

No.265

INSIDE: DIVIDING HEAD PLAN - SHEET ONE IN THIS ISSUE

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MARCH 2018

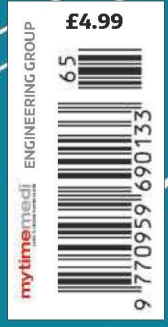
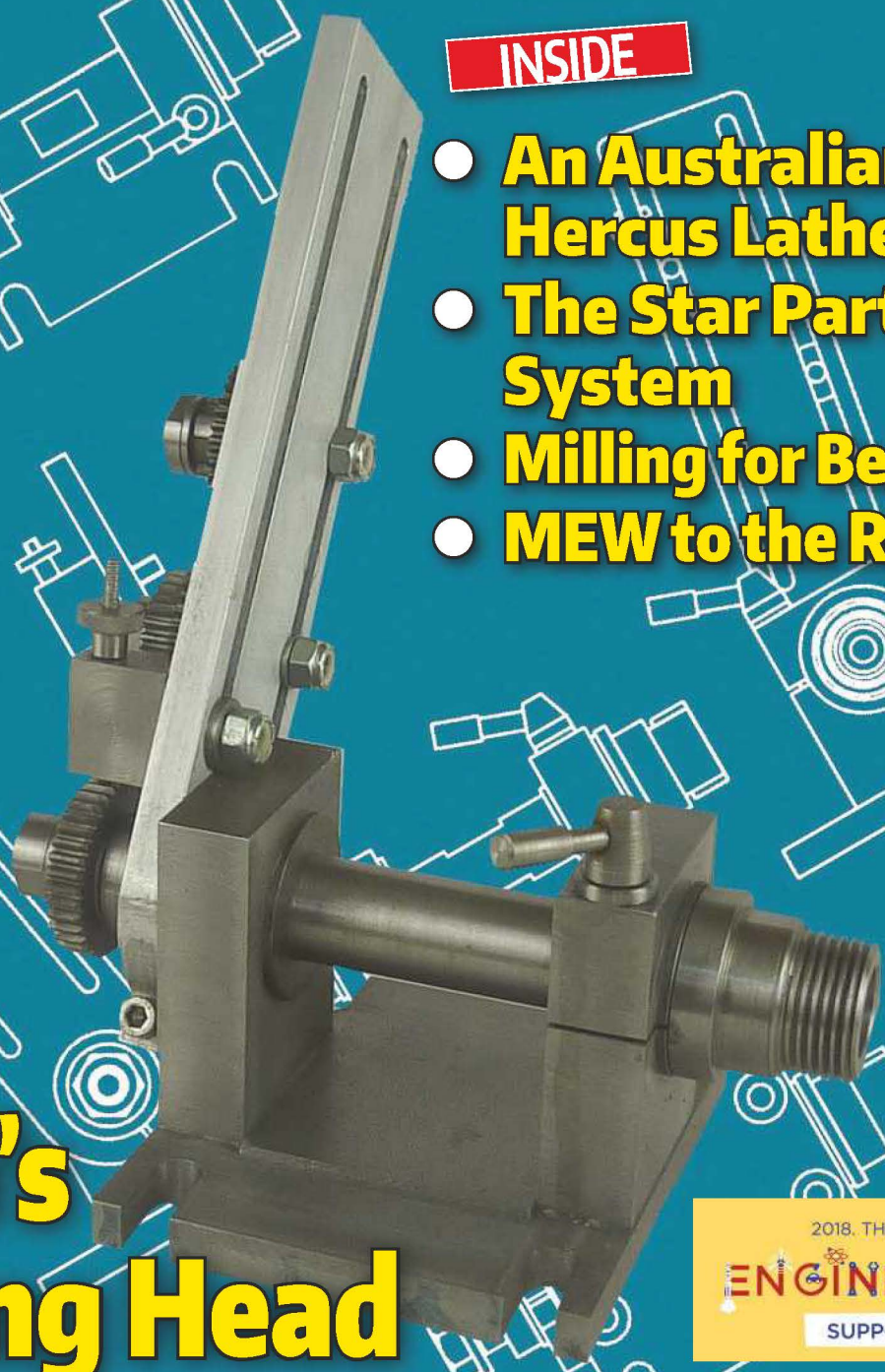


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- **The Star Parting System**
- **Milling for Beginners**
- **MEW to the Rescue!**

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On the Editor's Bench



John Wall

My current project is to make a refracting telescope, based around a very nice lens cell using an ED element. Ironically, the day I started work on the Crayford focuser, I heard the news that its inventor, John Wall had passed on at the end of January, aged 85. He didn't patent his focuser design preferring to make it freely available through the Journal of the British Astronomical Association and following this up with a constructional article in Model Engineer. It is now to be found on virtually all high-end amateur telescopes, or as an expensive CNC produced upgrade – ironic given the design was intended to allow amateurs with basic tools to make a simple but effective device! A design engineer for Vickers Armstrong, among his other inventions was the zerochromat telescope, its relatively thin lens requirement allowing him to build a 30" refractor, the equal fifth largest ever made and the biggest refractor ever made by an individual. You can download his article on the Crayford focuser from <https://tinyurl.com/MECrayford>.



Year of Engineering News

Following news of the 2018 Year of Engineering, Graham Meek got in touch to let me know some good news about an apprentice at an engineering firm local to him.

Ryan Heath from Gloucestershire based Grail Engineering Ltd scooped the prize of the UK Manufacturing Apprentice of January and receives £100 Amazon Vouchers as a reward. The initiative has been set up by AMI, a web design & marketing agency that specialises in supporting UK manufacturers.

Ryan now qualifies for the AMI UK Manufacturing Apprentice of the year, soon to be joined by the eventual winners of the remaining months of 2018. The competition has been launched to find and recognise the very best apprentices currently working within the UK manufacturing industry.

Julian Grail, Manager at Grail Engineering said: "Ryan is in his 4th year of a 5 year apprenticeship. He has made outstanding progress both academically and with his practical skills. Ryan is always professional, has outstanding communication skills, and is a great ambassador for our company."

"He has taken leadership in implementing new manufacturing technologies within the business. Specifically he is our most skilled operator of our state of the art Bystronic CNC 250 tonne press and has played a leading role in bringing into production our new CNC plasma cutter, Ryan is very much a team player and always contributes to continually improving our processes."

Grail have been training apprentices for over 30 years, bringing apprentices into the business brings fresh ideas and new perspectives. Training their own people also gives them the chance to develop bespoke high quality training programs to meet their specific needs.

If you know (or even employ) a young engineering apprentice why not let them know about the competition?



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080-030-00352	R8	Long	£1,381.24	

*Special offer price - Subject to availability

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Coming up...

in our next issue

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HOME FEATURES WORKSHOP EVENTS FORUMS ALBUMS

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THIS MONTH'S BONUS CONTENT

Log on to the website for extra content

A Free Plan for Bob Fletcher's Filing Rest, first published in mEW 19, October November 1993.
www.model-engineer.co.uk/filingrest



Any questions? If you are a beginner and you have any questions about our Lathework for Beginners or Milling for Beginners series, or you would like to suggest ideas or topics for future instalments, head over to www.model-engineer.co.uk where there are Forum Topics specially to support the series.

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Accurate Measurement
What are the practical differences between using a caliper and using a micrometer?

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Converting a Tailstock to Capstan Feed



This idea from Paul Zeusche could be usefully applied to many different lathes.

The aim of this modification was to convert the standard acme thread driven lathe tailstock quill to that of a rotary geared movement and to extend the travel to compensate for the loss of reach caused by the installation of a DRO on the rear face of the saddle. In addition, it was preferably to be completed from what I had lying around and with existing equipment. As with any modification a return to what existed originally is wise in case it turns out not as beneficial as expected.

My 16" lathe has a robust tailstock that weighs in at a hefty 175lb, but has several inherent deficiencies, as do most standard tailstocks for most small lathes. The width of the saddle is 6", about the same as the standard travel of the quill, but in my case further reduced by the space taken for an installed DRO and its protective cover on the rear face of the saddle, a further 1-1/2" in this instance.

When a larger diameter part is in the chuck that prevents the saddle moving under the part or the chuck jaws when they are extended, the amount of travel in the quill is often not enough for the operation in question.

Additionally, after heavy use the quill either has to be retracted fully to eject the Morse taper tool or extended fully



Disassembled original quill, LH acme shaft and bearings and nut.

to expose a transverse hole to allow a tapered drift to free the tool, so there is a lot of tedious winding back and forth to simply change from one tool to another or to repeatedly clear swarf from a deep

hole. Sometimes the entire tailstock has to be moved just to change a tool and any previous settings thereby lost.

The aim was at least to regain the lost reach caused by the DRO and also to



Turning a spigot on the extension piece to match the existing quill.



Drilling for fastenings on a matching PCD on the rear of the original quill.



Extension piece bolted to the quill and machined to matching diameter.



Reducing the rack to 3/8" x 3/8"

convert the quill movement from a rotary handwheel/acme thread at the rear to a geared rack more conveniently situated on the facing side of the tailstock body and toward the front where it is closer to the tool in use. A suitable mechanical advantage afforded by the gear ratio and handle length would suffice for larger hole drilling and a rapid withdrawal for chip clearing at the same time.

Some basic measurements, **photo 1**, were taken to determine the limiting factors, the full travel was a function of the effective installed acme shaft thread length and the overall length of the quill was governed by the position of the key in the bore while retaining a reasonable supported length in the housing at full extension, roughly the same as the extension plus a 'bit'

It was observed that any increase to the quill travel would require an extension to the rear of the quill as the keyway in the bottom would otherwise disengage from its key past the standard travel and that the quill itself would benefit from additional support within the tailstock casting. An arbitrary length of 3 1/2" was chosen for this addition.

A bored hole was provided in the quill extension with a corresponding guide deep inside the quill bore to allow a simple 3/4" rod to reside permanently inside as an 'ejector' for any tool in the quill regardless of where in the range of travel it may be.

A search through the scrap box turned up a length of 16 pitch gear rack and a matching plastic 28 tooth gear. The developing concept was to machine an extension to the quill that would replace the left-hand acme threaded nut and recess the newly modified gear rack in a blind slot at about 25 degrees below horizontal and just below the surface of the quill to avoid the oval slot provided for a drift to free a tool in the quill

The gear and drive pinion would be carried in a machined aluminium housing attached to the side of the tailstock with a slot through the casting and within the housing to allow the gear to mesh with the rack, the top end of the drive pinion was to have a large hex to take an existing three spoked handwheel borrowed from a



Assembled extension showing keyway slot in foreground and recessed rack.

machine vice on another machine.

The other requirement was to be able to return the quill to its original configuration, that is handwheel/acme thread driven, without problems or indeed a great deal of time or effort should this be required. If using a large diameter drill requiring significant pressure there is a choice to revert to the acme thread driven quill or use the Morse taper quick change tool holder, the latter being the easier option.

A timed change back to original only takes about 3 or 4 minutes and involves a single 8mm allen wrench.

The first part was to machine a lump of 3" diameter steel 4" long with a 1/2" long spigot to mate with the internal diameter of the back end of the 75mm diameter quill, **photo 2**. Three clearance holes were drilled to the matching PCD of the existing tapped holes in the quill that originally held fastenings for the left-hand acme threaded 'nut' and these were counterbored for three 8mm x 100 mm metric socket head cap screws, **photo 3**.

The quill was set up in the 4-jaw chuck and indicated to run true as possible, the back end was faced clean and the new part bolted in place. This was turned down to a coincident diameter and a 3/4" clearance hole drilled and bored for the future ejector rod, **photo 4**.

This machined and assembled part was transferred to the mill and the keyway extension in the bottom that prevents quill rotation extended fully through the new part. The keyway locates over a short floating key in the bottom of the tailstock bore to prevent the quill rotating. The quill therefore can only be entered from the chuck end, so the keyway must extend all the way through, a small tapped hole within the extended keyway was added for a socket head cap screw later on to act as a stop to the travel once assembled.

The total "new travel" was selected to be 8" with the position of the rack starting at the back end of the original quill, an additional one inch was added for gear

tooth engagement. In order to avoid the oval slot in the quill the position of slot was rotated about the axis by 25 degrees and given my gear was only 1.844" diameter this provided clearance for the pinion and the proposed handwheel as it emerged at an angle from the new housing. An additional benefit is the axis of the handle is more conveniently at an angle adding clearance to the lock handle and the sliding stop

The down side was some tricky set up work for all subsequent operations, a larger diameter gear could have avoided this, but decreased the mechanical advantage even further and made the housing larger as well.

The gear rack was reduced in dimension from 0.5" x 0.5" to 0.375 x 0.350" in the shaper as the large vice could hold the part securely and the cut taken in a single set up for the side and bottom, **photo 5**.

The quill without the extension piece was located on a table slot, that is along the X axis and rotated 25 degrees anticlockwise with the centreline of the spindle on part centreline. A slot was milled in the quill to a depth so that the rack was just below tangent at its edges and extended through the back end of the part, that is open to the end of the quill, **photo 6, photo 7**. Without disturbing the set up and with the extension piece bolted back in position the slot was extended now reduced in depth coincident to the bottom of the rack tooth plus 25 thou for the remaining length to allow the tailstock to be removed/installed with the drive gear in place.

As this becomes effectively a blind slot no fastenings were needed to hold it in place, the thrust being taken by the blind ends of the slot with the fit in the slot being a light press fit

The tailstock casting was removed from the lathe, disassembled and set up on the mill table with the quill temporarily in place so correct alignment could be achieved relative to the position of the slot in the quill, a clearance slot was milled in the body [with the quill removed] to provide future

clearance for the drive gear, **photo 8**.

Now the tricky part, the axis of the drive pinion has to be at 90 degrees to the plane of the gear and rack and precisely at the correct distance from the mesh point of the gear and rack. This can be determined from the drawing or more usefully taken directly from the job, **photo 9**.

Aluminium was selected for the housing for the drive gear and its external shape machined separately, in this case quickly on the shaper, **photo 10**. The position on the side of the casting was laid out and 4 holes drilled through the completed housing and tapped into the tailstock body, additionally two 1/8" dia locating dowel pin holes were drilled and reamed so the housing could always be returned to the same position, **photo 11**.

Without a right-angle drive for my mill a second setup was required to drill and ream the pinion hole through the partially completed housing and at the correct mesh offset distance. Once drilled through the aluminium housing down into the slot the housing was removed and a 1/2" long mill used to create a flat in the tailstock casting deep enough to provide enough of a flat for a centre drill followed with a long drill to complete the hole for the pinion and its



Component parts of the quill extension showing position of gear rack.



The tailstock set at 25 degrees and the gear access hole milled.

future bronze bearing.

The plastic gear was bored for the pilot hole needed for the 1/4" square broach I had and the broach pushed through the gear by the tailstock on a smaller lathe, **photo 12**. It could have been completed on an arbor press just as easily.

The gear housing was removed from the tailstock and the slot for the gear cut to match that of the one in the tailstock casting both 1/8" wider than the gear.

Due to the geometry the pinion that drives all this can only be installed with the

housing in place and the gear loose along with its compression spring, the sharp corners of the square section of the pinion as it became round were bevelled to allow easier entry into the square hole in the gear, **photo 13**. Gently pushing the pinion down wiggling it to pick up the square hole in the gear and through the centre of the spring and into its lower bearing completed the installation, a dowel ended set screw tapped through the housing and seating in a groove in the pinion keeps everything in place as intended and the spring under compression



The proposed gear in place for a trial fit.

10



The housing being roughed out under the shaper.

keeps the gear in position as it has to be a clearance fit on the pinion for assembly, additionally it provides an oil passage if removed.

The top of the pinion has a 7/8" AF hex head milled on it to suit the handwheel I planned on using, the top being drilled and tapped 5/16"-18 for a thumb screw to hold it in place

With the quill and its extension bolted up it is reassembled from the front end this

keeps lubricating oil within the housing and the original small hole feeding the acme threaded nut in the quill plugged as this no longer is required.

A length of 3/4" diameter shaft with a hefty knob on the exposed end passes through the quill and its extension and a plastic guide within the quill, **photo 14**. A bump by hand will usually dislodge an installed Morse taper tool, if not a rap with a soft face mallet will do the trick. This is

effective where ever the tailstock is within the full range of travel, **photo 15**. It was found that the end of this had to be further reduced to 5/8" diameter for about 3/4" to free those Morse taper tools without a locating tang.

While everything was disassembled and off the lathe a sliding depth stop was added, made from some small diameter stainless tubing and other scraps as I find this more useful than trying to drill or bore

11



Tailstock in second setup to pilot drill the housing.

12



Broaching a 1/4" square hole in the gear.



Component parts of the revised drive.



The completed modification fully retracted.

to a measurement, the depth to move can be set with a pair of calipers, gauge blocks or a simple measurement between the forward support and the sliding stop that is locked with a set screw.

The layout for all the above was done initially in a CAD program to be sure everything would work and the angle for the rack finessed so it didn't intrude into the cross slot in the quill, 25 degrees in this case.

For any lathe with a tailstock quill of sufficient diameter and wall thickness to take a milled slot for a gear rack without

detriment this is an inexpensive modification that is a great improvement over the conventional handwheel extension and has proven a worthwhile modification.

For a smaller tailstock without sufficient wall thickness there can be a similar approach with the gear rack being wholly in the extension piece and the gear drive at the rear of the tailstock housing. See Alan Jackson's Chipmaster Lathe article in MEW 253.

While everything was disassembled other minor improvements were made to the

tailstock and the inevitable dings and chips repaired before repainting.

As this improvement is specific to this lathe only the main measurements are given.

Post script:

The plastic gear has held up quite well, but the square broached drive hole eventually seemed to 'stretch' and develop excessive slop so to overcome this a small flanged steel insert was made with a similar 1/4" square broached centre hole bolted in the gear recess. ■



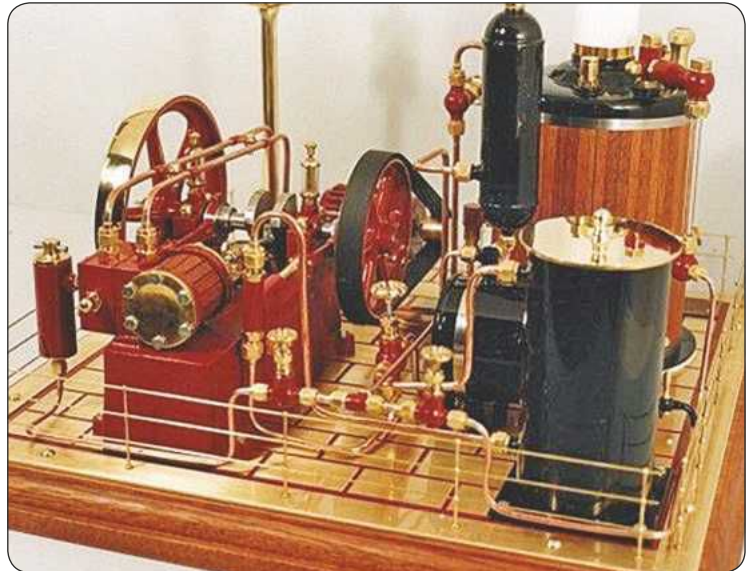
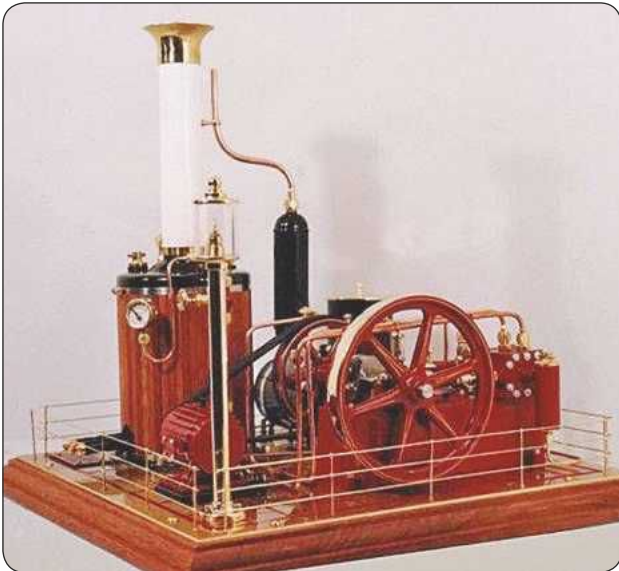
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Leather Washers

David Dunn describes his approach to making an essential part for repairing many old devices such as pumps and blowtorches.



A neighbour called recently, with a somewhat ancient brass garden spray device which he had retrieved from his shed with the intention of using it. Not a very practical man, he had found, not surprisingly that this long-abandoned instrument no longer worked.

I dismantled it expecting to find a dried-up washer or seal inside in need of a drop of oil, but such was the passage of time since it had been used the washer was virtually no more. Just a few bits of dust! Apart from that it was well made and seemed sound apart from the obvious fault. Next time I was near one of our local and relatively old-fashioned ironmonger shops, as opposed to the large multiples with everything in bubble packs and lacking in knowledge and expertise, I enquired after leather washers. I half expected to be offered a choice of new washer from a box of assorted sizes or failing that some advice on a suitable source. But it was suggested, with a wry smile, that I was about 30 years too late and neither was forthcoming. Back to the drawing board.

As most folk reading this (I am sure) will know this type of washer was used for years in so many appliances. Pressure lamps, Primus stoves, paraffin blowlamps and many various spraying tools. and indeed, in quite a range of sizes. Lesser mortals would probably have succumbed to the sales pressure to buy a newer and 'better' spray, made of plastic and using O-rings.

The all brass construction of this old sprayer appealed to my appreciation of quality of a past era, so a scheme was thought up to try and overcome this gap in the market. First find some leather of good quality, itself not too easy a task. Preferably at no cost.

The diameter of the brass tube was 3/4 inch and although there was no pattern to copy from it was fairly obvious what the original looked like. I had a pair of elastic sided Blunstone boots bought in Australia some 30 odd years ago which really were past their best. Soles worn though and all but abandoned... But never throw away anything which may be useful. The decision was made, and I carefully removed the uppers from the soles abandoning the latter, cutting the stitches that held the pieces of leather together. This proved to be supple and in good condition and was highly suitable for the washer task.

Not knowing the best or normal way to make these, I first bored a 3/4 " hole in a short piece of alloy from my 'useful bits' store making the bottom of the hole

reasonably flat with an end mill. Then turning another alloy scrap to a diameter of about 5/8" slightly rounding off the sharp edges at the bottom. This I estimated would be about right spacing to allow the leather to fit. A hole was made in the centre of the smaller alloy and threaded with a convenient size tap - probably M8 - into which was fitted a bolt for the purposes of extracting it later, **photo 1**. After guestimating the amount of material required and cutting a roughly circular section the leather was soaked in hot water for a while and then pressed in to the hole using a vice. Leaving it for a couple of days in a warm place to dry out, on extraction it was pleasing to see that the idea had worked perfectly, and the leather had moulded itself beautifully to the desired shape. The surplus part the top was trimmed off while in the mould and a suitable size hole punched in the end to fit the screw which held it to the plunger end of the pump shaft. A drop of oil was applied and a few pumping actions soon made things work smoothly. Since that I



Washer Mould

have produced yet more similar washers some up to about 35mm diameter using similar custom-made moulds, **photo 2**. I find satisfaction in the action of saving what would otherwise be scrap devices. ■



Washers to order

Milling for beginners



PART 3 - WORK HOLDING EQUIPMENT

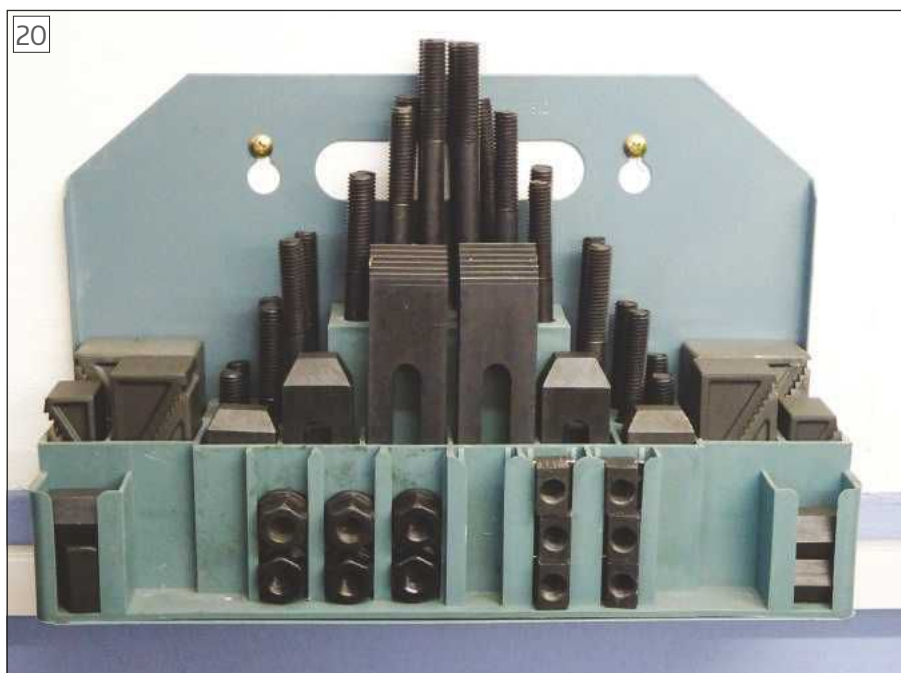
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UNBEATABLE VALUE ENGINEERING PRODUCTS

This month Jason Ballamy takes a look at the various options available to hold and position work pieces on the mill.

