

No. 106

MAY/JUNE 2005

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

**BORING
HEAD**
Light duty
version

**GRIP TRU
CHUCK**
Secrets
revealed

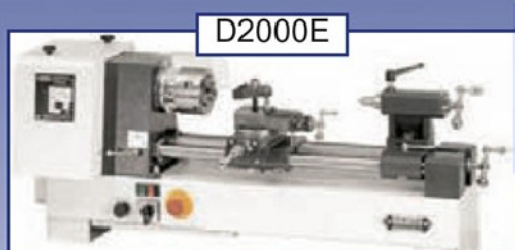
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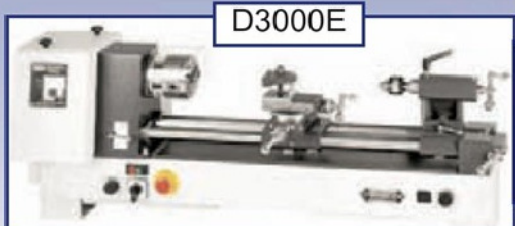
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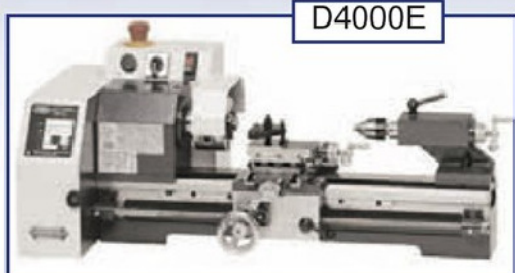
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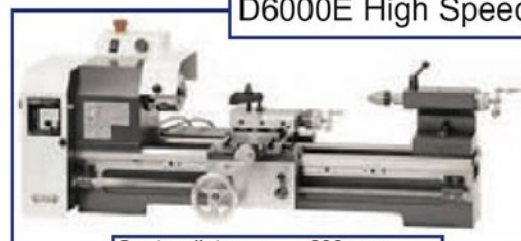
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The centering
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described by
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These films are good instructional aids - not only do you have your tutor there, on your TV, you can interrupt, go back over points and generally take the whole thing in at your speed, as and when you like. Rudy was American, and so are the techniques shown, but in the few instances where practice differs, it is covered in the tape. Rudy is no professional "on screen" performer, just an ordinary model engineer, but his presentation is all the more acceptable for that. These films really were shot in Rudy's workshop, which produced some problems, and a few "warts" are visible, despite attempts to eradicate them. Don't buy these tapes if you are experienced and know all about the operations involved - the 'Fundamentals' lathe tapes in particular are aimed at the raw beginner. And please don't expect them to turn you into an expert in a couple of hours, but they will give you a solid understanding of the operations involved.

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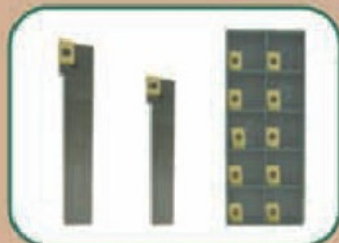
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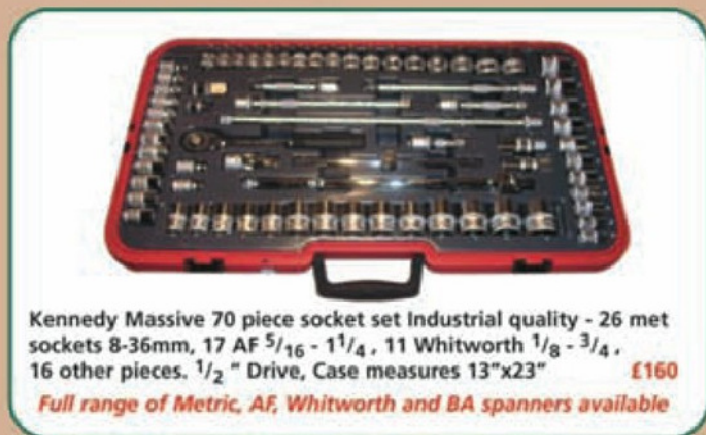
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1-2" **£10 each** 2-3" **£15 each** 125- 150mm **£28 each**

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Draper Japanese Micrometers 50-75mm **£28 each**

Mitutoyo Second Hand Micrometers 0-1" and 0-25mm 2-3" (all boxed) **£15 each**
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9 pce. Toolsteel Set HSS plus 10% Cobalt. 5 round, 8-15mm, 4 square 5-12mm approx. 100mm long **£17.50**

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Mitutoyo Depth Micrometer Set 0-150mm Original packaging/calibration certificate - unused **£75**

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CB8206	6 Dr chest	38kg	£84.95	£99.82
CB8209	9 Dr chest	38kg	£119.95	£140.94
CB8203	3 Dr step up	38kg	£54.95	£64.57
CB8215	5 Dr cab	43kg	£169.95	£199.69
CB8217	7 Dr cab	43kg	£199.95	£234.94
CB8212	3 Dr cab	43kg	£129.95	£152.69
CB8213	3 Dr cab	43kg	£159.95	£187.94

• REDUCED! CB8204 was £88.07 inc VAT. CB8206 was £111.57 inc VAT

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• Robust steel construction
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CT900	9 Drawer chest	19kg	£49.95	£58.69
CT500	5 Dr cabinet	35kg	£44.95	£53.82
CT800	5 Dr Chest/cab	19kg	£34.95	£41.82
CT700	7 Dr cabinet	35kg	£49.95	£58.69
CT1300	13 Dr Chest/cab set	19kg	£139.95	£164.44

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Parthor 25	2hp	8.2	24ltr	£129.95	£152.69
Parthor 50	2hp	8.2	50ltr	£169.95	£199.69
10/70H	2.0hp	9	50ltr	£254.95	£299.57
15/55	3.0hp	14	50ltr	£259.95	£305.44
15/65H	3.0hp	14	50ltr	£359.95	£422.94

Clarke **AIR TOOLS & SPRAY GUNS**

PRO12C

TYPE	MODEL	EX VAT	INC VAT
Pro Spray Gun		£16.95	£19.92
Super Pro Spray Gun	SP14C/SP18C	£27.95	£32.84
Air Hammer	CA129H	£15.95	£18.74
Die Grinder Set	CA136H	£19.95	£23.44
Grit Blasting Gun	SB3	£19.95	£23.44
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150TE Turbo*	30-150	£179.95	£211.44
165TE Turbo*	30-155	£239.95	£281.94
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205TE Turbo*	30-185	£329.95	£387.69

*Turbo fan cooled for longer welding at full output

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Inc. disc & handle

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MODEL	DISC SIZE	MOTOR	EX VAT	INC VAT
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CAG11S	115mm	500w	£25.95	£30.49
CAG232	230mm	2000w	£29.95	£35.19
CON11S	115mm	1010w	£29.95	£35.19

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Kit Box Included

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• Soldering iron stand
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WITH 2 SPEED MILL/DRILL

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• 150w/230v motor
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• MT2 Spindle Taper
• Face mill capacity 20mm, end mill 10mm
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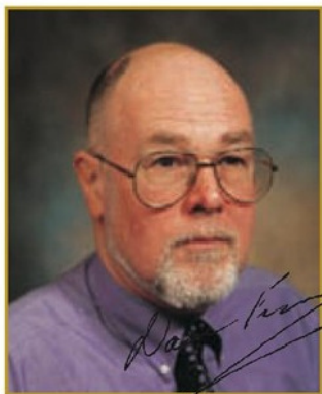
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ON THE EDITOR'S BENCH

Index

The index for *MEW* issues 93 to 104 will be found in the centre pages of this issue and may be either pulled out or copied. Earlier indexes were compiled by Harold Hall, who has now passed the baton to Barry Chamberlain. Our thanks go to Barry for continuing this work. As before the index will be available in updated disk form.

Also on the index front I would also commend Colin Usher's website to readers. On the site will be found not only indexes for *Model Engineers' Workshop*, *Model Engineer*, and *Engineering in Miniature*, but also a number of other sections of interest to the hobby. These include a suppliers' list, and technical information such as wheel and track standards for popular gauges.

Rip Off Britain?

In his articles describing the conversion of the X3 Mill to CNC operation, Dick Stephen has advocated the use of ballscrews. In particular, he had found just what he needed in the range produced by THK. In common with many other firms supplying to industry, THK sell via distributors specializing in bearing and related products. When such a distributor sells to an industrial client, two factors come into play. First, for the customer, it may be the solution to a problem (rather than just a spare part) and hence have a value, perhaps in reduced downtime, which far exceeds the quoted price of the item. Second, the person doing the purchasing is likely to be a buyer, spending company money rather than his own hard earned cash. These two factors can encourage the distributor to go for "what the market will stand" which may be a highly inflated price.

Dick has been in touch after being contacted by a number of disgruntled builders who have been quoted various amounts up to £300.00 for a single ballscrew. The prices posted by different branches of the same distributor also vary wildly. The advice to anyone shopping for ballscrews must be to research suppliers via the internet and then shop around. As a guide, any supplier quoting more than £140.00 for a ballscrew for the X3 project should be told politely where to get off.

Age and infirmity not a barrier

It is generally accepted that workshop enthusiasts and model engineers tend to fall

into the upper age group. Increasing weight and reducing fitness certainly discourages me nowadays from continued participation in motorsport. Following the publication of Peter Rawlinson's article describing his car hoist, which made reference to his electric scooter, several readers have in the course of phone conversations to the editorial office expressed their admiration for Peter's efforts to overcome adversity. On a similar related theme, elsewhere in this issue, will be found an article presented by "Blind Pugh". The author, a retired toolmaker rang me some time ago to enquire whether it would be possible to submit an article in audio tape form as he is now blind. Naturally my reaction was "Let's give it a try". Through the good offices of our local (Perth) Society for the Blind, it has been possible to transcribe the tape for publication, and I believe that the advice given in the article will be of great help to those seeking the ultimate in presentation of screwed assemblies.

Training at the Society of Model and Experimental Engineers

The following announcement was received from the SMEE.

Following the success of its Basic Training Course, the Society of Model & Experimental Engineers proposed to run a second course covering the building of a small oscillating engine. Unfortunately the records of those who expressed an interest in the course have been lost making it impossible for the society to contact them individually.

The volunteer group who put the basic training course together found they had underestimated the practicalities of developing the content of course covering the building of an engine. Even something superficially as simple as an oscillating engine. Practical experience has shown that tackling the Stuart engine as an initial project is too ambitious and would result in an engine requiring further work in boiler making to produce a working model. The Polly Engine, described in one of the "standard" model engineering books has been examined and a group are working on the design of a course covering the building of this model as an alternative "first" model.

The Polly engine combines a simple boiler and single acting oscillating engine in one model. However it does require a variety of skills to build including:

Understanding the legislation affecting model boilers. Sheet metal work including:

marking out: rolling a cylinder: flanging: riveting: silver soldering: Pipe fitting and bending connections and sealing. Boiler testing. Preparing and making special lathe tools, arbors, tool sharpening, drills, reamers, taps and dies. Turning-flanging plates, boiler fittings, safety valves, pistons, flywheels, cylinders. Soft soldering. Fitting.

The notes and lectures will be prepared to the same high standard as the Basic course to ensure even the novice will be able to follow it. Those who have experience of the way the information is presented will understand the amount of work involved in preparation.

As soon as the work is completed information will be released. In the meantime anyone who is interested can register to receive the information by writing to the Society at: The Society of Model & Experimental Engineers, Marshall House, 28 Wanless Road, London SE24 0HW

In the Workshop

Whilst my workshop houses a compressor suitable for car paint spraying, it is something of an overkill for an airbrush. At a recent autojumble, I chanced on a small compressor, which looked promising. The vendor claimed, "It goes but won't blow". For a fiver, I thought it would be worth the risk. Back home and plugged in, it didn't go either. After a partial stripdown it was apparent that the piston and rod were stuck with corrosion. Cleaned and reassembled it did go but didn't blow. The valve cover was then removed exposing the two valves. Each was found to have one moving part, a rubber moulding, flat on the underside, but with a deep "X" formed in the upper surface. This shape was intended to allow sealing on the flat face, but to pass air through the "X". In the "as found" configuration, both valves were trying to function as exhaust valves, and no air was being admitted. One rubber moulding was inverted and the whole reassembled. It now delivers 45psi with more than enough volume for an airbrush; well worth the fiver!

Compressor for a fiver



TWO HEADS BETTER THAN ONE? (1)



1. Large and small heads with typical tooling.

Background

A couple of years ago prompted by the purchase of my first milling machine and over enthusiasm brought about by misguided confidence, I purchased castings to produce the Quorn. After careful examination of the drawings I became aware of one or two gaping holes in my workshop armoury and so, with suppressed frustration, set about the task of increasing my capabilities before jumping headlong into the main project. The first obvious shortfall I foresaw, was machining the numerous and accurate bores. Originally Professor Chaddock machined them either by holding the casting on the faceplate and boring as normal, or by holding on the cross slide using a boring bar between centres. I didn't fancy either of these (I can't for the life of me adjust a boring bar accurately) and decided that a robust boring head, which could be used either in the milling machine or in the lathe, would suit me better.

In my defence, I did already have a boring head at that time; one of my first projects a lot of years ago, when I acquired my much loved and cherished ML7, was to make a light duty boring head. This was designed without dovetail slides because of the difficulty in machining them without a milling machine or vertical slide, or indeed the experience. So the main sliding component was based around a ground silver steel bar with a keyway to prevent rotation. This gave a relatively simple and compact tool, with a capacity of around 50 to 60mm diameter, has a low out of balance mass and was adequate for most of the work undertaken on my ML7, so long as the work rate was kept within reasonable limits.

The second boring head, therefore, was a more meaty and conventional design which did use dovetail slides and was designed to fit directly on to the Myford nose for rigidity in the lathe, or to a Morse taper adapter for the mill. The result was a tool that was built like the proverbial brick built outhouse, and chewed its way admirably through some pretty demanding castings at a satisfying rate. Having made both these designs and thought, subsequently, about ways to improve them, both the heads have been modified very slightly from the originals, however the more observant amongst us may notice that there are no photographs of the heavy duty head extension bar or the side hole. The reason for this, as you may have guessed is that this is an afterthought – still, better late than never!

So, there you have it, I ended up designing and making two very different types of boring heads, as shown in **Photo 1**. Both are made from stock materials, and this first article will deal with the light duty version, while the second, which will appear in the next issue, will cover the more meaty device, with a few notes about boring tools and techniques added at the end for good measure. Construction notes will assume the use of a lathe without a vertical slide for the light duty head and I will expand a little more on some of the techniques required for those who find that useful. For the heavy duty one, I will assume a more highly equipped shop with access to a vertical milling machine. The designs are based around metric dimensions and my apologies to those readers who prefer imperial. However, as a token olive branch, I have included information to provide an imperial dial and leadscrew alternative for both.

Will Bells describes two boring heads, one, covered here, for light duty, the second, in part two, for heavier work

The light duty boring head

Because this design (the key components are shown in **Photo 2**) doesn't involve a dovetail slide, the head is simple enough to be machined on the ML7 or similar lathe without the need for a vertical slide. There are some simple milling operations but, assuming the facility exists to clamp components to the cross slide, these are straight forward enough. Graduating the dial can be accomplished by use of a standard Myford change wheel train with a plunger detent set up.



2. Key components of light duty head.

Construction

Never, ever start a presentation (or in this case an article) with an apology! This was once hammered home to me as part of a 'thinking on your feet' course by a rather imposing lady. So in deference to her, I will not start this article by saying sorry. Instead, because this tool was constructed some 20 years ago and therefore the drawings have been retrospectively produced and there are no original photographs of construction, I will revel in the thought that there could be some confusion, and even more probably some errors in this article. Oh what the heck sorry.

Arbor

Perversely, the first component to make is the arbor. I say this because the top slide angle, once set for the Jacobs 33 taper, can be maintained for the mating socket in the body. You could of course choose to make the body fit directly on to the lathe nose in which case this is not necessary. The sensible approach to take is to

A few notes on taper turning

Setting the tool height

When turning a taper it is necessary to set the tool close to centre height otherwise the turned surface basically ends up curved and at a different angle to that set. Fortunately things are nowhere near as critical as some rumours have suggested on this, especially for shallow angles or larger diameter tapers. (The article by Peter McQueen in MEW Issue 81 discusses this.) As an example, for an MT2 a 0.5mm error on tool height would theoretically curve the surface by around 0.0002mm in the centre. The angular error, assuming the top slide was perfectly set would be equivalent to around 0.006mm at one end. For us mortals this is small to say the least and, of course, the angular error is compensated for anyway on most setting methods. Things do get a little more interesting though when smaller diameters or steeper angles are concerned, for example for an INT30 taper the errors are in the order of 0.003mm in the centre and .015mm angular which starts to become more important. So, the bottom line is set the tool as close as possible without being too pedantic about it.

An added complication, however, is that the shape of the tool can make a big difference to how you measure the centre height. Take, for example, a fairly standard knife type tool with a side rake angle of 10 degrees and a tip radius of 1.5mm. The difference between a casually measured height and actual cutting height can be a surprising 0.3mm. This is simply because the cutting edge is not at the highest part of the tip; it's around the corner and down the hill a bit! The answer to this, I guess, is either to use an eyeglass and judgement when setting matters, or to use a tool where the cutting point is the highest part, such as a round nose tool perpendicular to the surface.

Setting the top slide

Clocking with the DTI against an existing shank held between centres is often recommended for setting the top slide to a taper. If you are turning between centres (with the tool on centre line!) it is accurate because it helps to compensate for tailstock setting errors. Be very careful to ensure that the DTI stylus measures on the centre line. Those with taper turning attachments will have less problems, but with all methods always blue the taper (or a soft pencil line down the length of the taper) and try the fit before finally accepting as complete.

Everyone seems to have a preferred method of setting up for tapers, all with varying degrees of merit. My favourite method may not suit all tastes because it needs a bit of pre-setting up and a calculator during the operation, but from then on has much to commend it. Overall it's quick because there is minimal trial and error, mostly being correct after the first setting and needs only a small piece of bar as a test piece (frugality strikes

again). A piece of bar 20mm diameter, sticking out from the chuck by 30mm is perfect, as shown in **Diagram 1**. It sets the top slide to an accurate angle, so beware if you turn between centres and have a set up error.

As so often with these things, it is easier to do than to describe, but in essence the theory is that you use a small test piece (and a calculator) to accurately find the angle the top slide is currently set to. The next part is to adjust the top slide by using a dial gauge to remove the trial and error bit. Theoretically, there is a small error in the adjustment method, and it is small over small adjustments, but if you get to the stage where that makes a difference to you, you don't need this article!

Preparing the top slide

First of all you need to do some measuring on the top slide and mark two positions, 'A' and 'B' on the side of the topslide as shown in **Diagram 1** and in the **Photo 3**. With my ML7 these are 2in. apart towards the extremes of travel, and coincide with zero points on the dial, turning the handle in the clockwise direction to avoid backlash effects. Next you mark a convenient position for the dial gauge to touch, such as the back of the top slide, shown as position 'C' and in **Photo 4**. Measure the distance 'D' from the pivot point as shown, with the top slide at position 'A'.

You should check that the top slide leadscrew is accurate as this method relies on the fact that the leadscrew will move the topslide a defined amount. Move the slide between positions 'A' and 'B', from zero to zero on the dial and compare to the actual measured distance. If it is more than a few thou you can modify the formula, otherwise ignore it. Over 2in. my humble and well used ML7 is only 3 thou out, which gives a tiny error.

Now you are ready to set the top slide by the following;

- Hold the test piece in the chuck (see **Diagram 1**)
- Set the top slide approximately (ie as close as possible by the graduations



3. Reference marks used in measuring top slide angle.

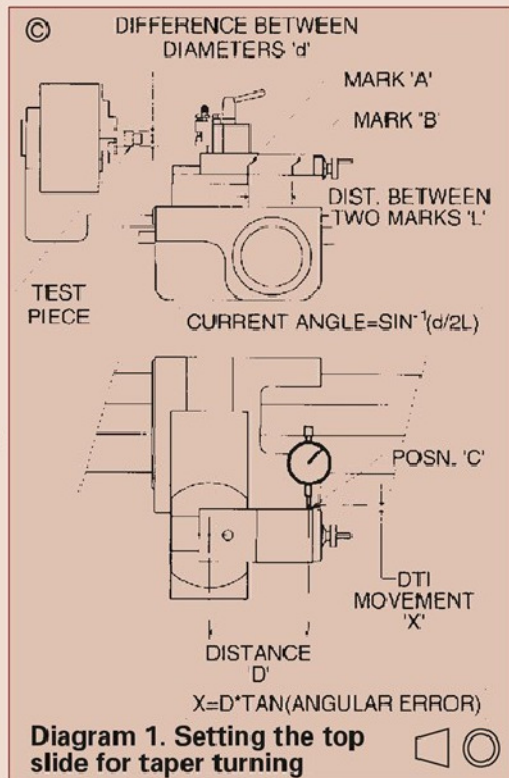


Diagram 1. Setting the top slide for taper turning

- or with a bevel gauge).
- Zero the topslide at mark 'B' and adjust the cross slide (and clamp) to skim the test piece.
- Retract the topslide to mark 'A' and skim the smaller diameter. If this is a new test piece, you will need to take incremental cuts as you move the slide towards the mark to machine a step.
- Measure the two diameters carefully with a micrometer.

Now you know, by following the calculations noted on Diagram 1, the angle that the top slide is precisely set to and, therefore, the error.

To adjust the topslide

- Keep the topslide at mark 'A' and place the DTI on position 'C' as shown.
- Adjust the topslide angle by the amount given by the formula and read off the dial gauge.

Repeat the method and adjust again if necessary.



4. Using dial gauge for checking topslide angle. Note this topslide has machined sides.

purchase a ready ground MT2 soft blank, available at bargain prices from our usual suppliers, and take it from there. The use of a ready made shank, complete with Jacobs taper, is possible. You will probably have to drill and tap the hole in the short end as the commercial items frequently lack this feature. I considered this is essential to safeguard it from slipping in use. For those brave souls made of harder stuff (or just plain mean like me), they can easily be made from scratch.

The best method of making the tapers depends on a number of factors such as preference, how worn or well set up the lathe is, which taper you choose and whether you prefer to make the shaft totally between centres. I do not (yet) own a taper turning attachment and rarely set the tailstock over, so my preferred method where possible is to hold bar in the chuck to turn the main taper with the angled topslide, then fit the Morse taper into the lathe spindle to complete the other end. The lathe must be in good order and light cuts taken to avoid chatter, but it allows unrestricted access of the top slide without fouling the tailstock centre.

Suggested operation sequence:

- Set the topslide to the correct angle for the required taper.
- Cut bar to length plus enough to grip in chuck.
- Face the end and turn Morse taper.
- Hacksaw or part off additional material
- Set top slide for Jacobs taper
- Remove chuck, clean bore and hold bar in spindle taper.
- Face, complete Jacobs taper and drill/tap M5

Assuming a bar or soft blank with the Morse taper now already turned or ground, hold in the headstock spindle, set the angle as above and turn the Jacobs taper. Keep the top slide setting unchanged for machining the body.

Large and small bullets

You may as well make these components next because the large bullet is useful to use to complete the body.

- Hold brass bar in chuck.
- Face, turn diameter and part to length.

Body

I used FCMS originally, but cast iron would be a good alternative because of its inherent lubricating properties and easy (but messy) machining characteristics.

- Cut bar to size (Hopefully already done by the supplier).
- Face first end in chuck, trying to ensure squareness.
- Skim outer diameter to within, say, 1mm of the final diameter over half the length, which will allow the chuck jaws to hold that end square when turned to face opposite end.
- At the same setting, machine the M5 clearance hole and the Jacobs taper.
- Reposition in chuck and face opposite end and turn remainder of diameter.
- Hold in 4 jaw chuck (or faceplate) and drill, bore and ream (if possible) main slide bore.
- Drill, ream and countersink the key retention hole.
- Drill and tap clamp screw hole and debur inside bore.
- Hold on a trued 20mm mandrel in the chuck (in the slide bore) and turn dial pocket detail and 8mm hole for leadscrew.
- Clamp on cross slide and mill top slot.
- Countersink taper retaining screw hole and debur inside bore.
- Assemble arbor with M5 screw and finish turn outer diameter and face

At this stage, keeping the outside diameter oversize (final diameter sizing can be done after fitting the shank), hold in 3 jaw chuck using the outside jaws and face the first end and rough turn half the diameter. Turn around, rough turn remainder of diameter and face end to length. Support with a centre if required. Ensure squareness of ends to outside diameter. Centre and drill 5.2mm hole all the way through the work piece, so that you have some means of removing the shaft if it gets stuck in the taper before completion. Then machine the taper socket.

The top slide still set from turning the shank means that the boring tool must now be used upside down cutting the opposite side to normal (unless you can cut in reverse) and remember the tool height. Bore the socket diameter close to size, then finalise taking small cuts using the shank to machine the taper as a gauge so that it fits within 1 to 2mm of the shoulder.

Bore, set up in the 4 jaw chuck, if it's big enough, then drill and bore, or ream to size. As an alternative to the 4 jaw, clamp to the faceplate, or to an angle plate bolted to the faceplate. If at all possible beg, borrow or steal a 20mm reamer; it will make life so much easier. Fine turn the diameter to within 0.1 to 0.2mm and then ream, setting the speed to around half turning speed, entering the reamer reasonably quickly with lots of lubricant.

If boring is the preferred route, try taking the final cuts with a sharp tool and the top slide set over, say to 6 degrees; 0.1mm advancement on the top slide dial moves the tool in by around 0.01mm which gives

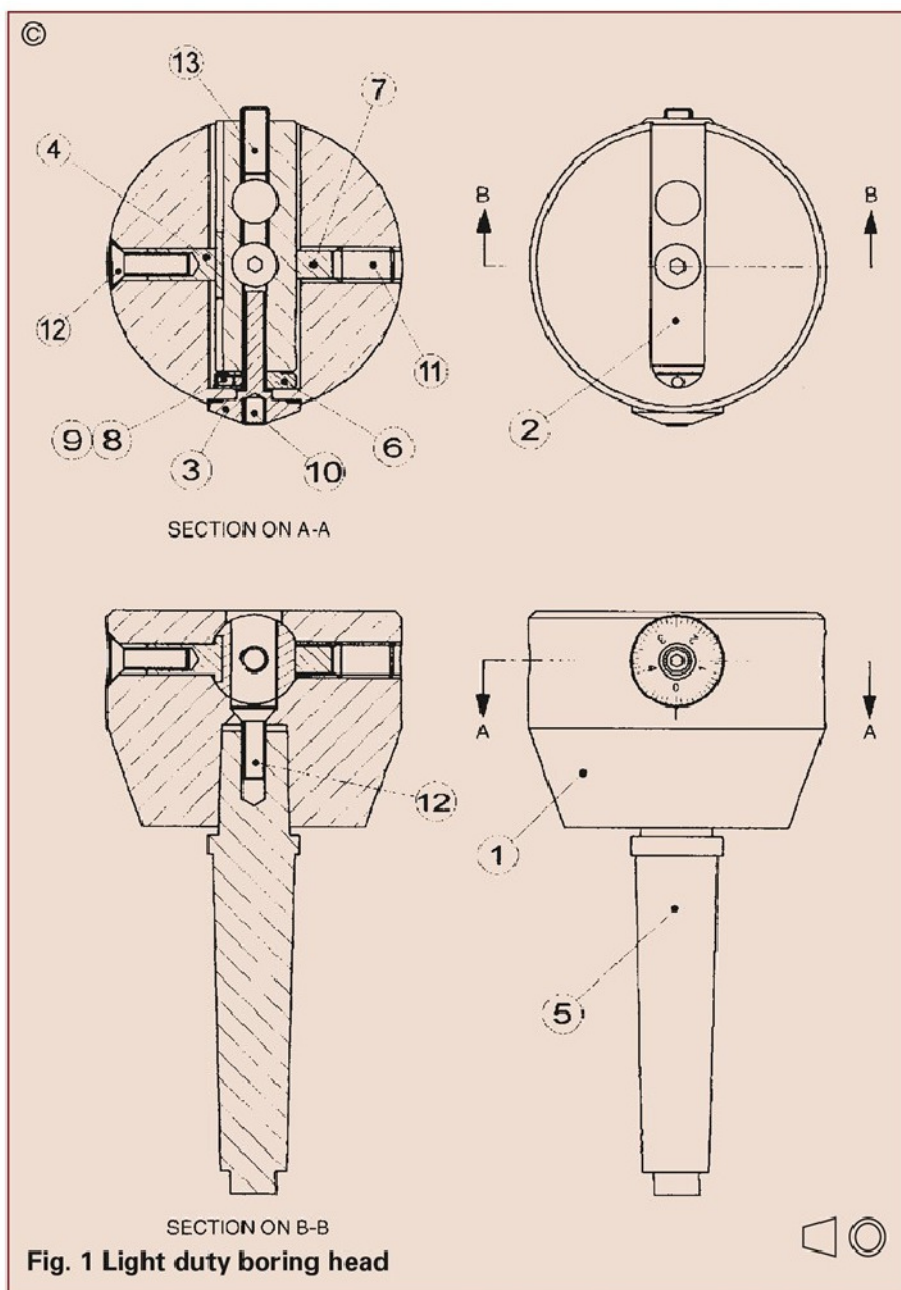


Fig. 1 Light duty boring head

good control when needed. Use the silver steel bar to carefully check the size of the bore. This is the part of the whole operation which demands the most accuracy - fit must be sliding but without play.

I seem to remember disaster struck for me at this point at my first attempt. I borrowed and used a reamer and when I gently pushed in the ground bar in it got stuck - very stuck and was scrapped. I guess that the reamer was either reground or was not to the normal sliding fit I expected. Anyway, the surfaces picked up and 'welded' together. A bored surface is not so fine, but excellent for the application. Remember if disaster strikes, and the bore ends up over size, $\frac{1}{8}$ " bar is the next size up.

The key location hole should be reamed if at all possible, and ensure that it is perpendicular and at centre height to the bore. The screw will prevent easy movement between the key and the body in use, but it will move with a heavy load if there is any appreciable play.

To machine the counterbore, a mandrel (silver steel from the same bar would do admirably) should be set to run true in the 4 jaw chuck and used to hold the body on the slider bore. Leave about 5mm clearance at the end and clamp in position with the brass plug and a grub screw. The 8mm bore and counterbore detail can now be machined to a fine finish to minimise friction. A slow speed should be selected to reduce any out of balance effects. Remember the chamfer.

Final operation at this stage is to mill the top slot and countersink for the taper retaining screw. Ensure that the screw is clear of the slider when assembled. Clamp the body on the cross slide packed to the correct height and mill, ideally with a slightly smaller slot drill finishing with an end mill of the correct diameter in one pass.

Slider

I used silver steel because it's ground already and is a little tougher than mild steel and, more importantly, was probably available at the time. Precision ground mild steel (PGMS), (or the free cutting variety) which is cheaper and easier to machine would be a viable alternative.

- Cut silver steel to length.
- Face and drill / tap non critical M6.
- Set up concentrically in 4 jaw and face and screw cut critical thread.
- Set up on cross slide and machine keyway with slot drill.
- Turn and machine flat with end mill.
- In 4 jaw, cross slide or drilling machine drill and ream bar holes.

The critical portion of the thread is the M5 part as marked. The bar should be set truly concentric in the 4 jaw and the hole drilled through then bored to tapping size to ensure concentricity. If you are unable to bore the full length required, bore as far as possible and finish with the same size drill.

