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MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

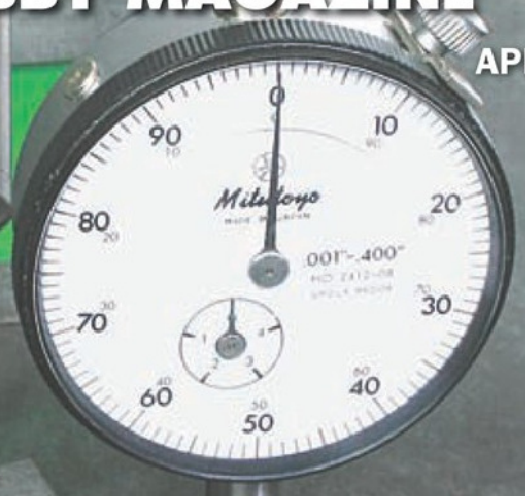
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68 FULL
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**REBUILDING
A CHIPMASTER
LATHE**

**RESURRECTING
BATTERY
POWERED
DRILLS**

**MAKING
A FILING
MACHINE**



**A BEGINNERS GUIDE
TO WORKSHOP MATERIALS**



**LOCATING
DATUMS
ON A
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Checking a casting after machining. See article on page 16. Photo by Harold Hall

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Distance Between Centres:	400mm
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Spindle Taper:	MT3
Tailstock Taper:	MT2
Spindle Speed:	100-2500 rpm
Thread Cutting	
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(10 Metric pitches)	
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(8 Imperial pitches)	

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Overall Dims:	800x320x330mm

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(Normal Price £481.00 saving you £30.00) (Subject to availability)

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Even Longer Bed:
400mm Between Centres

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Bore: 22mm

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180-005-01120	25m long	120 grit	£6.75
180-005-02040	50m long	40 grit	£13.95
180-005-02080	50m long	80 grit	£12.95
180-005-02120	50m long	120 grit	£10.95

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180-006-00300	Fine (Grey)	£0.75

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Made from premium quality aluminium oxide, each wheel is speed rated and comes complete with plastic reducing bushes incorporating bore sizes 32mm, 25mm, 20mm, 16mm and 1/2".



For general purpose use.

180-007-03036	ø150x20mm wide 36 grit	£10.50
180-007-03080	ø150x20mm wide 80 grit	£10.50
180-007-03120	ø150x20mm wide 120 grit	£10.50
180-007-07036	ø200x20mm wide 36 grit	£18.50
180-007-07080	ø200x20mm wide 80 grit	£18.50
180-007-07120	ø200x20mm wide 120 grit	£18.50

Bench Grinder Wheels - Silicone Carbide (Green Wheels)

Made from premium quality silicone carbide, each wheel is speed rated and comes complete with plastic reducing bushes incorporating bore sizes 32mm, 25mm, 20mm, 16mm and 1/2".



For grinding Tungsten Carbide tooling.

180-007-04080	ø150x20mm wide 80 grit	£11.50
180-007-08080	ø200x20mm wide 80 grit	£20.50

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Brass dipped and stainless steel hand wire brushes with a plastic handle. Thanks to the curved shape and narrow face, hard to reach places can be cleaned with high pressure.



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Solar Powered Caliper...



- Metric/inch conversion.
- Digital measurements without batteries.
- Storage case.

Part no	Range	WAS	SALE
ME-CAL-SOL-150	0-150mm/6"	£34.95	£26.36

Depth Gauges...



- Digital depth gauge with internal step measuring hook.
- *not present on ME-DEPTH-500.
- 100mm base size.

Part no	Range	WAS	SALE
ME-DEPTH-150	2-150mm/6"	£29.95	£23.96
ME-DEPTH-300	2-300mm/12"	£39.95	£31.96
ME-DEPTH-500	0-500mm/20"	£49.95	£35.96

Quill Clamp DTI Holder...

- Fits to most machines.
- 42mm to 54mm clamping range.

Part no	WAS	SALE
MT-QU-CLAMP	£9.95	£7.96

Cutter Tool Trays...

- Store milling cutters, drill bits, taps, solder tips etc..
- 102mm (4") wide, 215mm (8 1/2") long & 22mm (7/8") high
- Tough plastic.



£1.25 EACH *cutters/drill bits not included.

Left Handed Caliper...

- Left handed with the jaws opening to the left.
- Metric/imperial conversion.
- Comfortable left handed lathe work measurement.
- Storage case.



Part no	Range	WAS	SALE
ME-CAL-LH-150	0-150mm/6"	£29.95	£22.43

Magnetic Stand...

- Vee base and ground side face.
- Rigid locking mechanism.
- Fine screw adjustment.
- Dovetail & ring clamp indicator fixing.

Part no	WAS	SALE
MT-MG-BASE	£29.95	£23.95



Digital Angle Finder 200mm...

- Lock arm at any angle through 360 degrees.
- Absolute & relative display.
- Large LCD display.
- 200mm arm length.
- Spirit level bubble on top face.
- Aluminium body & stainless Arm.
- 0.05 degree resolution.

Part no	Range	WAS	SALE
ME-AN-MEAS	0-360°	£36.95	£29.56



Digital Indicator...

- Large easy to read LCD.
- mm / Inch.
- Set Zero at any position.

Part no	Range	WAS	SALE
ME-DI-IND-10	0-10mm / 3/8"	£39.95	£31.16
ME-DI-IND-30	0-30mm / 1 3/16"	£52.95	£42.36
ME-DI-IND-50	0-50mm / 2"	£64.95	£51.96



Dial Test Indicator- Imperial DTI...

- Automatic reversal.
- Dovetail mounted spigot, with dovetails on 3 sides.
- 1/4" and 3/8"mm diameter spigot
- 30mm dial diameter.

Part no	WAS	SALE
ME-IM-DIAL-DTI	£29.95	£24.48



Z Axis Dial Tool Setting Gauge...

- Accurate tool height setting.
- Magnetic base.
- Built in height calibration.
- Precision tool height setting to 50mm.

Part no	WAS	SALE
MT-ED-Z-DIAL	£82.95	£67.80



Vertical Digital Scales...

- mm / Inch.
- Set Zero at any position.
- Mounting bracket supplied.
- Data output.

Part no	Travel	WAS	SALE
ME-VT100	100mm/4"	£32.95	£25.56
ME-VT150	150mm/6"	£34.95	£27.95
ME-VT200	200mm/8"	£39.95	£31.96
ME-VT300	300mm/12"	£54.95	£46.36
ME-VT400	400mm/16"	£64.95	£50.36



Digital Angle Gauge...



- Digital angle/inclinometer.
- Zero calibration function.
- 0.1 degree resolution.
- Magnetic base.
- Compact size (51x51mm).

Part no	Range	WAS	SALE
WR300-KIT	+/-180°	£28.95	£22.50

External Digital Micrometers...

- Large LCD Display.
- Tolerance function - user defined under or over tolerance.
- Metric/imperial display.

Part no	Range	WAS	SALE
ME-DI-MIC-0-25	0-25mm/1"	£39.95	£31.96
ME-DI-MIC-25-50	25-50mm/1-2"	£62.95	£42.35
ME-DI-MIC-50-75	50-75mm/2-3"	£62.95	£50.36
ME-DI-MIC-75-100	75-100mm/3-4"	£75.95	£60.75



Imperial Caliper with Fractions...



- Imperial calipers with fractions 1/16, 1/2 etc..
- Displays decimal inches and fractions simultaneously

Part no	Range	WAS	SALE
WR100	0-150mm/6"	£32.95	£26.93

Co-ax Centering indicator...

- Simple method of centering a workpiece or assembly.
- Dial face remains stationary.
- Can be used horizontal or vertical.
- Internal or external setting.

ONLY £67.96
Part No. ME-DIAL-CENT



Horizontal Digital Scales...

- mm / Inch.
- Set Zero at any position.
- Mounting bracket supplied.
- Data output.

Part no	Travel	WAS	SALE
ME-HZ100	100mm/4"	£24.95	£21.55
ME-HZ200	200mm/8"	£32.95	£26.36
ME-HZ300	300mm/12"	£44.95	£33.56
ME-HZ450	450mm/18"	£62.95	£50.36
ME-HZ600	600mm/24"	£79.95	£67.96
ME-HZ800	800mm/31 1/2"	£129.95	£107.96



Digital Readout Systems...



Contact us for a DRO quote...

Depth Gauge (pin type)...



- Depth gauge with round pin.
- 60mm base size.
- Storage case.

Part no	Range	WAS	SALE
ME-DEPTH-30	0-25mm/1"	£24.95	£19.95

Standard Digital Calipers...



- Metric/imperial conversion.
- Storage case.

Part no	Range	WAS	SALE
ME-CAL-TOL-150	0-150mm/6"	£14.95	£12.50
ME-CAL-TOL-300	0-300mm/12"	£29.95	£23.95

500mm Caliper (20")...



- Metric/inch conversion.
- Large easy to read display.
- Large internal jaw capacity.
- Heavy duty scale beam.
- Wooden storage case.

Part no	Range	WAS	SALE
ME-CAL-LO-500	0-500mm/20"	£99.95	£79.96

1 Metre Caliper (40")...



- Metric/inch conversion.
- Large easy to read display.
- Large internal jaw capacity.
- Heavy duty scale beam.
- Wooden storage case.

Part no	Range	WAS	SALE
ME-CAL-LO-1000	0-1000mm/40"	£299.95	£191.96

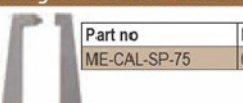
Centre Pitched Calipers...



- Measure between two hole centres and edge to hole centre.
- Adjustable ground points.
- Metric/imperial conversion.
- Wooden storage case.

Part no	Range	WAS	SALE
ME-CAL-CL-150	10-150mm/6"	£62.95	£42.36
ME-CAL-CL-300	10-300mm/12"	£69.95	£55.96

Single Point Thickness Caliper...



Part no	Range	WAS	SALE
ME-CAL-SP-75	0-75mm/3"	£39.95	£31.16

- 93mm deep jaws.
- Raised pointed measuring contact.
- Metric/inch conversion.
- Storage case.

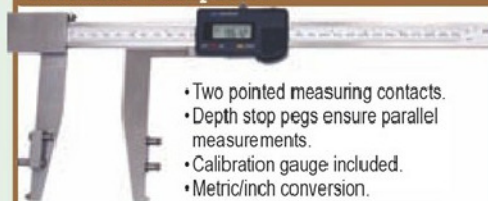
Internal Caliper...



- The measuring contact points are raised allowing for stepped bores, grooves, & circlip depth measurement.
- 62mm depth.
- Metric/inch conversion.

Part no	Range	WAS	SALE
ME-CAL-INT-150	19-150mm	£54.95	£43.96

Internal Caliper...



- Two pointed measuring contacts.
- Depth stop pegs ensure parallel measurements.
- Calibration gauge included.
- Metric/inch conversion.

Part no	Range	WAS	SALE
ME-CAL-INT-300	20-300mm/12"	£79.95	£63.96

Dial Bore Gauges...

- Measure bore diameter, or detect a taper or ovality.
- 55mm diameter dial indicator.
- 0.01mm resolution.
- Long reach stem.

Part no	Range	Reach	WAS	SALE
ME-BG-10-18	10-18mm	100mm	£44.95	£34.36
ME-BG-18-35	18-35mm	130mm	£44.95	£34.36
ME-BG-35-50	35-50mm	150mm	£34.95	£27.95
ME-BG-50-160	50-160mm	150mm	£44.95	£28.76
ME-BG-160-250	160-250mm	500mm	£69.95	£47.96

Plunger Digital Indicator...



- Sensitive sprung plunger.
- Mounting lug.
- Metric / Imperial conversion.

Part no	Range	WAS	SALE
ME-PLUN-10	0-10mm/ 3/8"	£31.95	£25.56
ME-PLUN-20	0-20mm/ 3/4"	£39.95	£27.16
ME-PLUN-100	0-100mm/4"	£64.95	£51.96

100mm/4" Digital Height Gauge...



- mm / Inch.
- Inch with Fraction display.
- 100mm / 4 Inch.
- Magnetic Base..
- Set Zero at any position.
- 0.05mm / 0.001 Inch Resolution.

Part no	Range	WAS	SALE
WR200	0-100mm/4"	£44.95	£36.77

150mm/6" Digital Height Gauge...



- mm / Inch display.
- Removable Carbide tip scribe.
- Fine wheel adjustment.
- Set Zero at any position.
- 0.01mm / 0.0005 Inch Resolution.

Part no	Range	WAS	SALE
ME-HG-150	0-150mm/6"	£62.95	£52.36

300mm/12" Digital Height Gauge...



- mm / Inch display.
- Removable Carbide tip scribe.
- Fine wheel adjustment.
- Set Zero at any position.
- 0.01mm / 0.0005 Inch Resolution.

Part no	Range	WAS	SALE
ME-HG-300	0-300mm/12"	£69.95	£57.18

600mm/24" Digital Height Gauge...



- mm / Inch display.
- Removable Carbide tip scribe.
- Fine wheel adjustment.
- Set Zero at any position.
- 0.01mm / 0.0005 Inch Resolution.

Part no	Range	WAS	SALE
ME-HG-600	0-600mm/24"	£159.95	£127.96

3" Wixey Digital Protractor...



- Compact 3" blade.
- Zero calibration function.
- 0.1 degree resolution.
- Magnets on blade edges.
- Blade lock.

Part no	Range	WAS	SALE
WR400	360°	£99.95	£31.96

8" Wixey Digital Protractor...



- 8" aluminium blade.
- Zero calibration function.
- 0.1 degree resolution.
- Magnets on blade edges.
- Blade lock.

Part no	Range	WAS	SALE
WR410	360°	£46.95	£36.76

Digital Spirit Level / Inclinator...



- Large LCD display with 0.1 degree resolution.
- Displays decimal degrees or percentage of slope.
- Audible beep at 0, 45 & 90°
- Class II laser pointer.
- Aluminium body with vertical & horizontal level bubbles.

Part no	Length	WAS	SALE
ME-AN-LEV-600	600mm/24"	£49.95	£39.96

1L Ultrasonic Cleaner...

- 1 litre tank capacity.
- 50w Ultrasonic power.
- Digital Count down timer.
- Stainless steel tank.
- Tank lid included.
- Basket included.



Part no	Size	PRICE
US-CU-928	1 litre tank	£36.95

1.3L Ultrasonic Cleaner...

- 1.3 litre tank capacity.
- 70w Ultrasonic power.
- 30w Tank heater.
- Count down timer.
- Stainless steel tank.
- Tank lid included.
- Cleaning baskets available. (Not included with tank)



Part no	Size	PRICE
US-CU-08A	1.3 litre tank	£79.95

3.2L Ultrasonic Cleaner...

- 3.2 litre tank capacity.
- 120w Ultrasonic power.
- 200w Tank heater.
- Mechanical timer.
- Stainless steel tank.
- Tank lid included.
- Cleaning baskets available. (Not included with tank)



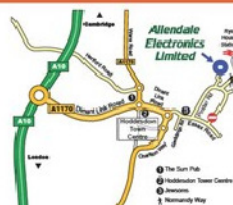
Part no	Size	PRICE
US-CU-20	3.2 litre tank	£109.95



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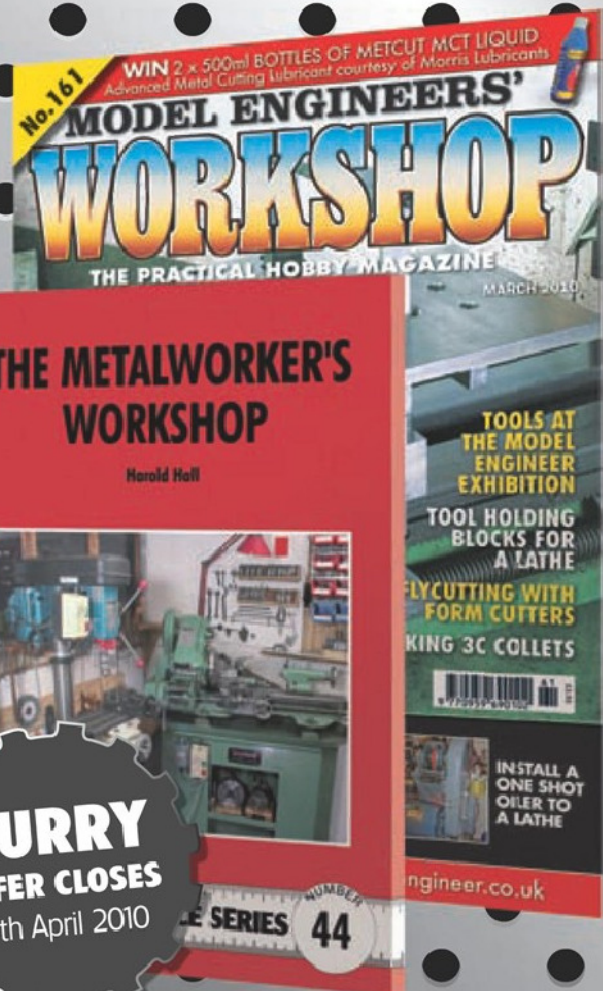
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David Clark

ON THE EDITOR'S BENCH

In the workshop

Again, the weather has been too cold to do much in the workshop. I have however, managed to fit in another decent size toolbox for storage as well as the one mentioned last time. I purchased the intermediate toolbox from Halfords, the one that goes between a base unit and the toolbox proper. This has a flat top and now has the surface plate on it. It was hard work lifting the surface plate onto the top of the toolbox. The only way I could do it was to lean the surface plate against the side of the toolbox and pivot it up onto the top of the box.

I am very pleased with this arrangement although I have to alter the mounting plate where the inverter controls on my Tom Senior are mounted so I can open the top drawer. This is a baking tray mounted horizontally and I need to turn it vertically so it is narrower.

I have been looking at storage for needle files and also for storing taps and dies into their types, BA, metric and Model Engineer series etc. I have bought several cheap pencil case tins from the local £ shop and these are ideal. They fit nicely into a drawer and when carefully labelled up will enable me to find things when I want them.

Homebase sell little red tool racks and I have purchased several, two for use with spanner sets and three with hooks on so I can hang up my milling machine and faceplate clamps. I also purchased the screwdriver version that should be ok for chuck keys on the lathe.

Arrand Engineering

Arrand have supplied us with a copy of their 16 page catalogue and price list. Arrand do a wide range of taper shank tooling as well as several other interesting items, a typical example being a flat standing toolmakers clamp as designed and used by Harold Hall. Contact Arrand, the Forge, Knossington, Nr. Oakham, Leicestershire, LE15 8LN. T: 01664 454566.

Myford 2010 Spring Show

The Myford Spring Show is on Thursday 15 April 9am to 5pm, Friday 16 April 9am to 4pm and Saturday 17 April 9am to 3pm. This twice yearly event is always well supported and last spring saw the first ever coach party.

I have been invited and will hopefully be there for all 3 days. I am looking forward to meeting many of you there.

There are two free to enter competitions, both are for £250. One is a free to enter

competition for any visitor and the other is for the best vintage/classic car or motorcycle used to get to the event.

Malcolm Townsend of Myford fame is retiring soon after the show. I hope you will all come and wish him well for the future. Many of you will have received help from Malcolm over the years and this is your chance to say thank you.

Ivan Law, Chief Judge of the Model Engineer Exhibition and Harry Paviour, Chief Judge at the National Model Engineering & Modelling Exhibition at Harrogate will be attending. Harry and his wife Doreen will be accompanied by Teddy Myford who will be collecting for charity, usually the RNLI. I don't know if Doreen will bake a cake this year but if she does, please donate to Teddy Myford generously. Last year's donations were a little disappointing and do remember, it costs Doreen quite a bit for ingredients to bake a cake of this size and quality.

Derek Brown is hoping to be there with Anna and Myfords are also hoping to fit Derek's metric thread conversion kit to a lathe for demonstrations.

John Wilding will be attending on Thursday and also Friday morning until lunch time. He will be signing copies of his new book, Tools For Clockmakers Volume 2.

The SMEE are attending and two model engineering societies, Erewash Valley and Nottingham will be there for the first time.

Bring plenty of money as there will be many bargains. There will be lots of tools on sale, Myford and otherwise. This event also gives you the opportunity to stock up on bar ends. This is all top quality material as used by Myfords to manufacture their superb range of lathes.

Two traders will be in attendance, Kirjeng M.E. Services supply a comprehensive range of quality British manufactured cutting tools including taps, dies and reamers, and they also stock the Clarkson/Osborn range.

Hemingway kits will again be attending, their stand is always popular, and if you would like a particular kit taken to the show to save on postage, contact Kirk or Sandra T: 01746 767739.

For the first time, Myford are holding an auction. Items must be registered prior to the show and pre-booked. The auction will take place on Saturday the 17 April at 11:30 am.

Several Myford staff will be on hand to demonstrate how to change belts and adjust your Myford bearings, saddles and slides to get the best from your lathe. Also the Myford electrician will be on hand to

answer any of your Myford related electrical questions.

Finally, Myford will be on hand to sell you a lathe or a mill. A wide range of refurbished machines will be on sale as well as new machines. Myford refurbish machines back to as new condition so you can be sure that you are getting something that will last you a lifetime.

Chester Sale

Chester UK are excited to announce 'Saturday Sale Days' to be held at their midlands premises in Burntwood near Cannock. The opening times will be 10 am to 4pm and on the day there will be a range of special offers on their extensive range of machines and tooling. The first of these exclusive sale days will be held on April 24, followed by 22 May and then 26 June, further dates will be advertised on their website or you can contact the Midlands or Chester offices.

Due to their commitment to these sale days the Chester showrooms will be closed on Saturday mornings after the 27 March. There will still be a telephone service available between 9am and 12 on Saturday mornings T: 01244 531631.

Chester UK Saturday Sale days will be held at the midlands premises: Unit 4 Plant Lane Business Park, Zone 2, Plant Lane, Burntwood, Staffs. WS7 3GN. T: 01543 448940 or email sales@chestermachinetools.com for more details.

Armortek new product

Armortek is a British engineering company manufacturing all metal 1:6 scale armoured vehicles in kit form. Having concentrated primarily on German vehicles Armortek is often asked 'why as a British Company do you not offer a British Kit?' In response to this, in 2010 Armortek released their first British Tank kit the A34 Comet.

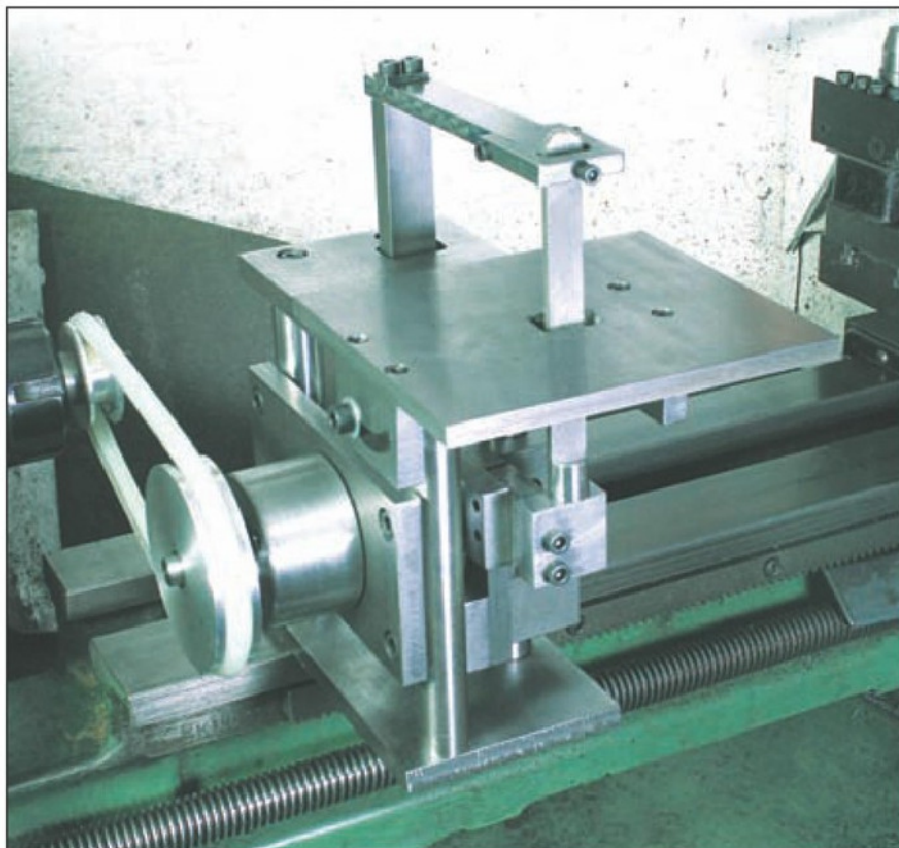
Based on a MK1A, the model is constructed primarily from steel and aluminium, complemented with other cast alloys and materials. The model features scale armour thickness and has fully working Christie suspension. This allows individual adjustment of the load and ride height on each axle. Weighing in at approximately 85 kilos for the basic kit, there are options available for radio control and additional special effects.

The prototype of the Comet will be on show for the first time at The South West Model Engineering, Model Making and Hobbies Exhibition at The Royal Bath & West Show Ground, Shepton Mallet on Saturday 17th & Sunday 18th April 2010.

HOW TO MAKE A FILING MACHINE

2

Harold Hall makes a useful machine



OVERVIEW

This article about making a filing machine following a request by the editor. This filing machine is the result. The second part covers the drive assembly.

the 36mm length at the tailstock end. Using a saddle stop to control the length will be a good idea as will be setting the top slide to 6deg. as 0.1mm axial feed of the top slide will then give 0.01mm radial feed making it easier to set on small increments when achieving the final diameter. Use one of the ball races as a gauge to check the result. If you would prefer that the finished result did not end up with a centre drilled end make the diameter longer than 36mm so that it can be reduced in length later.

Now, with a right hand knife tool fitted, the shorter 9mm section can be produced (photo 8) and as it will be impossible to use the ball race as a gauge it is essential that you accurately replicate the diameter of the longer end that has been proven to be acceptable. Part off, reverse in the chuck, and face the end to produce the 10mm length. Finally, drill and tap M6 as per the drawing. There remain two flats to be made, which can be done on the milling machine (photo 9). Note the small rectangular plate added to the end that easily enables the spindle to be rotated through 90deg. for the second flat.

Outer clamp ring (24)

This part being 40mm diameter by just 4mm thick presents a problem to avoid ending up with a small stub of material after it has been parted off that subsequently may not find a use. This is never a good idea but at larger diameters even more so. However, the following method avoids that. Take your length of 45mm diameter bar (45mm enables it to be turned to 40mm as concentricity is vital) and mount this in the 3-jaw chuck using the reverse jaws. DO NOT START UP THE LATHE as with the bar being gripped

Input drive spindle assembly (2)

This assembly was included in MEW issue 161, March 2010. This is an optional assembly (photo 7) as described on the basic assembly drawing, the need for it depending on the chosen method of achieving the drive input. The amount of turning involved in making the filing machine is though almost entirely within this assembly much of which is quite critical and provides some interesting processes. If making it therefore the following method should be considered.

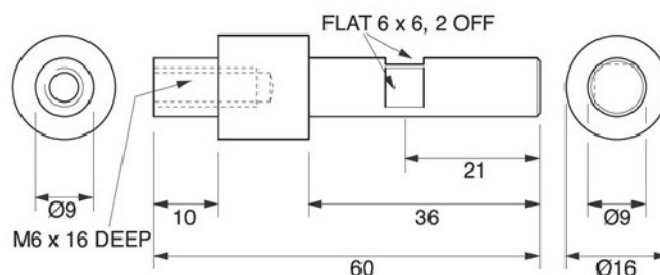
Spindle (26)

The essential feature of this part is that the two 9mm diameter lengths are concentric and are a light push fit within the ball races to be used. As a result, these diameters must be turned without removing the part from the lathe using left and right hand knife tools. Having made that statement, it is not totally correct as turning it between centres would also enable concentric diameters to be achieved easily. Even so, I think the method I am about to describe in detail, is marginally easier.

Fit a length of 16mm diameter steel in the 3-jaw chuck, face and lightly centre drill the end. Then extend the bar from the chuck by about 90mm, with the end supported by the tailstock centre, and turn



7. The Input Drive Spindle (2).

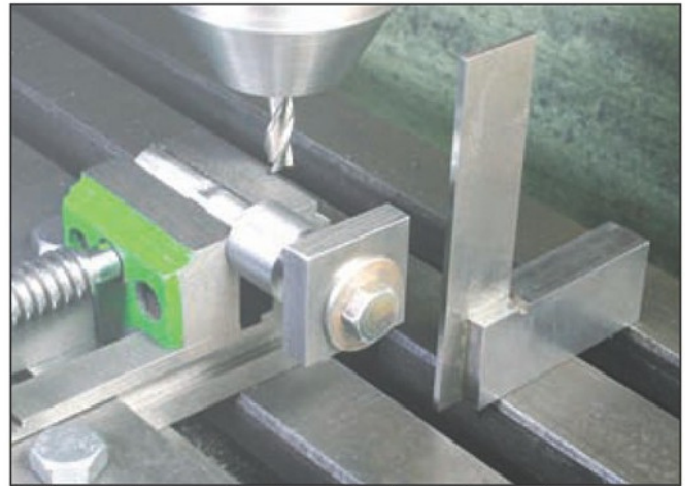


MATERIAL: 16 DIA. STEEL 230M07, QTY 1 OFF
SPINDLE

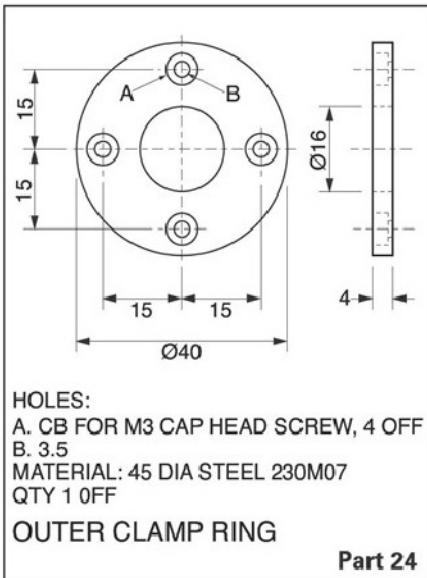
Part 26



8. Ensuring the two diameters for the ball races are concentric by using left and right hand knife tools.



9. The small rectangular plate makes it easy to turn the spindle through 90deg. for the two flats required.



by a very short jaw length it is highly likely that the end is well off centre and if started up centrifugal force is likely to throw the part from the chuck. With a short length of bar held on the top slide advance this slowly as you turn the lathe by hand until the end is running reasonably true and give the chuck a final tighten, STILL DO NOT START UP THE LATHE.

Now with a large centre drill in the drill chuck advance this using the tailstock until it is very firmly against the bar when the lathe can be started on a slowish speed and the end centre drilled. This must be done such that the angled portion of the drill enters by at least 7mm, the purpose being explained later. If you are using a very long bar, say 250mm plus, then as a precaution the fixed steady could be added but with a clearance of say 2mm between the bar and its arms.

Support the bar using the tailstock centre, face the end, and accurately turn to 40mm over a length of 8mm. Now, with the part still supported by the tailstock centre, add the fixed steady setting its arms on the 40mm diameter just turned. Remove the centre and bore the 16mm diameter, thereby ensuring that the inner and outer diameters are concentric. The bore should be no more than 4.5mm deep so as to ensure that there is still some of the centre drilled impression existing. Once more support the bar with the



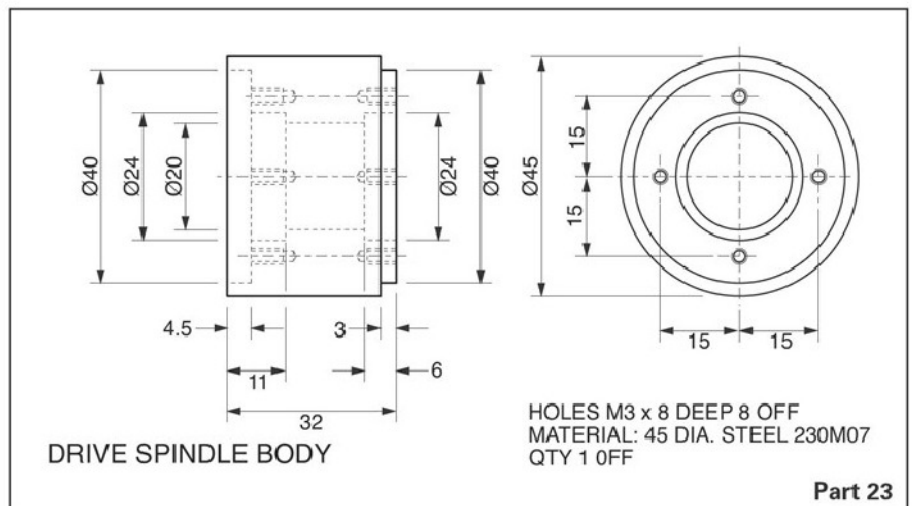
10. Parting off the Outer Clamp Ring (24) from the end of a long (not seen) bar.

