

No. 158

2009 Model Engineer
Exhibition Show Guide

FREE INSIDE



MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

DECEMBER 2009

HOW TO MAKE

- **A NOVEL QUICK CHANGE TOOLPOST**
- **MOBILE WORKSTATIONS**
- **SPUR GEARS**

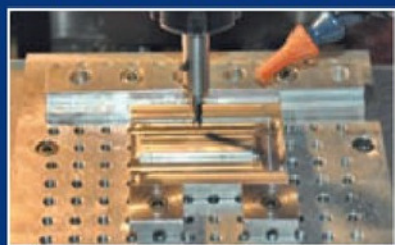
THE PRACTICAL ENGINEER



**MODEL
ENGINEER
EXHIBITION**

11-13 December 2009
Sandown Racecourse

**USING SMALL CNC
MILLING MACHINES**



**WORKSHOP
PHOTOGRAPHY**



**3D DESIGN
A STEP-BY-STEP GUIDE**





emco unimat 4

The Machining Centre



Basic Equipment



Lathe bed, head stock, tailstock, saddle and cross slide with single toolholder, 3-jaw chuck, fixed centre, drive motor, operating tools and operating instructions, spare part list.

EMCO Unimat 4:

Basic machine incl. bed for connecting vertical column

Price **£339.00 incl. Vat** Order No. **1770BC**

Technical data

Basic machine

Height of centres	46 mm
Distance between centres	200 mm
Spindle nose	M 14x1 mm
Swing over bed	92 mm
Turning Ø above cross slide	62 mm
Cross slide adjustment travel	52 mm
Leadscrew Ø	10 mm
Range of speeds	8 speeds 130-4000 rpm
Drive motor	Permanent magnet motor 65/95 W
Weight	6 kg

Vertical attachment

Max. working height	310 mm
Working radius	82 mm
Sleeve stroke	60 mm
Spindle nose	M 14x1 mm
Ø of vertical attachment	35 mm
Drive motor, speed	see basic machine

NEW!



Like this or like that?

Always the best solution

The Unimat 4 together with the new vertical attachment (also for Compact 5) is a universal-machine tool.

»Turning – drilling – milling – thread cutting«

The vertical attachment in connection with the new co-ordinate table can be used as a separate drilling and milling machine.



Easy – accurate – precise

The new compact milling- and drilling machine consists of following accessories: Vertical attachment, Motor package, Co-ordinate table.



Unimat 4: The machining centre for various requirements. Vertical support with machine vice and collet chuck holder for milling cutters.

Pro Machine Tools Ltd

17 Station Road Business Park,
Barnack, Stamford,
Lincolnshire PE9 3DW

Tel: (01780) 740956

Fax: (01780) 740957

Sales@emcomachinetools.co.uk

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Machining a casting. See 'THE PRACTICAL ENGINEER' article on page 32. Photo by David Clark



Subscribe today and **SAVE** up to 18%

See page 10

Arc Euro Trade

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Specifications:

Drilling Capacity: 25mm
 End Milling Capacity: 25mm
 Face Milling Capacity: 50mm
 Tapping Capacity: 12mm
 Spindle Stroke: 72mm
 Throat: 235mm
 Spindle Taper: Choice of R8 or MT3
 Spindle to Table Distance (with Guard)
 R8 Spindle: 30-380mm
 MT3 Spindle: TBA
 With Head tilted at 90°: 110mm Min.
 Spindle Speed: 100-1750 RPM $\pm 10\%$
 Table Cross Travel: 145mm
 Table Longitudinal Travel: 360mm
 Table Size: 550x160mm
 Effective Table Size: 475x204mm
 T-Slot Size: 12mm (M10 T-Nuts)
 Table Drain Hole Thread: M16x1.5mm
 Motor Output: 1000W DC (Brushless Motor)
 Overall Dims (W/D/H): 765x670x990mm (850mm to top of column)
 Weight (Net/Gross): TBA

Standard Equipment: 16mm Drill Chuck and Arbor, Drawbar.

NEW Super X3 Mill

Spindle Speed Display

Touch Panel Control for:
 • Spindle Start/Stop
 • Spindle Speed
 • Forward and Reverse
 • Tapping Mode

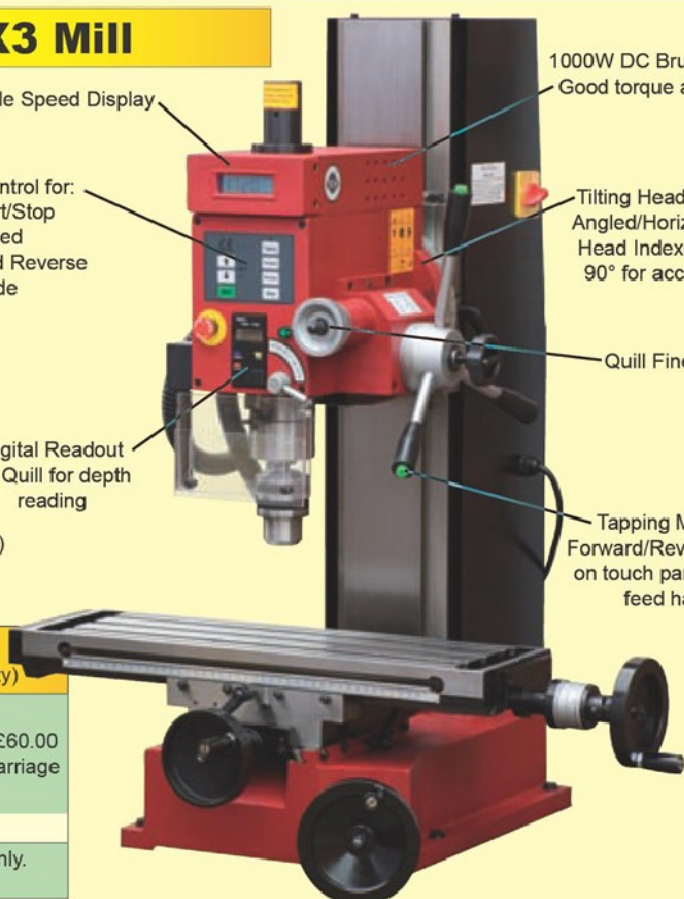
Digital Readout
 on Quill for depth
 reading

1000W DC Brushless Motor
 Good torque at all speeds

Tilting Head for Vertical/
 Angled/Horizontal milling
 Head Indexes at 0° and
 90° for accurate setup

Quill Fine Feed

Tapping Mode with
 Forward/Reverse buttons
 on touch panel and quill
 feed handles



Super X3 Mill Promotional Price: £895.00

(Normal Price £999.00 saving you £104.00) (Subject to availability)

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080-030-01100	Model Super X3 Mill R8 Imperial	£895.00	+£60.00
080-030-01200	Model Super X3 Mill MT3 Metric	£895.00	Carriage
080-030-01300	Model Super X3 Mill MT3 Imperial	£895.00	
080-030-01703	Model Super X3 Arc Preparation Service	£255.00	

R8 Metric normally stocked. All other machines by special order only.
 (Average delivery 90-120 days)

X0 Micro Mill



Chuck to Bed Distance: 0-205mm
 Drilling/End Milling Capacity: 6mm Max.
 Throat: 165mm, Spindle: JT1 (male)
 Variable Speed 0-5000rpm

Still Only £125.00 + £15.00 Carriage

Super X1L Mill



Long Table Version

Table Size: 400x145mm
 Table X Travel: 330mm
 Table Y Travel: 145mm
 Spindle to Table: 0-265mm
 Spindle Taper: MT2
 Variable Speed 0-2000rpm

Still Only £275.00
 + £25.00 Carriage
 Choice of Metric or Imperial

X3 Small Mill



Table Size: 550x160mm
 Drilling/End Milling Capacity: 25mm
 Spindle Taper: MT3 or R8
 Table Cross Travel: 145mm
 Table Longitudinal Travel: 360mm
 Spindle to Table Distance:
 MT3 Spindle: 105-400mm
 R8 Spindle: 85-380mm
 Variable Speed 0-2000rpm
 600w DC Motor

Still Only £751.00

+ £60.00 Carriage
 Choice of Metric or Imperial
 Choice of MT3 or R8 Spindle

C3 Mini Lathe



180mm Swing Over Bed
 350mm Between Centres
 Variable Speed 100-3000rpm
 Built-in Spindle Speed Display
 350w DC Motor
 MT3 Spindle Taper, MT2 Tailstock Taper
 Camlock Tailstock fitted as standard

C3 Standard: £361.00

C3 DRCD*: £421.00

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050-110-16240 3/8" **£5.60**

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050-110-20240 3/8" **£5.60**
050-110-20250 1/2" **£5.60**

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050-110-25240 3/8" **£5.20**
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050-110-25520 R8 Set with 6 Collets **£63.50**



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050-110-32510 R8 Set **£67.50**

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050-110-32505 MT3 Collet Chuck **£38.00**
050-110-32515 R8 Collet Chuck **£38.00**



ER16 Lathe Collet Chuck

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ER25 Lathe Collet Chucks

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115pc TiN Coated Imperial Drill Set

1/16" to 1/2" in 1/64" increments
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91pcs TiN Coated Metric Drill Set

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32pc HSS Metric Tap & Die Set

3 Taps each M3, M4, M5, M6, M8, M10 & M12 + Tap Wrench & Die Holder + Thread Gauge & Screwdriver
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Boring Head Arbors with 1.5" x 18tpi thread

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060-290-00800 MT3 M12 **£10.75**
060-290-00900 MT3 3/8" Whit **£10.75**
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Code	Table Size	Table Height	Swivel	T-Slot Width	Slots/Centres	Price
130-020-01100	5"x7"	3.3/4"	± 45°	3/8"	2 slots @ 1.5/8"	£56.00
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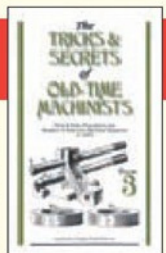


Alex Weiss has written a number of books on various aspects of model engineering and here, in his latest, he looks at the various methods of getting that 'right' finish on metal, be it for fit, or for viewing.

■ After a ten page introduction to the subject, 10 chapters follow covering: Grinding, Sanding, Buffing and Polishing, Honing and Lapping, Reaming, Broaching, Burnishing and Scraping, Bare Metal Finishes (these include plainishing and peening, chasing and repoussé, engraving, knurling, oil or grease coating, other rust barriers and etching), Metal Colouring and Painting.

■ Whilst you will not learn every last-thing on these subjects from this book - there is, after all, only so much that can be put into 120 A4 format pages, there is a huge amount of relevant information here, which any model engineer will find useful. High quality paperback, full of B&W photos, and diagrams, plus a listing of useful contact and suppliers.

Tricks & Secrets of Old-Time Machinists Vol. 3 • £ 9.50



■ The first two books in this series are deservedly 'best-sellers', presumably because they showed how engineers from 95 years ago used simple tools and materials to solve often complex problems - along with their number one tool - their brain (and a willingness to use it!)

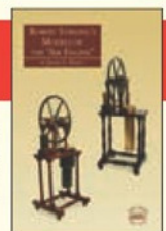
■ We gave up counting the ideas from 1915 & 1916 in this book somewhere round the 110 mark - and they are nearly all useful today.

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Robert Stirling's Models of the "Air Engine" • Rizzo • £15.15



■ A new book from James Rizzo is to be celebrated, and he certainly does not disappoint with this one. In it he describes in detail the two earliest surviving hot air engines, now at least 184 years old, and how to build working replicas, or reduced sized models, of them both.

■ The two engines are those demonstrating the principles of Robert Stirling's invention, the "Air Engine", which he built and presented, one to the University of Edinburgh, and slightly later, the second one to the University of Glasgow. The exact dates these were built is not known, but were certainly before 1825. The Edinburgh model is the more original, as the Glasgow model was discovered in an old store by Prof. William Thomson, later Lord Kelvin, in 1847. He dismantled it to see how it worked, and restored it to working order, along the way establishing the Absolute Scale of Temperature, the term "energy" and invented a new science - Thermodynamics.

■ James was granted unprecedented access to measure and inspect the original engines by both Universities. From the resulting drawings James himself made half-size models of both engines, but the drawings are dimensioned full size, with metric and decimal-inch measurements for accurate scaling. Hardwoods were used considerable in the original engines for frames and supports, but other than possibly for the flywheel (12" diameter in full size), no castings are required. There are detail differences between the two prototypes, so that making replicas or models of both is not an exercise in repetition.

■ This is an important historical record of two unique survivors from the very earliest days of mechanisation; it is also a great 'projects' book, providing the model engineer with full drawings and construction instructions, so he can build replicas or models of both these historically significant engines.

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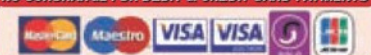
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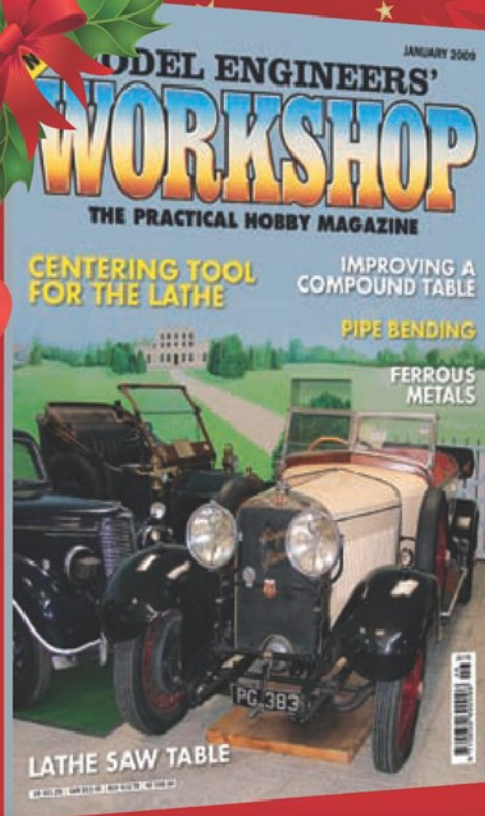
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David Clark

ON THE EDITOR'S BENCH

Model Engineer Exhibition

This is the last issue of Model Engineers' Workshop before the Model Engineer Exhibition. While we have many models entered into the competition tooling is thin on the ground. I don't quite know why this is? Perhaps you, the reader do not feel your work is worth displaying? If you don't enter, how will you know? It is not too late, there was an entry form in Model Engineers' Workshop issue 156 or you can download it from www.model-engineer.co.uk

Please fill in an entry form and enter your tooling into this year's Exhibition.

I hope you will visit Sandown; this year's Exhibition seems to be supported very well by both trade and the exhibitors, much more so than Ascot was. There are over 40 trade stands, 30 club stands and around 90 competition entries (more are arriving daily). I will be wandering around the exhibition so do come and say hello to me. Also, Dave Fenner is travelling down with me and he will be available to talk to you as well.

Unavailable

Please note that I will be at the Exhibition (including travelling time) from Wednesday the 9th until Monday 14th of December inclusive. Emails and phone calls will not be answered during this time.

Next issue

I do try to ensure that the advertised Next Issue contents do not change. On this occasion I have had to change the

More competitions

We have a new competition for this issue. Morris Lubricants have kindly offered a 5 Litre container of their Cora B metal cutting lubricant for every issue for the next year. Every four weeks, a lucky winner will receive a 5 Litre container. See page 29 or visit our website www.model-engineer.co.uk for full details. UK readers only please. Non subscribers are welcome to enter. There is also a competition for four bottles of MCT metal cutting fluid to be won in Model Engineer every four weeks. You can also enter on our website.



advertised articles due to fitting in the show guide. The article on collets will appear in issue 160.

Australia and the USA

The next issue of MEW, issue 159 sees an increased print run of several thousand. We have changed distributors to COMAG, a worldwide magazine distributor who is very proactive with magazine sales. They have almost doubled the supply into Australia and New Zealand over the past month and are sending an extra few thousand into USA (and possibly Canada) through the Barnes and Noble book stores. You can now ask Barnes and Noble to get/reserve you a copy. Also, they will also be able to get you a copy of Model Engineer as well. I believe this is the first time that Model Engineer has been available on sale in the USA other than through subscription. It will take some months for sales figures to filter through but it is hoped many US readers will soon be aware of Model Engineers' Workshop and also Model Engineer.

With the extra readership in mind, I have decided to make issue 159 a stand alone

issue. This means no continued series at all in this issue. The only article affected by this is 3D Design. Part 8 of this series will appear in issue 160.

Articles still required

Although I still have quite a few articles, more are required. We do pay well for articles. Articles received lately have been less than I would expect at this time of year. I don't expect a lot of articles through the summer months but the autumn, winter and spring should really be supplying more articles than are currently being received.

Do consider writing up your latest project for the benefit of other readers and your bank manager. It does not have to be a long article, although they are just as welcome, but a short one or two pager to dip your toe in the water might see you embark on a new part time career as a writer.

Guidelines are available; just send me an email requesting contributors note. Alternatively, send me a letter at the editorial address and I will get a set into the post to you.



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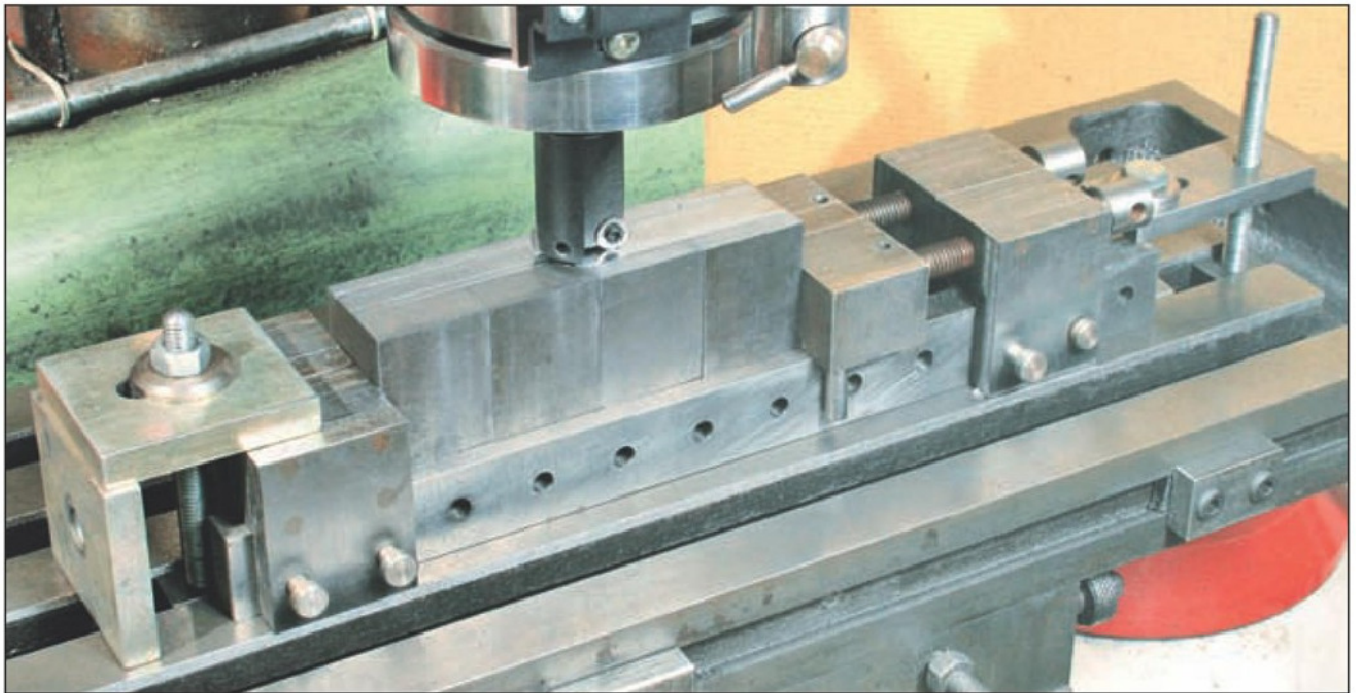


Photo 12. My method of machining the four jaw ends simultaneously. One at a time in a conventional vice would be just as good.

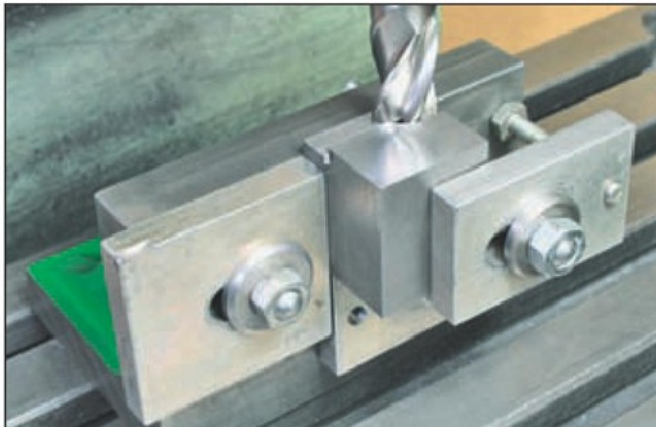


Photo 13. Machining the web on the base of the jaw.

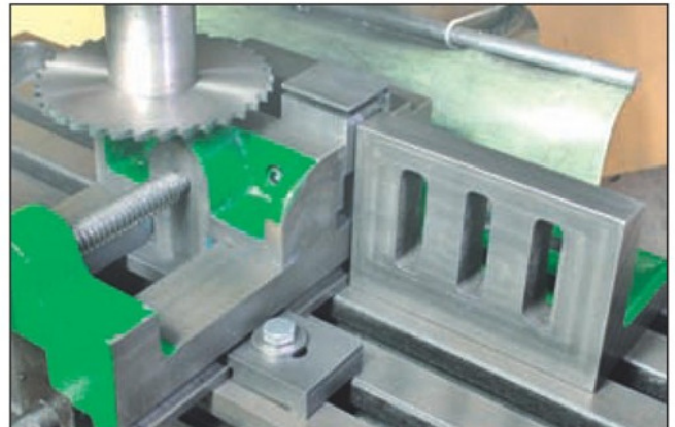


Photo 14. Making the slot in the jaw using a 75mm diameter slitting saw.

HOW TO MAKE A FOUR JAW CHUCK ALTERNATIVE ②

In the last issue the manufacture of the body was described leaving a number of smaller and much simpler parts to be made. A few examples of the device being put to use are also included.

OTHER PARTS The jaws (2)

Whilst the jaws are complex in terms of shape and position of the drilled holes none of the individual operations required are at all difficult, I do not intend therefore to go into each phase of their manufacture in detail.

If you already have a four jaw chuck then facing the ends whilst in this will be the easiest method to adopt, if not, then doing this on the milling machine is the only option. **Photo 12** shows my method of machining the four at the same time using my engineers sash clamps, **Ref. 2** but machining one at a time in a conventional

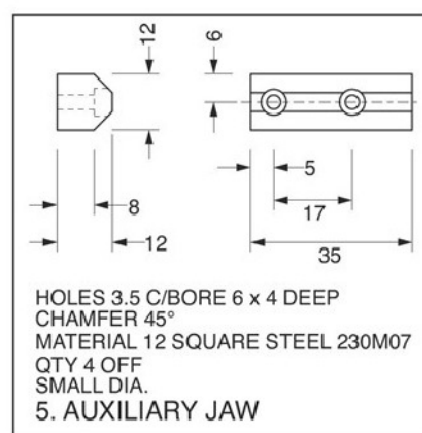
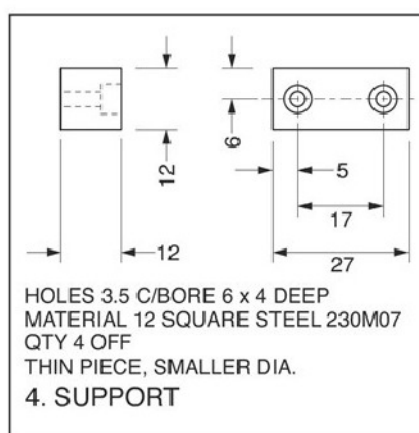
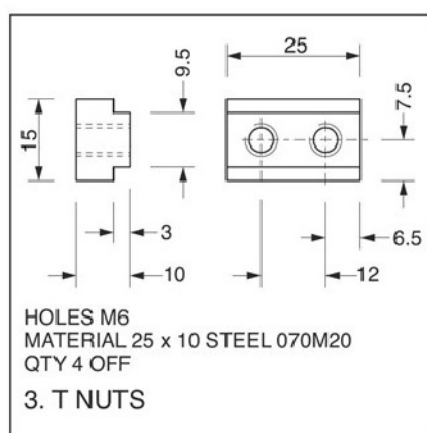
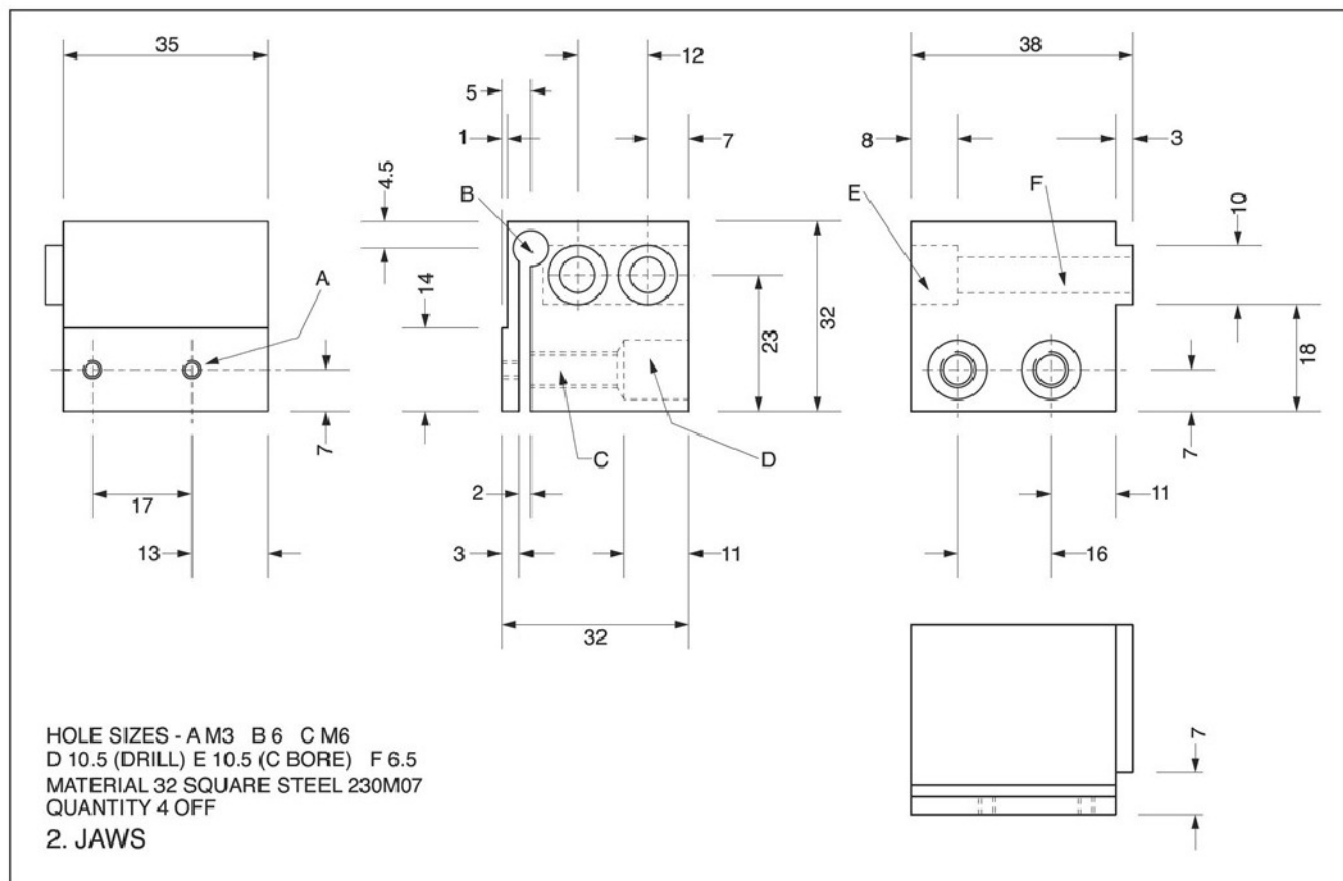
vice would be a perfectly acceptable method. If though you have had to hand saw the parts from bar stock it is likely that the ends will not be exactly square so do take care to get the jaw accurately upright within the vice.