The accuracy of the threads obviously effects the accuracy of the indicated travel on the dial, but, fortunately, it is pitch error in the leadscrew, which has the most significant effect. Added to this, the pitch error induced by an accurate tap is small compared to that likely with a die. So, use

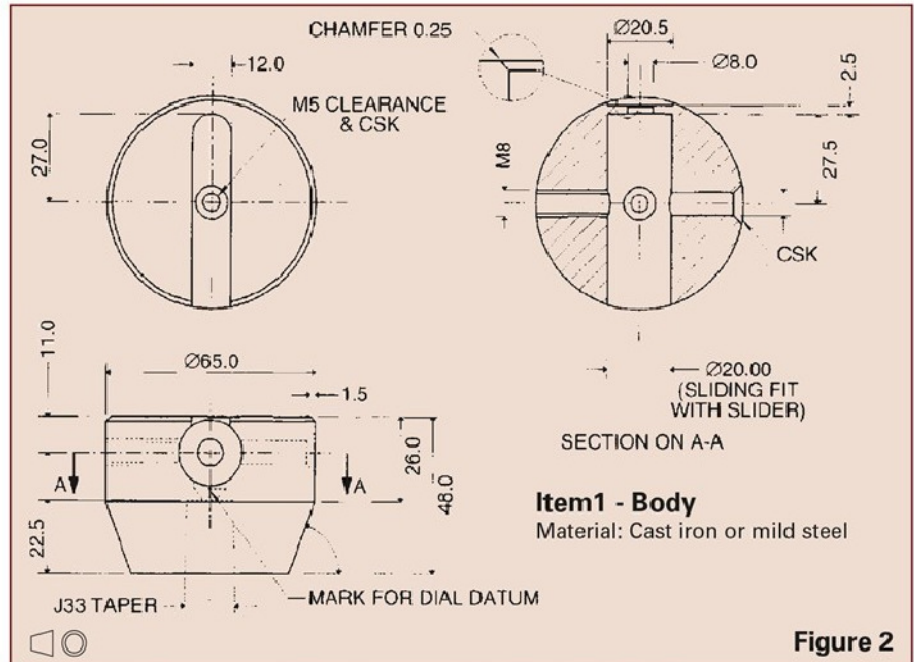


Figure 2

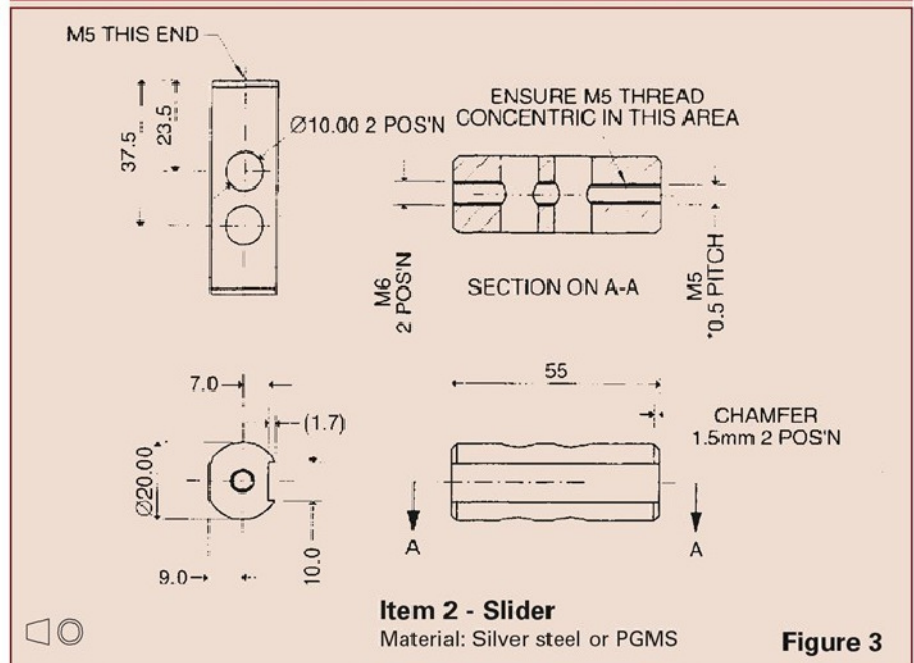


Figure 3

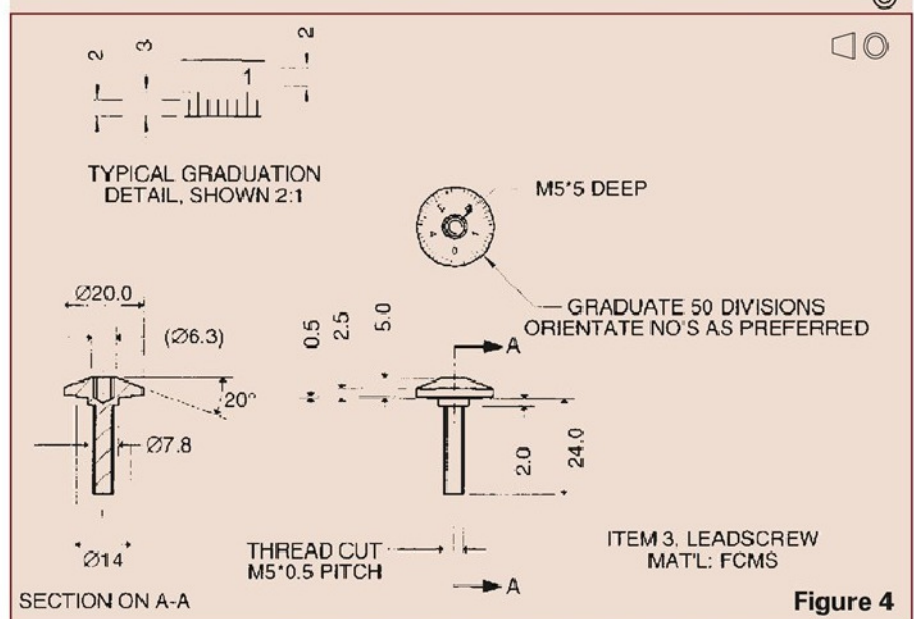


Figure 4

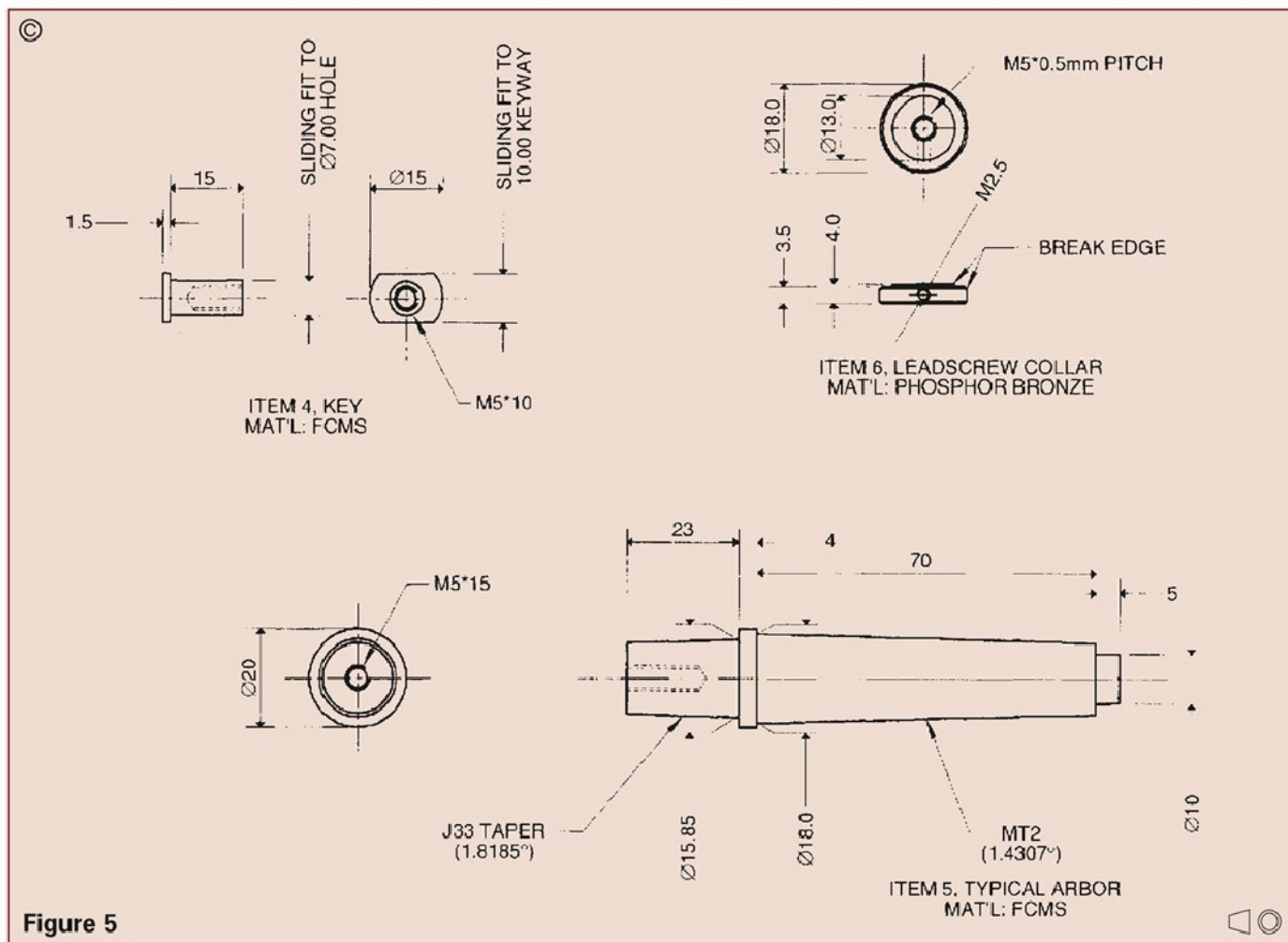


Figure 5

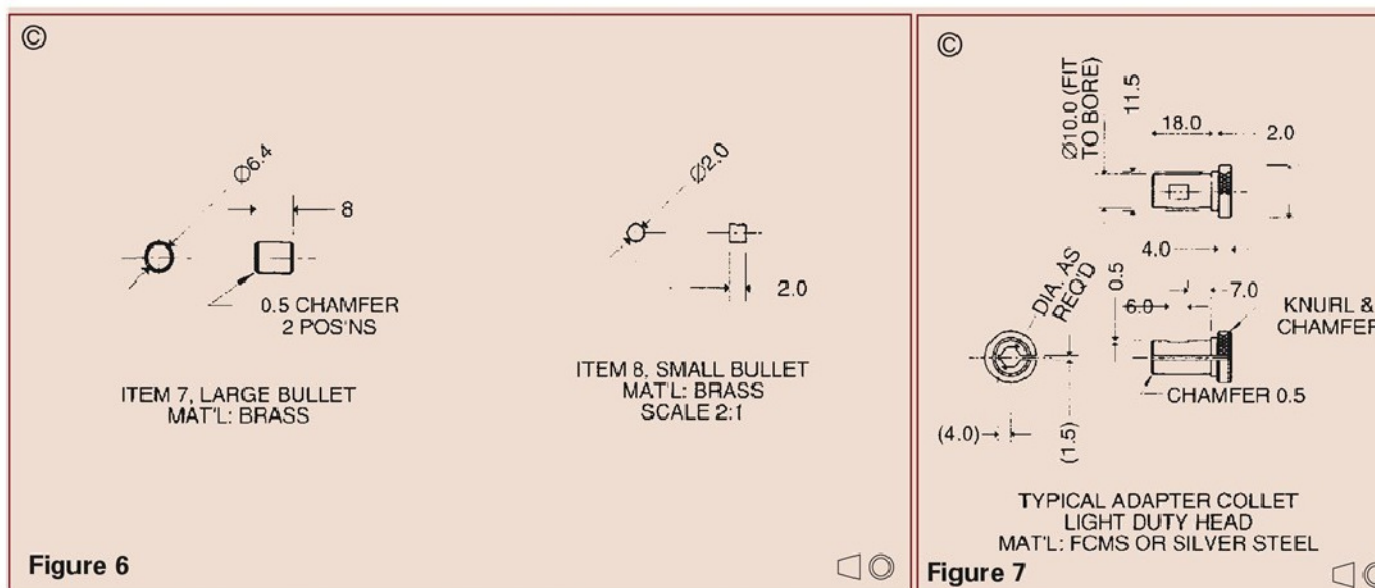


Figure 6

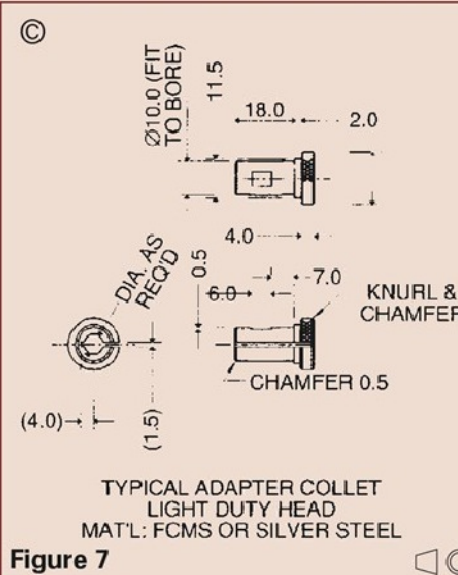


Figure 7

a good quality named HSS Ground tap, holding either in the tailstock chuck with the clamp off and turning the spindle chuck by hand, or with a tailstock tapping holder and use tapping lubricant.

The choice of thread can be to suit the builder. The fine series M5 has a 0.5mm pitch, which means that one full turn of the dial will give 0.5mm of travel, which is a nice convenient number. This means that the dial has 50 divisions, each with 0.01mm travel, or 0.02mm on the diameter. Unfortunately M6 fine has a pitch of 0.8mm, which is not very

convenient, but an M6 coarse series could be chosen which would have a pitch of 1mm and would also be very suitable.

For Imperial users, I would suggest that $\frac{1}{4}$ in. BSW, which has a 20TPI pitch, would be suitable. This would mean that each of the 50 divisions on the dial would give 1 thou movement (2 thou on diameter).

Leadscrew

- Chuck bar, face screw end first and turn to dial diameter.

- At same setting finish turn screw diameter.
- Screw cut and finish with a die
- Part to length
- Protect thread and true up in 4 jaw
- Face, turn angle, drill and tap M5
- At same setting, mark graduations or with dividing head etc.
- Apply Loctite Retainer and assemble M5 grub screw

The 7.9mm diameter should be a nice free fit in the reamed diameter in the Body, but should not be over tight, as a little bit

of misalignment capability is useful. Make sure the shoulder which takes the thrust is finely machined and the root is sharp to avoid clashes when adjusted up.

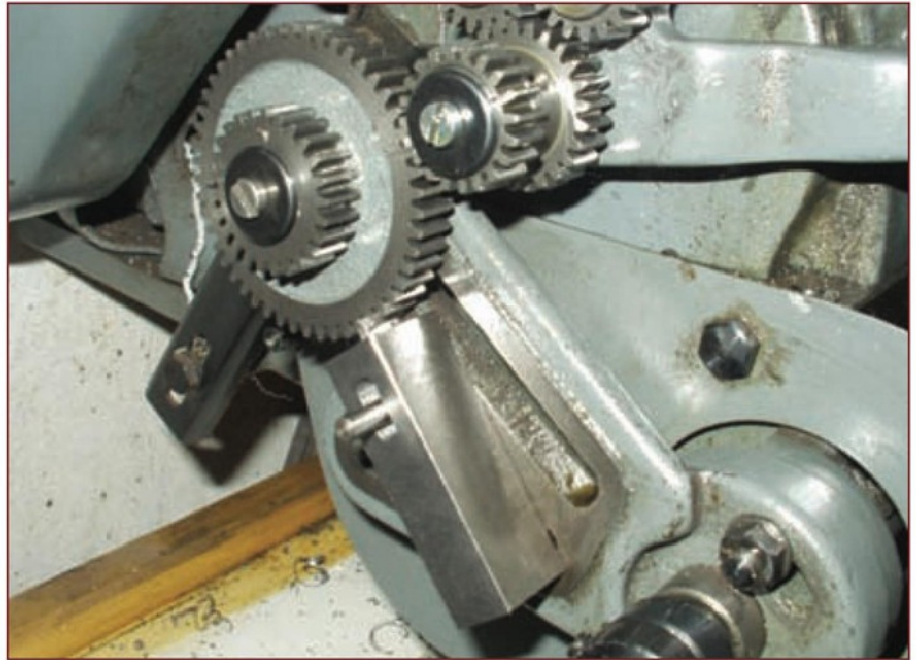
Screw cut the M5 thread, which is 0.5mm pitch, cutting as close to the shoulder as possible without touching, and leave the thread slightly oversize. Finish with a good HSS ground die and lubricant, progressively closing the die until a perfect fit with the slider is attained. My previous comments about good quality also apply to the die, and I have seen some truly awful taps and dies for sale (I even bought a set once – but not twice). Ensure you get one with the cutting portion the full width, not with a recess in the back.

Assuming more advanced equipment is not available (and I often use the lathe in preference to my rotary table), graduating the dial is conveniently done in situ in the lathe using a variety of dividing attachments. At its most elementary, change wheels are easily used for dividing, using a simple indent mechanism. A biasing method to compensate for backlash is required which is conveniently a length of string wrapped around the chuck with a suitable weight dangling on the end. 50 divisions can be indexed directly using a similar arrangement to **Photo 5**. 100 divisions require an additional stage, but the same principles apply. Of course if you have a 100 tooth change wheel, then a direct set up can be created.

Hold a sharp vee shaped tool on its side in the angled top slide and without changing the depth, drag forwards and backwards once only for every graduation line to give uniformity. The lengths can be kept uniform by marking stop positions on the top slide dial and cut towards and past the edge of the dial so that the swarf curl doesn't have to be removed from half way up the dial afterwards. Index to the next position by lifting the weight, releasing the detent and moving to the next gear tooth.

The numbers are always tricky to punch evenly and align correctly. George H. Thomas, the past master, designed the famous staking tool for the ultimate solution, but good results can still be achieved by lashing up a simple jig to guide the punch and rotate the dial by eye.

To make the numbers and divisions easier to read, try filling the lines with a permanent black pen and wiping off the excess. I once saw an article about someone who used paint, but I must admit I have never been successful in this. Any hints from anyone out there on



5. Typical lathe dividing set up.

how to do this better, would be most welcome.

Key

- Chuck bar, face end and turn 15 and 7mm diameters.
- Drill and tap M5
- Part to length
- Mill flats

The 7mm diameter should be a good fit without play in the reamed hole in the body. The flats need to be a sliding fit in the slider groove without play. After milling (and try hard to make the flats central and parallel), finish on fine wet and dry paper against a square edge to get the fit perfect if required.

Leadscrew collar

Again straight forward to make but there is not much margin for error in the retaining screw positions. Phosphor bronze is my first choice of materials.

- Hold suitable length of bar in chuck
- Turn outside diameter
- Carefully face end to a fine finish and put small chamfer on edge of thrust face.
- Drill, bore then tap M5
- Part to length
- Drill and tap M2.5 holes

Tap in situ, following the same points as for the slider, ensuring that the smaller diameter face is square to the tapped hole.

Final assembly

Assembly is reasonably straightforward for this design:

- Debur and clean all components before you start.
- Fit the key from inside the slider bore and lightly fit the M5 screw to hold in position.
- Assemble the leadscrew and leadscrew collar into position, applying a little grease to all bearing surfaces. Add brass bullet and 2.5mm grubscrew and tighten the collar to give a smooth rotary movement without axial play. Clamp by tightening the grubscrew.
- Apply a little oil to the leadscrew and push in the slider into position, and engage the leadscrew.
- Tighten the M5 key retaining screw and check for free movement. Adjust if necessary.
- Assemble 6mm brass bullet and 8mm grubscrew in body.
- Assemble 6mm grubscrew in Slider.

That completes the construction of the lightweight head (**Photo 6**). Part 2 in the next issue will address the more muscular version. The operation will be discussed in Part 3.



Fig 8 Table of fasteners required

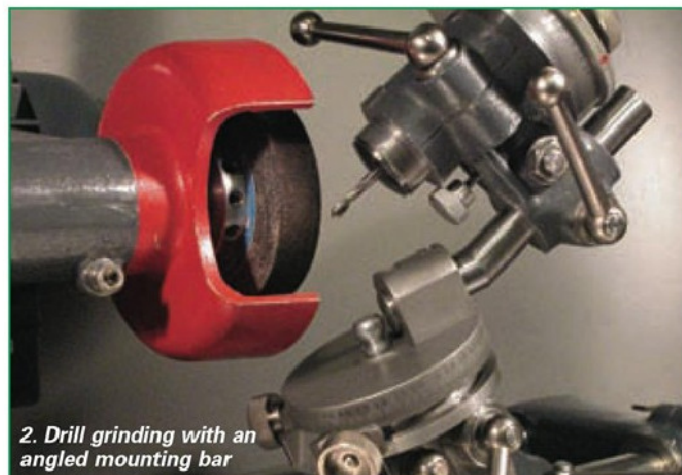
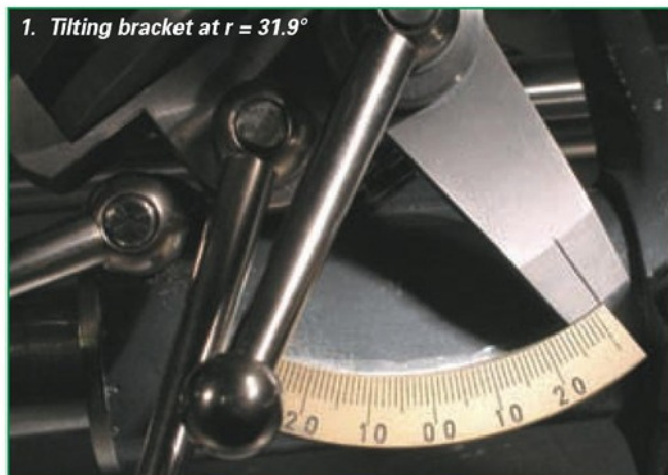
Item No.	Description	Qty
9	2.5 Grubscrew * 4mm, flat end	1
10	M5 Grubscrew * 6mm	1
11	M8 Grubscrew * 12mm	1
12	M5 Socket Head Countersunk Screw * 16mm	2
13	M6 Grubscrew * 15mm, flat end	1



6. Light duty head assembled.

DRILL GRINDING WITH AND CUTTE

Joerg Hugel suggests an angled bar accessory to speed up the process.



Twist drill sharpening by the four-facet method with the very popular Quorn tool and cutter grinder as explained by the late Prof. D.H. Chaddock in his booklet on the Quorn's construction and application, is a simple and straightforward procedure. The two clearance angles α_p for the primary and α_s for the secondary clearance are set with the tilting bracket. For a point angle δ the rotating base is set to the angle $\gamma = 90^\circ - \delta/2$; for standard drills with $\delta = 118^\circ$ the setting angle is $\gamma = 31^\circ$. With a half turn of the tool holder the second lip is brought into its grinding position. When switching between the two clearance angles the drill tip shows a considerable horizontal movement, which exceeds the range of the front bar micrometer and will therefore require a re-positioning of the work head base on the bar. The tilting bracket has repeatedly to be set by accurately reading the scale; this is trying for the eyes and so

another disadvantage of the standard procedure for drill grinding.

For positioning a tool face in relation to the wheel head in principle, two setting parameters would be sufficient. Very often a specific grinding operation could be performed with some quite different settings; with three elements for positioning a tool the Quorn offers some redundancy. Due to the limited angular range for setting the rotary base and especially the tilting bracket, the redundancy is limited too, but sufficient to be used with advantage for improving the drill grinding process. It is proposed now to give the tilting bracket a fixed position ρ , the rotary base is set σ_p for the primary and σ_s for the secondary clearance and τ will be a certain setting angle for the tool holder.

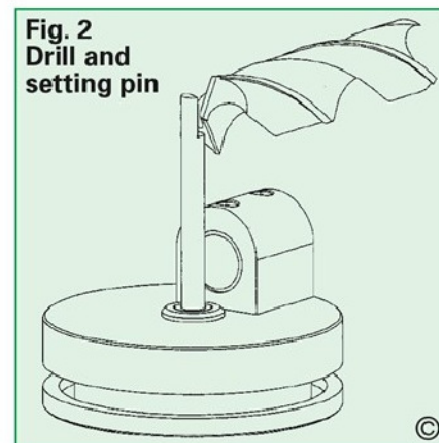
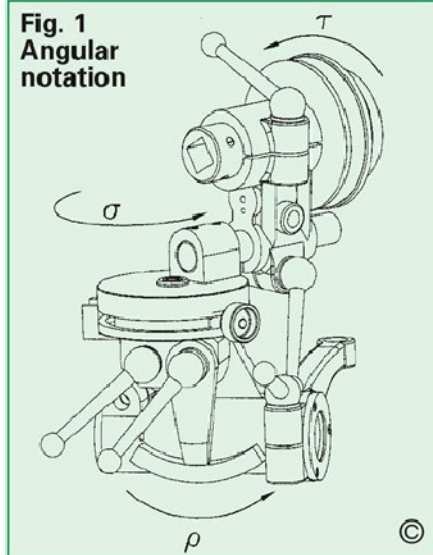
Notation and sign convention

The angular notation is shown and defined in **Figure 1**. It is important to observe the signs of these angles; the arrows indicate movement in the positive direction. Some care is necessary not to confuse the positive and negative figures of the scales. If the pointer is the moving part, as with the tilting bracket, the positive figures are on the arrow side. For the rotary base and the tool holder's index ring the opposite will be true, because the pointers are in a fixed position and the scales are movable. The preliminary alignment of the drill in the tool holder is perpendicular to the rotary base and performed in the usual way with the assistance of a setting pin as shown in **Figure 2**.

Setting angles

The setting angles are no longer simply related to the point and clearance angles;

this of course is a disadvantage of the method proposed here and might shock some readers, who are not so familiar with trigonometric calculations. But once the setting angles are known for a specific application, no further calculation would be necessary. The author has ground several dozens of drills all with the same settings for the standard point angle $\delta = 118^\circ$, the primary clearance angle $\alpha_p = 10^\circ$ and the secondary clearance angle $\alpha_s = 25^\circ$. Of course the theory behind the calculations for the setting parameters is outside the scope of this magazine and also not necessary for its practical application. All formulas are collected in the boxes and are by no means difficult to apply with a pocket calculator. For the example given above the result are received from the equations of the boxes A and B; it is for the tilting bracket $\rho = 31.9^\circ$, for the rotary base $\sigma_p = -6.1^\circ$, and $\sigma_s = -23.8^\circ$, and for the tool holder $\tau = 9.2^\circ$. There seems to be a problem with ρ greater than 30° . But all Quorn grinders the author has seen provide this small reserve, as demonstrated in **Photo 1**. The stops of the rotating base are set for the



WITH THE QUORN TOOL R GRINDER

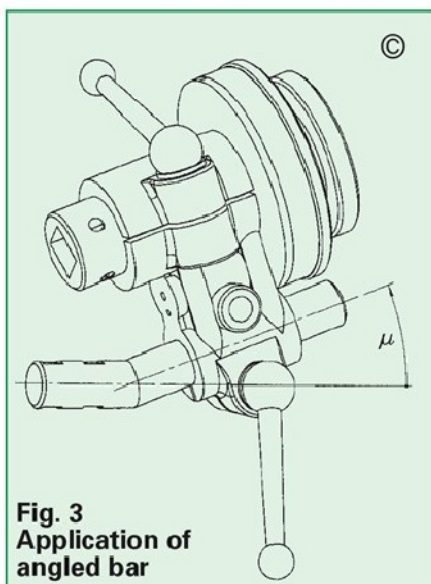


Fig. 3
Application of
angled bar

two σ -values; the negative sign asks for a turn in the opposite direction to the arrow. The tool should be rotated an angle τ from the initial position, shown in **Figure 2**. But it would be better to set the index ring of the tool holder directly to $-\tau = -9.2^\circ$. Then the drill is rotated 9.2° in the positive direction, this will bring the scale of the index ring to zero. Now any switching between the two lips is possible with the aid of division plate and arresting pin without any further application of the scale; the same would be true for positioning the rotary base from stop to stop when switching between the two clearance angles becomes necessary. The tip moves only a very short distance in horizontal direction and this can be corrected solely with the front bar micrometer.

Bent bar solution

The procedure described here is well suited for point angles greater than approximately 120° and comes to its limits for the standard 118° -drills. Grinding a 90° -drill for example would not be possible, at least not with a Quorn in its normal configuration. But with a simple modification, a "bent" or angled mounting bar between the rotary base and the tool holder as shown in **Figure 3**, the problem can be easily solved. This opens up the possibility to sharpen not only standard twist drills but also 90° drill with a tilting bracket set within its nominal angular range. An appropriate bent bar angle would be $\mu = 20^\circ$.

The construction of the bar from two parts with obliquely cut inner ends joined by an internal connecting pin is shown in **Figure 4**. The cutting angles are half the total angle, for example $\mu/2 = 10^\circ$. The two parts and the pin are best joined with

Table 1

A. Basic relations

Angle of the drill point:	δ	
Primary clearance angle:	α_p	Secondary clearance angle: α_s
Supplementary angle to the half point angle:		$\gamma = 90^\circ - \frac{\delta}{2}$
Auxiliary angles:	$\alpha_m = \frac{\alpha_s + \alpha_p}{2}$	$\alpha_d = \frac{\alpha_s - \alpha_p}{2}$

B. Tool holder mounted with a straight bar

$$\text{Setting angles: } \tau = \arctan(\sin \gamma \cdot \tan \alpha_m); \quad \rho = \arcsin\left(\frac{\sin \gamma \cdot \cos \alpha_d}{\sqrt{\cos^2 \alpha_m + \sin^2 \gamma \cdot \sin^2 \alpha_m}}\right)$$

$$\sigma_{p/s} = \arctan\left(\frac{\sin \alpha_m \cdot \sin^2 \gamma - \cos \alpha_m \cdot \tan \alpha_{p/s}}{\cos \gamma \cdot \sqrt{\cos^2 \alpha_m + \sin^2 \gamma \cdot \sin^2 \alpha_m}}\right)$$

C. Tool holder mounted with a bent bar

$$\text{Bending angle of the bar } \mu$$

$$\text{Setting angles: } \tau = \arctan(\tan \alpha_m \cdot \sin \gamma) - \arcsin\left(\frac{\sin \alpha_m \cdot \cos \gamma \cdot \tan \mu}{\sqrt{\sin^2 \alpha_m \cdot \sin^2 \gamma + \cos^2 \alpha_m}}\right)$$

$$\rho = \pm \arcsin\left((\sin \alpha_m \cdot \sin \tau + \cos \alpha_m \cdot (\sin \gamma \cdot \cos \tau - \cos \gamma \cdot \tan \mu)) \cdot \cos \alpha_d \cdot \cos \mu\right)$$

$$\sigma = \pm \arctan\left(\frac{\sin \gamma \cdot \cos \alpha \cdot \sin \tau - \sin \alpha \cdot \cos \tau}{\cos \gamma \cdot \cos \alpha \pm \sin \rho \cdot \sin \mu \cdot \cos \mu}\right)$$

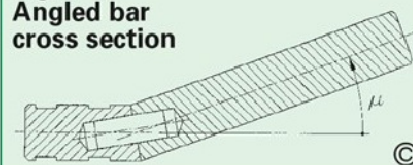
The upper sign is for positive μ -values ($\mu \geq 0$), the lower for negative values ($\mu < 0$).

Loctite. This device is correctly fastened to the Quorn if the plane, spanned by the two centre axes of the angled bar, is exactly parallel to the axis of the rotary base. In order to achieve this repeatedly without complicated adjustments each time the bent bar is mounted for drill grinding, two pairs of two flats may be milled, as seen in **Figures 3 and 4**. The flats of course, must be accurately machined with respect to the bar's plane of inclination and the setscrews of the rotary base. With four flats the bar can be inserted to point up or down an angle μ . In the second case μ would become negative.

