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MARCH 2009

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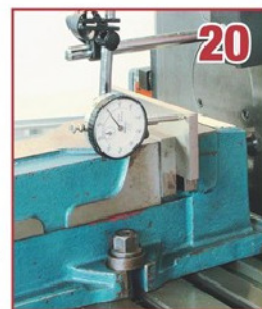
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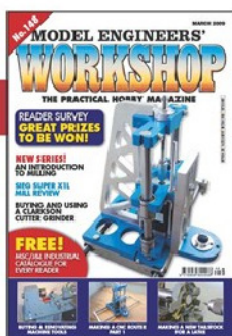
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John Rutter's CNC router.

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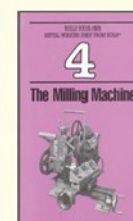
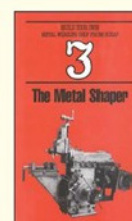
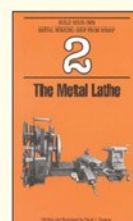
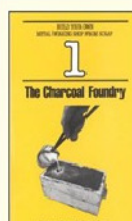
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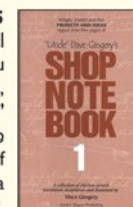
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Uncle Dave Gingery's Shop Notebook 1 • £ 8.25

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David Clark

ON THE EDITOR'S BENCH

Reader survey

I have printed a reader survey in this issue. I hope all of you fill it in. It will help me to know what you, the reader wants from Model Engineers' Workshop in the future. There are some great prizes to be won. These prizes, although the same as the Model Engineer survey ones, are being offered as well as the model Engineer prizes. Yes, two sets of prizes are up for grabs if you read both magazines. Please fill the survey in and return it. You will be helping yourself as well as the magazine.

Three a month

The only drawback to doing Model Engineer as well as Model Engineers' Workshop is that I have to do three pages of editorial every month. What do I write about?

Traditionally Dave Fenner used to talk about his workshop; I have not had time to go out in the workshop recently so that is out. I don't want to talk doom and gloom and the economy does not belong in these pages.

So what to talk about? I know a lot of readers' are not steam or I/C engine enthusiasts but some of you may be. So, here goes. Model Engineer no 4346 will have the start of a series of 6 double sided plans free inside. The first plan will have the first sheet of Martin Evans Metro tank locomotive on the front and Edgar Westbury's Zephyr petrol engine on the rear. The Metro tank will have the remaining five plans free over the next five issues.

On the reverse will be Trojan, a small steam engine, Corsair, another small steam engine, Cygnet Royal, a three cylinder steam engine and the last two plans will have sheets 1 and 2 of Edgar Westbury's Centaur Gas Engine on. I hope some of you will buy the relevant issues? Who knows, if this is a success and sales increase sufficiently, we may be able to do something similar with Model Engineers' Workshop. (Tool plans of course.)

Web site

The web site should be up and running soon. When I have the URL, I will print it. Hopefully this will be in the next issue. It will take a little time to load content up but it should be well worth waiting for. It will incorporate an open forum where you can air your views and read about Model Engineering and workshop activities.

There will be a gallery where you can display photos of your in progress or completed models. There will be a buy and sell page where you can list your surplus items at no cost or ask for items that you do want. (No traders though.) Also, we will be putting certain articles from Model Engineer into PDF files for free download. I have to be careful to ensure that I don't break copyright rules but I do have permission from quite a few people to put their articles onto the web site. Also certain articles are not copyright to the author but are copyright to the MyHobbyStore Ltd Company and we are legally entitled to put them on the web. I also have written permission from Tubal Cain's (Tom Walshaw) widow to put all of his articles onto the web site. It has been a long time coming but will be worth the wait. I intend to make this the best resource for model engineering on the web. Watch this space.

Enforced holiday

No doubt some of you have had an enforced holiday in the workshop because of the snow we are having as I write this in early February. It is nice to go into the workshop although for most people, they can't find enough hours in the day to go out there often. I know I seem to be very busy and only go out there to do the odd article.

I am still short of the make it in a day type of article. Perhaps some of you can do the occasional write up of the small tool you have just made? We do pay well for articles. I am sure the other readers' will be appreciative. Guidelines are available on request.

Myford Open Day

Myford are holding their spring open day again this year on Thursday 16th April 2009, 9.00am - 5.00pm, Friday 17th April 2009, 9.00am - 5.00pm and Saturday 18th April 2009, 9.00am - 4.00pm.

Myford have invited me to attend and I have agreed to go on the Thursday. I hope to meet some of you there. Please do come and say hello; you can bend my ear about Model Engineers'

Workshop (and Model Engineer) if you wish. I am looking forward to it. I have not been in a factory for over two years now so it is sure to bring back happy (unhappy) memories. Further details will be announced in the next issue.

Harold Hall

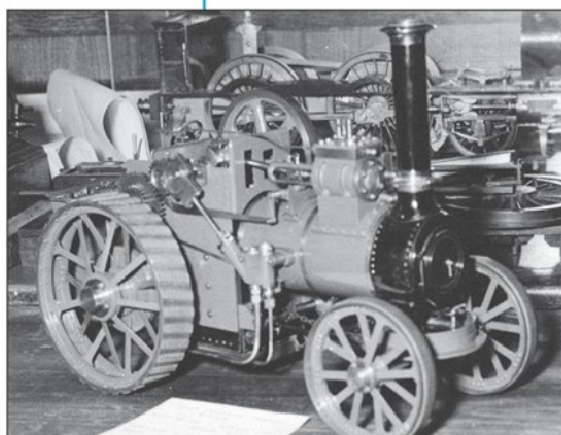
Harold is writing again. This is much appreciated and I am sure will be welcomed by readers'. Harold has not retired completely but is so busy with other projects, woodworking etc. that he will only be writing the occasional article.

Stolen 1in. scale traction engine

I have recently been informed of a stolen traction engine. This item will also appear in Model Engineer.

Steve Gotrel has had a 1in. scale traction engine stolen from his garage on the 22nd December 2008. It was built by his father, Vincent Gotrel (now deceased) about 30 years ago. It was based on the then 1in. scale Model Engineer drawings. The photo is black and white unfortunately. The main colour is light green (unlined), with a black smokebox and chimney. The flywheel spokes are red. If you have any knowledge of the whereabouts of this engine or are offered it for sale, please contact:

Andrew Humphriss Crime Investigator, Warwickshire Central Crime Desk, Stratford upon Avon Police Station. Tel: 02476 483432.



BUILDING A CNC ROUTER 1

John Rutter describes
construction of his
Mk2 router

Before ill health forced retirement upon me, I used to be a teacher. One of my successful "bids" while working was for a small CNC router that I felt would help pupils GCSE and A level work. The head accused me at the time of buying a new toy for ME rather the pupils and I have to admit that I did find a lot of other ways to use it while "training". It turned out to be very handy for turning out intricate parts for model aircraft for instance!

I always vowed to buy myself one when I finished teaching but when the time came I'm afraid I "bottled out" over the £2,500+ cost of the STEP FOUR machine I'd been using. I did miss the use of the thing though and eventually made a CNC router for myself, which saw regular service for around 18 months before I decided I needed something a bit better. This Mk1 machine used screwed rods for the drive (via stepper motors of course) and plain sliding bearings with mild steel shafts for movement. The majority of the construction was in wood, easy to use and versatile, while accurate enough for me.

The theoretical accuracy of the design was in thousandths of a millimetre (in practice nothing like this) but the screw drive was very slow when transitioning from one cut to the next with a maximum speed of only some 6 to 8mm/sec before a horrible squealing would indicate "misfiring" of the stepper motors and the plain bearings of the slides would either rattle (loose) or jam (tight). The Mk1 was a useful learning tool though, as was a friend's version of something similar so I had a better idea what was needed by the time I drew up the Mk2, **photo 1**.

By using toothed belt and pulley drive, this machine would sacrifice theoretical accuracy for transition speed and would use far better quality components for the slides to reduce friction and eliminate rattle. Specifically, these would be hardened steel bars with linear ball races,



Photo 1. The completed machine. My machine is on pulleys to enable it to be raised out of the way when not in use. The winding handle is in the right foreground.

16mm diameter for the X axis and 12mm for the other axis to keep the cost down.

I'd found from experience with the machines I'd been involved with that keeping the tool rigid is the key to accuracy (of course) but keeping the movement free is essential for control and these requirements tend to oppose each other. The bars and linear bearings should be the answer to free motion so I designed the Mk2 from the cutter back to keep everything as rigid as possible.

As I wanted to keep the weight of the moving parts light (reducing momentum problems in acceleration/deceleration) I drilled or otherwise removed material wherever possible. I hoped this would also help reduce the "ringing" or "drumming" that seemed to amplify whatever noise the motor or cutter made with the Mk1. Less

flat surfaces to reflect the noise due to all the holes should help, or so I hoped. The Mk1 had also been more of a series of parts bolted together rather than an integrated design so with the Mk2, I also wanted to tidy things up a bit.

I needed a machine that would cut within a 3ft x 1ft area, mainly for cutting light ply of around 3mm thickness, with the intention of cutting parts for model aircraft. A smaller machine would be a little cheaper to make and even more rigid.

The length of the bars and frame could easily be adjusted to suit your needs while using exactly the same components. The hardened steel shafts required are (2 off each length) 1117mm x 16mm, 457mm x 12mm and 203 x 12mm and together with the linear bearings came from www.midlandbearings.com, which at the time cost me a little under £150. Ouch! you might think but this was far cheaper than some of the quotes I got. Keep telling yourself that you're saving thousands of pounds over the cost of something commercial; it helps soften the blow to the wallet. Stepper motors were from www.arceurotrade.co.uk item no 160-010-00200. Stepper drivers and software were from www.routoutcnc.co.uk and cost £120, though I later tried MACH 3 software (free from the Routout site) and a driver kit from www.hobbycnc.com as it was more compact and cheaper at \$79 but P+P put this up to \$102 plus VAT and import duty was added in the UK of course. Also, I like fiddling with electronic kits.

Timing belt pulleys and belt came from a local bearing supplier, Bearing Traders Ltd, ring 01429 862555 if you're stuck. Imperial belts and pulleys were cheaper than metric so I used three 15t XL 0.2in. pitch pulleys and about 20 feet of belt in the final design costing around £30 I think. Pulleys are supplied "blank" incidentally, with centres

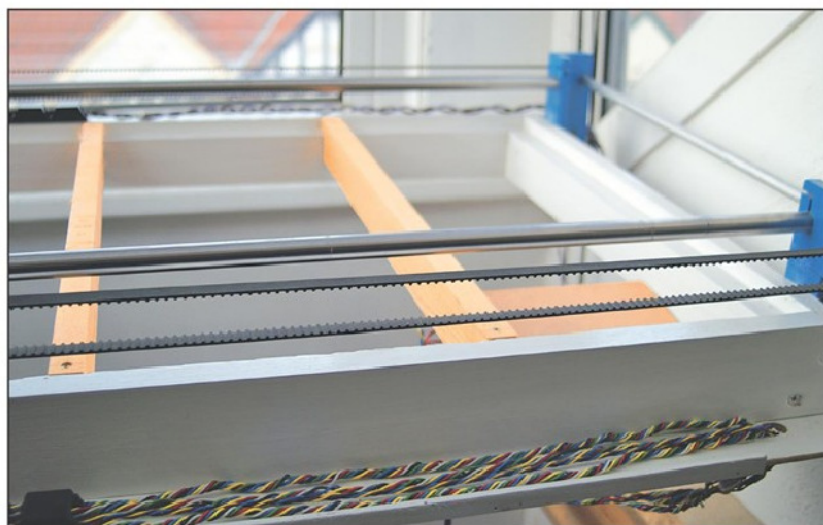


Photo 2. The machine uses pine cross braces to support the work.



"popped" and need drilling to suit (6mm), preferably in a lathe. The main support frame of the machine is 75 x 50mm pine and 1/2in. (12mm) birch ply is used for the rest of the wooden components. Some sources say that MDF "rings" less than the ply but I don't like the stuff.

The Mk1 used a large flat table for work mounting and it rang like a drum. The Mk2 uses cross braces and as little flat surface as possible, **photo 2**. I could have used my little X3 micro mill metal milling machine (or indeed the Mk1 CNC machine) for hole drilling but thought a standard drilling machine might be more widely available for people who might be interested in trying this project so used this instead to ensure the project could be completed satisfactorily with minimal machinery.

A variety of drills were used, twist bits, flat bits and even a hole saw. The flat bits are cheaply available (try the local £ shop for a set of 6) so I don't mind grinding the sides off these to get just the right sizes needed. Do remember to stamp their new size on them though!

Parts were cut out on a band saw usually, occasionally a scroll saw (internal cuts especially) but could be done with a fretsaw or jigsaw if need be. Generally if items were paired, such as motor mounts, they were cut out on a band saw, pinned together with fine panel pins, centred and drilled. If four items need the same paired centres they would be drilled in one hole only, pegged through that hole and then drilled as a clamped stack for the other centre. With the slide mounts for instance, all four pieces need exactly the same centres but one pair needs to hold only the shafts, the other pair needs a larger hole for the bearings. Drilling all the centres together keeps everything as close to correct as possible.

As I needed to make sure everything worked as well as possible (for this article, I'd have been less fussy otherwise) I think I made pretty much every plywood part probably about three times over with modifications and still had material left from a 4ft x 2ft sheet of birch ply so this material shouldn't bend the wallet too much. I wouldn't use cheaper "mahogany" ply though, it's too soft.

I used a lot of M5 and some M6 threaded rod in the construction, mainly in preference to trying to get hold of bolts of just the right length. Usually I'd silver solder a nut onto one end of the thread to make a bolt but this isn't absolutely necessary. For captive threads I'd cut a length of thread to size, clean the ends up on a grinder and slot an end with a hacksaw to allow them to be screwed into a drilled pilot hole with an electric screwdriver. I also used 30mm long M4 Allen head cap screws in many places as they look neat and are easy to adjust without fear of slipping off. A selection of countersunk wood screws was used, mainly 1in. no. 6's (ply parts) and 4in. no. 10's (frame).

The Z axis

I started construction with the Z axis, **photo 3**. I suggest you get a photocopy of your drawings, cut them out roughly and then use spray mount glue to stick the drawings to strips of ply (some need to be 50mm wide, some 60mm) before trimming excess paper and then centre punching the holes, **photo 4**. **Photo 5** shows the Z axis parts ready for assembly.

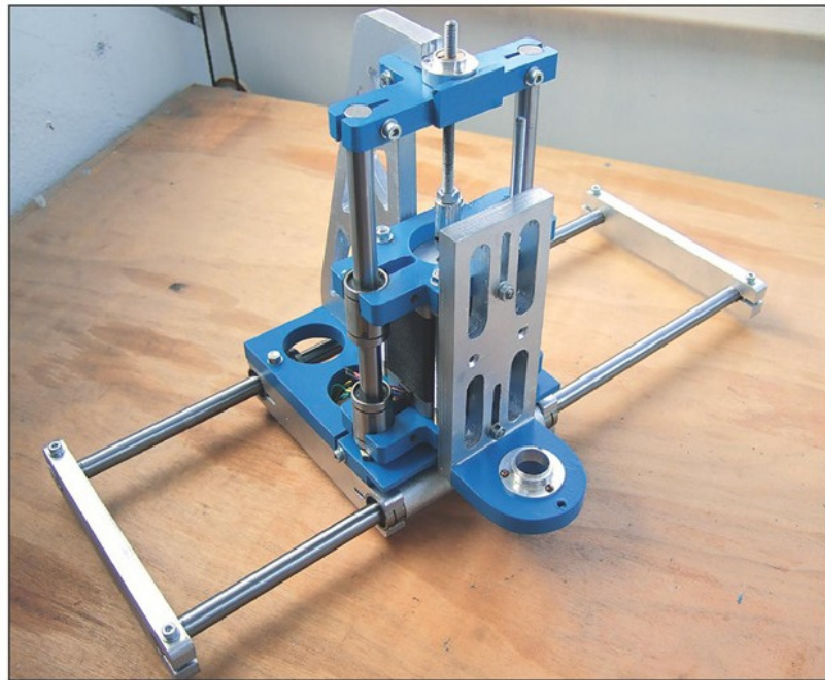


Photo 3. The finished Z axis and Y slide unit.

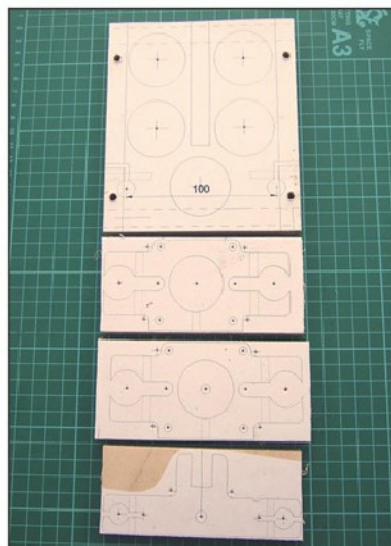


Photo 4. The photocopied parts drawings are fixed to the ply using spray mount adhesive.

You could of course simply mark out onto a sheet of ply from the drawings but this is likely to be time consuming. I used an optical centre punch for the holes that mattered, the two top shaft mounts and one end (left end or right, it doesn't matter so long as they're the same end) of the other parts. Drill a pilot hole (3mm in my case) in each punched mark, put a drill blank or another drill through the 4 pieces, line them up carefully and pilot drill through all 4 together using a long series drill, **photo 6**. They can now be separated into their individual parts and drilled, 12 mm for the shafts, 22 mm for the linear bearings (leave a bit of "waste" at the outer end of the 22mm holes until after drilling to stop the drill "grabbing") using flat bits. Cut the flex slots with a band saw.

Incidentally, I'd test your drills on a bit of scrap first. The parts (shafts and bearings)

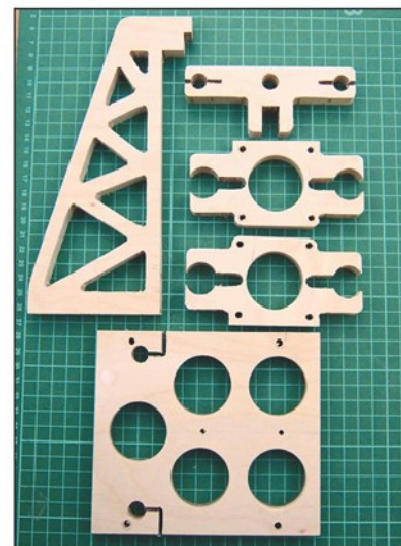


Photo 5. The finished Z axis parts after cutting out with a bandsaw and drilling.

should be a tight fit in the ply. If they are loose then grind a little off the side of the drills (assuming cheap flat bits are used). Another trick is to chop the shanks down to give a drill length more like a standard twist drill; it saves time when changing drills by not having to keep moving the table up and down. While you're on the grinder, sharpen the things properly, it's amazing they cut at all when they come out of the packet (£1 shop drills).

Ordinary twist drills are fine for the smaller holes. Apart from the motor mounting holes, the rest of the holes are less critical when it comes to drilling so a normal centre punch is quite adequate before drilling. Drill the large hole for the motor recess and the lightening holes with a hole saw and cut out the shapes with a band saw or scroll saw. Check fit the parts. The assembly, without the motor in it should slide easily under its



own weight when everything is put together. Measure between the shafts with vernier callipers and if any filing is needed to adjust gaps, then now is the time to do it.

I used either captive M5 threads with nuts or M4 Allen head cap screws to retain parts. I clearance drilled one side of a gap and used a tapping drill on the other side. I actually ran an M5 tap through the wood for the M5 thread but the M4 screws were just screwed into place. These screws are barely needed in use as my fits were adequately tight without them but better safe than sorry; don't over tighten in any case to avoid stripping threads in the wood.

I used a hole saw to drill the large holes in the Z base (or Y slide depending on how you look at it) and smaller holes with twist drills to mount the Y slide rails and Z support. A "late addition" was the rebate under the main plate to allow the passage of the Y belt, which I did with a friend's router table, **photo 7**. Saw and chisel could have the same effect of course if you don't have access to the machinery. The Z support is a bit of a "work of art" with lots of drilling and scrollsaw work but it adds a lot of stiffness to the Z structure. **Photo 8** shows the complete unpainted Z assembly.

Once checked for fit, the whole thing can be dismantled, painted and reassembled, **photo 9**. I used car touch up aerosol primer and finisher but I don't pretend it's anything other than "adequate" as far as finishing is concerned, I'm sure it could be improved upon. When re-assembling the wooden bits you may need to re-drill the holes as they tend to clog with paint. I also rolled a card tube to fit between the linear bearings of the Y slide at the front to keep the worst of the dust out although the bearings have seals of course.

While the paint dries, it's time to do the metalwork for the Z axis. This particular

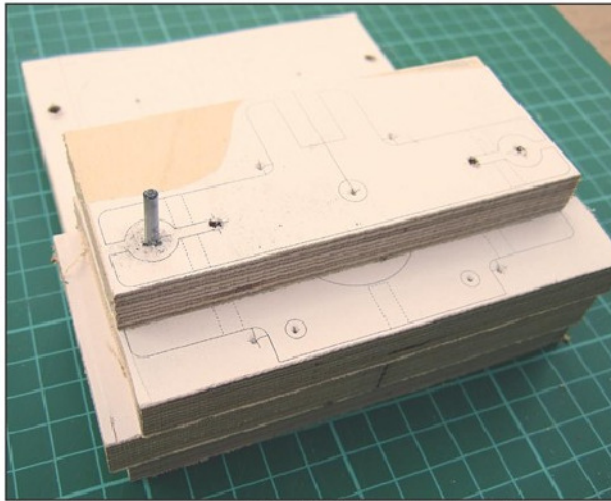


Photo 6. Some parts need identical hole centres for sliding so they were all drilled with a pilot hole in one end, an alignment pin was fitted and pilot holes were drilled in the second end before final drilling to size.

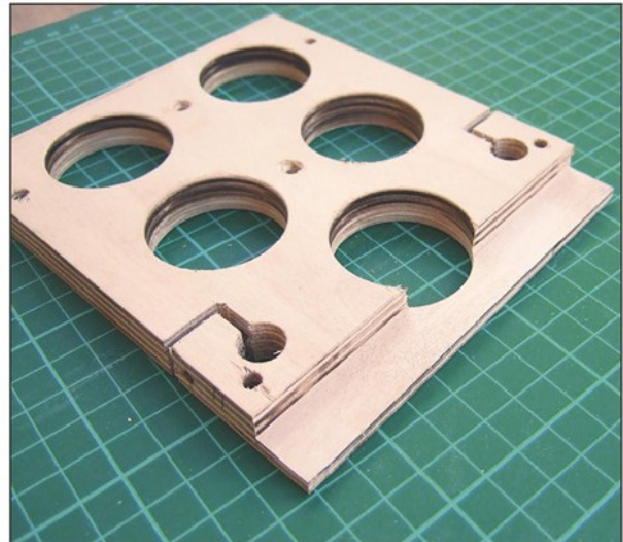


Photo 7. The underside of the mounting plate was relieved to allow easier belt passage.

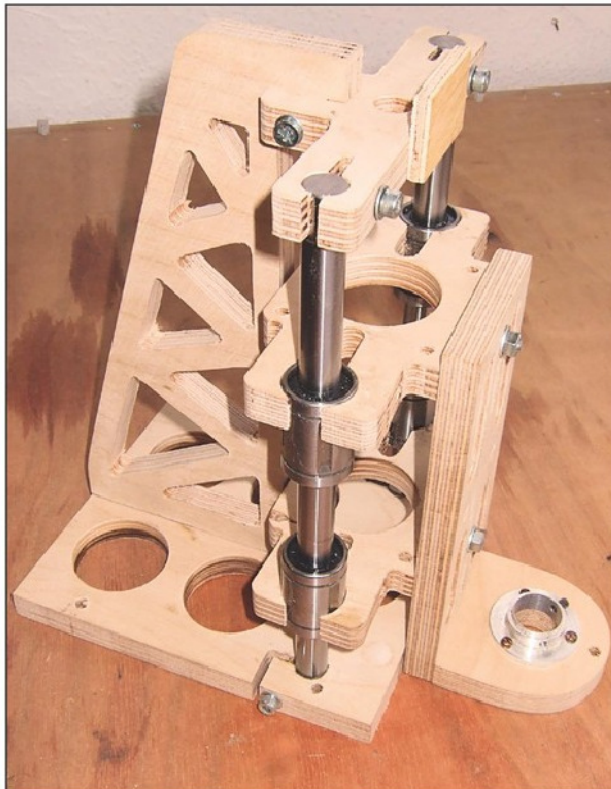


Photo 8. The assembled Z unit with the motor mount attached. Components must slide freely at this stage. If necessary, you can adjust positions by filling out the holes. The little bit of plywood on the top spreader bar is for a limit switch.

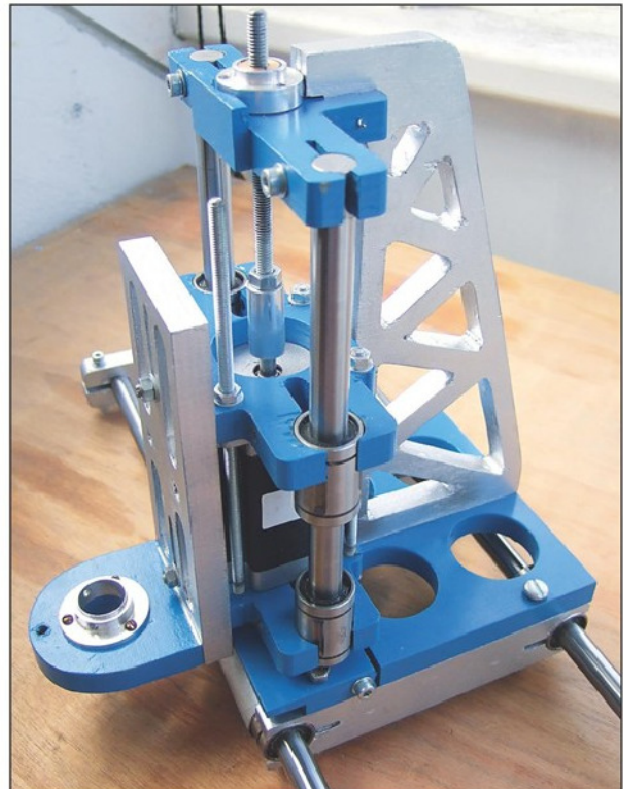


Photo 9. After painting, the final assembly looks like this. The stepper motor can just be seen in the middle of the frame together with the drive screw and adaptor. The adjustable cutter mount is also attached on the left hand side.

section of the machine doesn't have a lot of movement (around 75mm in my case) so is best suited to screw drive rather than the belts used elsewhere. I used M6 thread as it's easily available along with the necessary taps and its 1mm pitch is easy to programme into the software.

The attachment/ adapter to the stepper motor is made from 12.7mm aluminium about 25mm long. I centred it and drilled through 5mm in the lathe then drilled 6mm halfway through before tapping the rest M6. This should ensure the whole thing stays perfectly in line. Once released from the lathe, it's drilled and tapped for an M4 grub screw about 7.5mm in from the plain (not threaded) end, **photo 10**. This holds the adapter to the motor shaft. A locknut stops the M6 studding from moving, though you could gain a little Z movement by gluing the thread (or using another grub screw) and eliminating this nut. For the drive nut I had some 12.7mm aluminium bronze so cut a length about 12.7mm or so and drilled and tapped it M6. This in turn fits into an aluminium "top hat" shaped adapter made from 25mm aluminium with an M4 grub screw in the thickened "rim" and drilled for locating woodscrews at 120 degree intervals around the top of the "rim", **photo 11**.

Put the threaded drive nut in position and screw in the grub screw until tight. Remove the screw, remove the insert, centre pop the mark the screw has made and drill with a 4mm bit a couple of mm into the material, **photo 12**. This will now act as a positive locator for the screw. For backlash adjustment saw right through the insert at 90 degrees around the circumference from the grub screw and nearly all the way through at 90 degrees in the other direction (the opposite side of course). When positioned in the adapter the grub screw will now be able to compress the insert, eliminating backlash. An alternative is to saw down the length of the insert from the grub screw end, again almost to the bottom but not quite. **Photo 13** shows the completed assembly. A friend did something similar but completely cut the insert in half, this works fine too as the thread stops the two halves separating.

A final addition here came from David Solsylva who sells plans for CNC machines at www.solsylva.com. He experimented with a damper device on the stepper motor. I was dubious but tried one and it works well, enabling far faster motor rpm and travel speed (though for some reason it works better with the MACH 3 software than the Routout). It seems this device could be made from pretty much anything (he's used skateboard wheels and castors) but as I happened to have parts from a VCR (I take them to bits for the motor stators) I used these. The particular part used is from the tape drive and normally bolts to the top of the drive motor. All I did was remove the motor and shaft along with any unused "junk" bits of wire, screws etc, leaving just the aluminium outer (now a flywheel) and beautifully fitting brass inner.

The parts are normally held together with M3 screws. A little thin oil is all that should be needed between the brass and aluminium to give smooth movement but obviously this is worth checking before final assembly. I put the aluminium "flywheel" on a rotary table on a milling machine, lined up with the M3 screw holes and milled a 6mm slot through 5 degrees of arc right through the material. Repeat for the other



Photo 10. The stepper shaft adaptor; don't forget to put a flat on the stepper shaft to take the grub screw.



Photo 12. The mount has been drilled and tapped m4 and the drive nut has been shallow drilled for alignment as well as split for anti-backlash purposes. It has been slid out of position in the photo for clarity.



Photo 11. The drive nut mount is drilled for three retaining screws.



