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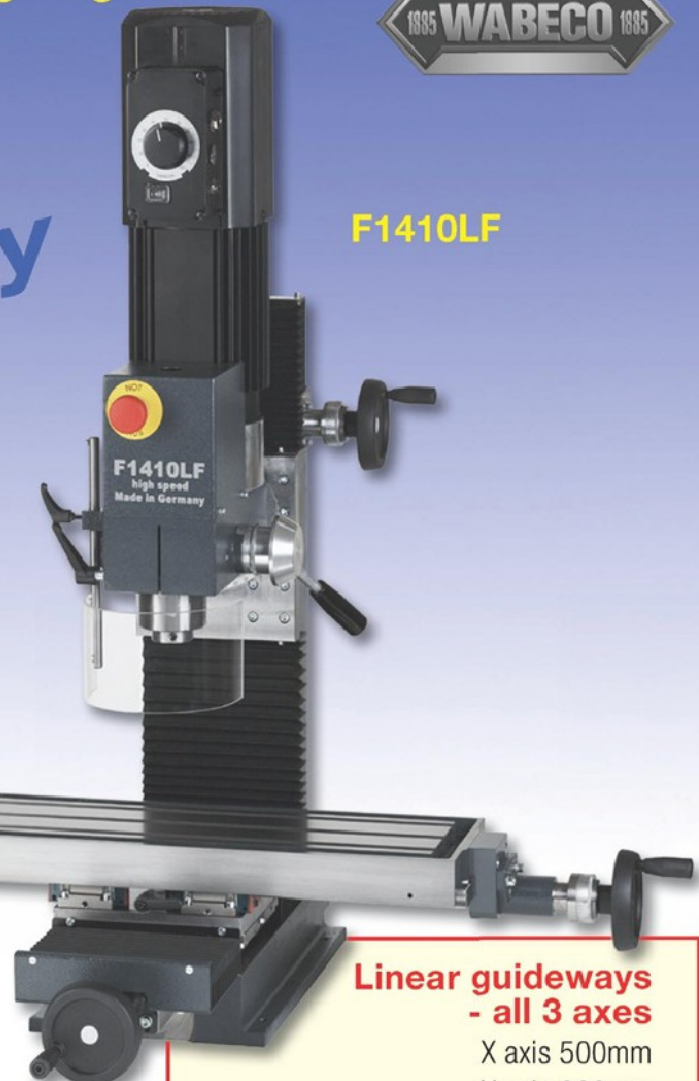
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Myford Series 7 Manual • Bradley • £ 9.90

A welcome return of this book, which has been out of print for some time. This is the 'classic' book on the 'classic' model engineer's lathe - the '7' series from Myford. It covers the features of the various models, installation, and how to use the machine including, for example, milling, gear cutting, taper turning and repetition work, as well as everything to do with turning itself. Covers the ML7, ML7-R and Super 7 models. And, of course, a lot of the information here can be applied to any lathe. 232 pages, full of B&W photos, diagrams, formulae and charts. Paperback.



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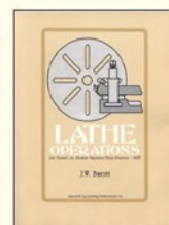
How to Run a Lathe • 1942 • South Bend • £ 8.30

For years Lindsay and ourselves sold 1000s of copies of the 1966 edition of this great book - then "South Bend" put the price through the roof.... Now Tom Lindsay has reprinted the 1942 edition, and it costs less! There are differences between the two editions, but the main text is identical - most of the changes are in the photos, with different hairstyles, and sometimes lathes. As a book to keep by your lathe (whatever its make) for everyday use, this really has no equal - buy a copy. 128 page illustrated paperback.



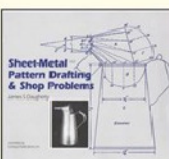
Lathe Operations • 1937 • Barritt • £ 14.70

The best lathe book we have seen that gives instructions for specific machining operations. Produced by the American Technical Society and intended for students, you get specific sections on the lathe, lathe tools and screw threads, plus 50 "job tickets" demonstrating a particular machining operation with both text and sketches of settings. You may not need to do the specific jobs shown, but they really illustrate a lot of skills you will probably need to use at some time. 164 page larger format paperback.



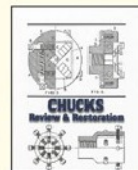
Sheet-Metal Pattern Drafting & Shop Problems • 1922 • Daugherty • £ 15.85

This book is all about how you lay out a pattern to be used for cutting sheet material which is then bent, folded and soldered into odd shapes such as water cans and roof ventilators - in other words it is a book of geometry. Working rather like *Lathe Operations* above, it looks at unusual shapes and then describes, in detail, the calculations involved in laying out for those shapes. What this book does not tell you is anything about cutting, bending or soldering the sheet metal - it is solely concerned with laying out, the process of which is very well covered. 173 pages. 153 drawings and 114 photos. Landscape format paperback.



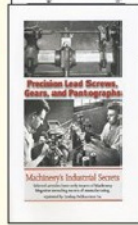
Chucks Review & Restoration • £ 6.15

Selected articles from MACHINERY MAGAZINE of circa 1913-1917, this is a useful book for anyone coping with a chuck that has gone out of true, as it contains a lot of useful ideas on how such a chuck can be brought back into line. Also included are detailed descriptions and drawings of virtually all types of chuck the amateur will come across. 48 pages. Over 80 detail drawings. Softcover.



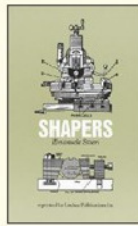
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More articles extracted from MACHINERY MAGAZINES from the 20s, mainly of interest if you are cutting small gears or considering pantograph engraving. As with many of these books, the applications considered were industrial, but they also have application in the workshop of today's model engineer. 48 pages. 52 photos, drawings and diagrams. Softcover.



Shapers • 1943 • Stierli • £ 9.75

Tom Lindsay says "there seems to be a shortage of good books on shapers. This not only tells you how to run a shaper, it does it quickly and clearly. You get a how-to book that is easy to read". And that just about sums it up - this is a really useful book if you are operating a shaper. 180 page well illustrated paperback.



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David Clark

ON THE EDITOR'S BENCH

In the workshop

At last I have managed to get editing three magazines every four weeks under control. I am making myself more efficient and am already down to a 5½ day week working 9 to 5 and some of Sunday afternoon. (Feel free to phone me outside those times.) It will soon be back to a 5 day week now the website is running reasonably efficiently.

This has meant that I have started to get back out into the workshop and the first task this month was to put the new digital readout onto the Tom Senior mill. I say new but I purchased it well over 18 months ago when I was still living in Poole. I have fixed the X axis on and that is working fine but I still have to fit the Y axis. I have enough aluminium angle and other odds and ends to fabricate the brackets so hopefully this will be fitted in this coming month. I think a readout is essential on a mill as once you get used to using it, and to relying on it, the speed that you can produce quality work is amazing.

A typical job would be to mill the ends on a length of bar to, say 180mm. If you have no readout fitted, you have to mill one end, move to the other end, lightly clean up the second end and measure the overall length then work out how much to take off to make the bar to size. If you are like me, you will take another cut almost to size then measure again and work out how much left to come off, move the table and take the finishing cut.

Now consider doing this with a readout. Same setup, 10mm cutter in the collet chuck. Clean up the first end and set readout to zero. Move to the other end of the job; mill the second end to 190mm on the readout (180mm + 10mm = 190mm) and job done. Wind back to the start and then move 5mm along the bar. Zero the readout and the spindle centreline is on the exact edge of the bar ready for drilling in the X axis. Put an edge finder into the collet and find the edge of the bar. Zero the readout, move over half the diameter of the edge finder diameter and you are again on the edge of the material in the Y axis ready to drill.

It sounds simple and it is. Once you start working with a readout on the mill, you will wonder how you ever managed without one.

Readout on a lathe

While I recommend you fit a readout to your mill if you don't already have one, it is nowhere near essential on a lathe. It would be far better to use a multi position stop in the Z axis direction (longitudinal travel). Yes, a readout might be useful in the Y (crosswise) direction but it is by no means essential. The only reason I would fit a readout to a lathe would be on the Y axis as a rough guide to how much I am taking off as I tend to forget that one thou on the dial takes two thou of the diameter. What would be much more useful on the Y axis would be a zero setting dial. I have fitted one to my Myford ML7R and use it all the time. They are readily available from Myford as a spares item at a very reasonable price. They have 100 divisions so are well suited to any lathe with a 10 TPI feedscrew to the cross slide. They are very easy to fit, being a 15 minute job - 10 minutes to find a suitable spanner and 5 minutes to fit the dial. (Try a bike spanner as you need a thin spanner for this.)

Another lathe

At the Myford open day, I purchased a lathe from Harry Paviour, one of the judges at the Model Engineer Exhibition. I had been after one of these little lathes for a while and this one with a lot of equipment was just what I was looking for. It is one of the old Emco Unimat SL lathes. This is the one with two round bars of steel for a bed. Although it will be very useful for small components, both drilling and milling, the main reason for buying it was so I can use the mandrel spindle and motor on the cross slide of the Myford, either mounted horizontally or vertically on a pillar for drilling and light milling in the lathe.

Aquamarine

I don't know if it was the recent visit to the Myford open day but the Myford aquamarine colour is beginning to grow on me. I used to find it a bit garish but after being surrounded by several new aquamarine Myfords at the show, I am getting used to it. So, I have decided that with interest rates at pennies rather than pounds I might as well invest some of the children's inheritance in a newish Myford. I have gone for a Super 7 plus, the one with the 1 inch spindle bore

and also selected one with a gearbox fitted. This was apparently a one owner machine and the gentleman who owned it only used it occasionally.

I also decided to keep my old ML7R as it has had very little use and I can set it up in a different way to the new one. I don't think you can use the Myford multi way stop and the Myford taper turning attachment on the same machine at the same time so one machine (probably the new machine) will have the multi way stop fitted and the old machine will have the taper turning attachment fitted. I will also be keeping my eye open for a Myford capstan turret, the bed mounted one rather than the cross slide one, to go on the ML7R. The only drawback to this might be the price and the carriage charge.

Williamson Engine

I have long admired the Williamson engine described by Tubal Cain in the *Model Engineer* magazine. I decided to ask on a model engineering Internet advertising site if anyone had a set of castings for this lovely little engine. A few days later an email arrived offering me the Williamson at a fair price. Money changed hands and I have yet another engine added to the growing pile in the workshop cupboards. This time however, I have the time to build it and the fully equipped workshop to do it. If you are after an engine kit or a tool or anything model engineering related, please put an advertisement in our wanted section at www.model-engineer.co.uk

Who knows, you might just get a bargain or alternatively, you can advertise that unfinished project and make a bit of cash and free some space up as well.

New locomotive and vacuum engine series

Our sister magazine, *Model Engineer* has just started two new series. The first is *Charlie*, a Southern Railway Q1 in 3½in. gauge especially designed for the beginner in locomotive construction and the second is a vacuum engine by everyone's favourite stationary engine designer, Anthony Mount. This is also an ideal beginner's engine as it only has about 50 component parts to it. Castings for both series can be obtained from Polly engineering. ■

DIAL INDICATOR/DIAL TEST INDICATOR ACCESSORIES ②

Harold Hall concludes his look at these useful accessories.

Following on from the last issue where we covered the simpler items and the main uses for the items that make up this kit of parts, in this issue we have a fine adjustment unit and will consider other possible uses.

Fine adjustment unit (part 8)
Frequently it is required to finely adjust the position of the indicator so that it displays the required value, zero in most cases, and often, using the machine's feed screws will provide this facility with ease.

However, there are occasionally instances where this is not possible and some other means of fine adjustment would be helpful. Such a facility is almost always incorporated into the most common forms of surface gauges and magnetic base assemblies.

The fine adjustment unit illustrated in this article provides such adjustment and is something a little more demanding to manufacture than the very simple items that make up the rest of the kit of parts.

Most important is the absence of clearance between various items so as to ensure that there is limited backlash or sideways movement that would affect the accuracy of the reading being taken. Sideways movement is easy as the two lock nuts (H2) on the pivot pin provide

adjustment for closing down the body (8e) onto the arm carrier (8b). This is of course assuming that there is very little clearance between the two parts in the first instance. These nuts should be tightened so as to make the assembly a little on the stiff side to counteract any backlash that will inevitably be present.

Photo 12 shows an application for this item where in this case the angle plate is being tested to check if the top surface is parallel with the base. The setup uses the base mentioned below but this is a little on the light side for this application. On the left is a base made from a casting available from CES (Ref. 2) that I would normally use but the user could of course make the base from thicker material to provide extra weight.

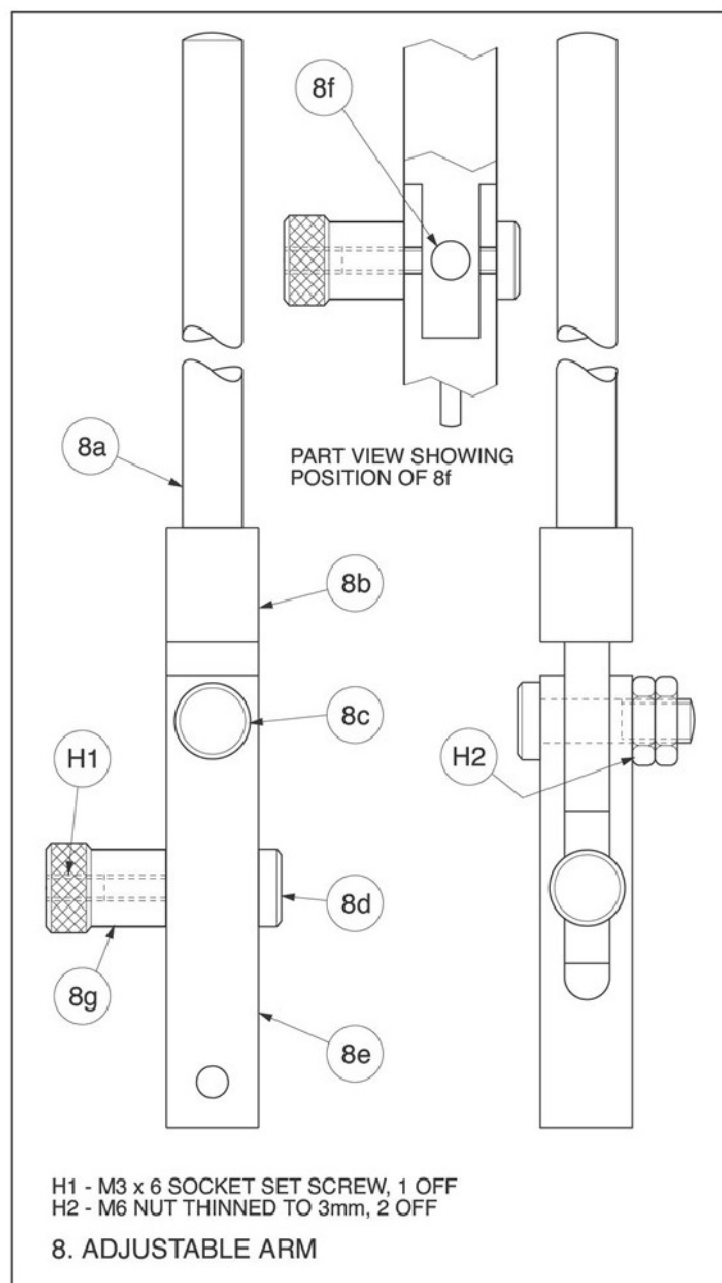
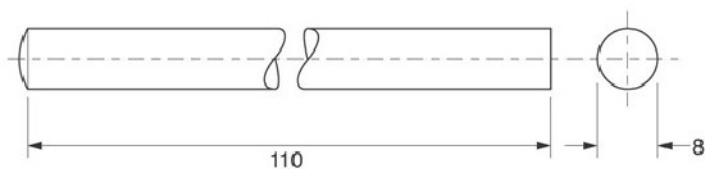


Photo 12. Showing a typical use for the Adjustable Arm. The photograph also shows an alternative base. (Ref. 2)

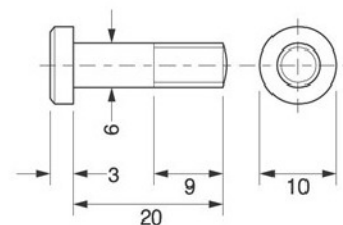


Photo 13. Three parts make up a very useful mini instrument makers vice, in this picture being used to shape a part for a model of a Monmouth Farm Wagon.



MATERIAL: Ø8 STEEL 230M07
QTY: 1 OFF

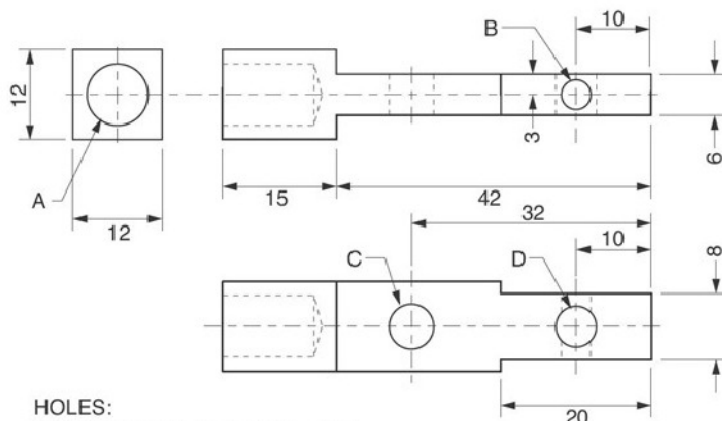
8a. ARM



MATERIAL: Ø10 STEEL 230M07
QTY: 1 OFF

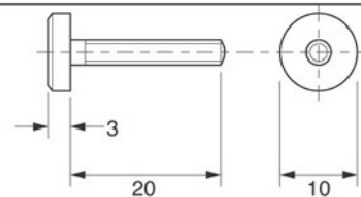
THREAD M6

8c. PIVOT PIN



HOLES:
A. 8 x 12 DEEP B. 4 C. 6 D. 5
MATERIAL: 12 x 12 STEEL 070M20 QTY: 1 OFF

8b. ARM CARRIER



MATERIAL: Ø10 STEEL 230M07
QTY: 1 OFF

THREAD M3

8d. SCREW

Non dial indicator uses

There remain just two other items that can be made which between them open up a wide range of other uses.

Base (part 9)

This is a very simple item but it needs the centre of the base to be relieved to ensure that it sits cleanly on the surface plate or other location. Even with that done the remaining edges will need scraping or lapping to ensure that it sits on the surface plate without rocking. Typical uses for this item are illustrated in the photographs that follow.

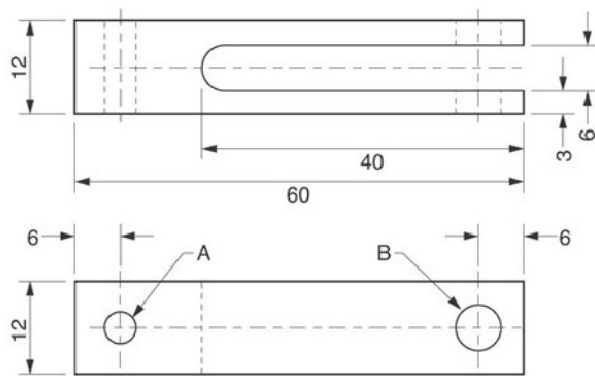
Clamps

These operate in the same way as a toolmaker's clamp but are shaped quite differently, a major feature being the small circular extension on the back end that enables them to be held by one half of a swivel joint or the table mount.

Manufacture is straight forward but the following approach is to be preferred. First, drill tapping size holes for holes A and B with B being drilled fully through and A only part way as per the drawing. This will ensure that after slitting the holes will line up when they can be tapped or opened up as is required. Slit on the milling machine using a slitting saw but this will need finalising using a hack saw to separate the two parts fully. These clamps can be very useful if used in isolation from the rest of the kit as mini toolmaker's clamps and with the other parts they can fill a multitude of other uses as some of the following photographs show.

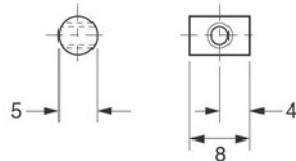
Mini instrument makers vice

Three items make up this assembly as should be obvious from photo 13 in which a small item for a model farm wagon is being finally shaped.



HOLES: A. 4.2 B. 6
MATERIAL: 12 x 12 STEEL 070M20
QTY: 1 OFF

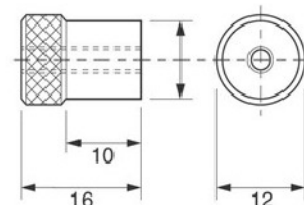
8e. BODY



MATERIAL:
Ø6 STEEL 230M07
QTY: 1 OFF

THREAD M3

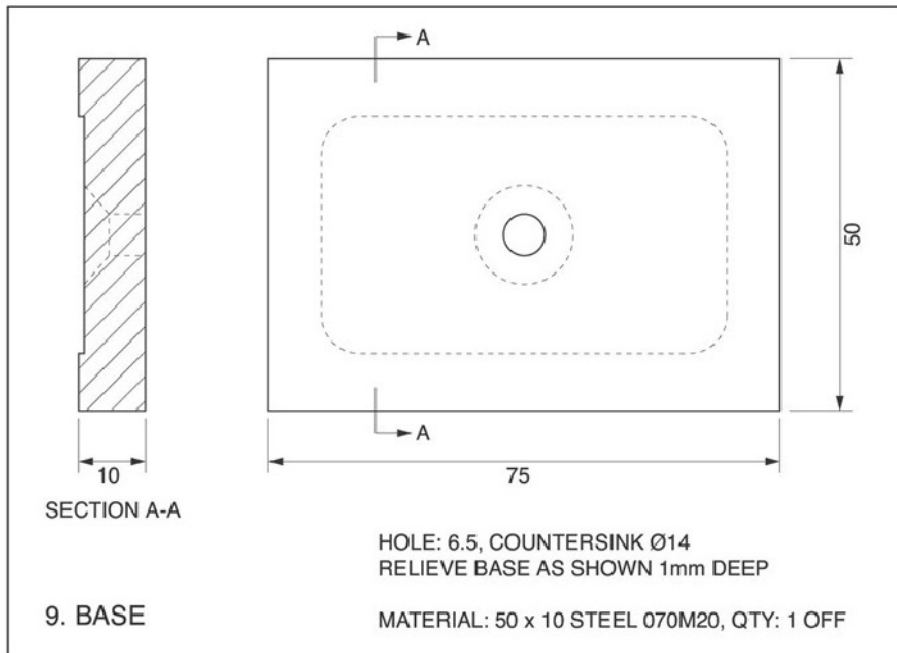
8f. FEED NUT



MATERIAL: Ø12 STEEL 230M07
QTY: 1 OFF

THREAD M3

8g. NUT



Magnifying glass stand

Photo 14 shows the system being set up as a magnifying stand. In this photo a centre punch is being accurately positioned. When in position the stand can be removed with the free hand and the hammer picked up to tap the head of the punch.

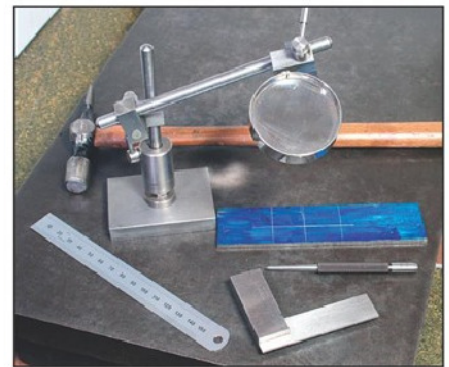
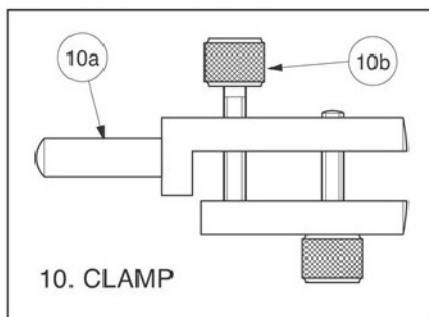


Photo 14. A magnifying glass added to assist with intricate tasks, locating a centre punch in this case.



Photo 15. The guard in this picture is not intended to prevent contact with the moving cutter, though it may help. Its intended purpose is to protect the operator from flying fragments of hot swarf.



Machine guard

The guard suggested here is not of the type to prevent accidental access to the moving parts, though it may help, but just to protect the machine user from flying fragments of hot metal. This can particularly be a problem when machining square material on the lathe. A typical example on the milling machine is shown in photo 15 but a similar set up would be equally appropriate for use on the lathe.

Heavy duty helping hand

This is shown in photo 16 holding a small PCB to enable the components to be placed and then with it swung down the board is positioned so that the leads can easily be soldered. If there was a need to hold two parts together whilst they were being soldered then each one could be held in a clamp with these being

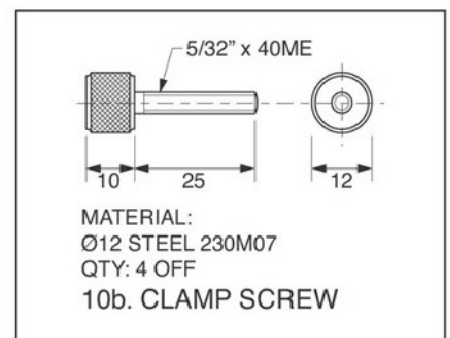
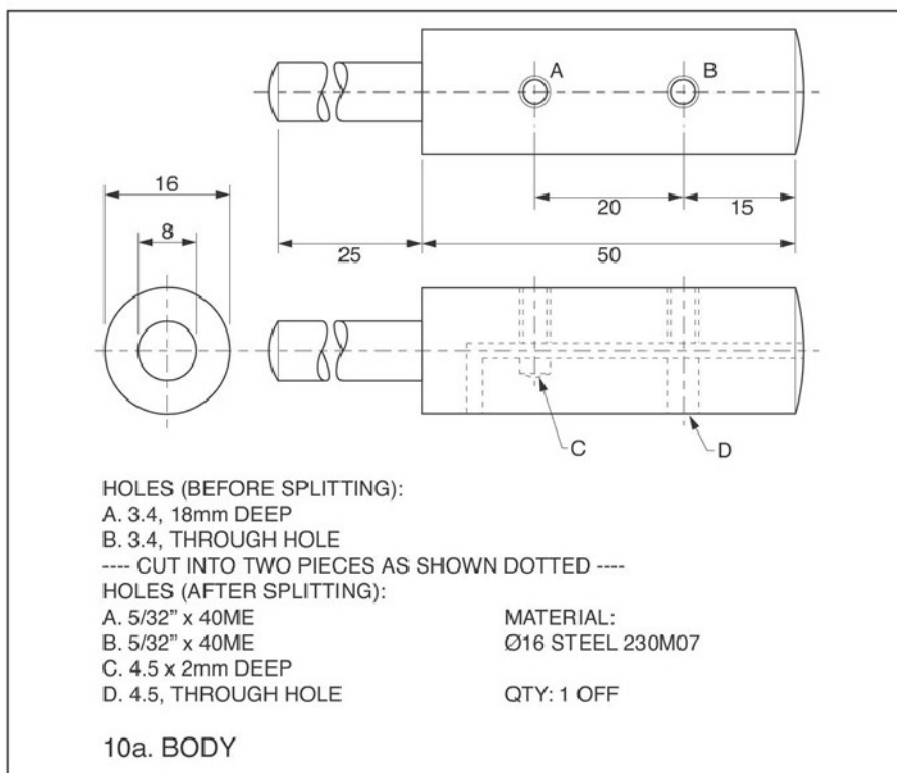


Photo 16. Being used as a heavy duty helping hand for assembly.

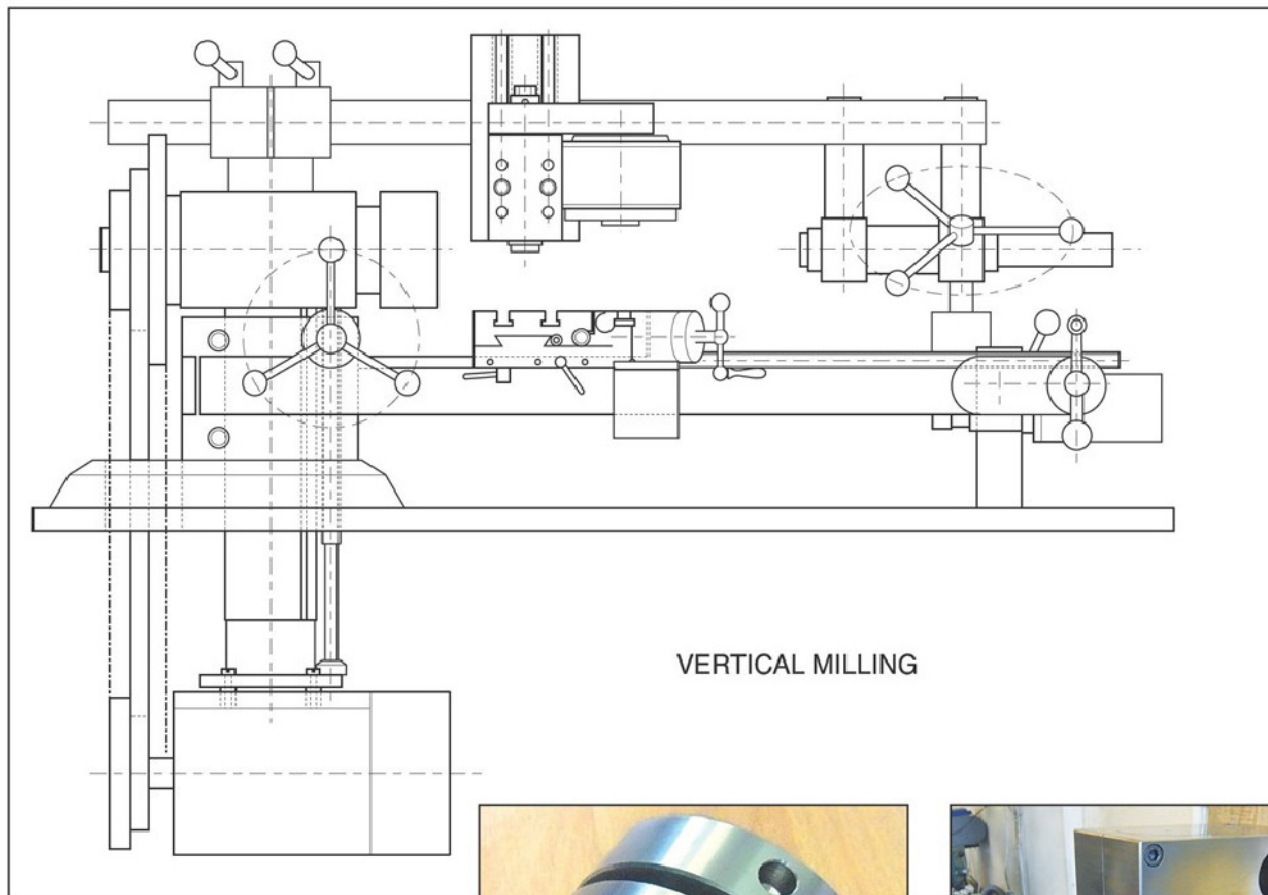
positioned to bring the parts together for soldering or brazing. A magnifying glass could easily be incorporated making it a heavy duty version of that commercially available. ■

References

2. Dial Test Indicator base casting Ref. 523, the base seen in photo 12 uses just 1/3rd of the casting's length. From The College Engineering Supply, 2 Sandy Lane, Codsall, Wolverhampton. WW8 1EJ Tel. 08451 662184 E-mail sales@collegeengineering.co.uk Web site www.collegeengineering.co.uk



THE STEPPERHEAD MULTI-MODE MACHINE 2



Alan Jackson continues his description of this versatile machine.

Headstock

To maximise rigidity the lathe mandrel, bearings and headstock attachment to the vertical column, were all made as massive as possible. The lathe mandrel has a 1in. dia. bore and the chuck is attached using a camlock style fitting, **photo 20**. D13 is the smallest size in the camlock standards, which is still too big for the Stepperhead so I evolved a simpler smaller version. It has the great advantage of being able to run forward or reverse safely and the chuck can be easily and quickly removed. No more stuck chucks and broken back gears.

I selected the largest taper roller bearings that could be fitted into the headstock block of 45 and 40mm bore which are 75 & 68mm o.d. The headstock was made from a solid 100 mm square by 150 mm long cast iron block. The vertical column extends through the block and provides the mounting for the horizontal overarm. The headstock block and vertical column assembly were bored together for the lathe mandrel. Contoured clamp bolts lock the headstock to the vertical column and allow radial adjustment relative to the Vee groove in the column, **photos 21 and 22**.



Photo 20. Collet chuck showing camlock fittings.



Photo 21. The headstock bored out for the bearings.

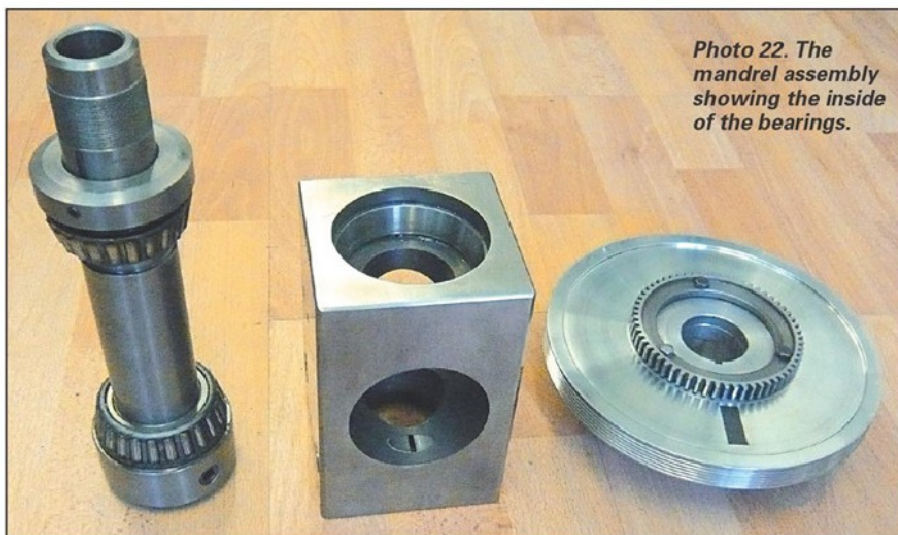


Photo 22. The mandrel assembly showing the inside of the bearings.

