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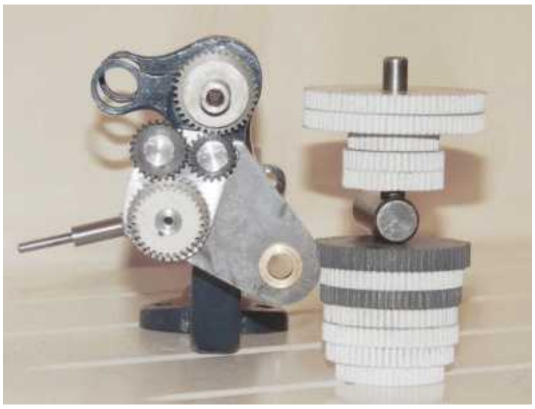
On the Editor's Bench

In this issue you'll see my 'stop press' report from the Model Engineer Exhibition. One thing I didn't mention in the report was that I entered a tool and three models and came away with three certificates, a commended, highly commended and a very highly commended. Now I'm not telling this to brag (OK, maybe just a little bit), it's that I want to make the point that my skills as a model engineer are NOT exceptional in any way. I just took care to enter some of my better work. I also took a critical look at it ahead of the exhibition and corrected a few obvious, but minor faults.

I am sure that many other people ought to consider entering, particularly I would like to see more tooling. For example, my Potts Spindle is a very simple piece of engineering to an established design, but I had taken a lot of care and, to my eyes at least, it was nicely finished and painted and has a very smooth movement. The commended certificate, I assume, recognised that I had made the effort to do a relatively simple job well.

While entries need to combine a high degree of originality, workmanship and complexity to achieve a medal, particularly a gold medal, there is great satisfaction from achieving a certificate. I am sure that many other pieces of work that feature in these pages that could secure an award in future exhibitions. So, when you are working on a new piece of workshop tooling over the next few months, take a bit of extra care with the fit and finish and consider entering it for the next Model Engineer Exhibition!



On Loan!

Naturally another way to be part of the exhibition is if a club you are a member of takes part, but there is a way that even a 'lone hand' can get involved, which is to enter a 'loan model'. Such models are not subject to the scrutiny of the judges, and are usually models entered to make or illustrate a point. Often such items are work in progress, a good example being Cherry Hill's Ice Locomotive, featured in the article in this issue. This is also why I took along my Super Adept lathe – from time to time I report on my snail-like progress, but I thought readers might like to see it 'in the flesh', so to speak. Two things that may be of interest are the gears. The larger ones were made using a single point cutter, shaped using the 'two button' method described by Ivan Law in Gears and Gear Cutting. In contrast the smaller gears in the screwcutting train (and many more change wheels left at home) were produced using a 'rack form hob'. This produces gears whose running surfaces are in fact a number of discrete facets. There are ways to arrange extra passes of the hob to produce finer gears, but at the small size (0.7 mod) I was using, the resulting gears are perfectly usable.

So, you now have no excuses – get your home made tooling lined up and ready for the next Model Engineer Exhibition!

MODEL ENGINEERS' WORKSHOP

Published by MyTimeMedia Ltd.
Suite 25, Eden House, Enterprise Way,
Edenbridge, Kent TN8 6HF
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Model Engineers' Workshop, ISSN 0959-6909, is published monthly with an additional issue in August by MYTIMEMEDIA Ltd, Enterprise House, Enterprise Way, Edenbridge, Kent TN8 6HF, UK. The US annual subscription price is 52.95GBP (equivalent to approximately 88USD). Airfreight and mailing in the USA by agent named Air Business Ltd, c/o Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA. Periodicals postage paid at Jamaica NY 11431. US Postmaster: Send address changes to Model Engineers' Workshop, Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA. Subscription records are maintained at dsb.net 3 Queensbridge, The Lakes, Northampton, NN4 7BF. Air Business Ltd is acting as our mailing agent.


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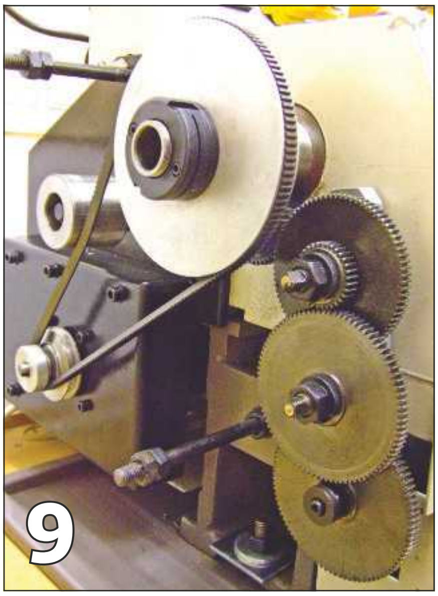

See page 26 for details.

Coming up...

in the November issue

Once you have enjoyed this issue, look out for the next, packed full of more tools and techniques!

Regulars

ON THE COVER »»

Visitors take a close look at some of the exhibits in the Model Engineer Exhibition at Brooklands.

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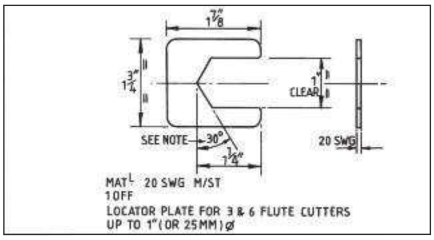
This month: Free plans for A Longworth's End Mill Grinder reprinted from MEW number 14
http://tinyurl.comendmillgrinder



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Manual control of the lead screw

Alastair Sinclair up-sizes his past design for a leadscrew handle to suit his new Chester DB8VS

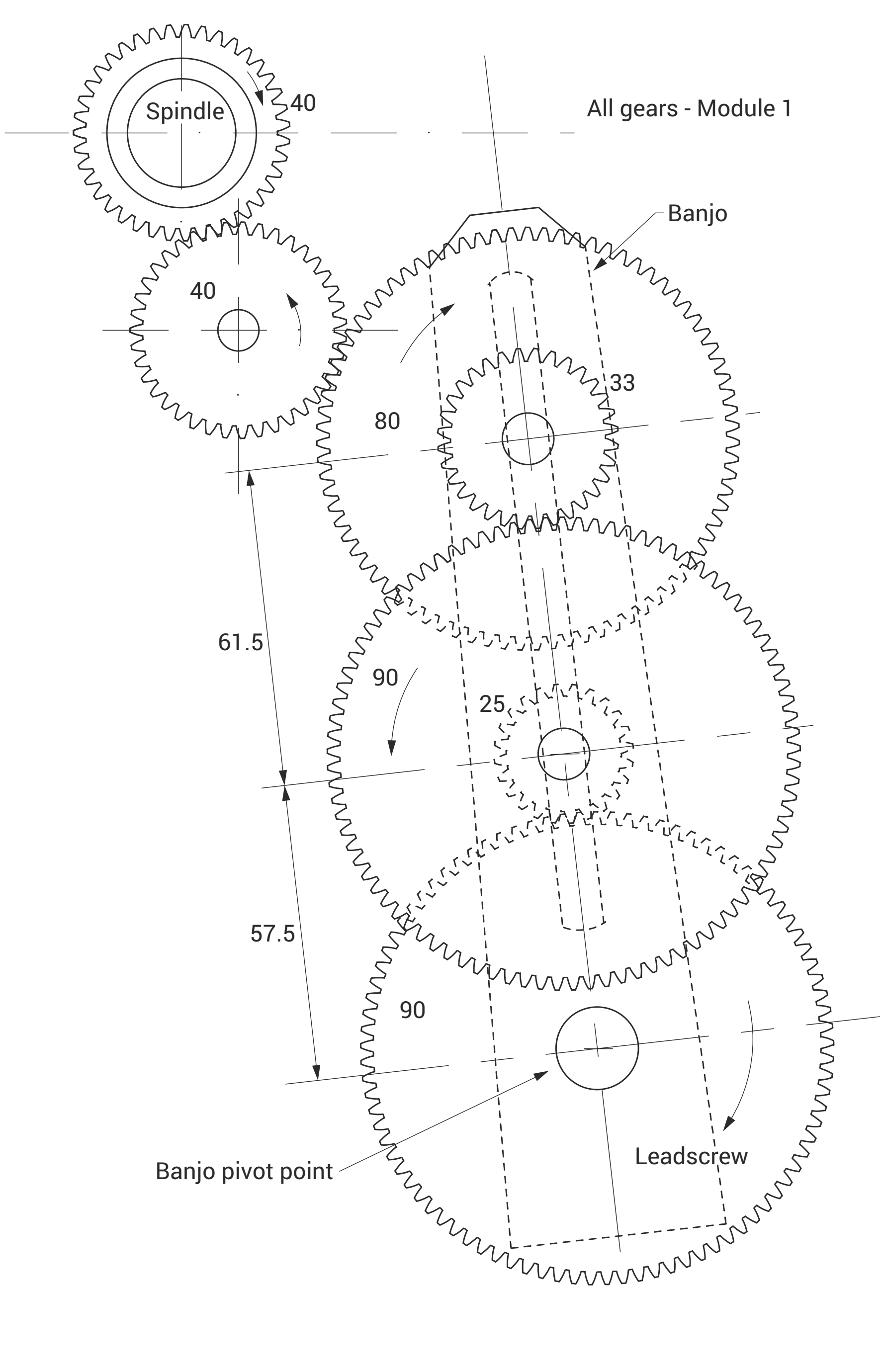
I have a bit of a thing about manual control of the lead screw. For good reasons, I believe. It bothers me that most of the lathes sold for the use of model engineers do not provide this type of control as a matter of good design. I refer principally to the ability to engage the lead screw and move the saddle along the bed by a precise amount using a hand wheel equipped with a graduated collar to obtain accurate machined lengths. Recent purchase of a new lathe has again raised this aspect and one possible solution to it is described.

Why Do I Need This?

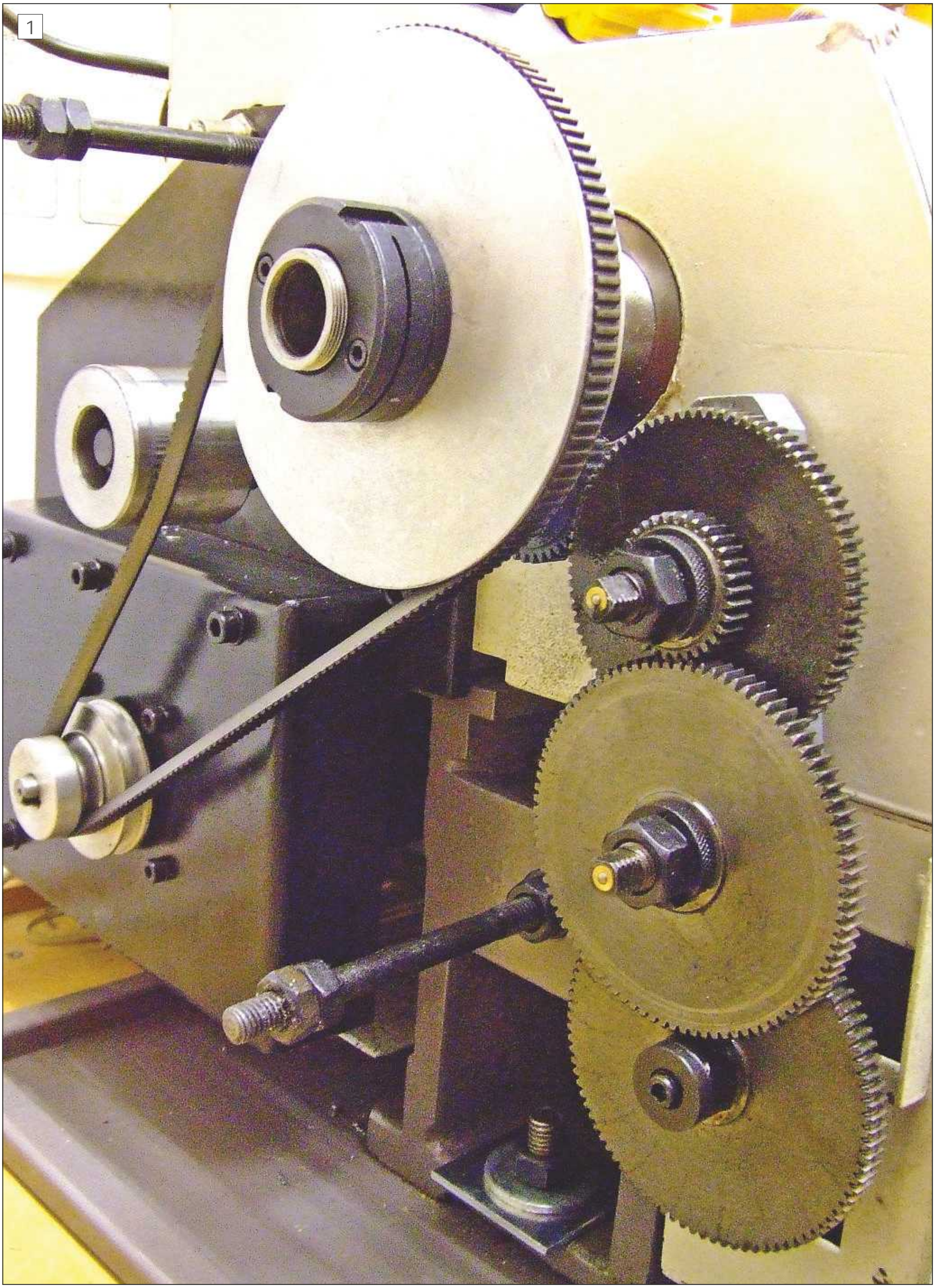
The large majority of turning jobs that model engineers need to make on the lathe are generally quite short in length and do not always need the built-in power feed to the lead screw. For finishing cuts, however, the power feed can be useful even for short lengths but it of course cannot be used to cut to a precise defined position longitudinally. Using the carriage rack and pinion hand wheel instead is not really an option for that purpose as the cut length cannot be determined with any real accuracy even if it is provided with a graduated collar since the graduations are generally too large for any position fix better than at the very best about 0.5 mm. Frequently the position to a shoulder on a turned work piece needs to be located to within 0.1 mm or so and occasionally to within 0.05 mm or better. What is needed therefore is a graduated lead screw hand wheel which can be used as the primary means of turning small work pieces to a precise length of cut but always with the option when necessary (or if desired) of combining both power feed and the hand wheel feed in sequence. For this latter requirement, changing over from power feed that is cutting toward a turned shoulder must be able to be altered to manual feed easily and quickly to allow careful finishing up to the shoulder at an accurate collar reading, or to a fixed saddle stop if previously set.

It could be argued that use of the top slide would be suitable for approaching by hand the end of the cut but this is often not set parallel to the longitudinal axis (see below) nor, in the case of a manual cut only, can it accurately deal with overall lengths of cut beyond the slide's limit of travel. The

Fig.1

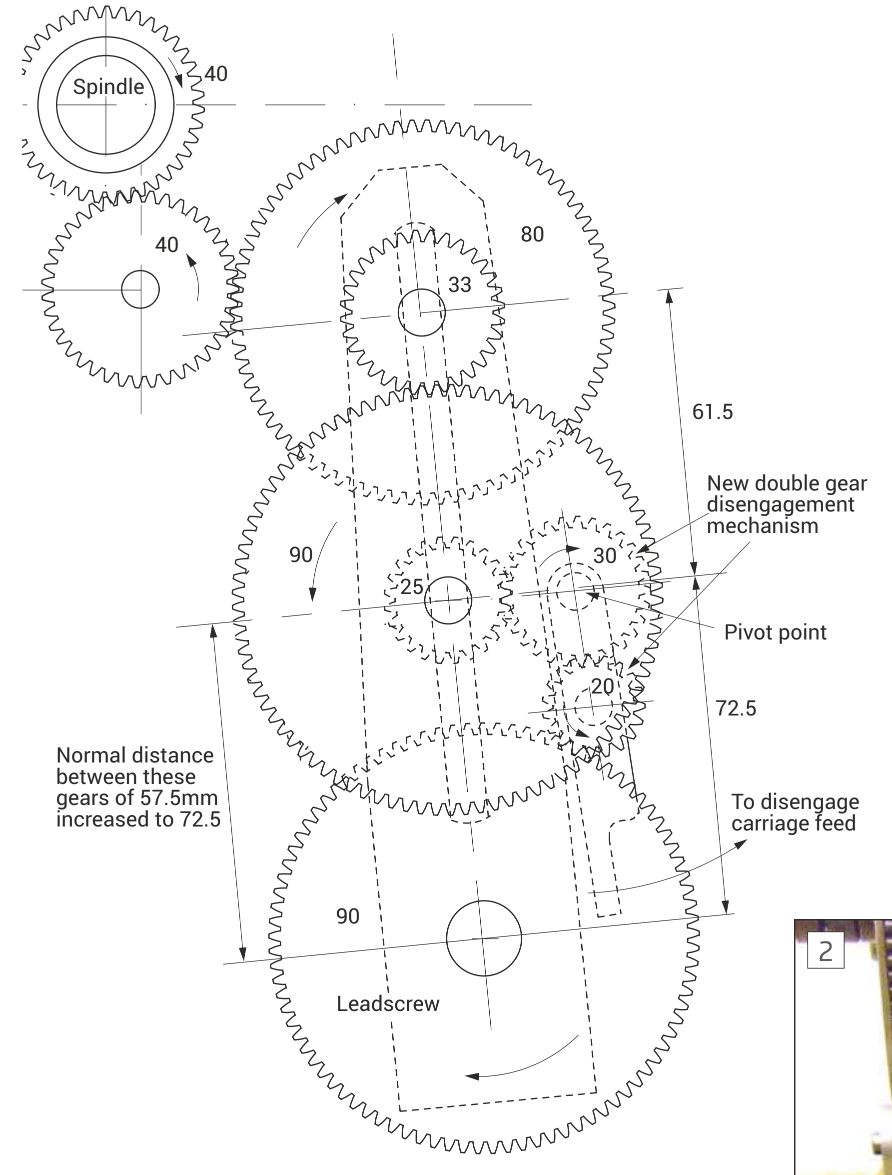


Standard change gear arrangement for fine feed



End view of normal change gear set-up for fine feed

Fig.2

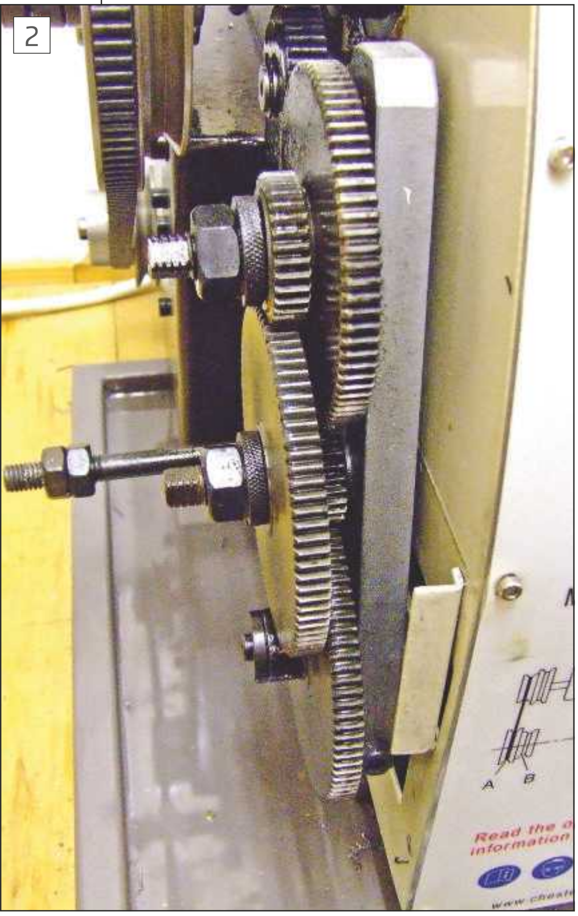


Modifications to change gears showing disengagement mechanism

Trying this with only a hand wheel fitted would lead to considerable resistance from the meshed gear train and would thus greatly inhibit convenient use of this feature. Detaching the spindle gear from the rest of the gear train is a necessary requirement for this either directly or by using a tumbler gear mechanism (if fitted) but actually does not help this aspect a great deal as the drag from the meshed gear train alone will still be too great. That is a difficulty which therefore results in the need when necessary to separate the gear train from the lead screw entirely either by incorporating an additional mechanism to do this or, if there is sufficient space, by the introduction of a simple dog clutch arrangement.

The ideal solution would be the clutch arrangement but such a design usually involves the need to cut the lead screw near the headstock end, introduce and fit the clutch mechanism together with additional bearings not to mention a disengagement lever pivoting arrangement to separate the clutch drive plates when required. All that assumes that there is in fact sufficient room to locate this where desired with the somewhat discouraging thought of having to cut the lead screw to achieve it. No doubt possible but one would wish for an easier way. Actually there is indeed an easier way and I previously addressed this problem for the mini-lathe, a satisfactory and simple solution being found which was part of an article published in MEW in 2003, recently

2



Front view of normal change gear set-up for fine feed

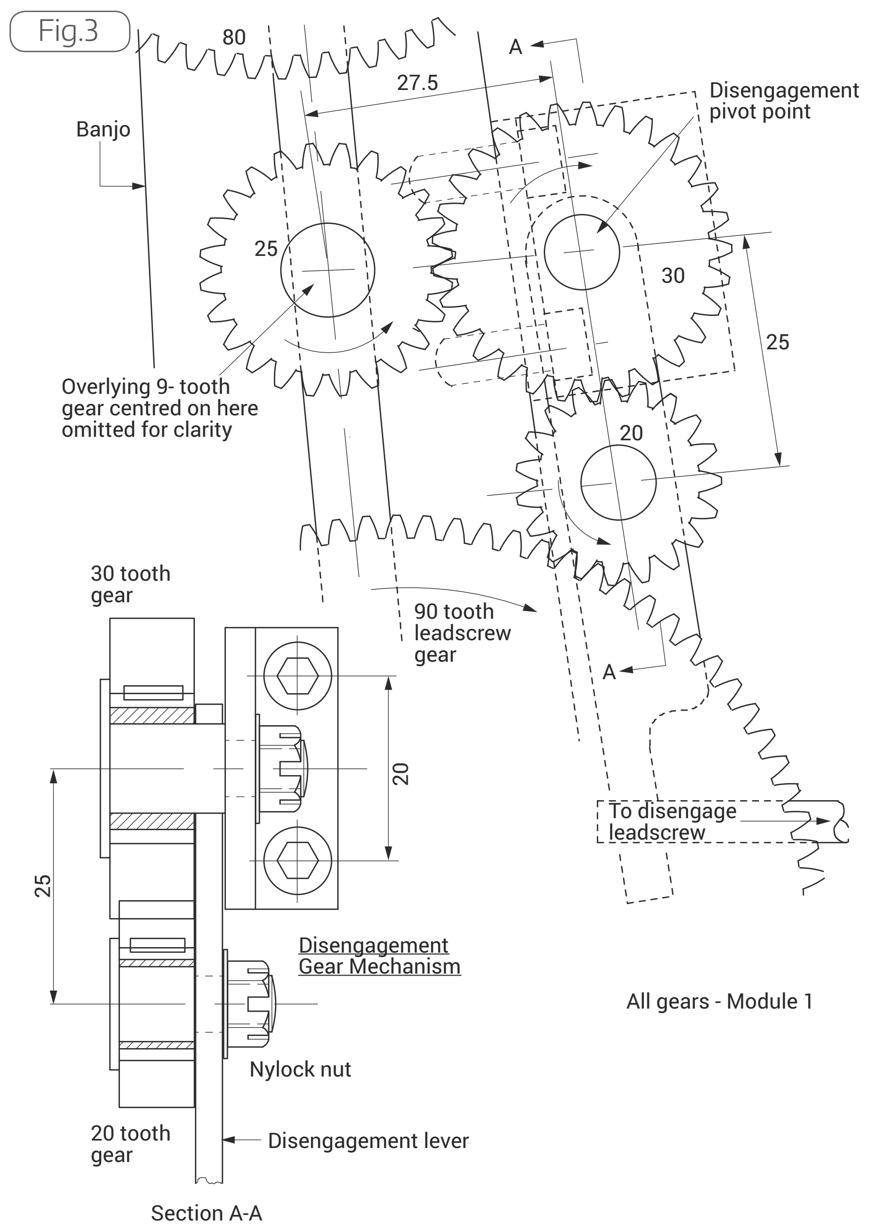
top slide is in any event primarily intended to be used for cutting short tapers and setting the tool angle for screw cutting, to both of which purposes I tend to restrict its use. In more general use I usually have the top slide permanently set at an angle of 30 deg to the longitudinal X axis between centres and this is then only used to put on the depth of cut. At that angle to the work piece, the reading of the top slide's graduated collar then conveniently gives the reduction to the diameter of the work piece, instead of its half diameter as is the case if the cross slide is used for this purpose. This method is I believe helpful in reducing errors when turning down to a specified diameter, especially when approaching close to the limiting dimension, as the finer top slide collar divisions thus lend greater accuracy to this than those of the cross slide.

Without the use of manual control directly to the lead screw as described I find it difficult to imagine how one can easily produce machined parts to an accurate longitudinal dimensions using only the power feed and the carriage hand wheel. I would find this extremely frustrating.

What Needed to be Done ?

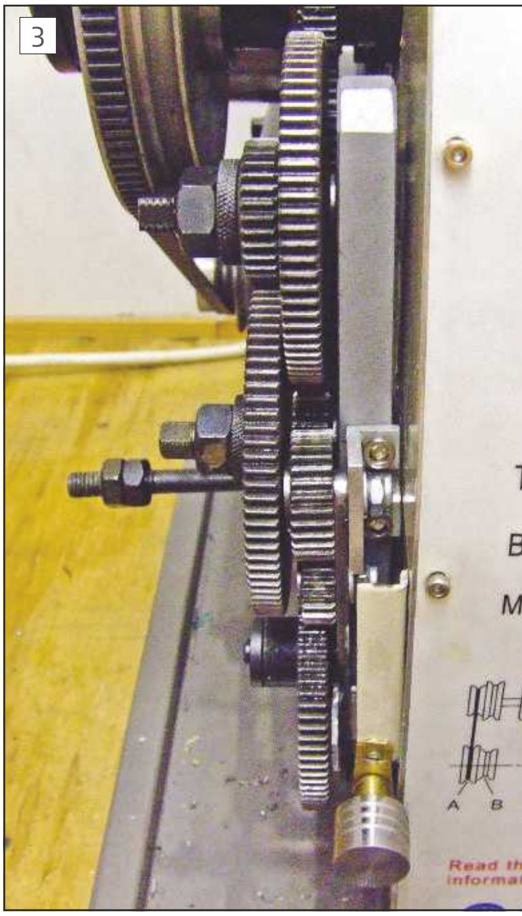
To achieve the desired flexibility of manual and power feed options requires more than just the mounting of a hand wheel on the end of the lead screw. Generally, other changes to the lathe are necessary to make this an easily available option which will allow switching between power feed and manual operation with ease.

Fig.3



Details of disengagement mechanism

3



Front view showing the added double gear assembly fitted

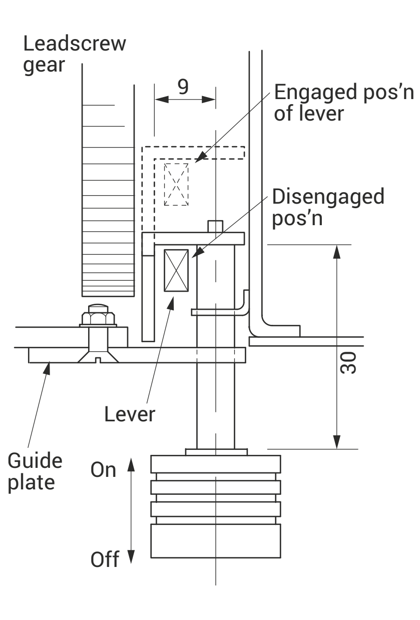
reprinted in MEW's 25 year anniversary special. That simple solution made that lathe so much easier and pleasurable to use.

I have now changed the lathe I use to a Chester DB8VS which represents the typical general design of a range of hobby lathes currently available from China and distributed by a number of UK suppliers. This brings different problems to this particular issue which did not arise in the case of the mini-lathe. In the first place the DB8VS does not have a tumbler reverse mechanism. This means that the direction of rotation of the lead screw cannot, as on the mini-lathe, be conveniently changed. With a tumbler reverse only a single additional pinion gear with a small spacing adjustment within the gear train would achieve a good solution. In addition, the power feed of the DB8VS to the lead screw is in semi-permanent engagement and cannot be disengaged without physically moving the banjo and hence the entire gear train out of mesh from the spindle gear. To say the least that would be quite inconvenient to do while in the midst of carrying out a powered cut on a work piece since the pivot point of the banjo is on the lead screw itself and must be kept fairly stiffly clamped. Even if it could, it would not remove the inherent drag effect of the entire gear train making manual control rather tedious. The need for a quick change from power feed to manual feed must therefore be capable of being carried out with no more than the movement of one simple control lever allowing an almost seamless jump from power to manual continuation of the cut by hand when desired. The remainder of this article is concerned with the changes needed to the DB8VS to achieve just that.