Having previously looked at how to hold the cutting tools the next logical step would seem to be holding and position the work piece before we move onto cutting tools and actually cutting metal.

Clamps and Clamping Sets

The most basic way to hold work is to fasten it directly to the mill's table. This is most commonly done by the use of a clamping bar which in it's basic form is a flat bar with a slot in it. A tee shaped nut is slipped into one of the tables slots, a suitable length stud screwed into that and the clamp bar slipped over the stud with one end bearing on the work and the other suitably supported, this support can be a simple block of metal but is more often a triangular block with stepped grooves to match similar grooves in the bar. Finally, a nut is screwed down onto the stud to apply pressure to the bar and via that to the work. These clamps, studs and tee nuts can be made but if like me you prefer to get on with a specific project



Typical Clamping Set



Premium Engineers Drill Vice

then sets can be purchased to suit your mill's tee slot size which will cover most needs, **photo 20**.

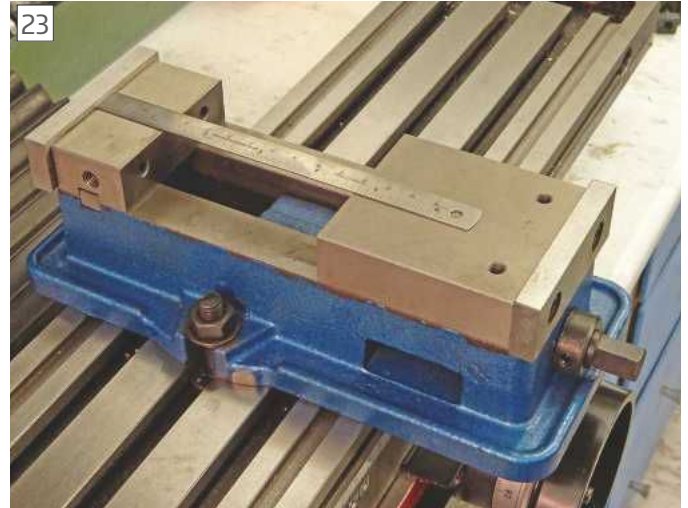
Vices

Most of the small bench top machines are described as "mill/drills" and for general drilling a drill vice can be used, **photo 21**. These tend to be a little less accurate and of a lighter build than machine vices so are best kept for general drilling and only used for milling as a last resort. They typically have a rebate in the top of the jaws which will allow thin work to be held clear of the vice base so the drill will not damage it as it breaks through the underside of the work, some will also have a horizontal vee in one or both jaws to quickly position round work.

For milling a machine vice will be far more suitable being of a much sturdier construction and with less play in the moving jaw which will help ensure the work is gripped firmly and true to the mill table. **Photograph 22** shows two typical machine vices, on the right is what is generally



80mm Versatile and 90mm Type 2 Precision Vice



Large Capacity of versatile Vice



Selection of parallel sets



Set of angle Blocks

referred to as a 'precision vice', this name refers to the style and may or may not reflect the precision of the actual vice. The jaw is tightened with an Allen key in the hex socket screw set at an angle in the moving jaw, this angle helps to stop the jaw lifting when the vice is tightened which would cant the work piece up at an angle. They either have holes or as in the case of this "type 2" vice, slots along each side which are used to locate clamping blocks to hold the vice down to the table, the slotted ones make it a bit easier when mounting at an angle to the X-Y axis.

The vice on the left is termed a "universal vice" these are often supplied with a swivel base as can be seen here that gives a graduated scale to easily rotate the vice to the desired angle. The down side of having the vice sitting on a swivel base is that it reduces the available head room so as the need for mounting at an angle is not that frequent the base is best removed and stored away until it is needed. These vices come with a removable knuckle bar type wrench to tighten them, others will have a cranked handle. In either case get into the habit of removing the handle before you start cutting as they can vibrate loose and your

toes are often directly below!

Another advantage of this particular style of vice is that the hardened jaws can be positioned on the outside edges of the main fixed and moving jaw which increases the holding capacity by more than double as can be seen in **photo 23**. The two jaws may not be the same height on some vices, so you might need to pack up the work at one end. One thing to bear in mind when using the vice in this configuration is that the load is all being taken by the jaw retaining screws and the actual contact area is small, so go lightly when tightening up the vice and don't take heavy cuts.

Although a bit outside the needs of a beginner there are a number of other vices that are available, for example ones on bases that allow them to be tilted in one or two planes which can also be mounted on a swivel base, ones where both jaws move so that whatever size work is held it will remain central and two part vices where the fixed and moving jaws are separate items that can be mounted anywhere along the mill's table so that long items can be held.

Parallels

More often than not the size of the item

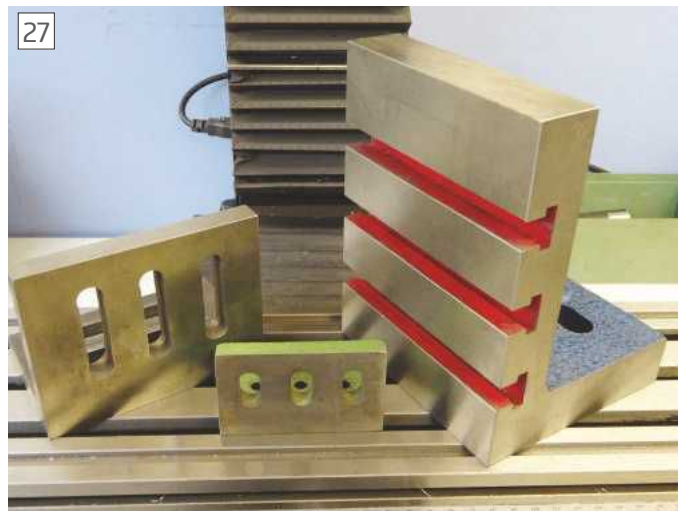
being worked on will be less than the height of your vice jaws so it will need to be packed up. Parallels are ideal for this task, they come in matched pairs ground to various heights and are placed on the base of the vice opening and then the work placed on top. **Photograph 24** shows some typical parallel sets, on the vice are economy ones which are just ground on the two faces that are used which is quite adequate. On the left is a more extensive set of precision parallels which are ground all over and being longer will suit those with larger capacity vices. On the right are some thin wavy parallels, these tend to be less likely to fall over in the vice and can also be used for thin work as they will compress flat as the vice is tightened. The only thing to watch with parallels is where they sit under the work if drilling or milling through holes if you don't remove them first.

Angle blocks

On some occasions you will want to hold the work at an angle rather than parallel to the mill table's surface, one way to do this is use a precision angle block or combination of blocks to set the work at the desired angle. **Photograph 25** shows a set of these angle blocks and one being used in the vice



Quick clamp and vice stop



Selection of Angle Plates



Angled Work table

position the work. They can also be used against an engineer's square to set vices and work at an angle across the table.

Vice Stops

If you are working on two or more similar parts, it is worth fitting a stop to the vice which will allow you to quickly change work pieces without having to locate their edge each time if they are simply butted up against a fixed stop. If your vice has hardened jaws that stand proud of the main body, then a quick clamp type stop can be used as shown in the left of **photo 26**. If using a precision type vice, then they often have a tapped hole in the side of the fixed jaw which a flat plate can be screwed to. For longer work this tapped hole in both vices can be used to hold a rod with a sliding stop though I find it as quick to just clamp something like an angle plate to the table and put the end of the work up against that.

Angle Plates

For items that are too big to fit in a vice or that need to be held on end/edge angle plates can be used. These are "L" shaped castings with either through slots or tee slots to take hold down clamps. Two can be bolted together which allows holding at any desired angle, **photo 27**.

Adjustable Tables.

A more rigid way of holding larger work items at an angle is to use an angled work table, this is a tee slotted table that pivots at one end and has a scale to indicate the angle to set it at, **photo 28**. There is also another design where the table rotates around a semi-circular base, but they do take up quite a lot of head room so are best used on large machines or ones with a riser block.

Rotary Tables

These are quite versatile items of tooling. When mounted horizontally onto the mill table with the work either clamped directly to their table or held in a chuck mounted to the table they can be used to mill circular feature into the work and also space holes evenly around a PCD, **photo 29**. When stood vertically so that the axis of the work runs horizontally they can be used to cut radial holes, mill hexagonal and square shapes, etc. With the addition of dividing plates and a tailstock they can be used to index the work for tasks such as gear cutting or milling multiple splines or flutes, **photo 30**.



Rotary Table with 3-jaw Chuck Attached

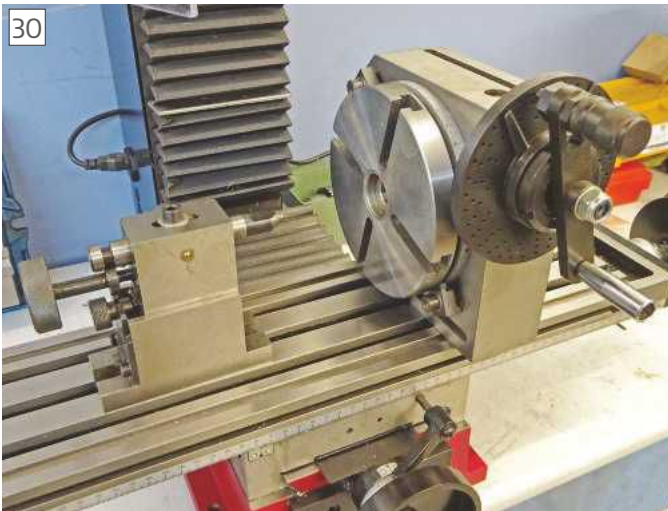
Spin Indexers

Much like the rotary table these allow the work to be rotated but by using a simple peg in a limited number of holes make the job a lot quicker than winding a hand wheel round and round. They are mostly used for common divisions such as 2, 4, 6, etc but can, by using the row of vernier holes, do one degree divisions. Most are designed to take a 5C collet but the "Stevenson's 5C Indexing Head" that Arc Euro Trade supply also comes with a sleeve and special closing nut that allows ER 32 collets to be easily fitted, which saves having to own both types of collet. A 5C to ER32 adaptor can be used in other makes but that does create more overhang, **photo 31**.

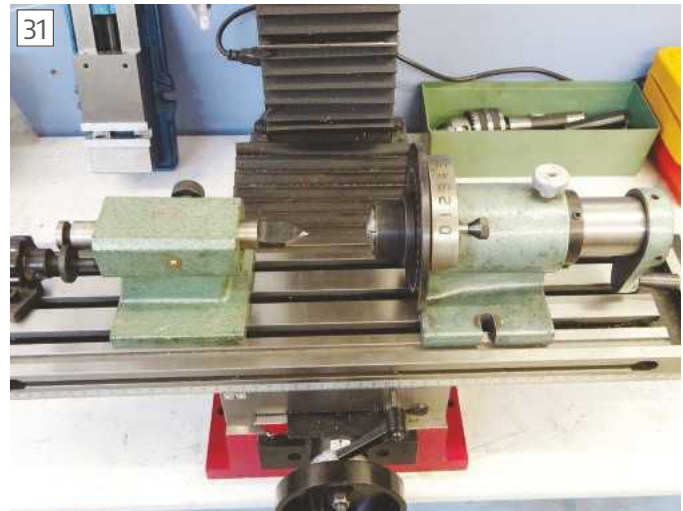
You can also buy various collet fixtures that will hold a collet vertically or horizontally that have a quick release lever, these are probably better suited to small production work and the hobby user would be better off with 5C or ER blocks which are more versatile and therefore offer better value for money.

Collet Blocks

Another way to simply index the work to four or six positions is to hold it in a collet



Rotary Table with Dividing Plates and Tailstock



Stevenson's 5C indexing Head with ER32 Nut & Adaptor

block and simply take a cut, reposition in the vice with the next face of the block against the fixed jaw and take the another cut and so on. The square block is also useful where you need two features to be machined at right angles to each other such as a slot for a forked end and a hole for a pin at 90 degrees to the slot. If you happen to have a set of 5C collets for use on your lathe then the 5C blocks would be the better option, but if you just have ER collets for your mill then the ER blocks to take your size of collets are the ones to go for, **photo 32**.

Vee Blocks

These blocks are ground all over and usually come in pairs with one or two vee-profile grooves milled along their length and a clamp for each. They can be used to hold round work horizontally or when placed vertically in a vice will hold round work vertically. If using with work laying in the vee then it is best to use hold down clamps when machining as the supplied horseshoe shaped ones are a bit weak and better kept for holding work when just marking out or taking measurements, **photo 33**.

10-20-40, 20-40-80 & 1-2-3 Blocks



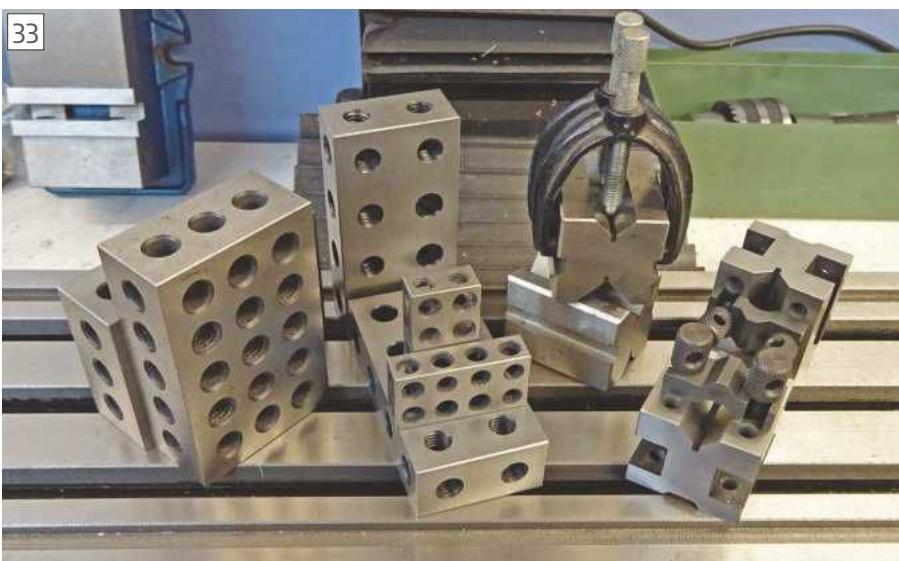
Collet Blocks

Also shown in the same photo are some 10-20-40 and 20-40-80 blocks these are the metric version of 1-2-3 blocks and have a number of uses. They can act like parallels in the vice to raise work up above

the jaws, be used to pack work up clear of the mill table when drilling or milling right through to avoid damaging the table. Being threaded they can also be bolted together in various configurations and used as stops to locate multiple similar work items. You can also bolt small items to them that may otherwise be difficult to hold while being machined.

Chucks

It is also possible to mount a 3-jaw, 4-jaw or ER collet to the mill table with the aid of a suitable backplate which is a good way for holding round work vertically particularly if there are several parts to have the same operation carried out on them. ■



Vee Blocks and 1-2-3, 10-20-30 & 20-40-80 Blocks

For a full list and links to the items featured which are available from Arc Euro Trade, <http://www.arceurotrade.co.uk>, who also sell the X series of mills see the accompanying thread on Model Engineer Forum <http://www.model-engineer.co.uk/forums/postings.asp?th=131318>

On the Wire **NEWS** from the World of Hobby Engineering

The John Stevenson Trophy



John was unique combining almost effortless skill in the workshop with an instinct for good design. John always had time and respect for anyone interested in engineering as a hobby. He helped a huge number of beginners and more experienced folk with advice and often practical help, bits of tooling or good deals. He was a well-known face at the model engineering shows, as well as being a prolific poster on many of the online engineering forums.

John appreciated the skill that went into 'glass-case models', but worried that sometimes these could put 'mere mortals' off having a go. The things John liked to see more than anything else were well-made, practical tools that showed a bit of ingenuity, good design and weren't over finished.

A large number of readers and forum members have generously contributed to a trophy in John's memory. The cup is engraved "John Stevenson, 1948 – 2017, Remembered by his many friends" with "Awarded for Excellence in Practical and Useful Workshop Equipment" on the plinth.

The John Stevenson Trophy is for just that, a well-made and usable piece of tooling, a modification to a machine or an accessory for a tool where the fact it works well is more important than making it look good.

Entry for the competition will be by nomination, a shortlist will then be prepared by the organisers, so that award of the cup can be judged by a popular vote. As he was such a mainstay of the Model Engineer Forum, users will vote on the best tool featured in MEW, ME or the forum each year, from a short-list of nominees. Voting will be via a poll on the forum and open to all. The cup to be awarded every year.

Naturally, we have to have some formal rules for the competition, these are:

All entries to the competition must have appeared in an issue of Model Engineers' Workshop or Model Engineer ('the magazines') with a cover date in the previous calendar year or featured as newly

completed work on www.model-engineer.co.uk ('the forum') during that year.

All entries must be a piece of practical workshop equipment i.e. a tool, jig, fixture or a modification to or accessory for an existing piece of equipment.

Entries can be nominated by readers, forum members or the editorial teams for the two magazines. It is acceptable for people to nominate their own work.

Nominations must be emailed to neil.wyatt@mytimemedia.com no later than 20 March 2018. Nominations will be kept confidential.

A short list of entries will be selected from the nominations by the competition organisers, a group of people who knew John and are familiar with his views on workshop equipment.

Criteria for inclusion on the shortlist will be that the tooling is practical and capable of being used for accurate work in a home workshop setting. It should demonstrate ingenuity, good design, economical use of materials and be appropriately finished for its function.

Inclusion on the final short list will be subject to the maker filling in an entry form confirming their permission, including permission to feature the entry in the magazines or on the forum. If practical, they will be invited to display their entries at the National Model Engineering Exhibition in Doncaster.

The shortlist will be published in Model Engineers' Workshop and the Model Engineer Forum.

The winner will be selected by a popular vote by forum members. Readers who join the forum in order to vote will be allowed to do so. Voting will be strictly one vote per person.

In the event that the judges consider invalid votes have been cast or that an attempt has been made to unduly influence the result of the vote (for example by canvassing the organisers or actively soliciting votes for an entry) any questionable votes will be disregarded or entries may be disqualified.

A deadline for the close of voting will be set ahead of the National Model Engineering Exhibition, where the winner will be announced and awarded the John Stevenson Trophy.

The trophy will remain the property of the competition organisers.

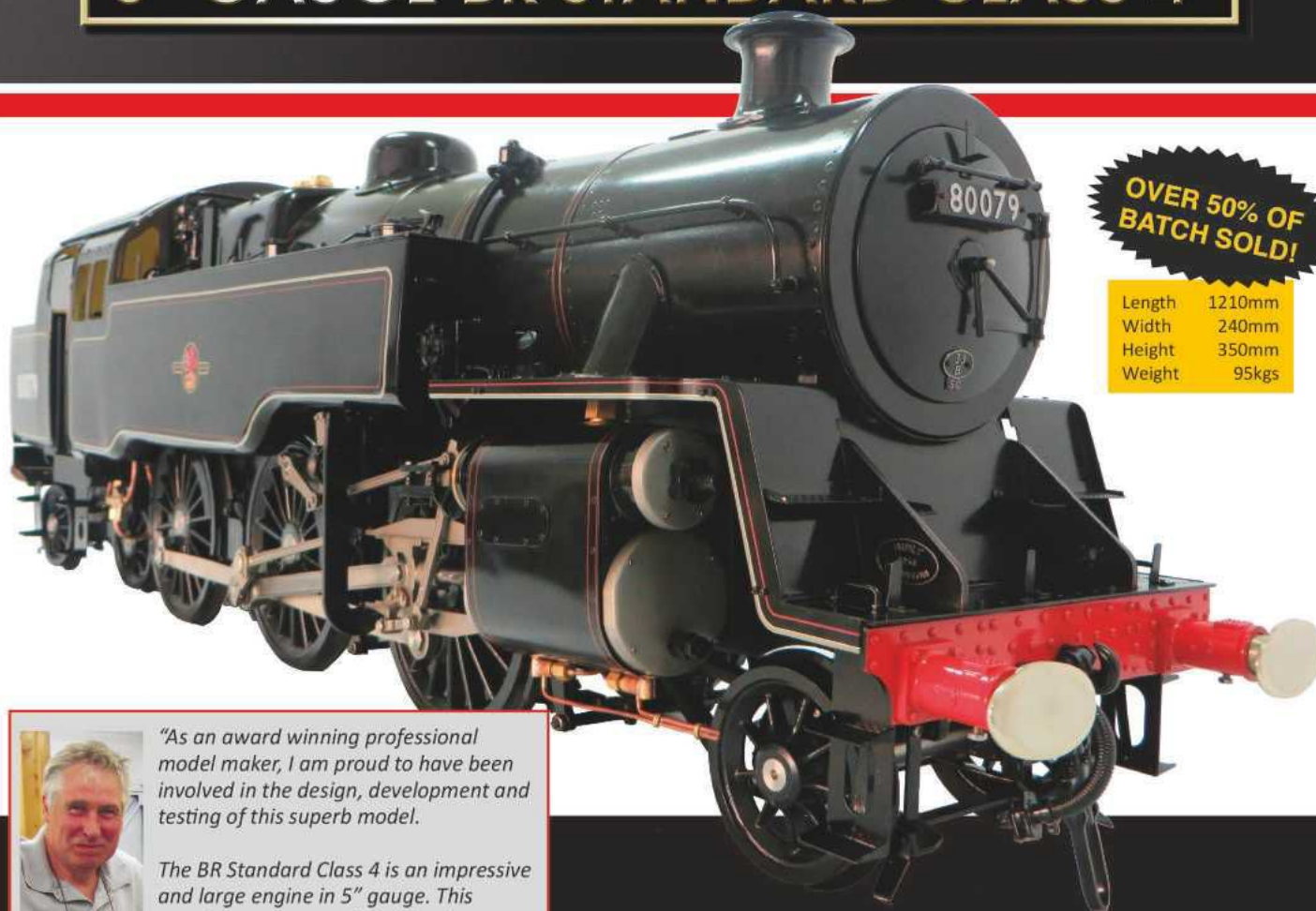
The winner will be able to keep the trophy for a period of approximately eleven months and will take responsibility for ensuring its safekeeping during that period. The trophy must be returned in good condition, in the supplied packaging, in good time for award to the winner of the subsequent competition.

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MEW to the Rescue



Laurie Leonard found a route to success thanks to an article in Model Engineers' Workshop.

As with many articles in MEW it is not the specific content which is of direct use but the ideas and experience of contributors that can be tailored to specific circumstances and available tools/materials. Brian Wood's work in MEW 247, relating to a band saw repair, was utilised but adapted to suit my Tom Senior M1 mill and circumstances.

The Story

No job seems to be simple. The task in hand was to make new feed nuts for my ancient

I am not sure I would have come up with the idea of major surgery if it had not been for the article



Saw cut run off

Tom Senior M1 milling machine and to that end it was partially dismantled. At some stage it envisaged that some thread cutting on the lathe would be required so the Digital Read Out system purchased earlier but still in its packing had to be installed. With that job completed it was evident



Bandsaw Guide Bearings



Blade wear mark on blade guide

that there was a large amount of backlash in the top slide and cross slide feed nuts so new nuts were to be fabricated from available brass. A slice was cut from a large off cut using my band saw but the result was a very "off" cut, **photo 1**. The band saw needed attention. The fault was initially diagnosed as a worn blade. This was replaced but no improvement was evident. The blade was also stalling: it must be the guide bearings, one set is



Main bandsaw casting clamped in line with swung vertical head



Packers under casting boss



New hole closure piece showing "o" ring seal



Drawing the bearings out using a piece of studbar

shown in **photo 2**, and the fact that the blade was running off was demonstrated but the wear mark on the blade guard, **photo 3**. The bearings were indeed very rough and inclined to jam, so they were replaced and on with the job. No! The blade was still stalling and the drive noisy. At this point Brian Wood's article in issue 247 of MEW came to mind.

