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MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

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12.	***UNF OR UNC TAP SET (2 Taps each size) & DIE SET:*** 1/8, 3/16, 1/4, 5/16, 3/8, 7/16, 1/2		***TAPS £18 SET*** ***DIES £18 SET***
13.	***UNF OR UNC TAP SET (2 Taps each size) & DIE SET:*** 9/16, 5/8, 3/4, 7/8, 1"		***TAPS £18 SET*** ***DIES £18 SET***
14.	***GAS (BSP) PIPE SET:*** 1/8, 1/4, 3/8, 1/2, 5/8, 3/4 (2 Taps each size)		***TAPS £30 SET*** ***DIES £25 SET***
15.	***METRIC FINE PITCH SETS*** (10 sizes from 3 - 12 m/m) TAPS & DIES		***(10) TAPS £18 SET*** ***DIES £25 SET***
16.	***METRIC FINE PITCH SETS*** (6 sizes from 14 - 24 m/m) TAPS & DIES		***(6) TAPS £18 SET*** ***DIES £25 SET***
17.	***ENDMILL SET (THREADED SHANK)*** [1/8, 3/16, 1/4, 5/16, 3/8, 7/16, 1/2] or (m/m 3, 4, 5, 6, 7, 8, 10, 12 m/m]		***£20 EACH SET***
18.	***SLOT DRILL SET (THREADED SHANK)*** [1/8, 3/16, 1/4, 5/16, 3/8, 7/16, 1/2] or (m/m 3, 4, 5, 6, 7, 8, 10, 12 m/m]		***£20 EACH SET***
19.	***ENDMILL SET,*** 5/8, 3/4, 7/8, 1" DIA. WITH 5/8 THREADED SHANK TO FIT COLLET CHUCK		***£25 SET OF 4***
20.	***COUNTERBORE SET (FOR SPOTFACING)*** [3/16, 1/4, 5/16, 3/8, 7/16, 1/2] OR [m/m 3, 4, 5, 6, 8 m/m]		***£30 EACH SET***
21.	***REAMER SET (STRAIGHT SHANK)*** [1/16, 3/32, 1/8, 5/32, 3/16, 1/4, 5/16, 3/8, 7/16, 1/2] or [m/m 2, 3, 4, 5, 6, 7, 8, 10, 12 m/m]		***£30 EACH SET***
22.	***DRILLS (LONG SERIES)*** 10 VARIOUS SIZES BETWEEN 1/16 - 5/16 STRAIGHT SHANK		***£6 LOT***
23.	***MORSE TAPER SOCKET REAMERS (FOR CLEANING MORSE TAPERS)*** *No. 0, 1, 2 M/T @ £18 EA.* *No. 3 @ £22.* *No. 4, 5, 6 m/t @ £35*		
	BALL-NOSE MILLING CUTTERS (THREADED SHANK) 1/8, 3/16, 1/4,		***£12 SET***
24.	***D-BIT SET (FOR DRILLING SQUARE BOTTOM HOLES)*** 1/16, 1/8, 3/16, 1/4, 5/16, 3/8, 7/16, 1/2 DIA		***£25 SET***
25.	***SLITTING SAW SET (HS) 3 PIECES,*** BETWEEN 1/64, - 1/16 (FINE TEETH)		*3" DIA @ £6 SET 2" DIA @ £5 SET*
26.	***CENTRE DRILL SET (HS)*** 1/8, 3/16, 1/4, 5/16, 7/16 ***@ £5 SET***	1/2 INDEXABLE ENDMILL (THREADED SHANK) ***@ £14 WITH TIP***	