Photo 13. The completed drive nut assembly.



Photo 14. The anti "squeal" device. Note the slightly enlarged holes just off centre and the silicone tubing on the assembly screws. Use thread lock on the assembly screws.

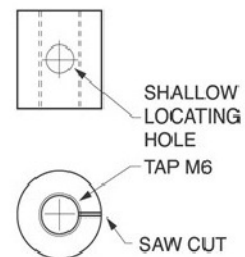
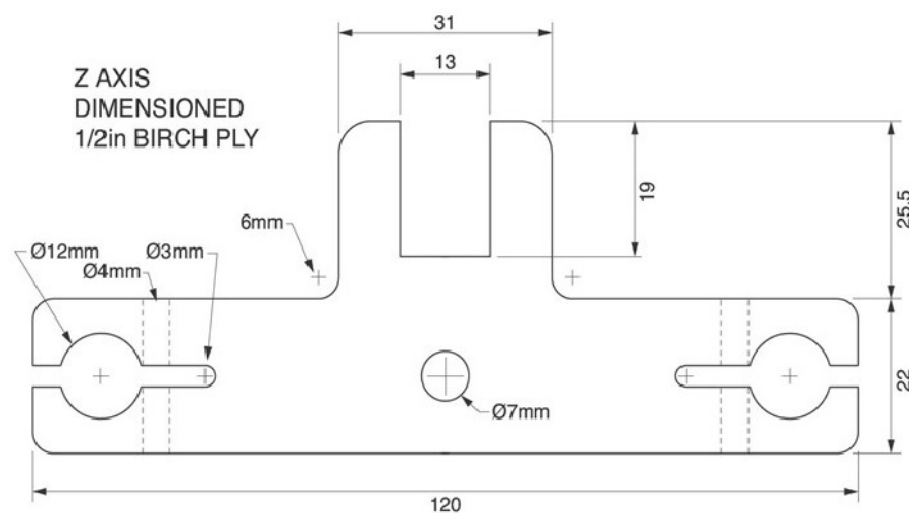
hole, diametrically opposite. Put a little silicone rubber tubing (model aeroplane fuel tubing) over the M3 retaining screws, add a little Loctite or similar to the threads and reassemble loosely, **photo 14**. The screws want to be just tight enough to stop too much play but still allow movement. The whole thing is then held onto excess threaded M6 studding from the Z axis motor by a couple of nuts either side of the brass, **photo 15**. In practice, this small amount of free play or "wobble" in the flywheel seems to stop the stepper motor resonating at a critical frequency (around 250rpm it seems) making it much smoother in operation. X and Y drives on my machine don't need this as, being direct drive, they never get anywhere near the critical rpm.

The motor is held by 4 long M5 bolts (studding with a nut silver soldered on one end) one of which is left long to hold part of the Z homing mechanism, a small ply plate. Having this plate on a thread enables you to move the micro switch contact point, allowing easy adjustment of the amount of movement used for "homing". ■

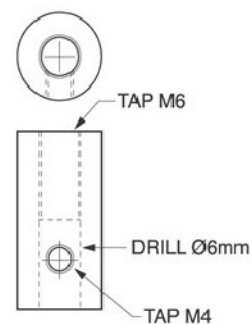
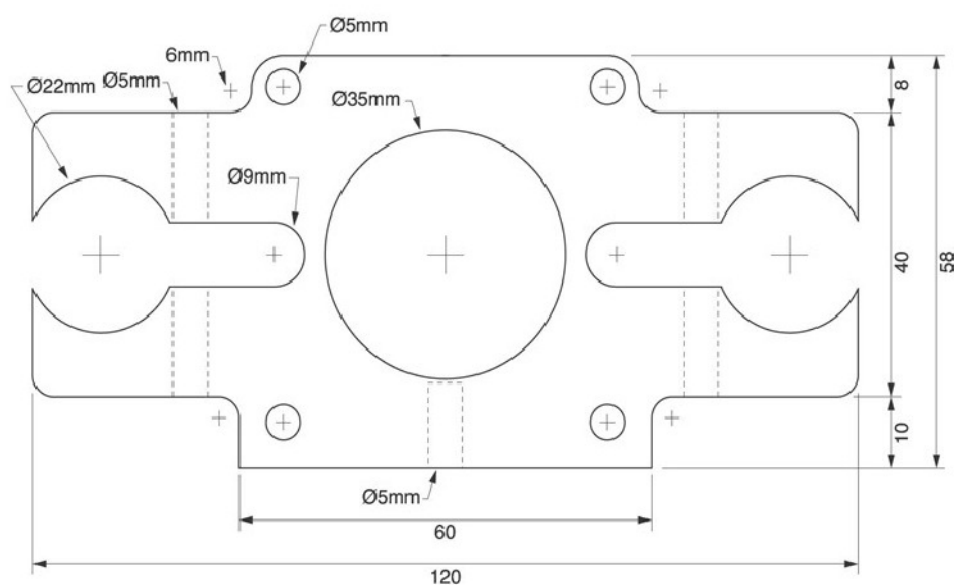
Next month, we look at the Y slide components.



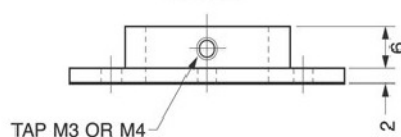
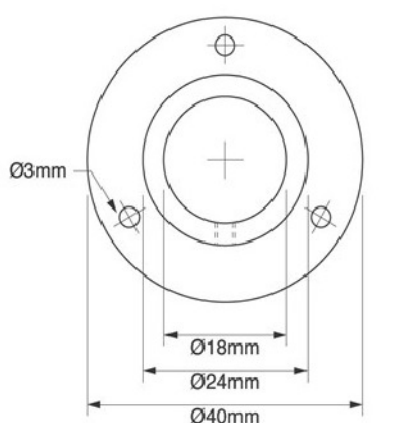
Photo 15. The anti "squeal" device is shown fitted here together with the Z homing micro switch and the long motor mounting screw used as a trigger.



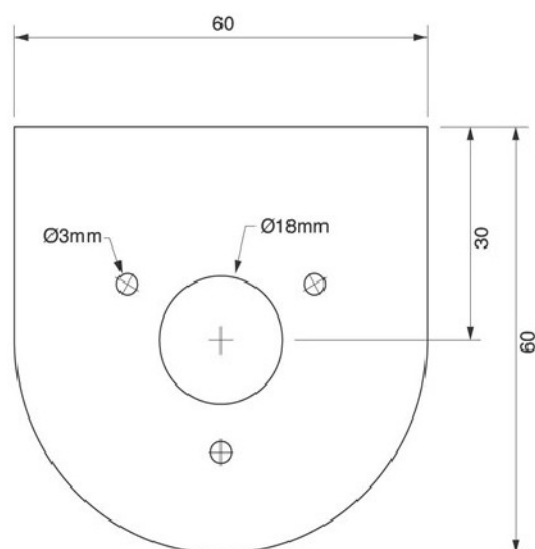
**DRIVE NUT INSERT
ALUMINIUM OR BRONZE**

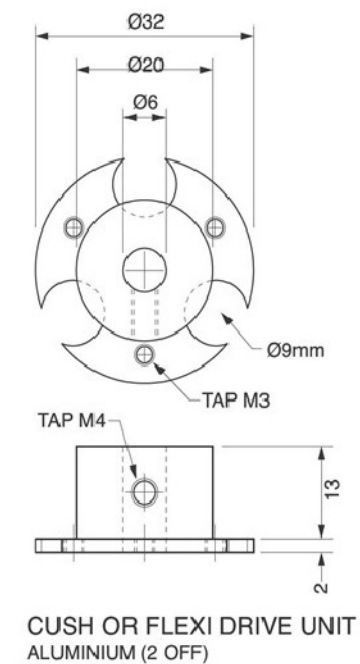


**Z MOTOR
THREAD ADAPTER
ALUMINIUM**

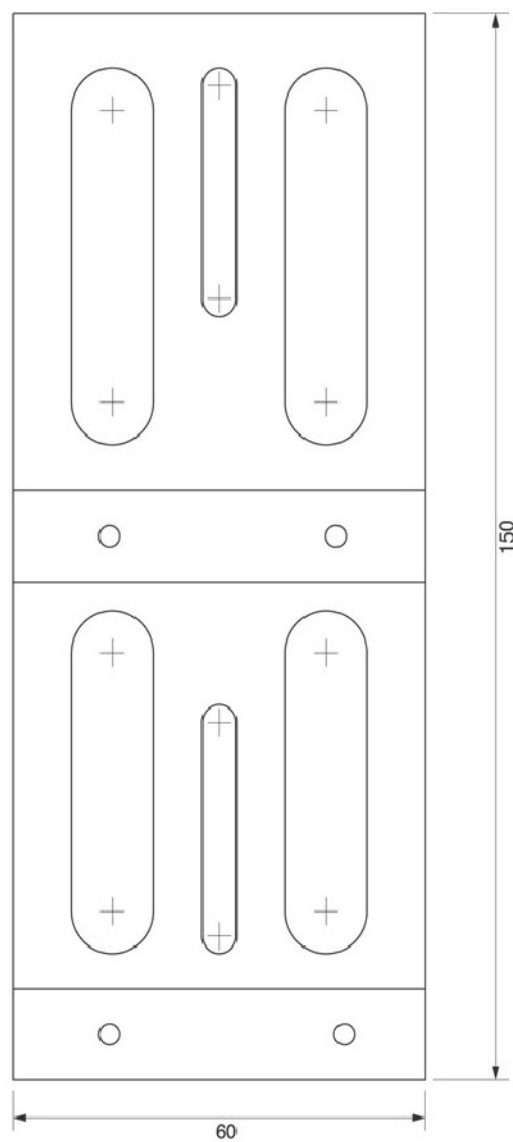
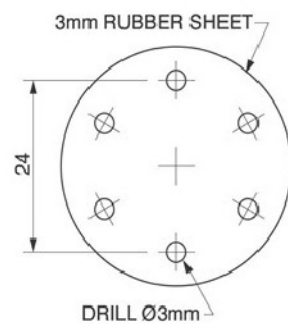
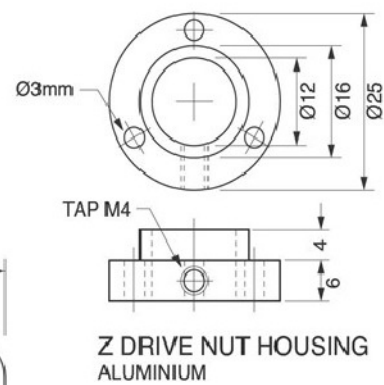
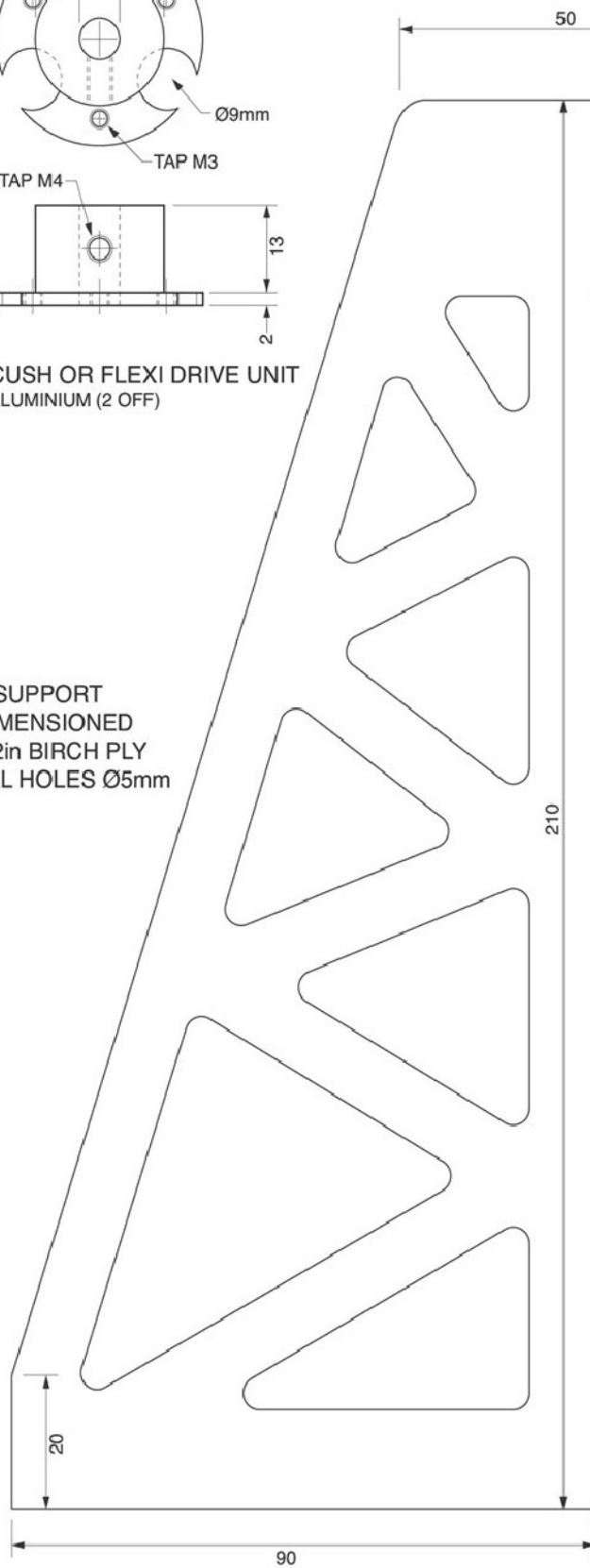


**MOTOR MOUNT
ALUMINIUM**





Z SUPPORT
DIMENSIONED
1/2in BIRCH PLY
ALL HOLES Ø5mm



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to limit its travel using a toolmakers clamp as shown in **photo 8**. When completed, reverse and face off the final 0.005in. using the cross slide feed and with the saddle clamped to the bed. **DO NOT FORGET** to reset the topslide screw to its original zero mark before machining the next blank.

I assume that you will be making a batch of identical components, so I recommend initially 'rough' turning and leave say 0.025in. on the diameter for final cleaning up to a fine finish with a different and sharp tool. The rough turning process on the larger size blanks produced quite a lot of swarf, **photo 9**, which will need careful disposal later. Note that the largest size for 1 5/16in. dies is longer than the other two.

Extended tooling

It will also be noted from the photos that I am using the topside set parallel to the lathe axis and with the "Piddington" extended 'Myford Dickson' type toolholder which I 'invented' in 1989 (see Model Engineer Volume 162 issue number 3844) and which Myford Ltd put into production a few years ago).

Also on view in these images is a crude piece of aluminium sheet fastened to the toolholder. Lathes, and particularly milling machines, are apt to throw swarf liberally around your workshop. My workshop is in a ground floor spare bedroom so additional precautions have to be made to keep swarf where it belongs and not trodden out, for example, into the living room. Your spouse will take a dim view of such happenings. My deflector keeps most of the turnings in the vicinity of the lathe, though the few bits that do escape may be swept up later. I also recommend keeping a piece of old carpet just inside your workshop door, which is usually successful at removing odd pieces of swarf from your shoes.

The larger blanks will require further machining at this same setting, so the original centre hole will be used again, though if you so wish you may do the other turning at the same time. I prefer one diameter at a time to avoid confusion with the various stop settings. So much depends on your lathe. Everything I do and describe is based on the Myford Series 7 machine having used them for 4 decades and being very satisfied.

Finishing to final diameter is self-explanatory except that you require a very finely ground and honed tool and the finest self-act feed you have. Give this tool a tiny radius on its tip and ensure that the tool's front, say 1/8in. is parallel to the turned diameter. By this means this front edge will actually rub against the work and smooth out any minor scratches left by the tool's tip. I recommend using a piece of similar grade steel to set the tool and to practice on first.

For the 30mm diameter blanks which are machined along their length to one diameter, bore out soft jaws to grip on the 1 3/16in. turned diameter but first pass over this a 1/8in. or 1mm thick washer which will allow tool run-out before it hits the chuck jaws as shown in **photo 10**. Using the live tailstock centre will force the washer completely flat against the chuck jaws.

It is important to set a saddle stop to prevent the tool hitting the jaws - a delicate adjustment, but necessary. If you don't, as sure as "eggs are eggs" there will be a loud crunching sound followed, if



Photo 9. Making lots of swarf.

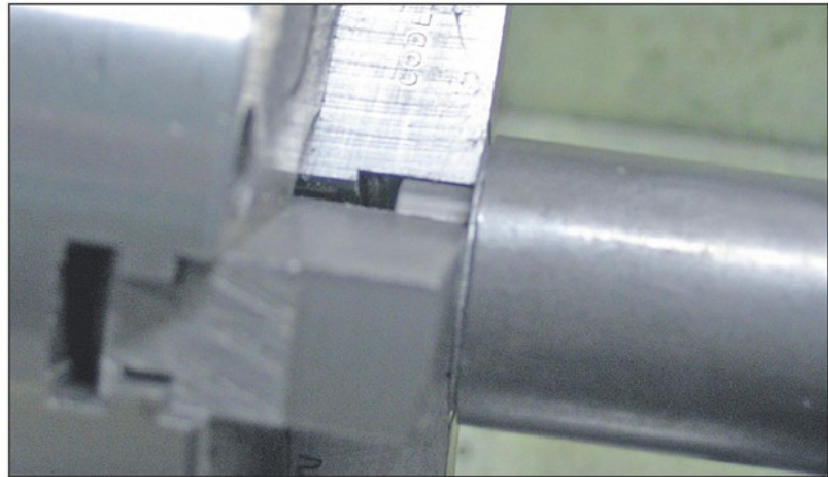
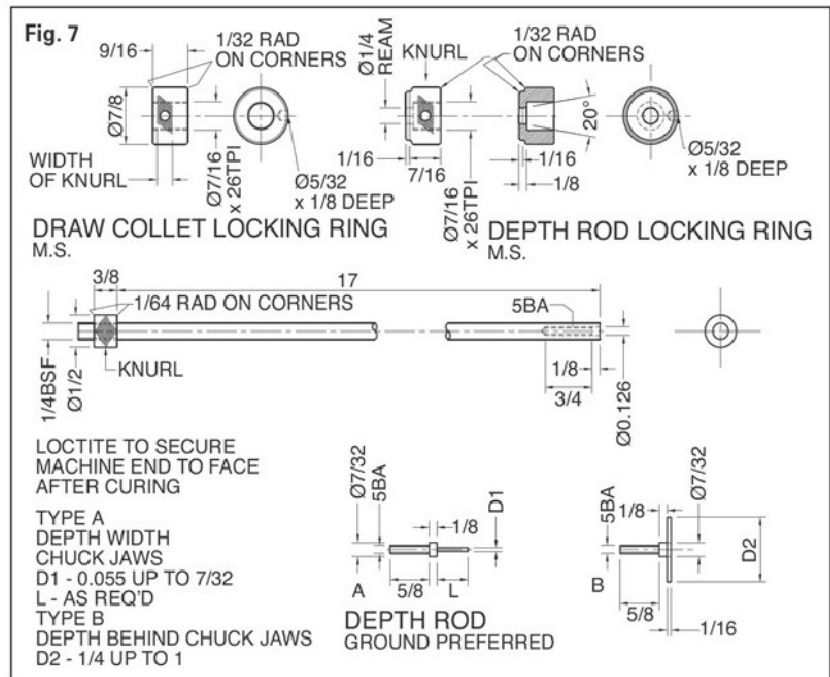


Photo 10. A thin washer between work and soft jaws.



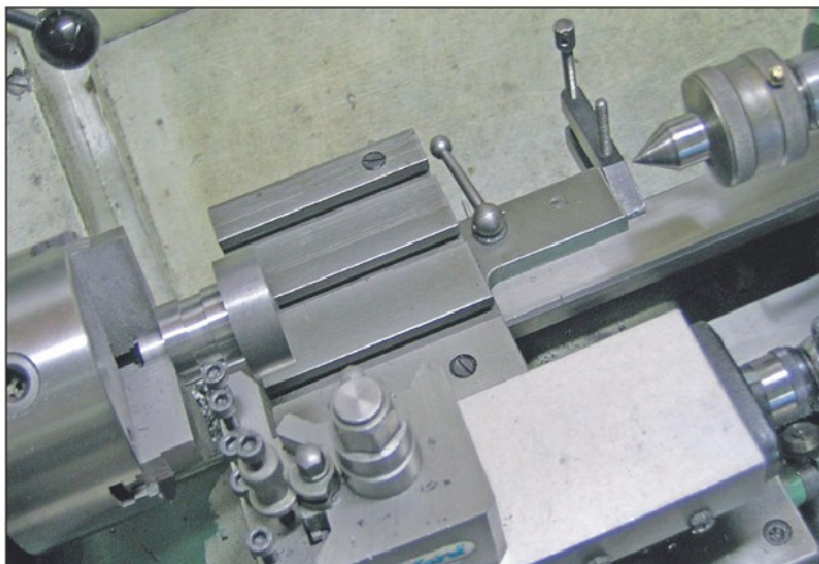


Photo 11. Using a rear bed stop for grooving.



Photo 12. Top view of rear cross slide stop used for boring.



Photo 13. As photo 12 with swarf deflector added.

your temperament is like mine, by an infinite number of naughty words. Don't say I didn't warn you.

The first batch of these dieholders I made was for the 20mm and $\frac{13}{16}$ in. dies, which have the parallel diameter. I already knew that a knurl grip would be satisfactory for the smaller sizes and this feature was positioned centrally on the length. Though my units are for work and not for competition, they still have to be pleasing to look at and so I grooved each side of the knurl as shown in the drawings. I used a wide parting tool and my normal saddle stop for the headstock end of the groove, and fitted a toolmakers clamp to the rear shear of the bed for the tailstock end of the groove, as you will see at upper right in **photo 11**. An additional toolmakers clamp is used at the front of the cross slide as before for setting the depth of cut.

The tailstock with its live centre is used during the process itself. Again finely hone your tool before using it. When the batch is finished, re-set the stops and repeat for the outer groove. The knurling process will be done later but before drilling for the 'tommy' bar holes.

The smaller die holders

The body diameter for the smaller size has been repeated on the other two so, if you are making some of each, you may now re-bore the soft jaws to accept this diameter, remembering that to grip correctly the jaws must be bored out to 0.002in. to 0.004in. smaller than the diameter to be gripped. It is most important here to insert at the back of the jaws a three-legged 'spider' to grip the chuck onto before boring. This accessory simulates the component you are about to grip. For smaller bores, find a slug of metal about the right diameter to grip on to. If you can obtain a copy of "Engineering in Miniature" Volume 12 issue Number 3 you will find a single article where I described this process in greater detail.

The main boring process is the easy part. With the embryo holder running truly in the chuck, centre drill and initially drill at around 600 rpm, which is the top speed of the low range on the Super 7. I used a four-facet $\frac{11}{16}$ in. drill, which I had to hand and which are good for this sort of work. Then I used an $\frac{11}{32}$ in. drill at the same lathe speed before slowing down to 300 rpm for the $\frac{39}{64}$ in. drill. These speeds are only approximate but suit 'dry' operation without lubricants or coolant.

The reaming was done on 210 rpm, which is the slowest in normal running without back gear. Use cutting oil for the reaming process and traverse the reamer slowly through the workpiece remembering that it is removing almost 0.008in. from each side of the hole AND because a very smooth, accurate, bore is essential.

Hot from the machine

The drilling and reaming process generates quite a lot of heat, so be careful when removing a holder from the chuck. It might not be hot enough to burn you, but certainly hot enough to make you want to put it down very quickly. The extra heat is an advantage as when the body cools the bore will contract slightly and be an even better fit on to the sliding arbor, which we will make later.



Photo 14. Cross slide stop with swarf sweeper clamped to first clamp.

Another 'trick' I use when using larger drills in the tailstock is to momentarily, and frequently, stop the feed motion. This breaks up the curls of swarf into short, manageable lengths for easier disposal. However do not do this when drilling stainless steel, as you will work-harden the bottom of the hole, blunt the drill and may be unable to restart the cut.

That achieved, the die holding outer diameter of the larger sized bodies may now be skimmed down to size, or if you have used nominally correct diameter bar, then simply skim off the surface truly to a good finish.

Now measure the thickness of your collection of dies and make up a chart showing these remembering that the adjusting screws used must be on the centre line though the die, or slightly in front of this. You may find a 'common denominator' size for the depth of the bore for each of the three nominal die diameters.

If you are making all three sizes, then I recommend doing the large ones first as the process is tedious if not downright boring (pun intended) but by doing the smaller sizes later the production speed can only get faster.

Set a saddle limit stop by whatever means you have available and lock the saddle against it. Use a suitable boring bar set exactly to lathe centre height and, with the top slide set exactly parallel to the bed, touch the tool tip against the workpiece. Set your screw dial to zero, then unlock the saddle and move it towards the tailstock. Wind in the boring tool until its tip is 0.005in. LESS than the final depth and lock the slide. Continue boring at depth of cut increments to suit whatever boring bar you use. The stouter the bar, the greater the cut you can apply, but I would urge caution as you do not wish to displace the embryo holder in the chuck.

When you approach final bore diameter, repeatedly check with callipers, or internal micrometer to compare with an external micrometer until the diameter is between 0.010in. and 0.015in. larger than the nominal die size. At this point, set a limit

stop to the cross-slide to suit your machine. **Photo 12** shows the process and **photo 13** is a plan view showing a swarf deflector. I found that even when using the toolmakers clamp method, swarf readily found its way to the vertical face between the clamp and the back of the saddle altering the stop setting, so a sweeper was inserted as shown made from a scrap oddment of steel sheet lightly kinked so as to press down on to the top of the saddle. This was then toolmaker-clamped to the main clamp and is shown in **photo 14**. Set your cross-slide dial to zero at this time and for subsequent operations you can bore to 0.005in. LESS than the finished size. I suggest that you use around 400rpm for this operation.

Now reset your topslide dial to finish depth and move the saddle to its own stop with the tool tip within the radius of the

reamed central hole. Wind the cross slide slowly towards you to face off the bottom of the hole to the cross slide stop. Wind it forward a few thou' and retract the saddle. Now reset the tool tip to make the final cut to finish the bore diameter. Break the sharp internal corners, remove from the chuck, clean off swarf etc, take up the next blank and continue.

It was at this point that I discovered a snag for Myford series 7 users. The topslide position for boring the 1in. and smaller die holes fouls the travel of the standard 1/2in. drill chuck. It was not possible to continue using the toolmakers clamp method of cross slide travel stop and I had to drill and ream the remaining blanks and then set up for boring as a second operation. Cross-slide stops have been described elsewhere but I never made one. Non-Myford users may have better luck in this respect. Either way it should be possible to re-set the blanks to run truly in the bored soft chuck jaws. If you find this is not possible, then set up your 3-point steady on to the major outside diameter for the boring process.

I next took on the challenge of drilling the four tapping holes in each of the holders. **Photo 15** shows my rotary table set vertically with the three-jaw chuck with its already correctly bored soft jaws now transferred from the lathe. Set the base at 90deg. to the table axis and, using a wiggler, locate the rotary table's axis co-incident with that of the machine's long table. When using the wiggler do not forget to add on half its tip diameter and half the diameter of the workpiece so that your measurement collar may be set to a known zero. Using the same methods locate the end of the first holder blank and set the drill axis in the same way. Linear scales, if fitted, are better still for this method especially the ones which retain the setting when switched off until the next time of switching on again. Provided that the scale is not reset, then even if the table is moved, it can be returned to exactly the same zero position regardless of any backlash between the feed screw and its nut. ■

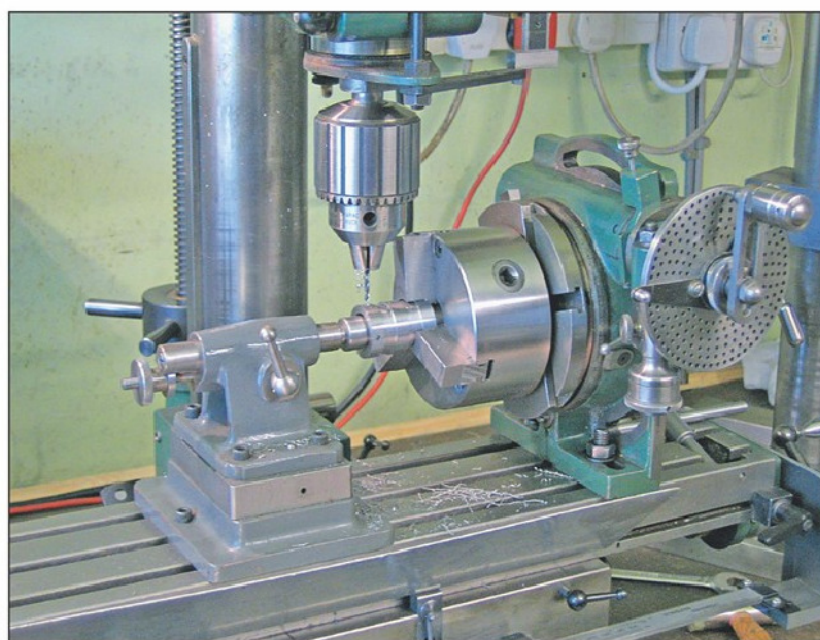


Photo 15. Setup for drilling radial holes using rotary table.

AN INTRODUCTION TO MILLING 1

Donald Brymer starts the series by showing you how to mill parallel and/or square faces using a machine vice.

Setting the vice true and square

As a machine vice is used to hold much of the smaller work to be milled, we should consider how to set the vice onto the machine table?