Disengagement Mechanism

The layout of the gear train set for fine feed is shown for the DB8VS in **figure 1** and **photos 1 & 2**. This is a fairly simple arrangement comprising a 40 tooth single pinion meshing with the spindle gear and engaging the two meshed compound sets of gears which finally connect through to the 90 tooth lead screw gear. There is clearly not a lot of room in the

Fig.4



Plan view of the control arrangement and pull knob

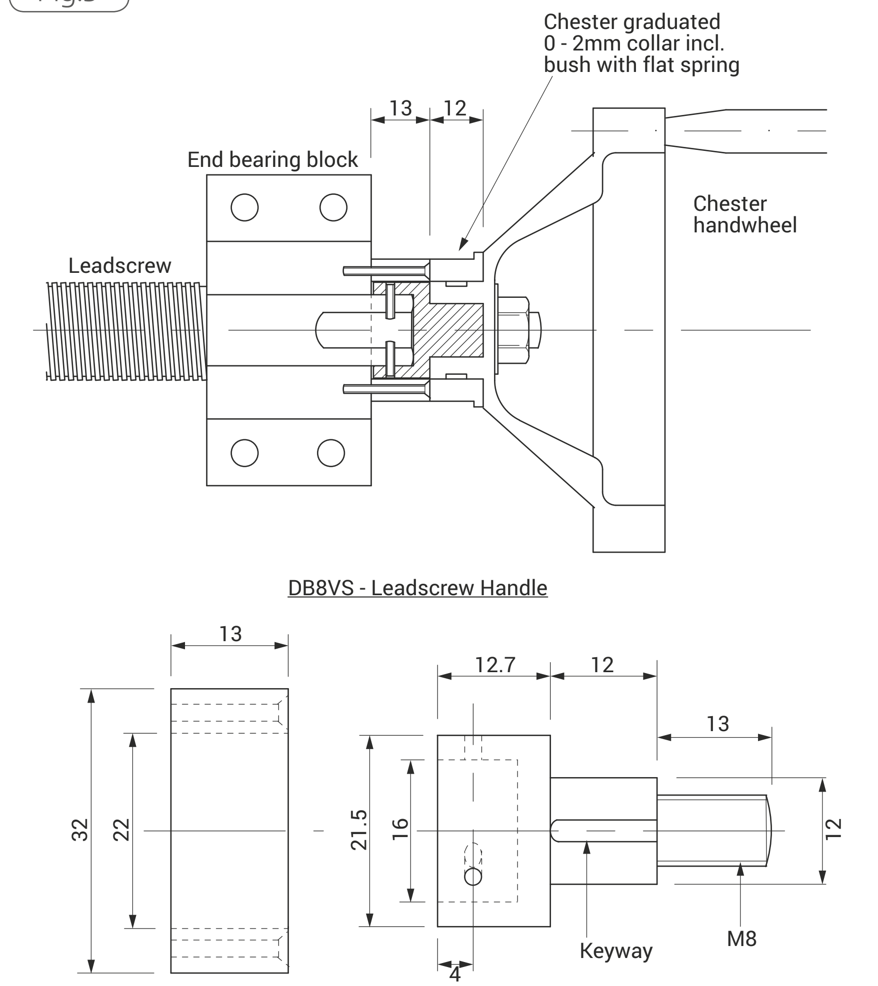
4

View on outer casing showing the control knob and front plate

area in front of the banjo for a suitable control mechanism with a lever where, for convenience, it is needed. If only a single pinion gear were to be introduced to the fine feed gear arrangement in that area it would, as mentioned above, lead to a reverse in the rotation of the lead screw which is not what is required. It clearly needs a twin gear arrangement to be positioned within that space to be capable of maintaining the lead screw rotation direction while also having the capability of being moved in and out of engagement when needed. The solution adopted is shown in **figure 2** and **photo 3**. This shows what is essentially a small two gear assembly which can be connected to the edge of the banjo, the top gear of which is in permanent mesh with the main gear train while the bottom gear can be rotated into mesh with the lead screw gear using the integral lever. It will be noted that an adjustment to the positions of the upper two compounded gear sets has to be made to accommodate this feature. An enlarged detail of the assembly described is shown in **figure 3**. The end of the lever hanging down from the assembly needs then to be connected to a suitable pull-out knob in order to change from power feed to manual. This is indicated in **figure 3** while **photo 4** shows the outer actuating knob and guide plate used on the front of the headstock enclosure box. The guide plate has a sideways slotted hole for the control shaft to enable the enclosure box to be removed when necessary. When operating manually, i.e. with the knob pulled out, all of the main gear train including the added two gear assembly is rotating but is not in mesh with the 90 tooth lead screw gear. Pushing the knob in allows the gear train to pick-up and 'draw in' the bottom gear of the assembly and thus actuate the lead screw for power feed. The draw-in capture effect on the small 20 tooth gear is sufficiently strong to prevent any accidental disengagement while the lathe is in operation until the knob is intentionally pulled out. The design of this arrangement was carried out immediately upon delivery of the lathe, completed within 2 weeks thereafter and has now been in daily use for about 8 months.

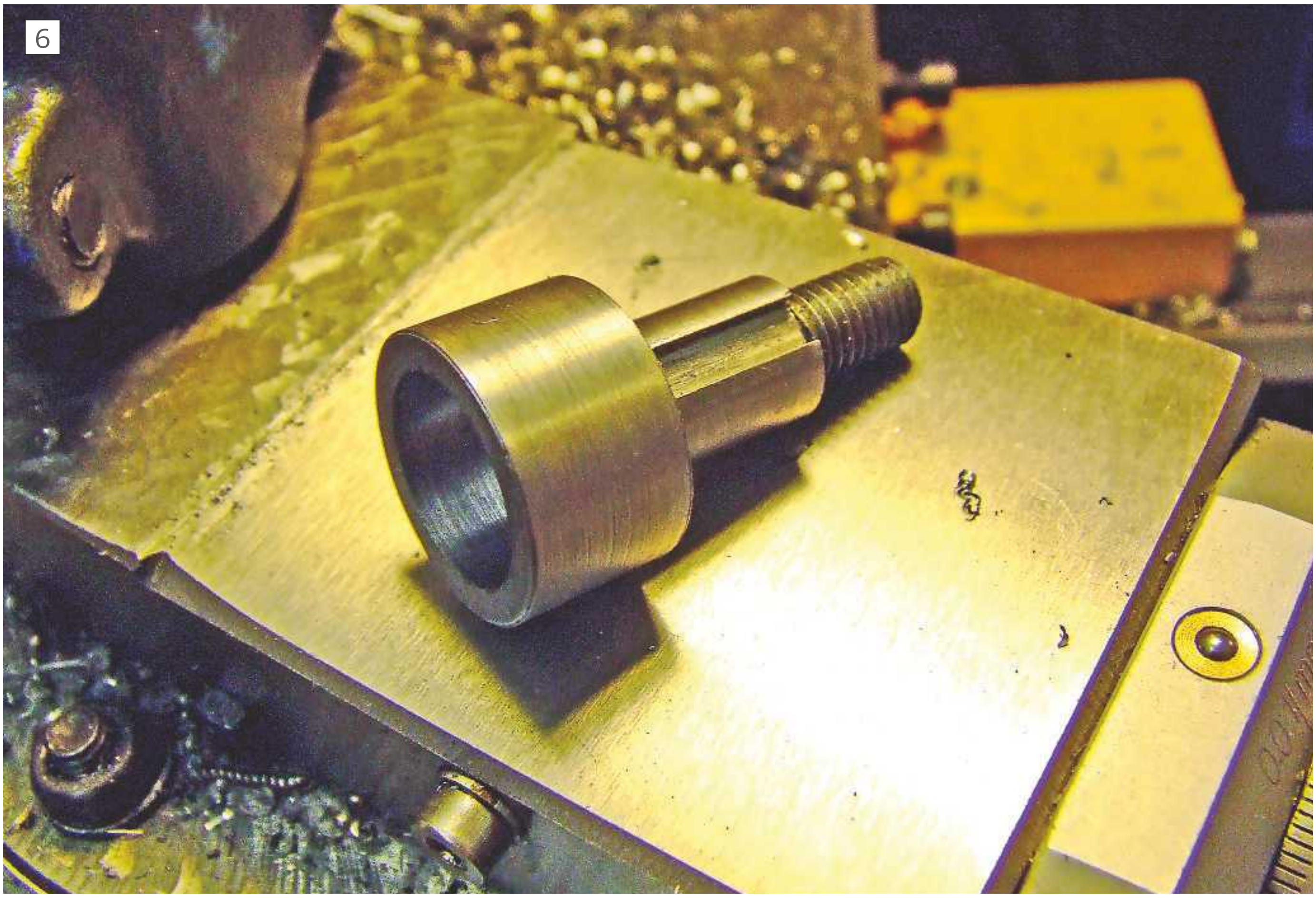
The construction details of the two gear assembly are shown in **fig 3** and it is probably necessary that the elements used to make this be sourced first and the final design based on these to suit whichever lathe is being altered. In my case the mounting angle piece is a 30 mm length of 3.4 mm thick extruded aluminium angle section 22 x 12 connected to the banjo with M5 cap screws and hence is easily removable when necessary to enable any screw-cutting gear trains to be assembled on the banjo when required. Two M5 threaded holes 20 mm apart require to be drilled and tapped in the edge of the banjo plate to fit this. The two gears, a 30 tooth and a 20 tooth (Mod 1), were obtained from Chester UK. The actuating lever upon which these gears are mounted is made from a 75 mm length of 3/8-inch x 1/8 inch bright mild steel. Bronze bushes have been fitted as the bearings for both gears. The control knob is a 19 diameter mild steel turning with 5.5 mm diameter shaft connected to an L shaped piece 16 x 15 which sits just behind the bottom part of the lever. A plan detail of this arrangement is shown in **figure 4**. **Photograph 5** shows the completed gear mechanism and the disengagement control knob assemblies.

Fig.5



Sectional view and details of the lead screw hand wheel

Disengagement and control actuator assemblies



The lead screw extension piece for extending the lead screw

Lead Screw Handle

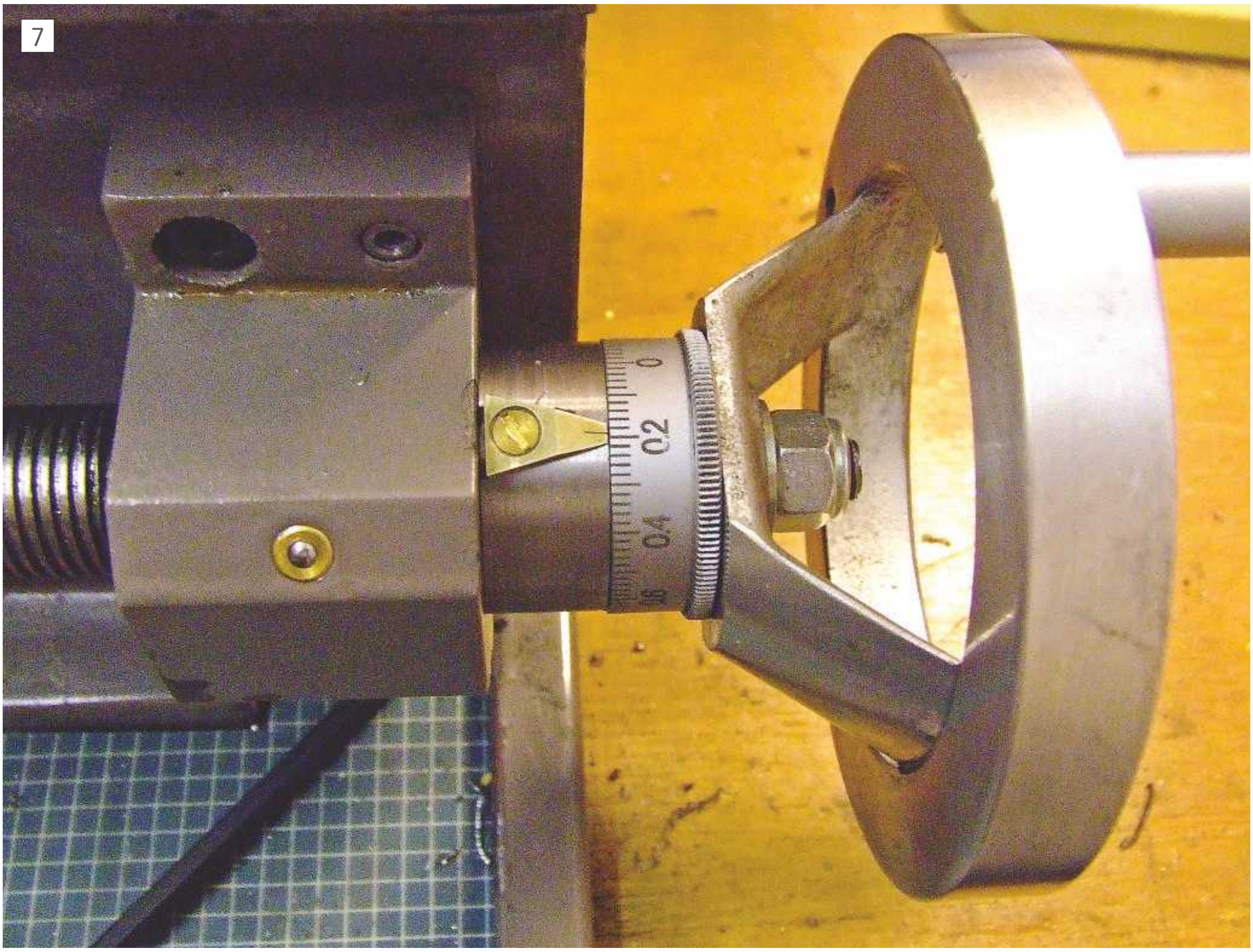
Examination of the projecting end of the lead screw at the right hand bearing initially revealed an 8 mm hole in the projecting end for a depth of about 40 mm or so. This looked ideal for being tapped with a suitable thread to allow a hand wheel arrangement to be simply bolted on. However, upon closer examination it turned out that the hole provided proved to be slightly off centre and additionally not in line with the axis of the lead screw. This could have been corrected of course but only by first removing the lead screw from the lathe. To re-machine the end to cure that would have meant using the lathe but measurement of the o/a diameter of the screw looked like it would be a relatively tight fit for the bore of the spindle. The alternative arrangement shown on **figure 5** was therefore decided upon as a quicker and simpler approach and proved to be quite satisfactory. The hand wheel and graduated collar were purchased from Chester so that the final fitment matched the others on the DB8VS. The most suitable parts for that purpose were in this case the ones already fitted to the tailstock the only slight difference being the direction of rotation which thus required that the graduation markings on the collar have to be interpreted in reverse. That creates no problem at all.

Two turned pieces are required as detailed in **figure 5**, the outer 32 diameter fixed annular piece being connected to the end bearing block using 3 countersunk screws requiring that the bearing be drilled and tapped in situ to suit. The inner lead screw extension piece is connected to the lead screw end using 3 equally spaced grub screws, these also being drilled and tapped in situ into the lead screw using predrilled holes in the piece as a guide. The remaining bit of the extension piece shown in **photo 6** supports the graduated collar while the hand wheel is fitted and keyed to it and clamped with an M8 Nylock nut and washer. The end result is as shown in **photo 7** and closely matches similar fittings elsewhere on this lathe. There is a little brass pointer which I had to hand and is now fitted to provide the required datum line but a small cut to the fixed annular piece would of course have worked just as well.

In Use

Over a period of about 8 months the lathe has had fairly constant use and the features described in this article have therefore been well tested. These have performed very satisfactorily and have greatly enhanced the pleasure and convenience of its use allowing work pieces to be machined to good lengthwise accuracy for a number of jobs including the current model project. The only design change I would in retrospect now make after that period of use is that it would probably be better if the actuating knob were arranged to be pushed in for manual use and pulled out for power feed. Extending the actuating lever upwards instead of downwards would deal with that and would neatly avoid the potential trauma of accidental bumping against the knob, which, if then sufficiently pushed in, could cause a sudden and unintended engagement of power feed while manual feed is being undertaken close to the chuck. I have now dealt with this using the alternative strategy of using an over clip on the knob which prevents this while still allowing easy actuation.

I have not personally used this lathe for light milling purposes as the modified Conquest mill I have does all that I need in that respect. Clearly though the additional control of the lead screw and hence the accurate traverse of the saddle as described above would be very useful for anyone intending to use it in that way. ■



The completed lead screw hand wheel fitment

A Diamond Disc Grinder for Carbide Tooling

Michael Cox describes his way to use steel-backed diamond disks with a bench grinder.

The normal way to sharpen carbide tooling is with a silicon carbide grinding wheel. In recent years diamond and cubic boron nitride wheels have also become available and these are also suitable but they tend to be expensive.

I have used diamond edged tile cutting discs to shape tungsten carbide tools freehand using an angle grinder but the result is not very satisfactory because the diamond grit is too coarse and it is difficult to achieve an accurate geometry.

A while back I bought a pack of assorted angle grinder discs in Aldi. As well as the usual tile and masonry cutting discs there was one labelled diamond grinding disc suitable for steel and stainless steel, **photo 1**. This disc was 115 mm in diameter, had a 22 mm centre hole and rated to run at up to 13,000 rpm. It had fine diamond grit distributed over most of the area of the steel backing disc. The mixed pack of discs was not expensive at around £5.

The disc was intended to be used with an angle grinder. I did think of mounting this disc onto a bench grinder in the same way as a conventional grinding wheel but this would only leave a little of the diamond impregnated disc showing. Really the disc needs to be accessible at the face and not the edge. Using the face of a conventional abrasive wheel would be dangerous due to the risk of it shattering but the diamond disc had a metal backing plate so this was not an issue.

I had an old 5-inch bench grinder lying under the bench, **photo 2**. This was a perfectly functional unit and the only

1

The diamond disc.

2

The 5" angle grinder.

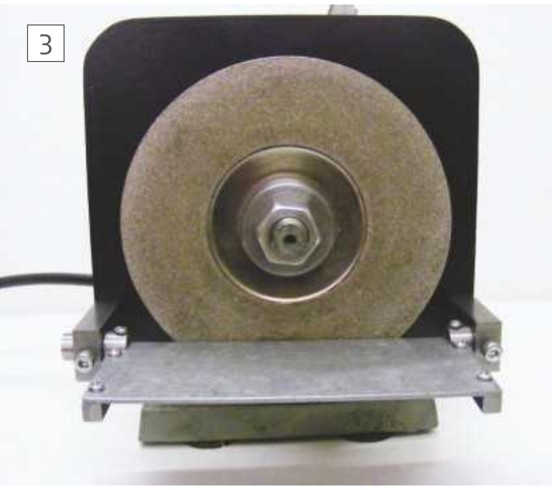
reason that I had stopped using it was because 5 inch grinding wheels are not nearly as readily available as 6 inch wheels. I decided to convert this old bench grinder so that it could be used in an optimal way with the diamond disc. There would be little need for heavy guarding of the rapidly rotating diamond disc since it was metal and unlikely to shatter.

The finished unit is shown in **photo 3**.

Dismantling the bench grinder

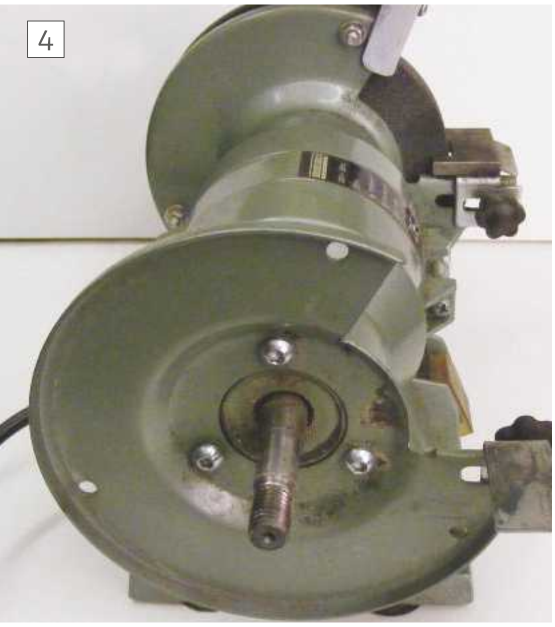
I decided to keep the fine wheel on the grinder and dismantle the side of the grinder with the coarse grind wheel. This was relatively straightforward. There were three screws holding the guards together. Once removed the nut securing the grinding wheel was undone and the wheel removed, **photo 4**. The three screws securing the right hand side of the guard to the body of the grinder could then be removed leaving just the drive shaft protruding from the body, **photo 5**. The drive shaft was 12.5 mm diameter. The bolt circle diameter was measured for the three screw holes. For my grinder this was 58 mm but other grinders will probably be different

3



The finished diamond grinder with adjustable grinding rest.

4



The old grinder after removing the guards and the grinding wheel.

The back plate

The back plate, **fig. 1**. was made from a piece of 2.5 mm steel plate. This was cut 150 mm square and marked out for the centre hole and for the three holes for attaching the plate to the body. The other two holes

Fig.1

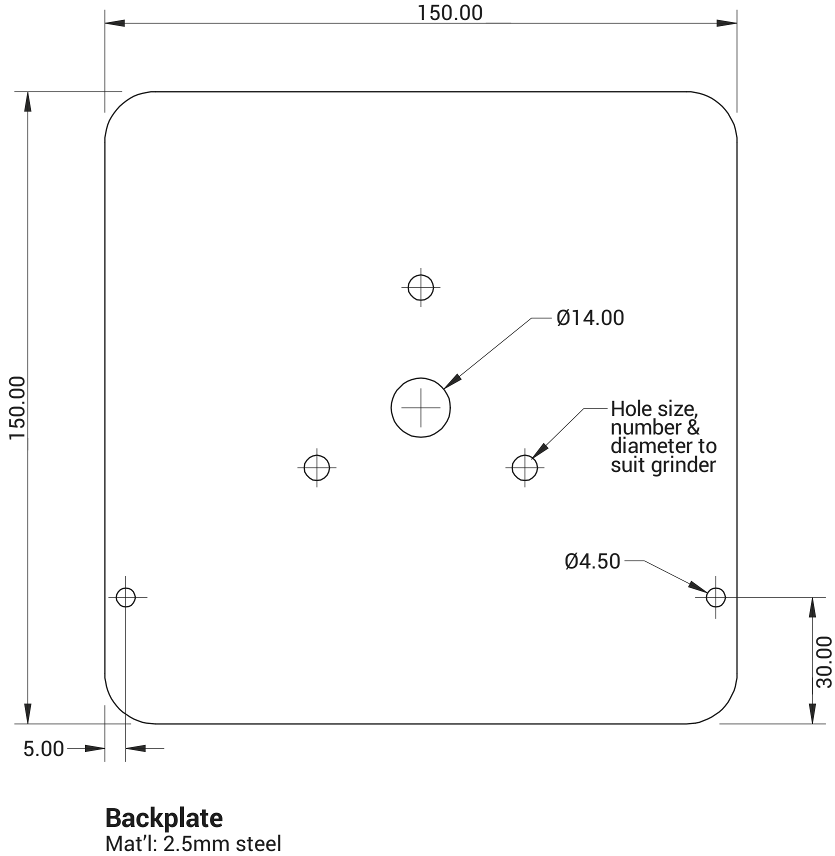
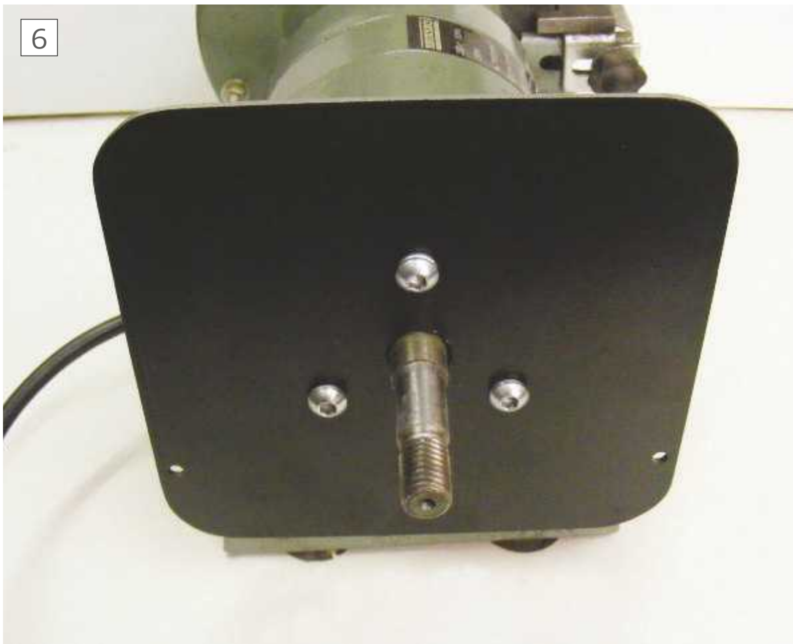


Fig.2

5


The fully stripped down grinder.

6


The grinder with the back plate installed.

in the back plate are used to attach the grinding rest. All these holes were then drilled. The corners were well rounded and the plate cleaned up with wet and dry silicon carbide paper. The plate was primed and painted black and attached to the grinder, **photo 6**.

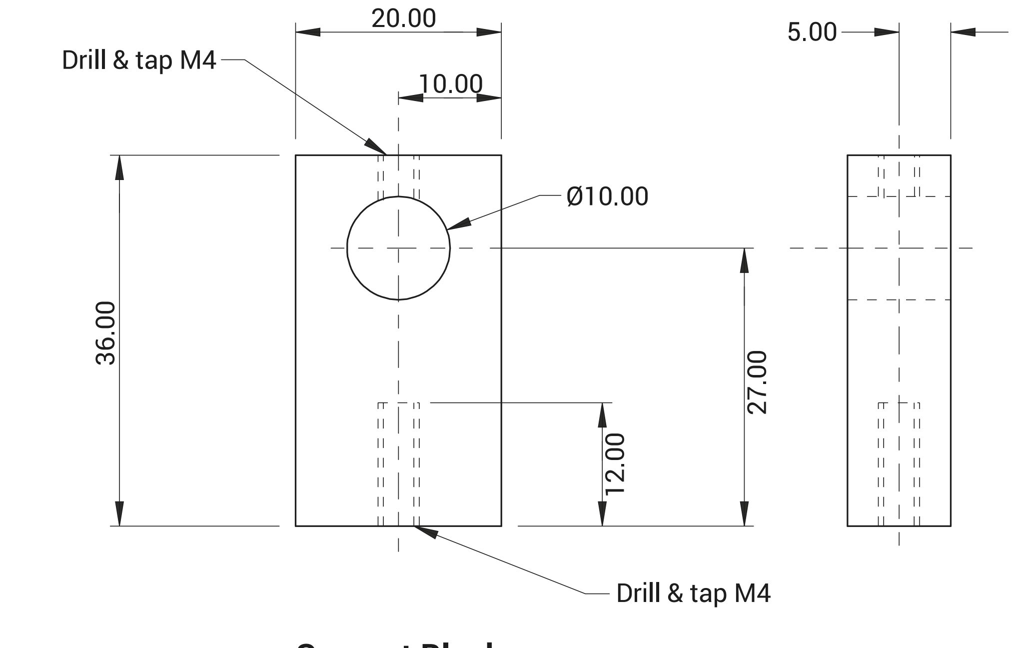
The disc arbour

This was turned from a piece of 32 mm steel round, **fig. 2**. A piece of 32 mm bar 30 mm long was chucked in the lathe and faced. It was drilled out 12.5 mm to fit over the grinder spindle. A 22 mm male register was then machined on the end of the bar for the disc for a depth of 1 mm. The bar was parted 6 mm from the shoulder.

The end of the bar was faced again and a 1 mm female register was machined in the

7


The arbour components.

Fig.3


Support Block

end of the bar. The bar was turned around and the other end faced. These two parts are shown in **photo 7**.

Using the two parts of the arbour the disc could be mounted on the grinder spindle, **photo 8**. On running the disc it was good to see that it was running true.

The bore and lengths given for the two parts of the arbour are correct for my grinder. Other grinders may require different dimensions but the objective should be to have the rear face of the disc about 25 mm from the back plate when the disc is mounted.

The grinding rest

The grinding rest is constructed so that when it is adjusted to different angles it stays about the same distance from the grinding disc.

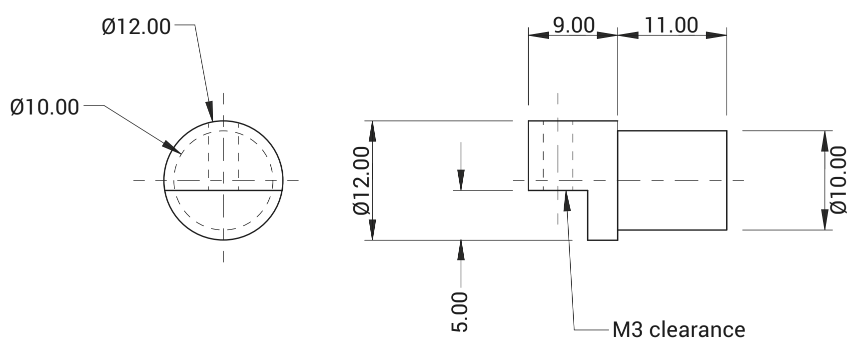
It consists of two support blocks, **fig. 3**. made from 10 x 20 mm steel bar. The support blocks were drilled and tapped M4 in the centre of the back face for the screws that attach the support blocks to the back plate. They are also drilled and tapped M4 on the front face for the screws that lock the table at the required angle. A support block is shown in **photo 9**.