27.	***TAPER SHANK DRILLS (No. 1 M/T)*** 10 VARIOUS SIZES UP TO 1/2 DIA		***@ £10***
28.	***DRILL SETS (HS) GROUND FLUTES,*** *No. 1 - 60 A - Z* ***@ £18,*** 1/16 - 1/2 *1 - 13m/m* ***@ £16,*** *1 - 6m/m x .1m/m* ***@ £18,*** *6 - 10m/m* ***@ £25 SET***		
	DIAL GAUGES (M/M OR IMP) ***@ £10 EACH*** ***STAINLESS STEEL DIAL CALIPERS*** (M/M OR IMP) ***@ £12 EACH*** ***MAGNETIC BASE @ £15 EACH***		
	WOODRUFFE CUTTER SET 1/4 .5/16 .3/8 ***@ £15 SET*** ***EXPANDING REAMER SET,*** FROM 1/4 - 1/2 ***@ £45 BOX*** ***RE-THREADING FILES*** (IMP OR M/M) ***@ £6 EACH***		
29.	***INVOLUTE GEAR CUTTERS*** - ALL SIZES FROM 2 DP - 120 DP, INCL. MODULE & CP. [ALSO STUB, BEVEL & SPROCKET CHAIN]		***@ £18 EACH***
30.	***TAPER PIN REAMER SET.*** 1/16, 5/64, 3/32, 7/64, 1/8, 5/32, 11/64, 3/16, 1/4, 7/16 (10 PIECE SET - SHEFFIELD MADE)		***@ £30 SET***
31.	***COLLET CHUCK, TO TAKE THREADED ENDMILLS,*** UP TO 1" DIA (2m/t, 3 m/t, R8 SHANK) IN STRONG WOODEN BOX		***@ £70 COMPLETE***
32.	***LATHE TOOLS (SET OF 8)*** 1/4 SQUARE VARIOUS SHAPES	IN HSS ***@ £15*** SET, OR CARBIDE TIPPED ***@ £18 SET***	
33.	***REVOLVING LATHE CENTRES,*** 1 M/T ***@ £18;*** 2,3 M/T ***@20*** ***DRILL GAUGES,*** IMP, M/M , LETTER, NUMBER ***@ £4 EACH*** 10 SMALL BURRS ***@ £5 LOT***		
34.	***DRILLS*** WITH 1/2 SHANK 9/16, 5/8, 3/4, 7/8, 1" DIA ***@ £18 SET*** ***DRILLS*** BELOW 1/4, DIA ***@ 50p ALL SIZES*** ***COVENTRY DIEHEAD CHASES*** - ALL SIZES		
35.	***3-WAY PRECISION ANGLE VICE, 50 m/m JAWS, 180 DEGREE COMPLETE CIRCLE***		***@ £80 + POSTAGE***
36.	***INDEXABLE TOOL HOLDERS (SWISS)*** 3/8 SHANK OR 1/2 SHANK		***@ £10 EACH, WITH TIP [EXTRA TIPS £2]***
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38.	***VARIOUS DRILLS,*** BELOW 1/4 DIA. ***10 EACH.*** STUB, QUICK SPIRAL, SLOW SPIRAL, LEFT HAND, ***@ £5 EACH TYPE***		
39.	***KNURLING TOOLS.*** 2 WHEEL SIZE ***@ £5,*** 6 WHEEL SIZE ***@ £10 (SPARE KNURLS £2 EACH)***		
40.	***ROHM PRECISION DRILL CHUCKS,*** WITH No. 1 OR No. 2 MORSE TAPER ARBOR	5/16 ***@ £7,*** 3/8 ***@ £8,*** 1/2 ***@ £10***	