Both the table surface and the vice mounting surface must be clean and free from any surface irregularities. Check that the machine quill is at 90deg. to the machine table, **photo 1**. Place the vice onto the machine table making sure that the tee slot locating dogs (if fitted) do not damage the table surface or the sides of the tee slots.

Use the correct size tee slot nuts and bolts for your machine. Use a heavy flat washer of at least 5mm thick as a minimum under the clamping nut and do not over tighten the nut. Check the vice base at the bottom of the jaws for parallelism to the table cross and longitudinal movements, **photos 2 and 3**. Check the fixed vice jaw for vertical alignment with the machine spindle, **photo 4**.

Even if you are machining flat surfaces only, the vice fixed jaw should be accurately aligned with the axis of the machine table movement. The next time you (or someone else) comes to use the vice, you will assume it is square. If your vice does not have tee slot dogs, push the vice toward the machine column until both the tee slot bolts contact the slots of the vice base. To align the fixed jaw with the table movement, clamp a parallel strip in the vice to put the fixed jaw under compression and set the jaw off the parallel strip **photo 5**.

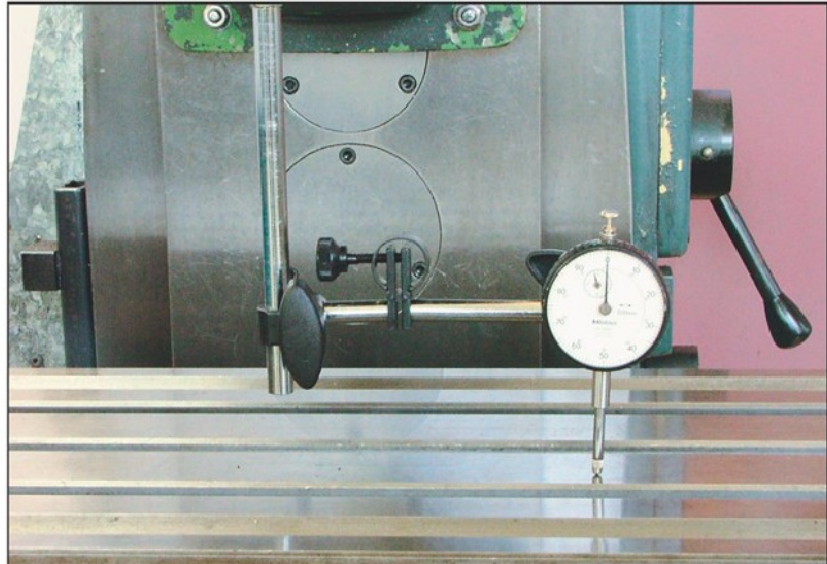


Photo 1. Check alignments at 90deg. increments.

Machining flat and parallel faces from black bar

Should a flat surface be required from black stock, position the material into the vice with a piece of thin paper (cigarette papers are ideal) under each end of the work, **photo 6**. This will indicate if the work is touching the vice along the length of the work/vice contact area. This step is not critical at this time if a reasonable amount of material is to be removed from both sides of the work and it is often impossible to achieve due to the inaccurate black surface. As the vice is being tightened, strike the work surface with a soft faced hammer (a dead blow hammer, one filled with lead shot is best as the bounce of the work and hammer are eliminated). Again avoid excessive tightening; hitting the vice handle with a hammer is not required.

Wherever possible, mount a milling cutter that is 5 mm to 10 mm larger in diameter than the width of the face to be machined. If this is impractical use the largest cutter available. The direction of the table feed must oppose the rotation of the cutter, this is referred to as conventional milling and is used on all machines not equipped with a table feed backlash eliminator. If climb milling is used, that is where the cutter rotation and table feed are both in the same direction, the cutter will try to climb or pull into the work. This often results in damage to both the cutter and the work.

Should the work height be less than the height of the vice jaws, use a matched set of parallel strips under the work to bring the work to a suitable height. A strip of cigarette paper can be placed between each end of the parallels and each corner



Photo 2. Check vice base over width.

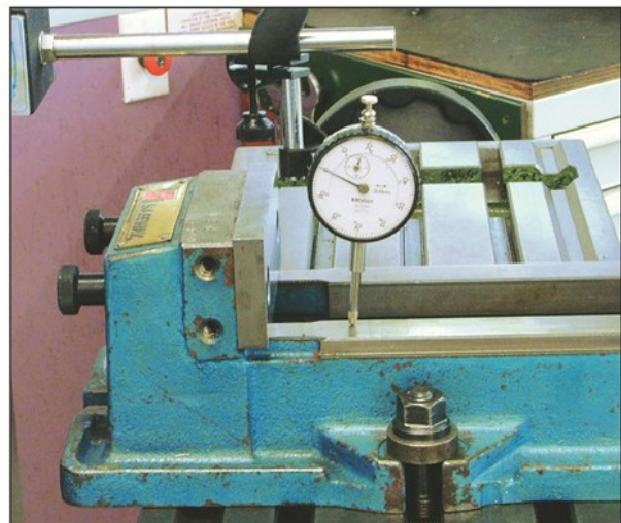


Photo 3. Check vice base over length.



of the work. This indicates if the work and parallels are in full contact. As stated previously full contact at this time is not critical as the parallels are only supporting the work to a suitable work height.

The work is now ready to be milled on one face to remove all of the mill scale and produce a flat bright surface. As a general rule remove the minimum amount of material from the first face. Bring the work to size when machining the parallel face.

After the work has had the initial surface machined, remove the work from the vice. File all new corners to deburr and clean the surface thoroughly. Remove all swarf from the vice jaws and base. Remember that cleanliness is essential for accurate parallel machining. Remount the work with a strip of paper between each corner of the previously machined face and the vice base or parallel strips and tighten the vice as previous. It is important to make sure that the paper pieces do not overlap and are not gripped between the work and the vice jaws. Now, lightly pull on each piece of paper in turn. If no movement of paper results, the second face is ready to be machined. If any piece of paper can be moved, strike the work surface with the soft hammer over the ungripped paper. If no movement of any paper now results, machine the face. If paper movement persists, it is possible that the clamping action of the vice is causing the work to twist away from the base due to the vice jaws gripping unmachined surfaces. If the second face is machined now the two faces will not be parallel. Remove the work from the vice, check for surface burrs and/or swarf, clean again and reclamp as previous. If paper movement still exists try the following.

Place a piece of 10 mm diameter bright mild steel round rod between the work and the moveable vice jaw in approximately the middle of the work height, **photo 7**. Retighten the vice and test for paper movement. The use of the round rod gives a line of contact between the work, the rod and the moveable jaw. This often allows unmachined materials to be held in a vice without the rolling action caused when gripping surfaces that are not square.

If movement still persists try the following; place the first machined face against the fixed jaw of the vice with the 10 mm rod

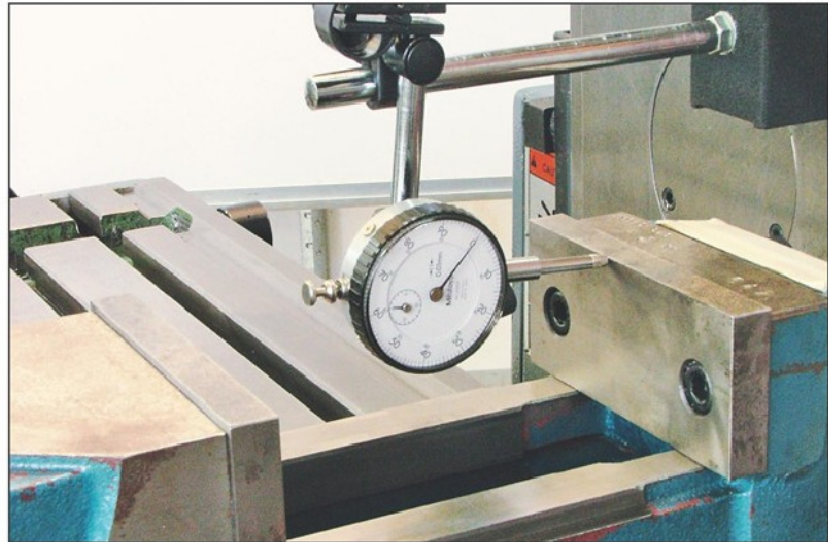


Photo 4. Check parallel to column over fixed jaw height.

between the work and the moveable jaw then machine the second face square to the first face. After machining, check for squareness between the two faces to suit the work requirements. If the work is not square, check the machine set up and the table movements and lightly remachine. When square, deburr and clean and set the first machined face onto the vice base with paper under each corner. With the second machined face against the fixed jaw, place the 10 mm rod in position and tighten the vice. All four paper strips should be captive between the work and vice base, a further strike or two with the hammer may be required, but this method usually does the trick. Two faces can now be machined parallel.

Machining parallel and square from black stock

To machine a square/rectangular block from black stock the method is very similar to the previous procedure but, I suggest that the work is machined in the following sequence. Carry out the machine and vice alignments if not already done. Machine the first face, deburr and clean. Set the machined face against the fixed vice jaw using the paper and rod. Machine the

second face, deburr and clean. Check for the degree of squareness required. Place the second machined face on the vice base keeping the first machined face against the fixed vice jaw. Using the paper and rod, machine the third face, deburr and clean, check squareness and parallelism.

Set the work in the vice to bring the last face to be machined into position. Use the paper strips only, the rod should not be needed as two parallel and square sides are being gripped between the vice jaws. If the rod is used, as may be required if the vice is old and worn, excessive clamping force will result in the face against the rod being bruised.

Two methods can be used to machine the ends of the work square to the faces.

If the fixed jaw of the vice has not been accurately set parallel to the table movement, the work is held with one unmachined end uppermost and a vertical machined face is either checked for squareness with an engineers square from the table or vice base, or a dial indicator is held in a suitable position to gauge the machine face by raising and lowering the machine knee to assess the face's parallelism with the machine spindle axis, **photo 8**. After any adjustments are made

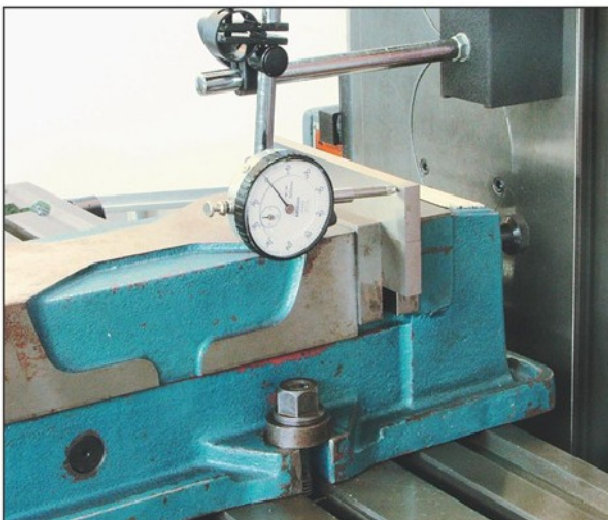


Photo 5. Check fixed jaw parallel to table movement over length.



Photo 6. Two cigarette papers under both ends of work.

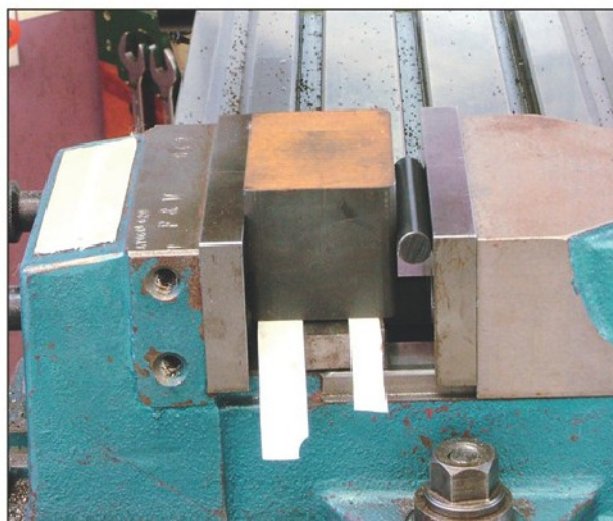


Photo 7. Round bright rod between work and moveable jaw.

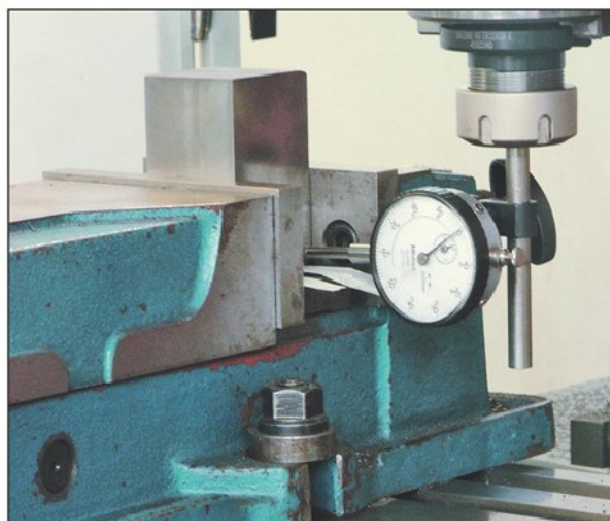


Photo 8. Alignment of length of machined face for 90deg. ends.

and finally checked, the end can be machined.

To machine the other end of the work, repeat the above method using paper strips under the work as a check on the parallelism of the ends. A note of caution; should the length of the work be such that more than 50 mm is above the top surface of the vice jaws this method is not recommended. This is due to the cutting action pushing the work away from the cutter and the associated work/cutter chatter problems that will exist. If the overhang is greater than 50 mm use the following method to machine the ends of the work.

The fixed jaw of the vice has to be set parallel to the table movement. The work is held with one end overhanging one side of the vice jaws to allow cutter access. Keep this overhang to the minimum distance practicable. In this method, the 10 mm rod is placed in the vertical position between the work and the moveable jaw. This will aid the horizontal alignment of the work and fixed jaw. Lock the table longitudinal clamps and machining can be carried out with the side cutting edges of a suitable end mill (largest diameter and shortest end mill possible) using the table cross traverse. Depending on the work thickness, several cuts may be required to machine the full face width of the work ends. This process is repeated for the other end.

Remember at all times, lock all machine slide clamps except the slide movement required. Cleanliness and burr removal are essential at all times. There is NO excuse for leaving burrs on machined surfaces or swarf under the work. ■

Editor's note, I have included **Table 1** showing cutter speeds to accompany this series. For cutter feeds, use no more than 0.025mm per tooth on the light machines found in the home workshop. As an example, if the cutter has 4 teeth, use a maximum power feed of 0.1mm per revolution of the cutter. A 20mm cutter with 4 teeth cutting free cutting mild steel would run at 485 RPM with a feed of 48.5 mm per minute. This is a guide only, use of coolant, the rigidity of the setup, the workpiece and the cutter should all be taken into account.

Table 1

CUTTING SPEEDS IN RPM							
METRIC SIZES				IMPERIAL SIZES			
Diameter				Diameter			
	Cast Iron	Brass	Aluminium		Cast Iron	Brass	Aluminium
	Steel	Bronze			Steel	Bronze	
	Stainless steel	Free cutting mild steel			Stainless Steel	Free cutting mild steel	
1.0	3878	9695	14542	1/16	2445	6112	9168
1.5	2589	6474	9711	5/64	1955	4888	7332
2.0	1941	4853	7280	3/32	1630	4075	6113
2.5	1552	3882	5823	7/64	1379	3492	5238
3.0	1294	3234	4851	1/8	1222	3056	4584
3.5	1108	2772	4158	9/64	1086	2716	4074
4.0	970	2425	3638	5/32	978	2444	3666
5.0	776	1941	2911	11/64	889	2222	3333
6.0	647	1617	2426	3/16	815	2038	3057
7.0	554	1386	2079	13/64	752	1880	2820
8.0	485	1213	1819	7/32	698	1746	2619
9.0	431	1078	1617	15/64	652	1629	2444
10.0	388	970	1455	1/4	611	1528	2292
11.0	353	882	1323	5/16	489	1222	1833
12.0	323	809	1213	3/8	407	1018	1527
14.0	277	693	1039	7/16	349	873	1309
16.0	243	607	910	1/2	306	764	1146
18.0	216	539	808	9/16	272	679	1019
20.0	194	485	728	5/8	244	611	916
22.0	176	441	662	3/4	204	509	764
26.0	149	373	560	7/8	174	436	654
30.0	129	324	485	1	153	382	573
34.0	114	285	428	1, 1/8	136	339	509
38.0	102	255	383	1, 1/4	122	306	459
42.0	93	231	347	1, 3/8	111	278	417
46.0	85	211	317	1, 1/2	102	254	381
50.0	78	194	291	1, 3/4	87	218	327

INTRODUCING FORM TOOLS

Dave Fenner looks at saving time with form tools

Those readers with a background in manufacturing industry will probably be completely conversant with the term, although with the advances in CNC which have occurred over the last twenty to thirty years, the use of form tools has declined somewhat. So what is a form tool? One answer might be "a tool which conveys a mirror image of part of its shape (form) to the workpiece". However, it may also be useful to think about how such tools are used, and here I am thinking primarily about turning work, although certain milling cutters will also come into the category. Form tools were traditionally used on industrial capstan lathes. One of the limitations of these machines was that, unless special attachments were employed, tools would typically be fed either radially into the work, the saddle being held stationary, or along the machine axis to an appropriate stop. Hence whereas a modern CNC machine might guide the tool around the required shape, the older generation machine relied on a form tool to deliver the same result.

An example which some older readers may have seen could be found in model aero engines. Back in the fifties and sixties, my recollection is that some engine manufacturers (e.g. ETA on some of their marks of engine, also Oliver on the Tiger) produced their connecting rods by creating two part spherical ends, these features being carved out by form tools. Fig 1 shows the general idea, whereby two incomplete spheres are generated in just two or three tool movements. The downside to this speed and convenience becomes apparent when you look carefully at the length of tool edge engaged in cutting. Next ask yourself the question, "Would you be able to use a front mounted part off tool having a width equal to this cutting length?" Unless you have a sturdy machine whose slides are really well adjusted, the answer is likely to be "No".

Construction of form tools

Two main categories exist. The first is made by grinding the form on the end of a typical turning tool. Photo 1 shows a typical example intended to produce a fillet radius. One point to remember

is that for tools where the form spans a significant radius, then if the tool is to maintain the accuracy of its form after sharpening, the top face may be ground with zero rake.

A second category of tool is made by turning the form on to a cylindrical blank, which might be several inches in diameter and maybe up to an inch in thickness. Part of the periphery is then cut away to create a cutting edge. The tool then starts to look a little like a single tooth milling cutter, which is mounted with the edge horizontal, and its axis parallel to that of the lathe. The cutter is easily sharpened by grinding just the horizontal face and then remounting to bring this face back to centre height. Going back to the production of model engines, I recall reading in Aeromodeller, of one factory which used a tool of this type to cut all of the cylinder fins in one pass. Another instance from the same product area concerns the making of spray bars. One end typically has a form which includes a taper, over which the fuel pipe is pushed. Amongst the recovered ETA drawings displayed on the internet, is one which suggests that one method used here, was to employ a double form tool which would create two ends in one cut. A part off tool would then separate the two embryo parts.

Simple form tools

Probably the most basic application relates to producing grooves of a particular width. Photo 2 shows a selection of grooving tools purchased as a job lot at a sale just to get the lengths of high speed steel. Photo 3 shows a job, which was passed to me several years ago, to add two grooves to each of several thousand M10 Allen screws. (Also shown in the picture is the home made collet for holding the workpiece for the second operation). The firm who had started the job were using



Photo 1. Form tool for fillet radius.



Photo 2. A selection of grooving tools.

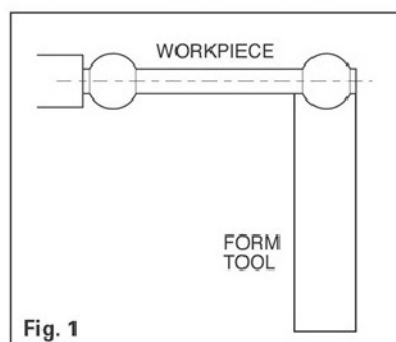


Fig. 1



Photo 3. Allen screw with two grooves and the home made collet.



Photo 4. In production both edges might be engaged to simultaneously chamfer successive workpieces.



Photo 5. Plan view of tool shows corner radius and edge angle.

specially ground carbide tools, where each insert cost around thirty pounds, and achieved only about fifty components per insert. They were to supply the tooling and the materials. It was interesting, that by changing to neat cutting oil, the output was raised to about 300 per insert. A few days later, the idea occurred, of annealing the screws, then machining then re-heat treating. The yield per insert went up to about 3000.

The chamfering tool shown in **photo 4** would normally be used on just one edge. However in a batch production set up, the final two operations might be to feed in the chamfering tool, positioned so that when it is fed in radially, it simultaneously cuts the chamfer on the rear of the near completed part and that on the front of the next component, prior to parting off probably with a rear parting tool. In this type of situation, the chamfering tool might have the tip ground off the vee, to reduce the depth of cut.

Photo 5 shows a home made form tool used on a Herbert 2D capstan lathe. It was made by grinding a generous tip radius on a standard carbide tip, then mounting this at the appropriate angle to cut the stem and underside of a valve. **Photo 6** shows one of the components placed against the tool. In operation, 16mm stainless was

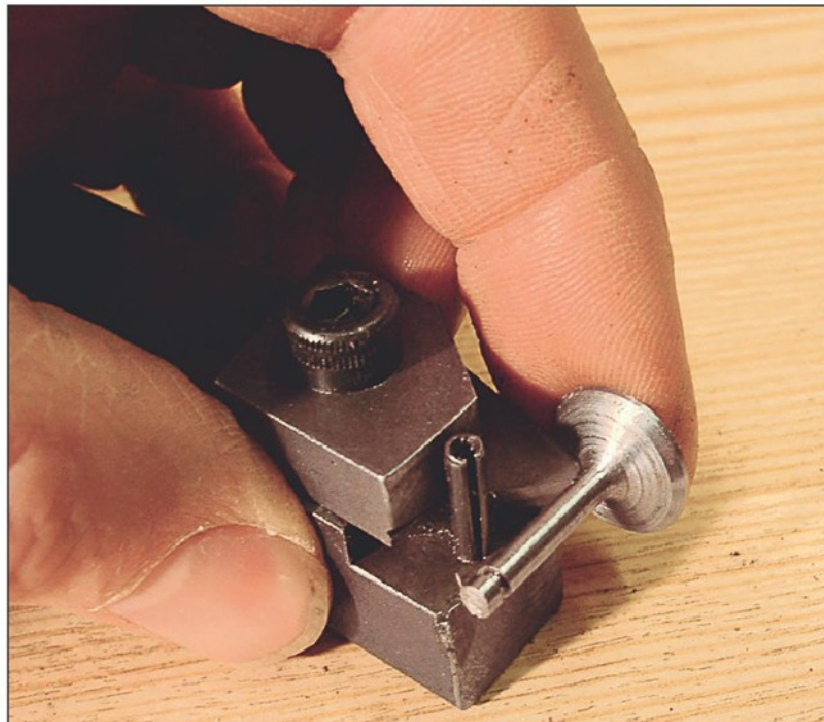


Photo 6. Valve tool with one of the valves.

reduced to the 0.125in. (3.175mm) stem diameter in one pass. This approach meant that the full rigidity of the bar was available and minimal deflection translated to high dimensional accuracy.

Form tools may also be fed in the axial direction and **photo 7** shows a tool which would be applied in this manner to cut a semicircular groove in a component face.

Making Form Tools

If you start with a length of High Speed Steel, then in order to create the form you will have to resort to grinding, although it is possible that water jet or laser cutting might work. On the other hand, gauge plate and silver steel are both easily worked in the unhardened state, after which hardening and tempering is straightforward. **Photo 8** shows a small tool made in gauge plate. It was made originally as an unsuccessful experiment in form turning small spheres but it found a use later turning radiused ridges.

As with any turning tool, the circular part of a spherical form tool requires clearance in order to cut. One method to achieve this is to drill the hole, then open up to size with a taper reamer or cutter such as that in **photo 9** entered from below.

Threading tools

In the amateur workshop, we tend to cut our threads with general purpose Vee tools ground with the correct flank angle, and perhaps a little attention to the nose radius. Industry often uses tool tips which are specific to the thread form being machined, having the correct tip radius. More refined versions cut not only the root but also the correct crest form.

I believe that Harold Hall in one of his articles in "Model Engineers' Workshop" mentioned the use of a tap as a "full form threading tool". A tap held in the toolpost might be used to work on either an internal or external thread.



Photo 7. Tipped tool to work on end face.



Photo 8. Home made form tool in gauge plate.



Photo 9. Although intended for opening up holes in car bodywork, this cutter will produce tapered holes though not in thick material.



Photo 10. A typical Coventry die head, this one a $\frac{3}{4}$ in. size.



Photo 11. Fette FU1 thread rolling head caters for diameters from 6 to 10mm.

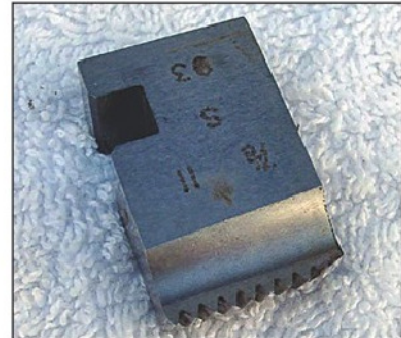


Photo 12. Single Coventry die may be used as from tool for threading.

For high speed threading, two devices popular in industry are the Coventry die head, **photo 10** and the Fette rolling head, **photo 11**. For those not familiar with these, they would typically be fitted to a capstan lathe although it is possible to mount them on centre in a toolpost. For the Coventry head, when the operating lever is moved to the cutting position, the dies are moved radially inwards, so that when fed over the prepared work, the thread is cut in a similar manner to a die. At a predetermined position, the internal mechanism is triggered and the dies move radially outwards allowing the tool to be withdrawn without having to stop and reverse. On Fette heads there are typically two or three hardened rolls which crush the thread form on to the work. Here the movement of the rolls is controlled by eccentric pivots.

For our purposes, it may be useful to think of a single Coventry die, **photo 12** as a basis for a full form thread cutting tool.

Anyone planning to make a Poly Vee drive system for their lathe, may be interested in a piece of advice from John Stevenson (Nottingham). He found that an 11 tpi die worked admirably for cutting grooves for one of the standard belts. Clearly to cut several grooves simultaneously demands a hefty machine, but it should be possible to adapt the technique using an angled topslide, thus cutting on one flank at a time, and indexing along by one pitch to cut the second and subsequent grooves.

Milling Cutter examples

It was mentioned that while form tools are primarily thought of in connection with turning, there are numerous milling cutters which might also be included. **Photos 13 and 14** show examples for cutting internal and external radii, and **photo 15** shows a typical involute gear cutter. ■



Photo 13. Ball nose/internal radius cutters.



Photo 14. Milling cutter for external radius.



Photo 15. Typical involute gear cutter.

THE Sieg Super X1L MILLING MACHINE

David White looks at this entry level machine

When I were a lad (don't ask) I was lucky enough to attend a Technical High School which had an extremely well equipped machine shop. I learnt the rudiments of machining and as I remember got a respectable O Level in metalwork. Over the years I became reasonably proficient in simple sheet metalwork to support my other hobby of electronics but didn't do any more machining.

During the last few years the fashion in casework for audio electronics has shifted away from sheet metalwork towards making cases, or the front panels at least, from 10mm thick aluminium plate. This is obviously no longer sheet metalwork and machine tools are required. Returning to machining after a long period of time entails a degree of caution; you don't want to buy a large, expensive machine and

then discover that you either can't learn the skills or you lose interest.

Which type of machine is it best to buy first, a lathe or a milling machine? I remember reading that a milling machine is the only simple machine tool that can replicate itself so I decided to buy a small milling machine. There are relatively few low cost small milling machines; the Sherline, the Peatol/Taig, and the Sieg X1. The first two machines are usually sold as sets of components that you mix and match and then put together yourself. By the time that you've bought enough components to make a complete machine the Sherline and Peatol turn out to be more expensive than the Sieg machine. The DIY aspect is also a bit off-putting to a nearly rank beginner as well so I settled on a Sieg X1 which seemed to be a plug in and go proposition.

The Machine

The Sieg X1 is available from at least four suppliers in the UK, but as far as I am aware Arc Euro Trade is the only one that sells the Super X1L version with the long table and extended XY travel as standard. They were also the cheapest supplier. Arc offer their machines either "out of the box" or "prepared". As far as I am able to discover pretty much every Chinese made

machine tool the hobbyist is likely to come across requires a complete strip down and clean up to remove casting sand, cast iron dust, and any other nasties as well as a thorough check to ensure that everything is flat, parallel, sliding, and assembled correctly. This has certainly been my own experience. You can use the machine straight out of the box in many cases, but don't expect either long life or any degree of precision from the machine if you do this.

At this stage of the game I wasn't confident enough to disassemble, clean, check, and reassemble the machine myself so I paid Arc to do it for me and bought a "prepared" machine. Subsequent

experience showed me that this was well worth the money. Incidentally Arc leave an inadvertent witness mark that they have really done the work in the depths of your machine. Arc are in love with Copaslip antiseize grease and cover pretty much everything with it during reassembly of your machine. When you gain enough confidence to disassemble the machine yourself you will find copious amounts of Copaslip everywhere.