Whilst there is no essential order for carrying out the remainder of the machining operations, I think that making the 10mm web along the base of the jaw is a good starting point. I say 10mm but there is a possibility that the slot drill if not running perfectly true will have cut a slot slightly oversize so measure the slot before machining the web. However, this is not a moving jaw like those in a four jaw chuck

so a very close fit is not a requirement.

Photo 13 shows my method of carrying out the machining having one fence to set the height and one to assist with opposing the cutting action, one clamp is therefore more than adequate. Still using this set-up, mill the 1mm deep recess, the purpose of which is to permit the jaws if required to be compressed by a small amount when holding larger rectangular items.

Drill, tap and counterbore the holes leaving just the jaw to be slit and if you have a large slitting saw then do this on the milling machine. **Photo 14** shows my method, the angle plate is just giving some added support to oppose the machining



force though this was probably unnecessary but it does serve a purpose with the next part so arranged to machine the slots in both whilst this set-up is on the table.

Whilst not seen, a similar thickness piece of steel was placed between the jaws at the other end as holding a component at the end of the jaw without this being done is definitely taboo, even with a quality vice.

If you do not have a suitable slitting saw then it is a task for the bandsaw and failing that a manual operation with hacksaw. Whilst neither of these methods will be visually as elegant they will function equally as well.

Thin piece larger diameter clamp (6)

This is another straightforward part but I have included a photo of my method of facing the ends. In this, **photo 15** the lower member packs the part up so as to keep the cutter well clear of the table's surface and a fence is clamped on top of this enabling the parts to be positioned so as to machine



Photo 15. Surfacing the end of a thin piece clamp.

their ends square. The head of the screw that secures the two parts to the table also acts as packing for the clamp that holds the workpiece down. The fence in front sets the position of the workpiece enabling a consistent length to be achieved with ease on the second end. This method was



Photo 16. Making the slot in one of the "thin piece larger diameter clamps".

much easier than fiddling around within a vice's jaws particularly when making a number of identical parts. I am though in the early stages of producing a design for a vice attachment that overcomes many of the problems in this respect, I hope though that it will not be another ten year wait.

After machining the recess and drilling the holes the part can be slotted using the same set-up as the jaws, in this case the angle plate also serves to set the part upright when being clamped into the vice, **photo 16**.

Small diameter auxiliary jaw (5)

This is a very simple part and will just show my method of chamfering the edges that avoid the need to use a tilting vice. In this, a small multi Vee block is placed between the vice's jaws and the part laid in one of the Vees making it easy to hold and machine the chamfer as can be seen in **photo 17**.

The remaining parts (3, 4 and 7) are very simple and need no explanation.

With all the parts now made all that needs doing is to double check that everything goes together as intended and with that done the body can be returned to the lathe and its face given a very light skim to remove the scribed marks and the marking blue. Having done that there is just one last machining operation to be done on the body and that is to make the shallow bore to take the setting pin (7) making it a close fit on the pin already made. The complete set of parts is seen in **photo 18**.

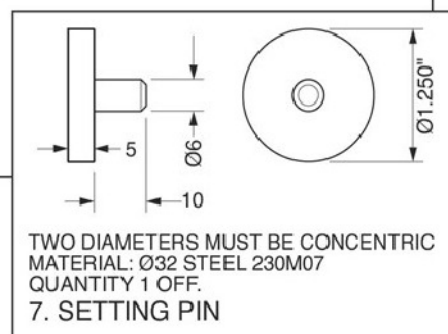
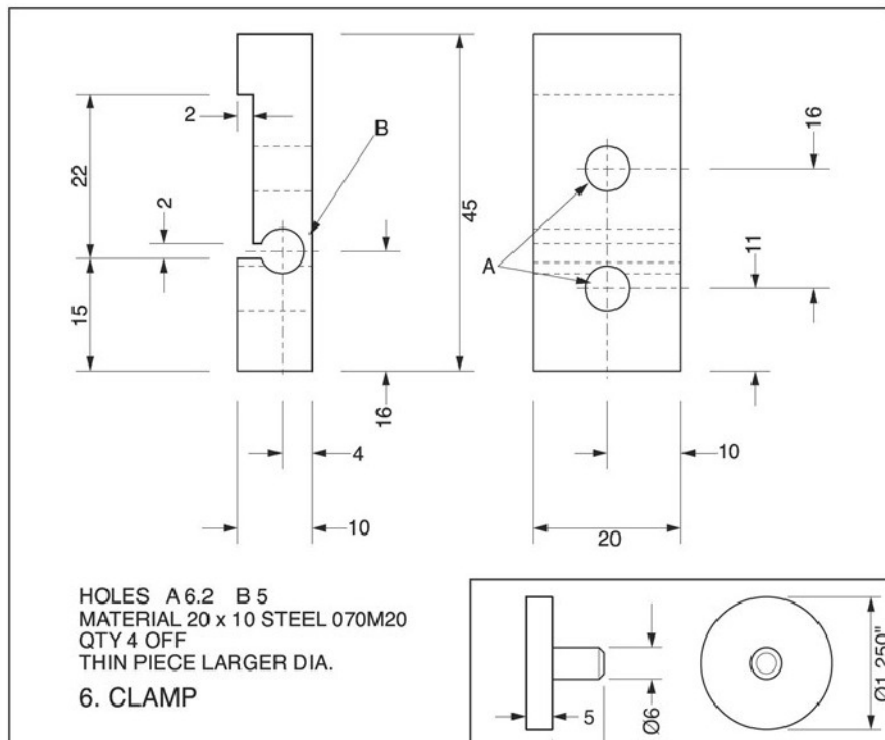


Photo 17. An easy method of holding the "Small diameter" jaw for chamfering.

Some typical uses

The examples that follow are just mock ups with whatever came to hand but I think give an indication of what can be achieved with this workshop item.

In most cases it will be preferable to set each jaw the correct distance from the setting pin to suit the size of the part to be held. Precision is not necessary as the jaws inbuilt adjustment will permit the position to be finally set when in place on the lathe. If the reader possesses slip gauges then these could be used though they are far more accurate than is required for the task. A good alternative would be to use a bore diameter gauge, having been set using a micrometer, as is illustrated in **photo 19**, even a rule and a traditional pair of inside callipers would suffice if used with care. An alternative would be to fit just two adjacent jaws and position these using a digital



Photo 18. The complete set of parts

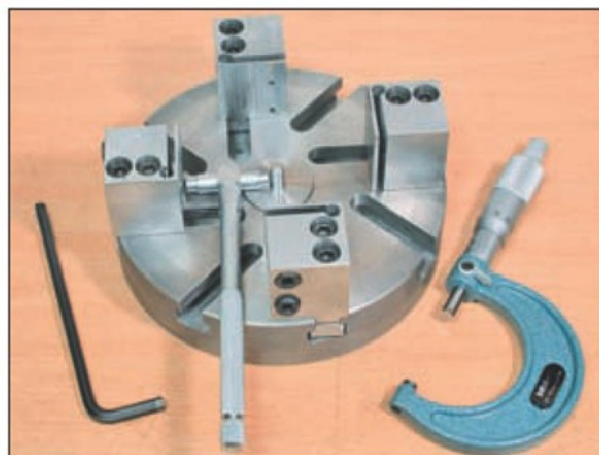


Photo 19. Typical method for initially setting the position of a jaw.

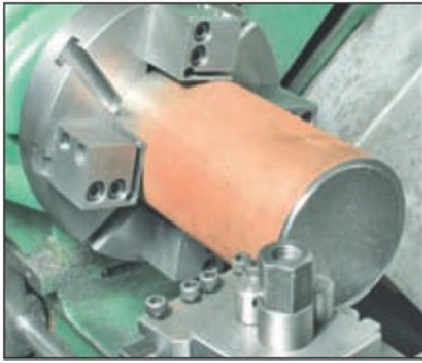


Photo 20. Taking a 4mm wide cut from a 75mm diameter 200mm long piece of rusty steel.

calliper then adding the other two jaws and setting each opposing pair of jaws by taking the dimension between the jaws.

With the jaws set the device can be fitted to the machine and the workpiece then added, finally set and machined. **Photo 20** shows a 75mm diameter piece of steel 200mm long being machined at a depth of 4mm, an operation that it did with ease.

Photo 21 shows a large disk being held using the "thin piece larger diameter clamps" (6). I have though since making my clamps increased the length given on the drawing by 3mm so as to increase the depth of the jaw available for gripping the workpiece. Actually, to avoid having to make another set of jaws I intend to slot the fixings to achieve a greater depth and it occurs to me that this may not be a bad idea as it will permit the clamps to be adjusted to suit the thickness of the part being held.

Photo 22 shows a more complex set up and is included just to highlight the fact that the system allows a mix of clamping methods. The reader may though consider that this would be better done on the faceplate and this may be so. However, the illustrated method does permit fine adjustments to be easily made to the workpiece's position that would not be so readily achieved if mounted on the faceplate.

Photo 23 just shows a largish casting being held and really needs no further explanation.

Small diameters and squares, also small disks are also catered for but I have not included any photographs of these set-ups, I have though included **photo 24** that shows the parts that are required for



Photo 23. Holding a mid size casting.

these situations. On the left is the jaw attachment that is used for small diameters and squares and on the right a support for small disks that are too small to use the set-up in **photo 21**. Do, when using the latter, only use the outer clamp screw for securing the workpiece.

Comparisons with a four jaw chuck

I would not be big headed enough to claim that this device wins in all aspects compared to using a four jaw chuck but I do consider that overall it has many more pluses than minuses.

Minus points

On the minus side I can only suggest that in a few cases it takes a little more time to initially set up and can then in a very few cases also be a little more difficult to finally set up the workpiece's position, though this latter problem may work to one's advantage in a few situations as explained below.

The major difference is as there are two clamping screws on each jaw, it makes it possible to tilt the jaw face. Once one becomes aware of this the difficulty that results is minimal and can work to one's advantage in some cases and in any case mainly applies to set ups as seen in **photo 20**. The way to proceed with round items is to first use just the clamp screw furthest from the body face and set the workpiece to run true adjacent to the jaws. With that done the outer end can then be set true by using the inner clamp screws which is really an advantage as with the conventional chuck one would have to accept just what resulted. With this set-up both ends can be set true.



Photo 21. Holding a large disk for machining. I have modified the drawings to make these jaws longer so as to increase the depth of the grip to those seen in the photograph.

Plus points

- You can use a mix of jaws and workpiece clamps and the chuck has deeper jaws than a comparable sized chuck, *35mm compared to 20mm.
- With the jaws still within the perimeter of the body it takes much larger diameters than a comparable sized chuck, *83mm compared to 58mm.
- Total projection from the lathe's mandrel mounting surface is less, *65mm compared to 73mm.
- The chuck is also much more adaptable for complex shaped workpieces.
- With the clamping screws having a much finer pitch clamping pressure is much more easily applied.
- Reversing the jaws, which is a slow process, is not required.
- Much easier to keep the mechanisms clean
- It can also be used without the jaws as a very adaptable faceplate.

*Comparisons are with my 6in. four jaw chuck.

Worthwhile?

If the reader makes much use of the four jaw chuck and faceplate then this alternative form will provide some useful additional capabilities whilst for the reader who is yet to possess a four jaw chuck then it is an option worth considering, saving money and providing an interesting project into the bargain. ■

References

Ref. 2 Drilling Projects (2) (Sash clamp) MEW issue 98 page 16



Photo 22. Showing that a mix of holding methods can be used on a single workpiece.



Photo 24. Jaw attachments, on the left for holding very small diameters and squares and on the right a support for small diameter disks.

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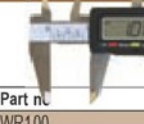
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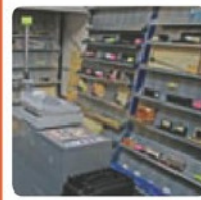


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WORKSHOP PHOTOGRAPHY



Photo 1. My set up for taking pictures of an individual item, or small groups, away from the machine. A similar method is though used for photographing the machines in action.

Harold Hall offers some tips

Whilst I do not consider myself an expert in workshop photography I do have a lot of experience having had approaching 2000 pictures published. I started taking pictures when writing my first articles but at the time I became editor the publishers had their own in house photographer who would take the pictures for such items as exhibitions, workshop and supplier visits. This necessitated me visiting to see if the subject was suitable and then a second time with the photographer. Being expensive in both time and finance I decided to take the photographs myself to avoid a second visit but had though learnt a lot from seeing the professional working.

At that time I used a Canon SLR camera type AT1 and have only very recently changed to digital working now using two Canon SLR camera's 350D and 400D, but almost all of what I am including is equally applicable to film or digital and neither is it necessary to possess an expensive SLR. Of course, an SLR camera has advantages but acceptable pictures have little to do with the camera and are more about lighting and subject presentation. There are though differences and I will initially describe the process in terms of using an SLR camera.

Lighting

This, more than any other aspect, is the item that will make or break a good picture, therefore, what we are attempting to achieve is a picture with an absence of sharply defined shadows or dark pockets where the light is not reaching. Some shadow is though an essential feature of most good photographs as without them the picture becomes very flat, a subject that will be commented on later.

Photo 1 shows my method where I am using two flash guns, the larger into the metal reflector on the right, and not seen, a smaller hand held flash, usually on the left, of course, left and right can be



Photo 2. Picture taken with direct flash, note the sharp shadows.



Photo 3. Picture taken with defused flash (bounced), the shadows whilst quite dark are much less defined.



Photo 4. By the use of a small fill in flash on the opposite side to the main flash the shadows have been considerably reduced making for a much better picture.

interchanged. Much the same set up is used for photographing the machines in action, etc. The purpose of the reflector is to produce a less direct light beam and therefore much less clearly defined shadows. The built in flash on the camera is not used.

In **photo 2**, only the larger flash unit is being used and rather than being directed into the reflector it is pointing at the item being photographed. With this done, it can be seen how defined the shadows are, even to the point of the holes in the dividing plate being very obvious in the shadow.

For **photo 3** the flash has been turned into the reflector resulting in the shadows being much less clearly defined although they are still quite dark.

To soften the shadows a second small hand-held flash unit is directed towards the areas of shadow, **photo 4**. This though would produce its own shadows, quite marked, if used directly. To subdue the beam so as to minimise secondary shadows the flash unit is held with a sheet of A4 white paper looped in front of it.

This is one area where the digital camera has advantages as it is possible to take multiple shots viewing each one as taken. Even so, I used this method with a film camera for fifteen years and with very few total failures.

If the reader compares the three pictures it should be obvious the changes that have been achieved, with **photo 4** being a distinct improvement, even over **photo 3**. Close examination of **photo 4** should just provide evidence of the smaller flash being used by the faint shadow now on the right of the dividing head.

The setup

Having explained the process, some details of the kit being used is necessary. **Photo 5** shows the major items with the camera being used seen at the rear.

On the right is the main flash that has a sensor for automatic applications and a swivel head. When used on a camera, both the flash and sensor would be facing the subject but when used with a reflector the sensor faces the subject and the flash beam the reflector, hence the flash unit needs a swivel head. When the flash is used in this way it should theoretically be placed at the same distance from the subject as is the camera though this is not critical.

As the unit is not mounted onto the camera a cable connection is made between it and the camera but if using a digital SLR camera most do not have a socket for this purpose and a hot shoe adapter will be necessary. The small device, seen right of front, provides this connection but see vital information below.

The small secondary flash unit is on the left and has mounted onto this an optical slave. This fires the unit when it sees that the main flash is fired, therefore no cabling is required between the two.

Many readers who are changing to digital will, like myself, wish to continue using their old style flash guns but many modern digital cameras cannot withstand the larger voltages developed by these. The device, seen front right, therefore serves a dual purpose, that is, to providing a connection point and an electrical barrier between the camera and the flash unit. This is the Wein Safe Sync (ref. 1).



Photo 5. The main items that make up the items used, left to right. The secondary flash unit with slave fitted. The Digital SLR camera. An automatic flash gun for the main flash and in front the adapter for connecting the main flash to the camera via a cable (Ref. 1).



Photo 6. Two Digital Slaves which ignore the camera's pre flash, firing the flash in sync with its main flash

Using a tripod

Ideally, the camera should be mounted on a tripod and operated by a cable release but whilst this theoretically avoids camera shake the very short duration of the flash tends to limit this problem even if hand held. More important is that it makes it easier to study, using the view finder, just what is being captured, and if using an SLR careful consideration of the focus being achieved. With the complexity of the assemblies being shot manual focusing is preferable over auto focusing.

Another advantage of using a tripod is that the camera can be set up prior to moving the flash unit into place, as in the close confines of a small workshop the flash reflector may have to overlap the rear of the camera being used. When space for the camera's tripod cannot be found then I do revert to hand held.

Non SLR Cameras

The vast majority of non SLR compact cameras (film or digital) do not have a hot shoe, or a socket for connecting a remote flash gun, making it impossible to use my method as described. At first, the obvious solution would appear to be to use the camera's built in flash to fire the master flash with this having an optical slave fitted. Unfortunately however, cameras, including SLR's in auto mode, fire a pre

flash to enable it to be automatically set up for the picture about to be taken. This resulting in the remote flash also firing and therefore not being able to respond to the second flash as there would be insufficient time for it to recharge itself.

The result of this is that using a second flash unit, predominantly for extra light when taking a picture in a large area, has not been possible since these cameras first appeared onto the market. Fortunately, the photographic industry has become aware of the need and optical slaves have started to appear that ignore the first flash so that they can fire the flash unit at the time of the camera's main flash. **Photo 6** shows two typical units (ref. 2). With one of these being used the process of taking the picture will follow closely that suggested above but there are though problems.

The on camera flash will though have to fire, (which it did not with my SLR method), giving some additional illumination. This together with the fact that the camera will not have so many adjustments available, aperture for example, some experimentation will be needed to determine the distance between the additional flash unit and the item being taken. I did though find it a little more difficult than just changing the distance of the flash from the subject.



Photo 7. This picture was taken using a digital compact camera with a Digital Slave to operate the remote flash guns. Compare with photo 4.

When taking the picture using the camera's own flash and the second flash projecting into the reflector the shot was very much over exposed due to the strength of the secondary flash. With the SLR method the camera's aperture could be reduced to compensate for this but this facility is not available on a compact camera. Some way was therefore needed to reduce the output of the second flash. To do this I hung a small white card about 150mm from the sensor so that it saw the light from this rather than the subject. Being white, and much closer than the subject being photographed, it switched off the flash much earlier; as a result the subject received much less light.

As the sensor was now just viewing the card the duration of the flash was constant irrespective of how close or far the flash was from the subject. The strength of the light received by the subject could therefore be adjusted by changing the distance between it and the flash unit.

However, **photo 7** was taken using a middle of the road digital compact camera with the system as described above and I think the results are reasonable though there is room for improvement which I am sure could be achieved had I more time to master the process.

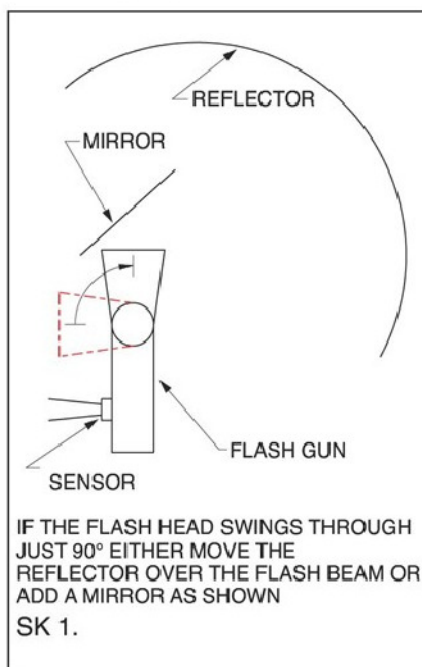


Photo 8. Two non dedicated flash guns that can be used with any camera, either hot shoe mounted, connected via a cable or using a Digital Slave.

The photo does have evidence of the additional flash being fired by virtue of the slight shadow to the left of the dividing head and to the left of the locking handle. A picture (not published) taken using just the camera's built in flash was well exposed but was very flat in appearance due to there being hardly any shadows as a result of the closeness of the flash and the lens on the camera, just a narrow shadow below the dividing plate. This showed that whilst shadows need to be subdued they are essential if a natural looking picture is required. The narrow shadow is still evident in the published photograph.

Available Flash Guns

Unfortunately, the situation with available flash guns has become much more complex since I purchased those I use, seen in **photo 5**. This is because of the greater emphasis placed on them being able to automatically adjust for the picture being taken resulting

in camera manufactures developing their own methods of achieving this. As a result, a high proportion of flash guns available are dedicated to the camera make on which they are used and there being a very limited range of general purpose flash units available, particularly those with a 180deg. rotating head. The guns seen in **photo 8**, Ref. 3 are two that will fit the bill but both can only adjust the light beam though 90deg. That is from directly forward to vertically up. To compensate for this the reflector will have to be set partially over the top of the unit, see **Sk. 1**.

Some lighting tips

I am aware, and fully understand this, that many readers will not wish to go to the lengths that I am proposing but consider that the information given will illustrate the importance of lighting when it comes to good pictures. The following are some suggestions that can be used in conjunction with my method or just with the built in camera flash.

One or more sheets of white faced hardboard, say 1m x 1m, could be used as a reflector with a smaller board for use in confined spaces.

A small mirror held just out of picture can be used to get light into dark areas.

When photographing a group of small items laying on the backing, drills for example, holding a second flash, directly above will almost totally eliminate shadows that may confuse their outline.

Using flash is not inevitable and if you have a very well lit workshop you may get by without flash though I doubt whether this will be a viable method for many shots, even in this case added reflectors may help. Another alternative is natural lighting but only if you can take the item to be photographed outside. In this case though, excellent results can easily be



Photo 9. A Dome Studio that enables photographs to be taken with a variety of light sources.



Photo 10 This picture taken with the dividing head in the dome and two small flash units outside, one on each side.

achieved provided quite simple precautions are taken, but taking the shot in full sun is out due to the very defined shadows that would result

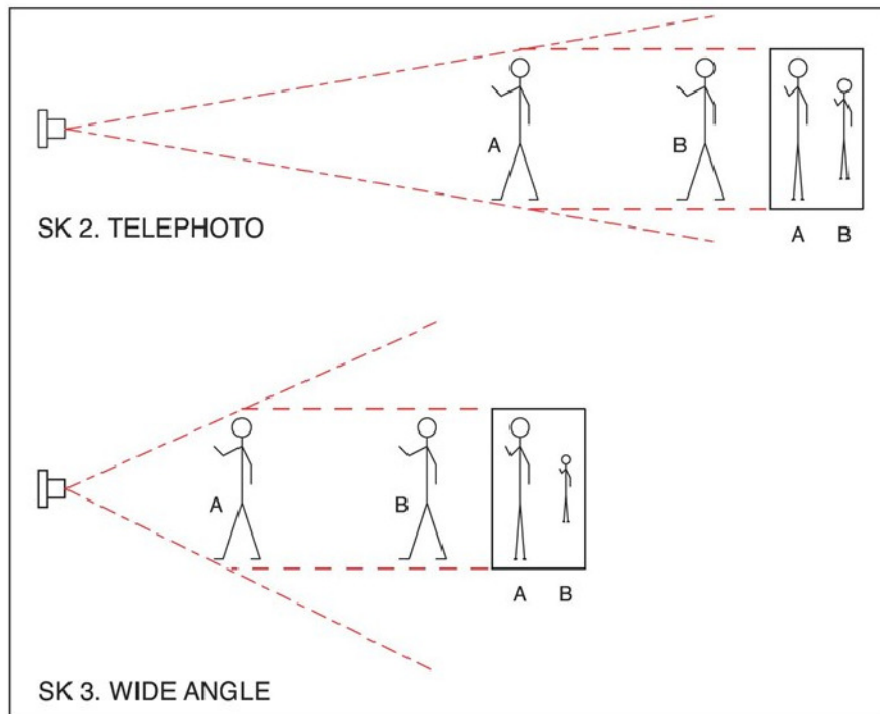
If photographing some model or item of workshop equipment and wishing to achieve a professional result then the following will give good results. With a piece of cord strung between two posts, or use the washing line, hang a white sheet across this and arrange to produce a basic tent. This should be done in full sunshine but even so the lighting in the tent will be soft and even, resulting in the right conditions for taking excellent photographs. Such a method is frequently used by the professional photographer within his or her studio but on a smaller scale, **photo 9** being a very small example. As an example of what can be achieved with this, **photo 10** shows a shot that was taken with a flash unit pointing directly at each side. The dome could be used with just a table lamp on either side, but if using a digital camera you will have to set white balance to tungsten if using old style bulbs. If using film then the correct type of film should be used. The unit can also be used outside using natural lighting as having flanges at the sides it can be weighted to prevent it being blown in the wind. For very occasional use a DIY version of this could easily be rigged up.

Having mentioned the professional, one catalogue, **Ref. 4** that I have shows a wide range of photographic equipment aimed at them and for the serious amateur and from this much can be learnt about the methods they adopt. Many of the items included, such as the flash guns seen in **photo 8** and the dome in **photo 9**, are also of interest to the occasional photographer.

Presentation

Having decided how to illuminate the subject for best effect this will be of little use if the items being photographed are not best arranged, a major subject that can only be dealt with very briefly.

When photographing a single item, or a group of items, do use a background that rests on the table and loops up at the back to provide a backing for the subject thereby avoiding a fold or a join being seen. The backing sheet will also give a measure of reflection to minimise shadows. If a group of items are being



shot do arrange them so that each one can be seen in isolation as has been achieved in **photo 5**. If, for whatever reason, you chose to work without a backing sheet do keep the background simple, that is as free of unconnected items as is possible.

The zoom facility

This is a facility that was an expensive luxury a few years ago but is now almost a standard item. It is easy to fall into the trap of considering that it is there just to enable one to get the picture extent that is required and this is largely correct. However, it should only be used when it is not possible to achieve the required result by either moving in or standing back to take the shot. Why is this? The reason is that the zoom facility also affects the perspective of the resulting picture.

If we look at **Sk. 2** we see two men being photographed from a distance using a telephoto lens setting whilst in **Sk. 3** the camera has been moved and the same scene shot with the camera lens set to a wide angle and in both shots it has been chosen so that man A almost fills the height of the picture. Comparing the two situations it can be seen with a wide angle lens that man B occupies a much smaller proportion of the height of the picture taken giving the impression that he is much further away than in the first shot. If you ever watch any of the housing programs on the television and are amazed at how large the rooms are, mostly they are not. They have only been taken with a wide angle lens making the far wall look farther away.