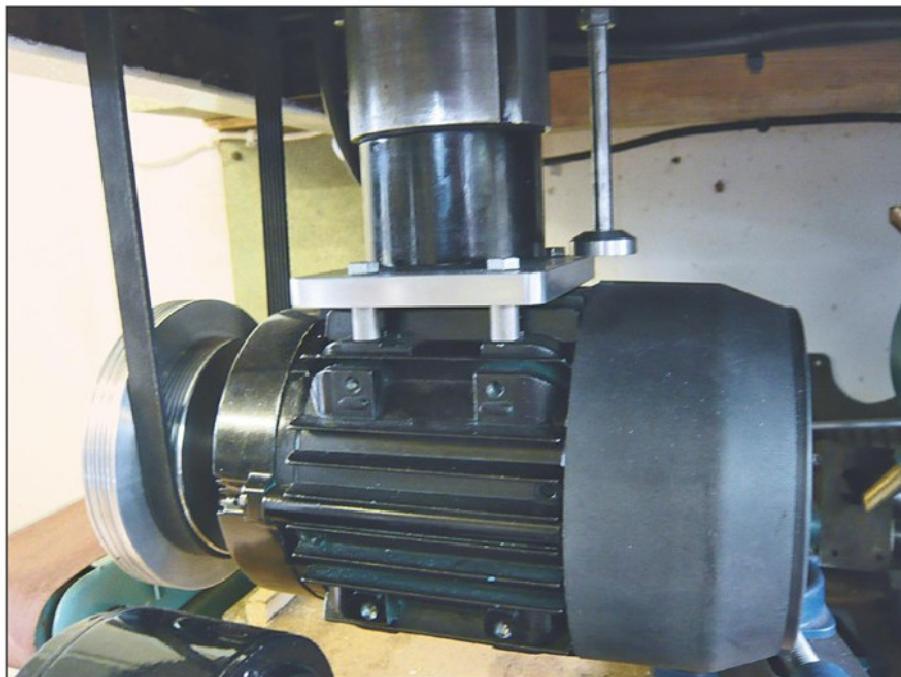


Photo 23. The motor mounting.

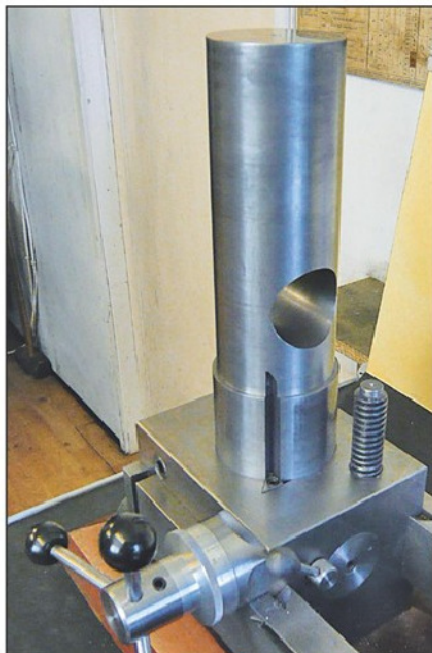


Photo 24. The column showing the triangular key.

A three-step Poly Vee pulley, fabricated and turned from 10 mm thick aluminium alloy sheet and a 60-tooth gearwheel for the mandrel stepper motor are fitted to the outer end of the mandrel with minimum overhang. The main motor could be located in many positions but I choose to mount it below the bench on the vertical column as this maintains the pulley centre distance, **photo 23**. It is as far away from the stepper motors as possible and well protected from swarf etc. and symmetrical for either rotation direction. The motor is a 430watt 1400 rpm three phase motor operating from 240v AC via an inverter. On/off, Speed and Direction are all selected at the control panel. The power output seems quite adequate.

The pulley sizes have been selected so that the belt tension is the same on each set of pulleys. A rectangular cut out is required in the bench for the belt drive. This simple direct arrangement eliminates countershafts and clutches etc. which helps to achieve a quiet, smooth operation, see photo 19 in MEW issue 150. The flat reference faces of the headstock body are useful for setting up items on the cross slide.



Photo 25. The headstock raising and lowering handle



Photo 26. The key can be removed to rotate the headstock.

Vertical column

In order to keep down the headstock block and the overarm block sizes the column has its upper section reduced from 75mm dia to 70mm dia. It is made from a solid 3in. dia x 450mm long mild steel bar. Four 24mm dia. x 250mm long holes have been bored in the lower section to reduce weight. A thick wall tube could have been used but it was not easily available. The radial triangular groove is cut the full length of the lower section, **photo 24**.

The motor is mounted directly on the vertical column via a wooden spacer with thin rubber spacers used to set the belt tension and give some flexure for easy belt changing.

Bed block

This is made from a 120mm square by 150mm long CI block. Tapered dovetails are cut into the sides for the bed bars. The elevating worm, wormwheel and screw are all in line and contained and guided in the bed block. A ball thrust bearing is fitted at the worm shaft. The elevating screw is positioned as near as possible to the centre of gravity of the moving components.

To avoid the possibility of the clamped column being unclamped and dropped, the elevating screw has a lower extension, which pushes down on the motor plate preventing the elevating screw being lowered when the column is clamped. This avoids the potentially dangerous situation whereby the raised and clamped column and headstock assembly could be unclamped and allowed to drop if the elevating screw has been wound down while the column is clamped. The column can be, adequately locked by the triangular gib lock. It has not yet been found necessary to use the two bolted clamps, which are also available to lock the column. These bolts would be required if the triangular gib is removed for say taper turning, **photos 25 and 26**.

Saddle and saddle drive

A conventional lathe saddle requires a drive connection from the lathe mandrel. Usually a gear train from the headstock transmits power to a horizontal leadscrew running from the headstock to the tailstock end of the lathe bed. The leadscrew is carefully located so that it drives the saddle with the minimum twisting moment to the saddle (racking).

Consider such a lathe using the leadscrew to drive the saddle to take a cut on a 1in. dia. bar in the chuck. The leadscrew pushes or pulls the saddle to overcome the force at the cutting tool. The resisting force at the cutting tool produces a twisting moment to the saddle. The saddle sliding along the lathe bed absorbs the twisting moment. If the fit between the saddle and lathe bed is very good the saddle will slide smoothly along the bed producing a good finish on the turned bar. If there is any slack between the saddle and bed, the saddle will be twisted until the slack is taken up. This action can result in the saddle twisting and releasing as it slides (walks) along the bed, the resultant finish on the bar mirrors this action. The long unsupported leadscrew is also prone to flexure due to the thrust. These conditions prevail whether the cut is towards or away from the headstock. In an ideal world the cutting tool would be pushed and guided in line with the cut reducing any twisting moment to zero.

The Stepperhead saddle drive and control is located at the tailstock end of the bed and eliminates the need for an apron attached to the saddle. There is no need for the leadscrew to mechanically interconnect with the mandrel because this is done electronically. This avoids a lead screw having to run the full length of the bed. Placing the leadscrew high and central minimises the racking effect on the saddle and is possible because the tailstock clears the bed. I think that if you tried to push the saddle along the bed with your finger this would be the best spot to push. To maximise the stiffness of the leadscrew it is fixed rigidly to the saddle and is as short as possible. The saddle drive thrust provision is also provided at the tailstock end of the bed. This avoids thrust provision at the saddle, which would be required for a rotating leadscrew.

The saddle is narrow and is guided by the front bed way. The rear bed way only contacts the saddle on the rear dovetail and, of course, the top. The saddle can be moved by the geared down handwheel. A 1:8 ratio provides 0.500in. movement for one complete rotation of the handwheel. The saddle stepper motor can be engaged or disengaged for automatic or manual operations. When the stepper motor is engaged the saddle can be manually fine fed via the incremented feed dial on the stepper motor when the motor is switched off. This is useful for setting up Z axis operations. The three gearwheels that give a 1 to 8 ratio at the handwheel generate a small amount of backlash (the gear centres could probably be closer) but the mesh between the stepper motor worm and the wormwheel and the leadscrew to the wormwheel can be adjusted to minimise backlash in the stepper drive. The leadscrew guide bearing block can be shimmed to adjust the mesh and the fixing arrangement at the saddle allows the leadscrew to be centralised by this bearing. Two opposed, angular contact ball bearings at the worm shaft absorb the axial thrust. Hopefully this design reduces inertia and start up forces of the saddle assembly, which assists the stepper motor drive.

Cross slide

A conventional lathe cross slide is usually operated via a feed screw moving the nut attached to the cross slide. The extent of travel is limited by the necessary location of the handwheel. The method used by the Stepperhead is unconventional but offers some advantages. The free space under the tailstock allows a full width saddle, rather than the conventional wings each side of the tailstock and permits this design.

A non-rotating feed screw fixed to the side of the cross slide meshes with a centrally positioned worm wheel. The operating handwheel rotates a worm, which meshes on the opposite side of this wormwheel. Handwheel rotation rotates the worm which rotates the wormwheel to move the cross slide. The handwheel shaft and worm are located 10 degrees from directly opposite the cross slide feed screw so that the axes of the feed screw and worm converge. The wormwheel pivot position is adjustable between these converging axes to position the wormwheel for minimum backlash with the worm and feed screw.

However the main advantage with this arrangement is that it allows unrestricted travel for the cross slide and positions the handwheel away from the cross slide movement. The 250mm long cross slide can travel the full 250mm. In fact the longer the cross slide, the longer the travel. This is very useful for milling operations etc. A full length tapered gib is used to adjust the slide. It is in essence similar to the rack feed saddle drive on conventional lathes but has the advantage of being adjustable for backlash. It is enclosed and well lubricated and the feed screw component sizes are maximised to reduce wear.

Cross slide stepper motor

The stepper motor drives a 20-tooth wormwheel mounted on the cross slide operating shaft. The drive worm is fitted directly to the stepper motor so that one turn of the stepper motor will move the cross slide 0.005in. The stepper motor drive can be engaged or disengaged via the actuating lever, which rotates an eccentric sleeve.

This arrangement conveniently positions the stepper motor out of the operator's way and allows an unobstructed surface for the cross slide. A large metal sheet can be mounted on the cross slide because the stepper motor drive components are lower than the top surface of the cross slide. The operating cable is contained in a tube under the bed, which moves radially as the saddle is moved along the lathe bed (a pivoting joint is located at the stepper motor). This keeps the cable protected and high under the bed for cleaning access.

Tailstock

Building the tailstock into the overarm has advantages in weight saving and rigidity by eliminating the need to slide and clamp the tailstock along the overarm. The tailstock can be moved along the bed when the clamps at the headstock and bed are released.

A clamp arrangement at the headstock would have still been necessary even if the tailstock slid along the overarm. The tailstock body is made in cast iron. To

reduce weight the cross members are made in aluminium and the vertical tubes in mild steel. The space below the tailstock barrel is clear and this enables the saddle to move under the tailstock, making more use of the bed length. The secondary vertical column can also be located in the forward tube of the tailstock to extend the maximum centre distance or maximise rigidity for milling operations.

The long tailstock barrel is a sliding fit in the mandrel bore. This feature was utilised to assemble and Loctite the tailstock components in position and in alignment. With the mandrel and overarm set parallel to the bed the tailstock components were Loctited together with the tailstock barrel inserted fully into the headstock bore. This ensured that the tailstock barrel was in line with the mandrel centreline.

Headstock stepper motor

Using a stepper motor to index the mandrel in conjunction with a separate milling head enables gear cutting, radial drilling, and spiral milling operations. The belt drive to the main motor can be left in place but it is probably better to remove it for these operations.

The stepper motor can be driven from the control panel or by the computer on its own as axis A or in conjunction with axes Z and X. The stepper motor worm drives a 30-tooth worm wheel, which drives a 20-tooth gear wheel meshing with the 60-tooth gear wheel mounted on the lathe mandrel. Ideally the worm would mesh directly with the mandrel gear but this arrangement permits housing the optical mandrel pulse sensor circuit board that enable screw cutting and inch/rev feeds as well. The gear mesh can be adjusted to minimise backlash. One turn of the stepper motor rotates the mandrel 4 degrees. An index wheel is provided on the stepper motor for manual setting, when the motor is switched off. The stepper motor assembly is moved up or down to engage or disengage the drive.

The motor belt can be positioned over the largest pulley only so that it does not drive the main motor and an eccentric cam located on the over arm can be used to lock the mandrel, **photo 27**. This also biases any backlash in one direction.

A single cable contains both the stepper motor control and screened pulse signal cables. I expected to have big problems with interference but it all works very well. This may be due to the fact that they do not both operate at the same time.

To be continued...



Photo 27. The cam is used to lock the mandrel.

BUILDING A CNC ROUTER 4

John Rutter concludes the series with a look at the cutter spindle options.

Having produced my milling machine and sent the article in for publication, David Clark, the editor, asked me to say a little more about the spindle or motor section of the machine. I'd originally produced the CNC article with a "how to" on making a brushless motor for the machine but chopped it because it's only a variation on the original design published previously published in this magazine and I was trying to keep things short.

It's perfectly possible to use a Dremel style mains powered mini drill to do the work. I used one for a little while as a teacher in the Step 4 machine we had but I have to say that they're incredibly noisy and not generally renowned for the quality of their bearings. After a while the cutting tool starts to cut a rather larger hole or slot than the one planned due to wobble in the bearings being accentuated by the length of the cutting tool. The Dremel style drill is very cheap however, usually with speed control built in and supplied with a variety of tools that may be of use. You don't need to find a stable power supply as they're mains powered so there are decided advantages to taking this simple option. If you go this route, remove the threaded collet to fit into the machine, **photo 1**. It'll go straight into the mounting previously described and the grub screw does a reasonable job of holding it, **photo 2** although it might be better to either modify the front (threaded portion) to take an aluminium collar or modify the mounting with an insert to spread the grip of the grub screw over a wider area.

Due to its great length I've always strapped the Dremel to the vertical slide to steady it; the ubiquitous cable tie is handy here. You may need to modify or turn up a new taper collet to hold 3mm shank tooling (the carbide cutters I use are all 39mm long and 3mm shank) unless you use imperial size cutters with a 1/8in. shank to suit the Dremel style device. I buy my cutters from www.drill-service.co.uk

The home produced brushless motor I've used for quite some time now is an "outrunner" - the magnets are held in the rotating outer can leaving the armature static - and has a kV (rpm/Volt) of around 2000 so giving around 24,000rpm on a 12V supply. I used a 28mm diameter stator, 10mm long, wound LRK style as the basis of the motor. A similar motor might be bought commercially in which case it might be described as a 28/10/x where the stator diameter and length is described along with x, the number of wire turns. Unfortunately it might also be described as a 35/18/x by some manufacturers, who use the outer dimensions of the rotating can for sizing, all very confusing I'm afraid.

As can be seen in **photo 3** the motor I made has rather oversized bearings and shaft (6mm) robbed from a VCR machine to give long life under the hard working conditions encountered in this application. Normally this size of motor would use a 4mm shaft and bearings to suit. To hold the tooling I made an adapter from 1/2in. aluminium, holding it to the motor shaft with a 3mm grub screw and using a similar grub screw to hold the cutting tool



Photo 1. Dremel style tool, collet removed and typical milling tool in front.

into the adapter. The adapter is a very snug fit on the motor shaft, tight enough that the grub screw is merely an insurance policy. The cutting tool is a snug fit for rotational accuracy but easily removed for replacement. I actually drew up a new motor with integral tool holder to avoid the long overhang between the cutting tip and lowest bearing but in practice the original motor works well enough that I didn't feel the need to complete the project. The motor is held in the machine mount by a single M4 grub screw, **photo 5** and although tiny by comparison to the Dremel, it's actually far more powerful and efficient. Being brushless it's controlled by an electronic speed controller (ESC) normally used in model aircraft. Current draw is fairly low, even when cutting, so the ESC doesn't need to be particularly large. I used an 18A version for quite a



Photo 2. Dremel style tool in the miller, note the cable tie to steady it.

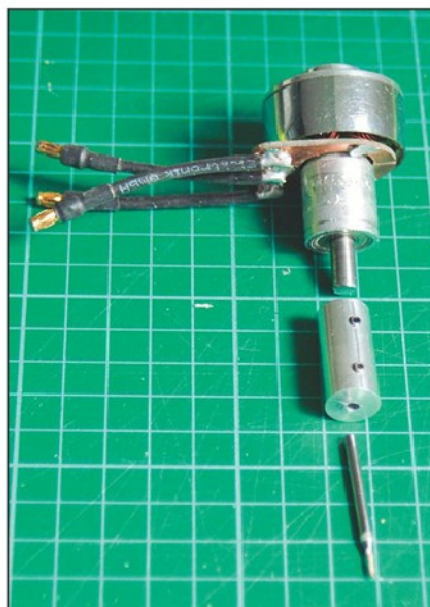


Photo 3. Home made outrunner style motor. Note the massive bearings and shaft as well as the adapter between shaft and cutting tool.



Photo 4. Motor or spindle assembly.



Photo 5. The motor assembly on the machine, compare its size to the Dremel in photo 2!

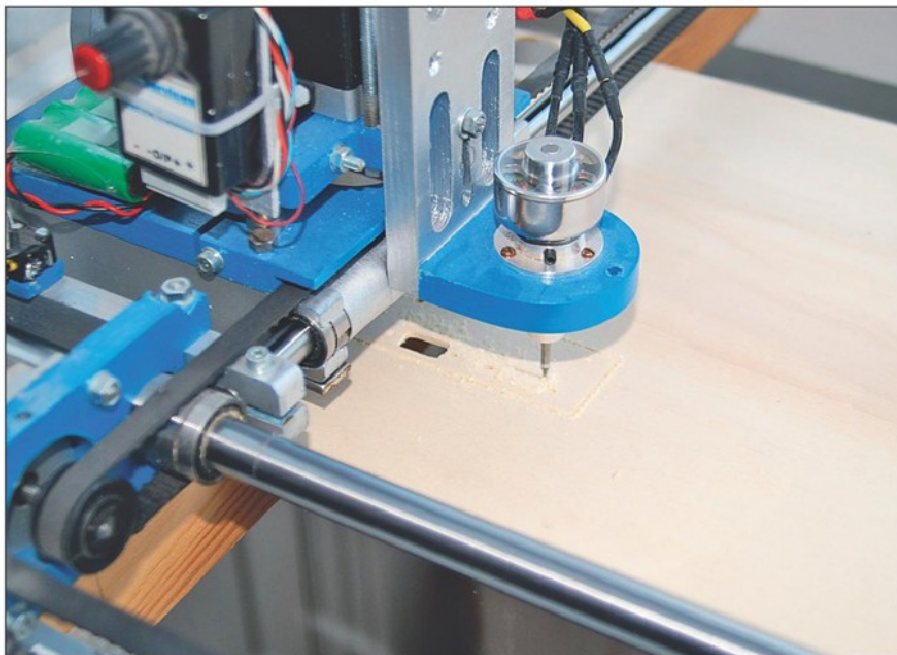


Photo 6. Cutting thin ply parts.

while, until the ESC was needed for a plane! The speed is set using a servo testing device, visible in the top left of **photo 6**, (from www.smservices.net, or other model suppliers) plugged into the ESC via the lead that would normally go to the receiver in a model. Power (12V) is most easily taken from a lead acid battery, which can be charged while in use if you like. In use the motor barely slows when cutting. Do be careful with polarity to the ESC. I "fried" one shortly before taking the pictures of the machine in action due to a hurried change-over to a fresher battery. Polarised plugs are a very good idea! If the motor turns in the wrong direction this is easily remedied by swapping any two of the three motor leads from the ESC, at this end their polarity is of no importance.

I usually cut thin ply with my machine and using a 1.5mm carbide cutter I can easily cut 3mm depth in one pass at around 800mm/min. Cutting slower can give a little better finish as can cutting in more than one pass but it's worth experimenting to give the best

compromise between finish and time on any particular material. When free running, off the machine, the brushless motor is almost silent, just a whine of bearings, but bolting it to the router seems to amplify the sound to an annoying level particularly when cutting thin materials, so I always wear ear defenders. Sometimes I use a vacuum cleaner to power a vacuum bed or to remove dust while the machine is working, so the defenders are doubly useful. "Elfin safety" would probably have a fit to find I rarely use eye protection when using the machine. I'm usually well away from it, watching the computer screen and with a finger over the "emergency stop" button!

Not that it looks a lot different but I recently made another motor for the spindle giving another 8,000rpm or so (up to 32,500rpm) which I thought might be useful when using 1mm diameter cutters. This would make the motor about 2700kv rather than the previous 2000kv. That's the trouble with this sort of project, it's forever being "fiddled with"! ■



Photo 7. The new 32,500 RPM motor.

MODEL ENGINEERS' WORKSHOP INDEX

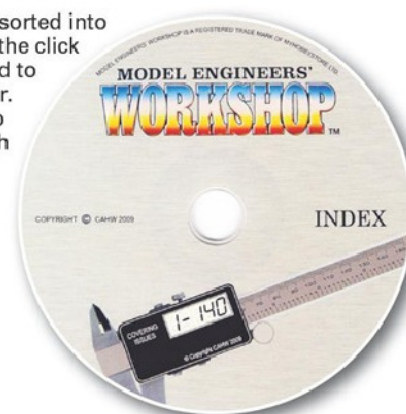
Barry Chamberlain has updated his MEW index. It is now available on CD as many readers no longer have floppy drives on their computers. It also runs under Windows. The index is very comprehensive and includes cover photos of each magazine. You can search for items you are interested in. The index is listed in:

Subject	Every subject covered in the index.
Author	Every author covered in the index.
Issue number	This displays a front cover thumbnail and the issue number of each magazine covered in the index.
Title	The title of every published article covered by the index.
Notes	This lists the source of any important corrections, amendments or comments about the content of articles covered in the index.

The columns are initially sorted into chronological order but at the click of an arrow can be changed to reverse chronological order. There is also a scroll bar so you can scroll through each column.

The price is £10.50 in the UK and £13 to overseas destinations. The index can be ordered by post from Barry Chamberlain 43 Waller Drive Banbury, Oxon OX16 9NS Tel: 01295 255744

Please note: Barry produces the printed index that appears in MEW every year. This will be published in a few issues time.



AN INTRODUCTION TO MILLING 5

Donald Brymer looks at dividing and the dividing head.

Dividing heads are used on numerous machine tools and are an invaluable addition to any milling machine for milling gears, splines, spacing holes on a pitch circle or cutting a helical lead groove etc.

In this article I would like to introduce direct, simple and angular indexing techniques on a universal dividing head with standard indexing plates. A typical simple indexing set up is shown in **photo 1**. In this instance, an 80 tooth spur gear with the sector arms behind the indexing crank as each movement is half a turn.

Direct indexing

Direct indexing is generally used for machining common divisions such as squares, hexagons and spanner flats and is the simplest form of indexing. A universal dividing head generally has a direct indexing plate behind the chuck mounting face and usually has (depending on size) 24 or 30 divisions. The direct indexing plate is the slotted plate on the left hand side of the chuck shown in **photo 1**. To direct index, the simple indexing plates at the front of the head are not used and the direct movement is obtained by dividing the number of divisions of the direct indexing plate by the number of divisions required. Example: a hexagon is required to be milled using a 24 hole direct indexing plate, $24 \div 6 = 4$ divisions for each flat of the hexagon. A couple of points here are to locate the direct indexing pin into hole 24 for the first flat of the hexagon. As the spaces are counted and not the holes the first indexing movement will be to hole 4, the second hole 8, third hole 12 and so on. If the indexing pin is in hole 1, then the first

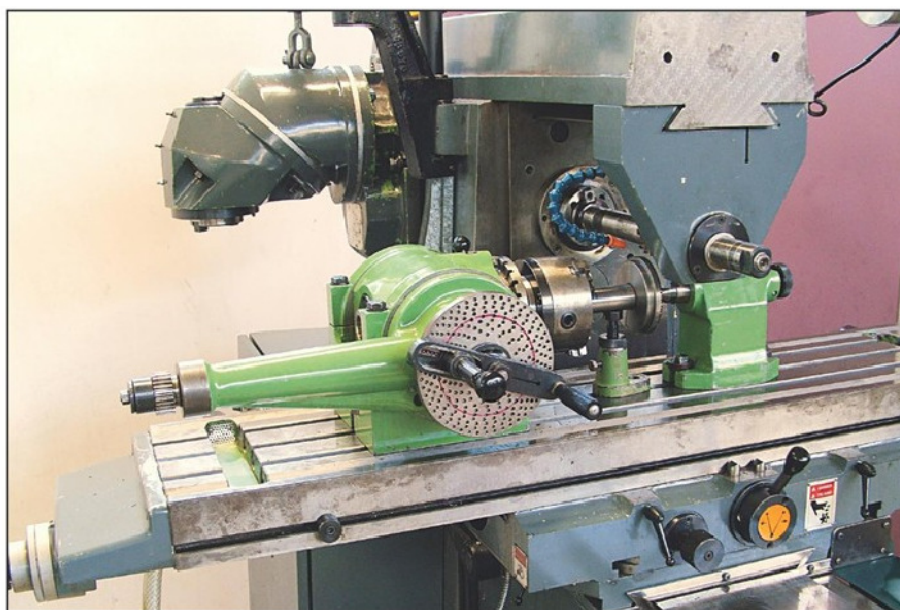


Photo 1. The dividing head.

movement is 5, second 9. It's easier to move in even numbers! When the head has been indexed past the third division allow the indexing pin to rest on the plate so that the pin locates itself into the next and fourth hole. This is better than trying to judge the locating position by eye. If the movement does pass the required hole the head must be wound back at least three divisions and then forward again to the required position. This will take care of any backlash that is between the worm and worm wheel of the head. Some like to disengage the worm and worm wheel and turn the head by hand but I prefer to

use the indexing crank but it is a matter of personal choice.

Simple indexing

Before any calculations can be done for simple indexing, the ratio between the turns of the indexing crank and one complete turn of the head must be established. This ratio is generally 40:1, (one turn of the indexing crank = $\frac{1}{40}$ th turn of the dividing head spindle), but 60:1 is also available.

Simple indexing is used when a greater number of divisions are required than can be obtained by direct indexing. The principle of simple indexing is, the worm and worm wheel of the dividing head are engaged, the indexing movement is calculated and the sector arms are set to the spacing required to enable the fraction of a turn to be obtained. **Fig. 1** shows the general arrangement of the indexing plate, crank and sector arms of a typical dividing head.

Simple indexing calculations.

The formula used to calculate the indexing movement for simple indexing is;

$$\text{Turns} = \frac{\text{ratio of dividing head}}{\text{number of divisions required}}$$

An example; calculate the indexing movement to cut a 12 sided spline.

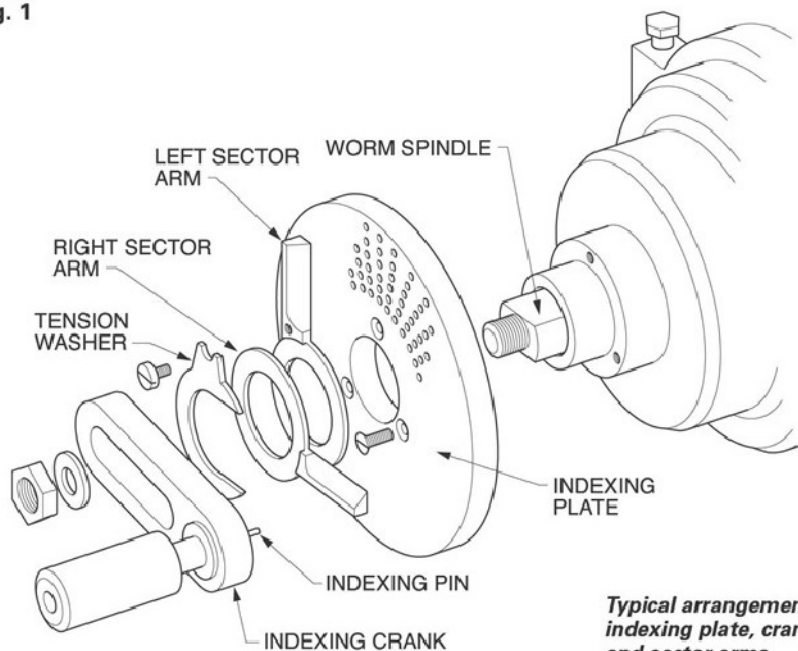
Step 1: Calculate the indexing movement.

$$\text{Turns} = \frac{40}{12}; \text{Turns} = 3 \frac{1}{3};$$

this equals 3 complete turns and $\frac{1}{3}$ rd turn for each spline.

The fraction of a turn of the indexing crank will depend on the indexing plates available. The selection of a suitable plate here must have a hole circle that is evenly divisible by 3, say a 27 hole plate. This will

Fig. 1



Typical arrangement indexing plate, crank and sector arms.

give 9 spaces, so the indexing movement will be 3 full turns and 9 spaces on a 27 hole plate.

Step 2: Set the sector arms

Fit the indexing plate with the 27 hole circle to the dividing head and mark the hole circle, (note the red marker ring on the plate in **photo 1**). This practice is to ensure that when counting the holes to set the sector arms that you do not wander into another hole circle. Set the sector arms to 9 holes, (see **figure 2**). Note here that when setting the sector arms, set the indexing pin into the hole that is numbered, set the left sector arm to the indexing pin and then count 9 holes from that position. Most importantly "do not count the hole that the pin is in". Set the right sector arm to the 9th hole. When setting the sector arms the chamfered section of the arms is against the indexing pin.

After setting the sector arms, test the indexing movement by turning the crank the full calculated movement. In this example, repeat three times and the sector arms should be in the original position. Two good habits to use here are, after the second last hole has been past, allow the indexing pin to rest on the plate so that the pin finds the next hole and to move the sector arms to the next position before leaving the dividing head. Leaving this step until the next indexing movement often results in an incorrect movement as the movement is started without moving the sector arms.

Should the indexing pin be moved past the required hole, the crank must be reversed at least half a full turn and then brought back to the correct hole. This will eliminate the backlash that exists in the worm and worm wheel. Indexing can be carried out in either clockwise or anti-clockwise directions setting the sector arms accordingly, but I suggest that one direction is chosen and used in most cases.

Step 3: Final test

As a final check that the indexing movement is correct, set the work and cutter to the job requirements and "nick" the end of the work only, withdraw the cutter and index, "nick" again. Repeat this until the last movement coincides with the first position. If this is achieved full machining begins. This practice is shown in **photo 2**. It is time consuming but not as time consuming as finishing a gear cutting sequence with the last tooth one and a bit teeth wide.

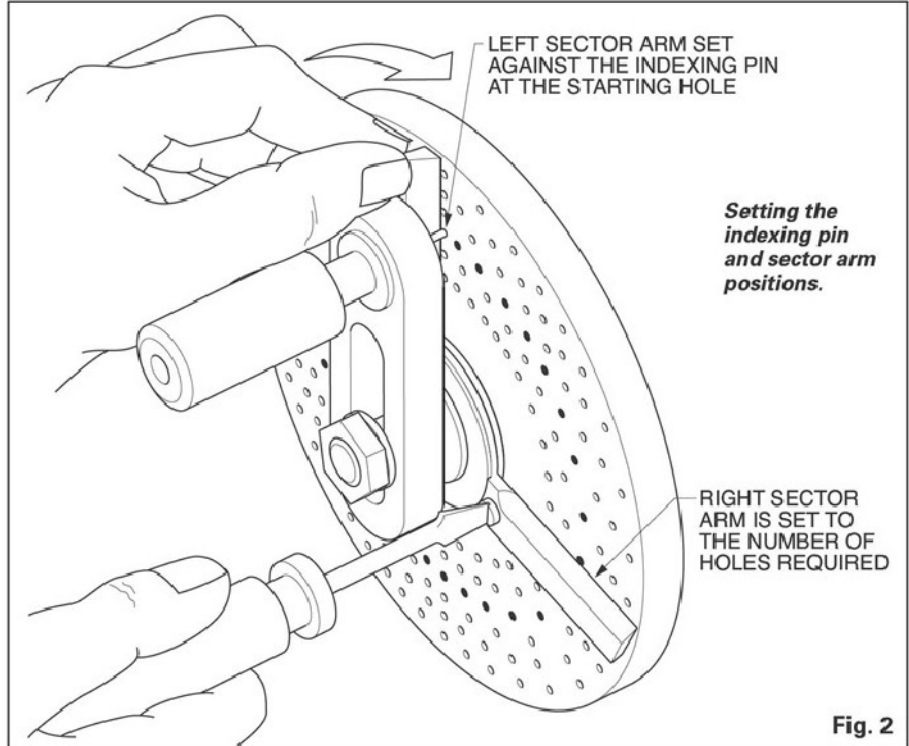


Fig. 2

Angular indexing in degrees

When the need arises to index a specific angle rather than a fraction of a revolution a 40:1 dividing head will give 9deg. per revolution of the indexing crank, ($360 \div 40 = 9\text{deg.}$). It then follows that a $\frac{1}{9}$ th turn of the indexing crank will give 1deg. One degree can be obtained by moving the indexing crank 2 holes on an 18 hole plate or 3 holes on a 27 hole plate etc.

Angular indexing calculations in degrees.

The formula used to calculate the indexing movement for angular indexing is;

$$\text{Turns} = \frac{\text{degrees to be indexed}}{9}$$

An example; movement required for 55deg.

$$\text{Turns} = \frac{55}{9}; \text{Turns} = 6\frac{1}{9};$$

this equals 6 full turns and $\frac{1}{9}$ th turn or 6 full turns and 2 spaces on an 18 hole circle or 6 full turns and 6 spaces on a 54 hole plate.

Angular indexing calculations in minutes.

As one turn of the indexing crank equals 9deg., it must then also equal 540 minutes. For calculating an indexing movement for degrees and minutes bring the whole angle to minutes. The formula for indexing movement is then;

$$\text{Turns} = \frac{\text{angle in minutes}}{540}$$

An example; movement required for 36deg. 40min.

$$\text{Turns} = \frac{2200}{540}; \text{Turns} = 4\frac{2}{27};$$

this equals 4 full turns and $\frac{2}{27}$ th of a turn or 4 full turns and 2 spaces on a 27 hole circle, or 4 full turns and 4 spaces on a 54 hole plate.

In a situation when the denominator of the fraction of a turn is not divisible into any hole circle e.g.

27deg. 35min. has an indexing movement of 3 turns and $\frac{7}{108}$ th of a turn a close approximation can be found. Divide the denominator by the numerator to find which two fractions the part movement falls between. In this example $\frac{7}{108}$ is between $\frac{1}{15}$ th and $\frac{1}{16}$ th, but is closest to $\frac{1}{15}$ th. This gives us 1 space on a 15 hole circle or 2 on 30 etc. to bring this to minutes $\frac{1}{15} \times \frac{540}{1} = 36'$.

So the indexing movement is one minute greater than required. For most purposes this degree of error may be acceptable, if not, add the two closest fractions together and this becomes $\frac{1}{15} + \frac{1}{16} = \frac{2}{31}$,

or two 2 places on a 31 hole plate.

$$\text{So. } \frac{2}{31} \times \frac{540}{1} = 34.84';$$

now the indexing movement gives 27deg. 34.84' or 27deg. 34' 50", a little closer to the required angle.

If the calculations are not for you then there are many machinery handbooks that have indexing movements for all situations pre calculated. I just like doing the calculations! ■

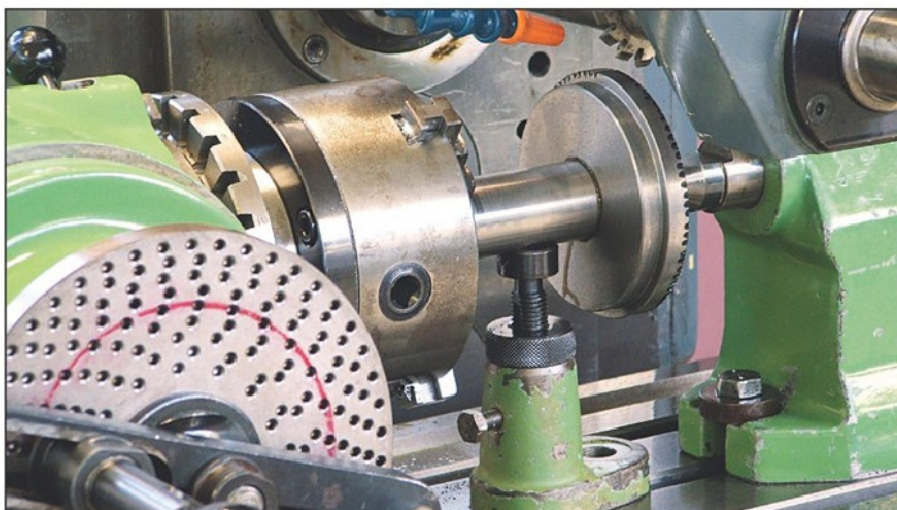


Photo 2. Cutting a gear, notice the trial nicks.