Specification

The manufacturer's specification of the Sieg X1L is given below:-

- Overall Dimensions 360x425x585mm
- Weight (Net/Gross) 40kg/56kg
- Table Cross Travel 145mm
- Table Size 400x145mm
- Table Longitudinal Travel 330mm
- Effective Table Size 400x145mm
- T-Slot Size 8mm (M6 T-Nuts)
- Column Tilt $\pm 90^\circ$ deg.
- Drilling Capacity 10mm
- End Milling Capacity 12mm
- Face Milling Capacity 30mm
- Throat 140mm
- Headstock Travel 235mm
- Spindle to Table Distance 0-265mm
- Spindle Stroke 30mm
- Spindle Taper MT2
- Motor Output 150w DC
- Spindle Speed (Variable) High gear 0-2000 rpm $\pm 10\%$
- Low gear 0-1000 rpm $\pm 10\%$
- Standard Equipment: Drawbar, 10mm Drill Chuck and Arbor

Notice that this is the specification for the metric machine, although an imperial version is also available. Only the various leadscrews are different between the two versions. All of the subsequent discussion relates to the metric machine. As you can see, the machine has a decent sized work envelope, a standard MT2 spindle taper giving access to a wide range of tooling, and a low enough weight so that it is easily manhandled onto the workbench by one person.

Photo 1 is of the machine.

If you research the Sieg X1 on the internet you will find that it is a popular beginners machine which is capable of "real" work, indeed some of the examples of work produced are little short of amazing - to me at least. My own experience of the machine is that you can do an awful lot with it, but slowly! You aren't ever going to be able to take 2mm deep roughing cuts at 20mm/sec feed rates but with a degree of patience a lot can be achieved. Let's now consider the various parts of the machine in a bit more detail.

The motor and drive train follows common Chinese practice by using a variable speed dc motor followed by a two speed geared drive to the spindle. The motor is a 150W 180Vdc permanent magnet type with mechanical commutation via carbon brushes. The motor is in general well made with decent bearings and replaceable brushes. The placing and shielding of the brushes is a weak point in the motor in that it is not unknown for carbon dust from the brushes to fall into the motor wiring and short it out. If you're lucky a new set of brushes will cure the problem, if not then you will also require a new pair of mosfets for the motor drive circuitry. I would recommend removing the brushes, one at a time, and using a vacuum cleaner to suck out any



Photo 1. Overall view of the super X1L.

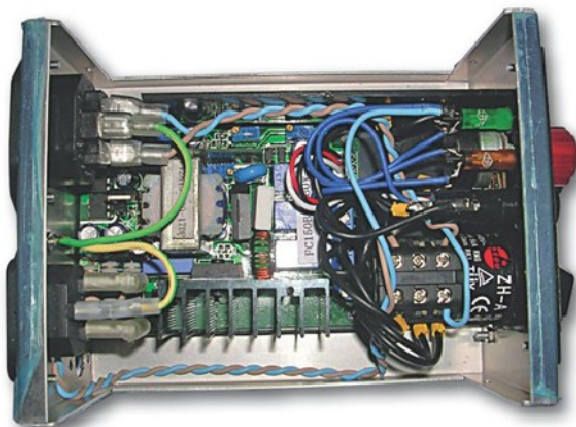


Photo 2. Motor controller pcb.

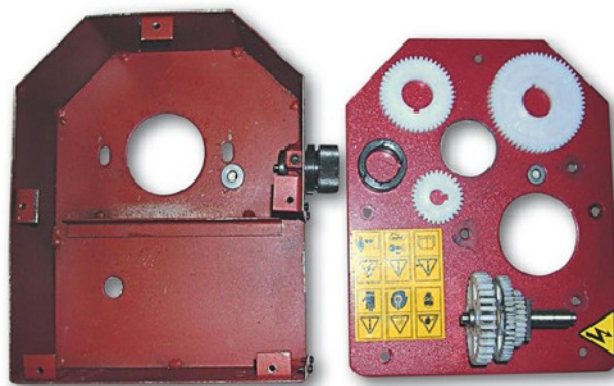


Photo 3. Disassembled gearbox.

lurking carbon dust once every six months or so. This also enables you to check the condition of the brushes to see if they need replacement. The motor drive circuitry is of the PWM (pulse width modulation) variety with voltage and current feedback to ensure that the motor speed remains substantially constant under varying load. I must admit to a preference for PWM controllers over the thyristor type because they result in a smoother running motor. The motor controller PCB is shown in **photo 2**.

Beginner abuse

For the majority of the time the details of the motor control circuitry are academic, but in the event of a really over ambitious cut or mistake resulting in serious tool dig-in then a thyristor controller is more likely to survive the event than its PWM counterpart. Having said that, my own experience is that the motor and controller will survive most events of beginner abuse.

The motor drives the spindle through a two speed gearbox composed of tough plastic gears. The plastic gears mean that the gearbox is pretty quiet in operation, but obviously not as robust as metal gears would be. This is in fact a deliberate design feature. In the event of a really serious tool dig in the small plastic gear wheel on the motor shaft is intended to shear off thereby protecting the motor and its drive circuitry. Most of the time it appears this is exactly what happens. The sacrificial motor gear is cheap and easy to replace. **Photo 3** shows the components of a disassembled gearbox.

Having said all of this I must say that I have never managed to strip the motor gears or blow any mosfets despite having been guilty of some fairly serious abuses. Overall, my impression is that the motor and gearbox are fairly robust and will last for quite a while if treated with even a modicum of respect.

The motor and gearbox are fixed to the top of the spindle housing and move up and down with it when either the coarse down feed handle, primarily for drilling, or the or fine down feed, for milling, are operated. The spindle is bored for a MT2 Morse taper and is supported by two fairly substantial ball bearings. The X1 is supplied with an M10 metric drawbar which fits down the centre of the spindle and is used to draw in and remove MT2 tooling. When I bought my machine Arc used to modify the top of the spindle so that the drawbar was captive, as shown in **photo 4**.

When you unscrew the drawbar from the tooling it jacks the tooling out of the spindle because the cap prevents the waisted drawbar from leaving the spindle bore. This means that no matter how tightly the tooling is fitted into the spindle it is always easy to remove. Without the captive fitting it is necessary to unscrew the drawbar slightly and give the top a sharp tap with a hammer to remove the tooling. If you overtighten the drawbar, a serious bang or other drastic measure, rather than a sharp tap with a hammer may be necessary to free the tooling. I dislike the idea of hitting machine tools with a hammer and am therefore a big

fan of captive drawbars. Unfortunately Arc no longer makes this modification to their machines.

Coarse feed

There are two means of controlling the spindle down feed; a lever for coarse motion and a handwheel for fine feed. Selection between the two options is made by depressing (fine) or pulling out (coarse) a clutch knob. Both the lever and handwheel have indexable dials. The graduations are 30x1mm for coarse feed and 40x0.05mm for fine feed. The indexable dial for the coarse feed also serves as a depth stop. In general these arrangements work quite well although the indexable dial for the fine feed handwheel is a bit difficult to see and set to zero. There is a fair amount of backlash in the fine feed arrangement but this is of no consequence because cutting is always in one direction only. A long socket head cap screw passing through a vertical slit in the headstock serves as a spindle lock. I have not found this to be very effective; even when the screw is tightened right up it is still possible to move the spindle. I must admit too that I'm worried continual use of this arrangement will crack the cast iron headstock. The headstock assembly is shown in **photo 5**.

The headstock, gearbox, electronics, and motor assembly move up and down on dovetails cut into the column by means of a leadscrew and ungraduated handwheel. There is a small pointer attached to the headstock, which in conjunction with a ruler stuck to the column, gives a rough



Photo 4. Captive drawbar nut.

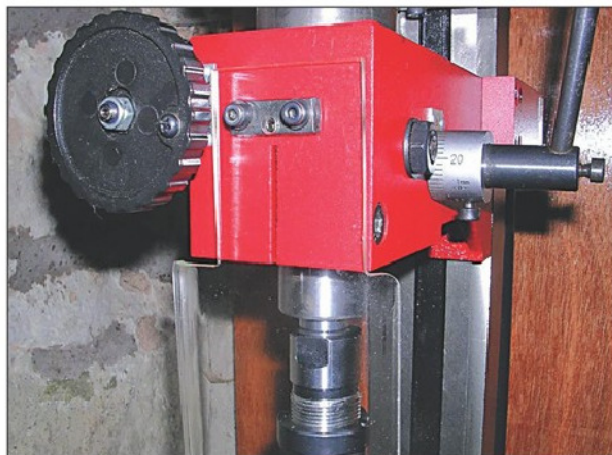


Photo 5. Headstock assembly.





Photo 6. Z axis gib strip.

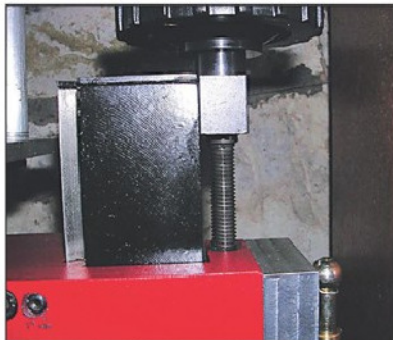


Photo 7. Z axis height adjustment.

indication of height. The dovetails have adjustable gib strips and an indexable lever for locking the headstock in position. The gib strip is unpolished and fairly crudely made from steel as shown in **photo 6**.

The headstock is not counterbalanced so winding the headstock down is easy but winding it back up again requires a lot more effort. There is a fair amount of backlash in this arrangement so if one were to convert the mill to CNC some improvements would need to be made in the vertical positioning. For manual use the overall height adjustment system is quite usable. Height adjuster detail is shown in **photo 7**.

The column can be adjusted by $\pm 90^\circ$ on either side of the vertical by loosening and retightening four bolts. Quite frankly it's not worth the effort as the column needs to be laboriously retrimmed back to exact verticality every time the column is used in the tilted position. It's much easier to tilt the workpiece than the column and no subsequent adjustment is required. The

column is fitted to the base by means of four recessed socket head cap screws, **photo 8**. The X1L will machine most materials satisfactorily but a very small depth of cut is necessary with hard steels.

The base, saddle, and table of the Super X1L are all machined from cast iron and most of the non-moving or non-mating surfaces are painted bright red. The table has three 8mm T slots. The X and Y leadscrews have a 2mm pitch and are driven by indexable handwheels, each with 80 x 0.025mm graduations. The leadscrews are not supported at the far end and run in simple cast iron sleeve bearings. There are no thrust bearings on any axis. The X and Y leadscrew assemblies are shown in **photos 9 and 10** where you can see the simple backlash adjustment mechanism on each cast iron leadscrew nut.

Each axis runs on dovetail slides with adjustable gib strips similar to those for the Z axis. The axes are locked by means of a socket head cap screw bearing on the centre of the gib strip. The backlash on my machine was quite small averaging around 0.06mm on each axis. The backlash can be reduced by tightening the locknut which retains the handwheel on the leadscrew; however this makes the handwheel more difficult to turn. It is therefore necessary to accept a compromise between low backlash and ease of rotation. Similar considerations apply to the tightness of the gib strips.

Photo 11 shows the component parts of the base, saddle, and table assembly.

You also get a drill chuck and arbor as well as a set of spanners, wrenches, and keys for adjusting and servicing the machine; the only obvious omission being a c-spanner for setting the spindle bearing preload. There are no vices, clamps, cutting tools or tool holders included with the machine so these must be purchased separately.

Essential tools

Opinions will vary slightly as to the details of what is essential and what can be left for later. However tool holders, cutting

tools, and clamping devices, of one form or another, are essential accessories.

For tool holding the choice is usually between end mill holders with integral MT2 taper shanks or a set of ER collets and an MT2 milling collet chuck. Most metric milling cutters will have 6, 10, or 12mm shanks regardless of the actual cutting size, so a set of three end mill holders for these sizes will cover most eventualities. This is the cheapest but least flexible option. Sooner or later you're going to want to grip something with a diameter other than 6, 10, or 12mm. The other thing to bear in mind if you have a mini lathe is that ER collets will fit into readily available lathe collet chucks whereas MT2 end mill holders will not fit into the MT3 spindle of the mini lathe.

The runout of an ER collet system will invariably be smaller than that of an end mill holder. The price of an MT2 milling collet chuck and a set of 6, 10, and 12mm collets is only marginally more than that of a set of end mill holders, and you can buy extra collets for a lot less than the cost of an extra end mill holder. Buying a set of ER collets individually is about twice the price of buying a complete boxed set; the downside is that you have to pay in advance for collets you may not get around to using for a while. What is the best size of ER collet system to use with the Sieg X1? I would suggest either ER20 or ER25. The latter is probably preferable because it's a popular size which means more accessories, more suppliers and lower prices. I discovered this after investing in ER20 collets! **Photo 12** shows my individually assembled collection in a homemade wooden box.

Cutting tools are much more of an individual preference. For everyday use I prefer the HSS TiN coated four flute end mills from Arc as shown in the **photo 13**.

Admittedly these don't last long when cutting steel, or anything harder, but they're sufficiently cheap that you don't feel too aggrieved chucking them away after a few uses.

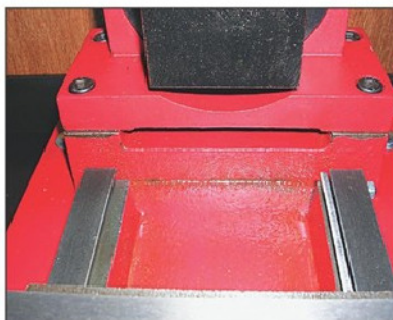


Photo 8. Base to column attachment.

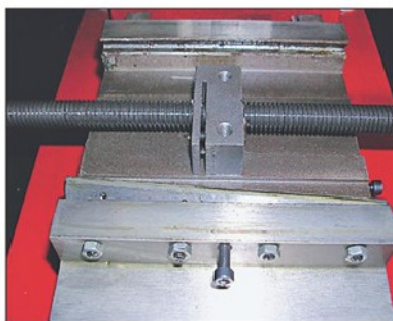


Photo 9. X axis leadscrew and nut.



Photo 10. Y axis leadscrew and nut.

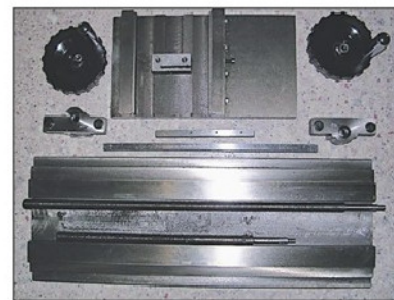


Photo 11. Disassembled base, saddle, and table.



Photo 12. ER20 collet set.



Photo 13. TiN coated HSS 4-flute end mills.

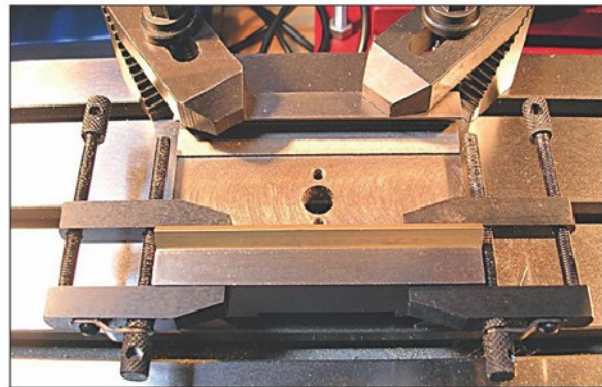


Photo 14. Use of strap clamps.

If you want a fine surface on a large area, then either a fly cutter or face mill is the only way to go. I personally prefer a large diameter face mill but I'm sure that fly cutters are just as good, and probably cheaper. In the context of the X1 a "large diameter" face mill means not more than 30mm or so. Whichever you use, only remove very small amounts of material, say a 0.1mm depth of cut, at a time. If you get too ambitious the cutter will dig in and probably strip the motor gear or worse.

You can fix workpieces to the milling table with T nuts, studding, and strap clamps, or you can use a milling vice, or a combination of both. In reality it is not an either/or situation; you really need both.

Photo 14 shows a situation that would be difficult to handle with a vice and photo 15 shows one where strap clamps would be of marginal use.

The T slots on the X1L are quite narrow at 8mm wide and the T nuts have an M6 thread. These small T nuts and accessories are not as widely available as the larger sizes. This is unfortunate because the popular 52 piece clamping sets widely available for the 10mm and up T slots do not appear to extend down to the 8mm T slots. However, Sieg make a 24 piece set which is available from the usual importers. The set comes shrink wrapped inside a cardboard box. For convenience I made a wooden box to house mine and the set is shown in photo 16.

Milling vices are things that most people find out about from bitter experience. Frequently beginners start out with a low cost drilling vice, only to find that the jaws

are not flat or square and lift the workpiece when tightened. These vices can be modified to make them suitable for milling use and such projects have been described in MEW. There are quite a number of milling vices available which are satisfactory in every other way apart from the question of jaw lift, which tilts the workpiece a fraction as the jaws are tightened. Some quite expensive vices suffer from this problem, including the one I bought. Judicious taps with a nylon or rubber hammer as the jaws are being tightened will seat the workpiece properly but this is a real nuisance. Regular style milling vices where the jaws exert downwards as well as linear pressure are available but tend to be more expensive than straightforward types.

Toolmakers precision vices exert both linear and downward pressure on the workpiece at the expense of marginally less convenience in use. A typical example is shown in photo 17. In use the vice is clamped to the table using the circular holes or slots in the sides and ends. The cap head clamping screw is loosened off, the jaw moved up to the workpiece, the round bar underneath the clamping screw located in the nearest channel underneath the jaws and the clamping screw is tightened up. The fixtures necessary to attach the vice to the table are not usually included and must often be made by the user. This type of vice earns its keep with beginner and experienced user alike. The only minor snag was that, until very recently, these vices were only obtainable in the UK at very high prices. Now at least one or two importers stock them at

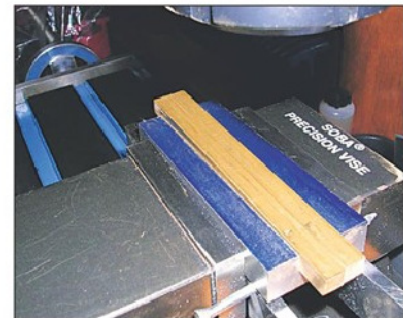


Photo 15. Use of milling vice.

sensible prices and the lowest price seems to be from Arc. I would suggest that either the 50mm or 80mm wide jaws would be best for the X1L.

Conclusions

I am not a professional engineer, nor have I had extensive experience of machining. Bodger third class (self taught) would probably be a fair description, but nonetheless I have been able to make reasonably precise parts with the Sieg X1L without any major disasters. I think that this is more a testament to the robustness of this nice little machine rather than my engineering skills! It's a useful little machine, even straight out of the box, and well worth the modest cost of £265 as is or £350 prepared. If, like me, you can't leave well enough alone, the Super X1L offers enormous scope for further adventures. Following articles chronicle how I scratched the itch! ■

Super X1L Supplier

Arc Eurotrade
www.arceurotrade.co.uk
Tel: 0116 269 5693

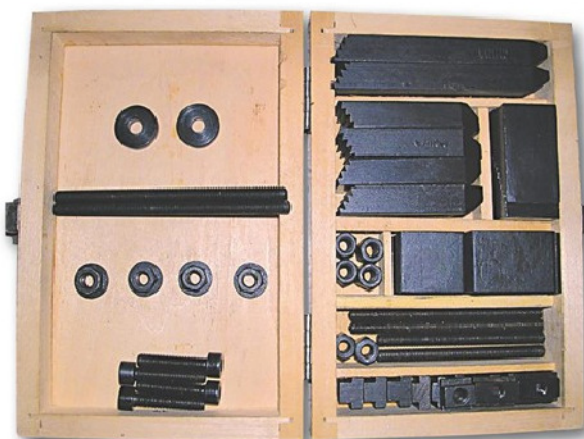


Photo 16. Clamping set.

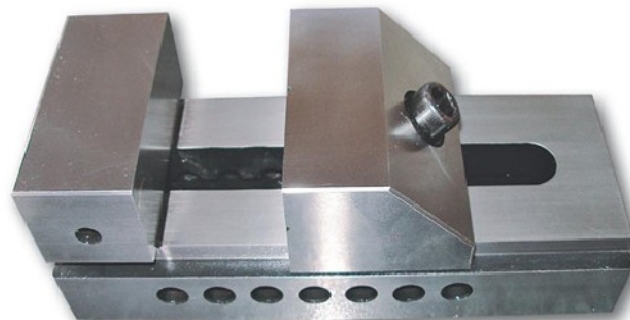


Photo 17. Toolmakers vice.

A DIGITAL FACELIFT FOR A WARCO MILL

Bob Davis fits a Z axis readout

At the recent Ascot exhibition an offer on a trade stand of a short vertical reading digital scale prompted the thought that it was time to do something to improve my old Warco mill drill. It is a sturdy, useful machine but with some drawbacks like the circular vertical column which cannot be raised or lowered without loss of setting. These foibles I had grown used to but what always offended was the cheap and nasty looking vertical scale, **photo 1**.

Behind the slotted scale plate is an adjusting screw carrying a block to which the indicator is fixed by a single screw, **photo 2**. It occurred to me that if this was

replaced by a pin which engaged in the back of the digital reader we should be in business. A new lengthened slotted plate was made using the original to spot through the mounting holes.

It was clear that the brackets supplied were going to take up too much space within the plastic housing recess where I aimed to mount the unit. After trimming them down and drilling the tapped holes to clear an M3 thread, they took up a lot less space as well as looking neater. Four 3mm standoff collars were made from aluminium rod to give clearance to the back of the readout, **photo 3**. I had been advised when purchasing the readout that it was possible to shorten the digital bar. It is tough material to cut but a micro drill with a diamond saw blade and some patience did the trick.

The diecast threaded block was a trifle slack on the screw so I tapped right through and inserted a short socket headed grub screw to bear on a piece of plastic cable insulation biting into the main thread to steady things up, **photo 4**. On assembly do not lock it tight. Leave it sufficiently free so that final raising or lowering of the readout head can be achieved by turning the large knurled nut at the bottom. Into this same tapped hole is screwed a new pin that projects through the front plate into one of the rear holes of the readout, **photo 5**. There are six holes tapped M3 in the back of the readout. Only one of the two centre holes is used. Turn down the diameter of the outer end of the pin to a close fit in a hole. It does not need to be threaded.

The actual length of pin projection can be determined on assembly. All that is

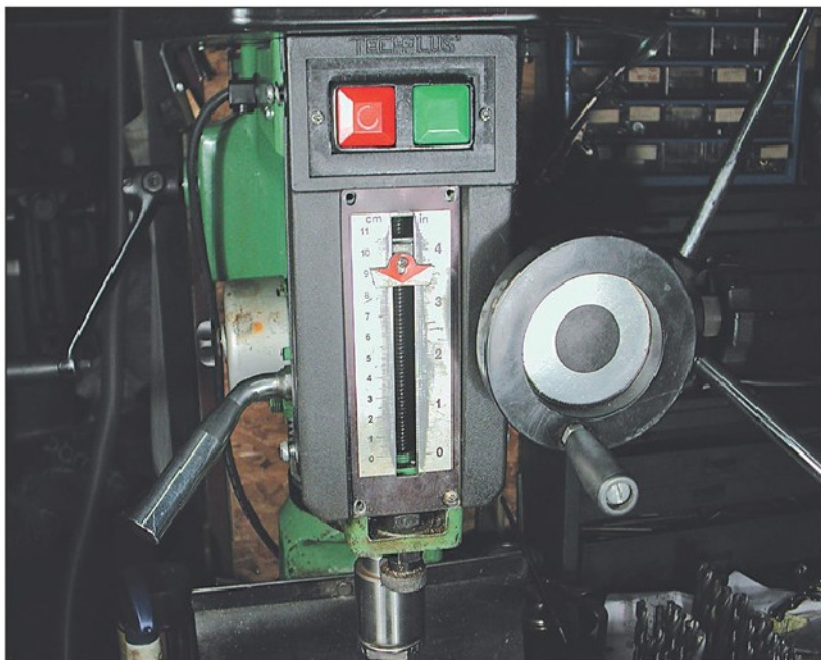


Photo 1. The original scale.



Photo 2. The scale block.

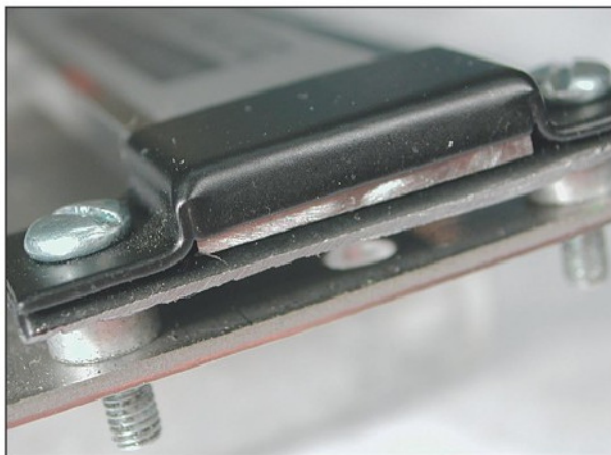


Photo 3. I used standoffs for clearance.



Photo 4. Fitting the grub screw.



needed is for it to engage into the back of the readout so as not to bind. Another method which may be preferred is to screw the pin into the back of the readout so as to pass through the plate from the front into the block.

For the final assembly it was found easier to move the pin block down near to the bottom of its travel leaving the plate fixing screws at the top loose. This will allow it to swing out and clear the pin whilst finding the hole in the back of the readout.

Keen eyed readers may notice that in the final photograph, one of the top screws is missing. It fell out during assembly but was found later on the floor luckily, **photo 6**.

For a job of this sort dimensioned sketches are of little use but one suggestion may be. The original scale plate is 162 mm. long. I made mine 190 mm. to accommodate the readout. This could be reduced to 175 mm. and still be in the comfort zone. The readout bar would need also to be reduced by the same amount. ■



Photo 5. The drive pin.



Photo 6. The finished article.

A REPLACEMENT QUILL LOCKING HANDLE FOR THE HOBBYMAT MILL

John Noakes makes a simple accessory

Locking the vertical movement of the quill on the Hobbymat mill was originally done with a socket cap head screw. While this is simple, it is not very convenient as locating the key can be fiddly and the key has to be removed after adjustment. I should do something about this and have tried various ideas that for one reason or another were not practical. I must have done some lateral thinking and this is the result shown in **photo 1**.

There is nothing critical about the outer shape except that it will fit in the space surrounding the screw. The material is steel that has been chemically blackened, mainly for appearance. The long arm of the Allen key has been shortened and a plastic ball press fitted to make the key easier to use. **Photo 2** gives an idea of the size of the various parts of the handle.

The handle is made from a piece of steel bar of suitable 16mm diameter, an Allen key and a small plastic ball. Drill a hole right through the piece of bar to suit the outer diameter of the M6 Allen key such that the key is a close fit in the hole. Then open out this hole at one end of the bar by milling a flat bottomed recess to fit the cap of the screw so that the screw seating face is just proud of the fitting.

The cap head is Loctited into its recess in my handle but other ways such as pressing the bar onto the screw's cap might be preferred. The angular relationship between the cap head screw and the key depends upon the position of

the Allen key when the quill is locked. This can only be found by trial and error.

I have not found it necessary to have any extra securing arrangement to prevent the Allen key falling out but it would be possible to fit a grub screw through the side of the bar if the key is too loose. I could not use a permanent method to fix the Allen key because that would make it impossible to completely remove the cap head screw from the mill. The key cannot make a full turn as it is stopped by the body of the milling head.

The X and Y table movements are also locked by cap head screws and it is my intention to make similar handles to replace these screws. ■

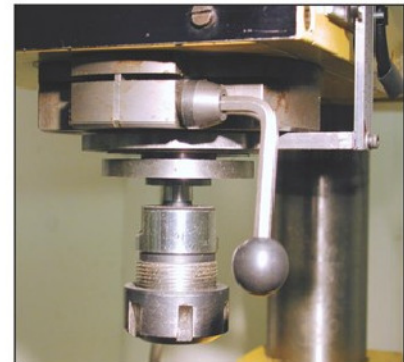


Photo 1. The handle in use.

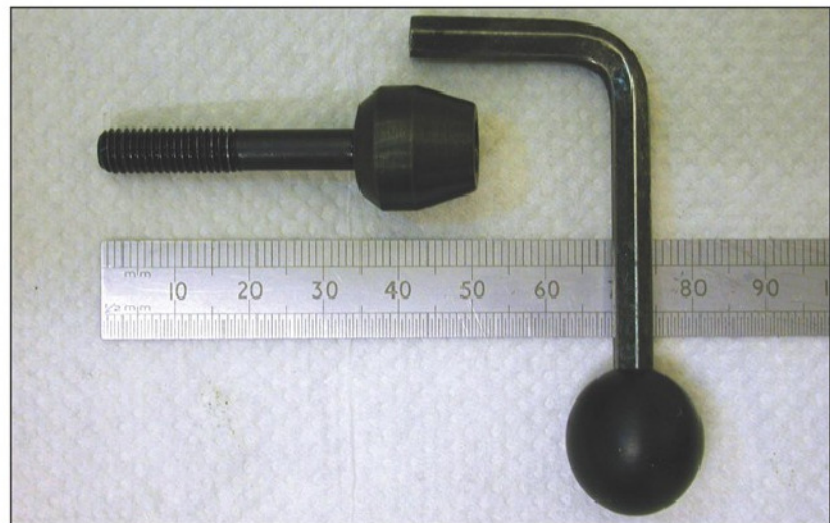


Photo 2. The component parts.