Work Done

The article in issue 247 described how the drive gearbox on the band saw was refurbished. To extract the input shaft and bearings the author ingeniously utilised his Westbury mill. I am not sure I would have come up with the idea of such major surgery if it had not been for the article, but my mill is different to the Westbury. Could it still do the job? First reassemble the mill! The vertical head on the M1 can be rotated so it was positioned with its axis parallel to the table and the band saw frame was clamped so that the axis of the head was in line with the centre line of the input shaft, **photo 4**. Note the rather unorthodox method of clamping. The frame is a large casting and a large portion of it overhung the table. It also has an irregular surface as it was in "as cast"



Replacement wiring gland after damage

finish. Plastic packers as bought for aligning door and window frames were used to level the casting. These provided a margin of cushioning but the casting had to be firm. The arrangement used can be seen in photo 4 and in **photo 5** where support was provided under a boss in the area where a clamping stud, out of focus, clamped the casting to the table. The position of clamps was carefully considered as wrongly placed clamps over voids in the casting may crack the casting when tightened.

I could not get a boring head into the area so opted to make a larger hole with a hole saw to ensure that the bearings would come out (I should have made my own boring bar with adjustable cutter but wisdom after the event...). This left a rough hole in the casting so the core plug solution to blank it could not be used. A thick disc of metal in the scrap box was shaped so that part of it entered the newly cut hole and provided a shoulder for an "o" ring that forms the seal, **photo 6**. As a scrap box item it had a hole all the way through and the clamping bolt carrying the large washer on the inside did not seal the hole hence the bolt on the outside with fibre washer. No way near as elegant as in the original article!

A piece of studbar was used to draw out



Motor support plate retainer



Cut off slice after refurbishment of machine

the bearing, which had had it, **photo 7**, as an alternative to drifting them out, more control being available.

The original article drew attention to the "design feature" of the motor providing tension (excessive) on the drive belt. I wish I had taken more notice of this aspect because as I dismantled the machine a stage reached when the motor swung down and damaged one of the cable glands, the new replacement can be seen in **photo 8**. My version, material to hand, of the motor support plate retainer is shown in **photo 9**.

Conclusion

I am indebted to Brian Wood and his article as they saved me a lot of head scratching and time, the photos being particularly useful. Yes, I departed from his plan due to tools and materials to hand but his account was invaluable for a successful conclusion to my refurbishment, not least the need to ensure that the worm and worm wheel meshed properly. Results of the refurbished bandsaw are shown in **photo 10** and this demonstrates the value of MEW articles even if they are not/can not be slavishly followed. ■

Yes, I departed from his plan due to tools and materials to hand but his account was invaluable for a successful conclusion to my refurbishment...

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Coming up in issue 266

On Sale 23rd March 2018

Content may be subject to change

The April issue, number 266, of Model Engineers' Workshop, will bring you:



The second sheet of **Alex du Pre's**
Dividing Head plan



Mark Noel's Mass damper



Mike Cox's Chain Drilling Jig

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One Man and his Lathe



David Thomas and his Hercus 260



Hercus 260 lathe. The very narrow workshop makes photography difficult.

This is a tale of four lathes...

In the 1950s a visit to my Grandmother's home was an adventure. The long drive across the Pennines from northwest to northeast in a 1939 Hillman was north thing but the reward (sorry, Grandma) was to get in to Uncle Ted's garage and workshop. The garage had parts from an AJS and a flat-twin Douglas hanging up, but the centrepiece was a G80 Matchless, I rode this much later but that is another story. The workshop was a 6' by 8' wooden shed raised on blocks and was, for me, a wonderland of fascinating bits and pieces. Materials, tools, more motorbike bits, and a mechanical computer from what I later came to know was a 1940s bomb sight, treasure indeed! However, the items that attracted me the most were the lathe and the rolling chassis of a 2 1/2 inch gauge

2-6-0 loco (LBSC's Dyak perhaps?). The lathe may have been an "Adept" or similar as I remember it standing on a single foot with a cantilevered bed, but it was a long time ago. I only used the little lathe once, but it was the rolling chassis that really caught my attention and started me on the way to becoming a model engineer. It hardly seemed possible that I would ever have a workshop of my own but 25 years later, on the other side of the world, we had a house and garage and it was possible to start building one up.

A 1950's ML7 was the first lathe and this served for a lot of years, but it was an old machine and well worn. Despite this and the machine's design deficiencies I was able to complete a sensitive drill and a small "Westbury" style mill, built from locally made castings and a ready-machined x-y

table, as well as a Gauge 1 LBSC "Mona". By that stage I had a much clearer idea of my requirements for a lathe in terms of speed range, stiffness, size and cost. When the chance came to buy a 1962 vintage, ex-university, Hercus 9" Model A I jumped at it. This was better made, stiffer, and offered power sliding and surfacing, screw cutting gearbox and a more useful centre height. Several year's use convinced me that this had been a good decision and the next opportunity that came my way was a 1980s Hercus 260 with a good range of accessories - the true subject of this article.

Description and dimensions

My machine is labelled as a model ATMH indicating that it has a screw cutting gearbox, sliding and facing power feeds, metric dials and lead screws and a high

speed headstock, an additional H stamped on the bed shows that it is hardened, **photo 1**.

The original specification includes:

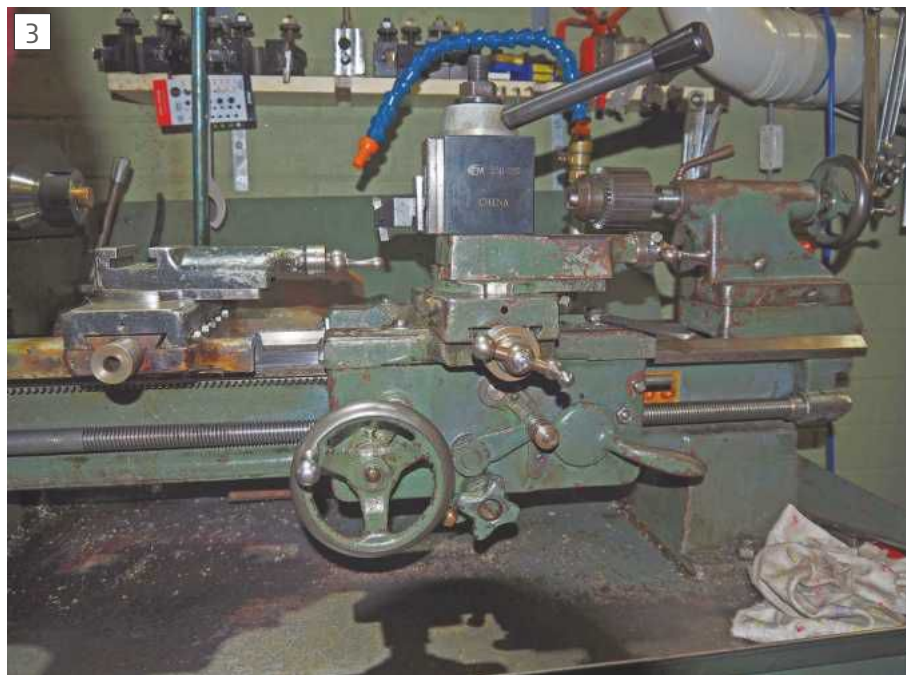
- Swing over bed: 260 mm
- Distance between centres: 535 mm (standard short bed length)
- Hole through spindle: 27 mm
- Spindle taper: 4MT
- Spindle nose mounting thread: 1 3/4" by 8 TPI
- Spindle bearings: Timken taper rollers
- Spindle speeds, direct: 360, 510, 690, 960, 1010, 1390, 1880, 2650
- Spindle speeds, back gear: 65, 95, 128, 180, 190, 260, 350, 490 (photo 2)

Screwcutting arrangements allow metric threads from 0.25 mm to 5 mm pitch to be cut and the lathe comes with a three-step dial thread indicator. The tailstock is locked by an over-centre cam and lever, has a travel of 54 mm and a 2MT taper.

The bed has two inverted "V" ways for the saddle and a single inverted "V" plus a flat surface for the tailstock.



Spindle speeds on the headstock. The serial number indicates a machine from about 1983.



The move from 4 1/2" (left) to 130 mm (right) centre height was accomplished very simply.

History and Condition as Bought

F. W. Hercus of Adelaide South Australia manufactured clones of the US made South Bend lathes from the late 1930s to around 2000. The 9" swing versions were very similar to the originals (almost identical apart from using Imperial threads for fasteners) and one of these was my first introduction to a Hercus machine. The later 260 mm swing version uses the same bed, apron, saddle and other components but with a new fully enclosed headstock with Timken roller bearings. Hercus didn't expend any more design effort than necessary for the increased centre height, **photo 3** shows the top slide and tailstock castings where the pattern has been very

simply increased in height.

According to its serial number my particular machine was made in early 1983 and survived a long career in a local secondary technical school which would have closed with all the other techs late in the 20th century. The lathe did not survive unscathed, with dents in the top of the tailstock barrel showing where hammers had been used to remove drill chucks, a piece missing from the flange of a countershaft pulley and chips out of the bed. The hardening of the bed had not prevented this damage but did reduce the size of the divots and prevented any distortion of the nearby metal, **photo 4**. The sharp-edged chips would have been nasty little things to have embedded in

a hand or face! Apart from the chips and hacksaw marks, actual wear on the bed was minimal. The area worn by the sliding of the saddle can be seen by its texture but the edges are impossible to feel. A QC tool post was already fitted, this is a bit on the large side but will stay until I can afford a better quality version.

Moving and installing

Sometime in the past our house had a two-storey extension added at the back. The builder couldn't work out what to do with a 6' 6" wide space against the old back wall so he poured a concrete floor, ran the plumbing from upstairs down the walls, added a tiny window and left it at that. The size isn't ideal for a workshop but it serves me well enough, **photos 5 & 6**. There is room for a fitting bench, lathe, small mill (Aciera F3) plus most of my tooling and work holding bits. The land is sloping so



Hardened beds don't distort when things are dropped on them, they chip.

elder son and I dug back under the house and made a cellar space that holds the grinders, brazing bench, heat treatment furnace, band saw, wine etc. When the outside air temperature gets to the low 40s (Celsius) this is the coolest place in the house (as if I needed an excuse); in winter overalls and a jumper are necessary. Unlike less fortunate (colder and damper anyway) parts of the world rust isn't a problem.

The seller delivered the lathe on a trailer and an engine crane made lifting it on to the driveway easy. Moving the Hercus downstairs and under the house was rather more complicated. The lathe went in separated from its stand and with the motor removed to improve the balance for lifting. Rather than disturbing the spindle setup we cut the final drive belt to allow partial dismantling of the headstock, this was replaced with link belting, **photo 7**. The rest of the formula for the move included the engine crane, chain block, 4-wheel dolly and a friend who used to play in the front row of the scrum. Two short flights of stairs (down) were negotiated using planks and the chain block as a safety anchor.

Repairs, Modifications and Additions

Mechanical

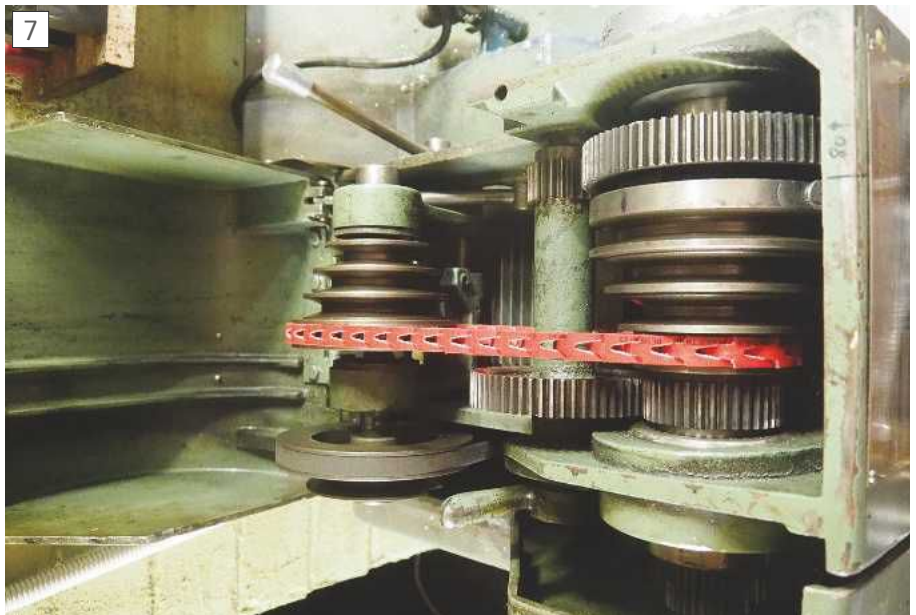
Mechanically the lathe was usable, the only broken bits were a missing tooth on the 60-tooth leadscrew gear and a sheared-off integral key on the end of the leadscrew itself, it's not hard to work out how those two things might have happened! I machined a slot in the lead screw to take a 1/8" key and a new gear was added to the shopping list. I'll come back to the source for spares and support later. A few minor parts were more worn than I liked: the cross-slide nut, felt bed wipers on the saddle and the screw cutting half-nuts were replaced. As mentioned above the tailstock spindle and quill had been given a hard life by the school and new Hercus parts were bought in to replace them. Small things



The north end of the workshop. It is a lot easier to take pictures of the Aciera mill than the lathe.



The south end of the workshop. The water pipes have leaked, fortunately the sewerage pipes are better made.



Inside the headstock. The link belt was used to avoid having to strip out the spindle but it also gives a very smooth drive.



The VFD fits neatly into the space left by the electro-mechanical controls. All external controls are low voltage.

such as the chewed-up dome nuts on the cross-slide and top-slide handles, whilst not vital, were available new and were replaced.

Electrical

Electrically the lathe was three-phase so it either needed a new single-phase motor or I had to learn about VFD installation and "tuning". The 750 W motor fitted is underpowered to allow a wide range of speeds from a VFD but I can use carbide cutting tools and have the chips coming off smoking. As it is there is little room to fit a larger motor so I'm content to leave this for now. The HuanYang HY02D223B VFD that I bought fitted neatly into the space in the cabinet stand under the headstock, **photo 8**, where the original switches and the 3-phase contactor were fitted. The small control panel on the front of the VFD is detachable and I made a ribbon cable



A neat feature of the VFD allows the control panel to be mounted remotely.

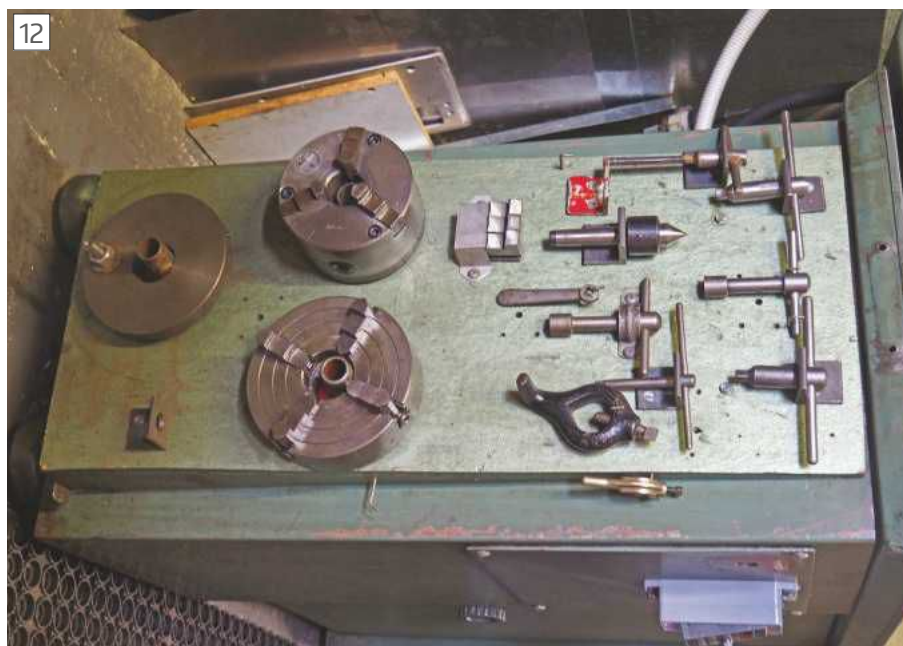


The basic controls are mounted on top of the headstock cover.

extension so that this could be mounted on the front of the stand where it is visible, **photo 9**. Having this panel visible allows me to monitor the motor current, frequency and voltage and, most importantly, see fault indications. Other low voltage controls, "forward", "reverse", "jog" and "speed", were brought out to a control box mounted on top of the headstock cover and including a cheap rev counter sensing a magnet glued to the spindle pulley, **photo 10**. The headstock has a single safety micro-switch which is operated via a rod when the top cover is opened or directly when the saddle stop touches it, **photo 11**. The micro-switch is wired in series with an emergency stop (by the operator's left knee) and the normal stop switch in the low voltage control circuit. The top cover also has a projection that prevents the change gear cover from opening unless the top cover is lifted. At the start I made up a bank of power resistors on a large heatsink in order to provide an external braking resistor but then found that in this model of VFD the components



The automatic saddle stop operates the headstock cover interlock switch via a separate lever.



The accessories board fitted for school use.

for switching to dump motor energy into this were not included. As a consequence there are occasions when stopping the lathe from its highest speed causes a motor overvoltage fault that trips out the VFD. This is easily reset and has had no lasting effects but remembering to turn the speed down a bit before a stop eliminates the problem. As it is, a moderate amount of DC braking is programmed, and this brings the machine to a stop as quickly as you could want, particularly keeping in mind the screw-on chuck mounting. The Huanyang VFD has around 180 programmable (or readable) registers but the whole exercise only required alterations to about twenty of these. Apart from learning a lot about inverter drives I also learnt not to trust that the default parameters set in the unit as supplied matched those listed in the manual. It took a long time to find out why the external speed control had a very limited range, PD070 ("Analogue Input") was not set to the stated "factory default".

Accessories supplied

As bought the machine came with three- and four-jaw chucks (both with internal mounting threads), catch plate, centres and drill chuck, **photo 12**. Unfortunately, the external jaws for the three-jaw are not a set, one jaw needs a ten thou shim to bring it into effect. It looks to be possible to buy replacement sets of jaws for Pratt-Burnerd brand chucks but the cost is off-putting.

Additions

I wanted to be able to cut Imperial threads as well as metric (the spindle nose of the lathe is 1 3/4" by 8 TPI) so translating gears and the necessary change wheels were purchased. For cutting Imperial threads using the 3 mm pitch leadscrew the 260 cannot use 127 – 100 for translating gears as the gears are too big for the cover to close over them, instead it uses 63-64 as an approximation, **photos 13 & 14**.

At each change over between lathes I've held on to the best of the chucks, I'd bought a 4-jaw self-centring chuck for the Myford



Motor drive belt in high speed. Projections on the covers are just visible close to the hinges. These form a mechanical interlock to prevent the gear cover being opened unless the top is first lifted to operate the safety micro-switch.



Set up for cutting Imperial threads. The chunk out of the countershaft pulley flange causes vibration at high speed and will have to be repaired or the pulley replaced eventually.



New production T-slotted cross slide. The round head screws fasten the travelling steady.

and the first Hercus came with two ordinary 4" three-jaws and, real treasure, a 4" GripTru. New chuck back plates, ER32 collet chuck, travelling steady, fixed steady and a faceplate (as a casting to be machined) were added to the collection. Later the main spares supplier introduced an extended T-slotted cross-slide with a longer gib strip, **photo 15**, and this was fitted recently.

The pictures show that the paintwork has been left as it was on arrival. The standard of paint finish has no effect on the quality of the work produced and refinishing is a project for that, possibly mythical, rainy day.

Support

In Australia Hercus lathes are very well supported with information and spares. Old Hercus training videos from the 1980s ('70s perhaps?) have been transferred to DVD and reissued; the company's "Textbook of Turning" is available second hand and spares and maintenance manuals are still for sale, **photo 16**. The "Australian Metal Working Hobbyist" website



All the original documentation is still available.



ER16 collets will grip down to 1 mm stock. High speeds and very sharp tools allow it to be machined easily.



A 2 mm cut in mild steel with an "Eccentric Engineering" tangential tool.



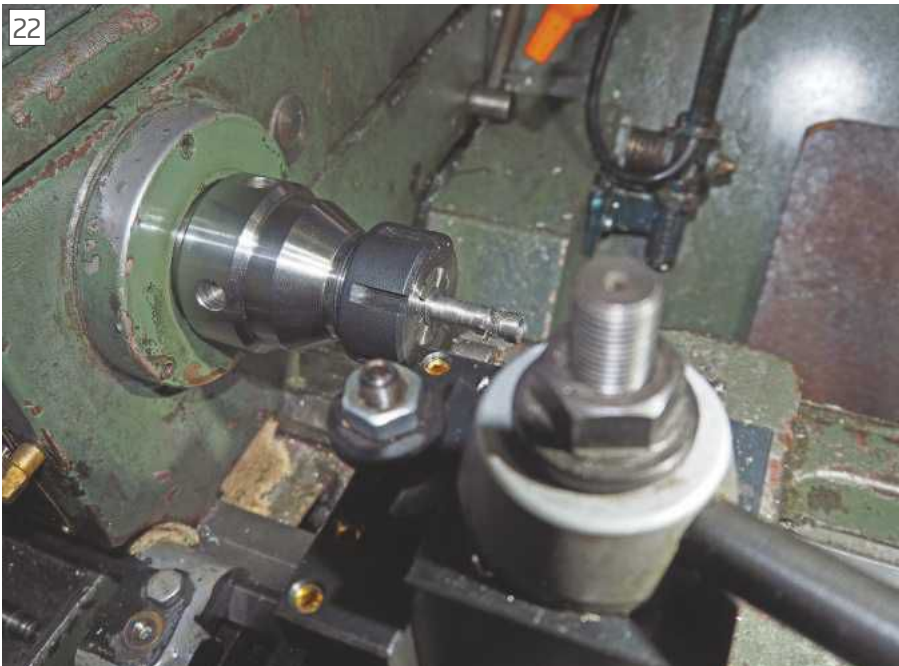
Setting up a part finished "Mastiff" cylinder block in the four-jaw chuck. Internally threaded chuck bodies give minimum overhang.



Boring a "Mastiff" crankcase from the solid on the faceplate makes a lot of swarf.



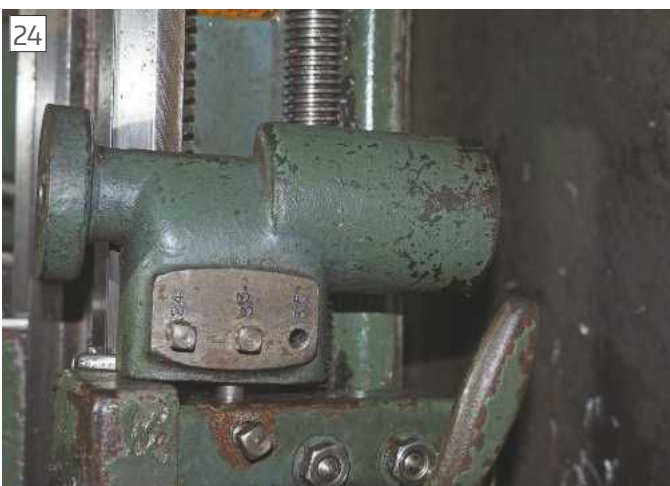
Turning a crankshaft between centres.



Parting off "Mastiff" cams with stock held in the ER32 chuck. The AXA type tool post is the weakest link for this.



Thread chasing dial information. The camera didn't move, the embossing and printing aren't registered. This is the only sloppy work anywhere on the machine.



Using a thread chasing dial on a metric leadscrew isn't straightforward!



I'm sure you would eventually get used to reading the dial and re-engaging the half-nuts correctly but using the VFD makes it unnecessary.

and shop run by Mal Conomy: <http://australianmetalworkinghobbyist.com> states that it is:

"dedicated to the maintaining of the Hercus lathe - made in South Australia since the 1920's by F.W. Hercus. Supplying both remaining genuine and aftermarket parts"

and, in my experience it does just that. Machines and parts also appear regularly in online auctions.

In Use

Installing the VFD hasn't altered the maximum speed of 2650 RPM but it reduces the effective low speed to about 15 RPM. This speed range allows work from the size of the faceplate, which was machined on the lathe from a part-finished casting, to around 1 mm in diameter, photo 17, to be machined. A sharp tangential tool will happily take a 2 mm cut in mild steel,

photo 18. My current project is a Len Mason "Mastiff" made without castings and there has been a lot of carving from solid blocks of alloy using the four-jaw and faceplate, **photos 19 & 20.** The crankshaft was the longest and most complicated I've made but the stiffness of the lathe and the fine control of speed helped me to make this on the first attempt, **photo 21.** A lot of the smaller parts for Mastiff (e.g. the cams and camshaft) have used the ER32 collet chuck, photo 22.