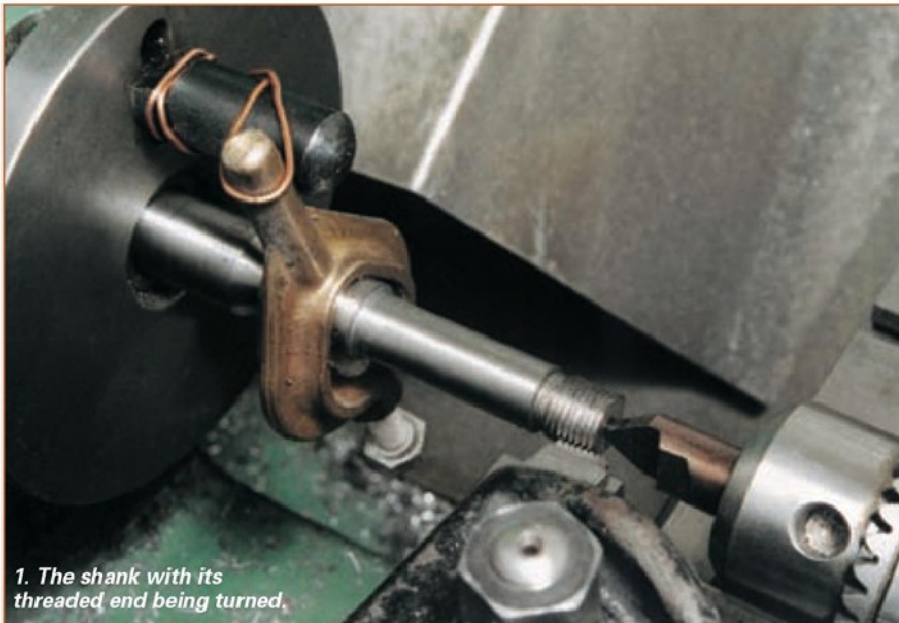
With a tool holder mounted with an inclination the calculations are a little bit more complicated; the results now are derived from the formulas shown in boxes A and C in the accompanying **Table 1**. The equations for the setting angles are no longer independent of each other and have to be evaluated in the given order; the

earlier results being needed for the later computation. The example given above, now with a bar angle $\mu = 20^\circ$ yields setting angles $\rho = 11.4^\circ$, $\sigma_p = -8.3^\circ$, $\sigma_s = -23.6^\circ$, and $\tau = 3.7^\circ$. The Quorn in **Photo 2** is prepared for drill grinding with these settings. Centre drills for numerically controlled machines are short twist drills with a 90° point. For grinding these with the clearance angles 10° and 25° the setting angles are $\rho = 25.6^\circ$, $\sigma_p = -8.0^\circ$, $\sigma_s = -21.4^\circ$, and $\tau = 8.0^\circ$. For $\mu = 0^\circ$ of course the equations of box B and C will give an identical solution.

Fig. 4
Angled bar
cross section



TEE SLOT CUTTER



1. The shank with its threaded end being turned.

Background

In a very early issue of the *Model Engineers' Workshop* magazine I provided an article (Ref. 1) describing how to cut Tee Slots using a single point cutter, rather like a modified fly cutter. The reasons for choosing that method at the time were as follows:

1. Being a large tee slot, a cutter would be very expensive to purchase.
2. Making one from a piece of silver steel would require a length of relatively large diameter material that would also be expensive as the unused length would be unlikely to find a use.
3. A requirement to cut such a large tee slot again was considered improbable.

Recently, two projects have been undertaken that required smaller tee slots and again cutters were not to hand, so had to be acquired. Using the single point cutter was again considered but at the smaller size was thought impracticable, though probably not totally impossible. Again the cost of buying a ready-made cutter was weighed against making one from silver steel. This time however, smaller diameter material was required and any excess material would likely find other uses. In fact the sizes required were already available being left over from previous projects. Taking this method would also be an interesting diversion for an hour or two and provide useful experience in hardening and tempering. Another factor was that the sizes, as called for in the design of the items being made, appeared to be non-standard, as cutters were not listed in the catalogues I had to hand.

Manufacture

To minimise material wastage I chose to carry out the turning operations between centres as this would not leave a small chucking stub that would be destined for the scrap bin. Had the lathe spindle been bored large enough to take the material being used this would not have been necessary, as then the part machined workpiece could have simply been parted off to length.

I cut a length of material just longer than required for the finished item, then faced and centre drilled each end whilst mounted in the three-jaw chuck. I used a small centre drill and then only made a

Cutters can be pricey, so Harold Hall suggests an exercise in machining and heat treatment to make your own.

very small tapered portion as I considered that the pilot portion of the drill might weaken the waist behind the cutter when hardened.

As a threaded shank cutter was being made, it was imperative that the driving dog did not slip, so a small flat was filed on the head end for the driving dog screw to bear against. This flat would eventually be removed by the action of cutting the teeth. I then reduced the material to shank diameter and produced the thread. **Photo 1.**

The cutter being made was then reversed between centres and the waist made; also the cutter head turned to the width required, **Photo 2.** Commercially available cutters are made slightly oversize in terms of diameter to allow for sharpening a number of times whilst still producing a slot large enough to take the width of the tee nut. As this was unlikely to be a requirement in my case I made my cutters, **Photo 3,** to their nominal diameters, 12 and 16 mm. This enabled silver steel of that size to be used, rather than a larger diameter that would require reducing in diameter. In the case of the larger this has been used to cut some 600 mm of slot without any sign of deterioration of the cutting edges.

When turning the cutter head to width I used left and right hand knife tools and as a final measure the tools were set round by a degree or so and each side very lightly skimmed with full width of the



2. Turning the waist and head using left and right hand knife tools.



3. 12 mm and 16 mm tee slot cutters.

cutting edge. This slightly undercut the two faces ensuring that the cutter was widest at the cutting edge, ensuring slight clearance towards the centre.

The cutter was then transferred to the milling machine whilst mounted in a dividing head that was set up to give six cutting edges. I made sure that the flat filed for the driving dog was in a position that would be machined away. Sketch 1 shows how the endmill was set relative to the cutter being made, to create a rake angle on the cutting edge. The depth of cut taken by the endmill was set to around 1 mm and six cuts taken around the tee slot cutter. The end mill was then lowered in stages and the process repeated until there was only about 1 mm of the original outer diameter left at each tooth **Photo 4**.

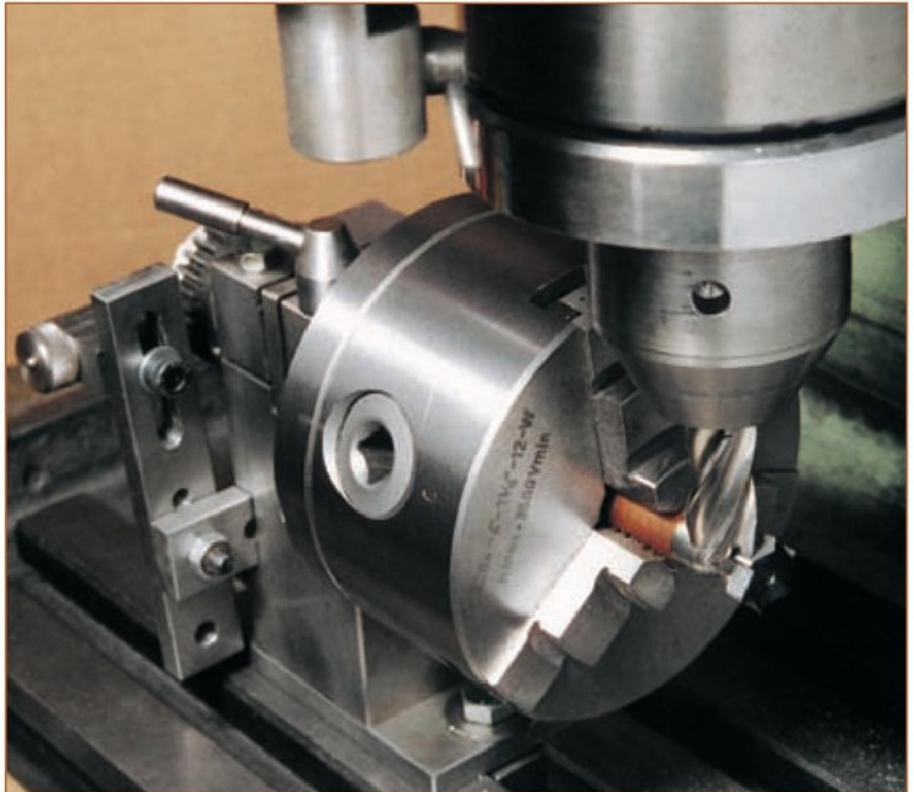
The need for the cutter to be made to rotate in the required direction when eventually used resulted in the cut having to be taken such that travel of the workpiece and rotation of the end mill coincided, i.e. climb milling. To ensure that this did not cause the cutter to snatch and take up the backlash in the table movement, the table locking screw was slightly tightened to stiffen the movement. Had the cutter head been appreciably larger than its shank diameter then the end mill could move from the shank end to the outer end eliminating the possibility of snatch.

The 1mm remaining of the outer diameter was marked with marking blue to aid visibility for the next stage. I then, using a small fine file, added a few degrees of rake to the outer diameter leaving just the slightest amount of the outer diameter, say less than 0.2 mm, see **sketch 1**.

Hardening and tempering

For one who does not often carry out the task of hardening and tempering, and I suspect that this is the case for most home workshop owners, completing the task, resulting in a workable tool, is very satisfying. This process alone makes the project worthwhile even discounting any financial savings.

As I do not often have need of this process, or that of brazing, I find a small brazing torch with its own gas canister is usually adequate for the size of parts I harden. This together with a small brazing hearth and an old pair of large pliers



4. Cutting six teeth of a cutter aided by a dividing head.

completed the necessary kit for the job. One other item, a large container filled with water for cooling the cutter.

I placed the cutter to the corner of the hearth and applied the flame to the cutter head and waited for the cutter to turn bright red. A good description for this is the colour of boiled carrots. I then held the cutter at this colour for a few minutes. The cutter was gripped vertically then plunged into the water, cutter head first. (I know the theory advocates an hour per inch of thickness, but I was not really too worried about achieving maximum hardness all the way through the section.)

The shank and cutter head were then cleaned and polished with a fine emery paper to enable the tempering colours to be seen. I then commenced to re-heat the cutter but this time with the flame at the threaded end. When the end took on a deep blue colour I observed the colours running up toward the head and when this became a light straw colour the part was then quickly placed head first in the water and agitated rapidly.

More detailed explanation

For those for whom hardening and tempering is a new process the, following which expands on my brief account above should be of help. Unless you have a large, well ventilated workshop, always carry out the activity in the open, though if it is windy you will need to find a sheltered spot. If sunny, also find a shaded area. This makes for consistent judging of the hardening and tempering colours as the task should never be done in bright light. The colour required should, when viewed in subdued lighting, approximate to that of boiled carrots. When the item arrives at the required

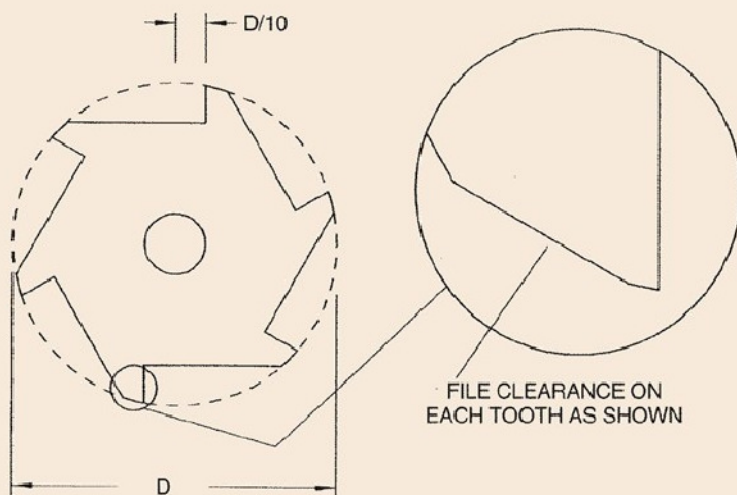
colour keep it at this for a minimum of five minutes, more if the part is large. To avoid the part becoming hotter during this period move the flame slightly further away, if it appears to be cooling the flame should be brought closer for a while.

If the part being hardened is large a small brazing torch may not be powerful enough. In this case making a small cavity out of a number of firebricks to house the part and aiming the flame into the hole will help considerably. I have also used two torches simultaneously for extra power.

Use a large pair of pliers to pick up the part and place in the water cutter head end first. The steam produced around the part will reduce the cooling effect so it is essential to agitate it vigorously in the water.

That completes the hardening process but if left in that state the part would in most instances be too brittle for the task it has to perform, because of this it needs tempering. The tempering will reduce the hardness the amount depending on how hot the part is made during the tempering process. Tempering is more critical than the hardening process as the task parts are called upon to withstand vary widely. A cutting tool will need to be harder and only slightly tempered whilst a screwdriver needs to be less hard but also less brittle. For more detail regarding tempering other reading on the subject should be studied (Refs. 2, 3, 4) For carbon steel cutting tools however tempering to a light straw colour should be about right.

In theory, lathe tools, which are normally well supported and used with a continuous cut, can be left harder than a cutter used in the milling machine where they are less well supported and the cut is intermittent. However, when using the colour method to determine tempering temperature the colour difference would



SK1

be too small to totally certain. Such precise tempering is really only appropriate when items are heated in a controlled environment such as an oven.

After hardening the part will have taken on a dirty black appearance, so that the tempering colours cannot easily be observed. This must be cleaned off and the surface brought to a polished finish. This will be easier if the part originally had a good surface finish. Few parts will need to be equally hard all over with many benefiting from a progressive tempering,

as is the case with the tee slot cutter. In such cases apply the heat to the end needing to be less hard, the threaded end in the case of the tee slot cutter. Wait till this becomes blue and watch carefully how the lighter colours commence to run towards the cutter head. Once the colours start to run, which will happen quite quickly, be ready with the pliers to once more place the part in the water, again agitating rapidly.

Be very careful with the tempering process, the speed at which the colours

travel makes it easy to over temper the cutter edge. If this is done it will be necessary to anneal the part and once more go through the hardening and tempering process. More reading will be necessary if you find yourself in this situation.

If a part needs to be equally tempered all over keep the torch further away from the part than when hardening and continually move the flame over the part until the colour required is even over the whole component. I am sure that when you first make your hardened cutter, be it a tee slot cutter or some other, you will gain much satisfaction when you see it cutting through the metal with ease. However, your silver steel cutter is not the equal of a high speed steel tool so cutting speeds will need to be on the low side.



References

1. A Tee Slot cutter *MEW* issue 17 page 36.
2. Heat Treatment of Metals *MEW* issue 3 page 26.
3. The Plain Man's Guide to Materials *MEW* issue 20 page 32.
4. Hardening, Tempering and Heat Treatment, Workshop Practice Series number 1 Author Tubal Cain, published by Special Interest Books, and available from customer services, Highbury Leisure, 01689 886 660

"ZAPPING" NI-CADS

Ted Fletcher gives advice on performance recovery

Background

Almost all the new cheaper cordless power tools and many of the expensive older ones are, or were powered by Nickel Cadmium batteries (Ni.Cads). Despite their advantages there are also disadvantages and one of them is the memory effect which prevents the battery from taking a full charge when being recharged. The so-called memory effect can be altered in two ways:

1. Recharge the battery in the normal way and then carry out a rapid discharge. Repeat this several times. I am told it is possible for the battery to explode, but I have never met anyone who has experience of this. Also you can ruin the battery altogether without a catastrophic bang.
2. Discharge the battery completely using a flash light bulb until the light goes out. This should be carried out quite a few times. This is the method I use, with success.

Cell failure

The best way of avoiding the memory effect is to avoid it in the first place. Always completely discharge the battery before recharging, using the bulb method. A 12 volt bulb acts as a rough and ready discharge indicator and goes out when the battery needs re-charging. A typical cheap power tool battery pack consists of a number of individual cells connected in series. A single Ni-Cad cell has a voltage of 1.2 volts, therefore a 7.2 volt power tool has 6 cells connected in series to form the battery. Should one cell fail to take a charge due to the memory effect, the tool then has only 6 volts, but more often one cell not only fails to take a charge, but also reverses its polarity, which in effect means that 2 cells are inoperative, taking the overall voltage down to 4.8 volts, a 33% reduction.

It's not unknown for a cell to have its polarity reversed due to the battery being left in a discharged state, or if a tool is used when the battery is below its 75% capacity. Excessive discharging can take place if one or more cells wears out quickly, then the other cells have to work



1. Battery pack opened up, revealing individual cells.

even harder to compensate. Murphy's law of course frequently dictates that the faulty cell will be the one in the centre of the pack, which means that the plastic power pack (usually solvent or thermally welded together when new) has to be dismantled.

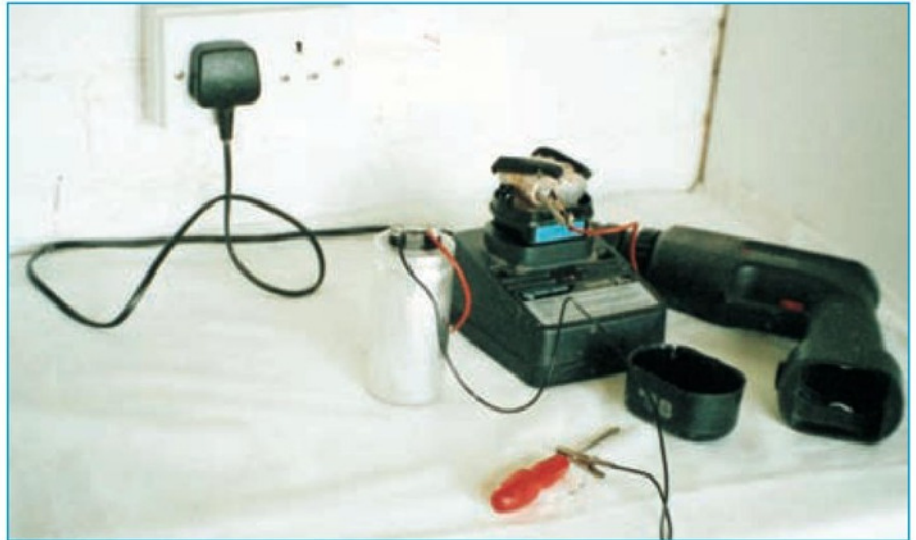
Recovery technique

Using a Stanley type knife, the weld can with care, be prised apart giving access to all the cells see **Photo 1**. Importantly, note how the cells are arranged, so that you can fit them back into the container later, and then lay them out in a string.

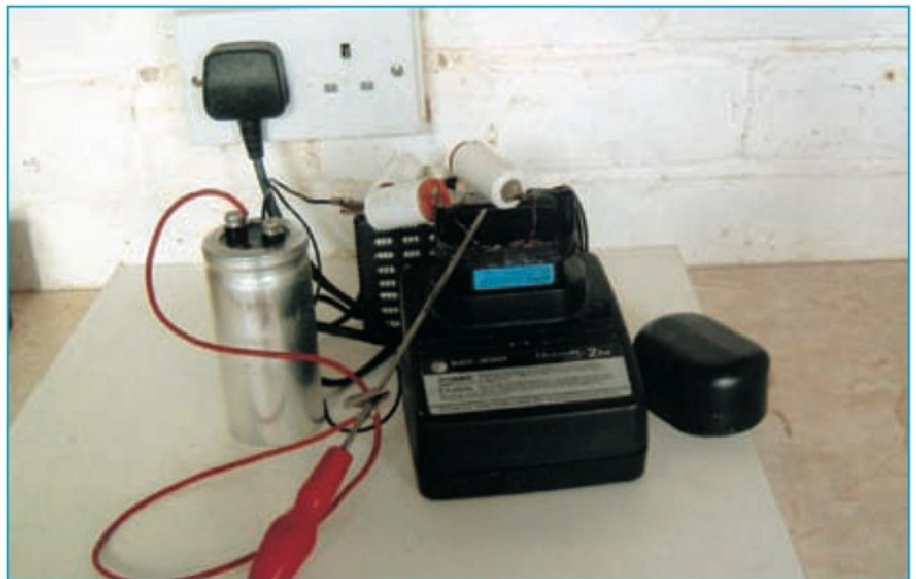
For the next stage you will need a multimeter, hopefully either you or one of your friends has one, set the meter to read low voltage dc, then measure the voltage of each cell, when you have located the faulty cell, mark it. Next you will need a fully charged car battery but not still gassing and a large capacitor say 50,000 μF with a working voltage of 16 volts or more, (Ex audio amplifier, copiers etc.) then attach a red wire to the positive terminal of the capacitor and a black to the negative.

Carefully insert the battery pack into its charger as shown in **photo 2** and switch on, so that normal charging is taking place. Having already noted the + and - terminals of the faulty cell, charge up the capacitor by connecting the red lead to positive and the black lead to negative of the 12 volt car battery (I do not consider that a power supply unit or battery charger are suitable here) see **photo 3**. Now, whilst normal charging is taking place, connect and discharge the capacitor across the faulty cell, observing polarity. Repeat this operation several times. After about 6 to 8 charge / discharge cycles of the capacitor, measure the battery voltage and if my experience is anything to go by, the faulty cell will have its polarity corrected and should be starting to take a charge. Leave the battery on charge over night or for the recommended charging time. When you connect the capacitor to the car battery and to the faulty cell, there will be a bit of arcing taking place, (this is the reason for not having a gassing battery). Don't worry, it's low voltage so you won't be electrocuted.

Don't expect the battery to have same capacity as when it was new, but that said, I have had few failures over the past 15 to 20 years. It is said that by discharging the capacitor across the duff cell you are



2. Normal charging in progress.



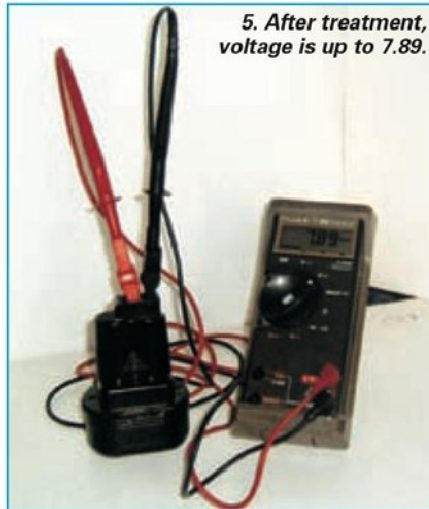
3. Stored charge in the capacitor is used to "Zap" the faulty cell.

burning off the internal insulating whiskers within the faulty cell. If all fails, it is extremely easy it is to buy new individual cells and replace them yourself. A good source of pre owned (the car salesman' term for second hand) Ni-Cads, is old emergency lighting units. Many are routinely scrapped after 5 years and still have a lot of life left in them, so look out

for them at car boot sales. **Photo 4** shows a rejuvenated 7.2-volt battery pack connected to a 12-volt car headlamp bulb note the brilliance of the bulb when connected 7.2 volts. **Photo 5** shows the battery pack voltage of 7.89 after charging and **Photo 6** shows the battery pack now re assembled and back on charge as normal.



4. Discharging through a bulb helps avoid "memory effect"



5. After treatment, voltage is up to 7.89.



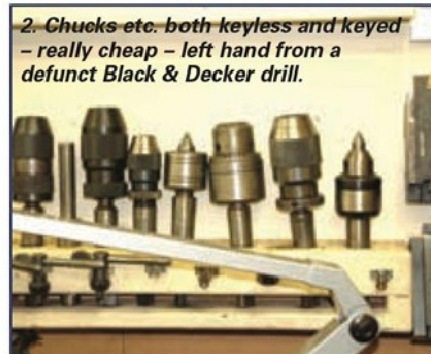
6. Following reassembly, the pack can be charged as usual.

THE BEGINNERS GUIDE TO THE ARTS OF WORKSHOP

Peter King offers advice on bargain hunting.



1. Reamers, adjustable and hand.



2. Chucks etc. both keyless and keyed – really cheap – left hand from a defunct Black & Decker drill.



3. Broaches, "funny looking saws"

The beginning of the black arts is to acquire some knowledge of what machine will do what job, and then some knowledge of actual tooling used with the machines. Neither of these is particularly difficult as a lot of information can be assimilated from these august pages or from the sister magazine. The real test of ones abilities then usually comes without warning in one of several possible places. (Throughout the article \$1 = about 34p)

Auctions

Firstly we will deal with auctions. At an auction one may have spotted a genuine 'Snodgrass Screwmangler' which you assess is in good condition under the filth, which is just what you want for the 'shop. These are usually really right out of your price range and after his assistant has called the item you hear the auctioneer calling something ridiculously low that you can afford out of pocket money, and he is repeating it. You have a few seconds to make up your mind before someone else who will probably only clean it and 'flick it on' moves in. There is no time for soul-searching as the very fact of you making a bid will move the 'cleaner' on as he is not looking at paying any respectable price and once that price starts to really rise, other bidders will take interest and will also move into the fray. You clearly call a figure slightly above that of the auctioneer or what he has specified – "I will take \$10 bids" – and see what happens, you may be lucky. Forget all the waving of brochures and eyebrows – they are for regular buyers that the auctioneer knows well. Afterwards if you were successful and if you have no transport, have a word with his assistant as they can usually put you in contact with a small trucking company who will deliver it home for you at a reasonable fee.

It is worth spending time going right round all the items that are up for auction and closely inspecting all of them so that you know whether they are worth

bothering with. Don't pay too much obvious attention to what to you is a bargain, as you will direct unwanted attention thereto. Remember that if the price is low enough some items may be very worthwhile. Always delve into the bottom of boxed assortments as a box of junk with one good, large, taper shank drill in the bottom going for a couple of dollars/pounds on the call is worth while – you can dump the junk and still be "quids in". But do not bid on a box you haven't inspected – I once at a market day auction saw two old fools furiously bidding on a cardboard box that I knew contained only various peoples empty fag packets, orange peel and screwed up paper packing! Occasionally you will see a box with something that you would like and you cannot stay for the actual auction – you can give a pre-sale bid to the auctioneer and this is what is happening when the auctioneer says that he has a "bid in hand". You can specify that you will bid up to a certain figure, the usual situation then is that when bidding slows to a stop below your figure, you will be successful and commonly you will be credited with a bid of 5 or 10 dollars/pounds above that last bid. I bought a mostly unused box of good brand hand and adjustable reamers (.1875in. to 1.625in.) this way, and because there were none missing from the sequence I set a top price of \$230 and actually paid \$120

Dealers

Secondly we come to the casual chance in a dealer's showroom, whilst looking at something else; you are offered an old piece of machinery, it's a 'Farnsbarnes Back Geared Nutbodger' not actually in the first flush of youth. This has probably happened because the dealer knows you as a regular customer and knows that he is stuck with this after trading it on a new machine and figures that perhaps ten dollars/pounds from you now is better than fifty in perhaps a year or so. Again if

you have a use for it your mind has to be made up really fast, if you accept you will probably get other deals offered in the future and if you take it on you can have some fun just 'tarting it up' and learn a lot as well. However do remember where you got it and don't later try to trade it back to him – try someone else!

In this group also comes the dealer who is moving to new premises, these are usually somewhat more up-market than where he is now and that old 'Entwhistle Foot Pedalled Over-Arm Mill will look too shabby for the new premises. He will want to get rid of it and you may be lucky enough to acquire it for a ridiculously low price. I got my 'Herbert' universal milling machine that way – over 60 years old but under the muck and chipped paint it was unworn (why is another story). Don't be scared of asking if the dealer knows of a particular machine for sale, he probably owes another dealer a favour for something and can repay it by directing you to them if they have one. A good example would be a small shaper, he may know of one in another town – maybe 100 miles away, a phone call is then necessary to see if it is still there – its then up to you.

Local works

Thirdly we come to local engineering works which few of us visit much – if at all. However sometimes there are jobs that even with the exercise of the typical model engineer's ingenuity are really too big to tackle on a three or four inch machine. Whilst arranging for the necessary machining to be done, one may – on very rare occasions – be asked if you were looking for say 'a bigger lathe'. This may be for two purposes, firstly to get rid of an old largish lathe in the back of their shop and secondly hopefully to get rid of you and your fiddly jobs. Always have a look at what they are offering as it may be quite a good lathe, (I was once offered one of the smaller and older 'Dean Smith & Grace' beauties – I had no room for it) that has

GUIDE TO THE BLACK SHOP ACQUISITION

become an eyesore because with lack of use it's now a dumping ground. They bought a new lathe with lots of bells and whistles a year ago and the old one hasn't been used since then. It may be a hefty 'Ramsbotham EXLCR' industrial six inch centre height brute that will do the very job that you have brought in. Check it over thoroughly, if it is better than the mangle that you use and it will fit in your workshop then make an offer well within your budget and prepare to start haggling. Now comes the application of psychology – they will extol its virtues, while you comment "gawd what a filthy knackered heap" etc. However do remember throughout that they have offered it because they NEED THE ROOM so you have a slight edge. They probably thought they would still use it so didn't try to trade it to the dealer they bought the other one from, then found that the new one did all they required. However this machine will almost certainly be fitted with a three phase motor so if you buy it you will have to convert it or whatever. You will, if you buy it, usually be able to get them to move it to your place with their delivery truck; they also often have roller sets for moving machinery that they will loan.

Boot sales and rallies

Fourthly we come to car boot sales / steam rallies / vintage swap meets etc. you may well find almost anything at these events, from a 'swoggle pump' (there is – so there!) to an electrically driven mobile commode (I have seen one), so be prepared and have some cash with you – folding stuff! The prices asked will range from the idiotically high to a pittance. The idiotic can be treated to the spectacle of you and a friend holding each other up while laughing fit to bust, the others to a quick exchange of cash. Be prepared to haggle – they have the item there because they want to sell it not take it back home. As in most of these situations you will need to make up your mind quickly, assess a price and boldly offer it – don't 'beat about the bush'. I have bought over 80 different metric and imperial new taper shank drills for about £20, they were in a box with some very tatty old large drills on top – I offered \$60 for the box less the large drills and got it. Another thing to watch out for at these sales is parts of machinery and accessories, when living in UK I once owned a Myford lathe and at a UK boot sale bought a complete set of gears and several accessories for the proverbial 'song', clearly the vendor did not know what they were. Remember that second hand blunt milling cutters can be re-sharpened for about a third the cost of new ones. Taking a large quantity of these

to a commercial sharpening shop will often allow of negotiating a reduction for bulk. You can of course sharpen them yourself if you have the kit. I once bought a box of about 50 assorted end / slot mills for about \$10 and also once got 20 assorted side & face / slab mills (up to 5in. dia.) for about \$12.

Junk shops

Fifthly there are junk / pawn / secondhand shops. You will never cease to be amazed at what these sell! The real coups – I have bought a new 'Cardinal' brand 7in. x .625in. 'side & face' staggered tooth cutter for \$10 – it was "a funny sort of saw". I have also bought a 'Minuteman' brand set of keyway broaches and guides for \$40, also described as "funny sort of saws", only one broach had been used. Mostly these shops sell items of no interest to model engineers, but as you can see from the above they are worth a look. Just look, if only for drills, and see how many part sets of perfectly good 'Dormer' twist drills they have on offer for about 10% of new price. These alone will keep an impecunious model engineer in drills for years.

Club sales

Sixthly, sadly (try saying that with your teeth out), there are model engineering club sales tables – terrible things have happened to novices at these – all the club pack-rats and s****-hawks will descend and there is no quarter given. Sometimes there are bargains to be had but the competition is fierce and all that novices will get near is boxes of assorted dog-ends of 'HSS' tool bar that turns out to be carbon steel; bent and tapered (worn) drills and short ends of unidentified steel. These will turn out to be wrought iron when you try to machine them and wreck your cutters. Never, ever buy a reamer from these tables – except for a laugh afterwards, and remember that micrometers from this source are often only fit for use as 'G' cramps. When you are much older, scarred, embittered and morose with steel tipped elbows and wearing hobnail boots you will have acquired the necessary technique for purchasing the occasional bargain from this source.