The lesson to be learnt is to use the facility sparingly. With a film SLR a lens having a focal length of 50mm was always considered to be that closest to natural vision but without going into the reason this equates to around 35mm on a digital SLR. In the case of a compact camera the lens focal length is not calibrated and I can only assume that the camera when first switched on sets itself at around this value. Ideally therefore the camera should



Photo 11. A method of converting slides to digital images.

be set and used at 50/35mm or in the case of a compact at the point it assumes on switch on.

Slides

I will finish very briefly with an item that has no bearing on workshop photography but feel many readers will have taken slide pictures and would like to transfer at least some to a digital format, **Photo 11** shows my method. There is more detail on my website and an example of the excellent results that are possible. The web address is www.homews.co.uk/page35.html ■

References

1. Wein Safe Sync. www.weinproducts.com/safesyncs.htm Whilst a US company there are numerous suppliers for this in the UK
2. The Sunpak DSU-01 and Portoflash digital slaves
3. The Metz 20C-2 and 36C-2 flash guns
4. Catalogue from Speed Graphics Tel 01420 560066. Web www.speedgraphic.co.uk

BASIC SPUR GEAR MILLING 7

Don Brymer continues his series on milling

In this article we will look at basic involute spur (straight tooth) gear cutting in the milling machine using form relieved gear milling cutters. This method of gear cutting does not produce the most accurate of gear tooth forms but few modellers will have any type of gear generating machine tools in their workshops. The reason for the inaccurate tooth forms is that a different cutter is required for each different number of gear teeth. As this is not possible, gear milling cutters are produced to cut a range of similar shaped teeth. Gear cutters are generally made to the correct form of the smallest number of teeth in the range the cutters are formed to cut and closely approximate the others in the range. In the average set of gear cutters for a particular tooth profile (say 2.5 module or 10 DP) there are eight cutters that cut from a rack to 12 teeth.

- No. 1 = 135 teeth to a rack
- No. 2 = 55 teeth to 134 teeth
- No. 3 = 35 teeth to 54 teeth
- No. 4 = 26 teeth to 34 teeth
- No. 5 = 21 teeth to 25 teeth
- No. 6 = 17 teeth to 20 teeth
- No. 7 = 14 teeth to 16 teeth
- No. 8 = 12 teeth to 13 teeth.

Should more accurate tooth forms be required, cutters are available in half numbered series (1½, 2½ etc) for cutting gears with tooth numbers that are between the numbers of the standard cutters.

Common gear tooth forms

The most common gear tooth standards used are;

- 1) Diametral Pitch tooth form (imperial, e.g. 20 DP).
The Diametral Pitch of a gear is a ratio between the number of teeth in a gear and the gear's pitch circle diameter (also referred to as reference circle diameter) and can be expressed as;
$$DP = \frac{\text{No. of teeth}}{\text{Pitch circle diameter}}$$

In the DP system the circular pitch of adjacent teeth measured around the pitch circle diameter is equal to π (3.1416) divided by the diametral pitch.

- 2) ISO metric module tooth form (metric, e.g. 3 Module).
The Module Pitch of a gear is a ratio between the pitch circle diameter of the gear and the number of teeth of the gear and can be expressed as;
$$\text{Module} = \frac{\text{Pitch circle diameter}}{\text{No. of teeth}}$$

In the module system the circular pitch of adjacent teeth measured around the pitch circle diameter is equal to the Module multiplied by π .

Gear tooth pressure angles

If you are milling new gears to replace damaged gears, as well as the tooth form the pressure angle must be known to enable correct cutter selection and will usually be 14½deg. or 20deg.

The pressure angle of a gear can be found by

$$PA = \left(\frac{\text{Base circle diameter}}{\text{Pitch circle diameter}} \right)^{\cos-1}$$

The 20deg pressure angle has widely been adopted for standard gearing as the tooth profile has less interference between mating teeth particularly for gears of less than 20 teeth. Gear teeth of 20deg. pressure angle are somewhat thicker and shorter than 14½deg. tooth forms. The 14½deg. pressure angle is more often used in older systems and has an advantage of producing less radial load during gear train operation than the 20deg. pressure angle forms.

Spur gear tooth elements and definitions.

(see figures 1 and 2)

- Addendum is the radial distance from the reference circle to the tip of the tooth.
- Dedendum is the radial distance from the reference circle to the root diameter of the tooth. The Dedendum equals the addendum plus working clearance.
- Whole tooth depth is the radial distance from the tooth tip to the tooth root.
- Flank is the surface between the reference circle and the tooth root.
- Face is the contact surface between the reference circle and the tooth tip.
- Chordal thickness is the tooth thickness measured at the reference circle across the chord of the arc.



Photo 1. A selection of gear cutters.

- Chordal height is the radial distance between the chord of the arc and the tooth tip.
- Circular pitch is the distance from a point on a tooth to the corresponding point on an adjacent tooth measured at the reference circle.

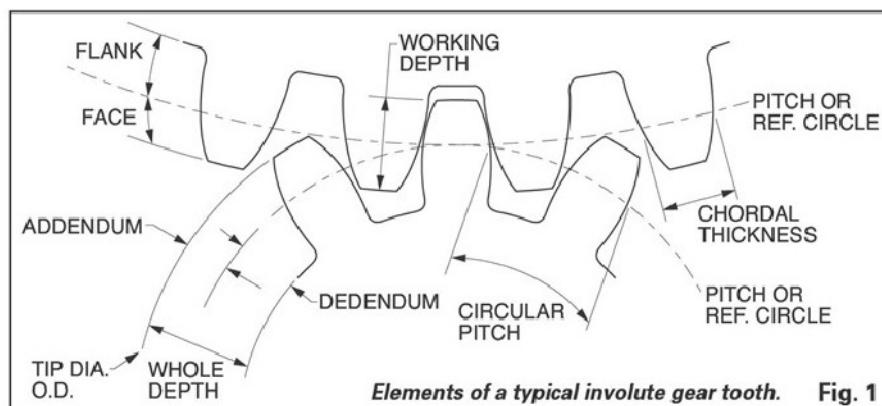
Gear tooth calculations

(See table 1)

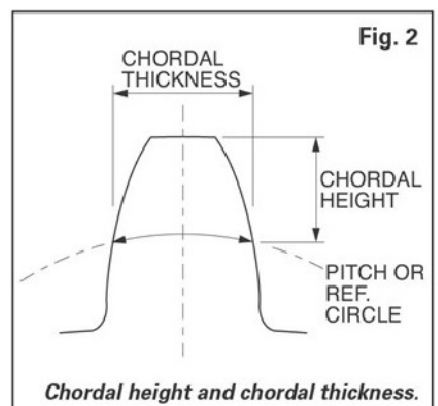
Possibly one of the most important calculations is that of the gear tip diameter (diameter of the blank). It is important that the gear blank is never oversize, any tolerance must be always a uni-directional negative tolerance.

A practical example of milling a 35 tooth gear in both Module and DP forms.

MODULE CALCULATIONS	DP CALCULATIONS
Module No. 3	8 DP
Tip diameter	
Tip $\phi = (35 + 2) \times 3$	Tip $\phi = \frac{35 + 2}{8}$
Tip $\phi = 111.00\text{mm}$	Tip $\phi = 4.625"$
Pitch circle diameter	
PD = 3×35	PD = $\frac{35}{8}$
PD = 105.00 mm	PD = $4.375"$
Tooth whole depth	
WD = 2.25×3	WD = $\frac{2.157}{8}$
WD = 6.75 mm	WD = $0.270"$
Chordal height	
CH = $\frac{105}{2} \left[1 - \cos\left(\frac{90^\circ}{35}\right) \right] + 3$	CH = $\frac{4.375}{2} \left[1 - \cos\left(\frac{90^\circ}{35}\right) \right] + 0.125$
CH = 3.053 mm	CH = $0.127"$



Elements of a typical involute gear tooth. Fig. 1



Chordal height and chordal thickness. Fig. 2

Table 1 Spur gear cutting formula 20° PA.		
To find	Module Formula	DP formula
Addendum (A)	$A = M$	$A = \frac{1}{DP}$
Dedendum (D)	$D = M \times 1.25$	$A = \frac{1.25}{DP}$
Clearance (CL)	$CL = M \times 0.25$	$CL = \frac{0.157}{DP}$
Whole depth (WD)	$WD = m \times 2.25$	$WD = \frac{2.157}{DP}$
Number of teeth (N)	$N = \frac{PD}{M}$	$N = PD \times DP$
Module (M)	$M = \frac{OD}{N + 2}$	N/A
Diametral Pitch (DP)	N/A	$DP = \frac{N}{PD}$
Pitch or reference circle diameter (PD)	$PD = M \times N$	$PD = \frac{N}{DP}$
Tip diameter (OD)	$OD = (N + 2) \times M$	$OD = \frac{N + 2}{DP}$
Circular pitch (CP)	$CP = M \times \pi$	$CP = \frac{\pi}{DP}$
Face width (FW)	$FW = 2.5 \text{ to } 3 \times CP$	$FW = 2.5 \text{ to } 3 \times CP$
Chordal thickness (CT)	$CT = PD \times \left[\sin \left(\frac{90}{n} \right)^{\circ} \right]$	$CT = PD \times \left[\sin \left(\frac{90}{n} \right)^{\circ} \right]$
Chordal height (CH)	$CH = \frac{PD}{2} \left[1 - \cos \left(\frac{90}{N} \right)^{\circ} \right] + A$	$CH = \frac{PD}{2} \left[1 - \cos \left(\frac{90}{N} \right)^{\circ} \right] + A$

Chordal thickness

$$CT = 105 \times \left[\sin \left(\frac{90}{35} \right)^{\circ} \right] \quad CT = 4.375 \times \left[\sin \left(\frac{90}{35} \right)^{\circ} \right]$$

$$CT = 4.71 \text{ mm} \quad CT = 0.196''$$

For the above example of 35 teeth, the constant is 10.8226 and is measured over four teeth.

For the module form $10.8226 \times 3 = 32.468$ mm and the DP form $10.8226 \div 8 = 1.353''$.

Backlash, for fixed centre gearing

When 14½deg. P.A. is used the extra depth of cut for each gear is equal to half the required backlash. In a gear and pinion drive apply all backlash to the gear.

When 20deg. P.A. is used the extra depth of cut for each gear is equal to the required backlash x 0.73. In a gear and pinion drive apply all backlash to the gear at 1.46 x required backlash.

Indexing movement

$$\text{Turns} = \frac{40}{35} = 1 \frac{5}{35} = 1 \text{ turn and 5 holes on a } 35 \text{ hole circle.}$$

Measurement of teeth

If the teeth can be measured with a gear tooth vernier while being cut, the vernier is set to the calculated chordal height and locked, while the chordal thickness is measured by adjusting the vernier to the gear tooth being measured to which backlash is subtracted if required. If a gear tooth vernier is not available then the "span" method of measurement is used, **Fig. 3**. To use this method a standard set of vernier callipers and a reference chart are all that is required. From the chart select either 14½deg. or 20deg. pressure angle figures. Select the number of teeth in the gear and find the constant (M) and the number of teeth the measurement is read over. If the gear is module form the constant (M) is multiplied by the module number, if DP form the constant (M) is divided by the DP. Subtract half the backlash from the measurement if required (see table 2).

Cutting a gear

- 1) Calculate all the required variables and turn the gear blank to size.
- 2) Mount the dividing head with the required indexing plate.
- 3) Test the parallelism of the dividing head to the table movement.
- 4) Set the indexing pin and sector arms to the required positions.
- 5) Mount the cutter in a suitable position with the arbor support/s as close as possible to the cutter.
- 6) Mount the work via a suitable method.
- 7) Centralise the cutter to the work (see earlier article). If the cutter is not centralised correctly the teeth will have long and short flanks.
- 8) Test index the entire gear by nicking each cut position.
- 9) Set the depth of cut to suit the tooth size and machine condition, leave enough allowance for a finishing cut and cut the number of teeth as calculated for the span

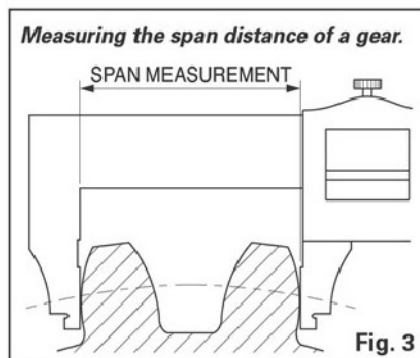


Table 2 Extract from a span measurement chart 20° PA.		
No. of teeth in gear	Constant "M"	No. of teeth spanned
28	10.7246	4
29	10.7386	4
30	10.7526	4
31	10.7666	4
32	10.7806	4
33	10.7946	4
34	10.8086	4
35	10.8226	4
36	10.8366	4

measurement. Measure to ensure the span measurement is oversize.

10) If span measurement is greater than required, rough out the entire gear. Be conscious of the heat of the cut, use a copious supply of coolant. If coolant is not available use a suitable neat cutting oil and try cutting a small number of teeth, index approximately 180deg. cut the same number of teeth, index 90deg. and cut, then index 180deg. and cut again. Finally cut any teeth remaining being careful with the indexing movements. Use the nicking as an indexing check.

11) Index approximately 180deg. from the original starting position to commence the finishing cuts.

12) Adjust the depth of cut to the calculated depth and cut the number of teeth to measure the span distance. Check and adjust as required and finish cut the gear.

13) When finished, check the span distance in a number of places around the gear.

Cutting a short rack

- 1) Set up the milling machine as above with cutter No. 1 of the required profile.
- 2) Set a machine vice at 90deg. to the machine column to take the place of the dividing head.
- 3) Mount the rack blank in the vice ensuring that it is parallel with the machine table.
- 4) Position a dial indicator on one end of the rack blank to index the cross slide movement.
- 5) The transverse pitch of the rack is equal to the circular pitch of the mating gear.
- 6) Set the depth of cut to allow a finishing cut and rough out the first tooth.
- 7) Finish the first tooth to the calculated whole depth before indexing to the second tooth. The reason for this method of cutting is to eliminate any error that may occur if the rack is moved back to the starting position for finishing cuts.
- 8) As the flanks of a rack are essentially straight, the angle of the flank of rack teeth is equal to the pressure angle of the gear.

As with a lot of machining operations the preparation and setting up can take longer than the actual machining, but the calculations, setting up and machining of your own gears will save a lot of money and should give you a lot of satisfaction. Good secondhand gear cutters are very well priced and available from the regular advertisers that advertise in MEW. If you have not tried gear milling in your home workshop give it a go. What have you got to lose? ■

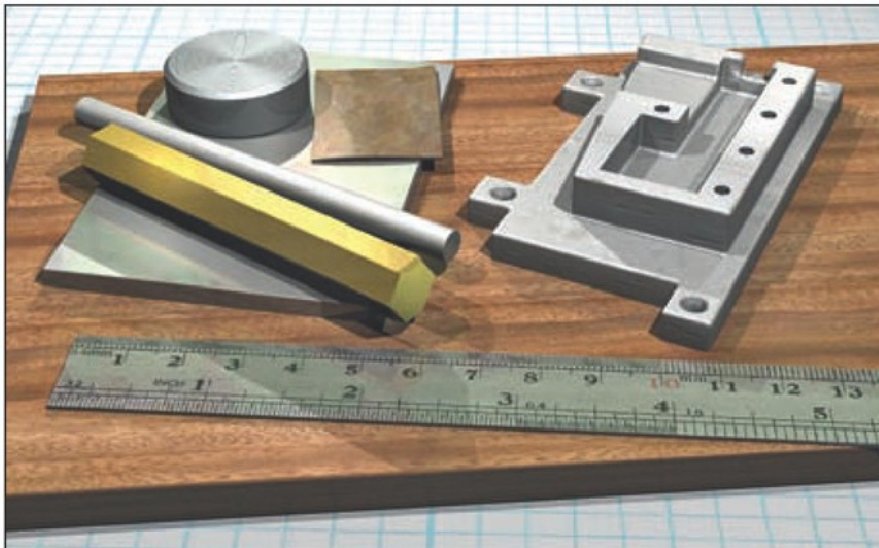


Fig. 157. Thirteen different virtual materials created with trueSpace.

FIRST STEPS IN DESIGN



Using modelling techniques and object materials to produce believable images

7

If you're using trueSpace purely as an engineering design tool, and the appearance of the models is unimportant, then you won't need any of the information in this article. I would guess, though, that anyone who has spent many hours on creating complex models would also like them to look realistic. With this aim, part seven begins with some general comments and a few tips on adding realism to models by using modelling methods. This is followed by the main subject of the article, which is on creating object materials. This is a big subject which can't be covered fully in a few pages, but as this is a series about engineering models, I'll focus mostly on creating realistic metal surfaces.

Adding detail by modelling

In principle, a model can be made realistic by adding more and more detail to it by using the techniques shown in earlier articles. Such detail can be chosen by looking closely at and analysing a real object, or, if the object does not yet exist, by imagining it. In practise, there is a limit on the number of finer elements that can be added to a model. There are two main reasons for this, the first is that, as a rough rule of thumb, if you double the amount of fine detail in a model, it will take twice as long, and be twice as difficult to build. There soon comes a point when further work is just not worth doing with modelling methods. The second reason against adding too much

modelling detail is that there is a limit on what the computer program and hardware can handle. If some of your modelling program functions stop working as they should, or the computer responsiveness becomes very sluggish, you have probably reached that limit.

An example of a model which has a moderate amount of detail is the engine which appeared on the cover of MEW 152. Some of the modelling is not especially obvious, unless looked at closely, but it does tend to increase the overall realism of the picture as a whole. Some details in the engine, however, were not modelled because this would be just too complex. Three examples of this are the knurling on the reversing lever, the threaded rod on the same component, and also the surface of the 50 pence piece; These were created by other methods (described further on).

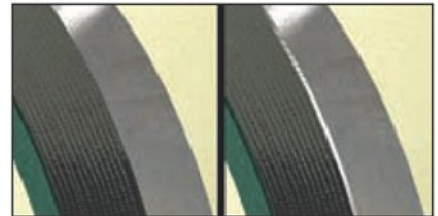
Although there are more parts in the engine compared with the example models shown in this series, it is still built up mostly from simple polyhedrons. It does, however, have a lot of fillets, chamfers and bevels, and you may like to add these in your own models as a quick way of increasing their realism.

Some modelling tips

The first tip follows on from the previous comment. A real component would have its sharp edges rounded over slightly with a file or other tool. This could also be done on a virtual model, but for a different reason. A sharp edge does not

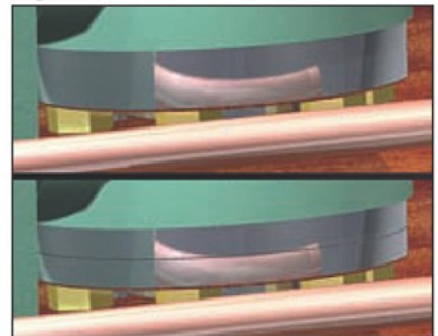
reflect light, but if it is given a small fillet, chamfer or bevel, it will just catch the light, creating a subtle, but realistic effect. A bevel of 0.1 to 0.5 mm (0.01 to 0.05 grid squares for the models in this series) is usually enough. The next picture shows a close-up of two similar objects, one with a sharp edge and the other bevelled.

Fig. 158



A second tip concerns gaps between objects. If two objects with the same cross section shape touch each other, they can appear to be a single object if they also share the same material. This problem can be cured by separating the objects with a small gap. This was done between the cylinder and its cover on the engine model mentioned above. The gap can only be seen on close inspection, but without it, the cylinder cover would not appear as a separate object. Here is a close up of the modelling, both with and without the gap:

Fig. 159



Even if a gap already exists between two objects, it may be worth increasing the separation distance to make it more noticeable. Conversely, removing a gap between objects (and possibly overlapping them) can also be useful if you want several unconnected objects to look like a single component.

One reason why 3D model images may not be very convincing is because they look too 'clean'. This shortcoming can often be improved by adding other unrelated, and perhaps almost insignificant, objects to a scene. Although it does take time to create these extra models, you could soon build up a collection of 'clutter' objects to include in other scenes. It's also worth having a stock of virtual tables, benches, shelves and stands to put your models on, as well as walls and floors. In comparison to many engineering components, these are easy objects to build. One final related tip is to use many lights in a scene. If these also cast shadows, it will help to reduce the cleanness.

Object materials

Part two described how the materials included with trueSpace could be applied to the objects in a scene. It's worth

experimenting with a large variety of these to get a feel for the extensive effects that can be produced. Often, though, just the right ready-made material does not exist, and you will then have to create your own. To show how an object material can be produced, I'll begin with a step-by-step description of transforming trueSpace's default material into a smooth surfaced brass material.

Click [Create New Scene], and add any object. When a fresh scene is started, all new objects are created with a default non-shiny grey material. Click [Material Editor], see part one, and a panel similar to the left-hand panel in Fig 160 will appear. The main feature on this panel is a sphere which shows a sample of the current material. Above the sphere is a horizontal group of four buttons for editing the current material's properties, and the seven vertically grouped buttons on the left are used for viewing and applying materials. The first step in this example will be to change the current colour from grey to a hue that simulates brass. Click [Color] (the first button in the horizontal group), and a Color Panel similar to that described in part two will be displayed. The current grey colour has red, green and blue settings of 188. Change the green value to 137, and blue to 2, and the material sample sphere should now be a brownish-yellow colour similar to that shown in Fig 160. (Sorry about the mixed spelling here; I've kept the American 'color' when it's used by trueSpace as a function name).

The last step in this example makes the material more brass-like by altering some surface properties. Start by left-clicking the [Reflectance] icon, Fig 160. Next, the category of the reflectance parameters will be set. If you move the mouse pointer over the sphere in the Reflectance Panel, the pop-up label 'Reflectance: phong' appears. Phong is the name of a set of reflectance characteristics, and the current material uses this set (it's a good general purpose set). Click [Reflectance] again, this time with the right mouse button. The new panel displayed has a collection of alternative sets of reflectance parameters. Pick the 'Mirror' thumbnail (third from the left and second down), and the Reflectance Panel should be like that shown on the top-right of Fig 160. Right-click the lower part of this panel, and a further numerical entry panel will be displayed. Type in these values if the ones in the panel are different: **Luminance:0, Diffuse:0.6, Shininess:0.8, Specular:0.2 and Reflection:0.2.**

Any new objects that you create will now be 'made' from this current brass material. The material can also be given to an existing object by first selecting it, then clicking [Paint Object], Fig 160.

Before continuing, a couple of trueSpace terms need explaining, these are Shader Channels, and Shaders. **Shader Channels** are a group of characteristics that define one aspect of a material's properties. Two of these have already been used - **Color** and **Reflectance**. There are another two channels - **Displacement** (also called **Bump**) and **Transparency**. The Transparency channel is used for modelling materials like glass and liquids, but won't be covered in this article. The Displacement Channel is very useful for reproducing some metal surface finishes and will be explained in some depth

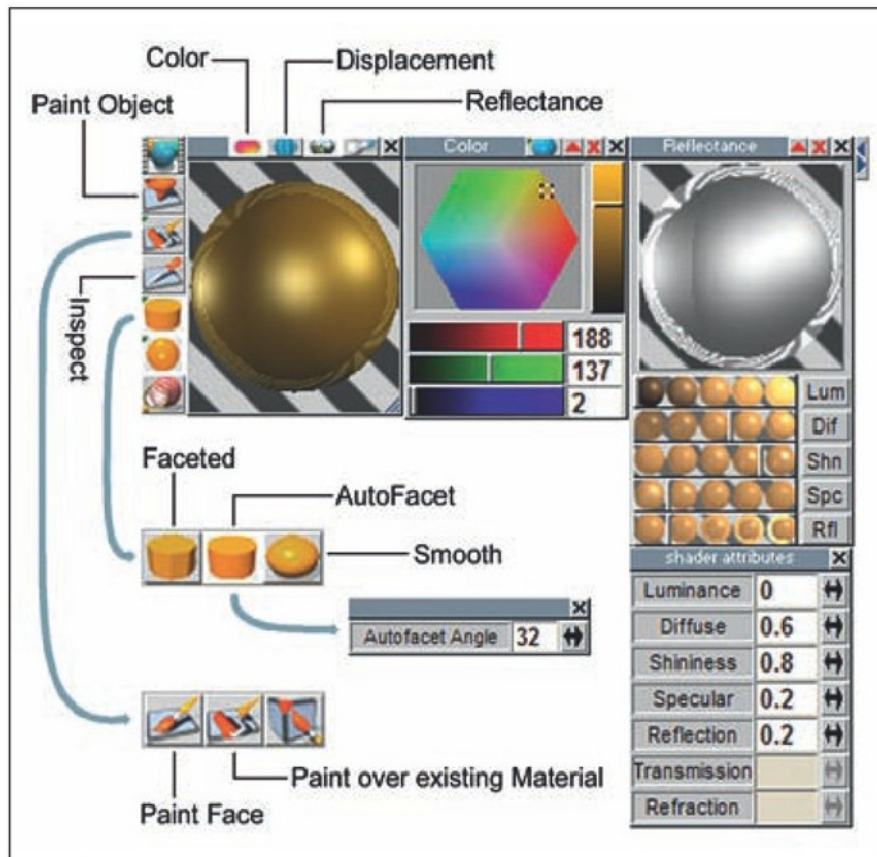


Fig. 160. Object material editor panels with a brass sample.

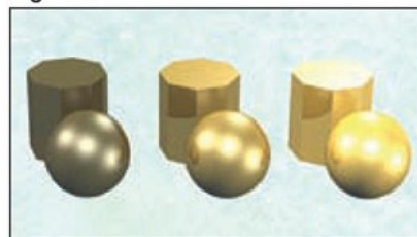
further on. **Shaders** are a specific group of characteristics which are used for a particular shader channel. Two reflectance shaders have already been mentioned - 'phong' and 'mirror'. The Color, Displacement and Transparency Channels also have their own shaders, and a few of these will be used later on.

Reflectance settings

The current material is a good starting point for giving objects the look of moderately tarnished brass. You may like to try modifying its colour and reflectance settings to simulate other types of brass with varying degrees of tarnishing. Also, colours chosen from near the centre of the hexagonal colour picker will produce materials which mimic steel. With a little experimentation, you should be able to reproduce many smooth surfaced metal effects (copper, bronze, aluminium etc.). The main effects produced by the reflectance parameters are shown in the images which follow, but as the interactions between parameters can be subtle, the best way to become familiar with them is to experiment for yourself. First of all, here's a quick tip about one of the parameters: The Luminance setting controls a material's brightness, but it can make it appear as though an object is emitting its own light (useful in modelling a red hot piece of metal perhaps). I usually keep this value at zero, and alter the brightness on the Color Panel (or use brighter lights in a scene).

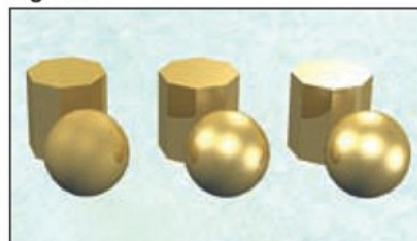
The first image shows two objects which have a low Diffuse value on the left, and two objects with a high Diffuse value on the right. For comparison, the central objects have the same brass material as created above (and kept the same for the three following images).

Fig. 161



Low Shininess on the left, and high shininess on the right:

Fig. 162



Low Specular value (left), and high Specular value (right):

Fig. 163



Low Reflection (left), high Reflection (right):

Fig. 164



Saving Materials

Materials can be saved in libraries in the same way that other trueSpace elements can. With the Material Editor showing the material you want to save, click **[Material Library]**, the fourth icon down in the Library Toolbar, see part 1. Right-click the new panel which appears, and in the list under 'Library' select 'New'. Right-click again, and pick 'Rename', then type 'FS Materials' (or other name) Return. Right-clicking the panel once more and choosing 'Insert' will store the current material in the new library.