Screw cutting is simpler without the need to disengage the half-nuts as stopping is near to instantaneous and reversing at a higher speed is easy. This method also removes the need to follow the complicated process of cutting threads using the chasing dial, the three pictures should show the problems, **photos 23, 24 & 25** Setting the electrical saddle stop

adds extra security for screw cutting and other repetitive operations (this was shown in photo 12). The "jog" frequency set in the VFD is 10 Hz which gives a handy immediate speed reduction for setting up and for starting threads from the tailstock.

Summary

The Hercus 260 with its accessories has proved to be a very versatile machine for a small workshop. The roller bearing headstock (Timken bearings, but without removing the spindle I can't tell what type) is smooth and stiff and, particularly with tangential cutting tools, allows both heavy and very fine cuts in a wide range of materials. With the addition of a VFD most common lathe operations are simple to do and accessories are easy to find so I think the 260 will be in the workshop for a long time yet. ■

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Building and Operating a Dividing Head



Alex du Pre describes the construction of a useful and practical dividing head. The first sheet of plans is included in the centre of this issue.

This article describes an easily-made dividing head suitable for many dividing operations using the lathe and milling machine in the home workshop. I will briefly describe dividing for those who may be unfamiliar with the process and then give an overview of the design of this particular dividing head. The bulk of the article consists of construction notes before explaining how to set up and use the device.

What is Dividing?

Dividing is a machining operation used to machine equally-spaced features, such as holes or gear teeth, around a circular path. These features are generally, but not necessarily, identical. They may be centred on the axis of a circular workpiece, or on any known point of an irregularly shaped workpiece. Dividing is an essential technique for producing gears, ratchets, splines, dial graduations and similar items, or where equally-spaced holes are required such as on pipe flanges, wheel hubs, brake discs, steam engine cylinders and any number of other applications.

The dividing head is a machine tool accessory designed for dividing operations. It achieves this using a spindle that can be rotated in precise increments generally using either a gear train or dividing plates. The workpiece is attached to the spindle via an appropriate workholding means and is rotated around the spindle axis in equal increments. To machine the workpiece, a cutting tool is held in the same position and moved across, or into, the workpiece.

Design Features

My dividing head, **fig. 1**, is designed for day-to-day use in the home workshop. I do make quite a few machine tool accessories, the dividing head being one example, but all my tools are made to be used and are part of a journey on the way to completing a bigger model engineering project. For this reason, my tools tend to be of simple, robust design and easily made. I tend to focus my time and energy on accurate



View from the spindle nose end.

construction where it matters, rather than cosmetic finishing. Using basic, readily available materials keeps the cost to a minimum means that the financial outlay is much less than buying a ready-made tool.

Another key advantage of home-made tooling is that it can be made specifically to fit your machine tools. The bolt holes on the dividing head are positioned to align with my milling machine table slots and the cross-slide t-bolt slots of my Myford and Warco lathes. In use, the dividing head is generally bolted directly to the milling machine table or the lathe cross slide. The centre height is approximately 53mm, and aligns exactly with my Myford's

spindle, being bored in-situ on the lathe. The centre height and bolt spacing can – indeed must – be adjusted to suit your machine tools. When bolted directly to the milling machine table, the centre height is sufficient to allow a four-inch chuck to be fitted. Larger chucks can be fitted by using a raising block, or by mounting the tool on the lathe cross slide and exploiting the overhang.

My design owes part of its provenance to Harold Hall's design, described in ref. 1, however, I wanted my design to be suitable for heavier duty use. It is of robust construction for rigidity and the spindle is supported by two well-spaced

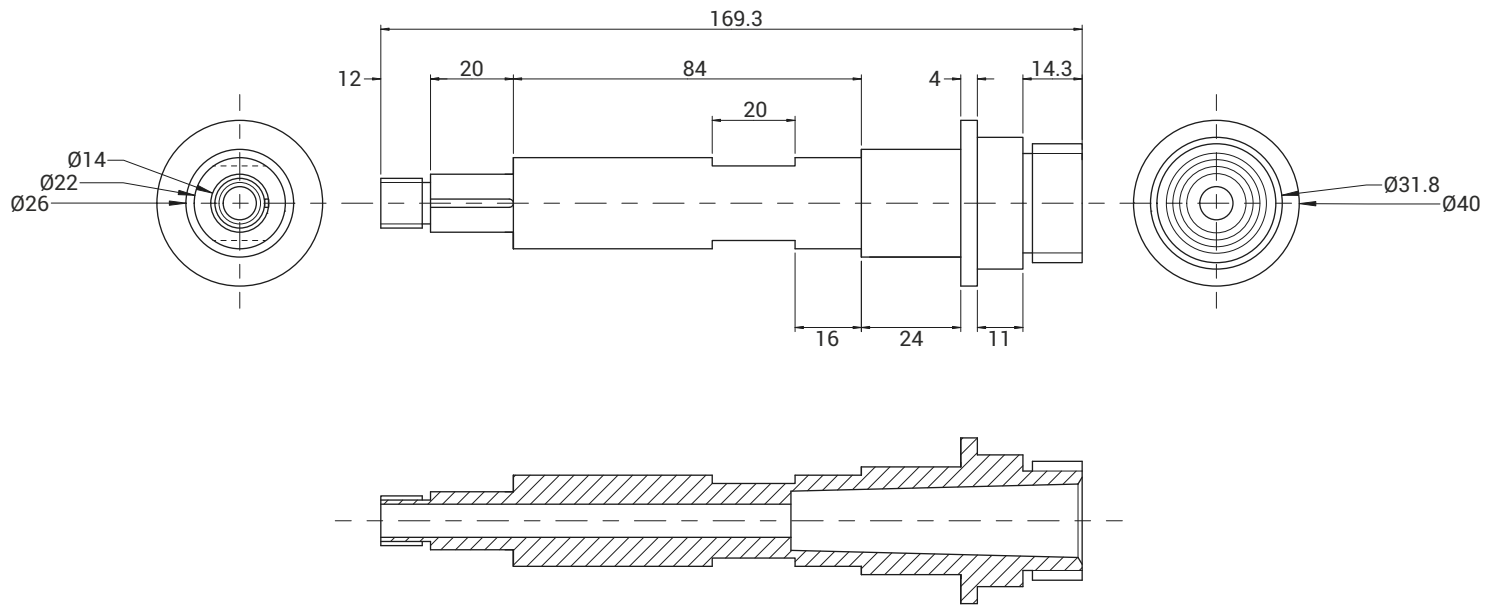
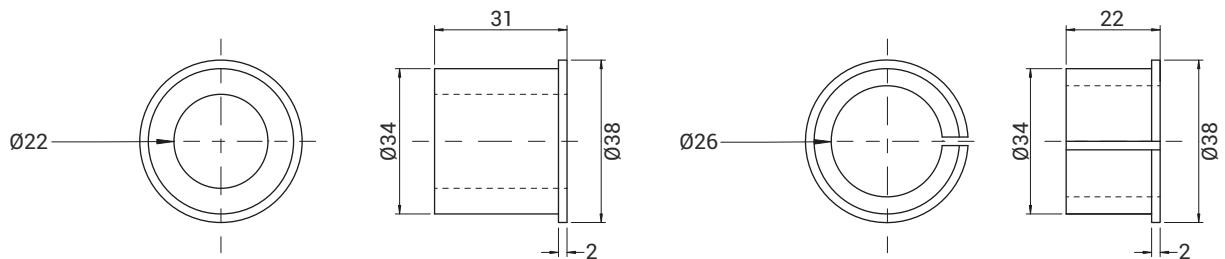


Fig.2

Spindle

To match Myford, thread spindle nose 12 TPI Whitworth form, Ø1.250"
 with No.2 Morse Taper bore
 M12 thread on LH end
 Drill through Ø8mm
 Provide suitable keyway
 Note spanner flat



Rear Bearing

Mat'l: Cast iron
 Secured to housings with epoxy

Fig.3

Front Bearing

Mat'l: Cast iron
 Secured to housings with epoxy
 Bearing split after bonding to housing

DIVIDING HEAD

By Alex du Pre

Presented with

Model Engineers' Workshop 265

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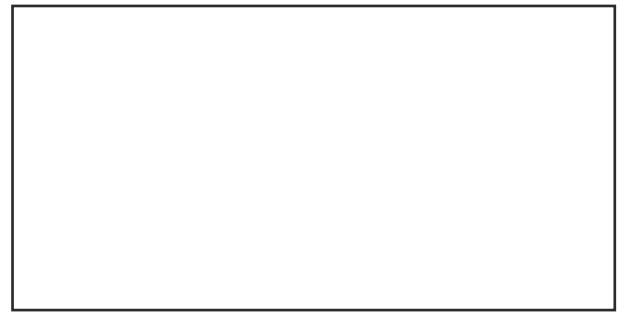
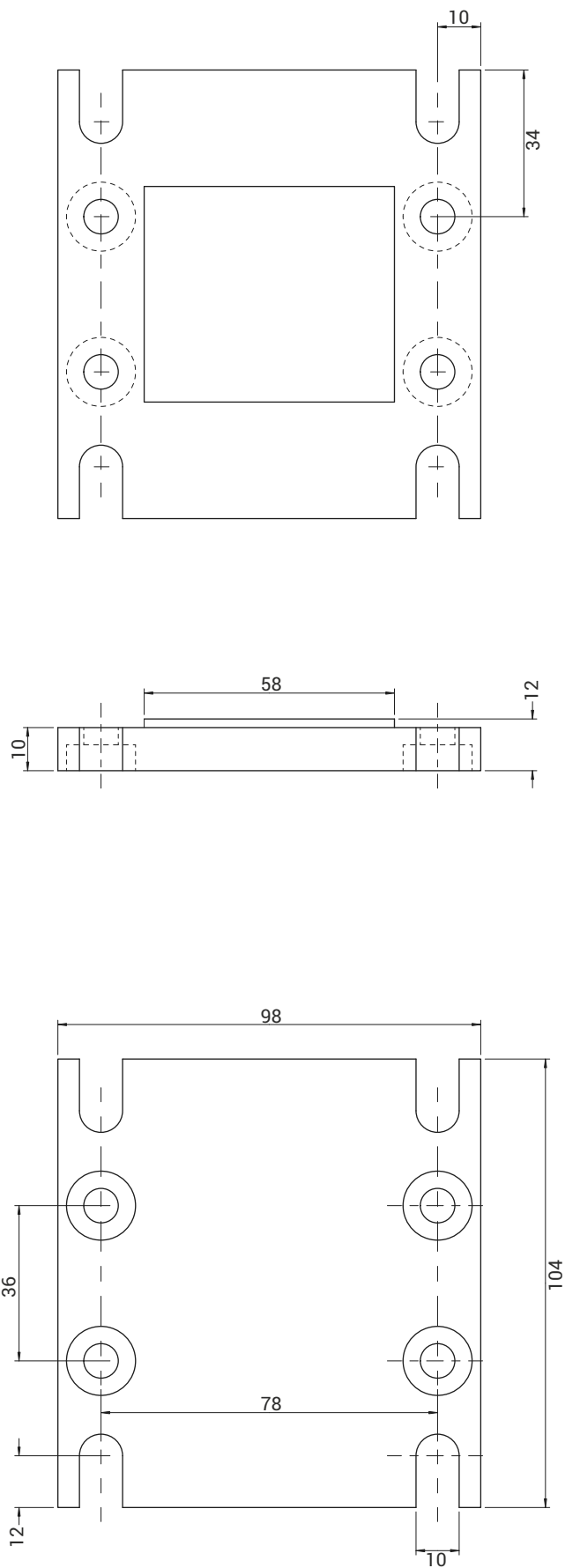
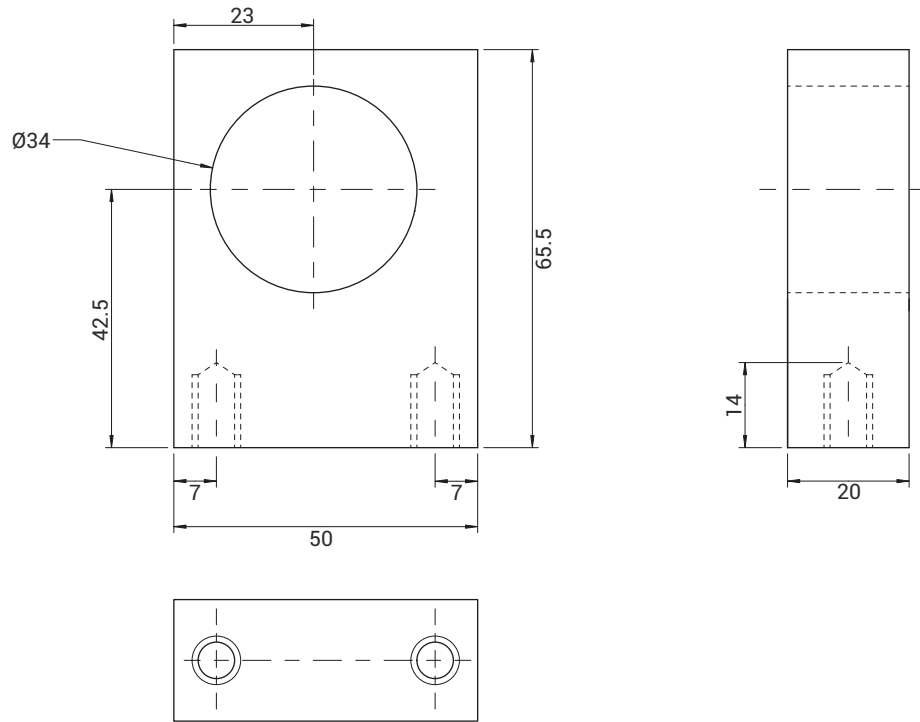


Fig.4

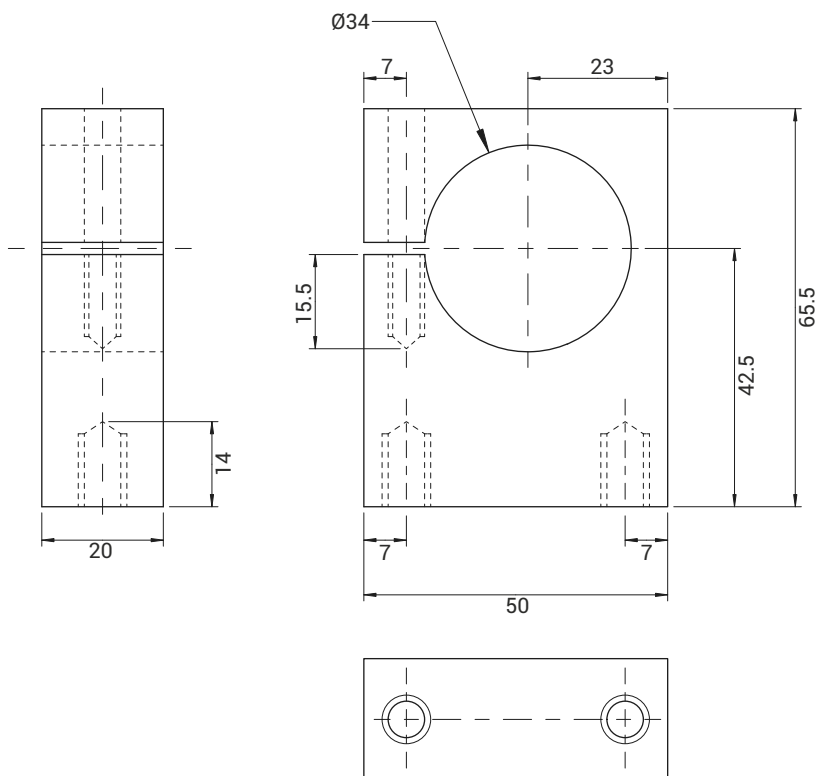
Base Plate

Holes $\varnothing 8\text{mm}$, c/bore under
 Drill holes slightly oversize to enable bearing
 housings to be positioned hard up against
 the shoulder
 Position and size slots to suit



Rear Bearing Housing
Position large hole to match
lathe centre height
Tap M8

Fig.5



Front Bearing Housing
Position large hole to match
lathe centre height
Split after fixing bearing in place
Top hole $\varnothing 6$ mm/M6
Lower holes M8

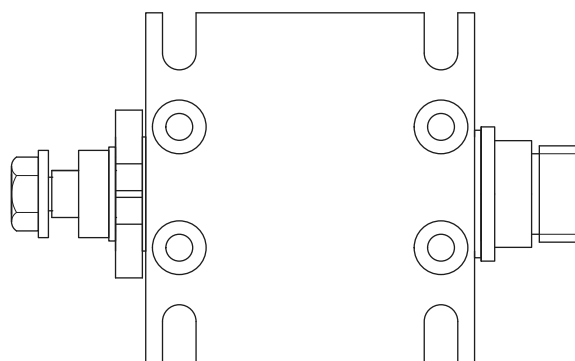
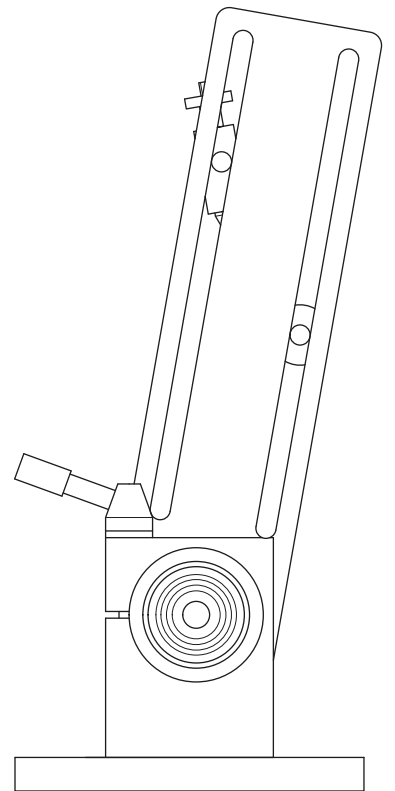
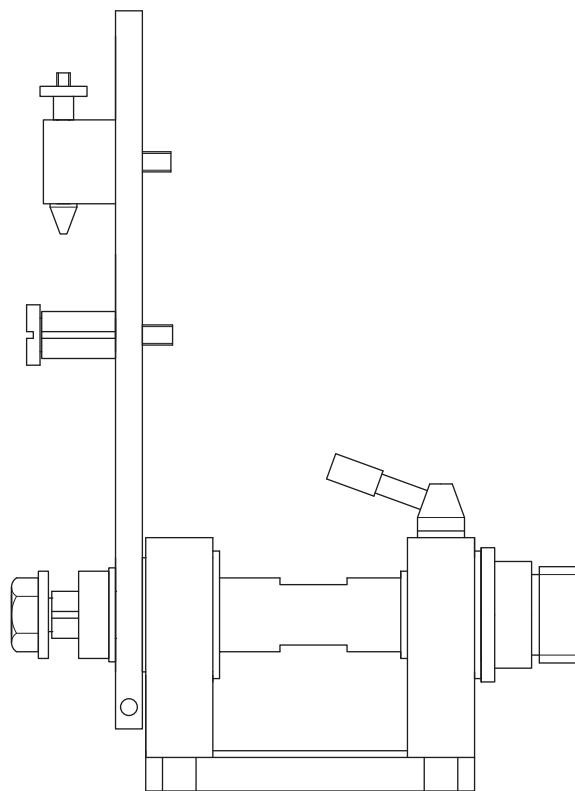
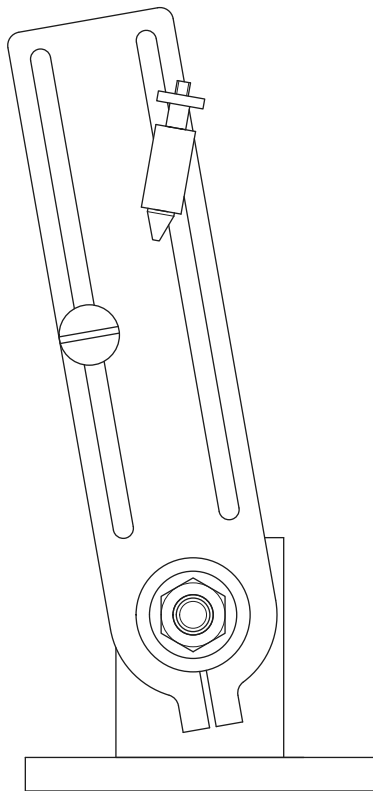
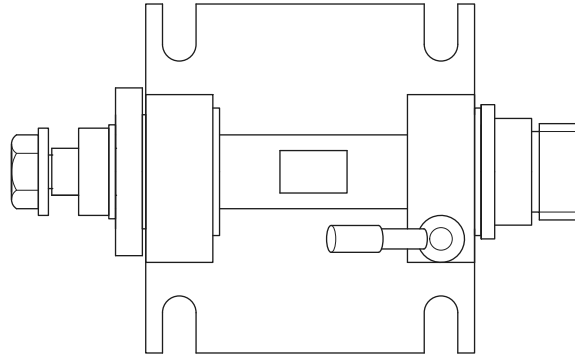


Fig.1

General Arrangement



View from the gear train end.

bearings. The mounting bolt holes are also well spaced to ensure security. This dividing head uses either a single gear or a gear train to rotate the spindle by the required number of divisions. Most lathes will be equipped with a set of change wheel gears for screwcutting purposes and these are ideal for use with the dividing head. A spindle lock is provided. The gears are supported on a banjo, which can be rotated about the spindle into any convenient position. A spring-loaded plunger, or detent, engages with the gear teeth.

The spindle nose is designed to match the Myford spindle nose to allow Myford accessories to be used. The MT2 bore is useful for a wide range of taper tooling. The spindle is hollow, allowing a draw-bar to be used, for example when using collets. The design can be changed to suit your tooling. **Photographs 1 and 2** give general views of the tool.

Materials

To ease construction and reduce costs, the tool is made entirely from bar stock with no castings required. The baseplate and bearing housings can be made from bright steel flat bar. The spindle bearings are cast iron, but phosphor bronze would be a suitable, but more costly, alternative. The spindle is free-machining steel, such as EN1A, which will allow a good surface finish to be achieved. The banjo is aluminium, but steel would be equally suitable. Smaller parts are generally steel from the scrap box.

Construction Notes

The drawings are all third angle projections. I must emphasize that since the device is intended to be used with whatever gears you can get or have available, you may need to redesign some parts or features. You may not need some of the parts shown or may need additional

parts not shown. For this reason, please plan ahead and don't just copy the design blindly.

Spindle

Start with a length of 38mm diameter EN1A or similar free machining steel. Face and centre drill each end, holding in a four-jaw and fixed steady if the bar is too large to enter the bore of your lathe. Note that the length of the outer end of the spindle, where the gear is attached, may need to be increased to match the available gears.

The spindle, **fig. 2**, is turned between centres. If you do not have a suitably sized lathe dog, one can be improvised from a short length of aluminium tubing, just larger than the bar diameter. Drill and tap a radial M8 hole in the tube and insert a short length of M8 stud, with a slotted end for a screwdriver. This clamps the dog to the workpiece and engages with the pin on the drive plate. File a small flat on the end of the workpiece for the lathe dog screw to locate. This flat will be turned away later, **photo 3**.

Fit the drive plate and lathe centres to the lathe and check for alignment using a test bar and dial test indicator, adjusting as necessary. Mount the workpiece between centres, securing the dog to the drive pin with wire or a rubber band to keep them in contact.

Starting with the tail end, rough out the outer dimensions and shoulders of the spindle leaving all areas oversize by 0.2mm or so, **photo 4**, reversing the part to rough out the spindle nose. The M12 threaded portion on the tail end can be cut at this stage using a tailstock die holder. When roughing out is complete, the tail end of the spindle, meaning all portions behind the collar, can be finish turned to final size. The part is now reversed, and the spindle nose and bore are machined using the following steps.

For the remaining operations on the spindle nose, the spindle is held in the lathe using a four-jaw chuck and fixed steady. Place the tail end of the spindle in the four-jaw chuck, using protective



Roughing out the spindle between centres on the lathe.



Continuing roughing out operations on the spindle.



Setting up the part-finished spindle in the four-jaw chuck and fixed steady ready to machine the spindle nose details.



Making the tapered spindle bore.