Summary

In all these situations have a clear idea of what – in general terms – you want for your workshop. Then when something good 'comes up', rapidly apply the following: "can I use it – yes or no", then "do I actually need it – yes it will do that job", followed by "can I afford it – at that crazy price – yes", or "no" as the case may be. The second part is important – don't

buy it if you don't need it or you will clutter your 'shop with junk and not have the ready when you find something you do want. Don't get 'Auction Fever', if the price is rising rapidly – walk away as it will go on rising. I have seen two old fools bidding against each other for a rusty old hand push mower worth about \$5 – they went to \$120, immediately after this my wife bid for and got at \$26 a very good petrol motor 26" cut rotary mower. It is worth going to a few auctions and seeing what people pay for items – very often they pay more than the store down the road is asking for a new one. Therefore spend some time getting an idea of what prices are being paid for tools and tooling.

Try not to get 'brand name fixation', if the machine will do what you want don't be put off by the name on it, unless you actually know that all that particular brand were 'dogs'. If on the other hand an ML4 Myford or 4" round bed Drummond is your dream, be prepared for a long wait as they are getting a bit rare now (an ML4 was my first lathe back in '67, before that I used the family 4" Drummond my Great Grandfather bought new sometime around 1908?).

I wish you the best of luck; you will have a lot of fun, make some real mistakes but acquire a shop full of machinery that you know, and cherish. My 'shop machinery has cost me about \$15,000 (about £5000) over the last 25+ years, most of the price being because of the size of the machinery. It has repaired a lot of cheap secondhand farm machinery and saved me a fortune in equipping a farm; restored a forward control Land Rover and several of the machines in the 'shop; made parts for a trials motorcycle; made a 'Stent' tool and cutter grinder and a 'Jacobs' gearcutting machine; made two dividing accessories and a 'dead length' collet chuck; made several accessories for the lathes; it has made innumerable bits and pieces for me and neighbours; restored the radial arm saw and a saw bench for woodworking, and is now making my 7.25" gauge 3.5in. to the foot 0-4-4-0 'Mallet'. Along the way I have had a lot of fun and satisfaction, a Golf or Ski club would have cost as much if not more and I would have much less to show for it.



4. Milling cutter – another funny looking saw.

TOOLROOM TIPS



1. Model chuck on Stewart model lathe to show the screw heads in chuck body all lined up with the circumference of the chuck.

In the days when I could see, I worked as a toolmaker in a small unit making pre-production machinery for the transistor and integrated circuit industry. We were part of a large engineering shop attached to the factory making the transistors and so everything was made in-house. There were about eight toolmakers on our section and the chargehand, Jolly Jack. Jolly Jack was a superb toolmaker so they promoted him to chargehand thus preventing him from ever making anything again. (It's a mad world). He was a very unlucky man, I remember he once bought a gas fire and there were about three options to the surround, you could have walnut, mahogany or stripped pine and he ordered mahogany. It came, it was walnut, he growled, complained, they sent him a stripped pine one and refused to take away the walnut one because they weren't programmed to take things away, only deliver them. So he complained again and he got another walnut one. So he complained again and they sent him a mahogany one, fantastic! They still didn't take any away and then he got another mahogany one and they still didn't take any away and as far as I know, he still has four or five surrounds up in his loft. One of Jack's foibles was that he had these sayings which are still quoted anytime to engineers he meets and the one I want to address today is: "countersinking 10thou. below the surface mate".

Counterboring

I want to start with counter boring which, I think, is easier and you start by "miking" the thickness of the diameter of the head of the screw you want to counterbore for. Select a number drill, a size, or possibly two sizes up, not too much, putting it in the machine and lowering it until the end of the drill sits in the clearance hole. Now go down the thickness of the screw head plus 10 thou, remove the drill and try the screw head in the holes to see if it drops in neatly. Now you need the same size number drill but flat ended. Take an ordinary number drill, grind it flat against

"Blind Pugh" talks through the ways and means of achieving high quality appearance of screws.

the wheel and back off the two lips so that you have something like a slot drill and lowering this into the hole, just take out the bottom corner until you have removed all but a small amount of the countersink that the end of the first drill left. Be sure you have left a small countersink just in case the head of the screw doesn't meet the body of the screw in a neat right angle but has a small radius under it. This is all that is necessary for cap end screws but if you are using slot headed screws then you really need to align the slots of the screws in the line parallel to the edge of the job or to the circumference of the job and this is done by fitting the flat bottom drill into a handbrace and just giving a couple of turns to the bottom of the hole and try again until you get the slots in line. Of course you might be lucky and when you screw the screw into the hole it comes out in line straight away but you'll be a luckier man than me! or Jolly Jack!

One point worth emphasising, is when counterboring, don't try going straight in with a flat bottom drill as you will probably get a triangular hole or even a broken drill, they are far too flexible. An endmill might do but you need to have one that is the right size for the screw head otherwise you get a well round the diameter of the screw which fills up with dirt and looks dreadful.

Countersinking

Now for countersinking, there are two rules: first of all remove the burs under the slots at the sides of the countersunk head; there is nearly always a curl of metal here and check the radius between the head and the body of the tool. And rule two – do not use a countersink bit.

The reason is of course is that unless the countersink bit is exactly the same size as the head of the screw you want to use, the deeper you go, the wider the counter sink gets and you finish up with a screw with a sizeable chamfer all the way round it, which isn't the effect you had in mind. Once again, mike the diameter of the screw head and pick a number drill, one or two sizes up at the most. Grind a ninety-degree angle on the end and back it off. If you have a tool and cutter grinder, use it. If you haven't, do it on the off hand grinder. You will find you can get very close to a ninety degree angle just by looking at it.

We conducted an experiment once by taking a combination set protractor and wandering round the factory showing it to anybody we met saying "set this to 90 degrees" and everyone could do it within one degree. Non-engineers, everybody! We are so used to seeing right angles wherever we look that it's programmed into our brain, so have no fear, you can do it by eye and it will be good enough for this job anyway. Lower the point of this drill into the clearance hole and go down

until the parallel part of the drill just starts to cut. Stop drilling and drop the screw head into the hole to see how it fits. Its then a case of opening the bottom of the hole with this same drill until the slots come out right. If you have a line of screws, every screw should have the slot in line so you could pass a string from one end to the other and then drop into the slots. All the screws in line and looking good. This is the sort of thing that impresses the uneducated and sometimes even judges and is well worth doing. I have a friend who went to work in the machine shop at a boatyard specialising in millionaires' floating gin palaces and he told me that the instrument panels were held on with Phillips screws and every one had the stars aligned all the way around the instruments and all the way round the instrument panel, so that it looked fantastic. Keep the two special drills you've made, the flat ended and the ninety degree one and make up a little stand out of mahogany or some other wood, (not oak which rusts steel) but mahogany is nice and easy to come by to store them and you will soon have a small collection which is all you will need. It won't be too expensive and worth every penny.

As far as the countersink bit goes, we always used to use these for milling chamfers on the edges of small base plates and possibly for the sort of slot you might use on a very tiny vee block. If we wanted something better than that then we would grind it on the surface grinder to take out the ripples that you get.

Screws

Now to the screws, the chances are the screws that you have will be too long for what you require and you have got to cut them down, some people think that capped screws are hardened and can't be shortened or attacked in any way other than with a grindstone. This isn't true, they are tough not hard and you can saw them off and file them nearly as easily as an ordinary screw. And if you can't see the end of the screw when it is in position, filing it across the end after you have sawn it off, putting a slight chamfer on before screwing it in is all that is necessary. But if the other end of the screw comes out, where it could be seen, it needs to be properly finished, possibly domed and then emery clothed. For this you need a thing called a lantern tool, which is the sort of tool that a clock maker uses quite often and you can make your own with a piece of $\frac{1}{2}$ in. diameter steel, about 2in. long and another piece of $\frac{1}{4}$ in. diameter and about 1in. long. This is what you do.

Face the two ends of the $\frac{1}{2}$ in. diameter, chamfer and thread one end for $\frac{1}{4}$ of an inch long with any handy die that you have, preferably a fine one, I think my one

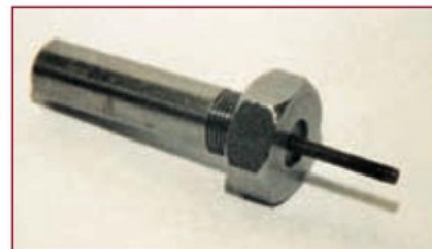


2. Lantern chuck with screw, disassembled.

is $\frac{1}{8}$ in. 26tpi, if you haven't got a tap and die this size or suitable alternative, then you are going to have to screw cut it but make the pitch fairly fine as you get a better pressure on the screw that you are going to work on if you use a fine thread on the tool. The $\frac{1}{8}$ in. shank is now complete and you can go onto the other piece which needs facing, then knurling if it is round or not if it is hexagonal. Drill down and flat bottom for about $\frac{1}{8}$ in. to the tapping size of the thread you have put on the $\frac{1}{8}$ in. diameter piece and then down the middle of this, put a drill and ream $\frac{1}{8}$ in. diameter hole for a further $\frac{1}{8}$ in. Chamfer, part off, chamfer again, and face the front face until you have a $\frac{1}{8}$ in. diameter hole visible and go back until that $\frac{1}{8}$ in. diameter hole is a $\frac{1}{8}$ in. long. You should now be able to screw the two parts together and there should be no or very little gap between the end of the half-inch shank and the bottom of the hole in the cap so that it is going to trap any screw that you put in.

Now you have to make a few adapters to suit the different screw sizes that you use. I have about eight of these to suit 2,4,5,6,7,8,10 and 12 BA. When I drill them through, I do not use the nominal

clearance size drill but as tight on the thread size as I can get with the number drills so that the screws slip in neatly and they don't rattle about. The adapters are made from a further length of the $\frac{1}{8}$ in. diameter used for the shank. Turn the outside down for a length of about 0.2in. so that it slips in underneath the thread in the cap, I think mine is about 0.47in. dia, or something like that. Then reduce the end to $\frac{1}{8}$ in. diameter for a length of $\frac{1}{8}$ in. and drill through the middle, for the size of the screw that you want to work on. Part off at $\frac{1}{8}$ in. long, face the other end, chamfer the hole slightly and the adapter should drop into the cap and be a nice sliding fit in the hole. You can now put the screw you want to work with through the centre hole, screw the cap onto the body and it should revolve neatly allowing you to work on the end of the screw with a file and emery cloth, and thus dome it off nicely. You can also of course put a point on or you can turn on a pip at the end which watchmakers do and this is ideal if you want a screw which will self-centre itself in the threaded part. Turn a couple of threads length down to the core size or just under the core size of the thread and then remove and put it into the clearance hole and you will find it will drop into the thread part and screw in as easy as anything. You cannot of course do this if the end sticks out through the piece you are screwing to as you don't want a lot of little projections on the other side but if it is thick enough to take this and hide it then it is quite a good idea to do specially on models where sometimes it is very difficult to get a screw into position, lined up in order to tie it up.



3. Assembled lantern chuck with screw.

Having done one end of the thread it is now time to do the other end, the head and these are improved by draw filing parallel to the slot if it is a slotted screw. For a cap head screw, you may decide that no further attention is needed, or in either case you may decide to polish it. For this you need to remember you cannot do it in a chuck if you want to retain the flat head, if you want a slightly domed head, that is okay, but a slotted head that is flat needs to be polished on a flat block and I usually use first draw filing then a piece of fine emery on a flat surface, then a piece of wood impregnated with one of the chrome polishes such as Solvol. That should bring you up a perfectly black shine, as the watchmakers say, as there is no reflected light unless you are looking directly at the reflection of the bulb; otherwise no light is scattered to your eye and it looks black.

After this you need to consider whether you are going to oil black these screws. Nothing on a machine looks better than blackened screws, collars, nuts, incidentals, and if you are going to oil black it then I will tell you how we used to do it in a future article.



OUT AND ABOUT



Right hand section of "Mr Cholmondley-Warner's Garden Railway"

It has been possible to visit a couple of exhibitions recently, neither being directly related to model engineering or workshop aspects but nevertheless of interest to me and I hope to many readers. Model Rail Scotland is staged annually in February at the SECC (Glasgow) and is the lead event north of the border for enthusiasts in scales from Z through 00 and 0 to garden G gauge. In some previous years the displays included a significant model engineering content, in the form of a display arranged by the Motherwell Model Engineering Society, but unfortunately not on this occasion. An 0 gauge model of the GT3 locomotive did

give a pertinent reminder of how Tim Coles' gas turbine powered model will look when complete.

One layout that took a rather different and humorous twist was entitled "Mr Cholmondley-Warner's Garden Railway" and exhibited by the Raven Model Railway Group. Using a backdrop of $\frac{1}{2}$ scale buildings, scenery and figures, N scale was used to represent 5in. gauge live steam, with Z working out at just a little larger than $\frac{1}{2}$ in. typical of "real" LGB garden railway stock.

March sees the Scottish Motor Cycle show at Ingliston, covering all shades of powered two wheelers from vintage classics to the most modern exotic machinery. Once again, both the Matchless and the Carfield, restored by local enthusiast Alex Gray (see MEW issue 93) were entered by their new owner. On arrival in the classics hall we were delighted to see the rosettes attached to both bikes, indicating that each machine had indeed again won its class. The overall best in show was awarded to the 1937 Rudge Ulster impeccably restored by Mr. A. Easton.

Outside, amusements for all the family, included helicopter flights, and for those really determined to recapture lost youth, a mini bike circuit.

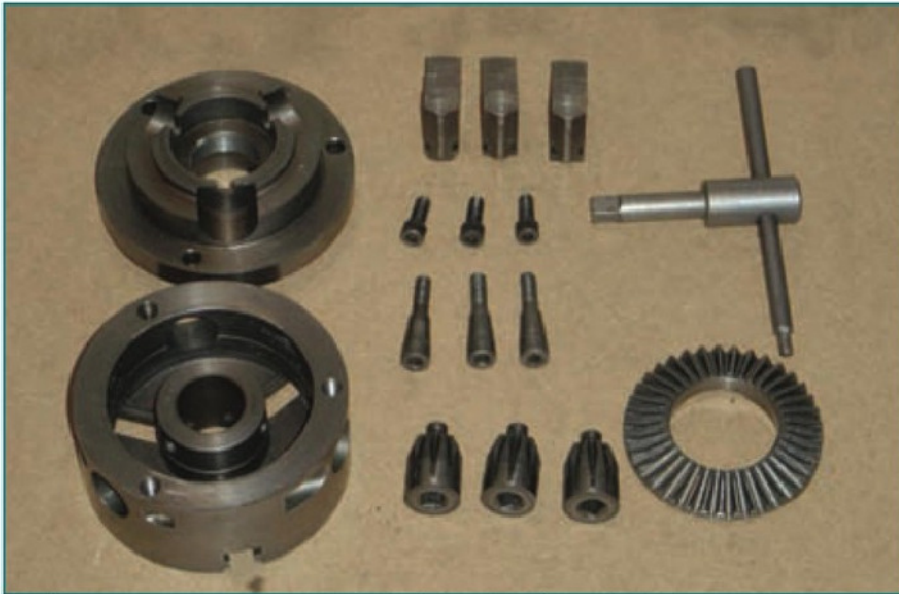


"0" gauge model of the GT3 locomotive.



Mr A Easton's Rudge Ulster won "Best in Show"

GETTING TO GRIPS WITH A GRIPTRU



1. All the components separated; the body is a loose fit on the backplate register.

Accuracy in context

Many years ago Burnerd chucks introduced an ingenious method of centring 3 and 6 jaw geared scroll chucks, with the claim that repeatability could be achieved to within 0.0002 in., thereby rivalling the best which could be attained using a collet. Let us take a step back for a moment to consider the significance of "two tenth" accuracy. In normal turning work on a centre lathe, vagaries of surface finish, temperature effects and lack of homogeneity of the raw material can easily lead to irregularities of this order. On the other hand, rolling contact bearings are made to standards of concentricity an order of magnitude better than this. Looking at the original test certificate for my Colchester Student lathe, the print-out from the "Talyrond" circular comparator illustrates that the makers achieved a figure better than 0.0001 in. total run-out from the mandrel when new. So don't think that there is such a thing as perfect concentricity in engineering artefacts.



2. Simple mandrel thread cleaning tool made from old coat hanger.

Traditional fitting

The traditional self-centring chuck fits to the mandrel either by means of a screw thread, or a Camlock fitting. Let us focus on the Myford screwed body arrangement, in which the backplate screws onto the mandrel and forms an integral part of the chuck, thereby reducing overhang and improving both rigidity and concentricity. Until the adoption of the large-bore spindle in the last few years, a 4 in. screwed body chuck was standard issue with new lathes. The accuracy achieved by these standard items was very good when new, the change to Polish manufacture not diminishing their performance, although I do grumble to myself from time to time about the relatively small bore through the body itself.

Perceived wisdom is that a register on the backplate forms an interference fit within the body. When the two are bolted together the joint line is virtually invisible and to strip down for cleaning, a smart knock with a soft mallet is needed to release the joint.

Enter the Griptru

In this design, a small amount of radial "adjustment" of the position of the body relative to the backplate is allowed, the position being controlled by three adjusting screws. The body is machined to a clearance over the spigot on the backplate. Rather surprisingly, I think, that clearance measures 0.016 in. on the example which is used for the photographs. I actually have two Griptru chucks, one (seen in bits) from an old lathe and my "Sunday best", which only comes

Derek (D.A.G.) Brown discusses the internal workings and adjusting for optimum concentricity.

out when the job justifies it! Let us strip down the mechanism and discover its workings:

1. Unwind and remove the jaws in the usual way.
2. Unscrew the three additional *fine adjusting screws* using the hexagon extension on the end of the chuck key.
3. Remove the three socket head screws holding the backplate to the body.
4. Separate the body, laying it on its front face. Remove the three pinions from their sockets.
5. Upturn the body and gently tap out the scroll.

The whole thing may now be cleaned, removing any small particles of swarf and other detritus, using either cotton cloth or absorbent paper. Here I must digress with a little story concerning one of the all time giants of Model Engineering. We went to lunch with Cherry Hill and her husband one day; after the meal my wife, being of a tidy and helpful nature, started to clear the table, bundling up the paper napkins to put in the waste bin. "Just a minute", said Cherry; if those are clean they will make ideal workshop wipers, particularly for jobs such as paint preparation which requires lint-free material. Lesson learnt, and ever since then I have had a polythene bag marked *Cherry Hills* hanging on the end of my lathe! It gets replenished whenever the occasion arises and the paper napkins are safe alongside rotating machinery, since they become torn if pulled too hard.

The clean components may be lightly oiled using slideway oil and reassembled in the reverse order to that above. Do not nip up any of the screws, but place the chuck on the Mandrel thread, taking extra care that things are scrupulously clean. Always wipe the surfaces before offering up a chuck and make sure that the female thread is clear, using a primitive scraper such as that shown in the photograph. I made mine from a wire coat hanger nearly fifty years ago and it is still not worn out!

Tighten the three cap screws loosely (if that is not Chinese), but with a light tap with a soft mallet make sure that the body will move relatively to the backplate. Close the jaws firmly on a piece of ground steel stock: ½ in. dia. silver steel for instance, which has been centre-less ground, is sufficiently accurate for our purpose. Make sure that you choose and use only one particular pinion to operate the chuck (say that adjacent to the maker's mark). This is because there is clearance between the

scroll and the body; the action of the chuck key on the scroll gives rise to a reaction between the scroll and the body which closes the gap at one particular position. I have often wondered why the makers of these critical chucks provide more than one pinion; some high precision toolroom chucks do in fact have only one.

We shall now centre the chuck body on its backplate, with reference to a dial gauge mounted on the cross-slide. Bring up the three *fine adjusting screws* until you can just feel resistance near the end of their travel. Note that if a screw is tightened, the taper on the screw causes the body to move towards it, so with the other two not quite tight, tighten the screw nearest the minimum reading on the dial gauge. A little practice soon brings the assembly into range and you should aim to finish with a concentric setting, and all three screws tight. Finally tighten the three socket cap screws and re-check for concentricity.

Strictly speaking the setting that you have just made is relevant to only that diameter, but resetting the chuck jaws using the favoured pinion should give the recognised concentricity performance. For other (widely different) diameters you may need to repeat the performance above with the Allen key and chuck key. Never forget, however, that in order to tighten one of the *fine adjusting screws*, the other two must be slightly slack.

There is one final check to be made: note the concentricity of the ground bar which is being gripped, say 3 in. from the chuck. In my experience you may discover a run-out, due to the failure of the body to seat truly to the backplate. Undo the *fine adjusting*



3. Alignment for concentricity: tightening the fine adjusting screw in the position shown throws the chuck body away from the dial gauge.

screws, remove the body and take the smallest possible facing cut across the bolting face of the backplate and a similar small amount across the narrow face which restrains the scroll; it is surprising just how

often such a correction is required, but it is analogous to the fitting of a conventional chuck to its backplate. Reassembly and adjustment now ought to lead to perfection.



IN OUR NEXT ISSUE

Coming up in Issue No. 107 will be

Drilling Holes in the Right Place

Bob Loader discusses techniques for accurate drilling.



Indexing Handwheel for Myford Lathes

A modification for added convenience from Maurice Cunningham



Kinematically Mounted Indicator Stand for a South Bend Lathe

Jim Wright describes his device which combines removability with repeatability.

A Copying Attachment for the Warco 300/2 Lathe/Mill

Alan Barrett gives details of an accessory originally conceived for making chess pieces.



Issue on sale 17th June 2005

(Contents may be subject to change)

Richard Bartlett continues his description of this "Intelligent DRO" system, extending towards a form of manually controlled CNC

What follows is not essential reading for the user of the system as described thus far, but Mode 3 does offer an opportunity to link your CAD data directly (well, almost) into the sequence of machine movements needed to produce the job, and to present these moves as a succession of targets on the screen. Consequently, a Mode 3 Compuguide .ROD file is very much like the .CON files needed for computer controlled operation (CNC) but relies on you to turn the machine handles, one at a time, whilst watching the screen targets.

Machining to CAD data

When a CAD program saves your drawing data as a .PLT file it uses a data format which was developed for driving pen plotters. Historically, the industry standard plotters were made almost exclusively by Hewlett Packard and are very precise 2-D machines. The data inputs for these plotters was to a format specified by HP as the 'Hewlett Packard Graphical Language' usually referred to as HPGL data.

As the output drawing was almost always for the attention of people, the resolution of the plotting had to be consistent with our ability to recognise for example, circles from polygons. To engineers used to looking at drawings a 72-sided polygon of about 4inches AF looks circular, so it is clearly a waste of money to process the data to draw 1000 sided polygons to represent circles. Working within these limitations, which particularly affect arcs and circles, it is very convenient to use the 2-D plotter data contained in HPGL .PLT files as a cost effective source of accurate positional data for our .ROD files since many CAD programs have the built in ability to produce it. Plot files are text files containing XY co-ordinates in the form: PAxxx,yyy; where the P signifies 'Plot' or 'move to', the A stands for Absolute dimensions, the digits up to the comma are the X-axis units and the following digits up to the semicolon are the Y-axis units.

PA123,456; is the HPGL command to 'Move to ABSolute units 123 in X and 456 in Y' When plotting or CNC machining these moves are made with linear interpolation, that is the path along the move is an oblique line. When Compuguiding these manual moves are made as two orthogonal moves due to our inability to synchronise both handles. For this and other reasons it is more convenient to use RELative units in Compuguide files. These are defined by the PRxxx,yyy; format as in PR123,456; The moves are made relative to the current XY position.

DraftChoice is a low cost CAD programme very suitable for this sort of application which saves all plot files in

ABSolute dimensions with units based on inches. (See Note 1 later) A plot file saved from CAD in ABSolute units which will contain dimensions in PAs can be converted to relative dimensions (PRs) by the Compuguide utility RELATIVE.exe. Some other CAD programs can write their plot files directly in RELative dimensions.

Another HPGL command that is of interest to us here is the 'Select Pen Number n' in the format SPn; This is a convenient file marker associating a block of data with a drawing layer.

HPGL commands that are always generated but unused here are the pen control commands PU; for PenUp and PD; for Pen Down.

For example:

The plot data SP2;PD; PA100,100; PA5100,100; PA5100,5100; PA100,5100; PA100,100; PU; when the CAD units were set to thous of an inch, would command the moving around a 5inch square whose bottom left corner was set at 0.1inchX and 0.1inchY, and the SP2 reminds us that this data defines lines on Layer 2 of our cad drawing.

It really is this simple, and this is all we need to know to combine our CAD generated plot files with the **Mode 3** facility of CompUguide.

Mode 3: Using the programmable functions

At its simplest this can be thought of as the 'Virtual Drill Jig' mode. Any job can be broken down into a list of moves to target positions.

Any position can be defined by a set of co-ordinates for each active axis. In a 4-axis system such as Compuguide, the ordinate quads would be of the form: x12, y34, z56, r78 this statement defines a specific point in 4-D space (see note 4) in RELative units.

Note, the ordinates in a Compuguide command line do not have to appear in this order and null values are not required for unaltered ordinates. Also note, we can only have one command per line in a .ROD program file.

So, a list or program of these co-ordinates can be written to provide the end points or targets for each sequential movement of the axes. a program consisting of a few orthogonal moves can be typed straight into the EDIT window from a list worked out from a sketch on the back of an envelope, but it is more likely that jobs which merit the effort of programming will need to be drawn in CAD.

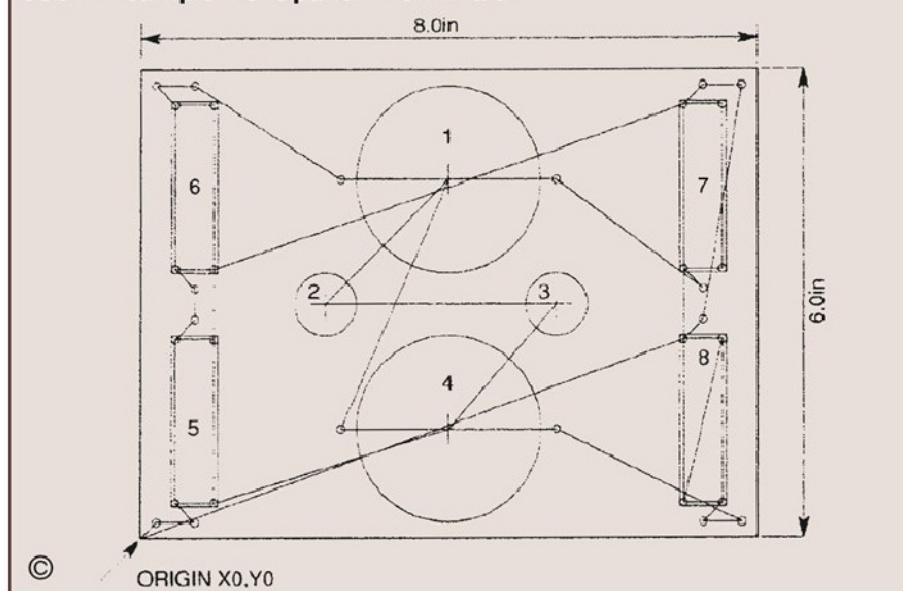
First example

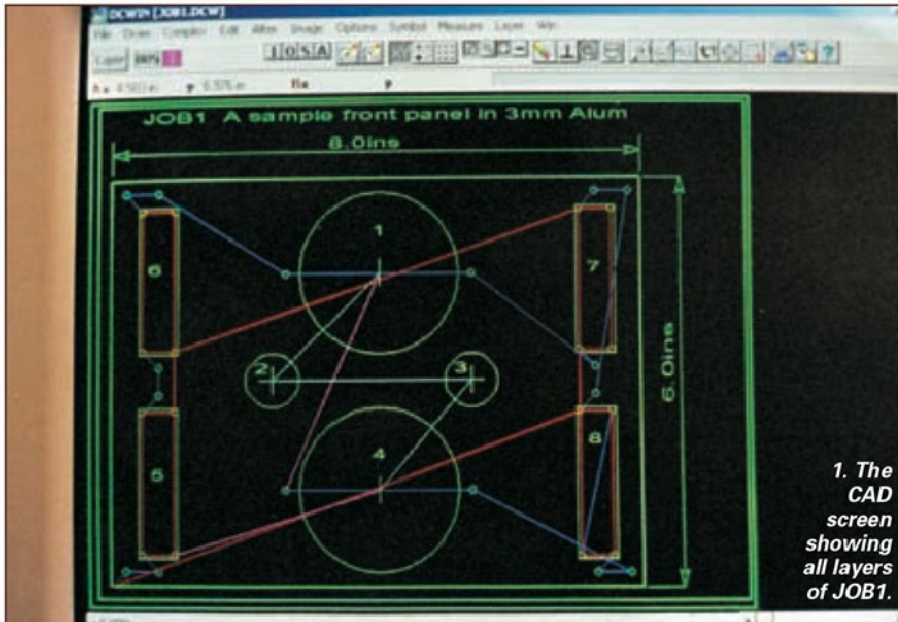
In the example illustrated, **JOB1** is drawn in any CAD program that will produce a 'plot' file in standard HPGL format. The screen shot is of DraftChoice, a cheap CAD program (available as shareware) and an adequate introduction to CAD if you haven't tried it.

This hypothetical job is a simple panel in 1/8in. aluminium of 8in. by 6in. containing two large circular cutouts for meters, each with two clamping holes, two smaller circular cutouts, four rectangular cutouts and a dozen fixing holes. The work datum is the bottom left corner of the panel and the drawing scale is set to give plotter units in thous of inches, ie 3000 = 3inches.

Select as coarse a 'Snap' mode as

Job1. A sample front panel in 3mm alum





possible, unless the apertures / hole centres are critically sized I usually snap to a 50thou grid.

The full drawing with all text and construction lines is drawn in green on Layer 1, which at plot time would be plotted with Pen1. Any output associated with Layer 1 can then be found in the plot file because it is prefixed by the command SP1; signifying 'Select pen 1'.

When cutting rectangular cutouts, I drill out all corner radii prior to fitting the routing cutter. Draw the centres of these corner drillings compensating for cutter radius towards the inside of the cutout. Check Layer 1 and make sure that it is complete.

Plan for cutting

The sequence needs to be traced on Layer 2 onwards in the order in which you will make the cuts. The four circles will be 'chain drilled' using the 'B' macro with a 50% overlapping pattern using an end-cutting or plunging router or milling cutter. I think a gently 'scaloped' circle is quite acceptable when hidden under a meter bezel, but if you like rounder holes then use a 75% overlap. Select the drill and router bit to be as large as will give adequate clearance in the corners of the rectangular cutouts. I chose 5mm diameter.

Layer 2: Drilling with 5mm stub drill, starting in bottom left corner. For panel work 5mm equates to 200thou allowing easy 'snapping'. Choose a POLYLINE from the COMPLEX menu. A complex line is stored as a succession of end points whereas a LINE selected from the DRAW menu is stored as start and end points which duplicates our data. From the work datum move round the work clicking on each centre in order of drilling, remembering not to click on the centres of the four circles as these do not need drilling.

Layer 3: Select Polyline and starting at the centre of circle 1 click on the centres of the four circles in order 1,2,3 and 4.

Layer 4: Select Polyline and start at the bottom right corner of rectangle 5 moving clockwise to click on each corner, terminate the line when the rectangle is

complete. I cut 1/2 alum in two cuts, so start a new polyline and click around the rectangle once more, terminate the line at the completion.

Repeat this process of digitising the two successive cuts around each of the rectangles 6,7 and 8. Finally, trace a Polyline from the end of rectangle 8 back to the work datum.

That's it. You have stored many pairs of XY ordinates in memory representing the cutter path for Drilling and Routing. SAVE AS the file as a drawing file (JOB1.dwg) and then EXPORT the drawing as a plot file (JOB1.plt). The plot file is a text file, so can be read or edited in any text editor such as EDIT, NOTEPAD, WORDPAD etc.

Start WordPad and Open the Job1.plt file.