Face painting and inspection

The material of a whole object is changed with the **[Paint Object]** function, but individual object faces can also be painted with the **[Paint Face]** tool. This is useful, for example, if you had a metal object, but wanted parts of it to have a painted surface. The flywheel shown in the main picture last month is an example of this. To use the tool, create an object with a metal material, then using a different material, pick **[Paint Face]**, Fig 160, then click individual faces on the object, or drag the mouse across several faces. If you still have the brass material showing in the Material Editor, this can be quickly changed to a **semi-gloss paint effect** by selecting a colour of your choice, then setting these Reflectance parameters: **Luminance:0, Diffuse:1, Shininess:0.3, Specular:1**, and **Reflection:0.05**.

If you had used the **[Paint Face]** tool on an object, but for some reason wanted to change the material on the painted faces, you don't have to repaint every single face again. Instead, set the new material, then click **[Paint over existing material]** and click just one of the faces. All faces which have the same material as the picked face will be then repainted with the new material.

To examine the material of a whole object or individual face click the **[Inspect]** tool, then pick the face. The material of the face will then become the current material and will be shown in the Material Editor.

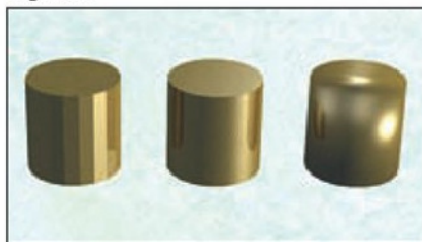
Faceted or smooth

There are three option buttons in the Material Editor that determine how a material is applied to an object's surface. With the **Faceted** option all faces look flat, and **Smooth** makes an object's surface appear rounded with no sharp internal edges. Objects painted with the third option, **AutoFacet**, will have a smooth appearance on all faces, except where the angle between the faces is greater than a specified value. This value, the **AutoFacet Angle**, can be set by right-clicking the **[AutoFacet]** icon. This option is very useful for giving a naturalistic appearance to

some objects; the cylinder, for instance, has a smooth perimeter and flat ends when painted with the **AutoFacet** option. With the pulley created in part four, I mentioned that this component did not have a well defined appearance. This is because the angle between its two central side faces and the adjoining faces is less than the **AutoFacet** threshold. If you have saved the pulley, you may like to reload it, then repaint it (perhaps with a different material) using an **AutoFacet Angle** value of 20.

Here are the three painting options illustrated on three cylinders:

Fig. 165



Modelling surface finishes

This section starts with the smooth metal materials created earlier, but will add some surface texture. In this way, some acceptable imitations of turned, milled, cast and other surfaces can be created. Some of the methods shown in this section (and the rest of the article) make use of images produced by CAD and image editing software, as well as by scanners or digital cameras. Some readers may not want to use some or any of these techniques, so I've given only a brief overview on them so that anyone familiar with working with images can try them out. Even if you don't want to create your own images, I hope that you will still find something of interest in the general description of the procedures.

Surface texture can be added to a material by using the **Displacement (Bump) Shader Channel**. The effect produced by this channel is to simulate an embossed surface effect on the material. TrueSpace has many Displacement Shaders, but this article will focus on the **Bump Map Shader**. A Bump Map is just a straightforward image which controls the depth of the embossing effect. For a first example of using a Bump Map, I'll use this image:

Fig. 166



Using the brass (or other smooth metal) material created earlier as the current material, left-click the **[Displacement]** button in the Material Editor. Move the mouse pointer over the sample in the Bump Panel, and the pop-up label 'Displacement: none' will be shown. Click the **[Displacement]** icon again, with the right mouse button this time, and in the Displacement Shaders Panel, select 'Bump Map' (first column, second thumbnail down). The Bump Panel should now show an image of the Caligari logo and a set of numerical parameters. You can use the logo in this example, or load a new image by clicking the button with 'Caligari' on, then double-clicking an image of your choice from the Bump Map Browser Panel (or create your own image and use the browser to find it; I'll use the image shown above). Set the Amp (amplitude) value to 10 (the maximum), add a **[Plane]**, and click **[Render Scene]**.

Fig. 167



The depth of the embossing effect is determined by how dark the parts of the bump map image are. You can also reverse the direction of the embossing by using negative Amp values. One thing to note about the Displacement Shader effects is that the embossing is only simulated, and the 3D appearance may be lost if an object is seen close up, or obliquely, or at the object's edges.

You can use multiple repeats of a bump map, or use only a section of it, and this effectively changes the scale of the bump effect. Try making the **U Repts** and **V Repts** values both more than and less than one, then repaint the plane and re-render the scene. The two **Offset** parameters control the positioning of the bump map on the object. Sometimes it needs some juggling of these four values to get the specific bump effect you want on an object.

A turned surface finish

Before beginning this example, I should perhaps mention that most of the displacement effects shown here have been exaggerated a little so they show up clearly when printed.

A reasonable impression of the surface finish produced by a lathe can be created by using a bump map image that has many parallel lines. Here's a close-up of one section of such an image:

Fig. 168



The lines in this image were created with a CAD program, adjusting the line spacing and thickness to get the best effect. Some noise (randomly placed dots of varying shades of grey) was then added with an image editing program; this last step is not essential, but the bump effect may look too 'clean' without it. An alternative way of producing a similar image would be to draw the lines on paper and then scan the image into the computer. Whatever method is used to create the image, the lines must be parallel to the image's sides.

The lined bump map image is then loaded in the Material Editor's Bump Panel as explained above, and with a little experimentation with the Bump parameters, a rendered image of a cylinder with this material should look something like this:

Fig. 169

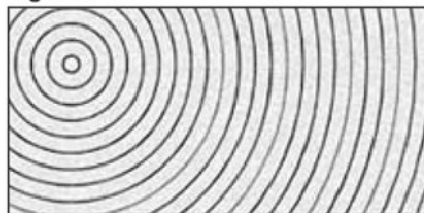


When seen as close as this, the effect is perhaps not realistic, but from moderate viewing distances it does give a reasonably convincing impression.

Standard cylinders will not show Displacement (and some other) effects on their end faces (as can be seen in the diagram above). This is because of a feature called **UV Mapping**. I'll just give the very briefest of accounts on how this important subject relates to cylinders, but more details can be found in section 6.1 of the Help Files. UV mapping is needed because of the difficulty of generating a 3D surface material from a 2D image (a bump map, in the present example). When an object is given a material, the material is 'projected' onto the object's surface and the projection is determined by a UV Map. Standard cylinders use a cylindrical projection map, but this does not produce any effect on the end faces of cylinders. However, if an alternative projection map is used, then a bump map effect will appear on cylinder ends. A Cubic Projection, for instance, will project a material onto a cylinder as if the material came from the six faces of a cube. Using a cylinder that has the lined bump map material, and is the Currently Selected Object, click [**Cubic UV Projection**]. This tool is found by holding down the left mouse button on the fifth icon from the right in the Model Toolbar, see part 1 (unlabelled in the diagram). The new projection is now represented by a cuboid enclosing the cylinder, and this could be moved, rotated and scaled just like any other object (but don't do it for this example). Click [**Object Tool**] to exit the projection editing mode, and then [**Render Scene**].

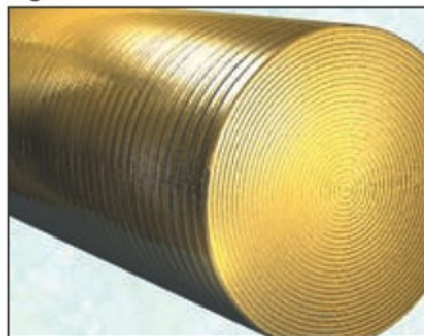
Although the cylinder end faces now show the bump effect, the straight lines are obviously not realistic as a turned finish! This can be rectified, however, by applying a different bump map image to the cylinder end. Here's a close-up from the centre of such an image:

Fig. 170



This image is created in the same way as the previous bump map, but has concentric circles instead of parallel lines. If it is loaded into the Bump Panel, and the end face of the cylinder painted with the [**Paint Face**] tool, this will be the result (I've also put a small bevel on the cylinder end face):

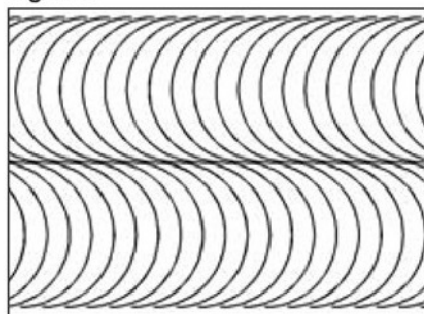
Fig. 171



Milled, cast and grinding finishes

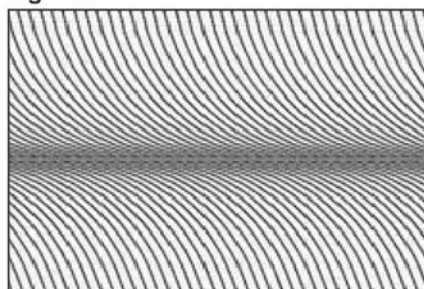
A milled finish on flat surfaces can be created with the same technique, but with a different bump map. The next illustration shows a diagrammatic representation of a suitable image:

Fig. 172



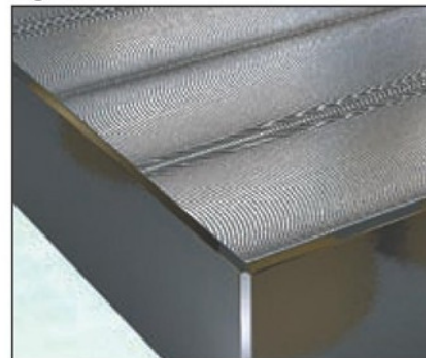
Here there are many uniformly spaced and identically sized semicircular arcs, arranged in two oppositely facing groups (optical illusion effects make this diagram look more complicated than it actually is). A close-up of a section of an actual milling effect bump map looks like this:

Fig. 173



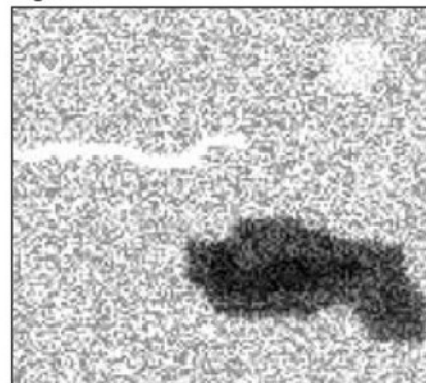
This has been created in much the same way as that described before. The junction between the two sets of arcs has been lightened, however, because if it was left dark, it would produce an unrealistic ridge between the simulated milling tool passes. This is the effect produced by this bump map when applied to a flat surface:

Fig. 174



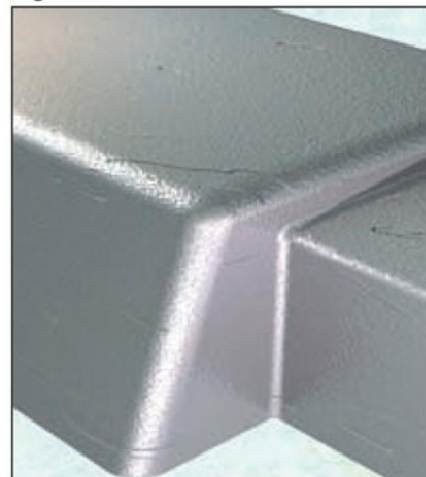
A portion of a bump map used to reproduce the surface of a casting looks like this:

Fig. 175



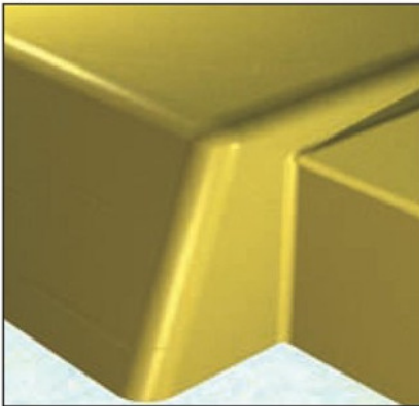
The dark and light patches in the image will produce sunken areas and bumps respectively on object surfaces, and the irregular lines will introduce wrinkles. The sand cast effect is created by adding a fair amount of noise to the image. When applied to an object surface, this bump map will create a surface effect similar to that shown in this example:

Fig. 176



The same bump map, can be easily transformed into another image which simulates a **painted casting** surface. If a copy of the image is blurred (smoothed) and the contrast reduced, this is the result:

Fig. 177



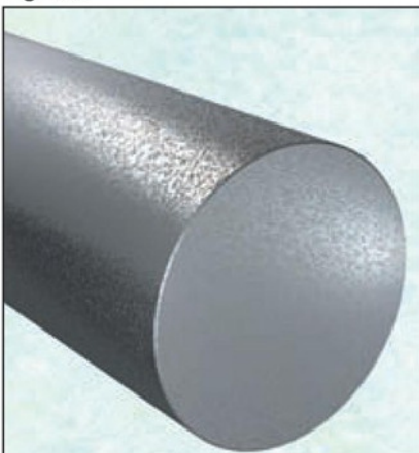
The final bump map shown is used to imitate a surface produced by **grinding**. Starting with a blank image, some noise is introduced. The image is then enlarged in one direction only, turning the noise into streaks, and finally a little more noise is again added:

Fig. 178



The next object demonstrates the effect of a material with this bump map:

Fig. 179



Texture maps

Before leaving the subject of Displacement shaders, I'll just mention that there are several alternative shaders that can be used instead of bump maps. These are called **Procedural shaders** (the bump effects are determined by mathematical procedures). These can be selected from the Displacement Shaders

Panel (right-click the Displacement icon in the Material Editor), and their effects can easily be discovered with a little experimentation. For engineering models, the 'Wrapped Knurl' and the 'Wrapped Tread Plate' shaders are probably the most useful.

The Color Shader Channel also has several alternative shaders. So far in this article only one of these - the 'Plain Color' shader - has been used, but another one - 'Texture Map' - will now be introduced. TrueSpace has many sophisticated functions which can be used to produce materials which have some very subtle properties. Creating such materials can, however, be time consuming. As an alternative, Texture Maps can be used to make realistic materials, and all for a modest amount of effort. A texture map can be thought of as just an image which is painted on a material's surface. As texture maps can be scanned images or photographs of real object surfaces, it will be evident why this technique can create convincing results. Here's an instant wall made from a single cuboid with a photograph of stonework used as a texture map:

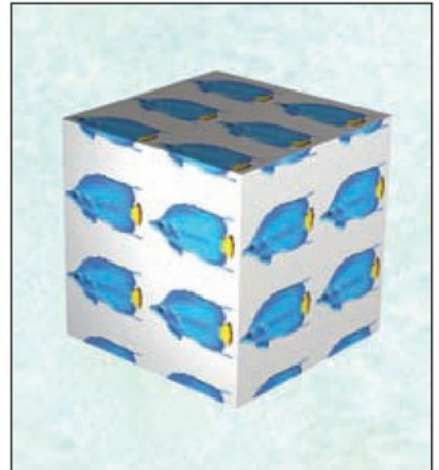
Fig. 180



Other examples of texture maps are the steel rule in **fig 157**, and the 50 pence piece on the cover of MEW 152.

Texture maps are used in the same way that bump maps are, except that the Color Panel is used instead of the Displacement Panel. First of all, in the next example, the Displacement effect will be turned off (but could be left on and used simultaneously in a material that also uses a texture map). Right-click the Displacement icon in the Material Editor, then select 'None' in the Displacement Shaders Panel. Now, left-and-right-click the Material Editor's Color icon, and select 'Texture Map' in the Color Shaders Panel (first column, second thumbnail down). In the Color Panel, click the button with 'Caligari' on, then double-click any image in the Texture Browser Panel (I've used 3DFish in this example). You could alternatively browse your computer, and select one of your own photographs or other images. Set the 'U Repts' and 'V Repts' values (I've used eight), add any new object to the scene, and click [Render Scene]:

Fig. 181



Making a seamless texture

A seamless texture is an image which won't show any discontinuities at its boundaries when multiple copies of it are placed side-by-side (tiled). They are often used as texture maps because they can be repeated many times across an object surface, and still look like a single uniform material. I'll show an example of creating a seamless wood texture as this material will make the steps obvious. The technique is also good for irregularly tarnished copper and brass, or corroded iron surfaces, for example. (Shiny metal surfaces, however, often look better when created with the methods described previously). Bump map images can also be made seamless with the technique shown here. The first step is to scan a piece of wood:

Fig. 182



(The lines and letters are not part of the scan, but will be used to explain a later step). If the wood has a uniform grain pattern (unlike this demonstration sample), this will make the task easier. Seamless textures can be made equally well from digital photographs, but if you have a choice, scanning is often better because of the uniformly illuminated images it produces. If this image was now used as a texture map with multiple U Repts and V Repts values, this would be the result:

Fig. 183



This is fine if you ever have the need to model parquet flooring, but not so good for a single piece of wood! The first step in making this image seamless, is to swap the positions of sections A and D, as well as those of B and C. This can be done manually in an image editing program by cutting and pasting the four sections. This selecting and repositioning should be done so that there are no gaps or overlaps between the sections, nor around the image border (zoom in close to check this). Some image editors may have a function which will make this whole process easier, Photoshop, for instance, has the Offset Filter. The position of the dividing lines between sections is not important, and they can be chosen to make the next editing step easier. This is the result at this stage:

Fig. 184



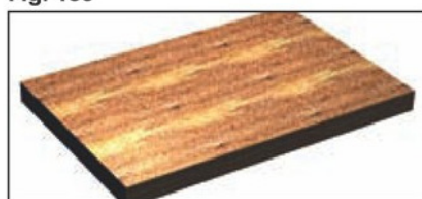
The original dividing lines now form the border of the image, and because the sections along these lines were formerly adjacent, this has now made the image seamless. The discontinuities in the middle of the image can now be disguised by cutting and pasting portions of the image (being careful not to alter the border) to give a more natural look:

Fig. 185



When used as a texture map, this is the improved result:

Fig. 186



Further possibilities

In addition to the Plain Color and Texture Map shaders, there are many alternative colour effects that can be used. Some of the possibilities include granite and marble simulations, as well as shaders which can produce some good diagrammatic wood surfaces. One colour shader has a specific engineering use: the **Draught Angle Evaluation Shader** may show up potential problems in objects which are to be cast or moulded. I say may because in my few attempts at using it, it has not proved completely reliable, but this could be my fault - you may get better results.

To use an appropriate metaphor, this article has only scratched the surface of the material effects that are possible with trueSpace. You may like to look at chapter six of the Help File to find out more about surfacing. I would particularly recommend section 6.1 on UV Tools, and sections 6.3.5 and following on Multi-Layer Materials.

In the next part: The series will return to modelling techniques with an article that is devoted entirely to gears.

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You can find out more about the wide range of lubricants available online at www.morrislubricantsonline.co.uk



On the first day of Christmas my true love sent to me:
A part which has no guarantee



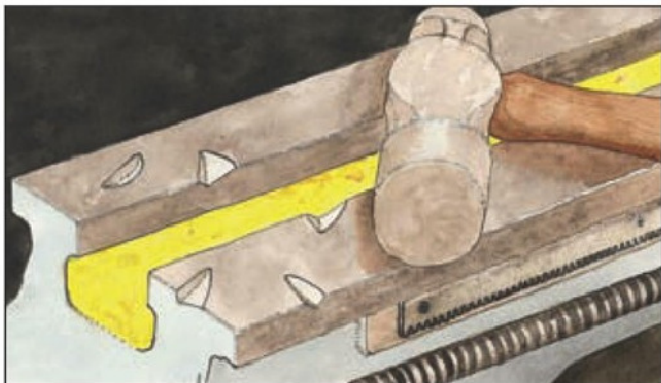
On the second day of Christmas my true love sent to me:
Two tapping trolls



On the third day of Christmas my true love sent to me:
Three forged frogs



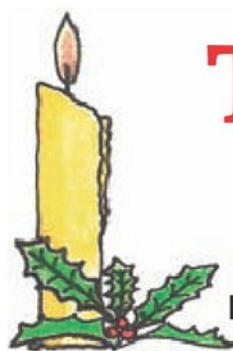
On the fourth day of Christmas my true love sent to me:
Four free-range threads



On the fifth day of Christmas my true love sent to me:
Five bold dings



On the sixth day of Christmas my true love sent to me:
Six sheep a shearing

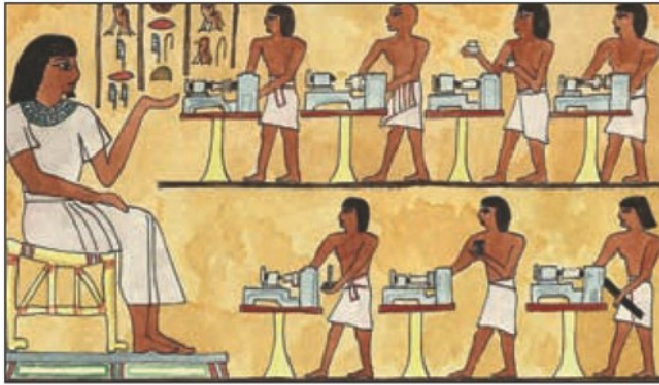


THE TWELVE OF CHRISTMAS

For the metal worker who has everything

To the engineer at Christmas time, a problem: which gift to choose? When a spouse or friend would like to send a prized workshop tool to use. Ill-judged gifts of doubtful value, by New Year may have vanished to a place obscure in a lonely drawer, with light forever banished.

An engineering wishing list - a hint of tools desired, could provide a handy guide, if one's loved one has enquired. With a list precise, come Christmas Day, the unwrapping should delight, but with list unclear, one may (I fear) still get an elephant white.



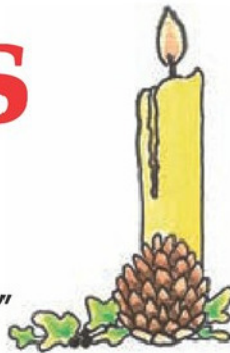
On the seventh day of Christmas my truelove sent to me:
Seven slaves a lathing



On the eighth day of Christmas my truelove sent to me:
Eight apes a painting

LVE DAYS ISTMAS

thing - Some gift ideas from "Eisengeist"



For tool drawer cemeteries everywhere -
to ease their inundation,
please, engineers send your good ideas
of gifts with commendation.
Inspired examples in Scribe a Line
that enlighten or amuse
may assist and show, engineer or no,
readers' Yuletide gifts to choose.

In return for workshop presents - those
tools received with pleasure,
the machinist skilled may care to build
special gifts which loved ones treasure.
Perhaps so heartened you have made
such appliance, game, or toy.
If so please send your insight penned so
that others can enjoy.



On the ninth day of Christmas my truelove sent to me:
Nine gnomes annealing



On the tenth day of Christmas my truelove sent to me:
Ten tons o' turnings



On the eleventh day of Christmas my truelove sent to me:
Eleven aliens oiling



On the twelfth day of Christmas my truelove sent to me:
Twelve elves a welding

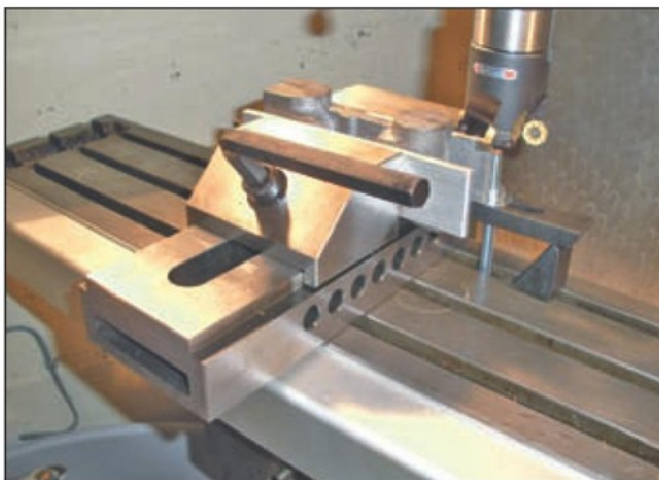


Photo 1. The drill head casting set up for milling.



Photo 2. Another of the milling setup showing the tipped cutter used.

THE PRACTICAL ENGINEER

It has probably been nearly twelve months since I last did a Practical Engineer article. The main reason has been taking over as editor of *Model Engineer*; a couple of minor accidents and illnesses have not helped either.

Now that I am starting to get ahead with magazine editing, I find I can spend a bit of time in the workshop. I am currently machining two steam engines in my workshop, a Stuart 10V and also a Stuart 10H and describing construction in *Model Engineer*. Before very long, I need to tap some holes square to a face and to do this I am making a George Thomas Tapping and Staking tool (and also the mini-drill head) from Hemingway castings.

I expect many readers are not sure how to tackle a casting so some notes of how I would do it might be of interest to readers. The first thing to do with any casting is to run a rule or vernier over it to ensure there is sufficient metal to remove. The Hemingway castings for this project have ample material so no problems there.

It can sometimes be difficult to decide which face to machine first on a casting. Any unmachined faces may need to be square and/or true to machined faces. I

decided to tackle the drill head casting first as there is only one of them to do. It was reasonably square so I placed it into the vice, holding on the sides of the casting, using a piece aluminium at each side to protect the vice jaws and allow any small protrusions to dig into the aluminium, **photo 1**.

The casting needs to be held reasonably solidly with no movement. At the Myford Spring event I purchased a 50mm diameter carbide insert cutter, **photo 2**. This takes four octagonal inserts. The ones that came with the cutter were actually round inserts which were correct for this cutter but I wanted to use the octagonal ones. Despite an intensive search on the Internet I failed to come up with the correct insert number. I posted a query on the forum at www.model-engineer.co.uk asking about the correct number and a reader very kindly sent me four tips. The cutter also needed a 2 Morse taper arbor which I purchased on Ebay.

Now I was set to machine the casting faces. I took light cuts of around ten thou at a time as there is a bit of overhang with the cutter and machined the casting down to size leaving about 5 thou then took a finishing cut, **photo 3**. The casting also needed machining between the bosses so I lined up the cutter, **photo 4** with the depressed centre of the casting then wound the table up (clear of the job) and cleaned up the face, **photo 5**. I will carefully file the remaining face and rounded corners at each end. Only the centre of the boss is used to take a nut and washer, the rest is in the wind.

This covers the first face of the drill head casting. This was flat with no steps but next we have the two arms to machine and they have a large end and a small end. Also, the faces of the boss are slightly out of square with the sides.

First thing to do is find out the difference in sizes between the large end and the small end. Do this by measuring the large end, measure the small end and take it from the large end then divide by two. This gives the approximate packing at each side of the small end. I did not have the exact size of packing, the nearest I could find was about ten thou to thick. For what we are doing here, this won't matter but I still needed to make



Photo 3. The casting being milled to thickness.



Photo 4. Lining up the lower central part.

sure the packing was still the same correct overall width.

The easiest way to do this was to insert a twist drill in the vice between the component and aluminium packing. I did this by trial and error changing drills until the vice just nipped both ends, **photo 6**. It was then an easy task to clean up the faces of the casting. There is no need to take the casting to size yet but it is handy if you machine both to the same setting at this stage.

Now we need to take the castings to the correct thickness. The drill head casting only needed the second side machined, the first side was already too width. I did

this by clamping the casting down to the machine table and took small cuts (about ten thou at a time) until I was about 5 thou from finished size, **photo 7**. Then turn the casting round to do the second end. Next take the finishing cut from the first end then move the end clamp to the other end of the casting and machine the far end to the same height, **photo 8**.