Photo 1. A front view of the DRO.



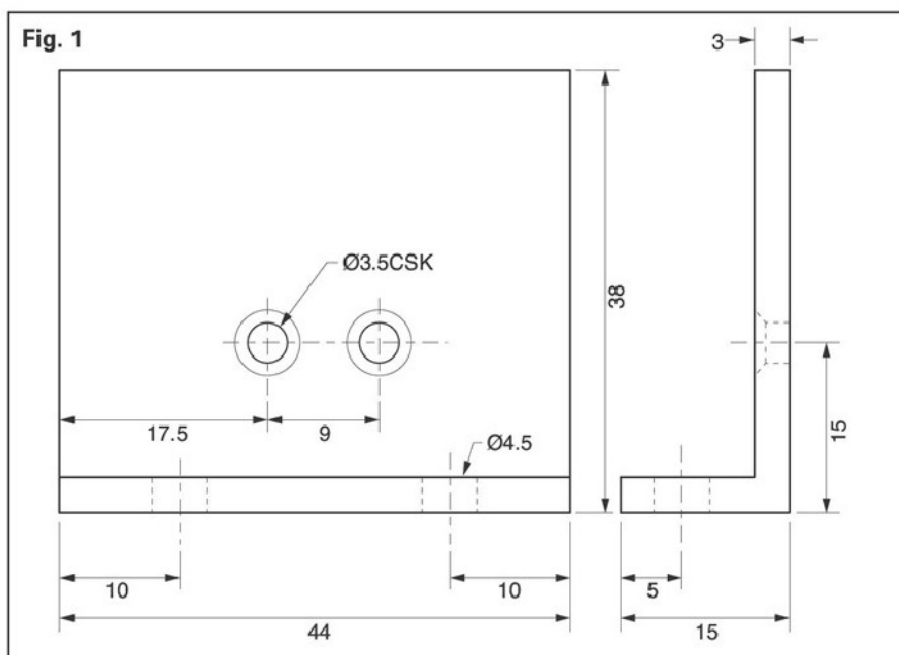
Photo 2. A rear view of the DRO.

HEADSTOCK AND BASE MODIFICATIONS TO THE SIEG SUPER X1L MILLING MACHINE

David White adds a fine feed digital readout and a spindle guard.

When used manually the depth of cut on the X1 mill is usually set by the fine down feed handwheel on the headstock. The main Z-axis leadscrew is simply used to position the headstock at the top end of the travel available via the fine down feed and then the headstock is locked in position. Because the X1 is a small milling machine the headstock is necessarily crowded with levers, handwheels, and the spindle guard. In particular the indexable dial on the fine down feed handwheel is obscured by the handwheel itself. This makes it impossible to watch the progress of the cutter and monitor the depth of cut simultaneously. There is also a degree of backlash in the fine down feed mechanism to bear in mind when altering the height of the milling cutter. Both of the problems mentioned here can be cured by fitting a digital readout (DRO) to the fine down feed. Various methods of fixing the DRO in position were experimented with before finally settling on the method described here.

Fig. 1



Sometimes it is necessary to remove the spindle guard temporarily from a milling machine in order to take measurements or to build a setup. I always operate my machines with the guards in position on the principle that the more material there is between me and potentially flying bits

of metal the better! The spindle guard on the X1 mill is fixed in position and time consuming to remove and replace. Possibly this is why the internet is littered with pictures of X1 mills with the guards permanently removed! The spindle guard on the next member of the Sieg mill



Photo 3. The simple mounting bracket.

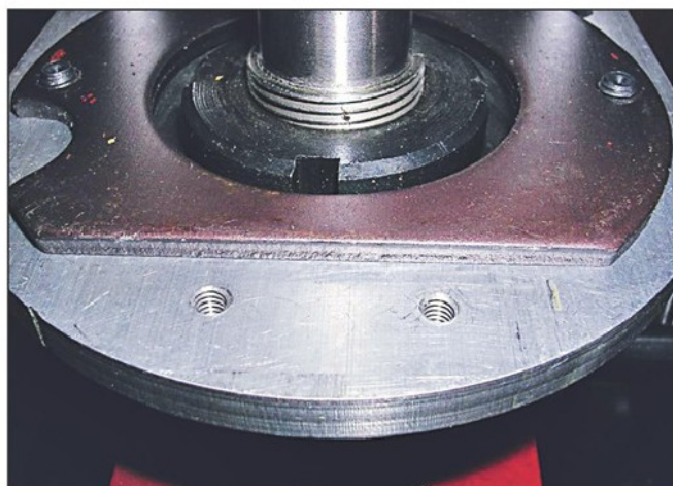


Photo 4. Motor plate holes.



Photo 5. The bracket fitted to the DRO body.

family up from the X1, namely the X2, is very quick and easy to remove and replace. It also has some height adjustment, and is bigger than the X1 guard. The X2 spindle guard assemblies are readily available as spare parts, and as it turns out, straightforward to attach to the X1 headstock. The impetus for this modification came about when the original spindle guard was broken during

headstock removal (I hadn't removed the spindle guard!)

In an earlier article I described how to fill the X1 column with epoxy granite in order to damp vibrations and reduce chatter. In addition the epoxy granite adds quite a bit of mass to the column and more mass is always good in machine tools. I have had my X1 in pieces more times than I can remember during the ongoing upgrade saga and it was during one of these teardowns that I noticed that the bottom of the X1 base casting is nicely pocketed and begging for an epoxy granite fill. The X1, as delivered, can be lifted and moved around single handed, but it's right at the top end of the safe recommended weight. If you fill the base and column of the X1 with epoxy granite I strongly recommend that you split it into at least two parts, perhaps by removing the headstock and motor assembly, before attempting to move the machine.

Fine feed DRO

The 4 inch vertical DRO used in this project is widely available from advertisers in MEW and on the internet. They are all extremely similar and most importantly are identical in respect of the mounting holes. Front and rear views of the DRO are shown in **photos 1 and 2**.

The DRO body is fitted to the front of the motor mounting plate with M4 cap head screws using the simple bracket shown in **photo 3 and Fig. 1**. The bracket is simple to make from a piece of equal angle 1.5in. by 1/8in. aluminium. The positions of the

holes for mounting the bracket onto the motor plate are not critical but must match the positions of the tapped holes in the motor plate typically shown in **photo 4**.

The bracket is fixed to the DRO body using the M3 countersunk screws that come with the DRO, as shown in **photo 5** before fixing to the motor mounting plate. The bottom end of the DRO scale is fixed to the front of the X1 headstock using the aluminium block shown in **photo 6 and Fig. 2**. The block is made from a small piece of 10mm aluminium plate and is mounted to the headstock using the M4 tapped holes that used to hold the spindle guard in position. The thickness of the step in this block is critical and is determined by trial and error as follows. Make the block according to **Fig. 2** but leave the step thickness at 6 or 7mm and mount it on the X1 headstock as shown in **photo 7**.

Fix the DRO to the motor mounting plate, using the bracket previously described, then fit the mounting hardware that came with the DRO to the bottom of the stainless steel scale. Make sure that the mounting hardware is properly seated on the scale and that the screws are tightened up. Pull the scale down until it contacts the top of the aluminium block previously mounted. **Photo 8** gives the general idea. Mark the top of the block where the rear of the mounting hardware touches it and remove the block from the headstock. Mill the step thinner until you are just above the mark previously made. Refix the block to the headstock and retest by pulling



Photo 6. The block carries the bottom end of the DRO.

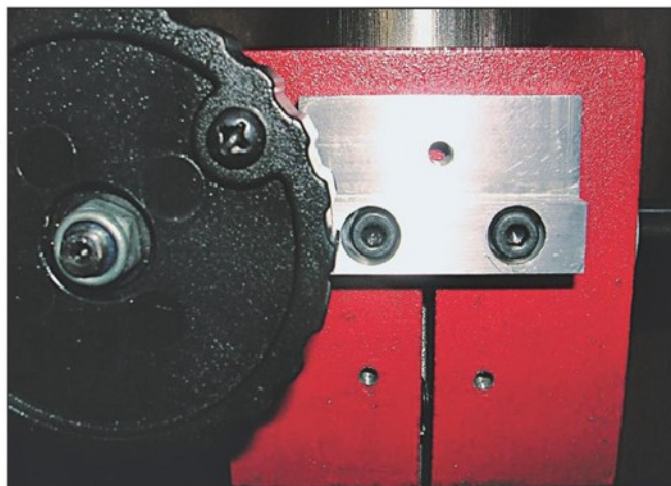


Photo 7. The block mounted on the headstock.

Fig. 2

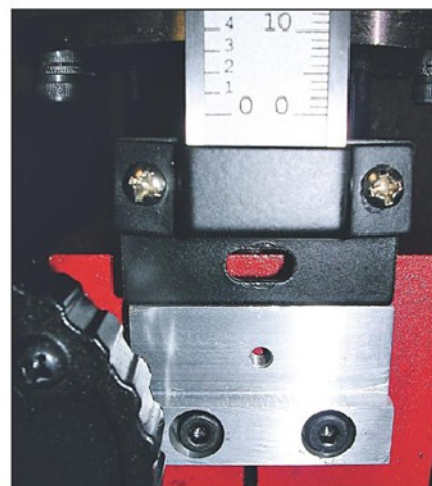
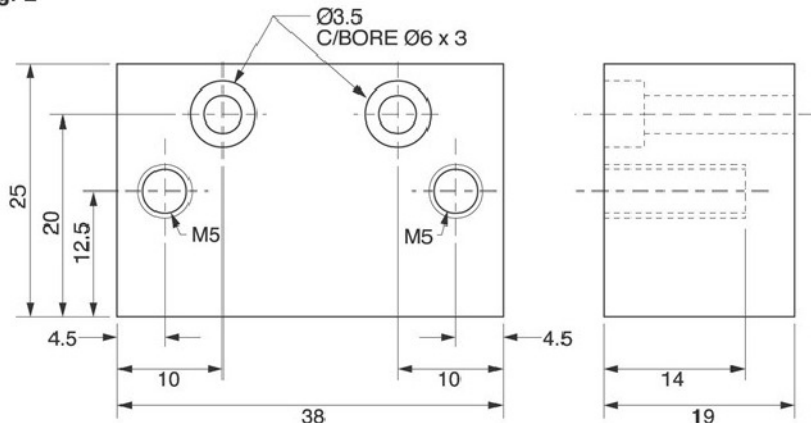


Photo 8. Mounting the lower end.

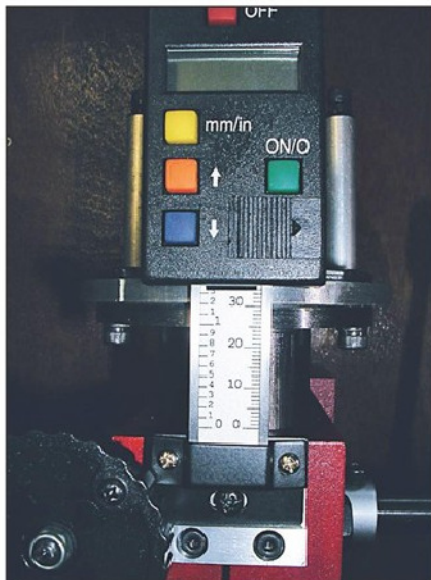


Photo 9. The readout fully assembled.



Photo 10. The spindle guard assembly.

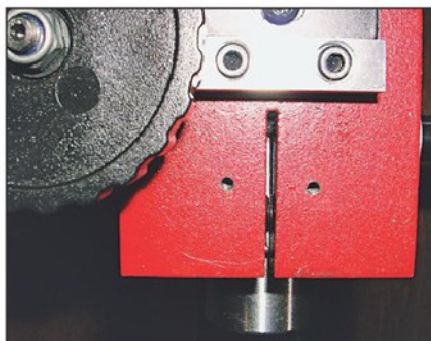


Photo 11. Holes for the guard spindle spacer block.

down the end of the scale. Stop this process when the fitting on the end of the scale JUST slides over the top of the step in the block when pulled down. It'll take three or four iterations to get the step depth correct to within 0.1mm. If the step depth isn't exactly correct the scale might bind in the DRO body when moved up and down. If you take too much metal off it's easy enough to correct the situation by placing thin plastic or aluminium shims

between the block and the mounting hardware on the DRO scale. When everything is finally assembled as shown in **photo 9** there should be smooth up and down movement when the quill is moved with the coarse feed drilling handle.

The DRO fittings described above assume that the belt drive modification has already been made. If you are starting from a stock X1 mill then the mounting parts required are largely similar/identical except that the angle mounting bracket for the DRO body is fixed to the top of the motor/gearbox assembly. Obviously the angle bracket needs to be inverted and is best fixed to the upper pair of mounting holes in the DRO body.

Spindle guard

As the holes previously used to mount the old spindle guard have been utilised for the DRO an alternative means of fixing the new spindle guard in position must be found. At first sight this appears to be a real problem because the mount must fit on the front of the headstock, and there isn't any space left that won't interfere with the operation of the spindle lock. The spindle lock is rarely required on the X1 because the fine down

feed is firm enough in operation to keep the cutter at the desired height. In any event the lock isn't absolute and can be defeated by a firm downwards pull on the drilling lever in coarse feed mode. There are alternative methods of locking the spindle, a topic to be returned to in a later article. If operation of the standard spindle lock is no longer required there is plenty of space available to mount the new spindle guard.

The spindle guard assembly consists of a plastic mounting fixture and a polycarbonate guard. The guard has a slot in it which mates with a protrusion in the plastic fixture and is retained in position by a thumbscrew. All of these components are shown in **photo 10**. The plastic mounting fixture for the guard cannot be fixed directly to the front of the headstock because the guard would foul the fine down feed handwheel. A spacer block is therefore necessary to position the guard far enough out so that the handwheel can still be operated. The spacer block is 19mm thick aluminium and fixed to the front of the headstock via a couple of holes drilled and tapped M3 into it as shown in **photo 11**. A pair of blind holes drilled and tapped M5 in the aluminium block retain the plastic mounting fixture for the spindle guard as shown in **Fig. 3**. The parts for the spindle guard assembly are shown in **photo 12**, whilst the spindle guard mounted on the X1 along with the DRO is shown in **photo 13**.

If you are familiar with the X2 spindle guard you may have noticed that the slot in the polycarbonate is somewhat longer than usual. This allows for some vertical adjustment of the guard position to suit the task at hand.

I had never milled polycarbonate before and was a little worried about shattering the guard if I extended the slot. The general recommendation for cutting polycarbonate involves high spindle speeds, special cutters, and flood coolant. I had access to none of these so I used a standard 6mm end mill at 500rpm, with some trepidation, on the smallest bit of the broken original guard. This worked fine giving nice, clean transparent edges. I therefore decided to see if I could make anything from the larger piece of the original guard. The original guard was T shaped with a thick crosspiece (the guard proper) and a thinner stem (for mounting). It was broken diagonally across



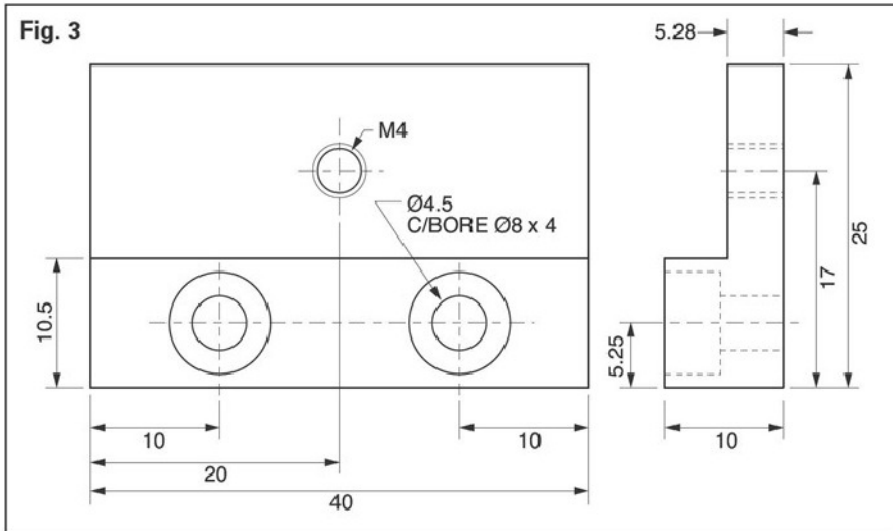
Photo 12. The parts for the new spindle guard assembly showing the spacer block.



Photo 13. The guard mounted on the mill.



Photo 14. The smaller guard.

Fig. 3

the stem. The stem was milled off and a slot cut in the crosspiece in one go using a sharp 10mm end mill at 400rpm. The slot fits in the X2 mounting fixture and yields a second, small, spindle guard to complement the larger one as shown in **photo 14**.

I subsequently discovered that polycarbonate is quite easy to mill at low speeds, and with large cutters, provided that the cutter is very sharp. Well used end mills simply rub the polycarbonate without cutting. After gaining confidence I enlarged the slot in the X2 spindle guard with a 10mm end mill as before.

X1 mill base

The bottom of the X1 base casting could almost have been deliberately designed for filling with epoxy granite. It is nicely compartmentalised and there are only three holes that need to be protected; the bottom gas strut mounting hole, and the two mounting holes for the y-axis leadscrew nut. The gas strut hole was protected with a cap head screw with the portion inside the casting covered in grease. The protected area for the leadscrew nut mounting holes needed to be much greater to allow for fitting the mounting screws through the

epoxy granite. Two lengths of well greased 15mm copper pipe were fixed in position with bolts and greased washers as shown in **photo 15**.

The lower washers abutting the casting were probably unnecessary as the copper alone is soft enough to mould to the roughness of the casting and form a seal against the epoxy. The final stage of preparation, before commencing the epoxy granite fill, is to mix up a small amount of resin and hardener to paint the inside of the casting. This ensures that the epoxy granite adheres to the casting as well as possible. The painted on epoxy can be seen glistening in **photo 16**.

Small batches of epoxy granite can now be mixed up to fill the compartments in the casting one at a time. The ingredients, mixing, and suppliers of the epoxy granite components were described in MEW No. 151 and will not be detailed again here. The compartments are filled one at a time because the mixed epoxy granite is only workable for 15 minutes and it takes time to pour and tamp the mixture so that air bubbles are eliminated as far as possible. The first compartment has been filled in **photo 17** and all of the compartments in **photo 18**.

The epoxy granite should be left for at least 24 hrs to cure, whereupon the protective screws, copper pipe, washers, and bolts can be removed. The washers between the casting and copper pipe obviously cannot be removed and will remain buried in the epoxy. ■



Photo 15. Copper tube between the washers protects the bolt holes.



Photo 16. The base has had a thin coat of resin.



Photo 17. The first component filled.



Photo 18. The base completed.



Photo 1. Job to do.

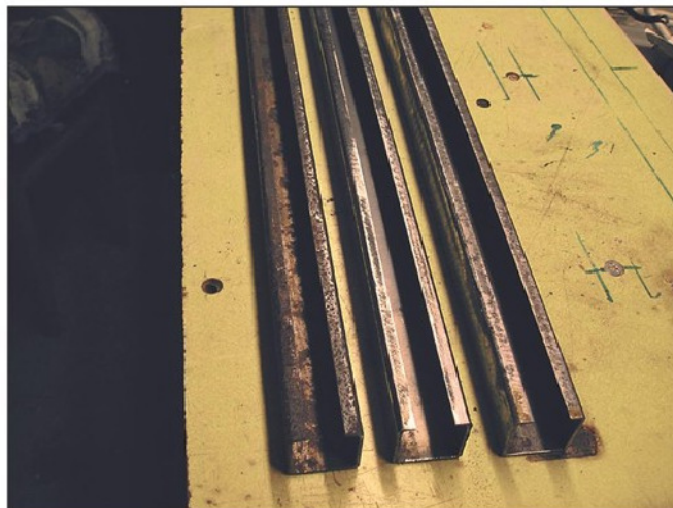


Photo 2. The job finished.

A VARIABLE FEED DRIVE FOR A MILL/DRILL

Wilf Baker speeds up production.

Why add a table feed?

Having a number of lengths of 36in. long X 25mm square box section steel that required a 12.5 mm slot the full length of them, the machine for the job was the mill/drill.

My mill/drill is a Sealy SM25 with a table screw 10 TPI. and no power feed. A quick calculation meaning that for each length it would take 360 turns of the handwheel for each one. That is if you cut alternate lengths right to left and left to right. If you want to keep cutting all the same way that is another 360 turns to rewind, a total of 720 turns per length. 100 lengths would mean a very tired arm with either 36,000 or 72,000 turns.

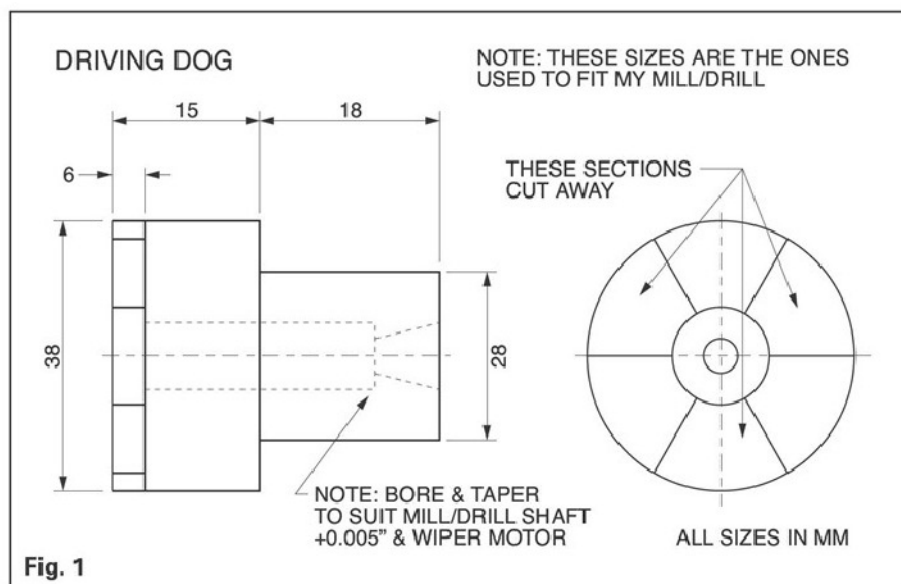
Photo 1 shows the raw material and photo 2 shows the finished job.

The answer is a power feed but it must be quick to make, cheap to produce and easy to fit. Likewise quick and easy to remove because I need the room to operate the Myford on the left hand side of the mill and the Hobbymat on the right hand side of the mill. Also I did not want to alter the milling machine much.

I had heard that a windscreen wiper motor had been used to do this job so the



Photo 3. Wiper motor.



first thing was a trip to the car breakers. I know the father of the lad that owns the yard and came away with a wiper motor off a VW Golf for £2. I said it had to be cheap. I think most makes would have done but this one was already off the car, photo 3.

A quick check with a 12-volt battery found that it worked in both directions if you changed the wires round, but it looked to be going a little too fast even with its gear box fitted. We have a member in our club that knows about things electrical, in fact he knows about everything, thank goodness. Therefore, the controller would be a nice little job for him. The wiring diagram is included later in this article.

The drive dog (Fig. 1)

On the end of the mill/drill table screw is a drive dog that the handwheel mates with to turn it, so a drive dog like that on the wiper motor was the next step. The drive dog was made from an odd end of mild

steel from the scrap box. Where would we get material if we did not have a scrap box? The outside is not important; I made mine the same size as the drive dog on the handwheel. The end of the wiper motor shaft was tapered with a 6 mm thread on the end. I am not sure if all wiper motors are, but this one was.

A 40 mm diameter billet of steel 40 mm long was set up true in the four jaw chuck on the lathe and a small cut taken on the outside to make sure it was true so it could be used for setting up when the item was turned round. Also, face the end. For those of you that do not have a dividing head or rotary table, or people that have never marked out a driving dog, put a small dimple in the centre with a centre drill. You are going to use this to mark out the sections of the dog. Remove from the lathe and paint the end with marking blue. Now with a set of compasses draw a circle on this end, any size will do. Using the same radius, scribe arcs around this circle

from one arc to the next. This will give you six sections. This method is near enough for this job. You can now lightly pop these lines. Re set this up in the four-jaw chuck with the face you have just marked out to the chuck face set true with a dial indicator. Face to length, and then centre drill and then drill a 6.5 mm hole in the centre of the drive dog. This does not have to be reamed as the fit is on the taper, which I did next by setting the compound slide to the correct taper and bored the driving dog out. If you are worried about getting the taper right then try doing it on a scrap piece of steel first. When you are satisfied with the taper fit on the wiper motor, turn the job round in the four jaw chuck and again using a dial indicator set true. Bore to the size of your mill/drill table shaft, and deep enough to get the nut on the wiper motor thread. Take off the sharp corners and the turning part of this job is completed.

Milling the dogs

If you have a rotary table then the next operation is straight forward, if not, this is where the marking out comes in. Set the dog true on the rotary table or on end in the vice with one of the lines you have marked on the end parallel with the cross slide or long slide, **photo 4**. Then, in my case, I found if I used a $\frac{3}{8}$ in. slot drill cutter it was just right to cut the slot. The size of your cutter will be half of the bore size of the driving dog. Set the edge of the cutter to the line that is parallel to your cross or long slide, and runs through the centre of the job and then set to the required depth and machine straight

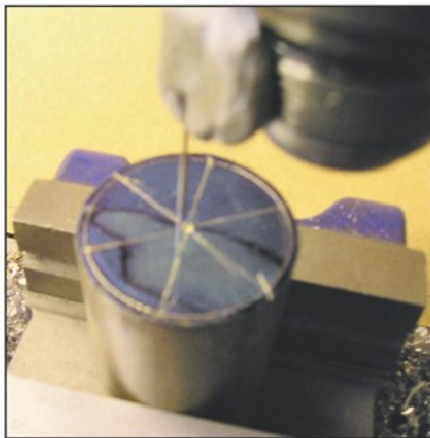
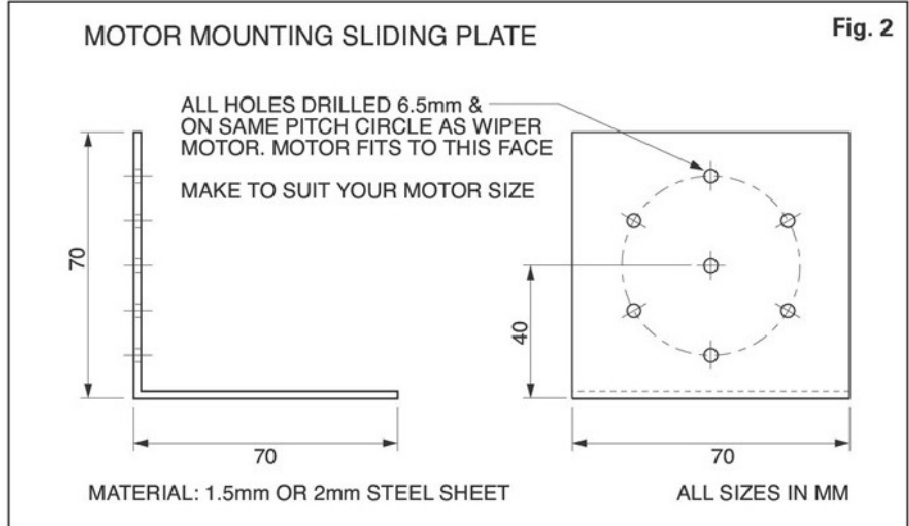


Photo 4. Setting up driving dog.



across the job. Lift the cutter clear and wind back to where you started. Turn the rotary table 60deg. or if using the vice turn to the next line and set it parallel to the machine. Take the cutter down to the same depth as before and again cut across the job. The milling is now completed. Of course, the edges will need dressing up to finish the job. If you are in doubt about what it should be like, you can always look at the hand wheel; it has to be the same as that. Once the milling and dressing up is complete then put the drive dog to one side and look at how we are going to fix the unit to the mill/drill. **Photo 5** shows the completed drive dog. **Photo 6** shows the handwheel for comparison.



Photo 5. Driving dog completed.

The motor mounting sliding plate (Fig. 2)

Now get a piece of 1.5 mm or 2 mm sheet steel 90 mm wide and 140 mm Long. Scribe a line exactly in the middle of the length and make a 90 degree bend across the width. If like me, you do not have a bending machine, clamp the sheet between two lengths of steel set on the centre line and you can fold it by hand. It will not matter if the bend is not sharp. On the vertical piece, make a mark 40 mm up from the bottom face and then mark the centre of the width and centre pop where they cross. The 40 mm height is not too important as adjustment is allowed for on the support brackets. From this centre pop, mark out the pitch circle for the mounting holes of the wiper motor.

On my wiper motor there are three mounting holes but I decided to drill six equally spaced on the pitch circle so the motor could be mounted in different positions. I am pleased I did because I would have ended up with it sticking up in the air and would have been unable to have long work over the table end and the feed motor. The only restriction now is the width of the shed. Drill the centre clearance hole; this is to clear the motor shaft and then drill the mounting holes. These I drilled 6.5 mm as the fixing screws were 6 mm. See **Fig. 2** and **photo 7**. The sizes are only a guide as different wiper motors will not be the same as mine but it will show you how I did it.

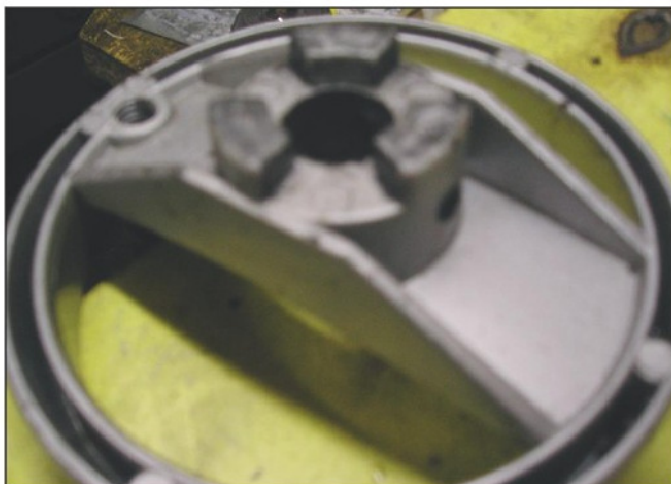


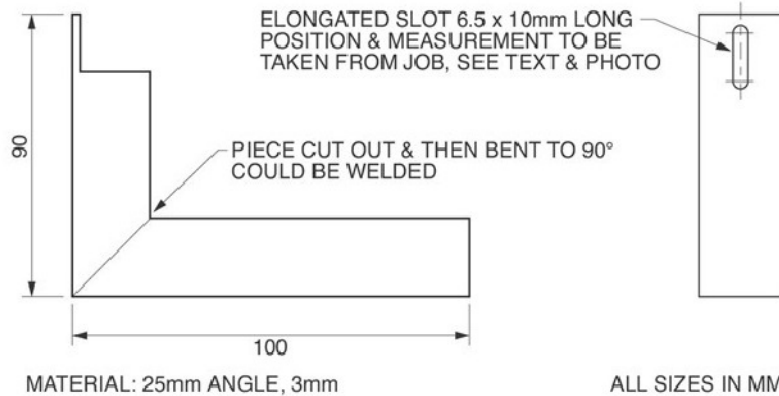
Photo 6. The handwheel dog.



Photo 7. Sliding plate.

SUPPORT BRACKETS FOR SLIDING PLATE

Fig. 3



SHAFT BEARINGPLATE OF MILL/DRILL

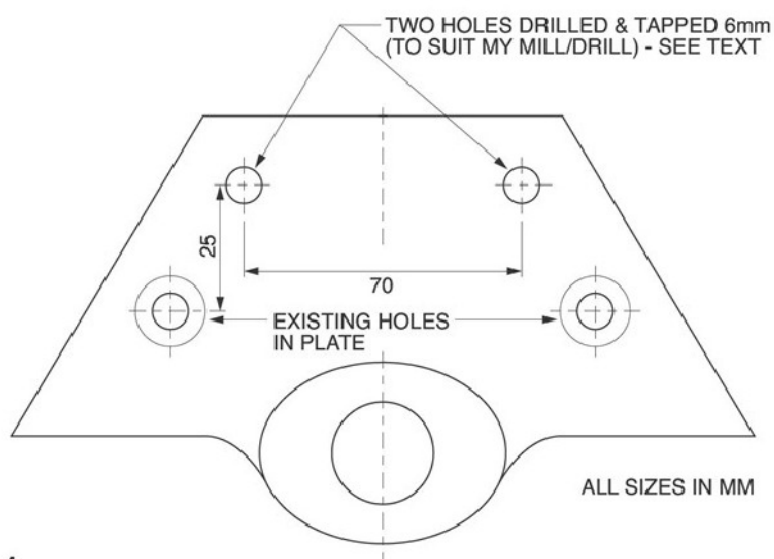


Fig. 4

Supports brackets for motor sliding plate (Fig. 3)

These are just two pieces of 25 mm angle iron 3 mm web, 190 mm long. Cut and bend as shown in Fig. 3 and then weld and drill 6.5 mm. The position of these holes is taken from the mill/drill when the bearing plates from the mill/drill have been drilled and refitted. After drilling, elongate these holes 5 mm above and below centre. This is for the adjustment. **NOTE:** one is left handed and one is right handed. The pieces removed at the top are just to make it easy to tighten

and undo the wing nuts. **Photo 8** shows the pieces being removed on the mill/drill. If you do not have the facility of welding I think, just bending will suffice, as there is not a lot of pressure on the joint, **photo 9**. It is easier sometimes to understand sketches and photos than the writing.

Altering the machine (Fig. 4)

There are four holes to be drilled and tapped in the bearing plates on the end of the table. (Only two if you are only going to use the feed motor at one end). It is

easier to remove this plate than try to mark them out, drill, and tap square when on the machine. The milling table screw runs in a bearing, which is in the bearing plate bolted on to the end of the table. In my case, I had to remove the driven dog piece that the handwheel fits in to. This was held in place with a roll pin; after knocking it out the dog just slipped off the shaft. There are two cap headed set screws holding the bearing plates to the table and on removing the bolts these plates just slide off. I say plates because I drilled two holes in both plates so the feed drive could be used at either end of the table.