These plot files are a list of 2-D plotter commands typically of the form PA123,4567; which is an instruction to move 123 units in X and 4567 units in Y. The dimensions are in ABSolute form (PA means plot ABSolute) referenced from the bottom left corner of the drawing.

Find the SP2; command which points to the start of our Layer 2 drilling data. Delete all SP1 data above it.

Edit in a new first line starting with REM (for remark), REM lines do not do anything but they are useful as reminders, so type: REM Job1.rod needs 8ins * 6ins of 1/2 Alum

Make sure that the last line of the file is SP0; which is taken as the 'end of file' marker and then Save the file as JOB1B.txt (The B signifies the second file in the sequence).

Use RELATIVE.exe to convert the ABSolute file JOB1B.txt to a RELative file JOB1C.rel.

Import the JOB1C.rel file into WordPad and remove all " " (quotes) characters.

We now edit the HPGL PR123,456; PR789,987; multi-statement lines to COMPUGUIDE x123,y456 single statement format.

Use the 'Replace' routine from the EDIT menu to change all PA to x and all commas to .y.

Remove all PU; and PD; commands and remove all semicolons, finally locate the cursor at the left of each x character and press Enter. This will insert a 'carriage return + line feed' giving the single

statement lines that we need.

Use the Find routine in the Edit menu to locate each occurrence of 'SP' and insert a blank line after each SPn; by pressing Enter.

These 'Select Pen' commands indicate which blocks of data are associated with our machining operations. Remember Layer 2 (SP2) was Drilling, Layer 3 (SP3) Chain drilling the circles and Layer 4 (SP4) was Routing rectangles.

The data following SP3 will be the centres of the circles in 1,2,3,4 order.

The 'B' command allows us to put any number of holes around a PCD so, using a 5mm cutter, 2.150inch (55mm) PCD for the larger circles and 50% overlap we need $(PI * 55 / 5) * 2$ holes which gives 69 holes.

The smaller circles of 0.6inch (15mm) PCD will need $(PI * 15 / 5) * 2 = 19$ holes

The Compuguide command B p2.15,h69,a0 will generate the data to display targets at run time to chain drill the larger circles (1 and 4) and return to the centre.

B p0.6,h19,a0 will generate the targets for the smaller circles (2 and 3)

Edit these 'B' commands into the SP3 data block following each 'move to centre'

Move the cursor to SP3 which is the start of the end cutting operations and add: 'Change to 5mm endcutting tool'

At run time the "Change to 5mm endcutting tool" will display on the screen and the program will pause until the user clicks on OK indicating that they are ready to proceed.

Change SP0; the 'end of file' maker to END.

Finally, Save this file as JOB1D.rod in the Compuguide folder from where it can be loaded by the COMPUGUIDE program.

To recap on the files used:

JOB1.dwg	The drawing program file where the job was created
JOB1.plt	The plot file in which are stored the ABSolute dimensions using SPn; PAx,y; PU; PD; commands
JOB1B.txt	The edited plot file ending with SP0;
JOB1C.rel	Plot file converted to RELative units (PRx,y;)
JOB1D.rod	File edited into Compuguide syntax x123,y456 .ROD because in time BC (Before Curtis) all transducers were RODentsClamp the panel blank onto some suitable backing such as hardboard etc. and set the spindle above X0,Y0.

Run COMPUGUIDE and select OPTIONS from the menu on the right of the screen.

Enable channel 1 as COM1 using a SCALE input to display on X with a SCALE of 0.001 with units of INCHES.

Enable channel 2 as COM1 using a SCALE input to display on Y with a SCALE of 0.001 with UNITS of INCHES.

If you have a third scale fitted, although optional for this example it would be useful as a depth gauge, enable this as channel 3 using a SCALE input to display on Z with a SCALE of 0.001 with UNITS of INCHES.

Store these settings, and click on 'LOAD a PROGRAM' from the right hand menu and select JOB1D.ROD. This will display in the EDIT window.

Start the cutter and click on START or

TABLE 1

REM JOB1D.ROD

S FIT 5MM CNC SPOTTING DRILL
AND SET TO WORK DATUMS DRILL THRO' AT ALL POSITIONS
UNTIL NEXT SCREENx 200, y 200
x 500, y 0
x-250, y 250
x 500, y 0
x 0, y 2100
x-500, y 0**TABLE 1** showing the initial remarks
and first six coordinates for hole
positions

use CNTL 'T' to start.

Clicking on the STEP button or using the
CNTL 'S' will step on one program line at a
time.

Each time a new pair of targets appear the SIGN of the move is noted. This has been reversed by the program to allow the user to drive the display to zero, then if required drive the other axis to zero. With 0X and 0Y displayed drill the hole then click on STEP, and the next set of targets will appear and ... Well, I guess you know the rest. Table 1 shows the first few lines of the program, giving the opening remarks and the coordinate information for the first half dozen holes. Later sections of the program, which guides to around 70 positions, deal with chain drilling the circles and clearing the rectangular cutouts. Clearly if this were to be done by more conventional means, there would be many opportunities for error.

Second example

It is possible to digitise an existing component using a cheap digitising tablet.

They come in all sizes from small at 150mm * 100mm through A4, A3 onto more expensive models. Currently, the A4 tablet seems a good cost/size buy. They fit into the USB or serial port and have both a mouse type puck and a pen stylus.

Follow the instructions on the installation disk for the tablet, and check that it duplicates the usual mouse functions in your CAD program.

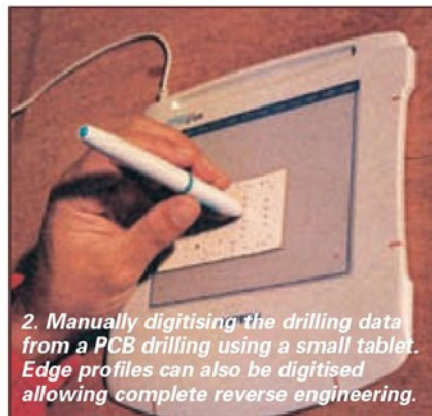
The photo shows a small tablet & pen being used to locate and save the centres of a series of holes in a printed circuit board.

Select two holes on the board that are far apart. Measure the XY co-ordinates of one hole from the other, Note these as TEXTX, TESTY.

Mount the pcb down on the tablet as square to the axes of the hole grid as possible. A thin card 'angle plate' will locate the edges of the pcb and will allow sticking down with double sided tape without spoiling the melanex type sheet of the tablet surface. The card fixture will be set square using the Pen stylus to return constant values along both X and Y axes in a similar way to 'clocking' the vice true.

Turn off the SNAP to grid feature.

Select a LINE from the DRAW menu and START the line at the bottom left of the pcb X0,Y0. Holding the pen vertically allow



2. Manually digitising the drilling data from a PCB drilling using a small tablet. Edge profiles can also be digitised allowing complete reverse engineering.

the nib to engage in the first hole. Move the pen vertically downwards to click with an equivalent to a 'left click' on the mouse. Move the pen to engage with the second hole and note the RELative co-ordinates on screen, they should be TESTX, TESTY. If not then reconfigure the scale values or correct for squareness on the tablet etc.

Now terminate the line and select POLYLINE from the COMPLEX menu. Introduce the nib of the pen vertically into each hole in turn and press the pen vertically downwards to record the centre position. Work around the board in the order that you wish to drill. Terminate the polyline at the end of the sequence. Save the drawing as a native drawing file .DCW and a plot file .PLT.

The plot file can be converted to RELative dimensions and then edited to add the Screen prompts for Z-axis moves, cutter changes etc, then saved as a .ROD file.

Hopefully these examples give a glimpse of the possibilities provided by a modest computer, interfaced to cheap X and Y scales fitted to your centre lathe with a quick-change toolpost, offering easy and accurate programming via a list of end points.

The thing is, what would we call such a hi-tech lathe? ... Supa lathe? Hang on, I've got it, how about Capstan lathe? That's a good new name for such a cool, new tool. OK, it would seem that we haven't broken much new ground here, we are still working to 'virtual stops', although with the advantage that the settings of all stops for a particular job are conveniently saved in memory waiting to be reset at the press of three buttons.

What might have been new ground for some readers is that a simple, by which I mean inexpensive and easy to learn, CAD program running on a fairly modest computer can provide instant access to all dimensions of any component that we have drawn. With only a little practice, and helped by the SPn; commands, any feature of the work can be traced to a short block of HPGL plot code giving the XY co-ordinates of each point along the cutter path in thou units.

PA 4000,2000; it doesn't take long to relate this code (assume current position is X2000 Y2000) to "Move 2 inches in X" assuming imperial units, or to "Move 20mm in X" if metric units are used.

To recap on mode 3 use:

- Draw the component to scale in 2-D cad
- Save a plot file of the cutter paths in absolute PA543,789; format
- Edit the .PLT file to a relative

dimensioned .ROD file in x543, y789 format

- Run CompUguide and load the .ROD file
- Set the OPTIONS to suit your machine and input devices
- STEP through the program, driving each pair of ordinates to zero

Once this basic level of familiarity has been reached you might be ready to think about converting the new 'capstan lathe' to an auto by fitting stepping motors to the leadscrews.

There is nothing more to generating a 2-D control file for computer controlled operation than creating a .ROD file for computer guided operation for jobs of similar complexity. The big plus for the auto machine is the ability to profile by driving two or three axes synchronously.

Note 1: For users requiring plot files in metric units of 1/100mm as well as 1/1000 inches, try the CAD program '2-D Design Tools' which can be configured for either.

Note 2: To define a point uniquely in Compuguide 4-D syntax we should state the scale and linear or rotary status of the axes. This is done automatically when the .ROD file is saved for future use. Do not assume that the 'R' axis is always rotary, as any channel can be either linear or rotary.



CAD Suppliers

There are dozens of programs available as free downloads for trial use. All require an investment in time and mental effort which varies with the facilities they offer. I have bought and use the programs below and find a & b very adequate for homeshop use and easy to learn.

'DraftChoice for Windows'

(USA product) Fully working program is available as 'Shareware' (try-before-you-buy) from: Public Domain and Shareware Library Tel 01892 663298 www.pdsl.com

'2-D Design Tools'

2-D CAD from TechSoft (UK product) Tel 01745 535007 www.techsoftuk.co.uk

A 'non-saving' demo is available for download to assess the program's facilities. This program is used widely throughout UK schools and consequently has been made easy to learn. It is just possible your grandchild could help out here with the 'keyboard skills'

'AUTO-CAD' (from AutoDesk USA)

This is not a cheap program for hobby use but is one of the industry standards for CAD programming. ACAD has the unique advantage that many colleges who offer part time evening tuition for engineers teach with this program. Courses are available at all levels of programming skill and those who like to assimilate their knowledge in a structured way can buy legal 'student copies' of the ACAD program at discounted rates to practise the college lessons at home. Needless to say, at 2-D level ACAD does it all.

INDEX FOR ISSUES 93 TO 104 OF MEW

The information contained in this index supplements that published in issue 95, and brings the information up to issue 104. A computer based index is also available for those with suitable equipment to run the software.

SUBJECT INDEX

This section is arranged by Subject, listing Articles, Quick tips, and letters to Scribe a Line. The key to the letters in the second and seventh columns is given at the end of the table. Columns five and six, e.g. 95 37 refer to the particular issue and page number.

Key to the Symbols used in the above section of the index
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Column 7 A=Article; T=Trade; L=Letter; Q=Quick tip; S=Subject

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MODEL ENGINEER'S WORKSHOP INDEX CROSS REFERENCE LIST

This list indicates subsequent references to earlier items in the form of a letter, post script or correction.

The columns are Issue No. containing the original item and its Page No. then the type of item A=Article, L=Letter, These are followed by the subsequent reference, together with its Issue No. and Page No.

To use the list, look up the Issue No. and Page No. of the item you are studying to see if there has been any further data. As there may be more than one letter to a page, the cross reference may refer to another letter on the same page. This list covers Issues 81 to 96 as letters and updates can occur many issues after the initial item.

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MODEL ENGINEERS' WORKSHOP PUBLICATION DATES

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6 August/September 1991	28 March/April 1995	53 October 1998	79 January 2002
7 October/November 1991	29 May/June 1995	54 November 1998	80 February/March 2002
8 December 1991/January 1992	30 July/August 1995	55 December 1998	81 April 2002
9 February/March 1992	31 September/October 1995	56 February 1999	82 May/June 2002
10 April/May 1992	32 November/December 1995	57 April 1999	83 July 2002
11 June/July 1992	33 January/February 1996	58 June 1999	84 August/September 2002
12 August/September 1992	34 March/April 1996	59 July 1999	85 October 2002
13 October/November 1992	35 May/June 1996	60 August 1999	86 November 2002
14 December 1992/January 1993	36 July/August 1996	61 October 1999	87 December 2002/January 2003
15 February/March 1993	37 September/October 1996	62 October/November 1999	88 February/March 2003
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24 July/August 1994	47 December 1997	71 January/February 2001	97 April 2004
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26 November/December 1994	49 March 1998	73 May 2001	99 July 2004
27 January/February 1995	50 May 1998	74 June 2001	100 August/September 2004
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	52 September 1998	76 September 2001	102 November 2004
		77 October 2001	103 December 2004/January 2005
		78 November/December 2001	104 February/March 2005

MODEL ENGINEERS' WORKSHOP COMPUTERISED AND INTERNET INDEXES

As noted in Trade Counter, the computer based index is available from CAHW. It is supplied in DOS format on two floppy discs with a full manual. Facilities are included to VIEW, SEARCH, SORT, EDIT, UPDATE, and PRINT. Cost is just £10.00 and non UK orders should add £2.00 carriage. CAHW are at: 61 Winchelsea Close, Hardwick, Banbury, Oxon. OX16 1XS
Readers with internet access may wish to examine Colin Usher's web site for model engineers which contains, inter alia, an index for MEW in Excel format.

TRADE COUNTER

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

Ten year warranty

Yes believe it, George Newton of Newton Tesla (Electric Drives) Ltd, has announced that the warranty of their successful lathe and milling machine speed controllers has been increased to an amazing ten years. "This is an indication of the great reliability and toughness of the Mitsubishi Electric inverters used at the heart of our speed controllers and our confidence in our product longevity" George says. "Buying an inverter system for your lathe is an investment and this ten year warranty will give the purchaser great peace of mind that it will give a long and trouble free service without any expensive repair bills." he added.

The extended warranty applies to the Mitsubishi inverter whilst the motor has a standard one year warranty. Conditions apply, details on request. **For further information and details phone Newton Tesla on 01925 444773, email to Info@Newton-Tesla.com**



Boost Energy

Boost Energy the well known manufacturers of single to three phase converters have recently launched a web site that accepts on-line sales and includes transportation rates for almost all the world (see www.boost-energy.com). The director David Sharman says, "We are pleased to be bucking the trend in British manufacturing industry and our hard work is paying off with global export sales now forming a substantial chunk of our turnover. The new website allows us to cost-effectively serve clients in other languages, such as Spanish and Russian". The web site includes a link to the well respected site operated by Colin Usher which contains much to interest model and amateur engineers

Carrs & C+L Finescale

These are associated businesses run by Brian Lewis, who has for many years, been closely involved with model railway supplies. I had contacted Brian after receiving the letter from Colin Usher (see Scribe a Line). The Carrs side of the business specialises in the supply of soft solders, fluxes, and associated materials and tools. The range of low temperature solders start at 70 deg.C, with others having melting temps. of 138, 145, 179, 188, 224, and 243deg. No fewer than seven fluxes are stocked, each with particular suitability for specific materials and working temperatures. For anyone whose knowledge of soft soldering is about as superficial as mine, an extremely informative 32 page soldering handbook is offered, which comes with a full product catalogue for £2.75. **Carrs & C+L Finescale can be contacted by phone on 01275 852 027 or by post to Longridge House, Cadbury Camp Lane, Clapton in Gordano, Bristol BS20 7SD. Additional information is available on their website: www.finescale.org.uk.**

MEW Index

Historically the indexes published with MEW were produced by former editor Harold Hall. Some time ago, Harold indicated his wish to wind down a little in retirement and pass on this activity. This has now taken place, and the computer based index (for which the update information appears in the centre pages of this issue) is now prepared by Barry Chamberlain. **Copies of the complete index which comes on two floppy discs with a full manual can be obtained from CAHW, 61 Winchelsea Close, Hardwick, Banbury, Oxon, OX16 1 XS. Price for the package is £10.00 which includes UK postage. Those ordering from outside the UK should add £2.00 to cover carriage.**

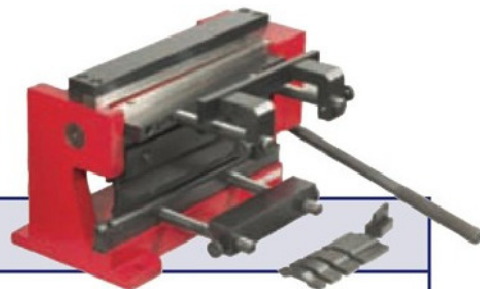
Hemingway Kits

Dick Stephen's article elsewhere in this issue describes the construction of the latest addition to the Hemingway range, the centering microscope. This is one of those devices where it would be very tempting to consider construction from the scrap box, but to it would require a most capacious box to include the various optical components. Indeed even to purchase these items would require a good bit of supplier research and then probably be costly on a one off basis. The kit, which contains all the materials required together with A3 drawings and instructions costs £84-45. So, not an ultra cheap item, but one offering the opportunity to create a piece of precision workshop optical equipment which would not only be an extremely useful accessory, but also compete with professional devices costing probably several hundred pounds. **Hemingway can be contacted by phone on 01746 767 739, or at 126 Dunval Road, Bridgenorth, Shropshire, WV16 4LZ**

Coming Soon from Arc Euro Trade

Arriving around the third week in May, a new 8in. Mini Shear Brake will be available from Arc Euro Trade. The device will shear or bend sheet materials e.g. aluminium up to 1.8mm up to a maximum length of 7.875in. The bending action operates on the same geometric principle as a full size industrial press brake, employing a top tool, which is forced down into one of two sizes of vee, formed in the bottom tool. Several short top tools are also included. These can be assembled to specific lengths to cater for second op. bending of boxes. Stops or fences are built in, and these will give consistent results when undertaking repeat bending.

The price for the tool has been set at £98.00 plus £15.00 UK carriage, including VAT. Arc Euro Trade can be contacted by phone on 0116 269 5693 or at 10 Archdale St. Syston, Leicester.



TIG WELDING OF ALUMINIUM ALLOYS IN THE HOME WORKSHOP



1. The controls and connections panel on the front of a typical AC/DC set. You will soon figure out what the glyphs mean, but figuring out the optimum settings for different procedures, different thickness of material and different weld types takes far longer.

In earlier articles, I described the considerable benefits and pleasure to be derived from Tungsten, Inert Gas ("TIG") welding in your home workshop. I described how, with a set costing in total about £500, you will be able to do beautiful welds in mild and structural steels, in most types of stainless, and in many other common metals. You might even venture into the quasi-exotics such as titanium and zirconium if you stringently exclude air from every warm surface. Where you will not be very successful is in your efforts to make satisfactory welds in the common light metals, aluminium and magnesium, and their alloys. The problem is that the oxides which will form on the surfaces of those weld pools will confound your best efforts to make any two pools run into one.

Fairly obviously, one way round that problem is to disperse those oxides. By moving to more sophisticated TIG welding sets, such dispersal becomes possible. You can, with those sets, then make welds in aluminium, magnesium and most of their alloys.

With that new capability, you might then reasonably hope to be able to recycle aluminium scrap for useful purposes, such as to make super-light structures. Or, you might hope to carry out simple repairs on alloy components, some of which might be impossible to replace, or if obtainable, can be ruinously expensive.

With such reasonable ambitions, you are not asking a lot, but it turns out that only some parts of your wish list are

practicable, for several reasons that we will come to later. A subtlety of the situation is that many of your welds that appear to merit "seems OK" will really deserve classification as "distinctly dodgy". Being aware of that risk does not do you a lot of good, because it can often not be practicably possible (in the home workshop) to tell good welds from bad welds.

As might be expected, as time goes by, your own performance will get a little better. It will be found that some of the "unsatisfactory" outcomes can be rectified by trawling other experience, by practice, and by fastidious preparation. The necessity for that total of extra effort means however that the man in the home workshop will never be able to TIG weld the light alloys with the same casual ease as he can weld mild and stainless steels. Often, an "apparently OK" outcome will only be possible by using filler material, which can be very irksome if (either for aesthetic or practical reasons) you would have preferred to make the weld without such addition. The hell of it is, that the "apparently OK" weld might then still not be fit for its intended purpose, for any of several reasons.

In the light of all these realities, we must carry out an assessment of value for your hard-earned money, the weighing up of what you can get against the cost of getting it. The sophisticated sets that are necessary for the aluminium and magnesium alloys cost something like four or more times what you might pay for the

Trevor Marlow assesses the desirability of this, more specialised, process.

simpler machines, those which are, remember, quite sufficient for mild steels, stainless steels, and much else. We should not quibble at the extra cost if the investment paid appropriate dividends, such as allowing useful recycling, totally useful fabrications, and truly useful repairs, repairs with better than a cosmetic value. Equally, if on close examination we find that we do not get such dividends, we then surely must question if the expenditure is justified.

Some details for all of these factors are given below. After providing those details, I will then suggest to you that the ability to TIG weld aluminium, magnesium and their alloys does not for home workshop purposes normally warrant the considerable investments in time and money. Just possibly, your own circumstances and priorities might dictate that the investment is warranted, in which case this article will serve to give you early warning about the problems, and will offer you the solace that those problems are not entirely due to your lack of manipulative skill. It will also point you towards such remedies as are available. Whichever applies, whether you choose to leave well alone or to take the big plunge, I think you might find the welding of the light alloys a quite fascinating topic!

Money well spent, or thrown away?

The DC TIG sets, the subject of earlier articles, are available at fairly affordable prices, a middle of the range machine being about £500 when you have added on the cost of a torch. By comparison, the AC/DC TIG sets are rather unaffordable, the final figure (with foot operated current controller, good quality torch etc.) being from about £2000 up to several times that figure. If during the purchase phase we remain mindful that the special value of the AC machine is primarily to enable welding of aluminium and magnesium, we then recognise that the high values of thermal conductivity of those metals means that it is not a good idea to settle for the lowest amperage machines. So, just for once, there is a good reason not to buy the cheapest.

There is now a multitude of DC sets on the market, offered for the most part at relatively fixed (i.e., non-negotiable) prices. In contrast, there are far fewer AC sets on the market. If you choose to contemplate purchase of one of the latter, it warrants

LUMINIUM AND ITS ME WORKSHOP (1)



2. If you are going to do lots of trial welds, you will need lots of rectangular sections. This simple little tool makes life so much easier when you are manhandling those big (2.5M x 1.25M) sheets of raw material. Made from heavy gauge wire or rod, with a bit of hose (or something similar) to spread the load where you grip it. All you do is put the hook under the centre of balance of the sheet, straighten your knees, and walk away, having the other arm across your chest to steady the top of the sheet. (Avoid strong winds if you do not have a pilot's licence.)



3. A popular torch, nicely made and sufficient for almost any task in the home workshop. The cables enter the bottom of the handgrip via a ball and socket arrangement, to provide extra flexibility. The only downside is that a thumb operated switch causes the hand to be positioned well down the handgrip, not good when you are trying to do delicate work.

your most diligent attention that the prices of those more expensive sets are usually subject to several levels of negotiation. Typically, at a first contact, the salesman will frighten you to death with a quite horrific "List Price". That figure will, often within minutes, and for all manner of reasons, tumble by a significant fraction, say by 20 to 30 percent. Finally, to secure the sale, various "goodies" may be thrown

in, such as MMA leads, packs of filler metal, a higher amperage machine at a lower amperage cost, or whatever. You will find that you save a lot of money, and much time in discussions, if you have done your homework re other availability before entering into any serious negotiations.

What do you get for all that extra cost?

Just about everything, and a little bit more, see **Photo 1**. The important thing, of course, is that you can dispel those oxides, which will otherwise prevent you from welding the aluminium alloys. However, since the cost makes them distinctly up-market, the machines allow just about every sophistication that you can imagine. Provided, that is, that you can figure out how to make appropriate settings! It does not help matters if the manual is in a foreign language (often Italian), and such translations as are provided seem to have been carried out in the local primary school.

Naturally, in course of time you do figure out what the glyphs mean, and can then start to use the machine to best advantage. Besides selection of weld modes (DC, AC, MMA), you can frequently set the rates of increase and decrease of current, the levels of current, the number of seconds that the gas flows after welding, the balance of best penetration against best oxide dispersal, and the frequency of reversal of polarity. There may be triggers to actuate any machinery that you might choose to facilitate the welding, such as allowing starting and stopping of motor-driven turntables, or whatever. If you have the time and the inclination you can automate without too much difficulty, and then you should start to reap rewards ... but primarily on steels, not necessarily reliably on aluminium, magnesium and their alloys!

Are the AC machines difficult to use?

All the bells and whistles provided by the sophisticated AC machines are at the same time both a blessing and a curse. They are great if they are set up properly, and the torch is then manipulated in a fashion appropriate to such pre-set values. However, the operative has to really know his machine before he can make a good guess at the value for each setting, and any settings that he gets



4. While it is tolerable to have many cables crossing the floor while you are welding, they need to be cleared away as soon as possible afterwards, to prevent risk of accident or damage. The usual strategy, of coiling the cables on the top surface, around the carrying handle, is not practicable if the cables are long and thick.



5. A simple shelf, with sidewalls, made from scrap material, can be made to overhang the control panel. Besides reducing the risk of accidental damage to the control panel, the shelf allows continued use of the carrying handle, and allows coiling of the many cables. With the cables tidied, the complete unit can be carried (just!) to a safe storage location. There is even room on the shelf for the foot pedal unit, packs of filler rods and so on.

wrong may well then throw his best torchwork into disarray. The situation calls for lots of investigative work and lots of discipline. By perseverance on one thickness and one weld type, it is fairly easy to derive the best settings. Those settings have then to be carefully noted before moving on to different thickness and weld types, otherwise all the good work can be wasted. If you approach the topic in a casual fashion, and do not keep records, then when you wish to go back to an earlier thickness and weld type, you

will almost certainly have forgotten the settings. One of the simplest options is to set the switches so that there is direct control of current, either at the torch or by foot pedal. Using that facility instead of the full "bells and whistles" makes it a much simpler operation, but for any particular job, you will still need to provide some setting values, such as for the current to be delivered at "full throttle". However you choose to play it, the end result is that when you are welding, your eyes and head will be processing an awful lot of information, just to tell your foot and wrist what to do!

Stand back, and what do you see...?

At this time, the situation re welding aluminium, magnesium and their alloys is, dare I suggest, not very satisfactory. Because nobody has yet marketed a better idea, the AC machine is the only obvious "TIG style" way to go for welding aluminium and magnesium and their alloys. The ability to disperse those tenacious oxides, which itself is a bit "iffy", has only been obtained at awful cost, by trading off some of the really nice things about TIG welding. That which remains is a rather sad compromise, one which is not attractive in terms of overall cost, not attractive in the need for fastidious preparation, is a nightmare re. weld integrity, seriously degrades the mechanical properties of the parent material, and could be thought quite over the top in the total of demands made on the operative.

Despite all that, there must be positives...?

The few positives are, that the AC machines at least allow you to think about trying to weld the light alloys, and the sophistication of such sets allows welding the steels etc. with far less care than is necessary with the cheaper DC machines. (For example, with the AC machines you can set the number of seconds that you wish the inert gas to continue to flow after cessation of the arc. With the cheaper DC sets you have to release the trigger gently, so that the arc stops but the gas keeps flowing, then you need to have the presence of mind to keep things like that until the electrode cools. Both methods are OK in a perfect world, but what often happens at the end of a DC welding session is that you have a blue electrode, whereas with an AC set and careful use, your electrode is no different at the end of the day to its condition when you started.)

The pleasure factor

Is there the same level of aesthetic pleasure in using an AC/DC "bells and whistles" machine on aluminium as there is in using a much cheaper DC (with controller) machine on mild steel and stainless? It must be a matter of opinion, but I suggest not. The welds in aluminium tend to be bigger, clumsy



6. Sometimes, it is possible to make reasonable autogenous (no filler) butt welds in thin (1 mm) "pure" aluminium without any "prepping" of any kind. You are perhaps more likely to make a good job on such thin stuff if you put little turn-ups on the butting edges, but the act of putting a turn-up on an edge tends to make it less straight than previously. That matters, because gap is critical.

things, the merits of which revolve around that they have been made despite the well-known difficulties. The welds in the steels, on the other hand, are made in much more forgiving circumstances, and everything is on your side. The DC welds can be teensy-weensy, beautiful things. (How teensy-weensy depends eventually on the acuity of your eyesight, as you peer through your magnifying spectacles, and the steadiness of your hand, as it rests comfortably on the supports that you have provided specially for that purpose...).

Are repaired items fit for service?

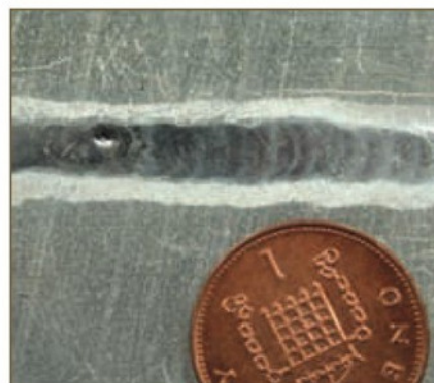
Of particular relevance to the question of investing in an AC/DC machine is the degree to which the welded objects in aluminium will then be suitable for your purposes. The ability to recycle scrap material into useful objects would be a most attractive feature, as also would be the ability to "remove" cracks from castings etc. without any hidden penalty. However, if the objects that you can make are not fully "useful", and the "removal" of cracks leaves local weakness in the castings, what then?

Let us visualise that, as an early exercise, you want to make a simple box or structure. Doesn't sound over-ambitious, does it? However, on examination of the autogenous weldability (i.e., using no filler) of materials from your scrap pile it will be found that much, or even most of it, will suffer serious solidification cracking even when there is no external restraint. That isn't the big problem, because fortunately, adding filler material that is relatively rich in silicon usually provides an easy cure for such cracking problems. So, if you can tolerate the use of the filler, you can start to think of using your scrap pile for useful purposes.

However, in one other critical respect the welded object or structure might then fail to serve your purposes. That deficiency being, that the weld and



7. Often, the only way to prevent the welds from cracking is to use a high-silicon filler material. Also, because of poor penetration, you have to "prep" the edges of all but the thinnest material, so one way or another, you have to use a fair bit of that filler. If then (as happened here) you do not have the correct thickness of filler rods to hand, it is difficult to lay down consistent deposits with straight edges. As here, you end up with welds that are free of cracks but are far from pretty or pleasing.



8. Once you get a weld running OK, normally it will continue to do so. If however you have been less than fastidious in the preparation of edges, in not getting them sufficiently straight and clean, then the poor penetration will contribute to surface tension becoming your enemy rather than your friend. In effect, the melded pool will locally revert to being two pools. Sometimes you can rectify the problem by lingering with the torch, but you then risk a big melting event.

adjacent material will usually end up being considerably softer, much less elastic and much more plastic than was the original "parent" alloy. The degree to which such weakening will be significant, and controllable, will vary from job to job. Strength derived from cold working will probably be lost for good and all. Some of the aluminium alloys can be heat treated after welding to restore the strength lost during welding, and some alloys will, over time, experience some restoration of strength without heat treatment. Such encouragement as that might offer should be tempered by recognition that usually you will not know the constitution (i.e. specification or identity) of your scrap. So, you cannot know if it will recover useful strength over

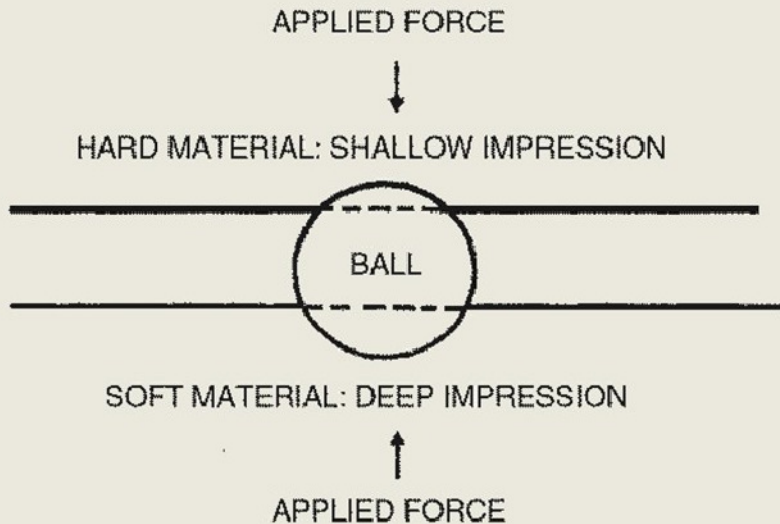


Fig. 1

time, or if there is any prospect of benefit from a heat treatment, or the details of that heat treatment.