The spindle key.

packing to protect the finished surface of the spindle. Centre the chuck using a DTI. At this point, the outer end of the spindle is still supported using a tailstock centre. It is essential that the spindle runs truly or the spindle taper bore will not be accurate. Before removing the tailstock centre, set up the fixed steady, bearing on the portion of the spindle that will ultimately be supported by the bearing, **photo 5**.

Drill through the spindle to 13mm, as far as the drill will go, to rough out the MT2 bore. Start with a small drill and open up in stages to avoid putting undue forces on the steady. As spindle heat up it may expand, causing it to seize between the steady jaws. Proceed slowly and allow it to cool if required. Plenty of cutting oil, sharp tools and patience are the main ingredients here. Resist the temptation to adjust the steady if it does seize, just wait for it to cool down.

To machine the MT2 bore, first the top slide must be set over to the required angle. One way of doing this is to remove the spindle and fit a test bar with an MT2 portion between centres. Fit a dial test indicator (DTI) to the lathe tool post and position the probe against the MT2 portion. Set over the top slide and wind the handwheel to move the DTI along the

taper. Repeat, adjusting the angle of the top slide until the DTI reading is constant along the length of the taper.

The MT2 spindle taper can now be bored using a suitable boring tool. As the bore nears final size, take very light cuts and check for fit against an MT2 male taper. Finally, chamfer the edge of the hole lightly to finish, **photo 6**.

The outer diameters of the spindle nose, i.e. the shoulder and seating area, are finish turned at this point, to ensure concentricity with the bore.

Screwcut the spindle nose thread, using a threading tool suitable for the required thread. The Myford has a 55° thread profile and a 12 tpi thread. As the thread nears the finished diameter, it can be checked for fit against a suitable lathe chuck but remember that it is the shoulder at the back of the thread that locates the chuck, not the thread itself, so it is best not to make the thread too tight a fit. The crown of the thread needs to be rounded off using a suitable profiling tool. It is best to leave the cutting of the screw thread until last as the cutting forces are comparatively large and this operation is

the most likely to upset the accuracy of the set up, especially if the cutting tool digs in.

Reverse the spindle, supporting the outer end in the fixed steady, and drill through the remainder of bore 8mm. Concentricity is not vital, but get it as good as you can.

When the dividing head is complete, you can test the accuracy of your work using a DTI on a test bar held in the spindle nose.

To machine the keyway at the outer end, set up the spindle in V blocks on the mill table. Centre the mill spindle over the spindle and cut the keyway using a slot drill, **photo 7**.

Various fittings, including washers and spacers, are required and these will have to be adjusted to suit the available gear wheels. These are described later.

The completed spindle is shown in **photo 8**.

Bearings

The bearings, **fig. 3**, are turned from cast iron. At this stage, turn the bearings to the correct outside diameter, bore



The completed spindle.

through about 2mm undersize, enough to accept the diameter of the boring bar that will be used later to finish the bores, and part off to length. The bearings will be line-bored using a boring bar in the lathe later, when they have been fitted to the body.

Body

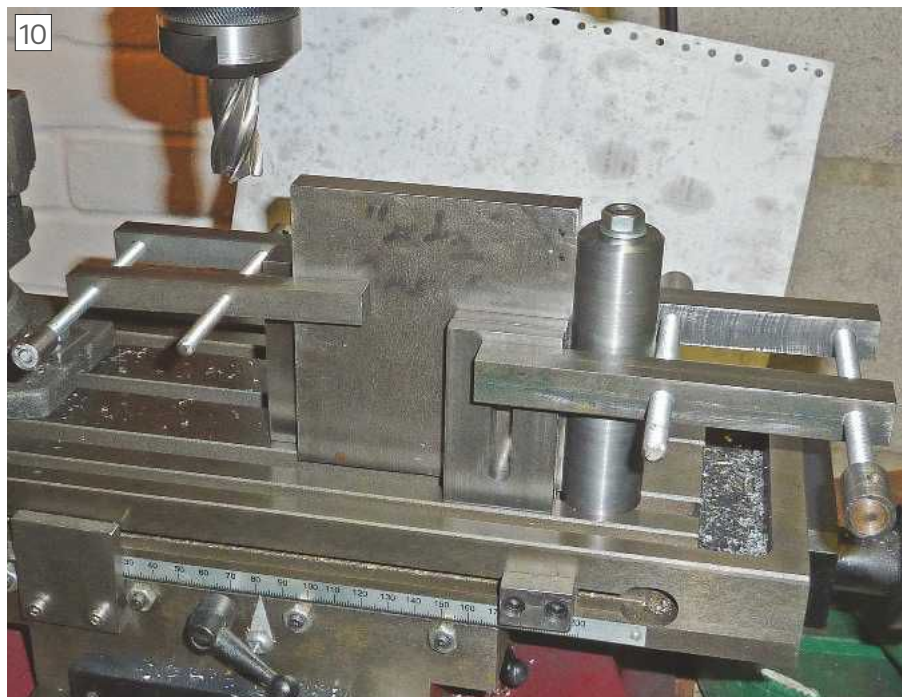
The body consists of two main parts, the baseplate and the bearing housings, which are permanently assembled to create the body.

Baseplate

Cut the piece for the baseplate, **fig. 4**, from flat section bar of suitable thickness, slightly oversize. The base needs to be machined accurately square and to size. The easiest way to do this is to use an angle plate and mill the edges with a suitable end mill. Bolt the angle plate to the mill table, parallel to the X axis. Bolt the baseplate to the angle plate such that it protrudes above the top edge of the angle plate, **photo 9**. Skim the top edge with the end mill until



Machining the first baseplate edge.



Machining the second baseplate edge at 90 degrees to the first edge using a cylindrical square.

it is flat and all saw marks are removed. Now rotate the part so that the edge just machined is resting on the mill table and bolt to the angle plate. If the angle plate is bigger than the baseplate, it will be necessary to rest the baseplate on a parallel. Skim the top edge and measure the width across the baseplate. Continue to machine the top edge until the required width is achieved. The two opposite edges should now be parallel and the correct distance apart.

The baseplate now needs to be rotated 90 degrees to machine the third edge accurately square to the first two edges. To achieve this, the baseplate is held against a cylindrical square which is bolted to the mill table next to the angle plate, **photo 10**. The third and

fourth edges are machined as before.

Mark out and drill the four bolt holes used to secure the bearing housings to the base plate. These are counterbored or countersunk from underneath, sufficiently deeply to enable the bolt heads to sit beneath the surface. They should also be drilled slightly oversize to enable the bearing housings to be positioned hard up against the shoulder. Bolt the baseplate flat onto the mill table with the underside uppermost using two of the holes just made, ensuring that the part is not strained or twisted. Now lightly skim across the underside of the baseplate to ensure it is completely flat.

The next job is to machine the shoulder

on the top surface of the baseplate that enables correct alignment of the bearing housings. Bolt the baseplate to the mill table the right way up using at least two milling clamps. Before fully tightening the clamps, clock the part square to the mill table or use an engineers' square. Machine the shoulder to size and depth using a suitable end mill. It will be necessary to reposition the milling clamps to finish this job. Move one clamp at a time to avoid disturbing the part.

Note that if you are using bright bar, machining the surface layer away can often result in distortion due to internal stresses in the material. If you experience distortion, it may be necessary to take further skims to flatten the part.

To complete the baseplate, the four slots for the mounting bolts are machined using a suitable slot drill. The positions of the slots can be changed to match the T-nut slots on your milling machine and lathe cross slide. As specified, they match both the X3 mill and Myford lathe. To machine the slots, rest the baseplate on parallels and bolt square to the mill table. This allows the slot drill to pass right through the material without damaging the mill table.

Bearing Housings

The bearing housings, **fig. 5**, are cut from suitable flat bar, slightly oversize. If the correct bar is available, it is only necessary to machine the ends square and to length. This can be done using the angle plate as just used for the baseplate or by holding the parts in a vice. The height of the bearing housings can be adjusted to suit specific equipment. The bolt holes in the bottom end of the bearing housings are spotted through from the baseplate and drilled tapping size, then tapped.

● To be continued

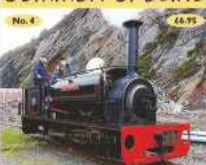
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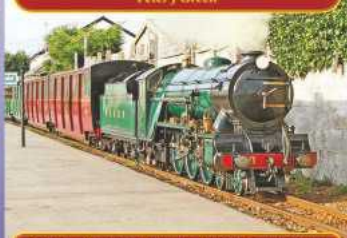


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Potty Clamping Drill Part 2

This design for a clamp drill by Stewart Hart generated a lot of interest on the forum



Clocking Mill Vice square



Cutting the Key way with a slot drill

Pillar Part 1 - Thread one end of the pillar M8 not forgetting to undercut the thread so that it pulls down nice and square, tighten the pillar home fully into the Top clamp and mark the position for the Key way. It's important for a smooth action that the Key way is parallel to the centre of the pillar, so the jaws of the milling vice were clocked up perfectly square, and the pillar set on top of a parallel for milling. Holes slightly larger than the slot drill to be used were drilled at the extremities of the way: this is so the slot drill will not pull into the corners, the way cut to depth, **photos 11, 12**



Key fitted in place

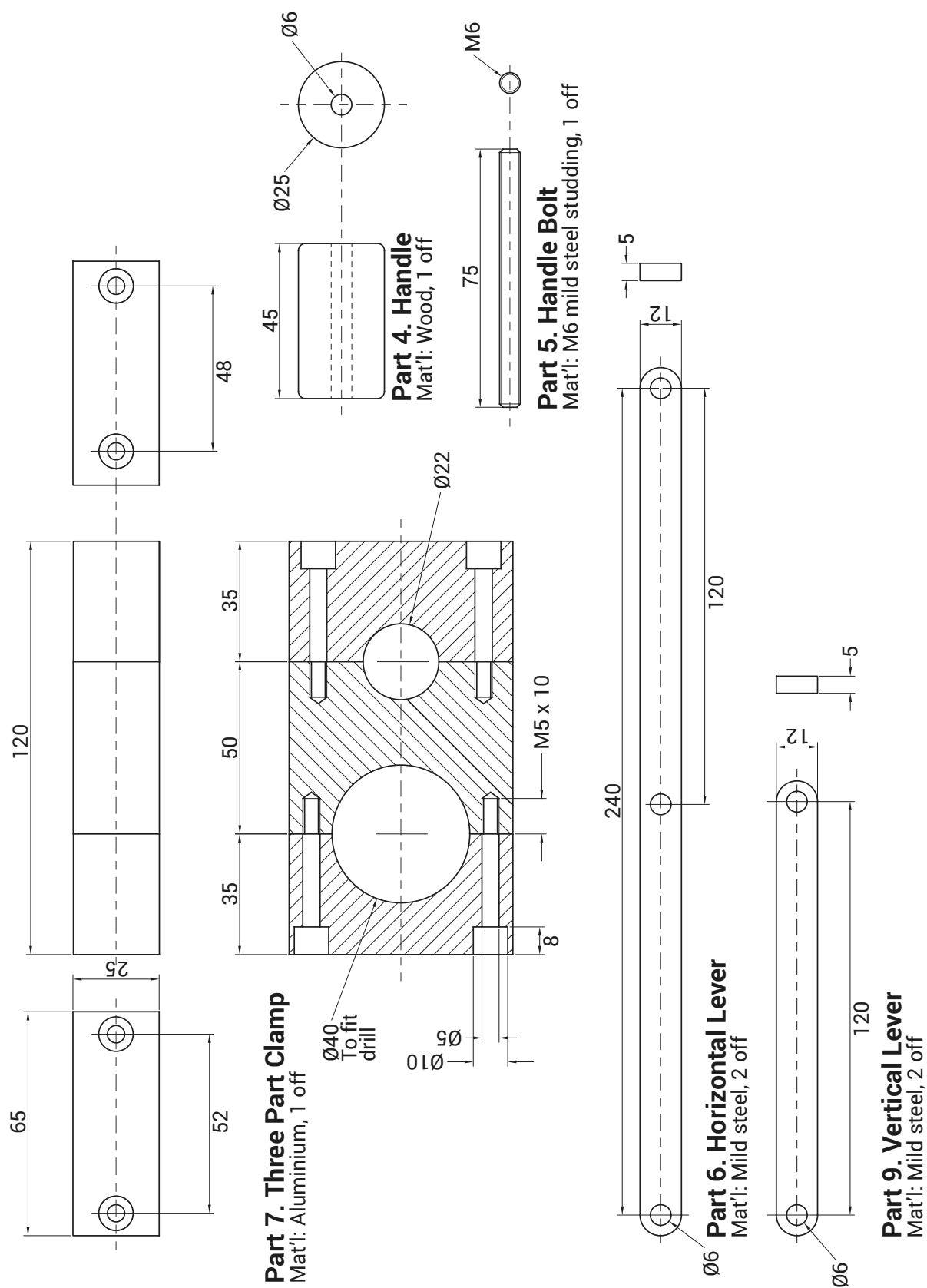


Cutting out the parts for the clamp

Key Part 2 - Made from a piece of square section mild steel - just machine or file so that it is a nice sliding fit in the way, it is held in place by a M5 screw adjusted to give a shake free fit, **photo 13**.

Three Part Clamp Part 7 - The design and layout of this clamp may have to be adjusted to suite the particular drill being used, But the general procedure will be - cut chunk of aluminium roughly to size, and squared up, cut off each piece and square up the cut faces, **photos 14, 15**. The centre part of the clamp was drilled and tapped and the two end clamps were drilled and countersunk for M5 cap screws, the three parts were tightly fastened together with a piece of card inserted in the joint so that you end up with a slight gap to pinch onto the part, **photo 16**. On the centre line and at the join put in a

Fig.4





Fly cutting the material for three way clamp square

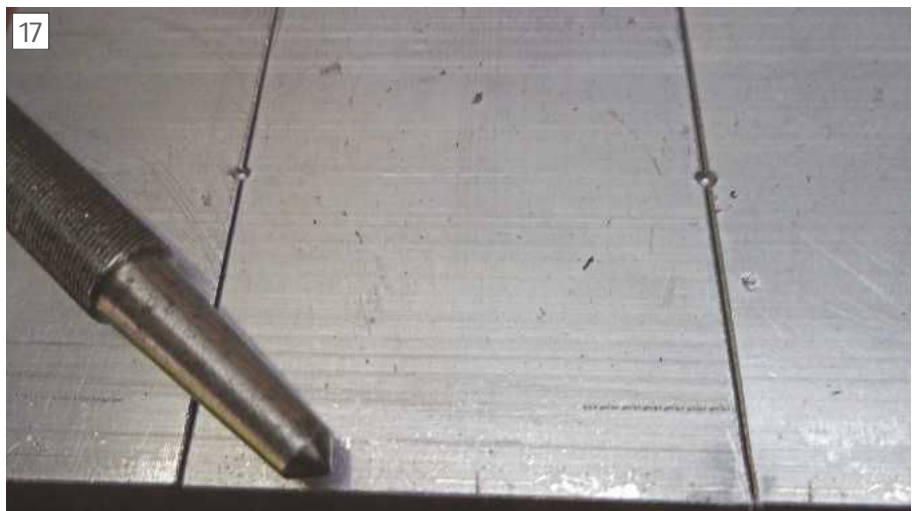


Card placed in the joint to give pinch

nice deep centre punch mark, using this mark and a wobble bar in a large four jaw chuck, clock to run true, **photos 17, 18**. If your four-jaw is not big enough this operation can be done just as well on a face plate. Then it is a relatively straight forward operation to drill a bore out to size, **photo 19**.

Pivot Bolt Parts 10 and 8 - You should have no trouble making these parts from mild steel hexagon bar, **photo 20**.

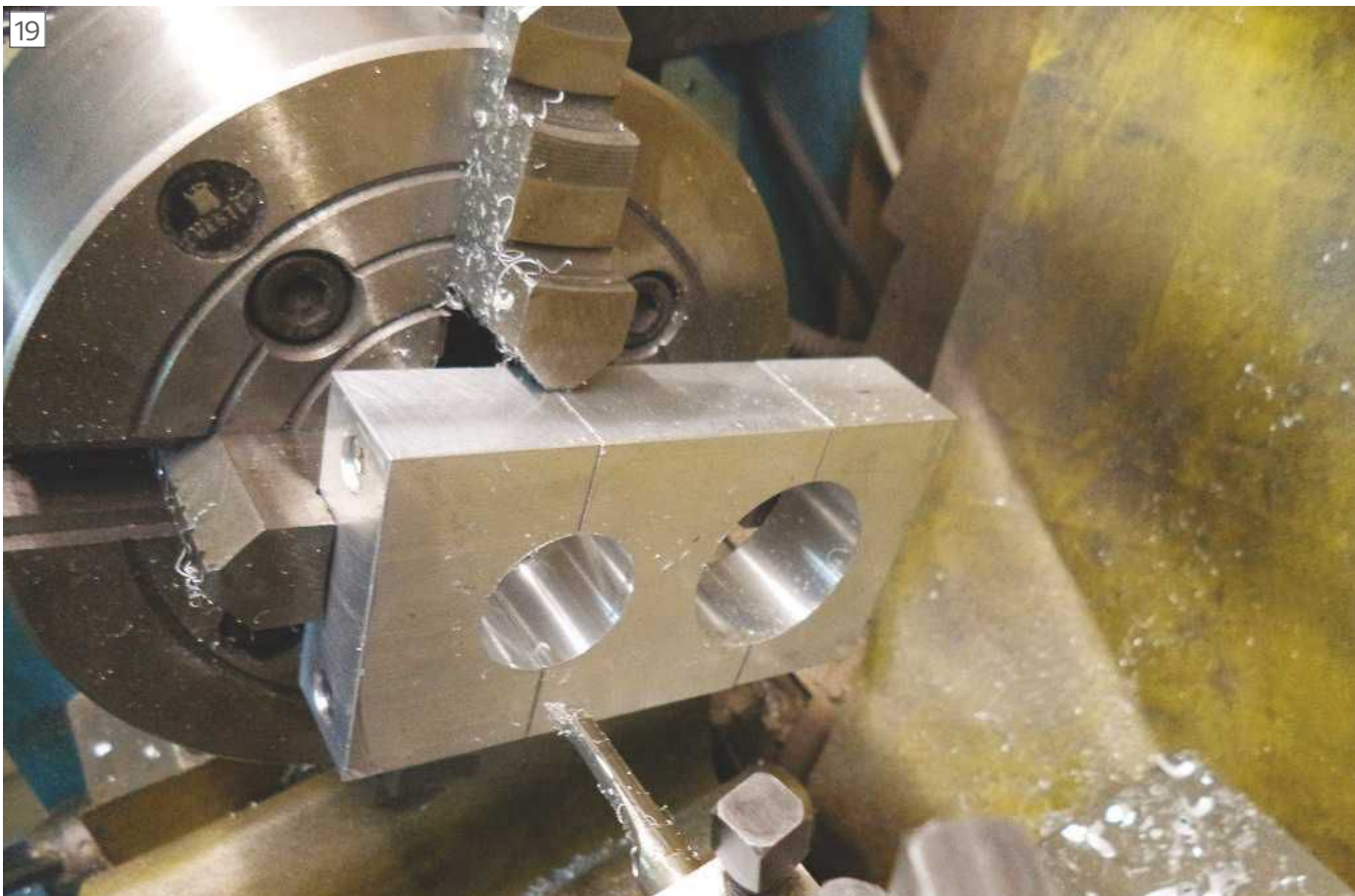
Horizontal and Vertical Levers Parts 6 and 9 - Made from salvaged mild steel strip just mark the centre line and hole positions centre pop and drill on the pillar drill and radius the ends with a file, no great precision is required, **photo 21**.



Centre pop hole position



Setting up position in four jaw using wobbler bar



Holes drilled and bored to fit parts



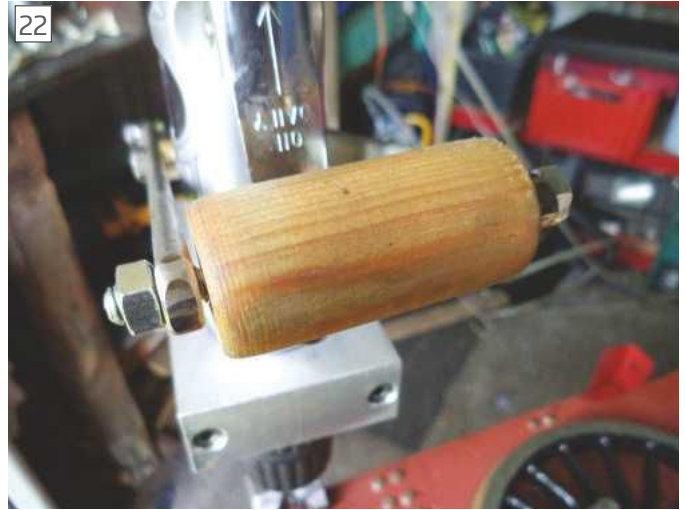
Turning Pivot Bolts

21



Drilling Levers

22



Completed handle fitted

Handle and Handle Bolt Parts 4 and 5 - Again no great precision is required a broom donated the wood for the handle and the bolt is just a length of M6 studding, **photos 22, 23. Photograph 24** is a close up of the 'business end' of the drill.

The Air Drill came complete with the male quick release connector which was fine as I already had a spare female connector and a length of suitable braided air hose, my compressor is one of the real cheap and cheerful far Eastern jobs, I've had it for about ten years and I'm quite happy with it, the tank is a little short of capacity for this job but I find I can drill holes up to 4mm which is all I require, and the tank is recharged and ready for the next hole in the time it takes to reposition the drill, I'm sure this will be a piece of kit that I will get a lot of use. ■

23



Drill in action

24



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Readers' Tips



**TIP OF
THE MONTH
WINNER!**

Worden Tips

Malcolm Tierney wins this month's Chester Vouchers with some ideas for users of this popular tool and cutter grinder.

I was given on a long-term loan a Worden tool and cutter grinder to grind 1/8" HSS boring tool bits for the Hobbymat. I found however that I wanted to sharpen end mills and slot drills. The problem with the Worden is that tools are advanced from the rear with a screw. This makes it difficult to sharpen the four faces of an end mill and means that the abrasive wheel will always be cutting on its corner. I decided to make Harold Hall's end mill sharpening jig and adapt it to the Worden as this allows the end mill to be plunged into the face of the wheel up to a stop limiting the cut equally on each of the cutter's facets. I made the tool holders and stop exactly as per Harold Halls instructions with the exception that I made my graduated wheel from brass and divided the graduations from a change wheel on the headstock mandrel.

The Worden was adapted by removing the screw advance mechanism, clamp and one side rail from the cutter holding cradle. the left-hand side of the cradle was replaced with a length of 1" x 3/16" mild steel. This steel strip was clamped into place with a pair of cutter holders in situ and a scrap of 2 thou' brass shim twist

blocks and the new strip to allow a tolerance. The screw holes were then spotted through, cleared and countersunk on the opposite face. With a cutter block in place the stop block was clamped into position with the shim twist the two and a hole position spotted through the front and rear fixing holes. These were then pilot drilled and tapped. With the block now fixed by its front hole another hole was now spotted through the rear hole, piloted and tapped and the procedure repeated to make a third hole so that a good range was available for sharpening a variety of end mills and slot drills.

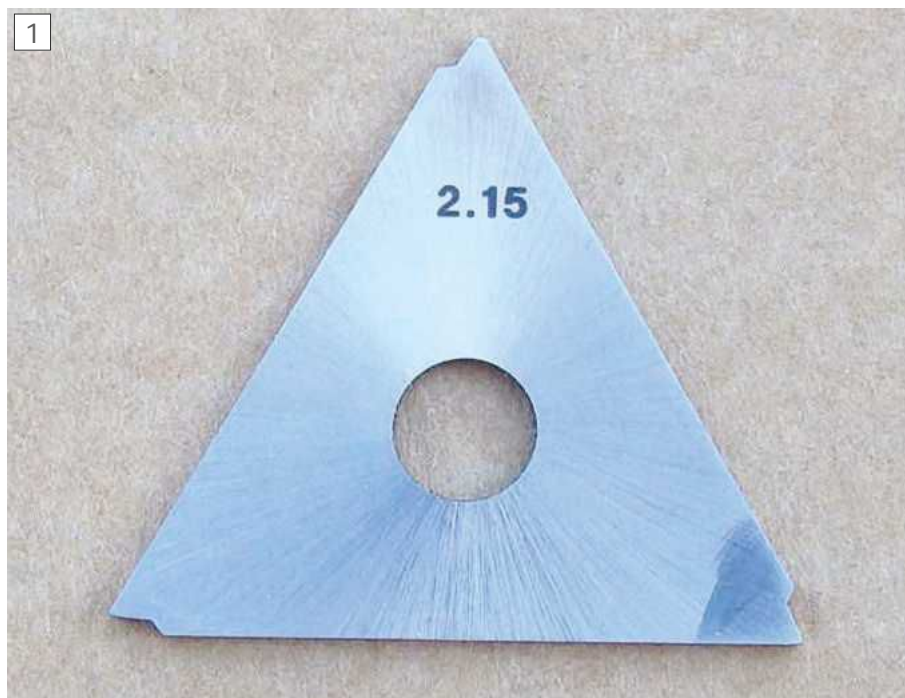
No grinding wheel was fitted to this machine when it was lent to me so I bought a diamond cup wheel from Arc Euro Trade. I failed to notice that this had a bore of 20mm whilst the Worden takes wheels with a 1 1/4" bore. I could not mount the cup wheel on the Hobbymat and so a local engineering firm put it in their large Colchester lathe and drilled it out.