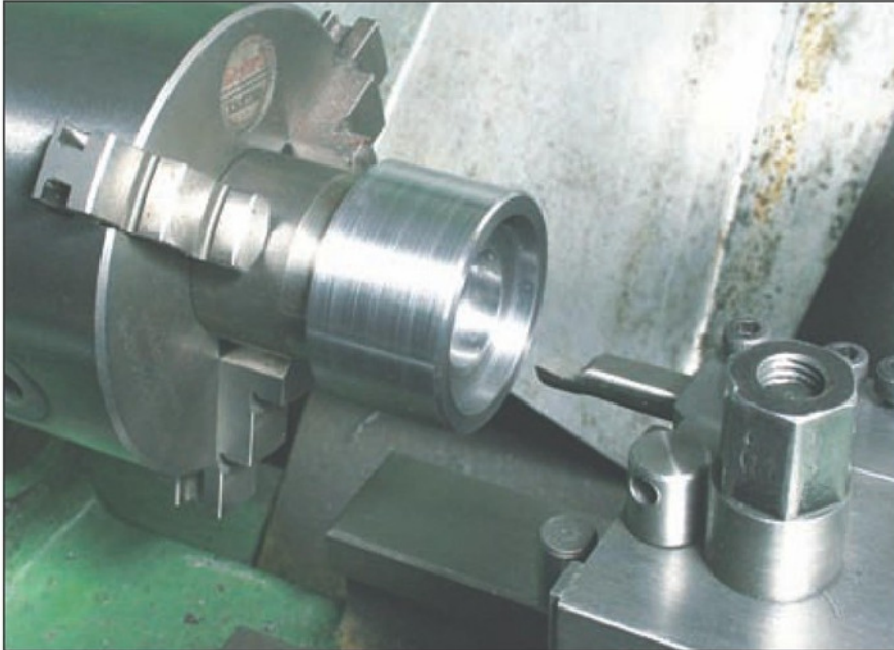
tailstock centre having removed the steady and part off to 4.5mm long (photo 10).

It is essential that the part is a uniform thickness and to achieve this I located some large washers that I added between the step of the reverse jaws and the workpiece enabling sufficient to project so that it could be reduced to 4mm thick. Otherwise, use some soft jaws suitably bored. Drilling the part will be described later.

Drive Spindle Body (23)

This is a critical part especially with the two 24mm diameters that house the ball races needing to be accurately concentric but, unlike the spindle, they cannot be done without removing the part from the chuck. The following method though achieves this relatively easily.





11. Making the bore for the second ball race whilst the part is held on a mandrel located in the bore for the first.

undersize and 0.5mm less in depth and remove the part from the chuck.

Add a short length of steel (diameter 30mm or larger) to the 3-jaw chuck with about 10mm projecting, face the end, drill and tap M8 and turn a spigot 24mm diameter by 3mm long. The 24mm diameter being a close fit in the bore made in the first end also ensure that the step is accurately made as this will also support the body.

Fit the workpiece onto this mandrel using an M8 screw the head of which now sits in the 18mm bore allowing the remaining machining to be carried out

unhindered. Face the end to achieve the 32mm length and make the 40mm and 24mm diameter bores using the outer clamp ring and ball race as gauges (**photo 11**). In both cases ensure that a good fit is obtained. Finally, whilst on the mandrel, skim the outer diameter purely for appearance sake.

To complete the turning operations, return the workpiece to the 3-jaw chuck and create the 20mm diameter bore completely through the part. This is just a generous clearance for the spindle so accuracy is not required. Adding the



12. Boring the Drive Spindle Carrier (22).

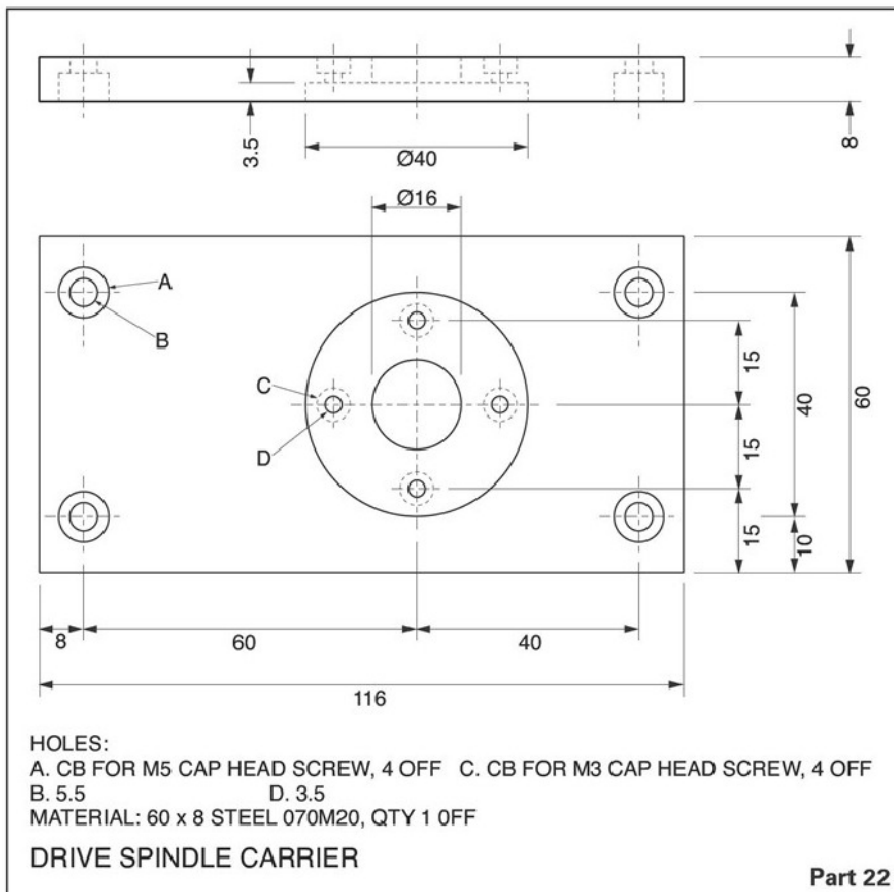
tapped holes will be detailed later as it depends on other parts being completed.

Drive spindle carrier (22)

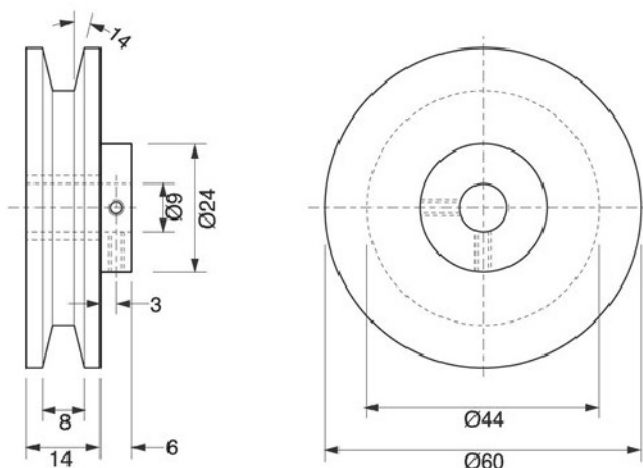
This being one of the many flat rectangular parts, it should be cut to size, marked out and drilled en masse with the similar parts. However, do mark out the position of the 16mm hole, just centre drilling this and initially drill the four holes around this tapping size for M3.

Mount the carrier on the faceplate using the tailstock centre to set its position. In my case, rather than using a conventional faceplate, **photo 12** shows that I used my 4-jaw alternative chuck that was recently published in MEW (ref 6). The chuck has some tee nuts to fix the jaws but with two tapped holes rather than the usual one. These I used with a jacking screw in the outer hole to support the clamp bar and the inner one to clamp the workpiece. This I found much simpler than using a conventional faceplate as there were no fixings to work with on the rear. Using the dual tapped tee nuts in this way was a facility that I had not envisaged when I first developed the item.

With the item mounted, bore the 40mm hole making it a close fit on either the Drive Spindle Body or the Outer Clamp Ring whichever is the larger, the reason for the Outer clamp ring being included becoming apparent later. The 16mm bore needs to be concentric with the bore just made but its diameter a little on the large



13. Using the Drive Spindle Carrier as a drilling jig for the holes in the Drive Spindle Body (23).



HOLES: M4, 2 OFF MATL. 60 DIA. ALUMINIUM 2011T6
QTY. 1 OFF
WIDTH OF GROOVE MUST SUIT DRIVE BELT BEING USED
WHICH SHOULD ONLY CONTACT THE SIDES OF THE GROOVE
TO ENSURE SUFFICIENT GRIP.
DIMENSIONS GIVEN SUIT A BELT HAVING A NOMINAL
8mm DIAMETER.

DRIVE SPINDLE PULLEY

Part 25



14. Producing the angled faces on one of the pulleys.

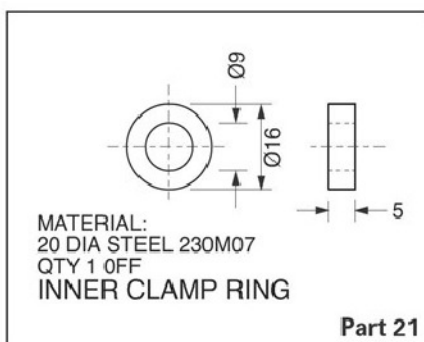
size, say about plus 0.05mm. With the carrier complete it can be used as a template for drilling the other parts.

As the four holes are unlikely to be accurately on a PCD it is improbable that the parts will assemble randomly, therefore add centre punch marks where appropriate to aid positioning the parts when assembled later.

Use the Drive Spindle Carrier as a jig for drilling both the Drive Spindle Body (photo 13) and the Outer Clamp Ring with the ring then being used as a template for the holes in the other end of the body. With that done the holes in the three parts can now be opened up, counterbored or tapped as required.

Drive spindle pulley (25)

The dimensions for the belt groove are given to suit an 8mm diameter plastic belt and may need changing for other forms



MATERIAL:
20 DIA STEEL 230M07
QTY 1 OFF
INNER CLAMP RING

Part 21

of belt. Cut a length of 60 mm diameter aluminium 21mm long, fit in the 3-jaw chuck, face the end and bore through at 9mm diameter. Next reverse in the 3-jaw chuck and face the second side.

Make a 9mm diameter stub mandrel, tapped M8 and mount the blank onto this and turn the 24mm diameter by 6mm wide boss. Rough out the pulley groove with the parting tool and finish the right hand side of the groove with a knife tool and the top slide set at 14deg. Remove the pulley, turn, replace on the mandrel and machine the second side of the groove.

Photograph 14 shows a similar pulley that I made earlier but this one does not have a boss, I subsequently made a steel bush for the bore and included the boss so that I could use this pulley for this application. This may be apparent in the photographs. You will need a second pulley but the diameter will depend on the drive speeds available and the ultimate speeds required, a subject that I will deal with later.



15. The parts that make up the Drive Spindle. The mandrel used in photo 11 is seen rear centre.

Inner clamp ring (21)

This small part is relatively simple but do take measures to ensure the inner and outer diameters are concentric and the faces parallel, the later point being quite important as it is a support between the ball race's central disk and the variable stroke assembly. With that finished the parts that make up the spindle are complete and are shown in photo 15. This also shows the stub mandrel (centre rear) that was used to hold the body whilst machining the bores in the second end of the body.

Oscillating assembly (3)

This is a comparatively simple assembly (see MEW 161 for drawing) as shown by photo 16 with only the Slider Blocks needing a little extra care, I will not therefore comment on the other parts.

Slider blocks (34)

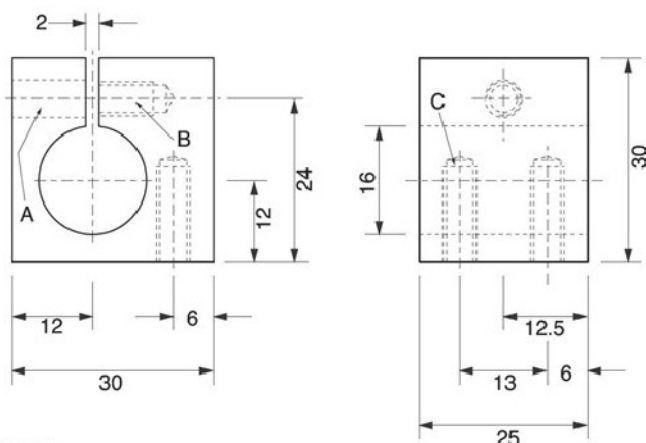
Being made from cast iron bar, do bear in mind that bar as supplied will need machining to bring it to the 30mm square required, this being the reason why I quote 35mm square. Do check with the supplier that this can be machined to 30mm as it frequently comes with a large radius on its corners that may make it a borderline case.

Machine the block on all six sides to give a 30 x 30 x 25mm block, mark out and drill and tap the holes, other than the one shown as 16mm diameter. The important feature is that this hole in each block must be precisely the same height from the base, the actual height being relatively unimportant.

Mark out the position of the 16mm hole in one block only and centre drill. Place in



16. The Oscillating Assembly (3).



HOLES:
A. 5.5 B. M5 x 8 DEEP C. M5 x 14 DEEP
MATERIAL: 35 SQ. CAST IRON, QTY. 2 OFF
SLIDER BLOCK

Part 34



17. Boring one of the Slider Blocks.

the four jaw and adjust so that the centre drill mark is on centre. Testing with a centre in the tailstock will be more than adequate, drill and bore the 16mm hole to be a close sliding fit on one of the posts, **photo 17**. The essential requirement from here is that the two jaws that set the two 12mm dimensions are not moved for the second block. Remove and fit the second block and machine similarly.

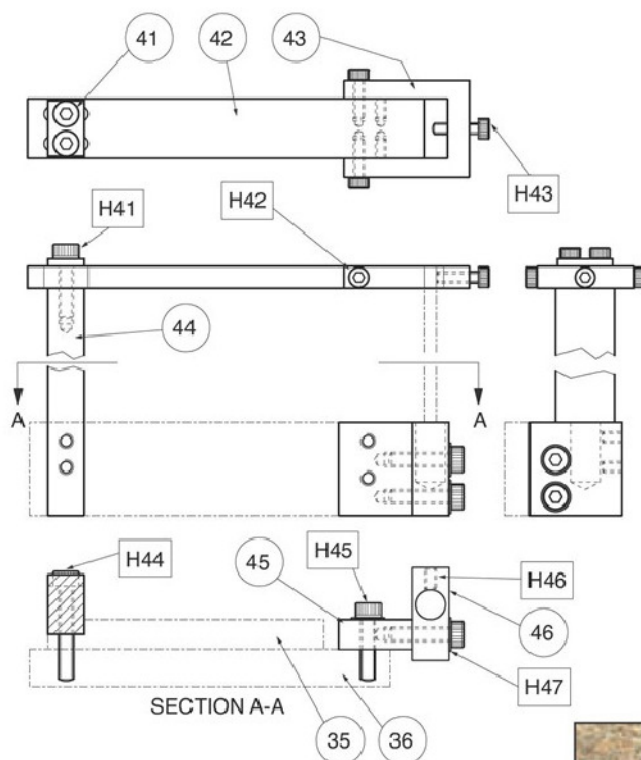
Test the result by placing one of the posts through both blocks and with them firmly held on a flat surface, check that the post can be slid through with ease. See my later notes regarding assembly.

Having bored the slider blocks they can be slotted to provide adjustment. However, I found that mine were such a good fit that I doubt if this was really necessary. It will though provide adjustment for wear if required at a later date.

File carrier assembly (4)

This is a very simple assembly as shown in **photo 18** and little needs saying about its manufacture. However, the design depends on my approach to modifying standard files being used. If not, then some changes to the method of holding them will be necessary. Also, if the workshop owner chooses always to use a single ended method of mounting the files then parts 41 to 44 will not be required. See my later comment though regarding using Abra files and ordinary saw blades.

To be continued...



HARDWARE

H41. M4 X 16 SOCKET CAP SCREW	2 OFF
H42. M3 X 10 SOCKET CAP SCREW	2 OFF
H43. M3 X 12 SOCKET CAP SCREW	1 OFF
H44. M4 X 25 SOCKET CAP SCREW	2 OFF
H45. M4 X 16 SOCKET CAP SCREW	4 OFF
H46. M4 X 6 SOCKET GRUB SCREW	2 OFF
H47. M4 STEEL WASHER	4 OFF

FILE CARRIER



18. The File Carrier Assembly (4).

FLYCUTTERS - C/W HSS TOOLBIT

CODE	ITEM	PRICE
MX1058	2MT	£10.00
MX1068	3MT	£12.00
MX1078	R8	£15.00



SOBA 3" BORING HEAD SET C/W 5 TCT & 5 HSS BORING TOOLS



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12mm Parallel Shank
3 Assorted 8mm Dia HSS Boring Bars
1 Tool steel Adaptor to accept 5mm HSS Tool Steel
1 x 5mm Dia HSS Tool Steel
1 x 8mm Dia HSS Tool Steel

IMPERIAL VERSION
ALSO AVAILABLE



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XP161	1/2	£15.00
XP162	10MM	£12.00
XP163	12MM	£15.00



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CODE	JAW WIDTH	PRICE
XC273	4" (K4)	£79.80 £89.95
XC274	5" (K5)	£105.00 £79.95
XC275	6" (K6)	£131.00 £99.00



SOBA PRECISION MILLING VICES

CODE	TYPE	PRICE
XC265	2" SWIVEL ONLY	£ 60.30
XC266	3" SWIVEL ONLY	£ 95.55
XC267	4" SWIVEL ONLY	£115.00
XC268	2" SWIVEL/TILT	£ 69.95
XC269	3" SWIVEL/TILT	£ 99.95
XC270	4" SWIVEL/TILT	£120.00
XC271	2" 3 WAY	£110.00
XC272	3" 3 WAY	£130.00



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CODE	TYPE	PRICE
QX48	3" JAW WIDTH	£25.95
GX49	4" JAW WIDTH	£28.95



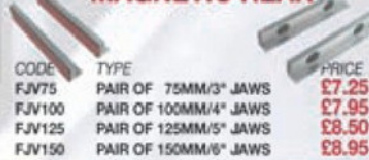
NEAL PRECISION VICES FOR DRILLING & LIGHT MILLING

CODE	SIZE	PRICE
XC262	3"	£19.00
XC263	4"	£24.95
XC264	5"	£38.50



NEW! FIBRE VICE JAWS WITH MAGNETIC REAR

CODE	TYPE	PRICE
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FJV100	PAIR OF 100MM/4" JAWS	£7.95
FJV125	PAIR OF 125MM/5" JAWS	£8.50
FJV150	PAIR OF 150MM/6" JAWS	£8.95



HSS ENDMILL PACK

CODE	SIZES	PRICE
ME11	5/32, 3/16, 7/32, 9/32, 5/16	£16.95



CROSS VICES

CODE	JAW WIDTH	PRICE
XC215	3"	£29.35
XC216	4"	£39.10
XC217	5"	£48.90



HSS SLOT DRILL PACK

CODE	SIZE	PRICE
DS11	1/8, 5/32, 3/16, 7/32, 1/4	£16.95



WEBBED ANGLE PLATES

CODE	SIZE	PRICE
MAP742	3 1/2 x 3 x 2 1/2	£19.95
MAP744	6 x 6 x 4 1/2	£28.95



ADJUSTABLE ANGLE PLATE 0-90 DEG

CODE	SIZE	PRICE
AAP	5 x 7	£65.00



ROUND MAGNETIC CHUCK 125MM DIA

CODE	PRICE
SAMCR001	£65.00



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SUITS MYFORD ETC. -
CAPACITY UP TO 1" -
MED DIAMOND KNURLS FITTED

CODE	PRICE
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VLC313	3MT	



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XC298	2MT	£24.75 £19.95
XC299	3MT	£26.75 £22.00



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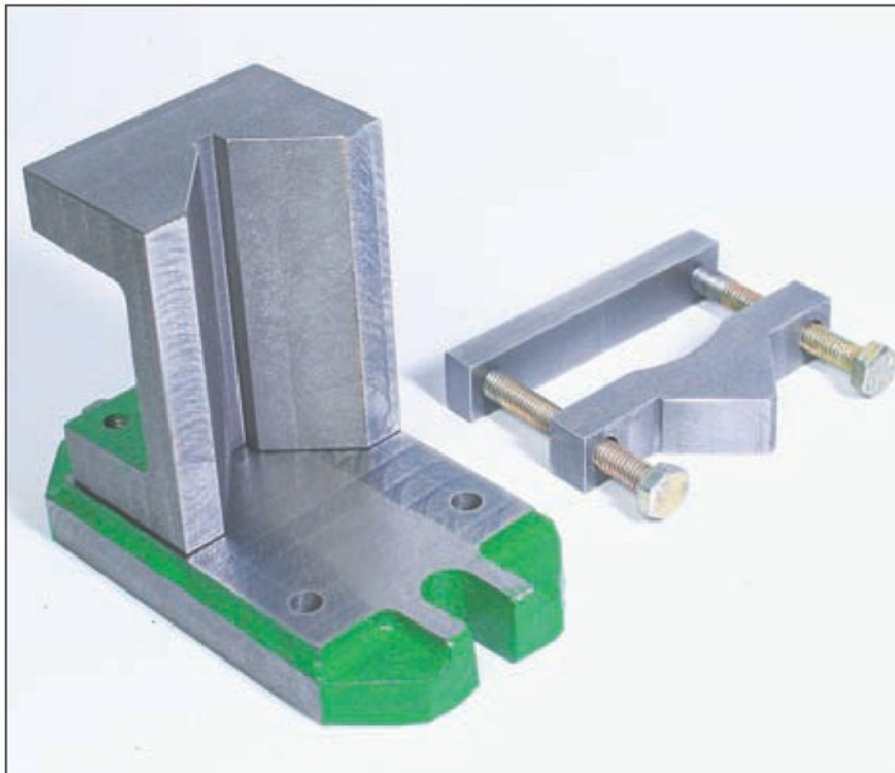
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HOW TO MACHINE CASTINGS

Harold Hall makes a small Vee angle plate



13. The finished Vee Angle Plate.

In the last issue, I discussed and illustrated the methods I adopted when making a Keats Angle Plate. This time I am making the Small Vee Angle Plate. Whilst performing much the same tasks as the Keats it is constructed quite differently so provides a range of other possibilities where machining is concerned. The castings for this are shown in **photo 14**.

The Vee block

The casting for this is basically a six sided block with the two larger faces parallel and the four shorter faces tapered with

the essential requirement for the finished block being that the six sides must all be at 90deg. with their adjacent faces. This is a major consideration when choosing the machining methods.

As was the case in the last issue, the first face to machine is one of the tapered faces and whilst any face would suffice, I chose one of the longer ones.

Having carried out the preliminary tasks of chamfering the edges and checking that the main face was adequately flat for it to be mounted on the angle plate, I machined the first face as shown in **photo 15**. Then, with the casting still clamped to the angle

OVERVIEW

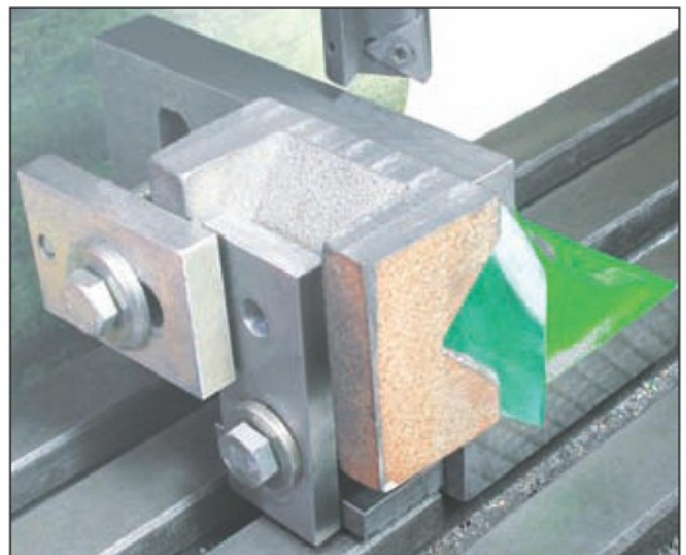
Last time we looked at the considerations necessary when choosing the sequence for machining castings for a Keats Vee angle plate. This time Harold continues with instructions for machining a small Vee angle plate (**photo 13**) which, like the Keats, is also available from The College Engineering Supply (see last issue).

plate, the angle plate was stood on its end, clamped to the machine table, and the first smaller face also machined (**photo 16**). This approach ensured that the two faces were at 90deg. to each other without the complications presented by other methods. Whilst not often a method to adopt, do not lose sight of the fact that using an angle plate in this way can occasionally be very beneficial, providing that is that your angle plate is accurately made.

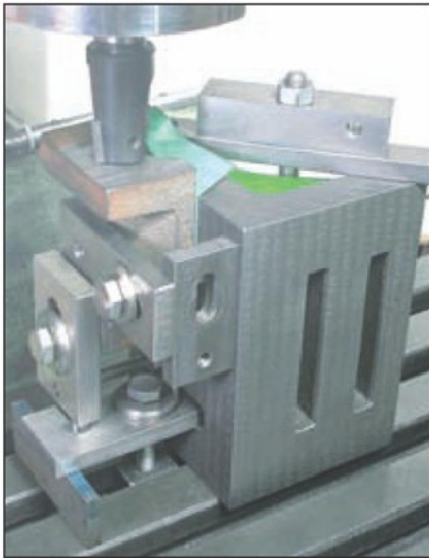
The next stage was to machine the opposite faces in a manner that would ensure they were parallel and was done by mounting the casting directly on the machine table (**photos 17 and 18**). The method shown in photo 17 may look dubious but there is a second clamp being used in the same way as that seen but hidden behind the casting being machined. The setup shown in photo 18, and also in **photo 19** uses my high profile clamps (to be described in a future MEW). With the four sides finished, photo 19 shows how the two remaining faces were machined with the casting mounted directly onto the machine table (well almost). I said, well almost, as it is essential that the machined face is fully in contact with the fixed post rather than the unmachined face below being against the machine table. Even so, not only does the



14. The castings as supplied.



15. The first face being machined.



16. The angle plate was stood on its end for machining the second face ensuring as a result that it was at 90deg. to the first face.

surface being machined need to be at 90deg. to the end face but also 90deg. to the long face, this being the reason for the front post seen in photo 19. The procedure therefore was to hold the Vee block firmly against both posts as it was being secured by the high profile clamp. However, this process is only valid providing the post's upright faces are accurately at 90deg. to the machine table. If you wish to adopt another method then using an accurate vice would be a suitable alternative but you will still have to be cautious how you position the workpiece to achieve both 90deg. angles. With the fifth face now surfaced the final one was machined with a similar set up but this time with the lower face firmly against the machine table, the front post was of course not necessary this time.

The next stage was to machine the Vee and to make it easy to set the width of this reasonably central I covered the top with marking blue and scribed a line on each face as a reference for the eventual width of the Vee. For positioning the casting I placed a shallow Vee block in the base of the vice so as to set the part accurately to 45deg. enabling it to be positioned with ease and then machined the first side (photo 20). The drawing does not indicate a groove in the base of the Vee but as this makes machining the Vee more complex I chose to include one. Having made that decision, I was able to stop machining just short of the second side as the groove would remove any unmachined surface. With the first side machined I turned the casting and machined the second side in the same way.

The groove in the base of the Vee was made with the block again being held in the vice thereby completing it except for the tapped holes that are used for fixing it to the base, more about that later.

Accuracy

Whilst the eight faces were now complete it seemed appropriate to check them for accuracy though the level of accuracy considered necessary is for the user to decide although in any case this is not expected to be a precision item. Having checked the item I did perform some additional machining which I think most



17. Machining the third face, there is a second clamp behind the casting.



19. The Vee block was firmly against the two square posts ensuring that the surface being machined would be at 90deg. to these faces.

will consider beyond what is required but being rather special I have chosen to publish them on the basis that they are good examples of specialised set ups and therefore of interest, especially to the newcomer to milling operations.

First I checked the six sides to see if they were at 90deg. to their neighbouring faces and found five to be very good but decided to give the sixth a very light skim as it was minutely out.

With that done I placed a round bar in the Vee and stood the assembly on the surface plate and checked that the bar was horizontal using a dial indicator, finding a difference of less than 0.05mm which I deemed to be acceptable. Next I clamped the bar to the block and stood it on its side doing that from both edges to check that it was central (photo 21). However, what I found was that the bar was lower one end



21. This test showed that the Vee was not quite parallel with the sides.



18. This method of machining the fourth face ensured that it was parallel with the other long edge.



20. Making the Vee.

to the other by more than I felt acceptable. Just why this was I have my theories but decided that for whatever the reason I would like to improve on the result and this is where the interesting setups emerged after much thought.

I have two very accurate angle plates and two cylindrical squares all of which I machined myself. I will not go into the method but the angle plates were machined without access to another angle plate and are therefore independent of the accuracy of one if one existed. The method was has been published in the magazine and one of my books (ref 3).

It occurred to me that if I mounted one of my cylindrical squares off one of the angle plates it should be horizontal and checked this as illustrated in photo 22. The error was about 0.03mm though it did appear to vary depending on the position on the surface plate indicating that my much used, and abused, plate was not perfectly flat. With that done I



22. Checking that the cylindrical square was accurate horizontally.



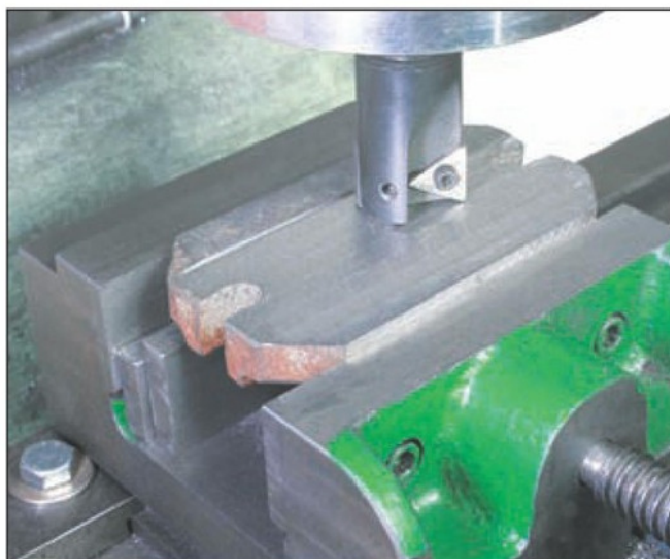
23. So that it could be used as in photo 24.



24. Correcting the error found in photo 21.



25. Milling the side of the base.



26. Surfacing the underside of the base.

then considered how I would clamp the block to this keeping the adjoining face perfectly upright whilst leaving the upper face free for machining. It was after many ideas came and went that I hit on the idea that placing my second angle plate against it would ensure that the face was accurately positioned. This still left the problem, I thought, as to how it was to be clamped. It was whilst holding the assembly together manually that I suddenly thought that possibly I did not need to clamp the parts together providing the cuts taken were light and that they were towards the angle plate having the cylindrical square fitted, this I did and it worked well, the setup is shown in **photo 23**. The side angle plate was then loosened and the block turned over when the side angle plate was once more secured. With that done the second side was also re-surfaced. The result of this was that the Vee was very easily placed accurately, both in line with, and central to, the sides of the block and was a very satisfying conclusion.

In carrying out this operation, I had obviously taken more off one end than the other resulting in the ends of the block not now being at right angles with the longer edges. This though was easily cured again by the use of the two angle plates as seen in **photo 24**. It was a little tricky to position as the block had to be held manually against both angle plates whilst the clamp was applied. The reader may like to know,

if they don't already, the dodge I used to simplify the process. The stud that passes through the clamp is nutted tight on both sides of it and therefore does not need to be held by a spanner. As a result, this enables one hand to position the Vee block whilst the other tightens the nut on the rear of the angle plate.

The base

This as can be seen from photo 14, is a thin casting that obviously has been cast as one would expect with the tapered faces being the shallow sides.

I chose to machine both of the large faces (essential) and the two long edges (optional) though as we shall see later it is very difficult to ensure that these are central and parallel to the Vee in the block. However, as I intended to hold the part in the vice when machining the larger faces it was also essential that I machined the edges for the purpose. **Photograph 25** shows that I held the part in the vice when machining the long edges, ensuring of course that the first edge was firmly against the bed of the vice when machining the second so as to ensure that the faces were parallel.

With the two longer edges now machined the base was held in the machine vice and the first main surface machined (**photo 26**). Then, rather than again using the vice, I chose to mount the part directly on the machine table (**photo 27**) using some low profile clamps (ref 4).

The advantage of this method is that it was potentially more accurate as it would bypass any errors in the bed of the vice, the effect of jaw lift and errors in any parallels used.

With the base machined this far I next marked out the position of the holes, doing this with it fixed to the angle plate, using one of the base's fixing lugs for the purpose and marked out the long axis positions first. Then, standing the angle plate on its end, I marked out the positions for the other axis ensuring by this method that the second axis was at right angles to the first (**photo 28**). The positions of the holes in the Vee block were also marked out but this was much easier with it being a regular shape.