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CTC500	5 Dr. cabinet	35Kg	£84.95	£99.82
CTC800	5 Dr. Chest/cab	19Kg	£84.95	£99.82
CTC700	7 Dr. cabinet	35Kg	£99.96	£117.45
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Includes free:

- Face mask
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*Turbo fan cooled for longer welding at full output

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Full range of accessories available

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- Compound slide with 4 way tool post
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CM145	150mm/6" Digital Vernier	£19.95	£23.44

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- 1.5Hp
- 24Ltr

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

Clarke ANGLE GRINDERS

Inc. disc & handle

FROM ONLY £24.95 EX VAT £29.32 INC VAT

MODEL	DISC SIZE	MOTOR	EX VAT	INC VAT
CAG115C	115mm	720w	£24.95	£29.32
CAG115	115mm	500w	£25.95	£30.49
CAG232	230mm	2000w	£29.95	£35.19
CON115	115mm	1010w	£29.95	£35.19

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HEAVY DUTY CWB1250

ONLY £49.95 EX VAT £58.69 INC VAT

- Large lockable cabinet
- Extra thick, reversible plywood faced worktop
- LWH: 1205x600x850mm
- Constructed from robust, heavy gauge steel

Clarke DRILL PRESSES

- Tables tilt 0-45° left and right
- Depth gauge
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MODEL	WATTS/SPEEDS	EX VAT	INC VAT
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CDP151B	300/5	£79.95	£93.94
CDP201B	370/12	£99.95	£117.44
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‡ REDUCED! CDP101B Was £64.57 inc.VAT

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CMD10

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- 150w/230v motor
- Variable speed 1000-2000rpm
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- Face mill capacity 20mm, end mill 10mm
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CSK100

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Kit Box Included

- 100w soldering gun
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CL300M

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PRO12C

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Air Hammer	CAT29B	£15.95	£18.74
Die Grinder Set	CAT36B	£19.95	£23.44
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- Spray pattern adjustable

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- Double action trigger for accurate air/paint control
- Precision machined nozzle
- Special lightweight hose

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- 1,020 ltr/h Max pump rate

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- Runners for optional drawer units

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CWB1500	1500x650x880	£149.95	£176.19
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Atmospheric Forge & Heat Treat Oven • Goodman & Holmes • £12.35
The first book from David J. Gingery Publishing not written by Dave or Vince Gingery, it only takes a quick glance at this to see why they were keen to publish it. Not only does this propane fired forge look good, it is ergonomically designed and extremely efficient - it will reach 2500 degrees in 2.5 mins from a cold start, and reduce a bottle to molten glass in 25 seconds. No fan or blower are needed, so there are no electrical connections. The oven has large openings at either end, so multiple jobs can be done at the same time, or one long piece can be worked on. And the opening means that this unit can also be used to melt aluminium and other metals, so it can be used for foundrywork. It is also straightforward to build - it is made from heavy gauge steel, so a metal cutting saw and a welder are needed, but they are the only major equipment you require. A great, and useful, project. 72 page paperback with 91 drawings and illustrations.

Aircraft Welding • 1942 • Elzea • £13.70
As a guide to oxy-acetylene welding this is hard to beat. Published in 1942 when wartime aircraft production was at its height, and skilled welders were in great demand, it is extremely clear and concise on all aspects of welding, obviously with reference to the aircraft of the period, so this is invaluable to those working on veteran aircraft. For others it is equally good, although it should be stressed that the brazing of copper, brass & gunmetal is not dealt with, steel, aluminium and stainless steel being the metals covered. 121 page larger format paperback crammed with drawings, diagrams, photos and charts.

Metal Casting: A Sand Casting Manual for the Small Foundry • Vol. 1 • £15.70
Metal Casting: A Sand Casting Manual for the Small Foundry • Vol. 2 • £15.70
Two excellent volumes from Steve Chastain which give a good and very comprehensive introduction to casting skills. The main headings in Vol. 1 are: *The Sand Casting Process, Foundry Projects* (including a *Match Plate Vibrator*), *Melting Equipment* (including simple charcoal and gas furnaces), *Temperature Measurement, Foundry Sands and Binders*, and *Coremaking*. In Vol. 2 they are: *Solidification of Metals, Aluminium Alloys, Copper Alloys, Brass & Bronze, Metallurgy of Iron, Gating Systems, Risers and Feeding of Castings, Pattern Making, Foundry Projects* and *Automotive Castings*. These books are focused on a generally low-tech approach applicable to anyone melting metal at home; they cover the ground well and are written in a concise and understandable way. 206 & 192 pages paperbacks respectively, full of photos, drawings tables and other helpful information.