As I received the Worden it was very rusty and so all the rusty parts were pickled clean in citric acid. The table was rubbed down to 1200 grit with silicone carbide paper and sent away for electroplating, hence the very shiny table which hopefully might be a little more reticent about corroding in future.

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

Please note that the first prize of Chester Vouchers is only available to UK readers. You can make multiple entries, but we reserve the right not to award repeat prizes to the same person in order to encourage new entrants. All prizes are at the discretion of the Editor.

The “Star System” and more for parting off



Triangular parting blade by Dormer

But there are some drawbacks too:

- Quite expensive.
- 60° cutting edge! So short edge life.
- Sharpening not so easy (see drawing 1).
The cutting plane must be parallel with its “as supplied” position, the cutting edge must follow a radial path, a 6° clearance is given for a longer edge life.

The Dormer blade holder (fig. 1 and photo 2)

The blade (part D2) is held on its bracket (part D1) by an eccentric (part D3). The screw D4 is here only to prevent losing the eccentric when no blade is set on. The eccentric D2 must be locked in a clockwise movement.

For machining the eccentric part of D3, use a 0.5mm packing piece under one jaw of the chuck.

When setting, put some glue on the screw D4 to avoid unscrewing.

The “Star System”

From these blades came the idea of making “star shape” cutters from standard slitting saws, photo 3, as they

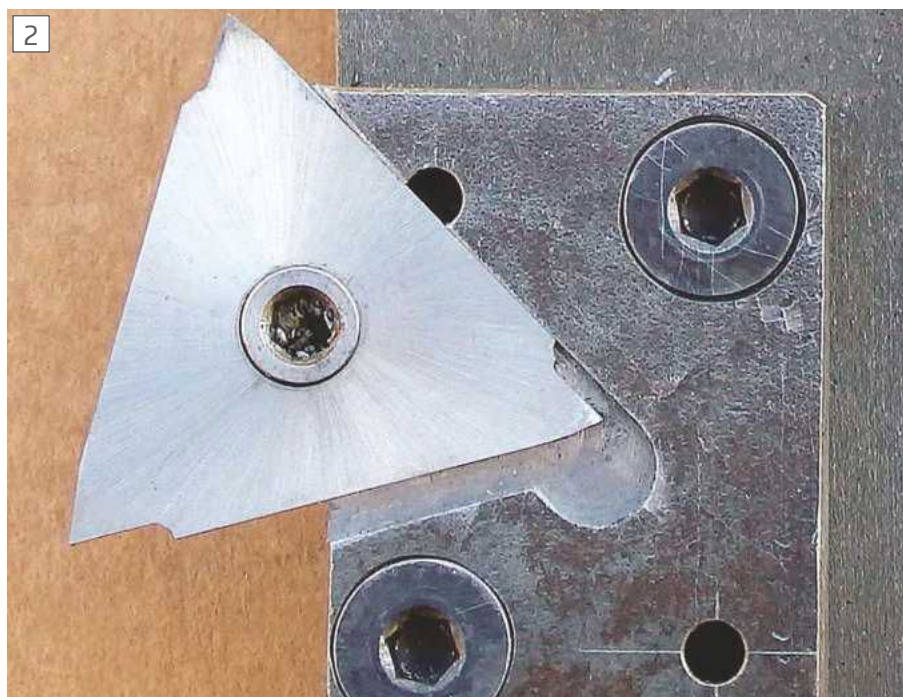
Jacques Maurel describes his approach to parting off smaller items.

I've discovered that most of my parting off was for making special hardware: screws, nuts, washers, spacers... The diameter of which being quite small (diameter 30 mm maximum), I found it worth using a thin parting blade (1.3 to 2.2mm maximum width) with 15mm protruding.

The Dormer blade: (see photo 1 and 2)

For many years I've used Dormer triangular (40mm side length, 2.15mm width) grooving blades with good results, the advantages of which are:

- Free cutting due to side relief (1.4mm width near the center) and great (too much!) clearance.
- The blade can be used flush with the lathe chuck.
- One blade gives 3 cutting edges.



The Dormer blade fitted to an 'upside down' rear toolholder.

3



Making the 'star system' parting blade

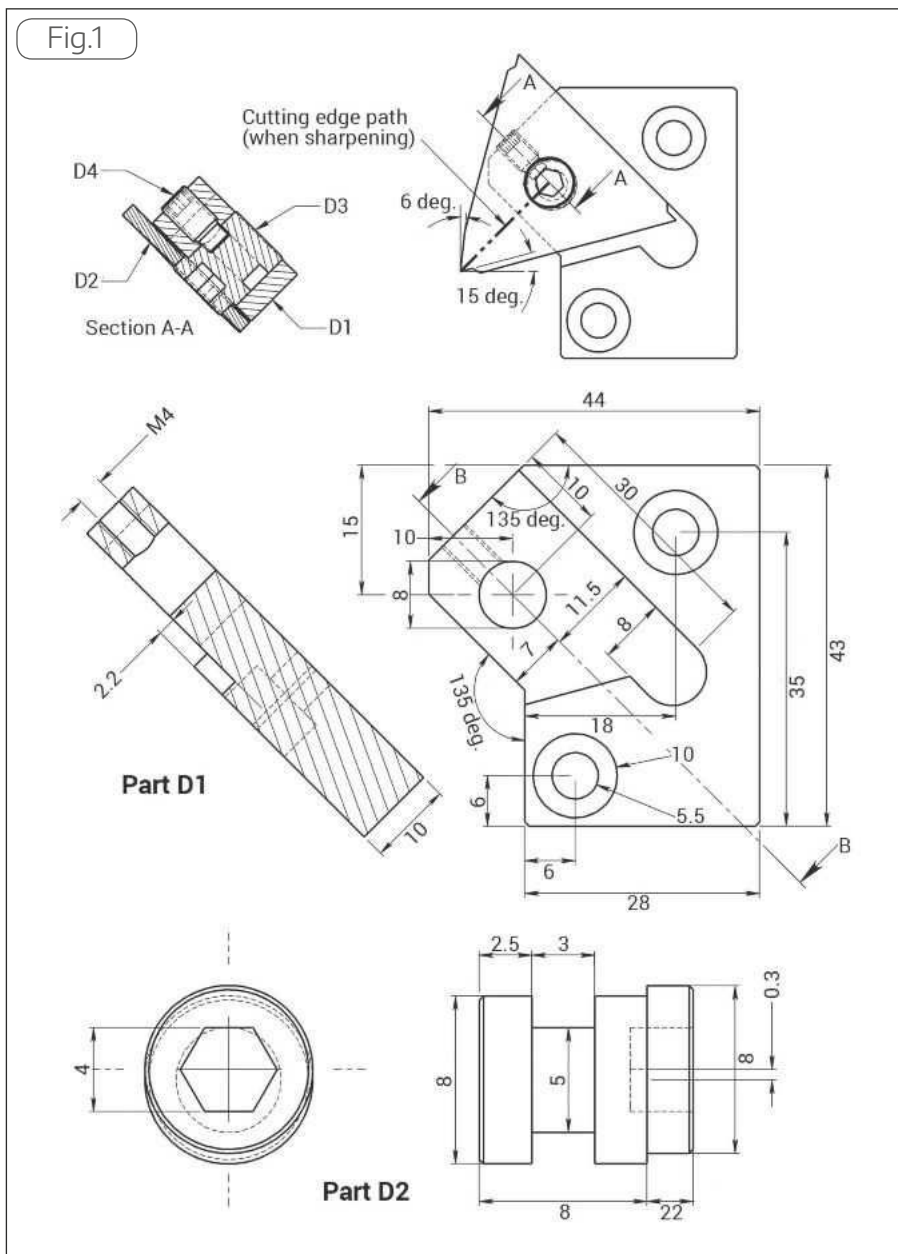
are slightly relieved (0.08mm less in width) toward the center.

I used 65mm diameter, 1.5mm width HSS saws with small teeth in which an eight-

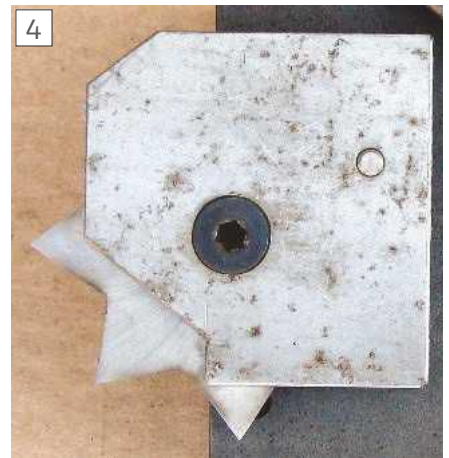
pointed 60 mm diameter star cutter was cut.

The star point angle chosen was 70° to get 6° relief angle and 14° cutting angle. A cardboard template was used to mark out

Fig.1



4



Holder for Star system blades

the blade with a felt pen.

The cut was made off hand using a 115mm diameter 1.6mm width grinding disc set in an angle grinder. The teeth must then be sharpened on a bench grinder for the cutting edges to be perpendicular with the plane of the blade and then stoned to be sharp. It's not necessary for the teeth to be exactly on the same diameter as we are not making a milling cutter.

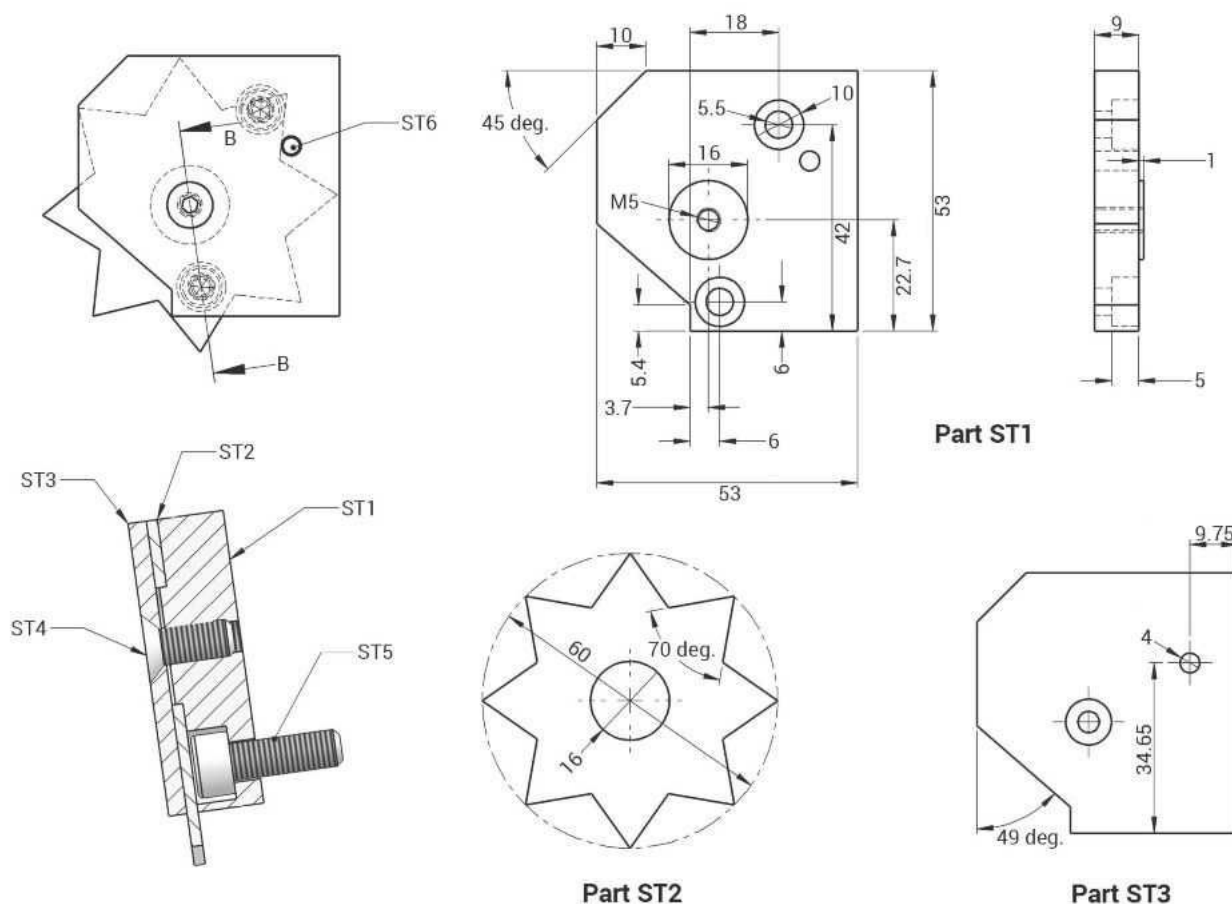
Further sharpening will be required for the cutting edge to follow a radial path while keeping the 70° angle.

5



Turning the boss on part ST1.

Fig.2



Parts list for the "star system":

N°	off	Name	Material	Remarks
ST1	1	Bracket	FCMS	
ST2	1	Blade	HSS	
ST3	1	Clamping plate	MS	2.5mm thick sheet
ST4	1	Clamping screw FHc/90 M5-10	8-8	
ST5	2	Screw CHc M5-12	8-8	
ST6	1	Blade stop	Silver steel	4mm diameter, 12.5mm long

The "star system" blade holder (fig. 2)

The cutter is set between 2 plates, **photo 4**, so we have now a quite stiff parting off blade with eight cutting edges for a very reasonable price.

Parts ST1 and ST3 have the same shape (some dimensions are shared between the two drawings) and can be milled together. The centre part of ST1 is turned, **photo 5**. The counter bored holes on ST1 are for fixing on the slider of a "switch off" attachment to be covered in a later article.

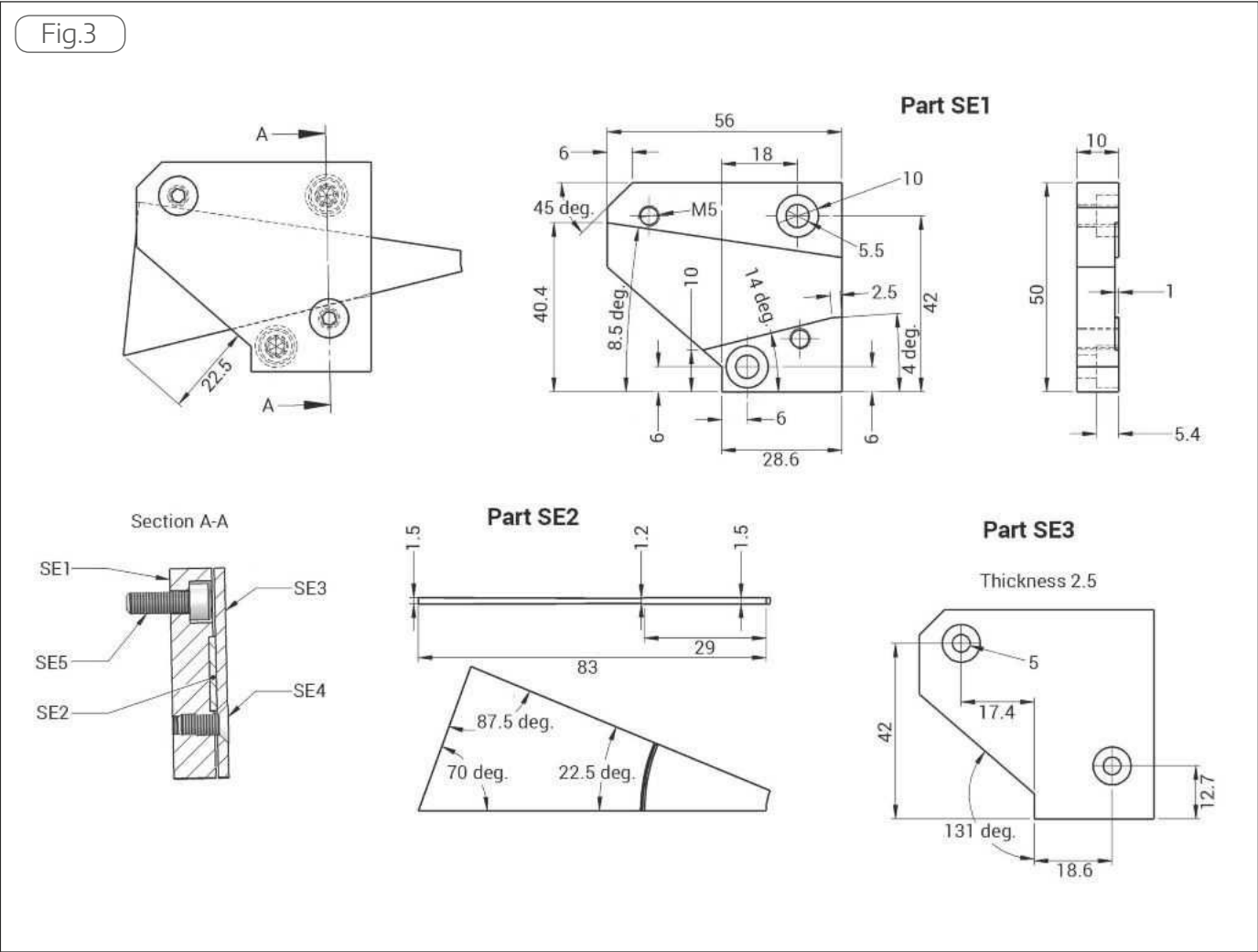


The 'sector' system



Sector marked on saw blade

Fig.3



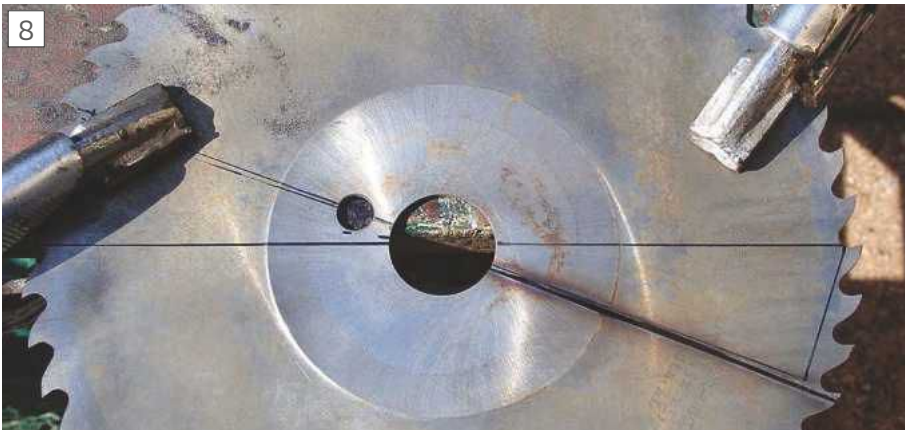
- The drawbacks:**
- The position of the cutting edge increases the risk of "digging in" so I only use it with my "switch off" attachment.
 - Due to the star shape, it's slightly more difficult to see the groove starting place than with the usual parting blades.
 - Due to the shape of part ST3, it's not possible for the blade to be flush with the chuck.

The "sector blade"
Following the idea of using slitting saws, I tried to use a 200mm diameter, 1.5mm width HSS circular saw and to cut it into sectors, **photo 7**. The humble B&D workmate was used as an altar to sacrifice the saw with the angle grinder, **photo 8**. The resulting blade was then sharpened and set in a convenient bracket to be used with the "switch off" attachment, **photo 6**.

As the prototype worked well, I decided to cut 16 blades from the slitting saw, using a grinding jig to guide the angle grinder and the saw to be cut, **photos 9** and **10**, a 1mm thick grinding disc was used.

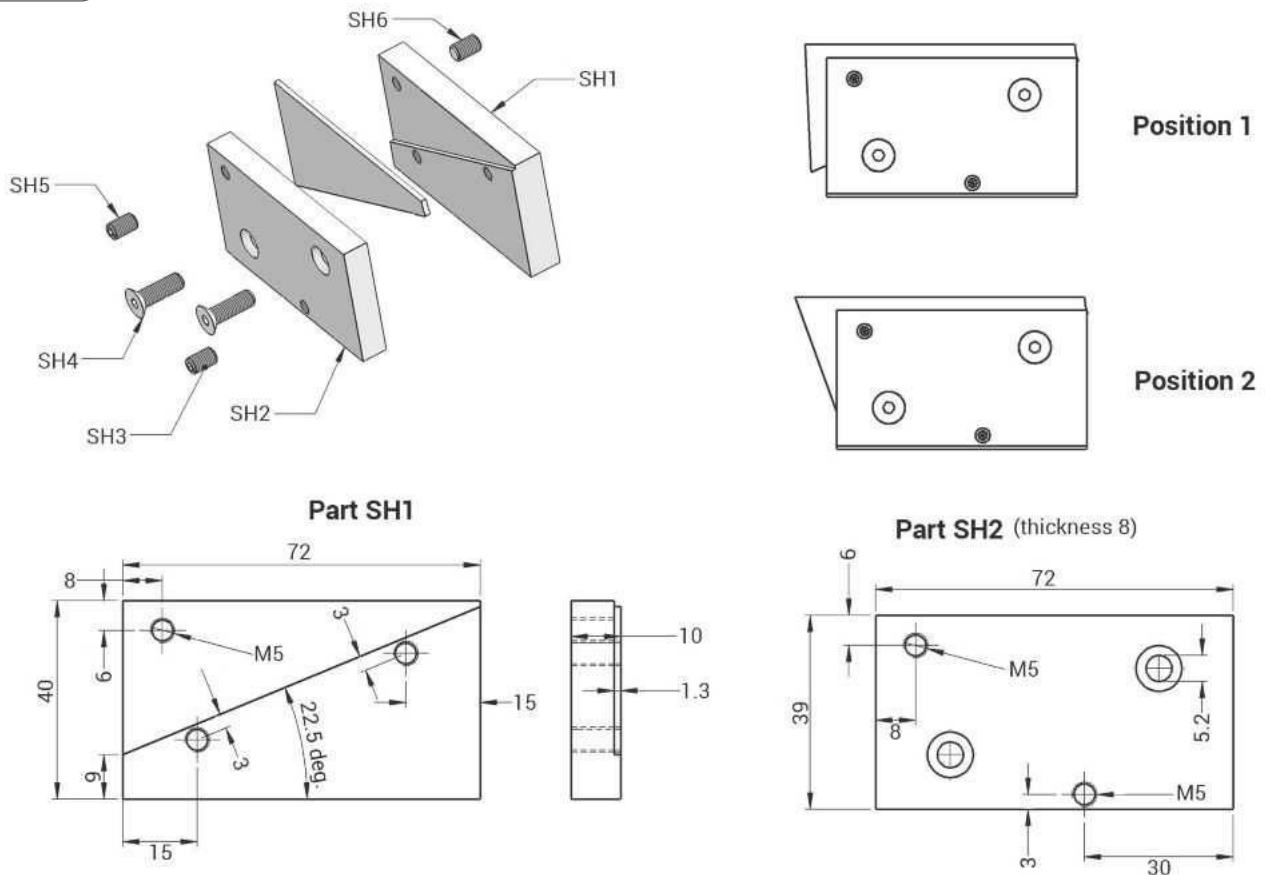
A grinding jig, **fig 4**, was also made for sharpening these blades (3 sides) on the cutter grinder, **photo 11**.

Parts list for the "sector blade" sharpening jig:				
N°	off	Name	material	remarks
SH1	1	Bracket	FCMS	
SH2	1	Clamping plate	FCMS	
SH3	1	Screw Hc M5-8	8-8	
SH4	2	Clamping screw FHc/90 M5-18	8-8	
SH5	1	Screw Hc M5-8	8-8	
SH6	1	Screw Hc M5-8	8-8	



Cutting the saw blade...