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MODEL ENGINEERS' WORKSHOP

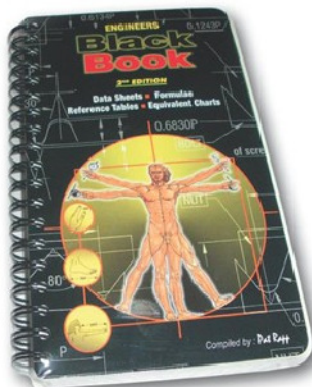
Readers' Survey 2009

It is a few years since a readers' survey was done so I have included one in this issue of *Model Engineers' Workshop*.

It is a comprehensive survey and the results should enable me to plan for the future. I would like every reader to fill in the survey and send it back. Help me to help you. If I know the sort of articles you like, I can try to include more of them in the magazine.

For UK readers I have purchased several good prizes to be given to readers who respond. There is a 0 to 4 in. micrometer set complete with setting standards. A 10 pair parallel set, a pair of toolmaker's 3, 2, 1, blocks and a set of drills from 1mm to 5.9 millimetres.

I also have some copies of the MSC/J&L Little Black Book, which is an advanced version of the well known Zeus book. One copy will be for the UK respondents and four copies will go to overseas respondents. If you want to win one of these great prizes, remember to fill in your name and address. The prizes will be awarded by picking surveys at random. The editor's decision on winners is final.



J&L Industrial Supply UK has become MSC/J&L Industrial Supply

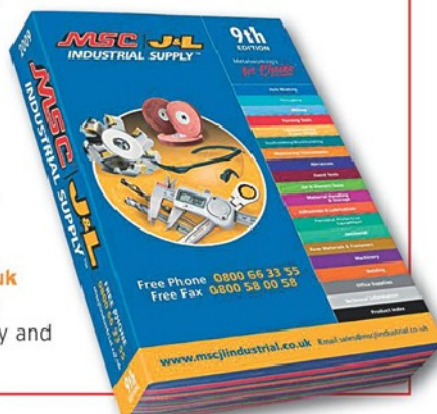
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MAKING A NEW TAILSTOCK BARREL

Dyson Watkins
replaces a worn
out component

The condition of the tailstock on my Super Seven lathe has given me grief ever since I bought the machine about eight years ago. My first priority was to send the machine to Myford for a bed regrind, only to find that the saddle was past refurbishment and needed to be replaced. Needless to say, the machine has been excellent since Myford carried out the work. I put up with the sloppy tailstock until I felt that I had to do something to put matters right. I was loathe to send the complete tailstock for repair and so I decided to give it a thorough check over to ascertain whether there was a means of sorting it out myself.

Worse for wear

After stripping it down, measurements were taken along the barrel and I found that the wear was worse towards the middle. The total slop in the worst case (vertically) was in the region of 0.03in. On checking the body, there was little damage, the only discernible wear being at the mouth, and quite close to the edge. This would appear to be quite understandable because this would be the point of contact where the load would be greatest. I turned up a short plug gauge and tried the fit along the inside of the bore and was pleased to find that this was the case. I decided therefore to make a replacement barrel. This meant that the

existing tailstock barrel would have to be pressed into use before ending up in the scrap bin, **Fig. 1**.

The replacement barrel's finished diameter in my case needed to be 1.1145in., so a length of 1½in. diameter bright mild steel was cut to length plus 0.5in. or so for gripping in the chuck. The extra 0.5in. length meant that the whole finished length could be turned. The free end needs to be faced and centred, and the fixed steady needs to be used for support. The best method for setting up the steady is to initially grip the headstock end of the bar in the four jaw chuck. Clock up the free end of the bar and adjust to get it running true. Fix the steady in place with the fingers drawn back. Next press the fingers carefully against the bar taking care not to push the bar out of position. Tighten the fingers. With the dial indicator still in position, press the bar to check that the steady is securely supported and no deflection can be detected. Finally check that the headstock end of the bar runs true using the dial indicator **photo 2**. Centre drill the end, **photo 3** followed by facing and chamfering the end. The majority of the waste is now drilled away using a series of drills successively, **photo 4**.

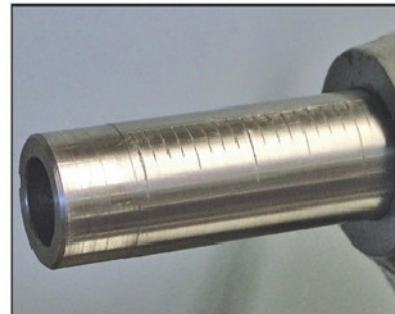


Photo 1. The new tailstock barrel.

Reaming the bore

The roughing reamer is used next, **photo 5**. **Photo 6** shows the roughing and finishing reamers. Determine how far the reamer has to be fed into the bore by pushing it gently into the old tailstock bore and making a reference mark on it using a felt pen. Do the same thing with the finishing reamer. Now ream the bore to depth and lightly chamfer the bore. Next drill the clearance hole down the centre to ⅝in. diameter. The next step is to turn the outside diameter. Clean



Photo 2. Clocking the end of the bar.

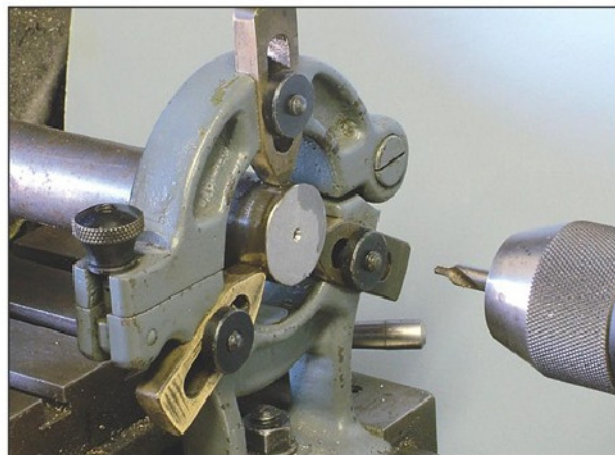
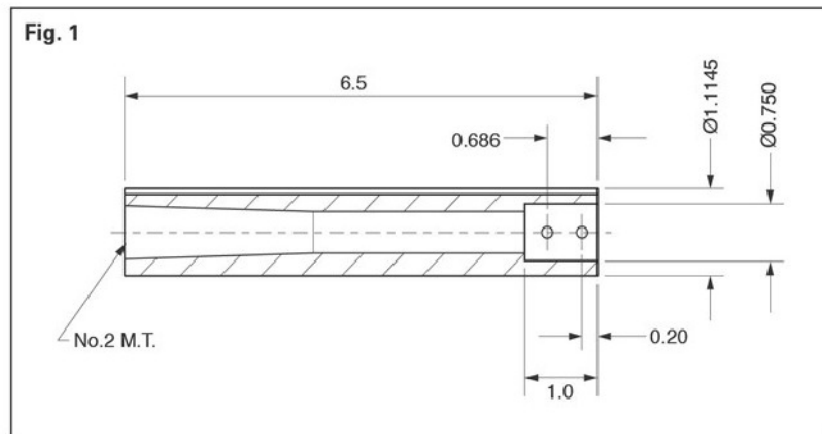


Photo 3. Centre drilling the end of the bar using the fixed steady.

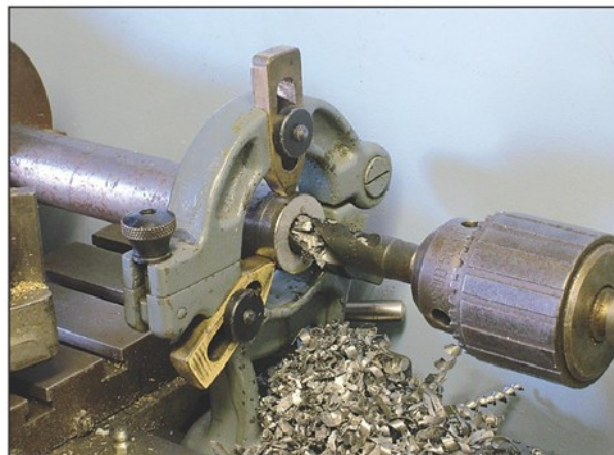


Photo 4. Drilling away the waste material.



the taper bores of both the old and the replacement barrels. Using a 1 - 2 Morse taper adaptor sleeve in good condition, insert it firmly into the tailstock barrel and then fit a centre into the end of the new barrel. I used a rotating centre for this. A solid centre should be fine, just make sure that it is well lubricated, **photo 7**.

Set the tailstock to turn parallel, once again using the dial indicator. Take a very light cut along the bar and check the diameter at each end. Adjust until the bar

is truly parallel and turn close to the finished diameter. Test the fit. Do this by removing the old barrel from the tailstock and sliding the tailstock to engage with the new one, **photo 8**. I found that there was a slight sticking when the barrel was almost fully engaged and decided to remove the tightness using some fine 'wet and dry' abrasive paper. Reverse the work in the chuck, and set up the steady as before. The work is now faced off to its finished length and chamfered. Bore to accept the threaded insert. This bore is

1.0in. deep and 0.750in. dia. The bore does need to provide a good fit with the insert, although the insert is secured by two grub screws.

To cut the keyway, the work was set up on a vertical slide on the Myford. It is important to set up the vice with the work mounted. Doing it this way, and squaring up the vice by clocking the work will be more accurate due to the overhang of the workpiece on both sides of the vice, **photos 9 & 10**. The keyway is 0.125in. wide and 0.070in. deep, **photo 11**.

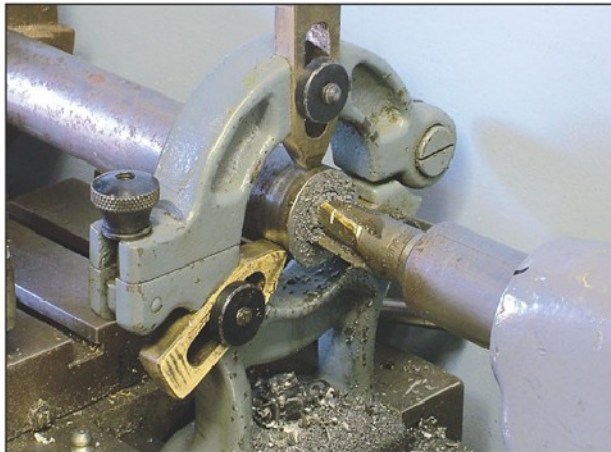


Photo 5. The internal taper is finished with roughing and finishing reamers.

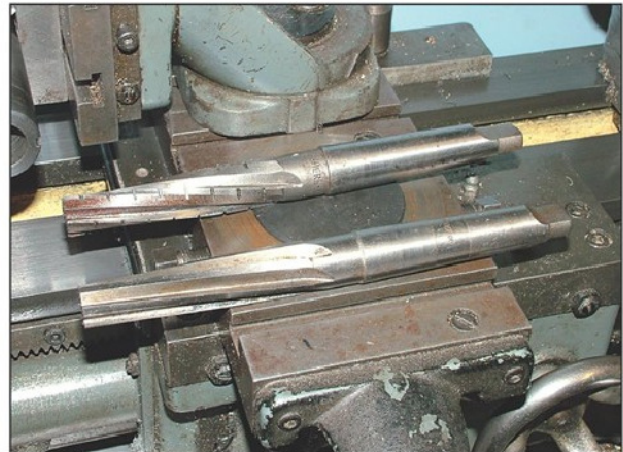


Photo 6. Using the roughing reamer.

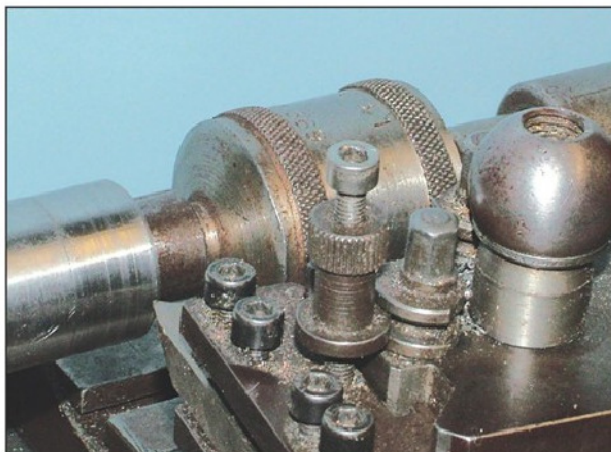


Photo 7. Support the new tailstock using a running centre. Note centre is in the new tailstock barrel and is running in the centre of the old barrel.

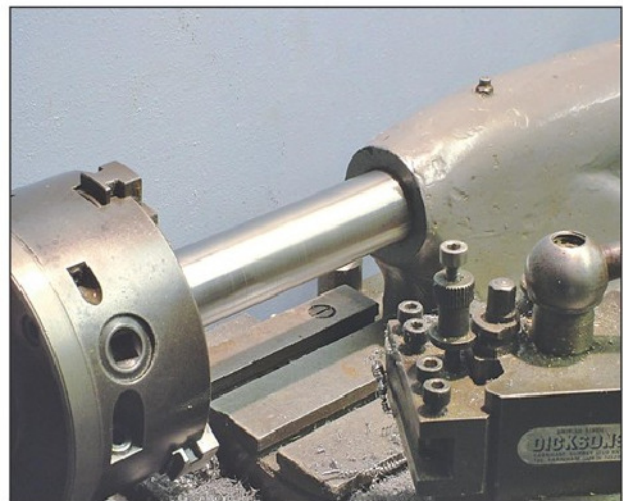


Photo 8. Testing the new barrel for fit.

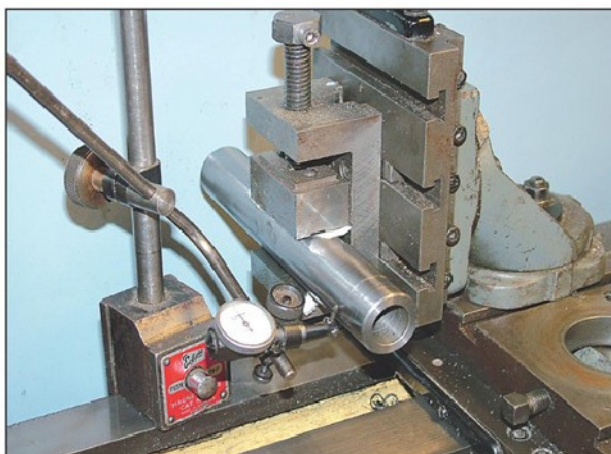


Photo 9. Clocking the new barrel parallel.

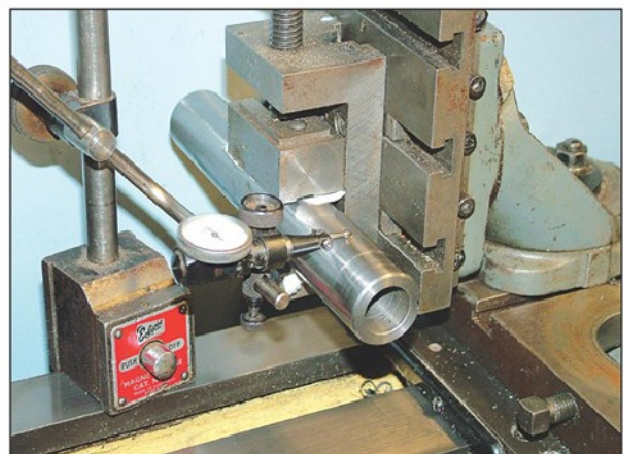


Photo 10. Clocking the new barrel horizontal.



Photo 11. Milling the new keyway.

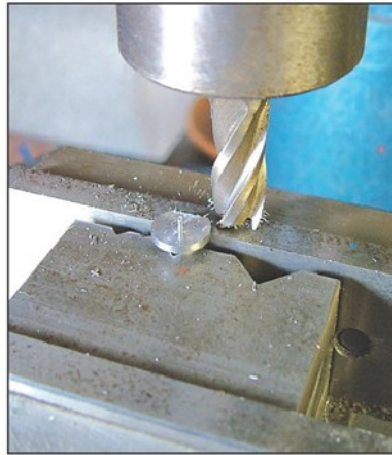


Photo 12. Milling the first side of the key.

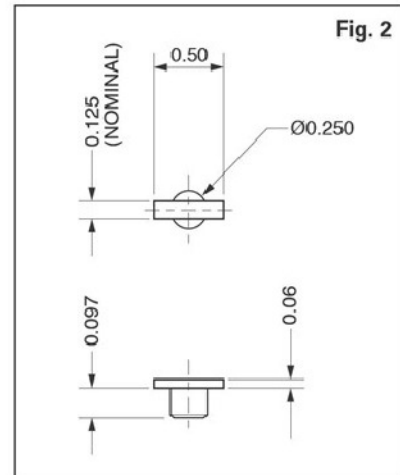


Fig. 2

The key to accuracy

It is worth making a new key which engages with the $\frac{1}{8}$ in. keyway if there is an appreciable amount of rotational slop, Fig. 2. The original key in my case had worn down to half its original width. This is made from $\frac{1}{2}$ in. diameter mild steel bar. Mount in the three-jaw chuck and turn a short length to clean up. Turn down to $\frac{1}{8}$ in. diameter for a length of about 0.75in. Part off to leave a flange of 0.060in. wide by $\frac{7}{8}$ in. diameter. (At this point in time, I purchased a milling machine and the work of milling the edges of the key was duly transferred to the mill. It could be completed on the Myford milling slide.) Mount in the vice. It is a good idea to seat the $\frac{1}{8}$ in. diameter shank in a small vee to prevent it slewing away from the cutter

when milling, or alternatively hold it in a three jaw chuck clamped to the bed of the mill. Now mill one edge of the flange to leave the remainder $\frac{1}{8}$ in. wide, photo 12. Next, from the other side, remove enough to leave a key thickness of $\frac{1}{8}$ in. nominal width, photo 13. Check its fit in the $\frac{1}{8}$ in. keyway before removing it from the vice. It is worth mentioning that sideways slop in the fit of this key combined with wear causing backlash in the thread insert formed a major cause of snatch with consequent damage to tooling mounted in the tailstock.

The engraving

I decided to engrave the scale along the side of the barrel starting further away from the front end because I have reduced the outside diameter to accommodate another accessory, and it was felt that a standard size would be useful for attachments to fit onto. The engraving was carried out using a Radford pattern of dividing head coupled to the headstock bull wheel. One end of the mandrel was held in the headstock, and the other supported in the mouth of the tailstock body, photo 14. The scale was kept at 2 in. long and was graduated in $\frac{1}{8}$ in. divisions, although I was very tempted to carry out the work in $\frac{1}{16}$ in. I rarely use fractions these days, preferring to work either in decimal Imperial, or metric. The tool point needs to be ground to about 35deg. and should not have any top rake. The reason

for this is that when it is being wound out of a cut, if it happens to have a positive rake, the tip will tend to break off. This is very frustrating because resetting has to be carried out following a regrind, and great care is needed to ensure that tool position is regained. Photo 15 shows the engraving underway. The lengths of the lines need to be calculated, there being three different line lengths. I decided to use 0.5in. for the zero and inch positions, 0.375in. for the half inch marks and for the $\frac{1}{8}$ in. marks I used 0.25in. These do not need to be absolutely exact as long as they are consistent. The easiest way to calculate them is as follows.

The barrel is roughly 1in. dia. which means that the circumference will be 3.14in length.

Taking the shortest lines first, divide 3.14 by 0.25 and we end up with 12.5. We can take this as 12.

The dividing head ratio is 60:1. Therefore $\frac{60}{12} = 5$. This simply means that we turn the dividing head handle five turns to engrave a line of about 0.25in. in length. For the $\frac{1}{2}$ in. lines, simply turn the handle twice as much. For the $\frac{3}{8}$ in. lines the number of turns will be 7½.

To get the positions along the mandrel, engage the leadscrew, and advance by one turn between each. The original mandrel is engraved over a length of 2½in. All that now remains to be done is to carefully remove the small burrs thrown up by the engraving tool and the job is done. ■

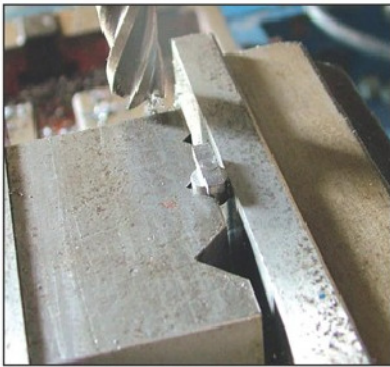


Photo 13. The key finish milled.

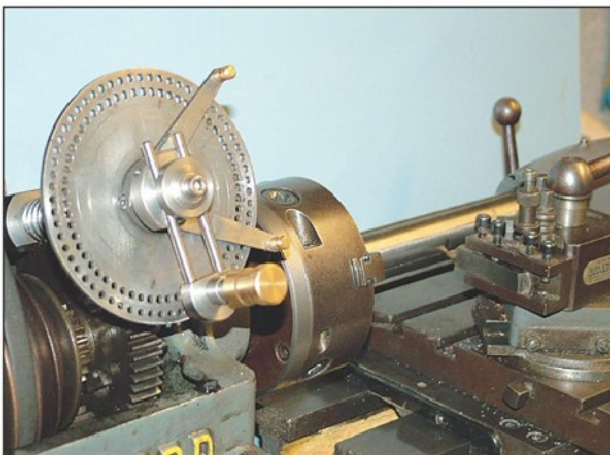


Photo 14. The new barrel set up for engraving.

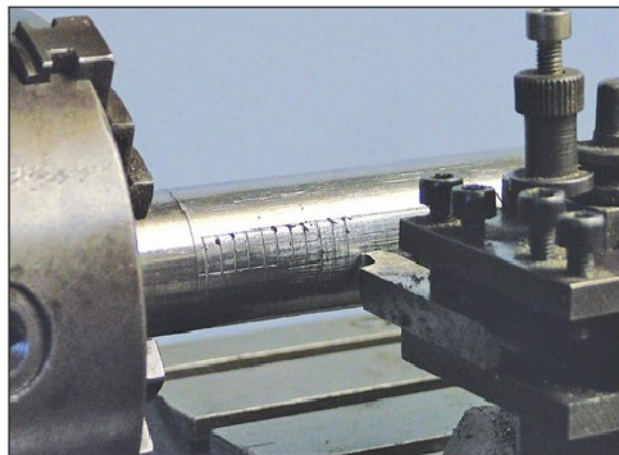


Photo 15. The engraving in progress.



Photo 1.
The Stanley no 66
beader C 1899 - 1902
as bought.

A TOOLPOST AND SPINDLE GRINDER

Tony Schroder makes
a useful tool and
renovates an old
Stanley No 66 beader

Background

Collecting, renovating and using antique metal woodworking tools is one of my hobbies. With a well equipped workshop I choose tools that have parts missing that can be made in my shop. I recently came by a 1899 Stanley No 66 Beader (also known as scratch stock) which had all the blades and one of the thumb screws missing. The manufacture of the thumb screw was reasonably straightforward. The manufacture of the blades proved a little more interesting.

Manufacture of the blades

The beader originally came with 7 blades and an unshaped spare. Each blade is profiled at each end giving 14 cutters. The profiles consist of 3 blades with single beads, 2 blades with reeds (multiple beads), 1 fluting blade and 1 router blade, **photo 1**.

In this article I have not given detailed drawings or sizes of components; more of an overview of the process which might stimulate thoughts and ingenuity.

There are lots of websites for antique Stanley tools and I quickly found a PDF file of a 1914 Stanley tool catalogue with pictures and details of the blades.

My first task was to source some suitable blade material. The original blades were tool steel hardened and tempered to a spring steel that is tough but can be sharpened by filing. Lee Nielsen markets a copy of this beader and sells spare blades. I discarded the idea of buying in favour of making them myself with materials that were available. After some searching I found an old wood saw of 1mm thickness and of the correct temper. This was cut to $\frac{5}{8} \times 2\frac{1}{2}$ in. pieces. The blanks were then filed square and to size. Then using needle

and chain saw files of the correct dia., a set of cutters were filed into shape, **photo 2**.

I found that pre-marking the shapes was not very helpful in achieving a good looking cutter. I am of the old engineering school 'if it looks right it is right'. First I marked the centre of each blade. Then with the round file of the correct dia., on the single beaded cutters I filed my radius in the centre to the correct depth. The sides were then filed evenly. I find this much easier and a more accurate way. By standing the blades upright in the vice I can use the vice jaws as a depth stop and see both sides as I work, **photo 3**.

The hardened jaws of the vice are used extensively as filing and sawing guides. All my vices have had the jaws ground flat on a surface grinder. On the multiple beaded blades with three beads I started the first radius in the centre, and then started the other two radii. Then I filed each bead alternately maintaining the spacing. In this way you can maintain their positions to each other and to the centre easily. On the four beaded blades I started the two centre beads to get them equally spaced either side of the centre then started the other two beads. Then I filed each bead alternately maintaining the spacing.

The work was completed in about 3 hours. The end result was pleasing to the eye, but when I used the beader on a piece of pine (beaders and scrapers do work better on hardwood) the tool worked easily and quickly giving a reasonable

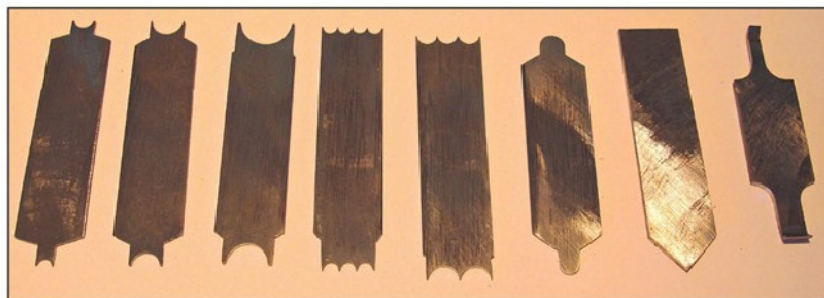


Photo 2. Homemade blades.

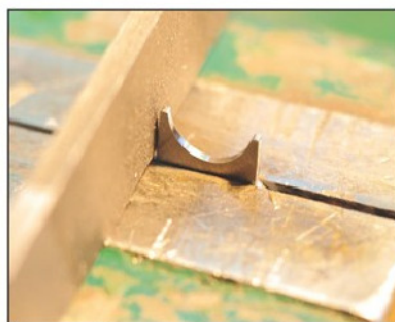


Photo 3. Using the vice as a filing guide.



Photo 4. The pillar grinder mounted for use as a toolpost grinder.



Photo 5. The aluminium bracket with the round table.



Photo 6. The grinder mounted in the vice.

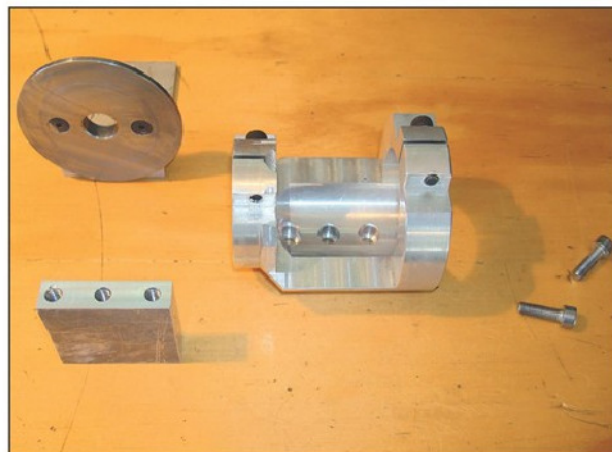


Photo 7. The component parts of the attachment.



Photo 8. The grinder is mounted at a convenient height.



Photo 9. Grinding a cutter by hand.

finish. I felt the finish could have been a lot better. After checking the blades' profile under a 3x magnifier I could see that the filed profile edges were not really sharp. Unlike metal cutting tools and chisels, beader blades are square cut and do not have cutting or clearance angles. They work like a scraper without a bezel.

The bed of the beader is angled at 75deg. to give the correct cutting and clearance angles on the blade. My first thoughts were that the profiles needed grinding. Could I use a mini die grinder with mounted wheels of the correct dia? The idea of trying to hand grind my pre-filed profiles was not given much thought. Looking further at the problem, the die grinder with mounted wheels used in a setup like a spindle router or sander might work.

I had already made a mounting bracket for my mini die grinder to use it as a tool post grinder, **photo 4** and as a pillar grinder on my Unimat 3. As usual my jigs and tools are governed by the need of the tool and the available material. I had a piece of aluminium angle and an unused large washer I had made for mounting a table saw blade, **photo 5**. These combined with the mounting bracket were worked into a spindle grinding table, **photo 6**. The completed bracket components are shown in **photo 7**.

I retained and used the tool post mounting bracket to hold the new table in the vice, giving a secure platform. This placed the table at a convenient height so that the blades can be ground using a

head magnifier while standing over the work without bending over, **photo 8**.

The grinding of the blades proved very easy. The mounted wheels are a very fine grit and run surprisingly true. This made guiding the blades by hand on to the wheel very easy, **photo 9**. These wheels do not bite or dig in and only polish when touched on metal. If I was a little off when pushing the blade onto the wheel no damage was done. In fact a bit of pressure is required to remove metal.

The end result on the blades is so much better, the radiuses look exact, and the cutting edges are square and sharp, **photo 10**.

The beads/ reeds cut in wood, **photo 11** are just what I was looking for, nicely formed and they have that scraped polished finish over the complete profile



Photo 10. A cutter after sharpening.

you only see when a sharp scraper is used. I am now looking at other uses for my new "Spindle Grinding Table"

Some of you might be thinking I could do that with a machine router. For large runs of mouldings and similar projects I would agree. When you only need to finish off a small piece of moulding or a piece of furniture that you want to make to your own individual design a scratch stock or beader is the only way to go. You can file up an old piece of blade to the shape you desired in half an hour, which you will find hard to match with an expensive router bit. If you do not own a beader you can make a wooden handle for your blade that will work very well. I found my beader on an internet auction for £13. Even with purchasing a couple of mounted wheels it all cost me less than a single router bit. ■



Photo 11. Reeds cut with the new homemade cutter.