With that done the holes were drilled, tapped and counterbored as required. Unfortunately though, as the holes in the base were counterbored their size was governed by the size of the pin on the counterbore being used, in my case, 5.5mm for a M5 screw. As a result there was a generous clearance between the screw and the hole and the Vee block could therefore return to the base in a different position each time it was removed and refitted. I had early in the process considered machining the edges of the base again at this stage to make them parallel with the Vee but now realised that this would be pointless. Should the reader wish to make this more of a precision item then dowelling the two

parts to ensure perfect re-alignment after dismantling would be the only sure method of alignment. I considered this to be more of a nicety rather than a necessity.

The reader may question why, having fitted the block to the base, will it be necessary to remove and refit it, the reason being that the block can be assembled on the base with the Vee both parallel, and at right angles, to the base.

The clamp assembly

The clamp is very similar in principle to that used with the Keats in the last issue but rather than it being a casting, it is machined from a piece of steel. I cut a piece to the overall dimensions and on this marked machine-to lines but to avoid the slow process of milling away all the surplus material I cut the bulk away using a metal cutting bandsaw. With that done, and as accuracy is far from important, I lined up the 45deg. line slightly above the vice jaw, just doing this visually, and milled down to the line, (photo 29)

repeating the process for the second angled face. The part was then placed in the vice with it supported on a parallel and the two remaining faces machined.

When clamping larger diameters, the design calls for a shallow curved recess rather than the normal Vee. For this, the part was mounted on the lathe's faceplate and the recess made as illustrated in photo 30.

The drawings show a piece of 1/4in. diameter steel bent into a U shape and threaded on its ends to complete the clamp assembly, the material for both of these having to be supplied by the one making the item. However, I chose to make a piece of steel to go under the Vee block (as does the U) and with this tapped, screws were used to provide the clamping pressure. Whilst this needs more than one length of screw, if used in the horizontal position, it would be more compact with smaller workpiece diameters,

With that done and some tidying up, chamfering corners for example, the parts

were finished with a lick of paint and can be seen in photo 1.

In the next issue I will very briefly compare the two designs; that is the Keats and the Vee angle plate giving what I feel are their pluses and minuses and suggest some uses to which they may be put. ■

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3. Making a Precision Angle Plate. MEW issue 26 page 38. Milling Projects for Beginners (2) An Angle Plate. MEW issue 85 page 14. Milling a Complete Course, Workshop Practice Series number 35.

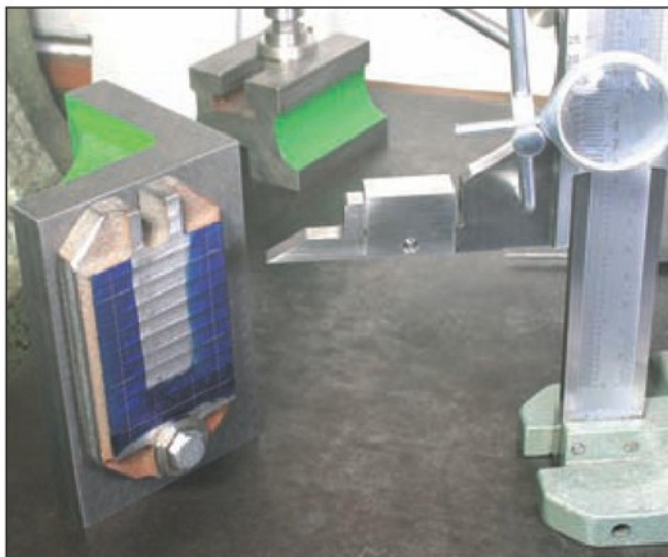
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4. Low Profile Workpiece Clamps. Model Engineer's Workshop, issue 118 page 12.



27. This method of milling the top surface of the base ensured that it was accurately parallel with the underside.



28. Marking out the base for the holes.



29. Shaping the clamp.



30. The clamp has a curved recess rather than the normal Vee.



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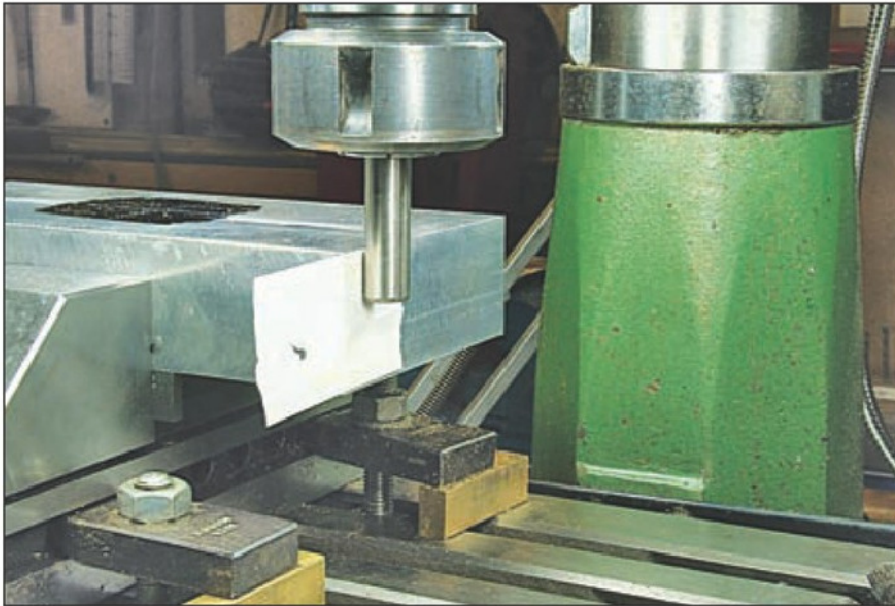
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EDGE AND CENTRE FINDING

Michel Christiaens looks at work setting



1. Silver steel and cigarette paper, all that is needed.

This article does not deal with lathe work, the principles of edge finding when milling in the lathe are similar to those described here.

The means and methods for edge and centre finding range from the very simple and cheap to the very expensive and complicated. From do-it-yourself, right out of the junk box, to high precision instruments. What you actually choose depends on what you want to spend and what comfort and precision you expect. But whatever you do, finding an edge or finding a centre, the precision of any method depends largely on how good (or bad) the edge or centre finder is mounted concentric with the spindle of your machine. In other words, the total run-out should be as small as possible. In that view collets are definitely more precise than even the best drill chuck. Of course it all depends on how precise a given task should be accomplished.

The simple approach

For years I have helped myself with a piece of silver steel (drill rod) and possibly a cigarette paper (photo 1). The latter not because I should advocate smoking but simply because cigarette paper is readily available, cheap, thin and of constant thickness (0.02 mm, 0.0008in. here on the continent). Silver steel on the other hand is centreless ground and quite precise both in cylindricity and dimensions. The method used to find the edge in this way is simple, though there are some preconditions, the plane you are referring to must be flat and perpendicular and the edge should not have any burrs. As a matter of fact, these conditions are important for all methods of edge finding. Chuck up the piece of silver steel (usually 10.00 mm or 3/8in. dia.) bring it slowly until it almost contacts the work. Now there are a couple of options. Either you

use the cigarette paper or... you don't. If the paper is used, it serves as kind of a feeler gauge. It can be stuck on the side of the work with a little oil or you can hold it between your fingers. Moving the paper back and forth you can feel when it makes a sliding fit between the shaft and the work. Of course you could do the same with a real feeler gauge but, as I said already, I keep the cigarette paper handy in one of my overloaded pockets and it serves me well in other instances too.

There is another option that does not involve anything more than the cylinder, the workpiece, a light source and your eye. Observe the gap between the dowel and the work, possibly with a light source behind it (a flashlight, for instance), and watch the gap grow narrower. The light all of a sudden disappears! Maybe it sounds a little suspect "eyeballing", but it's really amazing how precise this can be done. You must try it to be convinced. Just go slowly.

Keep in mind that once the above has been done, you're still not there. Take into account that the machine table (or the cutter) must be moved half the diameter of the dowel to have the centreline of the spindle precisely above the edge! Obvious, isn't it? But I can't count how many times I forgot just that! Or that I moved the table in the wrong direction. And don't forget to zero the dial or the DRO.

Another way to use the cylindrical probe is by smearing a thin layer of engineer's blue on the vertical surface and to move the work toward the dowel, turning the dowel by hand (!) until the blue can be seen on the piece of silver steel. Possible, but not my preferred method, I must add.

I upgraded from the silver steel dowel to something more sophisticated when I inherited a cabinet full of nice tools of Russian (!) origin. Among these was a mandrel with a Morse cone and a nice co-axially ground cylindrical part of 20mm in diameter (photo 2).

OVERVIEW

To accurately locate, for instance, a hole when a dimension is given from the edge of a workpiece, you must have a way to align the centre of the machine spindle with the edge of the workpiece. It is also quite possible that the location is given from the centreline of an existing hole (or slot or whatever symmetrical item). You can easily see the edge of a workpiece while the centre of a hole is immaterial. Obviously this calls for quite different approaches. To that end there are lots of methods and means and I am sure numerous people can (and will) come up with their own clever and inexpensive method to achieve their goal with the precision and repeatability that was called for or expected. Usually we stick to the method we found "good enough" and practical and, because we learned to use it to a certain degree of perfection, it brings us the results we want. Until... our tried and trusted method does not work anymore in a certain situation and we have to resort to something else.



2. A nice Russian tool instead of the silver steel cylinder.



3. A flat ground on the cylinder of a drill. As a matter of fact, I used a broken slot drill here.

The drill

Take a dull or broken drill of any reasonable diameter. Even one of 3.0mm or 1/8in. will do but a larger diameter is stiffer. However, it has to be hard. If not it will rapidly deteriorate and lose its usefulness. Measure the diameter carefully and remember it. Grind off the fluted portion. Grind a small flat on the cylindrical part you have now in hand. Now chuck these modified remains of a drill in a drill chuck or a matching collet (photo 3). Bring the shaft with its flat near



4. The flutes of a centre drill can act as "flats".



5. The sticky pin.

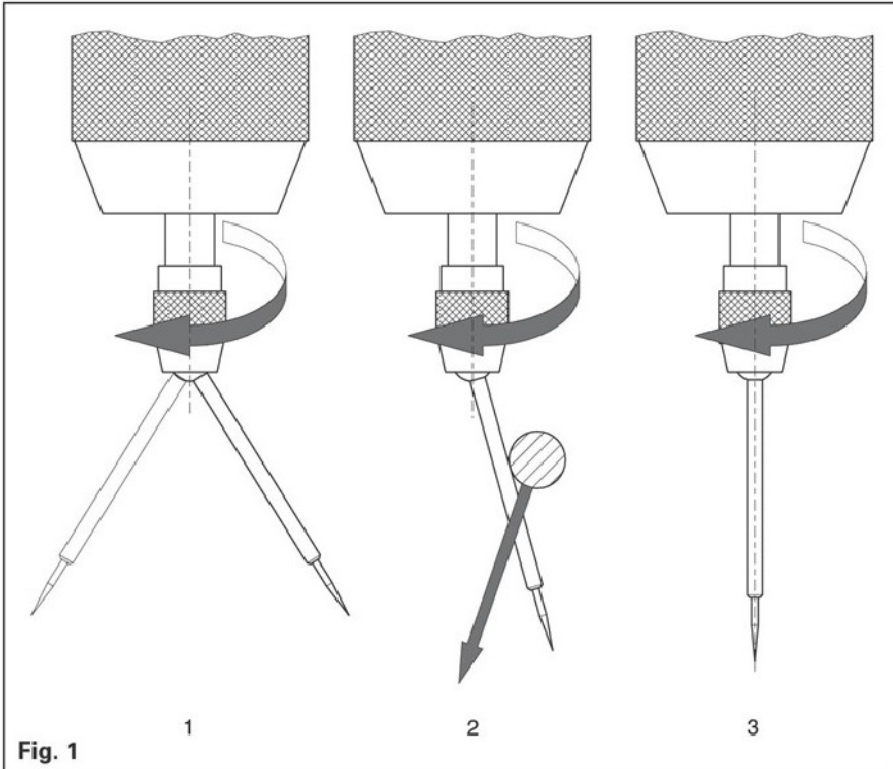


Fig. 1

the edge you want to locate and let the spindle turn at about 800 to 1,000 RPM. Once this shaft touches the work, a ticking or rattling sound can be heard. Now you know you are half the diameter away from the edge. Set the dial or the DRO to zero, remove the shaft and move the work or the cutter over half the diameter of the drill, in the right direction, and Zero again.

Eventually you don't have to sacrifice a drill for this. Often one or more holes have to be drilled at given distances from two sides of the workpiece. Then a centre drill can be used to do the alignment in exactly the same manner as the flattened drill shaft above! Simply because a centre drill comes with two short "flutes" that can act the same way as the flat on the drill shaft does (photo 4). If carefully used this serves

well. Careful, because the sides of the flutes actually cut! Still another advantage of this method is that the centre drill can be left chucked because we need it to drill a pilot hole anyway.

The sticky pin

What if you want to locate quite precisely the intersection of two scribed lines? Obviously none of the above methods can be used. If there isn't a dedicated tool within reach, it's possible to use a "sticky pin". It simply is a pin or a small sewing needle stuck in a blob of hobby clay, putty, chewing gum or whatever of that kind and the whole stuck on the end of the cutter (photo 5). While running the pin is pushed until it runs true and stays there. Making the pin run true can be done with your

fingers but it's not always a good idea for obvious reasons. Once the pin runs true, it can be used to locate the scribed lines. Do not try to locate the intersection of the lines though. Locate one line, away from the intersection and zero, locate the second line and zero the appropriate axis. All this must be done while the pin is almost (but not quite) touching the surface of the work.

The ruler

Often a round piece of stock must be drilled through its centre. The most simple, old time, method to reach this goal is to place a ruler between the work and the stationary drill. When the drill is on centre, the ruler lays horizontal on the work (photos 6 and 7). If off centre, the ruler will be inclined to one or the other side. This is not very precise but is more than good enough not to break any drills.

Out of line of the right-out-of-the-junk-box approach is a device I came across a couple of years ago (photo 8). Chuck it, place the "V" over the round stock and perpendicular with the axis of it, lower it and if the two marks meet, you're on centre. Nice idea, but the specimen I have is so sloppily made it's almost useless. It seems the indexes are made with an axe and overall it's very crude.

Using dedicated tools

Most of us have one or more and almost everyone knows about them; they are rotary edge finders of some sort, sometimes called wigglers, sometimes wobblers.

The wiggler

A wiggler consists of a body or holder and usually four interchangeable tool tips, which serve different purposes (photo 9). In spite of its many possible uses, it usually comes without instructions. So there may be some confusion as to how they should be used.

The accessories should be mounted not too snug in the holder. If too tight the function can be impaired. The point can be used to position a spindle over a scribed line (photo 10) similar to the way it is done with a sticky pin. The wiggler is, in this configuration, easier to use but also more dangerous. With the spindle running at 500 to 1,000 RPM the point is set to run true. Do this by using a pencil, a ruler and such as fig 1 shows. Keep your hands out of the way! If the pin is pushed too far it can start "helicoptering" and when your hand is in the described circle that point is really very, very sharp. When the point runs true, the work is positioned under the centre finder. Very close to it but without touching. Move the table(s) until the centreline of the spindle is directly overhead of the desired line or mark.

The feeler with a ball on each end and the one with a little disk on one end are used to locate the edges or vertical surfaces, slots, grooves or holes. With the spindle running the probe is oscillating slightly (fig 2-1). Move the table(s) (and the work) and make contact with the ball or disk. The oscillations get smaller and smaller and finally the attachment will run true. (fig 2-2) When the edge is reached, the probe will "run off" along the vertical surface of the work (fig 2-3). Now the distance between the spindle centre and the edge is half the diameter of the ball or disk.

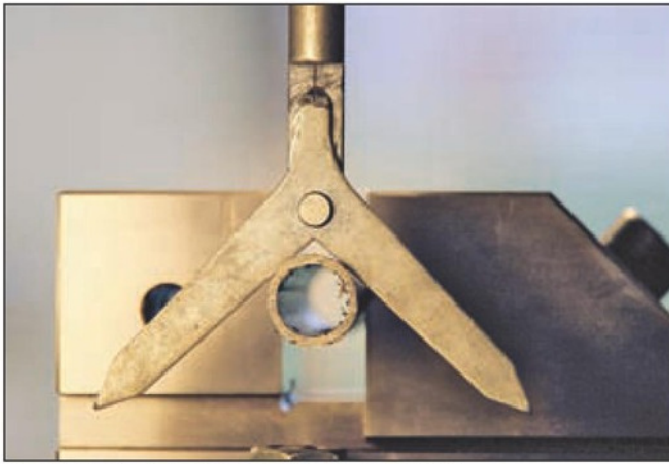
The fourth accessory is used to mount a dial test indicator on the cylindrical part. In



6. Off centre...



7. ...and on centre.



8. Another way to centre a drill on a cylinder.



9. A wiggler set.



10. The pointed probe of the wiggler to locate scribed lines. Not running true yet.

this setup the knurled nut of the holder should be very tight so the indicator can not be pushed out of its position when in use.

The mechanical edge finder

Sometimes called "eccentric edge finder", this is perhaps the most widespread of all. It's a mechanical device consisting of two equal, cylindrical parts, precisely ground and held together by an internal tension spring (photo 11) so the parts can move sideways a little against each other (photo 12). This is quite essential in the way it is used. The carefully chucked-up edge finder is spun at some 800 to 1,000 RPM. Better not exceed this speed too much or the part not chucked can fly away as the tension spring breaks. Don't ask how I know. The spinning edge finder is moved into contact with the edge that should be located. The loose part is running eccentrically (fig 3-1). As the lower cylinder touches the plane it begins to run more and more concentric (fig 3-2). Then, all of a sudden, the cylinder is "kicked" to one side (photo 13 and fig 3-3). At that point the axis of the spindle and the edge of the work are half the diameter of the finder apart. There are many different diameters in use so it's important to know exactly what diameter your particular edge finder has.

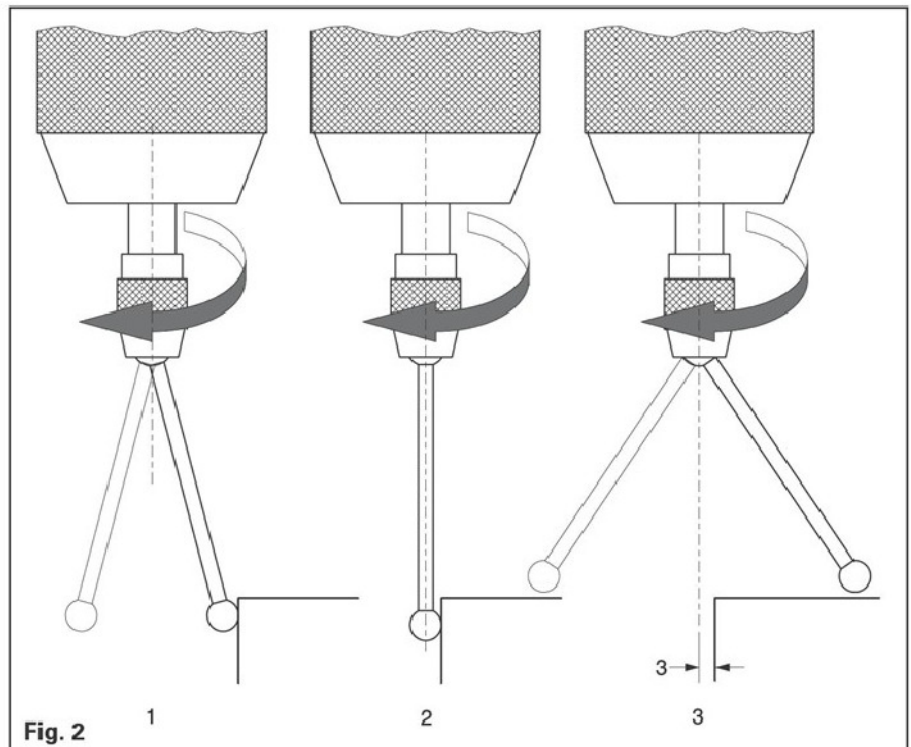


Fig. 2

Some of these edge finders do not only rely on the observable "kick" but also produce a clicking sound when the edge is reached.

There are some precautions when using this kind of tool:

- 1) If one of the ends of the tool has a smaller diameter, that is the part that should touch the edge.
- 2) Do not exert too much force to chuck-up the finder. It's hollow and can quite easily be damaged by too much pressure.



11. The eccentric edge finder.



12. The loose part can move a little sideways.



13. The revolving edge finder is kicked to the side.

- 3) Do away with burrs on the edge you want to locate.
- 4) As I already said, do not use a too high a speed.
- 5) Better leave the edge finder "rubbing" against the work for as short as possible. This saves the carefully lapped surfaces of the finder.
- 6) The point when the edge is reached is observed best when looking on the touched surface at an angle of approximately 90 degrees.
- 7) These tools don't ask for much maintenance. Just don't let it rust (you should avoid rust on any tool anyway) and carefully slide the two parts aside to give them a drop of light oil, once in a while. Certainly do not "break" the tool in two to apply the oil. The tension spring could be very unhappy with such a treatment.
- 8) If you are to buy this kind of tool, cheap usually is not better. A used edge finder of this kind can be a good buy but for the modest cost involved a new one is better.

If you buy a set of these edge finders (photo 14) there will certainly be one with a pointed end, a nice cone with a very fine point (photo 15). If you want a lively discussion among home shop machinists, just ask how this particular tool should be used! I have used this tool in three different ways which can be seen in fig 4:

- 1) To locate the centre of a small hole, which is difficult to do right. The edge of the hole should be "sharp" (without an uneven little chamfer) and without burrs. The stationary edge finder (now really a centre finder) is brought into contact with the hole. If you are extremely lucky, the two parts of the tool will be nicely aligned. Chances are, they are not. First the difference can be seen, and when things are getting tight it is possible to actually feel if there is still a little "step". Now this may sound suspicious, feeling instead of measuring. Well, it is truly amazing how good we can feel even the slightest step. When the two parts of the tool are aligned in all directions, we are there. The spindle is aligned with the centre line of the hole. The results are a little more consistent when a centre bore is located in this way. The point of the finder fits very nicely in the (clean) centre bore. The rest is as described above.

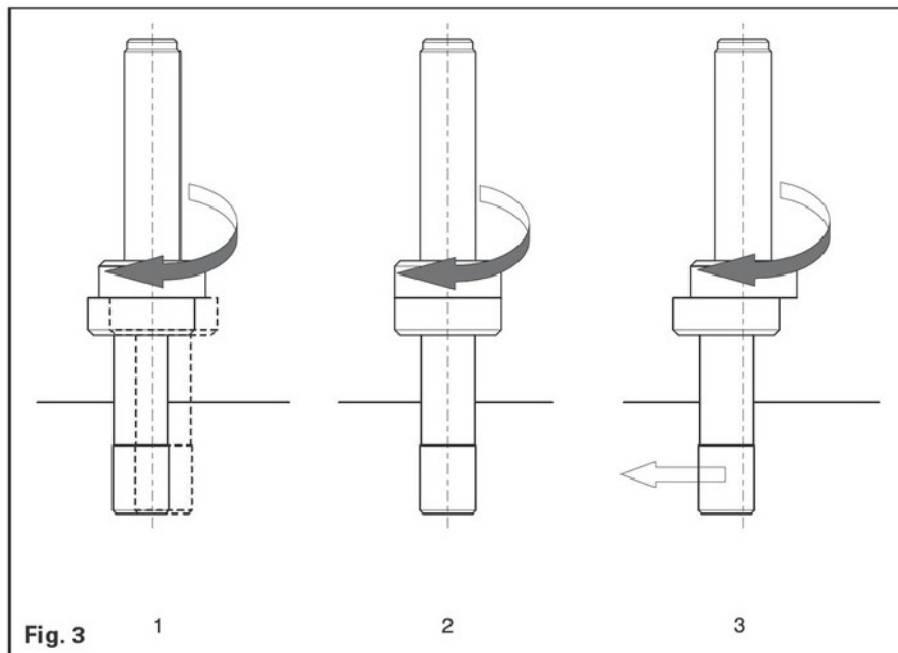


Fig. 3

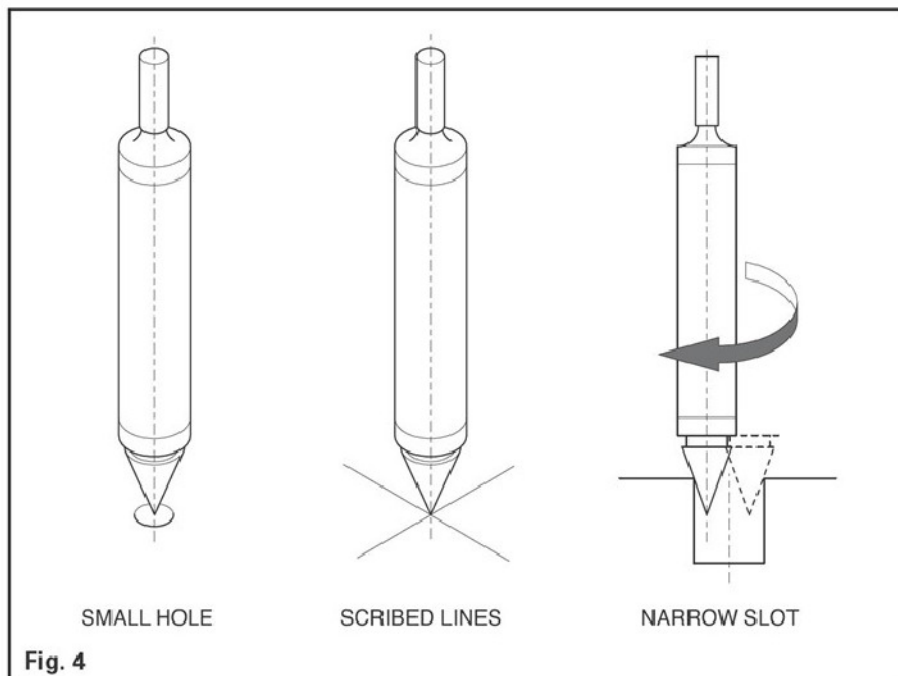


Fig. 4

- 2) To locate scribed lines. Much in the way a sticky pin or a wiggler is used to do that. First make the point of the tool run true. This is easily done. Then bring the point very near to the scribed line but not in contact with it. The point is fine and delicate and if it is misused and it becomes more or less blunt, it's useless. Do not try to align to the intersection of two scribed lines. It will not work, at least not with any degree of precision. Align to each of the lines separately and zero the dials or the DRO accordingly.
- 3) Finding the centre line of a narrow slot. Again, the edges should be sharp and free of burrs. Touch one edge with the edge finder running until the point "kicks". Zero. Touch the other edge without changing the height of the tool (Z-axis) and read how far the table is moved. Divide by two and you found the centre line of the slot.

To be continued...



14. A set of eccentric edge finders.



15. The controversial edge and centre finder with a conical point.



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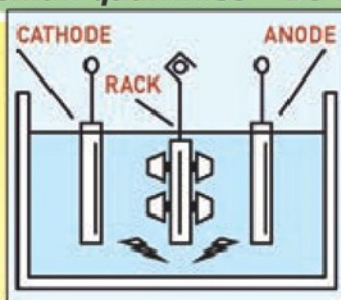
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A BEGINNER'S GUIDE TO WORKSHOP MATERIALS

Dave Fenner looks at different materials

The materials used in the home workshop will typically fall into the main categories of metal, wood, plastics, and others. These main categories may then be subdivided so that metal would be ferrous, and non ferrous, the former encompassing cast iron and the wide range of available steels, the latter including brass, copper, aluminium etc. Wood comes in many varieties: hardwoods to softwoods etc. from lignum vitae to balsa. Plastics is an area where new materials often appear on the market. The applications for plastics which come first to mind, include windows or lamp glasses, (clear and coloured sheet), bearings (often unlubricated) and insulators. This article will focus mainly on the different metals likely to be encountered by the amateur, but will touch upon the other areas. Before looking at materials, it may be useful to briefly consider a few material properties, which you may come across in descriptive material.

Tensile strength

In simplified terms, this is a measure of the ability of a bar to resist being pulled apart by forces at each end. In old imperial units, a bar having a cross section of one square inch made of 60 ton steel, would support a 60 ton load. (The tensile stress would be 60 tonf/sq. in.) Colin Chapman at Lotus is reputed to have observed "You can hang a double decker bus from a quarter inch bolt"

Shear strength

Here is where the applied loads are not in line, such as a rivet or bolt, or perhaps crankpin. Cutting sheet material with scissors or tin snips (**photo 1**) relies on a shear fracture to create the cut.

Fatigue strength

Although a component may quite happily support a static load, it may fail if subjected to repeat loading such as may result from vibration. One popular method of obtaining fatigue data on test pieces is by the rotating beam method. A bar type specimen is rotated at between 2000 and 5000 rpm while being subjected to a bending load. Thus during one rotation, longitudinal "fibres" are subjected to both tensile and compressive stress.

Hardness

For metals, this is generally measured by one of three systems, Vickers DPN, Brinell, or Rockwell. An indenter (diamond or ball) is pressed into the surface by a specified load, and the impression measured. Smaller impression - harder material. There is a degree of correlation between hardness and tensile strength, so



1. Cutting action by shear fracture.

a relatively simple hardness test can give a guide to the tensile properties. Materials such as rubber employ the Shore hardness system.

Creep strength

As metal is heated, it will ultimately reach melting point and become fluid. At a slightly lower temperature, it will be red hot and solid but easily worked by say a blacksmith. Coming further down the temperature range, the metal may appear normal. However, if kept at a high temperature, and loaded in tension, it will gradually extend or creep. This phenomenon is of particular interest to designers of gas turbines, where HP turbine blades are subject to high temperature and centrifugal force. Hence they could creep, thus reducing the diametral clearance. Special creep resistant alloys are therefore used for situations where both temperature and stress are high.

Metals - ferrous

Taking the metals category first, we will commence by looking at the ferrous sub sector, i.e. those metals having iron as the main constituent. Before looking at the different steel types, it may be worth commenting on the difference between bright and black. Most of the bar material on offer from the model engineering suppliers will be bright. In other words the final operations at the steel works have been done cold. This means that there will be stresses locked into the material.

When bar is turned down to size, material is removed all round, so any distortion due to stress relief is likely to be minimal. However, if material is removed from one side of a bright flat bar, then a bend along the length is not unusual, as the stress pattern which then remains is no longer symmetrical. Black or hot formed/rolled steel is worked hot, then cools after the mill operations, so does not have the distortion problem, but will have

a mill scale surface to be machined away. In terms of shape, you can generally find, aside from sheet, round, hexagon, square, rectangular flat, and angle sections.

Tubes may come as round, square, and rectangular in ERW (welded) form, and round as seamless.

As regards types of steel, there are numerous publications giving useful information. Two I can recommend from personal experiences are 1) the Macready's "Orange Book" otherwise titled Standard Stock Range of Quality Steels and Specifications" and 2) "The Mechanical and Physical properties of the British Standard EN Steels" compiled by Woolman and Mottram for the British Iron and Steel Research Association.

The former is available from Niagara who took over Macready's, a highly reputable supplier of carbon and alloy steels. The latter is a three volume set which was published between 1965 and 1967, and while officially the old En specifications have been superseded, the En range of steels is still recognised in many quarters, and the information is still valid.

My understanding of historical and current systems is as follows. The En (Emergency Number) series dates back to the Second World War, and then became a British Standard (BS 970: 1955). Other standard systems prevailed in other countries e.g. S.A.E. and A.I.S.I. in America, A.F.N.O.R. in France and D.I.N. in Germany. The system now in widespread use, defines steel by a series of three digits followed by one letter, then two digits. This may or may not be followed by a letter or letters, a single letter indicating condition (as regards heat treatment, or Pb indicating a lead content to improve machinability).

Thus what we used to know as En1A free machining steel becomes 230M07. The suffix Pb may be added to indicate the inclusion of a small amount of lead, but not all stockholders use this nomenclature.

Explanation of the system

The first three digits give the type of steel.

000 to 199	carbon and carbon-manganese steels
200 to 240	free cutting steels
250	silicon - manganese valve steels
300 to 499	stainless and heat resisting steels
500 to 999	alloy steels

The next part of the code is a single letter

A	the steel conforms to a chemical composition verified by Analysis
H	the steel conforms to a Hardenability specification
M	the steel meets specified Mechanical properties
S	the steel is a Stainless steel

The final two digits indicate the carbon as a percentage times 100. Thus for the En1A example given above, the carbon content would be 0.07 per cent.

A suffix letter from P to Z may be added if the steel has been heat treated and this indicates the condition of supply i.e tensile strength. The one I have encountered most frequently is in connection with the old En24T now 817M40 T where the T tells us that the material has been heat treated to give a tensile strength within the range 850 to 1000 MPa or 55 to 65 tonf/sq. in.

Table 1 lists the letters R to Y against tensile strengths, given here in old money tonf/sq.in. and the more up to date MPa. It will be seen that the conversion factor is 15.444.

Table 1		
Condition Code	Min. Tensile Strength	
Letter	Tonf/sq.in.	MPa
R	45	700
S	50	770
T	55	850
U	60	930
V	65	1000
W	70	1080
X	75	1150
Y	80	1240

Although a very large range of steels is available to industry, I would advocate just a few for model engineering purposes and for this I make a broad brush divide between high and low stressed applications. For the latter I try to go for the En1A leaded (230M07 Pb) mentioned earlier. It machines to a first class finish at high speed and gives good tool life.