The two pivot pins, **fig. 4**, were turned from 12 mm steel bar. The ends were turned down to fit the holes in the support blocks leaving an 8 mm shoulder on each. The piece is then mounted in the milling vice and a piece 6 mm x 5 mm milled from each. An M3 clearance hole was drilled in the centre of the milled flat. In the recess created by milling two pieces of 6 mm square bar, **fig. 5**, were fitted and secured with M3 screws.

The final part of the grinding rest is the table, fig. 6. A piece of 1.8 mm steel sheet was cut 50 x 125 mm and attached to the 6 mm square bars with M3 screws. It was necessary to cut away the corners to clear the shoulders of the pivots. **Photos 10** and **11** show the assembly of the pivots to table

The grinding rest was attached to the back plate using the two support blocks as shown in **photo 3**. The angle of the rest

Fig.4



Pivot Pins

Fig.5

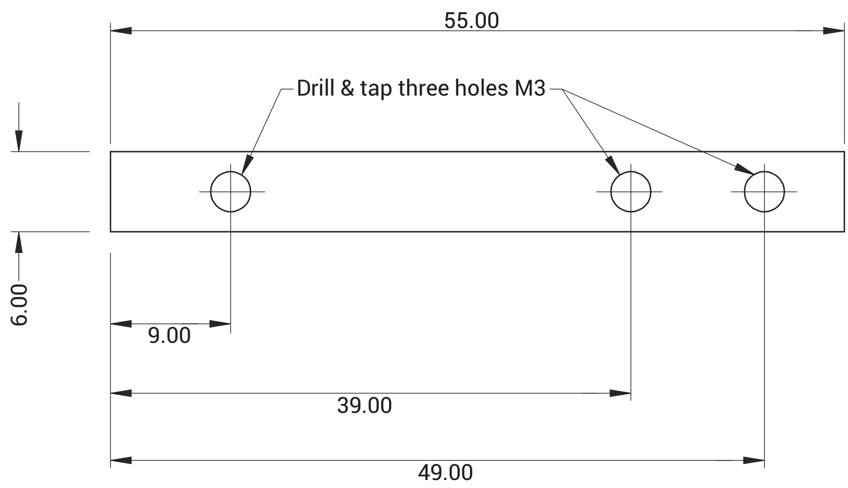
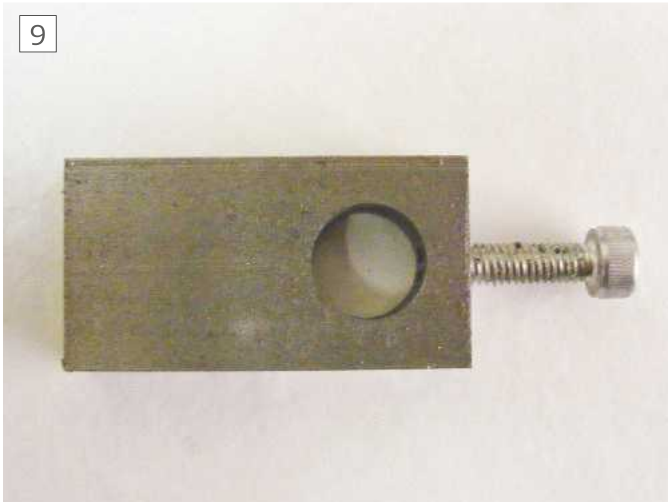


Table Supports

Mat'l: 6mm square steel

8

The grinder with the diamond disc mounted.



9

The support block.

can be easily adjusted by loosening the M4 screws on the front face of the support blocks. Once the angle is correct then the rest is locked in position by tightening the M4 screws.

Usage

This grinder is very good for grinding tungsten carbide lathe tools. It can also be used to 'touch up' insert tooling that has lost its edge. It will also grind HSS tooling but I tend to do this on more conventional aluminium oxide grinding wheels.

The large grinding rest provides good support for the tool during grinding. ■

The top side of the rest showing the pivot pins.

The underside of the rest. Note the support bars.

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Modifications to a Myford 7 Series Lathe

In a short series, Inchanga, in South Africa, describes work carried out on the tailstock and carriage of his lathe.

The Author's lathe

This article started out as just a modification to the tailstock but later investigation included the carriage assembly, cross slide and top slide to correct other problems. As the saying goes - the more you look the more you find that needs attention.

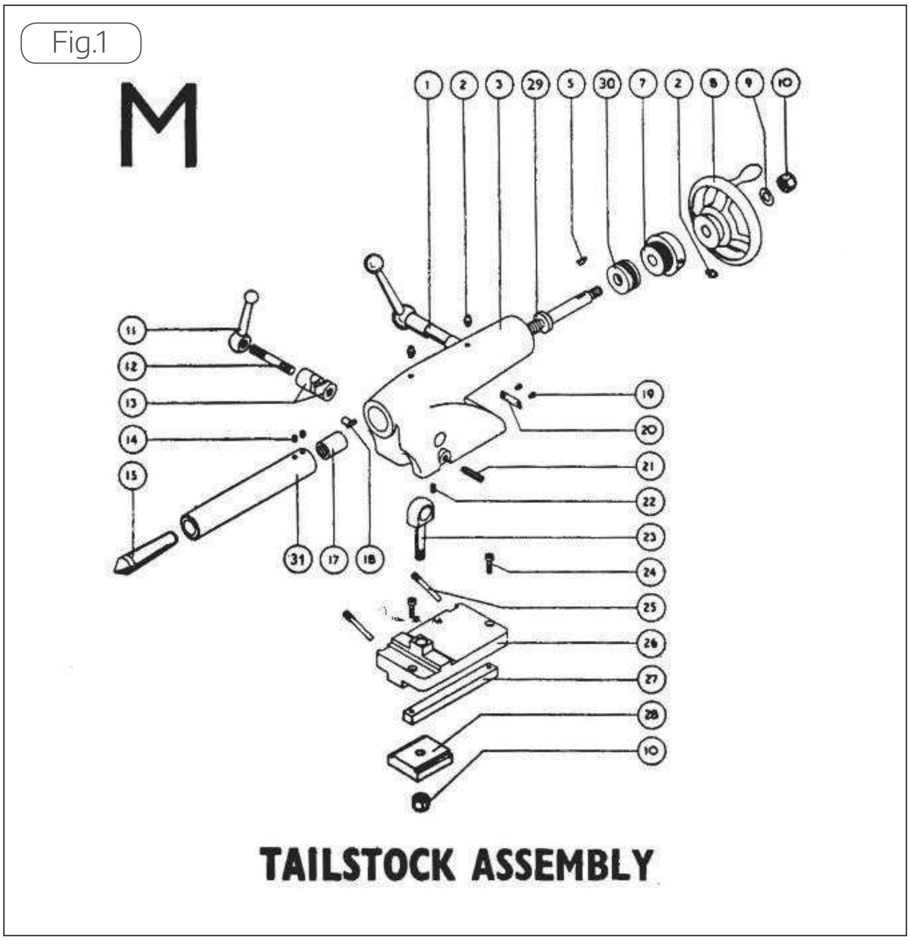
The Tailstock

The tailstock on any lathe has a hard life; it is often repositioned on the bed to support work or to drill holes in the work piece. Consequently, it is common to find it wears more rapidly than any other sliding surface on the lathe bed. An aggravating factor is that small pieces of metal shavings can become trapped between the tailstock and the bed that accelerates the wear. On the Myford 7 series of lathes the sliding surfaces of the tailstock and the bed are cast iron, although this is a good bearing material it is relatively soft and tiny pieces of swarf can become embedded which form an effective grinding paste. The gib plate that sets the tailstock position in the centre of the bed inner slideways is ground flat stock, also known as gauge-plate and is similar to silver steel. It is very hard and can be ground to a smooth finish which resists wear well. By comparison cast iron is easily abraded, so the slideways wear away faster than the gib plate.

The exploded diagram for the Myford Super 7 tailstock is shown in **fig. 1** from the Myford owners' manual, used with permission by Myford. The base plate and associated parts are what mostly concern us, the top portion normally gives very little trouble.

Myford ML7, Super 7 and ML7-R versions

The tailstock designs of the Super 7 and the earlier ML7 are different but use the same base plate in the later models. The early ML7 had the tenon key at the back of the base plate; the later versions have a tenon formed as part of the base plate casting



Myford Super 7 tailstock exploded diagram

width of the front shear to better resist heavy cutting loads. It made no economic sense to have two slightly different beds in production and the change to a single bed design occurred when the ML7 was withdrawn from production to be replaced by the ML7-R.

When the ML7-R was introduced it was in effect a stripped down version of the Super 7, with some of the features removed to reduce the price. These optional parts could be however ordered by the buyer at the time of purchase as extras fitted to the machine or bought later to effectively upgrade the ML7-R to the Super 7, but the differences were minor. When the ML7-R came into production it used the modified carriage assembly of the Super 7, the most noticeable difference is the early Super 7 version has the same hump at the base of the casting as used on the ML7 but it no longer serves any purpose. On the earlier ML7 the front face of this bit sticking downwards ran on the inner front vertical shear to control the thrust of the carriage. On the Super 7 this function is performed by the rear shears and the part that originally contacted the bed is now floating by about 1/8-inch and could be removed. Over the long production period of the Super 7 and ML7-R numerous small changes were also made, but most of these are minor. Many were due to difficulty in obtaining certain imperial screws and other parts at economic costs etc. that were

Scoring on underside of tailstock

at the front. The other major difference between the early ML7 and the later ML7-R (Revised) is that the R version used the same upper tailstock as the Super 7 with an ejector mechanism to remove the Morse taper tools. On the earlier ML7 the drill chuck or centre needed a bar put into the rear of the hollow barrel and a biff with a hammer to unstick the taper. When Myford discontinued the ML7 and introduced the ML7-R they were doing in reverse what they had done with the introduction of the Super 7. The two different lathes used many common parts in an effort to streamline production and keep the costs down. As time went by the ML7-R was discontinued and only the new Super 7 version was made.

Myford Super 7 version

The Super 7 was the uprated version of the standard ML7; it was the rich mans version! Its improvements were notably a clutch-countershaft arrangement, a 4-step belt drive instead of the 3-step on the ML7 and the most notable improvement was the headstock spindle now ran in a well engineered tapered bronze front bush and had end float adjustment by thrust ball bearings. This allowed higher spindle speeds for prolonged times. Although the original split white metal headstock bearings on the ML7 were fine for intermittent high speed operation they did tend to heat up and the oil supply by drip-feeders was considered old fashioned by that time. The front bush on the Super 7 was lubricated by a felt pad with a small oil cup on the front of the headstock instead of the tall drip-feed oil feeders on the less expensive version. Another improvement was the fitting of the long cross slide and proper adjustable micrometer collars on this and the top slide, which was also given a better means of slewing it over. All of this of course came at a price increase but the market clearly wanted something better and the Super 7 sold well. One of the other major modifications was to the bed. The original ML7 had equal width top shears; the Super 7 bed had an increase in the changed to the more commonly available metric equivalents and do not significantly alter the basic design, which remains one of the finest pieces of British engineering of the era.

One significant change to the tailstock was the position of the barrel locking lever. On the earlier versions this was at the back of the tailstock but when the rear tool post is fitted on the cross-slide it could foul when the tailstock was brought up close to the carriage, as the lever end pointed forward when locked. It was moved to the top of the tailstock barrel to eliminate this problem. This change of course was also applied to the ML7-R for commonality of components.

Myford lathes have given long and reliable service in thousands of workshops all over the world, very often being pressed well beyond their design limit in holding large pieces of metal and taking substantial depths of cut, which they seem to handle without too much objection. Very rarely does one hear of something breaking, and if they do it is usually due the operator doing something stupid or due to neglect in maintenance. They are rightly regarded by many as the Rolls Royce of small lathes and the standard against which other less expensive lathes are judged. As my late father used to say; 'If you are going to get married – get a good-un' and the same applies to machine tools. However, like any contrivance they can still be improved and a few niggling design quirks corrected for very little effort or expense. Most notably on the list is the subject of adequate lubrication. Myford stipulate the application of the oil gun to the various oil nipples on a daily basis but many people, myself included, seem to forget to do this as often as we should. The entrapment of fine particles of swarf between the working surfaces also causes wear and if a method of flushing these out with oil were provided the bulk of the problems with tight spots can be very much reduced.

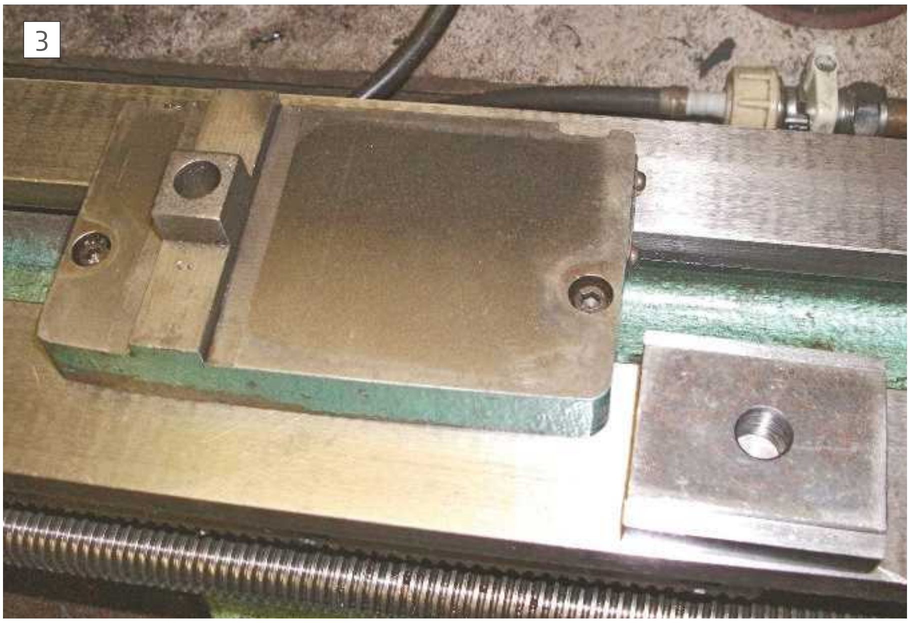
Tailstock modifications

By a simple modification the life of the tailstock base plate and bed can be increased considerably for very little effort.

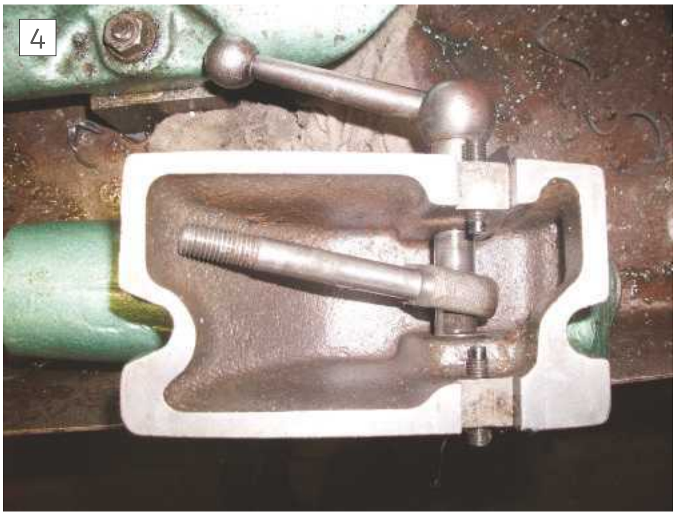
If the lathe slideways are closely examined on the Myford 7 series of lathes we see that the top bed surfaces being a large surface area wears quite slowly if it is kept reasonably clear of swarf and adequately lubricated. The carriage has a felt scraper pad fitted at the front to prevent swarf getting trapped between the carriage and the bed. The lathe bed slideways are lubricated by the two oil nipples on the lathe carriage assembly, one at the front and the second at the rear, both of which are not obvious at first glance and often neglected as a result. The front oil nipple is hidden under the top slide and the rear one is out of sight on the back apron of the carriage. How much better if these could be relocated to more accessible positions to remind the operator of the need to apply the oil gun. The inner and outer vertical bed slideways are lubricated by excess oil from the bed top surfaces, which by then is already contaminated with particles of dirt and swarf. An aggravating factor is that the whole depth of the two inner slideways is not used fully by the tailstock. If the inner slideways are closely examined we see that the top portion of about 2/3rd depth exhibits wear but the bottom portion is unworn. This is because the tailstock clamping plate (item 28 in **fig. 1**) under the bed needs clearance as it runs on the two inner slideways and is pulled upwards when clamped. Hence, the full depth of the inner vertical shears is not able to be used to its full. The inner slideways rub on the gib plate (item 27 in **fig. 1**) and the other side of the tailstock that locates the tailstock centrally. The other side of the tailstock (opposite the gib plate) is part of the tailstock casting (item 26 in **fig. 1**) and it is machined to present a smooth surface to the inner vertical slideways on the bed. This slide bearing is however severely compromised by the design, it is mostly cut away to provide clearance (quite why is a mystery only Myford may be able to answer) and as such has very little bearing surface compared to the gib strip which uses the full length available. Cast iron running on cast iron is not the best bearing material and trapped swarf causes wear. Particularly bad are tiny pieces of stainless steel chips. These when sheared off the parent material by the cutting tool undergo a hardening process due to the high temperature they reach that can become nearly as hard as high speed steel. If these get trapped between the tailstock and the bed, they will cause scoring and subsequent wear to occur. **Photograph 2** shows the underside of the writer's Super 7 tailstock base plate with severe scoring 'tramlines' evident. This machine is now over 40 years old so some wear is to be expected. There is a noticeable step that can be felt with the fingers between the unworn and the worn portion at the gib plate interface.

The tailstock on the Myford Super 7 has some other particularly poor design features, apart from the two isolated cast iron bearing sections already mentioned. (The writer intends reducing these in width and fastening a piece of thin gauge plate to run the full length as the adjustable gib strip is at present. This entails little effort). The first is that there is no positive lubrication channel supplied, unlike the carriage and other sliding parts where oil grooves and oil nipples are at least provided (although inadequate to reach all parts) to allow the oil to reach some of the wearing surfaces. Later versions may have this addition but I an unaware if they have been provided, it would have been very little extra effort and cost to provide them, as was done on the carriage assembly. This can however be easily rectified by the modification. The second design fault is that there no positive mechanism to ensure the top portion of the tailstock sits firmly on the base plate, except the two alignment 'pusher screws', which have no locking hole to run into on the base plate casting. (At least they are not included in my Super 7 and I don't find any mention in the makers' literature, so I assume they have not thought of this problem). If swarf becomes trapped between the top portion and the base plate, then the tailstock barrel ends up being out of alignment with the headstock spindle in the vertical plane. This effect had the writer puzzled for quite some time when a severe case of 'taperitis' was encountered. Finally, the inclusion of a wiper on the front face would reduce the possibility of dirt getting between the base plate and the bed, a system similar to the carriage front wiper could be added with little work. One other fact, which always puzzled me about my early Super 7, is why Myford chose such an unusual shape for the tailstock base plate casting. There are no flat surface on the outer of this - all curved. I can see on the later Super 7 illustrated sales brochure that Myford have now made these surfaces flat and it looks much better in my opinion, and easier to hold in a machine vice when making modifications. I suppose this falls into the same category as the acorn shaped knobs on the earlier machines.

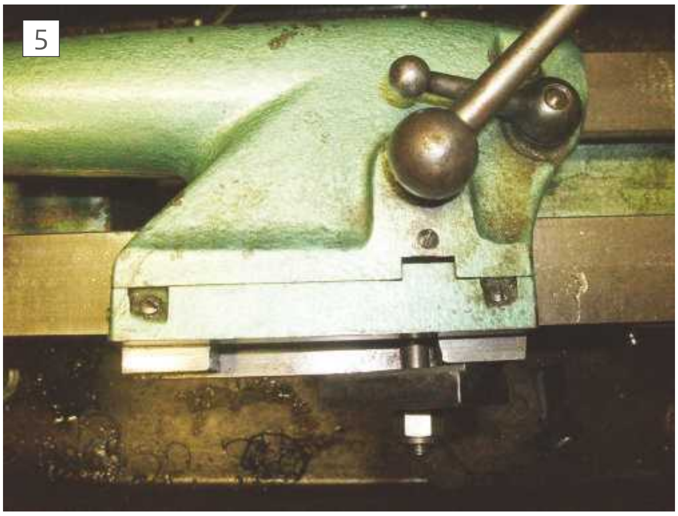
There are two main causes of the tailstock causing a long work piece to become tapered. Both involve misalignment of the tailstock barrel. Myford provided two pusher screws (item 21 in fig. 1) on the base plate to set over the tailstock in relation to



Top surface of base plate



Underside of tailstock upper portion



Assembled tailstock side view

the bed for taper turning of small angles. These screws either push the tailstock backwards or forwards in relation to the bed. (Backwards and forwards meaning away from the operator and towards the operator). For parallel turning the position of the tailstock barrel must be perfectly aligned with the headstock axis, both vertically and horizontally. However, even if these horizontal plane adjustments are correct if the tailstock barrel is either too high or too low in relation to the headstock (vertical axis) the same effect occurs. Swarf trapped between the tailstock base plate and the upper portion raises the tailstock barrel higher than the headstock axis.

Photograph 2 shows the cast iron base plate of the writers Super 7 with the gib plate removed. One can see the ground portion that the gib plate screws onto. The difference between this and the portion that rubs on the bed can be clearly seen. The deep gouges running along the base are due to trapped swarf. Measuring the difference in thickness showed that on average 2-thou had been worn away. I suppose in 40 years or so the rate of removal is acceptable. The top of the base plate is shown in **photo 3**. The top surface is also ground to a high finish; this is what the underside probably looked like when new. The two cap screws (item 24 in **fig. 1**) clamp the gib strip in place. Adjacent to the base plate in **photo 3** is the clamping plate to lock the tailstock on the bed. The square upright portion through which the clamping bolt passes is used for the pusher screws to bear against for horizontal alignment. This sits on top of the raised tenon key that aligns the base plate to the top portion.

The top portion of the tailstock has the telescopic barrel and the clamping for this and the bed clamping eccentric mechanism. **Photograph 4** shows the underside of the top portion with the two pusher screws to align the tailstock on the base plate. The mating surface is also ground to form a flat surface to mount on the base plate. The slot across the tailstock upper portion forms the keyway or tenon that the base plate slides on for front to back alignment across the bed.

Photograph 5 shows the tailstock fully assembled on the base plate. The observant viewer will see there is a gap between the base plate and the upper portion above the keyway tenon slot. By applying a thin screwdriver blade into this gap the top and bottom portions can be separated by levering the two apart. The only mechanism to hold the top portion flat on the base plate is the clamping bolt screw. If the tenon develops wear and the tailstock is slid along the bed, which of course means the clamping bolt is fully released, there is a good possibility that the movement by pressing down on the handle-wheel end, which is the natural way to push the tailstock along the bed, causes the front end of the top portion to rise and not get pulled down correctly when the clamping bolt is tightened. If the two pusher screws are in the slightest bit slack, then the alignment can be thrown out.

In **photo 5** can be seen the two gib adjusting screws (item 25 in **fig. 1)** and one of the pusher screws to align the tailstock. (The gib adjusting screws are Myford part A2137 and the same screws are used on the headstock to align it with the bed slot). The gib adjusting screws are used to set the clearance for front to back movement of the tailstock base plate so the running clearance in the inner slideways is almost zero, just sufficient for a film of lubricant. The adjustment is made with a perfectly dry bed, ensure you wipe off any oil before starting. To adjust this clearance, the base plate is placed onto the bed so that the gib plate and corresponding bearing faces run against the inner slides. The two 2BA cap screws are nipped lightly and the two gib screws tightened alternatively to move the gib plate into contact with the slide way, whilst sliding the base plate backwards and forwards on the bed. By grasping the base plate and trying to twist it you can feel and hear a click as the gap between the base plate rocks across the bed. When the two screws are correctly adjusted the base plate should slide easily along the bed but show no sign of rocking in the gap. Now the two 2BA cap screws are fully tightened and the movement checked for the same easy movement. If the gib screws are too tight the base plate will be immovable.

A common problem is that the tailstock spends almost all its time near the far end of the bed. This means the majority of the wear occurs near the far end of the bed. When it is brought close to the headstock it tightens up, as the inner vertical slideways are slightly narrower on the unworn portion of the bed. This minute difference in width can be corrected by lightly stoning the inner slideways with a fine abrasive slip stone to remove a tiny amount of metal. It is really polishing not gross metal removal; we are talking about a few microns. For the final polishing one can use a metal polish, such as Brasso, taking care to remove all traces after use with paraffin or some other solvent. Brasso is a liquid with finely ground up pumice stone, another alternative is toothpaste! Once the final adjustment is made apply a little light oil and try the base plate along the bed. It should still move freely but a little more effort will be needed, because it now has a microscopic film of lubricant between the two surfaces. This is the ideal setting and the base plate and bed will settle to a well running bearing surface over time, in the automotive industry we call it 'running in'.

The same wear also effects the carriage clearance, but this is the outer vertical shears. As the majority of time is spent with the carriage close to the headstock the gib screws are adjusted for this, but when run towards the tailstock end the carriage tightens up. Again careful light stoning of the two outer vertical slideways towards the tailstock end can remove the minute amount of metal required to obtain free running. A safe way to polish these vertical slideways on the front face where the rack gets in the way is a piece of 600 grit wet and dry or finer paper wrapped around a piece of ground flat stock and pressed against the vertical shears of the slides whilst it is moved along the bed to remove a few microns of metal. ■

To be continued...

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- Durable anodized finish
- This new model now means it is not necessary for the lathe to belevelled for the Speedy Lathe Gauge to work. The adjustable level vial housing can compensate for machines that have not been levelled.

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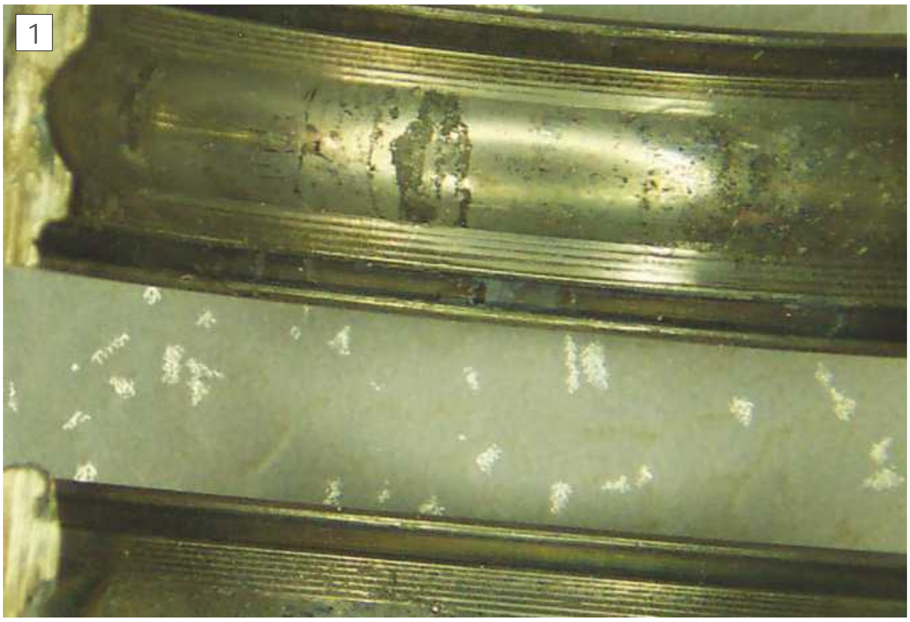
A big job for a small machine

After fifteen years, Brian Wood's bandsaw gave up the ghost. It was time to put a few things right.

During a recent cutting job on 80mm diameter bar, my bandsaw started making serious sounds of distress, to be quickly followed by the blade seizing in the cut. I was able to pull it out with pliers, but even when free it would no longer run and the ½ HP motor was slowed to the point of stalling This article describes what went wrong and what I did to put matters right. I also took advantage of the downtime to put some other less obvious faults right.

A feature of this job shows what can be achieved in work handling on a small milling machine.



Sectioned ball race

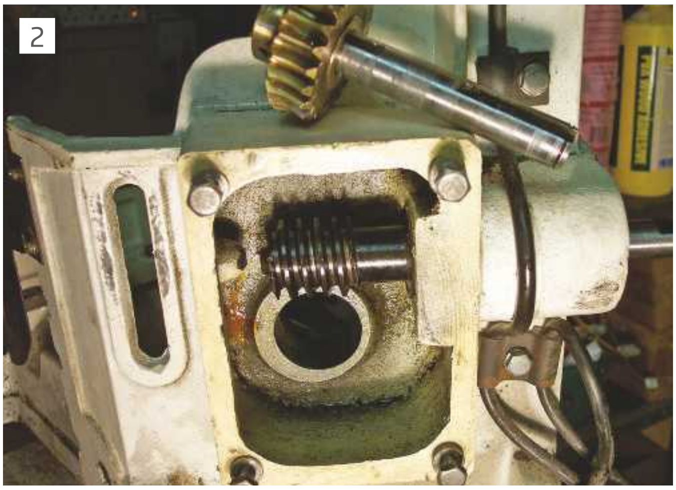
Machine history

The bandsaw is a model MB115, bought new from 15 years ago. I suppose it has done an average amount of work in that time.