As to the repair of components and castings, the big question is whether a cosmetic repair is entirely OK, or is a near-original strength necessary to a further service lifetime that will last more than a few minutes. It may well be relevant that a component needs repair in the first place. It might be broken for all manner of reasons, but a common reason is that that component has always had a hard life. The implications for replacing the failed component with a weaker-than-original component are obvious.

The loss of strength and elasticity near the weld suffered by the majority of aluminium alloys will either be all too obvious, or will just sit there, waiting to catch you out. One way to assess the extent and magnitude of the deterioration is to gently flex the weldment, then gently flex a similar piece of unwelded material, alternating back and forth between the two items until you get the feel (quite literally!) for the bending moments that would be required to impress a permanent deflection on each item. You will find that the heat affected material has an elastic limit comparable to warm toffee, whereas some original materials will astonish you with their elasticity and strength. *(Some alloys will fracture without taking on any obvious permanent deformation. Some are stronger than structural steels).*

There are several ways to assess the local deterioration in elasticity, if the attack of the droops does not already make it all too obvious. A spring-actuated centre punch can be quite useful, making bigger indents in softened material. Arguably, the only other way that is practicable in the home workshop is based on the olde worlde method for determination of hardness when you are far removed from the proper equipment. That method was loosely based on the familiar Brinell method for determination of hardness.

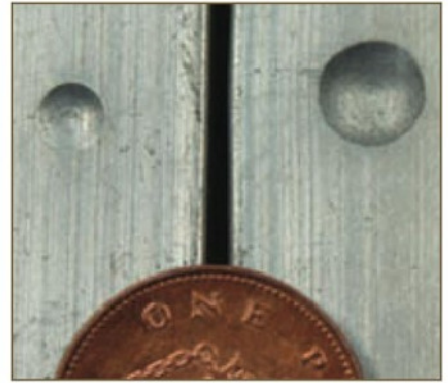
All you needed was a piece of similar material with a pre-determined (or post-determined) hardness, an appropriate ball bearing, a magnifier with measurement graticule, and (in the original method) a hammer. **Fig 1** illustrates the general arrangement.

By application of impact or compression, you caused the ball bearing to impress into the two materials. Provided via a vise, or via a slow thump from a big hammer, the indentation forces were essentially the same. Determination of the unknown hardness was possible since you knew the other hardness, you knew the diameter of the ball bearing, you could measure the diameter of each indentation, therefore you could derive the second hardness. *(Remember, if you decide to give it a try, that the Brinell value is given by: Brinell Number equals "load in kilograms divided by the curved surface area of the indentation in mm²". The curved area may be calculated from:*

$A = (\pi D/2)[D - \sqrt{D^2 - d^2}]$, where D is the ball diameter and d is the impression diameter).

The caveats applicable to Brinell Hardness testing apply, such as not testing near edges, not making indentations too close together, not having indentations too deep relative to thickness, and so on. The one thing that is clearly different between this little whimsy and pukka Brinell testing is that in pukka Brinell testing, you always apply the load slowly and gently. If in our home workshop test you apply load via a vice, you maintain that condition, whereas if you use a hammer, the loading is fleeting and, because of inertial effects and loss of opportunity for slow plastic flow, you can get results rather different from those generated by a pukka Brinell test. *(So, if the situation allows it, it is better to apply the loading via a substantial bench vice).*

As said, a test method from when Methuselah was a young lad, and not a lot of use for our current purposes.



9. On the left we have original extruded material, as delivered. On the right we have the same material, but as welded. The drastic loss of strength in the proximity of welds is illustrated by compressing a ball bearing between the two materials. The ball sinks further into the softened and weakened material. Although this original material would itself not be deemed as being particularly hard or strong, the heat affected material has lost about five eighths of that hardness and strength.

However, a simplified variant on the method can be useful. What you do in the variant method is to compress the ball between material that you have welded and a piece of the original (unwelded) material. With that arrangement, some of the figuring becomes redundant, and the **relative** hardness of the welded and unwelded materials is derived from each expression $D - \sqrt{D^2 - d^2}$. As example, the values shown in the photograph are: diameter of ball bearing 12.35 mm, diameter of impression in original material 4.45 mm, diameter of impression in welded material 7.05 mm. If you work that through you will find that the hardness of the welded material is about 37% of the hardness of the original, with the implication that the strength of the welded material is down to a similar figure. *(Note: The behaviour of the material round the edge of the indentation can be informative. If there is a raised ridge, it suggests that your*



10. If you bother to investigate the extent of weakening of parent metals due to thermal cycles, you will need a way to measure the diameter of the indentations made by the ball bearing. Both of these magnifiers, having calibrated reticules, will serve that purpose.

material may still have some cold worked properties, whereas if the material round the edge of the indentation sinks below the original surface, it suggests that you may have arrived at an annealed condition. That being said, it can however be deceptively difficult to judge whether an edge is raised or depressed. Decision is made easier if you use a powerful torch to provide illumination in grazing incidence with the surface, and/or rest a thin straight edge across the indentation ...)

...and to cap it all, no brakes!

Repairs to safety-related items are, with good reason, frowned upon. All the more reason therefore not to attempt renovations to hydraulic slave cylinders or disc callipers when, as is at times inevitable, you have broken the bleed valve. Your best efforts to remove the seized steel remnant will almost certainly destroy the threads in the alloy casting, at which point it is entirely natural to wonder whether the metal could be replaced, a new thread cut into that metal, and a new bleed valve inserted.

The material used for such castings will normally machine like a dream. After a repair, the machining characteristics of the deposit and adjacent metal are a nightmare! As a starter, it is not possible to drill a hole to an accurate size, because of the "warm toffee" characteristics of the material causing it to flow and re-adhere in chaotic fashion. Cutting accurate threads in the resultant rough-hewn tunnel then goes awry in so many ways that you may be reduced to hysterical laughter. I recollect that I was!

This example serves to make the point that when you construct or repair anything made of aluminium alloy you will generate regions that are no-go for any subsequent drilling, threading, reaming or whatever. It is a minefield that you will enter at your peril. Getting a good weld will appear to be a good start to a repair, but in reality will only mark the start of your problems.

What about when your supply of Al alloy scrap dries up?

One of the biggest attractions of an aluminium welding capability seems to be the prospect of using aluminium alloy scrap for useful purposes. In fact, the real availability of such scrap is largely illusory. You may at this time have several buckets full of all manner of extrusions, but when you come to examining the hoard in detail, you will find that almost all of it has been extruded for a special purpose, and hence has a special cross section that makes it useless for anything else. A trawl of friends and neighbours for the contents of their buckets will reveal contents that will, likewise, be largely useless. So, the reality that you discover when you start your recycling enterprise is that there is not a lot of gratis material out there, waiting for you to reclaim it. Most of it is just useless junk, cluttering up the

place and never again destined to have useful function. (Unless of course you melt it down and cast some "I've been to Bognor" badges!).

Weak metal supported by strong metal...

As said elsewhere, aluminium alloys are reduced to a fraction of their earlier strength by the temperatures experienced in material adjacent to welds. One of the strategies for minimising the consequences of that loss of strength is to keep the temperature excursions as local as possible, so that the weakened metal is supported and held in place by the stronger metals nearby. Use of that strategy in aluminium alloys is so commonly reported that there cannot be a lot wrong with the idea. The only cause for slight pause is awareness that some "weak supported by strong" situations can lead to some very odd failure phenomena, in which the weaker of the two materials will fail in a distinctly brittle fashion even though both materials, the weak and the strong, would in isolation each be deemed ductile.

In a nutshell then, which is the best TIG option for my home workshop?

Pulling it all together, I suggest that the optimum real benefit/total cost package comes from a DC machine plus home-made controller. Part of the thinking behind that statement is that often, for most purposes, aluminium can be joined very nicely either by riveting or by brazing. In particular, brazing via a propane torch is least likely to lead to a big melting catastrophe, and might well be sufficient for all your needs. (*Buy some 4043 sticks and a tub of Saffire flux. Give it a try. The trick is to take everything JUST up to the temperature where the 4043 is flowing AND NO MORE*). By all means consider the AC/DC TIG option, but recognise that it is an expensive and complicated tool that will require a more-than-usual level of attention before it produces hoped-for results on aluminium and its alloys. If you do take the plunge, you will soon manage to make a few reasonable welds, but during the practice period you will also begin to realise the many ways that everything can go pear-shaped. (*Both metaphorically and literally!*)

With the right machine, surely practice will make me perfect...?

If you are repetitively doing just one job, practice will almost certainly make you perfect if the properties of the material will allow such success, if the material is

weldable or can be made weldable. With that proviso, you will gradually evolve to the situation where all the machine settings are right, while at the same time your torch work will get better and better, and you will gradually learn all the little wrinkles that spell the difference between delight and disaster. The situation will however be very different if you are constantly faced with new tasks. You then will be faced with the problem of hitting on all the right settings, usually without any opportunity to practise. You will do much better than in your earliest efforts, because of familiarisation with the machine and the associations you realise between material thickness, weld type and welding current. Yes, your learning curves will be less protracted than previously, but curves there will be, and some failures will be beyond any hope of recovery! (*Visualise such scenarios as, for instance, an acquaintance having asked you to repair a crack in the timing cover of his early Hispano Suisa, and you are having to return it in the form of a rather ugly paper weight. You have knocked on his door, and can hear the footsteps approaching. While waiting, you have opportunity to wonder why he has earned the nickname Yosemite Sam...*).

But surely I could suss out all the machine and materials variables?

Indeed you could, but I suggest that, for non-repetitive tasks, the demands on your time might far exceed your expectations and even exceed your availability. If on the other hand you just want to do a few repetitive tasks, and frequently, then that might be another matter entirely. Also, you might be of the person type that positively revels in sorting out subtle problems. I will try to spell out the nature of those problems, and their origins.

Why such caution about investing in AC TIG?

A first reason to adopt caution follows from the mind-numbing quantity of data that makes up the topic of aluminium and its alloys: None of it is too difficult to understand, and there is system and pattern running through it all, but the time and effort required to achieve sufficient familiarity with it all must be beyond anyone not wearing an anorak. There are for instance more than 350 alloys in recent tables of the correspondence between Aluminium Association identities and the Unified Numbering System. So, if you were so lucky as to know the provenance of your material, had easy access to reference texts, and a lot of spare time, then you could find out how best to weld it and how you might recover as much parent strength as possible. However, the total of your information for a typical job in

hand might be that the metal was once part of a television aerial, or it was retrieved from a skip, or it came from old Fred's greenhouse. In other words, you can seldom know what you should be doing. *(To keep things in perspective, the range of alloy types that would come your way might be small in number, and the popular filler rods might render your cracking problems few and far between. So, although you would be working to rote, you might find that quite acceptable).*

In several ways you will find that "pure" aluminium, when welded, reverts to conditions that you will not like. As starters, the weld itself may lack integrity, as consequence to "pure" aluminium being deemed "weldable, but difficult". Over the range of constitutions that we will still call "pure aluminium", there is great variation of tendency to solidification cracking with slight changes in amounts of silicon and magnesium. If the weld turns out OK, you then will have opportunity to wonder where all the strength went. You will probably have obtained sheet in a strong and springy condition, it having been cold rolled to a "half hard" or similar condition. Your first recognition that things have changed for the worse might be that, after welding, your previously strong and springy material takes on unwanted deformations simply as a consequence of being handled. The only consolation is that you can easily reverse the deformation with unaided fingers. All the material that has seen about 150deg. C will be similarly degraded, and the hell of it is, you usually cannot recover the lost properties. Just occasionally you might be able to do something useful with a peening hammer, but usually not.

To recap: why AC for aluminium and its alloys?

The problems really start right at the beginning, from the well known property that aluminium readily forms a very tenacious oxide. That being so, the lesson from most experience in the wider world is that straightforward, conventional DC TIG welding is a non-runner. Even though the pure argon shield provides local protection, there are subtle and cumulative oxidation processes, which cause the molten pools to become increasingly isolated, until every pool of liquid metal is contained in its own little pouch of oxide. If

then any two pouches are brought together, they will remain isolated. Welding has become impossible. *(Note: Some skilled and respected welders have commented "It is possible to use DC at low currents".)*

The problems with the tenacious oxide has led, at times past, to the clever idea of simply reversing the polarity. Instead of the torch being made negative, as was usual, the torch was made positive, the earth then being negative. The benefit of that strategy was that ionised gas atoms, being positively charged, were accelerated towards the negative surface, arriving there with sufficient kinetic energy to disperse the surface oxide. Hey presto, welding of aluminium and its alloys had become possible. Or rather, it appeared to have become possible, until the electrodes started melting! *(Having the torch negative, as in conventional DC TIG, means that most of the arc heat is generated in the workpiece. Reverse the situation and that larger fraction of the heat is then generated in the tungsten electrode. Even tungsten cannot tolerate such temperatures.)*

It then having been shown that each of the two types of DC had some advantages and some disadvantages, it was realised that some mix of the two types might allow a practical welding method. In other words, use enough of the reversed polarity to disperse the oxide, and enough of the conventional polarity to allow the tungsten to cool to tolerable temperatures. That "mix of the two types" was brought about by applying the different polarities in appropriate time increments, so that the workpiece polarity might have a sequence such as illustrated in Fig. 2.

Note that the waveform need not be symmetrical around zero volts. Also that one of the polarities can have shorter time increments than the other. And that by shortening all of the time increments pro rata, we can work at a higher frequency. Note finally that we need not work with a sinusoidal waveform, we can work with a squared wave, which fosters a reliable and steady arc. Pull all those features together, add an ability to superimpose bursts of high voltage at high frequency, and you have a first picture of what lies behind some of the "bells and whistles" provided on a modern AC/DC TIG set. Those bells and whistles do allow the all-important dispersal of oxides, so the welding of aluminium and most of its alloys then becomes possible. Possible, yes, but when we make and examine those welds, we

start to realise that we face further problems.

Playing the Pools

Often, one of the primary difficulties when using AC on aluminium and its alloys is getting two weld pools to form into one pool. Possibly the two pools are not sufficiently in contact (see "Getting it together" in part two), or possibly there are occluded regions where the oxides are not dispersed, where the molten pools are still held apart by oxide on the surfaces. Efforts to cause local melding of the pools (say, by deft work with a touch of filler material) may sometimes be successful, but sometimes the two pools will remain stubbornly in isolation. In that latter situation, it is best to "cut your losses", clean things up and try again, because if you do not, the oxidation will only get worse, and you risk cataclysmic melting of your workpiece(s). *(Note: the "deft work with a touch of filler" brings benefit in several ways. If your problem is that two pools are not in contact, then a gobbet of filler can provide a first bridge that then allows surface tension to do good things. Also, provided that it has been fed properly, a clean filler can provide surfaces that are essentially oxide-free, surfaces that will meld on contact with a neighbour. Such benefits are additional to the primary benefit, that the additions of filler can prevent cracking on cooling.)*

Some thoughts about assembly ...

To have any hope of success, you have to get all surfaces beautifully clean, and you then have to assemble the parts to provide best probability of the pools melding. However, if you think about it, any handling of a beautifully clean component carries some risk of recontamination. So, do all your preparations for assembly before you do the cleaning, and after the cleaning, do not touch anything with greasy fingers. (Wear disposable gloves and make sure that clamps etc. are free of grease.)

In preparing for assembly, think about the details of the points of contact. If you assemble two notionally straight edges side by side on a flat surface, they will contact either at one or at two locations. If one of those locations happens to be situated where you start welding, great! If not, what must we expect to happen? That on melting, surface tension will pull the edges apart and we will have a non-recoverable situation.

Clearly, there is great benefit in matching each surface (or edge) to its intended neighbour. The use of some abrasives is deplored, but provided you then go through a sufficient cleaning process, as described below, you can do a good job with our old favourite the belt sander. You can check on progress directly visually, either by watching score marks replace saw marks, or you can identify the points of contact by holding the surfaces together against a strong back light.

To be continued.

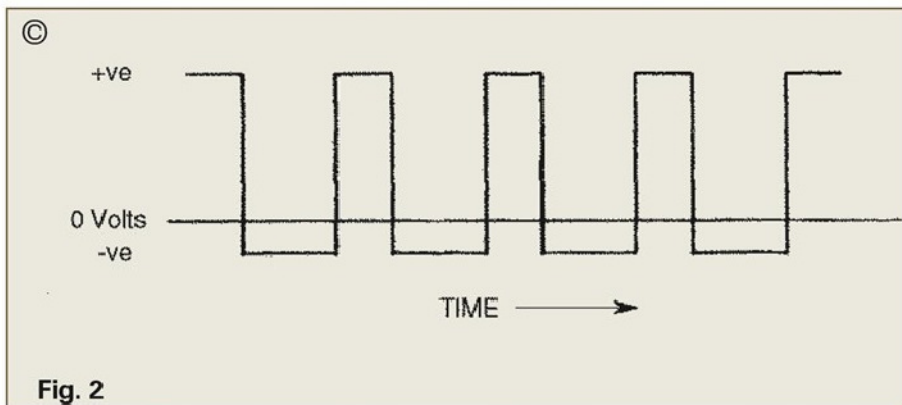
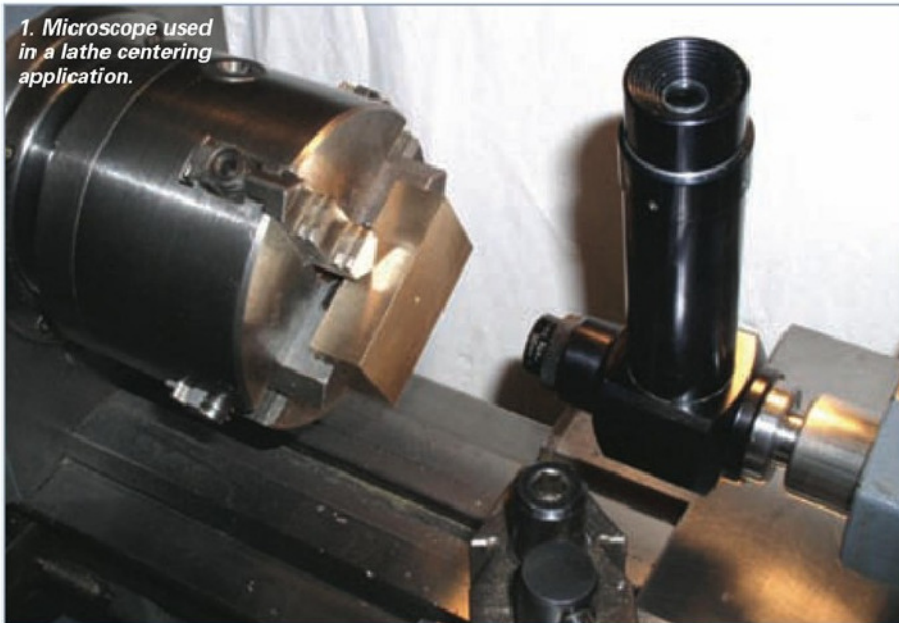


Fig. 2

THE CENTERING MICROSCOPE

1. Microscope used in a lathe centering application.



The history

I made my centering microscope nearly 15 years ago, when I bought my first milling machine. Since then it has been in almost constant use, both on the mill, and on the lathe. A typical application is illustrated in **Photo 1**. In fact, I really believe that I could now not manage without it. Accurate to within 0.025mm/0.001in. for both centre and edge finding, the microscope is also irreplaceable for finding the original hole centres when re-bushing worn clock plates.

Recently I have modified the original design to make it significantly easier to construct and have worked closely with Hemingway Kits to create a material package to further simplify the project. The optical items in particular can be difficult and expensive to source in one's and two's but Hemingway have managed to pull together a full material kit for less than I would have expected.

The microscope is made out of free machining aluminium bar unless otherwise specified. Without the "kit", you will also need to find the following items:

- A good quality objective lens of Ø12mm with a focal length of around 40mm.
- A standard microscope 10x eyepiece.
- A 17mm diameter graticule. The style required is concentric circles and cross-hairs.

This type of graticule is expensive and I have investigated making my own and have included my findings and instructions with this article. Though it is not as sharp as the chrome-on-glass commercial article, it is serviceable and was an interesting exercise.

- A 90° prism, silvered on its hypotenuse. A variety of sizes is available and suitable. I used one with 9.5mm sides and 18mm long.
- A soft ended arbour to suit the spindle of your milling machine.

A cross section of the microscope is shown in the drawings. The objective lens projects an image of the object being viewed on to the graticule. The image on the graticule is viewed through the eyepiece lens and appears at a magnification of around x20. The 90° silvered prism is used to bend the light from the object through a right angle for convenient viewing. With this layout an inverted image is obtained; this will neither affect accuracy nor the speed at which you can centre work.

The construction

There are no critical dimensions for any of the components of the microscope. The best way to proceed is to make the main

body of the instrument and then make each following part to accurately fit those already made. Do not make all the parts individually and then attempt to assemble the complete unit. This approach never

Dick Stephen describes the construction of the Hemingway Kit, and also gives guidance on anodising.



2. The components for the device shown before anodising.

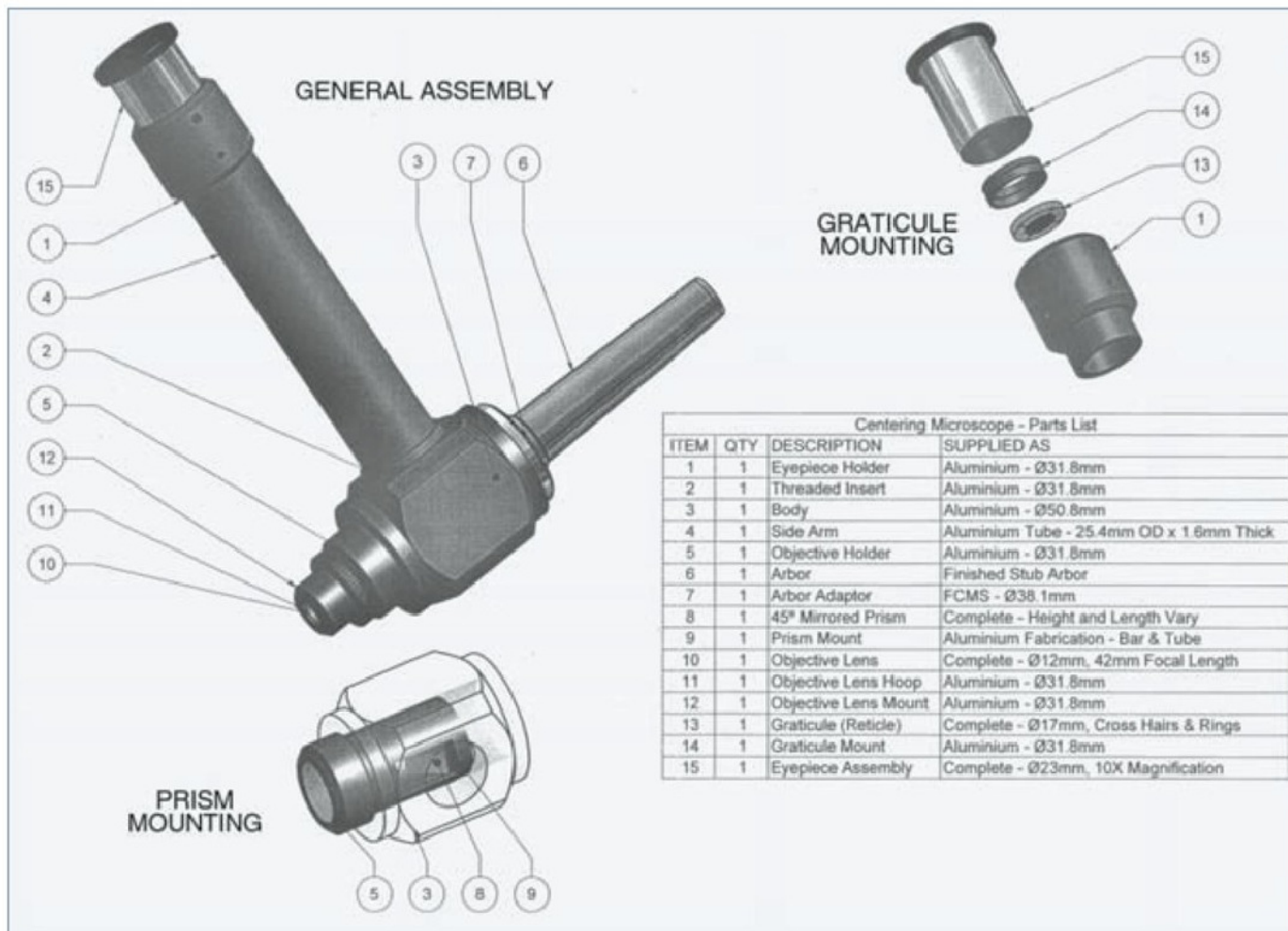
works, at least that is my experience. The component parts of the microscope are shown in **photo 2**.

The parts of the microscope will be anodised and dyed black before they are assembled. Anodising converts the surface of the aluminium into aluminium oxide. This marginally increases the size of the component. Several of the parts of the microscope are assembled with epoxy adhesive. The fit of these parts should not be made too tight otherwise it may be impossible to assemble them after anodising. The anodised surface is so hard that it becomes near impossible to modify the part.

The body

For the body of the instrument you require a 50mm length (finished) of 50.8mm dia. aluminium bar. Begin by facing both ends of the bar. Drill and bore a 25mm dia. hole through the full length of the bar. Turn down the end to 40mm dia. diameter for a length of 5mm and chamfer the end as shown in the drawing. Thread the first 12mm of the 25mm dia. hole with a 1mm pitch thread. The finished thread depth should be around 0.5mm.

Remove from the chuck and square the sides of the bar as shown in the drawing. You can either do this on a mill or vertical slide or using a 4-jaw chuck on the lathe. Make sure you take the same amount off each side, using the 40mm dia. turned down end as a guide. The finished size is 40mm x 40mm. Having squared off the last side, a 22mm dia. hole for attaching the side arm tube is drilled, bored and threaded through to the 25mm dia. bore with a 1mm pitch thread. Finished thread



depth should again be around 0.5mm. **The centre of this hole must be precisely in line with the centre of the 25mm hole bored through the body.** At the same setting, drill the M2.5 tapping size hole for the prism mount locking screw.

The remaining end of the body now needs to be turned down to 40mm dia. and chamfered. Grip the turned down end in a 3-jaw chuck. To support the work, make a plug with a centre hole to fit in the end and use a live centre.

The objective holder

For the objective holder you require a 22mm (finished) length of 31.8mm dia. aluminium bar. Begin by facing both ends of the bar. Turn down one end to 25mm dia. for a length of 10mm (to fit in the hole in the body). Now drill and bore a 19.6mm dia. hole through the length. If you do not have an accurate chuck or a collet, hold the 25mm end in a 4-jaw chuck and clock the hole to make sure it is running true. Thread the first 10mm of the hole with a 0.70mm thread (36 tpi), finished depth around 0.35mm. This is a standard microscope objective thread. This will enable you to use standard microscope objective lenses in your instrument.

The side arm

The side arm is made out of a length of 25.4mm dia. drawn aluminium tube. The precise length of the tube has not been specified. The microscope will be used mostly on your milling machine. The

length of the side arm tube should be sufficient so that you can comfortably view the work without banging your head against the machine! All that increasing the length of the side arm will do is to slightly increase the distance between the work and the objective (the working distance) as well as slightly increasing the magnification.

Cut off a length of 25.4mm dia. tube about 20mm longer than required. Make a plug with a centre hole to fit in the end of the tube. Grip the tube in a 3-jaw chuck and face off one end. Insert the plug and hold the tube in the chuck leaving the required length extended. Support the free end with a live centre. Skim the surface of the tube using a very sharp tool and plenty of suds as the tubing is not free cutting aluminium. Part off the required length of tubing. Clean off all burrs on the inside of the tube.

At one end, the tube is attached to the body with a threaded insert. At the other, it is attached to the eyepiece holder, in which the graticule mount and graticule are housed. Making these components should present few difficulties. Make sure that the holes for the graticule adjusting screws are precisely drilled. It is essential that the graticule lies in a plane at 90° to the axis of the side arm tube in order to focus the eyepiece correctly on the graticule.