Photograph 2 shows the different characteristics of swarf from free cutting compared to that from ordinary mild steel such as En3B (070M20). One drawback of the leaded variety concerns its weldability, where it is reportedly prone to cracking. My own experience on small parts using Mig and Tig welding in low load situations has been satisfactory.

There are situations where a designer specifies high tensile steel in an application where he is actually seeking rigidity. One point that should be noted is that Young's modulus (a measure of flexibility or rigidity) is roughly the same for all steels. Hence if the object is to achieve minimal deflection, then it is likely that a part made from mild steel will perform every bit as well as one made from a high strength alternative. For some situations, a case hardened steel may be called for. There are steels recommended for such duties, but for many applications, the case may be applied to a common or garden mild steel.

Moving up the strength scale a little, takes us to what used to be known as En8 or 080M40 which tells us that this is a "40" carbon steel. It is also available in a free machining version formerly designated as En8DM, now 212A42. Due to the carbon content, in sizes up to about 22mm dia. this material may be hardened and tempered to about 45 tons/sq.in.

For high strength applications, one steel sticks in my mind, En 24 (817M40), which I am told is what they make Allen screws from. It is usually commercially available in either of two forms, softened, in which case the hardness should not exceed Hb 277, or hardened and tempered to the "T" condition as mentioned above. It may be worth observing that Allen screws can be annealed and are then very much easier to machine. They can also be re-hardened to higher than original hardness to perform cutting tool duties. **Photograph 3** shows some examples.

If a high degree of corrosion resistance is wanted, then we may look to the

various stainless steels on offer. Those most likely to be encountered will be the 303 (En58M or 303S31), 304 (En 58E or 304S15) and 321 (321S31) grades. Grade 303 offers easier machining at the expense of reduced corrosion resistance when compared to 304. Several sub varieties of 304 are available including 304L which has a lower carbon content for improved weldability. Historically 304 was the "18/8" stainless, i.e. 18% chromium and 8% nickel, and as it may be deep drawn it has found extensive use in kitchen sinks etc. 321 also falls into the 18/8 category, and has similarities to 304, but it has the addition of niobium which can have implications for welding.

In general, stainless steels work harden and therefore it is essential that cutting tools really are sharp. A dull edge will cause work hardening and start a vicious circle.

Metals - non-ferrous Aluminium and its alloys

Previous articles in MEW by authors with a deeper knowledge of these materials have demonstrated the very extensive varieties of aluminium alloy now available. Most applications other than foil and electrical cabling require greater strength than is possessed by the soft and ductile pure aluminium. To gain greater strength, aluminium is alloyed with other elements which allow a rough division into two groups, the non-heat-treatable (alloyed with manganese, silicon, iron, and magnesium) and the heat-treatable (alloyed with copper, magnesium, zinc, and silicon).

For many applications, aluminium can demonstrate marked advantages over steel. Size for size, it is about one third of the weight, but this may be offset by a similar reduction in rigidity. In most cases, aluminium alloys can be machined more easily and considerably faster than mild steel, however there are some quite tough alloys. Even soft aluminium can cause difficulties due to the uninterrupted coils of swarf, and some of the casting alloys can blunt tools quite rapidly due to the silicon content.

Although there are a vast number of alloys available to industry, it is likely that just a handful will satisfy most amateur applications. Broadly speaking, aluminium is now designated by a four digit classification, where the first digit indicates the principal alloying element.



2. Swarf from free cutting steel below gives a quick test to confirm your material really is free cutting.



3. Three tools made from Allen screws. Top a punch; middle to cut internal groove; bottom keyway cutter.



4. Balsa plank within the letterbox would be "A" grain.



5. This would be "C" grain.

1xxx indicates near pure aluminium, 2xxx copper, 3xxx manganese, 4xxx silicon, 5xxx magnesium, 6xxx magnesium plus silicon, 7xxx zinc, and 8xxx lithium. Hitherto, a letter/number system was used e.g. HE30 etc.

For applications where much machining is involved, 2011 (FC1) would be my preferred choice however this material is unsuitable for welding. Many extruded sections will be commercially available in 6082 (HE30) and here the weldability is good. One point regarding aluminium which sticks in my mind from a college lecture in the sixties, is that aluminium has a very low (possibly zero) fatigue limit. In other words, if subjected to even a very low alternating stress then it will eventually fail. The previous year, I had produced a beautiful aluminium speedometer mounting for my Triumph Tiger 100. This disadvantageous property of aluminium explained why the mounting broke in two, after less than 300 miles. It may well be that developments over the ensuing 45 years have come up with alloys having improved fatigue resistance, but it is nevertheless a factor to bear in mind.

Magnesium

It is probably not permitted under modern health and safety legislation, but I remember both in school and domestically with a chemistry set, being able to set fire to a length of magnesium ribbon, and how fiercely the material burned. Magnesium alloys were used in the post war years notably for engine castings (motor cycle also model and full size aero). The main advantage is even lower weight than aluminium (about two thirds for equivalent volume) but care must be exercised during machining as the swarf can catch fire, and be difficult to extinguish. For this reason I would personally avoid these materials.

Copper

A number of years ago when my livelihood depended on making things efficiently, I acquired a couple of publications from the Copper Development Association, the first, ref. No. TN44 entitled "Cost-effective Manufacturing - Machining Brass, Copper & Its Alloys", the second, ref. No. 98 "Cost-effective Manufacturing - Joining of Copper and Copper Alloys". The first of these books suggests that in the European standards there would be about 40 specifications for cast copper and copper alloys, and about 140 for wrought materials. As with steel, for amateur purposes, just a few will cover most eventualities.

Copper is probably best known in model engineering circles as the material of choice for boilers. In the softened state, it is malleable and ductile, but work hardens. Thus when flanging boiler plates, it may be necessary to work in stages, re-softening between hammer work. Fortunately softening or annealing is a simple process, just heat to a temperature above 400 deg C. Without specialist equipment, judging temperature at this level is not easy, so one route for the amateur is to heat to "just red" viewed in subdued light, indicating something in the range 600 to 650 deg C. The hot material may be allowed to cool in air, or may be dunked in water. The latter may encourage distortion but will tend to clean off scale. Some copper material, notably tube may be supplied in either softened (typically coils) or half hard, (typically straight).

You will most likely be offered copper in one of two varieties, most usually C101 in bar, flat and sheet form, or C111 which is a free machining version, supplied in bar form (round, square, or hexagon).

Brass

Probably the most widely used alloy of copper is brass, a term which actually covers a range of alloys which contain mainly copper and zinc. Here, CZ121 is the most likely offering, which is a brass whose properties allow rapid machining, but with limited cold workability. Thus for bars which require tight bending, CZ108 could be a better bet. This material is also the norm for brass sheet, although a further variety CZ120 is designated as engraving sheet. When brass is used for boiler fittings, it is possible for dezincification to occur with a consequent loss of strength. While there is a brass alloy intended to be resistant to this, it is most likely that one of the bronzes will be more readily obtainable.

Bronze

Bronze is traditionally thought of as an alloy of copper and tin, however in the cast gunmetal form frequently employed for cylinders, feed pump bodies etc. it is likely to be a copper - tin - zinc mix, giving good corrosion resistance, and strength. A number of other bronzes may be encountered:

Manganese Bronze - more of a high tensile brass where added manganese gives good strength.

Aluminium Bronze - alloys which can include copper, aluminium, silicon & iron. High strength & corrosion resistance, in marine applications.

Lead Bronze - a series of copper, lead, tin alloys intended for moderate load bearing applications. Some (LB4 & LB5) are tolerant of poor or water lubrication.

Phosphor Bronze - alloys mainly of copper and tin which find widespread use for bearings and gears. Some varieties have added lead which improves machinability. The grades most frequently found will be PB102, and Colphos 90, a free machining version of PB102. Its machinability is rated at some 90 per cent of CZ121. SAE660 is really a leaded bronze but may be listed in the phos bronze section of some catalogues. Its popularity in industry particularly for bearings, has increased over the last decade, and in continuously cast form, is available in solid bars from 1/2in. diameter and hollow bars from 1in. OD.

Wood

From the outset here I will profess to limited experience of working with wood. Unlike metal, it is a "Natural" material, and as such, cannot be relied upon to maintain size or shape stability, unless precautions are taken concerning the moisture content. For a more detailed treatise on working with wood, I suggest readers look to the excellent article written by Harold Hall and published in MEW Issue 103, from which some of the following information is derived.

At the initial sawmill stage, the log may be converted to boards in one of two methods, through and through, or quarter sawn. The former is more economical and therefore more common, but creates boards, some of which are more likely to "cup" during drying, due to differential shrinkage.

In the model making sector, balsa wood is still widely used by the model aero fraternity. Its density can range from about 6 to 24lbs per cu. ft. with supplies typically falling within the range 8 to 12 lbs per cu. ft. in thicknesses from 1/2in. to 1/4in. and lengths of 36in. or 1metre, and widths of 3in. and 4in. Assuming "through and through" processing, a thin board cut near the top of a log will be near tangential to the growth rings and be regarded as "A" grain. One cut across the diameter will have rings at right angles to the board width and be referred to as "C" grain. The former should be better for bending, the latter for improved compressive strength.

Photographs 4 and 5 illustrate these grain effects with reference to a slice of beech.

Obeche is a wood that I remember back in the fifties as the preferred "higher

strength" wood, for such items as engine bearers in model aircraft. It is still available, but seems also to be supplied nowadays for veneering and sculpting work, being described as soft, very light and ideally suited to carving. Within the aero scene, higher strength duties now seem to be served more by spruce (strip and sheet), beech (strip) and lamin (dowels).

In addition, plywood may be obtained in thicknesses from about $\frac{1}{8}$ in to $\frac{1}{2}$ in. from hobby suppliers, and up to about 1in. from the building trade. Within the plywood section, a number of options are available. For model makers, a product known as "lite ply" is on offer. This seems to be a ply with a soft and lightweight mid section which is easily cut. In the larger sizes, the descriptions; interior grade, exterior grade, marine or structural will indicate the type of bonding or glue, particularly as regards its ability to withstand moisture. A plywood description may also include two grade letters (A to D) which indicate the quality and appearance of the two outside faces of the sheet. Thus grade AA has both faces well sanded and virtually blemish free, while AB would have one "good face", and CC or DD would be suitable for hidden structural or shuttering applications, where appearance is unimportant.

Interior ply should be used where the exposure to moisture is limited, and is available in a variety of hardwood types such as birch, cherry or oak. Most DIY stores will stock exterior grade ply, where the bonding used is very much more resistant to moisture.

In the case of marine ply, the bonding is by the best glues, and the timber quality is higher, however this is not generally available over the counter at the local store.

Structural ply combines high quality glue with timber of less than perfect appearance. For a lower cost application needing resistance to moisture, it may be worth a look.

Plastics

A glance through the relevant section of a catalogue such as that from R S Components will reveal just how wide the choice of modern plastics has become, with names such as Turlon, Peek, PTFE, Acetal, Nylon, Acrylic, Polyurethane, Polycarbonate, PVC, and Tufnol, to mention a selection. For industrial purposes, particularly where high production is intended, then the choice

of plastic may be critical to combine the required characteristics in a cost effective package. As with metals, most of our amateur needs can be satisfied with a small selection. PVC may be seen as a low cost, easily machined plastic with good mechanical strength and chemical resistance. Nylon may be found as the basic white nylon 6, or with the addition of glass, oil, or molybdenum disulphide. Glass adds rigidity, the latter two improve bearing performance.

Tufnol is a brand name covering several products, which are produced by laminating layers of fibrous reinforcement (cotton cloth, paper, or woven glass cloth) bonded together with thermosetting resins. Available as sheet, tube, and bar, the different grades have a wide range of applications including, electrical insulation, bearings, gears, etc.

Photograph 6 shows three forms of Tufnol.

Two other plastics which should be noted are the optically clear acrylic material (e.g. Perspex) and polycarbonate sheet (e.g. Lexan). The latter is riot shield material and has high impact resistance. The former is also available as sheet but in addition, may be obtained as rod or block (**photo 7**).

With a number of plastics, rather like wood, dimensional stability is affected by moisture absorption.

Others

Tungsten carbide will be familiar as a material used for cutting tools. I think I also recall it mentioned in connection with clock components. Cutting carbide is likely to require a diamond wheel, and if you plan to use it then you have probably progressed beyond the beginner stage.

There are two ceramics that should be mentioned, one is Macor, the other Duratec 750. Both are machinable. Macor is the harder, and the more expensive (considerably so). It is hoped to offer some notes on machining these in a future article. Applications are likely to be components involving high temperature electrical insulation such as spark plug bodies. Special ceramic screws would probably need the higher strength of Macor. These, along with other ceramic and glass materials are available from the Technical Glass Company.

Suppliers

The dedicated suppliers to the ME fraternity have a deep understanding of the principal amateur requirements

for metals and hold suitable stock to service these. Two firms I have dealt with frequently are College Engineering Supply and Folkestone Engineering Supplies.

For small size wood, you may be drawn to a model outlet catering for planes and boats. Larger quantities would be the province of a timber yard, sawmill or specialist supplier.

Plastics will probably need to be sourced from a dedicated company specialising in such. Interestingly, there seems to be a commercial divide between the rigid (plastics) and the deformable (rubbers). Similarly, you will probably need to find a specialist such as the one mentioned for ceramics. For local information, Yellow Pages will often give details of relevant local companies, and if this fails, then an internet search will almost certainly provide an answer. ■

MEW RESOURCE BOX

Suggested further reading and suppliers

- 1) "Standard Stock Range of Quality Steels and Specifications" Macreadys
- 2) "The Mechanical and Physical properties of the British Standard EN Steels" compiled by Woolman and Mottram for the British Iron and Steel Research Association.
- 3) Material Database www.matbase.com
- 4) R. S. Components www.rs-online.com
- 5) Tufnol www.tufnol.co.uk
- 6) The Technical Glass Company www.technicalglass.co.uk/
- 7) College Engineering Supply www.collegeengineering.co.uk
- 8) Folkestone Engineering Supplies www.metal2models.btinternet.co.uk
- 9) Copper development Association www.copperinfo.co.uk
- 10) MEW Issue 103 pages 12 - 16 Wood in the Metalworking Workshop - Harold Hall
- 11) Model Engineering a Foundation Course - Peter Wright published by Special Interest Model Books



6. Three varieties of Tufnol.



7. Two offerings of acrylic which depart from the more usual "Perspex" sheet.

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3. BA TAP SET (2 Taps each size) & BA DIE SET: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 BA
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6. BSF TAP SET (2 Taps each size) & BSF DIE SET: $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, 1"
7. BSW TAP SET (2 Taps each size) & BSW DIES: $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{2}$
8. BSW TAP SET (2 Taps each size) & BSW DIES: $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, 1"
9. METRIC COARSE TAP SET (2 Taps each size) & METRIC DIE SET: 2, 3, 4, 5, 6, 7, 8, 9, 10, 12 mm
10. METRIC COARSE TAP SET (2 Taps each size) & METRIC DIE SET: 14, 16, 18, 20, 22, 24 mm
11. UNF OR UNC TAP SET (2 Taps each size) & DIE SET: 0 to 12 UNF or 1-12 UNC
12. UNF OR UNC TAP SET (2 Taps each size) & DIE SET: $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{2}$
13. UNF OR UNC TAP SET (2 Taps each size) & DIE SET: $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, 1"
14. GAS (BSP) PIPE SET: $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$ (2 Taps each size)
15. METRIC FINE PITCH SETS (10 sizes from 3 - 12 mm) TAPS & DIES
16. METRIC FINE PITCH SETS (6 sizes from 14 - 24 mm) TAPS & DIES
17. ENDMILL SET (THREADED SHANK) $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, $\frac{1}{4}$ or (mm) 3, 4, 5, 6, 7, 8, 10, 12 mm
18. SLOT DRILL SET (THREADED SHANK) $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, $\frac{1}{4}$ or (mm) 3, 4, 5, 6, 7, 8, 10, 12 mm
19. ENDMILL SET, $\frac{1}{16}$, $\frac{1}{8}$, 1" DIA WITH $\frac{1}{8}$ THREADED SHANK TO FIT COLLET CHUCK
20. COUNTERBORE SET (FOR SPOTFACING) $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$
21. REAMER SET (STRAIGHT SHANK) $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{2}$ or (mm) 2, 3, 4, 5, 6, 7, 8, 10, 12 mm
22. DRILLS (LONG SERIES) TO VARIOUS SIZES BETWEEN $\frac{1}{16}$ - $\frac{9}{16}$ STRAIGHT SHANK
23. MORSE TAPER SOCKET REAMERS (FOR CLEANING MORSE TAPERS) No. 0, 1, 2 M/T @ £18 EA.
24. BALL-NOSE MILLING CUTTERS (THREADED SHANK) $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$ No. 3 @ £22.
25. D-BIT SET (FOR DRILLING SQUARE BOTTOM HOLES) $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{2}$ DIA. No. 4, 5, 6 M/T @ £35
26. SLITTING SAW SET (HS) 3 PIECES, BETWEEN $\frac{1}{16}$ - $\frac{1}{2}$ (FINE TEETH) £12 SET
27. TAPER SHANK DRILLS (No. 1 M/T) TO VARIOUS SIZES UP TO $\frac{1}{2}$ DIA. £25 SET
28. DRILL SETS (HS) GROUND FLUTES, No. 1 - 80 A-Z @ £18, $\frac{1}{16}$ - $\frac{1}{2}$ 1 - 13mm @ £18, 1 - 6mm x 1mm @ £20
- DIAL GAUGES (MM OR IMP) @ £10 EACH STAINLESS STEEL DIAL CALIPERS (MM OR IMP) @ £12 EACH
- WOODRUFF CUTTER SET $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$ @ £15 SET MAGNETIC BASE @ £15 EACH
- INVOLUTE GEAR CUTTERS - ALL SIZES FROM 2 DP - 120 DP, INCL. MODULE & CP. (ALSO STUB, BEVEL & SPURGEON CHAIN) PLEASE PHONE @ £8 EACH
- TAPER PIN REAMER SET, $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{2}$ (10 PIECE SET - SHEFFIELD MADE) @ £18 EACH
- LATHE TOOLS (SET OF 6) $\frac{1}{4}$ SQUARE VARIOUS SHAPES @ £30 SET
- REVOLVING LATHE CENTRES, 1 M/T @ £18; 2 M/T @ £20 IN HSS @ £15 SET, OR CARBIDE TIPPED @ £18 SET
- DRILLS WITH $\frac{1}{8}$ SHANK, $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$, $\frac{1}{2}$, 1" DIA @ £18 SET COVENTRY DIEHEAD CHASES - ALL SIZES
- 10 - HIGH SPEED DRILL BLANKS, UP TO $\frac{1}{2}$ DIA, (CAN BE USED FOR BORING BARS, OR SMALL TOOLBITS @ £5 @ £10 EACH, WITH TIP [EXTRA TIPS £2]
- INDEXABLE TOOL HOLDERS $\frac{1}{8}$ SHANK $\frac{1}{16}$, $\frac{1}{8}$, $\frac{9}{16}$ @ £13, $\frac{1}{2}$ @ £14, $\frac{1}{4}$ @ £16 EACH
- PARTING OFF TOOLHOLDERS, COMPLETE WITH COBALT BLADE $\frac{1}{16}$ @ £7, $\frac{1}{8}$ @ £8, $\frac{1}{2}$ @ £10
- VARIOUS DRILLS, BELOW $\frac{1}{8}$ DIA. 10 EACH. STUB, QUICK SPIRAL, SLOW SPIRAL, LEFT HAND, @ £5 EACH TYPE
- ROHM PRECISION DRILL CHUCKS, WITH No. 1 OR No. 2 MORSE TAPER ARBOR

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FIRST STEPS IN DESIGN



Linton Wedlock
concludes his
interesting series

10

OVERVIEW

This issue sees the conclusion of this series about 3D Design. Linton has covered many different techniques for modeling various components, from the simple to the complex. I think most readers have enjoyed this series and I would like to thank Linton for writing it for your benefit.

The concluding part of this series on 3D modelling has a mixed selection of topics including using other programs in conjunction with trueSpace, and producing stereograms.

To begin with, a couple more examples of modelling moderately complex objects are described. This is followed by the main theme of the article which is on supplementing trueSpace's 3D capabilities with features available in other programs. The closing topic of the series - creating stereo images from trueSpace models - could be regarded as a novelty. Nonetheless, it can at times be a great aid when the modelling gets complex, as well as being an interesting subject in its own right.

A simple cam

Several years ago I would probably have created this component by constructing its 2D outline in a CAD program, imported it into trueSpace, and then extruded it with the Sweep tool. I suppose this is because I have been conditioned by five years of technical drawing at school, followed sometime later with a similar period of working with 2D CAD. Designing a component entirely with 3D methods is not necessarily quicker or easier than using traditional drawing techniques on a computer, but it can be, and the cam shown here is one such instance.

The 2D CAD construction for the cam shape would look something like this:

Fig. 247

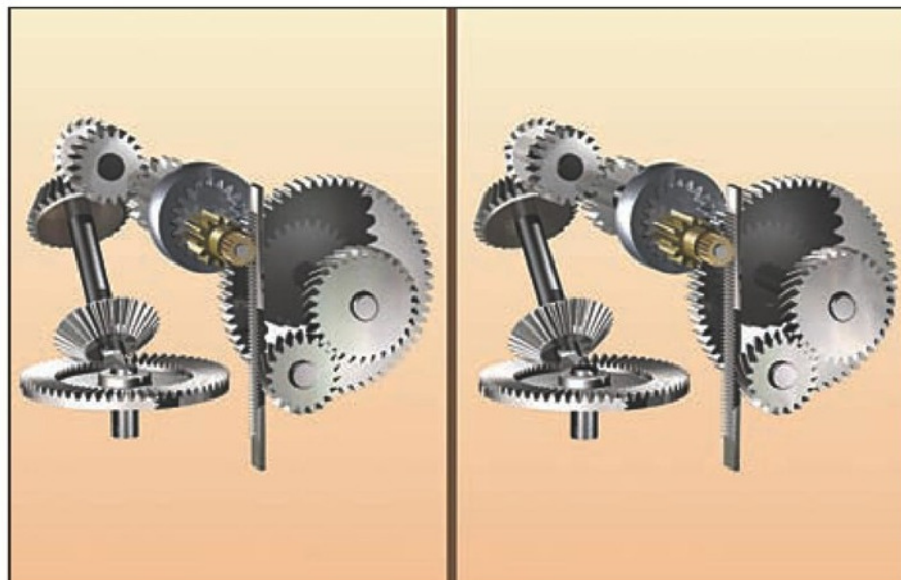
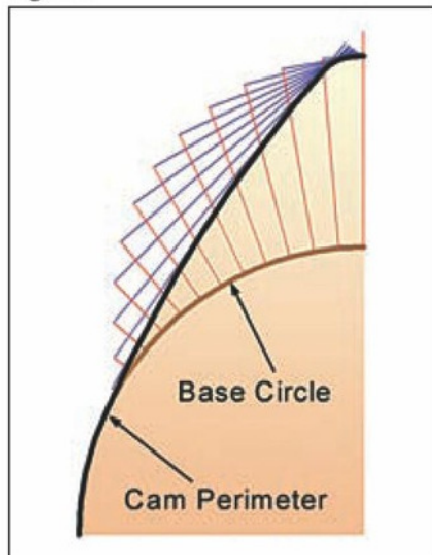


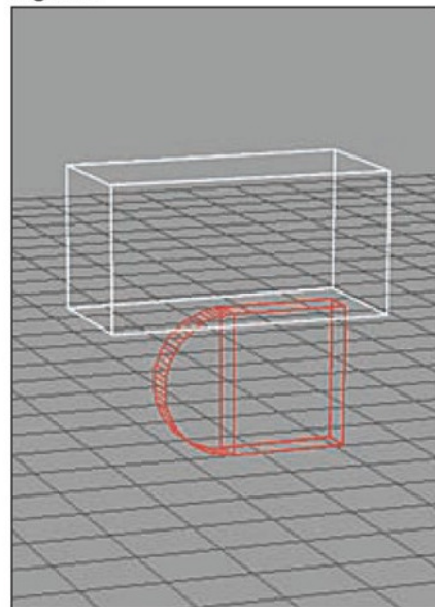
Fig 1. A stereogram created with trueSpace. See text for method of viewing this image.

In summary, the method starts with a base circle, followed by drawing a series of equally spaced radial lines (red) from the circle's centre. Perpendiculars (blue) to the radial lines are then drawn which represent the 'lift' of the cam follower above the base circle when the cam is rotated to the angle of the radial line. A closed polyline is next drawn following these tangent lines to make the cam 2D outline. (Further information on the layout and machining of this type of cam are given in, for example, [ref 1](#)).

The radial lines in the above drawing are comparatively widely spaced at 5deg, but even so it is time consuming to make this diagram. With a closer radial line spacing, it would also be quite easy to make mistakes with the maze of construction lines needed for the drawing.

One way of making this same cam entirely within trueSpace is not fundamentally very different from the construction described above, but in practise the modelling is very much quicker. Start with [Cube:XS4], followed by [Cylinder:ZL0/XR90/ZS0.5] with Longitude:72 (one face per 5°). Using the **Keep Drill** option in the Booleans Panel, **Subtract** the cuboid. Select the flat face of the half disc object (with [Point Edit: Faces]), then [Sweep], [ZL1.665] and [Object Tool]. This value is the maximum extension of the cam profile from its centre (the base circle radius plus the maximum lift). Type [ZR90], then click [Axes], [Normalize Rotation], and [Axes]. Raise the cuboid with [ZL2] so that its lowest face rests on the base circle of the cam.

Fig. 248



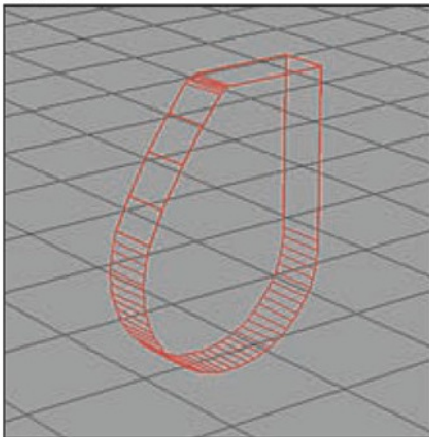
The modelling in this example could be thought of as the virtual equivalent of the method of making a cam shown in [reference 1](#), with the lowest face of the cuboid representing the cutting plane produced by a milling cutter. There is one difference, though, (which speeds up the modelling) - the subtracting cuboid will be kept at a fixed height, and the cam object will be lowered to create each lift for each rotation position. These are half of the lift values for each 5° rotation of a symmetrical cam:

Fig. 249

YR	ZL	YR	ZL
- 5	0.000	- 50	- 0.329
- 10	0.000	- 55	- 0.407
- 15	0.000	- 60	- 0.476
- 20	0.000	- 65	- 0.534
- 25	0.000	- 70	- 0.583
- 30	- 0.021	- 75	- 0.621
- 35	- 0.071	- 80	- 0.646
- 40	- 0.147	- 85	- 0.662
- 45	- 0.241	- 90	- 0.665

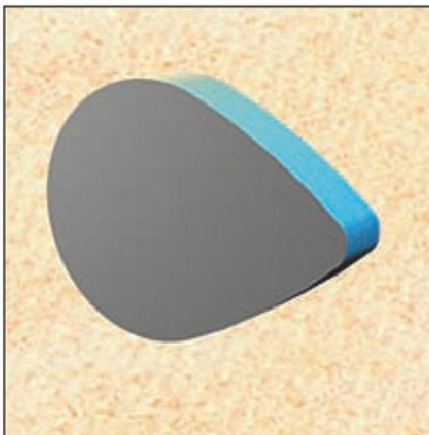
With the cam selected, type [YR-5], then **Subtract** the cuboid. Repeat this process another 17 times, each time typing the YR and ZL values given in the table above. The cuboid can now be erased and you should have this:

Fig. 250



Reset the cam rotation with [YR0]. This cam is symmetrical, so create a mirror image with [Copy: XR180], then use [Object Intersection] with the two halves of the cam (turn **Keep Drill off** for this).

Fig. 251



2D shapes from coordinates

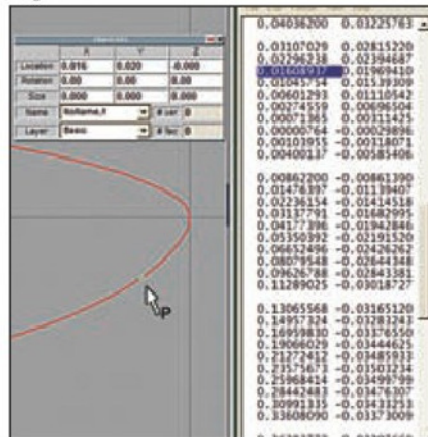
In the cam object, its outline was defined by a set of tangents specified by angle/length value pairs. Another way of defining complex 2D shapes is with points specified by pairs of X and Y location values (Cartesian coordinates). Simple examples of such outlines have already been used in

previous articles in the construction of gear and sprocket teeth. The same procedure that was used to create those shapes can also be used for complex outlines consisting of many more points. Although the process is quite time consuming, it only has to be done once for each shape. I'll give a short summary of using this method to create an **aircraft wing cross-section**. This is not an engineering component, but it is a good example which demonstrates a technique that can be applied with any other 2D profile.

The first step begins with a table of coordinates for the object. These can be in printed form (reference 2 is an excellent source for aerofoil outlines), but a lot of typing can be saved if you have the coordinates in a text file on your computer (downloaded from websites perhaps). In trueSpace, create a closed **Polyline** by roughly positioning the points in the shape to get its approximate outline and size. Do this by first examining the coordinates to get a feel for their distribution - the convention for specifying aerofoil coordinates will mean these shapes will be drawn upside-down, for example. Try to add the same number of points as there are coordinates (points can be added or deleted later if needed using tools from the Point Edit Panel). You may want to save this rough outline if you later want to create further similar shapes which have a comparable number of coordinates.

With [Point Edit: Vertices], pick each point in turn, and type its X and Y coordinate values in the Info Panel. This is a slow error-prone process, especially if the coordinates are specified to many decimal places. However, if you have a text file of the coordinates, display this on the screen (in Notepad, for example) close to trueSpace's Info Panel, then cut and paste the values (Control C and Control V keyboard shortcuts) from the coordinate table to the Info Panel.

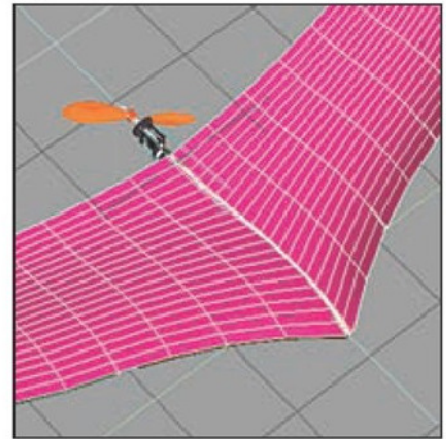
Fig. 252



As mentioned in part eight, these X and Y positions are stored internally at the precision specified by the number of decimal places typed in, even though they are shown in the Info Panel to only three decimal places (this can be verified by scaling the object by 10, 100, 1000 . . . , and examining the points).

The completed aerofoil 2D shape can now be saved. To model aircraft wings, the shape can be rotated, scaled proportionally, and then extruded in one or more (scaled) stages.

Fig. 253



Automated 2D drawing

If you do a lot of work which requires creating 2D profiles, you may want to use a program which will load tables of coordinates and turn these into a graphics file format, which can then be imported into trueSpace. There are several such programs available which are either for general purpose use, or for specific applications (aerofoils for instance). One graphics file specification used frequently by these programs is the **DXF** format (there are many others), and this can be read by trueSpace. (I should point out that I've not tried any of these conversion programs).

There may also be one further possibility available to you: if you are familiar with programming methods, it's not too difficult to write a coordinate to DXF file conversion program for 2D shapes.

TurboCAD

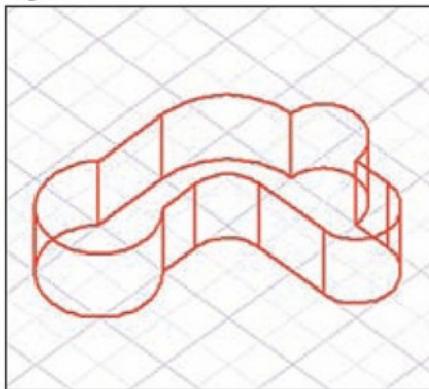
TrueSpace is a very powerful 3D application, but it has not been developed specifically for creating engineering models. However, its capabilities can be significantly enhanced if it is used in conjunction with a CAD program. The only CAD application I have had recent experience with is TurboCAD, but I have found that this program is an effective modelling supplement to trueSpace. In this article, I'll mention a small number of TurboCAD's functions which complement trueSpace, but without going into details on the program's operation. I hope that this will also give an indication of how CAD programs in general can be used with trueSpace. TurboCAD is available in several versions, but in this description I've kept to features which are included with the Deluxe version only as this is relatively inexpensive (older versions of this have been made available for £30 in the past).