In common with other owners of these small band saws, I have made strengthening alterations to the stand, altered the vice position and made corrections to numerous other niggling details.

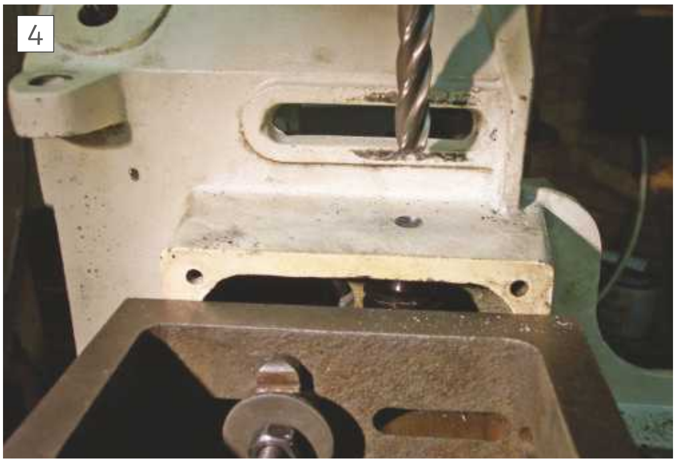
Last year I had to machine the seating faces for the ball bearing blade guide blocks to correct a long standing problem of blade run off from the internal wheels. This was finally traced to poor alignment of badly finished mounting faces, one set of which were just as cast.

That set of guides tried to steer the blade back onto the drive wheel and was actually

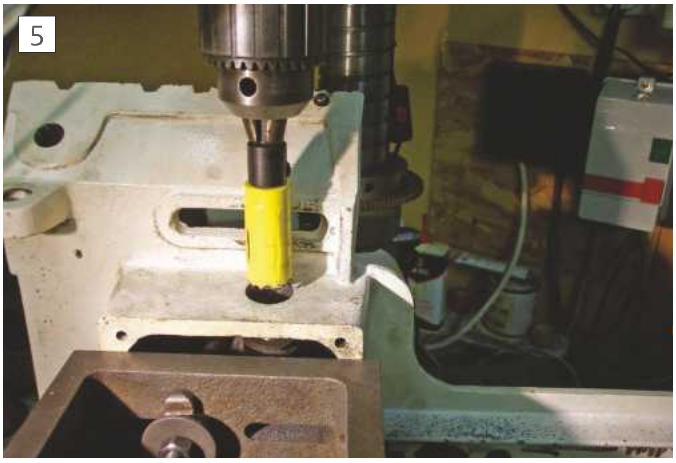


Shafts separated

Frame mounted on mill table



Ball end mill roughly positioned



Enlarging hole with hole saw

Enlarging hole with boring head

Worm shaft being extracted

twisted as a result of poor workmanship. It was very obvious when proper alignment measurements were made with a wired tensioned across the blade wheels.

This seizure was however something quite new and it was very inconveniently timed.

Faults discovered

When the belt cover was opened, the inside was black with rubber dust from belt wear. The belt itself was reduced to about two thirds thickness and it was stretched. Despite this damage, it was considered reusable.

The stretching was enough to allow the motor shaft to run in contact with the curved clearance slot cut for it in the inner skin of the sheet metal cover.

With the belt off and both hands gripping the pulley on the shaft into the reduction gearbox, attempts were made to turn it. Little more than 1200 in either direction was possible and even that small degree of motion felt decidedly 'digital' as well as being very rough.

Inside the gearbox, the oil was black and heavily loaded with bronze from the worm wheel. Admittedly, it was some time ago I last checked the oil, but it was then still relatively clean with some bronze flecks floating in it. This time the steel worm also showed signs of flank wear on the turns that engaged the wheel.

With the oil drained out and the inside cleaned up, more wear damage to the bronze wheel was seen in the roots of the gear teeth. Clearly the worm had been grinding the material away there.

Gearbox work.

The first action was to separate the two gears. The wheel shaft to the inside of the saw frame was stripped down and the plate holding the shaft oil seal in place was removed. The shaft was then partially driven out of the gearbox and even with the gears disengaged both shafts felt rough and exhibited all the hallmarks of brinelling of the ball races.

For those unfamiliar with the term, it occurs when a bearing is fitted into a seating that is too small to contain it comfortably. The outer race deforms slightly to fit the bore and the balls are forced into hard contact with the raceways. In severe cases they will indent the raceways and flats will form on the surface

Worm shaft bearings and oil seal fitment


Rough surface on worm wheel


Paint in one of the shaft bores


View through new access hole


Clearance for meshing

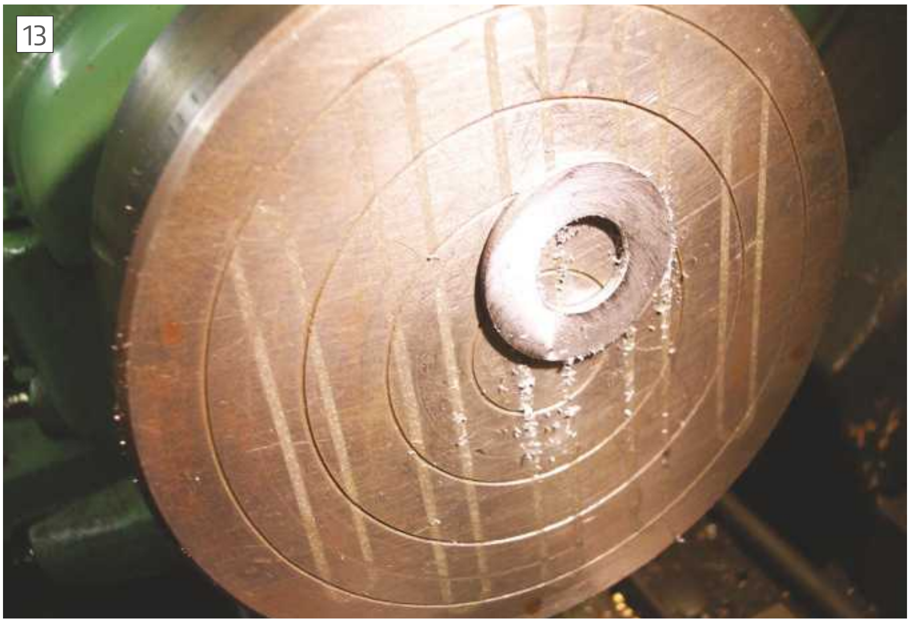
of the balls. Bearings stressed and damaged in this way have but a short life ahead of them, even if they feel smooth when removed.

The word comes from the internationally accepted hardness test method invented by Swedish engineer Johan Brinell in 1900 in which a hard steel ball is forced into the surface of a test specimen under the action of a known load. The diameter of the indentation is then a measure of the hardness of the specimen.

Photo 1 was taken after all the work had been done and shows one half of the roughest bearing and the damaged track. Much of the marking seen here comes from compacted metal debris from gear wear, but even with that removed there was damage to the surface of the raceway that could be felt with the point of a scriber.

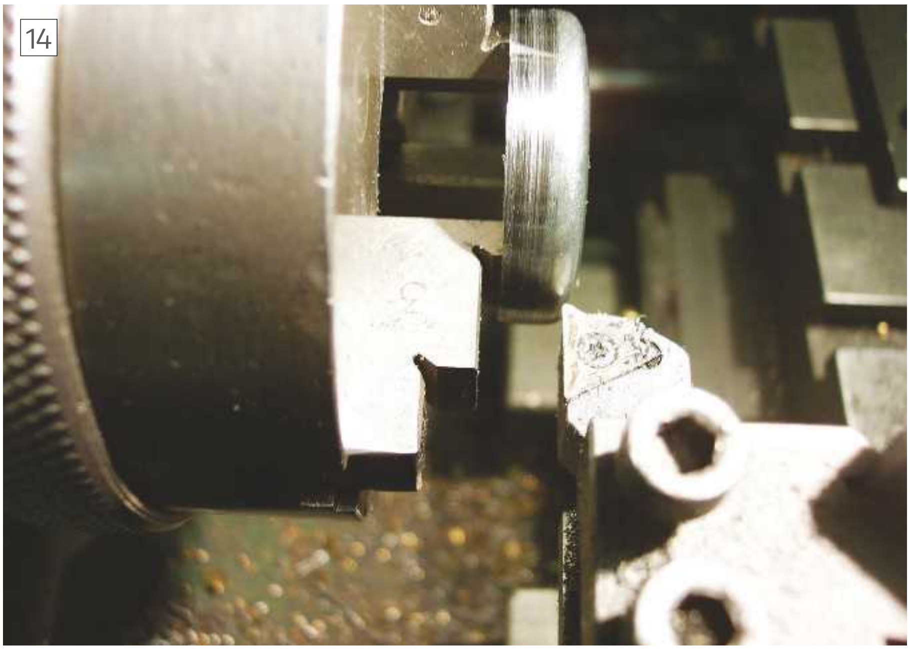
Photograph 2 shows the gearbox housing with the worm shaft still in place. It is very obvious that there was no easy way of extracting the shaft.

Fruitless attempts were made to try levering it out against the strange knuckle on the gearbox wall opposite the shaft. These attempts were quickly abandoned since there was a real risk of breaking the relatively thin wall of the gearbox casting.

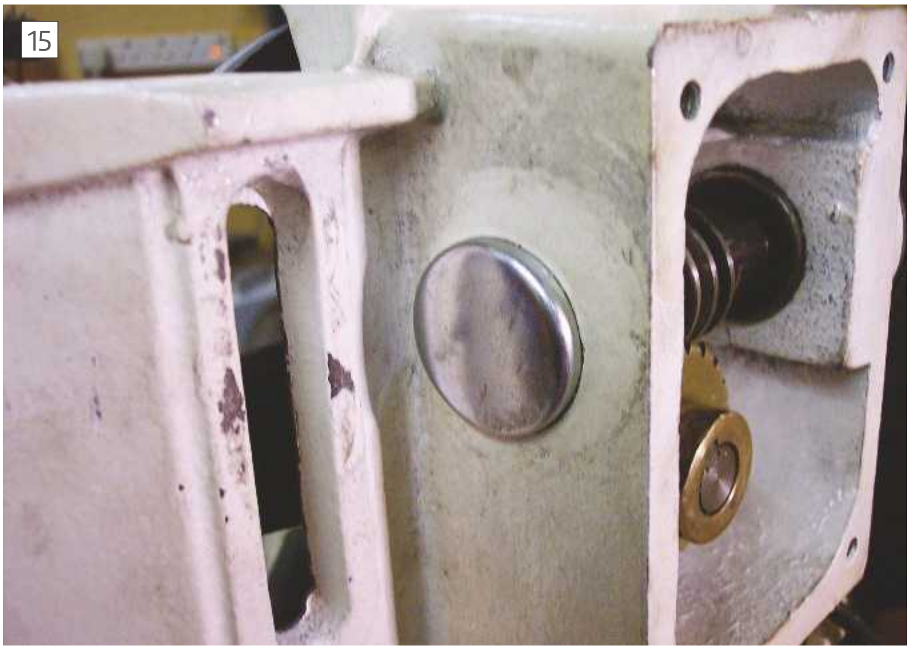

Spacing shim on magnetic chuck

The shaft itself could be moved within the constraints of the gearbox using a nylon faced hammer on the drive end and then levered back into position with a large screwdriver, but pushing out two ball races that way was a much more demanding task.

Clearly a different approach was needed to allow it to be driven out and **photo 3** shows the whole frame mounted up on my Dore Westbury mill table. The table



Core plug machining



Core plug fitted

size is just over 16 inches long and a little over 5 inches deep, the saw frame is roughly 31 inches in length and weighs several kilograms. As can be seen, quite a lot of additional support was needed at the gearbox end on the left in this photo where good clamping onto the gearbox opening was possible; the whole job had to be slewed across the bed to allow clamping down at the right hand end.

One feature of the Westbury mill is the round column support for the head and one that can cause great frustration with loss of position if the head has to be repositioned in the course of work.

On this occasion though that feature became a positive asset since the head could be swung over the job like a radial arm drill; something simply impossible on rigid column machines of similar capacity.

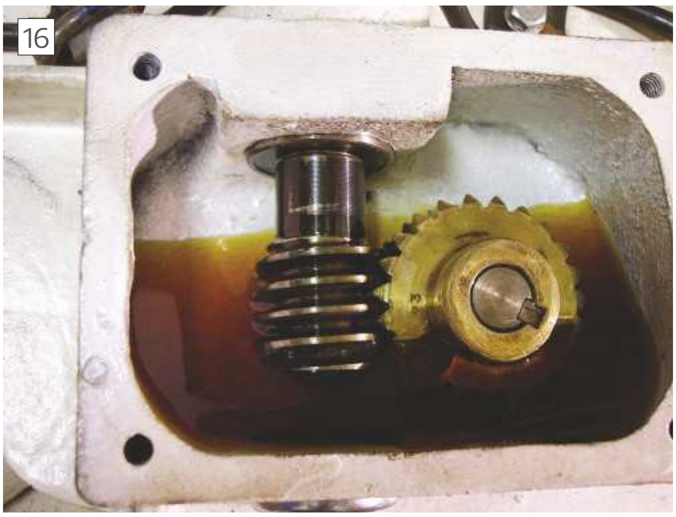
Photograph 4 shows a ball ended 12mm end mill being positioned approximately over the worm shaft. After drilling the hole the head axis could be properly aligned with the end of the worm spindle and **photo 5** shows the hole being enlarged with a 24mm diameter hole saw, the guide drill for which is deliberately absent.

Photograph 6 shows further enlargement being made with my boring head until the socket shown could be cleared; the diameter of the hole was then 33mm and an easy clearance diameter for the worm. **Photograph 7** is of the worm and shaft being driven out through the new access hole.

The bearings were then driven out individually and are shown in photo 8 which also shows a real surprise. Not only was the oil seal fitted in front of the outer bearing, it had been fitted backwards so that any pressure build up in the box would have forced oil through the seal. Clearly this had been assembled by someone who had no idea what they were doing.

And at last, the reason for the excessive tightness of the bearings can be seen with the paint adhering to the outer bearing.

Photograph 9 shows the very rough condition of the inner face of the bronze wheel and **photo 10** is a rather poor view of



Gearbox filled with new oil

Motor platform pivot axis


A detail view of adjustment screw

one of the shaft bores with paint from over spray inside. Both shaft bores were similarly affected; the paint was thick enough in places to be scraped out by a fingernail.

The shaft bores were both cleaned and opened out slightly with a piece of Scotchbrite wrapped around a suitable 'mandrel' that could be driven by a power drill rather on the lines of honing a bore. The process was continued until one of the damaged bearings could be push fitted into all four locations. The shafts were then refitted on the old bearings to check fit and alignment. **Photograph 11** shows the view through the newly bored hole and **photo 12** the gap between the bronze gear and inner face of the gearbox when correctly aligned. Feeler gauges measured this at almost 2 mm wide (actually 0.070 inches).

When the gearbox was first assembled none of these alignment checks would have been possible; the worm shaft must have been pressed in from outside with the inner bearing fitted, engaging with the worm wheel as it entered. The spacer, oil seal and outer race would then have been pressed in and the gearbox closed up with a dose of light oil.

This time there was just a nice degree of backlash between the gears and they ran quietly together even when dry.

Photograph 13 shows a shim of 0.070 inch thickness being made from a washer, using a magnetic chuck on the lathe. **photo 14** shows a new core plug being machined with a 30 taper and duly fitted in **photo 15** to close the access hole.

Photograph 16 shows the gearbox, complete with new bearings and seals and filled with an appropriate grade of gear oil before closing up again. The untidy ends of the worm and the ragged side edge on the worm wheel have both been cleaned up; the worm was also given the lightest skim on the surface and polished with Scotchbrite. I have great respect for this material and what it can restore.

One final mechanical improvement I made was to the drive wheel for the saw blade. When spun over by hand on its shaft there was a visible run out of about 1/2mm on the running surface for the saw blade. With all the other work that had been done, it would have been silly to ignore it.

The only way I could hold this was on the face plate for my Myford lathe, clamped down onto the rear face of the wheel which did run true. Light and gentle cuts put matters right. I didn't bother with a picture for this simple job.

Motor mounting

Attention now turned to the motor mounting. To a casual look when using the machine, there appeared to be a satisfactory means of adjusting belt tension. All was not what it seemed as **photo 17** shows with the white bar through the motor plate pivot holes.

Photograph 18 shows the adjustment screw with its locknut in more detail. The plate is upside down in both views.

The adjustment as designed works only one way and serves to increase the tension on the belt. It already has plenty of that with the weight of the motor acting as a cantilever load on the other side of the pivot, there being no load limiting set screw at all.

This of course explains the belt stretch and degree of belt wear seen when the belt guard was opened.

Photograph 19 shows the simple bracket and support screw fitted up under the motor platform to provide a stop and allow belt tension to be set and locked. **Photograph 20** shows the machine back in use again, the chalk marks show the depth of cut reached when it failed.

And what a transformation! It now runs quietly, progress in cutting is a good deal faster than before, due presumably to all the motor effort doing what it should and other than the hum from the motor and some gentle gear noise, the swish of the saw blade at work is a sound I have never heard from it before.

I have always, up until now that is, had reservations about the success or otherwise of a cut of any kind with expectations of the saw blade running off the guide wheels or breaking for no apparent reason.

Time will tell of course, but for the moment at least I feel the effort has been well worthwhile. I can't in all fairness expect to claim that the machine is now a silk purse but it is certainly no longer a pig's ear. ■


New support screw below motor platform


Saw back in operation

Scribe a line

YOUR CHANCE TO TALK TO US!

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

Dave Lammas small Vickers hardness tester

Dear Neil, the following is an appreciation of the late Dave Lammas design as described in Model Engineer 7th July 1989, and currently written up in MEW by Rod Jenkins in 245.

My machine (see photos) was made in 1990 from castings from M.J. Engineering at the princely cost of £31 – no V.A.T. & £24 carriage Uk / New Zealand. It has been used many times since in my home workshop. A friend who had purchased a full size Vicker's Diamond Pyramid machine gave me a spare diamond indenter which replaced the described Tungsten Carbide one. (so Carbide, hardened tool steel and HSS can be tested). To measure the indent diagonal I used a "Mity Mike" 20 : 1 magnification viewer shown in front of the machine.

I found it an interesting project, not too difficult and I would suggest one or two Minor improvements: -

1. Make all small mechanisms from stainless steel (no worry with rust)
2. Install small dowels (3/16" diameter) in the tops of the lead weights with corresponding recesses underneath and on the weight suspension. These to minimise movement sideways.
3. Add "Tommy bar" holes to adjust the table raising nut to make "zero" setting easy.

Major Incident

One interesting incident that required its use was when as a Mechanical Engineering Consultant, I was asked to inspect the debris of a failed re-erected grain silo. Approximately 8 metres in diameter by 20 metres high, constructed from bolted rolled corrugated iron located at a grain storage and processing plant 80 kilometres South of Christchurch NZ. The components had been carted about 200 kilometers.

The silo, one of two, was re-erected on a steel fabricated ring on legs about 1.5 metres high. The integral bottom of the sheet metal silo was conical. The cone made from sheet metal 'petals' bolted together with M10 bolts & nuts at about 100mm pitch. The centre of the cone fed a 200mm screw conveyor to facilitate silo emptying. So far, nothing unusual for this type of equipment.

The owners of the "new" silo promptly started to fill the first silo with grain (about 100 tonnes of wheat). When it was about 2/3rd full a creaking and groaning started to occur. At some risk to themselves the owners quickly placed PVC sheeting under the cone and over the adjacent shingle yard. As they quickly retired they watched the 'petal bolts' as they successively sheared. (As soon as one bolt sheared the load on the adjacent bolt doubled) and the silo almost instantly emptied out at about 1 metre deep across the adjacent yard!

The immediate consequence of this was that because of the rapid discharge the normal air vent at the silo roof could not cope and the high sides of the silo imploded: - "one wrecked silo".

On returning home with samples of the sheared bolts my hardness tester soon confirmed that they were only mild steel not Hi-tensile as expected.

The originals had been "lost" by the contractor. I was not party to the negotiations between the contractor / owner and insurer, so I assume the contractor picked up the considerable cost of one new silo plus replacement of bolts on the 2nd silo. "Don't lose parts when something is being disassembled".

Conclusion

I found building the tester an interesting exercise and well worth the effort in manufacture. A professional metallurgist supplied me with a tested steel sample and results from my machine were in more than adequate agreement for home engineering. Hardness is a reasonable indication of Ultimate Tensile Strength – "At least that piece of unidentified steel is identified".

So those readers that may disregard the unit as a toy, it does work, and if they follow the 'words and music' of the MEW #245 just out and the original ME of July 1989 etc. they will have a useful 'piece of kit'.

Regards,

Jock Miller, New Zealand (With thanks to Peter King for the photos)

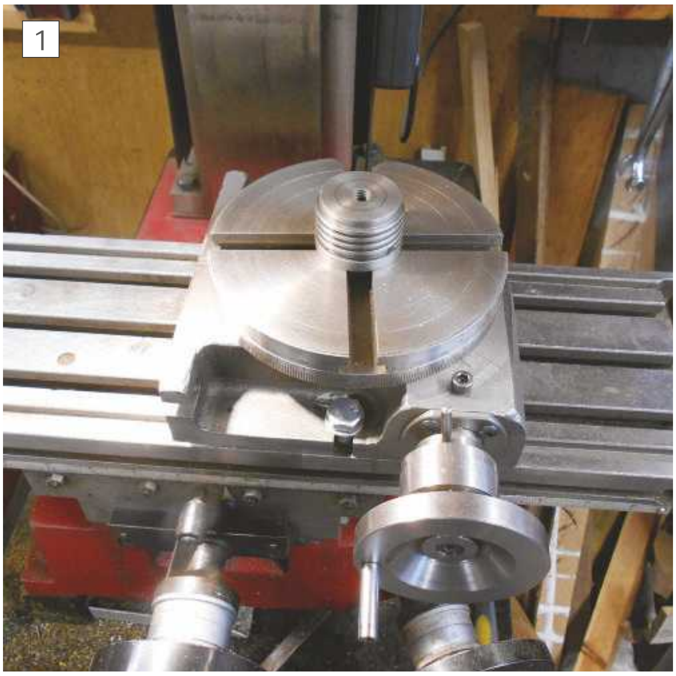
Reference.: "Mity Mike" was available c/o Travers Tools and made by Du Maurier Co Inc, Virginia Beach, VA 23454.

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

Write to The Editor, Neil Wyatt, Model Engineers' Workshop, MyTimeMedia Ltd., Suite 25, Eden House, Enterprise Way, Edenbridge, Kent TN8 6HF. Alternatively, email: neil.wyatt@mytimemedia.com

Making your own Division Plates

John F. Firth describes his technique for making custom division plates.



CES Dividing Head

CES Dividing Head fitted with Wood Faceplate

This article that sets out to describe the design, method and production of a set of purpose designed homemade division plates suitable for use in a home workshop.

To avoid any doubt, it also goes on to explain some of the details of the machining of some gearwheels for both my Clock project and for my Raglan 5 inch Lathe using my own division plates, however, I do not intend here to go into detail of the various ways that clock and gear wheels are made.

Machining gears can be a complex area to which I am not an expert, and there are many others far more qualified than I am to do this and I will willingly leave that to them.

I did feel that some manufacturing details needed to be shown If only to give some confidence to the process and when others reading this article need to be convinced that the theory behind this method can give acceptable results.

Background and development

For a number of years, I had planned to build my first clock, a Regulator Clock, but in order to proceed I quickly realized that there would be many things I would have to learn to do. One of these was the ability to develop methods of creating and cutting the teeth for wheels for the project if I wanted to machine these for myself. My Regulator Blog shows my current Progress www.clockworkengineer.wordpress.com.

I had a reasonably new small milling machine, but I knew that I would need some form of dividing head to create the required divisions for each wheel, so I looked at prices for proprietary dividing heads such as Vertex, and others, and I quickly realized that while the quality was excellent, the cost for such a device could only be effective if needed for more than just one or two projects.

After some research I arrived at the solution that making my own Home Machined Dividing Head (by CES Ltd) could be an acceptable solution to the problem.

Around 5 years ago I obtained a full set of castings and proceeded to machine the same to dimensions given by CES, **photo 1**. The machining of the casting took me approximately one week to complete, but I also realized that to complete the wheels I also needed a set of division plates for the tooth numbers not readily divided by my homemade dividing head.

I obtained a set with of Division Plates and adapted my Dividing Head to use them, and I then went on to machine a full set of wheels for my clock. When complete and I took a close look at my work I was not completely happy when I saw the quality of the wheels, they were not as good a job as I would like.

I put this down to the quality of my workmanship when machining the parts for the dividing head and felt that the solutions left to me were to either purchase a top grade dividing head and plates and start to make a new set, or to purchase a set of digital scales and software to allow me to accurately machine the divisions in my milling machine using the coordinate method.

Either of these solutions would no doubt provide the required acceptable result, but they also entailed spending some £200 - £300 to arrive at a solution, and for me this seemed to be far too much to spend for something that could only be used maybe once or twice in my lifetime.

I decided to give some thought to making a purpose made division plate suited to a full range of clock wheels I would encounter for clock making and it seemed to me that 12 division circles of 144/120/100/96/90/84/80/78/70/64/62/50 would be likely to provide all that I should ever need.

Change Gears

I recently needed to cut some unusual threads on my lathe. This was when I realised that my Raglan 5 inch lathe when purchased in 1964 did not include all the common change wheels for many of the threads I was likely to encounter and it was definitely short of some of the change wheels for cutting the threads I needed, they being 32/35/36/55/57 teeth, so after some thought I decided I needed to devise a novel approach to solving both of my problems using methods of yesteryear.

It occurred to me that if I could produce an accurate purpose designed division plate, machined with all the divisions I thought that could be needed at the moment, and furthermore I could design it such that further additional plates could be made and added as required, this would enable me to solve my problem while working to an acceptable degree of accuracy for machining.

I should also add that for this division plate to be of use I had to devise a method of mounting the dividing plate in the milling machine which would in turn allow me to rigidly mount a wheel blank on the same spindle as the plate with a detent device for indexing each hole as required.

The division plate consists of a spindle fitted with a flange face plate on which a series of division are machined and to which further smaller division plates can be machined and attached as needed, **photo 2**. An extra plate is needed as the main plate mounting screws for the faceplate rule out machining a full set in the main plate, however by making a second smaller plate more division can be added easily as required, and it was in this extra plate that further sets of division holes were added.

A dividing plate blank was turned up in the lathe using BMS from a piece of MS Plate stock I had. It was 6 x ½ inches and needed to machined up in the lathe.

Both Division Plates as machined

I also machined a cast iron flanged hollow shaft so that the un-drilled division plate could be mounted on the dividing head on the milling machine, ready to machine the divisions as required.

The plate was bored out to mate with the Flanged shaft and fitted to it using Loctite. It was then machined up round in the lathe and left as large as I could make it. (The final size is not really important but should be as large as you can make it in my view), this would then be mounted on the wood face plate on the milling machine for machining later.

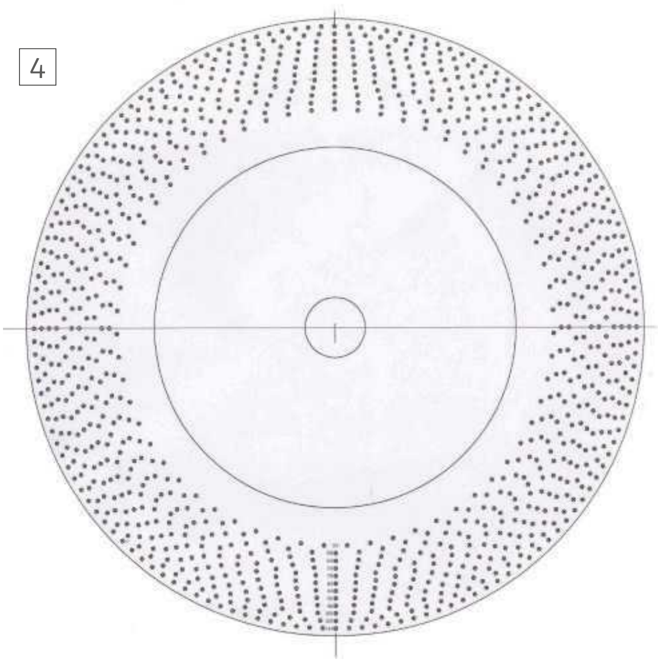
The first (permanent) plate would have eight rings of holes machined in it, then when fitted with a second plate a further set of holes would be machined in it to complete the twelve 'Clock Making' sets, **photo 3**.