Do the same with the two arm castings but make sure that the main arm is reasonably in the centre. As you are machining both ends of both castings without altering the height of the cutter, the thickness of both castings and ends should be equal.

To stop the cutter from moving the component, bolt a stop to the table to take the thrust from the cutter, **photo 9**.

The three castings are shown in **photo 10**. They took me about 5 hours to machine but they are flat and parallel. In industry, I would have to machine them a lot faster, probably the three castings would take no more than about 90 minutes but it would be done on a bigger machine, much more substantial and heavier cuts would be taken. It does not matter about time though, we are in a hobby environment and it is more important that we machine the castings so they end up accurate than we knock a few hours off the machining time. ■



Photo 5. The lower milling complete.

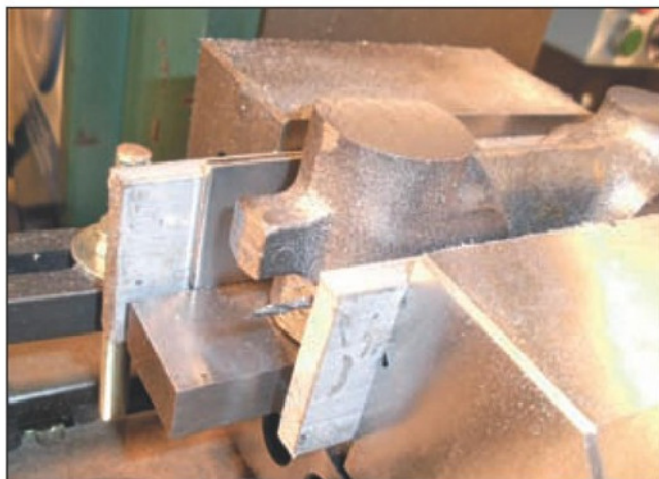


Photo 6. The tapping arms set up for milling.



Photo 7. Finishing the drill head casting parallel.



Photo 8. Finishing cut being taken



Photo 9. Note the stop to stop the casting moving.



Photo 10. The three machined to width components.

A CENTERING MICROSCOPE

Dave Fenner converts a commercial item

Anyone involved in engineering or model engineering within a fifty mile radius of Dundee will know of H. M. Brand Ltd. (run by Harry Brand and son David) as a reputed supplier of tooling and equipment. It also pays to visit their premises whenever passing, as they frequently have interesting second hand items available. It was during one such visit that I mentioned centering microscopes, having seen Harry with a Bridgeport example awaiting repair some years earlier. He promptly delved below a shelf and produced a wooden box badged "Hensoldt Wetzlar", with a comment "See if this is any good to you?"

As can be seen from **photo 1**, the box contained what certainly appeared to be a centering microscope fitted with a large tapered arbor and a 20mm dia. buttress form draw in thread. The cable feeds four small bulbs which illuminate the work. A space in the box would have presumably accommodated a battery pack but this was not present.

Looking through the 'scope' in the as received condition, I could see the workpiece, but no evidence of cross hairs or a graticule. At that point I did wonder if its purpose was not centering, but merely surface examination. It was also noted that there was a mysterious rattle from within. Whether it "would be of any good to me" would be determined by whether I could dismantle the unit without damage to the optics, manufacture an alternative R8 arbor, arrange some form of cross hairs and reassemble again. Before reaching for the screwdrivers etc, I decided to search for the maker on the internet. It seemed that Hensoldt was indeed a reputable manufacturer of microscopes and telescope gun sights; however, I found no mention of centering microscopes. Wetzlar is the town where the firm was based, and it appears that they were taken over by the Carl Zeiss organisation.



Photo 2. Threaded end cap beneath which was the loose retaining nut.

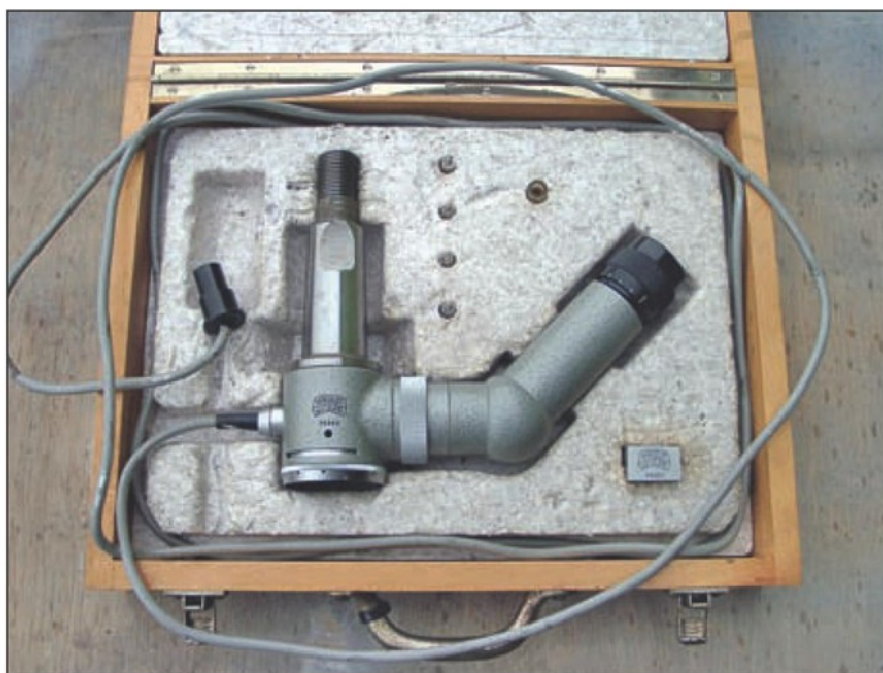


Photo 1. The boxed microscope with spanner flats ground on the tapered arbor.

Dismantling

Optical equipment frequently features fine threaded retaining rings with diametral screwdriver slots which in turn require special drivers. In this instance, however, the disassembly process was accomplished with nothing more specialised than small screwdrivers and a six inch rule. The cover glass was unscrewed and the four bulbs removed using the length of plastic tube supplied in the box. Removing a retaining ring then released the reflector, exposing four screws which retained what was assumed a mirror or prism assembly.

It was at this point that matters took a turn for the unexpected. I had anticipated a simple reflector as in the designs previously given in MEW by Dick Stephen and Colin Golding but this was clearly something different. In addition, when the prism assembly was withdrawn, the cause of the

rattle became apparent. Out fell a small round mirror about 16mm in diameter. To the naked eye, this looked to be nothing more than a slightly concave mirror, but with the aid of a loupe, very fine graticule markings could be seen. Removal of a threaded cap at the arbor end, **photo 2** then brought to view the round retaining nut no longer keeping the mirror in place. A hurried reassembly confirmed that the graticule could now be clearly seen, and eliminated one potential problem. It appears that the prism assembly may be some form of beam splitter, and that light travels to/from the work and to/from the concave mirror located several inches up inside the arbor. A repeat disassembly then followed such that all delicate optics were removed, leaving just the body (cast aluminium) and the arbor (hardened steel). **Photo 3** shows the lower lens and illumination components.

Examination of the components and joint suggested that the method of assembly

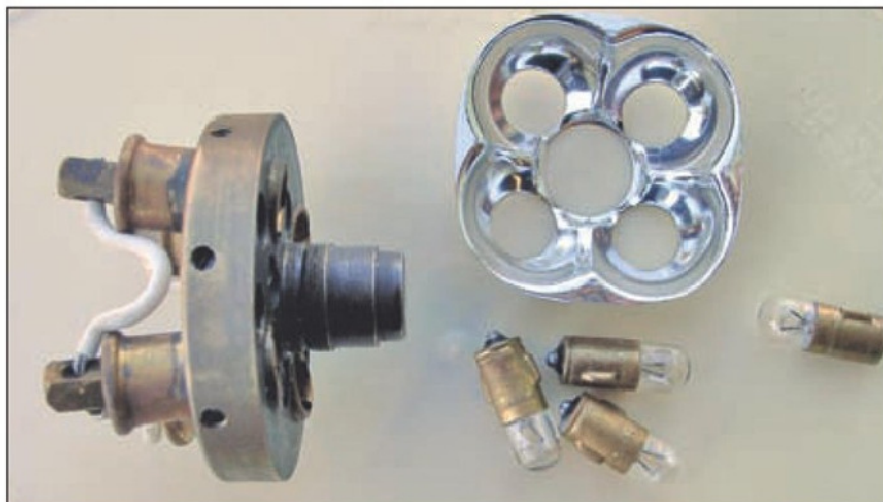


Photo 3. Central lens is surrounded by four bulbs and reflector.

would be a male thread on the casting screwed into the arbor. To avoid damage to the casting, a piece of aluminium flat was found which fitted reasonably across the internal recesses. This could then be gripped in a vice. Applying torque to the arbor proved more involved, as Molegrips etc. just skated on the hardened surface. The solution was to grind a pair of spanner flats, after which the components were successfully parted. Yes they had been assembled with Loctite, and yes I had tried heat earlier without success.

New arbor

A sketch was prepared embodying the external features of an R8 adaptor, and the internal details as measured from the original tapered arbor. To ensure that the device functions as intended, the distance from joint face to mirror location needs to be held as accurately as possible, although it is likely that the eyepiece focus facility would allow a little leeway. The location thread turned out to be 20diam x 1mm pitch, and **photo 4** shows the counterbore being cut after a satisfactory thread fit had been achieved. (Cutting the thread first allowed it to be checked independently of the counterbore, which could then be checked as a follow up exercise).

R8 requires a keyway along the length approx 4mm wide and 2.5mm deep. I

chose to use a $\frac{1}{8}$ in. slitting saw. It could have also been cut using a small throwaway end mill, but I always feel that long keyways are asking a lot of a small tool. **Photo 5** shows the mating face of the old arbor, and the depth gauge is set to indicate the dimension (about 66mm) to the locating face for the mirror.

Reassembly

Two of the components have facility for positional adjustment, the prism and the adjacent lens. After an initial trial assembly, it was found adjusting the prism was fiddly and critical. The lens can be moved by very small amounts using two pairs of diametrically opposed adjustment/clamping screws. To obtain more sensitive control over the prism, four "keys" were made up from 12mm bar, each cut away at one end, and fitted with a roll pin, **photo 6**. The part assembly was then located inverted on the bench with overhead lighting and lightly gripped in a three jaw chuck, **photo 7**. The eyepiece extension was then rotated 180degrees, allowing the graticule to be viewed in this upside down configuration. It was then a process of manipulating the four keys until the graticule was accurately centred when viewed through the eyepiece, and the location screws tightened. It was then felt that things would be better if



Photo 4. Machining the new arbor.

the graticule could be rotated so that the crossed lines would run vertically and horizontally. Another special tool was indicated, this time a hollow screwdriver, **photo 8** through which could be placed a normal longer driver. The combination of



Photo 5. Depth gauge shows how far in the mirror is located.



Photo 6. One of the four keys to manipulate the prism assembly.



Photo 7. Setting the prism using four keys. The eyepiece has been rotated to allow the graticule to be viewed, whilst the assembly is inverted.



Photo 8. Hollow screwdriver to adjust the orientation of the crosshairs.



Photo 9. Checking mill head for squareness.

these then allowed simultaneous control of the graticule rotation and tightening of the retaining nut.

The lower lens and bulb holder assembly was then added, along with the wiring to feed the bulbs. The location screws were lightly nipped and the adjustment screws backed off. At this stage, it was necessary to prepare a marked workpiece in the mill, and as this would involve significant movement of the quill, I thought it prudent to first check for squareness.

A short digression

Checking the mill head for squareness (also known as tramming the head - to our American cousins) is one of those operations that is worth including on say a weekly basis especially after a bout of heavy milling. The vibration set up by the inherent intermittent cutting action can cause an apparently well clamped head to move slightly. Yes that's a comment from personal experience. Smaller mill-drills may have no facility for head inclination, however as many of us have found in the past, the check is still worthwhile and any error may be corrected once and for all on these simpler machines, typically by the addition of shims below the pillar.

Larger toolroom mills such as the Bridgeport or Beaver have provision for the head to be inclined in two planes, so the check takes a little longer. In my own case, the VMC mill allows the head to incline sideways only. In essence, a clock gauge is placed in the spindle, set at a radius of perhaps four inches, and then used to check left and right of centre that the spindle is truly vertical to the table. Various authorities have suggested placing a piece of flat steel plate or glass on the mill table to allow the gauge to be brought down and then rotated a full revolution. The purpose of the plate is to avoid the problem of the clock dropping down the Tee slots.

Since the VMC requires setting in only one plane my simpler approach is as follows. Having cleaned the table and

fitted the clock lower the quill to contact the quill stop. Rotate the spindle so that the clock is close to the extreme left of its sweep then bring the table up to contact the clock and zero it. Lock the knee at this stage. Lift the quill and lower again to confirm consistent readings. (If necessary clean the area under the quill stop.) Lift the quill then rotate the spindle 180degrees so that the clock is to the right and lower once more, **photo 9**. If the clock readings are not identical then an error exists, in which case unclamp the head and apply gentle pressure by tapping with a hide mallet - or even the palm of the hand in the direction to reduce the error. (Note that larger machines have worm gears to facilitate the adjustment.)

Just to put the sort of error in context, I rechecked the VMC prior to writing these paragraphs, and initially found a five thou discrepancy. Taken over a circle of diameter eight inches, this would indicate an angular error of 0.035 degrees or a little over 2 minutes. After readjustment, the readings were within one thou.

Although this error was slight, two types of problem may arise. First, changing from long to short cutters will move the centre by several thous, and second, when using a fly cutter, if this has a significant radius, then the cut in the X direction will actually produce a slightly concave surface, while one in Y will be high one side and low the other.

Back to reassembly

Having checked that the quill was truly perpendicular to the table, a piece of aluminium was clamped in place and the table locked. The spindle was started and the work touched lightly with a small centre drill. This created an on centre

reference mark. The microscope was then fitted to the spindle, which was then lowered to bring the reference mark into focus. Adjustment of the opposed screws then allowed the image of the mark to be centralised on the graticule. Again this was a fiddly operation, as at this stage, without the built in illumination, I relied on the machine worklight which made it awkward to avoid shadows, but after some perseverance, success ensued.

It then remained to just fit the bulbs, reflector and front cover glass. For the moment, six volts for the four bulbs comes from a variable power supply.

Photo 10 shows the modified microscope fitted to the mill. As mentioned above, thus far I have used a variable voltage bench power supply made some years ago, turned up to the correct voltage. However, for the future, it may be more convenient to wire in a fixed resistor to allow the use of a 12 volt battery, as I have these readily to hand. It would of course also be possible to set up a miniature 6 volt battery pack, using rechargeable cells.

Taking a real leap into the twenty-first century would of course suggest converting to LED illumination. Due to their very low current consumption, this would probably allow the battery pack to be miniaturised and mounted inside the microscope case. One factor which may mitigate against this approach is the question of beam width. The existing bulbs emit light in all directions, and the four reflectors then do a respectable job of providing even lighting at the required area of the work. LED's might tend to give a multiple "spotlight effect" unless carefully aligned. No doubt others will know more about this than I do, and may well wish to add their comments in due course. ■



photo 10. Microscope successfully fitted to the VMC mill.

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USING SMALL CNC MILLING MACHINES

Mike Palmer looks at what they don't tell you in the manuals

Readers of Model Engineers' Workshop will be aware of the recent availability of small CNC machine tools, also individuals converting manual machines, and articles introducing readers to the use of these very useful tools.

After 30 years of model engineering and always up for a challenge (as by definition most model engineers are) I purchased a Syil converted X3 mill, eighteen months ago. With next to zero knowledge of how to use these machines I took the plunge. Here are some notes of my experiences using the mill.

If you are familiar with using a manual machine, you have only yourself to blame if you cut into your table. If you are now the proud owner of your first CNC milling machine remember that they have a habit of making unexpected moves. This will still be your fault as you will have entered wrong values, but as this movement is via a computer you tend to blame the ***** machine. It is very easy to enter incorrect values into G code; say you want to make a cut 50 thou deep you should enter Z-0.05. It is not beyond the most experienced machinist to enter Z-0.500, with the resulting disastrous results unless you are quick to hit the E stop.

With the above in mind and due to lack of experience, I fitted a 1/4in. thick aluminium plate drilled and tapped 6mm at 2in. centres along the Tee slots of the table, also adding two locating pins that go into one Tee slot to keep the plate square to the table, this makes holding small work easier and protects your table and of course is replaceable unlike the table, and yes I have cut into it!

Workholding

This is almost a subject in itself; with manual machines most cuts are done one axis at a time, allowing clamps to be moved if fouling the tool path, but with CNC machine tools the job is cut in one operation, so you need to give some thought so the clamps or vice don't foul the tool path. Industry has some very sophisticated methods of work holding and hence they are very expensive. I have made my own version of one method, as follows.

Take a piece of 1/2in. thick aluminium plate 6in. x 8in. or whatever suits your table and drill and tap 6mm holes at 1in. centres. No marking out, just write a few lines of code and using a centre drill, your machine will spot all the holes. Counterbore the middle hole of the row on each side of the plate to suit a cap screw to hold the plate to the table. (I can fix this block anywhere on the plate described above). Now take a piece of 1in. x 1/2in. x 6in. aluminium and drill, tap and

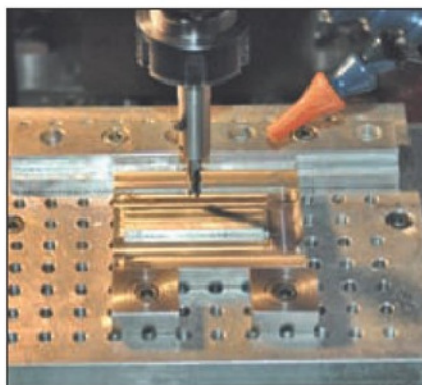


Photo 1. Showing work held by cam clamps, drilled plate, and anvil bar.

counterbore for M6 cap screws a row of holes at 1in. centres. This piece bolts anywhere on to the 6 x 8 plate to suit the job, photo 1.

Now for the clamps, take a piece of 1in. square free cutting steel and cut six off 1/4in. slices. Face one side in the four jaw chuck, reverse, face to 3/4in. thick and now offsetting 1/4in. in one axis and 1/4in. in the other, bore 1/2in. dia clearance 1/4in. deep. Chuck a piece of 1/2in. bar in the four jaw and offset by .0500in and bore to an interference fit the head of an M6 cap screw, (as they are serrated the head will bite into the buttons), part of to 1/4in. thick. Make six of these buttons and clean up by chamfering the edges. Force the cap screw heads into the buttons, these in turn go into the 1in. squares, you now have cam clamps, photo 2.

To use this kit, fix the multi-hole plate to the table; fix the 1in. aluminium bar to one side of plate, set one side of job to the bar. Now with the narrowest edge of the button facing the job, rotate the square choosing the side of the square that just clears the job. Remove the job, screw down the clamps to the plate and back off half a turn, replace the job, turn the button and the cam action clamps the job against the bar, use clamps to suit your job. If the part requires cutting through set the part on spacers, or a sacrificial plate. You will now see the work area is clean with nothing to obstruct the tool path.

All well and good you think? Not so! If your part is to be cut through what holds the part as you come to the end of the cut?

I have two solutions. One, don't cut all the way through but leave 5 or 10 thou at the base of the cut. This will hold the part in place during the cut. On removing the part you should be able to push the part out and clean up with a file. A second idea is to form tabs as in a chemical etching process to hold parts to the mainsheet. This is not easy to do from a DXF file, but it is easy using the 'edit G code' on the Run screen in Mach3. Say you want to cut a rectangle 2in. x 3in. x 1/4in. out of a piece of 1/2in. plate, using a 1/4in. dia cutter, to make two cuts 1/4in. deep, the G code would be

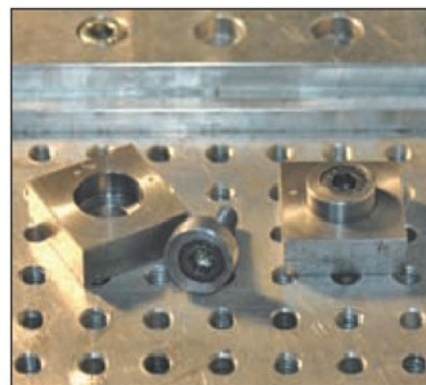


Photo 2. Showing buttons and clamps.

```
N10 G1 X0.00 Y0.00 Z-0.0620 F6.00
N20 X3.00 Y0.00
N30 X3.00 Y2.00
N40 X0.00 Y2.00
N50 X0.00 Y0.00
N60 Z-0.1400
N70 X3.00 Y0.00
N80 X3.00 Y2.00
N90 X0.00 Y2.00
N100 X0.00 Y0.00
N110 M30
```

To create tabs in the second cut, drop in four lines of code to make the tool hop, leaving small tabs 1/4in. wide 1/4in. thick, for the first cut layer.

```
N80 X3.00 Y0.9370
N81 Z0.100
N82 X3.00 Y1.3120
N83 Z-0.1400
N84 X3.00 Y2.00
```

Now copy and paste to line 90, changing X and Y values, for second layer, so code should be

```
N10 G1 X0.00 Y0.00 Z-0.0620 F6.00
N20 X3.00 Y0.00
N30 X3.00 Y2.00
N40 X0.00 Y2.00
N50 X0.00 Y0.00
N60 Z-0.1400
N70 X3.00 Y0.00
N80 X3.00 Y0.9370
N81 Z0.100
N82 X3.00 Y1.3120
N83 Z-0.1400
N84 X3.00 Y2.00
N90 X0.00 Y2.00
N91 X0.00 Y1.0620
N92 Z0.100
N93 X0.00 Y0.6870
N94 Z-0.1400
N100 X0.00 Y0.00
N110 M30
```

You now have two tabs holding your part in place, so the principle of tool hopping to create tabs can be applied to any part, their design is up to you, the larger the tool the bigger you should make the tab to counter larger cutting forces.

Tool changing

Industrial machines are equipped with sophisticated auto tool carousels; some large machines can hold 20 or more tools with air-powered drawbars, all wonderful kit, at a price. For those of us who take a more frugal approach there is more than one way to skin a cat.

ER collets are now more or less standard on mills these days, and thus reasonably easy to change a tool, but I found undoing the nut with two spanners every time, quite tedious. As a model maker I use small dia cutters, mostly of the inexpensive three flute, throw away type, these have either 6mm or $\frac{1}{4}$ in. dia shanks, and as metric cutters are standard in industry they are cheaper than imperial ones. I came up with a fast, dual purpose, tool change method, as follows. Take a piece of $\frac{1}{4}$ in. or 12mm dia free cutting steel bar say 3in. long, chuck in the lathe and take a skim cut to .4370in. dia x $1\frac{1}{4}$ in. long, then bore $\frac{1}{4}$ in. dia to the length of the cutter shank. Turn the bar around and skim. Bore 6mm dia, again to the shank length and chamfer both ends. Now drill and tap a hole for small locking cap screw that coincides with the flat on the cutter shank.

This cutter holder now goes into the appropriate ER collet and will take any cutter with the same shank by just undoing the locking screw, if you wish to use a centre drill just make a split brass bush to suit the drill dia, you might need to tap another hole nearer the nose of the holder to lock the bush/drill, **photo 3**. Keen toolmakers will make a set of holders to suit the shanks of all their smaller cutters. Another advantage of the cutter holder is that it distances the large lock nut of the ER chuck away from the job, thus if using work clamps you can place them closer to the tool path.

There is another point worth considering regarding ER collets as they are designed to be used with plain shanks. The Clarkson system had threaded shanks and tightening the chuck ring locked the cutter into a threaded collet to stop any vertical movement. With the ER collets, the cutter can move even with a tightly locked nut. A way around this problem is a simple piece of bar the same dia as the cutter which goes into the top of the collet and hits the top of the chuck bore, effectively extending the length of the cutter, and thus stopping any vertical movement. The tool holder described above works in the same way.

Drawings

When making your drawings, make sure the entities, i.e. lines meet by zooming

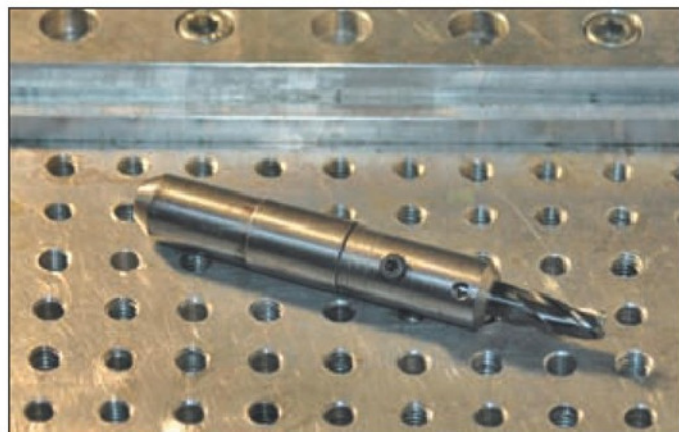


Photo 3. Showing the tool holder.

into the line joins, as you can't always use line snaps. Although you can adjust the tolerance of line joints in a CAM programme it is good practice to have good quality drawings. If you have a suspect drawing, your controller will generate some very strange paths. Always run your G code file on the simulator 'toolpath' screen in Mach Mill, to prove the file runs correctly. I have a copy of Mach 3 on the same computer as my drawing programme so I can run the file and make any corrections before loading on to the mill. One other point to consider is internal radii; these must be the same as your tool radius or larger otherwise your file will not run.

Running a file

Although most of the time you run a file from the beginning, you can run a file from any line of G code using the 'run from here' button, but be very careful as the machine will move to the line before the one you have chosen. This can cause problems if your tool is near the work surface and you have clamps holding down the job, the machine can move at rapid speed resulting in breaking the tool on a clamp, so always raise the tool height to clear any obstructions before hitting the 'run from here' button. The same applies to using the 'return to zero' button.

As with manual machines, matching spindle r.p.m. to feed rate is relevant to cutter dia, and material. Industry run their CNC machines at high r.p.m. and feeds, but their machines are larger and can cope with the stresses generated. It is good practice to use a smaller F value on your initial cut to evaluate speed and feed are in harmony. The F value can easily be changed using 'edit G code'. This in turn leads us to roughing and finishing cuts. If you want to leave 10 thou for a finishing cut, add that value to your cutter dia in the 'tool dia' box assuming you are using G41-G42 tool offset, for a roughing pass, then enter the true cutter dia for your finish pass. Sometimes 'climb milling' can give a better finish depending on material.

Coolant

Another detail of using a CNC mill worth giving some thought to is the relationship of coolant delivery to machine enclosure. Industrial machines are fully enclosed to manage coolant, thus they tend to pump copious amounts of suds onto the job. The more coolant you pump onto the tool the more containment is required. I have found enclosing my machine hinders

ease of use; so the problem is how to get enough coolant on to the tool without suds going everywhere. The answer is to pulse the pump. My coolant system is a home made affair, the tank is a 10 litre plastic food container feeding a 12V windscreen washer pump powered by a model railway controller, so I can adjust the flow rate and turn it on and off easily. I also fitted a brass choke drilled No 55, into the nozzle of the flex pipe, to give a fine jet of suds. If using small cutters you really don't need that much coolant. I have made a three-sided Perspex shield that sits on the edge of table, and low enough so as not to foul head, the shield contains spray from coolant when using larger cutters, **photo 4**.

Making multiple parts

One example could be a spring hanger link, a plate with two holes and radiused ends, and you need eight of them. Say the footprint is 0.250in. X 0.562in. so you need a piece of material approx 1in. x 4.5in. Clamp this down with the sacrificial plate underneath.