TrueSpace is not a drawing program. The closest it can get to a drawing is with wireframe and hidden line renderings, but it's not possible to specify line thicknesses, for example, or to easily use hatching on faces (hatching could just about be created with texture maps). Also, trueSpace's dimension tools are not worth mentioning (although I just have!), and it has only one isometric view (in the Workspace only, not in Model View). However, drawing is what TurboCAD does best, and it is therefore a very good complement to trueSpace in this function.

Like trueSpace, TurboCAD has an extensive collection of 3D tools. The programs are not directly comparable,

however, because they have been developed for different markets, but there is a large overlap with the 3D features found in the two applications. Many of the 3D tools described earlier in this series have similar equivalents in the Professional version of TurboCAD (although a number of significant features are not included in TurboCAD Deluxe). For several reasons I prefer working in trueSpace - perhaps 95% of the time - but TurboCAD is very useful in some circumstances when the modelling in trueSpace is complex or time consuming. Sometimes, just because a tool in TurboCAD works differently from a similar tool in trueSpace can make it easier to construct some objects. Here's one example:

Fig. 254



This object is made in a few seconds by using TurboCAD's Polyline tool with the Grid Snap Mode on, and following this by applying a Simple Extrude to the 2D shape. There are several ways of making this same shape in trueSpace, but in all of them the modelling would take longer.

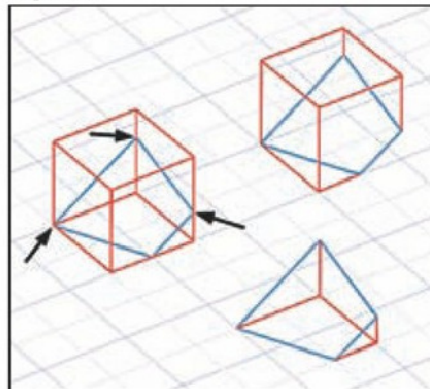
It's likely that anyone familiar with either trueSpace or TurboCAD will need some time to adapt to the other program. This is partly because, although they have many 3D tools in common, they have a lot of small (and some big) functional differences, and the equivalent tools sometimes even have different names (Cube/Box, Lathe/Revolve, Object Union/3D Add, etc.). Also, the dissimilar approaches to 3D modelling by trueSpace and TurboCAD often mean that a different way of thinking is required when each program is used. For instance, one major difference between TurboCAD and trueSpace is the way in which components are created in 3D space. In trueSpace, objects are positioned directly in respect to the World Axes. TurboCAD has a similar **World Coordinate System (WCS)**, but it also uses the concept of the **Workplane**. A workplane can be imagined as a grid that can be located and orientated anywhere in the WCS (unlike the trueSpace grid which is unalterable). Newly created objects in TurboCAD are positioned in respect to the current workplane. As some extra steps are often required to manipulate the workplane during object creation, most straightforward modelling can be significantly slower in TurboCAD than it is in trueSpace. On the other hand, some complex modelling tasks are made substantially easier because of the workplane.

Snap Modes

From an engineering point of view, a big advantage TurboCAD has over trueSpace is its many Snap Modes. Some modelling in trueSpace can be relatively difficult or time consuming because it only has grid mode snapping (mental arithmetic and sometimes a calculator are needed more frequently with this program). It's not all one sided, though - using the mouse with trueSpace's grid mode active can produce some very fast modelling indeed.

To illustrate the value of snap modes in 3D modelling, here is an example with TurboCAD's 3D Slice tool:

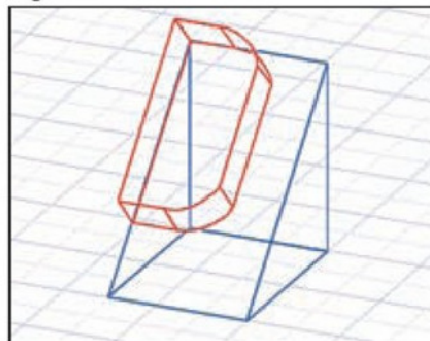
Fig. 255



The Box (Cube) on the left has been sliced by a plane (in blue). The three defining points of the plane, indicated by arrows, have been snapped to the box (at one vertex and two divide points). The resulting separated object is shown on the right. Although trueSpace also has similar tools to slice 3D objects into several parts (there're in the Point Edit Panel), it's not able to apply these tools with snapping as shown here.

In the next diagram an object created with a TurboCAD Polyline and Simple Extrude, has been positioned quickly on the top face of a Wedge with one of TurboCAD's Assemble tools. These functions have some aspects in common with trueSpace's Vertex Snap and Magnetic tools (shown in part five), but again the ability to use them with the numerous TurboCAD snap modes mean their use is more controllable than it is in trueSpace.

Fig. 256



Importing and exporting

Any objects created in TurboCAD can be loaded into trueSpace and used as if they were produced in trueSpace itself. The components can be transferred by means of imported files (trueSpace does

not make use of the Windows' Clipboard for copying and pasting objects). In TurboCAD, save the objects as a DXF file, and then load this in trueSpace with the 'TS6Files'/'Load'/'Object' menus. This transfer process is also possible in reverse (although there may be compatibility problems - I've not worked with trueSpace objects in TurboCAD).

File transfer by means of DXF files between TurboCAD and trueSpace is a fairly painless procedure, but it may not necessarily be so when importing objects from other CAD or graphics applications. The main problem can be in finding a suitable file format that is compatible between both the source program and trueSpace. The DXF format, being widely used, would be the first one to try (some experimentation with saving/loading options in both programs may be needed). If this does not work, the source program may have alternative file save/export formats, and it may be possible to load one of these files into trueSpace.

A second problem in transferring objects into trueSpace is that you may find their appearance has changed, or there may be editing or other compatibility problems. If this is the case, try using the **[Flip all normals of object]** or the **[Try to fix bad geometry]** tools. These can be found in the Model Toolbar, third icon group from the right. In the same position in the Model Toolbar is the **[Decompose into objects]** tool. If your file, with several separate objects, is imported as one single object, this tool should split the objects up, putting them into a group. One problem I've had, though, with some programs is that if several overlapping objects are saved together and then imported into trueSpace, the **[Decompose into objects]** tool won't work. A solution to this is to separate the objects in the source program by a known distance, then restore their original positions after separating them in trueSpace. This is usually quicker than importing the objects one at a time.

The faces of imported objects will probably be divided up into triangles. If you like, these components can be simplified with the clean-up trick described in part four, that is intersecting the objects with a cube that encloses them completely.

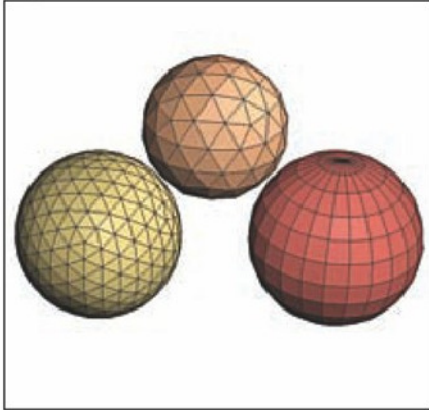
CAD components are not the only objects that can be imported in trueSpace. Any general purpose or specialised graphics programs can be used, as long as it can save files in a suitable format. All the objects in the next image were created as quick 2D shapes in the **Vector Graphics** application Serif DrawPlus, saved as a DXF file, imported, and given some thickness with the Sweep tool.

Fig. 257



The next diagram shows a more specialised example. The two objects on the left are geodesic domes (with a trueSpace sphere for comparison). They were created as a DXF file with the freeware program WinDome (I downloaded this years ago and it may not now be available).

Fig. 258



Advanced trueSpace

Before ending this series which has focused on trueSpace, I'll mention some further aspects of the program you may like to look at. The first of these is **animation**. I have not used this at all in the current version of trueSpace, but I have found the animation feature of previous trueSpace versions to be an invaluable design tool while working with technical models. This is particularly true for intricate dynamic mechanisms which are difficult to visualise from still images. Even if models are static, it can be fun to create animations of them with virtual cameras (described further on), 'flying' around and in and out of the scene. Animation is described in Chapter nine of the Help Files.

A second feature (used in conjunction with animation) which may have some use in engineering is **physical modelling** (Help Files, chapter ten - Physics). Again, I have not used this in trueSpace7, and when I tried it in version 3, its value seemed limited as a practical engineering tool. However, it looks more sophisticated in trueSpace 7, so you may find it worthwhile looking at it.

TrueSpace as supplied may not be able to do every type of 3D modelling or work in exactly the way you want, but it may be possible to adapt it to your needs with two features included with the program. These are the ability to customise the modelling interface, and the use of scripts (Help File chapter 2). The first of these can control the look of the program, and the way a user can interact with and structure the models being built. **Scripts** could be thought of as the virtual equivalent of CNC programming, but this analogy only hints at what is possible with this feature. So far, I've only used these two aspects of trueSpace in a small way, but potentially they do look very powerful indeed.

Using stereograms

Although trueSpace has an excellent interface for viewing and moving around 3D models, there are occasions when it can be difficult to get a full impression of the detail in a piece of complex modelling. When the 2D image on the screen is

frustrating like this, I just wish I could grab the virtual model in my hands in order to examine it closely! There are modelling systems which use three-dimensional viewing equipment, but it would be nice to be able to see the models on a standard monitor screen in 3D. Well, this is possible by using **stereo images** (which are also called **stereograms** or **stereographs**).

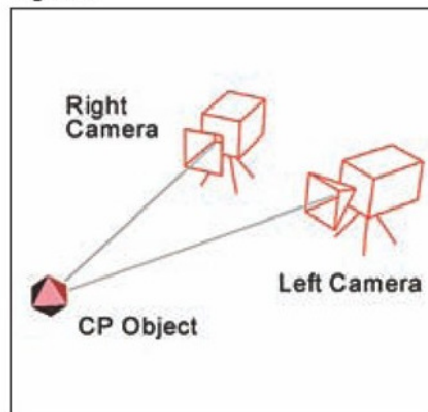
There are several different types of stereogram. The one described here uses two separate images on the screen or in printed form, and by using a special (equipment free) viewing technique, they will appear as a single three-dimensional image. The skill of viewing these images does, however, require practise, the amount of which varies considerably between individuals. Some people can master the technique in a very short time, but others have to expend a lot of effort to develop it (even after several years I still find it difficult to bring one form of stereogram into focus). There are also a few people (I've read it's 4%) who are unable to see the 3D effect with any amount of practise.

Stereo images have been around for a long time. They were first developed in the mid nineteenth century, and coincidentally at the same time as the invention of photography. Until the introduction of computers, most of these images were stereo photographs. The method shown here for producing stereo images in trueSpace has a lot in common with stereo photography, and starts by creating a virtual stereo camera.

Camera objects

Cameras in trueSpace are non-rendering objects which are used to create views of the 3D model. If you place several cameras in a scene, you can switch between their views, and therefore reduce the amount of continual viewpoint readjusting in the view windows. Cameras can also be made to move when making animations. In this demonstration two cameras will be grouped together so that they produce stereo images. Shown diagrammatically, this is the stereo camera:

Fig. 259



In setups like this (both virtual and photographic), three parameters control the 3D effect. The first of these is the spacing between the cameras (the **axial separation**). In simple configurations, as shown here, this is made equal to the distance between the eyes (averages about 64 mm). The second parameter is the **axial convergence**, or how much the

cameras are angled inwards. This will be set in this example by aiming the cameras at a convergence point (CP) object. The third parameter is the magnification or degree of zooming used by the cameras.

To make the virtual stereo camera in trueSpace, click [**Create new scene**], then select 'Display Options...' from the 'Ts6Files' menu. In the panel, click the [**Make cameras visible**] icon (it has a blue camera). Next, add any object you wish for the convergent point object (I've used a red sphere with Latitude:2, Longitude:4 and XYZ sizes of 1). Type in the name 'CP Object'.

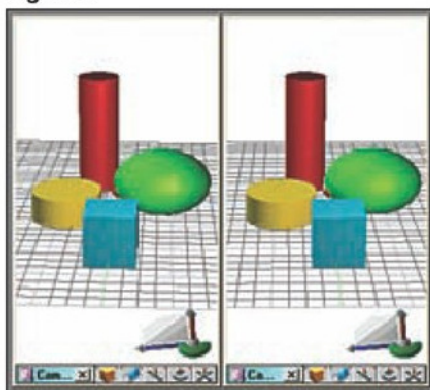
For the first camera click [**Camera**], which is the third icon from the left in the Model Toolbar, **fig B**. Type [**XL-60/YL-3.2/ZL1/ZS4**]; this puts the camera 60cm away from the CP object, gives it half the axial separation value, and the Z size determines the camera's magnification. Name this object 'Right Camera', click [**Copy**], [**YL3.2**], and type in 'Left Camera' in the Info Panel. The cameras' axial convergence will now be set by pointing them at the CP object. Zoom out of the scene to see all three objects. Move the mouse pointer over the small square next to the Layers Toolbar (**fig A**, top left), then in the pop-up (Animation) Toolbar, hold down the mouse on the eighth icon from the right. Select the [**Look at**] tool, then click the CP Object. The camera should rotate slightly so that its line of sight (shown by the 'lens' direction) points towards the CP Object. Repeat this step again by using the [**Look at**] tool to point the Right Camera at the CP Object. The [**Look at**] tool has not been mentioned before, but it has a valuable modelling use - it aligns one object so that its Z axis points to the centre of the axes of a second object (a camera's line of sight is in the Z axis direction).

Assigning camera views

The next stage puts two views on the screen, one for each camera. Add two small Perspective Views. Drag the mouse on the views' side edges and make them both 60mm (2 1/4 inches) wide, and place them close together side by side on the screen. Select the **Right Camera**, then click the left-hand view window. Hold down the mouse on the second-left icon in this view ('Perspective Small View' icon), then drag the mouse to select [**Small View from Object**] (blue camera icon). Repeat this procedure to assign the view from the Left Camera to the small right-hand subsidiary view window. To finish the virtual stereo camera, Select the CP Object and group this to the two camera objects with [**Glue as Sibling**], then save the camera object group (when a copy of this object is loaded, the cameras will need reassigning to the subsidiary views as just described).

Put a few simple objects in the scene, pick the camera group, then press the 'x' keyboard key ([**Object Rotate**] shortcut). Turn off the [**Toggle navigation using X axis**] option in the View Aspect Toolbar, **fig F** (preventing any tilt between the cameras). Now, if you right-drag with the mouse, the views from both cameras in the subsidiary view panels will swing together around the CP object position. Left-dragging the mouse will tilt the views up and down.

Fig. 259



Before continuing, I should confess that I was getting problems with this stereo camera in trueSpace7 (it's worked fine in earlier versions). The trouble is that as the group is rotated, the two cameras gradually shift their rotational and spatial alignment within the group. The more the object is manipulated, the greater the misalignment. This will at first alter, then eventually destroy the 3D effect. I would suggest that, when the virtual camera is loaded, any rotation by the mouse is kept to a minimum. Alternatively, the stereo camera can be positioned by typing rotations in the Info panel: type a ZR value, then [Axes], [Normalize Rotation], [Axes], then type YR (the Z and Y order can be reversed; the axes realignment is needed for the reason given when the lathe tool was made in part two).

Free-viewing technique

With the two views set up on the screen, now comes the part which may require some practise. The two images from the cameras (the stereo pair) correspond to the separate right and left views from the eyes. The trick of free-viewing involves making your right eye look at the left image, and your left eye look at the right image (surgery's not involved!). Look at the images on the screen from a distance of 2-3 feet. Put a finger up in front of the stereo views, placing it slightly nearer to you than the halfway distance from your eyes to the screen. Look at your finger, then take it away, but keep your eyes focused at the same spot. What you should see on the screen is not two images from the cameras, but three. Concentrate on the middle image, and eventually you should notice that it is three-dimensional. You will know when you have got this right because the effect is quite striking when seen for the first time. With experience, the step of looking at a finger first will not be needed.

The stereo images can be viewed while the cameras are moved around the scene with the mouse (bearing in mind the comments on misalignment given above). Both wireframe and solid render displays can be used. Also, static views can be generated by rendering each of the two panels on the screen, and rendering can be done to files at a high resolution for printing out and viewing; **figs 1 and 2** are examples.

An alternative method

If you can't see the 3D effect straight away, you may like to try another way of viewing stereo images which some people find easier. In the method just shown, the eyes are actually slightly cross-eyed, but

stereograms can also be viewed when the lines of sight from the eyes are parallel. The only difference needed in trueSpace is to swap the position of the right and left views on the screen, again putting them close together. To free-view the images, place your monitor screen so that you can see a distant object behind it. If this is not possible, try the technique with **figs 3 and 4**, holding up the magazine in front of a far view. Look at a far distant object, and without altering your focus, transfer your gaze to the stereo images on the screen or page. Again, you should see three images. Concentrate on the middle one until the 3D effect develops. It's very likely that the image will be out of focus - if so, altering the viewing distance may help (this is the type of image that, even now, I find difficult to see in focus). With practise, it should be possible to see parallel stereo images simply by staring blankly at them until the 3D effect emerges.

There is one difference between the two viewing techniques, and this gives the cross-eyed method an advantage. Here the images can be made wider than the 60mm that has been used so far. The only limit is how far the eyes can be crossed without becoming uncomfortable (a

greater viewing distance will reduce the degree of eye crossing). In the parallel technique, the lines of sight from the eyes cannot diverge outwards, which restricts the maximum image width to that of the eye separation distance.

It's easy to tell which of the two alternative viewing methods are needed to view a stereo pair. Try one method, and if it appears strange, with far objects in the scene somehow appearing nearer than distant ones, then the other technique should be used (or, if it's possible, swap the two image positions).

Stereogram use

Stereo images are not essential when 3D modelling, but on rare occasions I have found them to be of immense value when looking at complex interrelationships between objects. It is not just the three-dimensional effect itself; stereo images look as if they have more vibrant colours and an enhanced appearance compared with normal 2D viewing. This heightened visual effect makes many details obvious, when in 2D they could be missed. Even if you don't need stereograms for practical virtual modelling, it can be fun creating them just for their own sake.

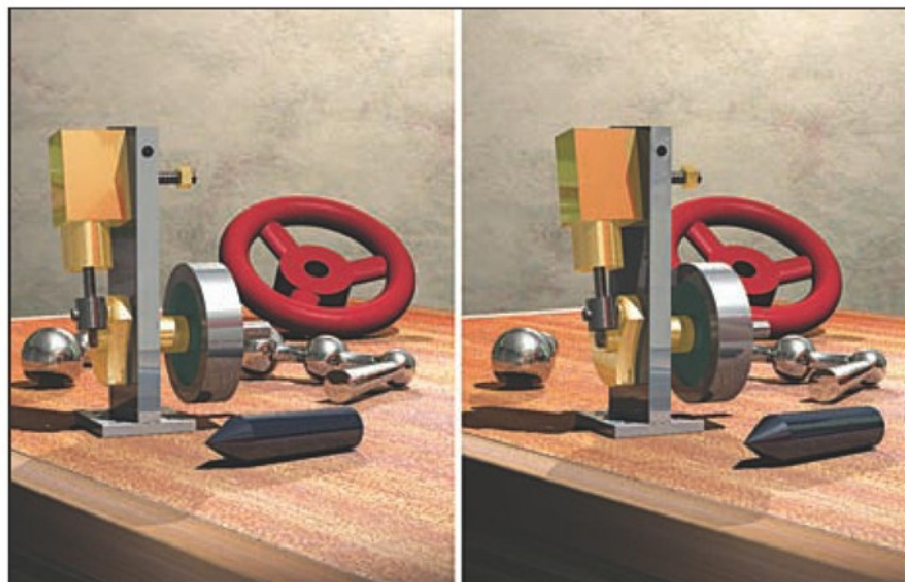


Fig 2. A second stereogram for the crossed eyes viewing method.

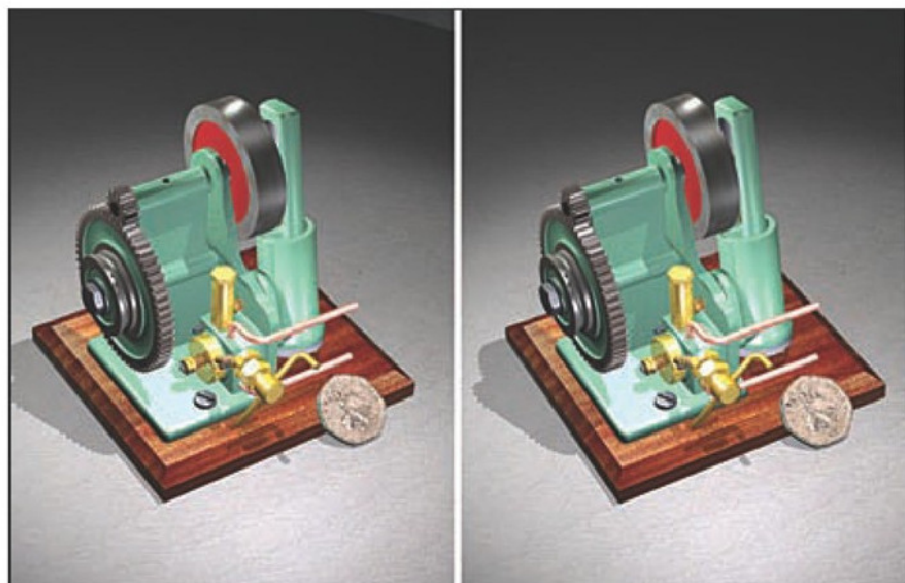


Fig 3. A parallel viewing method stereogram.

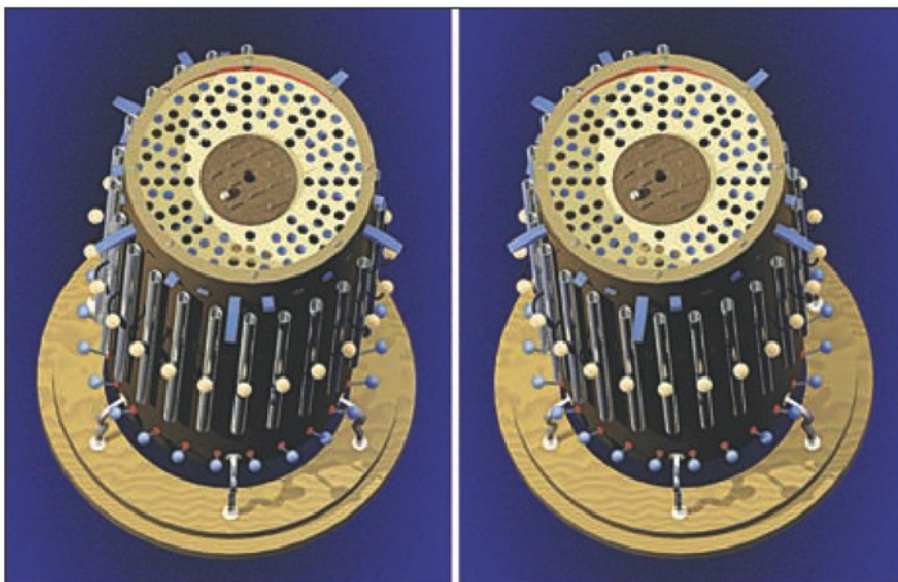


Fig 4. A second parallel viewing stereogram.

There are many popular and a few technical books on stereograms.

Reference 3 is a good overall survey of the different types of these images (photographs, paintings, and computer generated) and has a little on the technical side and history of the subject. **Reference 4** is an introduction to the mathematics behind stereograms, which may be useful if you want to create images which are more sophisticated than the simple setup shown in this article.

Series conclusion

When I first started using 3D modelling, it seemed like this was the design tool I had always been looking for. It has, however, taken some time to become familiar with this new way of working (even after 13 years I'm still learning). While writing these articles, I have tried to think back to the time when I was just starting out in 3D. At the time, it would have been helpful to have had practical examples to follow of the technical side of 3D modelling. This

MEW RESOURCE BOX

References

1. Tubal Cain, *Milling Operations in the Lathe*, Workshop Practice Series No.5, Special Interest Model Books, ISBN 0-85242-840-5, pages 106-109.
2. Martin Simons, *Model Aircraft Aerodynamics*, Nexus Special Interests, ISBN 1-85486-190-5.
3. *Stereogram*, The Book People, ISBN 0-7522-0924-8.
4. Charles W. Smith, *3-D or not 3-D?*, New Scientist, 26 April 1984, pages 40-44.

is therefore what I've included the most in this series and I hope that the model examples have been useful.

Looking back, my recollection of learning 3D modelling is that it required a big commitment with many hours of practise. Mostly the time spent was enjoyable, but sometimes, especially at the start, it could also be frustrating. In the end, though, I have found 3D modelling to be an supremely valuable design tool. I hope that you also will find this to be true, and that this series has gone some way to help you with that aim. ■

THE STORY BEHIND THE MODELS DVD

This DVD was filmed at the 2009 Model Engineer Exhibition

It is divided into three sections. In the first section Ivan Law, the Chief Judge at the 2009 Exhibition talks to Cherry Hill.

I was very surprised when I first saw the cover of this DVD and found that Cherry was on it as she is a very private and modest person. Ivan talks to Cherry about her latest project, the 1863 Robert Blackburn Agricultural Engine. This superb engine was designed and built from scratch from very basic information from contemporary books, magazines and public records such as patent applications. Cherry offers some very interesting insights into the construction and finishing of her models. For instance, every nut and bolt is individually spray painted prior to final assembly. This is an excellent start to the DVD and there is more to come.

In part 2, Ivan talks to Mike Sayers about his 1:3 scale vintage Bentley engine. This engine is scaled from an original engine and is correct in the finest detail. Mike had to learn a lot of new techniques to make this engine including helical gear cutting. The camshaft was made using an attachment made by Mike

specifically to grind the cams. The model includes scale replicas of the carburettors and the original radiator. The model works as the original although one of the carburettors has been blanked off as the engine won't run properly with both carburettors working. This is to do with the scaling down effect of air volume and not a fault with the model.

Part 3, the final section is a talk by James Hill, the Chairman of The Gas Turbine Builders Association. James starts with a simple model of a basic pulse jet using a jam jar, a cigarette lighter and some fuel. (Don't try this at home.) James talks us through the development of his gas turbine from the first example, with wooden rotor, through to the latest all singing all dancing model. James tells us about construction details, materials used and problems encountered during the development. Some of the components are even welded together using a home made spot welder based on a microwave transformer.

The heat and speed of these engines is probably higher than anything normally encountered in model engineering and it is a credit to the association that they can



get these engines to work so well. Although I will never build a gas turbine, I thoroughly enjoyed the presentation. I think you will enjoy it too.

The DVD is available for £7.99 + £1.98 P&P to the UK. T: 08448 488822 MyHobbyStore Ltd, PO Box 718, Orpington, Kent BR6 1AP.
For overseas enquiries T: +441689 869881. Or you can order online at
<http://www.myhobbystore.co.uk/product/25905/model-engineer-exhibition-2009-dvd>

3 MORSE TAPER TO 3C COLLET ADAPTER ②

Richard Gordon puts his ORAC CNC lathe to work



The Orac CNC lathe.

Writing the G-Code

Table 1 gives the G-Code for the test taper. If you are familiar with milling G-Code then you will have no trouble understanding what is going on. If not, then first we set up the machine as noted remembering we are in Diameter Mode and you don't have to enter the line numbers. G95 sets the feedrate to mm per rev, which is more "lathe like" and simple to understand if you are used to change gears! The T0101 is perhaps new to you. This is different to a mill "tool"

command. This means use tool 01 and use the offsets stored in the offset table position 01. This is more relevant later when we use multiple tools. M06 is the tool change, which I've put in as a pause in the programme for you to check all is correct before starting the spindle and the axis moving. M03 S1400 starts the spindle at 1400rpm. You can set this yourself if not directly controlled by Mach 3. Then we start the roughing.

G0 (G zero) is a rapid to the outside of the stock and is a "safe position". We then

OVERVIEW

Having the good fortune to buy an ORAC CNC lathe on EBay, I designed this 3 Morse Taper to 3C collet adapter system. It will hold stock from 1.5mm to 12.7mm diameter and is a very good match for the ORAC lathe or similar.

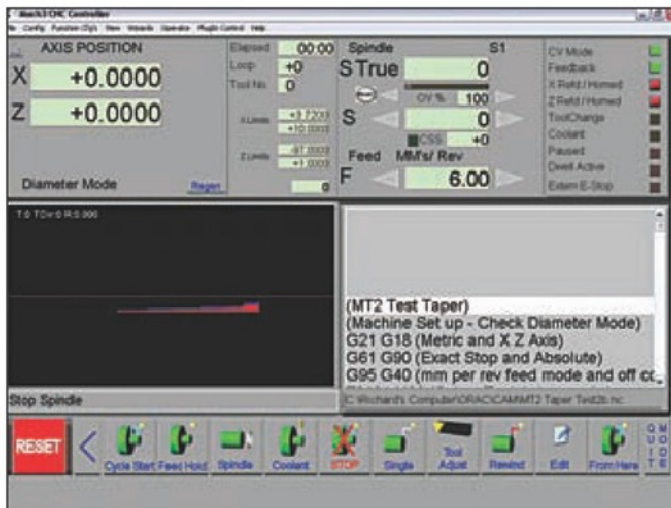
rapid move to the outer most horizontal green line on sketch 5 (see issue 161) and then start the cut using G1. Note there is only a Z-79.0, you do not need to repeat dimensions that do not change, so we know this will be a parallel cut. Also note the feed rate set by F0.15. This is 0.15mm/rev. At the end of this cut we rapid to X19.0 Z0.0. This is a taper away from the material, back to the end of the bar. This prevents the tip rubbing on the work. We then carry on roughing out. You can see we don't have to enter a G0 or a G1 if we stay in that mode.

By N461 we are ready to cut the first profile. We rapid to the start of the taper then just enter the coordinates of each end point on a separate line, not repeating those that don't change, all as G1, then rapid back to the safe position.

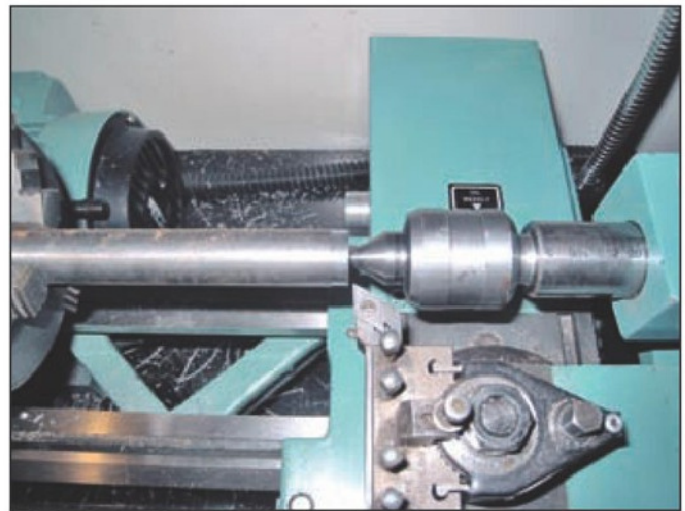
N561 is the last roughing taper then N661 is the final profile, for which I've reduced the feed rate a little. We then move again back out to the safe diameter of 20mm and back to the safe Z of 1mm from the face. Its tempting to go

Table 1

• N001 (MT2 Test Taper)	• N221 X15.6	• N511 X15.3 Z-11
• N011 (Machine Set up - Check Diameter Mode)	• N231 G1 Z-16.8 F0.15	• N521 X18.6 Z-76.4
• N021 G21 G18 (Metric and X Z Axis)	• N241 G0 X16.1 Z0.0	• N531 X18.6 Z-78.9
• N031 G61 G90 (Exact Stop and Absolute)	• N251 X14.8	• N541 X19.1 Z-79.2
• N041 G95 G40 (mm per rev feed mode and off compensations)	• N261 G1 Z-10.8 F0.15	• N551 G0 Z0.0
• N051 T0101 M06 (Select Tool 1 data and do a tool change)	• N271 G0 X15.3 Z0.0	• N561 (Rough Profile 2 0.4MM Deep)
• N061 M03 S1400 (Start Spindle at 1400rpm)	• N281 X14.0	• N571 X7.72
• N071 (Place tool at X20 Z2 as safe starting point)	• N291 G1 Z-10.4 F0.15	• N581 G1 X10.2 Z-1.24 F0.15
• N081 (Rough out with 0.4mm deep cuts with 0.4mm nose rad tip)	• N301 G0 X14.5 Z0.0	• N591 Z-9.90
• N091 G0 X20.0 Z1.0	• N311 X13.2	• N601 X12.14
• N101 G0 X18.8 Z0.0	• N321 G1 Z-10 F0.15	• N611 X14.72 Z-11.19
• N111 G1 Z-79.0 F0.15	• N331 G0 X13.7 Z0.0	• N621 X17.98 Z-76.45
• N121 G0 X19.0 Z0.0	• N341 X12.4	• N631 Z-79.01
• N131 X18.0 Z0.0	• N351 G1 Z-9.6 F0.15	• N641 X19.04 Z-79.56
• N141 G1 Z-64.8 F0.15	• N361 G0 X12.9 Z0.0	• N651 G0 X20 Z0.0
• N151 G0 X18.5 Z0.0	• N371 X11.6	• N661 (Cut final profile 0.1MM Deep)
• N161 X17.2	• N381 G1 Z-9.6 F0.15	• N671 G1 X7.44 Z0.0 F0.11
• N171 G1 Z-48.8 F0.15	• N391 G0 X12.1 Z0.0	• N681 X10.0 Z-1.28
• N181 G0 X17.7 Z0.0	• N401 X10.8	• N691 Z-10
• N191 X16.4	• N411 G1 Z-9.6 F0.15	• N701 X12.06
• N201 G1 Z-32.8 F0.15	• N421 G0 X11.3 Z0.0	• N711 X14.52 Z-11.23
• N211 G0 X16.9 Z0.0	• N431 X9.7	• N721 X17.78 Z-76.46
	• N441 G1 X10.8 Z-0.55 F0.15	• N731 Z-79.06
	• N451 G0 X11 Z0.0	• N741 X19.0 Z-79.67
	• N461 (Rough Profile 1)	• N751 Z-97.0 (end of profile)
	• N471 X8.57	• N761 G0 X20
	• N481 G1 X10.8 Z-1.1 F0.15	• N771 Z1
	• N491 Z-9.6	• N781 M05 (Stop Spindle)
	• N501 X12.39	• N791 M30 (End and Rewind)



3. Mach 3 screen shot showing program and tool path.



4. The bar has been set up using the tailstock centre.

to X0 Z0 as you may in a mill. But this is a real no-no in a lathe as you will crash the tool into the supporting live centre, so don't get into this habit. Also, it's tempting to specify a "safe" distance well away from the workpiece like Z50 and X50. But if you do this you will crash into the tailstock. So, you have to bear these things in mind at the beginning and end of programmes and when you change tools.