The Template

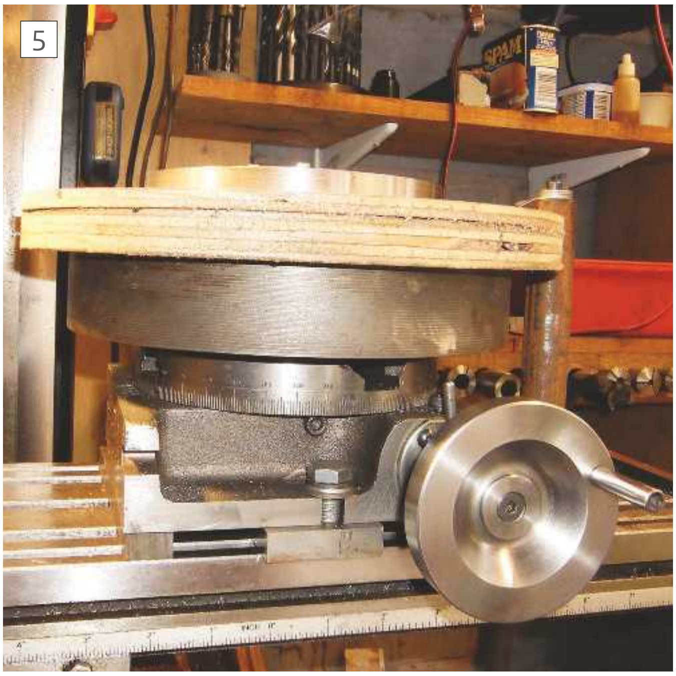
I decided to try an oversize template of each division ring to a high degree of accuracy on paper be drawn out, and then for this then to be transferred concentrically to a faceplate on my rotating table set in my milling machine, I would be able to use this drawing with a suitably placed pointer to set the machining position for each division hole.

The ability to produce the required accuracy rested on three main points.

- The first was that a drawing could be produced and printed accurately enough to ensure that the divisions were appropriately spaced.
- The second was to arrive at an acceptable solution to producing accurate division circles for the job.
- The third was to ensure that when setting out to machine each hole, a suitable method of pointer was designed to



Auto CAD image of Division Plate setting circles



Wood Faceplate mounted on Dividing Head, fastened down to Milling Machine bed.

Machining first Ring of Holes

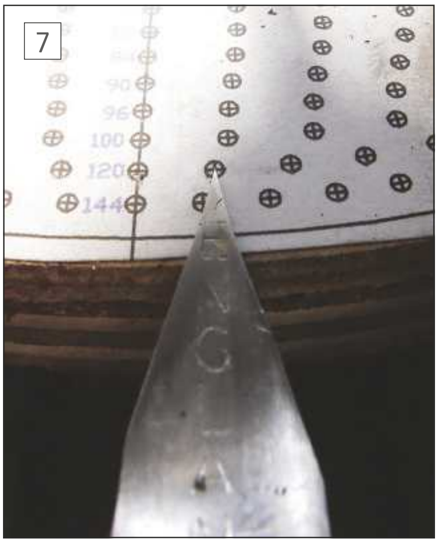
ensure adequate accuracy.

Points one and two were addressed together when I decided to produce a full set of division circles on a single drawing using AutoCAD. There are other CAD programs available but AutoCAD is magnificent at generating dividing circles to any number of points however it is also required that the printing to paper was also accurate. Point three was fulfilled by printing at a scale of 1:2 using a 2400dpi printer, keeping all lines as thin as possible, which in the event were 0.3 mm or some 13 thou.

I gave some further thought to the repeatable level of accuracy available from a printer. My wife is a surface pattern designer and her studio is kitted out with a number of high resolution printers, so I decided to examine some prints, both photographic and line drawing, to see if any discernible problems with accuracy and repeatability could be established.

After a run of around 10 prints I found that a good quality printer with a resolution of 2400 DPI gave very accurate and repeatable results. When I printed out figures of known dimensions I found it quite difficult to find any obvious fault in measured sizes when examining the prints by eye (with an X10 glass).

I decided that this method of printing a set of division plate drawing could work for me, so the next thing was to reproduce the same accuracy at a local print house where due



Pointer Setup

to the size I had selected to ensure the best accuracy, our printer was a little too small.

A local company was found with the ability to plot AutoCAD files on good quality paper and a test print was produced to enable measurements to be taken to check the accuracy of the print with respect to the measurements.

When they were completed and then checked using an eye glass it seemed that each test measurement was within a couple of thou of its indicated measurement and they were likely to be more than adequate for the job.

The benefit of the 1:2 reduction would bring each actual hole position to with a thou or so of the required position, and I felt it quite unlikely that they would be easily be distinguishable from other methods of machining.

The Method. Stage1

The drawing for the divisions was produced, **photo 4**, and sent to the print house for printing.

A Wooden faceplate was added to the lathe faceplate and machined flat and true in the lathe, **photo 5**. The diameter was made as large as possible (in my case a fraction under 10 inches) to create a base for the template drawing to be mounted to it using 3M Spray Mount. This template reduction was as great as my machining setup would allow and it would ensure that maximum accuracy possible for me.

The paper template was cut out and mounted concentrically on the wood faceplate using a hole machined in the wood surface to provide an accurate centre. 3M Photo Mount was used, which enabled easy repositioning and removal at a later date for other divisions to be added if needed.

While care is needed to ensure centring of the paper template, I feel that this is not as critical as is the accuracy of the drawing, however after some careful positioning I was able to position it to within a few thou.

Photograph 6 shows the first ring of holes being machined. The table was rotated so that the pointer was splitting the cross of the first hole on the '144' ring, **photo 7**. The pointer was made with a very sharp fine point so that the cross in the centre of each circle could be accurately defined using a 10x magnification loupe. (I estimate to within 2/3 thou).

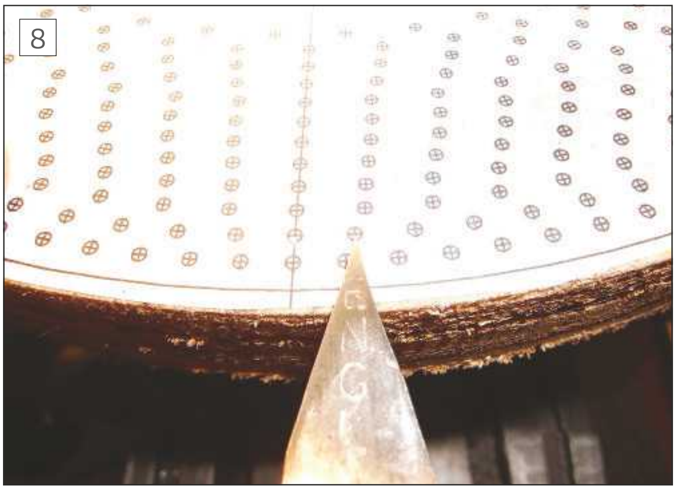
The table was locked up and the first hole was drilled using a 1/16 inch centre drill. (The drill you use is up to you, but in my view a centre drill allows the taper of the detent pin to pull the plate exactly to the correct position).

Once the optimum hole depth is established, the settings on the Milling Machine spindle were established to ensure each hole was machined to the same depth

When the first hole was machined, all that was needed was to unlock the Rotating Table, then rotate the Table to the next division, lock up the Table again and drill the next hole, and so on. This method was repeated for each position in the ring of holes until they were all complete and the first 144 holes took around 20 minutes or so.

Then the pointer was moved in to the next ring and locked in position for the '120' ring, **photo 8**. This was then repeated for this and the next six circles, **photo 9**.

It was now the turn of the smaller Plate fitted on the top of the main plate. This plate was machined in the lathe to fit the



Pointer on last hole of '120' ring

First 8 Hole Circles Machined

Inner Division Plate First Ring

Completed Clock Wheel Second Division Plate

collar of the top of the division plate and it is located in position with 4 small 5mm Allen Cap Screws. This method would allow for further plates to be made for other wheels/gears and fitted at a later date if needed.

The small division plate was fitted to the centre hub and tightened down ready for the next set of four circles.

Each subsequent circle of hole positions was set up as for the first eight, **photo 10**, and all four circles were machined in maybe 40 minutes for the lot.

The next image shows the pair of completed plates mated together after machining was completed.

The completed division plate can be seen still on the dividing head with the template underneath it, **photo 11**.

The next part of the project was to make a suitable division plate holder which would allow it to be mounted in the milling machine complete with a suitable holder to take the wheel to be cut.

I have not gone into great detail as to how this should be made here, as I feel it's not beyond the scope of readers to decide such a thing for themselves, however I have included here a set of photographs to show how is constructed and then fitted to the milling machine bed ready for machining.

The main things to note are that the main bearing which supports the division plate sleeve needs to be a good machined fit to prevent any slop in the bearing area, and further, the detent screw also need to be made to a reasonably high standard without play in any of the pins or the threads. This is to ensure accuracy and repeatability when positioning the wheel for each of the teeth to be cut.

Photograph 12 is a close-up of the completed paired up plates, and I am more than happy with the result

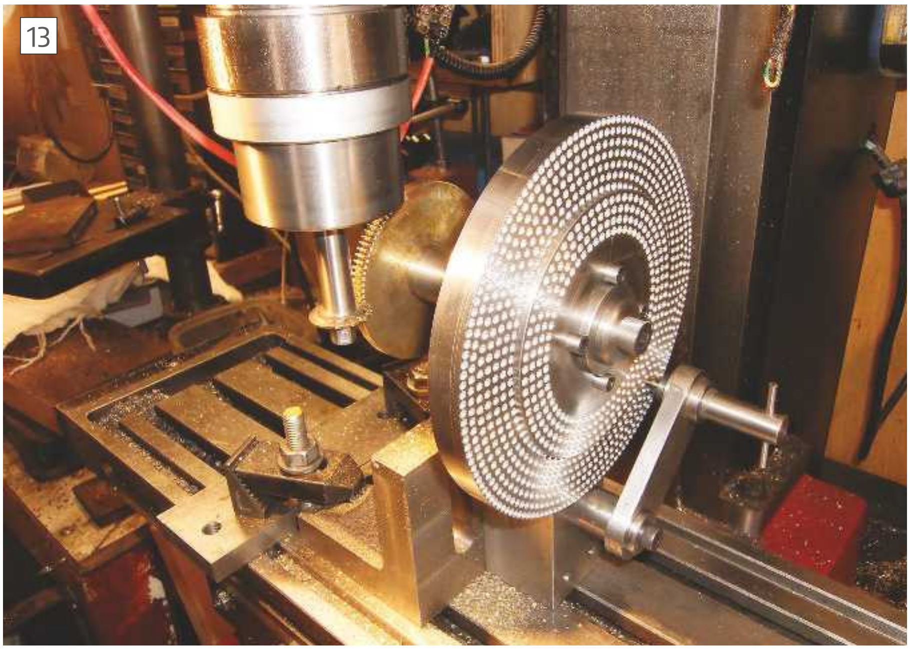
I went ahead and cut a 'test wheel', **photos 13 & 14**. The completed Division Plate was mounted up on its holder on the Milling Machine bed with the detent set at 120 teeth and the wheel was set at the correct centre height for the cutter.

Completed Clock Wheel Division Plates

The 0.8 module cutter depth was set to the correct value ready for a cut and the first cut was taken. The second and third teeth quickly followed, and the rest were completed in around 45 minutes.

The Completed Test Wheel was cut from a wheel blank that was scrapped early on in the Clock Project, so the discoloured appearance was caused by a need to Silver Solder up two ruined teeth cut previously, and then to re-machine the wheel to size before cutting teeth.

I have checked to tooth meshing against several 0.8 Mod wheels and they all seem to match up well.



Cutting a Clock Wheel 1

Making Change Gears

I needed to cut some unusual threads (19 TPI) in my Raglan lathe and discovered that I was missing some change-wheels for the job. When I looked at the original catalogue for the lathe (which I still have) I was able to list the 5 wheels I was likely to be missing as 32/35/36/55/57 teeth.

The change wheel gears for the Raglan 5-inch with a Gearbox fitted are 14 DP and 14½° pressure angle, but I did not have any cutters for this job and decided to do some research on the internet for a solution.

After some hours of work searching the UK market I finally settled on a supplier in China. Finally, after some haggling I

14

Cutting a Clock Wheel 2

15

Completed Clock Wheel

decided to take the risk of such a long range transaction, I was then able to order a full set of 8 HSS cutters for £120 including shipping. This was very competitive with some of the UK bases suppliers and I took the plunge!

They arrived 7 days later by courier from China. They were fully packed and boxed in a thick protective grease and paper (which took some time to remove).

I unpacked them all to look at the quality. They looked really very good, photo 16, but the question was, would they be any good at cutting the required tooth profile properly?

However, whereas before I had already made a cutter mandrel for the small 0.8 Module cutter, I now needed to make a new cutter mandrel for the much larger 14DP cutter for these new wheels. **Photograph 17** shows the completed cutter mandrel and **photo 18** shows it in the milling machine.

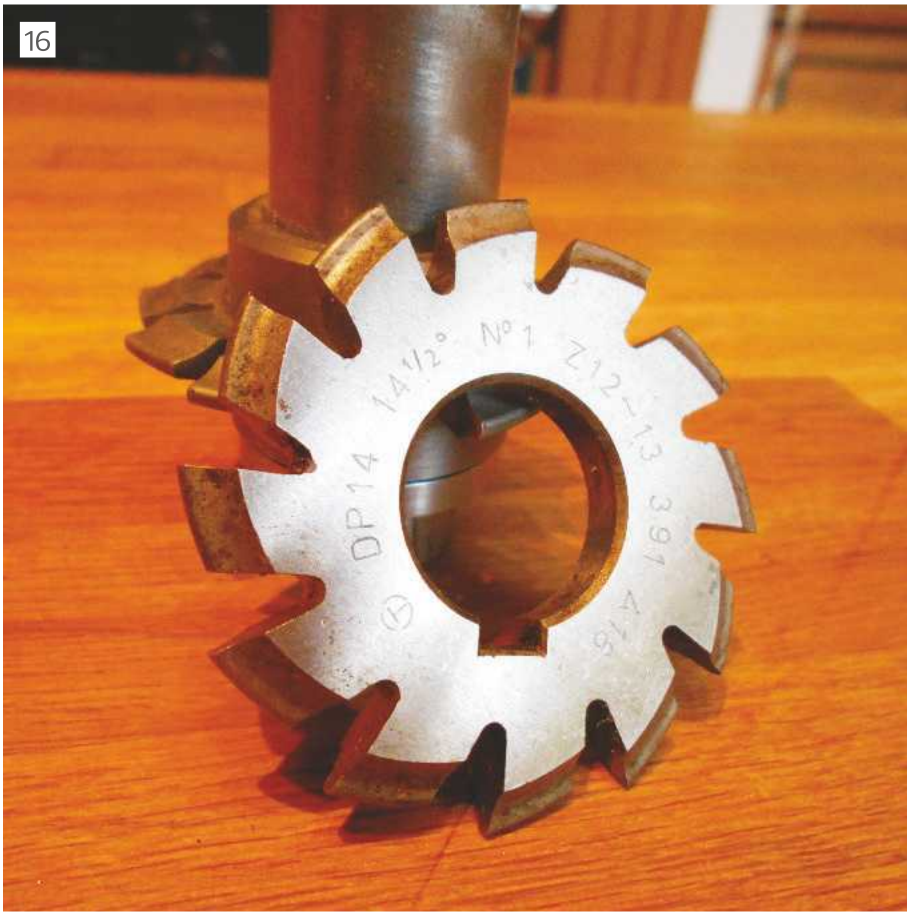
Using the same method as earlier I needed to make another small division plate to fit the main plate to the tooth numbers required. Another template was made as before and a second small plate was made, **photo 19**, and added to the main, it was mounted on the dividing head just as before and made ready for cutting.

I was a little unsure of my milling machines ability to reliably cut such large teeth in grey cast iron, so being much softer; I decided to cut the first two in Brass. I visited my local stockist and purchased 2 brass blanks sawn from brass round bar and made them ready for turning up and boring to the new wheel holder I had to make to fit the wheel blanks into my dividing head.

Once faced up and bored to size the gear blank was mounted on the wheel holder, placed in collets fitted to the lathe headstock and turned to the appropriate size for the first wheel of 32 teeth. I do not intend to dwell on the correct sizes and tooth depth's needed here. I am sure anyone capable of this work will have little trouble in finding the information needed for such things.

The first wheel was setup to the drawing template just as before. The method

16



14 DP Cutter Closeup Unmounted

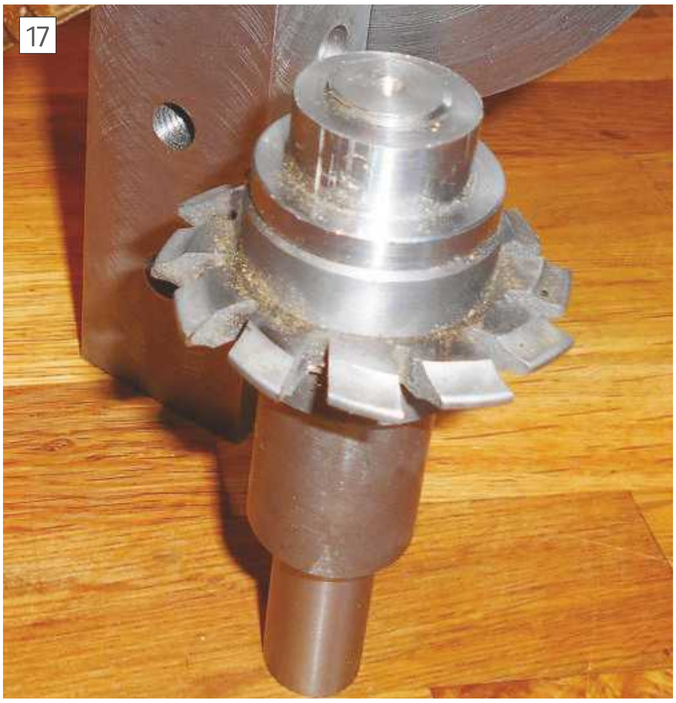
was identical to the former other than a much bigger cut was to be taken and I had a concern that rigidity was now more important to minimise the risk of chattering or vibration while each tooth was being cut.

I proceeded to take the first cut carefully by traversing the bed over the rotating cutter. I need not have worried, as the cut was 'as sweet and a nut', with none of the things I was worrying about. I transferred to the second tooth which was completed in about 2 minutes. This went on for all 32 teeth without incident and the whole set were completed in around 40 minutes.

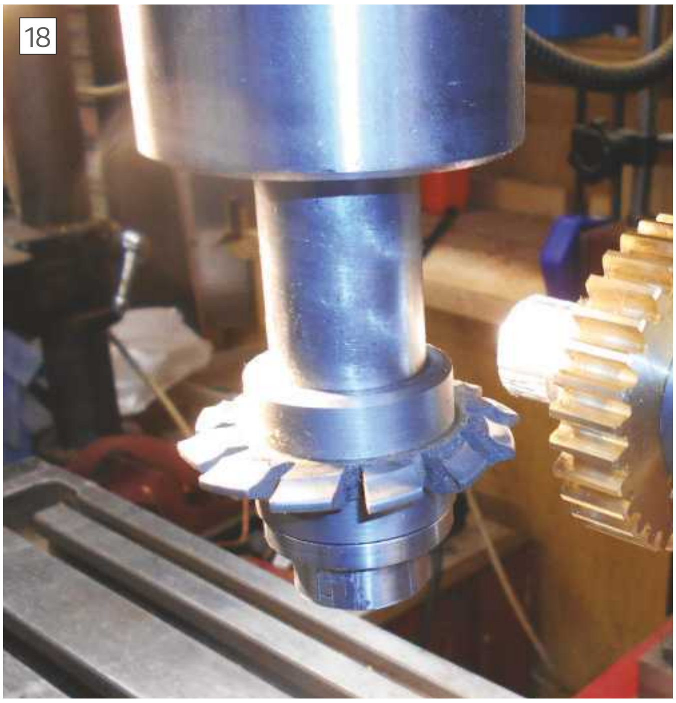
The Chinese cutter I was so worried about worked extremely well. The tooth profiles looked bright, uniform and of good quality.

I proceeded to cut the rest of the gear wheels I needed without incident, however for the last two wheels I had become so confident at my set-up that I decided to purchase cast iron blanks for these and give this harder (but possibly stronger) material a try in my set up.

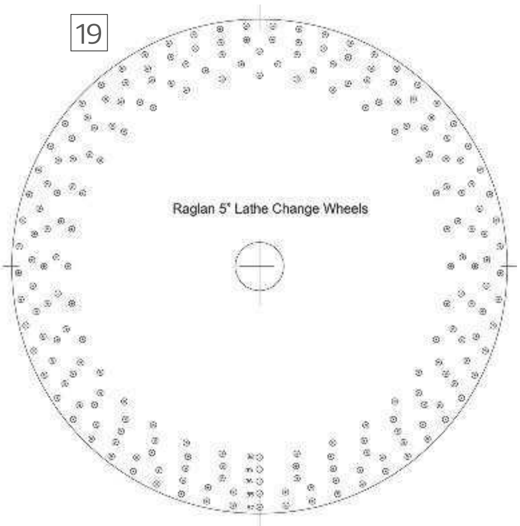
Cutting cast iron was as easy as the brass. To be honest it seems to me that it was slightly easier to machine than brass blanks. I was able to cut each tooth with much



14 DP Cutter Mounted in a Tool Holder



14 DP Cutter Mounted in the Milling Machine with 32 tooth Wheel



Raglan Lathe Change wheel Division Plate Drawing

greater feed than the brass and the Chinese cutter was magnificent at the job.

I needed five change wheels for my lathe, **photo 20**. In the event I was to cut six, as the first cast iron blank I cut was sized at 32 teeth, which I had already machined in brass.

To test out the Cast Iron as a material I first cut a 30 tooth wheel from some scrap bar stock before I visited my stockist for material. (So I now have a 30 tooth Cast Iron change wheel to suit a Raglan if anyone needs one).

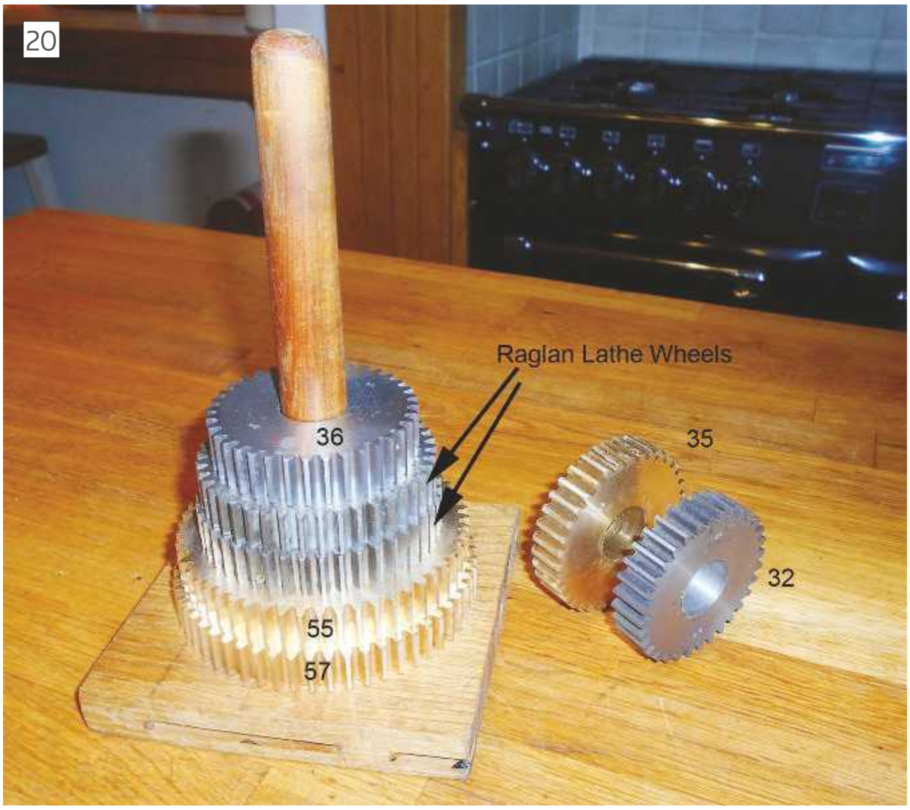
For me, with maybe with 3 years of less than acceptable solutions to the machining of good quality Gears and Clock Wheels, I found this method of developing dividing plates extremely quick and easy using materials and methods already had to hand.

I used AutoCAD, however there is other software available, including a basic copy of TurboCAD, or even a free copy of 'DraftSight' which seems to me to be very similar to AutoCAD. Once a CAD package is mastered it is possible to produce a full set of division plate circles ready for printing in around 20 minutes or so, and once the division plate and its associated equipment and support bracket are made its possible go from a drawing into a completed plate easily in a day.

This method of producing the seventeen (in total) Division Circles worked extremely well for me, and one most unusual aspect of this method was I did have a need to feed the scrap bin once throughout the work.

In future should I need to make another individual division plate; this is the method I will use. It is very inexpensive and quick to complete and I hope that anyone embarking on this process finds that to be the case.

I can be contacted by email on johnfredfirth@gmail.com for anyone needing to ask questions or for clarification. ■



Full set of Lathe Change Wheels

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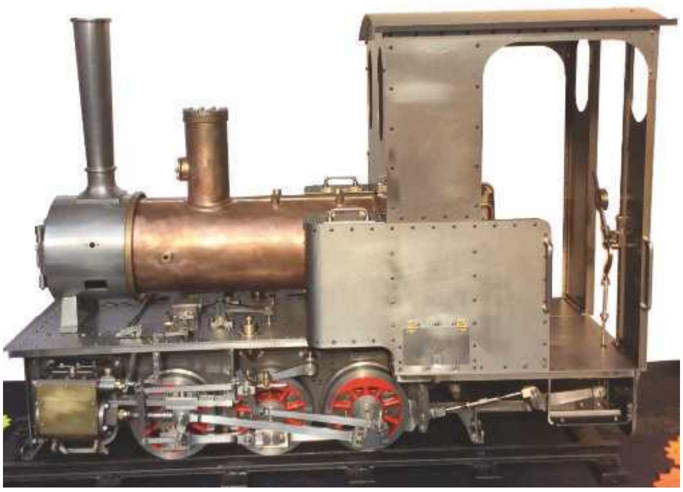
7 ¼" gauge GWR Collett Goods Doncaster 2016



7 ¼" Narrow Gauge Koppel 0-6-0 under development based on Ken Swan Design.



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Easy Hex Making

TIP OF THE MONTH WINNER!

Our winning tip from Richard Gordon wins this months sheaf of Chester Vouchers!.

I recently had to make a few clamping nuts, requiring some non-standard hex bar. I didn't want to spend time setting up the rotary table on the mill for this so instead I drilled and threaded the end of some suitably sized rod M6 and screwed in a bolt with a hex head. I put this rod in the mill vice with a horizontal vee block with enough material protruding, with the bolt head on the end sticking out.

I then rotated the bar so one flat of the bolt head was aligned with a square, nipped up the vice and milled (using the side of an end mill) both sides of the bar to the A/F distance (18 mm in my case). Rotated again to align the next flat with the square and repeated milling the flats. After the third time the hex was complete as per the photo. The bolt was then unscrewed and the clamping nuts were turned up from the new "hex stock". All in all, just 20 minutes work and not a bad result. So, if you don't need absolute accuracy, this may save you some time.

Simple friction hinge for a swarf guard.

Our runner up tip from **Barry Chamberlain** makes use of his lathe a bit more comfortable. Barry wins ten Shaviv deburring blades and a 'Mango' handle.

Having grazed my knuckles several times using a hex key to release the Saddle Clamp Screw on my Warco lathe I have replaced the 40mm Cap Head Screw with a Clamp Handle which provides a much more positive and safe locking/unlocking action.

As supplied, the hex shank of the 40mm M8 Clamp Handle was too short. A new one was made from a 60mm length of hexagon steel stock. The 12mm hex bar was fitted in the 3-jaw chuck and a 4.2mm hole 10mm deep was drilled in one end then tapped M5 x 0.8 to accept the spring/handle retaining screw. The bar was reversed and turned down to 8mm diameter over 40mm. As it is not necessary to fully thread the shaft the first half only was threaded M8 x 1.25. Finally, although not absolutely necessary, the machined item was chemically blackened resulting in a pleasant, rust resistant finish.

I'm sure that this tip might well be useful on other machines which rely on the use of a hex key to lock off the saddle.

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.chesterhobbystore.com** to plan how to spend yours!

Please note that the first prize of Chester Vouchers is only available to UK readers. Other prizes are at the discretion of the Editor.