Learning the Lost Art of Hand Scraping • 1880-1919 • £ 4.95
This book not only replaces *Old Time Mechanics*, it also includes it, along with 7 other articles on Hand Scraping. This is a skill learnt by practice rather than reading, but there is a lot of good stuff here to help you get started, notably on grinding a scraper to the right shape. 48 well illustrated pages. Softcover.

How I Pour Babbitt Bearings • Gingery • £ 7.70
In this book Vince Gingery gives a brief look at this type of bearing and then gets down to the business of explaining how to clean old bearings, re-metal them and prepare them for re-fitting. Usual clear and concise Gingery information. 43 well produced pages. 59 photos and drawings. Paperback.

The Amateur's Lathe • Sparey • £ 10.60
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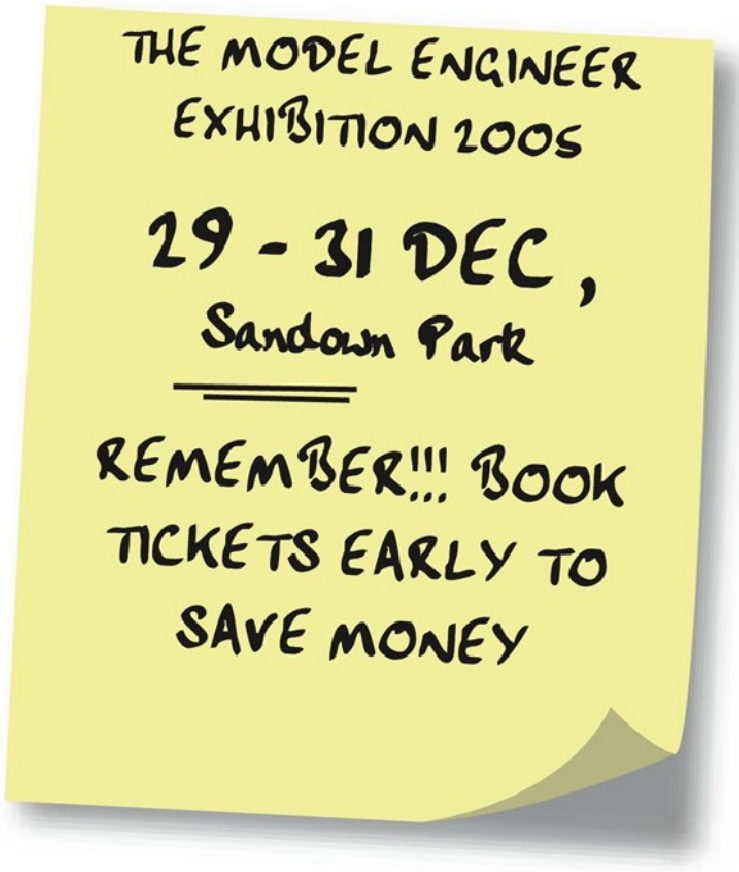
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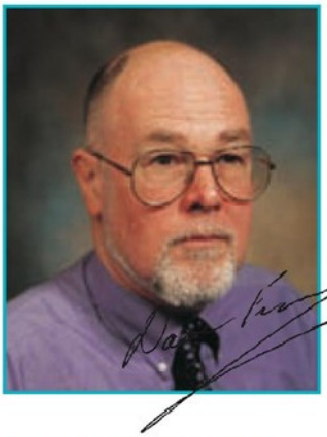


REMAP 2005 Yearbook

I am well aware that quite a number of readers are actively involved with Remap or one of the similar organisations overseas. For those who may not be aware, the charity functions to provide "a unique service to anyone who is unable to carry out daily tasks because of some form of disability" dealing with people very much as individuals, and solving problems which commercially available equipment does not address. At the "coal face" are local panels of multi disciplinary volunteers which may include engineers, designers etc, working along with health professionals. The ninety-six page yearbook describes in some 23 Hamilton Index categories, many of the aids produced within the last year, but acknowledges that those featured represent just a sample of the 3500 cases normally handled annually.