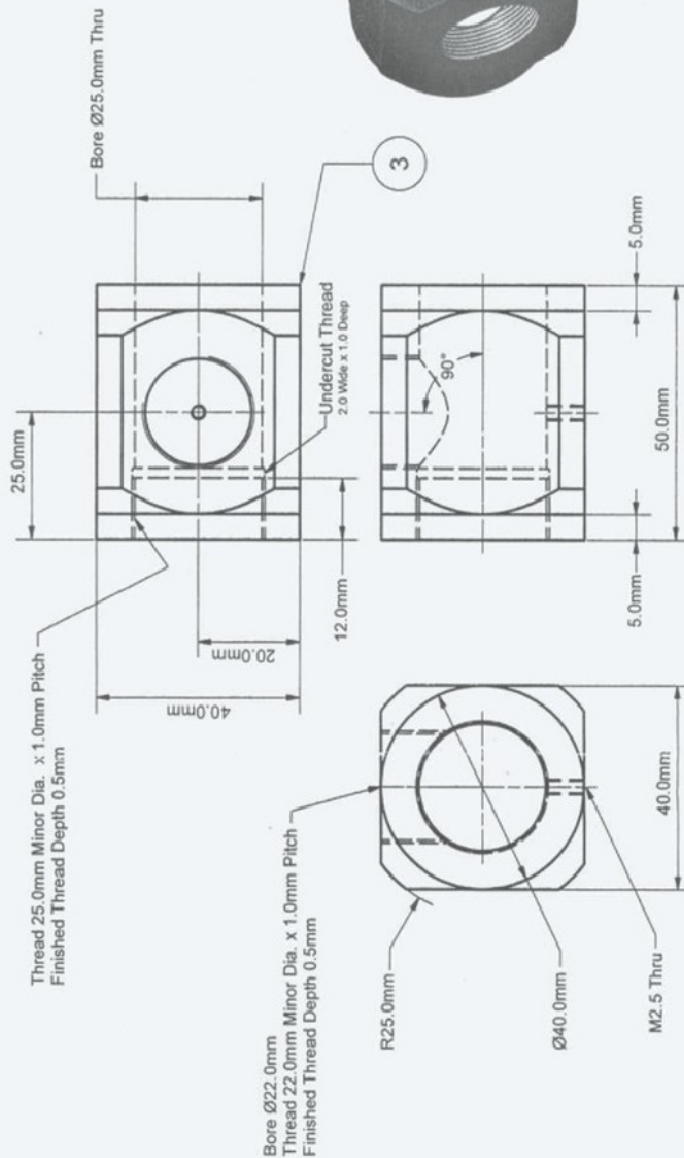
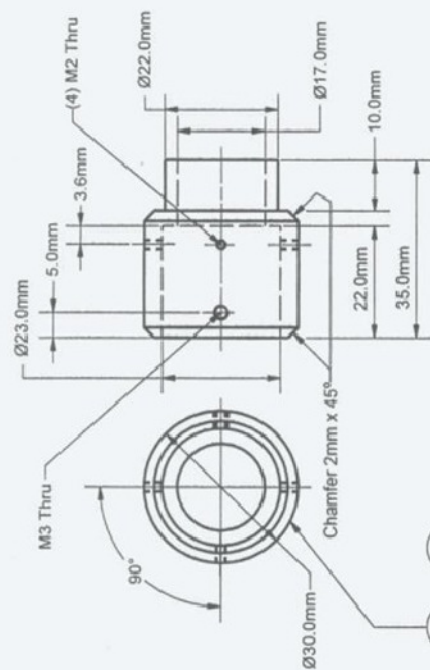
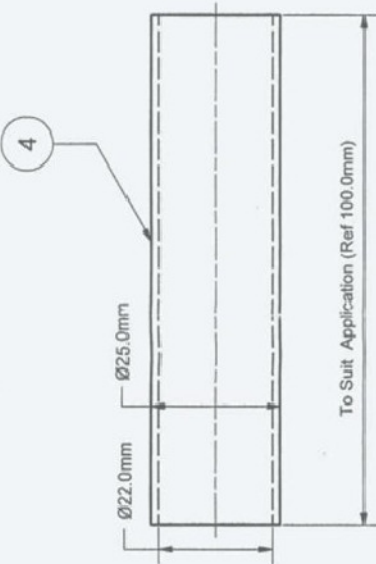
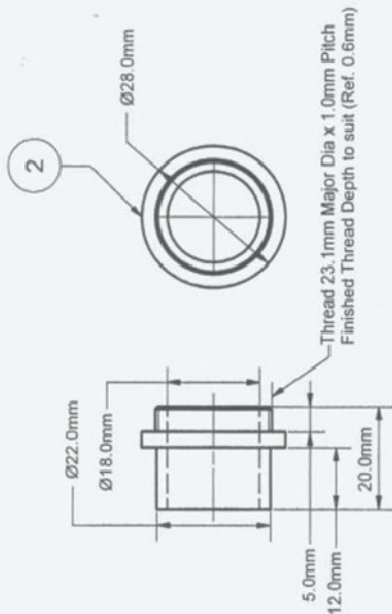
The arbor

A No.2 Morse taper is probably the most common taper found on hobby milling machines and lathes, so it is this standard which has been adopted for the kit. If you

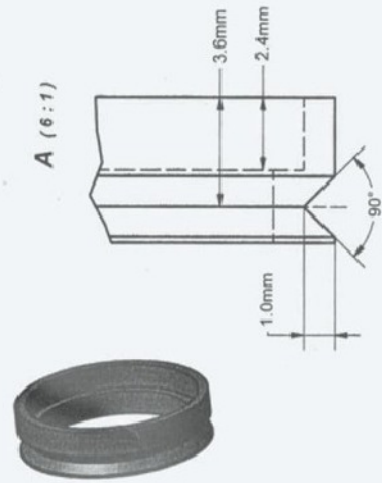
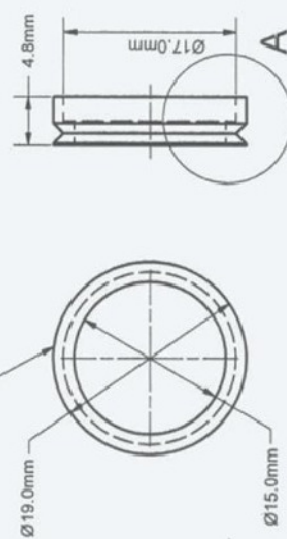
have say a Myford ML7 lathe, machining the end of a No.2 Morse taper blank is easy as the spindle is bored for a No.2 Morse. My lathe unfortunately does not have a Morse spindle so holding the taper to machine it presented a problem.

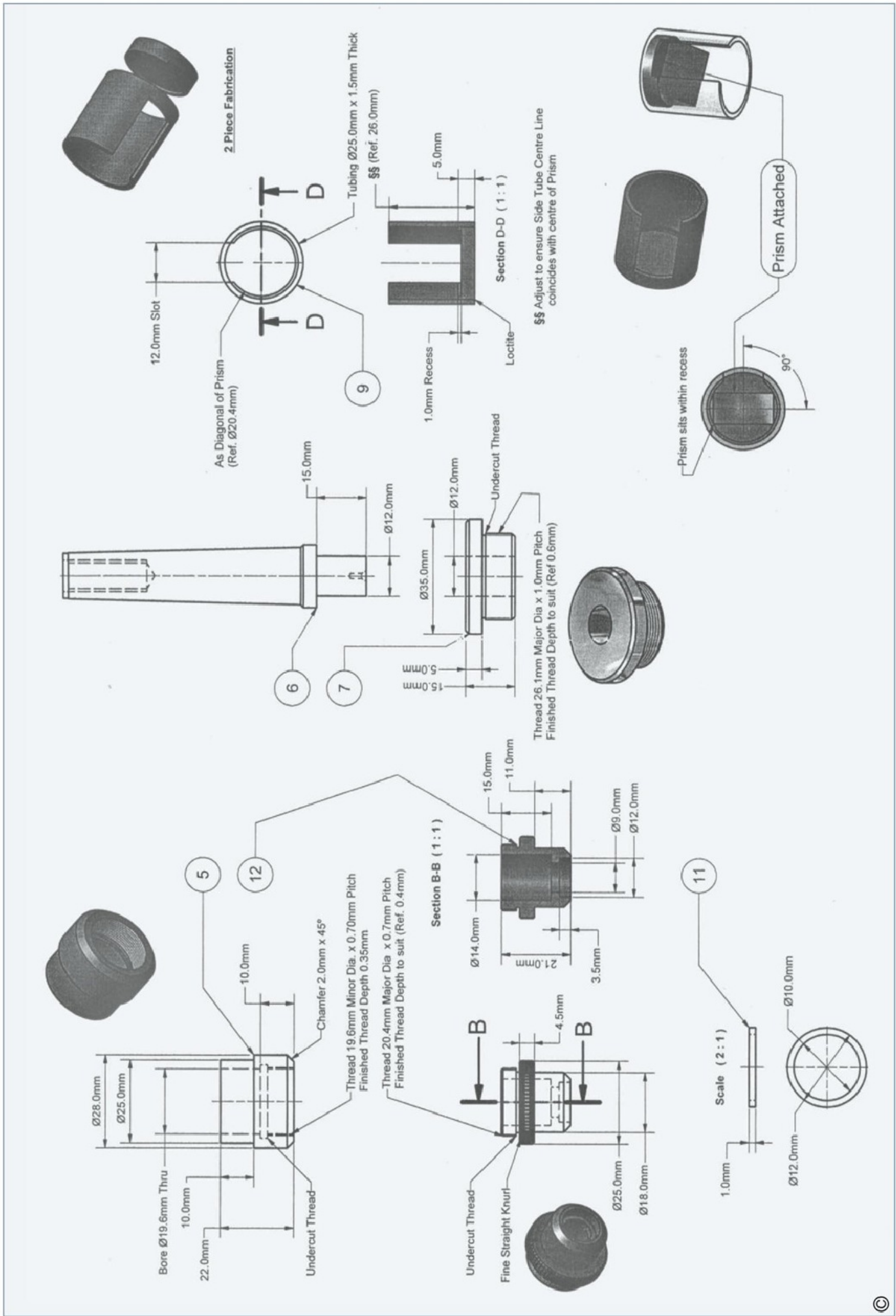
Fortunately I was able to borrow a No.2 Morse reamer from a friend. I clamped a 30mm length of 31.8mm dia. diameter aluminium rod in the 3-jaw chuck. I then drilled and reamed a tapered hole in the piece of bar. If you do not have a No.2 Morse reamer, you will have to bore the taper. Only make this taper when you are ready to turn down the end of the blank. Once made, do not remove it from the chuck until you have completed all that has to be done.

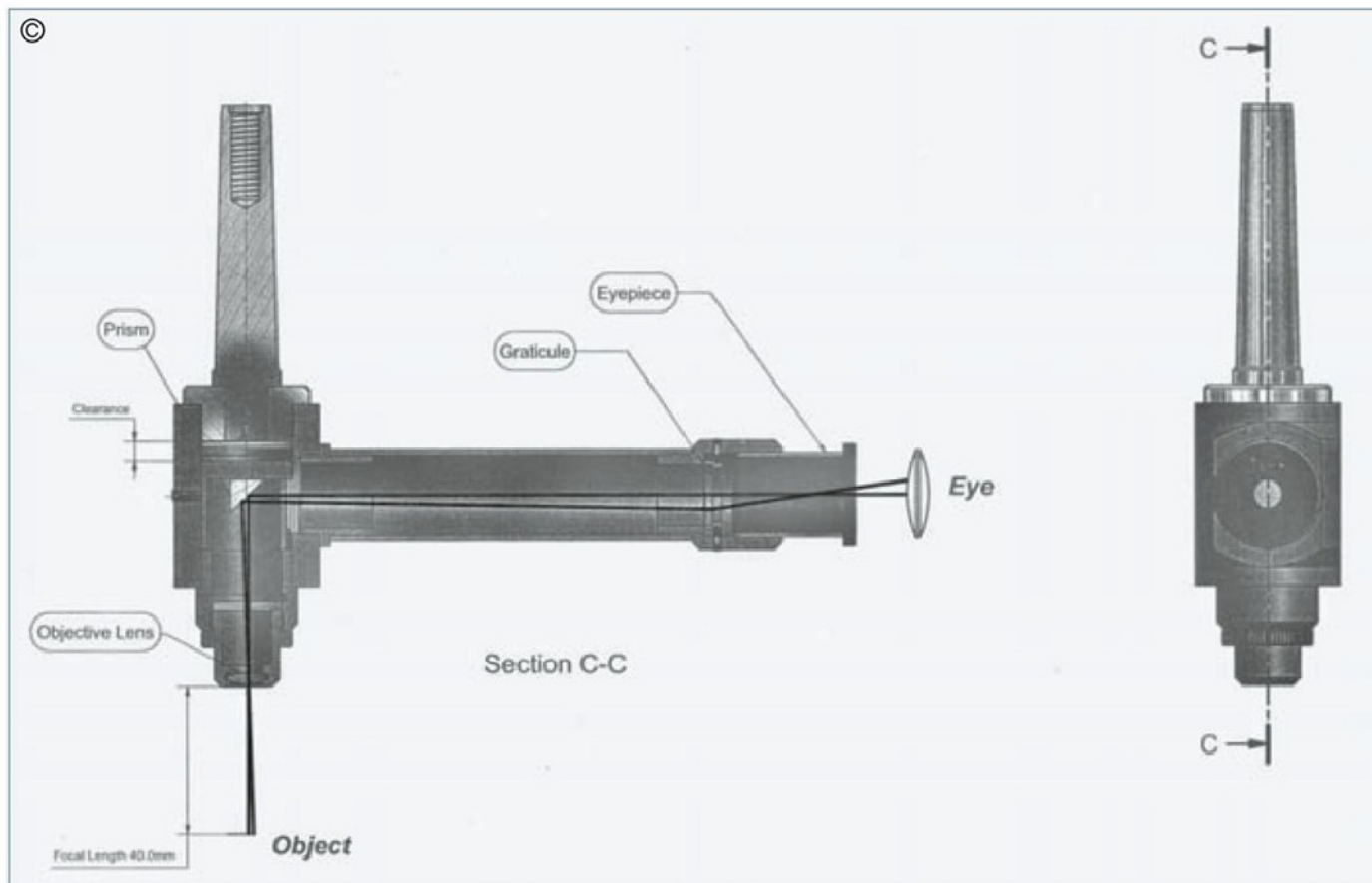
Begin by facing the ends of a 15mm length of 40mm dia. EN1A mild steel. Drill and ream a 12mm dia. hole through the full length. Fit the No.2 Morse blank into the taper (spindle or bar) and support the free end with a live centre. Check that it is running true with a dial indicator then turn down the end for a length of 15mm to 12mm dia. I found that the Morse blanks were best machined using a carbide tipped tool. Now glue the length of EN1A bar onto the turned down end of the blank using Loctite 326 or similar. Leave the blank in place to do this. When the adhesive has cured turn down the bar to a diameter of Ø35mm then turn down the end, for a length of 10mm to 26.2mm dia. and cut a 1.0mm pitch thread. Initially, cut the thread to a depth of 0.5mm. Gradually increase the depth of cut until it screws into the body snugly.



Scale (2:1)







The prism mounting

The mounting for the prism is fabricated out of a 26mm length of drawn tube and an insert made from 31.8mm dia. bar. Turn down the end of the piece of bar for a length of about 5mm to fit in the piece of tube. Now turn a recess 1 mm deep in the end of the bar with a diameter equal to the diagonal across the base of the prism. Glue the piece of tube onto the insert using Loctite 326 adhesive or similar. When the adhesive has cured, turn down the tube to fit snugly into the hole in the body. Part off the prism mount. Mill out the 12mm slot as shown in the side of the tube. The bottom of the slot should be level with the bottom of the recess.

Insert the objective mount into the body. The prism mount rests on the end of the objective mount. The prism is attached to the recess with a spot of epoxy resin glue (don't glue it now!) and with the mount resting on the end of the objective mount, the centre of the prism should be in line with the axis of the side arm. The prism mount will need to be reduced in length. You will need to check your measurements to determine how much to reduce the length by.

Objective lens mount

The mount is made from a 30mm length of 31.8mm dia. aluminium bar. The lens used within the mounting was 12mm dia. Begin by facing both ends. Drill and ream a 9mm dia. hole through the length of the piece of bar. Bore a recess 3mm deep in the end, the diameter of the lens. Turn down the end for a length of 11mm to 18 mm dia.

and chamfer the end as shown. Reduce the diameter to Ø25mm and knurl the bar for about 6mm and chamfer the corner of the knurl. Holding the mount by the Ø18mm end, reduce the length to 22mm. Turn down the end to 20.4 mm dia. for a length of 6mm. Thread the end 0.7mm pitch, initially to a depth of 0.3mm. Gradually increase the depth of cut until the mount screws easily into the objective holder.

Making a graticule

As mentioned, you can either buy a suitable graticule or you can make your own from a glass microscope slide. The home-made ones are serviceable but certainly not as crisp as the commercial ones. To make your own you will need a short length of 20mm dia. copper tube to make the disc cutter. The cutter I used is shown in **photo 3**, as well as the set up for cutting the glass disc.

The glass slides need to be held so that they cannot twist when the cutter is pressed



3. Set up to cut a graticule disc.

on to the surface. The support shown was made out of scraps of Perspex; plywood would be just as good. The support must be clamped to the table of the drill press. You will need two glass slides, which need to be stuck together. To stick the slides together use bee's wax, as this makes it easy to separate the slides using boiling water. If you cannot find any bee's wax, get some fly tying wax from a fishing tackle shop. Fit the slides in the support and clamp it to the drill table. Using either children's modelling clay (Plasticine) or Blutak, make a circular dam around the cutter's position. Place about ¼ of a teaspoon of 220 grit carborundum powder in the dam and add a few drops of washing up liquid and a little water. Don't use a high drill speed or you will have carborundum everywhere. Touch the glass surface with the cutter for no longer than couple of seconds and withdraw. Keep on repeating this until you have cut through the top slide and begun to cut into the bottom (sacrificial) slide. You can cut two discs from one pair of slides, so while you are set up, cut a second. In fact I would make four discs while you are set up. Separate the discs from the lower slide using boiling water. Clean off all the wax using a solvent.

Scribing the circles

The commercial graticules suitable for this microscope consist of a series of concentric circles and two crosshairs. Whilst this is the ideal configuration, rather than crosshairs I opted for a central spot and concentric circles. To mark the glass surface I used a diamond pointed marking "pen" of the type used for security marking. The set up I used is shown in the **photo 4**.

Remove the diamond point from the plastic pen and set it in an 80mm length of 6mm dia. brass rod using Loctite. Face both ends of a 40mm length of 10mm dia. brass bar and drill and ream a 6mm dia. hole through the full length. This is used as a guide for the diamond point. A holder for the glass disc is made next. Face both ends of a 25mm length of 25mm dia. aluminium bar. Turn a recess 1mm deep in one end, the diameter of the glass disc. Warm the piece of aluminium and melt a small amount of wax in the recess and press the glass disc into the molten wax. Allow it to cool. Return the holder to the lathe. Check that the disc is running true. Fit the diamond point in the tailstock drill chuck and, with the lathe running slowly, bring the diamond point up to the glass surface and just touch the surface to make a mark. Fit the 10mm dia. brass guide in the tool holder and set it parallel to the axis of the lathe. Centre the diamond point. Retract the cross slide 1mm (or 0.5 mm if you want a smaller central circle). With the lathe again running slowly, touch the glass surface with the point to scribe a circle. Scribe four or five circles in all. To remove the graticule from the holder, place it in boiling water to melt the wax. Clean off all the wax with solvent.

This completes the construction of all the components. Before you can use the microscope however, the surface of the aluminium needs to be treated and blackened. If the inside of the microscope is left bright, reflected light from the interior surfaces will seriously degrade the image.

Anodising the microscope

The surfaces of the microscope need to be anodised and dyed. This protects the surface and improves the image. You can either have the parts professionally anodised or you can do it yourself. To do the anodising you need a 15 volt DC power supply delivering a minimum of 1 amp. A car battery charger should work. In addition you will need about 100ml of battery acid (sulphuric acid), a glass or rigid plastic container large enough to

immerse the parts of the microscope, a piece of sheet lead 150mm x 50mm for the cathode, some aluminium wire or thin strips of aluminium sheet and a tin of black Dylan dye. To connect the part being anodised to the power supply, aluminium conductors must be used.

Clean and polish all the parts to be anodised. Make sure you remove all oil from the surface. Once clean, don't touch the parts with your fingers, wear vinyl gloves to handle the parts. Fill the glass or plastic container with clean rainwater or distilled water and add the acid slowly. Wear protective glasses and vinyl gloves whenever you work with the acid. Immerse the lead cathode and connect it to the power supply. Attach the part using aluminium conductor to the anode of the supply. **Photo 5** shows my set up.

Turn on the power and gradually increase the current until the small bubbles begin to form on the surface of the part. Leave for about 30 minutes and then remove the part and rinse it several times in clean water. Some aluminium alloys anodise more easily than some others. The surface should have a slightly pearly appearance. If you are not sure that the surface is anodised, return the piece to the bath for a further period. The anodising has converted the surface into aluminium oxide (what grindstones are made of), a very hard and durable surface. Boil up the black Dylan in about 1 litre of water and immerse the part for a couple of minutes.

Remove and rinse in clean water and wipe dry with a tissue. Anodise the remaining parts and dye them. You now need to dispose of the acid. The best way is to neutralise the acid using washing soda or marble chips (sodium or calcium carbonate). Keep adding the soda or chips until all the fizzing has ceased. The liquid can now be safely disposed.

Assembling and centering the microscope

Several of the components of the microscope are permanently assembled with an adhesive. The natural choice

would have been Loctite. Unfortunately having anodised the aluminium the Loctite will not work. As a consequence the assembly is completed using an epoxy resin adhesive.

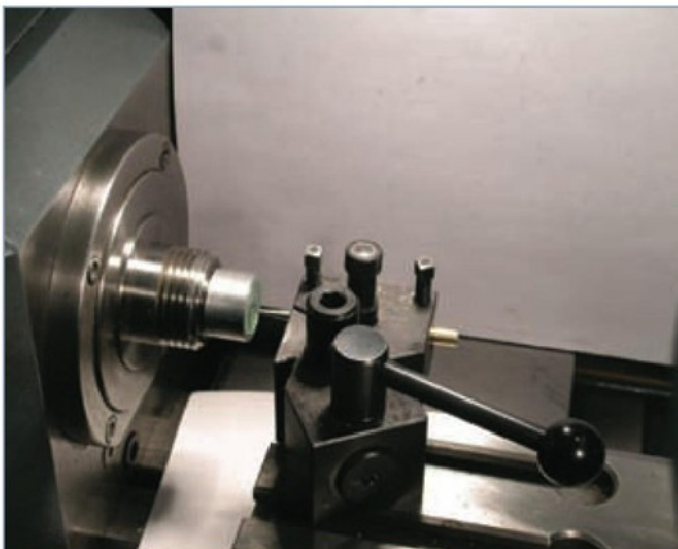
Glue the objective mount into the body and the threaded insert and eyepiece holder into the side arm. Orientate the graticule adjusting screws so that with the side arm horizontal, the screws move the graticule horizontally and vertically. The prism can now be set into the recess in the mount with either epoxy resin or double sided adhesive tape. The reflecting surface wants to be at 90° to the slot.

The objective lens hoop is glued into the objective lens mount, "sandwiching" the objective lens in place. If the graticule has any numbers marked on it, pay particular attention to which way up it must sit in its mount. The glass graticule should then be glued directly into the 17mm dia. recess in the graticule mount. Clearly you should avoid getting glue on the working surfaces of either the objective lens or the graticule.

The ends of the M2 grub screws should be filed or ground to a point so they can engage the chamfered groove on the graticule mount. Completely assemble the microscope ready for use.

The unit now needs to be accurately centred. Clamp a piece of sheet metal (say a scrap of 3mm brass) to the table of your mill. Using a sharp point in a drill chuck, make a small indent on the surface of the metal. Replace the drill chuck with the microscope and focus on the metal's surface. Lock the eyepiece with the M3 Grub screw. If the prism is orientated exactly at 90° to the axis of the side arm tube, an image of the indentation should appear close to the centre of the graticule. If the image is way over to one side you will need to rotate the prism to bring the image towards the centre. Now use the four graticule adjusting screws to precisely centre the image of the indentation.

That completes the project. A friend who recently made one told me that he does not know how he managed without one as his is now in constant use. Combined with a digital readout, the microscope is very useful indeed for measuring small odd shaped components.

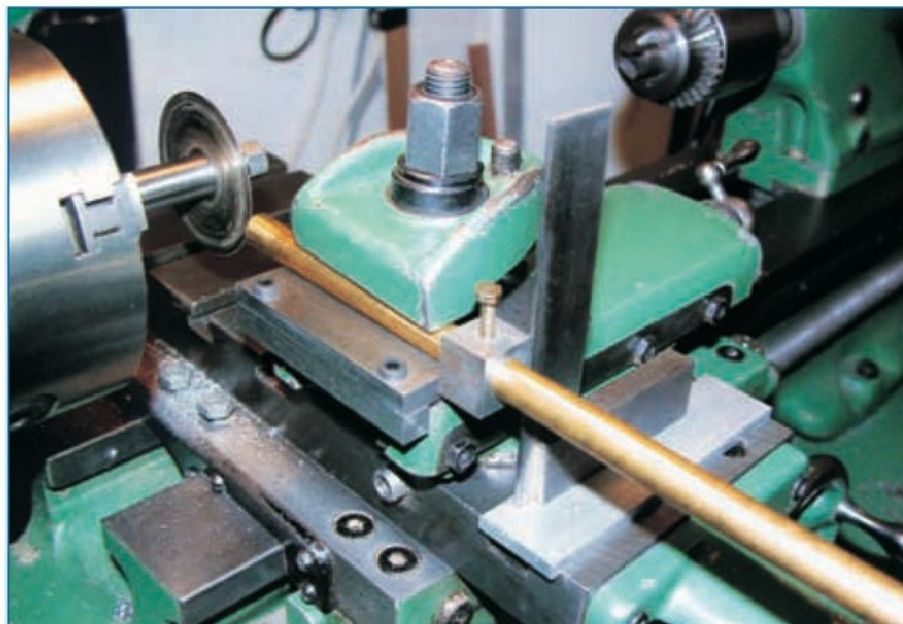


4. Scribing circles on graticule with diamond tip.



5. Arrangement for anodising.

A COLLET SLITTING JIG FOR THE LATHE



1. The set up in operation on a Myford lathe.

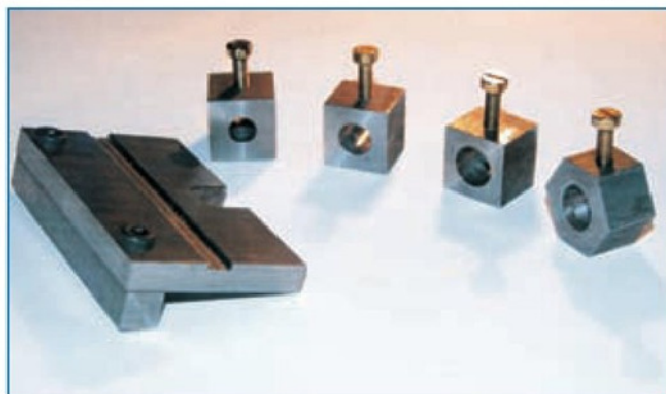
Rationale

At some point during the construction of clocks, besides the cutting of gears, it becomes necessary to slit small collets to provide a good friction fit of gears to their bosses. Whilst this operation could be done, as for gear cutting on the lathe or milling machine, this would be somewhat of an overkill for such a simple process. In fact it is regularly done, in the amateur's workshop, by holding the stock under the tool post on the top slide and advancing the work piece towards a slitting saw rotating on an arbor held in the chuck. There is nothing wrong with this but with the help of a jig simply made from odd pieces from the scrap box this method could be aided from the points of view of accuracy and repeatability of the set up and particularly by ease of indexation of the work piece for the angular spacing of the saw cuts. Some purists may argue that the device should more correctly be described as a fixture (traditionally a jig guides the cutting tool – a fixture holds the workpiece) but the word jig rolls off the tongue more readily.

Construction

The jig consists of a mild steel plate, about $\frac{1}{4}$ inch thick will do, and of length and width to sit on the top slide with a piece of rectangular section steel bolted to it on the

underside to locate it against the end of the top slide. A cut-out to fit around the tool post is desirable to provide positive location. A shallow groove, a V-shaped one would be ideal if you have a suitable cutter, is cut parallel to the end of the top



2. The jig (location bar and groove clearly visible) and a selection of collets for indexing.

Bill Brading advocates an elegantly simple arrangement

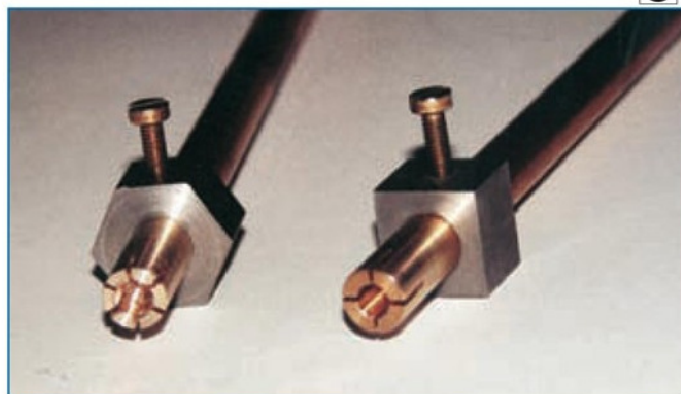
slide. As can be seen from the photo, mine has been cut to a rectangular section.

Use

In use the work piece is clamped in the groove by the normal tool holder and at this stage the setting can be checked for perpendicularity against the lathe axis. This can be done in various ways, for example by butting the jig against piece of parallel stock held in the lathe chuck or against a faceplate. I am not sure if the end of the Myford top slide is a machined reference surface but mine is pretty good so it needed no further adjustment.

The end of the stock towards the operator can now be fitted with a variety of collars to provide a means of indexation. Most common of these would be those cut from square section brass or steel allowing two cuts to be made at right angles in the end of the work piece. At each setting a small square located on the cross-slide as shown in the heading photo, is used to check this. The stock must now be located so that the saw cut is exactly on its centre line. This can be helped by leaving a small pip when facing the end or by drilling a small hole. A dental mirror will assist in this adjustment, as few of us are able to walk around the back of the lathe to examine it. Alternatively if you keep a piece of the same stock material with a well centred cut in the end you can use this to position the slitting saw. The saddle must be locked to eliminate leadscrew backlash once the correct position is determined.

The photographs show the arrangement set up in the Myford lathe, the jig with a selection of collars and two examples of bars cut by this method.



3. Detail of collars and associated saw cuts.

ANOTHER PENNY FINALLY DROPS

Dave Fenner offers a simple time saver.

Background

The train of thought probably started when I recently had to produce a number of parts on the Herbert 2D capstan lathe. The set up involved various drills and a knee turning tool on the turret, with a front and rear tool on the cross slide, (photo 1). Of these two, the former created a Vee groove, the latter parted off, their positions being set so that part of the Vee remained as a chamfer on the component. Correctly arranged, no movement of the saddle was required. Moving back to do some work on the Myford Seven, I again found it necessary to remove the front tool to gain clearance to engage the rear. This is fine for the odd one off, but becomes a chore for multiple parts.

If we go back in history, this was probably not always the case. Photo 2 shows the Super Seven equipped with front and rear tools as the company originally intended, and it can be seen that the tools are in approximate alignment. What has subsequently changed for me, is the addition of a quick change front tool post. Mine is home made, but the effect will be similar with the commercial items – i.e. to move the front tool an inch or so closer to the chuck. Note that Myford provide a rear toolpost to accommodate Myford Dickson holders, and if you have this accessory then the problem is solved.

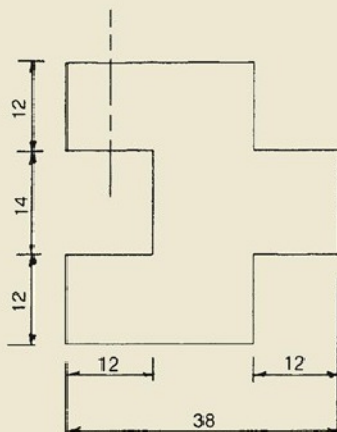
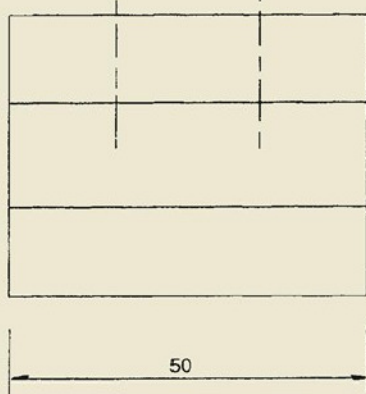
1. Tools on Herbert Capstan lathe in rough alignment



Fig. 1 Offset tool block for Myford 7 etc

DRILL & TAP M5
2 PLACES

MAT'L: MILD STEEL



Solutions

Two avenues of thought arose, move the front tool to the right or move the rear tool to the left. The former might be possible, but would probably require a re-machined topslide. For the latter, all that is needed is a simple block, machined as Fig 1 which can be clamped in the existing rear tool post, and which in turn, will clamp the parting tool. I did briefly question the wisdom of introducing this lateral overhang, but it is in essence merely what has already occurred with the front tool.

Construction

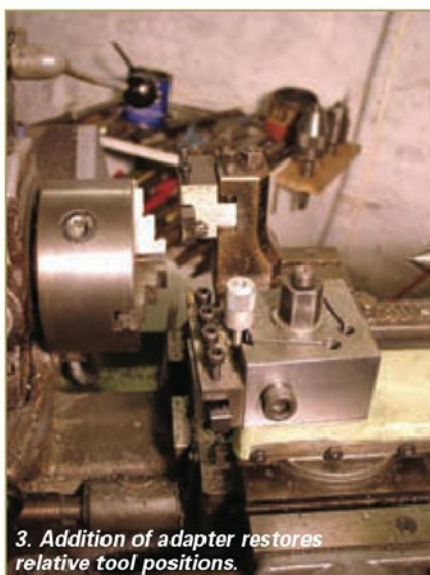
My material store (a.k.a. scrap box) yielded a length of 1.5in. square steel. A piece roughly 2 inches in length was sliced off in the bandsaw. The features shown were then milled, the groove first as this left more meat for the vice to grip when cutting the tongue. Finally, the holes were drilled and tapped for the M5 clamping screws. If you want to produce an exhibition quality article, you will no doubt carefully face the ends. As may be seen in the photo, my priority was to get the thing working, so the faces have been left as sawn.