After removing the bearing plate, mark them out for the two holes for the support brackets. The distance these holes are apart must be the same size as the width of the motor mounting slide plate plus 22 mm which is the inside measurement of one of the support brackets. This should then bring the holes in the support brackets in the centre of each of them. The height for these holes is the best position on the bearing plate. On my mill/drill it worked out to be the equal distance between the existing holes in the bearing plate and the top edge of them. After marking out drill and tap 6 mm. I used 6 mm because I had some 6 mm wing nuts but any size could be used. I loctited some short lengths of 6 mm studding into the wing nuts to make the fixing screws. The only thing left to do, except for the controller, is drill the holes in the support brackets. The best way to get the position of these holes is to stand the support brackets on the bench with the uprights facing you and the insides facing each other with the sliding plate in between them. The distance that you drilled and tapped the holes in the bearing plates is the distance that these holes should be apart on the support brackets. This should be equal from both outside edges. To work out the centre height of these holes, fix the motor to the motor sliding plate and fit the driving dog to the motor. Now slide the driving dog onto the drill/mill shaft engaging the dogs together. If you now measure from the underside of the sliding plate to the centre of the holes you have drilled in the bearing plate (the motor plate must be level) both fixing hole centres should be the same. Transfer this size to the inside of the support brackets or add 3 mm to the thickness of the brackets to the size and make on the outside. You can now drill these holes 6.5 mm and elongate 5 mm above and below centre. **Photo 10** shows the bearing plate drilled and tapped ready to be put back. **Photo 11** Shows it on the mill/drill.



Photo 8. Milling the brackets.

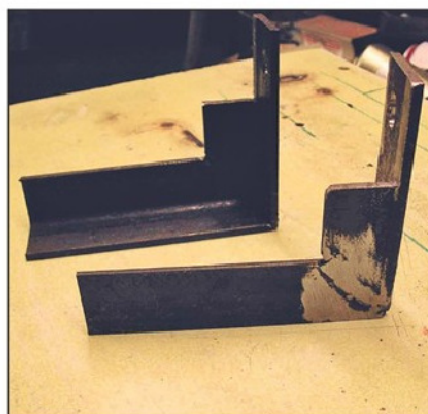


Photo 9. The support brackets.



Photo 10. Bearing plate drilled and tapped.



Photo 11. Bearing plate back on machine.



Photo 12. Brackets fixed to machine.

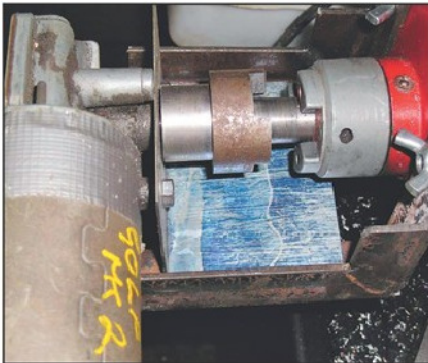


Photo 13. Dog disengaged allowing shaft to be turned from other end.

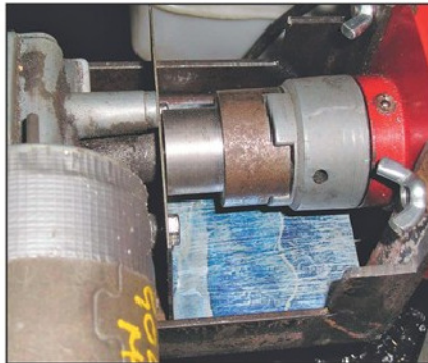


Photo 14. Unit slid in to engage for drive.

Fitting to the mill/drill and operating

This is the easy part; loosely bolt the support brackets with the inside of the angle facing each other to the end of the mill/drill using the wing bolts in the holes you drilled in the bearing plates, **photo 12**. Next engage the driving dogs on the shaft of the mill/drill and now by squeezing the support brackets together and lifting them to take the weight of the motor, which will level up the sliding plate, tighten the wing bolts up. To operate you just slide the plate in and out to engage the dogs. Of course, if you are like me and need the room you can just lift it off and leave on the table or on top of the mill/drill.

Photo 13 shows the drive disengaged. By sliding the motor up to the driving dog it engages, **photo 14**. I found that on other than the fastest speed it is possible to engage/disengage without stopping the wiper motor.

With the wiper motor and controller I used with the 10 TPI screw, I can have a feed rate from nothing to just over 100 mm per minute. Because of the ease and quickness of use, hand winding is a thing of the past even on very short jobs.

The control box is shown in **photo 15** and the internal wiring is in **photo 16**. **Fig. 5** shows the complete wiring diagram for the controller. ■



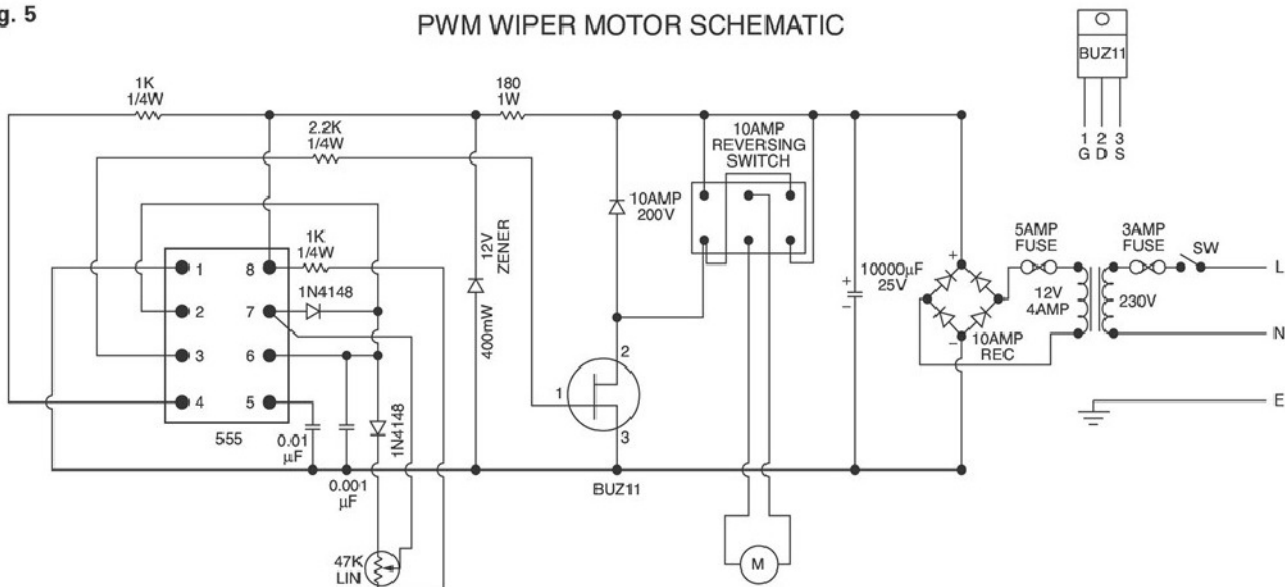
Photo 15. The control box.



Photo 16. Inside of the controller.

Fig. 5

PWM WIPER MOTOR SCHEMATIC



A Clarkson Tool and Cutter Grinder 5

Mike Haughton looks at sharpening the flutes of milling cutters, slitting saws, side and face cutters and resharpening lathe tools and looks at the problems of sharpening carbide tooling on a tool and cutter grinder.

17) Sharpening the flutes

Close examination of the flutes of a used cutter will probably show wear, usually more wear towards the tip, the effective diameter of the cutter being reduced towards its end. Early resharpening is desirable because if you don't take action, it is most likely that bits will chip out of the cutter points and it could be ruined. Flutes often have primary and secondary relief but you want to sharpen just the primary relief very lightly taking the absolute minimum off as the effective diameter of the cutter will be reduced. **Fig. 7** (last issue) shows how the primary relief is produced with a cup wheel or a flat plate wheel. The wheel centreline is raised above the edge being sharpened by an amount that depends on the diameter of the wheel. The tooth to be ground is supported on an indexing finger so that the cutting edge is exactly at the centre height of the cutter being sharpened.

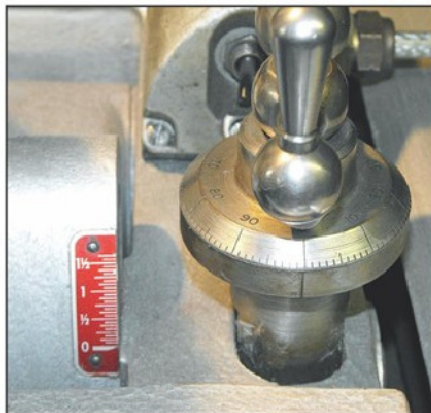


Photo 49. The height setting scale.

The Clarkson operator's handbook gives tables of setting figures for the distance below the wheel centre. Since the centres are fixed, the wheel head is actually raised. The Clarkson Mk2 has a scale in 0.001in. for the elevation of the wheel head and a rough scale 0 to 1½in. **photo 49**. The wheel head can be raised and lowered a lot more than this to around 4in. This is a very useful feature of the machine when attempting simple surface grinding. On my machine the scale is correct, zero does correspond to the wheel centre and the table centres being at the same height.

On my example the centres measure 3⅜in. above the table (approx 81mm) and it's a simple matter to zero the thimble when the wheel is on centre and then raise the wheel by the amount given in the tables. So for a 10mm end mill and a 4degree primary relief angle the 125mm dia. wheel elevation is 0.500in. **Photos 50 and 51** show the two centres and the indexing finger in use. I use the left hand centre to set the height of the indexing finger. The wheel used is a 125mm dia. saucer with the edge dressed so that it cuts on the left hand side only. Smaller wheels don't work for small diameter cutters as you cannot get the table with the centres mounted on it close enough to the wheel. However there is a way around this, by rotating the swivel base by, say 10degrees clockwise. The cutter flutes then pass the left hand side of the wheel when moved by the rack and pinion.

It's good practice to find the start of in feeding with the very lightest cut at the shank end of the cutter; the flutes will probably be more worn at the other end. For very precise work it's advisable to measure the diameter over the flutes at both ends before and after sharpening. If the cutter does not become parallel a very small adjustment of the top swivel plate may be necessary to compensate.

Table 9 Operation - Milling cutter- end mill and slot drill sharpening flutes	
ABRASIVE WHEEL	38A60 -KVBE Dish (Shape12) 125mmdia x 10mm deep. No wheel extension. Dress the wheel cutting edge to profile, left cutting.
WHEELHEAD	Raise wheel head above centre by distance found from tables.
Table	Set at 180° to wheel head spindle. Fit 2 centres, mount cutter, shank to right.
Top swivel plate	Rotate to 0°. Adjust with static wheel to produce positive rake to tooth.
Tooth rests and brackets	Fit rear table tooth rest bracket and sliding base. Fit tooth rest ground to helix angle of cutter and position at centre height directly in front of the cutting edge of the wheel. Adjust forward to support cutter flute.
Feed	Traverse the table with the rack and pinion, keeping the cutter flutes helix in contact with the tooth rest. Advance the table to get a slight cut at the shank end of the cutter, traverse. Repeat at the same setting for all the cutter's flutes. Measure both ends to ensure parallel.
Notes	Resist the temptation to take too big a cut. Least is best to extend the life of the cutter. If the primary clearance becomes too wide, raise the wheel head and re-sharpen the secondary clearance. Don't cut your fingers on the flutes!



Photo 50. Using the centre brackets.



Photo 51. The finger set up for use.

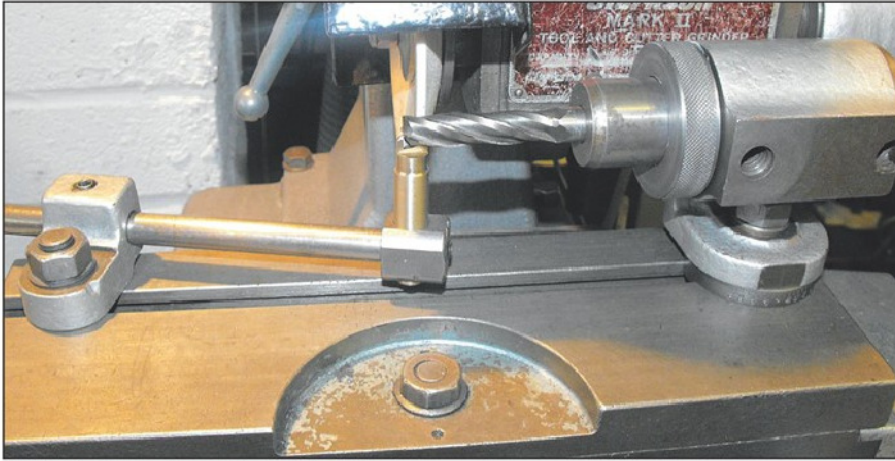


Photo 52. Using the universal head.

Warning: after sharpening, the flutes can seriously cut your fingers, they are razor sharp.

Should your milling cutter not have centres at both ends, the cutter can be held in a collet or sleeve in the universal head. If you decide to use a collet, you should be using the fixed tooth rest detailed above. Using the Clarkson collet system allows one to use a tooth rest attached to the table and to advance the cutter being ground by sliding and twisting the cutter against the tooth rest as it traverses the wheel. Unfortunately the centre height of the universal head when mounted on the table, with its graduated circular base is only $2\frac{5}{16}$ in. (approx 67mm) so you have to allow for this when adjusting the wheel head centre height. **Photo 52** shows the set up, which is used in a very similar fashion to the between centres method described in detail above except the tool and sleeve slide left to right across the face of the wheel. I have found a few problems with this method. To sharpen cutters smaller than 10mm dia. you need a grinding wheel greater than 125mm dia. otherwise the head fouls the wheel head. The way around this is, as above, to rotate the bottom swivel by say 10 degrees clockwise. The index fingers need very careful positioning and shaping to get under the tooth being sharpened and under the point where the wheel strikes the cutter flute, especially for cutters below 10mm.

Clarkson introduced an air bearing flute grinding attachment but unfortunately I only have the booklet! The idea of an air bearing is to reduce the "stiction" and make the movement of the tool over the wheel very free. Probably for really small cutters grinding on the side face of a cup wheel would be easier. Results show that cutters with resharpened flutes and end teeth really give a good performance and are worth the effort, especially in the larger, more expensive sizes.

18) Resharpening slitting saws

I use quite a lot of these HSS saws in my vertical mill. They get through a lot of work but eventually, well quite quickly really, become blunt and accumulate in the drawer. I seem to have a large number of bore sizes, both metric and imperial and hence the R8 holder was made. R8 fits the mill of course. The Clarkson sleeve I have is only for 1in.

bore saws and mills. There are a lot of inexpensive imported slitting saws about, which if you examine them closely, seem to have never been tooth sharpened after hardening! The clearance(s) are not bright. Some when used on the mill only cut on some of the teeth, probably because their bores are slightly off centre? A properly sharpened slitting saw should "sizzle" when it hits the workpiece, with all the teeth cutting.

The tooth shape on slitting saws follows the primary, secondary and rake angles given in the table above. Normally, I only resharpen the primary relief.

However, many smaller saws with small teeth show only one sharpening angle.

Photo 53 shows the set up. Because the space for the indexing finger between the wheel and saw are so small, the brass finger is shaped to come in from the side.

By mounting the finger to the right of the saw the saw arbor can be moved left, indexed round and the next cut made with the rack and pinion in seconds. The hook shaped tooth rest is shown in **photo 54**. The only limitation to this method is on larger diameter saws with very fine teeth. You may notice that having gone round all the teeth of a saw the wheel no longer cuts. This is simply because of wheel wear, for the best work it's good to advance the wheel again and go around a second time.

19) Resharpening side and face cutters

The peripheral teeth are tackled in the same way as the slitting saw above. Relieving the side teeth of a side and face cutter involves a bit of creativity! The older



Photo 54. The hook shaped finger for sharpening saws.

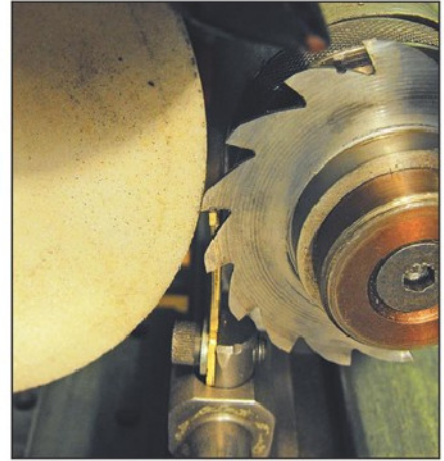


Photo 53. Sharpening a slitting saw.

Clarkson method was to mount the cutter on an arbor, work between centres and to raise the left hand centre on two small packing pieces to incline the arbour. In later operators manuals the universal head was used with a tapered cup wheel and the head inclined 3 degrees.

20) Resharpening tee slot and key slot cutters

A typical small tee slot cutter is shown in **photo 55**. You will notice that the face teeth are angled alternately and there are no secondary clearances. Fortunately there is plenty of space between the teeth to work in. Using the universal head and a cup wheel it is possible to sharpen all the cutting edges on cutters of this type. As before, offer up a static wheel to the existing cutting facets to estimate the angles involved.

21) Resharpening reamers

For reamers with Morse tapered shanks, Clarkson supplied sleeves. If the reamer has a good centre at each end, I prefer to use the centre brackets and centres described earlier for milling cutter flute sharpening. Obviously, if you sharpen the flutes of a reamer it will cut a smaller size. Old collections of reamers often show specimens with engraved marks indicating how much has been taken off by re-grinding. This flute regrinding could be OK if you are sharpening an old metric reamer down to the next imperial size (or vice versa) or you need a "special". There is a distinction between machine and hand reamers in that the lead length and angle differs. The lead is the tapered bit at the

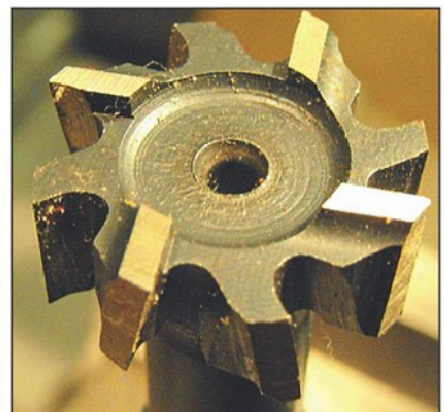
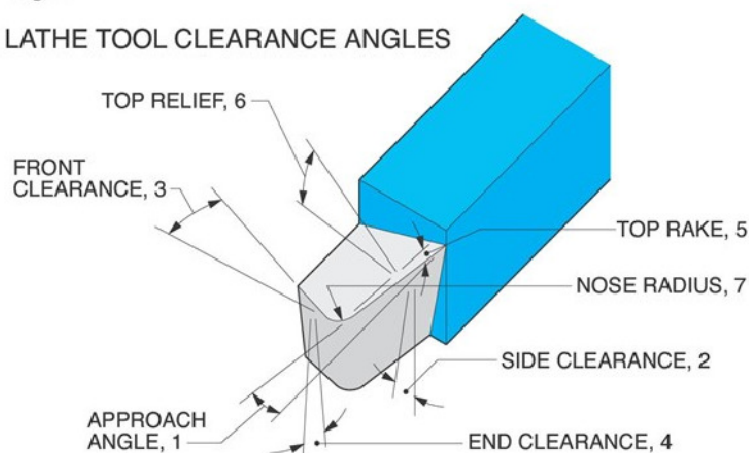


Photo 55. A typical Tee slot cutter.

Fig. 8**LATHE TOOL CLEARANCE ANGLES**

entry end of the reamer. It can be safely sharpened without affecting the final diameter. In a hand reamer the lead can be 1 or 2 degrees and on a machine reamer up to 45degrees. These angles can be achieved by swinging the top swivel plate and sharpening with just a primary relief.

Further notes

If you decide to use an arbor in the Universal Head mounted on its bracket, you get the benefit of a greater centre height, 4in. on my machine, but corrections again have to be made when setting the wheel head height to produce clearances. The angular scale on my Universal Head was checked against the digital scale described in part 4 and found to be 2.7 degrees out, compared to the machine table.

22) Making and reshaping single point lathe tools

You are likely to find a mixture of turning tool materials in the average home workshop. Most probably they will be made from either solid High Speed Steel (HSS) or HSS butt welded onto a tool steel shank or carbide pieces brazed onto a tool steel shank. Few will have solid carbide lathe tools although they do exist and few will still use tools made from hardened and tempered 1+% carbon tool steel ("silver steel", "drill rod" etc). In these days of indexable carbide insert tooling it's easy to forget that the older HSS types work well under the sort of machining conditions we normally have in our shops and HSS can very readily be resharpened or reshaped for a "special" or one-off.

The traditional HSS resharpening method is offhand grinding on a bench grinder, so why use something more complicated? You only have to look at some collections of used and reground lathe tools to see weird clearance (relief, rake) angles, grinding marks from coarse wheels and "personalised" shapes. I well remember a very skilled machinist who would regrind a great deal off a new Myford butt welded HSS tool right out of the packet to achieve his preferred shapes. What a waste? Fig 8 shows a generalised drawing of the seven clearances (relief and rake) on a right handed (cutting to the left) lathe tool. The numbers 1 to 7 are the grinding order that some references seem to use, Ref. 29. To resharpen a used lathe

tool it will probably only require resharpening on at most four of the above. There seems to be quite a bit of variation in the use of the terms, rake, clearance and relief. I have tried to be consistent and use clearance and rake. The actual clearance angles should, for the best results, reflect the material being turned and the following is a typical guide for tool grinders, Fig. 9.

I have been using the three way 2in. vice described in part 3 of this series to hold lathe tools for grinding. For smaller tools, especially round ones, life is much easier if you mount the bit in a square or rectangular block and secure it with a grub screw with a flat on the shaft to aid relocation. You can grind the shaft flat on the Clarkson. My original blocks were made from 20mm square black bar; this fitted the lathe four way tool post. Lately I have moved to a quick change tool holder system on the Chester UK Craftsman that will only accept tools that are up to 16mm high so I now use blocks machined down to 19 x 16 x 90mm long. The additional length allows me to place a tool bit in each end, if necessary.

Photo 56 shows the three way vice set up for hand regrinding the clearances, rakes and the nose radius. As before the digital angle gauge is invaluable for setting the clearances. For general purpose use I use a 7degree inclination for the end and side clearances. The 10mm thick top plate shown has a square tongue attached to its underside so this can be clamped in the vice. You can see one of my small tool bits mounted in a block next to the digital gauge. This is a very rigid support for the tool bit and far superior to a bench grinder. Also, your average cheapie bench grinder has wheels that are too coarse A36/A60 and probably the wrong bond.

The wheel is a cup shaped white aluminium oxide wheel with the front edge dressed back at about a 5 degree angle so it only cuts on the outer corner. If I am roughing out a new HSS tool blank it can be quicker to do the preliminary grinding on a bench grinder then switch to the Clarkson for accurate angles. Don't use water to cool the tool bit as the shock can lead to cracking.

An 80 grit white wheel gives a better surface finish and hence edge to the tool than the bench grinder but it can be

Fig. 9**High Speed Steel Tool Angles**

Material	End Clearance 4	Side Clearance 2	Top Rake 5	Top Clearance 6
Aluminium	9deg.	9deg.	30deg.	15deg.
Brass	7deg.	6deg.	0deg.	5deg.
Cast iron	5deg.	4deg.	10deg.	9deg.
Mild steel	8deg.	6deg.	20deg.	15deg.
Plastic	10deg.	8deg.	25deg.	25deg.

**Photo 56. Three way vice set up to grind lathe tools.**

improved upon for the best turned surface finish. I have been using a very fine diamond plate to "file" or "burnish" or "hone" lathe tool cutting edges straight off the grinder and it is just a small step to try diamond wheels on the Clarkson. The diamond plate is 600 or 1200 grit, available from Ref. 30. These steel plates have diamonds nickel electroplated on one surface.

23) Carbide turning tools

We have had carbide tooling for quite a number of years now. Initially as small pieces brazed onto tool steel shanks and more recently as solid carbide. See my series of articles on insert tooling in MEW 136 (March 2008) to MEW 139 (May 2008) if you would like to read about carbides and how they are made etc. Traditionally carbide was resharpened using silicon carbide green grit abrasive wheels because the white aluminium oxide wheels described earlier in this series will not work. Silicon carbide dressing sticks can be used to dress and reshape white wheels. My Clarkson came with a number of Norton flared cup 85mm dia. Wheels marked 39C60-JOV. The marking follows

the convention described in part 3. i.e. Silicon Carbide, 60 grit, soft bond, 62% abrasive and a vitrified bond.

I have experimented with the set-up shown in **photo 56** with a green 60 grit silicon carbide cup wheel to "rough out" shapes in HSS for profile cutters, but found that the wheel wear was quite fast and the dressed shape was quite quickly lost. Similarly when I sharpened brazed carbide lathe tools on the same wheel the wheel soon lost its dressed shape and the edge appearance was rough and scratched.

Photo 57 shows a 125 mm dia. resin bonded diamond wheel from **Ref. 31** substituted for the green grit one. This wheel does sharpen brazed carbide efficiently and leaves a better surface finish. I will give more details on Diamond wheels later.

Sharpening brazed carbide tools with a diamond is little different in process from HSS. Carbide tipped tools for turning often have a flat top and 7 degree side and end clearances and they are usually very simple shapes, which makes re-sharpening quite easy. Some cheaper tipped lathe and boring bars seem to improve in performance if they are re-sharpened before you use them! A used and re-sharpened tipped boring bar is shown in **photo 58**.

In **photo 57** you can see a 5C collet block held in the three way vice. To sharpen the second edge the top slide has been swivelled through 90 degrees, the tool inverted and the clearance reset.

24) Diamond grinding wheels

Along with Cubic Boron Nitride (CBN), Diamond wheels are often described as "Super abrasives". CBN wheels don't seem to have come down to a price where they can have home shop use, but they are very extensively used in Industry. Diamond wheels seem relatively cheap and very available in smaller sizes although still perhaps twice the price of a white aluminium oxide wheel. Four distinctly different diamond technologies are available but only two of them are likely to find use in our workshops, **photo 59**. The wheel on the top is 100 dia. x 1mm thick, including the diamond layers that are on both sides. The actual diamond layer is approx 0.2mm thick and appears to be nickel electroplated. The wheel appears to be steel, magnetic. According to the supplier, Arc Euro Trade **Ref. 32**, the diamond mesh size is 200, usually written #200. The other two wheels are aluminium alloy with a resin containing diamond particles bonded on. The unused wheel in the box is a pink colour resin. After use, the colour dulls and becomes grey with metal particles, as in the wheel above it.

A quick survey of the 10 or so diamond wheels I have shows that only one, from Arc Euro Trade, actually has a description etched on it; all the others are unmarked! The box descriptions from either supplier are none too useful either. They usually describe the wheel shape and size and the dimensions of the resin cutting area.

e.g. D12A2 13x20x5x3 or WCW03 125*32*3285*3. In both cases the 5X3 are the dimensions of the resin layer containing the diamond particles, that is, 5mm wide and 3 mm thick. In most cases there is no mention of the diamond concentration in the resin or its particle

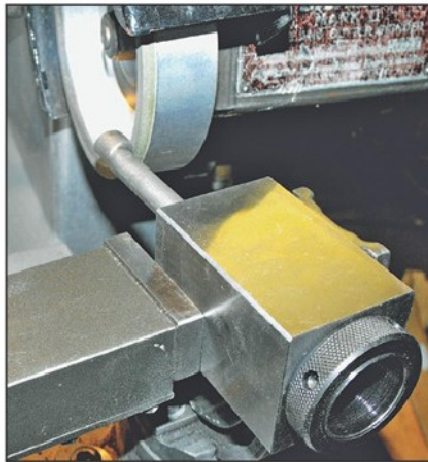


Photo 57. A resin bonded diamond wheel sharpening a carbide tipped boring tool.

size. Both of these are critical factors in my opinion. I have asked the two suppliers referenced and they are both asking their importers or manufacturers for more information.

My marked wheel is 12A2 100x13x20x5x3 C75 D150. The vital information is the D150, diamond 150 mesh size and the C75 the concentration of microdiamonds in the resin. 100 concentration is 72 carats of diamond per cubic inch of bond. High concentrations, 100, are very hard and will last longer but cost more. Low concentrations, 50, behave as a softer wheel.

See the very useful Argon website, **Ref. 33**, resin bonded wheels and the FEPA website, **Ref. 34**.

25) Mounting and dressing diamond wheels.

None of my diamond wheels fit the Clarkson without bushes. You really need accurate bushes as any run out of the diamond resin or plated diamond disk is undesirable because dressing will remove the resin bond and there isn't much there. I have carefully turned brass bushes for my wheels to bush them down from 32mm or 20mm to 0.5in. They have to be as true as you can make them. I found that the plastic wheel bushes often supplied with white wheels are not accurate enough. The plated diamond cut off wheel in **photo 59** cannot be dressed as it only has a single diamond layer on the edge and both sides. These wheels are disposable and fortunately cost less than the resin bonded variety. I notice that "fleabay" has several Hong Kong suppliers listing these but be careful, some are intended for use on stone and on angle grinders.

Reshaping resin bonded wheels can be done with a mounted diamond, but you will seriously shorten the life of the wheel. It's a better bet to get a wheel that is as close to the profile that you need and use that, hence all my diamond wheels. Also, most resin wheels have only one small abrasive area. I have been dressing my resin bonded diamond wheels very lightly with a mounted diamond alternating with a fine white aluminium oxide stick to remove resin and debris, **Ref. 33**.

26) Diamond cut off wheels

My experience of these is based entirely on the wheel shown in **photo 59**. This

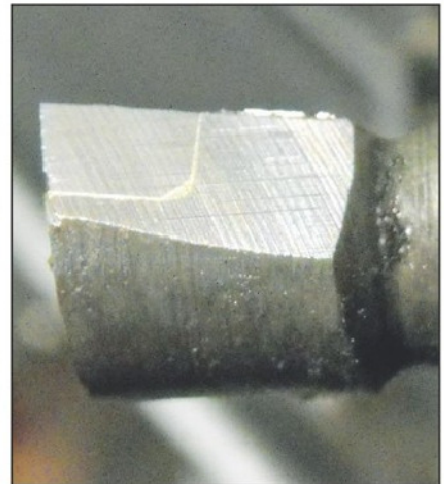


Photo 58. The resharpened boring tool.

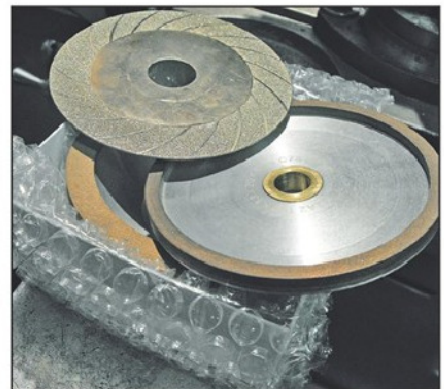


Photo 59. Various diamond coated grinding wheels.

wheel will cut off HS steel and solid carbide to give a very polished surface. The general set up was described in part 3. It will gash end and slot mills, see part 4 but is really too thin and square edged except for the smallest cutters. I was reluctant to use the sides of this wheel and made a 3mm aluminium alloy backing plate to mount behind the side being used for grinding. It seems to work. I have no idea what the life of this wheel will be.

Some of the websites of professional tool regrinders shows that they often manually modify carbide tool edges with a diamond hone, after diamond wheel sharpening. This particularly applies to solid carbide tooling. Of course they don't tell you how they do it! **To be continued...**

References

- Ref. 29.** Basic lathe tool sharpening <http://www.sherline.com/grinding.htm> also The Engineers Black Book ISBN 0-8580571-1-7 Sutton Tools Pty Ltd, Australia distributed by JLLIndustrial in the UK.
Ref. 30. <http://www.arceurotrade.co.uk/Catalogue/Diamond-Tools/Diamond-Stones>
Ref. 31. http://www.rdgtools.co.uk/acatalog/DIAMOND_GRINDING_WHEEL_S.html
Ref. 32. http://www.arceurotrade.co.uk/projects/d_wheels/dwdoc.html
Ref. 33. <http://www.btinternet.com/~argoncorp/resin.htm> Click on the brochure link to see advice on dressing diamond wheels.
Ref. 34. <http://www.fepa-abrasives.org/>

FIRST STEPS IN DESIGN



Linton Wedlock starts a series of articles on an introduction to virtual engineering - modelling on a computer.

In recent years, with the widespread availability of powerful computer programs and hardware, it is now relatively easy for anyone with an interest in 3D modelling to get started. Aspiring modellers may, however, be discouraged because the initial steps in learning to use any 3D modelling program are quite challenging. This series of articles has been written to help beginners in 3D, and starts by showing how some simple virtual models can be created. Later, as the series progresses, some moderately advanced techniques will be used to construct specific engineering components. I have aimed to make the articles as practical as possible, so that anyone with an interest in 3D can start quickly creating their own models.

Simple models can be created solely in 3D applications alone, but some complex components may require additional construction work. This can be done manually on paper, or, preferably, by using a 2D CAD program. A practical knowledge of basic 2D CAD may also be useful because 2D drawings, imported into the 3D program, can form the starting point for creating complex objects.

The modelling program

For this series, the 3D application I have chosen to use is **trueSpace**. This is one of the easier 3D programs to learn because it has a highly visual and interactive modelling interface. The models created with trueSpace can be used to make

diagrammatic or photorealistic images, or to produce animations, or to do simple physical simulation. For many years I have found trueSpace a pleasure to use and I hope that you will too.

Another reason for recommending trueSpace is that it can be obtained for no cost! Version 7.6 of the program can be downloaded from the **Caligari** website <http://www.caligari.com> free of charge. Incidentally, trueSpace7 would have cost you several hundred dollars a few months ago.

One minor disadvantage of trueSpace from an engineering perspective is that it is not a CAD program. TrueSpace is aimed primarily at artists and animators, and it has only a few technical construction functions. Nonetheless, it can still be used to produce complex models; just a little more effort is required.

TrueSpace is a big program, and a complete description of using it would likely fill a magazine of this size for a year or more! Fortunately, engineering models can be built using only a small fraction of trueSpace's features; in this series, it has been my aim to show the largest amount of modelling that can be done with the smallest number of functions.

Computer hardware

To work efficiently, version seven of trueSpace requires an up-to-date computer (the hardware requirements are given on the Caligari website).

TrueSpace has the facility of altering the modelling viewpoint with the aid of a wheel mouse. As this feature is so useful, it is well worth using one of these devices. You may also find that a scanner and digital camera have their uses when creating engineering models, but they are not essential.

The benefits

I personally find that 3D modelling on a computer is an enjoyable experience, perhaps even mildly addictive. I guess it's a little like playing computer games, but with the additional satisfaction of doing something creative and productive!

Besides its obvious use as a design tool, virtual modelling is an excellent way of showing yourself and others how a finished article will look. You can generate photorealistic images of your models from any viewpoint - even impossible real-world views. A further possibility is to make an animation of your model - a technique that is particularly useful in visualising a working piece of equipment.

Another less obvious benefit of 3D modelling is that it can reduce the time needed to physically make an item. To create a complete virtual model, every small constructional detail has to be considered, and every dimension worked out. As you will then be thoroughly familiar with an article's design and appearance, very little time and effort should be wasted during the actual building.

The negative side

Acquiring 3D modelling skills can be a challenge. It's not that any parts of it are particularly difficult to learn, but at first it can seem a little overwhelming at times, frustrating even. If you find that this is so, please persevere; the rewards are worth it! Initially, if you try using trueSpace often, and for short periods only, it should soon start to make sense. As a note of encouragement, anyone with engineering experience will already be used to thinking three dimensionally, and this will be a big advantage while learning virtual modelling.