Devices range from the simple such as a Car Start Key Aid, a "U" shaped metal holder which contains the key, and permits leverage to be easily applied, to the more complex Electronic Aid for a Deaf Client, who was unable to tell if he was shouting during a normal conversation. The solution here comprises a belt mounted device which compares the level of the clients voice with the ambient noise, and vibrates if a set difference is exceeded.

Like any other charity, Remap seeks funds, but unlike most others welcomes assistance from volunteers with workshop facilities. If you are interested in learning more, the year book is available, price £5.60 from Remap, 9D Chaucer Business Park, Kemsing, Sevenoaks, Kent, TN15 6YU or phone 0845 1300 456

In the workshop

A straightforward refurbishment

The winter storms brought flash floods to many parts of the country and further north, a number of areas close to rivers were affected (in some cases just for a matter of hours). However, it's an ill wind.

One of the consequences was that our model engineering club fell heir to some water damaged woodworking machinery, and I became volunteered to strip, assess, and if possible repair the first of these, a Record band saw, which had been submerged up to an inch or so above the table.

With the blade and belt drive removed, it was apparent that the lower blade guide bearings had seized, as had the motor. Water had not reached the upper guides or wheel, and the lower wheel rotated freely.

The guide bearing assembly was removed, and then the individual bearings unbolted. Replacing the guide bearings was then a straightforward matter of fitting new, obtained from one of our regular suppliers.

Before taking off the motor, the cable was first disconnected from the plastic housing which also contains a capacitor. Removing four M6 bolts then allowed the motor to be lifted away. Before removing the poly vee pulley, its axial position on the shaft was noted after measurement with a depth gauge. This would later save time at reassembly in achieving the correct position. Next to come off were the fan cover and plastic fan. Six screws, (three at each end) which retain the motor end covers were then removed, and a significant quantity of water then ran out of the motor. Gentle application of plastic mallet and levers achieved the removal of both ends without damage. The motor windings could then be electrically checked and no shorts were evident.

On another occasion some time ago, when stripping a seized motor of unknown provenance, I found that the bearings were perfectly OK, but the rotor had become rusted to the stator. In that instance, a few taps with the mallet got the rotor out, and after a good clean up all was as good as new. Here the situation was reversed. Relatively little rusting had occurred to the surfaces of the rotor and stator, but the bearings were indeed stuck fast. Interestingly, after being extracted from the shaft, they did once again rotate fairly smoothly, but I would expect the pulling process (applied to the outer rings) to have caused some brinelling of the tracks. In any case, having dismantled the items, it would be false economy not to replace. Again a new pair of bearings gave the necessary rejuvenation. Interestingly, this motor is of the type where both sets of windings are energised all the time, i.e. there is no centrifugal switch to cut the starter windings. Had there been one, then it would have been necessary to check it out for correct operation, and probably lubricate the pivots.

The motor was reassembled, the pulley fitted, and the assembly returned to the saw. After refitting the table and a blade, the guides were adjusted and the machine electrically checked with a meter before initial switch on.

"Kennet" style assembly with Wickes double-ended grinder

New projects

One of the items offered for sale at our club's recent "Bring and Buy" was a part built tool and cutter grinder based on the Kennet which is available from Model Engineering Services. Knowing the builder, I had no doubts about the quality and managed a successful bid. The principal items missing were a motor and switch, and my first thoughts turned to unearthing a spare half horsepower motor and switch. I then remembered Harold Hall's use of a cheap bench grinder for a similar application, and visited B&Q and Wickes. The first of these had a 150watt grinder priced at about £17.00, and while I was examining it, another customer commented that Wickes offered a more substantial unit for about £20.00. Five minutes later I had popped across the road and purchased the said item, a six inch 250watt grinder fitted with two wheels, all for the price quoted. As with that used by Harold, a bit of attention will be needed to improve the squareness of the wheel location, and then some thought as to the best means of mounting. Here I am keen to add to the basic versatility by arranging that the "wheel head" should be able to rotate about a vertical axis, to make best use of both ends, and of different types of wheel. Thinking ahead, it may be useful to have a green grit wheel at one end, and a diamond at the other for rough and fine work on carbide tooling.