Enter your G code, assuming you are going to centre drill the two holes at the beginning of the program, go to 'edit G code' and put in a line of code to move the tool in the X axis the width of hanger, plus tool dia say 0.187in. and say 0.113in. to keep the material together, total .250 +.187 +.113 i.e. X0.550, you put this line in following the last drill function line, followed by the line M30 and save. When you run the program the machine should drill two holes and move along the X axis and stop, you then zero the X axis and repeat the procedure eight times. The tool is now at position 0.550 x 8 i.e. 4.400in. zero X axis and jog X -4.400 and zero X again and then press 'go to zero' the tool is now back to the start position.

Now change the tool to the milling cutter, don't forget to reset the Z 0.000 position, then go to 'edit G code' highlight the two lines you introduced and copy them, now delete them, thus restoring to original programme. You now paste info into the last but one of the G code (the M30 line might already be there depending on how the programme was created) and save.

To cut out the links identify the line of the program after the one that starts the cutting sequence (remember earlier paragraph) and press 'run from here'. Cut link, zero X as before and repeat 'run from here' to cut all parts. This might sound long winded but having gone through the exercise it's easier than it sounds. ■



Photo 4. The Perspex guard, and all parts described.

COMING TO A DEAD STOP

Mike Havard fits a quill stop to his new mill

With varied interests and a small workshop it inevitably meant that when I treated myself to a milling machine, my old pillar drill had to go as I didn't have space for both. My specifications for the mill/drill were also a compromise, trying to retain the facilities, throat, quill travel etc. that I was used to with the pillar drill, while still finding a mill/drill that I could comfortably house in my workshop.

In the end I settled on a Sieg machine from Engineers Tool Room, though the machine or a similar version of it is available from Arc Euro Trade and Axminster. Measurement of depth (Z axis) is by way of a digital read-out, which is great for milling, **photo 1**. Most pillar drills have a depth stop and although there wasn't one on the mill/drill I thought the digital read-out would suffice. However, if drilling to specific depths in wood the read-out proves to be slow and not particularly easy to use. Drill bits would be spending far longer than necessary plunged into the wood without achieving any great accuracy or repeatability.

I wanted to fix up a depth stop similar to my old pillar drill, ideally without requiring too much modification to the machine. I considered studding with a stop on the quill but thought it would get in the way and would not be that easy to mount. In the end I decided on the traditional 'collars' on the handle assembly and the result can be seen in **photo 2**. My first thoughts on



Photo 1.

how to achieve this would not have been very neat but in the end I was quite happy with the results. It is quick and easy to set, reasonably accurate and did not require any modification to the machine. **Photo 3** shows a close-up of the stop.

The unit consists of two rings made from steel plate obtained from the local steel fabricators scrap bin. Construction should be clear from the diagrams but I have added a few words in case it helps. Sizes can be varied to suit your own machine.

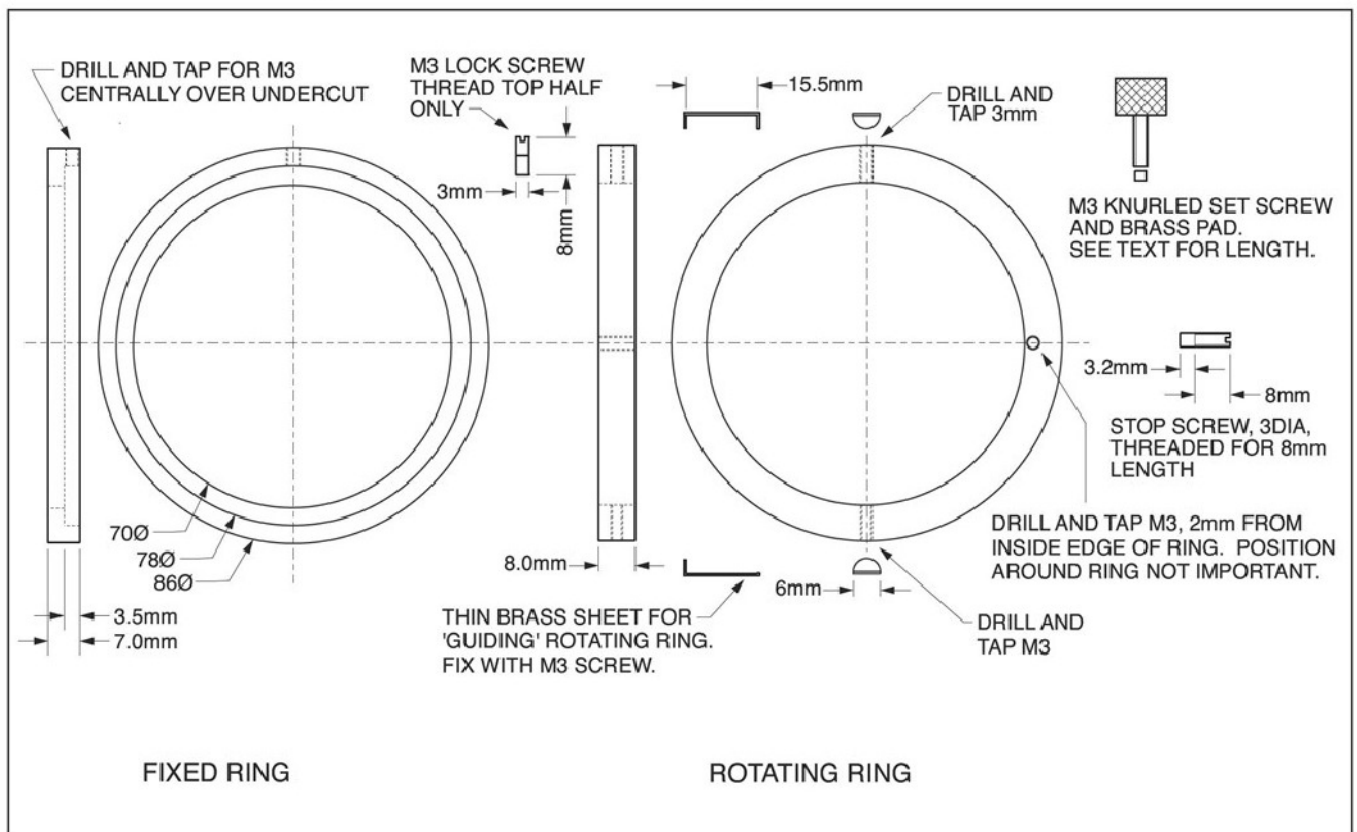
The fixed ring

This is positioned on the fixed part of the handle assembly with a width slightly less than the fixed part. It is positioned so that there is sufficient space between the back of the ring and the head of the machine for thin brass plate guides to



Photo 2.

pass. Hacksaw roughly to size, mount in the four jaw chuck then face and bore to a snug fit on the drill handle assembly. Bore a step inside the ring to a depth and width of 4mm. Turn over, mount on a three jaw chuck and face to the required thickness (in my case 7mm). Finally, drill and tap a hole (3mm) centrally over the bored step. A pin that acts both as the stop for the unit and to fix the ring in position, is made from 3mm steel, threaded for the top portion, it was slotted and assembled from the inside of the ring. When in position the top of this pin should be just below the surface of the ring.



The adjustable ring

Turn to the same outer diameter as the fixed ring but a looser fit on the handle assembly and without the counterbored step. Another pin is made, this time fitted to project inside the step of the fixed ring. Again, thread and slot the top half so that it is inserted from the 'inside' of the assembly for neatness. This acts as the other half of the stop. Drill and tap two more holes, diametrically opposed, for the locking screw and guide fixing screw.

Guide plates

Without some restraint, the adjustable ring will be in danger of falling off if left loose. To overcome this two guides are made from thin brass plate as shown. One is held by the locking screw, which should not be too long, as it closes down on the guide to hold in position and to lock the ring for the depth setting. This guide is best made so that it fits over the sides of both rings - this stops it skewing and binding when the lock screw is loose. The locking screw is simply turned and knurled but I did also make a small brass 'pip' to go under the locking screw in the hope of protecting the machine a little. The second guide is simply held in place with a short 3mm screw. The two rings are shown in photo 4.

The scale

The scale is best done by engraving the adjustable ring appropriately - but taking a short cut, this is not what I did. I marked the extent of the quill travel on the outer ring and using a flexible



Photo 3.

tape measure gave me the distance between the two marks. I then used a CAD program to produce a line of this length and used the 'divide by' function to divide this into 72 equal parts (the quill travel being 72mm). Major and minor marks were placed on this line along with appropriate numbers. When printed, double sided sticky tape was used to stick it onto the ring. Single

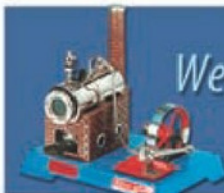


Photo 4.

sided sticky tape covers the scale and the edges are trimmed flush with a razor blade. I'm sure the scale will eventually come un-stuck but it will be a simple job to print and fix a new one.

My first scale came out to within 0.5mm over the 72mm and a new scale could easily be produced on the CAD program to get this exact but this is quite adequate for my purposes. When I need to print a new scale, perhaps I'll make the adjustment!

Purists will work out the required divisions and use a dividing head to graduate and make a proper job. It is easiest to make the reference point on the fixed ring after the scale has been put on the rotating ring. Make sure the ring is fully against the stop first. ■



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MAKING SPACE SAVING MOBILE WORKSTATIONS

Ian Strickland offers a useful storage solution

The Problem

Like most of us I guess, my workshop is not big enough for all of my tools and workbenches etc. Having recently retired, the time had come to liberate some workbench space and generally sort out the workshop. My workshop is an insulated timber shed about 5.5m long x 2.25m wide, with a 2m x 0.9m left hand side extension added some years ago to accommodate the ML7. Workbenches on the right hand side support a drill press, vice, hacksaw machine and, until recently, a Quorn tool and cutter grinder and a linisher. In between the two benches is a storage space for a table saw and a planer thicknesser - both on wheels, so they can be wheeled out of the workshop to free up some space, or when the weather permits for woodworking, especially when dealing with long lengths of wood, and it also helps to keep sawdust and wood shavings out of the workshop.

The Solution

The purchase of an old ML8 woodturning lathe in recent years caused a problem as I had no workbench space for it. It had to be on wheels and the only place to store it was in front of the ML7, but it was too long for the space available. I claim no originality for the solution which was to store the lathe tipped on end, bolted to an old stout table top hinged onto a square steel tube base frame welded up from one of my sons' redundant exercise frames, **photo 1**. In use it is rotated to the horizontal and wheeled into the space between two workbenches, and clamped firmly thereto. **Photos 2** shows the lathe horizontal. Note that it is not shown clamped to the workbenches either side.

This set my mind thinking to do something similar with the Quorn and linisher. The idea, which finally emerged, was a mini bench on wheels with a flip over top having the Quorn on one side



Photo 1. The ML8 in the working position.

and the linisher on the other. **Photo 3** is in "linisher mode." **Photo 4** is the transition phase and **photo 5** is in "Quorn mode."

Construction

The basic frame is 50mm x 50mm softwood sawn from old roof joists, and for ease and speed of construction, held together with large coach screws. The base provides a useful storage space for linisher belts and attachments for the Quorn, etc, and is of self-finished chipboard sheet screwed in place, **photo 6**. Overall approximate sizes are 600mm wide, 400mm deep and 800mm high, but raised off the floor by 100mm on castoring wheels.

Details

The tilting table is made out of 18mm plywood faced with stainless steel sheet both sides to provide a durable and easily

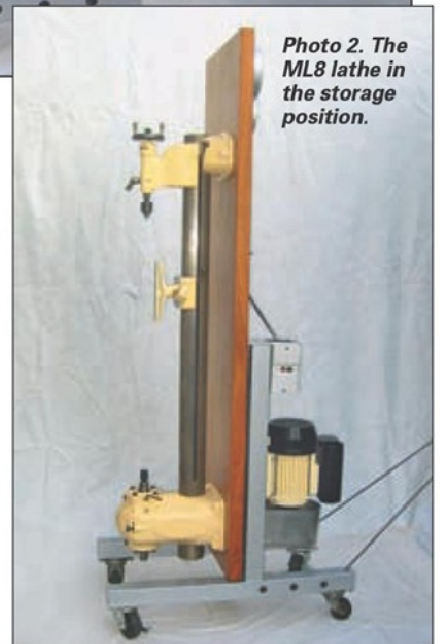


Photo 2. The ML8 lathe in the storage position.



Photo 3. The small bench in linisher mode.



Photo 4. Changing over of machines.

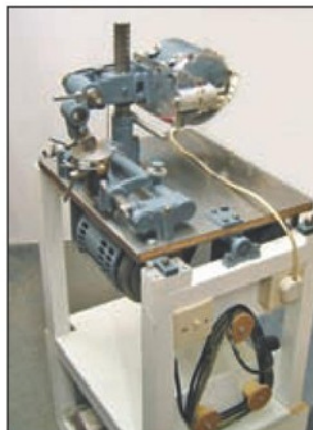


Photo 5. The Quorn ready to use.



Photo 6. The main frame, cupboard and wiring.

cleaned surface. I had thought of painting the wood surfaces but the residue, especially from the finisher, leaves a dust which readily forms rust stains. So stainless it had to be, as I had a surplus stainless worktop from an old kitchen unit. Aluminium sheet would also serve.

The pivots and bearings, **photo 7** came from the "spares box" being a couple of Picador plunger blocks fitted with double shielded ball races. **Photo 8** shows a square steel shaft turned down to fit into the bearing and brazed to a 6mm thick piece of steel plate. A similar plate is fixed to the other side of the table top with 8mm or equivalent Imperial bolts.

Photo 7 also shows one of the rear corner clamps to lock the tabletop. It was found that clamps at each corner were needed for rigidity. As the tabletop is lower in "finisher mode" the rear clamps are used, whereas the front clamps are used in "Quorn mode." The clamps were cut down from 50 x 6mm angle. The base plates are 6mm aluminium from the scrap box with an 8mm bolt inserted from the underside to which a wing nut is fitted. A light spring under the clamp aids operation. One of the front clamps (just visible top right) is shown in **photo 8** and you will notice that the tabletop is above the pivot axis in "Quorn mode" so the Quorn is at a better height to use.

The electrics comprise a long lead wired via a switch to a 13amp power point into which one either plugs the finisher or the Quorn.

Finally

In use, the small diameter castoring wheels ruck up the workshop mats and carpet as the combined weight of the

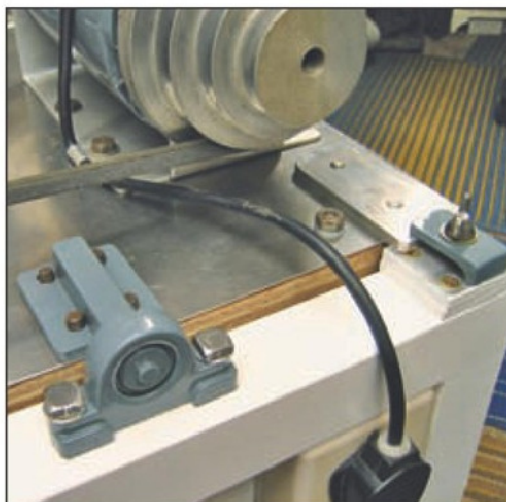


Photo 7. A pivot bearing and rear clamp.



Photo 8. A close-up of the pivot detail.

Quorn and finisher is around 40kg. so bigger wheels are to be fitted.

A little experimentation with the location of the finisher and Quorn on their respective sides of the pivoting top produced almost perfect balance. Had this not been the case it would have been necessary to fix some counterbalance weights. (To balance the woodturning lathe hefty lead weights left over from my son's weight training kit were pressed into service.) Belt guards have been omitted for clarity.

Finding a suitable paint proved a problem as hitherto I had used Humbrol enamels on various tools and the lathe, which are no longer supplied in the larger

tins. Searching the Internet eventually yielded the answer, namely engine enamel as supplied by Craftmaster Paints, or Narrowboat Paint by Rapidpaint. (Usual disclaimer.) Their products can be applied to bare metal and are pretty much oil proof. The minimum quantity is 1litre but as I have a milling machine and other tools to refurbish and repaint, the quantity should be more than enough.

The time and effort has been well worthwhile, and if the weather is fine, the unit can be wheeled out of the workshop so that grit and dust are kept away from the lathe etc. The fact that the wheels do not lock has not proved to be a problem in use. ■

IN OUR NEXT ISSUE

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TRADE COUNTER

Warco DH-1 Vice Review

Dave Fenner looks at the new vice and test indicator stands from Warco



Photo 1. The vice as it arrived in a fitted wooden box.

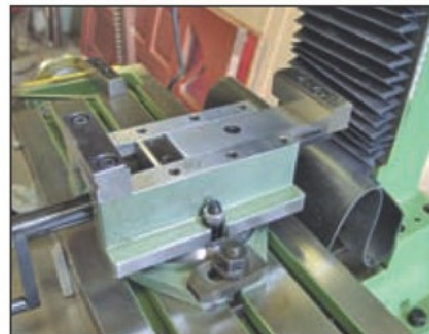


Photo 2. Jaw position set for gripping up to 175mm. Location recess for second moving jaw may also be seen.

I was recently fortunate to be offered the loan of one of the DH-1 vices, with the optional vee jaws, to try out on the WM-18 mill already in the workshop for review, **photo 1**. Now I remembered seeing the prototypes of this vice, and the bigger brother the DH-4, being demonstrated at Harrogate by designer Doug House. The main idea was to offer a robust and versatile vice which would give a great jaw opening capacity within a small table footprint. To achieve this, the DH-1 comes fitted with one moving and two fixed jaws, each of which can be detached and re fixed in alternative positions to give a series of gripping ranges. The maximum extent is some 175mm, as can be seen in **photo 2**. This is quite something when you realise that this dimension is the same as the overall length of the vice body. One of the standard jaws is machined with Vee grooves to grip bar material, as may be seen in **photo 3**. In addition, optional Vee jaws, **photo 4** allow four point gripping of round work. As illustrated in **photo 5** the steps cut in the faces of jaws, allow work to be held clear of the vice body without the need for separate parallels.

One of the bug bears of many machine vices is the tendency for the moving jaw (and hence work) to lift as the grip is applied. Articles have appeared in MEW from time to time, describing how to modify budget vices to minimise this effect. On the DH-1, the sliding member extends the full length of the base, and thus the tendency is immediately well controlled. I did try levering up on the slide and clocked a lift of just 0.001in. (0.025mm). However when work was clamped in the vice, with the clock applied, **photo 6** no lift was detected. This is presumably because the line of action of the screw is located below the slide, and actually tends to draw the jaw downwards. Thus the underlying geometry of the vice pulls the work down and does not create lift.

Both the fixed and moving jaws are held in place by substantial M8 Allen screws, the positions of the moving jaws also being determined by close fitting recesses. Thus when squaring the vice to the machine, my preferred procedure would be: first adjust the vice position by clocking along a fitted moving jaw; then set the fixed jaw in place, but only lightly nip the two Allen screws. Next,

lightly clamp the work, to align the fixed jaw, before finally tightening down its M8 screws.

The natural inclination is to fit the Vee jaws as shown in **photo 4**, and arranged thus, round work of up to 160mm can be held. If one jaw is reversed, small diameter work can be gripped at three points, and in this mode, the range goes down to around three mm diameter.

Model and amateur engineers are famous for trying to get quarts into pint pots and get more out of their equipment than it may have originally been designed for. So, looking at the Vee jaws set in small diameter mode, it occurred to me, that an additional non advertised function might be as a lightweight bender. A strip of brass sheet was gripped between point and Vee, **photo 7** and then the jaws were closed. **Photo 8** shows the result. This of course will bend to precisely 90 degrees, so it is likely that a little hand work may be needed to counter any spring back.

As befits a piece of precision equipment, the vice is supplied well lubricated, in a wooden case, **photo 1** with, surprisingly for a vice, an inspection certificate giving tolerance details. All in all, it is an impressive piece of kit which I am not rushing to return to Warco.

Warco Magnetic bases

The traditional magnetic base tended to be characterised by two features, a fixed vertical rod and a "push on push off" arrangement for switching the magnet, which often needed significant strength. Attaching the clock or DTI might then need a separate set of attachment and articulation parts. Warco have introduced a family of three magnetic bases, **photo 9** giving a range of sizes to a new and different type of design, colour according to size, each being attractively anodised.

As may be seen, the on-off magnet control is by a quarter turn "switch" which requires only very light finger pressure. Flexibility to position the clock is given by two main arms articulated by - ball joint - elbow joint - ball joint and a "fine adjustment" attachment for holding the clock. A clever feature here is that tightening just one knob at the elbow, locks all the joints simultaneously.

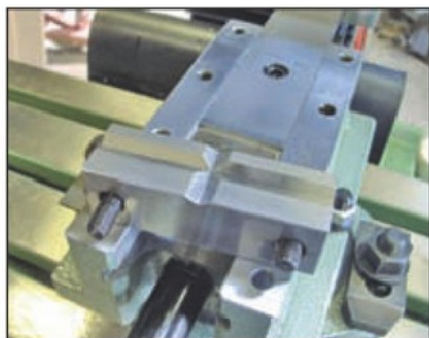


Photo 3. One jaw removed to show the vee grooves for bar material. Behind the jaw, the long slide can be seen.



Photo 4. Optional Vee jaws for use with medium diameter work.

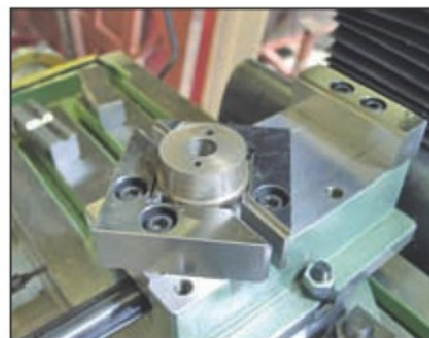


Photo 5. Work is located on the steps in the jaws avoiding the need for parallels.

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



Photo 6. No lift was discernible when clamping work.



Photo 7. "Non approved" bending operation.



Photo 8. Crisply formed brass strip



Photo 9. The family of three magnetic bases set on the WM-18 mill table.



Photo 10. Some clocks have a dovetail fitting. This clock has three dovetail locations.



Photo 11. Detail of fine adjustment feature, with clock and adapter bush.



Photo 12. The vice may be clocked square by attaching the mag base to a machined face on the mill head.



Photo 13. Centering up in the four jaw on the Myford with the smallest unit.



Photo 14. Either the mid sized (shown) or largest would be suitable on the larger lathe.

Two attachment faces are provided, on one side and the underside. Both will fix to flat surfaces and in addition, the underside is machined with a Vee form so that it can be attached to round items such as the column of a traditional mill drill.

Two attachment arrangements are provided for holding clocks, an 8mm round, and the industry standard dovetail, **photo 10**.

Several of my clocks have $\frac{1}{4}$ in. (6.35mm) mounting spigots, so I have adapted by turning a split aluminium bush having an OD of 8mm and an ID of 6.35mm. This is shown in **photo 11** along with the relevant clock and the fine adjustment arrangement feature.

My only slight criticism relates to this fine adjustment hinge arrangement which permits a trace of sideways movement. Provided this is set at right angles to the clock measurement, it should not detract from the accuracy of readings. Certainly, when the various bases were tried out in earnest, no effect on readings

could be detected, presumably due to the very light loads fed back from each clock stylus.

Mills such as the Warco WM 18 have a convenient flat face within the head, so that a vice may be trued up as in **photo 12**, giving an alternative to mounting the clock on the spindle.

For setting lathe work accurately in a four jaw chuck on a modest size of lathe, the smallest mounting set shown in **photo 13** proved ideal, while for a five and a half inch (140mm) machine both of the larger types worked well. **Photo 14** shows the mid size base and a clock held by the 8mm feature.

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MAKE A NOVEL QUICK CHANGE TOOLPOST

Mike Cox improves an Asian Mini-Lathe

Background

I purchased an Asian Minilathe (Clarke CL300M) some time ago and after a few months I found changing tools rather irritating. The lathe is supplied with a four-way toolpost and every time it was necessary to change tools there was the hunt for bits of shim to pack the tool to the correct height. I contemplated purchasing a quick change toolpost (QCTP) from one of the many suppliers but they were all rather expensive, especially as typically circa eight toolholders would be required. I also thought about copying one of the commercial designs but the work involved in making the toolpost and even one toolholder is quite significant.

All the commercial QCTP use a design that requires accurately cut dovetails. At the time I did not have a milling machine and copying a commercial design would not have been easy. At this stage I came across a much simpler design by Bruce Simpson (www.ardvark.co.nz/pjet/qctp.shtml) that used a simple cylindrical pillar and a toolholder that could be clamped to it. This design could be constructed easily using only the lathe and the toolholders were very simple to make being essentially a block of steel with a hole bored slightly bigger than the post. The steel was slit parallel to the bore and the toolholder just clamped to the pillar with a pinch bolt. The height of the tool was adjusted by means of a screw running parallel to the bore and the tool is jacked up to the correct height before clamping the toolholder to the pillar.

A little bit of lateral thinking around the pillar concept came up with an alternative approach. Why not make the pillar expand to clamp the toolholder? Doing this means the pinch bolt is not needed and there is then room for two tools in each toolholder. This would halve the number of toolholders required.

This however gives rise to a second problem. How do you adjust the height of each tool independently when they are sharing the same toolholder? Making the toolholder sit on a small step such that only one height adjuster screw is on the step at any one time solved this. The current design is such that the toolholder can be swivelled through nearly 180 degrees with one height adjuster screw on the step and any further rotation brings the other height adjuster screw onto the step. The toolpost and holders, **photo 1** can be made using only the lathe.

The pillar

The completed pillar is shown assembled on the topslide in **photo 2** and the components of the toolpost pillar are shown in **photo 3**.

All the main components of the pillar are shown in **Fig. 1**. The pillar is constructed from a piece of 1in. diameter EN1A mild



Photo 1. The completed toolpost



Photo 2. The pillar fitted to the top slide.



Photo 3. Component parts of the pillar assembly.

steel. The actual toolpost is only 35mm long but a piece about twice this length should be used to start with since at a later stage the extra length is needed in order to hold the toolpost during slitting.

Chuck the piece in the lathe and face the end and then turn down the outside to 25mm. The final cuts should be very shallow to achieve a good surface finish. Centre drill the end and then drill out the piece for a length of 40mm using successively larger drills to end up with a 10mm bore. Set the topside at an angle of 45 degrees and using a boring tool open out the entrance to the bore to make the conical lead in. Chamfer the outside edge slightly at 45 degrees.

The pillar must now be marked up for cross drilling and slitting. The easiest way to do this is to make a packing piece that fits between the jaws of the three-jaw chuck and the lathe bed. This packing piece can be of metal or even of wood and the length should be adjusted so that with the packing piece between the jaw and the lathe bed then the jaw is horizontal. With a sharp lathe tool in the lathe toolholder scribe a line along the length of the toolpost using the carriage handwheel to move the carriage. Continue the line across the front face of the toolpost. Now rotate the chuck to bring the next jaw horizontal and scribe the lines again. Repeat this operation until there are 6 lines equally spaced on the toolpost. Now use a pointed lathe tool to mark two lines around the post at 30 and 35mm from the

faced end. In these operations it is important that the lathe tool is exactly on the centreline.

All of the above sequence of operations should be carried out without removing the piece from the chuck to ensure concentricity.