To become proficient in 3D modelling, there is something you will need that this series cannot provide: lots of practice. TrueSpace is primarily a visual, icon driven, application and while this is great for experienced users, it does make it a little difficult for beginners to gain familiarity with the program. I have tried to ease this problem by including two pages of diagrams, **Figs A - H**, showing the features of trueSpace used in the first parts of this series. For convenience, you may like to remove the pages from the magazine and use them as a reference chart. Although only a small number of trueSpace tools are shown in the diagrams, they may still look a little intimidating at first. The articles will, however, be focused on model creation, and the tools will be only introduced, one or two at a time, as they are required.

Series overview

The basics of 3D modelling - introducing the most useful trueSpace tools - will be covered first, with practical demonstrations showing the steps needed to make a variety of simple engineering models. Following this, some methods of building more advanced models will be shown.



Exploded view of the main components of a simple oscillating engine. The steps needed to construct this 3D computer model are shown in the text.

Although this series will centre on model creation, there will be also be a little on how you can produce realistic images of your models.

After the above general introduction, the articles will then focus on modelling specific types of engineering component (gears, for example), and on particular topics (like turning 2D CAD drawings into 3D objects).

Using trueSpace

TrueSpace has a general operating manual in its **help files**. It would be wasteful to duplicate any of this information in the articles, so, occasionally, I'll give specific help file references which will have more detail on the tools covered. If you are interested also in creating non-engineering models, the help files will show you how to use the many other aspects of trueSpace that won't be included in the series.

The images shown in the articles are screen-shots of trueSpace as it is being used. Because of different window sizes, viewpoints, etc, what you see on your screen will differ a little from the images shown here. Also, I have sometimes changed the colour or appearance of objects so that they stand out better when printed in the magazine. Occasionally, some objects may also have been made invisible to show the modelling more clearly. If, however, the modelling steps do not seem to work as I have described them, it could be because some program settings have been changed. If this is the case, you can try the remedies given later in the 'Useful functions' section.

On starting trueSpace, you can see that the program does not have the standard Windows look. TrueSpace has a highly visual interface, and most program functions are chosen by picking icons from toolbars. There are a few menus, but these are used rarely.

Version 7 of trueSpace is a program in transition. It has two modelling areas: an older **Model View**, and the newer **Workspace**. This series will start by using the **Model View** alone. Although this view is less showy than the Workspace, and is likely to be phased out in future versions of the program, it is currently the best suited for creating engineering models. To set up trueSpace for the initial modelling in this series, do the following: click the '**trueSpace6**' tab at the top of the screen (the '**Model**' tab will be selected automatically, displaying the **Model View**). You should now have a view similar to that shown in **Fig A**.

The modelling area contains a guide **grid**, with the toolbars and the **View Navigation Control** around the edge. Only a small number of trueSpace's function icons are visible at any one time. Each icon represents one tool, but many other tools are hidden. If you look at a toolbar, you will see that many icons have a small green triangle in their top-left corner. Hold the left mouse button down on one of these icons, and a pop-up toolbar will appear showing further tool icons. Drag the mouse to one of these icons to select it. If you decide not to select a new tool, drag the mouse away from the toolbar. Some of the icons in the pop-up also have green triangles, and if you continue dragging the mouse over these, a further pop-up toolbar will appear.

Some tool icons have a small red triangle in the top-right corner. If you click such an icon, this time with the right mouse button, a panel will appear which allows you to set the parameters for the selected tool.

With a little practise, this method of selecting program functions using icons works well and it also keeps the screen uncluttered. **Figs B, D, F and H** are diagrams of the four main toolbars, expanded to show many of their pop-ups. These may help beginners to become familiar with the function of the numerous icons, and also the location of the hidden tools. The labelled tools are those used in the first few parts of this series. When any of the tools are referred to in the text, I will enclose their names in square brackets, for example: [Object Subtraction]. You can find further useful information on toolbars in the Help file, section 2.4.

Modelling with the mouse

To start modelling, first of all do the following: Click the 'TS6 Files' menu (screen top-right), then 'Preferences'. In the panel that appears, deselect the Magic Ring box and then hold down the left mouse button on the 'Scalable' button and select 'Automatic'. (The Magic Ring function is useful for some non-engineering models, but won't be covered in this series). To create your first object in trueSpace, click on the [Cube] icon in the **Model Toolbar**, **Fig B**. A grey cube, placed with its base on the grid, will appear as in **Fig 2**.

The newly created cube has automatically become the **currently selected object**, and as such is surrounded by the light blue **Object Navigation Control**. With this control, you can move, rotate and change the size of the object. If you move the mouse pointer over the control, its various parts will change colour. Move near a part until it turns yellow, then click and drag the left mouse button and observe the effect that is produced on the cube. The main actions produced using the Object Navigation Control by dragging with the left mouse button are shown in **Fig E** (see the help file section 2.14.5 for more functions). I won't give a long description of using the control because you can discover this for yourself by experimenting with it. Try manipulating the cube by moving, rotating and scaling it. If the shape becomes unmanageable and you want to start afresh, press the Delete keyboard key, then click [Cube] again. One thing to note is that the initial direction that you start dragging the mouse is significant with the Move and Scale actions.

As well as freehand manipulation using the mouse, you can also move, rotate and scale objects with precision using the **Grid Mode**. Start with a new cube by pressing

the Delete key, and clicking [Cube]. Select [Toggle Grid Mode] from the **TrueSpace Window Tools**, **Fig H**, and manipulate the cube as described above (large mouse position changes may be needed). This time, the changes will occur in discrete steps. The size of the steps for each of the move, rotate and scale functions are set initially by trueSpace, but you can change them to any value you want. When you select [Toggle Grid Mode] its icon will have a yellow border, indicating that this function is active. To turn the Grid Mode off, click [Toggle Grid Mode] again.

Useful functions

TrueSpace has a few general functions which you will probably need: [Undo] will cancel the last program action, and [Redo] will restore the cancelled action. To remove an object, you can click [Erase] as an alternative to pressing the Delete keyboard key. These functions are in the **TrueSpace Window Tools**, **Fig H**.

While learning trueSpace, you may encounter problems and not know how to resolve them. The following may be of some help: A disorientated view can be reset to trueSpace's starting viewpoint with the [Reset View] tool. [Reset Tool Bars Layout] will similarly restore the initial toolbar configuration. These are two **TrueSpace Window Tools**, **Fig H**. If you get really stuck, you can exit trueSpace, then restart it while holding down the Control key. Select 'Use Default Configuration' in the panel and click 'Ok'.

Changing the viewpoint

While 3D modelling, you will frequently need to move around your model as you create and modify it. This is done by changing the viewpoint with the **View Navigation Control**, **Fig C**. With this control, you can move around the **scene** (a scene is the name used in trueSpace for the collection of objects and other elements, like lights, that are in the model). You can also adjust the viewpoint to zoom in on an object to work on its detail, or zoom out to get an overall view of the scene.

As with the Object Navigation Control, I won't detail the use of the View Navigation Control as you can discover this for yourself. Try clicking and dragging with the left mouse button on the various parts of the control labelled in **Fig C**, and see how the viewpoint changes. One particularly useful function on the control is the 'rotate around selected object' function. To use this, first make sure you have a new or modified cube selected in the scene with the Object Navigation Control visible around it. Next, move the mouse pointer over the green semicircle in the View Navigation Control until the semicircle turns yellow. Click and drag the left mouse button and the viewpoint will swing around the selected cube allowing you to quickly view all sides of it.

After some practise of using both the Object and View Navigation Controls, their use will become instinctive, and you will not have to think about the mechanics of using them as you create your models.

Navigation: an alternative way

There are a group of six icons in the **Navigation Tools**, **Fig D** that you can use as an alternative way of modifying objects, or changing the viewpoint. [Eye Move],

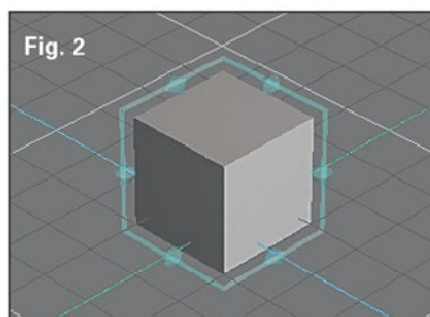


Fig. 2

Fig A MODEL VIEW

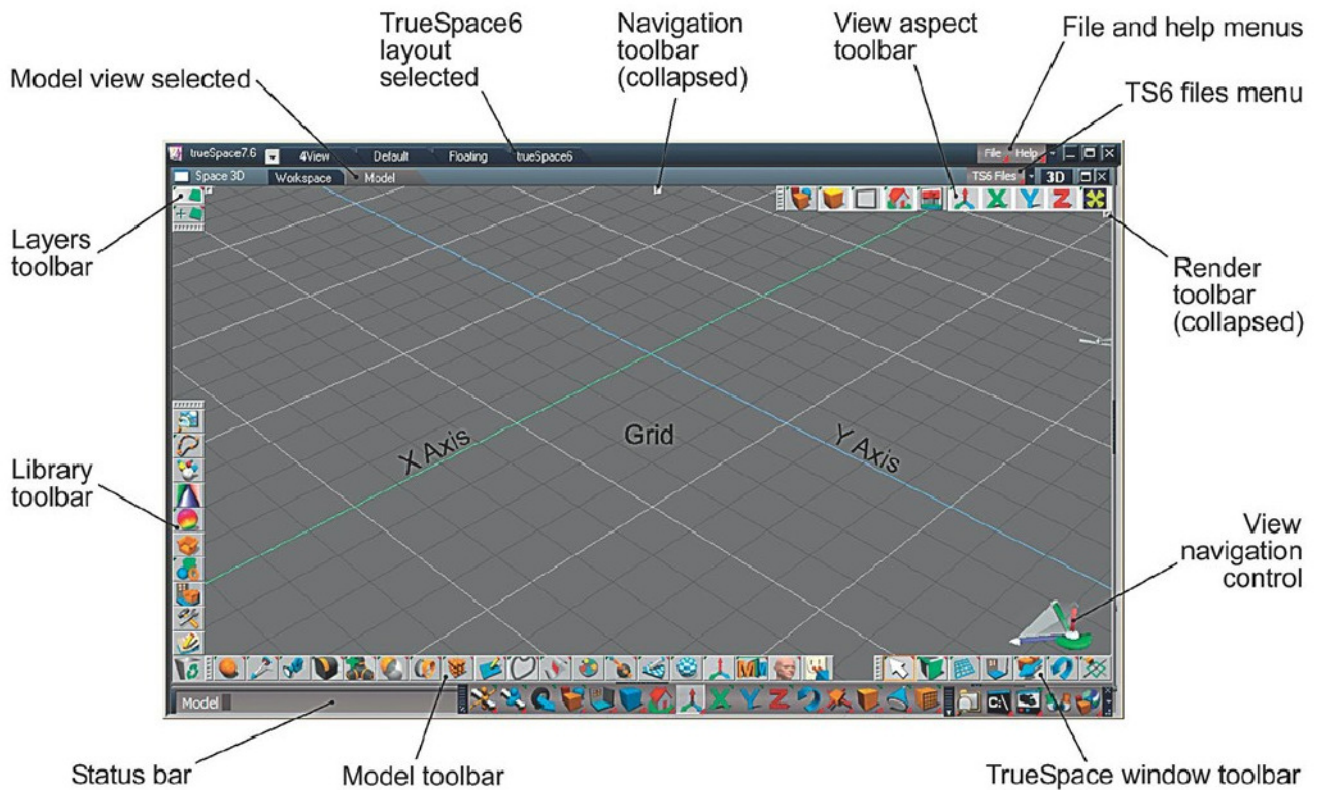


Fig B MODEL TOOLBAR

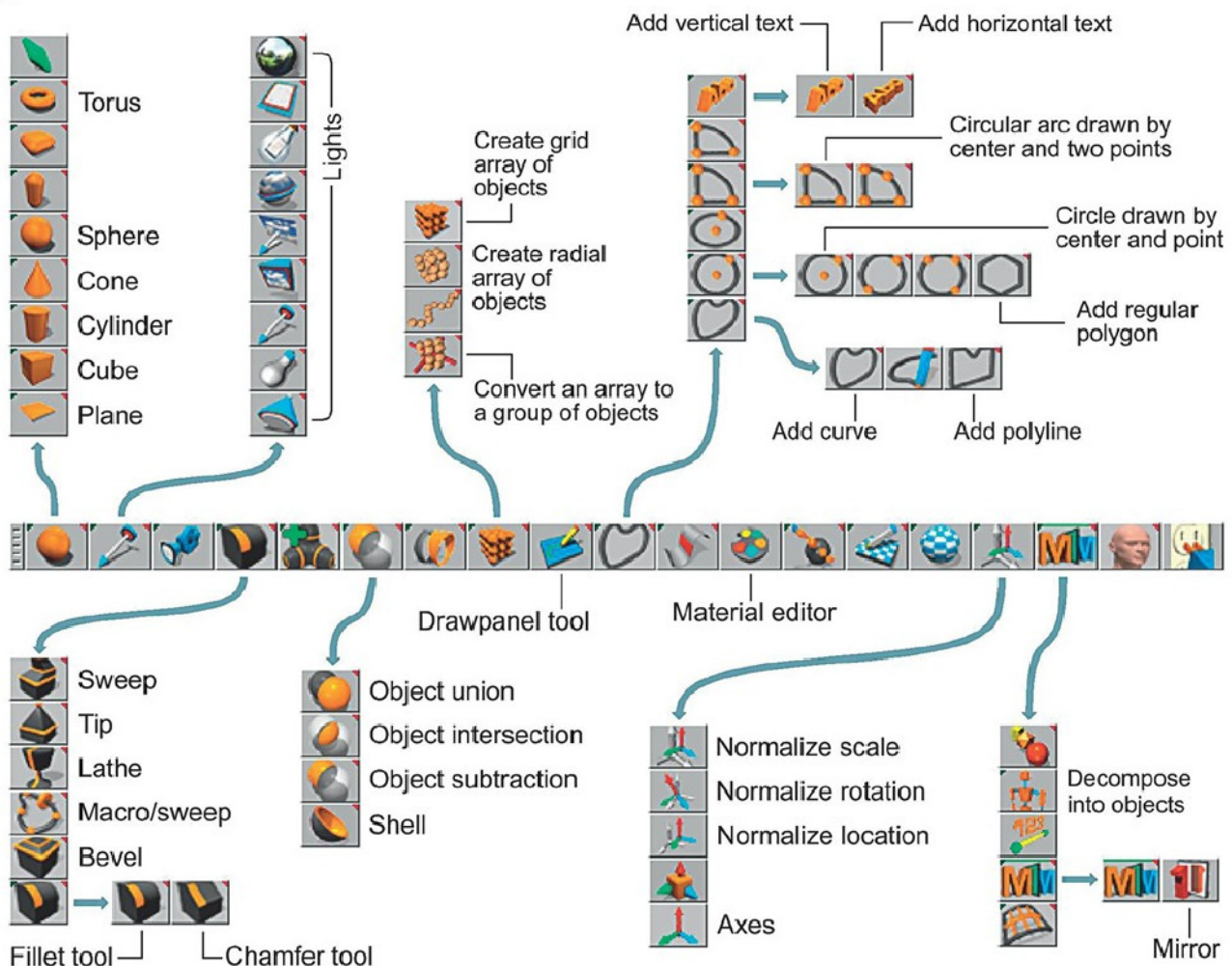


Fig C VIEW NAVIGATION CONTROL

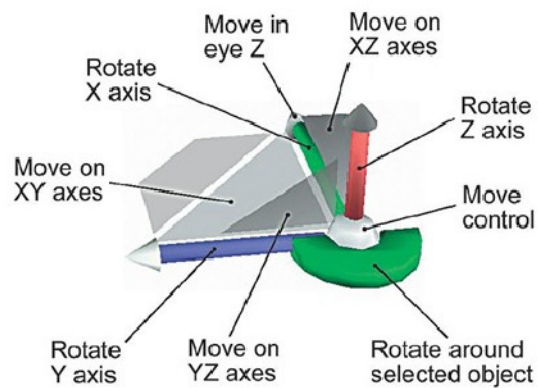


Fig D NAVIGATION TOOLS

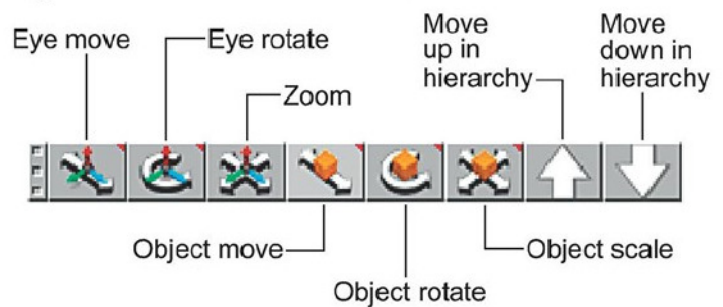


Fig E OBJECT NAVIGATION CONTROL

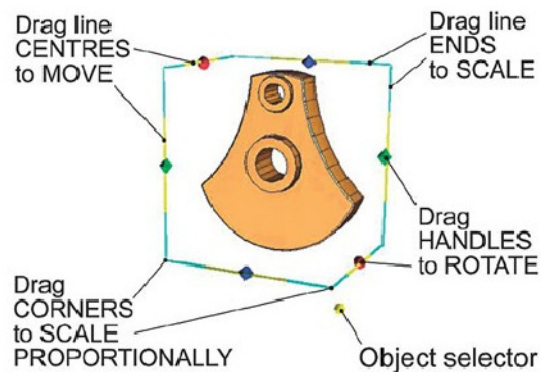


Fig G OBJECT INFO PANEL

object info			
	X	Y	Z
Location	0.000	0.000	1.000
Rotation	0.00	0.00	0.00
Size	2.000	2.000	2.000
Name	Cube		# ver 8
Layer	Basic		# fac 6

Fig F VIEW ASPECT TOOLBAR

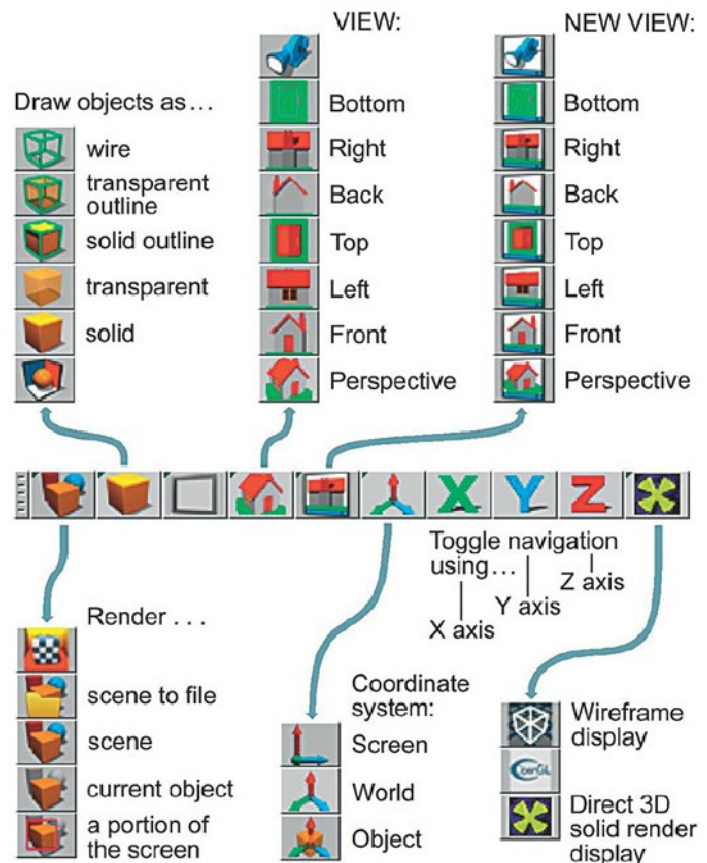
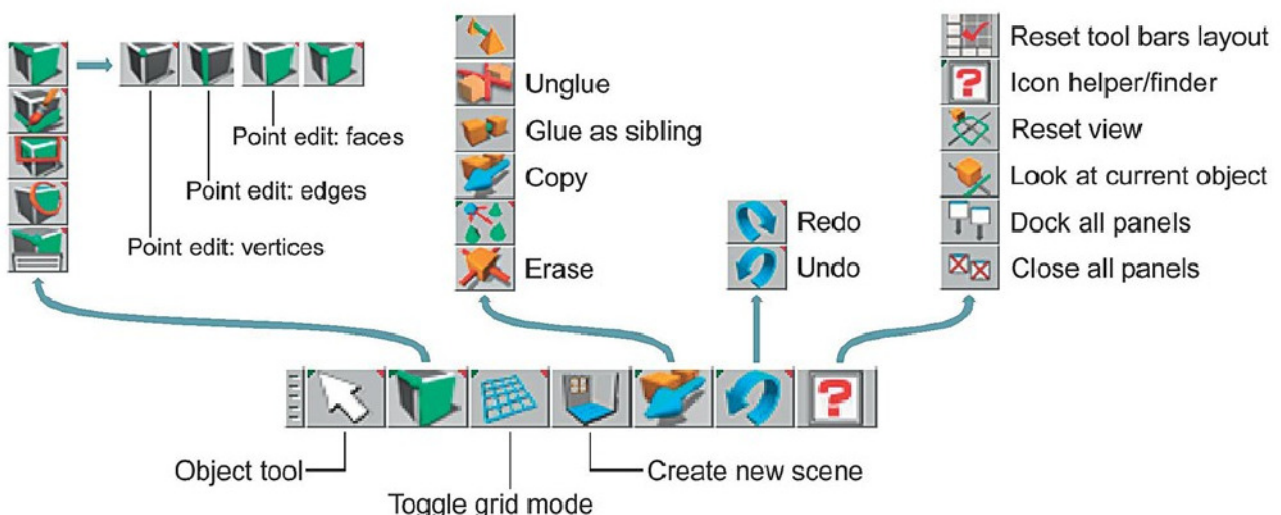


Fig H TRUESPACE WINDOW TOOLS



[Eye Rotate] and [Zoom] will adjust the view, and [Object Move], [Object Rotate] and [Object Scale] will modify an object. The Navigation Tools are collapsed into a small square at the top centre of the screen, **Fig A**; move the mouse pointer over the square, and the full toolbar will be displayed.

To use one of the six tools, click its icon, then click and drag the mouse anywhere in the workspace. I'm using 'workspace' with a small 'w' for the modelling area on the screen. This shouldn't be confused with the trueSpace Workspace mentioned earlier. The changes performed with the six navigation functions depend on whether the left, right or both mouse buttons are used. The help file, section 2.7.4 has more details on this (this section also has more information on the Object Navigation Control). A Navigation tool will remain active until you select another trueSpace function.

Whether you use the Object and View Navigation Controls, or the six Navigation functions, or a mixture of both, is often a matter of preference; after a while you will develop your own working methods.

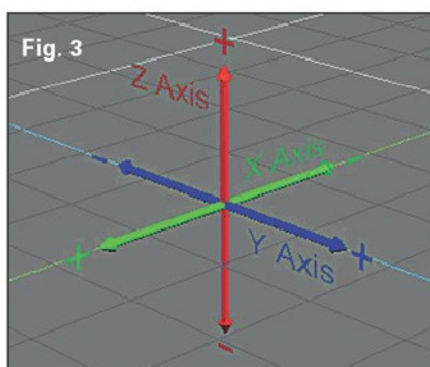
Modelling with precision

TrueSpace has primarily been designed so that 3D modelling can be done interactively and visually by using the mouse. This means that complex 'freehand' objects and models can be created very quickly indeed. There are also a few trueSpace functions which can be used to introduce some precision when using the mouse (these will be covered later in the series).

For engineering uses, however, a more controllable and precise method of creating and altering objects is often needed. This is achieved by typing numerical values into the **Object Property** (or **Info**) **Panel**, **Fig G**. Right click on the [Object Tool] icon in the **TrueSpace Window Tools**, **Fig H**, and this panel will appear.

Before describing the use of the Object Property panel, a digression is needed on how the location and orientation of objects in three dimensional space is specified in trueSpace. The location of an object is defined by its position with respect to three perpendicular **axes**, the X, Y and Z axes. These three axes, collectively called the **World axes**, are never displayed, but if they were, they could look something like this: **Fig 3**.

The axes colours in this image correspond to the trueSpace colour convention (as used, for example, in the View Navigation Control). The intersection of the three axes is where X, Y and Z are all equal to zero. In the default view shown, X is positive towards the lower-



left, and negative towards the upper-right. Similarly, positive values of Y occur on the lower-right, and negative on the upper-left. The guide grid is on a plane positioned on the X and Y axes. The grid is always in this location, and so acts as a visual reference for the orientation of the view and the World axes. In addition, the grid lines coincident with the X and Y axes are coloured green and blue, respectively. The Z axis is perpendicular to the X and Y axes (and guide grid). In the default view shown the value of Z increases vertically upwards, and decreases downwards. At all positions on the grid, the Z value is zero.

To see how the Object Info Panel is used, Clear the previously created cube, and create a new one. Now, try moving, rotating and scaling the cube with the mouse as described before, and notice how the numerical fields in the Object Info panel change as the cube is moved or altered.

Delete the cube and then create a new one. Click the mouse in one of the numerical fields of the Object Info panel, delete the existing number, type in a new value, press Enter, and observe the affect on the cube (don't use large location values, as the cube may disappear off screen). Try this a few times by typing in different parameter values for the cube. As well as numbers, simple mathematical equations can be entered in the fields. Addition (+), subtraction (-), multiplication (*), division (/) and brackets can be used (examples are $2*3.8$, and $(2.4+5.8)/3$). On pressing Enter, the equation's result will be calculated and displayed in the field, and the object modified. This useful program feature can save a lot of mental arithmetic.

The numerical values in the Location and Size fields of the Object Info Panel are in terms of the grid square size (the dark grey squares in the grid). So, for instance, a new cube, with X, Y and Z sizes of 2.0 is two grid squares long, wide and high. It's possible to set the unit size of the grid squares in TrueSpace, but for now, you can imagine that each grid square represents any suitable unit of measurement you wish. In this series, unless stated otherwise, one grid square will represent one centimetre (10 mm). For your own models, you may prefer to have one grid square equal to one inch. The Rotation values in the Object Info panel are in degrees, and range from -180 through 0 to +180.

To recreate the models in these articles, numerical values will often need to be typed in the fields in the Object Info panel. To show the values as concisely as possible, I will use the abbreviations **L**, **R** and **S** for **Location**, **Rotation** and **Size** respectively. Lists of parameters will be enclosed in square brackets, with the values separated by oblique lines. If a particular parameter value is not in any such list, it means its value is either unchanged from a previous setting, or unimportant. So, for example:

[XL-1/YL3.25/ZR-45/ZS1.2] shows that the X location should be changed to a value of minus 1, Y location to 3.25, Z rotation to minus 45, and Z size to 1.2. All such values should be typed in carefully, as small mistakes could produce unexpected results. Watch out especially for any minus signs and decimal points.

In the Object Info panel, there is also a **Name** field. TrueSpace automatically gives new objects a name ('Cube', 'Sphere', '3'),

but these are not very meaningful in a scene with tens or hundreds of objects. You can rename an object by typing it in the Info Panel (press Enter afterwards). Sometimes I will suggest an object name in a parameter list, or on its own like this: ['Flywheel'].

A first model

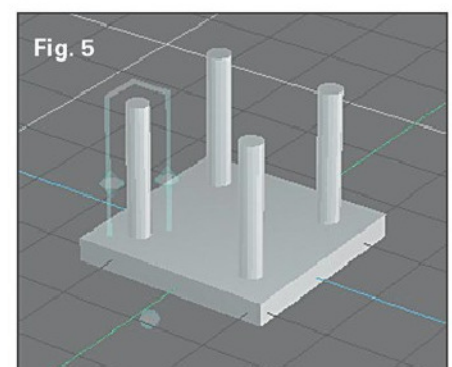
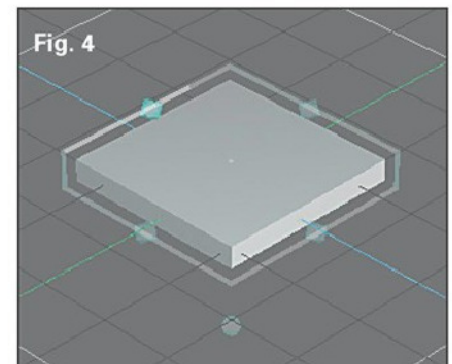
This series starts by showing the steps needed to create the main components of a **simple oscillating engine**, **Fig 1**. I should perhaps say that this model in particular, and many of the other models shown in the series, have been chosen primarily to demonstrate 3D modelling techniques, and they may not necessarily represent best engineering practice, or include every last nut and bolt. In general, however, the models will become more sophisticated as the series progresses.

The engine model will be built up entirely from cubes and cylinders. These basic geometrical shapes are two examples of objects called **polyhedrons**. To start modelling, erase any previously created objects, press [Reset View], and if the Object Info Panel isn't visible, right-click [Object Tool]. To create the engine Foot, click [Cube], and in the Info Panel, type:

[ZL0.15/XS2.6/YS2.6/ZS0.3/'Foot'], and you should have a cuboid like **Fig 4**.

The next step makes four mounting holes in the Foot. Select [Cylinder], **Fig B**, and a new cylinder object is created. Notice that the Object Navigation Control has moved from the Foot to the cylinder, showing that the cylinder is now the currently selected object. The values in the Object Info panel are always those of the currently selected object. In the panel, type [XS0.3/YS0.3] to give the cylinder a diameter of 3 mm. This shape will be used to make one of the four mounting holes, so, position the cylinder with [XL0.8/YL0.8].

Three more identically sized cylinders are needed for the other holes. Although these could be created in the same way just described, it is easier to make copies of the existing cylinder. Before doing this,



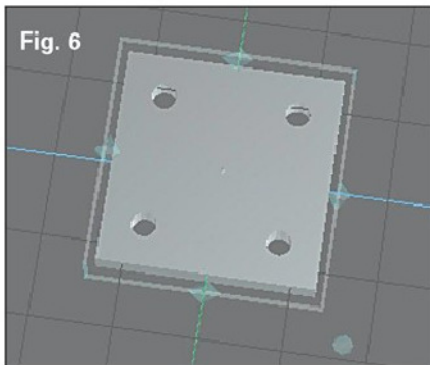


Fig. 6

first note that the current object is named 'Cylinder' in the Info Panel. Now, click [Copy], Fig H. You won't see any difference in the workspace because the newly created cylinder has exactly the same size and location as the first one. Notice, though, that the object name in the Info Panel has changed to 'Cylinder.1'. Position the new cylinder with [XL-0.8/YL0.8]. Click [Copy], and enter [XL-0.8/YL-0.8], [Copy] again, and [XL0.8/YL-0.8]. You should now have Fig 5.

Before continuing with the model, here is a small digression on selecting objects. Whether an object is selected or not is important because, in most cases, an object has to be selected first before it can be modified with a tool. There are three main alternative ways of selecting objects. First, enter the object selection mode by clicking [Object Tool], then click on the desired object. Second, in the Info Panel, click the arrow button in the Name field. A pop-up list of the scene's objects appears, and you can pick one of these. Thirdly, you can cycle through a scene's objects by using the left and right arrow keys on the keyboard.

Now, back to the engine model. The four holes in the Foot are made by subtracting the cylinder shapes from it. Select the Foot by using one of the methods described above, click [Object Subtraction], Fig B, (the cursor will change to show the subtraction tool is active) then click one of the cylinders. The cylinder will disappear, and where it originally overlapped the foot, a hole will be created. Click the other three cylinders to complete the mounting holes in the Foot, Fig 6 To exit the object subtraction mode, click [Object Tool].

Subtracting solid objects from each other is a type of function known as a **3D Boolean operation**. There are two other related functions, [Object Union] (combining two objects), and [Object Intersection]; these will be introduced later.

Using Libraries

As the first object is complete, it would now be a good time to start regularly saving the model scene. This can be done from the 'File' menu, but here I will use a more visual method which at the same time introduces the subject of **Libraries**. A Library is a collection of trueSpace components (scenes, objects, light configurations etc.) that are stored on the computer. You don't need to know the details of how or where components are stored because you can move or copy them between the libraries and your model using drag-and-drop methods. This is quicker and more visually interactive than using the Windows file system.

To save the current scene, left-click the 'Scene Library' icon, which is eighth from the top in the Library Toolbar, Fig A far left. A panel will appear showing thumbnails of the scenes which are supplied with trueSpace (you may like to load these later to get a feel for what can be done with the program). Right-click the panel, and in the list under 'Library', select 'New'. A new scene library will be created, and an empty panel displayed. Right-click the panel, then select 'Rename', and in the new panel type 'First Steps' (Enter), or any other appropriate name you wish. To save the current scene in this new scene library, right-click the panel, then select 'Insert'. Right-click the new thumbnail, select 'Rename' (under Item, not Library), and type 'FS01' (or another name). Later, when you have done some more work on the engine model and want to resave it, right-click its thumbnail in the Scene Library Panel, then select 'Replace'.

The Standard

Start with a rectangular block: [Cube], [ZL4.05/XS0.6/YS2.6/ZS7.5/'Standard'], fig 7.

The holes for the Crankshaft Bearing, Cylinder Pivot Pin and the ports are made by the same method as the holes in the Foot were. The cylinders to be subtracted from the Standard all have different parameters, so it is simpler to click [Cylinder] five times (rather than use the [Copy] function). Type in the values for each new cylinder as follows:

Crankshaft Bearing hole:
[ZL2.3/YR90/XS0.8/YS0.8]
Cylinder Pivot Pin hole:
[ZL6.5/YR90/XS0.3/YS0.3]
Inlet port hole 1:
[YL1.1/ZL7.374/XR90/XS0.3/YS0.3]
Inlet port hole 2:
[XL1.0/YL0.214/ZL7.374/YR90/XS0.2/YS0.2]
Exhaust port hole:
[YL-0.214/ZL7.374/YR90/XS0.2/YS0.2]

The positions of these cylinders are examples of details which have to be determined beforehand. I used 2D CAD, but they could have been found using a manual drawing or by trigonometry. Select the Standard, and make the holes by selecting [Object Subtraction] then clicking each of the cylinders in turn. Click [Object Tool] to exit the subtraction function.