In a recent issue, I commented that another of the stepper drives on the Matchmaker had expired. The larger stepper motors and drives are now in stock at Arc Euro Trade, and I was probably first in the queue for a couple of each. With a torque rating of 6.5Nm which equates to about 900oz.in. these motors should have the grunt to handle CNC conversions on Bridgeport size machinery. The whole Matchmaker system will now be reconfigured to operate with these motors on 34volts D.C. There will undoubtedly be some trials and tribulations encountered during the conversion, and these will be covered in a future issue.

1. Three useful scribers.

DRILLING HOLES IN THE RIGHT PLACE

Bob Loader discusses a variety of techniques

Drilling is an indispensable operation. If you cannot drill accurately, you will find making anything difficult. A shame then, that it can be a neglected part of our hobby. We expect to put a drill into a chuck and use it, with little attention to anything other than shoving it through the material. Alas, there is more to it than that.

Problems with marking for drilling

Fig 1 shows some of the difficulties in putting a centre punch mark in the right place. To begin with, a scriber ploughs a furrow in the material, the depth and width of it will depend on the force used and the sharpness of the scriber. The ideal is the scriber mark in **Fig 1B**, the 'furrow' is deep enough to locate the punch without it lodging against the dip caused by the distortion, sometimes not easy to dodge. The larger the punch mark, the greater the distortion, as in **Fig 1A**. The worst case, **Fig 1C** is where the furrow is so big that the punch will drop into the wrong place. All the drawings have, of course, been enlarged and in some cases grossly distorted to make the point.

Small drills like the one in **Fig 1D** will bend, given the slightest encouragement so it is always a good idea to use a centre drill, which will often ignore the furrow and start true. Even when a false start has been made, it can be corrected by starting again carefully, as in **Fig 1E**, and it is possible to pull a centre drill over, as long as it isn't too deep. Do not try this with a centre drill

