sure many might think it was just "sales talk" and a cheap Chinese toy being sent out. Remember the old Chinese plastic of years gone by?

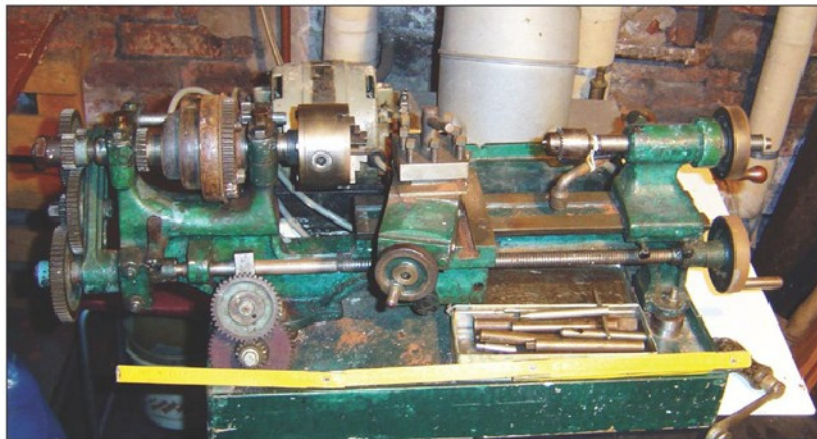
Anyone, yes anyone who does not take up your offer is missing out on a treat of a

Another unidentified lathe

I enclose a photograph (below) of an unidentified lathe that I've been asked to sell on behalf of the widow of its late owner. I hope you do not mind this direct approach but at the moment I am completely stuck as to who the maker might be. There is no manufacturer's plate, model number or machine number at all, indeed nothing to hint at its parentage. My instinct wants me to label it as from Drummond/ Myford but I have nothing positive to go on and have drawn a blank with other searches. Is it one you recognise? Failing this can you think of another direction (or person) that might be worth following? There are a few tools with the lathe which I am assured is in working condition and was in use not too long before the owner died. I do hope a reader can help for I would like to see it continue in use as well as some return for the family.

Trevor Jones by email

The Editor replies: I don't recognise this lathe. Can any reader help Trevor? We had a tremendous response to the last request for information about a lathe. Email me or write to me at the Berwick house address.



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Tel: 01641 541216 Thurso.

■ Vertex BS2 dividing head, little used, £250 ono. **Tel: 01664 454409 Melton Mowbray.**

■ Vertex Horizontal/ vertical rotary table, 150mm (6in.) diameter, 2 Morse taper, brand new with instructions, £125 +carriage.
Tel: 01270 568506 Crewe.

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■ Transwave static converter, 13 amp in, .75KW (1HP) three phase out, purchased in error, £175.
Tel: 01484 662491 Holmfirth.

■ Blacksmith's equipment, 1/2cwt anvil, stakes, tinman's horse heads (various), tinman's hammers and bench vice with 4in. jaws. **Tel: 01256 862932 Hampshire.**

■ Myford bench lathe, not sure of model, good condition, £250 ono. Myford bench lathe, old but

good condition, £50 ono. Buyer to collect. **Tel: 01782 538199 Stoke-on-Trent.**

■ Harrison 140 centre lathe, 3 phase with 3 jaw, 4 jaw and full screw cutting gearbox in excellent condition. **Tel: 01522 870993 Lincoln.**

■ Workshop sale, lathe, mill, tooling, material, measuring equipment, surface table, toggle press and band saw. All are in reasonable condition. **Tel: 01493 844015 Great Yarmouth.**

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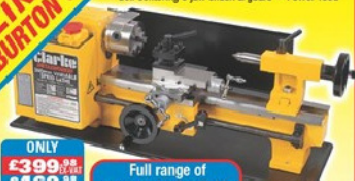
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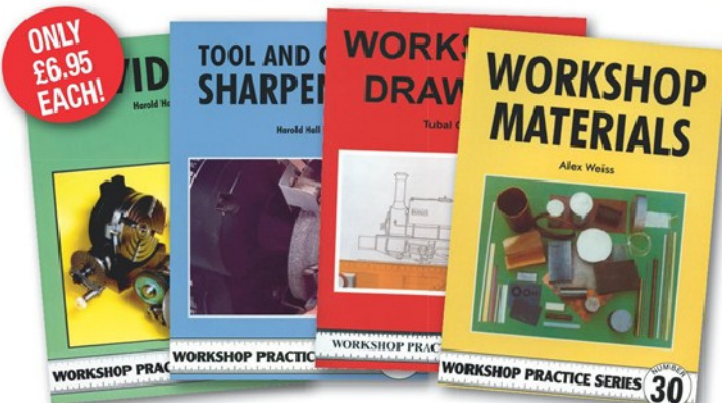
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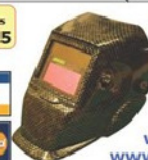


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4 Foot treadle guillotine, modern machine cut 1/5mm, good condition.....	£450	chuck - superb	
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8" cap ajax power hacksaw.....	£275	Reglan Lathe - vari speed (2 x plastic change wheel broken).....	£850
Denford Viceroy lathe with gear box.....	£850	90° Head for Bridgeport (M head).....	£325
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Model Engineers' Workshop

To advertise on these pages contact Duncan Armstrong on 01689 899 212 or duncan.armstrong@magicalia.com



£50 each

'LO' Colchester drive/catch plates



£20 each

Myford MA99E collet chuck collets



Just in
£345

Q and S 6" power hacksaw + coolant



£1250

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Colchester Student 1200 + dual dials



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Cowells miniature milling machine



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



£1500

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Boxford 'Little Giant' toolpost grinder



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Myford Super 7B lathe



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(we have 2MT-SMT and 30INT to 50INT in stock!!)



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Harrison L5 travelling steady
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From
£20

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Lurem Universal woodworking
machine No.C260N



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Van Norman 944 boring bar + tools



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Emco (original Austrian machine vice)



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More broaches metric and imperial



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Burnerd Boxford 4jaw chuck
(more variations available)



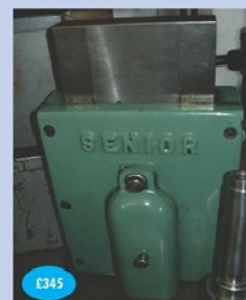
£950

Colchester Student 1500 6" x 24" lathe



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420w	
240kva	
1300 x 653 x 12.5mm	

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Table Size	600x180mm
Weight	135kgs

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Standard Accessories
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Face Mill Capacity
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Table Size
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Motor
600w
Shown with optional stand

CHAMPION 20V



£779

Features
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Face Mill Capacity
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Table Size
700x180mm
Spindle Taper
MT2
Motor
1hp
Shown with optional stand

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£949 **Special Offer**

Features
Variable Speed
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Metric & Imperial Thread Cutting
Fully equipped with 3 & 4 Jaw Chucks, Steadies, Centres and Lathe Tool

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Distance between Centres	550mm
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Supplied With
3-Jaw Chuck • Quick Change Toolpost Change Gears • Variable speed • Lathe Tools

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Swing over bed	180mm
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