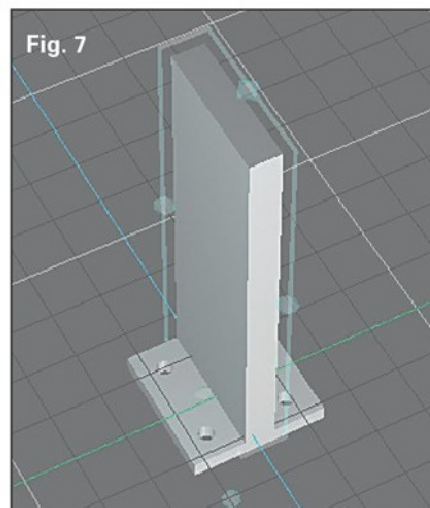


Fig. 7

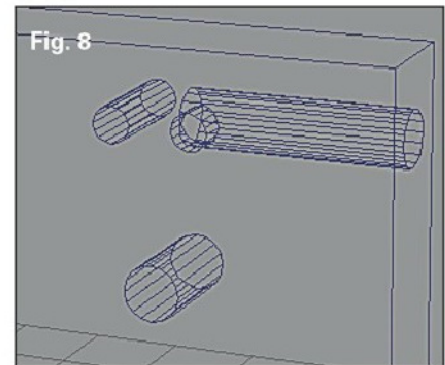


Fig. 8

So far, you have been using the trueSpace default display mode: the **Direct 3D Solid Render Display**. As objects are drawn as solids in this mode, the structure of the internal holes in the standard is not obvious. TrueSpace has an alternative display mode which you can use by clicking [Wireframe Display], Fig F. In some ways, this display mode is better suited for creating precision models, and also, as it is less computationally demanding, it is drawn quicker (useful if you have a slower computer). Here, in wireframe mode is a close-up of the holes at the top of the Standard, Fig 8.

If you want to return to the solid display, click [Direct 3D Solid Render Display], Fig F. From now on, I'll use both solid and wireframe images, depending on which shows the modelling most clearly.

Crankshaft Bearing

The modelling of this component demonstrates the use of both combining and subtracting objects. Click [Cylinder] twice, type in the values for the two cylinders:

[XL-0.85/ZL2.3/YR90/XS1/YS1/ZS1.1]
[XL-0.5/ZL2.3/YR90/XS0.8/YS0.8/ZS1.8]

Select either cylinder, click [Object Union], Fig B, then click the second cylinder, then [Object Tool]; the two cylinders will be combined into one object (to avoid accidentally unioning the Standard, you may have to change the viewpoint). Now, create another [Cylinder] to make the bore:

[ZL2.3/YR90/XS0.5/YS0.5/ZS3.0]

To complete the Bearing, select the combined object, and then subtract the new cylinder. Name the object ['CS Bearing']. You should now have Fig 9.

This is a wireframe image, but the Bearing has been rendered. **Rendering** is the process of producing an image of a 3D model, or (as in this case) an individual object. More details will be given on

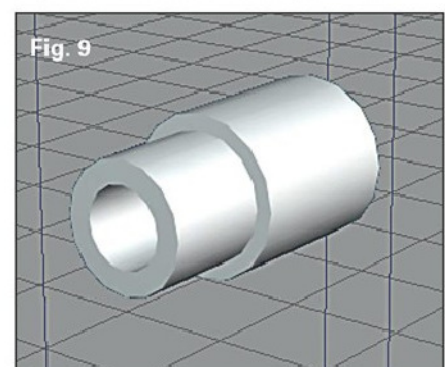


Fig. 9

rendering in next month's article, but for now, if wireframe mode is active and you want to see how an object will look as a solid, first select it, then click **[Render Current Object]**, Fig F.

Crankshaft and flywheel

The Crankshaft is simply a cylinder:
[XL-1.4/ZL2.3/YR90/XS0.5/YS0.5/ZS5.1]

For the flywheel, start with another cylinder for the boss:
[XL2.0/ZL2.3/YR90/XS1/YS1/ZS1.5]

The circumferences of all the cylinders used so far in the engine model have been made up from 16 polygons (also called faces). If you click **[Render Current Object]** and look closely at the boss, you can see that the perimeter of the circular face has a slightly angular look. This is usually acceptable with a small object like this, but if the larger outer diameter of the flywheel had a circumference with only 16 polygons, this would be very noticeable. The number of polygons specified for any cylinder perimeter can however, be changed. Right-click **[Cylinder]**, and a subsidiary panel will appear. Change the **Longitude** value from 16 to 64 (press Enter). Now, click **[Cylinder]** to see the difference. Every curved surface in a 3D model is approximated by using flat polygons - the more polygons present, the smoother the surface will appear. In general, objects should be created with the minimum of polygons that will produce realistic images; unnecessarily detailed objects will tend to slow the computer redrawing rate down, and result in larger computer file sizes.

Set the parameters for the last cylinder:
[ZL2.3/YR90/XS3.8/YS3.8/ZS1.0]

To make two recesses in the flywheel, use **[Copy]** and type [XL-1.9/XS2.8/YS2.8], click **[Copy]** again and [ZS0.6]. **Subtract** this last cylinder from the previous one (a change of viewpoint first may be needed for this operation), and you should have one object separated into two disc-shaped parts (plus the boss and the large cylinder). The objects should look like those in the Fig 10 (for clarity, I've made the non-flywheel parts invisible).

Exit subtraction mode by clicking **[Object Tool]**, then select the large cylinder and type [XL-1.9]. Click **[Object Subtraction]**, click the two-disc object, and a recess on either side of the flywheel will be created. To join the boss to the flywheel, click **[Object Tool]**, then click the boss, and [XL-2.15]. Select **[Object Union]**, then click the main Flywheel part.

The Flywheel bore can be created by subtracting the Crankshaft, but to do this

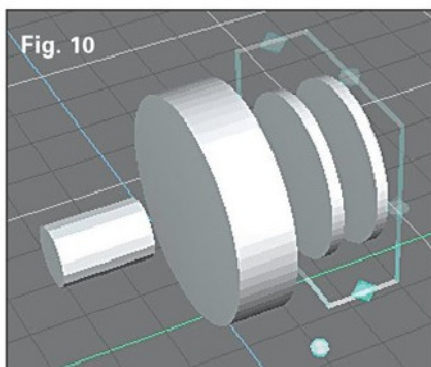


Fig. 11

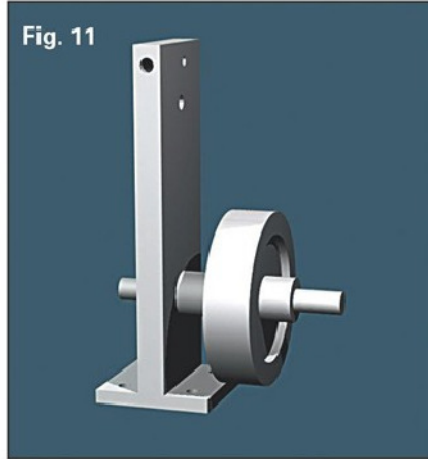


Fig. 12



without deleting the Crankshaft at the same time, first do the following: right-click on **[Object Subtraction]**, and click the **Keep Drill** box in the subsidiary panel. With this option active, subtracted objects are not deleted. Click **[Object Subtraction]**, the Crankshaft, then **[Object Tool]**. Type **['Flywheel']** in the Info Panel.

To get an impression how the five created objects of the engine are looking, adjust the viewpoint to your liking, and then click on **[Render Scene]**, Fig F and Fig 11.

If you study the Flywheel building steps closely, you may notice that they are more complicated than is really necessary; to show the modelling clearly, I've kept the cylinders separate and moved them into position when they are needed.

Crank

In the Cylinder panel, set the **Longitude** to 16, select **[Cylinder]** and set values to [XL0.75/ZL2.3/YR90/XS0.8/YS0.8/ZS0.7] **[Copy]** cylinder and change the following values: [XL0.7/ZL1.3/XS0.5/YS0.5/ZS0.6]

Create a new **[Cylinder]** with **Longitude: 64**: [XL0.65/ZL2.3/YR90/XS2.6/YS2.6/ZS0.5] **[Copy]** cylinder and change the following: [YL2.9/ZL0.9/XS5.0/YS5.0] **[Copy]** again and [YL-2.9]

Select the 2.6 cm diameter cylinder, and **[Object Subtract]** the two 5 cm cylinders (uncheck the **Keep Drill** box in the Booleans panel if still set). **[Object Union]** the resulting object with the first two cylinders.

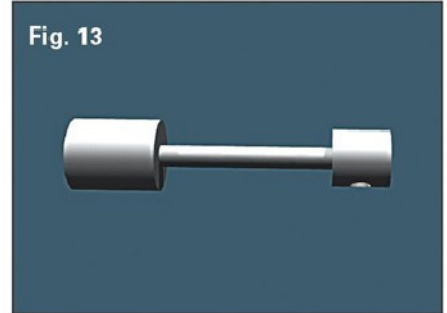
Create a new **[Cylinder]**, **Longitude: 16**, for the Crank Pin:
[XL1.15/ZL1.3/YR90/XS0.3/YS0.3/ZS1.5]

Finally, **[Object Subtract]** the Crank Pin and Crankshaft from the Crank (use **Keep Drill**). With **[Render Scene]**, these three objects should look like Fig 12.

Piston

This component should present no new challenges, being made straightforwardly from three cylinders.

Fig. 13



Create the **cylinders** with **longitude 16**, and with the following values:

[XL1.4/ZL4.7/XS1/YS1/ZS1.2]
[XL1.4/ZL2.9/XS0.3/YS0.3/ZS2.4]
[XL1.4/ZL1.3/XS0.8/YS0.8/ZS0.8]

Join them together with **[Object Union]** (Keep Drill off), then **subtract** the Crank Pin (use Keep Drill), and voilà - one Piston (shown horizontal in Fig 13).

Cylinder Block

This is the most complex object in the model, but the same technique of combining and subtracting polyhedrons is used to make it. Start with a **[Cube]**, and change its values to:

[XL1.2/ZL6.5/XS1.8/YS1.3/ZS2.4]

Create two cylinders with longitude 24 and values:

[XL1.4/ZL4.7/XS1.3/YS1.3/ZS1.2]
[XL1.4/ZL5.8/XS1.0/YS1.0/ZS3.4]

[Object Union] the altered cube with the first cylinder (Keep Drill off), then **subtract** the second cylinder to form the bore. Next, a shallow recess is made around the Pivot Pin position by subtracting this cylinder:
[XL0.35/ZL6.5/YR90/XS1.2/YS1.2/ZS0.1]

Subtract another cylinder, **longitude 16**, to form the Cylinder Port:
[XL0.6/ZL7.4/YR90/XS0.2/YS0.2/ZS0.7]

Create a cylinder for the Pivot Pin:
[XL-0.45/ZL6.5/YR90/XS0.3/YS0.3/ZS2.5], and **subtract** this from the Cylinder Block (use Keep Drill).

Finally, to complete the whole model, a basic representation of a Nut can be made for the Pivot Pin. This is simply done with **[Cylinder]**, in this case, with the **longitude set to 6**, a hexagonal prism shape will be created, Fig 14 Change its values to:
[XL-1.5/ZL6.5/YR90/XS0.6/YS0.52/ZS0.3].

To be continued...

Next Month: Part two will show how model images can be made more realistic by using **materials** and **lights**. This part will also have more demonstrations of using polyhedrons to construct some simple engineering components.

Fig. 14





Photo 1. Evidence of progress on the Flying Scotsman.



Photo 2. Judging in progress with Geoff Sheppard (left) and Mike Chrisp (right).

Harrogate 2009

Dave Fenner visits the National Model Engineering and Modelling Exhibition at Harrogate

Our travel arrangements this year followed those established last year, i.e. travel to Yorkshire on Thursday, stay over and attend the exhibition on Friday. On the journey south, we stopped at Scotch Corner and considered whether to either make a repeat visit to the National Railway Museum in York or to take a trip across country to visit the North Yorkshire Moors Railway. Not having done any prior research on the web, we figured that Tornado might be at the museum, also the added mileage would shorten the afternoons enjoyment, so it was off to York, where Murphy's Law prevailed, and reception advised us that Tornado was visiting the NYMR.

Never mind, the NRM is one of those places, a bit like the Science Museum at South Kensington, where no matter how many times you visit, there is always something you missed earlier. Walking round the gallery in the workshop gives an overhead view of some of the ongoing restoration work. **Photo 1** gives an impression of progress on the Flying Scotsman chassis. We found plenty to hold our attention until closing time.

On Friday morning, it was clear after a quick walk round, that Lou Rex, B.E.M. had once again worked his organisational magic to create a superb show. Whether you wanted to see particular types of models, or examine new machinery, or just stock up on materials and tools, there was something of interest.



Photo 3. Mr K Harrison's modified dividing head for spiral milling.

Judging competition entries at an exhibition is an activity which may have some parallels to football refereeing, in that, on occasion, someone feels that their efforts are not sufficiently recognised. A great deal of work is undertaken by the chief judge Harry Paviour and his team, both in prior research and actual detailed examination of exhibits. **Photo 2** shows two members of the team of judges, Geoff Sheppard and Mike Chrisp (known to many as respective former editors of Model Engineers' Workshop and Model Engineer).

From some points of view, model engineering has become narrower in context, with an accent on steam power but also admitting disciplines such as clock making and I/C engines. For me, one of the great strengths of the Harrogate

show is that it extends to fully encompass the disciplines of model boats and aircraft. In the I/C engine field, the Bentley engine constructed by Mr M Sayers, is a superb piece of work and this year I managed to be in the right place at the right time to witness it running - very smooth and surprisingly quiet. A fellow PEEMS club member, Mr B Rees also demonstrated an interesting single cylinder engine.

Competition

This year the workshop equipment category was supported by five entries from two entrants.

Mr K Harrison presented two items. The first of these was a conversion of a dividing head for spiral milling and is shown in **photo 3**. A master spiral and



Photo 4. Long top slide with QC toolpost and tooling exhibited by Mr K Harrison.



Photo 5. Low level scribing block, small height gauge and rule holder by Mr P Bowler.

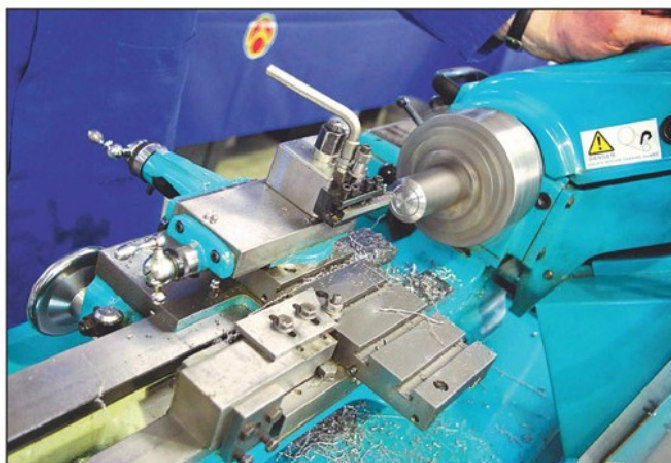


Photo 6. Demonstration of large radius turning.

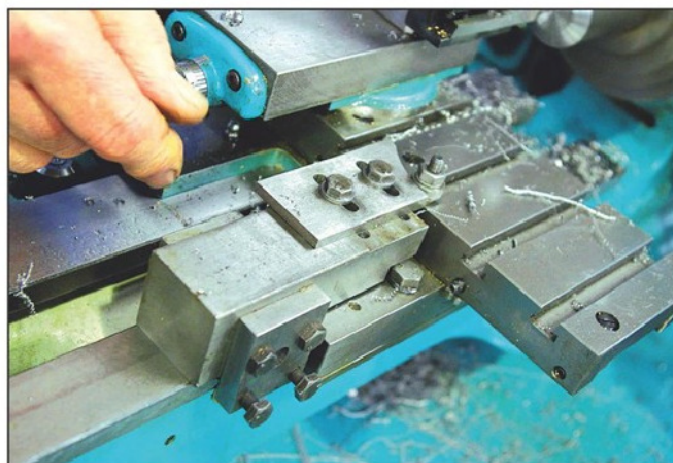


Photo 7. Detail of profile plate.

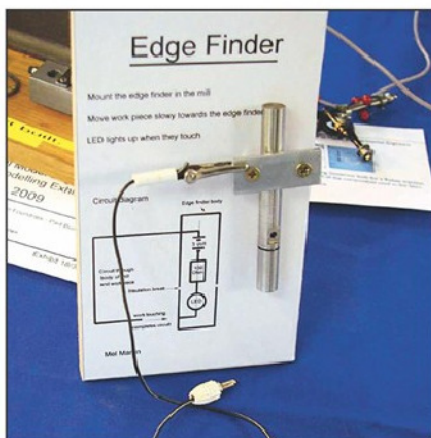


Photo 8. Electronic edge finder designed and built by Mr Mel Martin.

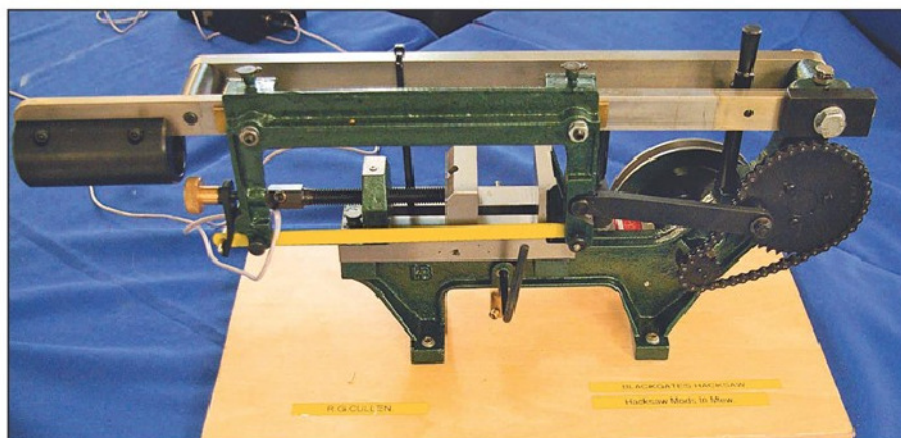


Photo 9. Power hacksaw to Blackgates design by Mr R Cullen.

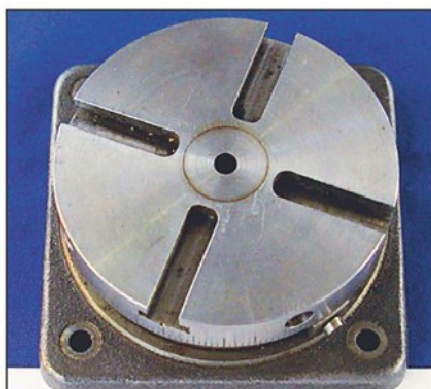


Photo 10. GHT designed small rotary table, by Mr C Ager.

follower ensures that the work is cut to match the master. The second exhibit from Mr Harrison, **photo 4** comprised a long top slide fitted with quick change block boring bar holders. Mr Harrison's efforts were rewarded by a "Commended" from the judges.

The second entrant, Mr Paul Bowler, has been a consistent supporter of this competition class for a number of years, and this year fielded three items, a low level scribing block, a small height gauge, and a rule holder. **Photo 5** shows these entries.

Club Stands

The SMEE stand as expected contained a number of interesting exhibits, also a demonstration by Derek Brown using a

Myford lathe to produce a surface having a large radius of curvature. This technique might be usefully applied to work such as locomotive buffers. The method employed a "contour plate" working with a small roller to give the correct radius, and feed was supplied by the power cross feed.

Photo 6 shows the overall set up and **photo 7** the detail of the plate and roller.

Mel Martin showed his own design of electronic edge finder. The body houses batteries, resistor and an LED, which illuminates as the probe contacts the (metal) work piece. We hope that Mr Martin will write up this project, **photo 8** for publication in due course. **Photo 9** is of the Blackgates designed powered hacksaw produced by Mr R Cullen, while



Photo 11. Press tool for small boiler throat plate - Peter Haycock.



Photo 12. Peter Haycock's fixture for handling slip eccentrics.



Photo 13. Wheel quartering jig for gauges 0 and 1 - Peter Haycock.

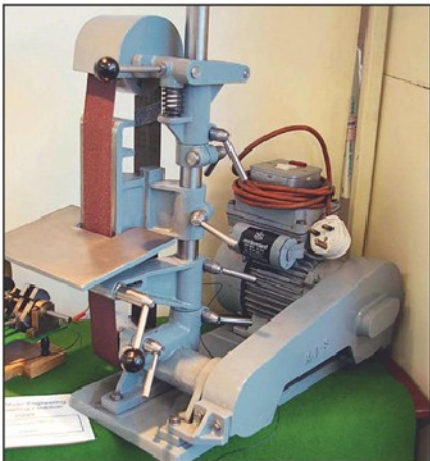


Photo 14. MES Linisher by Mr G Jackson.

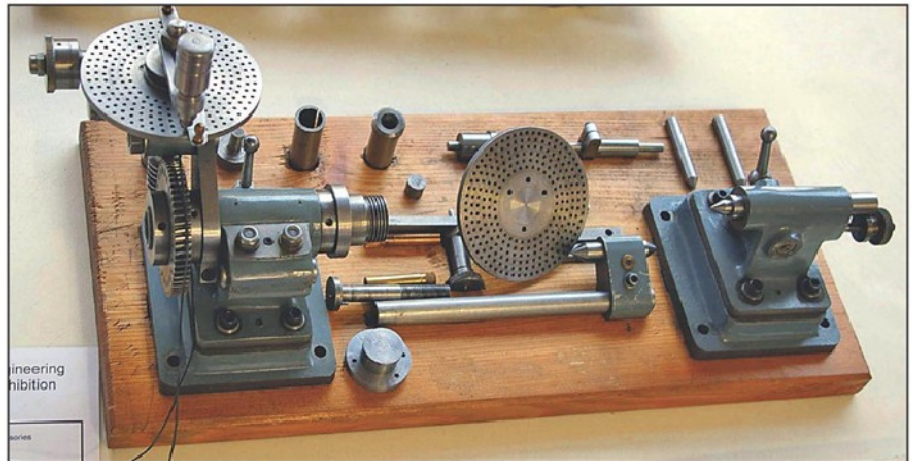


Photo 15. Dividing head and accessories from Allan Hopwood.

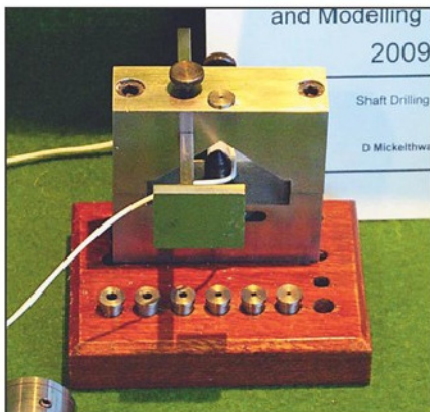


Photo 16. Shaft cross drilling jig by Mr D Mickelthwait.



Photo 17. Modified ball turning tool by Mr S Hauptman.

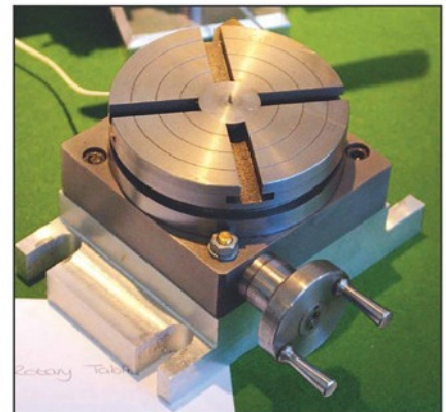


Photo 18. Mr K Bateman's 4 inch rotary table.

photo 10 illustrates the small rotary table made by Mr C Ager to a George Thomas design.

Peter Haycock's exhibits included a number of tools and jigs relevant to producing small locomotives.

Photo 11 is of a press tool for the throat plate of a G1 boiler, while photos 12 and 13 show respectively a fixture to allow two drilling and milling operations on slip eccentrics, and a quartering jig for G1 and G0 wheels.

York Society clearly has several members with an interest in workshop equipment, and a number of the exhibits reflected this. Mr G Jackson displayed his MES abrasive band machine, photo 14 (entered in competition last year). From

Allan Hopwood came the dividing head and accessories, photo 15 and from Mr D Mickelthwait, the shaft cross drilling jig shown in photo 16. Work from other York members included the ball turning tool by Mr S Hauptman, photo 17 and the rotary tables by Mr K Bateman photo 18 and Mr P Inwood photo 19.

Exhibits spied on the Leeds Society stand included a vertical spindle MES Surface Grinder, photo 20 by Mr A Bootland, and a cycle spoke tensioning device, photo 21 by Mr T Knight.

Mr J Mathie of the Carlisle club displayed a selection of items including the simple dividing head and filing rest shown in photo 22 and the bending rolls in photo 23. It may be seen that these feature two

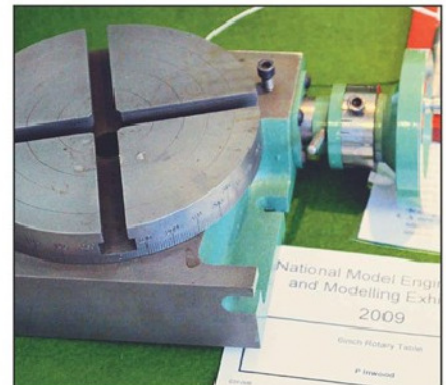


Photo 19. Six inch rotary table by Mr P Inwood.



Photo 20. MES surface grinder by Mr A Bootland.

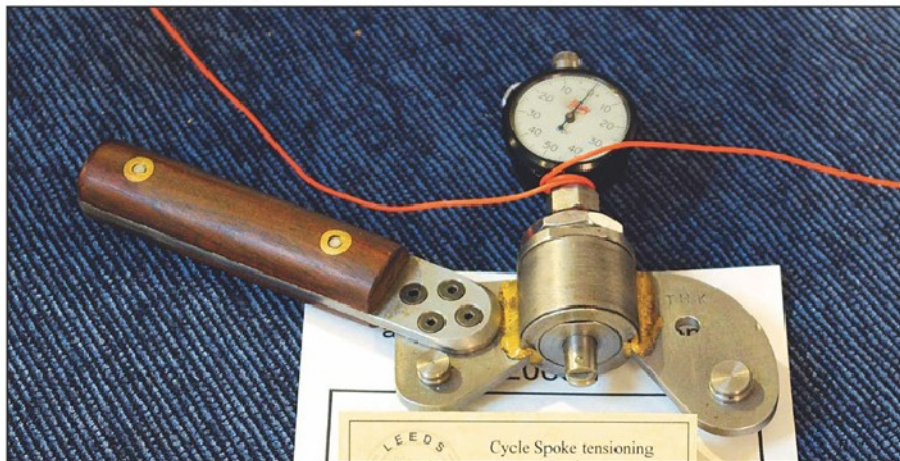


Photo 21. Terry Knight's cycle spoke tensioning device.

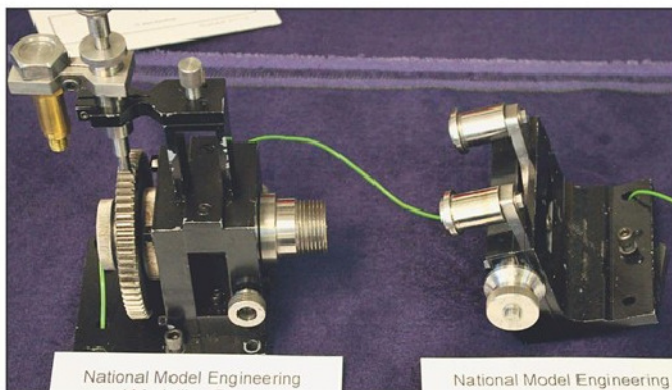


Photo 22. Simple dividing head and filing rest by Mr J Mathie.



Photo 23. Bending rolls also from Mr J Mathie.



Photo 24. KX1 CNC mill from Arc Euro Trade.



Photo 25. "Prewired then cut to size" readout from Warco.



Photo 26. Harry Paviour's superb model of M.V. Goldcrest.

sizeable handwheels which may be an effective alternative to gear or chain drive between rolls.

Trade Exhibitors

No model engineering show would be complete without a healthy attendance from the trade, and many of the well known suppliers had booked stands. Arc Euro Trade were demonstrating their CNC mills, **photo 24**. It is interesting to see how amateur CNC has developed over the last decade or so, from the pioneering work undertaken by Richard Bartlett, then the emergence of several control systems and affordable software to speed up the creation of control programs. Now we have small mills fully configured for CNC operation thus by passing the need to convert a manual machine.

Warco displayed their latest in readout scales, **photo 25**. Historically for DRO systems using the lower cost Chinese

scales, there has been a general question mark over the quality and compatibility of the connector plugs. (For my own Shumatec system, I dispensed with the plugs and soldered the wires directly into the scales) The new Warco offering gives two advantages. First the scale is supplied to a generous standard length which can then be cut to just the length required on the machine, and second, the scale comes prewired with its remote read out, so all you have to do is mechanically mount the hardware.

Tail pieces

At one stage in the day, during a conversation with chief judge Harry Paviour, he asked whether I had seen his boat. Well, at that stage I had to admit that no I had not. Early in his career, Harry had spent some time at sea, and still has fond memories of the Goldcrest, so he has produced a model of this ship, shown in **photo 26**.



Photo 27. Special bolts from Mr T Sanders.

Finally, some readers may have seen drawings of special bolts for non standard applications. Mr T Sanders of Scunthorpe society has made a series of samples as illustrated in **photo 27**. ■

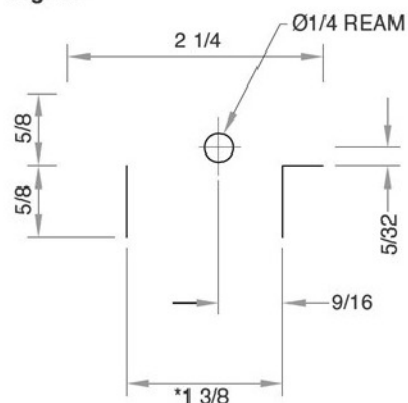
To Die, Now! (Better than 'Yesterdie'?) ⑥

David Piddington concludes his look at dieholders.

Coupling marking jig

Returning to the matter in hand I had already decided that the method of boring the front end of the tailstock to take the die holder attachment bush was to tow it along the bed with the saddle. What was needed was a coupling device with a hook on the saddle and the tailstock with a link between, both ends being in line. I fabricated a marking device with two pieces of $\frac{5}{8}$ in. square mild steel that I found in my 'odds' box as drawn in Fig. 15. As an alternative it could have been milled from the solid. Any thickness greater than $\frac{1}{2}$ in. will do. Mark out for,

Fig. 15



*CLOSE FIT BETWEEN
BED SHEARS
FABRICATE OR MILL FROM SOLID
DRILLING JIG FOR COUPLING

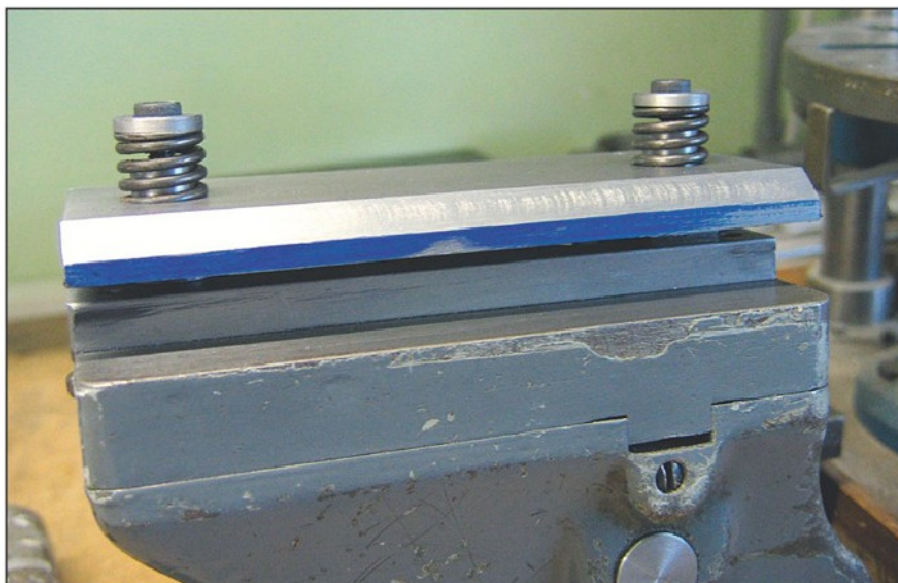


Photo 60. Method of marking the rub areas on the underplate.

then drill and ream $\frac{1}{4}$ in. diameter and deburr the hole's edges. Now find a piece of $\frac{1}{4}$ in. diameter silver steel, turn a 60deg. (ish) point on it and then harden and temper. I already had a suitable punch, made from a broken end mill where the point had been ground on the shank at the appropriate angle. Using this as shown in photos 61, 62 and 63 the points where the hook bolt will fasten may be marked and then drilled and tapped 2BA. I repeated this process for the standard tailstock as it would be feasible now to 'tow' this one as well. Carefully check that the tapped hole in the saddle and tailstock goes into parent metal and avoid a conflict of adjusting strips while making the setting jig. Dimensions given may not exactly suit other machines.

Drilling and tapping the tailstock is done on the bench drill while suitable fixed to an angle plate, but the hole in the saddle requires a different attack and an extended drill is required. Take a 6in. length of $\frac{1}{4}$ in. diameter mild steel and after facing both ends, drill one end number 24 diameter, which gives 86% thread engagement for 2BA, Drill dry; do not use lubricant. The drill may now be reversed and after careful cleaning 'Loctite high strength 603' is applied to the shank and it is inserted into the hole and allowed to cure.

Use the setting jig with its $\frac{1}{4}$ in. hole to align the drill. Photo 64 shows the procedure with the jig clamped from the cross slide. Do this first if, like me, you have only one number 24 drill. The drill may be removed by applying a flame, hot but not

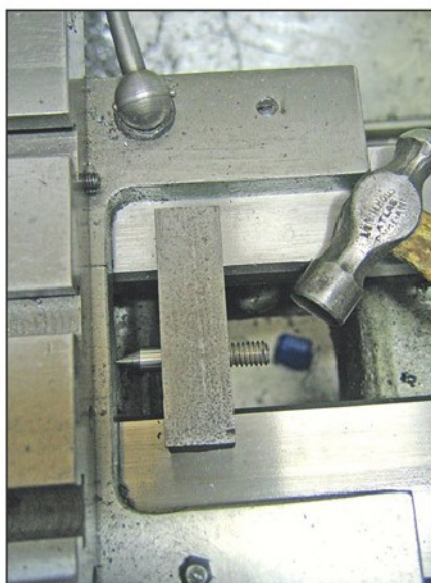


Photo 61. Using the hook marking jig on the lathe saddle.

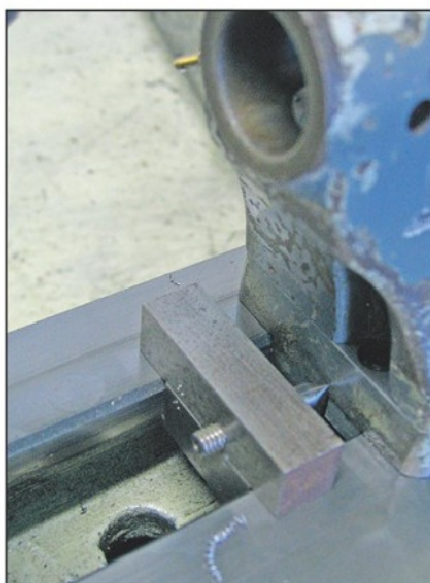


Photo 62. Using the hook marking jig on the new lathe tailstock.