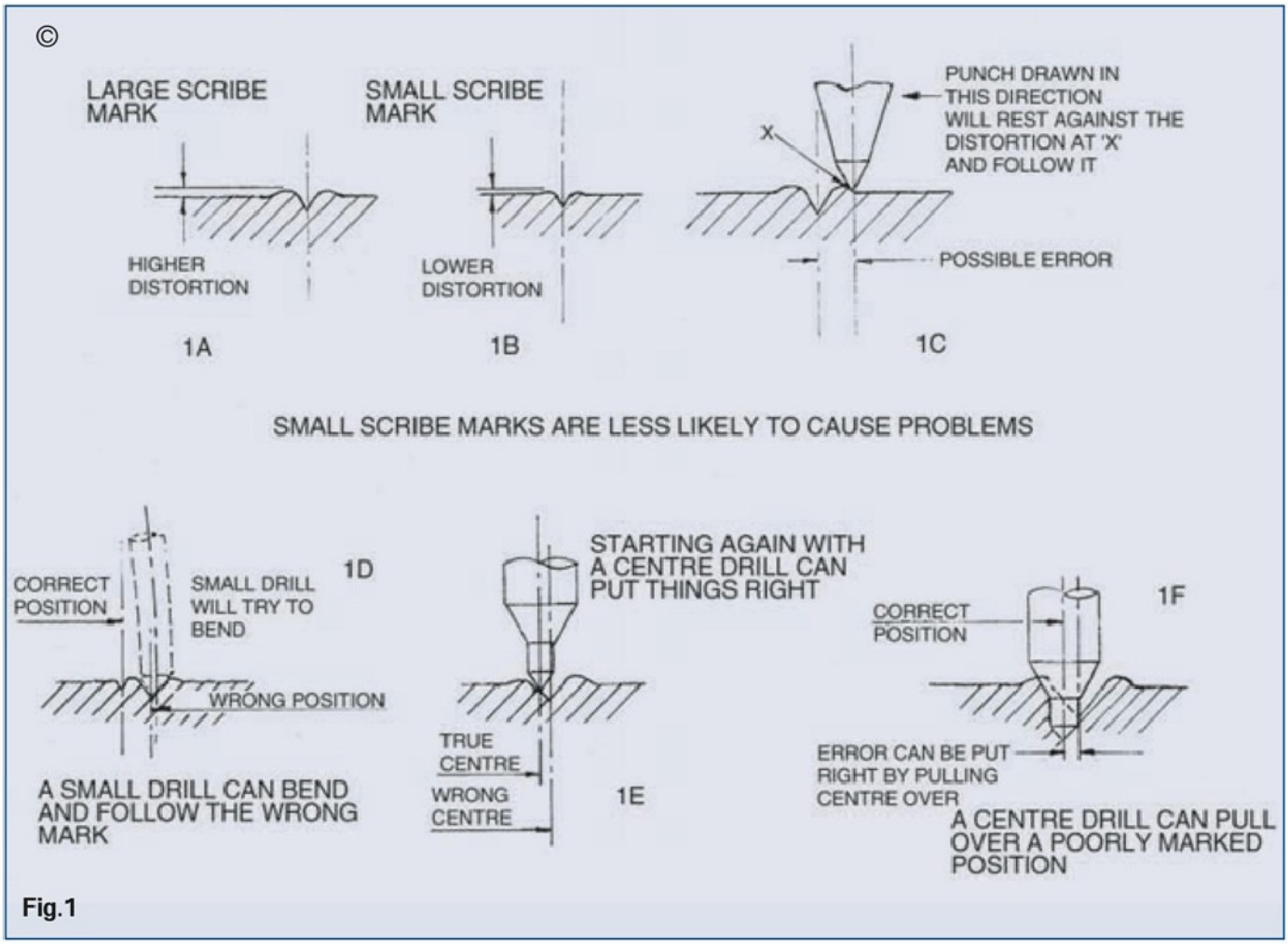
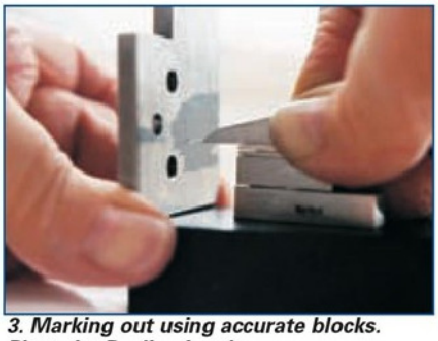


Fig.1

2. A component marked out using a marker pen.



3. Marking out using accurate blocks. Photo by Pauline Loader.

4. A selection of blocks for marking out.

smaller than a No.3; small ones have a very fragile pilot. A lot depends on the marking and therefore on the scriber used.

Scribers

Photo 1 shows three scribers. The left-hand one is a favourite of mine and is out of a combination square, fitting into the base of the square head. It is an ideal size and shape and should be kept stoned to a sharp point for about the last 3mm. For very fine marking, the middle one is one of Pauline's sewing needles held in a pin chuck, there is a variety of thicknesses, all of them useful in one way or another, but always ask first, or buy your own packet. The right-hand one looks a bit of a shambles and it has had no attention for some time. It was made from a piece of ¼in.high speed steel, I use it mostly for rough work and it cuts a goodly furrow and, looking at the photo, urgently needs re-pointing.