Gear Cutter

Alan James Aldridge describes a flexible machine for the production of gears in the home workshop – part three

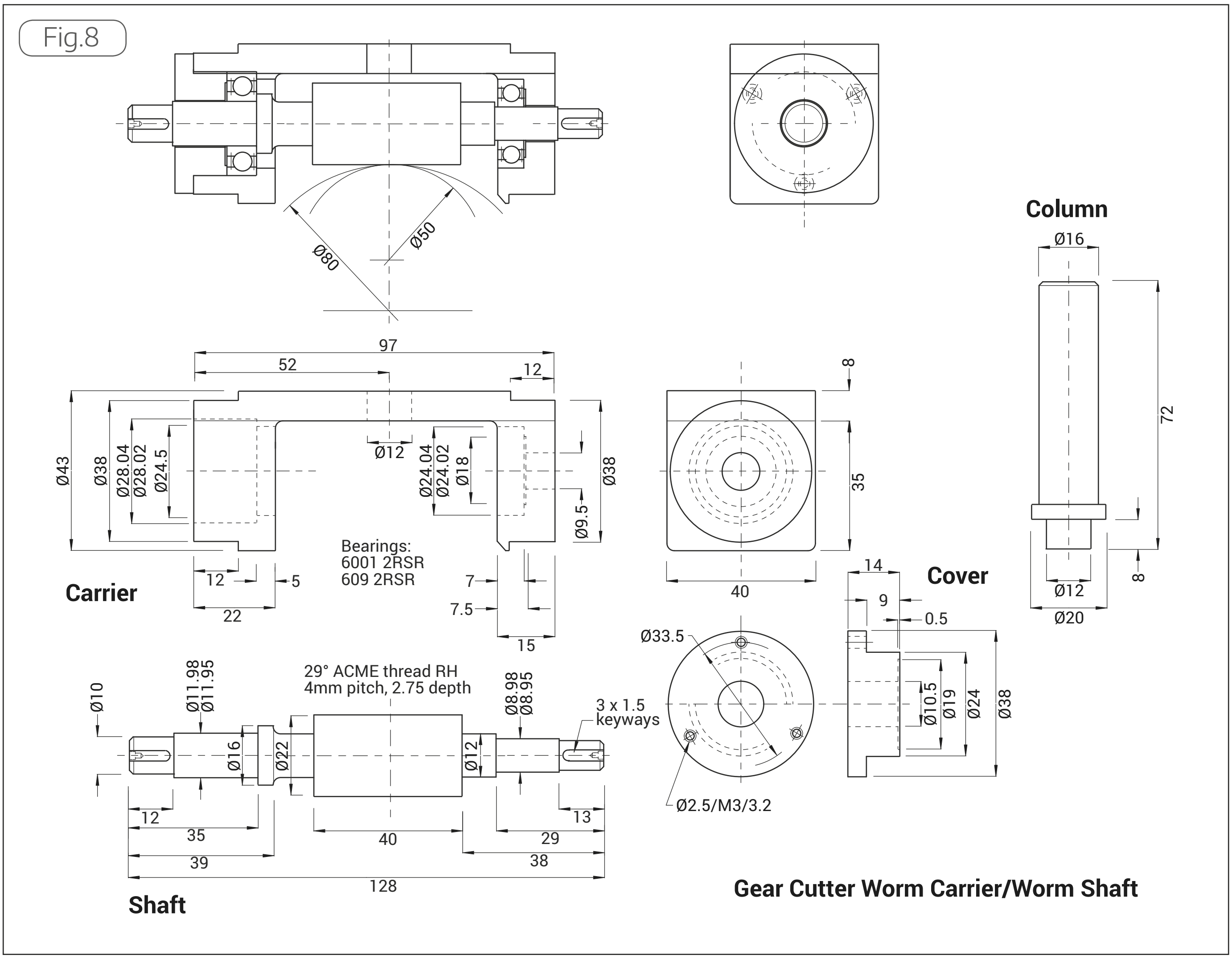


Fig.8

Gear Cutter Worm Carrier/Worm Shaft

Shaft Locking

In the Jacobs machine there was a locking lever that prevented the shaft from turning inadvertently during tooth cutting by closing up a bronze bearing. One cannot do that with ball bearings and an alternative method for the lock is not immediately obvious. One is to have screw that impinges on the 18mm diameter section of the shaft but that will tend to kick the shaft around as it engages because of the screw's turning motion. The drawing (**fig. 7**) of a more suitable lock may not be welcome as it is a lot more work but it will deliver the right answer. There is nothing particularly difficult about the parts but there are a few wrinkles. The blue piece rides in a hole and is prevented from turning with a round key and a keyway drilled on the intersection of the blue piece and the sidewall which requires, at least initially, a very good fit of the two parts. The arc should be a good fit to the shaft. Mine started as a 20mm square bar through which the 18 mm hole was drilled on a centre line, then the bar was set in the four jaw chuck brought to centre and the outer sides turned down to 12 mm. The red pieces are the two piece operator and are split to form a stop collar. The ball end is optional and here the lever will be either made as an integral part of the round end or is silver soldered into a hole which has to come in below the M4 screw countersink. Turning the handle moves the blue 'nut' downwards. Putting the lot together in the workhead is fiddly but not too difficult. A split cotter would be another alternative.

On one side of the block is another hole which takes a flanged column, which has to be fixed firmly in place. It can be bolted down or welded into place. The column supports an arm for the worm carrier which has to be able to move through an angle to set the worm and gear wheel it engages at the correct lead angle. The structure does not look particularly robust, but it is stiff enough for the service conditions. The worm drive is there for the hobbing operations but can be used before then to drive the feed, which would be less tiring and more controlled that the hand can provide.

Cutter Head

The parts of the cutter head (**fig. 7**) are straight forward machining of a round bar for the cutter shaft, head housing and covers. The housing has ball bearings which I employ almost without exception rather than use bronze bushes. They are fit and forget parts. The housings do need very accurately made and the job in hand that requires the two housings to be to the nominated size and on the same centres through the complete unit. To comply with the latter requirement the bought round bar has to have a chucking piece about 20 mm long. The housing is machined after setting the bar roughly on centre then turning the full length to a good smooth all over finish. The bar now becomes its own button and when turned about for facing centring and boring out the other end goes into the four jaw chuck and the dial indicator will run on the machined outer diameter. The centre can be drilled out to the largest drill in the drawer, mine is 22 mm. The bearing housing at each end is machined conventionally referenced to the outer diameter.

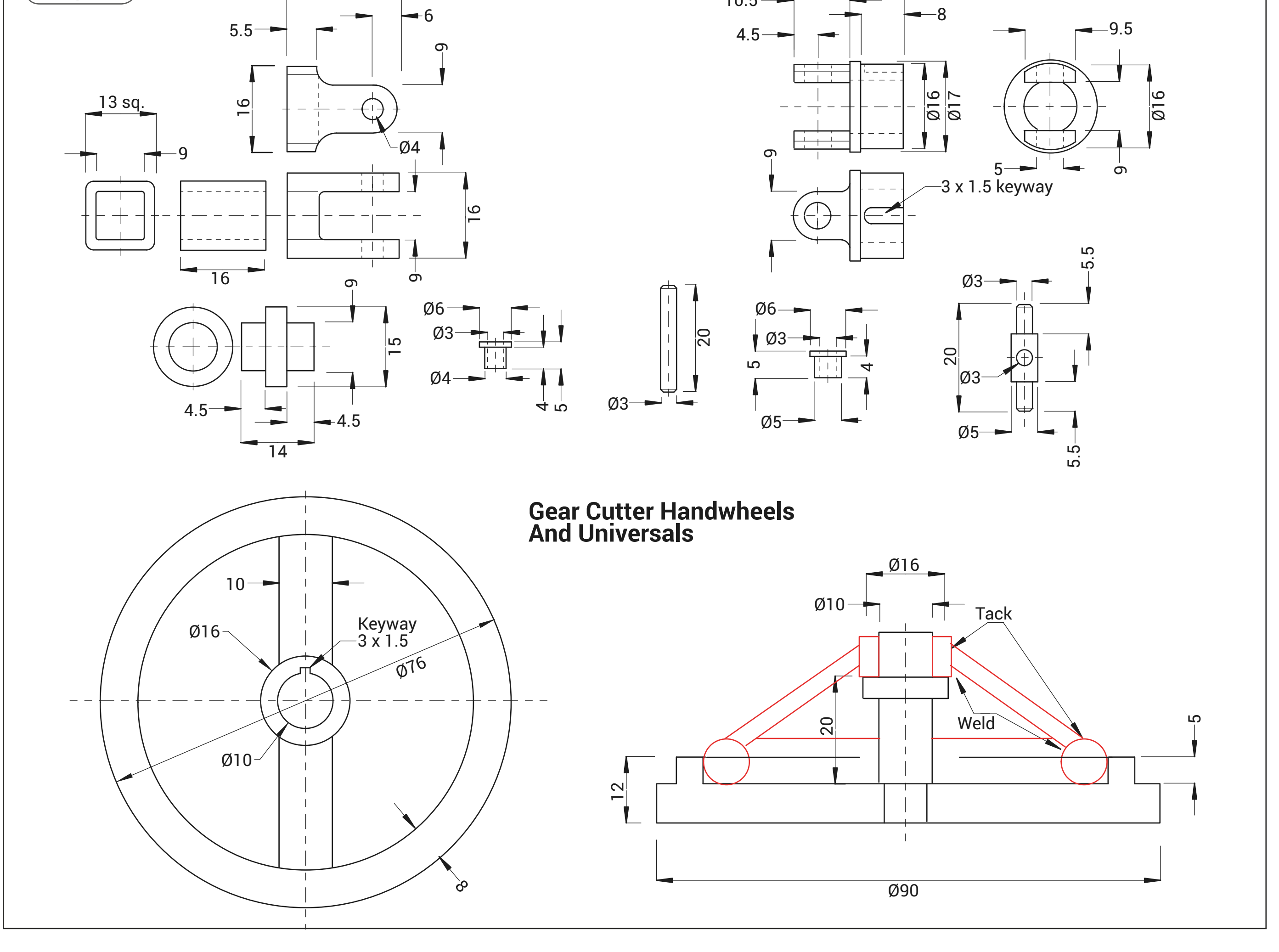
For the covers the 35 mm diameter should be referenced to the ball bearing with a small clearance. Scribe a circle lightly indicating the pitch circle for the fixing screws during facing. Once the cover is complete on diameters it can be parted off. The full depth is given as 4 mm but the requirement is that the both covers sit hard against the bearing and housing. That is not likely to be easily attained therefore the covers may have to have a slight gap between the inside edge of cover and housing. This presents no problem as the bearings are sealed for life. Both ball bearings are 35 x 17 x 10 mm, type 6003, the bearing can be used as a gauge - it should not but we all do it. Be ware that the ball bearing has to have a clearance of 0.02 to 0.03 mm in the housing and should not be push fitted, otherwise, it will be difficult to remove from the housing. On the drawings the bearings are shown as having seals, that is not strictly necessary but I have found that as some of the suppliers appear to have a single price, one effectively gets a bearing with the seals for free. Bearings without seals need an oil or grease hole in the housing to make sure there is sufficient lubrication. All shafts, as usual are keyed.

The cutter head sits down on the stand base plate through a base of its own which has four holding screws and two dowels One can work out to within a millimetre or so where the positioning is and drill the four holes for the holding screws. The dowels will go in later when everything is aligned.

Universal Joints

These universal joints (**fig. 9**) are actually easier to make for the gear cutter than I first thought, as there is plenty of space. In the drawing the ends are shown as being fabricated from square bar and circular inserts with heavy push fit and then a brazed joint. The arms which carry the cross are cut from the square by saw and file. The pin holes have to be square the body of the universal and are sized so that the cross can be inserted into the jaws and then the bronze bushes are pushed home and lightly silver soldered. The cross is the part which requires some close work. The thicker 5mm diameter half of the cross is drilled exactly on the diameter and that can be done in a variety of ways. I have a concentrically machined, very sharp, hardened pin which fits a collet and with a rule I can set the pointer over the rule and see the tip to right or left or the true line I want when the rule is parallel to the vertical slide or a vice on the vertical slide. The through hole leaves very little metal around the hole but once the other 3mm part of the cross is fitted and lightly silver soldered it will not break. The 5mm half needs to be cut back by machining at each end to get the correct dimension to fit the gap in the universal, less the amount of the protrusion of the two bushes and equally set about the centre hole. It can be done by having a way over-length 5mm pin and working towards one end for the build of the cross, then the long end is held in the chuck for final machining. The bushes need to be sized for a 0.025 mm interference fit

Fig.9

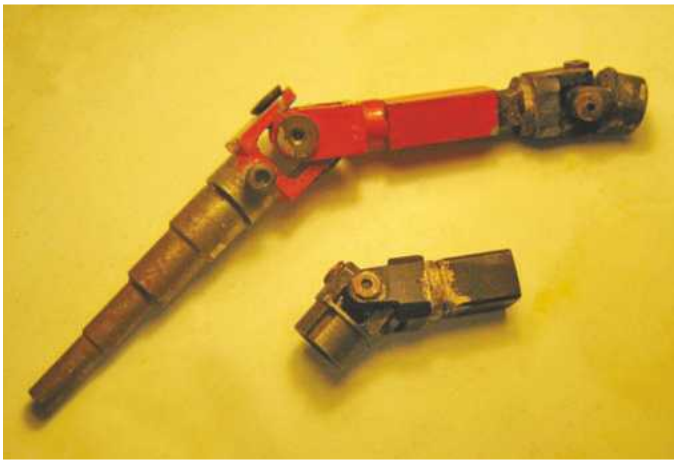


to the holes and 0.025mm clear on the pins. The latter I obtained without any effort as the brand new 3mm drill cut just a touch over size. The 5mm pin ends required a little work with worn emery tape. The pins should have enough room, just, to slip into the open holes and then the bushes are pressed home.

The universal joints made to this design can have a swing of slightly more than 45 degrees either side of zero. To achieve those sort of figures may require some further fitting work rounding off edges or cutting the base of the pocket to allow the further travel. It is doubtful that the full 45 degrees will ever be used, but there does have to be good clearance between the moving members. **Photograph 17** of the three joints has the red one and black one connected and though it is not readily apparent the square end of the black half slots into the female tubing of the red half thus providing the very necessary adjustment for the apparent lengthening and shortening of the shaft during rotation. These two have to be a good fit one to the other but sufficient free to do their job. One cannot get 9mm square bar therefore the end has to be machined or filed to size concentric to the through centre line. If one sets the bar up in a lathe four jaw chuck on centre and turns a short round on the one end, then one has a good guide to the sizing for the remaining machining. The red universal was made for a different machine but was used here to illustrate a point.

Handwheels

For single tooth cutting the small handwheel made from steel was found wanting and hard on the hand. In its place a much larger wooden wheel was made with a steel core which has proved to be far easier to use but elsewhere the small wheels were made from 76 mm ornamental rings in steel bought from a fencing and gate supplier. A simple fixture was made to hold the ring to weld it closed and to set the positioning of the two arm connections to the centre boss, with the latter held on a pin sat in the centre of the fixture. Four welded joints are required and the plan is to tack the outside, easily accessible, areas then, off the fixture, weld the inner sides of the arms. Brazing can also be used, which would reduce cleaning up welds to be a more presentable shape. Handwheels should be keyed to their shafts.



A pair of universal joints

Indexing

At the tail end of the worm carrier is the indexing equipment. This consists of a ratchet and a pawl held on an arm, which clamps around the machined register on the carrier. Ratchets (**fig. 10**) can be used in two distinct ways; one is to drive another piece of machinery and the other is to indicate and stop a new position. In the carrier it is the latter use. It also follows that the pawl can be lighter and here I use an old cleaned up saw blade into which two holes have been punched. In the several machines in which this type of pawl has been used no trouble has been experienced.

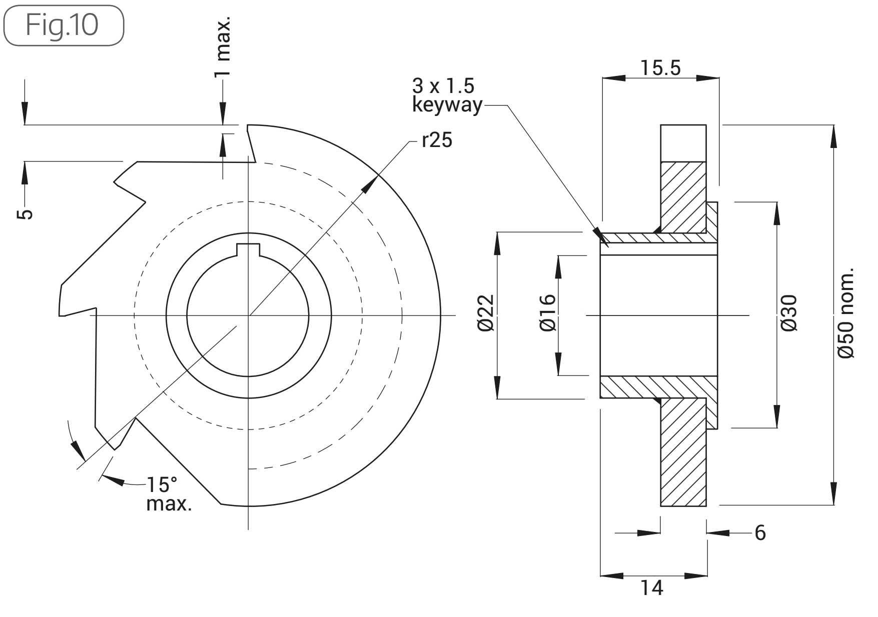
The working of the worm, ratchet and pawl needs a little explanation. Rotating the worm one full 360 degrees will move the wheel it drives one tooth space. If the wheel has 40 teeth and the gear wheel blank to be cut is to have 20 teeth and both have the same diametric pitch, then the ratchet comes into play. The ratchet turns the worm two turns and therefore any even numbered ratchet will do. One could count teeth on the wheel under the ratchet which I find fraught with danger, where the numbers are in fractions. If the wheel to be cut has 35 teeth then the ratchet has to turn a 40 tooth wheel through 1 1/7 turns. To do that requires a 7 tooth ratchet, so we get one turn plus 1 extra lobe. Once one has a 35 t wheel it can be used to generate a 21 t wheel, which is also the one for converting imperial lead screws for metric threads. The ratchet would have 6 or 12 teeth to achieve 1 2/3 turns. If you want more information, go back to Model Engineer, March 18 1966 to review Martin Cleeve's excellent article on the matter.

As already mentioned ratchets are able to tackle two different but related operations, to index and to act as a type of lever to force an intermittent rotational motion to some piece of equipment. The design of the latter can be quite complicated once a pawl is added to the mix. The pawl can be seen as a beam pivoted at its one end and shaped to fit into the ratchet tooth and in most cases this area will be formed with an undercut so the pawl drops vertically and freely in a split second under spring force on the pawl beam. The spring is there to overcome, just, the inertia, weight and friction in a pivot for which one can make some mathematical equation to solve the problem. Industrially, setting out the actual ratchet notches requires a clear understanding and a good drawing to reach a satisfactory answer. We can get away with much less but the pawl will have to be fitted to the ratchet on assembly, to gain the required operation which is sometimes a long and tiresome job.

Photograph 18 shows a ratchet being machined on a universal dividing head by milling, the one shown is for a prime number, 11, which requires a sophisticated dividing method. Undercutting the notches can be done by filing but the tip of the ratchet tooth must not be touched as that would give, however slight, poor indexing.

Pawls used as levers should be made from a heat treatable steel and I normally use 5 or 6 mm thick gauge plate. Ratchets used for pure indexing can be in plain steel though I tend to heat treat all of them. After machining the heat treating operations can be done at home with the ratchet and pawls sat in a bed of sand in

Fig.10



Typical Ratchet

a suitable tin dish, which is covered with a thin flat steel plate and then heated from below. If one has a barbecue kettle then the fire can be started as usual and then some coal to increase the temperature. Once red heat is reached hold the temperature for a minute or two then lift and dunk the tin and contents in cold water. The tempering will require a lower heat so charcoal will do in the kettle and can be done in much the same way and here the workpiece is uncovered as it is necessary to watch the colours change. The work is dumped in water as soon as the outer ring shows a distinct yellowing. With permission one could use the kitchen oven as the temperature we want is about the 250 C mark which has the advantage that the ratchet is heated more gently from room temperature.

In this instance the pawl is a plain strip of saw blade with the worn teeth cut back by grinding and two holes punched into the blade for a fixing. The punch works through a fixture that holds the blade steady while a hefty blow with a 2 pound hammer drives a hardened steel punch through. In indexing alone the pawl/ blade is pulled back from the tooth and held until the count is made and the pawl released to drop back into the notch on its own accord. These pawls need to be longer than usual to get good flexibility and sufficient clearance from the tooth. Using the ratchet in this way has to be a deliberate repeating process and this has to be worked continuously and at one time I had the stages written up on a board right in front of me to insure I got it correct.

Of the twelve ratchets made only two are different on diameter, although the outer diameter does not altogether matter. The depth of a tooth will change as more teeth are required. One gets a very positive stop even with a 1 mm drop down but I think most of us would want more, but at the same time do not get carried away as with the saw blade pawl which has to be pulled back and out of contact with the ratchet there will be a step size which one should not exceed. It will require some draughting work to get some sense into the design wanted. A quick drawing showing the geometry of pawl and ratchet tooth will show the limits for any particular arrangement.

For this purpose the ratchet is a two piece construction with the thin gauge plate toothed part coupled to a longer mild steel centre. The ratchet, if it is to serve as an indexing tool has to be keyed to the shaft.

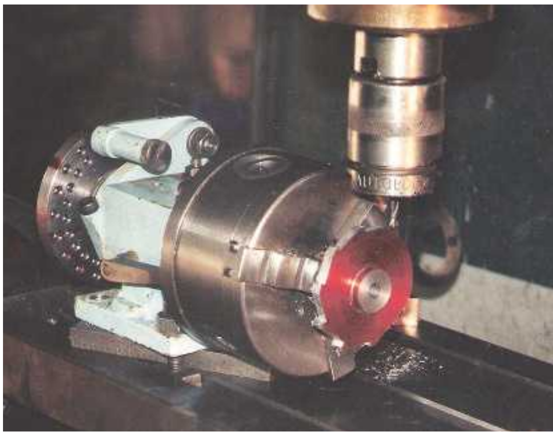
Once the first ratchet and the vertical slide with workhead and worm are complete it is possible to machine the first and most popular of gears, the spur. The vertical slide and its associated equipment is mounted edge on to the cutter (held in the chuck on the lathe), bolted down to the cross slide or top slide. The cross slide will be fed in towards the cutter. However, at present there is no cutter: that will have to wait for later.

Motor and Cutter Head Drive

A standard single phase motor is employed on the gear cutter. The frame is a D71 and the output 0.37KW which is enough for all the work expected. There is a standard on and off switchbox for start and stop mounted on the motor, which has to be in full view and reach. When first built this was not the case but has since been changed simply by placing the motor on the other side of its mounting plate.

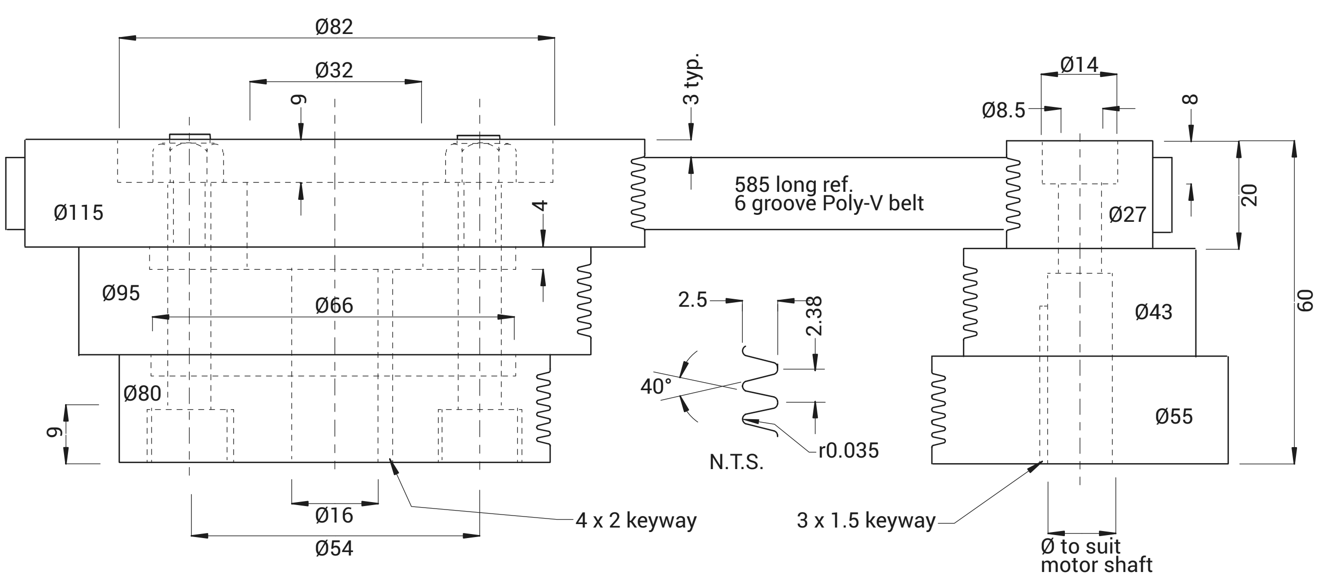
The drive to the cutter head is through Poly–V belting and pulleys. Poly–V belting is more expensive than normal V belts, but if one wants to make the best use of space Poly – V belts are the ones to go for. They also have a better wrap to a pulley. The gear cutter is the third machine I have built with Poly-V belting and in each freedom from slipping is high on its list of attributes. However, these belts do not like misalignment and where there is some they will run off the pulley. The instructions received when buying the first set of belts suggested that the groove sizing was to be exact to the third decimal! A little investigation showed that the figures were derived from the conversion of the imperial spacing to metric sizes. A more representative set of figures is shown on the pulley drawing (**fig. 11**).

To be continued...



Ratchet being machined on a universal dividing head

Fig.11



Pulley Group

On the Wire NEWS from the World of Hobby Engineering

LAZER*BOND

Recently the forum has seen a few mentions of UV activated adhesives, which are ideal for joining transparent materials but have other uses as well. The problems are that they tend to be available in large (i.e. expensive) quantities and you need a UV source to set them – the sun isn't always available or convenient!

Enter 'Lazer Bond' from JML, which is intended as a consumer product but that could well have many useful applications in the workshop. It combines a neat pen-style dispenser with a little UV-LED torch on top.

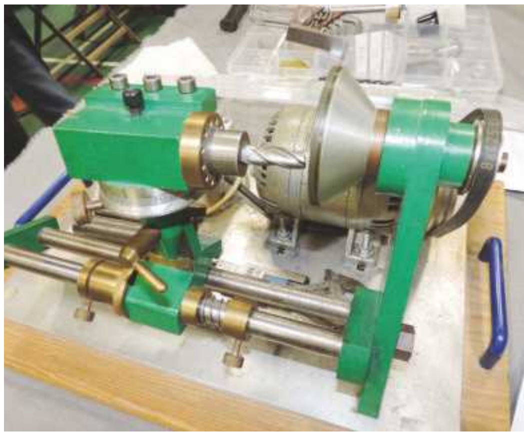
The adhesive, a mix of several chemicals with very long names is a clear gel. On shining the LED at it, it moves slightly and sets firm, clear and slightly flexible with a tiny puff of vapour steam! The instructions say no more than 1mm thick and use the LED for 3-8 seconds, but I had no problems setting a slightly thicker layer in no more than a couple of seconds. This is an ideal adhesive for jobs needing more bulk than superglues, as you can build up fillets and join almost anything except greasy plastics. Lazer Bond from JML is available for £11.99 from JMLdirect.com and 'selected stockists'.

The Bristol Model Engineering and Model Making Exhibition

This was my first visit to this exhibition, and I found it friendly and well organised, although the catering was a bit basic. There was a good showing of trade stands, particularly for the aeromodelling and boatmaking hobbies and some impressive 3D printers. Club exhibits covered a wide range of disciplines and there were some fine model engineering exhibits on display. One example was Adrian Garner's ambitious astronomical clock, a work in progress, on the SMEE stand. I greatly liked Tom Polatch's model bandsaw, the real thing is so huge his model was almost large enough to use the workshop! There was some interesting tooling on club stands, including the Colyer Casely tool and cutter grinder described in Model Engineer. There was also a challenging 'name the tool' competition from the Newcomen Society. I must also mention 'Grandad's Shed' where an engineered model of a wooden windmill was being made, the metal parts being turned on an ancient round-bed Drummond. ■

The main hall at the Bristol Show

Adrian Garner's astronomical clock



Colyer Casely grinder

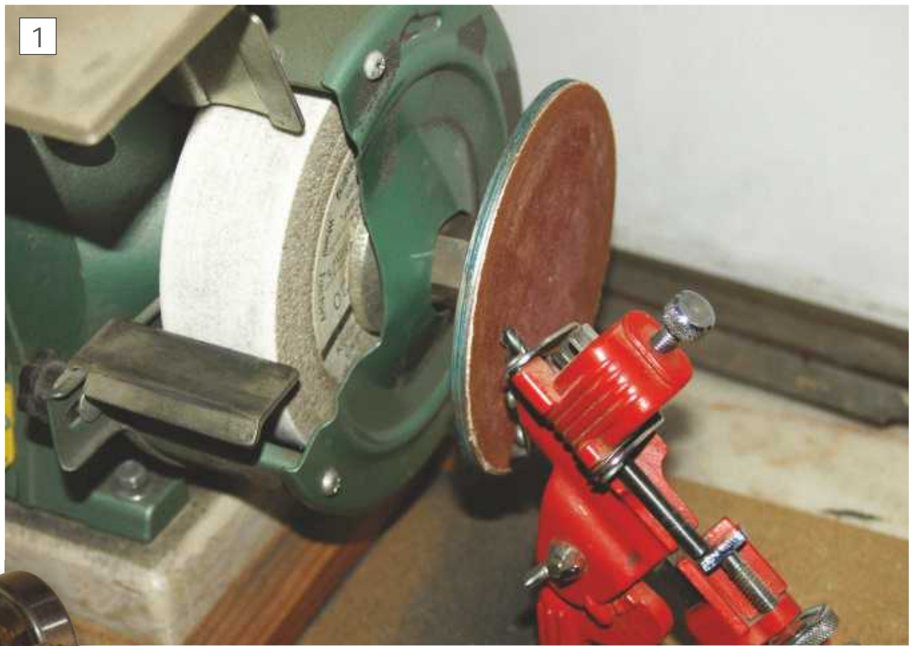
Sharpening and related matters

A light hearted look at workshop matters with Marcos Diniz.