A Clarkson Tool and Cutter Grinder ①

Mike Houghton describes buying, renovating and learning to use a Clarkson Mk2 tool and cutter grinder

Background

There is a case for the use of small industrial machines in the home workshop. Owners or prospective owners of any make of "universal" tool and cutter grinder should find interest in this short series of articles.

Of course we all do things differently. It's a part of the independence that a home 'shop can give you. "I did it my way"; "Your mileage may vary" etc. Here are the reasons that took me into this tool and cutter grinder project.

I built a Dore-Westbury vertical mill and later replaced it with a Chester UK 626 vertical mill. I couldn't sharpen end mills and slot mills on the offhand grinder in the way that I had learnt to sharpen lathe tools and drills. Clearly I needed something a bit more sophisticated or was I destined to spend a lot more money on end mills etc.?

I purchased the Quorn book by Professor Dennis Chaddock **Ref. 1** and subsequently purchased a set of castings from Model Engineering Services **Ref. 2**. The book is a reprint of 17 articles in ME volume 140, 1974. Unfortunately the greyscale photographs in this book are just as bad as they were in the original ME articles. Fortunately, the Quorn drawings supplied by MES are excellently drafted, clear, and accurate and had been updated.

The Quorn is now so well known worldwide that there are suppliers of castings in the USA, **Ref. 3** and Australia, **Ref. 4** and maybe other countries. Versions of the Quorn have appeared regularly on the front cover of this magazine (e.g 131, 96, 83 and 62) and can be seen at most ME shows in competition and on display. As one cynical friend commented as we stood admiring an exhibition Quorn, complete with fitted mahogany box and many accessories, "I wonder if the maker has ever actually used that in anger." It didn't look like it had ever struck a bat and we noticed that it was back in the show the following year! Is that the fate of many (most) completed Quorn's?

MEW 62 contains a useful compendium of Quorn modifications and additional accessories; there have been many over the years. The requirement to add more accessories to extend the capabilities of the Quorn and many of the home workshop machines referenced later in this article is a common and recurrent theme that has occupied many minds and created many column feet of articles in this and other magazines.

My cynical friend went away from that ME show and subsequently bought, in a private sale, a used Clarkson Mk1 with some accessories for less than I paid for the un-machined Quorn castings, materials and drawings! Am I doing something wrong?

There is a fairly active Yahoo Group on the Internet devoted to Quorn Owners **Ref. 5** and they have an extensive and useful picture gallery and files sections covering the Quorn and similar machines e.g. The Bonnelle and related topics. I would recommend any prospective Quorn buyer or builder join this Group. There is also a Yahoo tool grinding group, also **Ref. 5** that contains a wealth of files and photographs for anybody with wider interests in tool grinding; it is highly recommended in my opinion.

It saddens me to report that my Quorn project remains in an incomplete state! (It has got past the maturing the castings under the bench stage.) I think it's safe to say that making a Quorn exercises just about every model engineering skill except boiler making and sheet metal work; and it's very time consuming. I have read estimates that to complete a Quorn requires at least 1700 workshop hours. Apparently that's about half a modest steam loco construction time with no short cuts. (I.e. without laser cut frames and purchased boiler.) You just have to be single minded and dedicated to complete a Quorn. Some Home Workshops must be more productive than mine!

A bit more Quorn

The Quorn was, or has evolved into, a truly "universal" tool and cutter grinder of some complexity. Several UK home workshop machines have been developed to provide some or most of the Quorn's functionality but at supposed reduced construction time and complexity, but not necessarily reduced materials cost. In the UK we have the Stent, **Ref. 6**, the Worden, **Ref. 7**, the Kennet, **Ref. 8**, and there may be more. There is a very brief review of some of these machines in a recent book by Harold Hall, **Ref. 9**. In addition there is the Tinker modification to a standard bench grinder. The Stent was apparently developed to provide affordable Clarkson capabilities to the Home Workshop.

In the 1970's when the Quorn was designed by Prof. Chaddock, Clarkson were manufacturing all 3 versions of their Tool and Cutter Grinder. At that time, the new cost of even the cheapest Clarkson Mk1 would have been completely outside what any home workshop owner could afford, probably 20 times the Quorn castings cost at the time. So I can easily appreciate the good Professors' motives for designing the Quorn. He must have had access to professional tool and cutter grinding machines at the Loughborough University Workshops where he was Prof. of Engineering Design at the time. In the 1960's I used to sneak into the some of the engineering workshops at Loughborough; they seemed pretty well equipped to me, but I was only an undergraduate at the time.



Photo 1. Clarkson MK2 installed.

Quorn is of course the name of a small town close to Loughborough where Chaddock lived, not something a vegetarian might eat.

Small Industrial tool and cutter grinders (and drill sharpeners)

There are a remarkable number of these machines and they vary a lot in their design objectives. Many are not common in home workshops and many are worth serious consideration should you come across a used one. These tend to be single purpose machines rather than the one machine does everything approach. Unfortunately the usual reference, the Lathes website, **Ref. 10** is somewhat lacking when it comes to these machines. If you Google for names like Brierley (Cuttermaster, now owned by Chester UK), Boremasters (Tiplap), Deckel, Alexander, Drill Doctor, Darex and Gorton. The Alexander/ Deckel SO and SOE style of engraving and milling cutter grinders have been extensively "copied" by a number of Asian manufacturers and imports are

available under the Vertex and other brand names in the UK. I have heard slightly variable reports but don't have any first hand experience, but the £600 or so fully equipped model from RDGtools sets the price standard at the time of writing.

Other Factors

So with a Quorn more than half built and a list of modifications for it already in mind, why did I change horses and look for a Clarkson Tool and Cutter Grinder? I'm sure some, if not all of these factors will resonate with most of our readers.

A retired engineer gave me a large part of the tools collected over a working lifetime by his brother and himself. This was a substantial collection of taps, drills, reamers, end mills and slot drills, slitting saws and milling cutters. All this tooling was High Speed Steel by respected Sheffield makers with lesser quantities of German and Australian manufacture. I think one of the brothers worked in Adelaide at one point. Most of the hoard of tooling was in need of re-sharpening and some de-rusting. See MEW 127 for my article on electrolytic de-rusting of tools. Some of this tooling had already been badly re-sharpened and was in need of reworking. Some of the larger tooling in this hoard was ideal to practice tool sharpening on.

Used tooling in a very similar condition to the above often appears at car boot sales at very attractive prices, and provided you can re-sharpen them, they are often worth purchasing. Even though the supply of tooling from local engineering closures is drying up, there is still a steady trickle of stuff from private workshops and house clearances. FleaBay is another source, but I prefer to see the stuff in the flesh before purchasing.

A local factory, with extensive modern CNC milling and turning facilities has decided not to re-sharpen any tooling below 13mm dia. They use it until the performance falls then they scrap it. I have been lucky; some of it comes my way. This factory makes medical equipment components and machines a lot of stainless steel and tough steels. The tooling, mostly drills and end mills in HSS and carbide comes from very reputable manufacturers, though most is, sadly, no longer made in Sheffield.

You can learn a lot from studying the cutting edges applied to this quality



Photo 2. Clarkson MK2 table and tooling.

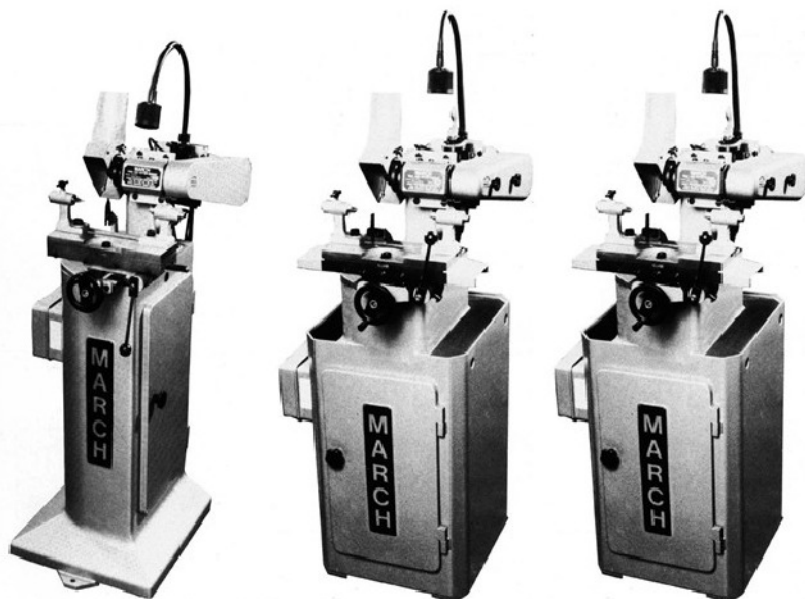


Photo 3. Clarkson March MK1, 2 and 3.

tooling, especially when you compare it to some of the cheap Asian stuff. You can also learn a lot from the tool wear produced by repetitive high speed and high feed rate machining on modern rigid machines.

A friend visiting from South Africa with origins in the Sheffield Tool industry pushed me to consider a Clarkson Tool and Cutter Grinder as an alternative to the Quorn. His company still uses 40 or so Clarkson Mk1's for low volume and specials production for the local SA and export markets. (Some to the USA). I have some of their tools and they are good quality. Their high volume precision stuff in carbide and HSS is increasingly produced on 5 axis CNC grinding machines with auto size adjustment to allow for wheel wear, but the Clarkson's never the less remain in use.

Clearly these Clarkson's can have a very long life, even under very heavy industrial use. No spares are available in SA, so they make their own. I was even offered a spindle should a purchased used machine require one. Whilst my friend was staying, we took a look at Clarkson's advertised on UK Ebay and a few dealers stocks on the internet. Evidently there are a lot of them about still. Apparently there were quite a lot of Indian produced Clarkson clones being traded at one time. These may not have made it into the UK, but buyers beware.

Purchase

I placed a free advert on the excellent Home Workshop website. Ref. 11. I also decided to ask at my local club to see if anybody had a suitable machine. Returning from a weekend away, I found 10 machines offered from the internet advert plus an additional 2 from club members.

Most of the Tool and Cutter grinders offered were Clarkson Mk1 and 2, but there were a couple of Boxford G200's. Prices varied from £100 to completely silly money, more akin to Dealers prices. Look in this and other magazines adverts to see what I mean. One of the most important price determining factors seems to be the number and type of accessories offered with the machines. However if you can't afford

specialised accessories such as radius grinding, 3 axis vices, drill point and tap lead grinding, air bearing and controlled spiral attachments don't despair; there may be cheaper alternatives once you have learnt the basics of tool and cutter grinding.

I bought a Clarkson Mk2, a 3 phase machine, serial number MT1058, photo 1 plus some of the basic accessories and grinding wheels from a local private seller. I saw the machine operate before purchase. To keep costs down I declined the radius attachment and this sold quickly on EBay a few days later for almost as much as I paid for the Mk2.

Although Clarkson produced several hard to get i.e. expensive attachments there are alternatives available as I shall detail later.

Photo 2 shows the top half of the machine with some basic attachments and sleeves on the table. The Clarkson is small enough to fit into most home workshops, and is considerably smaller than say the Cincinnati No2 or the Jones and Shipman 310T. I have seen Clarkson Mk1's converted to bench mounting, but I wouldn't recommend it.

About Clarkson and the spare parts situation

Tony Griffiths has some information about the company and its three Tool and Cutter Grinder products on his website. Most of this material has been re-published in ME. Ref. 12.

I have been unable to find anything about the origins of the Clarkson Company; maybe a reader with inside knowledge of the Sheffield Tool Industry could enlighten us all? I'm sure it would be an interesting story.

Clarkson were certainly very innovative and famous for their development of screwed shank milling cutters and milling cutter holders. (Trade names Autolock, Dedlock etc) Of course the Clarkson name lives on as manufacturer of cutters. (Now as Clarkson Osborn International.)

Clarkson appear to have started manufacture of the MK1 at their factory in Nuneaton to support their own cutter manufacture in Sheffield and other



Photo 4. March Mk3.

locations. The Company seems to have eventually become a part of the ill-fated Thorn EMI group, the Nuneaton Plant and all its work in progress, spares and drawings, but not the Clarkson name, were transferred to March Engineering Ltd who had become a big sub contractor to the Clarkson Operations at Nuneaton. March continued the manufacture of all three versions of the Clarkson with very small changes. March Engineering finally went into liquidation in 2004 and the assets were bought by Machine Spares, Ref. 13, who can supply manuals and spare parts for March and Clarkson badged machines. I have visited Machine Spares in Brierley Hill and was very impressed by their stock of complete machines (even a rare Mk3) also spares, drawings, belts, casting patterns, unmachined and machined castings. They are definitely worth a try should you require spares, advice etc.

March machines are very like their Clarkson cousins, many of the spares and parts sharing the same part numbers. March moved to fabricating their machine bases whilst Clarkson used cast iron construction, although it's hard to tell from the external appearance.

March reconditioned Clarkson's do occasionally appear second-hand and it seems that March did quite a bit of rebuilding of older Clarkson Machines.

The following illustrations of the three machines are taken from fairly late March Sales Literature, courtesy of Machine Spares, and show the later fabricated bases, photo 3.

The Mk3 machine is very rare, few were sold and they were very expensive. The Mk3 is bigger in capacity than the earlier models and has a rotating and elevating column. Machine Spares have the demonstration/ sales room Mk3, photo 4.

Refurbishment of my Mk2

Although the Mk2 machine weighs in at about 500lb (225Kg) it was very easily broken down into four major man-sized chunks for transport. I needed 2 helpers to unload the heavy base casting from the VW Touran, but otherwise the move was simple and didn't involve engine hoists and lifting tackle.

Although the machine looked clean and tidy as viewed, on getting it into my workshop in bits it was obviously in need of a good clean up and paint. Years of grinding dust proved extremely difficult to shift and wire wool and soap (Brillo Pads) followed by hot water and a lot of elbow grease eventually did the trick. The

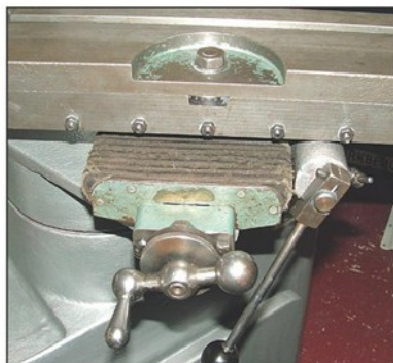


Photo 5. The MK2 slides are protected from grit.

machine was stripped down to the major castings and repainted. Because of the age of my machine, probably 1970's, all the fixings are Imperial threads.

The first thing that struck me about my Mk2 during restoration was the enormous amount of metal in the castings, the rigidity of the design and its overall simplicity. After all it was designed for hard industrial use by "semi-skilled" tool grinders doing a very repetitive job. It's no wonder there are still lots of these around in the UK still capable of good work.

Several users, including the Editor, advised against any sort of lubrication for the swivelling and sliding bits as oil or grease convert to a grinding paste when wheel and steel dust are added to it.

I reassembled my machine with a very small amount of Aeroshell Grease 15 which contains PTFE suspended in it applied lightly to all the moving parts. I'll find out with time if that was a good idea or not! This is helicopter grease, a car boot purchase, and it has a very high tech specification!

The Mk2 is somewhat better protected from grinding dust than the Mk1, having alloy covers over the rack and pinion ends and concertina covers over the dovetail slides, photo 5.

My machine had, at some time, been converted to roller bearings for the top slide. See photo 6, which clearly shows the grinding debris that had to be cleaned away. The slides were manufactured by Cleveland.

I say "converted" because the set screw and nut adjusters for the original gib strips are still on the front of the table, but don't seem to do much.

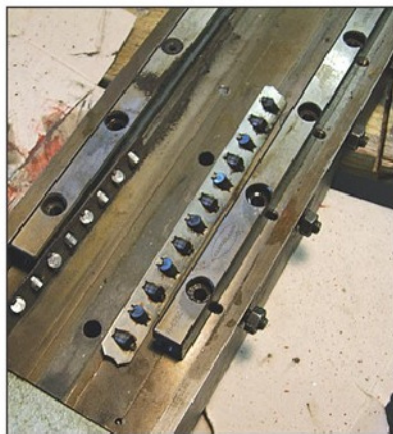


Photo 6. Table roller slides.

The roller slide movement became very free after cleaning and greasing but there was a lot of slop in the rack and pinion that moves the table. With the pinion shaft locked the table could be pushed several mm in either direction. I judged this to be unacceptable so I used a feeler gauge to estimate how much I could pack the rack down to get a tighter engagement on the pinion; then a 0.15mm (0.006in.) brass shim was made and inserted between the rack and the table bottom to remove the slop down to acceptable proportions, photo 7.

The only other signs of wear on my machine are the slide acme screw and bronze nut, (10tpi left hand thread) which at some point I shall replace. There appears to be no method of lubricating the wheel spindle assembly and I was reluctant to take it apart as it runs quietly and the measured run-out on the wheel side is below 0.0005in. I have a GA drawing of the Mk1 spindle and it seems that everything runs on "standard" ball races so replacement shouldn't be a problem.

In the next part I shall cover the addition of an inverter, wheel guarding and extraction. ■

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Photo 7. Adjustment of MK2 rack and pinion.

BUYING AND RENOVATING USED MACHINERY

Mick Whittingham
gets quality
machines at low cost

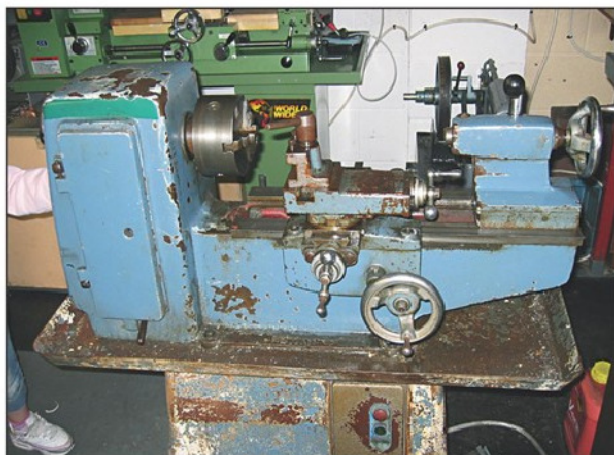


Photo 1. The Raglan Loughborough as received.

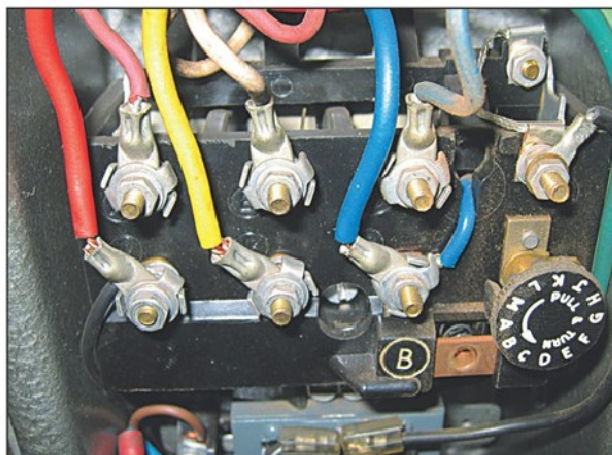


Photo 2. Switch wiring is easy to get wrong; good photos help.

In order to equip my new model engineering workshop, I was faced with the decision of whether to buy new or used machinery. Initially, I did buy a brand new Eastern Lathe/Mill as a first purchase but was never 100% happy with it; it just wasn't right somehow. Maybe the memories of using British built lathes at school was a factor. But this combination unit gave me the capacity to have a go at machine renovation and so I decided to buy used machines rather than new. Having taken on a few old timers I thought I would share some of my experiences and add to the debate about old versus new.

My reasons for going down the second hand route were that I had a few used machinery dealers nearby and I liked the idea of re-using a machine that still had lots of life left in it. Reading reviews on old machines also encouraged me to buy something not in its first flush of youth. Modern machines are no doubt excellent value and quality, but there is something about machines that were conceived and built in the heyday of our engineering past. Whatever your feelings on the topic used machinery can still provide hobby engineers with quality tooling. Tony Griffiths' excellent web site www.lathes.co.uk is a wonderful source of reference material and I always check this site during the decision making stages of buying a used machine.

The price argument

One of the prime considerations is, for most of us, COST. I have a budget and exceeding the limits set invariably leads to marital strife; I therefore try to get the best value for money possible. A used machine can seem a much cheaper alternative to a brand new one but this depends a lot on how much work needs doing to it and the cost and availability of spares and accessories.

Many machines are also quoted Ex - VAT and this means you must factor in 15% for The Chancellor. Add to this the possibility of delivery costs and a used machine suddenly looks dearer than at first glance. On the plus side, a quality used machine should hold its value (I am told) better than an imported machine but that remains to be seen when the current crop of shiny new lathes and millers become more mature (Hem hem, worn out).

What to buy

An obvious question but the answer should be buy something you can use. The best bargain in the world is no good if it is just going to sit and gather dust. I came close to buying a cylindrical grinder that was a bargain, but I had absolutely no idea what it was or how I would use it. I could have bought it and sold it on but I don't really want to go down that line. Other factors that may enter the decision making process are the amount of room you have available, the amount of work the new machine will be doing, the cost of renovating it and the cost of running it. All things you should be thinking about before setting off to the shops.

If you are tied to single phase electrics then you may need to consider the type of machine you can buy. Three phase machines are more readily available than single phase and there are less people after them so you should have a wider choice. There is the possibility of swapping to single phase motors but I have not gone down that path due to the technical and physical problems thrown up. It is not simply a case of finding a suitable motor and swapping it over, lots of problems abound and I am not qualified to solve them so I gave up. Also bear in mind that the machine was designed to run with a three phase motor and the performance on a single phase unit might not be as you

want. Instead, I bought a three phase rotary converter to give me three phase power for my machines and have never looked back.

What to take along

Assuming you can visit a machinery dealer, being able to have a good look at a particular machine before investing in it is also a good reason for the used machine approach. My local dealers let me browse around and inspect machines in detail, which allows me to identify possible problems before I decide to buy. I always ask before wandering round and if I mention that I am interested in machines that may need a bit of TLC I usually get to see stuff that is tucked away out of sight as not being saleable.

I take basic tools along with me and a digital camera so I can take a few images to jog my memory when thinking things through. A list of tools you may find useful would be:

- Tape measure
- Small torch
- Small adjustable spanner
- Wire brush/scraper
- Clean wipes or cloth



Photo 3. Parts are removed, cleaned and stored.



Photo 4. The main casting is taken down to bare metal...

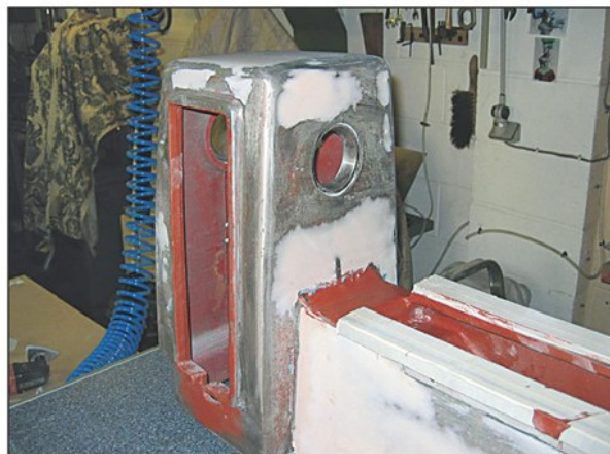


Photo 5.then filled and rubbed down.



Photo 6. The stand has been completely rubbed down and is ready for priming.

A tape measure may seem really basic but you have to make sure that your new unit will fit into your available space. A lathe sitting next to a huge miller in the corner of a warehouse looks tiny, but when it arrives home to the workshop its proportions suddenly grow.

A torch helps as getting to see inside machines can be hard, even if the dealership is well lit. Most are poorly lit and I have often had to use a torch to see my way round the machine itself.

A movable spanner lets you adjust and tighten suspect fittings. But be careful not to damage anything though and ask the

dealer if he minds you tinkering with the machine, he should be OK if he feels you are genuinely interested.

I take a small brass wire brush, like a suede cleaning brush and a retractable razorblade type scraper, along with a cloth these can allow you to look for serial numbers, motor plates, and other information which might help your decision making process.

Hand wipes also keep you out of trouble as driving home with grubby hands after you got carried away looking at machines is sure to upset the boss, I take along a pack of tough wet wipes to clean hands and machine parts.

What to check for

I am no machinery expert but I spend time looking at wear on slides, leadscrews and bearings etc. The more free movement there is then the more I worry. If the wear can be adjusted out then fine, if the bearings can be replaced then there should be no problem, if worn screws and nuts can be re-machined or replaced then all should be well. If any major wear and tear is not going to be easy to address then look for another machine. Similarly cracks in castings may be fatal to your plans so look carefully for them.

As regards electrical soundness, most machines rely on some form of electric motor and control system and it is worth checking these out as thoroughly as possible. Many dealers will offer to show you the machine under power and it is

worth doing this to allay any fears about its electrical soundness. If you are considering swapping a motor to single phase remember that other systems on the machine may not work from a single phase supply.

If a machine has drive belts or other parts which may need replacing it is important to find out if they can still be obtained with ease. Transmission specialists are a great source of bearings and belts and I have not been stuck for a replacement so far. If you cannot find parts and belts it may be better to look for another machine.

If the machine has a handbook with it then make sure it is the correct one for the model AND will be included in the sale. If you need to find a copy of the handbook for settings and operation then it might be an idea to see if you can obtain one before committing to buy. There are some good suppliers on the web and you should be able to find at least some information about most machines.

If you are buying from a dealer without being able to inspect the machine then you are in a much less secure position, I have bought like this but you have to rely solely on the traders description and you cannot guarantee that their idea of "needs a bit of tidying up" matches your own.

Buying and delivery

The part I hate most about buying a used machine is settling on the price. Some dealers display their prices clearly and



Photo 7. The tray and stand painted and ready for reassembly.



Photo 8. The stand and main casting have been reunited.

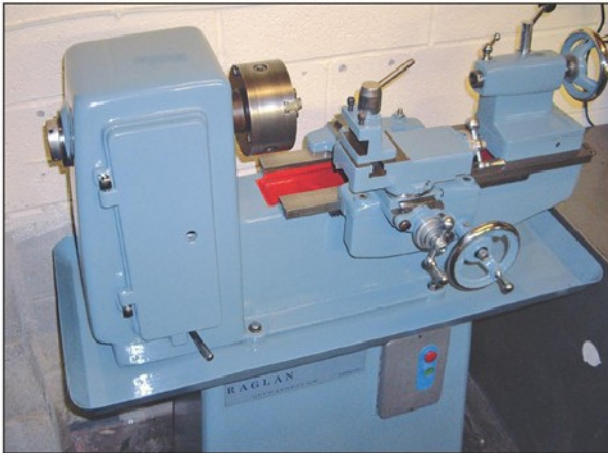


Photo 9. The finished lathe.



Photo 10. The transfer was made on the PC using waterslide paper.

simply, others do not and I have had to ask how much a given unit is. This can lead to much sucking of teeth, Humming and Aaahing and the like.

The best way to overcome this is to get a good idea of how much similar machines are going for and set yourself a budget. I have found that most dealers will help out on price and come to some mutually acceptable deal if a sale is to be clinched. I am not a good haggler but have never felt I lost out on a deal. I take an open approach and politely ask if there is a discount for cash. If you can't get money knocked off the ticket price, ask if you can get any tooling, spares or bits and bobs thrown in. If it helps to close a deal then the dealer may offer you a few sweeteners. Once the deal is closed you can relax and start to plan collection or delivery.

This is also the point at which I decide if the machine will be a long term project or a short term clean up. I can get the shop ready for whichever course of action and buy in any consumables like white spirit and sandpaper ready to start cleaning.

Getting the new purchase home is not always as easy as it at first seems. I got a Raglan vertical miller in a small hatchback but I would not recommend it. The family car is not the ideal repository for an oily, smelly and heavy hunk of metal so think about getting the thing back before you pay. If the car is the only option for a small item then make sure to have plenty of polythene and old sheets to cover the flooring; something is bound to leak out. Also the amount of effort needed to shift some items should not be underestimated; having got the miller in the car using the help of three burly dealers I arrived home alone and could not get it back out!

Most dealers offer palletised delivery over long distances but beware; I recently took delivery of a palletised lathe which was left sitting on my drive on its pallet as promised. I could not move it and had to strip it into manageable chunks to get it into my shop and rebuild it there, not fun when it is cold and wet outdoors.

A good machinery delivery service is definitely the best option and for anything not remotely bench mounted may be the only option, despite the additional cost. My larger lathe was delivered this way and the extra muscle and expertise was much appreciated by me.

How much renovation to do

Over the last couple of years I have bought several items of used machinery and all have required some attention when they arrive at my workshop. The amount of time and effort spent on a particular machine is entirely up to you. At its most basic a used machine may just need a good clean and a power supply to get it up and running. But if you want to completely strip a machine and rebuild it to showroom condition, then that is possible. Indeed I seem to spend

much of my time and energy in really trying to get a machine looking its best. But if you want you can just clean it and then use it. If you are in any way worried about the electrical side of things then get the machine checked out by an electrician before using it. I am no electrician and steer well clear of anything I am not 100% sure of.