Now remove the piece from the chuck and transfer it to the drilling machine vice for cross drilling. Mount the piece horizontally in the drill vice and with a centre punch, indent the intersections of the 35mm line with the longitudinal lines. Transfer the vice to the drilling machine and set the vice accurately centered on the post. I use a flat ruler and a point mounted in the drill press to do this. Lower the point onto the ruler resting on the post and adjust the position so that the ruler is horizontal. Clamp the vice down. Now drill a 4mm hole at each of the centre punch



Photo 4. Hacksawing the slots in the pillar.

indents until it breaks through into the centre bore of the post.

The next stage is to slit the toolpost along the marked lines down as far as the 3mm holes, **photo 4**.

This is done, with the piece mounted in a bench vice, using a hacksaw. The piece should be gripped by the unturned portion. A sharp blade and light pressure should be used to avoid the saw wandering. Keep the saw blade in line with the marked lines on the side and the face of the piece. Alternatively, if you own a mill, this operation could be carried out using a 1.5mm slitting saw.

The toolpost can now be sawn from the unturned piece just a little longer than the 35mm mark. Take a bit of 10mm bar (or the shank of the drill used to bore the centre hole) and place it in the bore. Chuck the assembly lightly in the lathe chuck with the rough end protruding towards the tailstock. Move the mandrel so that it is just below the level of the cut face and tighten the chuck. Then face of the cut end of the piece to bring the length to 35mm. It is important that this face is absolutely flat so remove the piece from the lathe and check that there is no wobble when the piece is standing on a flat surface. If the end is not flat then remount in the chuck and carefully machine circa 0.5mm from the centre of the face leaving a rim 3mm wide around the outer edge.

Expander cone

This is made from a piece of $\frac{3}{4}$ in. diameter bar. Face the end of the bar and then bore it out to 10mm as described previously. With the topslide at 45 degrees, cut the conical end and part the conical expander from the bar. If necessary, remount the cone in the lathe and true up the parted face.

The step plate

This was made from a 50mm diameter washer with a 12mm hole. The washer thickness is circa 1.5mm. This was cut to shape using a hacksaw and file. It could also be made easily from a piece of 1.5mm sheet if no large washer is available.

All the components for the toolpost are now made and the next step is to construct the toolholder.

The toolholder

The toolholder, **Fig. 2** is made from 2in. X 1in. mild steel bar. Cut off a piece just over 50mm long. Using odd leg callipers mark the centre of each of the cut faces and indent with a centre punch. Set the piece in the 4 jaw chuck with one of the indented ends towards the tailstock. Adjust the piece so that the indent is roughly centred and then face off the end of the bar. Repeat this with the other end of the bar and adjust the length to 50mm.

Remove the piece from the chuck. With odd leg callipers mark and indent the centre of one of the large faces of the block. Remount the block in the chuck with the indent towards the tailstock. Adjust the chuck to bring the indent accurately to the centre using a dial indicator. Now centre drill and drill the block all the way through. Expand the hole with successively large drills to 12mm and then using a boring bar open out the hole to 25mm. As you approach 25mm check with the pillar frequently until a good sliding fit is achieved.

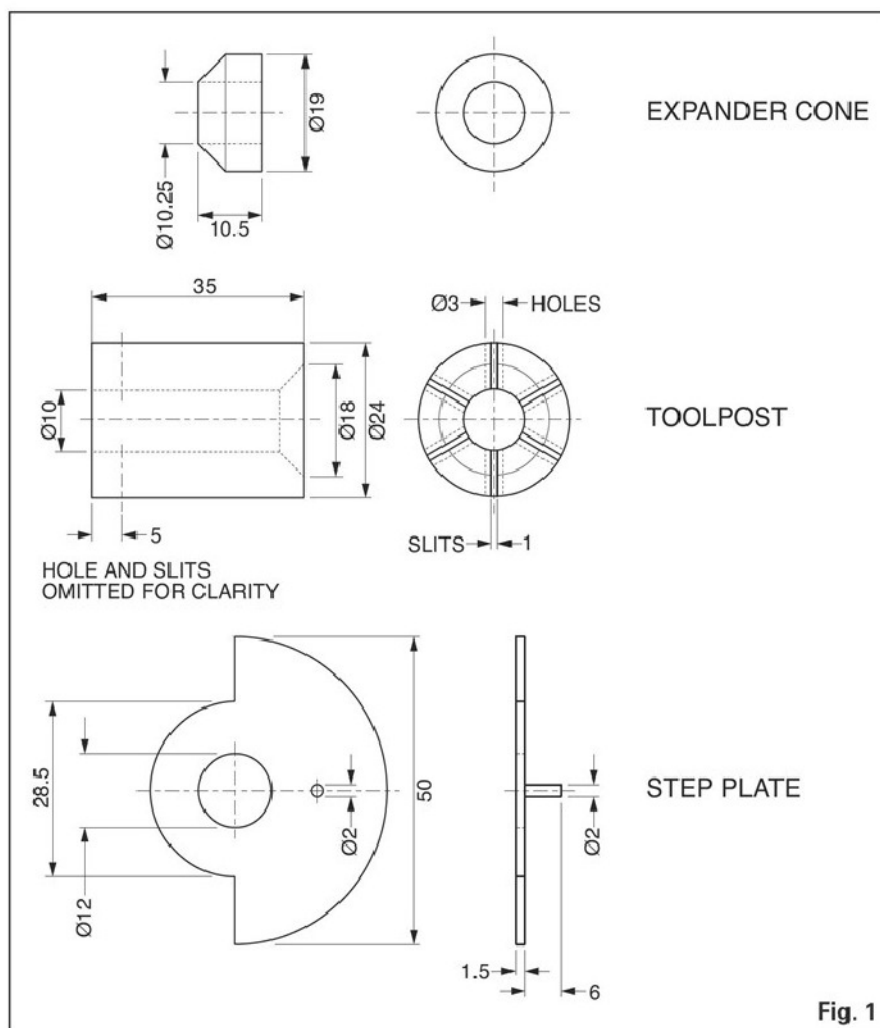


Fig. 1

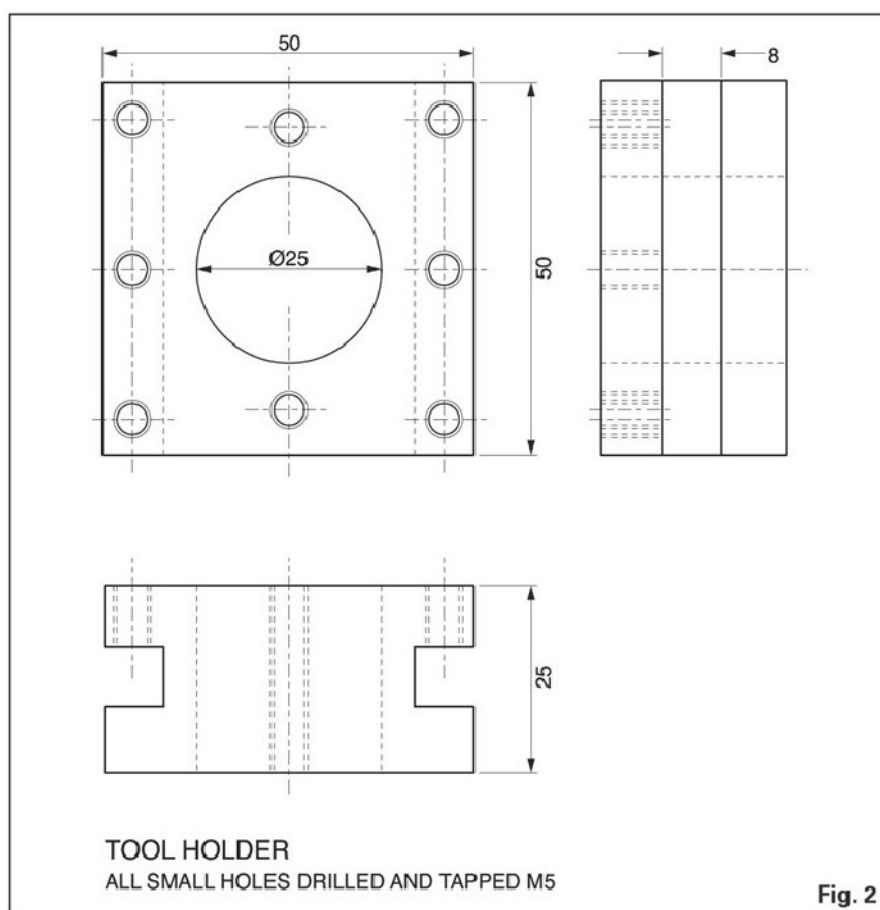


Fig. 2

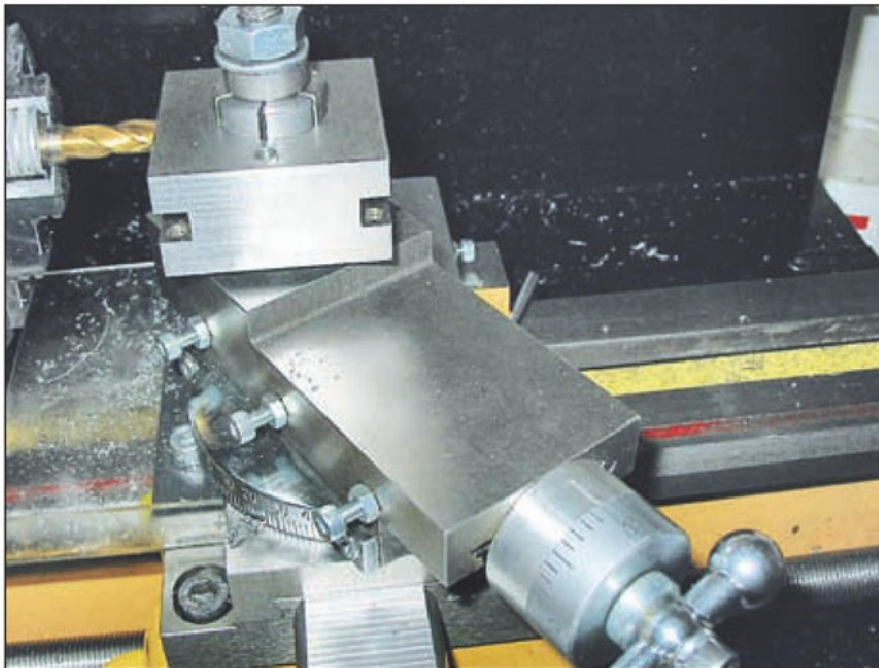


Photo 5. Milling slots in a toolholder.



Photo 6. A finished toolholder.

Remove the piece from the chuck and mark on one of the faced ends, a line 4mm in from the narrow edge of the block and another line at half the thickness of the block. Indent the intersection with a centre punch. Repeat the marking and indent at the other side of the face. Mount the block in the drilling machine vice and bore a 7mm hole at each of the indents. The reason for drilling these holes is that it removes most of the material prior to milling out the slots in which the tools will be clamped.

Lay the block flat on the bench and mark a line 6mm from the edge at right angles to the holes just drilled; in the centre of the line mark an indent. Repeat on the opposite side. Drill a 5mm tapping hole at each of these indents. Tap the holes to M5 and screw a long screw, at least 30mm long, into one of them.

Remove the original toolpost from the lathe and put the pillar over the M10 stud in the topline. Then put on the conical expander and an M10 nut. Position the topline at circa 60 degrees. Adjust the toolholder so that the 7mm holes are towards the chuck and tailstock. **Photo 5** shows the set up for milling.

Put an 8mm end mill in the three jaw chuck. This should be tightened hard in the chuck. Bring the block up to the end mill and adjust the height so that the mill is at the centre of the face using the M5



Photo 7. A collection of different styles of toolholders.

screw. Starting with the mill just touching the centre of the face move the cross slide slowly in both directions to get the face parallel to the chuck. Clamp the block to the post by tightening the M10 nut to expand the post. Recheck the level of the block and that it is parallel to the chuck. Check that there is sufficient travel to enable the mill to traverse the whole length of the block face. Check that the M10 nut is really tight. Wind the cross slide in until the tip of the cutter is close to the far side of the block.

Before starting the milling operation check that the lathe is well adjusted and that all the slides are free moving but on the tight side.

Start the lathe and using a speed of about 500 rpm (i.e. turn the speed control up halfway in low gear) and carefully bring the cutter into the block until it just starts to cut. If you have fitted a carriage lock then use this to lock the carriage before each cut (see note at the end of this article). Wind the crossslide out slowly. Check that the cut is right along the face. Advance the carriage towards the cutter by a small amount (not more than 0.1mm) and wind the cross slide in. Continue in this manner until you have milled out the slot for the tool to a depth of 8mm. Once the tool starts to cut into the predrilled hole the carriage advance can be increased between the cuts but towards

the end only light cuts should be used. The lathe will soon tell you if you are attempting to take too deep a cut as it will become very noisy. Cutting the slot is a slow process.

Once the first slot is cut then rotate the toolholder on the post to bring the second face around for slotting and then repeat the above operations.

When both slots are cut then the remaining operation is to drill holes for the tool retaining screws. Mark off a line 4mm from the edge above the tool slots. Mark the centre and also 5mm in from the end of the line at both ends. Centre punch the intersections, drill and tap for 5mm screws. The completed toolholder is shown in **photo 6**.

It is also possible to cut the slots the hard way by cutting with a hacksaw and finishing with a file. This is quite hard work but takes about the same time as milling. The end result is fully functional but the finish of the slot is not so good. The first toolholder I made was produced in this way.

Final assembly

Place the step over the 10 mm stud and position it as shown in **photo 2**. With a 2mm drill make a small hole through the step into the topline. This hole should be approx 6mm deep. Insert a small pin through the hole and adjust the length of the pin so that it is just below the surface of the step. This pin is to stop the step from rotating.

Place the post over the stud and then expansion cone and then the 10mm nut. Do not tighten the nut without a toolholder on the post. Place the toolholder on the post and clamp. Put two tools in the slots and adjust each to centre height with the tool pointing inwards using the appropriate height adjusting screw. The toolpost is now ready for use, see **photo 1**.

The toolholder described above is designed to accept $\frac{1}{4}$ in. square tools. Other toolholders can be made for other purposes. I have one that is bored on one side to take a boring tool and the other side is usually set up with a clamp type knurling tool. **Photo 7** shows a selection of the author's toolholders.

I have replaced the 10mm stud with a 10mm bolt cut to the correct length. This is a little neater.

I have been using this toolpost for about 2 years and it is very convenient to use and it requires less equipment and less effort to produce than alternative QCTP's. It is possible to change from one tool to another in the same toolholder in a matter of seconds. Changing toolholders is almost as quick, just loosen the clamping nut, lift off, replace with another and reclamp.

Note on milling in the Mini-Lathe

I strongly advise locking the carriage in position during any milling operation since otherwise the whole carriage tends to drift towards the tailstock. A very simple carriage lock can be made by cutting a small piece of brass or aluminium rod 5mm in diameter and about 3mm long. This is placed in the rear hole for mounting the travelling steady and a 6mm screw inserted. Tightening this screw will lock the carriage firmly to the lathe bed. The small plug of aluminium or brass is to protect the lathe ways. ■

YOUR CHANCE TO TALK TO US!

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opinions with other readers.

SCRIBE A LINE

Tom Senior paint

A copy of issue 156 of "Model Engineers Workshop" was recently passed to me by a good friend who ask me to pay particular attention to the article detailing the refurbishment of a Tom Senior Milling machine.

In response to Mick Whittingham's request for information regarding the correct paint code for Tom Senior Milling machines I can confirm that to the best of my knowledge no such code or number exists. Some years back, to aid my own Tom Senior refurbishment, I made contact with an ex management employee of the Tom Senior's, Atlas works of Liversedge of whom I am sorry to say I can no longer remember the name of but he did kindly confirm for me that the exact shade of the machines produced over the years varied somewhat, albeit staying on the very pleasant but instantly recognisable shade of green.

With considerable effort to locate samples from a reasonably wide selection of differently dated machines, I was able to arrive at what I believe to be a very true likeness of the most common original shade which I have been retailing on my website www.stationaryengineparts.com/Machinery-Colours/ under the "Enamels, paint & accessories" section for the last year or so with very good feedback. The enamel is a high temperature alkalyd based blend of quality base materials and rich lead based pigments which will give a quality finish able to tolerate temperatures of up to 130 Degrees C, very hard wearing and resistant to petrol, diesel and most cutting fluids. It is available in 1 litre tins and can be brushed straight from the can or sprayed when thinned by approximately 15% with a fully synthetic thinners. Priced at £21.52 per litre I believe this offers superb value for money for a true machinery enamel finish which many describe as yesteryears paint made with today's technology.

Further to this I would also like to pick up on Mick's other article regarding the labels and decals of machines. Should any of your readers require a professionally printed self adhesive label for the Tom Senior gear box I do have these available too. The early machines were fitted with a riveted brass plaque but the later machines simply had a sticker which inevitably over time becomes marked or lost, no doubt a cost cutting exercise. When completing the refurbishment of my own machine I was forced to have some 50 of these self adhesive stickers manufactured because of the suppliers minimum order quantity. These are also for sale in the same section of my website priced £2.30 each.

Lastly, I would just like to say that I have the facilities to offer the same quality machinery enamel in almost any shade

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Beat the rust fairy

I have been following the theme of beating rust in the workshop, but as far as I remember I have not seen anybody recommend covering up machines, jobs, models etc, with insulating materials. I cover mine with layers of fabric materials, e.g., old towels, cut up duvets, dressing gowns - the thick variety, fleecy shirts etc. I generally put about 4 layers over and have no problems with rust. My workshop is a large timber shed with between 1in. and 2in. polystyrene or Celotex board insulation in the walls and the roof, mostly covered with white painted hardboard. The floor is concrete. As I also do woodwork in the workshop, dust is kept off the equipment too.

I have many wooden drawers and boxes which provide good insulation for the contents. My chucks I keep in the stout cardboard boxes they came in years ago, and they too are rust free.

I try to do brazing etc., outside - weather permitting, or inside, but not until cupboards have been closed and covers put over the tools etc. I leave the door open as well to let the fumes and moisture vapour out. I am sure that our readers know that burning any fuel produces large amounts of water vapour as part of the combustion process.

For heating in the winter I use a 1 kW infra red heater at floor level rather than a 3 kW blow heater, which is not only cheaper to run, but also more effective. I find if my feet and legs are warm I am comfortable. Just don't step on the heater or drop anything on it.

Ian Strickland, by email.

Not an error

I would like to pick up on a letter from Marcus Middlehurst in issue 156 where he took issue with the article by Harold Hall in issue 155. I am afraid that Marcus has made a wrong assumption (all be it an easy assumption to make) in his attempt to correct the drawings that Harold has published.

The assumption was that the setting bar is 120mm long, and the distance between

the scribed marks is 100mm. This is not correct- the bar is in fact 110mm long and the distance between the scribed lines is 90mm. Thus each scribed line is exactly 100mm from the opposite end of the bar. On this basis Harold is quite correct in his sketch and text. Why have two scribed lines? The reason is that the same setting bar can be used for a normal taper and a reverse taper, such as on a double taper connecting rod.

I have made a setting bar to the dimensions given above, and used it to make a large set of tapered arbors from 1/4 inch up to 1 1/2 inches.

Bob Middleton, by email.

Newbie problems

Many thanks for an excellent magazine! I get mine from WH Smith here and look forward to the next issue - maybe I will subscribe some day!

There are a couple of suggestions I would like to make as a newbie to the world of mechanical engineering.

It would be great if the scale of the excellent photos in your magazine could be displayed. Many times I look at a photo of a piece of equipment I have never seen before next to another photo with a completely different scale. Unfortunately not being versed in mechanical engineering I have absolutely no idea how big or small anything actually is. After all a 30mm milling cutter looks pretty much the same as a 3mm milling cutter depending on the scale of the photo. So my suggestion would be to have something in the photo that I can relate to - a hand, a ruler, a coin or whatever. I would find that very helpful!

Some of the writers of articles assume that everyone knows what they are talking about. It took me some time to discover on the web that a sensitive drill isn't one that is moody! but is extremely useful when drilling smaller holes, providing the user feedback of the drilling process via finger tips. The suggestion would be either to have a brief paragraph explaining what the tool is for and how to use it at the beginning of the article or have another article explaining what all the various machines and tools that appear in that issue are for. This way experienced users could skip over the bits they know and us newbies could learn new techniques and equipment uses.

As a newbie I do not have the years of experience that many of your writers and yourself have so I would find both of the above extremely useful - and perhaps others may find these helpful too.

I was really impressed that you took note of the writer who wanted to know more about reaming and that you commissioned and published an article on that subject so quickly!

Phil Sydor, Jersey.

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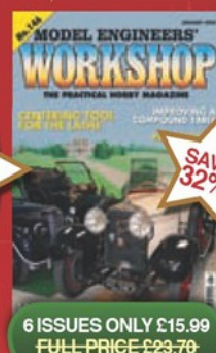
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| • Bridgeport Mill, Belt Head, 42" table, power feed D.R.O. nice condition | £2200 | • Viceroy 10" ped grinder polisher, lovely modern machine | £300 |
| • Bridgeport Mill, Belt Head, no power feed, 36" table, nice condition | £1500 | • Viceroy D.E. 10" polisher | £235 |
| • Bridgeport Mill, 48" table, x + y power feed, belt head, very nice | £2250 | • Viceroy 10" heavy duty ped grinder | £200 |
| • Boxford VM30 Mill, 24" x 6" table, vari speed with inverter with vice & collet chuck, outstanding condition | £1750 | • Startright Saw Benches. Tilt Arbor 23" x 22" table, 8" plate, ex school. (2 Off) | Each £400 |
| • Colchester Master 2500 gap bed lathe with Q.C.T. 3 pt steady | £3000 | • Centec 2A Quill head mill. Single phase, average condition | £890 |
| • chucks and taper turning | | • Record DMB 65 vert wood band saw, as new | £150 |
| • Tom Senior "Major" with quill feed head, outstanding condition | £1850 | • Well Saw 4" cap, power hacksaw, lovely small British made machine | £300 |
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Bridgeport heads also fit A&S 2E mills



Colchester Student 1500 gap bed + gearbox

£1500



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



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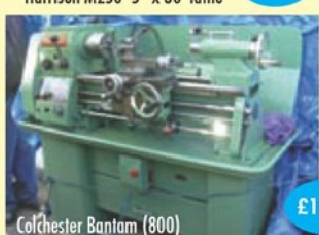
Excel 1440E lathe + chucks, steadies (1997)

£1250



Harrison M250 5" x 30 lathe

£2950



Colchester Bantam (800)

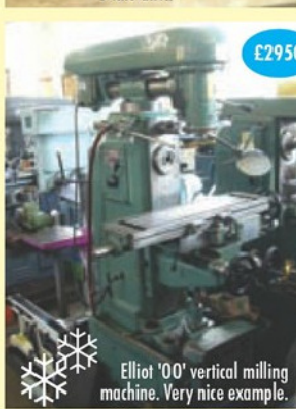
Rare from NEW 240 volts lathe

£1575



5 kilo anvil

£24



Elliot '00' vertical milling machine. Very nice example.

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Elliot 10" shaper

£345



Prazimat lathe

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- Elliot Sturdimill (coming in) £2250
- Colchester Mascot (single) back toolpost £245
- Elliot 10" shaper £375
- Startrite 352 bandsaw £975
- Startrite TA1250 sawbench £1950
- Marlco keyway broaches just in!
- Harrison L5/L5A/140/L6 T/steadies
- Harrison D14 faceplates
- Eclipse De-magnetiser £80
- Hofmann dividing head + gears £625
- Clarkson Autolock chucks Selection
- Colchester Triumph 2000 fixed steady £245
- Harrison M300 Aijnest attachment £345



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Harrison/Colchester etc. D14 tooling

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Harrison vertical / horizontal mill

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RJH Swordfish fretsaw + extractor

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very nice condition

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NEW £125

Milling/Drilling ground X-Y table



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Q&S 6" hacksaw

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Motor 1200w
Spindle Speeds 125-2500rpm
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FEATURES

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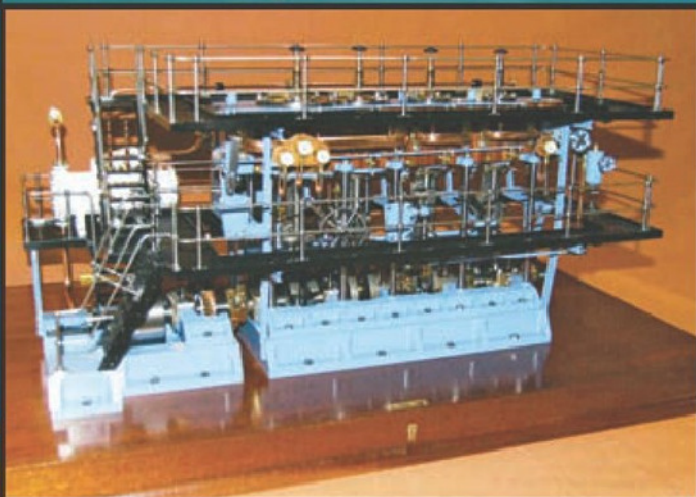
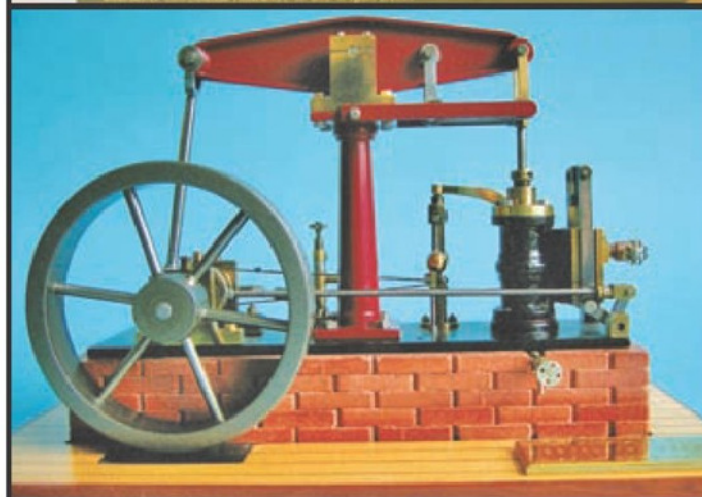
MODEL ENGINEER EXHIBITION