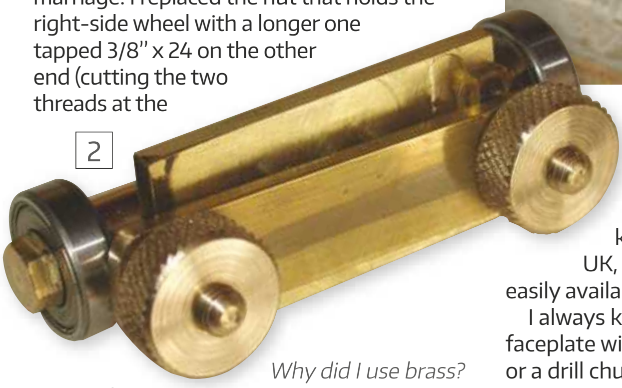
I thought it might be interesting to share with you some items I've made during the (now rather long) time I've had some sort of workshop, in this case specially to solve sharpening problems.

Some 30 or more years ago, Black & Decker (alas, I'm not one of the owners, just a not-always-satisfied customer) put on sale those 5" diameter faceplates they meant you to glue a sandpaper disk on but that could also be used as flimsy faceplates. Being unable to resist a bargain, I bought a few.

Some time later I bought a drill sharpening jig (the kind some of you are happy with, some not quite) and found the usual problem arising from trying to sharpen a drill on the side of the grinding wheel. The idea didn't really convince me, especially as it meant you would soon be using a far from flat surface. And that led to a successful marriage: I replaced the nut that holds the right-side wheel with a longer one tapped 3/8" x 24 on the other end (cutting the two threads at the same setting). Of course you have to cut a hole in the side-guard, but it is worth it, **photo 1**.



The faceplate and jig ready to sharpen a drill



Why did I use brass? A friend says it looks like something out of Jules Verne. That might be the reason...

This enables you to use one of the B&D faceplates, with whatever sandpaper grain you choose. 120 works well, but I think I'll try something finer, when I find it. (You don't know how lucky you are in the UK, with all sorts of tools and stuff easily available. Not always so abroad).

I always knew I could replace the faceplate with, for instance, a wire brush or a drill chuck. As it happens, last week I inherited a lot of my father-in-law's tools, badly rusted.

I thought I would get rid of the rust using electrolysis, but it takes forever. So I tried the wire brush. Great! It removes rust at a rate of knots! Not only better than with an electric drill, there is practically no noise, and we all know how noisy electric drills can be.

It still leaves some pits, but I intend to treat the pieces with a blackening formula that should stabilize the whole thing.

As you can see in the photo, I needed to raise the grinder about 2" in order to have it at a convenient height for drill grinding. I used a piece of marble someone had discarded.

If you happen to have several faceplates, changing grain is done in moments. And when the sandpaper is worn, you just replace it and keep having a nicely flat grinding surface.

For those unable to find the faceplates, they can be replaced by any suitable metal disk, fixed in the manner of your choice.

Being made of metal, I decided it would be safe enough to use them without a guard. They never gave me motive to think otherwise. BUT DO WEAR YOUR SAFETY GLASSES!

Speaking of glasses, a couple of days ago I had an unexpected bonus: I had an old port glass, chipped here and there on the edge. (How many of those have you thrown away? I know I have, now and then.) I decided to try and grind the chipped edge on the sand disk. It worked! All you have to

On the right-hand side you see a piece of brass, milled in place, to ensure the chisel is positioned correctly

Nicely balanced, I thought.

5

I intended to use two screws, but I find one is enough to hold the chisel. (And this one is still waiting for a handle. Shouldn't be a long wait. No, I wouldn't dream of using one without a handle. I don't even like to think about it.)

do is go slowly, never let the glass overheat. When the edge looks right, just let it cool down and smooth it with 400 wet-and-dry sandpaper, making sure you don't leave anything that might cut somebody's lips. Next I'm going to restore the edges of a couple of crystal glasses I didn't have the courage to throw away. Thank Heavens!

Still on the subject of sharpening, even using the above mod I didn't feel happy with my chisels and plane irons. Yes I do a lot of woodworking.

Trawling the net (now that's odd!) I came across several honing jigs, some simpler, some rather elaborate. The more convincing ones were quite expensive, especially when you have to add p&p to the price.

Being a rather compulsive do-it-yourselfer I decided to make one. It came out like **photos 2 and 3**.

I won't give you a blow-by-blow description. Mostly, what you make depends on the roller bearings you have in your shop (or, if desperate enough, you buy). And the materials to go with them.

And believe me, it is a joy to use a really sharp chisel or plane, almost effortlessly. I wish I had made the jig long ago. Way back when I couldn't find the time... (It's great to be retired, isn't it?)

Still on the subject of chisels I was rather stumped when it came to box-chisels. They are so thick there is no way to use this jig to sharpen them. Something else was needed.

(Do I use them a lot? Not really, but I like them for woodturning.)

After overheating the old grey cells a good bit I tried a somewhat different approach. I milled a groove wide enough for my widest box-chisel on a block of aluminium (didn't have a piece of brass this size) and **photo 4** is the result.

But this was far too long (70mm), it wouldn't permit the chisel to be mounted at the adequate angle for honing. So I shortened the forward part and it now works nicely. The total length is now 50mm. I could also have cut a deeper slot, but I felt that would weaken the jig, **photo 5**.

As for the angles, I've been using only one, somewhere between 25 and 30°. I know the experts advise you to sharpen at 25° and add a 30° edge. You decide what suits you.

For honing I use diamond "files" (on sale every once in a while from LIDL; same disclaimer, but more contented this time). I made a wooden mount to hold them, **photo 6**.

This works well, but I intend to try some wet and dry sandpaper on a glass plate. I just haven't got around to it yet.

And I fear I have to digress a moment. Ever since my parents gave me a tool-box of sorts (I think I was 6 then. I still have one or two of those tools) I always tried to have a bit of a workshop. Not that I made any fancy stuff, I merely dabbled.

My tool kit kept growing and I got to the point of building an annex to the garage, all of about 45 square feet. Then it was necessary to start invading the car space, of course.

In 2009 we had to sell that house, alas, and moved to a nice roomy sunny flat, but, THERE WAS NO GARAGE!

So I looked around and found a garage for sale only a couple of minutes away. Luxury! About 40 square metres, it could house all my tools, and then some, at an affordable price.

Before I even started painting it I planned the various areas, workbenches, storage and so on. Using the marble tops from the old kitchen cabinets I now have two snazzy marble-topped workbenches, **photo 7**, one for "clean work", electronics, soft-soldering, marking out (it includes a 60cm square piece of granite, astonishingly flat, some kindly selfless soul left in the dustbin; a nice neighbourhood, right?) and (to get to the point) a smaller one for general grinding and sharpening.

Oh, and I laid tiles on the walls behind the two lathes and the sharpening bench; they make cleaning much easier than painted walls.

My idea was to create a kind of "moveable islands" (grinders, drill sharpening jig and so forth mounted on heavy bases, like the marble riser I mentioned before) that I would place according to the activity of the moment. I thought the idea had merit, but in use the islands kept skating away. This led to another solution I'm still working on: a piece of chipboard with a wooden frame to hold a grinder, with the drill grinding jig more or less permanently in place. My intension is to create a bench where I can change the jig I need and position it near one of the two grinders, according to the grit and type of wheel I want.

This, I may add, is a work in progress. Since we moved I finally managed to retire and (if all goes according to plan) in the next 378 years I'll be making assorted jigs, a press, a tool and cutter grinder and whatever else seems interesting. After that, I'm not sure yet, but I'm sure I'll find something.

6

Here you see the wooden mount on the woodworker's bench. If your eyes are sharp enough, you can see two black lines to indicate the angles (The one on the left, more visible, is for chisels and plane irons; the other one is for box-chisels; being much thicker they must project further to get the correct angle)

7

The marble topped bench. The granite surface plate was too wide for the bench but I decided to keep it as it is. There was a gap I had to fill with two pieces of marble. Guess where I found them...

A Look at Drill Sharpening

informed by 3D CAD

Jacques Maurel takes a detailed look at the constraints on the geometry for drill tips, and describes a jig for drill grinding with concave wheels.

Using a bench grinder and a grinding rest:

See **photo 12**, here the clearance surfaces are convex cylinders, but nearly planes as the wheel radius is far greater than the drill one. **Photograph 13** shows the template used to set the clearance angles.

The knurled knob is used for fine feeding.

12

13

How to deal with small drills:

Use a special jig like the "wishbone sharpener", **photo 14**. The point angle is adjusted by the drill protruding (a template is given). The clearance angle is made by the hand tilting during the grinding stroke on the slip stone. The symmetry is measured "by eye", this is satisfactory as the drill is of a small diameter. I think that this is the easiest way to use for sharpening drills being less than Ø3mm, an improved version of this device will be described in a later article.

Notes

For those not afraid of a bit of geometry, the following notes provide an explanation of how the formulae given above were derived.

Note 1: No web drill geometry (condition for not rubbing, flat flank):

In **drawing 16**, "A" is just on the hole cone (rubbing limit), AB = BD = R (drill radius). ABD is a plane perpendicular with the drill axis. AB is vertical, CA is a line of greatest slope.

$\sin\beta = BC/BD = BC/R$

So $BC = R.\sin\beta$

$\tan\alpha = BC/AB = BC/R$

Hence: $\tan\alpha = \sin\beta$

so: $\alpha = \tan^{-1}. \sin\beta$

Note 2: Chisel edge geometry (flat flank): Relation between α, β and θ.

Drawing 17 shows a flat drill with a very big web thickness AC = e. AD is a line of greatest slope.

$\tan\alpha = CD/AC = CD/e$

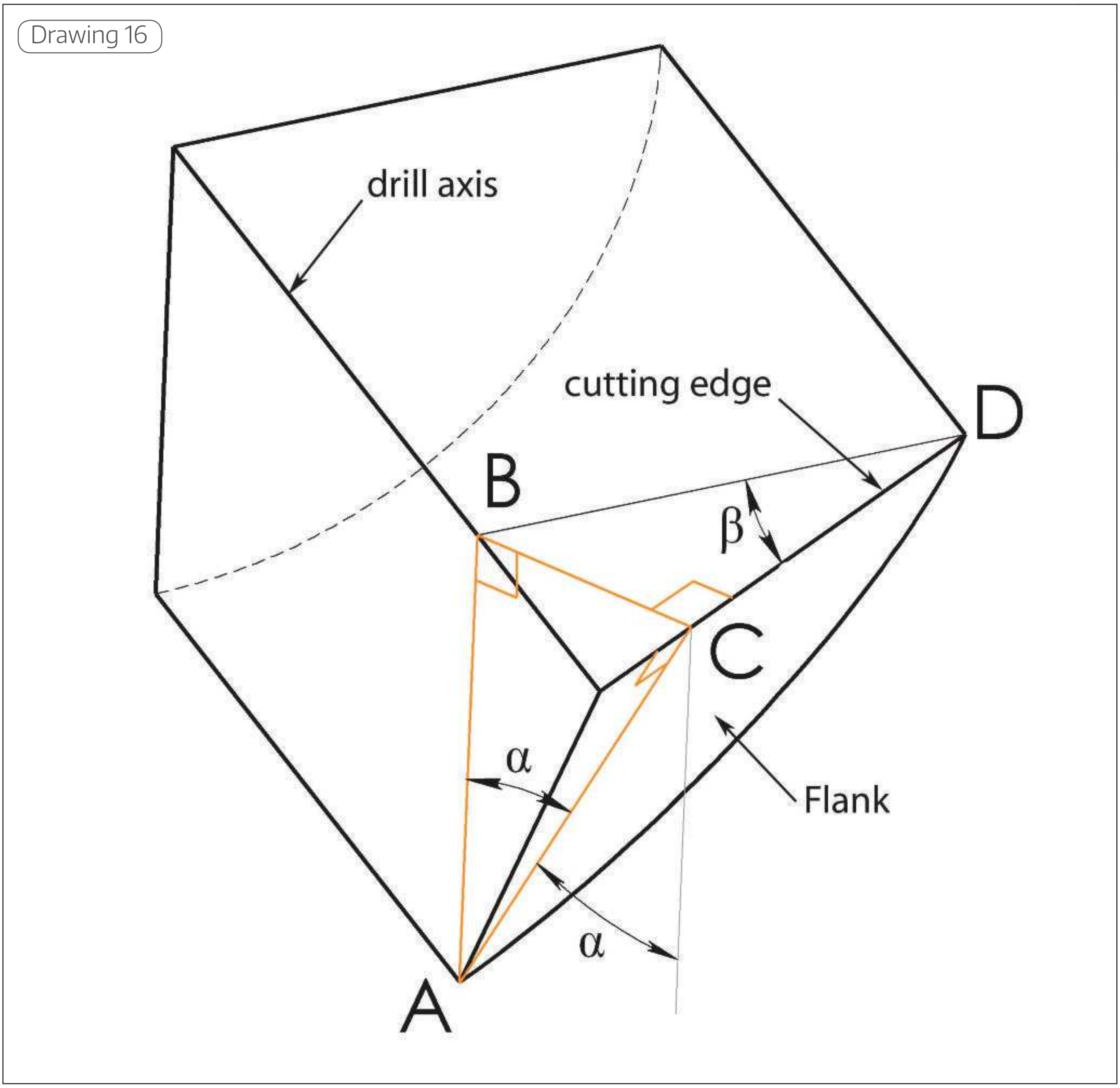
so : $CD = e.\tan\alpha$

$\tan\theta = AC/BC = e/BC$

so: $BC = e/\tan\theta$

$\sin\beta = CD/BC = \tan\alpha.\tan\theta$

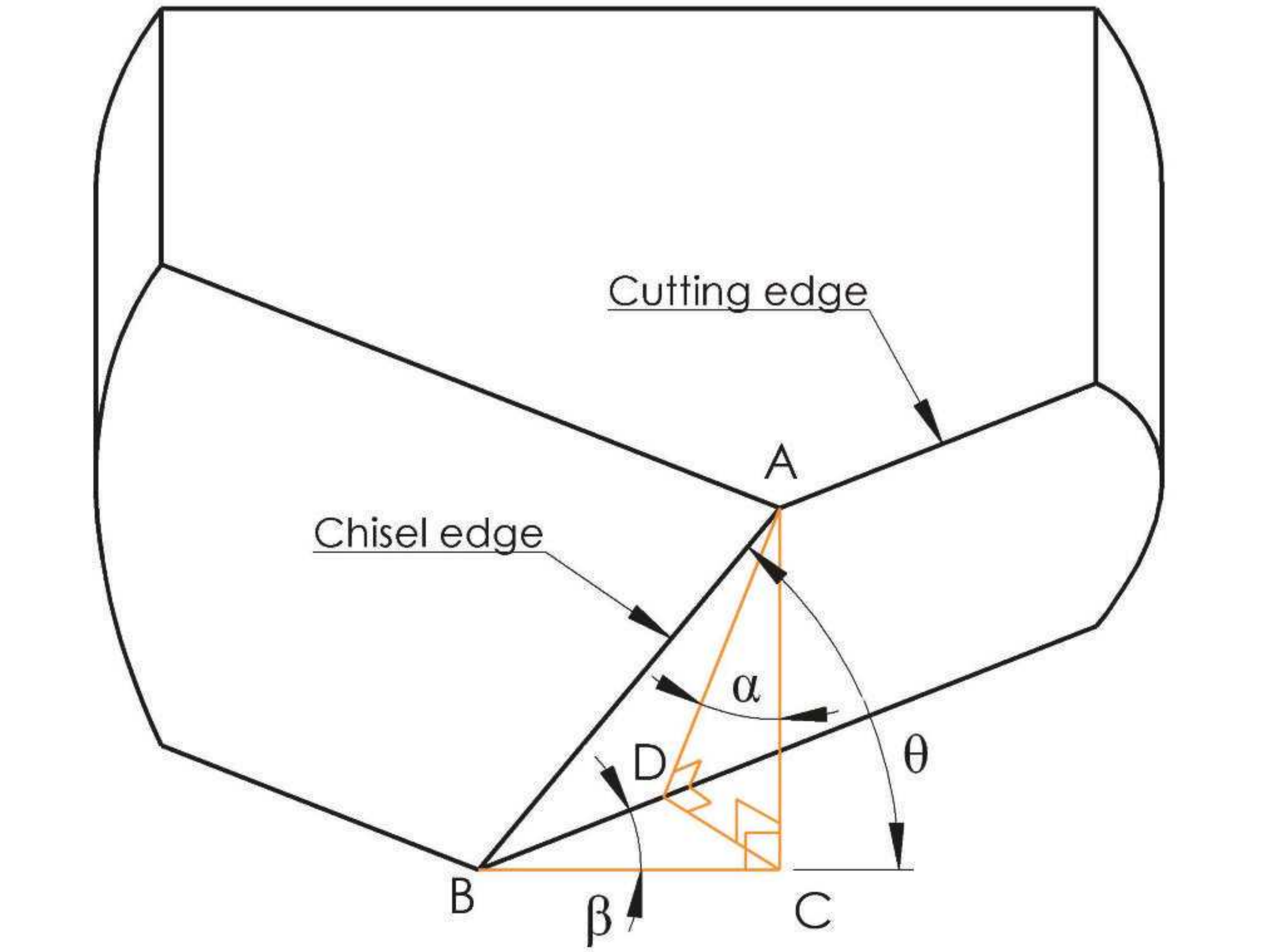
Hence : $\alpha = \tan^{-1}(\sin\beta/\tan\theta)$



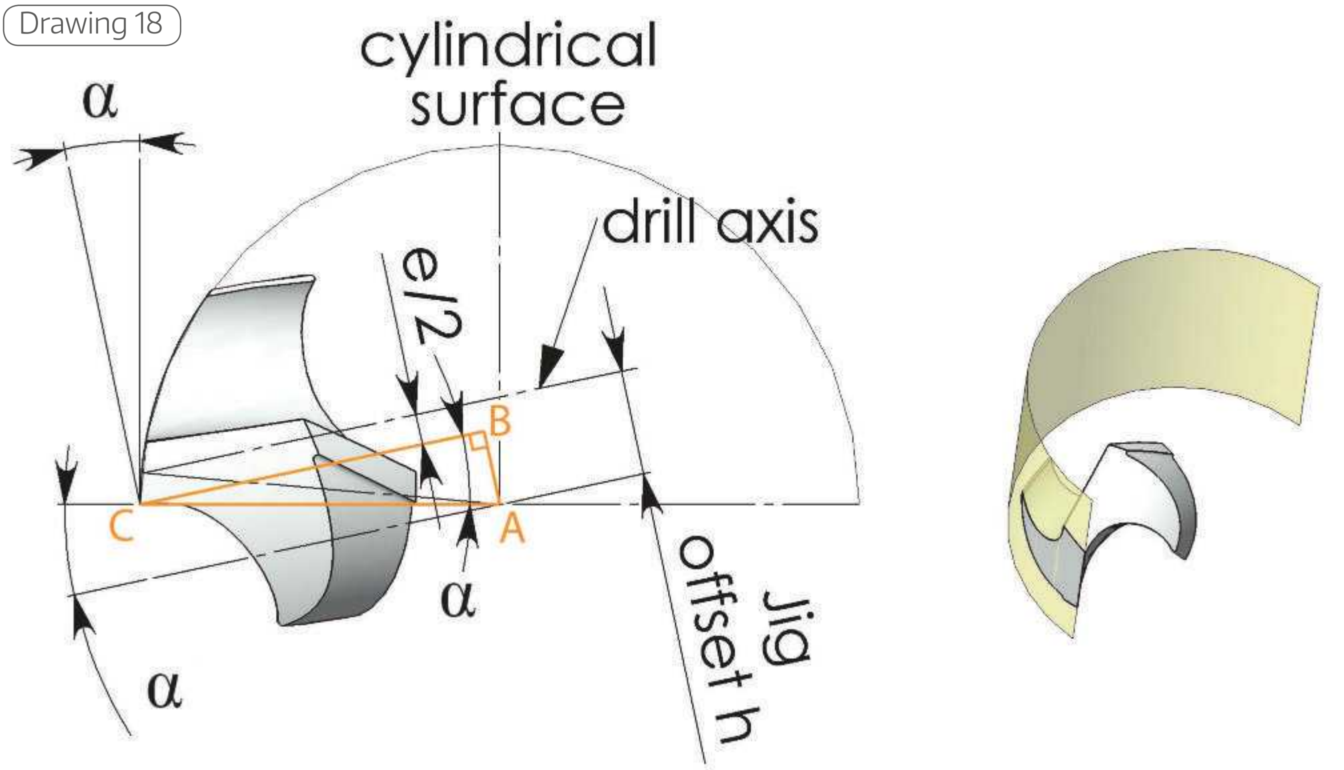
Note 3: Cylindrical clearance geometry: (calculation of the clearance angle α).
Refer to **Drawing 18**.
AC = R = cylinder radius ; e = web thickness ; h = jig offset. sin α = AB/AC = (h-e/2)/R
Hence: α = sin-1 [(h-e/2)/R]
or if you want h from α: h = R sin α + e/2

Note 4: Grinding inside a saucer wheel: calculation of the actual cylinder radius R:
Please refer to **drawing 19** which is a repeat of **drawing 11**.
Grinding wheel radius AC = r ; actual grinding radius BC = R.
sin ϕ = AC/BC = r/R
Hence: R = r/sin ϕ ■

Drawing 17



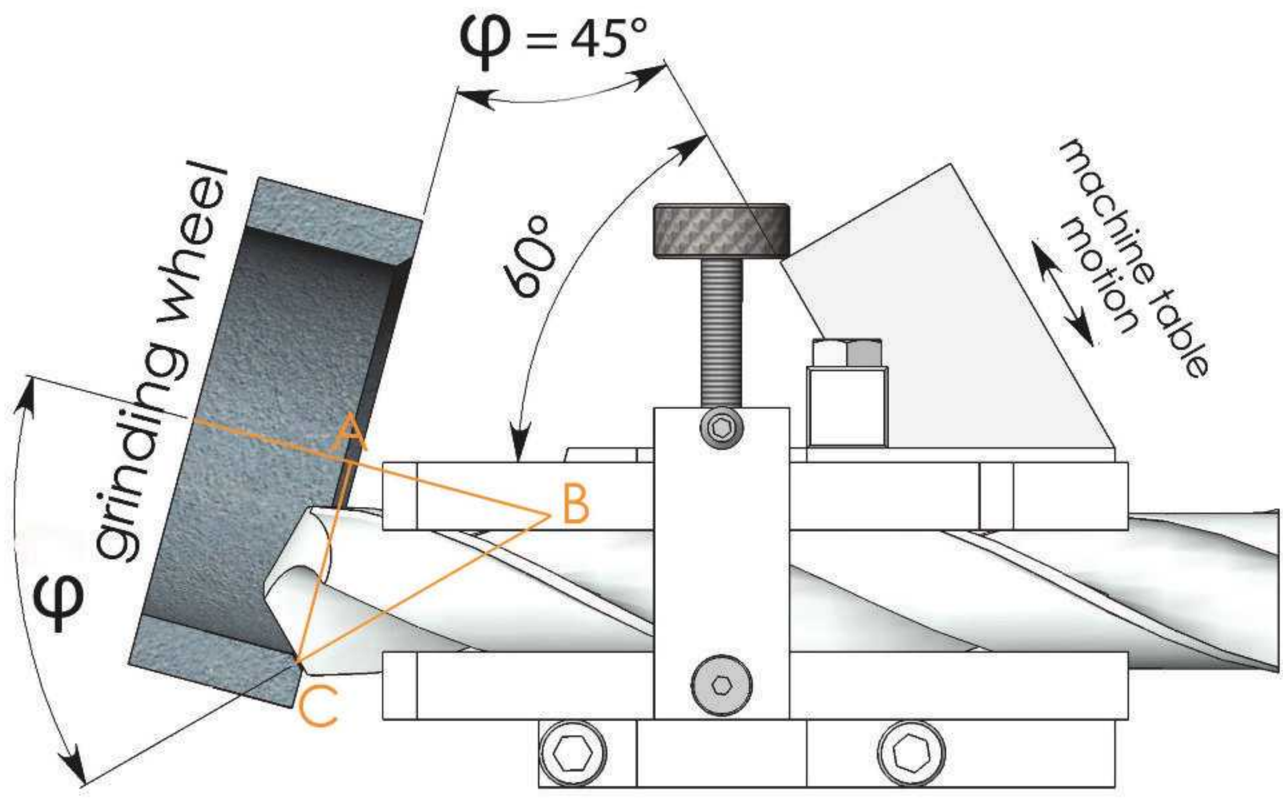
Drawing 18



PARTS LIST

No.	Qty	Name	Material	Remarks
1	1	Bracket	CRS	
2	1	Locking screw holder	CRS	
3	1	Rear stop	8-8	CHc M6-15 screw
4	1	Screw H M6-25	8-8	
5	1	Locking screw	8-8	M6 Threaded rod. L = 53
6	2	Side stop	CRS	
7	1	Bracket tang	CRS	
8	2	Screw CHc M6-25	8-8	
23	3	Fixed shell	CRS	See text
24	1	Adjusting pin	CRS	
25	3	Moving shell	CRS	
26	6	Screw FHc/90 M4-10	8-8	
27	6	Guides	CRS	
28	6	Screw FHc/90 M4-10	8-8	
29	3	Clamp	CRS	
30	3	Shell locking screw	8-8	See text L = 21/30/37

Drawing 19



The 2016 Model Engineer Exhibition

The 2016 Model Engineer Exhibition will certainly go down as a landmark in the history of the event. The broad consensus was that two things stood out – the first of these was that most people found the choice of the Brooklands Museum an inspired one, adding considerably to the enjoyment and content of a day's (or days') visit. The second was that it was an unusually cheerful event; perhaps it was the more intimate surroundings and being spread over many, smaller rooms rather than a few large halls that did it, but people seemed to be chattier and interacting with each other and the various displays more than at most exhibitions.

Naturally there were some teething troubles with a new venue in particular some people found it a bit hard to navigate around such a large and complex site. As the site is a museum it is laid out so that 'following your nose' brings you to most things, but extra signs were put up on Saturday and we realise that more attention needs to be given to this.

Before diving into the exhibition proper, some of the Brooklands exhibits that caught my eye included the magnificent racing cars in the ERA 'shed' including the

2

The Vickers Vimy replica

3

The old and the new (ish)

This airport tow truck might struggle with a 747...

Engineering models on display

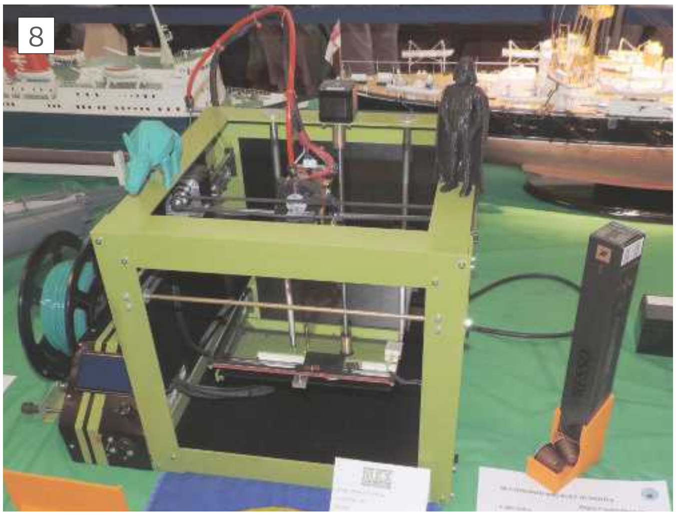
Cuthbert Riley Special and Salmson Grand Sport, **photo 1**. Temporarily moved to a large hanger, the Vickers Vimy replica was just one of a fantastic collection of aircraft, **photo 2**. The Vimy is of particular interest to me as I have a model in progress of an early Vickers airliner with essentially the same wing plan as a Vimy. Certainly the aircraft collection provided an unusual backdrop for the model traction engines that where wheeling around the site on each day, **photo 3**. I was also knocked out by this little pug of an airfield tow truck, **photo 4,** this would make a great fun radio controlled runabout in, say 1:12 or even 1:6 scale.

The main exhibition hall contained most, but not all, of the competition and loan models, **photos 5 & 6**, as well as several clubs including the Gas Turbine Builders Association and the Guild of Model Wheelwrights. Many people have commented that using a layout that enabled people to see both sides of each model was a definite plus. Workshop equipment included those items previewed in our last issue, I will represent these with Ken Willson's modified version of the GHT retracting top-slide, **photo 7**. One item of tooling we were not able to preview was sixteen-year-old Angus French's medal-winning 3D printer, **photo 8**, which he made entirely from scratch. A robust design benefiting from a very rigid framework the example prints were to a very high standard. Other tooling included my own part-modified Super Adept Lathe on loan; the general consensus was that it is, after all, too small to be of any use as an anchor!

And some fine ship models

Ken Willson's retracting top slide

Not strictly tooling, but of great interest from a workshop perspective was Stephen Wessel's display of patterns, core boxes, cores and the resulting crankcase casting for a V8 aero engine, **photo 9**. This was truly remarkable piece of patternmaking, despite the use of a number of unconventional materials and techniques. I have twisted Stephen's arm and he will be writing an introduction to patternmaking for MEW in the hopes of encouraging more of us to have a go.