If you want the machine to earn its living immediately then do the minimum required; nice paint will not make it any more accurate or improve its results. But

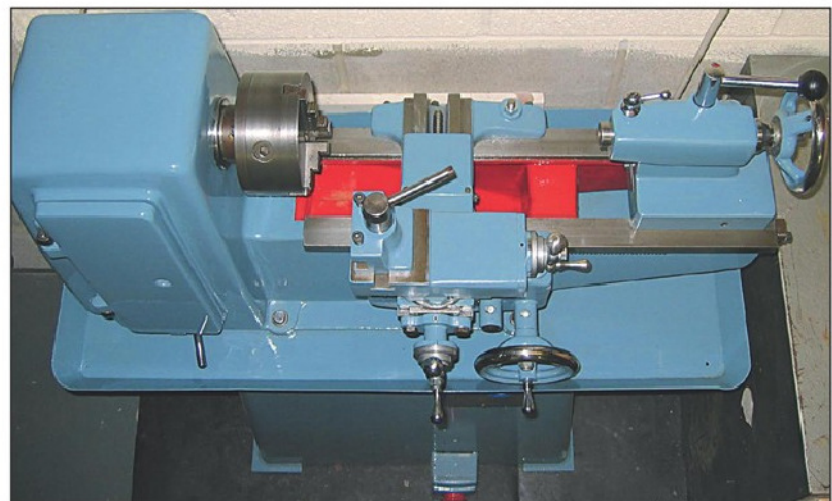


Photo 11. An overhead view of the lathe.

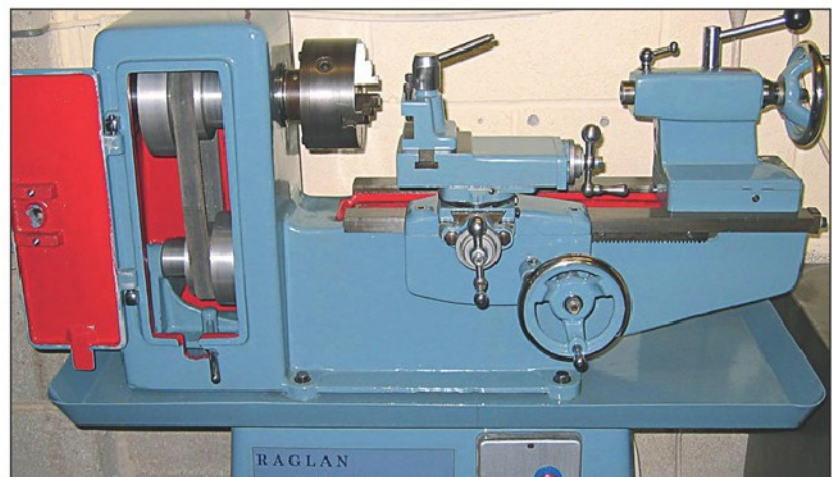


Photo 12. The drive belt door open showing the flat belt drive.



Photo 13. This dormer drill grinder is an intensive care patient.

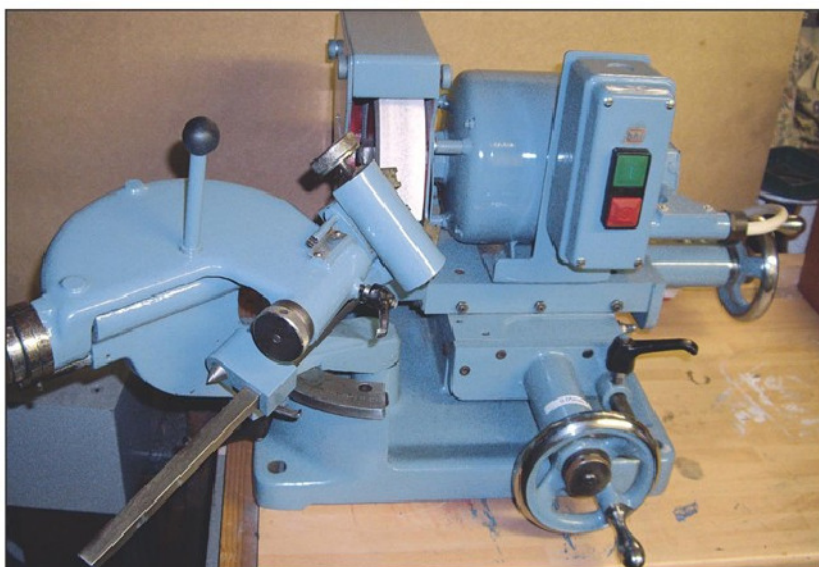


Photo 14. A few weeks later, it is feeling much better.



Photo 15. The belt guard of a Raglan vertical miller.

be aware that once you start using a machine, it becomes very difficult to switch it off and strip it down. This sudden status as an indispensable item in the shop means that I make the decision of how much I am going to do before the machine arrives, then I know the shop needs to be ready for a new patient rather than a new addition and I can plan accordingly.

Getting started

Once the new item is in the workshop I take photos before beginning work. General views of the unit to show its condition are a great reference point for your work. I then take a photo of every identifying mark and information label in case I need to refer to it later. Finally I take photos of transfers, logo's and the like in case I need to make new ones if the originals don't survive the renovation.

When I actually start work I take photos as I go, stripping off larger assemblies and showing the position of fixing screws, collars etc. which I might forget when the time comes to rebuild. Taking a good series of photo's is a great help and I have relied on them to identify where certain bits go, which way round they fit and even to help with those "spares" I always end up with. Wiring is especially important and I take pictures of junction boxes, connectors, plugs and anything I remove so that I can replace it exactly as it was fitted. I also make written notes of wiring to help when the time comes to rebuild.

One particularly neat trick was to make up a fixed mounting for my camera so that I could take photos from the same viewpoint over a long time period. This gave me a series of "time lapse" images and shows my projects as they progressed through their various stages.

As each large lump comes off the machine, I soak it in white spirit until I am ready to strip it further. I use old washing up bowls as they are not attacked by the white spirit and are big enough for most items. This makes the cleaning a lot easier and lets the white spirit soften even long term gunge before I tackle it with wire brushes and cleaning cloths. When I have finished cleaning, I filter the dirty spirit through an old flour sieve into a suitable container (make sure it is an OLD sieve, SWMBO did not take well to me snaffling her current one). This allows me to find any stray small parts that may have become detached during cleaning; I have "found" broken gear teeth, grub screws and other small bits which would ordinarily have been thrown away with the mucky spirit.

I take an interest in the weekly shop as many of the trays and packaging which our meat and veg arrive in are ideal containers for parts. SWMBO now retains all likely items and as long as I remember to take them into the shop promptly does not grumble, too much.

I put whole sub-assemblies in the larger trays and strip them into smaller trays for cleaning and storage. Jars are great for screws, springs, washers and pins but the trick is to keep all the parts together with the ones they came from. In my shop a shelf unit is left aside for the storage of work in progress and I have not yet lost any bits using this method of working.

Making written notes of the methods I used to strip particular assemblies helps when rebuilding. If you are not a good



note taker then consider a voice recorder, I use one in a plastic bag when I am gunked up and write notes from it later on.

When I have finally arrived at a fully stripped machine and there is nothing left to remove, I clean everything thoroughly. This includes stripping paint finishes down to bare metal and cleaning off surface rust. This is the dirtiest part of the process but the most satisfying as you see the machine in its simplest form, warts and all.

The cleaning process may also highlight any items that need replacement or repair. My miller needed new bronze nuts and these had to be specially made, so I sent them off whilst getting the machine ready to rebuild saving a good bit of time.

I spend a lot of time preparing the surface for painting, and that includes using car body filler to smooth out any casting imperfections etc. I can hear most of you now and agree this is just cosmetic frippery, but let me say this; many older manufacturers lavished this level of care on their machines and it does make a difference. Using good quality primer and plenty of rubbing down between coats is the only way to a machine that looks like new. Additionally any "new" holes that have been introduced over the years to take light fittings, tensioners etc. can be filled and forgotten so that the casing returns to its former glory.

Once I am happy that all the work has been done then I can clear the decks and prepare to paint the machine. First I get rid of all the dust and dirt which cleaning and surface preparation generated in the shop. Time spent here will pay dividends when painting the final finish. Dust dropping from light fittings and blowing off shelves and ledges ruined a lot of my early painting efforts.

The only piece of advice on painting I feel qualified to give is to use the best machinery enamel you can get hold of and allow plenty of drying time between coats. I was able to find a supplier of the original paint for most of my machines and the finish looks great. Whether you brush, paint or spray is up to you and the facilities you have to hand. I brush painted the final coats for my machines and rubbed them down with very fine wet and dry. The results are pretty good and more than sufficient for a machine tool.

I take a systematic approach to painting. Some items need to be painted in their unassembled state while others can be built up, masked and then painted. There is a lot of information and advice out there about painting and if you want "concours de elegance" results I would consult an appropriate source. For my purposes the manufacturer's instructions have served me well.

When the painted machine has been rebuilt, rewired and run I attend to the little details such as transfers etc. which finish the project off. Waterslide transfers are easy to deal with using the home PC and appropriate printer paper, printing from your computer onto transfer paper and then attaching it to the machine. The type I use dries with a white background, but a thin application of oil based varnish seals the transfer and makes the background transparent so that the end result looks much like the original. Motor plates and metal badges etc. can be ordered from specialist providers if you want to achieve the best results possible.

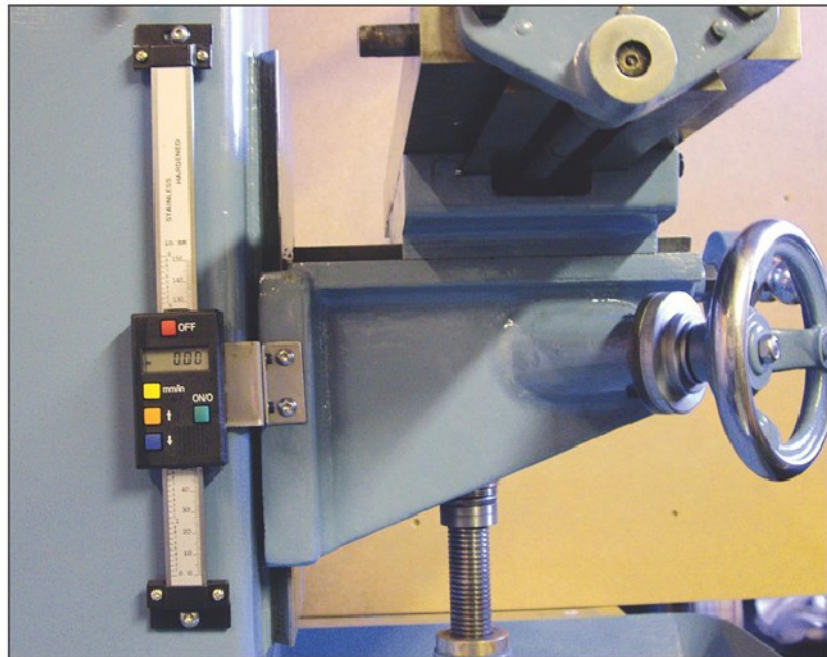


Photo 16. Although the machines are restored to original factory equivalent, improvements can be added where necessary.

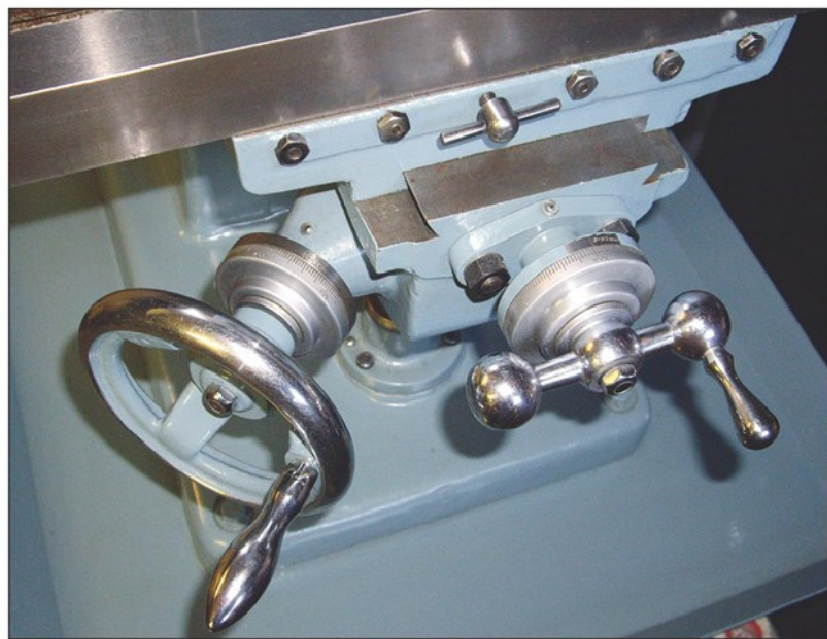


Photo 17. The Raglan mill has been renovated to the same high standard as the rest of the machines.

All in all I enjoy the challenge of finding, buying, renovating and then using second hand machinery. I have been fortunate in finding machines that were ripe for renovation, not too clean that they could be used straight away, but not too damaged that they were beyond my level of ability to repair.

If you feel that buying and renovating a used machine may be for you then have a go, there are still lots of bargains out there and your efforts will be rewarded.

I have been able to build a useful range of tooling which I am sure would have been unavailable to me had I set out to buy it new. I continue looking for new machines to "do up" and one day I might even get around to making something using one of them. ■



Photo 18. The next project is this Raglan centre lathe.



FIRESIDE READING

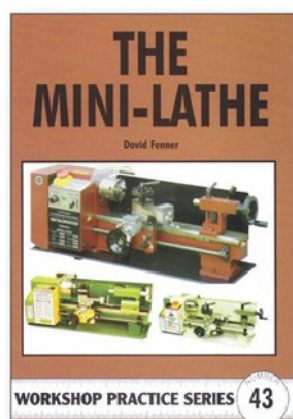
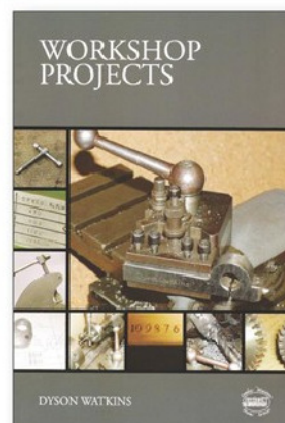
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Workshop Projects

Dyson Watkins is a well known contributor to Model Engineer's Workshop. He has taken several of his published projects and turned them into a book. There are several useful tool

designs in this book as well as a complete wood turning lathe. The book concludes with some very useful charts and information including details of Poly Vee belts.

The book is available from Camden Miniature Steam Services, FREEPOST (BA 1502), Rode, Frome, Somerset, BA11 6UB
Tel: 01373 830151
www.camdenmin.co.uk



The Mini Lathe

Dave Fenner has taken the series of articles he wrote for Model Engineers' Workshop about the Arc Euro Trade C3 Mini-Lathe and turned them into a book. This book is no 43 in the Workshop Practice series. The book is applicable to the Warco Mini-Lathe and the Chester Conquest lathe as well as

the Arc Euro Trade one. No doubt it is applicable for some of the US versions of this little lathe as well.

Now I know you may have all the articles in your copies of Model Engineers' Workshop but it would be handy to have all the articles in one place in an easy to use format. It is a very comprehensive book

and covers all sorts of simple modifications and includes designs for tools and accessories. If you have a C3 lathe, buy a copy of this book. You will not regret it.

The book is available from www.myhobbystore.com or
Tel: 0844 8488822 10am to 4-30pm Mon. to Fri.

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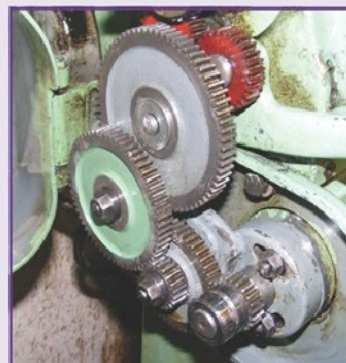
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Letter

Computer aided design

A great many readers of Model Engineers' Workshop have already started to use Computer Aided Drawing in one form or another for their hobby. Some may wish to change their system; still others may not have taken the plunge and started to use any of the various systems on offer. Some of these systems can cost a considerable sum of money and getting the right one can seem a daunting task, particularly if you have friends with very differing views on which system the newcomer should go for.

On the Internet there are at least two sites offered by my provider AOL that offer you the choice of being able to test and see, which if any system meets your needs and also better suits your purse. These include advertisers in the hobby's magazines, both British and International; there may well be others I have not found. Some of the systems are totally free while others ask for a donation to the developer, who in some cases seems to be a student using the development of the Software as a University project.

One of the most basic but useful bits of software I ever bought was from the now closed shop Woolworth! It cost less than £10 and enabled a friend of mine when he tried it to decide that CAD was not for him and he continued with his pen and paper approach.

One site can be got to by typing 2D3D into the box and the other is found by typing www.eland.org.uk in and then waiting for the site to appear.

In some cases other sorts of Free Software are also on offer; some of the free CAD software is either limited in some ways or merely offered to get you to buy the more complete or unlimited set of facilities they offer, but when I looked you could get a least basic CAD for nothing. I suggest you read any information on the various sites very carefully and take a print copy of anything you at least consider using. If you are involved with a group who send their drawings to each other for comment or modification do make sure that your new system is capable of both sending and receiving their type of drawings, some will only send, others only receive, and no I don't know why either! Hope that this proves useful.

Phil Humphrey by email

Tolerancing

In his article "To Die Now" David Piddington refers to the problem of adding tolerances to dimensions in AutoCad commenting that you can only use them if applied to all dimensions,

This however is not so; there are at least two ways in which to achieve individually toleranced dimensions. The easiest for a single dimension is to open the properties dialog box (modify menu, properties) Then click on the dimension that requires modifying. Select tolerances in this case and then clicking in the field next to tolerance display will bring up a drop down menu from which you can select different methods. Depending upon your

Multipart articles

I'm afraid my purpose in writing this may lead to another editorial comment such as ".... Now I know most readers expect all articles to be to their taste" (MEW issue 146). I don't for one moment believe this is true. I think it is a misinterpretation and does a disservice to the common sense of your readers. What most of them expect is that the content will at least reflect the purpose of the magazine as implied by its title and not include items that are only vaguely related on the justification that any topic contains something buried therein that may be relevant to someone. Most people are actually quite philosophical about articles that, while not of specific interest to them, are relevant and not out of place in the magazine.

Nonetheless, I feel a certain amount of trepidation to note that no less than 5 articles in issue 146 are (parts of) multi-part articles. I know this has been discussed before and I agree that a limited number of multi-part pieces may be useful in covering some topics. However, this is going far beyond that and seems to be rapidly going down the same road as "Model Engineer". And frankly, ME's big Achilles Heel is exemplified completely by its multi-part-article-gone-mad syndrome. It is time consuming and expensive to "break into it" on a subscription basis and, if buying it from a news-stand you risk missing the odd part of a series. If a major article does fail to appeal, it's hard to be philosophical when you are faced

preference you can then enter the upper and lower limits. If you want the tolerances to be either all positive or all negative then you need to put a plus or minus in front of the upper or lower values; a little bit of experimentation will soon make this clear.

The other method is to create a dimensioning style via the dimension style manager where it is possible to control all the aspects of a dimension and save as a style. This can be applied by either setting it as the current style, using the drop down incorporated in the dimensioning tool bar, or selecting the dimension first and then setting the style required. David's preference for horizontal annotations can also be accommodated although only by the new style method. In the dimension style manager under the text tab change the text alignment to horizontal and save. In the interests of error reduction readers may like to consider the point they select for the initial datum point. On the die holder drawings, the datum has been picked as the lower left corner and all horizontal dimensions are to the right, however when you come to turn this part you will be working from the other end, so these dimensions are now the wrong way round. Ideally the dimensions should all emanate from the right hand end eliminating the need to recalculate. This

with it consuming a significant portion of the magazine for the next 6 months or a year in some cases.

The resale value of used Model Engineer copies suffers too. Single issues are not worth much (unless you just so happen to find the issue you are missing from a lengthy multi-part of interest) and even contiguous volumes have a lot of waste at the start and end.

If one of the magazines must emulate the other, it would be far better to use MEW as the model than ME

One man's opinion and reader feedback.
Sid Herbage, Ontario, Canada

The Editor replies: I did not realise there were so many multi part series in issue 146. However, most of the articles received are too long to fit into one issue. If readers' wrote shorter articles, I would be pleased to publish them.

Model engineer articles can be 20 or 30 or more parts long. That won't happen in Model Engineers' workshop. Apart from Harold Hall's Metalworking series and Dave Fenner's C3 lathe series, most MEW series are a maximum of five parts long. The current articles on the Sieg x1 mill were originally offered as a series but they are being printed as stand alone articles.

The recent CNC cutter grinder series ran to 5 parts. This is a typical maximum length of an MEW series. I was very pleased to publish this series of articles but could not have done it as a single article. It would have filled a complete magazine.

generally is the best way for turning applications; for milling and jig drilling other methods are better suited.

Steven Gray by email

Soft jaw availability

I have just been reading the latest edition of Model Engineers Workshop and the Star Letter from Norm. Williams. In it he complains that no one stocks soft jaws for the cheapo Chinese chucks as fitted to the mini-lathes, etc. Can you tell him to look on the Chester Machine Tools web site (or in their catalogue) as they list soft jaws for the various sizes of chucks? I am sure a quick phone call to them should sort out his requirements.

Ian Pemberton by email

CAD dimensions & tolerances

David Piddington's article mentions that tolerances cannot be put on one dimension without being put on all. This is not so. I use AutoCAD at work & at home and have used all versions almost daily over the past 11 years from Release 13 up to the present.

The following method is written using the screens that appear in AutoCAD 2002, which I use here at home. Other versions may have slightly different looking screens, but all except the earliest non-Windows versions should have all of these commands.

SCRIBE A LINE

All one needs to do is to go into the Dimension Style Manager window (by clicking the Dimension Style button on the Dimension toolbar, or type `dimstyle` into the command line), then highlight the dimension style (e.g. Iso-25, or whatever you are using in the drawing) in the left-hand box, then press the New button in the right hand box. This opens a new window called Create New Dimension Style. Change the top box from e.g. Copy of Iso-25 to, say, Iso-25-TOL, then click on Continue. A new window called New Dimension Style: Iso-25-TOL will then open. In this window, click on the right-most tab called Tolerances. Initially this will be set to Method: None in the top box. By changing this box to one of the drop-down options - Symmetrical, Deviation, or Limits. An example shows in the right box to give you an idea of each annotation style and you can set the tolerance limits in the boxes below.

To use in the way we want, create the normal untoleranced dimensions throughout, then you can pick out and change to the toleranced dimension style the critical ones using the dropdown at the

right of the Dimension toolbar (this only appears when this toolbar is horizontal), or use the dropdown in the Properties toolbar under Misc and Dim Style.

If you have more than one set of tolerances, e.g. ± 0.001 and ± 0.005 or $+0/-0.002$, just create that many different styles with names to suit, e.g. DIM, DIM001, DIM005, etc.

CAD is like building a wall, knowledge grows brick by brick, just adding more tricks as the years go by. I was slow and stumbling when I started. It has helped me most to have daily contact with other CAD users who share tips and hints and can be called upon when you just know the darned machine ought to be able to do that thing you want!

Peter Woods by email

Destroying old hard disks

Drilling a hole through the drive unit will not normally destroy the data beyond any chance of recovery. The only certain way, so far as I know, is to remove the unit from the computer and then melt it with oxy/acetylene or oxy/propane. That is what I do.

John Partridge Scotland

Metric and very old contributors

In common with many of the readers, World War II was a matter of fact for me, (My way of saying I'm 70+) the austerity and shortages in many ways shaped the way in which we grew up as did the education we received. (Both at school, post war where Engineering drawing, Metalwork and Woodwork were standard curriculum subjects reinforced in later years during my Engineering apprenticeship with a company manufacturing Steam turbines, Material handling equipment, Winding Engines etc.)

Everyday life with its differing scales and units (£s.d - st.lbs oz to name but two) forced us to compute in the mind without thinking every working day. Working in fractions of an inch was commonplace as was working in decimals we could switch from one to the other without flinching. 8 X 7 was 56 instantly without a calculator (they didn't yet exist) and half of $1\frac{1}{32}$ in. was $1\frac{1}{64}$ in., .625 was 5/8 of anything! OK I picked some easy ones but I think the point is made. Move on a few years and I was given the task of repairing a German Sailplane (Glider) with all dimensions on the drawing in metric.

Suddenly the light dawned; gone are the computations, my eye can

Guesstimate - see $\frac{1}{4}$ mm on a rule, an accuracy approaching .01 in. not bad without a micrometer! At this stage I went down the Metric route (although I still have most of my tooling from Imperial days. The years rolled by, six decades have passed and suddenly retirement looms, all those experiences, wood-working tools, metal-working tools "collected" over the years and now languishing in the "workshop" awaiting my attention. What do I do?

I Purchase a mini-lathe manufactured in the Far East! by the Real Bull co. At this juncture fate played a hand when I picked up a copy of MEW in the dentist's waiting room would you believe? In it was the first of Mr. Fenner's excellent articles on the Sieg C3 which I read avidly. I was hooked, a year has now passed and I am pleased to say a much improved machine sits upon the bench and many of the tooling projects have been completed to a standard that I would never have thought possible with such a small machine.

Every month I look forward to your publication date and the next issue. Thank you all.

OH! by the way, it was with fascination I read David Piddington's ("To Die Now - better than Yesterday") not for the content matter of the article, interesting as it was but the information on page 25 column 1 that suggests, nay states that "Model engineers like me who have been around for 30 to 40 decades or more may feel similarly etc. etc...."

Could David be persuaded to write an article revealing his secrets of longevity? As one who has by his own admission been around for some 3 to 4 hundred years (a decade being 10 years) he must have witnessed such events as the English civil war and he must surely have followed with interest the achievements of Isambard Kingdom Brunel not forgetting the industrial revolution.

Terry Thomas by email

PS. If this should make David feel a bit creaky I apologise sincerely.

The Editor replies: Sorry about that. It slipped through. An article would be inappropriate as it is not relevant subject matter.

Call me Methusala!

I had been die-ing (pun intended) to see the first instalment of my item regarding threading in the lathe and was reading issue 147 page 25 with a certain amount of pleasure, when I noticed the sentence containing the words "Model engineers like me who have been around for 30 to 40 decades or more..." and at the time of my proof reading I fear that the dreaded imposition of metrication had percolated into my ageing brain cells and moved the decimal point one place to the right in error.

In regard to metrication it will be noted in my series that Imperial inch fractions have, in the main, been used except where a greater accuracy is asked for and those sizes given in decimal inches. This is solely because this was the system I was trained in as an apprentice and which I am comfortable with. Later I became considerably involved with the model-engineering hobby and found that, effectively, we are engineering historians recreating in miniature working replicas of our engineering heritage. I submit therefore that if the originals were designed to the inch/foot system, then it is right and proper for our hobby creations to be made to the same standards adopted throughout the English-speaking lands of our planet. It is equally right and proper that those creations in metric should be miniaturised to a metric system.

In the early 1980s I was asked to design an engine in metric and I did my best. One builder said, quite correctly, "the designer was thinking in Imperial inches and inserting the nearest corresponding metric dimensions". Absolutely right! How could this "Methusala cum techno-dinosaur do anything else?

Recently the EC has absolved the UK from abandoning our system of measurement. That is a great relief for many who saw the imposition of metrication as one more nail in the coffin of our individuality. Metric and Imperial are only systems and I see no harm in educating people to learn another though I see a lack of sense in having one, or the other, forced on people who continue to support our hobby with the system they prefer.

David Piddington, Birmingham.

MEW issue 147 Letter from Ebbe Normark Sorensen

I have no objection to people adding the above if they so wish, but would advise that the magazine is available throughout the world and if you publish your e-mail and mobile phone number do not be surprised if you get e-mails and calls that you would rather not receive. I ask that you do not publish my e-mail address if this reply is published.

Geoff. France by email

Grinding on the side of a wheel

Greetings from Phalaborwa, South Africa.

Phalaborwa means: Better Than the South. It is also referred to the town with two summers. We are the only town bordering the Kruger National Park.

YOUR CHANCE TO TALK TO US!

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

I am a newbie to the game; my metal lathe has just had its first anniversary!

The saying goes: Men do not grow up, the toys just get more expensive!

Thanks for the great magazine, I discovered it and start buying from issue 124. The current one on our shelves is issue 143. We are a few copies behind the actual issue date. Just as I think of something to read or get more detail about an article appears in MEW. Having a large collection of Workshop practice books, some of the articles are extracts from the books and refer back to the books. In issue 143 the matter of reference to previous issues is raised, I visit the website regularly. I have just been there. What is the estimate date of the website being up and running? I would like to see the articles from previous issues on the web, say lagging publication date by about 6 months. That would give us, the non UK residents time to still buy an issue and you the publishers time to sell the printed copies.

I see on the web and in magazines that people tend to grind on the side and not the face of the wheel, this is a dangerous practice. The grinding wheel is designed to work on the face and not designed to take load on the axial direction. The wheel becomes thinner and cannot be dressed to have a sharp cutting edge. This causes more heat to build up and more potential disaster.

My mentor gave me the following pointers to keep in mind.

They are posted in my workshop and apply to metal and wood.

As I enjoy making swarf or sawdust. Remember!

- No Clearance! No Cut!
- No Rake! No Chip break! Except for brass.
- Beware of Flying chips.
- A rough edge doesn't cut, it shears and shearing takes more power!
- A ground edge does not cut clean.
- Grind Sharp and Hone Keen!
- More contact needs more torque.
- For a good surface, the land area must be about 2.5 times the feed rate.
- Tools do not cut properly because they are blunt; it is because they are not sharp.
- Coolant is as the name says to keep the tool cool!
- With enough force you can break anything.
- A sharp tool at almost the correct angle is much better than a dull tool at the correct angle!
- When in doubt, stop and think through the process.