MODEL ENGINEER

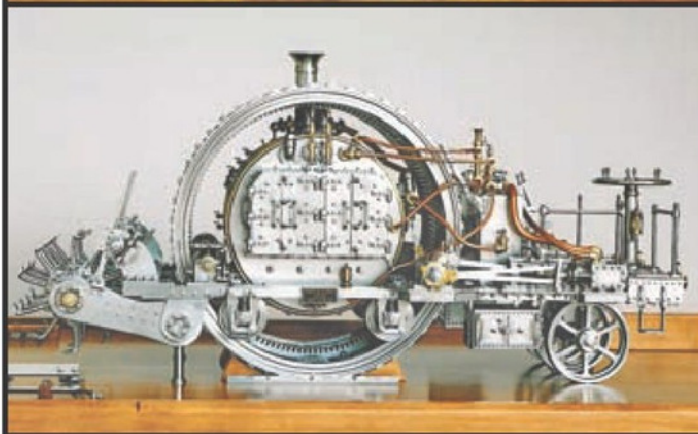
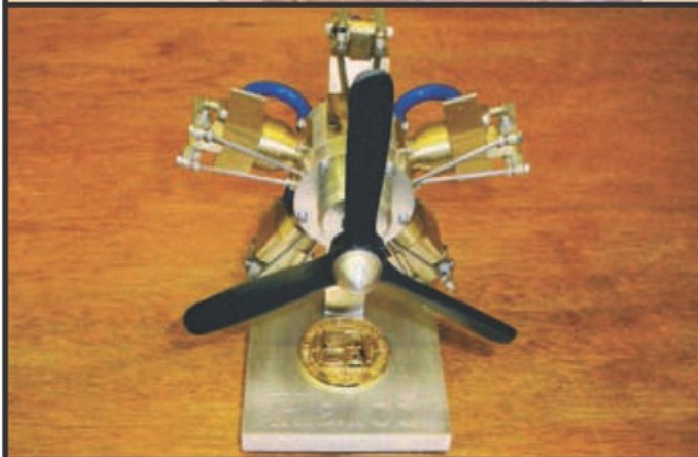
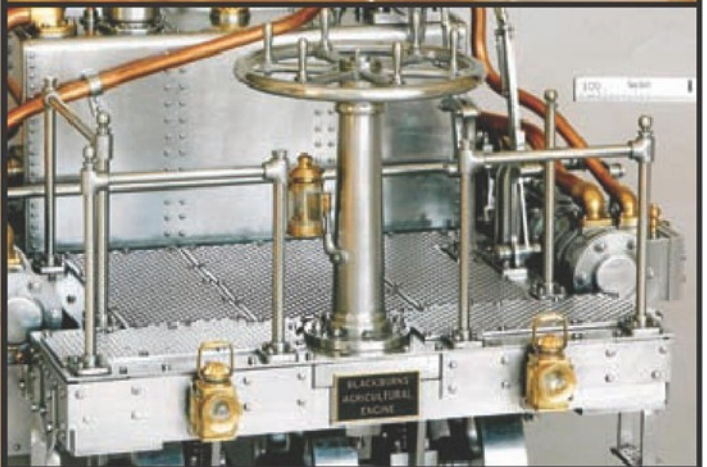
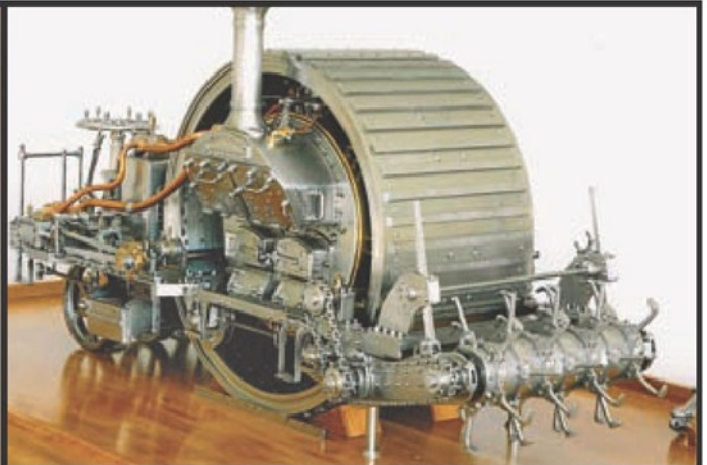
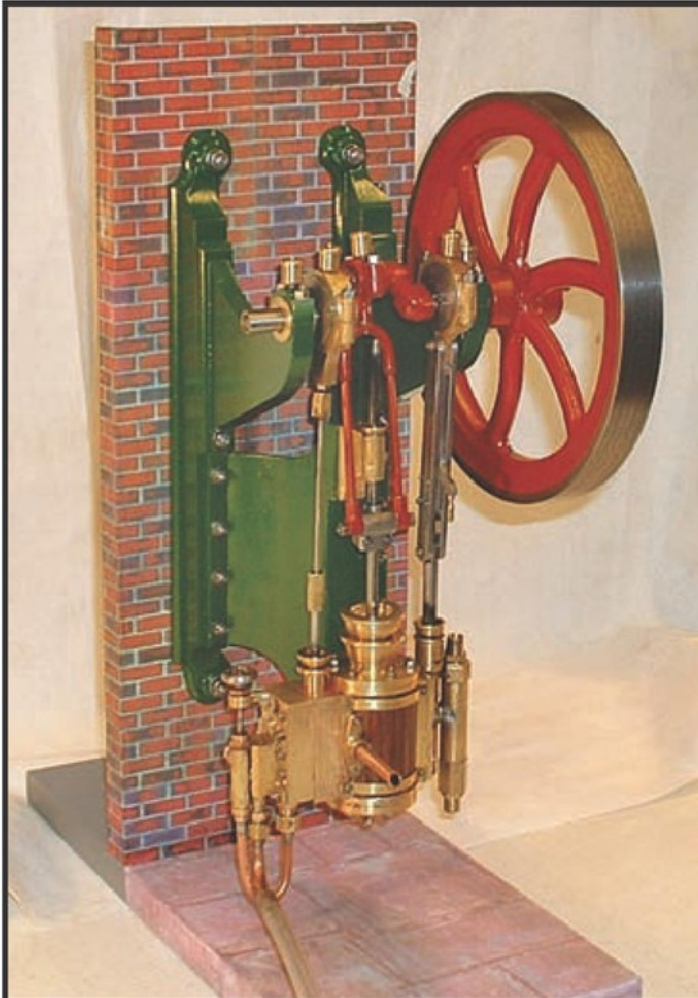
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11-13 December 2009 • Sandown Park Racecourse

SHOW GUIDE



EXHIBITION OPENING HOURS: 10:00 - 17:00 FRI & SAT / 10:00 - 16:00 SUN
Last admission: One hour before the show closes each day





MODEL ENGINEER EXHIBITION



DAVID CLARK
Editor

I would like to invite all of you to this year's Model Engineer Exhibition at Sandown Park. I know some of you won't be able to make it but for those of you who can, you will be in for a treat. Many models have already been entered into the competitions (see opposite) and many more are expected by the start of the show.

There are 31 club stands at the time of writing and over 40 traders. Most of the main model engineering suppliers will be present. If you want a

particular kit or tool bought to the show for you, so you can save on postage, please contact the supplier well in advance.

As usual The Society Of Model And Experimental Engineers (SMEE) will be at the show. I would like to thank all the members of SMEE that are helping to support this years' show. Particular thanks go to Stuart Walker who has done so much this year, Mike Chrisp for just being there when needed and to all the people who have given their time to do the demonstrations and lectures. Without them, there would be no show.

I would like to add a special thank you to Gill and Geoff Sheppard for their time and efforts booking in models.

PHOTOS

All photos in this show guide are of actual entries to this year's show.

Front cover

- Top left:** 7½in. gauge GWR King
Top right: Foster 2in. Showman's Engine
Middle left: Manchester Tramway No 502
Middle right: Steam Launch Florence
Bottom left: A simple beam engine (loan section)
Bottom right: Quadruple expansion marine engine

Page 2

- Top left:** Rachel wall engine
Top right: Blackburn 1863 engine (loan section)
Middle left: Five cylinder radial engine (DOE)
Middle right: Blackburn 1863 engine (loan section)
Bottom left: Blackburn 1863 engine (loan section)
Bottom right: Dean Goods in 7½in. gauge

Page 8

- Top left:** Universal Heliochronometer
Top right: Centaur gas engine (loan)
Middle left: Invicta in 7½in. gauge
Middle right: Twin cylinder Stirling engine
Bottom left: Small working lathe
Bottom right: Moon dial

The SMEE Demonstration stand is C27 and the main SMEE stand is C23

SMEE Daily Lectures at Sandown MEX 2009

ROOM NO 1

11.00 - 11.50

The diversity of 19th century monorails: An inspiration for future models?
By Adrian Garner

12.30 - 1.20

Tramcar Modelling in the Larger Scales by Ashley Best

1.30 - 2.20

Modern Adhesives and Paints by Norman Billingham

2.30 - 3.20

Mastering the challenges of lining and lettering models by Chris Vine

ROOM NO 2

11.00 - 11.50

The Evolution of the Radial Aircraft Engine by Mike Tull

12.30 - 1.20

Miniature Gas Turbines and Locomotives by James Hill, Jerry Burchell and Tim Coles

1.30 - 2.20

Making your own Spark Erosion Machines by Mike Kapp and Alan Wragg

2.30 - 3.20

Sharpening lathe tools that really cut! by Mike Chrisp

Note: The full Lecture and Demonstration programme will only be available on Friday and Saturday. To accommodate the prize giving on Sunday, only the morning demonstrations will take place.

Presentation of Awards

This will be held on Sunday starting at 1:30PM in the Loch Fyne Restaurant.

SMEE Daily Workshop Demonstrations on stand C27

MORNING

10.30 - 10.55

Making small steam injectors by Derek Brown

11.00 - 11.25

Thread cutting on the lathe by Tony Phillips

11.30 - 11.50

Forming copper to make a model Bentley radiator shell by Mike Sayers

12.00 - 12.25

Making steam whistles by Derek Brown

12.30 - 12.55

Tool grinding using air bearings by Paul Gammon

1.00 - 1.25

Soft soldering techniques by Jim Lugsden

AFTERNOON

1.30 - 1.55

Making small steam injectors by Derek Brown

2.00 - 2.25

Thread cutting on the lathe by Tony Phillips

2.30 - 2.55

Forming copper to make a model Bentley radiator shell by Mike Sayers

3.00 - 3.25

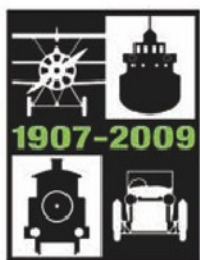
Making steam whistles by Derek Brown

3.30 - 3.55

Tool grinding using air bearings by Paul Gammon

4.00 - 4.25

Soft soldering techniques by Jim Lugsden



MODEL ENGINEER EXHIBITION

SITE MAPS

(All details are correct at time of going to press.)

Map 1 below shows the ground floor of the exhibition. This section includes all of the trade stands, 15 or so club stands and part of the model display (rows M1, M2, M3 and M4). This year, we also have a pool for the model boats.

The Association of 16mm Narrow Gauge Modellers (East Surrey Group) will be running their Llymarch Chilfach layout.

Both gas and meths firing locomotives will be running.

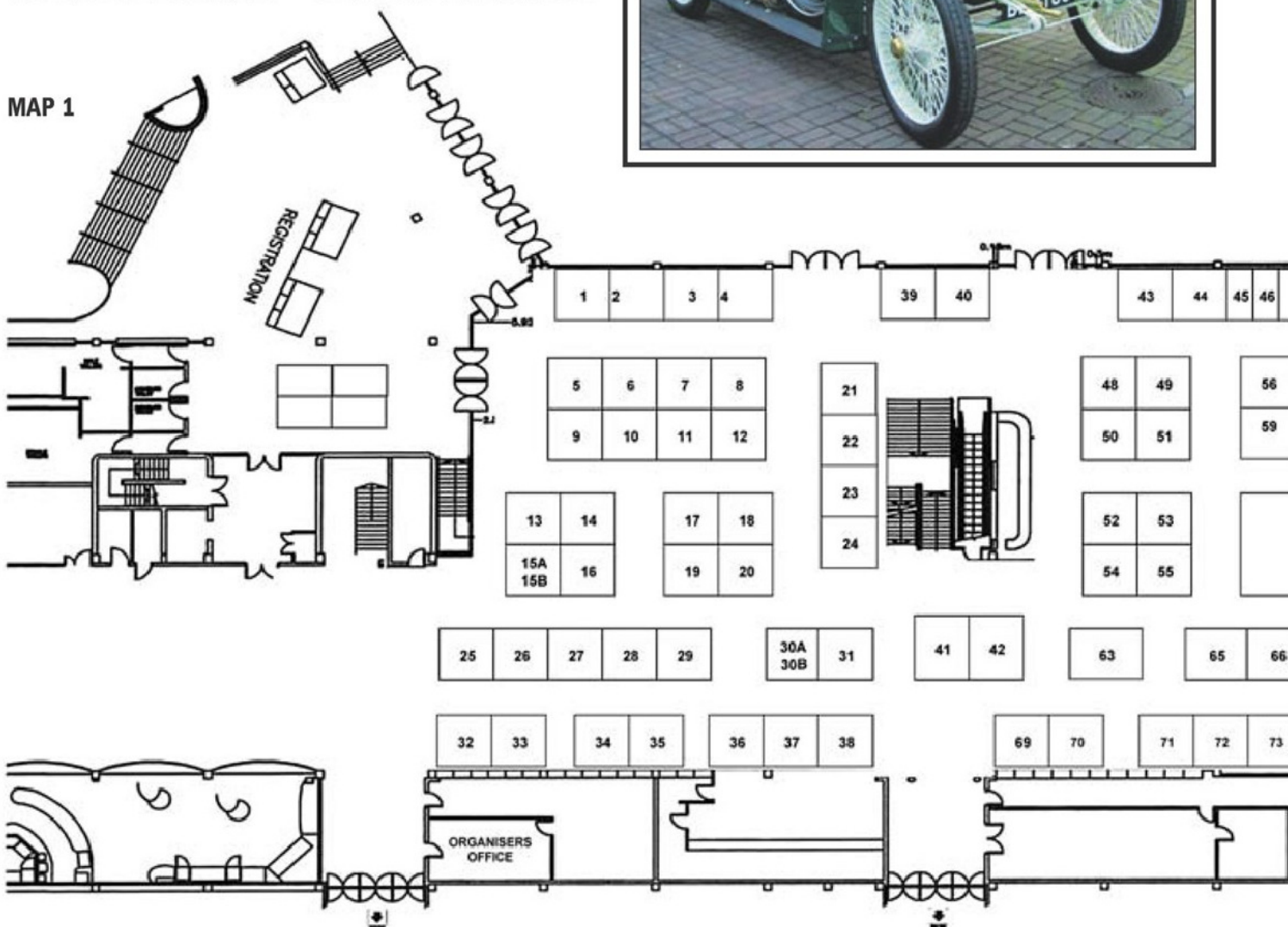
The main model area is upstairs in the Sandown View room (no map). Map 2 opposite shows the Grandstand View room where 14 of the 30+ clubs will be located. A full list of traders and clubs attending is listed overleaf. Traders will continue to book over the next couple of weeks so the list will increase.

ON DISPLAY

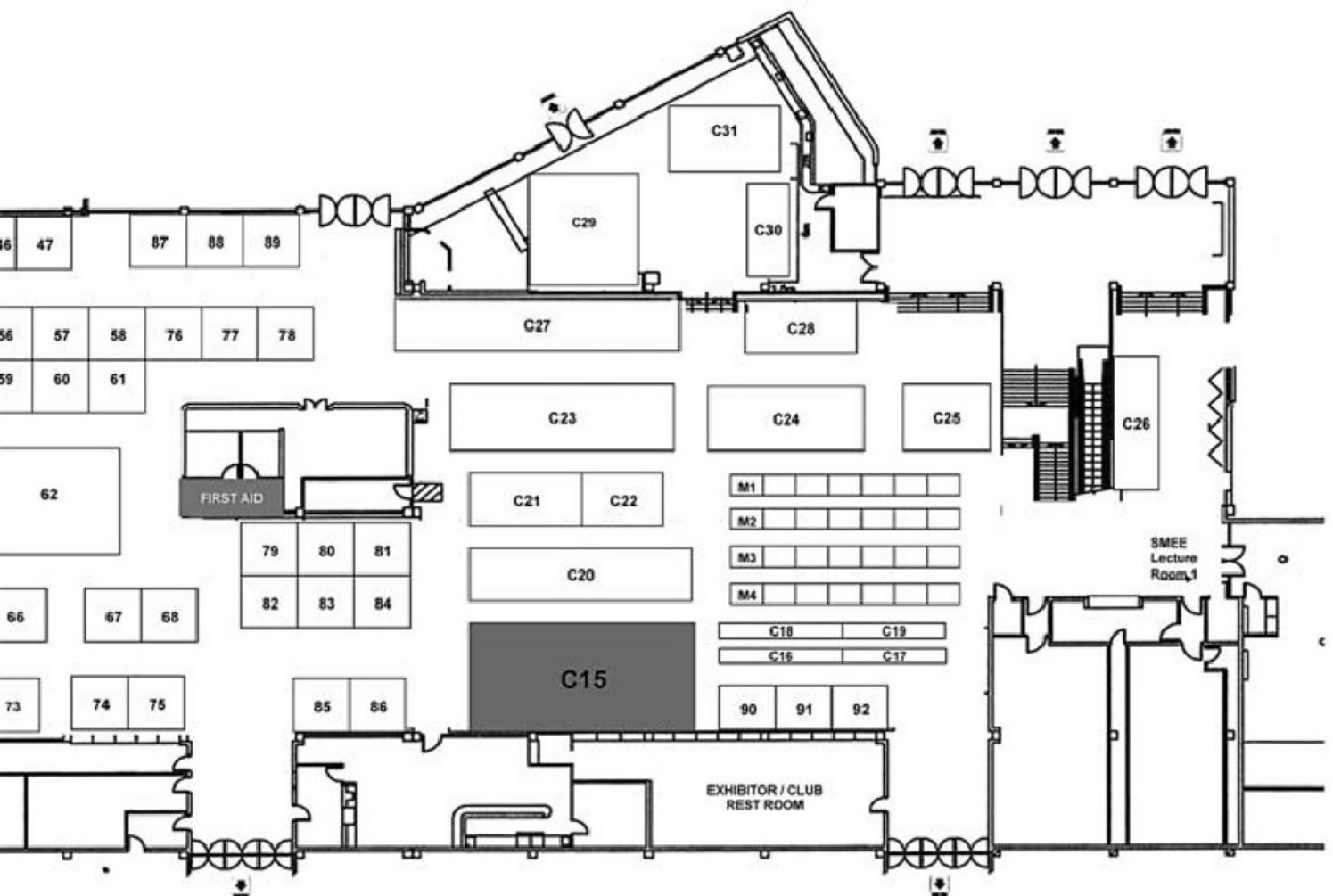
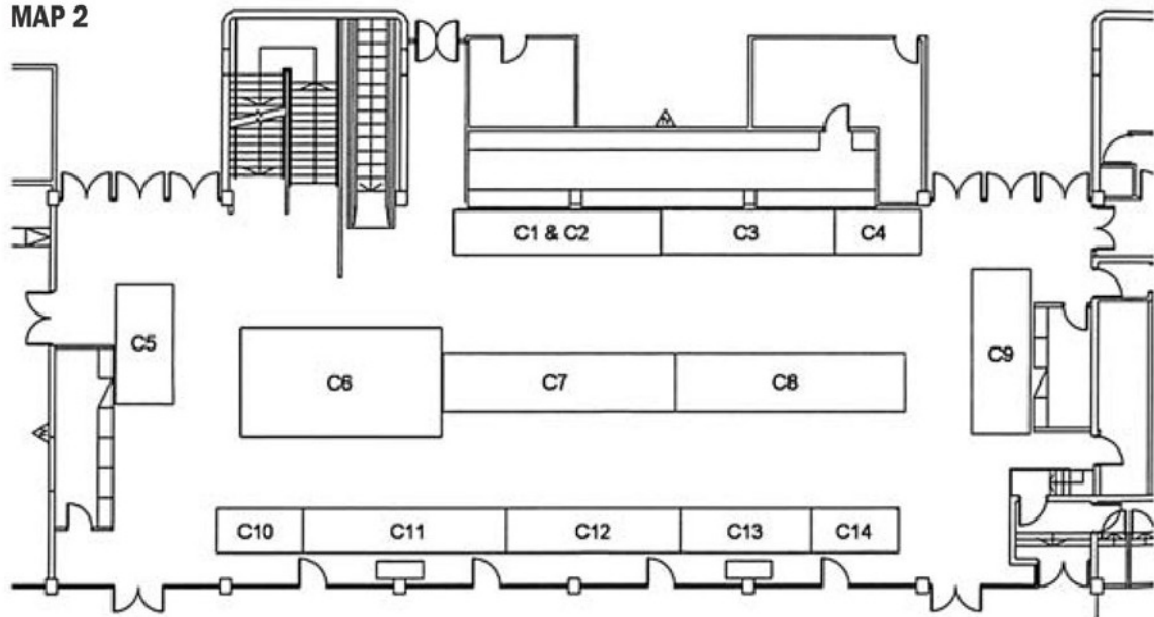
An immaculate Stanley Vanderbilt Steam Racer belonging to Gerry Stoneman will be on display at the exhibition. It is hoped to have this in the Foyer if it will go through the main doors. Several 4 inch scale traction engines have been booked to run outside and it is hoped more will be in steam.



MAP 1



MAP 2



Trade stands are shown on
Map 1 on pages 4 and 5.

■ STANDS 25 TO 29

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■ STANDS 46 AND 47

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■ STAND 38

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■ STAND 70

Compass House Model Engineering

High Street
Rotherfield
TN6 3LH
www.compass-house.co.uk
T: 07711717067

■ STAND 89

Discount lighting

32 Gunton Lane
Lowestoft
NR32 4LF
T: 01502 587598

■ STAND 35

GWR Precision Ltd

Ash Tree Cottage
Llangedwyn, Oswestry
SY10 9JT
www.gwrprecision.co.uk
T: 01691 828010

■ STAND 41

Hafix

Park Royal House
Park Royal Road
London
NW10 7JH
T: 0208 9693034

■ STANDS 43 TO 45

Home And Workshop Machinery

144 Maidstone Road
Foots Cray
Sidcup
Kent
DA14 5HS
www.homeandworkshop.co.uk
T: 0208 3009070

■ STAND 69

JB Cutting Tools

The Cottage
Hundall Lane
Apperknowle
Dronfield,
Sheffield
South Yorkshire
S18 4BP
T: 01246 418110

■ STAND 33

Just Bases

21 Graham Road
Paignton
Devon
TQ3 1BB
<http://www.just-bases.co.uk>
T: 01803 558520

■ STAND 18

Langdon

81 Northumbria Road
Maidenhead
Berkshire
SL6 3DQ
T: 01628 629892

■ STAND 87

LA services (Engineers Emporium)

Bramcote
Warwickshire
CV11 6QL
www.theengineersemporium.co.uk
Tel: 01455 220340

■ STAND 16

MJ Engineering

The Forge
Cricket Hill Lane
Yateley
Hampshire
GU46 6BB
www.mjeng.co.uk
Tel: 01252 890777

■ STAND 20

Model Engineers Laser

Miller House
Main Street
Hampole
Doncaster
DN6 7ET
www.modelengineerslaser.co.uk
T: 01302 337772

■ STAND 63

Model Power

3 Church Walk
Manchester
Atherstone
Warwickshire
CV9 1PZ
T: 01827 711501

■ STANDS 71 TO 73

Myford Ltd

Wilmot Lane,
Chilwell Road,
Beeston
Nottingham,
NG9 1ER
www.myford.com
T: 0115 925 4222

■ STAND 62

MyHobbyStore Ltd

PO Box 718
Orpington
Kent
BR6 1AP
www.myhobbystore.com
T: 0844 4122262

■ STAND 32

Noggin End Metals

(by appointment only)
Unit 13, Bridge Industrial
Estate
Hot Lane
Burslem
Stoke on Trent
ST6 2DL
<http://www.nogginend.com>
T: 01782 865428

■ **STANDS 74 AND 75****Peak Tools**

Unit 8 Rock Mill Business Park
Stoney Middleton
Hope Park
S32 4TF

www.modelmakingtools.com

T: 0791 8779353

■ **STAND 13****Phoenix Locomotives Ltd**

1 Colchester Road
Southport
PR8 6XJ

www.phoenixlocos.com

T: 01704 546957

■ **STANDS 48 TO 51****Polly Model****Engineering Ltd**

Bridge Court
Bridge Street
Long Eaton
Nottingham
NG10 4GG

www.pollymodelengineering.co.uk

T: 0115 9736700

■ **STAND 1****Power capacitors Ltd
(Transwave)**

Redfern Road
Tyseley
Birmingham
B11 2BH

www.powercapacitors.co.uk

T: 0121 708 4511

■ **STANDS 2 AND 3****Reeves 2000**

Appleby Hill
Austrey
Warks
CV9 3ER

www.ajreeves.com

T: 01827 830894

■ **STAND 88****StarLoc****FiveStar Adhesives**

12-14 Arkwright Court,
Astmoor Ind.Est.
Runcorn
Cheshire
WA71NX

www.starloc.eu/

T: 01928 560044

■ **STANDS 85 AND 86****Tools 2000****Expo Drills & Tools**

Unit 1 Barn Hill Farm
The Ridgeway
Lamphey
Pembroke
SA71 5PB

<http://www.expo-tools.com>

T: 01646 672440

■ **STANDS 65 AND 66****Toolstop**

11 Ambassador Mill Park
Bracknell
Berks
RG12 8XP

T: 01344 421718

■ **STANDS 21 TO 23****Tracy Tools Ltd**

Unit 1 Parkfield
Industrial Estate
Barton Hill Way
Torquay
Devon
TQ2 8JG

www.tracytools.com

T: 01803 328603

■ **STAND 14****Walker Midgley Insurance**

Brokers Ltd
Yorkshire Bank Chambers
Fargate
Sheffield
S1 2HD

www.walkermidgley.co.uk

T: 0114 250 2770

■ **STANDS 56 TO 61
AND 76 TO 78****WARCO**

Fisher Lane
Chiddingfold
Surrey
GU8 4TD

www.warco.co.uk

T: 01428 682929

■ **STAND 31****Williams tools**

5 Knighton Close
Broughton Astle
Leicestershire
LE9 6UG

T: 01455 285897

CLUBS AND SOCIETIES

The following is a list of clubs who have agreed to attend at the time of writing. This may change without notice due to circumstances beyond our control.

Note that clubs are numbered C1 to C31 while Trade stands are numbered from 1 onwards.

The Grandstand View situated on the first floor and is accessible using the lift & stairs at the West facing end of the exhibition hall. The first of the 14 clubs are upstairs in this room. (See map 2 on page 5.)

C1 Malden & District

& 2 Society of Model Engineers Ltd.

C3 The National 2½in. Gauge Association.

C4 The GWR Preservation Society.

C5 The Staines Society of Model Engineers.

C6 Sussex Miniature Locomotive Club.

C7 Reading Model Engineering Society.

C8 The Guild of Model Wheelwrights.

C9 Guildford Model Engineering Society.

C10 Ruislip Lido Railway Preservation Society.

C11 Sutton Model Engineering Club Ltd.

C12 The Napier Power Heritage Trust.

C13 Lynton & Barnstable Railway Trust.

C14 Salisbury & District Model Engineering Society.

The following club stands are on the ground floor:

C15 Boating pool.

C16 Phoenix Marine Model Club.

C17 Victoria MPBA

C18 The association of Model Barge Owners (AMBO)

C19 Blackheath MPBA

C20 Model Yacht Association

C21 Canterbury and District MES

C22 St Albans And District Model Engineering Society.

C23 Society of Model And Experimental Engineers (SMEE)

C24 Stirling Engine Society

C25 East Surrey 16mm Association Llymarch Chilfach layout

C26 Ickenham and District Society of Model Engineers

C27 SMEE demonstration area

C28 North London SME

C29 I/C Engine Group

C30 Society of Ornamental Turners

C31 Gas Turbine Association

SMEE will be putting on various demonstrations during the exhibition on stand **C27**. They will be well worth a visit.

INDIVIDUAL STANDS

There are also two individual stands, Roddy Turner is on Stand **4** and will be demonstrating his model dragline excavator throughout the show.

Martin Ranson will be in the downstairs model section with a collection of model steamboats and he will also be exhibiting his beam engine which is currently being serialised in Model Engineer.

Polly Engineering will have some of Neville Evans locomotives on display on their stand, **48, 49, 50 and 51**. Nick Feast's Q1 Charlie will also be on display. Anthony Mount will be in the Polly section where you can talk to him about his engines and see some of them running.