Operation

The rear toolpost is a near permanent fixture on my lathe. Since adding the adapter block, facing and parting have become just that bit more of a pleasure now that the front tool can be left in place. Experience indicates that the added overhang noted earlier is not a problem, and as the thing took less than an hour to knock up, I consider it time well spent.



2. Myford 7 set up with original front and rear toolposts.



3. Addition of adapter restores relative tool positions.

Scribe A Line

Jim Whetren writes:

Re. Jim Smith's Letter, issue 104

I have a Star Drilling machine, and have found adjusting the table with vice and work in situ quite exciting! I notice in the published photo of the drilling head, that the head is above the stop collar. I presume like me, when the best position is found it is then left alone. I have re-positioned this collar under the table, and replaced the securing nut with a lever operated one. This way the table can be rotated freely without fear of the table dropping and losing the depth setting (or fingers).

A clamp ring, made from thin strip is placed under the head as a safety measure, should it be required to swing the head. A large Jubilee clip would serve the same purpose had I had one. This mod, together with my method of securing the vice to the table as described in Scribe A Line, issue 100, makes positioning work under the drill bit a breeze.

Ian Hewson of Leeds writes:

Having just read Bill Morris's article on ER collet holders in *Model Engineers' Workshop* 104, I can confirm the usefulness of the collets and Bill's method of construction. I made up a couple of similar holders for my Myford ML7 and 254 lathes. They are also used on the Dore Westbury mill and Quorn tool and cutter grinder.

Sometimes though they can tend to stick when the closer is released, no problem with larger tools, but with small drills the closer has to be taken off to release the collet.

Whilst the commercial closer has a ring that engages with the groove in the collet to release it, all you have to do is measure from the front face of the closer to the centre of the collet groove when it is installed, drill a small hole say, $\frac{1}{8}$ of an inch dia. and Loctite or press in a square ended peg. This will effectively release the collet for you.

Regarding finish, I now follow advice given in your pages some time ago, and when using tipped tools I increase the speed and feed rather than reduce them. This works for me. Also I use a pumped system to deliver neat cutting oil to all my machines from the same sump. With care this is not particularly messy and stops rust that I used to get with soluble oil. The only problem is that you need some form of air extraction if heavy cuts are taken, as smoke can result.

Albert Hawkrige writes:

I recall that many years ago, my late father made a demagnetiser from an old electric motor stator. Just how he made the device I have little idea, but the tool to be treated was placed within the space formerly occupied by the motor armature or rotor. I suspect that the current to the stator was gradually reduced leaving the tool demagnetized. But I am only guessing.

Perhaps amongst the readers of *MEW* there is someone who knows the method and could describe it more precisely. I have many small tools which could do with again making neutral, and am sure that many other readers would benefit from such a device.

On a second topic, an article in issue No. 39 page 35, referred to induction heating. Whilst the article is interesting, it does not indicate whether this technique is within the scope of the amateur engineer. An article covering the details of making such a device would be most welcome.

Peter Littlejohn from New Zealand writes:

I have just read your "On the Editor's Bench" in *MEW* 103 about your fun and games with leaky fuel tanks. Having repaired the tank on my Ducati Pantah 600 I know what "fun" it is chasing pin holes around a repaired seam and using up all the welding gas at the same time. Your comment about using water to purge fuel/ gas residues is definitely the best way, unless you have mentality of a bomber.

May I suggest a tank sealant called Kreem. This is a three stage sealant which is approved for aviation use. The first part removes rust and etches the tank. The second part rinses the tank ready for the sealer coat. The third part seals the tank. Full instructions come with the sealer kit. It will fill quite big holes and the left over sealant can be saved for use later if necessary. It's not cheapest sealant around, but then really good stuff never is!

Dennis Monk of Derby writes:

Ref. Harold Hall's article Taps and Dies - Choosing and Using (*MEW* No.104, February 2005) in which he discusses thread depth and bemoans the fact that very few drill charts give an indication of the percentage of thread depth or truncation. I came across this problem many years ago when I broke a tap in a gunmetal cylinder casting. The job stopped while the matter was investigated. It was found that the problem lay in plastic flow of the softer gunmetal, as compared with say, harder cast iron, which filled the clearance, jamming the tap in the tapping hole.

A long departed friend in Nottingham SMEE provided me with a chart devised by the late Mr. Allen of the Society of Model and Experimental Engineers, giving a list of tapping sizes, with percentage depth of engagement for Whitworth, BSF, and some BA taps. Calculations were made for the ME and Brass (26 tpi. constant pitch threads, useful for boiler work and model engineering in general) with additional BA threads and the tables prepared, those for Whitworth, BSF, and Brass being reproduced here. Note that the percentage depth of engagement increases as the hardness of the material increases, the harder material being cut and broken into chips rather than being swaged out of the way and into the root of the thread.

I am afraid I have no interest in metric threads. They have coarser tolerances and those in the range equivalent to 3BA and below have coarser pitches. The BA range of threads is much to be preferred for model engineering; in fact the standard should be revived for model engineering along with the ME and brass thread series. I only have the few metric taps necessary for the Bletchley Park Bombe rebuild project. I know there are the 2nd and 3rd series, but has anyone ever seen them and what would be the cost? The chart of twist drills from No.80 to $\frac{1}{8}$ in., herewith, is useful for selecting drills.

Perhaps it might be possible to publish similar charts for metric, UNC, UNF, and the US number series of taps, to supplement the above.

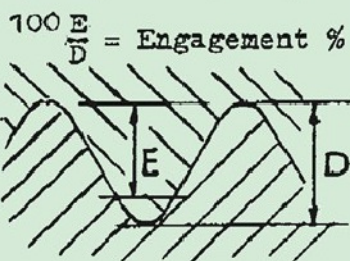
The principle of truncation is quite legitimate, even if the plastic flow is not great, for it is the effective diameter which is important; Rolls Royce have used it for years.

It would be interesting to see how the range of metric drills compares with the miscellany of number, letter, fractional and metric drills in the table herewith.

TAPPING SIZE DRILLS

WITH PERCENTAGE DEPTH OF ENGAGEMENT

WHITWORTH					
Dia TPI	Drill	%D	Dia TPI	Drill	%D
1/16in. 60	57 56	91 75	1/8in. 18	C D	99 93
1/32in. 48	50 49 48 54in.	89 77 66 58		1/16in., E 6.5mm F G	87 79 78 72
1/16in. 40	42 3/32in. 41 40 2.5mm 39 38	98 97 90 84 83 79 73		7/64in. 7.5mm 19/64in. N 1/4in. 8mm O P	66 99 98 91 78 75 74 65
1/16in. 32	31 1/16in. 30	90 78 69		21/64in. 58	58
1/8in. 24	29 3.5mm 28 3/16in. 27 26 25 24 23 5/32in.	96 93 88 88 81 76 71 66 63 58		S 9mm T 23/64in. U 9.5mm 1/4in.	98 91 87 85 76 69 68
1/8in. 20	19 18 1 1/16in. 17 16 4.5mm 15 14 13 3/8in.	99 92 88 86 78 78 72 69 63 58		10mm X Y 13/32in. Z 10.5mm 27/64in. 11mm 1/2in.	99 97 90 88 81 81 73 62 58
1/4in. 20	11 10 9 5mm 8 7 1 1/4in. 6	97 95 92 88 84 83 79 75 73 72		13mm 1/2in. 33/64in. 17/32in. 13.5mm 3/4in. 10 16mm 41/64in.	97 94 94 86
1/2in. 20	2 1 A 1 1/4in. 6mm B	97 94 83 74 73 70 67		7/8in. 9 1in. 8 21.5mm 35/64in. 22mm	99 89 88 84



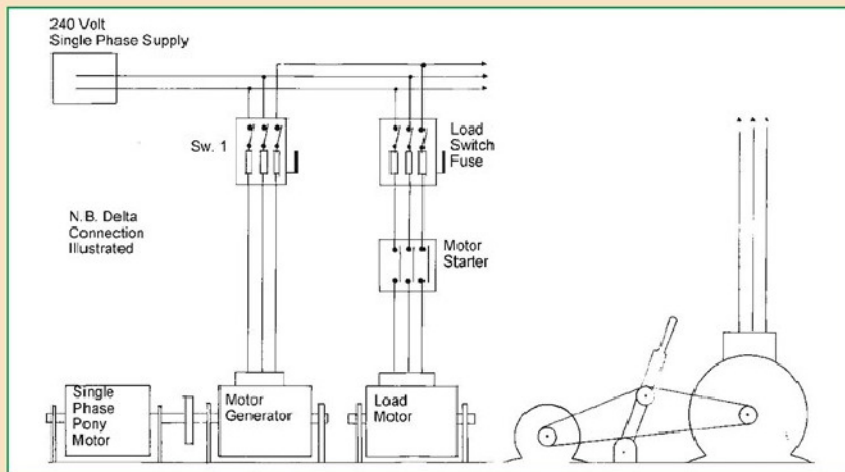
Allowance suitable:-
Copper, Aluminium
W. Iron, Gunmetal
M. Steel, W. Brass
C. Iron, C. Brass

Small to Large
55 to 65%
60 to 75%
70 to 85%
80 to 100%

BSF		
Dia TPI	Drill	%D
1/8in. 32	25 24 23 5/32in. 22 4mm 21	96 89 84 78 76 75 71
7/32in. 28	17 16 4.5mm 15 14 13 3/8in.	100 91 91 85 80 74 68
1/4in. 26	13/64in. 6 5 4 3 5.5mm 7/32in.	95 93 90 83 75 68 63
1/2in. 26	A 1 1/2in. 6mm B C D 1/4in. E	96 95 91 88 79 71 63
5/8in. 22	6.5mm F G 1 1/4in. H I	97 95 88 80 80 69
3/8in. 20	5/8in. 8mm O P 2 1/4in. Q	97 94 92 81 73 67
1/2in. 18	U 9.5mm 3/4in. V W	98 89 88 85 72
1/4in. 16	27/64in. 11mm 3/8in.	98 83 78
5/8in. 14	35/64in. 14mm 1/2in.	85 81 68
1/2in. 12	16.5mm 2 1/2in. 17mm	94 88 75
1/4in. 11	49/64in. 19.5mm 2 3/4in.	94 92 80
1in. 10	1in. 22.5mm 5 1/4in.	98 89 86

BRASS		
Dia TPI	Drill	%D
1/8in. 26	5/16in. 47 2mm 46 45 44 43 42 3/32in. 41	95 94 94 89 87 79 73 64 63 59
3/8in. 26	28 5/8in. 27 26 25 24 23 5/32in.	95 95 87 82 77 72 68 63
1/2in. 26	1 1/8in. 6 5 4 3 5.5mm 7/32in. 1 1/4in. H I 7mm J K 3/2in.	95 93 90 83 75 68 63 95 94 82 75 72 64 63
3/4in. 26	2 1/4in. Q 8.5mm R 1 1/2in.	95 87 82 73 63
1in. 26	2 3/4in. 10mm X Y 1 3/4in.	95 89 82 68 63
1 1/2in. 26	11.5mm 2 3/4in. 1 3/4in. 12mm	96 95 63 56
2in. 26	3 1/4in. 14.75mm 15mm 1 7/8in.	95 90 70 63
2 1/2in. 26	4 1/4in. 18mm 2 3/4in.	95 84 63
3in. 26	5 1/4in. 21.25mm 2 7/8in.	95 78 63
3 1/2in. 26	6 1/4in. 24.5mm 3 1/4in.	95 72 63

Ted Fletcher of Scarborough writes:



With reference to the letter in "Scribe a line" issue 103 from Ted Wale, running a three phase electric motor on single phase electric supply and using a single phase motor as a "pony motor" to start it off; then that three phase motor act as a generator to produce the third phase, and from there on you can run other motors from the system. Well it is a tried and tested arrangement which a friend and I made up several years ago. I don't know where we got the idea from, but I'm certain that I was not the originator. We made it such that my friend had a single phase motor with a vee pulley and a long vee belt. On the generator/ motor there was a similar pulley. He made a sprung loaded jockey pulley lever arrangement.

The sequence of operation is:- start the single phase motor (the pony motor), with a lever take up the tension on the vee belt which causes the generator/ motor to rotate, when up to speed 1425 rpm, close the three pole switch (Sw. 1.) which then connects the generator/ motor to the single phase supply and gives a three phase output to other load motors. It is possible to get either 240 volt (Delta connection) output, or connect the 240 volt input to the generator/motor between the star point (A1, A2 and A3) and one phase (A2,B2 or C2) and get 415 volt output. I prefer the 240 volt arrangement and use starters etc with 240 volt control coils. It all sounds a bit iffy, but for the home operator it is cheap and works, I'm sure interlocks and guards could be made for the less brave. The accompanying sketch gives the general details and wiring for delta operation.

Harold Cohon writes:

Mr. Derek Winks solution for converting from an "American" type tool post was excellent. I also was not completely happy with the rocker type but, being an amateur, do not believe I am yet ready to go that route.

My approach to the problem is shown in the accompanying photo. The aluminum collar is just about the correct height. To get dead on, I use one or two brass shims under the tool holder. My three tool holders are left hand, right hand and "centre". Each holder is kept separately with its own shims. This solution has been problem free for me. An experienced engineer, Mr. David Douglas of Bromsgrove, had no negative comments about this setup.

Also, my ability to sharpen tools is not that good; so I use tool holders that accept inserts. This has worked out very well. The inserts are inexpensive and each one has three cutting edges, making them even less expensive.

However, it seems Mr. Winks and I do share some memories. When in high school I became aware that a very loud noise could be generated by rapidly compressing a mixture of potassium chlorate with a chemical readily available from drug stores. I very carefully mixed these two, put a bit on a piece of paper, folded the paper and taped it to the street car track. When rolled over by the car wheel the loud bang and billowing smoke were quite a spectacle.

Of course street cars are a thing of the past and in retrospect realize this was not a nice thing to do. If caught today I'd be surrounded by the bomb squad and labeled a terrorist. Things were different then.



Giles Parkes writes:

I was surprised to see Bill Morris advising 26tpi or 1mm for the thread of the collet holder and nut. All the commercial ER collet holders that I have seen have a metric 1.5 pitch and this is just as easy to screwcut and then the holder can be used with a bought nut if you are feeling lazy. ER 16 holders have M22x1.5 thread, ER 20 have M25x1.5, ER25 have M32x1.5 and ER32 have M40x1.5. I don't have the ER 40s but I suspect they are also 1.5.

I first had ER collets when Neil Hemingway told me they would hold drills accurately by the lands and I used this property in the four facet drill sharpening jig published some years ago in MEW.

Bill Morris replies:

It really does not seem to matter greatly what thread you use as long as the closing cap and the body have the same one. I live in a remote area as far North as it is possible to get in New Zealand and (as I stated in the article), I didn't have a "real" collet chuck to examine. If I had owned one, I probably would not have bothered to make one from scratch. If I had been able to examine one, then I might well have adopted the standard, or perhaps as observed in the article, used a commercial closing cap. Having made it "my way", it does occur that the finer pitch should give higher closing and gripping forces for a given tightening torque.

Colin Usher writes:

Mention has been made from time to time of the EC Legislation commonly known as the WEE Directive. This is legislation covering Waste in Electrical & Electronic Equipment and comes into force in April 2006. One of the main targets of this legislation is Lead. This common metal is well known for being potentially hazardous and it is the intention of this legislation to ban the use of this and other dangerous substances in the Electrical & Electronics industry.

Solder is an alloy consisting of 40 parts Lead & 60 parts Tin (Sn60/Pb40) and its use goes back to at least Roman times. (there are literally hundreds of similar soldering alloys but most contain Lead in varying degrees) This alloy is much favored by the Electronics industry as it has " a eutectic composition ". That is, it goes from solid to liquid without a "pasty" or slushy stage.

All this may seem to be of little consequence to the Model Engineering world as the legislation does not directly affect our activities. It was proposed to ban leaded steels but this proposal has been dropped, at least for the time being. However, as virtually the sole market for 60/40 solder is the Electronics industry, it is almost certain that the traditional 60/40 solder and other similar leaded alloys will eventually disappear.

Most of the new lead free replacement solders are based on alloys of Tin/Copper/Silver. They are duller than traditional alloys, have higher melting points (+50C) but are stronger in all respects. As far as modelers are concerned the main drawback lies in their lack of "wetting". ie: it does not flow as well.

Currently the only short term solution for modelers, and this includes Model Aircraft, Boats, Cars, Electronics, Model Railways etc. is to build up a stock of your favourite solder. A couple of large reels will probably last most of us a lifetime. If you are a heavy user then you need to act accordingly. Fortunately cored solder wire has a very long shelf life. If tightly wrapped up well in an airtight bag, oxidation of the wire will be very low and is usually confined to the outer layers of wire, the rosin core used as a flux is virtually inert and will remain active more or less forever.

Any readers wishing further advice or information please contact Colin Usher e-mail indexes@colinusher.info

Robin Hale writes:

Being disabled, I read the article about the in-car hoist with interest, more so once I realised that the scooter featured was exactly the same as mine. Two things occurred to me about the article. Firstly, if the winch motor blew fuses, why not double the hoist cable back from the hook to the tip of the gallows, thus halving the motor load. Secondly, according to the manual for the scooter, it weighs only 34 Kgs, excluding battery. The battery is about the same weight as the seat. Since Mr Rawlinson loads the scooter without the seat, but with the battery, the scooter will weigh about 34Kgs as loaded, not 100kgs as estimated in the article. It occurs to me that anyone making this hoist as described Mr Rawlinson, but attempting to lift 100kgs might be in for a surprise.

Mr G. H. Anderson of Queensland Australia, writes:

I have attached a couple of photos of speed increasers made by me after prompting by the article in Issue 101. As was noted by a previous correspondent, the original, and my first version give reverse rotation. I overcame this by wiring a reversing switch into my mill/drill. However it was impractical to do the same with my drill press. I therefore constructed a second speed increaser, partly my design, which rotates correctly.

My units are: Mk 1 (Above) using Sturmey Archer gears and axle giving 3:1 ratio but reverse rotation. Mill/drill max rpm now 6000.

Mk.2 (lower) using gearbox pinions from manual shift cordless drill. Six pinions arranged as shown give 4.666:1 ratio. Mill/drill max rpm 9300 Approx. Drill press max rpm 11,600 approx.

All parts came from the magic scrap box.



Stan Bray writes:

I refer to the query from Mr. Carson in issue 104 regarding chuck keys. All good tool suppliers have a range of such keys, and should have one to suit. By all good tool suppliers, I mean the large companies such as Brown brothers, Buck and Hickman, Cromwell Tools etc. Cromwell list thirty-five different chuck keys of that type in their catalogue and no doubt, other companies have a similar range.

Should there be no success in purchasing one, then making a chuck key is a comparatively simple task and calls for no special equipment. They were regularly made by members of the forces during world war two, it being impossible to send for a replacement when one was needed at short notice.

Take a length of steel the outside diameter the same as that of the key segments, and turn down for the barrel. Without taking it from the chuck drill a hole right through the same diameter as the central spigot. Mark out the position of the number of teeth or segments required, put a hack-saw cut along each and simply file the teeth to the required shape; it is not a difficult operation. Next machine any tapers that are required. Fit a length of steel in the hole to act as a spigot, cross drill for the tommy bar, and the job is done. It was usual to hold the spigot in place with the tommy bar, but in this day and age, a retaining compound would make more sense.

As far as material is concerned, old car half shafts are in my opinion, the best metal for any job such as this and they are remarkably cheap to obtain. The local scrap merchant will usually let you have a couple of broken ones for a pound or so and they are useful for a variety of jobs.

I am a little surprised that these keys should break on a regular basis. Many years ago, I used to demonstrate the lathe at exhibitions and never had a problem with broken keys. I also own a Toyo ML1 that uses a similar key and have not had any problems at all, in spite of it being used extensively.

I wonder if perhaps the key is not being pushed into full engagement and so causing it to operate on a smaller area of the teeth than it was designed for. This might arise if the spigot is a little long or the holes a little shallow. Alternatively, if the holes that accept the spigot have become a little worn, this could allow the key to work at an angle.

Mr Guy Smith writes:

In reply to Mr. W Pendreigh's problem

Whilst I have no experience of Mr. Pendreigh's particular gearbox, a number of solutions have sprung to mind from my limited experience of working on similar units, albeit employing rubber belts. The suggestions are:

1. Replace the solid steel ring with a flat band of either rubber or perhaps leather
2. Increase the distance between the two shafts, similar to tensioning a vee belt

3. Decrease the distance between the two sliding cheeks, giving an increase in pulley PCD.

Taking point 3 (as one will probably find points 1 and 2 have been thought of and discounted) Mr. Pendreigh's drawing seems to indicate a thread linking the two sliding members. If this is so, then perhaps a quarter turn or so will have the necessary effect of tightening the drive ring. If the drawing is wrong then perhaps the insertion of some shim between the thrust bearing assembly and the sliding cheeks will have the effect of increasing the pulley PCD.

One final thought is the manufacture of a new slightly smaller drive ring, or building up one of wearing faces with weld (or metal spraying or vulcanising a rubber layer) and machining the drive ring to a wider width.

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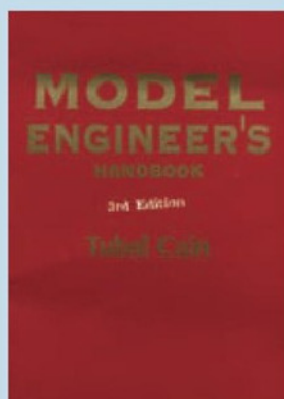
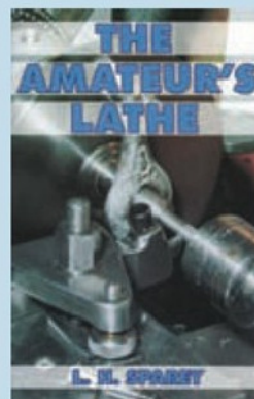
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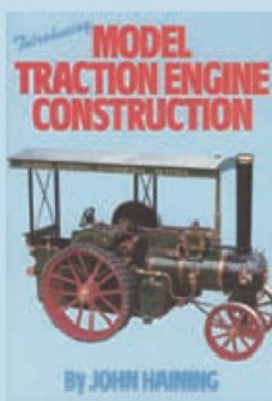
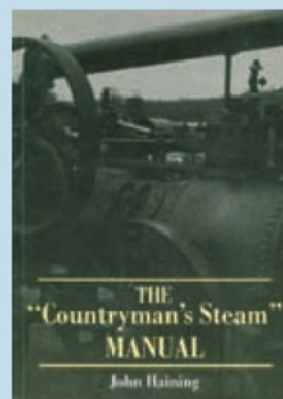
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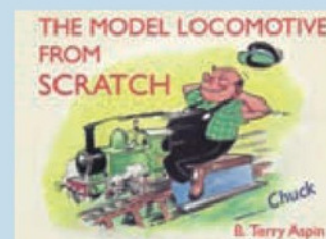
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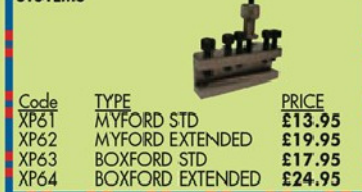
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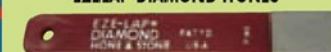
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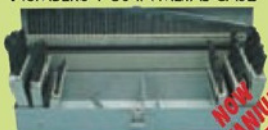
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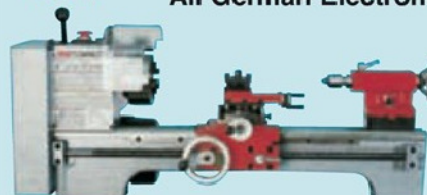
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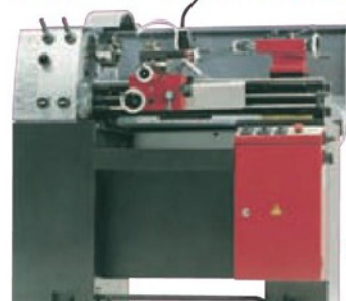
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- Halogen lighting
- Telescopic leadscrew covers
- Four way tool post

Also available as 750mm between centres.
£2,990.00



BH-600 Lathe ONLY £1,600 inc VAT & Delivery

For a limited period we will include a revolving centre, tailstock drill chuck and a set of 16mm index lathe tools FREE of charge!

Optional equipment

- Quick change tool post hardened and ground, supplied with 3 tool holders and parting off holder with blade £170 inc VAT with fitting kit to suit BH-600 fitting
- Coolant system £130 inc VAT
- Tailstock die holder £39 inc VAT

- THE ULTIMATE MODEL ENGINEERS LATHE
- HARDENED AND GROUND BEDWAYS
- TAPER ROLLER BEARING HEADSTOCK SPINDLE
- TEE SLOTTED CROSS SLIDE
- POWER CROSS FEED
- NORTON THREAD CUTTING GEARBOX
- 2HP SINGLE PHASE MOTOR
- BACK GEAR WITH 50 RPM LOW SPEED
- 1 3/8" SPINDLE BORE

- SUPPLIED WITH ACCESSORIES AT NO EXTRA CHARGE
- 6" 3 JAW CHUCK
 - 8" 4 JAW CHUCK
 - 10" FACE PLATE
 - FIXED & TRAVELLING STEADIES
 - FOUR WAY TOOL POST
 - IMP/MET THREADING
 - STAND, COOLANT TRAY, REAR SPLASH BACK



VMC Mill ONLY £1,450 inc VAT & Delivery

SUPPLIED WITH POWER FEED TO X TRAVEL AT NO EXTRA COST

- ILLUSTRATED WITH OPTIONAL D.R.O AND POWER FEEDS
- TABLE SIZE 26" X 6"
- MOTOR 1 1/2 HP
- AVAILABLE 3MT R8 - METRIC - IMPERIAL



BV-20 Lathe ONLY £525 inc VAT & Delivery

Optional floor stand £99

- FULL ENCLOSED GEARED HEADSTOCK
- SPEED SELECTION BY LEVER
- PRECISION GROUND VEE BEDWAYS
- LARGE BORE SPINDLE RUNNING ON TAPER ROLLER BEARINGS
- COVERED LEADSCREW
- SET OVER TAILSTOCK FACILITY
- INDIVIDUAL ACCURACY TEST REPORT
- SAFE ELECTRICAL INTERLOCKS TO CHUCK GUARD AND GEAR TRAIN COVER

SPECIFICATION:

- CENTRE HEIGHT 4"
- DISTANCE BETWEEN CENTRES 14"
- SWING OVER CROSS SLIDE 5"
- SPINDLE BORE 3/4" CLEARANCE
- SPINDLE SPEEDS (6) 140/1710 RPM
- HEADSTOCK TAPER 3MT
- TAILSTOCK TAPER 2MT
- RANGE OF IMPERIAL THREADS 8-24 TPI RANGE OF METRIC THREADS 0.4MM - 3MM
- MOTOR 1/2 HP 1 PHASE
- DIMENSIONS 38" LONG X 19" WIDE X 15" HIGH
- WEIGHT 230 LB

SUPPLIED WITH:

- 4" 3 JAW SELF CENTERING CHUCK
- 4" 4 JAW INDEPENDENT CHUCK
- FIXED STEADY
- TRAVELLING STEADY
- FACE PLATE
- FOUR WAY INDEXING TOOL POST
- 3MT AND 2MT DEAD CENTRES
- METRIC & IMPERIAL THREAD CUTTING CHANGE GEARS
- SWarf TRAY
- REAR CHIP GUARD



Warco Mini Lathe

ONLY £375 inc VAT & Delivery

- 3 1/2" CENTRE HEIGHT X 12" BETWEEN CENTRES
- SUPPLIED WITH 3 JAW CHUCK
- FACEPLATE
- THREADCUTTING
- COOLANT TRAY AND SPLASH BACK
- VARIABLE SPEED 0-2500RPM WITH BACK GEAR FOR MAXIMUM TORQUE
- HARDENED AND GROUND VEE BEDWAYS
- ACCURACY TEST CERTIFICATE WITH EACH LATHE
- RELIABLE USA BUILT PRINTED CIRCUIT BOARD - THE HEART OF THE MACHINE
- OPTIONAL ACCESSORIES STEADIES AND VERTICAL SLIDE.

Special offer

Tailstock drill chuck and TCT indexable lathe tool set with each machine.



Warco WMT 300/1

ONLY £799 inc VAT & Delivery

- Combination Lathe Mill
- 6" CENTRE HEIGHT X 20" BETWEEN CENTRES
 - SUPPLIED WITH:
 - 6" 3 JAW CHUCK
 - TEE SLOTTED FACE PLATE
 - FIXED AND TRAVELLING STEADIES
 - VICE
 - DRILL CHUCK
 - FACE CUTTER
 - LATHE TOOL SET
 - IMP/MET THREADCUTTING



Warco WMT 300/2

ONLY £1099 inc VAT & Delivery

- SAME CAPACITY AND ACCESSORIES AS THE WMT-300/1 WITH THE ADDED BENEFIT OF A LARGER MILLING TABLE - 17" X 6" COMPARED TO 8" X 6" RACK AND PINION FEED TO SADDLE AND LEFT HAND THREADING FACILITY.



Warco WMT 500

ONLY £1399 inc VAT & Delivery

- SIMILAR TO THE SPECIFICATION AND ACCESSORIES TO WMT-300/2. POWER CROSS FEED TO MILLING TABLE/CROSS SLIDE. DEEP THROAT FOR EXTRA MILLING CAPACITY.



WM-20 MILLING MACHINE NEW

ONLY £3,500 inc VAT & Delivery

- INVERTOR DRIVE - INFINITE SPEED CONTROL
- SPEED RANGE 25 - 1480RPM
- TABLE SIZE 9" X 36"
- R8 SPINDLE
- 1.5HP WILL OPERATE FROM 13AMP SOCKET
- WEIGHT 750KGS

ONLY £550

inc VAT & Delivery Optional Stand £89
Ideally matched to the BV-20 Lathe

Table size	654mm x 150mm
Longitudinal travel	455mm
Cross Travel	145mm
Spindle Stroke	90mm
Spindle Taper	3MT
Diameter of Spindle	63.5mm
Diameter of Column	66.65mm
Throat	165mm

Max distance spindle to table 320mm

Height with head at top of column	1067mm
Width	775mm
Depth	559mm
Spindle speeds	400-1640
Motor	1 phase 1/2hp with F/R switch
Weight	295lb
Head tilting	90-0-90 worm gear tilt mechanism



ZX-15 Milling Machine

Delivery UK-Mainland

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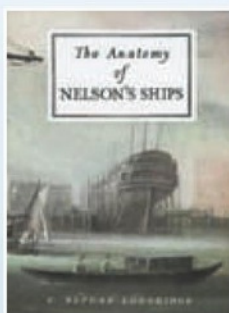
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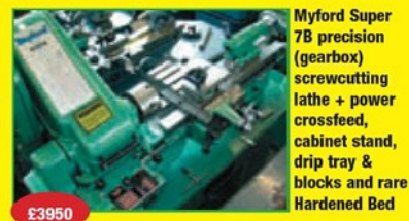
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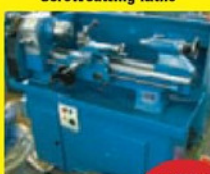
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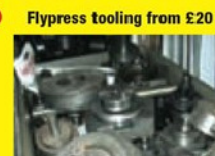


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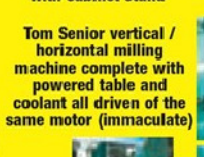
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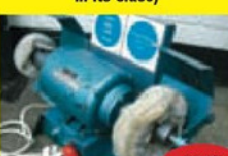
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- Spindle Taper MT5
- Spindle Speeds 50-1200rpm
- Metric Threads 0.25 to 7.5mm
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- Motor 1.5hp
- Power Supply 240volt

Standard Accessories

- 3 Jaw Self Centering Chuck 160mm
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- Machine Stand
- Fixed Steady
- Travelling Steady
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Features:

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