Sulphuric acid

In response to the letter from Alan Sayner, I would suggest he checks the yellow pages or classified directory for a local supplier of batteries, lead/acid type. Many years ago I obtained sulphuric acid from a company that actually manufactured traction batteries. There are a couple of problems with sulphuric acid that MUST be taken into account. Firstly it is acid and will burn through any clothing it comes into contact with, so rubber gauntlets and rubber apron along with a full face shield are essential. Secondly because it is acid it can not be sent through the

post and most carriers will not transport it. Sulphuric acid for batteries is normally "hotter" than is required for metal treatment, by that I mean the specific gravity is usually around 1.4 to 1.5 when purchased. When diluting the acid with distilled water it is essential to add the acid to the water, very carefully pour down a glass or plastic rod do not tip the acid into the water. Other suppliers may be companies that service fork lift trucks or electric vehicles or companies that supply automotive electrical parts. I hope that this helps.

Les Pitt by email

Is a tool Right or left handed? Hold your hands with thumbs up. Bend your fingers at 90degrees with hand palms. The cutting happens at the finger tips. Now look at your tool tip, right side up. Where is the cutting edge pointing to, like your right or left hand?

If the cut must be symmetrical, the tool must be symmetrical. Drills and thread-cutting tools must be ground to be symmetrical; no exceptions.

Drilling thin material requires a drill sharpened to a larger angle. The default of 59 degrees is difficult to set accurately; an angle of 60 degrees can be set more accurately and repeatable at the exact angle. Hobby and Model builders are more likely to drill thinner material, requiring drills of more than 59 degrees.

Edward Potgieter by email

Dave Fenner and tube bending

In response to Dave's query, whilst I have not previously come across the use of candle wax (or the commercial variant of paraffin wax), I did use Cerrobend many years ago although I still use compacted sand to limited effect for both cold and hot forming.

I would query the ability of wax to retain an adequate tube profile against flattening and consideration may be necessary for a practicable working temperature range where breakage could result in a total loss of internal support. Should the use of wax prove to be suitable, an effective working range of temperature may be gained by blending the molten wax with other ingredients, e.g. olive oil, to provide increased pliability to achieve a consistency between that of candle and ear wax (not the natural type but that available for noise reduction plugs). An increase in filler material integrity during tube forming may be achieved by adding some fibrous material to the blend with chopped strand glass being one of the more readily

available although choice of fibre length may present some limitations. This material is used in simple hand glass reinforced plastic constructions to strengthen vulnerable regions with a typical fibre length of 6 and 13mm being listed as available from Fibreglass Supplies in Leeds. Such fibres are generally used to add strength to polyester based filler materials, either alone or in conjunction with powdered fillers where large volumes of resin only tend to generate significant heat during curing. Flammability would be a risk together with using solvent to ensure complete removal before any subsequent welding or brazing operations.

A couple of years back, whilst visiting one of my specialist sub-contractors to produce some tight radius bends in stainless steel tube (8mm OD x 1mm wall) the general subject of tube bending was discussed with advice being given that on some jobs limited use was still made of a loading material described as 'gum rosin' which was supplied to them in 250kg units. Other similar users describe this material as 'gum resin'. It has been in general use for a significant period of time but has a number of potential problems for major uses in that it is a 'sensitiser' for skin allergies and again requires use of solvent for complete removal.

Although a bit too big a quantity for most private applications, it is possible that reduced size packs may be obtained from suppliers to other industries or hobby users.

One possibility is for gem stones where I understand it is used for temporary workholding although here the pack sizes may be too small and hence have an associated cost elevation.

A far better material would now seem to be available and which has only been around for about a year, are a couple of 'bending' grade resins that are available from John Neale in the West Midlands, WS8

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, Magicalia Publishing Ltd., Berwick House, 8-10 Knoll Rise, Orpington, Kent BR6 0EL. Alternatively email: david.clark@magicalia.com

THE STAR LETTER OF THE MONTH WINS A WORKSHOP PRACTICE BOOK

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Pyrometer help

I suggest David Gregg telephones Carbolite Furnaces, Parsons Lane, Hope, Nr Sheffield on 01433 620011 who manufacture bench-top and other laboratory type furnaces. Whilst I would recommend them, I have no connection whatsoever apart from acquiring thro' auction one of their computer controlled furnaces which has performed brilliantly over the past 5-6 years!

I have enjoyed both MEW & ME for plus 50 yrs. I'm not happy about the possible future price rise, which I suppose is inevitable these days, but can't you consider a touch of the Percival Marshal philosophy in penny-pinching and publish on less expensive paper and 'flash' printing during this recession so that we can continue to support you at a reasonable price! You should know that we (Model Engineers) are a tight lot!

Grahame Hibbert by email

for 2.5xD bends at around £8/kg (presumably plus P&P and vat) with WS10 @ £10 for 1xD bends. Melting point is quoted at 70deg.C with the latter grade having fibre reinforcement. Material density is around 1.0 so 1kg is equivalent to 1 litre. Surplus resin can be readily removed by simply water washing after melting out the majority! High fluidity is reported permitting use on smaller tube sizes although some preheating may be necessary to alleviate 'the chill effect' of the metal.

Discussion with existing users would indicate suitability for use on a large range of pipe/tube diameters (3 to 160mm diameter) where the diameter/thickness ratio is particularly large, including exhaust system pipe work in carbon and stainless steels.

It would be interesting if any readers have first hand experience of these special resins and if suitable to meet with the general requirements for model engineering together with applications of motorcycle frame and special vehicle chassis and suspension constructions.

I may even be tempted to deviate from my current workshop tasks to procure sufficient of these resins to conduct some trials myself!

I would however add a footnote to the effect that bent tubes should not ideally be used in structural applications as the pre-bent tube is effectively in a failed condition and could lead to premature collapse under some loading conditions.

However vehicle exhaust, cooling and oil system use would be considered satisfactory.

Steve Keil by email

Tailstock dieholders

The article on threading with a tailstock mounted die holder in MEW 147 by David Piddington has several points I found interesting, but can I add a small suggestion? The levers, ball ended or

plain on the actual die holders are 'thumb smashers' and I have removed them from all of my die holders. Instead I use a redundant arc welder's glove on - in my case - my right hand, to grip the knurling of the holder to operate. One can use a bare hand but it gets rather sore rather quickly. I find that one's application of grip and release is much more finely adjustable than the use of the 'thumb smashers'. The added advantage is that there is then nothing to catch on any part of the lathe creating an uncontrolled application or damage to self, job or machine. I would also add that with manufacture of a sliding holder with a keyless chuck attached, internal threading can be done with similar celerity, using the same method.

Peter King by email

Metric or imperial

I have just read issue 147 of MEW and would like to add a modicum (metric or imperial) of humour to the subject. About 40 years ago a friend of mine went into a shop to buy some $\frac{3}{16}$ Whitworth bolts only to be told by the shopkeeper that he had gone over to all metric. He enquired what the metric equivalent was to which the shop keeper replied 2BA.

David Sterling, Essex

Electric etching pen

During a lifetime in engineering, if you wished to mark hardened tools or gauges etc, you could use an electric etching pen. Basically this is a transformer plugged into the mains with the negative output to the job and the positive output to the etching pen. This was a crude device consisting of a wooden handle with a gramophone type of needle clamped to it. Then you could write onto the component.

It was not a gramophone needle because we had to send to the manufacturers for replacements as they were made from special steel. Basically, it operated like a small arc welder.

Are these etchers still available or could one of the readers design one?

I have tried a Burgess Vibro Etch but it is not as good as the electric etcher especially on round parts. I imagine it was the older readers like me who would have used them. I think it was originally called the etching pen.

G Bird, Herts

Broken Tee nut 1

Peter Shaw's Teen nut could be a stress related problem. The crystalline structure suggests it, especially as it starts at the corners. I would say high carbon steel content and blunt cutters causing unnecessary stress combined with lack of tempering of the component after manufacture would have caused it.

I would anneal the other Tee nuts before use by heating to a dull red and allowing to cool in fine sand, that should do it.

As an afterthought, try a hardness test on the broken nut with an old file to prove it. If not, it may be cast iron. I am a retired toolmaker (machine tools was my apprentice time) which I enjoyed and I

kept changing jobs every two or three years to learn another aspect of tooling or precision engineering. I have an ML7 lathe and combined mill/ drill. I have spent a lot of my life as a horizontal/ vertical jig borer and still have an interest in it. This is why I like Model Engineers' Workshop. I'm not keen on CNC, I tried it in the late 60's but got bored with it. I like to make and repair things by hand, usually what someone else can't do.

Dick Newton, London

Broken Tee nut 2

Mr Peter Shaw described a failed Tee Nut. I seldom use them as they are too expensive! I use cup-square bolts which are cheap and plentiful. You find a suitable size bolt for the tee slot you are using. For the Myford I use 8mm bolts. You pop them in the vice and file down the top of the mushroom bolt head until it will just slide into the bottom half of the tee slot. You then file two flats on the side of the bolt's head. To do this you hold the bolt in the vice by the mushroom shaped head and file a flat on one side of the head. Rotate the bolt and file another flat opposite to the first one. The amount to file off will depend on how wide your tee nut slot is. This is not very critical I like to make them a nice sliding fit. Underneath both the Myford and my milling machine (which uses 10 MM bolts) I have boxes containing various lengths of bolts. There are very often much easier and quicker to use than tee nuts and do not tend to get jammed up with swarf.

I hope readers will find this useful I can't claim to be the author of the idea because my father used them.

Dick Parsons

Broken Tee nut 3

The cause of why Peter Shaw's Tee nut broke is quite obvious: brittle failure. From there onwards, however, I can only make an educated guess. This guess goes as follows:

The material is some iron alloy, possibly cast iron, but not necessarily so. It may be just plain mild steel. The brown appearance of the fracture surface then would be due to material of any composition (lets call it "A"), of any colour, with a thickness in the order of micrometers, so that the colour is created by interference between the top and the bottom layer of material "A", in the same way that annealing colours (ranging from straw yellow via brown to blue and eventually near-black) are due to a thin layer of mill scale, yellow denoting the thinnest, brown and blue increasingly thicker and near-black the "bulk" colour of the iron(II,III)oxide, better known as magnetite or Fe3O4 which forms the bulk of mill scale. If you have some knowledge about gold you may recall that very thin sheets of it are green and transparent, for similar reasons.

Brittle failure is, to the uninitiated, just a name. To the student of material properties, it is the opposite of "ductile failure". It means essentially that the property of metals we all take for granted, its ductility, was not present at the

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moment of failure and that material A behaved like a piece of glass would have, shattering at the slightest provocation and well below its load rating. All ferritic steel is subject to brittle failure below the "Impact Transition Temperature, ITT", but austenitic steel is not. Ferritic steel is magnetic at room temperature and may be hardened by quenching, austenitic is not and softens with quenching. Stainless steel may be either ferritic (knives!) or austenitic (pots and pans), depending upon alloy content. The ITT may be as low as -80 Centigrade (Offshore Steel, BS 4360 grade 50E with additional certification) or as high as 200 Centigrade (high carbon steel). In-between everything goes, and do not assume that the ITT is specific to some alloy content. It is not. By appropriate mistreatment, the ITT can be moved upwards by at least 60 degrees. That is where my experiments with Offshore Steel ended - the trick in making structural steel is to keep the ITT down and avoid like the plague what moves the impact transition temperature up. These experiments, by the way, were done to demonstrate to the construction guys why not to punch holes in girders (cheap but bad for ITT) but to drill, or what happens when they start welding (the ITT goes up), or, worst of all construction crimes, to repair or modify a crane hook by welding (that's scrap, and no excuse is accepted).

This is the likeliest scenario. In it, the brown fracture surface would have retained some residue of metallic lustre, and the failure would have happened during a cold spot. The large "crystals" visible are not genuine, but this may only be seen in a scanning electron microscope. Optical microscopy does not have an adequate combination of depth-of-field and resolution.

Another scenario I can think of implies stress corrosion cracking. There, the requirements are: long-term stresses in a corrosive environment, preferably with chloride (sea spray) present. I am not aware of mild steel behaving such, but some high tensile and high alloy steels have been documented to suffer from it. The brown layer then is ordinary rust, running in veins through the steel along grain boundaries. The long-term stresses may be internal and not apparent.

Wolfgang Vogelbein by email

Broken Tee nut 4

I have now tested one of the remaining tee-nuts, the broken bits and a homemade mild steel nut. All are magnetic, and hence ferritic. They also look as if they have been heat treated to prevent rusting rather than being painted. Wolfgang's "educated guess" suggests to me that these tee-nuts have possibly been incorrectly heat treated with the result that the Impact Transition Temperature, ITT has been moved upwards with the result that extra stress resulted in the broken tee-nut.

Wolfgang says: "the failure would have happened during a cold spot". I assume by that he means during a period when the workshop temperature was low. I don't

actually recall the temperature at that time, but I do know that I have had occasions when in order to allow my grandson to use the workshop equipment, I have had to switch on the fan-heater. It does therefore seem possible that the metal may have been very cold.

In respect of long term stresses and corrosion, I have only owned these tee-nuts for a few months now, although obviously I don't know how long they have been in store. I do live 8 miles from the coast, but cannot see sea-spray reaching that far!

It will be interesting to see if I can break the remaining tee-nuts!

Finally, I mentioned above my grandson. Readers may be interested to read about him. Jamie is 13, and from a very early age, showed a keen interest in using tools and doing practical things. He is very quick to understand and always wants to have a go, so much so that I now encourage him to have a go at anything, saying "there is only one rule - don't hurt yourself!". I take the attitude that I am not bothered if he breaks something, at least he has tried and will have learned from the experience. So far he has done turning, milling, screw-cutting using taps and dies, drill sharpening, used the bench grinder, bench and hand drills. Of course, I insist on safety goggles, and a dustcoat, and I show him how to do it first. In the near future I hope to discuss and show the difference between diamond and carborundum stones, and to use a metal cutting grinding disk to cut up an old file in preparation for conversion to lathe tools.

I consider myself very lucky to have such an able grandson.

Peter G. Shaw by email

About marking out

When marking out an intricate pattern on steel in order to fretsaw it out, the use of marking out fluid is an obvious choice. The marking stands out clear and crisp when you have used your sharp scriber, but this condition will not last. After a minute or two of handling the piece while fretting, the crisp lines begin to smudge and are soon unreadable.

There is, however, a cheap and easy way to avoid this. Prepare a marking out fluid by extracting the innards of a discarded black or blue marking pen with about 30 ml (cubic centimetres) of methylated spirit in a small jar with a tight lid. After it has been left standing for an hour or so fish up and

squeeze out the extracted innards of the pen. Now dissolve 2 - 3 grams of flaked shellac in the dark fluid or if you can get hold of ready made French polish add about 3 - 4 ml of that instead. The shellac will make the dried layout impermeable to water solutions. Kept in well closed jar the lay out fluid will keep for a very long time and is now ready to use. You can also use an acid solution of copper sulphate. In a plastic jar with a tight lid, an empty medicine jar will fit the bill, dissolve about 2 - 3 grams of copper sulphate and 2 gram of citric acid in about 30 ml water containing one drop of washing up fluid.

This solution also keeps almost indefinitely.

Procedure: Cover the bright steel with an even coat of the marking out fluid with the help of a pin covered with cotton or a soft brush. (The cotton pin is disposable, the brush must be cleaned in spirit or it will dry hard and be unusable). Leave the steel to dry in a moderately warm place until dry. Do the desired marking out with a sharp scriber so that the bare steel will be seen. That done swab over the marking out with the copper sulphate solution using another cotton covered pin taking care that every line has been wetted. Rinse in water and wash off the lay out colour with a cotton wad moistened with meths. The marking out will now stand out nicely in bright copper which will not smudge during handling.

Göran Zdansky by email

A challenge

So far, readers have come up with every type of cutter grinder bar one. I need one that will sharpen multi-blade razors. They cost more than indexable carbide tips but when they lose their edge, we simply throw them in the bin. Single blade razors are easy to sharpen on a strop but as this cannot be done with multi-blades, I am throwing down a challenge to readers to see what they can come up with.

David Sterling, Essex

Steel and brass supplies

Just to let readers' know that if they only want small amounts of steel & brass etc, B&Q keep these in 1 metre lengths, I have also found that the brass price from them does not follow the upward trend so quickly, ideal for model engineers in the small scales who do not want to keep visiting stockholders or buying minimum quantities.

Rob Wolfenstein by email

Future articles - A reply to Roger Vane MEW 147

After another look at my article on the Stent, I realise I concentrated on the machine design and hardly mentioned workholding, mainly because at that time I had only just finished the machine and it hadn't had much use. With experience I've found some things work better than others, and so there have been additions and modifications. It is time for an update. I've had a word with David Clark and I've agreed to write a follow up covering work holding and use of the grinder. As part

of the modifications, I fitted a 150 dia x 6mm wide wheel to the machine, which necessitated providing a wheel balancing arrangement which I will include in the article.

The drill grinding attachment I referred to is fitted to a colleague's machine and is the "Potts Drill Grinding Jig" for drills from 1/16in. to 1/2in. dia. It was originally supplied by Woking Precision Models and is now available from Hemingway Kits.

Charles Woodward by email

TRADE COUNTER

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Myford metal preservatives

Back in April 2007, the Trade Counter section of Issue 124 of MEW carried an item from Dave Fenner announcing the introduction of two rust inhibiting products supplied by Myford. He also set up three steel test pieces, one untreated, each of the others being coated with one of the products. The three were then hung up in the workshop. Dave has recently looked at these pieces and gives the following comments.

"It was actually on the 9th February 2007 that I set up the test pieces and took **photo 1**, so, at the time of writing almost exactly two years have elapsed, during which time the weather has moved back and forth across the full spectrum we expect in Scotland, and the untreated workshop has enjoyed wide variations in temperature and humidity.

To recap, three strips of 3mm thick black steel were cleaned up to remove (almost all) the mill scale. No. 1 was left bare; No.2 coated with Rust Ban 393 and No.3 with Calpreve 91.

Photo 2 was taken on 4th February 2009 and shows how each has fared. Clearly No.1 is well rusted. Nos.2 and 3 show some tiny spots of corrosion. Comparing carefully with **photo 1**, it looks as if these have emanated



Photo 1.



Photo 2.

from points where the mill scale was not completely removed. If there are readers with expertise in corrosion propagation/prevention, they may wish to comment.

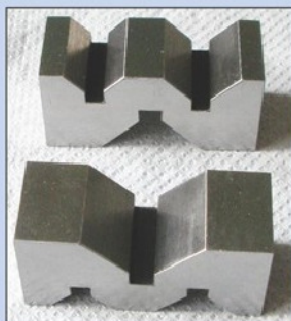
At this stage, rather than wash off the protective films for closer examination, I have hung the steel pieces up again to continue the test. Thus far, I feel to see such a result after this length of time speaks for itself and gives a ringing endorsement to the products, which are displayed in **photo 3**."



Photo 3.

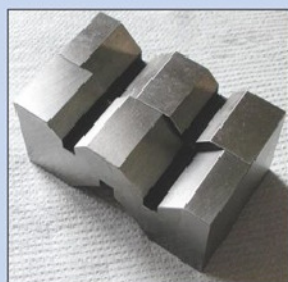
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Warco Vee blocks

Warco have introduced two different sets of small Vee blocks. The first set is 50mm (2in.) long, 19mm (3/4in.) wide and 24mm (1 1/8in.) high. When I first looked at these, I thought they had been ground off



centre. Then I realised that the double Vee side actually had two different depths of Vee. This is a useful feature as you can put the round bar into whichever Vee is suitable.

The larger set is similar and is 75mm (3in.) long, 25mm (1in.) wide and 35mm (1 3/8in.) high. They are all

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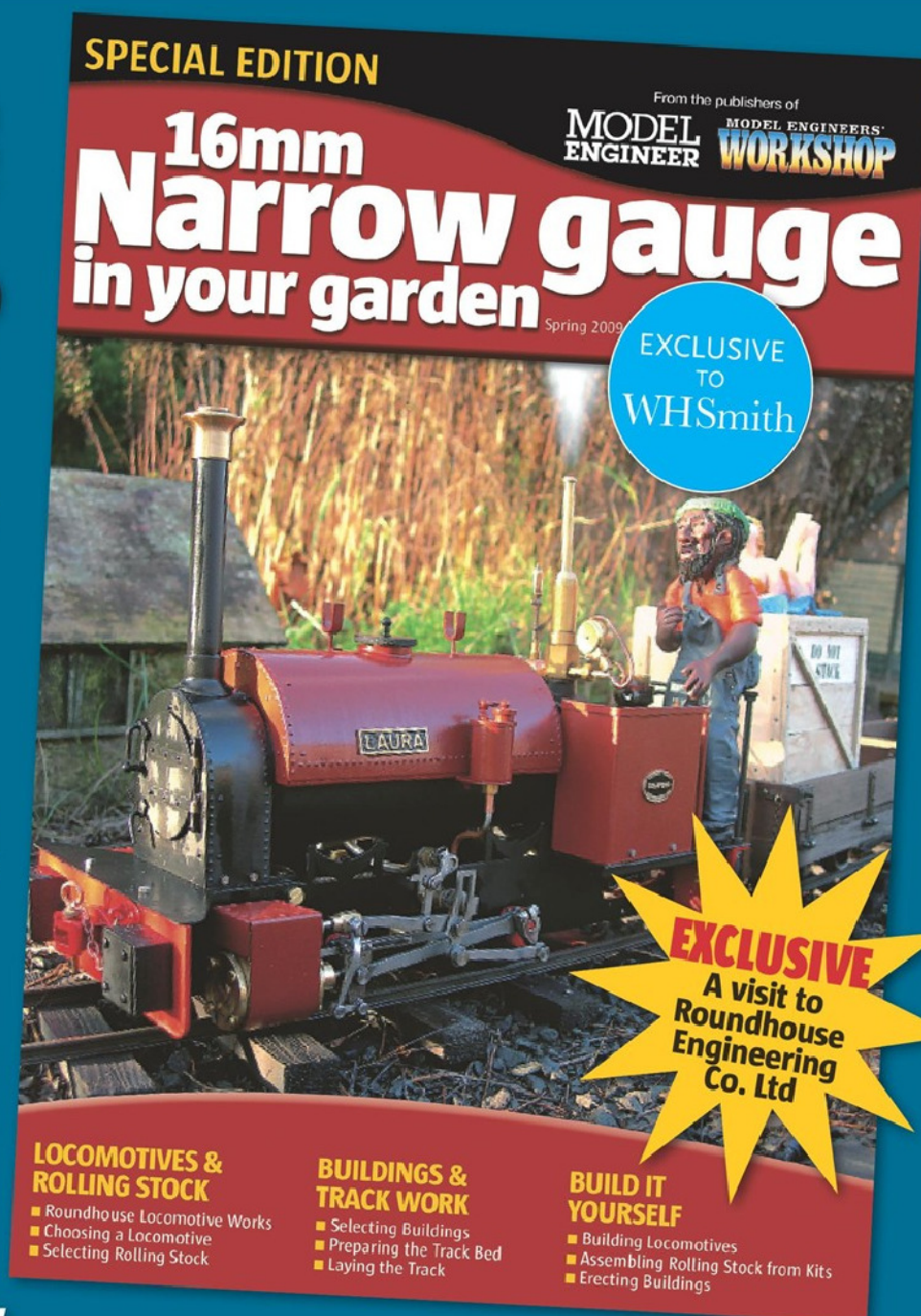
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■ Imperial tumbler reverse gears (metal) and thread dial for Boxford ME10. **Tel: 01565 653916 Cheshire.**

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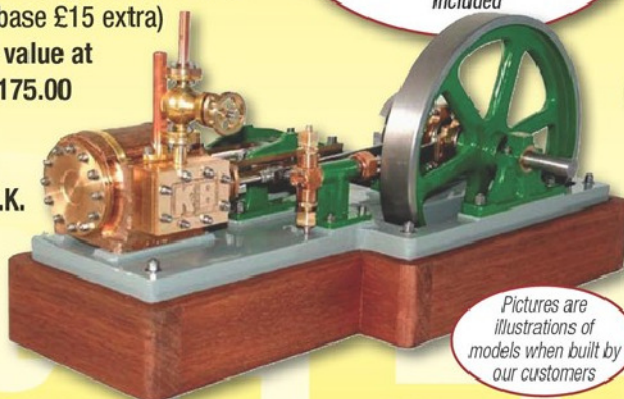
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CPD10B 245/5 £59.99 £69.99

CPD15B 300/5 £79.99 £91.99

CPD10B 370/12 £89.99 £103.48

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CVR150B 150x180x80 mm £33.99 £39.09

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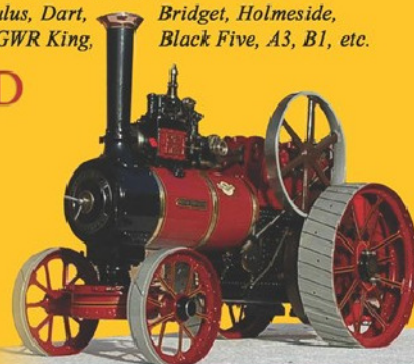
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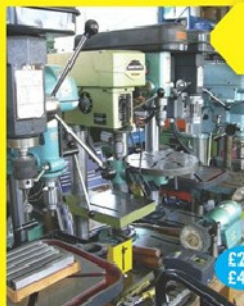
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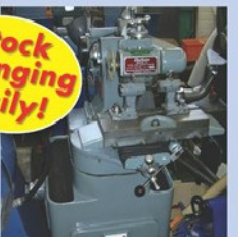
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Boxford 250STS (rare 240 volts model)



£1125

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RJH Trimtool grinder (240 volts)



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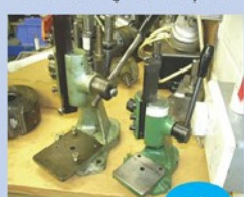
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< Swage block

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From £20

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Speeds	7 - Lathe 14 - milling 0.2-3mm
Metric Threading	8-12TPI
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Headstock Bearing	300x 150mm
Milling Table Size	300x 150mm
Motor	3/4hp-240volt
Size	930 x 690 x 1090mm
Weight	155kgs

FEATURES
• Large 16" Swing
• All Tapers MT3
• Cast Iron Construction
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Supplied with
• 3-Jaw Chuck
• Steel Centres
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• Dula Purpose Vice
• Change gears



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Motor	420w
Power	240volt
Blade Size	1300 x 0.63 x 12.5mm
Packing Size	760 x 295 465mm

FEATURES

- Cast Iron Base and Arm • Can be used with stand supplied or bench mounted
- Roller Bearing Blade Guides • Angled Cutting • Auto Switch off when cutting finished
- Ideal machine for the Home Workshop providing large capacity cutting in a small space.

£145.00



DB11VS

Centre Distance	700mm
Swing over Bed	280mm
Spindle Bore	26mm
Motor	1200w
Spindle Speeds	125-2500rpm
Net Weight	180kgs

FEATURES

- Digital Speed Readout • T Slotted Crossslide • Variable Spindle Speed • Metric & Imperial Thread Cutting • Longitudinal Power Feed

STANDARD ACCESSORIES

- 3-Jaw Chuck • 4-Jaw Chuck • Face Plate • Coolant Tray • Rear Splash Guard • Lathe Tool Set • Chip Guard

£1188

CENTURY MILL



FEATURES

- Variable Speed Spindle
- Digital Depth Readout
- Fine Feed Quill
- Heavy Duty Cast Iron Construction
- Strong 1.5hp Motor
- Angled Milling Head
- Wide Speed Range

Max Drilling Capacity	20mm
Max End Mill Capacity	22mm
Max Face Mill Capacity	70mm
Table Size	600x180mm
Cross Travel	200mm
Long Travel	350mm
Taper	MT3
Speeds	50-3000rpm
Size	720x565x1020mm
Weight	135kgs

£875.00

D13 AND D13R BENCH DRILLING MACHINE



FEATURES

- Supplied with Keyless Drill Chuck and Arbor
- Rigid Cast Iron Construction
- Drilling Table can tilt for angled drilling
- These are a quality drilling machine with high standard of finish that would complement the home users works

DR13R £95

DR13 £65

	D13	D13R
Drilling Capacity	13mm	13mm
Chuck Size	1-13mm	1-13mm
Spindle Travel	50mm	60mm
Spindle Distance to base	350mm	535mm
Spindle Distance to table	210mm	415mm
Spindle Taper	MT2	MT2
Speeds	5 x 600-2500rpm	5 x 460-2890rpm
Height	585mm	800mm
Motor	250w	370w
Weight	17kgs	29kgs

WHY CHOOSE CHESTER?

• ONE YEAR WARRANTY -

All machines come supplied with a 12 month manufacturers parts warranty from date of receipt of delivery

• MADE TO LAST -

Chester Machines are built to high standards. All machines are made from cast iron and quality checked throughout production.

• WE KNOW MACHINE TOOLS -

A good understand of machine tools and there environment is essential to provide you the customer with the right machine.

• LATEST TECHNOLOGY -

Chester continue to expand their range of machine tools and accessories, enabling us to offer the widest range of machines and tooling in the UK.

• SERVICE AND SUPPORT -

Chester offer parts and after sales service from both our Chester HQ and Midlands Showroom alongwith local agents here in the UK and Overseas.

• EXPERIENCE -

Chester have been distributing and installing machine tools all over the UK and Overseas, for many years, including private individuals, training establishments, schools and industrial customers.

For full details on these and other machine tools please contact

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