Fig.4



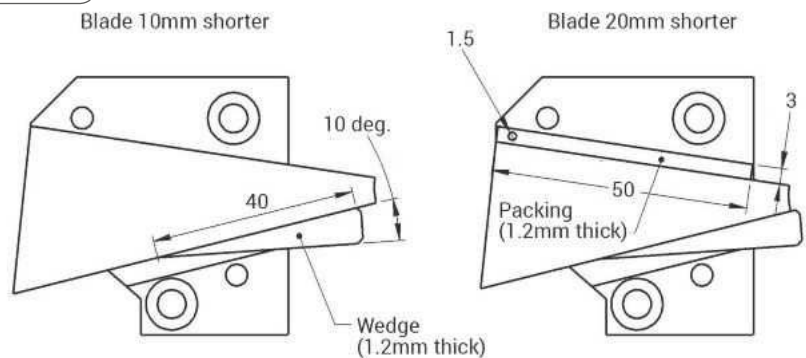
The “sector blade” holder (fig. 3)

Here the blade is also set between 2 plates to get a stiff parting off tool. Parts SE1 and SE3 having the same shape, again some dimensions are shared between the two drawings and they can be milled together. The counter bored holes on SE1 are for fixing on the slider of the “switch off” attachment.

The “sector blade” sharpening jig, photo 11 and fig. 4

To use this jig, the screws SH3, SH5, SH6 must be adjusted to get good clamping for the blades.

Fig.5



... into sixteen pieces



Cutting off the teeth

11



Sharpening the blades

Sharpening the long sides of the blades:
photo 11, left

Position 1 is used for sharpening the shortest long side of the blade, and position 2 for sharpening the other long side.

Sharpening the short side of the blades:
photo 11, right

Position 1 is used for sharpening the short side of the blades.

Further sharpening:

Any further sharpening must be made on the small side of the blade, so the blade will become shorter and the cutting edge moved upwards, **fig. 5 left**. For a great shortening it will be necessary to put

Parts list for the "sector blade":

Nº	off	Name	material	remarks
SE1	1	Bracket	FCMS	
SE2	1	Blade	HSS	
SE3	1	Clamping plate	MS	2.5mm thick sheet
SE4	2	Clamping screw FHc/90 M5-10	8-8	
SE5	2	Screw CHc M5-12	8-8	

some packing between the back of the blade and the blade holder for the height adjustment of the blade to be possible, **fig. 5 right**. A short elastic pin is set in the

1.5mm hole to keep the packing in place (a corresponding 1.7mm hole must be drilled in part SE 1. Experiments proved that the wedge was not necessary. ■

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Chris Rayward completes his LNWR tender tool chests.

● ENV Aero Engine

Stephen Wessel continues his description of the electroforming process and points out some of the pitfalls.

● FALCOR

A new, gas powered 32mm easy to build locomotive for your garden railway, described by Martin Ranson.

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David Earnshaw makes an attachment for fitting a Coventry diehead to a small lathe.

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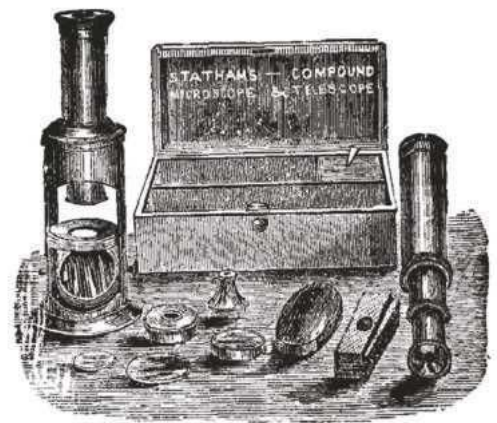
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Shaping up Part 3

Cutting Metal

Bill Morris continues his introduction to shaping machines with some practical advice on their use.

Safety first

Before we start to cut metal, it is as well to have a few tips about safety when using the shaping machine. If you are not confident of what you are doing when wiring up the machine to the mains electricity, do get someone who is, to help you, bearing in mind that confidence is the feeling someone has when he has failed to fully understand a complex matter. While many amateurs will make do with a simple double pole on-off switch (there is no need to reverse a shaping machine) it makes a lot of sense to incorporate a circuit breaker that has to be reset if the power fails. It takes little imagination to see what might happen if the power is restored after a failure if hands or head are in the vicinity of the ram or driving belt ("dangerous restart"). The breaker is sometimes called a "no volts release" switch. You must also pay careful attention to earthing, even if you think you are in an earth-free environment like a wooden shed, and best of all is to have all your workshop wiring controlled via a two pole "residual current device (RCD)" which will cut the current before it reaches fatal levels. These do not protect against over-currents and some form of fuse or breaker will also be needed in the circuit. These are sometimes combined as a residual current-circuit breaker with overcurrent protection (RCBO).

There are two good reasons for not standing in line with the ram while the shaping machine is operating. One is that



Catching a vice (these are posed photos... please don't write in!)

the chips that fly off the work piece can be very hot and can also get in your eyes. The other is that if you have forgotten to attach the vice firmly or have forgotten to tighten the jaws, you may end up having to catch a heavy piece of metal in flight if you are lucky, **photo 1**, or receive it on your shins or feet if you are not.

After tightening the vice and bringing the workpiece to the tool, remove the vice and cross feed handles. They hurt if they vibrate off and land on your toes, **photo 2**. While an employee is likely to have reinforced toe caps that s/he must wear, some of us like to live dangerously. Broken great toes feel uncomfortable for months after the bones



Dropped handle



Ouch!



Keep fingers clear



Machine vice on shaper

have healed.

Another danger from the feed handle is that it can easily trap a finger between it and the vertical feed shaft. If the feed is coarse, it will remove the part of the finger that is in the way before you can even think about it, **photo 3**.

Less obvious is the danger to the fingers of the cross feed crank, **photo 4**, if the vice is positioned across the table and the feed is coarse. Again, a finger can get crushed, but as the pawl knob is smooth, the results are likely to be less catastrophic. Occasionally it is necessary to take off the feed while the ram is operating, but most of the time the machine can be brought to a halt before doing so.

Holding the work

When it is relatively easy to do so and the shape of the work piece allows it, I suggest you hold it down directly on the table. Doing so reduces the height and hence leverage of the work against the tool forces. In what follows, you will occasionally see how I have followed my own advice. However, when



Checking vice base is horizontal



Aligning fixed jaw with the ram

time is money, many people will prefer to use a machine vice, which is usually supplied with a swivel base, **photo 5**. The latter of course adds to the height of the vice, but this is countered by the convenience of placing the workpiece at various angles to the path of the tool.

Before relying on the vice, it is as well to check that its base is parallel to the movement of the ram, by running a dial gauge along a parallel that sits across the ways of the vice, which in most cases form a datum for machining the work piece, **photo 6**.

When shaping a surface along the long axis of a work piece and it is important that another face is parallel to the edge of that surface, you will also have to check that the fixed jaw of the vice is parallel to the movement of the ram, **photo 7**.

A machine vice in which the fixed jaw is not square to its ways is a nuisance, as it is not then possible to assure that one surface is square to another and it is also



Checking the fixed jaw is vertical



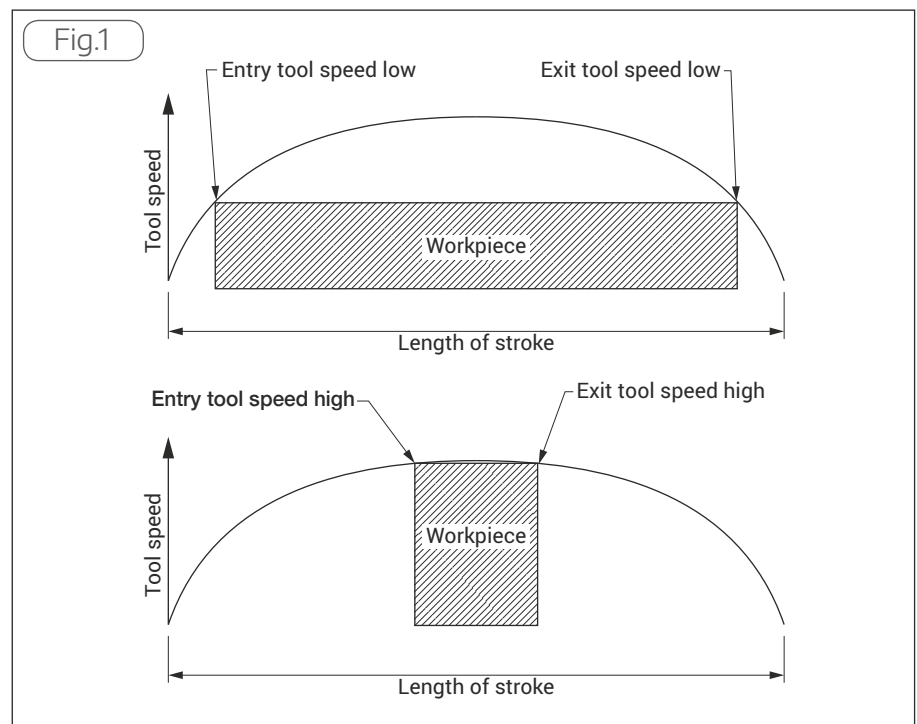
Round bar ensures the work is aligned with the fixed jaw

sometimes difficult to get the work to seat itself properly in the vice. It can be checked with a small precision square or by holding a parallel by its edges vertically in the vice and moving the table up and down while exploring the edge with a dial test indicator, **photo 8**. This assumes that the edges of the shaper's vertical ways are truly vertical and square to the table. The same testing set up can also be used to set the travel of the tool slide truly vertical. Note the piece of round brass bar, which serves to ensure that it is the fixed jaw that is being tested, and without bruising the parallel.

Setting up for cutting

As an illustrative exercise, I have used the shaping machine to make a vee block. Normally, one would make these in matched pairs, but I already have vee blocks, so an example will have to do. My material was a lump of cast iron that I cut from an old X-ray table counter-weight, so there was one sawn surface and five cast ones, fortunately without hard spots. After knocking off any obvious bumps with a file the next step was to seat it in the vice on a pair of parallels. Even if it is not necessary to raise the surface to be machined above the level of the vice jaws, I suggest that one uses parallels as a matter of course, as it is much easier to true up a bruised or chipped parallel than it is to re-surface a vice base. In the photographs that follow I have added a white arrow to indicate the direction of feed.

You will produce a smaller total weight of swarf if you start with the smoothest surface against the fixed jaw of the vice and then press the work piece down on to the parallels with one hand while tightening the vice with the other. While in the set up shown in **photo 9**, we are relying on friction to hold the work in the vice against cutting forces, and we cannot follow the principle of having the cutting forces borne by the fixed jaw because of the shape of the vice, if you have seen someone using a hammer on the vice handle, please do not imitate them. It should not be necessary if the vice is well constructed and the handle is of a sensible size. Note the piece of round bar which



ensures that the best face sits against the fixed jaw.

We are not yet ready to cut metal as the stroke of the ram and its starting position have to be set, and the speed of cut chosen. **Figure 1** is a diagram of stroke length versus the speed of the tool. In the upper half of the diagram the stroke length has been set to match the length of the work piece, with an allowance for the tool to run free at the end and for the clapper box to re-seat at the beginning. The tool starts cutting at low speed and enters the work smoothly, builds up to a maximum speed and then slows down for a slow exit. In the lower half of the diagram, the stroke has been set to be much longer than the workpiece. Since it traverses a longer distance in the same time, its speed at entry is much higher, leading to shock, vibration and tool chipping, while its exit speed is also higher, projecting hot chips to far corners of the work shop and, in cast iron, causing

crumbling of the edge.

After setting the stroke length, the starting position of the ram is set by engaging the clutch with the motor off and moving the ram by turning the pulley wheel by hand until it is at the rear end of its stroke. The ram position adjusting nut or handle is then released and the ram slid by hand until the tool is resting behind the workpiece. At the back there should be enough space for the clapper box to re-seat at the end of the return stroke, while at the front there should be just enough space for the heel of the tool to drop free of the work piece. To some extent, the setting at the back will depend on the speed of the stroke, but 20 mm between the face of the tool and the work piece will be enough in most cases. Pull the ram through a full cycle to check that the tool clears at the front too and does not foul anything on its way, before applying power.

The stroke rate and hence the cutting speed depends on the length of the stroke

for a given material. Most amateurs will make an educated guess and slow down the stroke rate if the machine grumbles, shakes or visibly distorts. As the cutting speed varies throughout the stroke, most authorities take the average tool speed into account and use standard figures for cutting speed as applied to turning. Thus, strokes per minute (complete cycles) = $1000 \times \text{cutting speed (m/minute)} / 2 \times \text{length (mm)}$; or = $\text{cutting speed (feet /min)} / 2 \times \text{stroke length (feet)}$.

Finally, the feed rate for horizontal surfacing has to be selected. This can be taken from the maker's handbook if available, but if it is not it can easily be calculated knowing the number of teeth in the ratchet wheel (n) and the pitch of the cross-feed leadscrew (p), whence the feed for one tooth of the ratchet is p/n . For example, if the pitch of the leadscrew is $1/8$ in and there are 20 teeth in the ratchet wheel, the feed for one tooth is $0.125/20 = 0.00625$ in/tooth. In most cases 2 or 3 teeth can be used for roughing and 1 tooth for finishing. Feed for vertical or angular surfaces has to be put on by hand on the return stroke (when it is a good idea to increase the tool clearance at the back) and the rate is guesstimated, depending on the finish achieved.

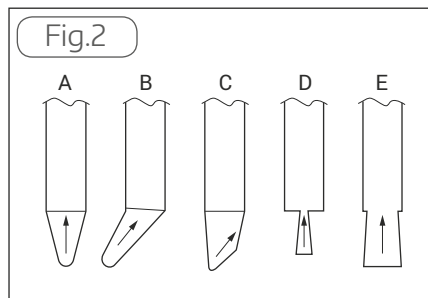
A cut can now be put on, the clutch engaged and the tool wound up to the edge of the work, then letting the ratchet and pawl take over. When the other side of the work is reached the clutch is disengaged, the pawl disengaged and the table wound back by hand, ready for the next cut to take place. This is perhaps a good point to emphasize that the feed is always made during the return stroke of the ram and never during the cutting stroke, as to do so may damage the cross-feed mechanism.

Squaring up

As most of the controls are on the right hand side of the machine, it makes sense to stand there with the work being fed towards



Effect of different feed rates



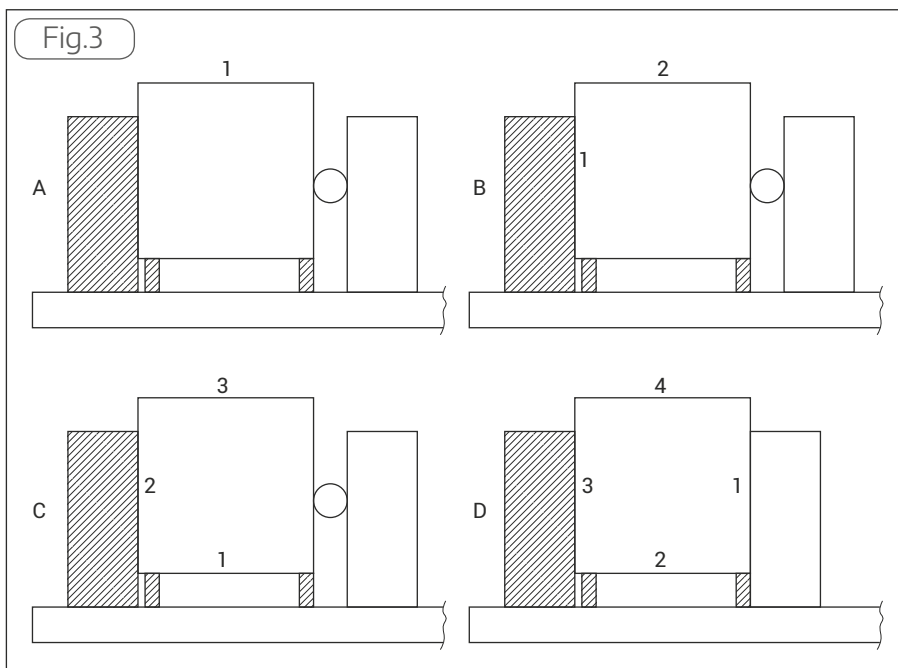
the operator so that the newly cut surface can be seen. It follows that the tools must usually cut on its left hand edge. Older books showed a variety of tools, but most simple work on the shaping machine can be done with a tool identical to a left hand lathe roughing tool, without top rake for cast iron

and brass and with top rake for steel.

In **fig. 2**, which shows the rake directions for cutting steel, tool A is a traditional round nosed roughing tool, but I nearly always use a tool shaped as in tool C and find it gives a good finish. If the tip is slightly rounded, the same tool can be used for roughing and finishing by adjusting the feed rate.

Photograph 10 compares the finish in cast iron with roughing and finishing cuts made by the same tool. Occasionally I will use a bluntly rounded tool to get a good finish in steel. The cranked tool as in B, right or left handed is used for vertical or undercut surfaces and the slotting tool D for cutting slots. The flat nosed tool D is the traditional one for fine finish in cast iron, when the feed is adjusted to match the width of the tool, but the variety of swan neck tools shown in older texts seem to have fallen into disuse.

We have our workpiece held in the vice with its long axis parallel to the vice jaws and to the movement of the ram as shown in photo 9, and this is usually how things are set up in the vice. In **fig. 3** the fixed jaw of the vice and parallels are shown hatched. At "A" is the first position, with the work piece resting on parallels where they fit and the best surface held against the fixed jaw by the moving jaw is a piece of round bar. Cut can now be put on, the feed selected and the ram started, adjusting the tool speed and depth of cut if necessary. This is not the point at which to walk away and do something else, as with rough castings the tool may start to clear the material or, which is worse if you have walked away, the tool may encounter a thicker part which the machine is no longer happy to cut. In a small machine like the Alba 1 A, a 2mm depth of cut would be a fairly heavy one in cast iron especially if combined with a coarse feed.



● To be continued ➤

Scribe a line

YOUR CHANCE TO TALK TO US!

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

British Horological Institute Open day



Dear Neil, In the Year of Engineering, the BHI Open Day may be of interest to your readers.

At our open day last year, we found young children and adults alike, fascinated by the hands-on exhibits and displays to be seen and touched.

The event is free and runs from 10am to 4pm on Saturday 14th April at Soper Hall, Caterham, Surrey CR3 6HY.

For more details go to www.slbbhi.co.uk or scan the QR code.

Michael McDonell. By email



Ceramic Discs

Dear Neil, I know that model engineers are some of the most creative people on the planet, so I wondered if anybody had thought of using ceramic disk inserts from domestic taps for steam inlet/exhaust valves in models. The seal is perfect and yet the friction even without any lubrication is very low.

Gervais Sawyer, Croydon



Grog Clip

Dear Neil, suffering with Parkinson's I find it difficult to hold a glass or cup without spilling the contents. A storm in a teacup, literally! A straw is good, but it tends to dance around quite a lot. So I invented the "Grog clip" Thin brass, or aluminium cut from a drinks can, drilled and bent as required.

Please don't use plastic straws, or paper ones either. Plastic waste harms the environment, and paper causes litter. I bought stainless steel straws, which can be cleaned and reused.

Geoff Theasby, by email

Geoff insists his grog is cranberry juice, although it looks suspiciously like either used brake fluid or rum to me – Ed.



More Condensation

In recent articles on condensation and rust problems (Issue 263 and 264) – too much emphasis has been placed on temperature and not enough on the moisture content of the air.

Let's start with the definition of Dew Point Temperature. Dew point temperature – the temperature at which moist air, saturated with respect to water, has a saturation mixing ratio equal to the actual mixing ratio when the pressure is held constant. So, we have a temperature where two mixing ratios are equal. Let's ignore pressure as generally it doesn't play an important part for ground level atmospheric pressures.

But the important term here is moist air – not temperature. So what is a mixing ratio? This is the ratio of the mass of water vapour to the associated mass of dry air which can be restated as the ratio of the densities of moist air to dry air.

Notice from the mixing ratio that there is no mention of temperature, and temperature has no effect on mass (in the strict scientific sense – nothing to do with expansion making "masses" bigger)

So – as Martyn Harrold says in Issue 264 – no matter what the temperature is in your workshop, the dew-point temperature remains the same – provided you haven't changed the amount of moisture in the air. And as both Martyn and Silly Old Duffer point out – if any surface drops below the dew-point temperature – water vapour will condense on its surface. It's the basis for many dew-point hygrometers and portable moisture meters. More accurate instruments use a clean polished metal mirror, whose temperature is controlled by electronic feedback until moisture just starts to condense on it as sensed by an optoelectronic device.

While maintaining workshops and, more importantly, the tools within the workshop at a higher than ambient temperature will ensure that surfaces do not approach the dew-point temperature – it may be more beneficial, and cheaper, to reduce the amount of moisture in the air – thus altering the mixing ratio and lowering the dew-point temperature.

While Martyn is also correct in both mentioning a well-sealed workshop limiting the ingress of moisture, and our activity (breathing, cutting fluids etc) adding to the moisture content of the air – the idea of leaving the workshop open to remove moisture depends on the outside ambient moisture content of the air being less than that inside the workshop – OK on a dry spell summer day – not so good during a wet period in the winter.

During the winter I keep the inside of our touring caravan dry with sacrificial drying blocks (Unibond Aero 360 De-humidifier).

But perhaps even better might be to run an partially open freezer in the corner of the workshop acting as a dew-point collector of water vapour – it would collect water vapour as ice inside.

Colin Lloyd, by email



Clamp Nuts 1

Dear Neil, I enjoyed reading Ian Priest's article on clamping, particularly with regard to the potential problems of tightening a stud into a tee nut so it over-stresses the tee slot lip resulting in fracture.

When I have made tee nuts, I have drilled right through at tapping size, and then threaded the nut using a taper tap until the end of the tap is flush with the underside of the nut. I then follow this up with a plug tap, until it is about 2 turns short of the bottom of the nut, so that the thread does not go all the way through. That way, when screwing a stud in, it cannot go right through and lift the nut up so that it over-stresses the tee slot.

Graham Astbury, Skipton



Clamp Nuts 2

Dear Neil, with reference to the article in MEW 264 about clamping. I deform the bottom of the thread in the tee nut with a small cold chisel. This prevents the clamping stud from screwing right through into the bottom of the slot, which is a fail- safe method of preventing damage even if the stud is too long. Most of the tee nuts I have purchased are like this, but I have found the odd one or two that I have had to deform. Obviously, you can add this feature on home made tee nuts which are much nicer than the mass produced ones that I buy. Still enjoying MEW having been a keen reader since issue 1.

Mervyn Dale. By email



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A modern approach to **Condensation Management**

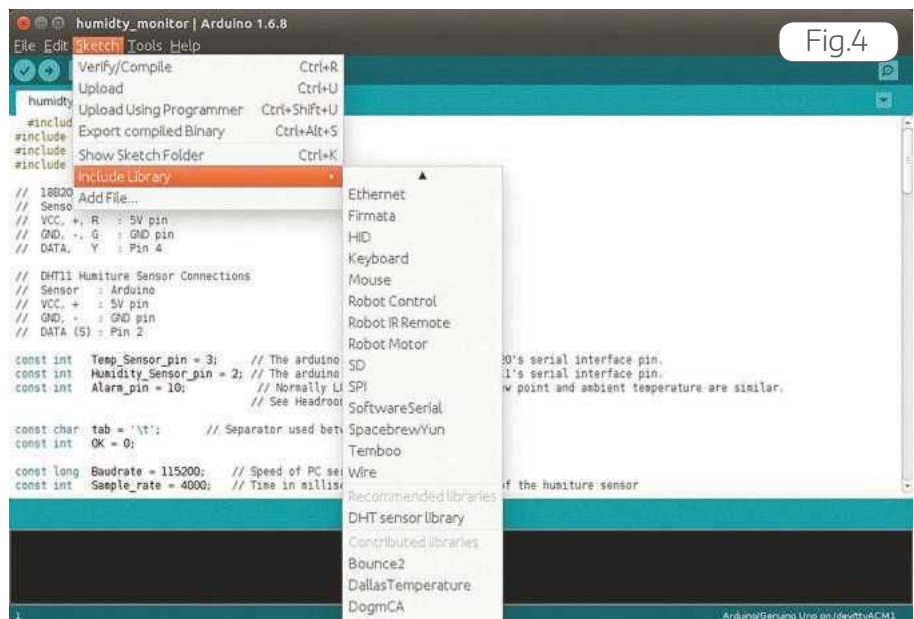


Silly Old Duffer uses an Arduino Uno Micro-controller to monitor and manage a condensation problem - Part 2.

The Liquid Crystal Display is based on the ubiquitous 1802 chip. Again, the LCD is easiest to use when already mounted on a plug-in Shield. There are several variants: I used a DF-Robot Keypad Shield. Once again, the Arduino IDE provides a library to do the hard work.