The M05 stops the spindle and M30 states the programme has ended and it "rewinds" the programme back to the start ready for the next piece.

And that is all there is to it. Now save it with a ".nc" ending and it is ready to try in MACH3Turn.

Machine setup and cutting the taper

Assuming you have configured MACH3 as previously stated, go to the "AUTO" mode from the first MACH3Turn page, load your ".nc" file and click on the "CYCLE" button to reach the path and G-Code window. Hopefully you will get the image as in **photo 3** where you can see the full path in the window and no error messages in the text area under it. If you do have errors it usually refers to a line number or at least gives you a hint of some kind. If you double click on the G-Code, it will display the line numbers MACH3 has determined - not always what you expect. Then you can see what it is referring to.

I use a separate PC to the one that controls the lathe for design and checking with MACH3 and so it is easy to try the path "cutting" without a machine moving. I suggest now you re-read section 7 of the MACH3Turn manual about machine setup.

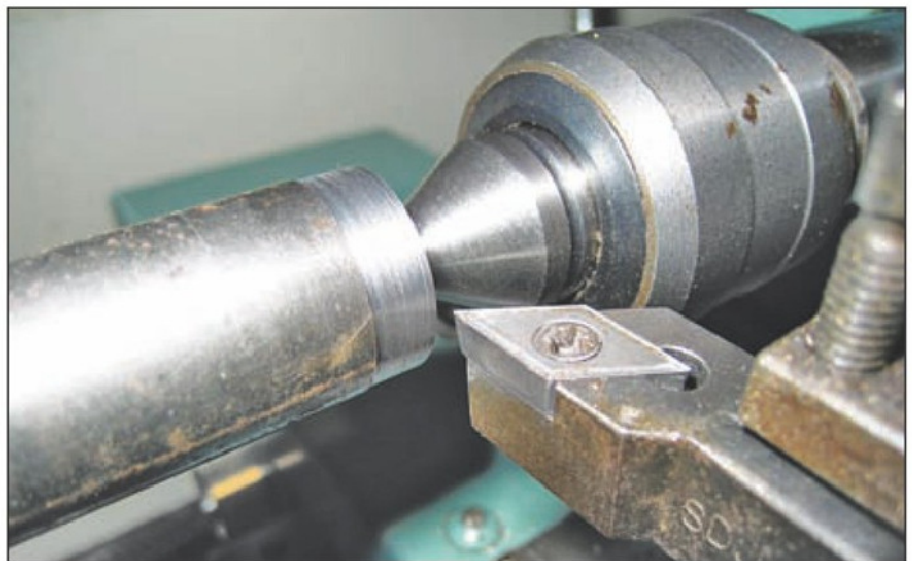
I do not use automatic "Homing" or "Soft Limits" on my lathe at the moment as I don't have any multiple tool, complex set-ups planned that would benefit from this. Homing sets the Machine Coordinates, which is useful if you plan to power down the machine between set-ups. I don't and so only set the "Program Coordinates" following this sequence:

- 1) Go to the "MANUAL" screen and click on "Program Coordinates",
- 2) Load the stock into the chuck, 110mm sticking out and load a normal left cutting tool into the tool holder,

- 3) Centre drill and, using the manual jog functions, face (in that order so as not to damage the tip) as in **photo 4** and when you finish facing, click the Z axis DRO "Zero" button and it should go to zero,
- 4) Jog to turn a section of the bar as in **photo 5**. Don't adjust the X axis after turning but move the Z axis so the tip is clear. Now measure the diameter, enter this DIAMETER into the X axis DRO,

- 5) Now jog in -ve X direction to a distinct diameter about 0.1mm diameter less than point 4 above. Turn that and measure it. It should match within about 0.01mm diameter. If not, enter the new reading, and try again.

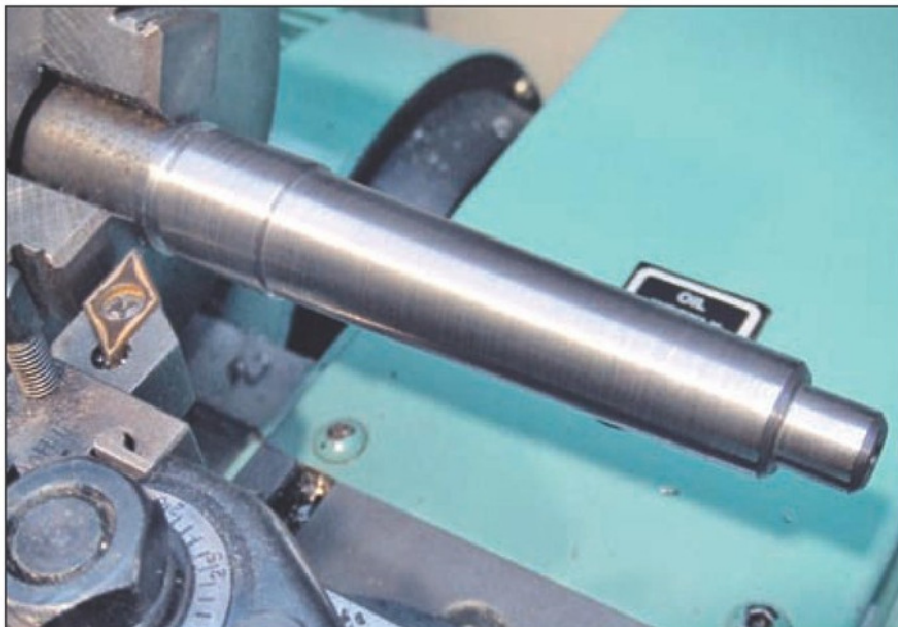
The lathe is now set up for turning for just that tool as MACH3 knows the tip Z and X positions precisely. Later we will look at setting up multiple tools.



5. Setting the tool to zero.



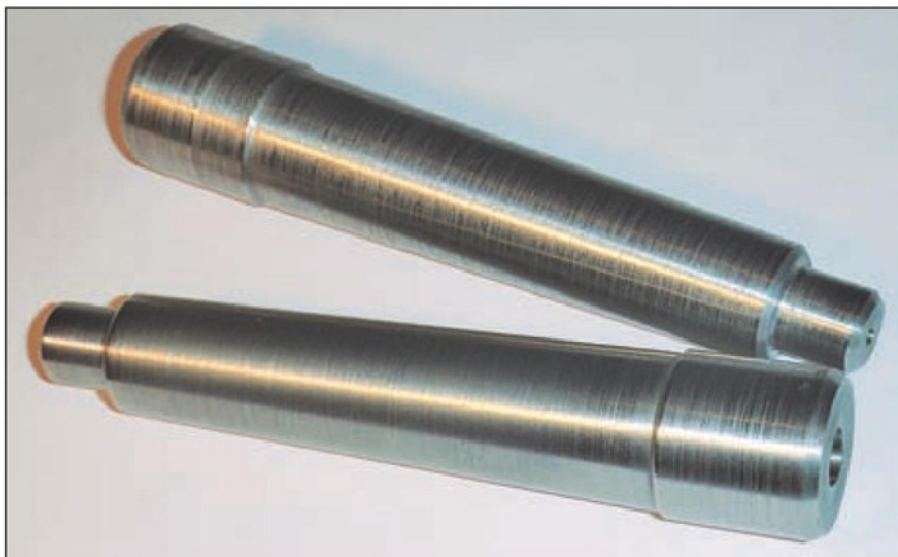
6. Roughing out the bar using steps.



7. A finished taper.



8. Reaming to $\frac{1}{4}$ in. diameter before splitting the collet.



9. Collet blanks.

Now, if this is the first time you've run the G-Code, it's best to check that it does what's expected. To do this, I offset the Z axis by 1.5 times the part length and run the cycle. To do this, move the tailstock safely out the way and jog the Z axis to +150mm exactly. (Use the "user entry" bar on the "Manual" screen and type G0 Z150. Then "zero" the Z axis. Your tool is now 150mm away from the stock but MACH3 now sees this as the bar end. The X diameter is still correct. (If you have a trustworthy quick-change tool post, which you really do need for CNC, you can also remove the tool.)

Assuming the path looks exactly as you expect on the screen, go to "AUTO" screen then the "CYCLE" screen and click "start" with your hand over the stop button. You will need to hit "start" again after the tool-change "check" wait that I included. I also usually start the spindle so the feed per rev is correct. Hopefully it will run as expected and you should have satisfied yourself with the feed rates.

Stop the spindle, jog to exactly Z-150 (or use the manual G-Code entry again) and "zero" the Z axis. Put the tool back and it should line up perfectly with the end of the stock. Put the tailstock back (with at least 25mm clearance to the saddle at Z0) and re-apply pressure to the centre. You are now ready for cutting. If you are being really careful, you can re-check the X diameter, but this should not be necessary.

Check that the code is back at the beginning, if not hit the rewind button. Put your guard and safety specs in place and start the cycle.

It will seem quite aggressive but actually, this is the minimum surface speed and feed for tipped tools with 0.4mm radius, at least the grade I had. Even so, quite a lot of hot swarf is produced so do take care.

Photograph 6 shows part way through the roughing and you can see I did actually change the tip before running the job (and re-referenced the tool) as it was blunt.

After a few minutes the job is finished, which is pretty impressive I think. Try doing it that quick by hand, including the set up. To finish, I applied a little oiled, fine wet'n'dry, paper (stuck to a flat backing) along the taper to smooth out the surface.

Photograph 7 shows the result. Now you can test the taper with a MT2-MT3 taper sleeve, if you have one, after putting a black line or two along the length with a permanent marker. I found quite even witness marks along its length after my second attempt... If you don't you may need to check your headstock and tailstock alignment. Which end of the taper is touching will help you diagnose the fix. When it comes out well, run off a few more whilst you are set up!

I manually feed in the tool at the left end of the piece to leave the chamfer and make sawing off easier. I didn't bother to part-off. I finished them in my Boxford lathe by hand by facing, checking they ran true and drilling and reaming $\frac{1}{4}$ in. dia. in one, **photo 8**, and just a centre in the other - ready for whatever is needed in the future - **photo 9**. I actually used EN8 and, as you can see, the surface finish is not as good as you should achieve with EN1a.

With that success behind us, we are ready to start making lots of collets with confidence.

To be continued...

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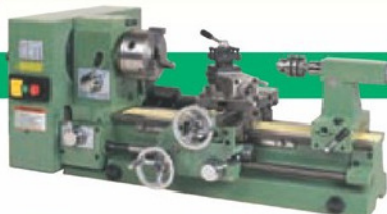
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1. Showing first attempt using IEC plug and socket on drill.



2. Original IEC plug conversion.

PHOENIX BATTERY DRILLS

Martin Gearing considers how to make use of all those low voltage drills with spent or lost batteries

I detest waste and don't experience the blind joy of the majority buying new to replace something that would still be usable if a simple repair or modification was carried out. I've got several corded drills but they are really too powerful and too fast for a lot of jobs, plus on the variable speed types the armatures get so hot running slow as the fan is not effective at low speed. The 600-750 watts has to go somewhere.

I bought my first drill/driver around 1994, because it was a good branded make at a price too good to miss! It was 9.6V and it was a revelation in how much it eased a job. It was provided with only one battery but survived for nearly three years. During that time I had been given another of the same brand and voltage, but yes, you've guessed it, a different shape of battery, and no charger so I used it with a lash up of adaptor leads off the original charger.

A little later I was lucky enough to be given a top quality 14v drill with two batteries and two chargers. By now I was hooked! But all too soon I noticed that one of the batteries didn't hold much of a charge despite always discharging with a load to avoid the "Memory Effect. I took the battery pack apart and replaced the defective cells and this was repeated until it became obvious that the battery packs (by now I had started repairing all the batteries as they went down) were consuming more time being repaired than being used. Perhaps a little exaggeration, but the novelty of unsoldering, checking and re-soldering was wearing thin.

So having a job to do, in a tight time frame to a price, I had to bite the bullet and buy a new 14.4v unit. As it has to be said, nothing makes a job easier than a decent battery drill, particularly when you're on a roof. It did the job, but within a year followed the same route as the earlier examples.

By now the box of dead drills was getting to the size that demanded action -

fix or throw. Then a silly job that involved drilling and tapping around a hundred M6 holes in 3mm plate forced me to hook one of the last casualties up to a car battery (it was a very cheap 12volt unit that had been given to me, with no battery or charger) and this action seeded an idea, as the results far exceeded expectation.

I bought a 12v gel battery similar to the type used in alarms and using IEC 16 Amp plugs and sockets, (as found on computer power supplies) converted all the dead drills to having a socket, in place of the battery, into which could be connected a plug from the gel battery by way of a two metre lead (photos 1 and 2). Yes I know that technically it loses the proper battery drill status, but in my defence it also achieves a great deal more portability and safety than using a corded drill.

Now as some of the drills are 9.6 volt rating, I realise that some of you are set to rear up and point out that feeding 12v into a 9.6v motor will lead to the end of creation and probably contravene volumes of regulations and I should be publicly flogged for doing it, as it is so terrible. But if you check the voltage when a 9.6-volt drill is being used on the 12v battery as I am suggesting, then it will be found that the voltage at the drill is not so far off the 9.6 volt specified. It does in fact drop slightly lower when made to work hard, probably the lead resistance playing a part. But the fact can't be avoided, that the drills, which would otherwise be SCRAP after 3 years of hard use, are still going strong. Think of the saving to the planet! Not to mention my bank balance; shame that the drill manufacturers didn't get to sell another 4 drills - so sad!

Regarding the 14.4V unit. Well in the last days of the dying battery, after charging, they often only produced between 10 - 13 volts and worked reasonably well even at that. When connected to this set up I honestly can't tell the difference. However, what I do notice is the fact that the battery keeps

■ OVERVIEW

How many old 9, 12 or 14 volt battery drills do you have laying around that are of no further use because the batteries no longer hold a charge or you've lost the dedicated charger? How many have you seen at the car boot/garage sales, missing the charger, being sold for peanuts? Have you given up using a drill because it would cost nearly as much to buy a new battery as the original drill cost? If you can answer yes to even one of these questions then perhaps my solution may be of interest.

going for the full duration of a job. Now I realise that I'm not talking continuous use, but I have worked the units for a full day and would be using the drill on about a 25% duty cycle. Admittedly this is not full power for full operation but that's the whole reason for using one of these drills; they're so controllable and still quite powerful.

We recently drilled pilot holes, countersunk and put in over 320 by 45mm long and 240 by 20mm long, coarse threaded screws into chipboard during a day. The job was a breeze as each task was carried out by a dedicated drill/drill bit and all I had to do was plug it into the lead as the tasks changed, which was a lot easier than changing bits and I was able to assign the most suitable drill to the allotted task. As the collection of drills has amassed, I found all have slightly different characteristics and excel in certain duties. Fact is there is no such thing as a universal anything.

I used this set up for about two years with the three drills and was so impressed that I bought another AGM (Absorbent Glass Mat) battery so that I had back up (and if needed, could use more than one drill at a time without changing leads) in addition to a dedicated charger suited to the batteries. Truth is, the original battery is still going strong and for the work I do lasts for a full day of quite intensive use.



3. Mark the contacts to maintain polarity (this is the original IEC installation).



4. Strain relief bushes in place with cables installed.

When I looked into the conversion (giving it a far more important title than what actually happened, which was to look round and see what I had that could be used to do the job!) I read an article in Model Engineers Workshop I think, assessing the current draw of battery drills. The given figure was alarming, but I reasoned that given the size of the internal wiring that the five manufacturers that I've had experience of all had specified (and given they must have far better research facilities than me) I estimated that if everything was sized for 15amp minimum there should be no problems.

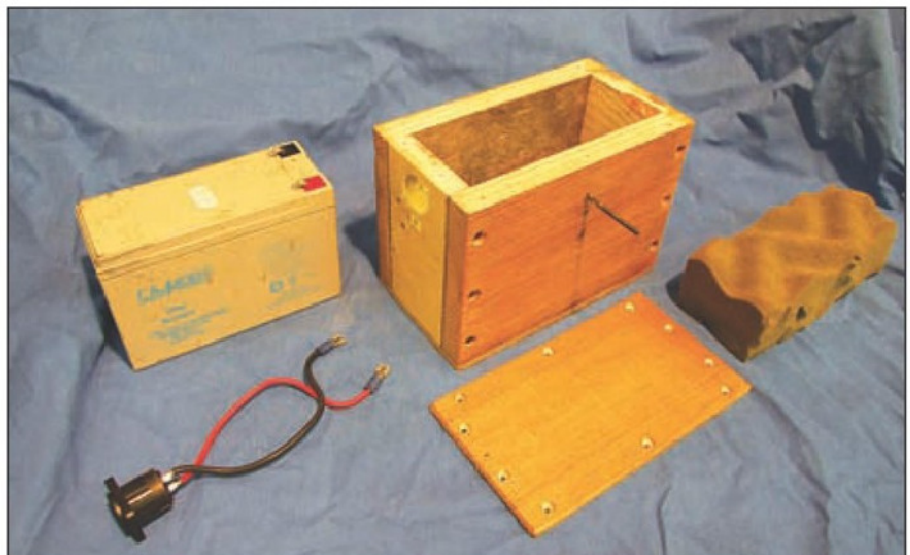
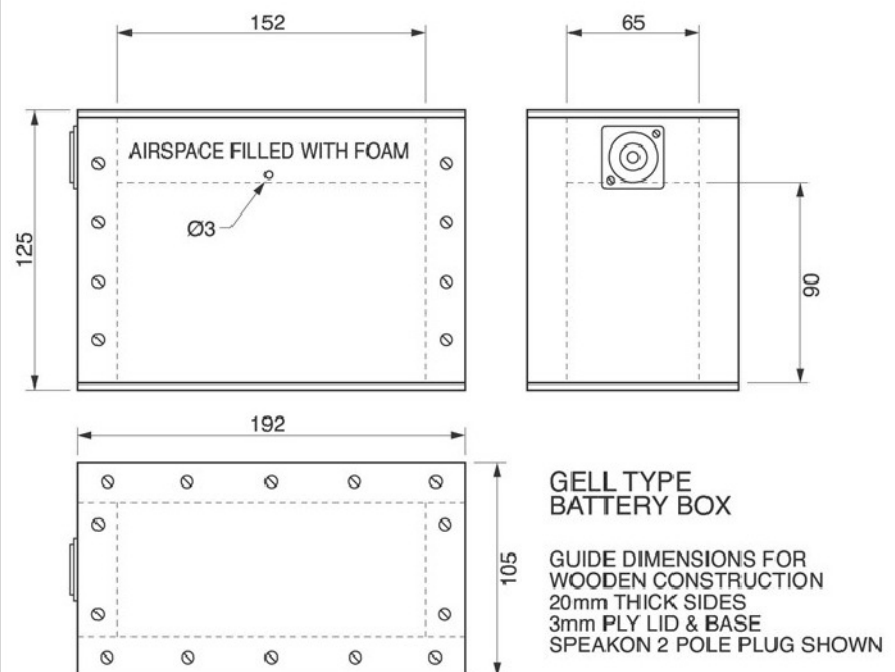
This has proved to be the case and has stood hard practical use for over three years. What has proven to be problematic is the method I chose for connecting the battery to the drills as the plug originally used is not positive and works loose in use. Also because of the success of the method, the need to be able to use more than one drill without constantly changing the battery lead would be a "nice to have," feature and as I now have additional (underused) batteries I thought they should be factored in to the improvements.

So the latest mutation of the concept has formed into the following: -

- Easily available batteries at a reasonable cost.
- Batteries easily connected to a charging supply when required.
- Leads secured to drill body so that power is maintained when the "Going gets tough" (Real world people will relate to that - I'm not going to explain!)
- Type of lead should be such that when it gets cold it doesn't do an impersonation of a piece of 6mm metal rod.
- All the items used should be capable of carrying 15 Amp minimum.

What I've produced satisfies all the points raised. I hope this will give suitable inspiration to some of you to get those defunct drills going, or give you a chance to get a bargain from the car boot and turn it into something that once you get used to you'll wonder how on earth you did anything before you had one. There is also the added bonus that it involves only a small outlay and is readily transferable as drills come and go, regardless of make.

Fig. 1



5. A bit of wood engineering! All the parts for the battery box - note vent hole.



6. Gel battery installed and connected - note foam packing to fill space.



7. Lid foam filler in, lid on, cut down timing belt handle to be fitted.



8. Showing finished box with charger connected.

Conversion is simple. The polarity of the original battery contacts inside the handle needs to be confirmed, (I mark them as soon as they've been identified to save mistakes!). This is usually found marked on the battery, near to the contacts. The lead has to be prepared, and the conductor (pre-tinned) soldered on to the drill contacts, (Brown or Red for +ve Blue or Black for -ve). A filler piece, to allow the installation to the handle of a cable bush, preferably with strain relief, then has to be fashioned and secured to the opening in the handle where the original battery used to go (photos 3 and 4). The other end of the lead has to have a "Speakon" plug fitted, again make sure to keep the polarity correct, (only the +ve is marked on the plug). The Speakon Plugs and sockets have proven to be ideal and are designed for connecting commercial PA and audio systems as used by the music profession. They come in solder or screw terminal forms, I've used the two pole type with solder terminals as they were cheaper.

To protect the battery from damage I needed to make a case, and as it happened to be convenient, I chose wood (fig 1).

Most metal "manglers" have a deep rooted dislike about having anything to do with wood of any form, but if treated like a soft metal with an unfortunate predilection for splitting, (if the time is not taken to drill pilot holes before fitting screws) then a reasonable job can be quickly made.

I glued and nailed the base on with staples after squaring up the pieces to the sizes shown and screwed together, (after drilling pilot holes) using plasterboard screws. Using staples instead of pins gives

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	12v 7.5 Ah Lead Acid Gel	CPC - BT 02860
• Plugs	Speakon 30A rating	CPC - CN04523
• Sockets	Speakon 30A rating	CPC - AV09132
• Lead	2 core 1.5mm 15A Artic Flex	CPC - CBBR4558 £0.64/Mtr
• Strain relief bush	5 - 10 mm	CPC - CB02113 £0.98
• Charger	12v -1A	CPC - BT03017 £23.05

I have no connection with CPC, but have been happy to use them for the past 10 years. The codes quoted are correct at this time. I must confess however that all the items I purchased where when CPC had special promotional offers.

a greater area under the "head" which is of benefit when using thin ply and the plasterboard drywall screws are very cheap and have a protective phosphate coating in addition to having a coarse sharp thread with a thin core, all things that help stop splitting.

Lick over with a belt sander after initial assembly (or rub over with abrasive paper on a block if no sander is available) and give a coat of varnish to protect.

Make sure that the breather holes in each side are not blocked as the battery has to breathe in the same way as a normal lead acid type (photo 5).

Fit the battery in the case, install the socket and connect to the battery terminals (photo 6) before fitting the foam

filler and screwing on the lid. I made a carrying handle out of an old cam belt, cut down and secured after punching two holes at each end with a couple of screws each side (photo 7).

The charger needed to have a "Speakon" plug fitted in place of the supplied crocodile clips so that the battery can be maintained (photo 8).

The drill that is most used is a 14.4 Volt unit (photo 9) however, the three work well together (photo 10) because as I mentioned before, each excels in different functions and when a job needs to have a number of tapping size holes drilled, tapped and the bolts run down to a preset torque, what used to be a tedious job becomes tolerable! ■



9. The complete package - my favourite most used drill.



10. Two 9.6 and one 14.4 volt drills - ready to go.

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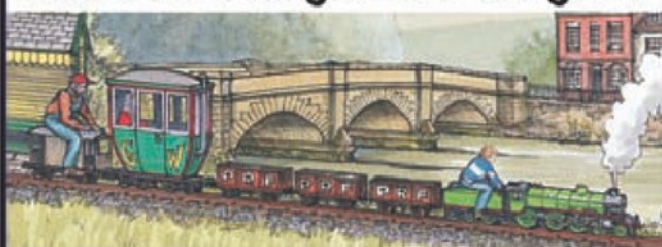
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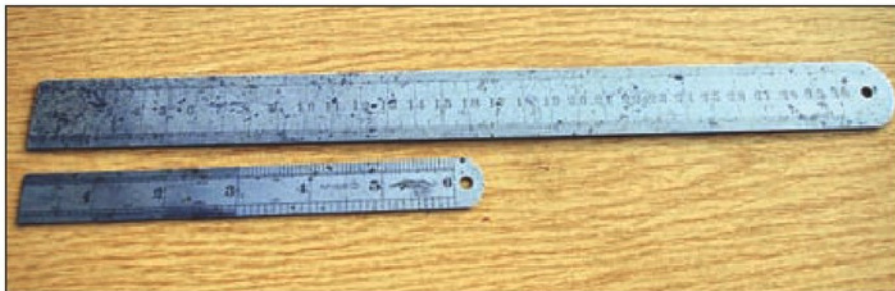
1. Top to bottom, a cheap plastic ruler, 12 inch wooden draughting scale, six inch composite scale and a folding 24 inch brass rule more suited to woodworking.

ENGINEERING MEASUREMENT

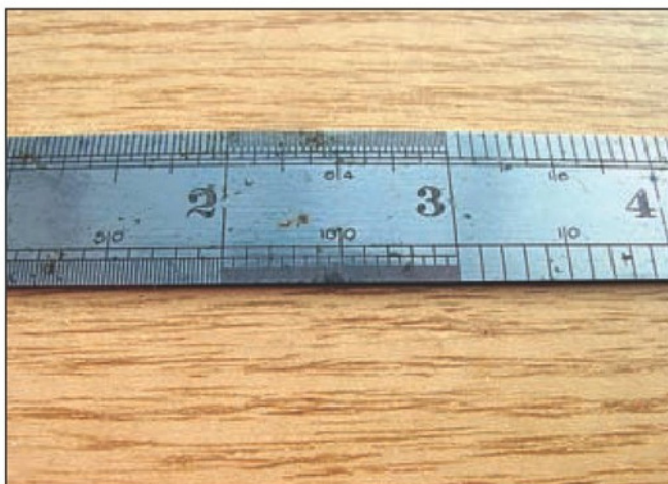
Dave Fenner looks at accuracy in the home workshop

Although the cost of precision measuring kit has fallen dramatically over the last couple of decades, it is still possible to spend quite considerable sums on metrology equipment, so while it is

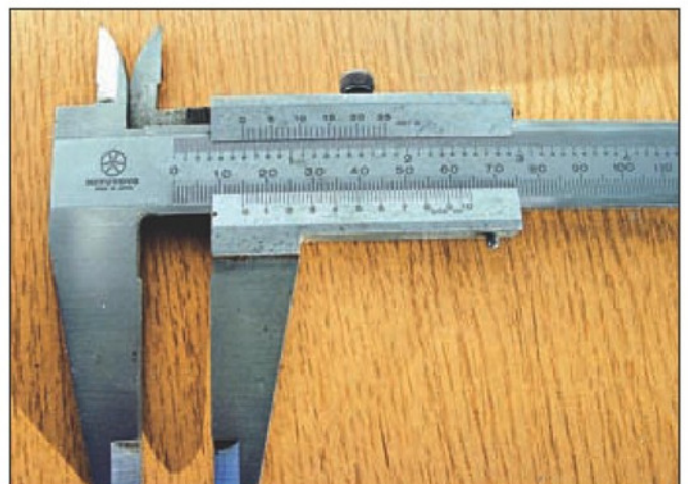
worth knowing about what is commercially available, it is also important to think carefully about what is really needed, in relation to the work being undertaken. Initially we will consider the various items employed for direct measurement.



2. Six and twelve inch steel rules.



3. Fine divisions on a steel rule.



4. 12 inch vernier calipers. Note: fine adjustment assembly is missing.

OVERVIEW

It goes without saying that if you intend to make parts to an accurately determined size, then you are also likely to need some means of measuring that size. This article attempts to look at some of the measuring equipment available, and comment on its usefulness in the amateur setting and examine how it may be used. The content will be influenced by those items of which I have direct experience, including some more production oriented items, which would not be on the "must have" list for the amateur shop, but which may nevertheless be useful, and worth acquiring if an unmissable bargain is encountered.

Rules and rulers

Going back to schooldays in an earlier era, the near universal tool for measuring things was the wooden (later plastic) twelve inch ruler (also used for rapping miscreant's knuckles). Those whose education included a spell of technical drawing might have been instructed to acquire an "engine divided scale rule" for more accurate work. Again these might typically be wood or plastic or even composite construction. **Photograph 1** includes a pair of scales specifically manufactured for marine work in the 70s, which have both imperial and metric divisions in scales of 1:10, 1:20, 1:50, and 1:100.

Moving into the metal work environment, such rulers or rules, unless used carefully, would quickly become damaged, so something more robust is appropriate, bringing us to the steel rule. What we are after is a precision item with clear divisions. Unlike the school ruler where the graduated length starts several millimetres from the end, the end of the steel rule is the zero. Although rules are available in a variety of lengths, a six inch rule will serve most of the needs, and if a twelve inch one is added then that will be a luxury (**photo 2**). Nowadays, for a larger order of magnitude, steel tapes allow measurement of say up to five metres with an accuracy likely to be in the region of plus or minus a millimetre.

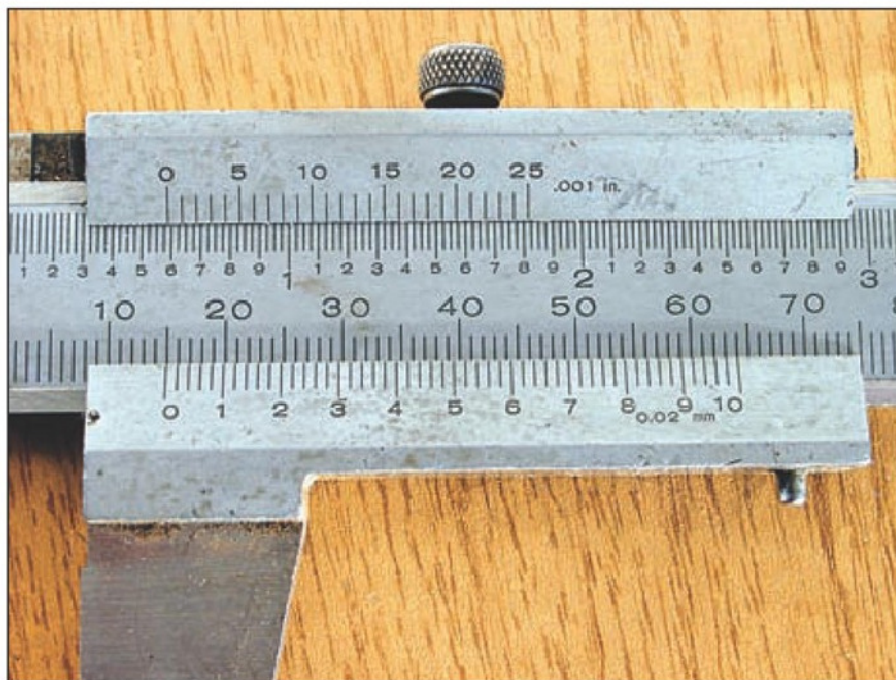
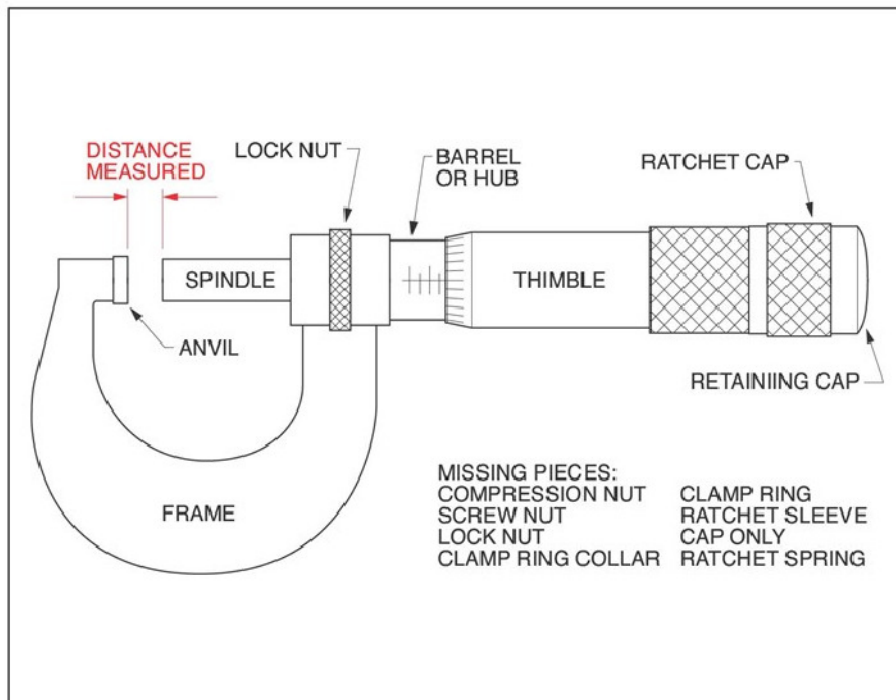
Rules are likely to be equipped with graduations in one or more of three formats, fractional inch (to sixty fourths), decimal inch (to hundredths), and metric (to half millimetres), and accurate determination of a dimension may be aided by a simple magnifying glass or jeweller's loupe. **Photo 3** shows typical fine divisions (64ths and 100ths of an inch). Steel, like most materials, expands with rising temperature, so a quality rule is likely to carry an engraved note such as "Standard at 20 deg Centigrade".