Angus French's 3D printer

Stephen Wessel's core box

Jason Ballamy's Tidman Organ Engine

Cherry Hill's Ice Locomotive in progress

Part of the stratospheric chamber

George Punter and his tractor

A close up of the fully working control gear

Andrew McLeish's Allchin

The 1831 engine on the SMEE display

The engine next to Ivan Law's 1831

Among the competition models, regular users of the forum at www.model-engineer.co.uk will be familiar with the characteristic clean lines and crisp fabrications of moderator Jason Ballamy's models. He brought along several to set up what became known as 'Jason's Corner' with several of them winning awards. My personal (and I suspect his) favourite is the two-thirds scale Tidman Organ engine, **photo 10**.

As always there was a magnificent collection of loan model including several by Cherry Hill, photo 11 shows current progress with her ice locomotive. Cherry is probably one of the most accomplished of model engineers, yet she is full of encouragement and admiration for the work of others, many of whom have been inspired by her work.

Much of the exhibition was housed in room centred on Barnes Wallis's incredible 'stratospheric chamber' which looks like something out of an early James Bond movie, complete with airlock, **photo 12**. The nearby Vickers room, for example, housed several displays including 16mm locomotives in steam and George Punter with his remarkable Saunderson & Mills Tractor as recently serialised in Model Engineer, **photos 13 & 14**. just next to George was Andrew McLeish's Alchin traction engine which won the Duke of Edinburgh trophy this year, **photo 15**.

There isn't space to run through all the wonderful club stands, but I will make special mention of the SMEE display which included some cunning and curious gadgets as well as live demonstrations of turning and scraping as well as some very special model engines: Professor Dennis Chaddock's BRM V8, and many engines by Edgar T.Westbury including the record breaking Atom Minor and a magnificent example of the two cylinder engine he designed for 1831. Mostly of brass, this example was made by peter Spenlove Spenlove and recently refurbished and completed by Bob Bramson. It was displayed next to Ivan Law's completed 1831, **photos 16 & 17**,

Full reports of the competition classes, with many more pictures of the tremendous models on display, will be published in Model Engineer magazine in forthcoming issues. Finally, one more of the museum exhibits – the 'Clerk of the Course's Office' bear an uncanny resemblance to the MEW editorial desk, **photo 18**.

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Workshop door security

Alan Wood offers some useful advice on keeping workshops with electric garage doors safe from light fingered foes.

My workshop lives in the garage or according to my wife "the space where her car is supposed to be on a winter's night". The garage door has an electrically operated door by Hormann with a controller by Liftronics , **photo 1**. It has worked very well since installation. The door physics have allowed me to line the inside with 25mm Xtratherm insulation sheet which has added to my winter comfort and this has not unduly loaded the door motor.

The door is operated by key fobs and also by an internal wall mounted push button. There is some suggestion that a cunning thief with a customised rolling code control pad could 'crack the code' of a door controller and gain access. Switching off the electronics would negate this but the door could still be levered up. Putting extra external hasp padlocks would be one solution but to me that simply advertises the fact there is something inside worth having. External locks are also inconvenient to live with.

My first step to increased security was to fit two swivelling plates on the frame top section. These utilised two existing mounting holes in the door into which I fitted M5 nutserts. These plates gave an added sense of security if we were away from home for any length of time. This presumed that I remembered to put them in place before we departed. I would also switch off the door controller during these absences, **photo 2**.

Door controller

Following a break in and theft at a local house I began to wonder about a more secure system that would not need manual implementation but which would give additional security for day to day absences.

The Plan

Ebay offers solenoids of various types, movements and voltages. I decided I could replace the swing plates with a solenoid activated pin. This would allow me to put the additional security in place at the flick of a switch albeit a separate one to the key fobs. The downside to this would be that I now needed to be conscious not to try to open the door with the fob while the pins were in their down/locked position. Clearly I needed to create some interlock between the two actions.

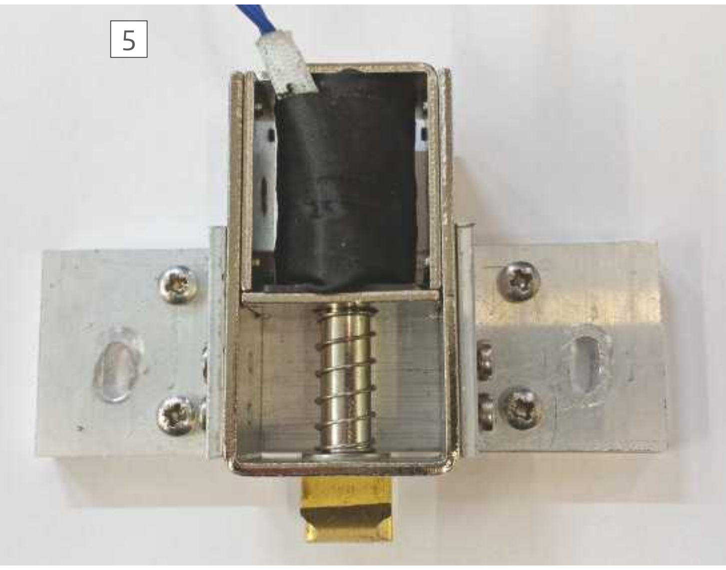
Inspection of the internal electronics of the door controller revealed a mains to 24V DC powered unit. If I could somehow link the solenoids with the door opening electronics mechanism this would solve the problem. One button press on the key fob would give a double unlocking action.

When the key fob is pressed the controller decodes the radio signal and powers the motor to lift the door. The voltage is applied to the motor with one polarity for opening and the opposite way for closing. By putting a 24V relay in parallel with the motor wiring I could take a dry contact pair out of the control unit to activate the solenoids. A relay coil is not polarity sensitive so it would activate on both opening and closing. I found a 24V relay rated at 10A in my junk box. Searching on EBay I found two 12V operated electronic door lock solenoids, **photo 3**. These were quite substantial and pulled 2.5A on energising. I would need a suitably rated external 12V power supply to power these. The solenoids would be mounted on new brackets to replace the swing plates. The only minor issue that would need addressing would be the back EMF from the solenoids leading to possible relay contact

Swing plate

Solenoid

Motor wiring



Bracket 1

erosion. A reverse polarity diode across the solenoid coils would solve this.

In theory the same back EMF problem would be present with the relay coil. It is normal to put a reverse polarity diode across any inductive load. The fact that the voltage applied to the motor could change polarity between opening and closing would not allow a diode to be fitted. The theoretical solution for this would be to connect a bridge rectifier in line with the motor drive voltage. This would accommodate the change in polarity of the drive voltage and give a reverse diode path as a matter of course. In the end I opted to ignore this issue on the basis that the motor was already a serious inductive load to the controller electronics and it probably had protection built into the unit. My tiny relay was hopefully not going to additionally burden this.

This looked like a working solution and would mean the door and solenoids could be simultaneously be activated from the key fobs for day to day absences and when away for longer periods the power could be switched off to disable the controller and leave the solenoids pins in place.

Implementation

Materials

Solenoids: 2 off, 12V x 2.5A door mechanism solenoids Ebay

Power supply: 1 off, 12V DC @ 6A power brick from Ebay or Amazon

Relay: 1 off, 24V coil, single pole rated at 10A CPC / Maplin

Diodes: 2 off,1N4001 CPC/Maplin

Misc: Cable, chocolate block connectors, cable ties +pads

Controller Mods

Please note that modifying your door controller do will almost certainly invalidate its warranty.

Remove the controller cover and check the door opener motor rating. Usually this is 12V or 24V. If in doubt activate the door and measure with a multi-meter across the motor terminals. You will need a relay coil that matches this voltage.

Switch off the mains supply to the controller and solder two wires onto the motor connections and bring this pair of wires out of the unit to control the external relay. Note that while the colour of the wires on the motor might be red and black, the colours do not strictly indicate a polarity as the voltage polarity changes between opening and closing states. I used grey wire for my connections, **photo 4.**

Garage Door

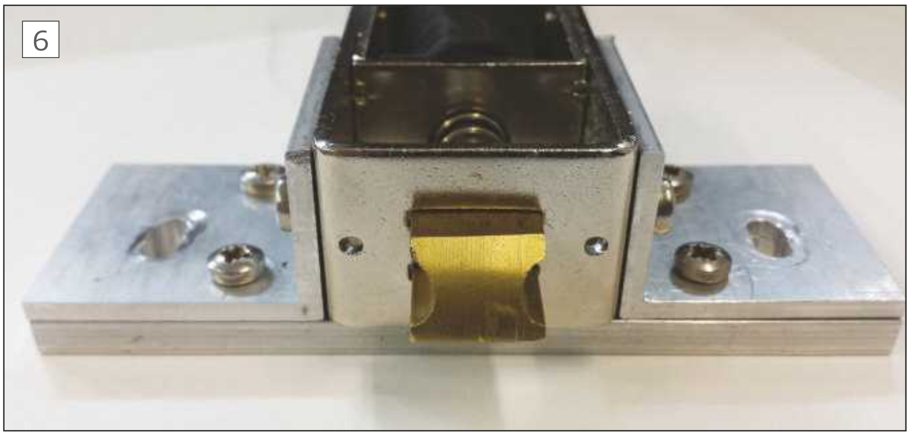
If your door is a Hormann you could well have a similar two groups of four pre-drilled holes on the top of the garage door and the adjacent frame. Enlarge the holes in the frame and fit 4 x M5 nutserts. If no holes are present, then drill and fit as appropriate.

Make up two sets of brackets to mount the solenoids onto the frame to match the nutsert mounting holes. The details of my versions are shown. I made these from aluminium and each consisted of a backing plate with two pieces of angle. Note that I milled elongated slots in the brackets to allow adjustment of the solenoid position, **photos 5,6 & 7**.

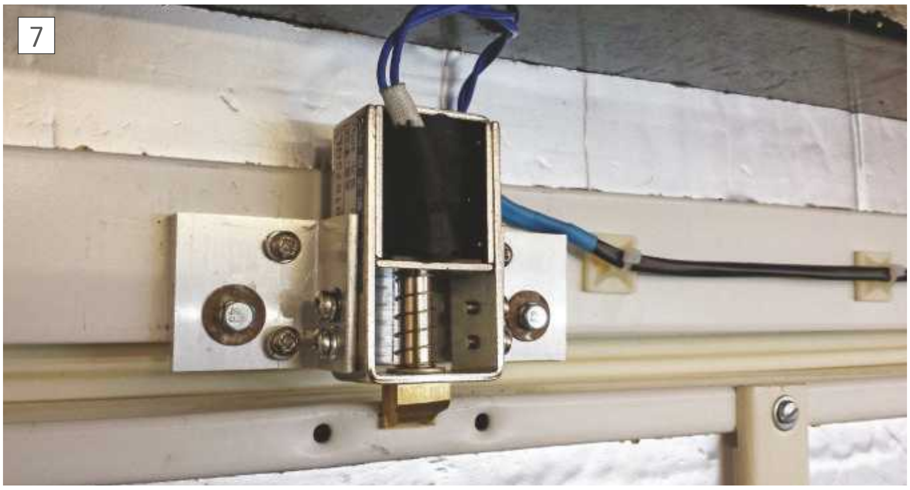
Wiring

My door controller is mounted onto the garage ceiling with Dexion style angle strip and has an adjacent 13A socket for the power feed.

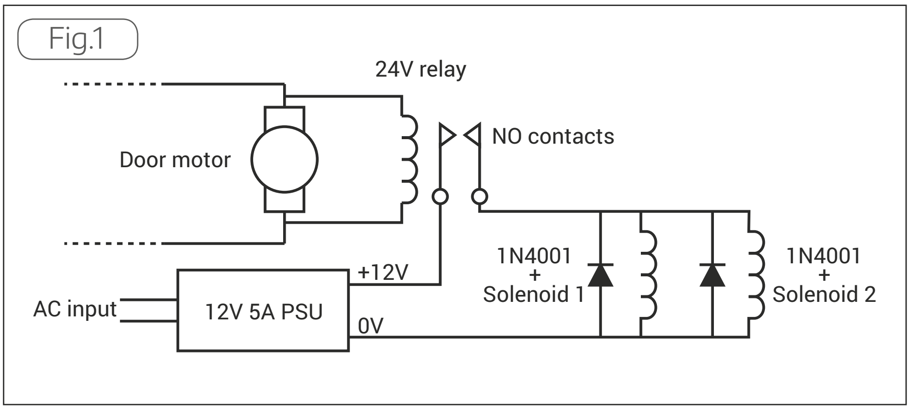
I made a small MDF panel on which I mounted the 12V 5A power supply block for the solenoids and also the relay and connecting wiring, **photo 8**. I mounted



Bracket 2



Bracket fitted in place



the panel on the Dexion bracket. I used standard chocolate block connectors for the interconnections. The wiring diagram is shown in **figure 1**.

My opener installation has a central steel extrusion running from the electronic controller to the door frame. This was ideal to run the cable for powering the solenoids. I ran a single substantial twin core cable along this extrusion to the door. Here I fitted a simple distribution plate with the back EMF diodes mounted on this, **photo 9**. Two twin core cables run from this small panel, one to each solenoid, **photo 10**.

All cables were held in place using sticky backed cable tie pads.

Checking Out

Before connecting the relay to the solenoids, I checked that the relay closed with a click when the garage door was activated. I then checked out the solenoids by temporarily connecting them to the 12V power supply. They should 'clunk' quite loudly as the energised coils pull the pins in. I then connected the solenoids to the normally open (NO) relay contacts and protected the connections with heat shrink sleeving.

The solenoid mounts were adjusted to give an adequate clearance so as not to foul the door. When a key fob was activated, the motor started in sync with a loud 'clunk' as the two solenoids pulled in with their pins clearing the top edge of the door. The solenoids remained active until the door motor stopped. In reverse the solenoids stayed active until the door closed and the motor stopped whereupon the pins dropped to secure the top of the door.

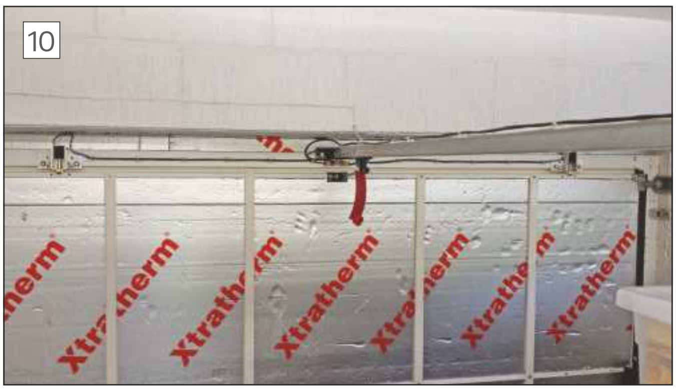
Solenoid Power Supply Panel

Conclusion

Day to day I now have additional protection against forced entry and while away for any length of time I switch off the controller and the solenoid power supply so the door is secure against a rolling code blitz.

Clearly the details of my installation are unique to the type of garage door and the controller in use. Nevertheless, I hope my notes will help stimulated other readers to consider their own solutions to improving their man cave security. ■

Distribution Panel



Door Overview

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A compact machine light for hobby lathes

Alan Wain recounts how an opportune purchase solved the problem of poor lathe lighting.

1

I recently up-sized my lathe from a Hobbymat to a Warco WM240 and found that lighting, previously adequate, was now severely lacking. The lathe is positioned beneath a wall-mounted cupboard and the extra bulk and height of the WM240 puts the work much closer to the underside of the cupboard. For a while, I made do with a magnetic-based gooseneck mains voltage lamp with a 6-inch diameter shade and no guard; silly, I know, but when desperate! The magnetic base stuck very nicely to the splash-guard but the whole arrangement was bulky and often in the way. A chance purchase of a couple of GU4 12V led reflector lights from the 'clearance' counter in my local Aldi store provided the catalyst for action to miniaturise the local lighting. The result is shown in the **photo 1**.

The type of bulb I bought, **photo 2**, has 3 leds, 3 Watts power and declared as 210 lumens, equivalent to a 23W incandescent bulb. Similar types are readily available on the internet, albeit with a variety of specifications and led count. I already had a 13-inch microphone gooseneck, bought for this purpose long ago after reading an article by 'Bluey' in MEW issue 2, so all excuses for not solving the lighting problem had disappeared.

Before moving on to construction, I must mention the issue of 'strobing' associated with led lighting. Other than compatibility issues with led bulbs and dimmers, led lighting powered from an ac source is known to flicker, in common with all types of lighting, including the good old incandescent bulb. The type I am using here is low voltage and powered via a 12Vdc non-switching power source (transformer/rectifier as opposed to 'switched-mode' power supply). Although this will not totally eliminate ripple, I cannot detect any flicker and have not observed stroboscopic effects at any lathe spindle speed. It would be sensible, however, to check individual combinations of power supply and led light, for the sake of safety. If necessary, a power supply designed specifically for led lighting would probably be a better option.

The mounting clamp

Machine lights can be purchased that attach to the splash guard by means of a clamp similar to a market stall clip or tarpaulin clip. This seemed like a good idea, except that I didn't have a suitable clip and the top of my splash guard is very close to a shelf erected only recently to keep regularly-used items to hand. Instead, I opted for an arrangement more like a 'g' clamp but designed specifically to fit the splash guard snugly. **Photograph 3** and **figure 1** show the principle, which allows the assembly to slide along the top of the splash guard for optimum positioning. I have included the dimensions that I used but the only important ones are dependent on the splash guard stiffening channel and gooseneck thread. I used Tufnol (Novotext) for my mounting clamp because it is light, strong and less likely to damage the splash guard paint finish. I also just happened to have a piece of nominally 25mm thick material waiting for a purpose in life. Nylon would be a reasonable substitute but probably not sufficiently rigid at the dimensions I used. I suppose aluminium would be alright but likely to scratch the paintwork when sliding along the splash guard. Any heavier material would certainly be overkill.

Manufacture is simple; machine, or saw and file, to the required outline before turning and threading the spigot in the lathe four-jaw chuck. My gooseneck threads are to the American standard 5/8 inch by 27tpi, so I cut the spigot thread accordingly. At this point I must thank Andrew Wharton, from the model-engineer.co.uk forum/Sieg C6 new threading possibilities. He very kindly entered the WM240 data into a computer program to calculate change gear combinations for a metric lathe using the supplied gear set; the result was a comprehensive range of imperial threads. A little therapy making slightly longer change gear studs and a couple of spacers and, hey presto, plenty of pitches to choose from! Thanks Graham. Whilst still in the four-jaw chuck after threading, drill co-axially 6.0mm for a little over half the mounting clamp length to accommodate the power supply cable. Remove from the lathe to a bench drill and drill the 6.0mm cable entry hole from the channel side, to intersect the spigot bore at 90 degrees. Drill the cable-clamp hole from the tail end to intersect the cable entry hole

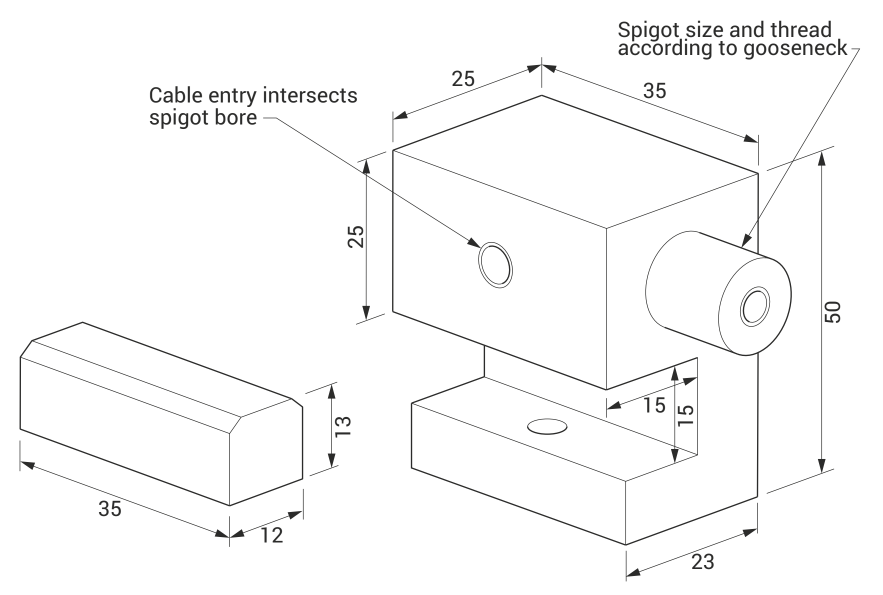


Fig. 1. Machine Light Mounting Clamp

and tap M5 for a grub screw. Chamfer both with a countersink bit, the cable entry hole generously. I milled the slot for the channel and clamp pad but this could also be hack-sawed and filed. Finally, lightly chamfer all edges with a fine file. The top could be rounded but I didn't bother.

The channel clamp pad is another small piece of Tufnol, finished to the same length as the mounting clamp body and to a loose but slop-free fit in the splash guard stiffening channel.

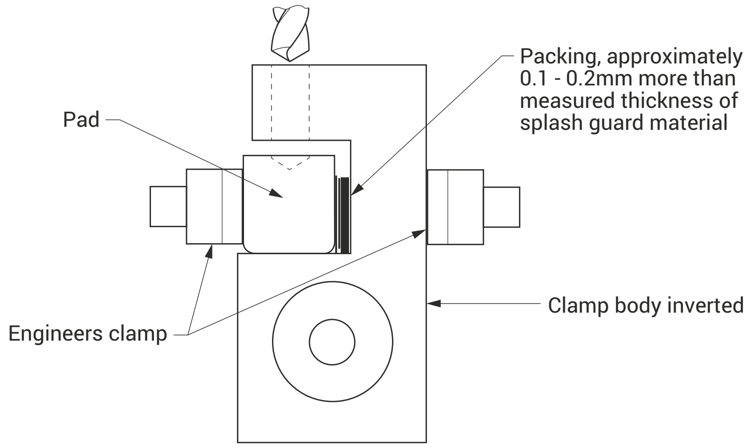
Use approximately 1.5mm packing to position the clamp pad in the slot for drilling, **sketch 1**. This dimension could differ on other machine splash guards. The intention is to position the pad from the slot bottom by the thickness of the splash guard material plus paint thickness so that, when clamped up in use, the pad will bear on the inside surfaces of the top and front of the stiffening channel for rigidity. I used a mixture of steel sheet and paper to achieve the required spacing. Clamp up and drill the clamp screw hole 5.0mm to just spot through into the clamp pad. Remove the pad and tap the clamp screw hole in the body M6. Where marked from spotting through, drill the clamp pad 5.0mm to a depth of 10.0mm. Chamfer or round the

›

top edges of the pad to easily fit inside the bend radius of the splash guard stiffening channel. Lightly chamfer all other edges.

The clamp screw is simply a socket cap screw with the end turned to a 118 degree included point and the threads turned off the end for 10.5mm, for a close but free fit in the 5.0mm hole in the pad. The screw point should bear on the bottom of the hole rather than the face of the threaded portion touching the pad surface. To hold the screw for machining, I used a short bush tapped M6 and split longitudinally down the side so that it clamps onto the screw when tightened up in the lathe chuck. Light cuts are necessary to avoid the work 'unscrewing'.

The M5 cable clamp grub screw is nylon, cut from a cheese head machine screw and slotted using a junior hack saw. An alternative, if no nylon screws are available, could be a loose-fitting nylon or plastic slug pushed into contact with the cable by a steel grub screw.



Sketch 1. Spotting Through Into The Clamp Pad

The light head

I kept this as simple as possible with the body made from aluminium for lightness. The flange formed by the bulb major diameter (see **photo 2)** seats on the rim of the light head body and is retained by a step inside the close-fitting PVC bezel, **photo 4** and **figure 2**.

The body of my light head finished up at 52mm long but could probably be a little shorter. Chuck a piece of 40mm aluminium round with 30mm protruding and finish turn this, as far as the chuck jaws allow, down to approximately 38mm for a snug sliding fit into a piece of 1½ inch(40mm) push fit PVC bath waste pipe. This needs to be a fairly firm fit because the embryo light head body is first used as a mandrel to machine the PVC pipe. Push a short length (about 40mm) of the pipe onto the turned bar to overhang the mandrel by 10mm or so, and clean up the end with a thin parting tool. De-burr the end and then part off a ring approximately 6mm long. De-burr the end again, and then turn the piece of pipe around on the mandrel, allowing enough overhang for machining to about 25mm long without cutting into the mandrel. The need for a snug fit will be obvious by now. This parting off should also be done at low speed and gentle in-feed to avoid the work being ripped off the mandrel or melted. Using a Stanley-type knife, cut axially through the wall of the short ring so that the ends can be overlapped and the ring pushed inside the longer ring. Mark the overlap and then trim the short ring, using the mark as a guide only, to achieve a tidy butt-joint of the ends and a snug fit of the short ring inside the longer one. Align the outer edges of the two rings against a flat surface before running PVC welding solvent around the inside of the joint. Set aside until the solvent has done its job.

Push the now flanged 25mm long ring onto the mandrel, thick side outwards (it will only go on that way anyway) and clean up and profile the outer end with a facing tool and reducing grit size abrasive cloth.

Returning to the light head body (still in the chuck) centre and drill through to around 12mm. Bore 20mm diameter to 33mm deep, and then approximately 33mm diameter to 20mm deep until the bulb will just drop in easily but not too loose. Turn the work around and re-chuck, protecting

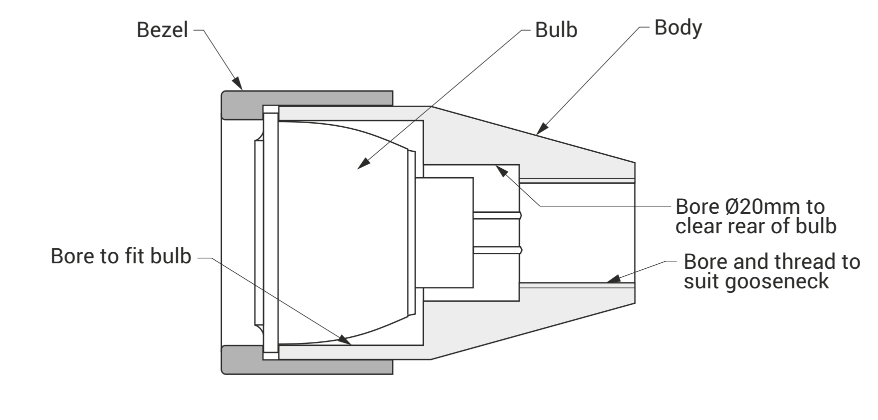


Fig. 2. Detail Of Light Head Construction

the finish-machined outer diameter from jaw damage using whichever material you prefer. Allow for around 35 mm to protrude after facing to length (52mm). Bore and cut the internal thread to suit the gooseneck male thread. I chose to do this mainly for the practice at internal threading on a non-critical job, but just bored to a fairly close fit on the gooseneck threads and retained by epoxy resin or radial grub screws could be alternative fixing methods. Whichever method is used, once satisfied, set the top slide over to 15 degrees and turn the outside taper until it blends with the outer diameter at around 30mm from the gooseneck end. The only reason for this is to reduce weight but it also looks far better, in my opinion.

Power supply

As stated in the introduction, power supply choice is important. My bulb is rated at 420mA and I use a redundant 600mA power supply from a long-deceased cordless telephone. This works well and cost nothing. Although the bulb is marked as ac/dc, the internal rectifier circuitry may only be half-wave, therefore I would not recommend the use of the output straight from a transformer secondary winding, or even a car battery charger, where the smoothing may be poor.

Assembly

Assemble the light head body to the gooseneck by whichever method decided upon.

Cut any connector from the power supply output lead. Feed the cable into the cable entry hole and pull through the spigot for the length of the gooseneck plus about 150mm. Feed the cable through the gooseneck and screw the gooseneck to the spigot.

Separate the two cable cores at the free end of the cable for 25 to 30mm and strip 4mm of insulation from each. Tin the bared ends and also the bulb pins. Slip a 12mm length of suitable size heat-shrink sleeve onto each stripped and tinned cable core. Solder each wire to the inside of a pin; polarity doesn't matter because the bulb is designed for ac or dc. When the soldered joints have cooled, slide the heat-shrink sleeves down over the pins and shrink over the solder joints.

Ease the cable back through gooseneck and mounting clamp until the bulb will seat fully into the body leaving a little surplus cable to accommodate bending of the gooseneck. Fit the nylon clamp screw or slug and screw, and tighten just sufficient to act as a strain relief.

Slide the PVC bezel onto the body to hold the bulb in place.

Screw the clamp screw into the clamp body until the tip is flush with the end of the tapped hole. Fit the clamp block the right way around into the lathe splash guard stiffening channel and hold in place whilst positioning the clamp body over both. Align the ends of the body and clamp pad, and wind in the clamp screw to engage the hole in the clamp pad. Screw in all the way, using a hex wrench (a ball-end wrench makes the job easier), until the assembly is firmly clamped to the splash guard. In my case, I found that by backing off the clamp screw a little, the assembly will slide along the channel but remain fastened firmly enough without further tightening.

Conclusion

This was a simple project that solved my problem of poor lighting at the lathe. The light can be easily positioned to where required, doesn't generate any heat and the cable is safely tucked away behind the splash-back. The next job is to make one for the mill-drill. ■

4

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