As the Arduino website provides comprehensive instructions for setting up and programming Arduino microcontrollers I shall not detail them here. Briefly, if you haven't already done so, download the free Arduino IDE (integrated development environment); Create a new sketch and copy the source code provided with this article into it; select the library, **fig. 4**, needed to interface with the humidity sensor with sketch->include library->SimpleDHT; do similar for the libraries needed to run the temperature sensor and LCD display. Connect an Arduino Uno with a USB Cable; Use the IDE tools->board to select an Arduino Uno processor as the target; Use the IDE tools->port to select the port that your Arduino is connected to; verify the source; and upload the program.

At this point the Arduino will run the code. Sensor events are timed and tab



Arduino IDE Screenshot

separated results reported back to the PC. Values are also displayed on the DFRobot LCD Screen. Results sent to the PC through the USB cable may be captured

with the IDE's Serial Monitor set to 115,200 Baud. Tab separated results from the monitor screen may be cut and pasted into a spreadsheet to do calculations or graph the results.

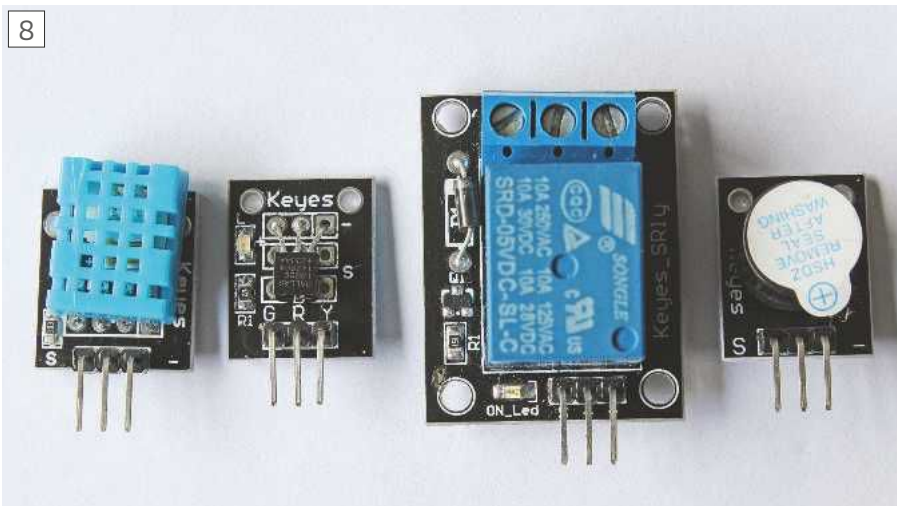
To avoid soldering the sensor is wired to the Arduino with jumper wire connectors.

The easiest way to get suitable sensors for an Arduino is to buy them ready made! An internet search for a humidity sensor will quickly reveal sources of sensors aimed at the Arduino hobbyist. There are a few variants of the humidity sensor, this program works with those based on the DHT11 chip.

A second sensor is needed to measure the temperature of the cold object on which condensation might occur. The project uses a DS18B20, for which a plug-in Keyes module is also available. It is also possible to connect an active alarm module or a mains-power relay module, **photo 8**.

Wire the sensors to the Arduino as shown in the circuit diagram and connect the Arduino to a powered-up PC with a USB

8



Keyes Modules

cable. An Arduino with LCD fitted will draw about 80mA.

The Arduino will work whether or not it is connected to a PC, likewise the LCD is optional. This very simple configuration may be useful if the alarm function only is wanted.

A note on power supplies

The Arduino is normally powered by 5V from a USB connection. Power can be provided by plugging into either a host computer or a USB wall-wart power unit. It is also possible to power an Arduino from a 6V to 12V battery. Either way there are no dangerous voltages in or near the electronics unless the alarm output is used to switch a mains powered dehumidifier via a relay. All due care should be taken if that option is taken up.

Setting up a data logger

A Windows, Apple or LINUX computer may be used to collect data from an Arduino. The easiest way is to use the Arduino IDE's Serial Monitor to read the data and then to cut and paste it into a file or spreadsheet.

I used a £30 RaspberryPi. It does the data logging job well and is much safer to leave running headless unattended in a damp workshop than an expensive laptop. Running headless means that the computer operates without having a keyboard or screen attached. As such it doesn't take up much space and there is little to break. The easiest way to connect to a headless Raspberry is with an Ethernet cable between the Pi and your Router. On power-up, a modern Pi should automatically obtain a network address and listen on the network for ssh (secure shell) login requests. Older Pi's may require some configuration: if it does the internet is your friend.

RaspberryPi computers run at 5V. I used a RaspberryPi 1 Model B+. Depending on what else is connected the Model B draws up to 2.5A from a charging USB port. A 1.5A 'wall-wart' USB power supply is sufficient to power this project. Many powered USB

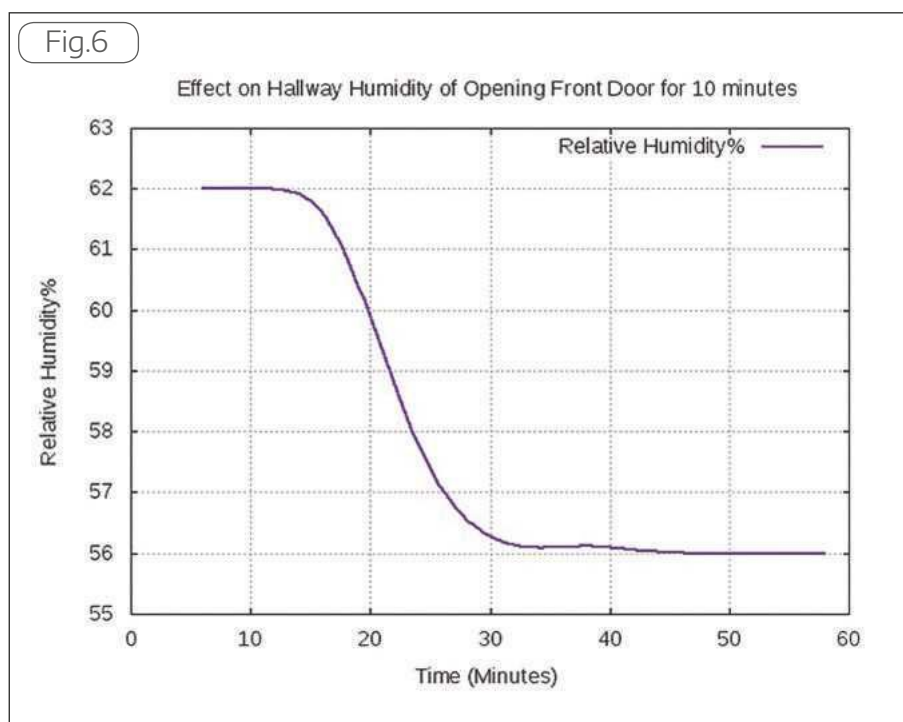
```
pi@rpi4:~
dave@hawk:/$ ssh pi@rpi4
pi@rpi4's password:
Linux rpi4 4.1.13+ #826 PREEMPT Fri Nov 13 20:13:22 GMT 2015 armv6l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sun Nov 13 11:03:09 2016 from hawk.hone
pi@rpi4 ~ $
```

Fig.5

Secure shell (ssh) from the linux command line (password is not shown)



Humidity Falls When Moist Air Can Escape



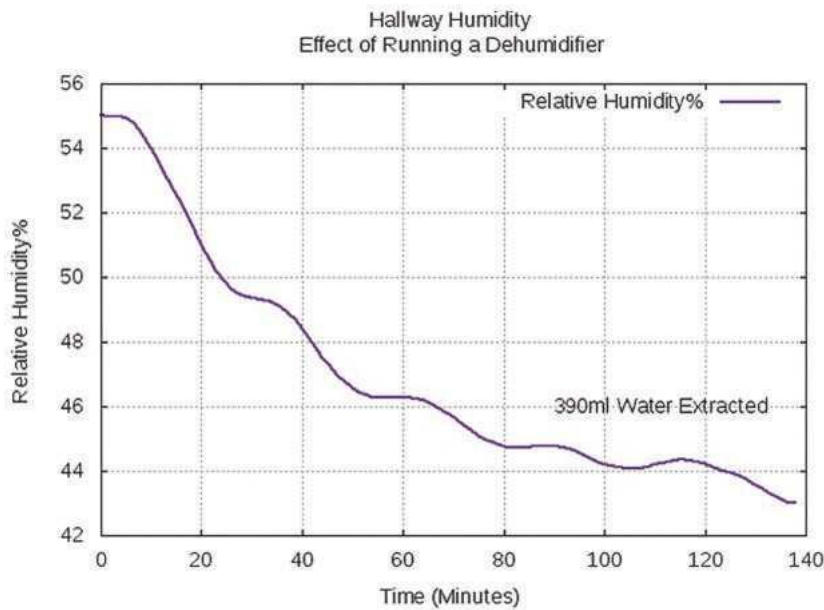
A Wrongly Placed Temperature Sensor

hubs and some computer USB ports will be able to provide sufficient power to run a Raspberry but confirming this is a 'read the manual' question.

Any of the RaspberryPi family will do the job: being considerably more powerful than the one I used, the latest model is good value.

Windows, Linux and Apple computers support terminal emulator programs many of which provide ssh, serial connectivity and data capture. Putty is a popular free example available on all 3 platforms, but installing it on an Apple is somewhat convoluted. Apple users may prefer to use minicom to data log from an Arduino, and ssh to connect to the Raspberry. Minicom and ssh both run from the command line, that is from the Apple terminal. Minicom and ssh also work on Linux.

Fig.7



Humidity Falls When Moist Air is Dehumidified

From the Linux command line, ssh does the job directly, **fig. 5**.

The default login for a RaspberryPi is 'pi', password 'raspberry'. Once logged in list the serial devices available to the pi with the (highly intuitive) command:

```
ls /dev/tty*
```

Device names are allocated when a device is plugged in, and the system has to allow for many of them. The Arduino will probably connect to as Raspberry as /dev/ttyACM0, or possibly /dev/ttyUSB0. The 0 may be some other number if other devices have been plugged in before.

Before use a serial port needs to be set to the right speed. To communicate with our Arduino, enter:

```
stty -F /dev/ttyACM0 115200
```

Now the port can be used. Capture data arriving on port /dev/ttyACM0 to the file arduino.log by entering:

```
cat /dev/ttyACM0 > arduino.log
```

There is a slight problem with this which is that logging out or a network connectivity problem will stop the data capture. We don't want this so enter:

```
nohup cat /dev/ttyACM0 > arduino.log &
```

The ampersand tells the Arduino to run the data capture in background, that is independent of the keyboard and display. The effect of 'nohup' is to tell the raspberry not to stop running the data capture program even if the user logs out.

Log out now. The Arduino and Raspberry combination will carry on capturing data without you. We can log in later, perhaps much later, to copy the file into a spreadsheet. Reporting once per minute the volume of data captured is only about 30kB per day, so a Pi fitted with an 8Gb memory card will be good for a few hundred years.

Problems, problems, problems

The most serious difficulty was attaching the Keyes DS18B20 temperature sensor to the cold object. It is important that the sensor chip be directly in contact with the cold surface; if it isn't the chip will measure air temperature rather than object temperature. Care is needed to ensure that the sensor contacted the surface and stayed put, not adrift as shown in **photo 9**. Sticky tape and blue tack may refuse to adhere to a damp surface. It may be easier to connect a naked DS18B20 directly to the Arduino because the chip is unencumbered by a circuit board. A 4k7 pull-up resistor is

required between +5 and DQ.

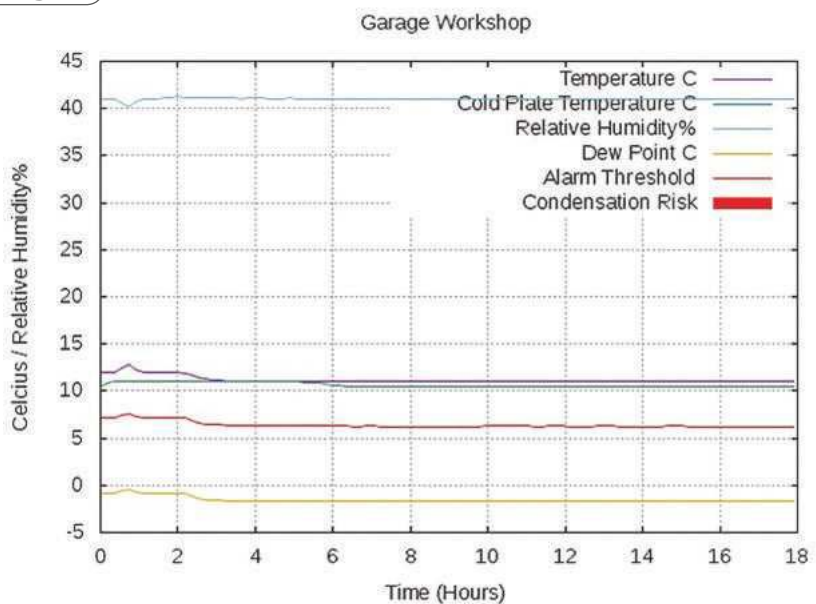
A second problem was that the Arduino and LCD itself proved sensitive to condensation! Moving it from the cold hallway to a warm dining room caused the cold temperature to read 85°C and the LCD reset button to stop working. After about an hour it dried out and started working again. This led me to wonder how many workshop problems with items like digital calipers and motor controllers are due to condensation?

Most unexpected was a lack of cooperation from the weather. It is frustrating to record a succession of overnight logs only to find that natural levels of air temperature and humidity made condensation unlikely, and that in fact the hallway was dry as a bone.

I also hit a problem with the DHT11 sensor. After getting wet it consistently underestimated relative humidity. Checking the web disclosed that this is a known problem. The data sheet suggests that the cure is to: step one: keep the sensor at temperature 50~60 Celsius, humidity<10%RH for 2 hours; Step two: keep the sensor at temperature 20-30 Celsius, humidity > 70%RH for 5 hours. It worked for me.

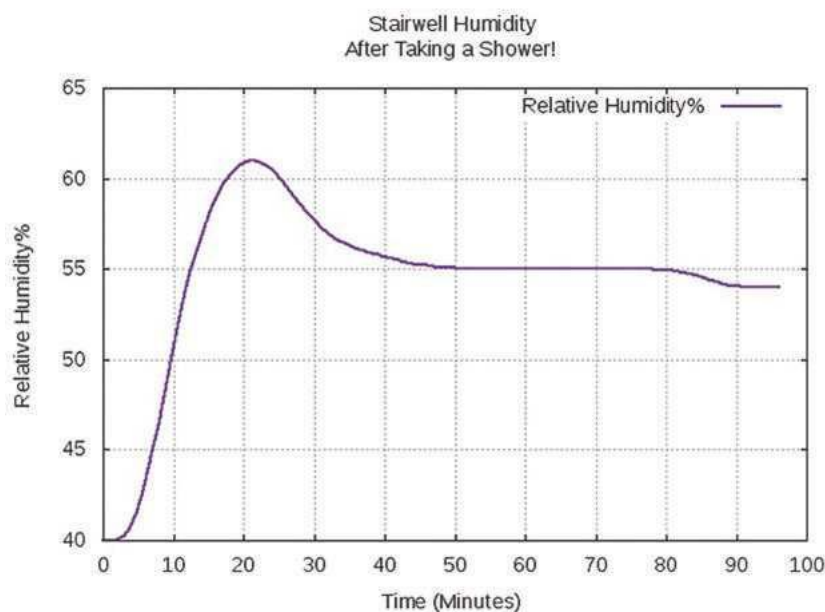
Two 'fudge factors' are available in the program. The Arduino code contains a variable called 'headroom'. This value is added to the dew point temperature to determine the alarm trigger level. Its purpose is to trigger the alarm before condensation actually occurs. Setting headroom too high will cause false alarms; setting it too low will result in alarms that are too late. The default headroom is 4 degrees Celsius. A second variable called 'T_compensate' is used to increase the sensitivity of the cold object sensor. As already mentioned it is important to firmly attach the DS18B20 temperature sensor

Fig.8



A Night in the Workshop

Fig.9



Daughter Takes a Shower

to the cold object. If not properly fixed the sensor measures air temperature rather than that of the cold object: in fact, the sensor always reads high because the wires and five sides of the sensor can't be thermally connected to the cold object. As it is difficult to insulate or embed the sensor, $T_{\text{compensate}}$ is used to counter-balance this effect. The necessary adjustment can be found by observing the difference between the measured temperature and the dew point temperature at the point condensation occurs. My sensor showed a 2 degree 'error'.

Examples

The graphs in these examples were drawn with Gnuplot. There is no reason why the graph capability of Excel or any other capable spreadsheet should not be used.

The first example is a measurement taken in my condensation prone hallway. Opening the front door for 10 minutes shows an immediate fall in relative humidity. The graph, **fig. 6**, demonstrates that ventilation is effective and confirms that installation of an air-brick should be helpful in this case. The disadvantage is that the door cannot be left open unattended. I got cold and closed it before all the moist air had escaped.

The second example, **fig. 7**, shows the effect of running a 300W Dehumidifier in the same hallway after allowing condensation to recur. The advantages are that the door can be left closed whilst the fan stirs the air. The Dehumidifier costs money to buy and run, and the rate of humidity reduction appears to be about 4 times slower than opening the door!

Checking the workshop

I wouldn't be surprised to find condensation in my garage workshop.

No special measures have been taken apart from periodic oiling of metal tools. Although part of the house, the workshop is unheated and on the weather side. The big door is metal and faces north. Driving rain from due north sometimes penetrates under the door causing a damp patch up to 500mm into the building, and up to 1.5m along the outer wall. Despite water occasionally getting in, the worst rust I've had in two decades is mild spotting on a few hand tools.

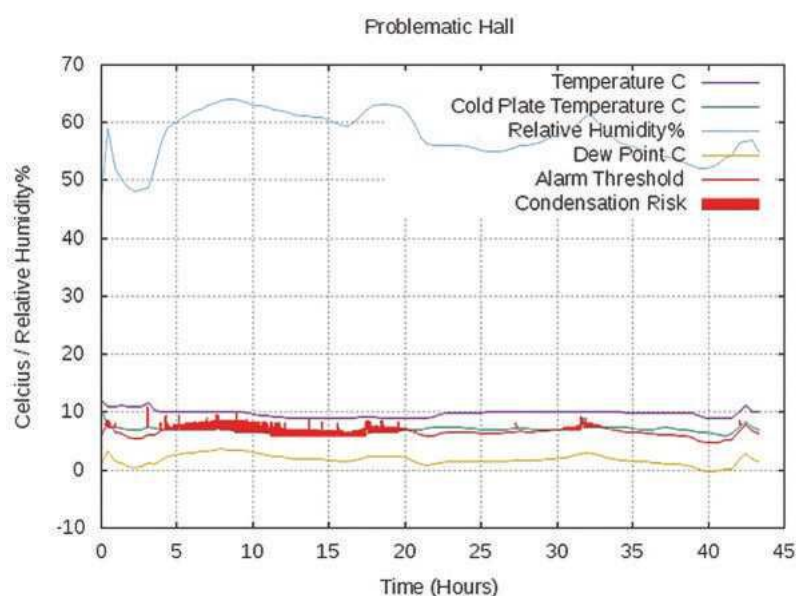
I put this immunity down to good luck rather than application of engineering best

practice! In use, the workshop is brightly lit by four 60W fluorescent tubes and these are the only continuous source of heat. In winter it's essential to dress warmly, but the combination of lighting and running machinery gradually lifts the temperature to a comfortable level. It appears that the slow rise in temperature discourages condensation. An experiment with a 1.5kW fan heater did cause condensation to appear on the metal door. That door is not a good fit, and there is a 10 – 20mm gap between it and the building. There is nothing to stop heavy moist air escaping under the door. It is the combination of slow heating and this unplanned ventilation that keeps the dew point low. **Figure 8** is a typical overnight measurement. The initial bump in temperature and humidity in the graph is down to me using the workshop for a couple of hours to blunt an HSS tool! Although cold and wet outside, it shows that the dew point in my workshop stays safely below ambient temperature.

A condensation problem investigated

I have been less lucky inside the house. Condensation occurs in my hallway during winter. The hallway is a single storied flat-roofed protuberance on the north side of my house. It contains an adjacent downstairs toilet, two windows, ingress for power and water and the electric consumer unit. Access to ground-floor accommodation is via a closed door but the stairwell to the top-floor is open. On the upper floor close to the stairwell is the Bathroom. Apart from the hallway the whole house is centrally heated but only during the evening and early morning. During winter most of the house windows are kept closed.

Fig.10



Condensation Strikes!



Measuring humidity revealed that the hallway and bathroom both have higher levels of humidity than the rest of the house. The bathroom is humid because people splash about in it. The source of condensation in the hallway is less obvious, a leaky flat roof being suspected initially. No leaks were found when the roof was inspected. It is in good condition. Hallway humidity varies considerably. Sometimes it is just higher than the rest of the house, but one morning it was nearly 25% higher. About 20% seems typical.

Measuring temperature in the hallway revealed that the temperature changes more here than in any other part of the house. I was also able to see humidity rising in the hallway shortly after my daughter emerged from the shower leaving the Bathroom covered in condensation, the floor wet, and many towels soaked, **fig. 9**. Cherchez la femme!

Equally revealing was an overnight log starting at 17:00. The red blocking in **fig. 10** shows the condensation alarm is repeatedly triggered overnight, the trouble starting at bedtime after the family hit the bathroom and stay upstairs breathing in bed. Outside the weather was very damp; during the measurements there was heavy drizzle with humidity forecast at 95%.

The condensation problem in my

Bashing holes through the wall is a job for next summer. In the meantime, an Arduino dehumidifier is doing a sterling job.

hallway is mainly due to a combination of cold exposure and water vapour coming from the upper floor adding to naturally high values. Cycling internal temperatures do not help. The main source of water is the bathroom though no doubt snoring humanity add their contribution. A 70kg human breaths out about 400ml water per day and sweats about the same. Heavy moist air falls down the stairwell and collects in the unventilated entrance hallway. Normally the dew point inside the hallway is too high for condensation to take place. However, when it is sufficiently

cold outside, condensation occurs on the windows, front door metal work, and to a lesser extent on the walls, particularly in the most exposed lower corner. Before double glazing the old wooden windows and front-door presumably leaked enough to prevent moist air collecting. The cure will be to fit a low-level air-brick. Looking at similar houses nearby, it appears that a few neighbours have hit the same problem: some have newish air-bricks. Bashing holes through the wall is a job for next summer. In the meantime, an Arduino dehumidifier is doing a sterling job. It only comes on occasionally, usually early in the morning. Interestingly, the amount of water collected is surprisingly low, usually less than 0.5 litres per day.

Source code

Source code for this project is available at www.model-engineer.co.uk/condensation ■

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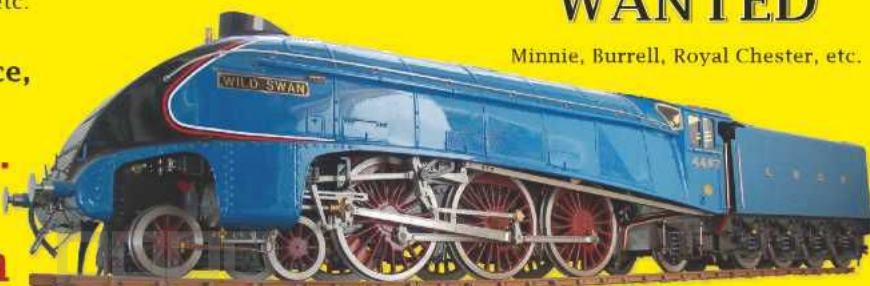
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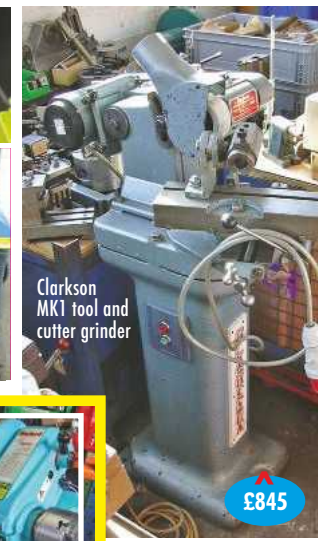
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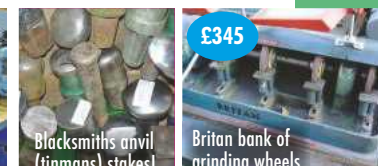


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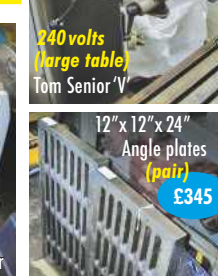
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