Digital and vernier calipers

Moving on to a slightly higher order of accuracy takes us to two forms of caliper, the vernier and the digital. (Other forms of caliper for indirect measurement will be considered later). In either case the instrument gives the advantage of a range of measurement comparable with a steel rule, but to an improved order of accuracy. Older style vernier calipers (**photo 4**) could be easily read with the naked eye to 0.1mm, but for the 0.02mm and the imperial divisions it may be found that either good eyesight or a magnifier is needed to read to the theoretical best accuracy. The system depends on having a set of graduations on the moving part, whose spacing is less than those on the fixed scale. For metric divisions, the spacing will typically be 0.98mm so that 50 spaces occupy 49mm. **Photograph 5** illustrates the arrangement on a 12inch Mitutoyo device. Moving the sliding jaw in 0.02mm increments brings successive graduations into alignment on the metric scale. For imperial measurement, the main scale is divided into tenths and fortieths of an inch (twenty - five thous). The sliding scale has twenty five divisions which allow measurement to one thou (0.001 inch). Vernier calipers are often cheaply available ex industry where they have been superseded by the digital variety, but for amateur work they should not be dismissed as they are easily checked for condition, and damage/wear is often confined to the area close to the points.

Like vernier calipers, the newer digital type is available in a succession of sizes starting at about 3 or 4 inches. For most model making work, the popular six inch size will cover a large proportion of what is required. Most digital calipers also feature a rod attached to the sliding section, which functions as a depth gauge. Care does need to be taken though as the rod can wear in use so it is worth setting to zero on a flat surface, before measuring depth.

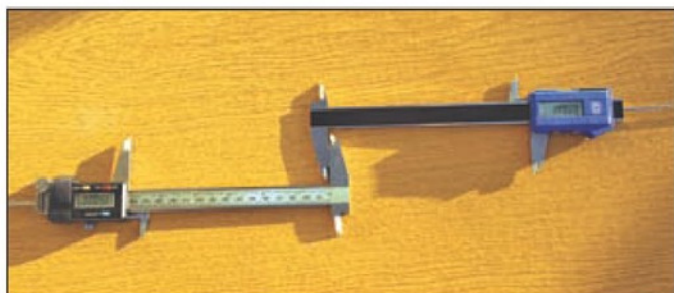
If you do need to measure larger sizes, then hooking two calipers together, as in **photo 6**, can provide a makeshift solution, one being locked at a known setting. Alternatively, larger instruments are available, (**photo 7**) but usually at a



5. Detail of the graduations on the vernier.

disproportionate price. Those shown in their boxes were acquired secondhand at prices typical of the cheapest six inch types. Drawing a comparison between the vernier and the digital calliper, the digital wins on being able to set a false zero and make instant conversions between metric and imperial, while conversely, the vernier

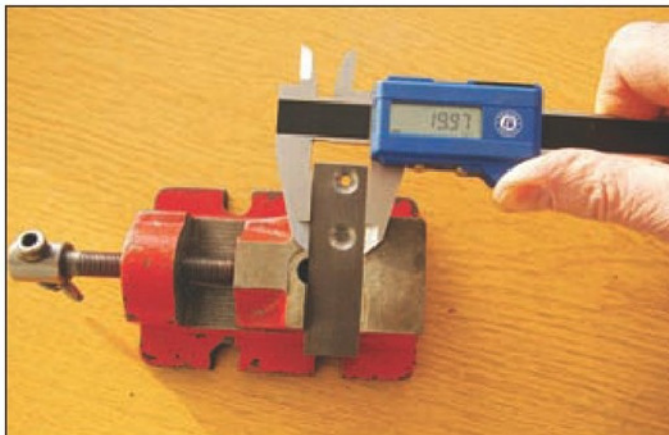
never goes dead in winter with a flat battery. One point that should be noted concerns the measurement of outside and inside diameters with the same caliper. Theoretically this should not be a problem, however unless your calipers have been purchased new or have a known calibration history, then it is quite



6. Two six inch calipers may be hooked together to measure up to 12inches.



7. Larger digital calipers from Mitutoyo (12inch and 24inch).



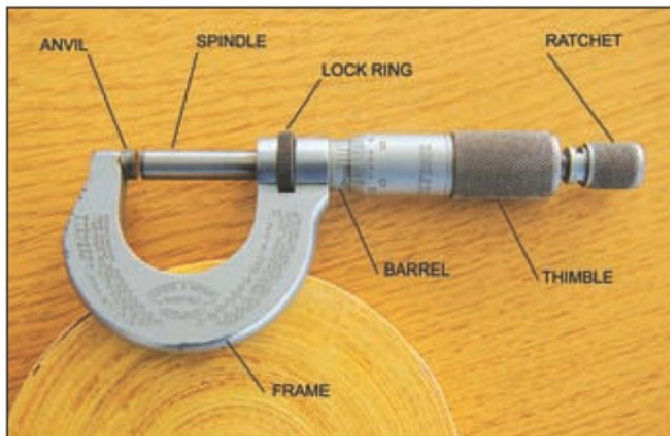
8. Measuring over the flat with the outside jaws.



9. Measuring between the vice jaws with the inside points.



10. Four Micrometers covering a range of 0 to 4 inches. Top to bottom: 0 to 1in. Moore & Wright, 1 to 2in. Etalon, 50 to 75mm GKN Shardlow, 3 to 4in. Moore & Wright.



11. Nomenclature for main parts of a micrometer.

likely that slight damage will have occurred to the inside points, so that a measurement taken with these will deviate slightly from the same measurement made with the outside jaws. This can become significant when machining accurate piston - cylinder assemblies.

Photographs 8 and 9 show one basic method of checking the inside - outside reading of a caliper, using just a piece of steel flat and a small machine vice. The first measurement is taken over the steel, here a piece of 20 x 8mm flat bar, the second between the jaws. If the readings are not the same, then the instrument is likely to be at fault. In this case, the variation is 0.04mm probably sufficiently precise for most work. A more sophisticated check might be undertaken if other inspection equipment is to hand. When assessing pre-owned calipers, if the jaws are held up to the light, it may be seen that a slight gap exists toward the points indicating wear in this area. For some sheet metal workers it used to be common practice to use their vernier calipers much as a woodworker might use a mitre gauge, for scribing a line parallel to a sheet edge. As a result, wear would occur to one jaw edge and one jaw point.

Obtaining a reliable reading with either type of caliper requires care, and in the author's experience, this is particularly so when measuring bores. Surprisingly, in the absence of dedicated bore gauges, it has often been found preferable to take an indirect measurement with a spring caliper, and to check this against an outside measuring device (either caliper or micrometer).

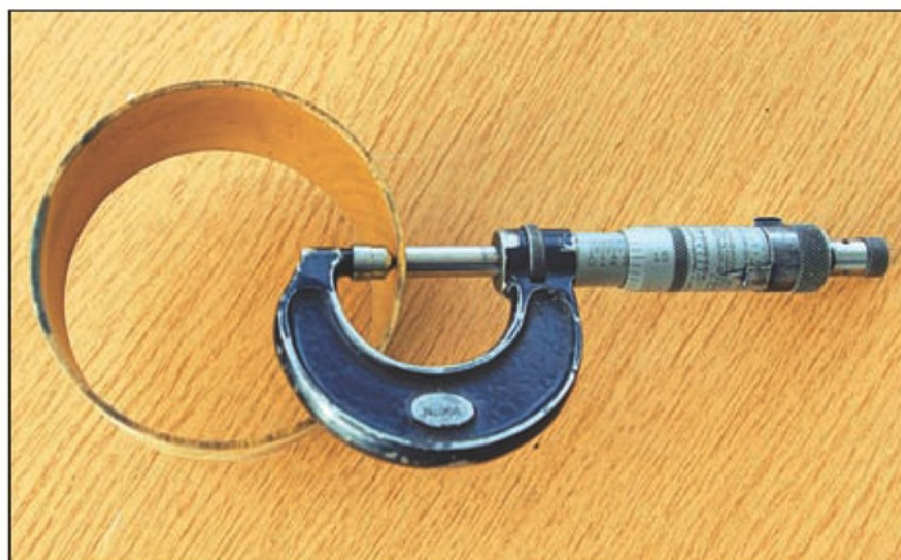
Now that the cost of six inch digital calipers has fallen to below £10.00 from sources such as Aldi supermarkets, obtaining one of these for the home workshop has really become a no brainer.

Micrometer

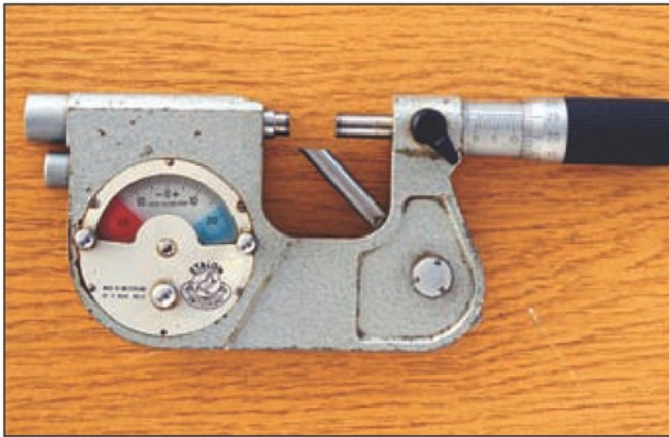
Mention of the micrometer (or micrometer screw gauge) brings us to this next category of measuring instrument. Usually each one will have a measuring range of just one inch or 25mm, so to achieve the range offered by a six inch caliper would require six micrometers, unless one of the

specialist devices is obtained which have a series of adapter rods catering for different ranges. Such a tool is however likely to be more cumbersome in use than the normal pattern. **Photograph 10** shows a selection of mikes to measure 0-1in. 1-2in. 50-75mm. and 3-4in.

Photograph 11 shows the main components of a 0-1inch mike and for right handed operators, the frame may be gripped in the palm by one finger, while the thimble is rotated by finger and thumb, the work being held in the left hand. It depends for its operation on an accurate screw thread (forty t.p.i. for



12. The ball accessory used to measure tube wall thickness.



13. Etalon micrometer intended for volume inspection work.



14. Typical lever action dial gauge.

imperial, and 0.5mm pitch for metric) so that the spindle/thimble assembly may be screwed into the barrel.

In the case of the imperial device, one complete turn equates to a linear movement of 0.025inch, and so with twenty five divisions around the thimble, measurements may be read to 0.001inch. Further refinements on some models are carbide faces on the spindle and anvil, also the inclusion of a vernier scale around the barrel. In theory this permits measurement down to the nearest 0.0001inch, however it must be noted that such accuracy requires the application of consistent torque, either by experienced "feel" or by the action of the ratchet. Reading a mike is a matter of taking the linear scale reading to the last visible line (25 thou increments in imperial) and adding the number of thous indicated by the thimble. At this point I would venture to suggest that a 0 - 1 in. or 0 - 25mm micrometer should be included in the shopping list, to complement the rule and calipers suggested above.

If we need to measure the wall thickness of a tube, then this could be achieved by deducting the inside from the outside diameter and halving the result. If a mike is applied directly to check the wall, then the anvil on the inside of the tube will make incorrect corner contact with the work giving an erroneous reading. A small accessory is available (Photo 12) which fits on the anvil, this one housing a 0.250in. diameter ball bearing. This then allows correct contact, but you do need to remember to deduct the ball diameter from the indicated measurement.

For dimensions up to one inch, my personal preference is to work with the micrometer. My feeling is that this gives more repeatable results more easily, but it may just be a hangover from the Rolls Royce training school, where in the pre digital age, vernier calipers were not in evidence.

As a digression, I have included the metric Etalon mike shown in photo 13. This is very much an inspection tool for measuring a specific diameter in a volume production application. The angled anvil is adjusted as a depth stop, so that the measuring anvil and spindle bear across the work diameter. Next the spindle is set to the nominal size, then the two coloured sectors are adjusted to give the upper and lower tolerance limits (to a maximum range of plus/minus 25 thousandths of a millimetre). The anvil (which would be fixed on a standard mike, but here slides

back against a spring) is withdrawn slightly by a plunger, the component placed in position, and the plunger released. The anvil then slides back to contact the work and the needle indicates the actual size to a theoretical accuracy of one thousandth of a millimetre. This example was purchased cheaply at a sale many years ago, and is believed to have been used at the long gone Timex watch factory in Dundee.

Clock gauge or dial test indicator

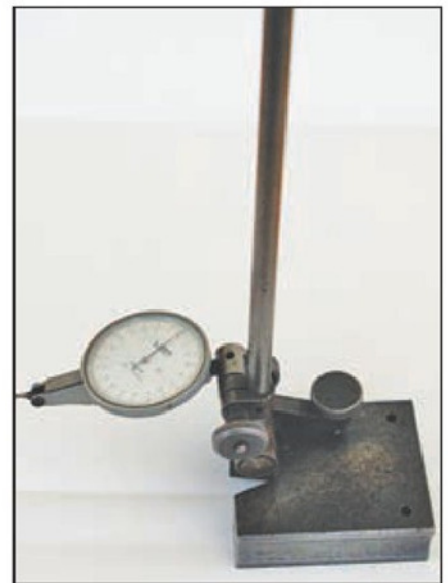
These come in two main geometric forms, lever action photo 14 and plunger action photo 15. They will also be found with different levels of precision so that in

imperial terms, you may find 0.0001in. or 0.0005in. or 0.001in. per scale division. Plunger action clocks may be found with travel up to an inch or so, while lever action have a lower measuring range. Long travel plunger type clocks will have a small second dial which indicates the number of revolutions of the main indicator hand. Rather as the digital caliper may need to be zeroed before use, a clock will not instantly tell you how long or how thick etc. What it will typically do is indicate a variation or difference between sizes.

A clock will frequently be attached to a magnetic base, and in this form can easily be used to check concentricity of work in a four-jaw chuck. If attached to an



15. Plunger action dial gauge.



16. Clock fitted to surface gauge.



17. Set of feeler gauges showing evidence of over forty years usage.



18. Two sets of thread gauges. Imperial covers 4 to 60 tpi Whitworth and 4 to 42 tpi unified. The metric set gives pitches ranging from 6mm down to 0.25mm.

arbor, then it can be fitted to a mill spindle and employed to "tram" the head or to check the squareness of a vice. Fitted to a surface gauge (**photo 16**) the height of work on a surface plate or table may be compared to some other dimension.

Feeler gauges, thread gauges, and radius gauges

Those of us old enough to remember ignition contact breakers on our cars will no doubt be familiar with feeler gauges, (**photo 17**) which were also used to set tappets before hydraulic lifters were invented. These are really just strips of shim steel each accurately produced to a specified thickness. The imperial set shown comprises 1.5, 2, 3, 4, 6, 8, 10, 12, 15, and

25 thou thicknesses, allowing any thickness 0.0015in. up to 0.0865in. to be stacked for measuring the width of small slots etc. The most frequent use to which mine are put these days, is for edge finding on the mill, where a known diameter rod is set in the chuck, and a feeler interposed between it and the work. The table is moved until the feeler is just nipped, whereupon the offset is the thickness of the feeler plus half the rod diameter.

Photograph 18 illustrates two sets of thread gauges, one from Moore & Wright for Whitworth and Unified thread sizes, and a second, obtained very cheaply for metric work. It may have even been a give away with a motoring magazine. These serve to underline that you get what you pay for. The M&W has crisply cut serrations even

on the finest size, while the effectiveness of the metric set falls away at pitches less than about 0.6mm. My most frequent use of thread gauges is to identify an unknown thread. Offering up successive blades will quickly determine the pitch or TPI, and this information, along with the measured diameter, will usually give an answer.

A typical set of radius gauges is shown in **photo 19** and it may be seen that the construction is similar to the feeler and thread gauge sets. Here each blade is profiled with a known radius - internal and external.

As with the thread gauges, an unknown radius may be tested for fit against successive blades, or a specified size checked against the relevant gauge. My set was acquired as part of a job lot and I would probably not have purchased them as an individual choice. On those rare occasions where they have been used, a makeshift gauge could have been produced either by using a short length of rod, or by punching/drilling a hole in thin sheet metal.

Calipers - spring and friction hinge

These are tools for indirect measurement. To determine a size, the caliper is first set to contact the work and then the dimension across the caliper points is measured with say a micrometer. I would tend to relegate the friction hinge type (**photo 20**) to less demanding marking out work, but the internal version of the spring variety seen in the group illustrated in **photo 21** can be extremely useful, particularly for measuring small bores. The small size and light weight make them easy to manipulate when checking work on the lathe. Care is needed to ensure that a setting is made truly on the diameter and at right angles to the axis. When just a little drag is found when moving the caliper along the bore, the size may be checked with a mike, aiming to get the same light drag, when the caliper is moved across the faces of anvil and spindle.

Measurement of angles

For setting or checking right angles, try squares are made in a variety of sizes, two are shown in **photo 22**. For general angular measurement, one should not overlook the usefulness of basic plastic set squares and protractors as supplied for school use. For some applications it may be found



19. Typical imperial radius gauges.



20. Assorted friction hinge calipers. L to R: Jennies (usually for marking out), Two typical external types, and finally a Set for visible indication of a hidden dimension.



21. Assorted spring joint calipers. L to R: dividers, Jennies, small external, internal and large external.



22. Six inch and three inch try squares shown with a 150mm depth gauge.

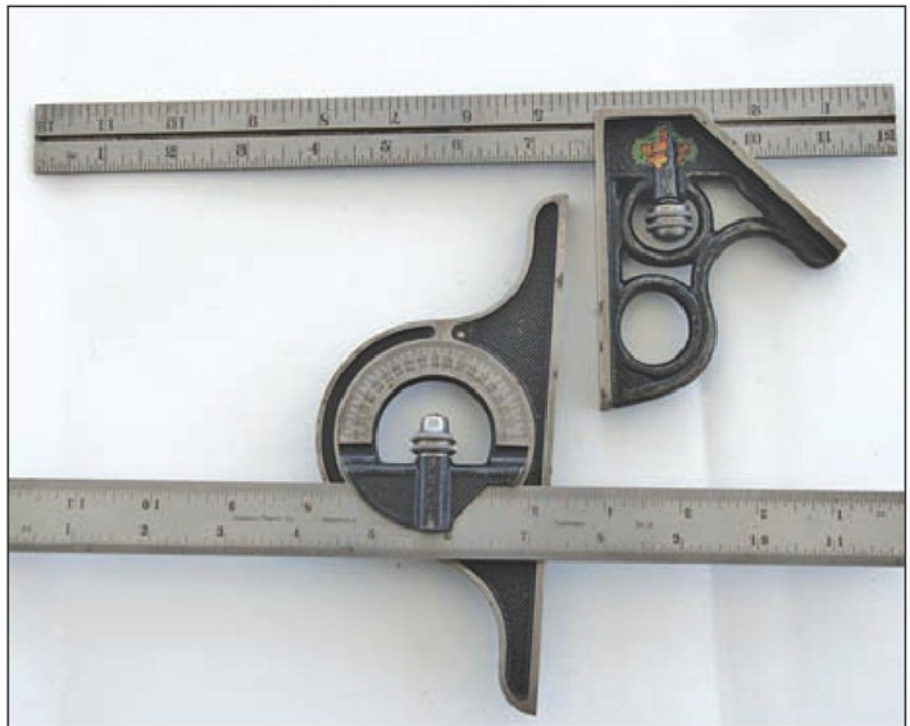
advantageous to trim off the edge of a protractor flush with the zero - 180degree line, creating a situation similar to the steel rule (zero at the end). More accurate protractor devices are available equipped with either a magnifier or a vernier scale to allow precise readings to be taken. I have to admit that over my 30 ish years of amateur workshop endeavours, for general angular work, I have not progressed much beyond the kit shown in **photo 23**. Such items are often available as "Combination Sets" including the protractor, a square and a 45 degree centrefinder.

The probable reason for not needing a better protractor stems from easy methods of setting angles by means of division equipment, such as headstock dividing attachment, rotary table and dividing head. If we do need to measure an angle to a better order of precision, then a sine bar might be employed. This will be touched upon later.

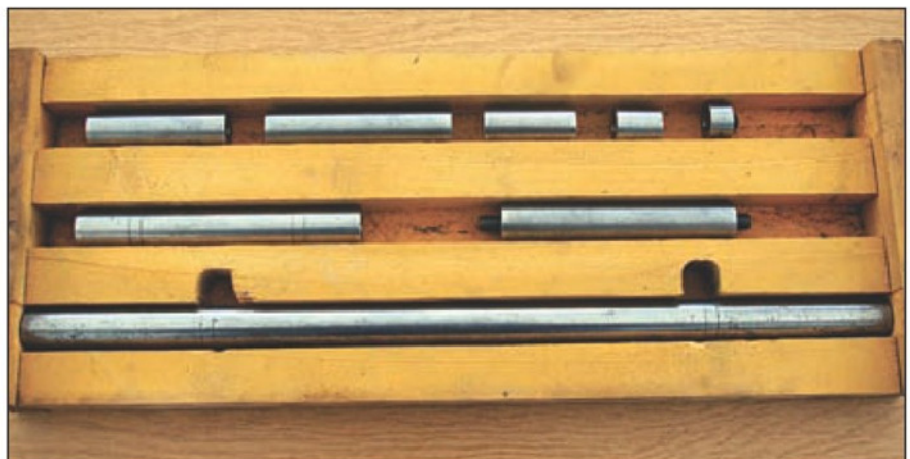
Reference equipment

One might include the feeler, thread and radius gauges here, but I prefer to restrict the description to items such as precision bars and gauge blocks. These are items which are less frequently used and therefore of limited value to the average home workshop. The potential value is that once checked for dimensional accuracy at the time of acquisition, they may be relied upon as an "in house" reference standard.

The original purpose of bars shown in **photo 24** was probably in connection with accurate milling. I recall a milling machine in the seventies, fitted with a sort of trough holder running along the front edge of the table. Bars could be dropped into the trough which would engage with the stop, limiting travel to a precise amount. You may come across gadgets like these which became redundant with the arrival of the digital read out. If cheaply obtained, they are cost effective as standards to check the accuracy of micrometers. The set shown may also be coupled together to create known lengths in increments of half an inch with a range from half an inch to 39.5 inch.



23. Protractor and square with spirit level. These are often available as a combination set with centre finder.



24. Set of precision bars, half inch to 18 inches.



25. Incomplete set of gauge blocks.

Gauge blocks, also known as slip gauges, or Jo blocks after the Johanssen firm, which made many of them, are shown in **photo 25**. This is a metric set by Coventry Gauge, and is missing the two protection slips. These sets comprise a number of very accurately produced blocks, (usually made from hardened steel or carbide). The metric set shown allows dimensions to be stacked in increments of 0.0005mm. In use, the blocks are held together and rotated about 90 degrees into alignment. If they are clean, they will then stick together. This "rotating and sticking" procedure is known as wringing.

Gauge blocks find a variety of applications such as creating a reference height for a surface gauge, and in conjunction with the sine bar mentioned earlier for setting and measuring angles. Like many other pieces of kit, sine bars come in different sizes. For imperial workers, this usually means five inch and ten inch. As may be seen from **photo 26**, the bar is basically a length of steel, flat on its top surface and supported by two cylinders of equal size. For the one shown, the spacing between the axes of the cylinders is precisely five inches. Thus if the bar is lifted at one end to say ten degrees, then one cylinder will have been lifted by an amount h where :

$$h = 5 \sin 10 \text{deg. inches or}$$

$$h = 0.8682409 \text{ inches or } 22.05332 \text{mm}$$

In photo 26 the packing is a 12mm (0.47244in.) gauge block. Thus the sine of the angle is 0.094488, and the angle set is 5.42186 degrees or 5 degrees, 25 minutes, and 19 seconds.

It was noted before that metric gauge blocks permit setting to intervals of 0.0005mm or 0.0000197inch, and the sine bar tables in Machinery's Handbook give the height for an angle of one minute as 0.00145in. so theoretically our sine bar may be set to angular intervals of less than one second of arc.

It is also possible to use the sine bar to adjust the lathe topslide to precise angles.

The cost of a set of gauge blocks is not insignificant, and their use somewhat specialised, so these are not likely to feature high on the priority list. Some micrometers are now supplied with appropriate gauge rods, and it is probable that some form of reference standard will be useful on occasion, for instance when you drop your favourite micrometer, (or your favourite grandson uses it as a shifting spanner) and are not sure whether its accuracy has been compromised. Alternatively you may have simply decided to strip and clean the mike, then wish to rebuild and calibrate. Certainly a 0-1in. may be checked at zero, but this is not possible for larger sizes. One low cost method of achieving this with reasonable precision is to turn gauge rods in the lathe. The work is best held in a collet chuck to ensure the optimal true running and then the ends are faced using a

radiused tool to gain the best possible finish. The length is then measured with a micrometer of proven accuracy and this length engraved on the cylindrical part of the rod, which is then oiled and stored carefully. An alternative approach for smaller sizes is to turn cylinders and use the diametral figure.

If you have access to heat treatment and grinding facilities, then a better and more durable result can be obtained, perhaps looking more like a gauge block. Other routes to a similar goal include commercial items such as precision ground bar, bearing races, balls and rollers, although again the first step is to determine the actual size, since this may vary by a thou or so from nominal.

Conclusion

Harking back to my initial efforts, during the seventies, in my home shop, turning work was undertaken on a very secondhand ML7, drilling courtesy of a Black and Decker on a drill stand, and measurement by means of a six inch steel rule, a set of feeler gauges, a 0-1in. micrometer and a six inch vernier caliper. Sadly the caliper was lost some time back, but it does deserve at least passing comment. It was made of plastic and if my memory serves correctly, was a freebie give away with one of the practical car magazines. Although cheap and cheerful, and in spite of having been bashed around in a toolbox for several years, it was, however, accurate to about a couple of thous, and gave repeatable readings. With this very basic equipment, a Stuart 10V steam engine and a Jones 605 two stroke were successfully constructed.

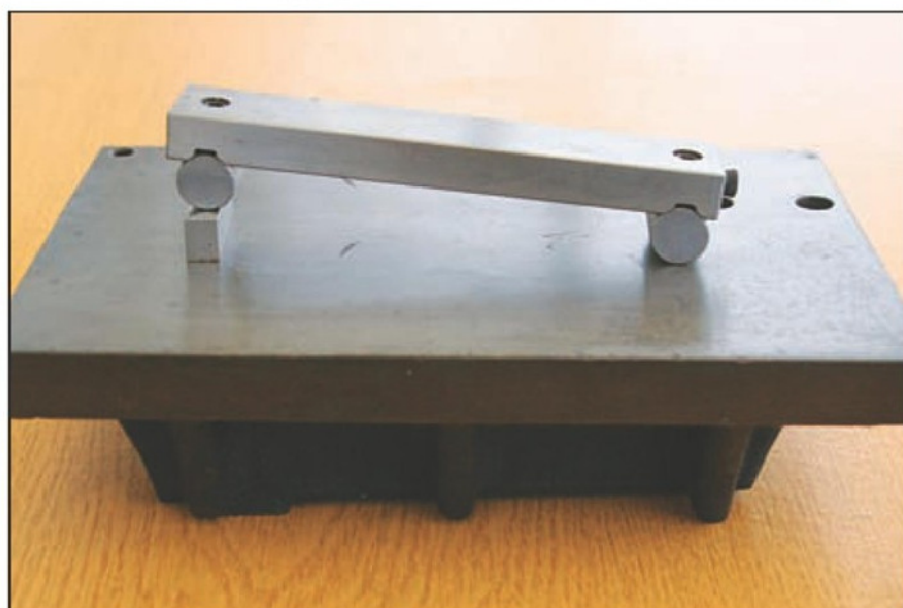
For the novice making a start today, I would suggest initially:

- Six inch rule
- Six inch digital caliper
- Four or six inch try square

Then if funds permit:

- 0-1in. micrometer
- Clock gauge with magnetic base

Growing experience will then give a guide to further additions to the armoury. ■



26. Sine bar with 12mm gauge block.

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I was so impressed with this engine that as soon as I finished watching the second DVD, I went on to Ebay to order some aluminium to start construction. As you have probably realised, I quite like the look of this little engine!

David Clark - Editor 'Model Engineers' Workshop' Issue No. 149 April 2009

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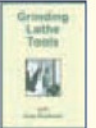
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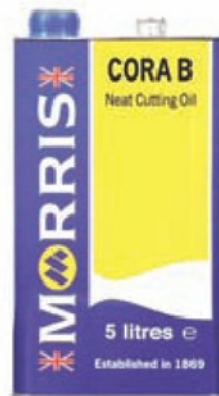
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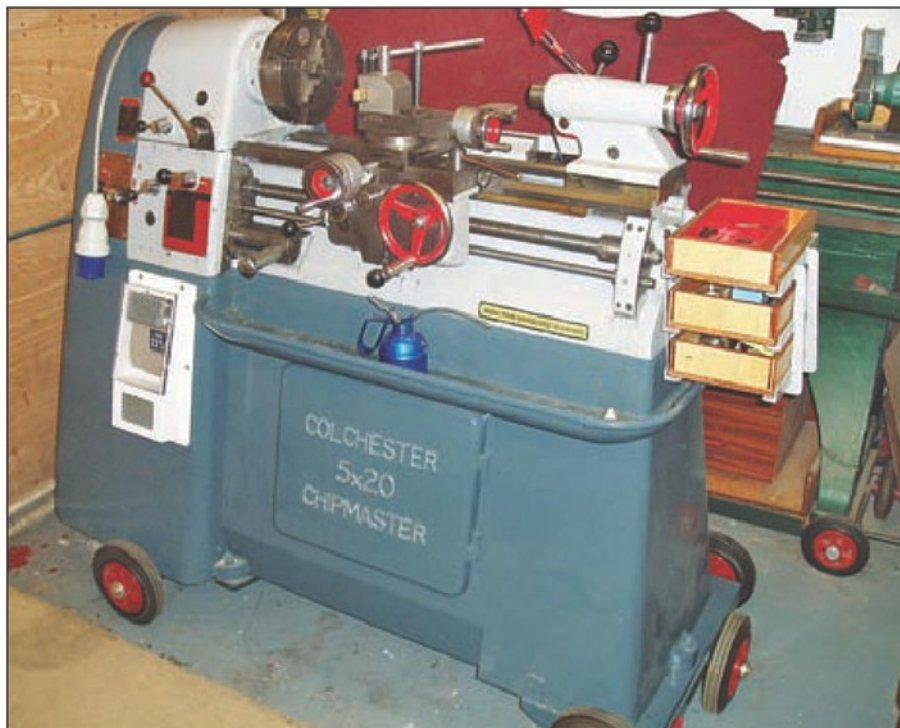
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RESURRECTING A COLCHESTER CHIPMASTER LATHE

Jim Perry brings an aging Chipmaster back to life



1. The finished lathe.

Choosing the lathe

I've used a venerable Mondial Simplex lathe since it was first dispensed with by our training department in Jamaica in 1972. It's almost a museum piece, two metres long overall with a flat belt drive (photo 2).

I thought it was about time I had a lathe on which I could take heavy and precise cuts reliably without all the jumping and juddering, it just doesn't like parting off.

I wanted quality although I didn't want a Boxford or a Myford. I decided a Chipmaster offered the best compromise on quality and cost.