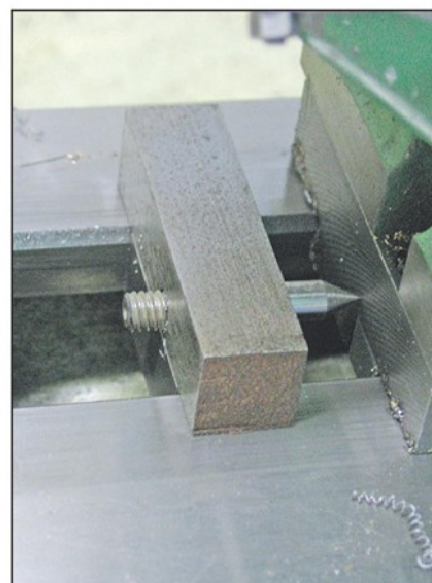


Photo 63. Using the marking block on the original lathe saddle.

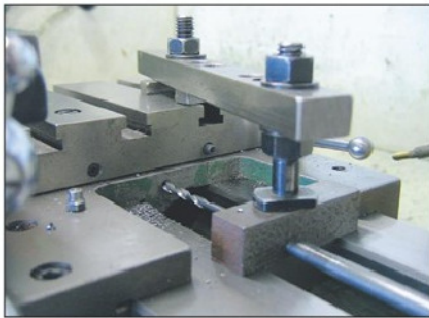


Photo 64. Using an extended drill to drill for the hook.

red hot, to the extension where the drill shank is fitted. When smoke arises, grip the drill with pliers and gently pull it out.

Next requirement is for an extended tap wrench. Mine still has number 31 - my clocking in number - stamped into its shank from my apprentice days. It is also rather long for this particular job but it will serve. To make one for this job, take a $6\frac{1}{2}$ in. length of $\frac{3}{16}$ in. diameter mild steel and in one end drill a hole 0.196in. diameter and about $\frac{3}{16}$ in. deep. Alternatively measure the across corners size of your 2BA taps and drill that diameter. With a great deal of bad luck previously, you will have kept a 2BA broken tap shank especially if of HSS which

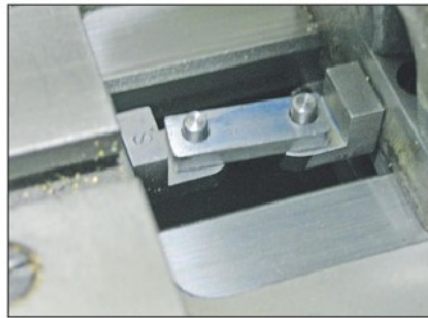
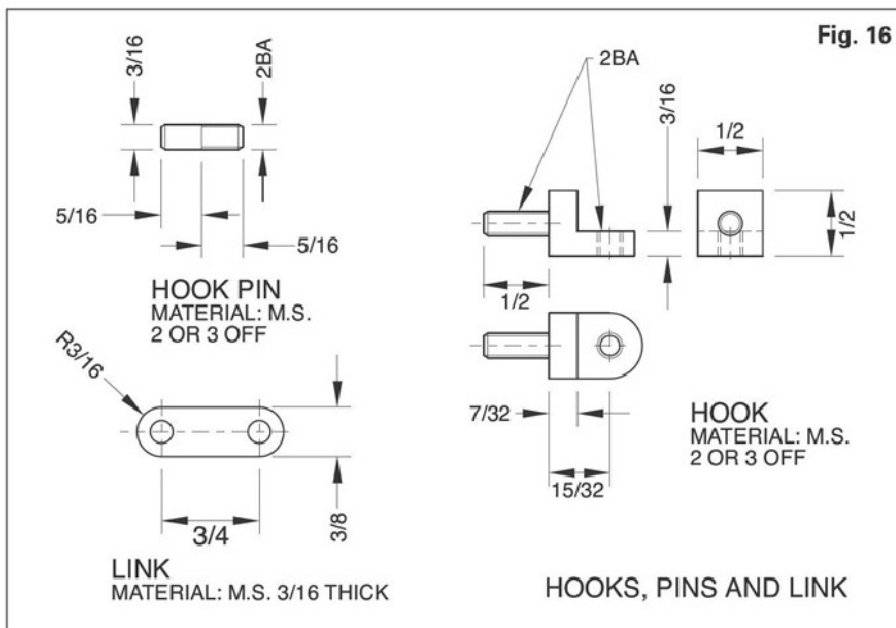


Photo 65. The completed hook and link.

is very hard. Grind the end off square and then very carefully with a corner of the grindstone nick across the centres of the square leaving, effectively, a crude broach. Hammer this into the drilled hole with the bar held upright in your bench vice. You will need to remove and replace between hammer blows in order to remove chips of steel. Eventually your hole will be of sufficient length to grip taps with this size of square securely. Cross drill number 13 at about $\frac{1}{2}$ in. from the other end and press in a 5in. length of $\frac{3}{16}$ in. diameter mild steel to form a cross handle. Do take your time tapping this hole. This is the wrong place to break a tap.



At this point I stopped for lunch and on return had a flash of inspiration! The hole in the tailstock could be done in exactly the same way by putting the tailstock/s in backwards, handle end towards the chuck and turning the jig through 180deg. The under plate has also to be reversed due to the clearance chamfer for the leadscrew handwheel.

Hooks and link

We now need two (or three) hooks and a link, Fig. 16, of which there are numerous ways of achieving this. I used some $\frac{1}{2}$ in. square MS that I had to hand. Possibly hexagon might have been better but I didn't have any about that size. Machine as shown, with the 2BA thread at $\frac{1}{2}$ in. long cut first. Two or three of these are wanted. The third if you wish to 'tow' your lathe's original tailstock as well. Face off the blanks at $1\frac{1}{4}$ in. long, turn down a $\frac{1}{2}$ in. length to 0.185in. diameter and thread up to the head 2BA. Take one threaded blank and insert into the saddle's tapped hole and tighten carefully until one of the sides is vertical with the blank tight home, or very nearly so. Mark this face with a letter punch "S" = 'saddle' immediately next to the saddle so it will not be machined away. That for the dieholder tailstock will have a "DT" punched on it and for the original I suggest "LT" = 'lathe tailstock'. Next mill away the front of the 'hook', then drill and tap vertically for 2BA. As an optional extra the front may be rounded off as shown. Make three single ended pivots as per the drawing and fit them tightly into the holes. The connecting link is made from $\frac{3}{16}$ x $\frac{3}{16}$ in. MS drilled at both ends number 10 drill clearance for $\frac{3}{16}$ in. I assembled the parts and found there had been a discrepancy and my unit was not quite parallel with the lathe axis though this will not matter overmuch. Photo 65 shows a bird's eye view of the finished link.

The hook and link holes in the saddle and tailstock/s should be plugged when these are not in use. If you do not do this, then the holes will inevitably collect swarf and the next time you wish to use them, you will have to clear out the hole with a tap. Not a major task but inconvenient. Use either socket grub screws, say $\frac{1}{2}$ in. long, or simple slotted screws, which you can make now with your 2BA preset die in its holder. I recommend also that you make a dedicated storage area or box in your workshop and a note of where this is kept. You will need somewhere for the finished dieholder tailstock, so both together will be appropriate.

Dieholder adapter

Now we approach the alignment of the tailstock bore with the lathe centres to enable insertion of the adapter, Fig. 17. The headstock end of the tailstock bore must be machined out to accept this. We can machine the adapter first and use it as a plug gauge, or we can bore out the tailstock first and then make the adapter diameter to suit. I thought long and hard about which to adopt but decided in favour of the latter as the former will require continual removal and replacement of the between-centres boring bar which will have to be used because of the distance away from the lathe's headstock. I hope that is clear?

Before this however, I decided to retain the tailstock's original barrel clamp lock,

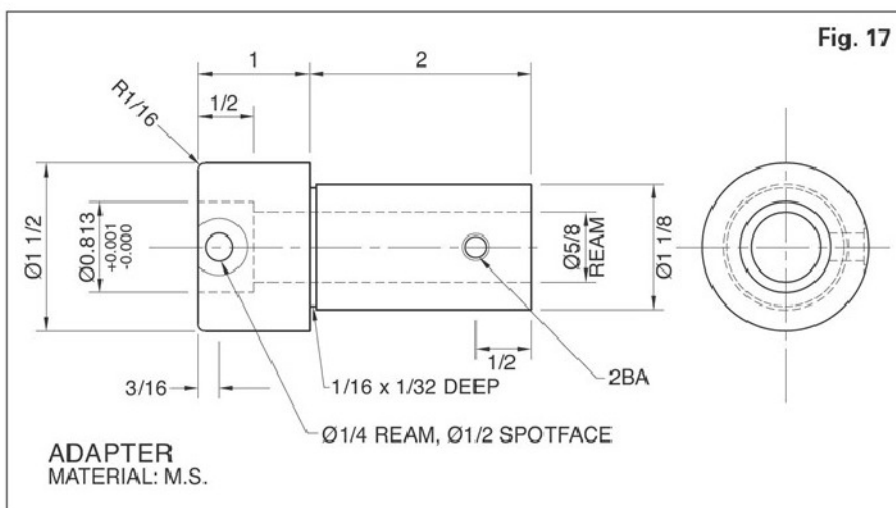




Photo 66. The adaptor clamp with spacer prior to remachining.



Photo 67. Excess metal is removed prior to boring.

which, because of its split nature and radius, will have to be machined at the same setting. First, with the clamp lever removed, put a short stub of 1in. bar down the tailstock barrel and, with half the clamp visible and touching this bar, measure the gap between the halves. Machine a spacer collar of this thickness, place between the halves as shown in **photo 66** and clamp with two 1/4in. BSF locknuts for a reason that will become apparent shortly. Next with the clamp halves approximately in line, file away the upper part of the spacer to approximately the same curve as the clamp halves, **photo 67**. By this means most of the intermittent cut of the boring tool can be avoided. This item is now inserted into predetermined position and secured with a G-clamp, **photo 68** now explains the locknuts, which protrude beyond the end of the thread. One, or two thin washers will be required



Photo 68. The method of securing the split clamp prior to boring.

at the bottom of the hole to centralise the split clamp prior to the boring procedure. I made one omission, to be rectified later. The 1/4in. hole near the tailstock front and on the barrel centre line originally held a special key to guide the tailstock barrel to stop its rotation. Before the next process this hole should be plugged. A short stub of steel should be press fitted into the hole (not too tight as we don't want to crack the

casting) to its depth only where it will be machined away on its internal end by the boring cutter. Cut off short near the outer body and trim with a file.

Boring bar

Over the years I have made a few between centre boring bars and have kept them - just in case of a future need. Luckily I had one, which, while not perfect, enabled me to complete this particular task. I lengthened it with a detachable end as the original fitted into a dedicated slot in its storage chest. **Fig. 18** shows the final dimensions. Both ends should have a BS3 centre drill put in, this operation being performed using the lathe three-point steady appropriately. A 1/4in. round HSS tool bit not greater than 7/8in. long should have an appropriate point ground on it and secured with a 2BA socket grub screw. Slackening the grub screw and lightly tapping the blunt end with a small hammer advances the cut. Primitive, but effective! I initially had problems of tool-chatter. This was finally resolved by having a pointed tool with a very small radius at the tip. **Photo 69** shows what may be a unique event, certainly very unusual, of a Myford Series 7 lathe with two tailstocks in action at the same time

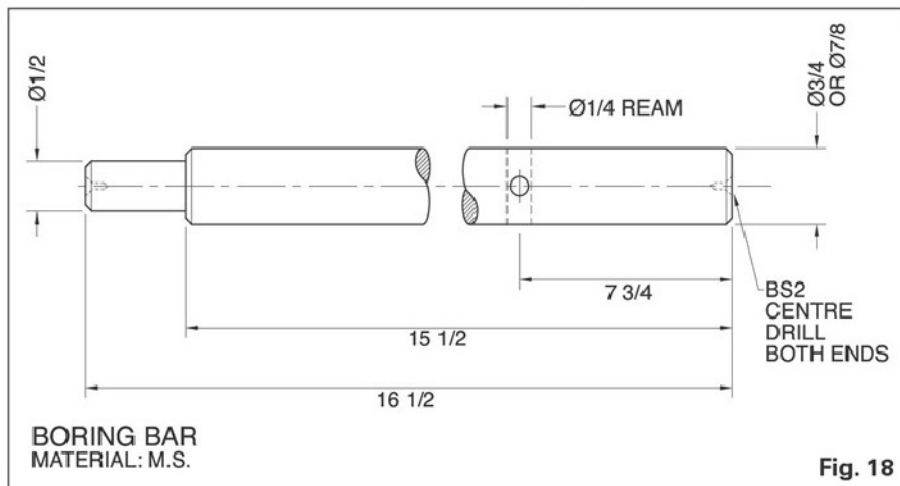


Photo 69. The boring process with both tailstocks in use.

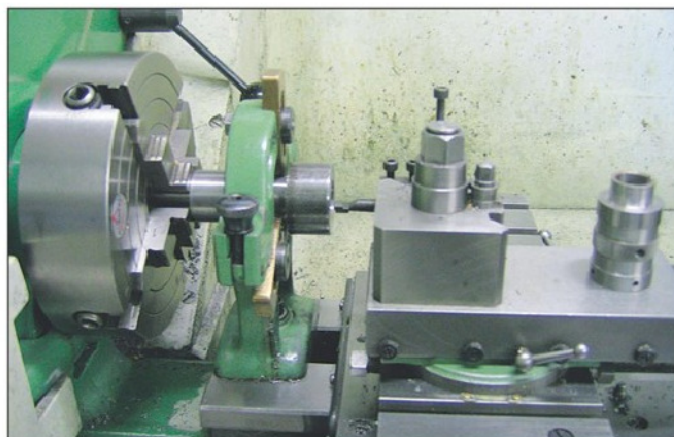
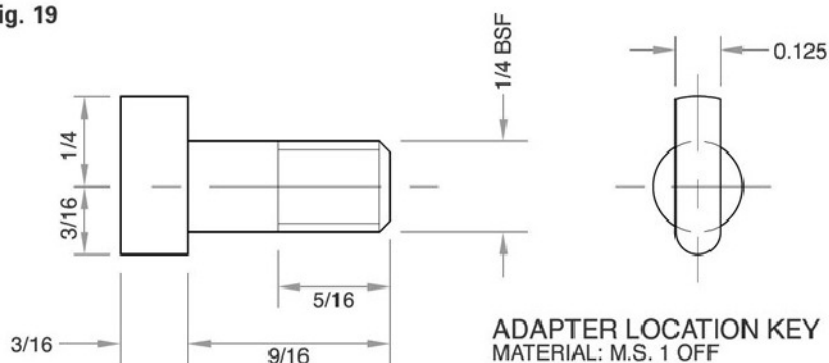
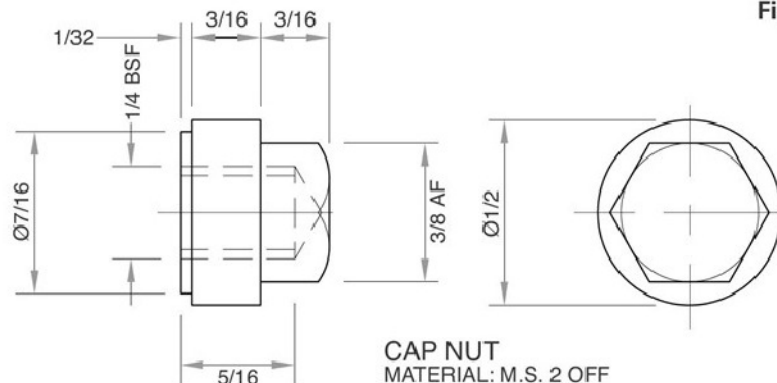


Photo 70. The fixed steady in use to machine the adaptor.

Fig. 19**Fig. 20**

on the same bed doing different tasks. The brass coloured 'thing' beneath the one being bored is my swarf shovel, this time pressed into service to catch the cast iron bits which I noticed were mixing with the oil I had put on to the bed in front of the sliding tailstock and making a sort of lapping paste; undesirable in this instance. Remember to set a saddle stop at, say 2 1/4 in., which is longer than the mating diameter of the adapter. Having attained a reasonable surface finish at 1.088 in. diameter I stopped. There is no real need to go larger unless, of course, you have already made the adapter.

Remove the clamp and separate the parts in order to break the sharp corners where the boring tool cut them. The 'sacrifice' separator can be discarded unless you can find a use for a "D" shaped thick washer. As with the saddle and under plate, do not remove the sharp edge of the bore. There is an undercut on the adapter to correspond with this and enable the

adapter back face to fit against the tailstock front. The adapter itself should not need specific manufacture instruction except to note that both the front bore to accept the die holders and the outside of the 2 in. long location spigot must be accurately concentric to each other. My recommendation would be to drill and ream through 5/8 in. diameter and then, supporting the spigot end with a live centre, machine the outer diameter to a close running fit in the newly bored tailstock. Then with a length of 5/8 in. diameter ground mild steel bar set to run truly in either a "Griptru" chuck or a four-jaw independent chuck, and protruding from it by 2 in. secure the adapter body, large end outwards to this bar with a temporary screw. However, position, drill and tap, and 'dimple' the support bar for rotational grip before setting the bar to run truly. Practice what you preach? I forgot to do this and rather than waste time re-setting I filed a flat

across the bar instead - just as effective. Your three-point steady could also be used supporting just behind the larger diameter, **photo 70**. Then the outer end may be faced off to length and the bore put in to mate with the corresponding diameter of the die holder bodies.

Location key

The location key **Fig. 19** fits into a reamed hole at the front of the adapter, which is then spotfaced to accept a closing nut. The overall length of the key bolt is critical and it can only just be inserted into its hole from inside the larger bore of the adapter. Removal of burrs on the bolt and hole is essential. **Photo 71** shows the spotfacing with an end mill after the hole has been drilled and reamed. We can now try an assembly after reducing the key end of the bolt back to the adapter face and filing the outer end to a 1/16 in. radius to fit in the dieholder drive slots.

Location key nut + locking clamp nut

A standard 1/4 in. retaining nut can be used **photo 72** but, quite frankly, its appearance is ugly. My own version is shown in **photo 73** and in **Fig. 20** is more pleasing to the eye. You will need a plug tap ground off very square at the tip to ensure full depth of thread. The hexagon size was a guess and, unknowing, I discovered that a 1BA spanner fits exactly. A second nut of this type could also be used on the adapter clamp bolt instead of the Myford original finger and thumb lever.

I had already decided that I would paint the tailstock to match the green of the Super 7 and I already had a tin of their "touch up" left from a previous job that was still in good condition. Myfords have at their Beeston, Nottingham, works an on-site spares shop to which visitors are welcome and can supply most spares off the shelf. I was typing these notes at the beginning of the week of their October 2008 open days and could, had the weather forecast been better - it was not good for motorcycling, have visited their show. To the job in hand, a plain plug was made for the aforementioned hole and for the one at top, which is already tapped 2BA for the oil nipple, a threaded one for that. Other 1/4 in. BSF plugs were made to replace the side adjustment screws. Keep the originals safely as they are peg pointed and may be useful sometime.

The 1/4 in. slot, or what I thought was a 1/4 in. slot is nearer to a 3mm slot, which I

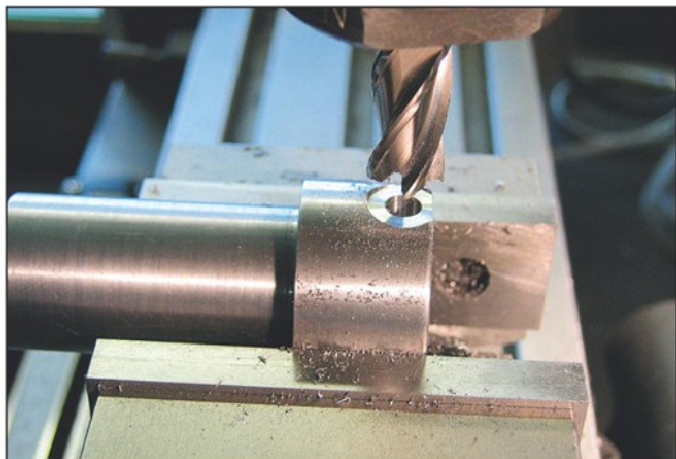
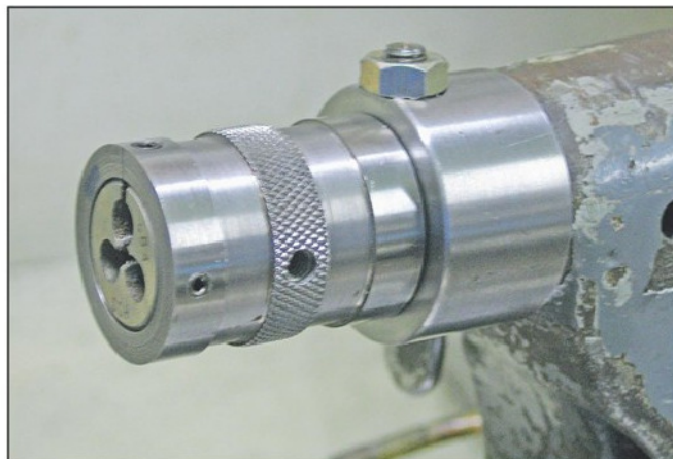
**Photo 71. Spotfacing the adapter to accept the location key.****Photo 72. The ugly standard adapter securing nut.**



Photo 73. The improved adaptor securing nut.

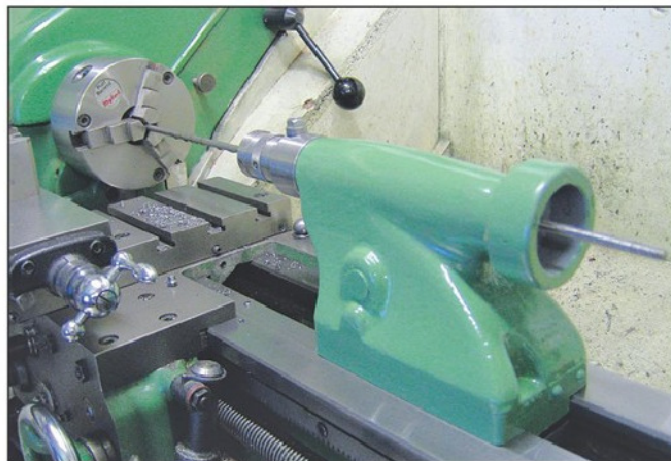


Photo 74. The initial testing, making a length of 2BA studding.

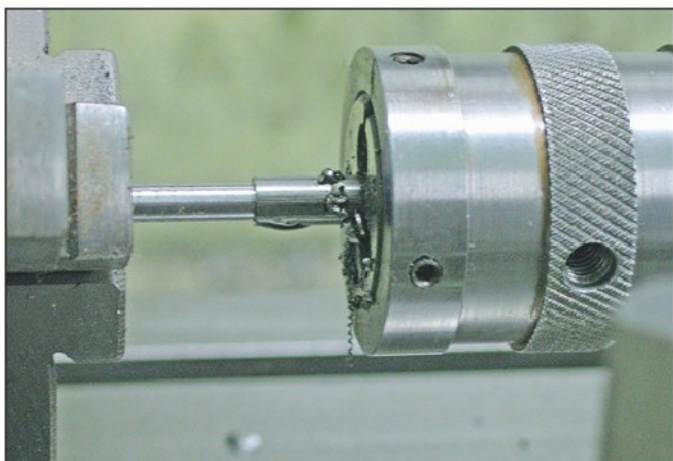


Photo 75. Initial testing, the die runs out onto previously machined bar.



Photo 76. A small diameter steady for turning.

find surprising for an Imperial inch manufactured machine of at least 3 decades old. Anyway, half way around the tail end boss is a slot where this semicircular key was inserted to run in a groove around the handwheel boss and to retain the latter. This should be mimicked by a similar piece of steel plate and, in addition to replacing the top uppermost screw; two more at the lower extremes should be fitted with countersink screw heads. These are 4BA x 3/4in. long. Use "Loctite" and file the heads off flush after the 'adhesive' has set. Do not blank the major hole off altogether as clearance must be left for longer threads to pass through.

The original casting had been carefully coated with filler after minimal fettling and then painted. It had seen much use for the topcoat of paint at the filler had worn away completely by hand usage. All extraneous holes and gaps can be filled with quick setting "Araldite" which is filed off flush after hardening. After rubbing down, not forgetting to put a screw into the hook hole to keep this free of paint, coat the surfaces with a primer and then with the Myford paint, or to suit your own machine. The main bores and that for the adapter clamp should be plugged and the under bed-contact surfaces may be protected with masking tape.

After painting, and allowing time for the top coat to harden, remove all plugs and tape and then clean off the very few surfaces that have to be left 'as machined'. Now comes the moment of truth - testing. **Photo 74** shows my first attempt to cut a full length (nominally 2 feet) of 2BA

studding from standard 3/16in. diameter steel bar. But, before doing this, machine about 3/4in. of one end down to a few thou' less than core diameter of the thread which for 2BA is 0.147in. Machine the end to, say 0.140in. and this, as seen in **photo 75**, allows the die to pass into the relief and then, after releasing the chuck, the studding may be easily removed. If you neglect to do this, then the only extraction method is to reverse the lathe and wind the whole thread length out by this tiresome means. One other point I should make is that the torque action of the threading will retain the dieholder in the adapter by means of friction on the sides of the keyway, which action should be sufficient to carry the whole tailstock with it. Very fine threads may have to be assisted with light hand pressure, just sufficient to keep the adapter in contact with the dieholder on the rear of the tailstock. If you choose to lubricate the bed in advance of the tailstock, then use a very light oil such as '3 in 1' which was popular in my youth. More viscous oils will add drag rather than reduce it to what we require here.

For long bars of non-commercially available metal one can do no better than adopt a turning device such as that shown in **photo 76**, which I made a decade ago and have rarely wanted since. The idea, not new even then, was described in, I think, Model Engineer in the early to mid-1990s with a plain bush as the bearing. I used this a lot during the last years of my employment as described previously. However, its drawback was the amount of wear on the bush, which



Photo 77. A better view of the small diameter turning steady.

needed frequent renewal. I thought it would be better with a ball race and hardened bushes. It was unsuccessful as the bar to be reduced in size rotated inside the special bushes, as there was too much 'drag' from the ball race. However, I am showing it here in **photo 77** if only to show how a useful and simple attachment can be made for your machine. It is located on the saddle using the same attachment hole as for the lathe's sliding steady and, after securing with one face touching the cross slide, is bored though co-incident with lathe centres.

Should you have decided that towing the original tailstock is a good idea especially for drilling deep holes and similar work, a repeat of this process could be done with another spring-retained under plate. In this instance the original tailstock-to-bed clamp will be retained but carefully adjusted so that its action does not interfere with the sliding facility. ■

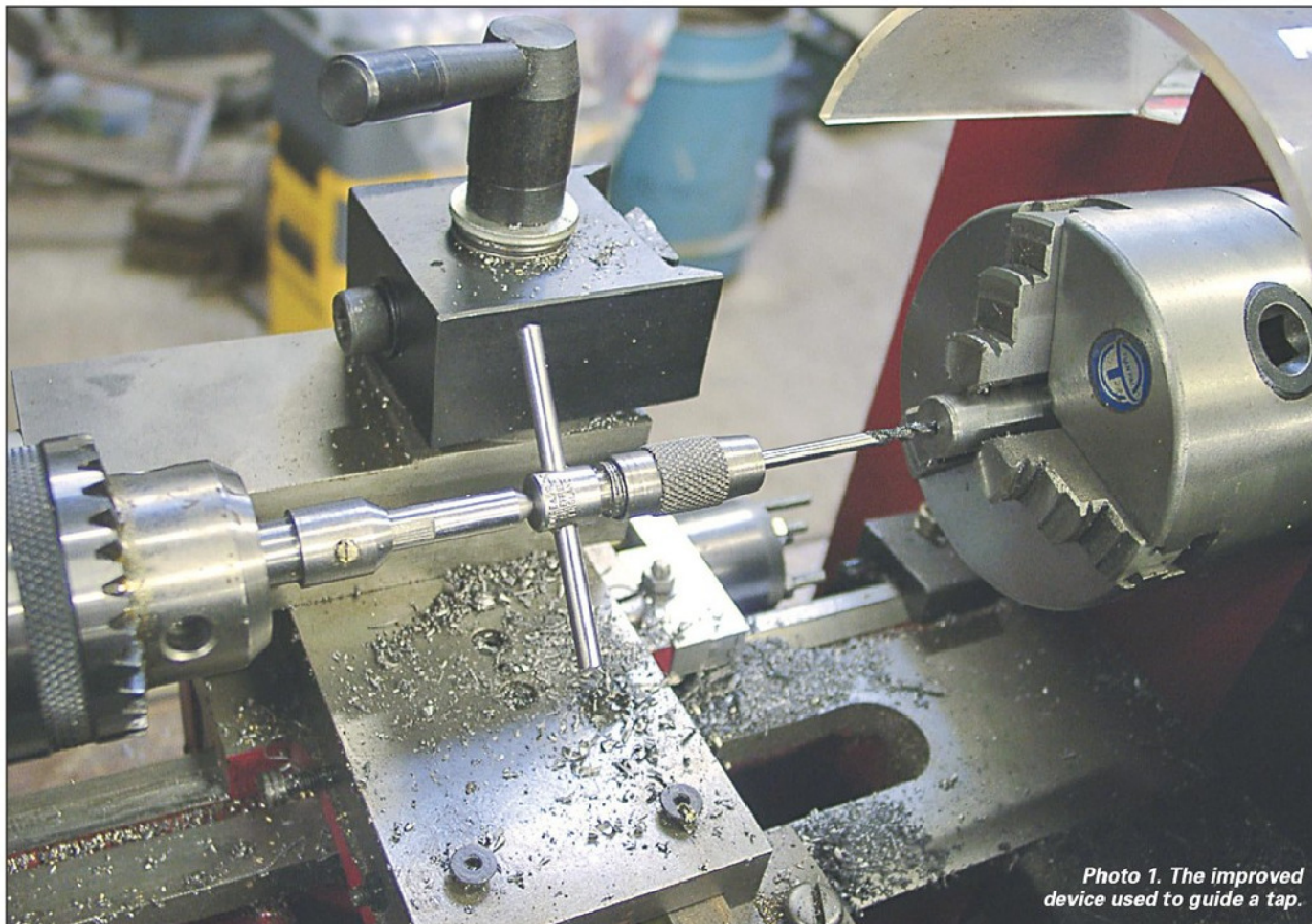


Photo 1. The improved device used to guide a tap.

PUMP CENTRE FOR A LATHE OR MILL

Dave Fenner describes a useful workshop accessory

Background

I first came across this concept in an article by Peter Rawlinson published in MEW Issue 88, where the accessory was designed primarily as a tapping aid for use in medium sized lathes having a No 3 Morse taper arbor, though the point was made that it could be reduced to No2 Morse to fit a typical model engineering lathe. I later came across a reference to a similar device in "Machine Shop Practice" by K.H. Moltrecht, but here the primary use was for centering up work in a four jaw chuck. The Mk 2 version is shown in photo 1.

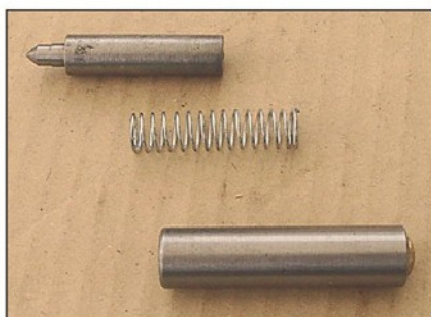


Photo 2. Component parts of the Mk 1 lash up.

Immediately after reading the MEW article, I latched on to the potential advantages of the gadget and decided to cobble up something similar. I use the term cobble up advisedly, as it was probably put together in under half an hour, with the primary aim of assisting tapping in the mill. The parts of this are shown in photo 2 and it may be realized that no provision was made for keeping the components together. Thus setting it up could require a bit of manual dexterity to keep everything in its proper place. Nevertheless the added convenience when tapping small threads has meant that the Heath Robinson version has survived as made for all of six years.

The primitive version was composed of just four parts, body, rear plug, spring, and rod. The body was a piece of 1/2in. (12.7mm) diameter by 16 gauge steel tube, plugged at the rear with a press fitted brass plug. A piece of 3/8in. (9.5mm) diameter bar was given a point and pushed in after the spring.

More recently, when dealing with a small tapping job in the Mini-Lathe, it transpired that the standard tailstock chuck (10mm capacity) would not accept the original pump centre. This provided the necessary impetus to make another, slightly smaller device, with means of retention for the rod

and generally improved in terms of fit. The Mk 2 version has just five components, the extra one being a grub screw.

General design

I chose to use a 1/4in. (6.35mm) diameter rod because 1) I had some suitable silver steel, and 2) because I also had a suitable reamer. If you work in metric, then by all means change to 6mm. As made, my version gives some 0.7in. (18mm) of compression movement, which is thought to be adequate for most model applications. The body, made from free cutting bright mild steel bar, is reduced for most of its length to under 10mm for easy accommodation in the chuck. A short section is left at the original (12mm) diameter allowing extra meat to take a grub screw. The sliding silver steel rod is given a 60 degree point at one end. A filed flattened section, working with the grub screw gives the means of restricting its travel.

In general, no great precision is needed to make this device, especially if it is to be used as a tapping aid. My original version has a decidedly sloppy fit but nevertheless gives good support for tapping. If, on the other hand you plan to use it for centering work in a four jaw chuck, then a good

sliding fit becomes more important. The other dimensions, especially lengths, should be considered as guidance rather than absolute requirements.

Manufacture

Body

Cut a length of 12mm diameter BMS bar and face to about 51mm. Grip in the three-jaw chuck with about 38mm showing, and turn down a length of 37mm to a diameter of 9.5mm, **photo 3**. Centre drill and drill through $\frac{15}{64}$ in. or 6mm, then ream $\frac{1}{4}$ in. (6.35mm) If you do not have a suitable reamer, then open up by running a $\frac{1}{4}$ in. drill through, taking care to feed slowly.

Reverse the work in the chuck, swing the topslide to 30degrees and cut a generous chamfer for appearance, **photo 4**. If your bar is not in pristine condition, feel free to take a light cut to clean up the 12mm O.D.

You now need to drill and tap the location for the grubscrew. I chose M3 (because I had some M3 brass screwed rod) but 5 or 6 BA would work well. The hole was drilled 2.5mm dia. then tapped by hand. After this, you need to run the reamer back through to remove the burrs raised inside the bore. This is a good time to check the fit of the chosen silver steel.