I was aware of its "Achilles heel", i.e. the Kopp Variator, and knew I was going to dispense with it. My choice was inspired in part by Tony Griffith's excellent website www.lathes.co.uk particularly the comments on quality of manufacture.

I was lucky enough to find Bede Tools & Machinery (Jarrow) in my part of the country advertising a Chipmaster for sale.

Bede is run by Barry Macpherson and his son Andrew. Whilst I was too late for the one advertised, Barry promised to look out for another for me. Within a week or so, another did appear. Barry dutifully had it up and running in his workshop for my

OVERVIEW

I thought that my restoration of my Chipmaster lathe might be of interest to readers of MEW.

Photograph 1 shows the lathe as it now is (before I think of something else to do on it). Replacing the Kopp Variator with an inverter is nothing new as I've seen it mentioned quite a few times, but I've never seen a detailed write up of it.

The photo sequence didn't start out as a beautifully detailed step by step record a la Hall/Fenner but I hope it shows what I was up to. Apologies for the quality of some of the close ups.

appraisal. Considering its age (1975) it was in reasonable order. It had some nice features such as hardened bedways with negligible signs of wear, dual dials and a taper turning attachment.

The only obvious problems were two broken teeth on the long travel rack and an almost seized gear change rod.

Even the Kopp was, I believe, "a good un", although still very noisy. I have nice tolerant neighbours but enthusiastic turning before anyone else was up would have been pushing my luck.

Barry delivered the lathe on his trailer (nicely strapped down). The Kopp and the Drive Motor were removed to reduce weight during transit. They represent a considerable lump.

First steps

The interior of the drive compartment was thick with a hardened mixture of swarf and congealed grease (photo 3). Over the years, swarf had entered places where it wouldn't be expected swarf could enter. The first job was to clean the whole thing up so that I could work on it without becoming covered in grot. This was achieved using scrapers, degreaser, a compressed air lance and a large sack of sawdust (from one of my wood turning friends). Despite the sawdust,



2. The Mondial Simplex lathe.



3. Inside the motor/variator housing.

the degreaser still managed to lift the paint from parts of my nice clean garage workshop floor.

I would have liked to have totally dismantled the lathe for a thorough inspection and paint job. As I got to them, parts did get a fairly respectable lick and a promise, but my aim was to arrive at something I could use sooner rather than later. The thorough strip down will happen sometime I suppose.

The second job was to mount the lathe on wheels. **Photograph 4** shows the method I use for my machines. I abandoned swivelling castors years ago. Lateral stability could be unnervingly reduced on occasion. My system is robust and stable. The slewing wheel at the lighter end enables me to position the machine exactly where I want it. The eccentric axle lifts the two long travel wheels off the ground at that end. It can mean several 3 point turns but I can position a half ton machine by myself with relative ease.

My Workshop has to double as a garage, so manoeuvrability is all important.

A sad point to note though, my car hasn't seen the inside of the garage for over a year. Parkinson's Law seems to take over every time.

Damaged rack

The reason for the broken rack teeth was a puzzle until I inspected the taper turning attachment. At the position of the

saddle where the teeth were broken, the draw rod for the taper turning attachment had obviously dropped out of its clamp. Clearly some ham fisted individual had tried to force the saddle back along without first looking to see what was stopping it. Not only did it damage the rack teeth, it bent the draw bar. It was also Murphy's Law that the break should occur at a weak point on the rack adjacent to its fixing holes (**photo 5**). Although it was possible to feel the slight "clunk" as the saddle passed the bad teeth it didn't appear to have caused damage to the gears driving it. Safe practise would normally be to remove the drawbar until the taper turning device was required.

The rack was removed and the teeth were built up with weld after first clamping the rack to a heavy flat piece of plate to act as a heat sink. The object was to avoid distortion and minimise softening of adjacent teeth.

Whilst the rack is probably hardened, the new teeth would only be mild steel. This however would be perfectly adequate for my use. The adjacent good teeth were covered by slips of copper plate to prevent weld spatter affecting them (**photo 6**).

Recutting the teeth was done carefully by file. The fortunate thing of course is that rack teeth have nice flat flanks (no necessity to follow involute profiles etc). I used car body filler epoxy to produce a profile of a section of good teeth. The still slightly oily surface of the rack meant that

the set epoxy separated cleanly to give a smart result. **Photograph 7** shows the epoxy mould (not very pretty but effective). It can also be seen sitting on good teeth in the right of photo 5. As the filing progressed carefully, the mould was used as a Go-No-go gauge checking that it settled down cleanly over the new teeth. The result was pleasing. The saddle now drives smoothly past the new teeth with no apparent hiccup.

Drive considerations

When the Chipmaster was built, the specification was first class. The trouble was that at that time, to provide continuous speed variation, nothing existed other than noisy and power wasting mechanical devices. Now we have electronic methods, which I am sure would have been the method of choice had they been available then.

The object then was to fit an Inverter to drive the 3 phase motor. This in turn would drive the lathe directly. From a single phase 240 volt input the Inverter would produce a 240 volt 3 phase output with the very useful facility of easy frequency, hence speed, variation.

The drive compartment on the Chipmaster is capacious and lends itself to any such mods. As already mentioned the drive area was like the Black Hole of Calcutta when received. I always find that a good coat of gleaming white paint does wonders for internal areas. Even with the



4. How the wheels are fitted.



5. The damaged rack.



6. Protecting the rack from splatter.



7. Use the moulding as a gauge.



8. The motor on its new frame.

eventual spread of oily splashes, the improved visibility makes it well worth while. Photographs 3 and 8 show the "before and after" situation

The drive layout

Tony Griffith's web site gives useful explanations on the use of inverters etc. There are others but this one also shows pertinent views of the Chipmaster drive system. Click on "Colchester", then "Chipmaster", finally "Variator".

The Kopp Variator is mounted on a robust "inverted U" shaped cast iron bracket with its drive motor mounted beneath. The Kopp is connected via twin belts to the lathe.

The intention was to mount the motor on top of the bracket in place of the Kopp. It was necessary of course to fit a further support frame under the motor to lift it, to give the same base to centre distance as the Kopp (and hence use the same pulley and drive belts). The extra support frame was built of welded angle (photo 8).

The drive motor

All of the write ups I've seen on the Chipmaster talk about a 3 HP motor. Indeed my M/C was equipped with a 3 HP 440v 3 phase motor. Interestingly both copies of the manual I have (one from 1972 and the other from 1978) call up a 2 HP motor. Is this a misprint or a Freudian slip? I have been unable to find design characteristics for the Kopp but I reckon it must consume at least half a horsepower. It is massively heavy and very stiff to turn as all similar swash plate speed changers were. The point being of course that perhaps I only needed 2 HP to drive the lathe. Anecdotal reports talk about successful motor conversions down to 1 HP.

Inverters are expensive. Going from 2HP (1.5Kw) up to 3HP (2.2Kw) costs at least another £100. Clearly I didn't need 3HP so the decision was easy. To save money my intention was to retain the existing 3 HP motor and turn the overload heaters down to suit 2 HP (2.2 Kw), thereby derating it. It would have been a very marginal loss in efficiency. Anyway that was my excuse and I am stuck with it! As it happened things turned out differently.

My motor had three terminals. Obviously not a dual voltage device. I dismantled it

to discover what the connection configuration was, hopefully to reconnect it to suit 240 volts (still 3 phase). Unfortunately the windings and end connections were thoroughly immersed in brittle shellac. Touching them would have destroyed the motor. I talked to a couple of motor rewind companies, who convinced me that it would cost too much for them to do it. For the logic behind any reconnection see www.lathes.co.uk click "electrical matters".

I was unable to find a second hand 2HP dual voltage unit so I bought a new one from TEC. Unless you have an account with them it's only possible to buy via one of their agents. Despite that they were extremely helpful over the phone and their agent for my area of the country proved to be quite close.

The motor was again a Totally Enclosed Fan Cooled (TEFC) of aluminium construction. It had 6 terminals allowing it to be configured for either 240v or 440v. Most importantly it was cheaper than anything else I could find on the internet.

Buying the new motor also cleared up a point that puzzled me. Different people, including one of the rewind firms, suggested that older motors are not (necessarily) suited to inverter drives. None explained clearly why.

Reading the spec for the new motor clarified it. The insulation was guaranteed for higher frequencies. Older motors, however, designed for 50Hz will continue to be used with inverters at higher frequencies. With age as well as looser specification, they are going to be prone to insulation leakage if not breakdown.

Having justified the new motor then and burnished my halo accordingly, I moved on.

The vee belt drive

Keeping the motor drive shaft at the same height as the Kopp output shaft meant I could use the same belts and indeed the same pulley as before. Even the bore looked the same (or so I thought). However Murphy's Law struck again. The motor shaft was 25mm dia. And the pulley had a bore of 1 inch. I was quite happy to overbore, bush and rebore the pulley to 25mm but it meant the need to recut the keyway. I didn't have the equipment for it and I didn't fancy sawing and filing a keyway (or putting it out to local Eng. Workshops).

Instead I turned up a shell sleeve to fit over the motor shaft to make up the bore difference. I had some suitable aluminium rod and with constant careful checks via mike and callipers produced a shell which fitted smoothly over the motor shaft as well as inside the pulley bore with no discernable slack. Before parting it off (yes,



9. The turned shim on the motor shaft.

my Mondial Simplex can be persuaded to part off some jobs) I carefully drilled a hole where the end of the keyway would be. After parting off I completed the slot for the keyway by hacksawing (holding it by hand, no vise clamping).

My worry was that when pushing the pulley over the sleeved motor shaft, the sleeve would simply crumple up. I was never more surprised when it didn't. I had expected to be doing this job several times before I got it right (photo 9).

The power supply

It is absolutely necessary to point out that unless you are conversant with the latest version of the Electricity Regulations including Part P, it is best to get someone qualified, to give you guidance on any electrical work.

The 1.5Kw inverter input current is 15.5Amps. Considering the output current is only 7.5 Amps, this raises other questions but more on that later.

It therefore needs a supply fused (or MCB) at 20 Amps. Fortunately my consumer unit has a split feed with a spare slot divorced from the rest of the house. This I equipped with 20 Amp MCB and a 4mm supply cable from it to a wall mounted 30 Amp plug and socket.

To simplify the arrangement I decided to mount the inverter on the lathe. This meant that I only needed one flying lead from the lathe to the power plug. A 4mm flexible cable with a woven steel wire shield was installed to connect the 30 Amp plug to the switch box on the lathe. It means when moving the lathe around I merely have to unplug one lead.

The switch box

A feature typifying the quality and attention to detail in the lathe construction is the switch box. It is an elaborately cast aluminium box profiled to match the pyramid shape of the machine. These days, a standard starter unit would be slapped on somewhere (if not as an extra). My intention was to retain as many of the original features as possible.

The inverter had to be connected directly to the motor via screened cable with no other switches or potential discontinuities between them. This means that all conventional overload and thermister trips etc must be interlocked before the inverter.

It was necessary to reconfigure the contactor etc to suit the 240volt single phase input. In all of this work I found Workshop Practice book 24 'Electric Motors in the Home Workshop' by Jim Cox to be of great help. (Available from www.myhobbystore.com)



10. The lever stack switch.



11. The modified switch.

The original 3 phase motor would have consumed about 7 Amps and the switch box was equipped accordingly. A check of the two switches showed them to be rated in excess of 25 Amps. The thermal trips on the contactor could only be set at a max. of 10 Amps however. Since I wanted double pole operation, it was pointless trying to use the existing contactor by twinning contacts. So I bought a new ABB contactor to suit the required current in its single phase operation. The lower Switch is the incoming power isolator and needed no special attention. For the single phase supply, only two of the three sets of contacts were required.

The upper switch was a multi layer stack operated from a lever over the headstock. Chipmaster owners will recognise it from **photo 10**. It is restrained to three positions: "Reverse Rotation/Off/Forward Rotation". A combination of the layered switches (the top three) enabled two of the three phase leads to the motor to be changed over for the opposite rotation. The two lower layers operated the holding coil circuit. Surprisingly, unless I've missed something obvious, it didn't provide a No-Volt release (unexpected even for 1975). The original wiring layout for this can be seen in the Chipmaster Manual.

As already mentioned, no switching arrangements are allowed between the inverter and the motor. This proves not to be a problem since reverse can be called up within the inverter software.



12. The electrical controls.

In my arrangement, I have limited the top switch and its over-the-headstock lever to two positions: "Power On/Motor Running". This was done by redesigning the switch to use two "press to make/break" switches operated via a spring loaded rocker (**photo 11**).

A nice feature of the original design is a transparent illuminated knob on the end of the operating lever at the top of **photo 12**. The bulb inside was a 6V miniature Edison screw powered from a 440V:6V transformer. The transformer was burnt out and so dispensed with. I replaced the bulb with a dual colour LED powered from a 5 volt power supply (from my "waiting to be used" box). Using spare contacts on the rocker switches, the appropriate LED can be powered up. This gives two signals - red for "power on" and green for "motor running". Photograph 12 also shows the finished switchbox layout.

One circuit which was long gone from the switch box was a 240V:50V transformer and fuses for the low voltage lamp. This is not missed since I needed the space to mount the running capacitor

for the suds pump as well as the 5V power supply. Furthermore the low voltage lamp is now a 12V Halogen unit courtesy of IKEA (**photo 13**).

The inverter

I bought the inverter from Transwave (Power Capacitors Ltd.). They were particularly helpful with advice and general guidance. There seemed to be little point in choosing anything more complicated than their entry level IMO iDrive. I discovered later that IP64 enclosures were available. I seem to remember this means you can almost fire a hose at it. Anyway I continue to placate myself with the knowledge that the extra cost of such an enclosure would be well in excess of the cost of my method.

As shown, the drive compartment is generously sized. There is a lot of wasted room under the "U" frame but not only would I need to provide remote controls for the inverter if mounted there, it would certainly be vulnerable to ingress of oil and swarf.

The decision was therefore to set the inverter into the front of the drive compartment.

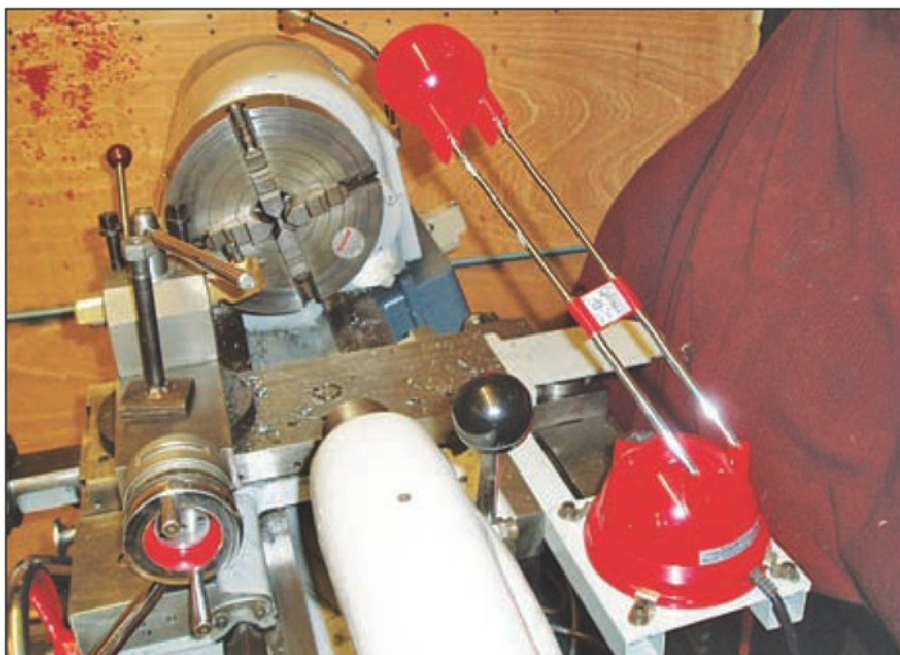
In doing this particular attention was still needed on two fronts:

- Proof against ingress of swarf which we all know to our cost, does tend to get in everywhere.
- Adequate ventilation. As already mentioned the inverter uses a lot of current which can only come out as heat.

Photograph 14 shows the slot cut out of the front panel with the new mounting frame screwed to it. **Photograph 15** shows the new enclosure tacked in position ready for final welding. A trial assembly of the almost completed enclosure is shown in **photo 16**.

To give as much room as possible, I moved the motor and its mounting frame back a further 30mm. In **photo 17** the inverter, front plate and new cooling fan are installed.

The top cover is fitted in **photo 18**. This lifts off for access to the inverter controls.



13. The IKEA light.



14. The new mounting frame.

With the benefit of hindsight, I wish I had hinged the polycarbonate panel.

The integrity of the top cover is most important. It incorporates air filters and covers the extra fan which, apart from increasing cooling air, maintains the enclosure under a slight positive pressure to keep out "that which I don't want in". Time will tell!

The filters behind the mesh are simply green pan scrubbers which can be readily replaced should they become clogged with swarf.

The suds pump motor

This was definitely one of the easier jobs. The motor, flange mounted onto the centrifugal pump, was a 2 pole Dual Voltage unit. Once I had reconnected the jumpers for 240/50/3phase operation, I found on the bench, I could make it run on single phase with a running capacitor of anything from 1microfarad to 12 microfarad. Again, with Jim Cox's book as a guide I ended up with a capacitor of 8 microfarad from Maplin.

The tool post and others

Photograph 19 shows the rather tired tool post bolt the lathe came fitted with, alongside the properly made one, (awaiting its ball end - when I can find one).

The saddle locking screw head is recessed into the top of the saddle but is inconveniently under the top slide. It was therefore worth making a dedicated socket for this which could remain in position. This can also be seen in photo 19.

The bend in the taper turning draw bar was confined to the male stud at one end. It proved a simple matter to chop the stud off, set the bar up in the steady, drill and tap a new female socket in the end and fit a new Whitworth stud.

While I was at it I also replaced the worn plastic handles on the tailstock and saddle handwheels with stainless steel (very pretty).

A worthwhile hint at this point.

We all resent paying a fortune for very small pieces of metal. Like everyone else I keep my eyes open for free or inexpensive additions to my metal stock. Old computer printers and photocopiers are a great source of ground rod. Another one I particularly like - how many times have you had your car shocks replaced? Retrieve the defective units. They are a beautiful source of hard chromed and polished rod. Note the rod on the saddle locking socket above. It's only necessary to very lightly grind the outside of the rod to remove the chrome to make easy lathe cuts.

Gearbox operator

The almost seized gear change rod showed up a surprising lack of attention to detail in the original design. The engaging slots for the various ratios are open at the tops, directly below the workpiece and positively asking for the ingress of swarf.

On mine, so much swarf had entered that it had virtually welded itself to the operating rod, almost seizing it up. With the help of a compressed air lance and a lot of pushing and shoving I was able to clear the swarf and carefully grind away the welded-on debris. I haven't been inside the gearbox yet but it doesn't seem to have affected the operation. I make sure now I lay a piece of 20mm x 5mm flat along the tops of the slots to keep swarf out.



15. The new enclosure.



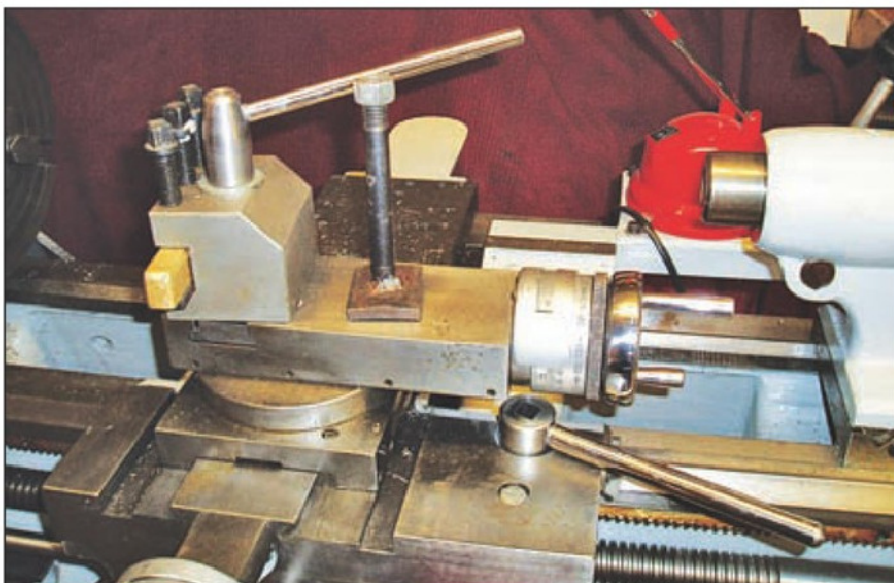
16. A trial assembly.



17. The inverter and cooling fan fitted.



18. The transparent cover.



19. The new toolpost handle.

Brake

One unexpected annoyance which surfaced was that whilst the drive clutch worked happily there was no reverse braking effect. The brake is separate from the clutch proper and is accessed via a port

just behind the chuck on the headstock. Whilst the oil level has to be lowered, it isn't necessary to open up the headstock. **Photograph 20** shows the port with the cover off. The brake comprises a fibre male cone (photo 21) inside a steel female mate.



20. The brake port.

It seemed that age had caught up with it. It had worn sufficiently that the fibre cone "bottomed out" inside its mate. I made an executive decision (a guess) and decided 30 thou needed to be machined off the smaller end of the cone to prevent it bottoming (My ancient Mondial continues to be useful). This proved to be sufficient and so far we remain "with brake".

Tooling

In the past I found that I've scratched around for a particular tool for whatever Machine I was using. This time I intended to have the Chipmaster fully equipped with dedicated tools (definitely not to be used elsewhere).

To this end, I installed a set of tool trays (1in. angle gets used for everything) at the tailstock end to supplement the cupboard beneath the bed (photo 22). All of the tools for the Chipmaster are spray painted one colour. (Would you believe GOLD - I



21. The fibre brake cone.

regularly collect half used cans from my wife's Christmas activities.)

The lathe came with a 3-jaw chuck and a spare set of reverse jaws for the bigger dimensions. Since then I've acquired a 4-jaw chuck and both steadies. I'm currently thinking about a faceplate. I'll almost certainly make that, since I want parallel slots similar to the one recently featured in MEW. The three Jaw doesn't centre particularly well so that's a grinding job for the future (after I've made a suitable spindle!).

The paint job

Barry Macpherson is a Boxford fan. I was impressed by the renovations he was doing and his resultant paint jobs. It was Macpherson's Trade Paint he used (no, he doesn't own the Company). I used the same. The colours however were nothing like I started out with. I am happy with the results but it took various additions from

other paint pots I had before I achieved the colours I wanted.

Little things please little minds. You will note the polished raised lettering on the tool cupboard door.

Finally

I am very pleased with my choice and the results so far achieved. After spending the last 35 years (albeit intermittently) using what is now at least an 80 year old lathe, an almost silent drive and precise cuts continue to come as a pleasant surprise.

I have glossed over a lot of detail. I imagine however that anyone doing something similar would use their own dimensions and methods. I find I regularly get some great ideas from MEW but invariably modify them to suit my requirements. I would of course always be happy to go into more detail if anyone wanted it.

PS. Does anyone know of a good home for a very heavy second hand Kopp Variator? ■



22. The tailstock tool racks.

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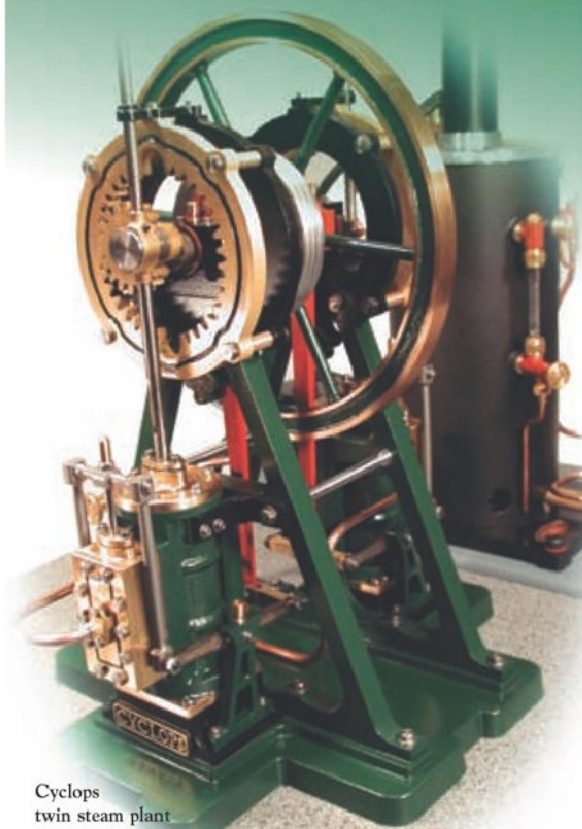
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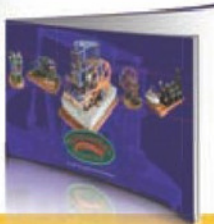
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Coventry die heads

What is the normal way of holding a Coventry die head on a machine, what are the pros and cons of using them?

Ken Willson, by email.

Electric clutches

Ian Strickland asks a few questions under the Electric clutches heading.

- 1) They work when an armature, normally fixed to the free pulley, coupled by the belts to say the headstock input shaft, is attracted *magnetically over a very short movement* to a metal face attached to the motor shaft. The coil is held *still* at all times. The armature is held by a spring plate which allows the small axial movement required.
- 2) They are normally "off", i.e. *they fail to safe* should the controlling electric power be lost.
- 3) No you cannot slip them. Inching by means of a clutch would normally mean slipping it, you cannot lift these just off as you would a car clutch by limiting the controlling movement. If I really wanted to inch a shaft, I would disengage the clutch, stop the motor, set a low jog speed on an Inverter System and then engage the clutch, these could all be switch movements.

Ken Willson, by email.

Dividing in the lathe

I'd like to take this opportunity to thank Roy Smalley for his "Dividing on the Lathe" article in the Nov 09 issue of MEW. There are many good articles in MEW but this was a particularly excellent piece which really explained a useful, new to me and perhaps tricky to understand technique very well. I look forward to putting this to use with my new rotary table. It is very enjoyable to learn a new, simple approach to improving accuracy in the workshop. If you can pass on these thanks or print this in the Scribe A Line piece, I'd be grateful.

Richard Gordon, by email.

Slideway oil 1

Michael Green asks about Slideway Oil, I always use slideway oil (Rotol Ultraglide X5) on all machine ways and would not use it on other applications. It is specifically designed to "cling" to the slideway and on vertical ways it ensures

lubrication does not just drain away as lubricating oil would. Other bearing and gearboxes require manufacturer specified grades and here again they are best followed. As to holding metal particles in suspension, the wipers will do their job in keeping the ways clear behind the wiper as usual. It is probably better if the particles are in suspension rather than if they have settled to the oil/bed interface. Totally covered ways are preferable, but if not possible always use the correct oil for the job.

Ken Willson by email

Slideway oil 2

Firstly congratulations on the changes to the magazine, keep up the good work. In response to Michael Green's query about slide-way oil, I'd like to throw in my tuppence worth. Firstly all oil will hold particles in suspension, 'while it's moving'. It's part of its job to move contaminants away from the surfaces being protected to somewhere it can be removed from the oil either by filtering or slowing the oil down in a large sump to allow settlement. The thought of carrying particles into the wearing surfaces is probably brought about by the sticky nature of the slide-way oil.

As to whether it should be used on your machines depends on your machines. If you have an industrial machine fitted with (working) slide-way wipers and a saddle oil pump, then definitely yes.

If, like most people reading this magazine, you have a model makers lathe or like me some old mangle, then as long as you wipe your ways regularly and apply a few drops from a can, that's fine.

However, if as you suggest, you only want to keep one type of oil 'in stock' then definitely not. Slide-way oil is for slide-ways, it will tend to carry particles on the leadscrew and into the half nuts. While in the headstock, if you have plain bearings the oil is to viscose to flow into the narrow clearance and form the correct film around the journal. If you are looking for a one can solution I would recommend a lightweight hydraulic oil.

I have a number of old lathes, millers and a shaper, and also look after a selection of manual and CNC machines at work. After looking through the manufacturer's manuals and looking

A letter from the editor

I am short of letters for Scribe a Line. While I have some, several with photos, I could do with some more, especially shorter letters. I am ok for the next issue but to keep Scribe a Line a regular item, I need something to put into it. I am sure many of you have a question to ask or a tip to pass on to your fellow readers so please write me a letter or send me an email. Although we don't pay for letters, you will have the pleasure of seeing your name in print. When writing, even if by email, please include the general location of where you are in the country or even which country you are in if you are not in the UK. Other readers like to know where you are writing from.

through oil producer's cross references, I found a lightweight hydraulic oil such as Shell Tellus R37 or BP HLP32 etc, will cover all my needs. Although we do use a dedicated slideway oil in the works machines, all the headstocks/gearboxes and aprons/leadscrews use HLP32. These are production machines working flat out 8 hours a day without trouble. One lathe is 50 years old and still turning out good work.

At home I use Mobile DTE light for everything. I did bring some slide-way oil home from work, but keep forgetting to use it as I've been using the other oil for so long. For those with watch makers lathes or those machines with high speed spindles, use a turbine oil such as Tellus R10 or Castrol Hyspin AWS10 etc.

As an aside, you shouldn't use engine oils or gear oils for machine tools. They are designed to work in different environments; they tend not to work until at higher temperatures and/or pressures. I have also been told they contain additives that can damage some plain headstock bearings, although I can't personally confirm or dispute this.

I have no affiliation with the oil companies mentioned, it's just they are oils I have used. Hope this helps.

Mark Williams, Mid Wales.

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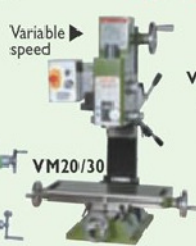
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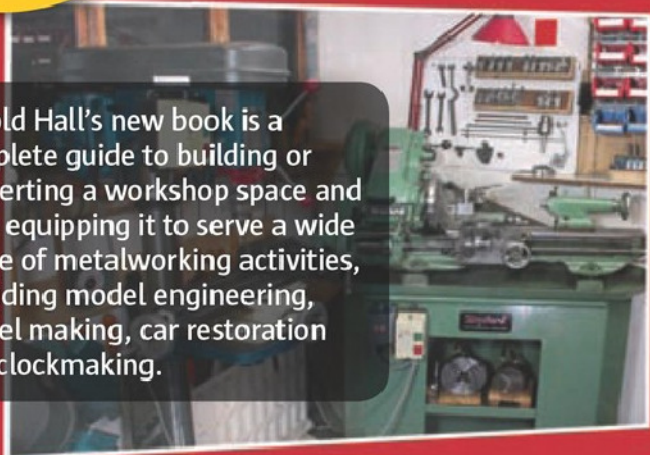
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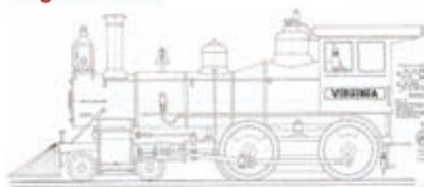
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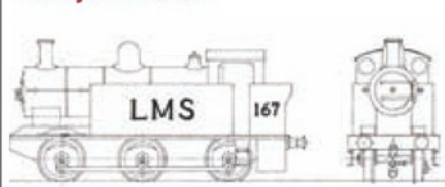


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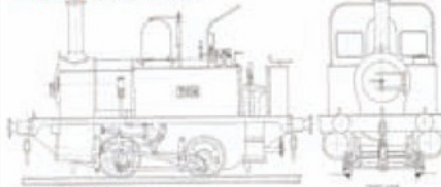


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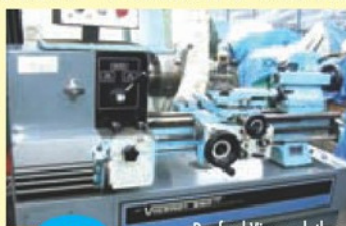
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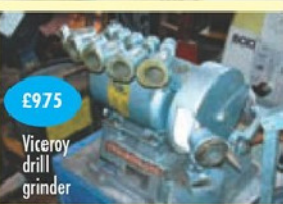


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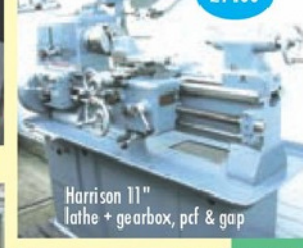
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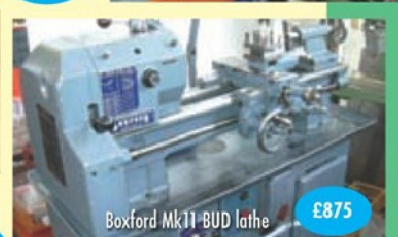


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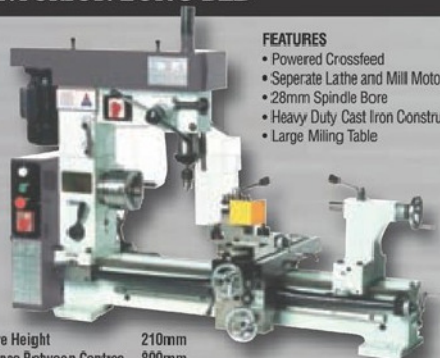
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