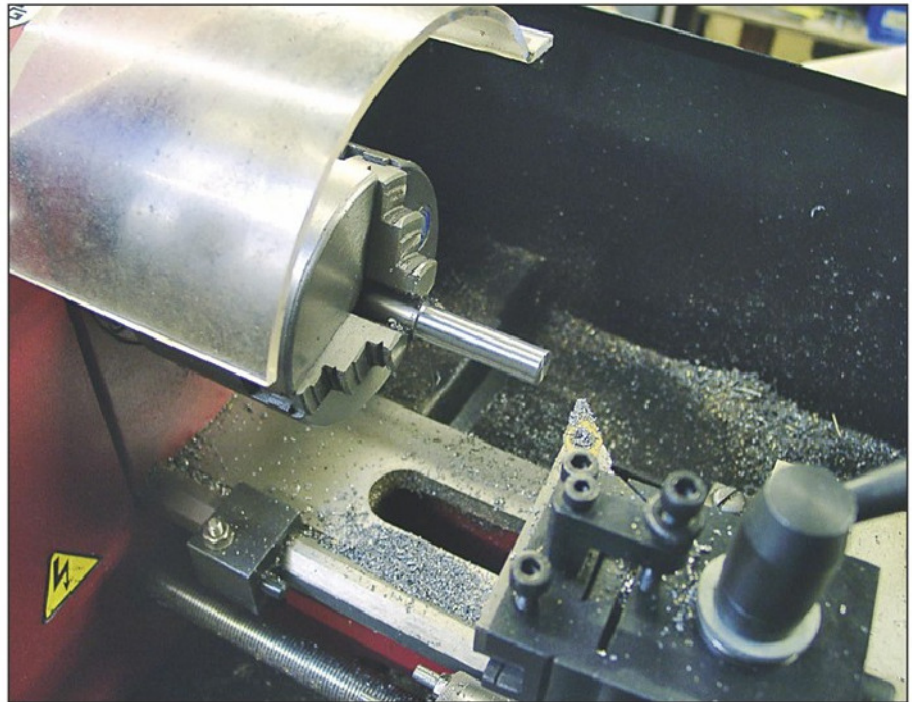
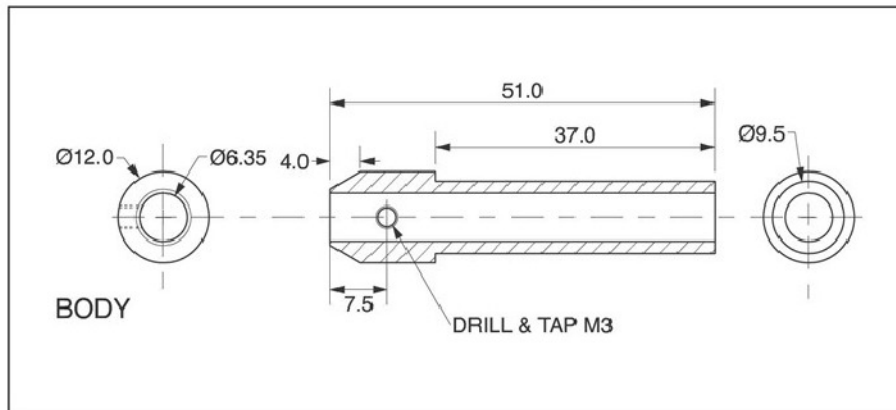


Photo 3. Turning down the location diameter for the body.



Rear cap

The same 12mm free cutting steel is used. Start by facing one end and then turn the shoulder to fit the $\frac{1}{4}$ in. 6.35mm bore in the body. I chose to turn this with a slight interference and then file a slight taper. The piece was then parted off and reversed to face and chamfer the other side. If you plan to use the finished article for centering, then by all means drill a centre while the work is on the lathe. I adopted a belt and braces approach to cap retention, adding a dab of Loctite 638 then pressing in. **Photo 5** shows the body, spring and cap.



Photo 4. Adding a chamfer.

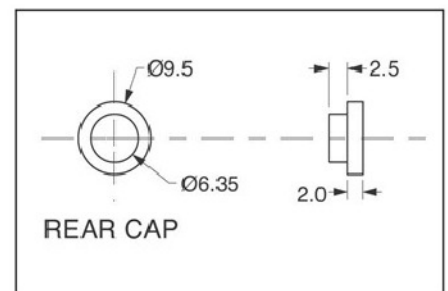


Photo 5. Body, spring, and rear cap.

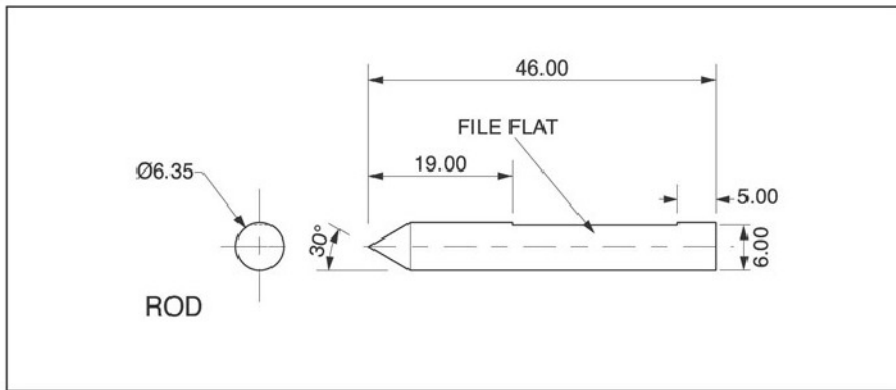


Photo 6. Work is easier to hold if left long.

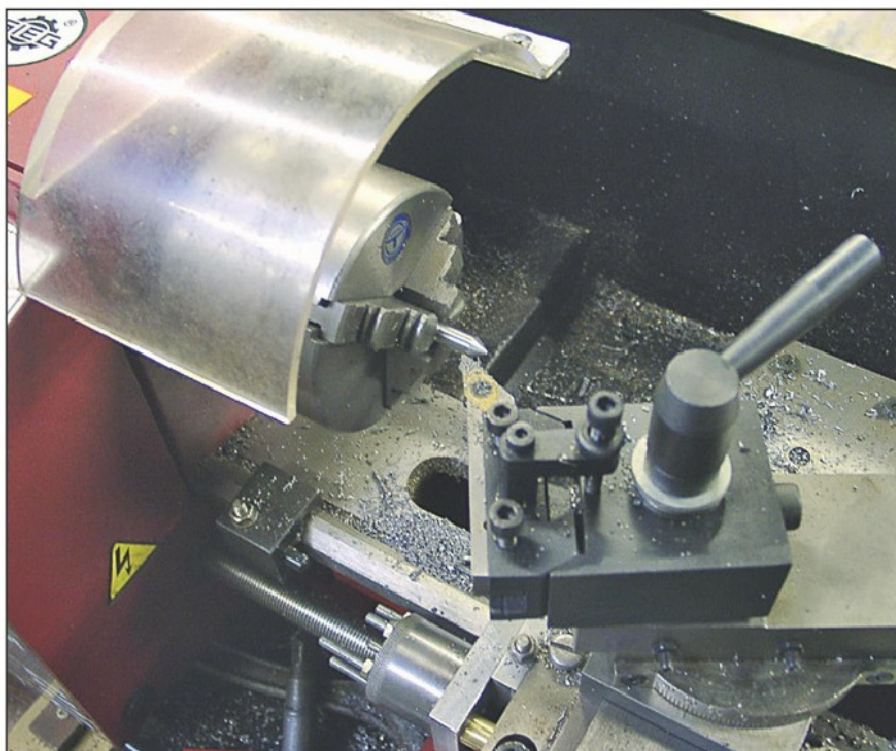


Photo 7. Top slide set over to machine the point.

Rod

One essential feature of the rod is the flat into which the grubscrew will engage. It can be a little tricky to hold things like this for filing, so I chose to do this while there was still additional length to hold in the vice. The silver steel was first faced at one end. A quick dry assembly with the spring enabled the determination of the positions for the ends of the flat. It was then an easy matter to grip the rod in the vice, **photo 6** with this part in fresh air, and file down to achieve a thickness of about 6.0mm (i.e. about 0.35mm or 0.014in. metal removed)

The rod was then sawn to length after which it was gripped in the three jaw chuck, making sure that the jaws missed the flat. The topslide was then set over to create the 60 degree point, as shown in **photo 7**.

Grubscrew

If you have a convenient screw, then by all means use it. I happened to have some offcuts of M3 brass screwed rod, so taking one of these, I flattened one end by filing in the lathe and screwed it in to engage the flat. It was then sawn off about one millimetre clear of the body, filed slightly, then given a screwdriver slot courtesy of the jewellers hacksaw. At this stage it is worth checking the fit of the screw over the length of the flat and if necessary filing a little to achieve a level feature.

Spring

I found a suitable spring amongst a bargain job lot purchased at one of the shows, probably Harrogate. Its vital statistics are:

Coil diameter	5.6mm
Wire diameter	0.6mm
Free length	31mm
Number of coils	approx. 16

Final Assembly

This consisted of inserting the spring and rod into the body, then fitting the grubscrew. It should be possible to nip the screw into place, then back off about a quarter of a turn to get a nice sliding fit of rod in body. If this is the case, then just add a smear of Loctite to keep the screw in place. **Photo 8** gives a comparison between the old and new versions. ■

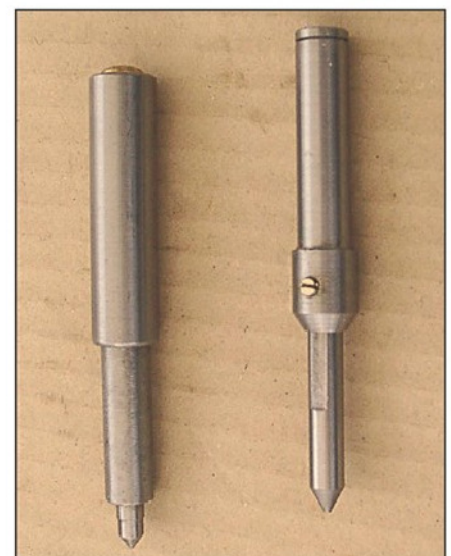


Photo 8. Mk 1 above and improved Mk 2 below.

FIRESIDE READING

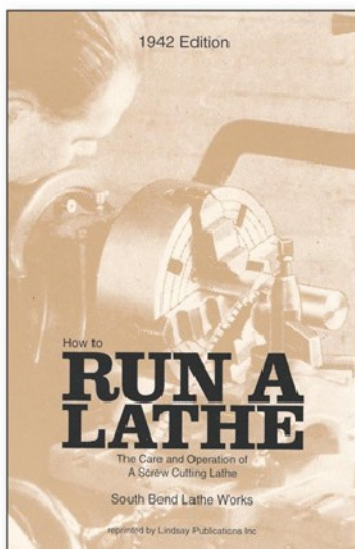
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How To Run A Lathe

The care and operating of a screwcutting lathe

South Bend
Lathe Works

This is a reprint of the 1942 edition of this book. It covers all the requirements of setting up a lathe, tool sharpening and using the attachments often offered by lathe suppliers. Although the photos and illustrations are based on the South Bend lathe, they are relevant to almost any modern day lathe. The beginner to turning will find much of interest in the pages; the expert should still find that he can learn something new.



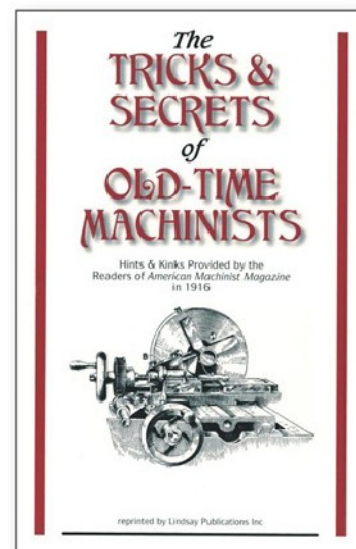
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The Tricks & Secrets of Old-time Machinists

Hints & Kinks Provided
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American Machinist
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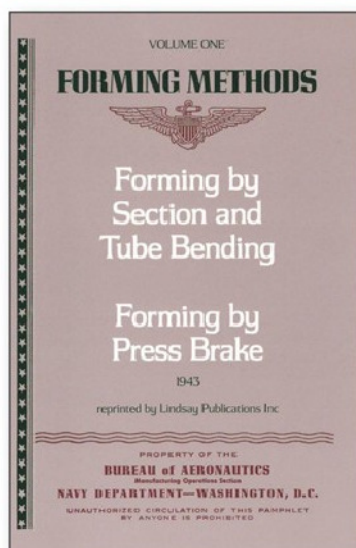
This book is a compilation of hints and tips published in American Machinist Magazine in 1916. It has 96 pages packed with line drawings and text; most pages have at least two tips on them. I quite enjoyed this book and I am sure you will enjoy it as well.

Price £7.95 +P&P.



Forming Methods Vol 1

Forming by Press Brake



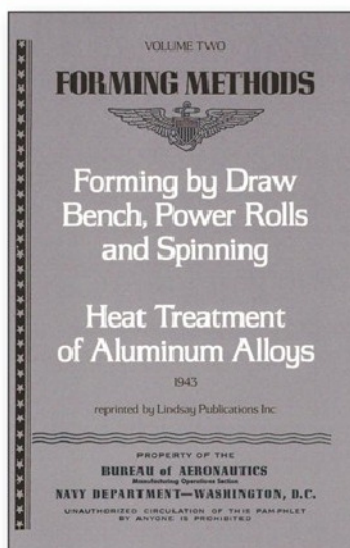
Forming by Section
and Tube Bending

Forming by section is basically about bending components that are most often used in aircraft manufacture. Tube bending is as the name suggests and forming by press brake is about bending strips of metal and although the tool sections shown are for bending long strips, the sketches are also relevant to press tools as could be made and used in the amateur workshop.

Price £8.10 + P&P.

Forming Methods Vol 2

Heat treatment of Aluminum Alloys



Forming by Draw
Bench, Power Rolls
and Spinning

Although an interesting book and worth a read for historical interest, the techniques are really outside of the knowledge required in a model engineering workshop. The machinery used is far too large to be found in the home workshop. The section on power rolls might be of interest if you have to form sheet metal in folded up shapes.

Price £8.10 + P&P.

The books are available from Camden Miniature Steam Services
Barrow Farm, Rode, Frome, Somerset BA11 6PS
Tel: 44 (0)1373 830151 www.camdenmin.co.uk

SCRIBE A LINE

Rolling mill

Dave Fenner's rolling mill is quite an interesting project. This combination mill is ideal with the tertiary roller for bending sheet, it would be of great use for silversmithing students and craft designer/makers that need a mill and are on a budget. With the separate adjuster screws it gives you the ability to mill slightly tapered wedges, but setting the rollers parallel may be difficult. One solution would be indexed adjuster screw heads, initially set to zero with a torque wrench then matched to a scribed datum on the top edge of the side plates. (Hope that makes sense.)

Dave also plans to machine Vee grooves. They would be best left with a flat at the apex of about 10% to 20% of the finished square wires' dimension. This helps limit the stress to the roller and helps prevent breaking the roller in half. This sounds unlikely but I have heard of two goldsmiths that have broken rollers, both believed to be standard 60mm diameter. Sounds like real abuse to me over a long period. Also, a final finish can be put on the rollers once assembled by feeding in a doubled over sheet of very fine emery or wet and dry with a clean round bar trapped inside. (Both sheet and bar to suit full width of mills.) Trap the paper so that the rollers can still move fairly easily and turn the handle until tired. You should be hearing a god-awful screeching when set right, so spray with WD40. Stand back and enjoy a perfect, practically polished set of rollers.

Mark Rose by email

The rust fairy

After reading a letter in my father's copy of your magazine, I thought I'd write with my solution of stopping things rusting in my work shed in case anyone else finds it useful.

My work shed is only small (9' x 9') and insulated with 4" of Rockwool in the roof and walls. My lathe and mill are three phase so as well as stopping things rusting I am keen to prevent any damage to the expensive single to three phase inverter.

Originally I was horrified by the amount of condensation inside the shed at certain times, mainly cold weather followed by warmer wet weather. A Peltier effect dehumidifier has totally solved the problem. So much so that sawn bar can be left for several months with no sign of rust in winter or summer. The dehumidifier runs off 12VDC and has a fan built in that seems effective enough to keep all areas of the shed dry. Although 60W in power, my fridge and freezer in the house are 80W each and each runs for 12 hours per day so it costs no more than keeping peas frozen and milk cold!

To save some electricity (and prevent the dehumidifier freezing at lower temperatures) I have fitted two thermostats. One turns the unit off if the

Milling series

I have been a regular subscriber to both M.E. & M.E.W. for many years but until my recent retirement, time for the practical work has been limited. My only practical training being one afternoon a week for two years in the Tech College workshops during early apprentice years so I find the practical tips and wrinkles etc in the magazines of particular interest. I had always known about the use of cigarette papers for setting up milling machines but never exactly how. The term picking up the paper without cutting it and the attendant photograph in a recent article on milling is the type of article that I find particularly useful.

As a member of the grey hair club my maths at school involved all the translations between Imperial & Metric measurements so in your recent questionnaire I was happy to say that either system was ok. However, having just started work on a 7/16in. gauge loco which has drawings in fractions of an inch, my vernier height gauge reads in decimals and as most of the materials are in metric it does sometimes get very tedious when laying out frames etc so I am fast changing my mind. It is hard to see a viable solution however as

temperature falls below 6deg.C, the other if the temperature rises above 23deg.C. I decided against a humidistat due to their cost and the possibility of the unit still freezing. Thank you for an inspiring and helpful magazine.

Steve Bell by email

Hard disc failure and rogue traders

I've just got my latest copy of MEW (#147 Feb 09) from the local book store and was reading the comments on your page "on the Editor's bench" about disposing of hard drives and rouge traders. I've had personal experience of this myself in recent months. You have probably had others send their comments and experience since you wrote your column, but it's always worth repeating the message.

Hard disc failure:

About the time you wrote your comments I was given an old computer from a friend that he was throwing out. I had the intention of setting this up in my Garage/Workshop. When I fired it up I was shocked to find he still had all his personal & work files on it. These were mainly family photo's and some letters etc from his divorce a few years back and he was somewhat embarrassed that he had forgotten to delete these files.

It turned out the computer had a fault which shut it down after about ten minutes running, so I stripped it for parts which I sold on TradeMe for \$5 - \$10 each and destroyed the hard drive as you

manufacturers are unlikely to go back to providing Imperial stock again and the cost of redrawing all the old available designs would be prohibitive. I guess we are going to have to continue with the calculations for some time to come but luckily the modern electronic calculator is a real boon for the little grey cells.

In a recent letter Marcus Middlehurst had a query with the 'cheap' drill he had purchased running out of true. I bought a far eastern drill a while back which had a similar problem and whilst I cannot comment on his possible bent shaft I would suggest that he take a good look at the chuck. This turned out to be the fault with mine and the cure was simply to take off the supplied chuck and replaced it with a new Jacobs one. I have achieved excellent results ever since. A Burnerd or other good quality item would do equally as well of course. I have purchased many hand held drills etc for use in the electronics industry and have had to return many of them with the same fault so I believe it is not an uncommon problem.

John Pollard by email



mentioned in your item. Apparently this method isn't completely foolproof either, as information can still be retrieved from the remains of the disc. Some Government departments now demand the complete destruction of the hard drive to prevent information being lifted from the remains.

An interesting thing I found out was that hard drives have one or two VERY powerful magnets in them which can be handy in the workshop, e.g. holding the chuck key on the lathe if you have the strength to pull the key off when you need it. Note; don't get your fingers caught between them.

Rogue Traders:

Well what can be said about these scumbags? If a trader is insisting on a cash only payment with no pick-up, walk away from the deal no matter how good it is. It's the old story "If it sounds too good to be true it probably is!" Report these traders to the site administrator or publisher immediately; it's better to have an innocent but naive trader pulled up, than these thieves get away with your hard earned money. Thankfully the vast majority of traders are honest, but you do need to guard against these thieves.

Peter Littlejohn Paraparaumu
New Zealand

Metrication

I cannot understand why the fuss over imperial or metric units continues. The system of units has changed a good number of times over the years starting

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questions and opinions with other readers.

back in my own memory with the Imperial system. The c.g.s system came and went, followed by the rationalised m.k.s. system. We now have the Metric system. What will the future hold for us? If I design anything, then I use the Imperial system simply because my machinery is graduated in inches. When I make something designed by someone else, which happens to be in metric, I no longer reach for a slide rule or a set of log tables or an abacus. I use a cheap little gadget called a calculator. It is held with sticky pads to the headstock of my lathe and I simply divide the offending millimetres by 25.4. Youngsters are spoilt for choice nowadays.

Dyson Watkins by email

Recycling plastic bags

In these days of green ideas and security consciousness we are all told to shred any items with address details on before disposal. I recently realised that the wrappers on your magazines are all grey plastic with our personal details printed on. This does not go in my shredder so I have to cut up with scissors and even this is not easy to do. Some other magazines I receive have clear plastic wrappers with the address details on paper inside and others have brown paper. I realise that this is probably done as a cost saving measure and I can only applaud that as we are all looking to save as much as possible these days. The above is not intended as a complaint but rather an observation which you may be able to consider at a later date.

Please keep up the good work on these two excellent magazines.

John Pollard

The editor replies: I expect the magazines are packaged by machine so this suggestion is unlikely to happen, certainly in the near future. Perhaps readers could put the magazine wrappers into the recycle bins for carrier bags outside their local Tesco store?

Compressor article

I felt that I must respond to Ian Moignard's uncheery attack on Richard Wightman's compressor article. I am a degree qualified aerospace engineer with 22 years experience and therefore I have some experience with pressure vessel design and structural testing i.e. aircraft fuselages. Are alarm bells instantly ringing "Trust me, I'm an engineer"?

Whilst I agree that personal safety must be paramount, and that there are some

shortfalls in Richard's design (lack of a drain and no warnings about potential dangers), there are ways of constructively criticising a design without causing insult. I think that this kind of response to an article can only make people think twice about submitting a design for publication.

I must stress that I know virtually nothing about fridges or fire extinguishers! I did a quick search on the internet regarding the working pressures of small fire extinguishers and it would appear that working pressures are typically 175psi or greater (I might be wrong!). The hoop stress (circumferential stress) for a pressure cylinder is directly proportional to pressure, diameter, and wall thickness (hoop stress = $PD/2T$). If we assume that a minimum factor of safety of 2 (engineering assumption not fact) is typically applied to fire extinguisher design, and the fact Richard's working design pressure is 50psi, then we end up with a factor of safety of 7 ($(175/50) \times 2$). This means that the thickness of the extinguisher wall could be reduced by a factor of 7 (ignoring the potential change in diameter) before rupture would occur or alternatively the pressure could be increased by a magnitude of 7. This

obviously assumes that the state of the pressure vessel is in as new condition, which I whole heartedly accept cannot possibly be established with a visual inspection.

Perhaps a potential builder could or should approach a local model engineering club who could pressure test the extinguisher on a boiler testing rig (constructive criticism)?

Whilst not playing down the issue of safety, I would ask how many readers own or have used or purchased a second hand compressor that doesn't possess or has ever held any valid pressure test safety certificate?

Could in future we all please try to apply constructive criticism to articles written and published with the best of intentions?

Gary Mostyn by email

The editor replies: It has been a long while (2½ years) since I worked in a factory environment and a lot more years than I care to remember since part of the daily duties were to drain the compressor. It never occurred to me that there should have been a drain valve or plug fitted. I will be more careful in future.

Shimming lathe tools

I have a non Myford, lathe only workshop with a lathe of Eastern Origin.

I use the standard supplied four way tool post. Due to the minister of finances take on tools, a quick change tool post is still marked as a "Future Addition".

I made a boring tool holder with a built in datum to set the tool tip to the centre of the lathe, when the tool is loaded outside the lathe.

No shims are used, so it can be changed and returned as set. I am starting the second one now. If you are interested, I can start taking photos from raw material and explaining the steps as I go along.

The other tool currently in the design phase is a parting tool holder with fine adjustment to get the tip at the lathe centre height. The parting bit holder is a commercial type, holding a 12mm parting bit. The tool will hold the parting tool holder and the tool height is adjustable to get the tip at the correct height.

Tip on easy packing of tools

Place an unsharpened tool bit in the tool post without the shims.

Measure the height difference from the top of the tool to the centre of the lathe. Make a solid packing with this thickness, by whatever means you have and call it the "starter pack" for this tool bit. Sharpen the tool then place it upside down on a flat surface.

Measure the difference between the sharp tip and the surface, with a feeler gauge or shims. Add the shims and the "Starter pack" to the tool holder.

The cutting tip will now be at the centre of the lathe. On re-sharpening the tool bit repeat the shim setting and you are back on the centre line.

If you are interested in the two tool holder, please send me the article guide lines.

Edward Potgieter by email

The editor replies: Edward has won star letter for his simple tip about shimming a tool. You too could win a book. Write a letter for the benefit of your fellow readers.



WRITE TO US!

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

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

THE STAR LETTER OF THE MONTH WINS A WORKSHOP PRACTICE BOOK

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Latest Model Engineer

The next issue of *Model Engineer* in the shops is issue 4352. This should hit subscriber's doorsteps on 16 May and will be in the newsagent on the 22 of May.



The contents of the latest issue are:

An Engineer's Day Out -

Latest Model Engineers Workshop

The latest issue of *Model Engineers' Workshop* in the shops is issue 151. It went on sale on the 15 May.



The contents of the latest issue are:

Dial Indicator/Dial Test Indicator

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website

At last, after two years of waiting the Model Engineer website is live. Although it says Model Engineer, it is also for Model Engineers' Workshop readers as well. You are all welcome to join the community. It is very easy to join. All you need is an email address. You can view most of the site without joining but you won't be able to post to the forum or place classified ads unless you join.

It is early days yet but there is still plenty to see and do. At the time of writing, five days after the official launch, we have 318 members. This is rising fast and many more people are expected to join soon.

You can place a classified advert free of charge (no traders please) in the 'for sale' or the 'wanted' sections. You place the advert yourself and in the for sale section, you can add a picture and when the item

has sold you can remove the advert all without any intervention from us. This means that all adverts can be placed immediately rather than relying on a member of the web team to do it for you.

You can interact with other members in the forum. You can ask questions or you can answer someone's question. This seems to be a very popular feature with plenty of interesting questions being asked.

You can also post pictures of your latest project into the Album section for other members to enjoy or to share with your family and friends or perhaps your local model engineering club.

When you join there will be a few simple questions to answer. These are mainly for the marketing department. I have no control over these questions. They are not very intrusive and you have the option to opt out of the regular weekly emails but I

suggest that you tick the box to opt in. You will get an update of what is coming in the next Model Engineer or Model Engineers' Workshop and you might get a special offer for some Workshop Practice books or a reduced rate for a subscription.

Some readers have mentioned they don't like joining up if marketing questions are asked. I don't see this as a problem. It is no more intrusive than if say you use a Tesco's Clubcard or a Nectar card or any other loyalty card. It is the same principle, a little bit of information so marketers look like they are doing their job so go ahead, join today. There is nothing to worry about and who knows, you might enjoy the experience and even learn something. When you join, you should receive an email asking you to validate your membership. You will need to do this so you can post messages and adverts etc. ■

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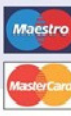
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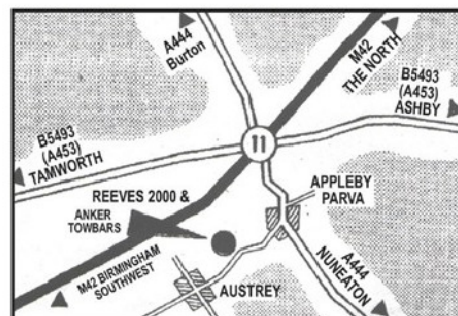
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Telephone: 0208 300 9070 - Evenings: 01959 532199 - Facsimile: 0208 309 6311

www.homeandworkshop.co.uk • stevehwm@btopenworld.com

Opening Times: Monday-Friday 9am-5.30pm - Saturday Morning 9am-1pm

10 minutes from M25 - Junction 3 and South Circular - A205



Progress 2MT back geared pedestal drills

£375 each



£1475

Prazimat DLZ 180 x 450 precision (German) lathe



£1250 each

Bridgeport heads also fit A&S 2E mills



£950

Colchester Chipmaster lathe



£1350

Tom Senior M1 milling machine

Colchester Triumph 12" 4 jaw chuck

£295



£675

RJH 4" vertical belt finisher (240 volts)



£2950

Harrison M250 5" x 30 lathe



£2450

Boxford 1130 lathe (not finished)



£950

Colchester Student lathe



Foundry equipment



£750

Raglan milling machine



£725

Bridgeport slotting head



£850

Myford ML10 lathe (greased)



£164.50

Crompton/Tyco NEW motor for ML7/Super 7



£1250

Boxford Mk111 lathe + stand



£375

PVE 200mm sine centres (extremely rare)



£1250

Waltons 50" 16g guillotine + stops



£3750

Colchester Student 1800; 6" x 24" + gap bed, 3 & 4 jaw chucks + 240 volts!



£950

Scheppach Basato 5-4 woodworking bandsaw

SIP NEW (old stock) drilling machines, better quality!

£125



£1750

Harrison 140 lathe + gearbox + power cross feed



£869

SIP NEW mill, Two in, Grade A factory
Limited stock/special price

PLEASE PHONE 0208 300 9070 TO CHECK AVAILABILITY OR TO OBTAIN OUR LIST

DISTANCE NO PROBLEM! DEFINITELY WORTH A VISIT ALL PRICES EXCLUSIVE OF VAT

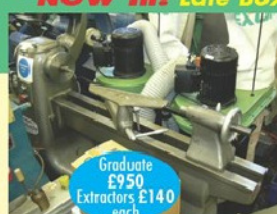
Just a small selection of our current stock photographed!

We have wood lathes, saw benches, bandsaws, morticers and Record vices etc - large selection!

Milling/Drilling ground X-Y table



**** NOW in: Late Boxford pedestal drills, Progress back geared drills, Viceroy Sharpedge 16" chisel grinders ++ more! ****



Graduate wood lathe + Rexon dust extractors



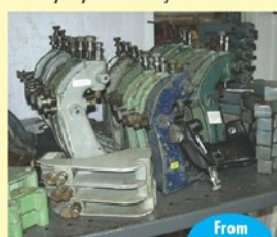
Myford vertical slides and accessories



Kingsland pedestal guillotine



Keyway brooches 7/16" 18mm



Lathe travelling steadies



Eclipse 18" x 6" magnetic chuck



Adcock and Shipley vertical head



Harrison M300 Ainject attachment + bar



Oxford Model HV460 oil cooled welder



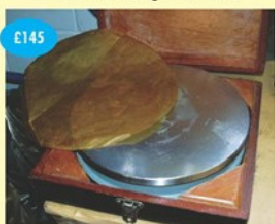
Clarkson radius fixture



Harrison L5 travelling steady (L5A, L6, Student, Master also)



Elloiot 2E slotting attachment



Engineers flat PVE (cased)



Dickson toolposts to suit Colchester Mascot (others available)



J & S grinding wheel balancer + level



Clarkson 40INT collet chuck + collets

(we have 2MT-5MT and 30INT to 50INT in stock!!)



Bridgeport slotting head



Eclipse 10" x 5" magnetic chuck



Marlco broach set 8-10-12-14mm



Crompton Parkinson Foot Mounted 2HP 240V / single phase 1400 revs as new.



Dickson (Student size) parting tool holders + new blades



Anvil (European double horn)



Surface plate 24" X 18"



Quality measuring tools



Emco Unimat 3 lathe



Harrison / Colchester D14 face, catch & 4 jaw chucks



Q and S 6" power hacksaw + coolant



Flamefast hearth DS120F



Startrite TA1250 12" full sliding table saw bench (240 volts)



Burnerd 'LO', D13 & D14 collet chucks



Pultra lathe (less drive)



Colchester round head rear tool post



Burnerd D14 collet chuck + 3 collets



Raglan 5" x 24" lathe



Denford Viceroy buffer's



Myford imperial MA99E / full set



Eclipse angle plates



Compound sine table + 10" x 5" magnetic built in chuck



Myford ML10 (Rodney) milling attachment

We are still **OPEN SATURDAY MORNINGS** dedicated to the model engineer

DELIVERY
£15
TO ALL EU
COUNTRIES
Free Delivery UK Mainland



SAWS



LATHES



MILLS



DRILLS

SEE OUR WEBSITE
www.chestermachinetools.com
FOR OUR EXCLUSIVE
ONLINE OFFERS

Chester Machine Tools



DB8VS LATHE

FEATURES

- Digital Speed Readout
- Variable Speed Spindle
- Metric and Imperial Thread Cutting
- Hardened and Ground Bedways
- Cast Iron Construction

~~£969.65~~
£775.00

Centre Distance 400mm
Swing 210mm
Speeds Variable 50-2000rpm
Motor 750w
Weight 110kgs

H80 BANDSAW



~~£129.00~~
£125.00

Max Cutting Capacity @ 90°
Max Cutting capacity @ 45°
Blade Speed
Motor 420w
Power 240volt
Blade Size 1300 x 0.63 x 12.5mm
Packing Size 760 x 295 x 465mm

CENTURY MILL



~~£1049.00~~
£899.00

FEATURES

- Variable Speed Spindle
- Digital Depth Readout
- Fine Feed Quill
- Heavy Duty Cast Iron Construction

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

CHAMPION 16VS



~~£699.00~~
£629.00

FEATURES

- Variable Speed Spindle
- Dovetail Column
- Tilting Head
- Wide Spindle Speed Range

Table Size 500 x 140mm
Spindle Taper MT2
Speeds Variable 50-2500rpm
Motor 600w
Weight 90kgs



DB11VS

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

~~£1469.00~~
£1199.00

FEATURES

- Digital Speed Readout
- Variable Spindle Speed
- Metric & Imperial Thread Cutting

STANDARD ACCESSORIES

3-Jaw Chuck • 4-Jaw Chuck • Coolant Tray • Rear Splash Guard



100mm
3-Jaw
Chuck

~~£69.00~~
£60.00



Mag
Base and
Dial
Gauge

~~£36.00~~
£30.00



100mm
4-Jaw
Independent
Chuck

~~£64.00~~
£55.00



Boring
Tool Set
MT2

~~£59.00~~
£51.00



Quick
Action
Vice

Low
Working
Height

£39.00



T1 Quick
Change
Toolpost
and 5
Holders

~~£128.00~~
£115.00



Machine
Angle
Level

~~£69.00~~
£60.00



5" Bench
Hand
Shears

~~£44.95~~ **£40.00**



V Blocks
and
Clamps

1" Capacity
~~£12.00~~
£10.00



Slip Rolls

12" £109.00 / 16" £199.00
20" £249.00



Magnifier
Lamp

£40.00



Centre
Punch
Set

£4.50

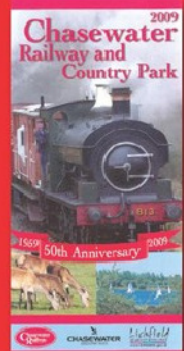


Hoist
250kgs

~~£69.00~~
£60.00

MIDLANDS OPEN DAYS 09

Saturday 20th JUNE 9am - 5pm
Sunday 21st JUNE 9am - 4pm



- 20% Discount on all New Tooling
- Ex-demo Machines at Low Prices
- Big Reductions on New Machines
- Lathes, Mills, Drills, Saws etc
- Refreshments

In conjunction with :-

CHASEWATER RAILWAY 50th GALA.

Chasewater Railway, Pool Road,
Brownhills, Staffs, WS8 7NL
www.chasewater railway.co.uk

Upto 8 Steam Engines running throughout the weekend. Historic Vehicles on display, visit the Heritage Centre and Gift and Model shops.

All prices include VAT. Delivery Free to UK mainland - excluding certain Scottish postcodes. (Unless otherwise stated) Prices valid for duration of this issue only.



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Southern Showroom: TPH Machine Tools, Fairview Industrial Park, Rainham, Essex, RM13 8UA

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