For some materials, a scriber is bad news, especially if the work surface is highly finished, even the lightest scribed lines take a lot of cleaning off afterwards. One solution is to use a finely sharpened pencil, see **photo 15** It is also a useful way of marking a bend line in the softer metals, like the softer brasses and aluminium alloys where a scribed line can easily turn into a crack.

Make it visible

Photo 2 shows a component marked out for a drilling operation. The scribed lines show up well against the patches made by a marker pen. It stays put very well, even when scratched by swarf and I have used it on a variety of materials. Should I need a dark colour on steel, I temper it to a purple or blue colour and quench it in oil. Lines show up well and will stay. It is a good method for work which may have to be left unfinished for a while. Keep scribers sharp, preferably by stoning them and avoid making a needle point. The last little bit is best with an included angle of about 20°, it will be stronger and last longer.

Use every possible aid

When centre punching a hole position, use an eye glass, it is surprising how inaccurate a punch mark can be when looked at closely with some magnification and it is easily put right by angling the punch the right way. There are ways of assuring precision if it is important, the best way is to use a vernier height gauge if you have one; if you haven't it is possible to improvise by using a similar scriber on a stack of precision blocks, **photo 3**. I was lucky to acquire some accurately ground blocks, **photo 4**, which were rejected for some reason. They are ground flat and parallel. The odd one out marked "Matrix" is an internal caliper jaw from a slip gauge accessory set which was dropped and snapped off. For the last awkward little bit, which always crops up, you can use feelers or things like cooking foil. A set of blocks can be made from turned bits and pieces or anything which can be made parallel.

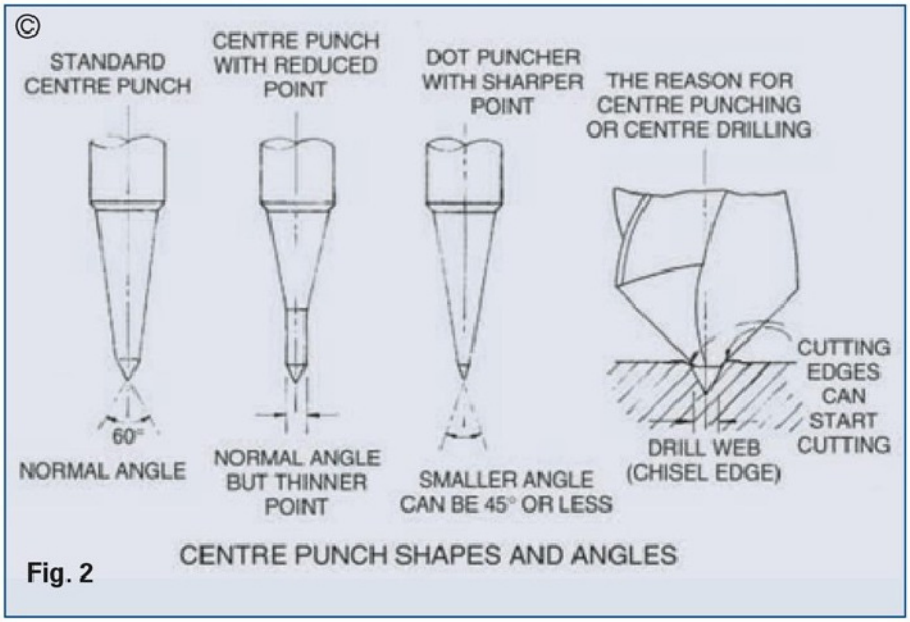


Fig. 2

Aids for centre punching

There are one or two gadgets, which can make the marking of a centre easier. One, which is very good, is the optical centre finder and there are many versions in the tool catalogues. The system is to line up the marked centre lines with a graticule in the finder. Once lined up the graticule is replaced with a punch and the punch lightly tapped. They are accurate and can be made and there have been articles on the making. My favourite way for marking a centre is to use a dot punch like the one in **Fig 2**. The sharper point angle will find a precise position more easily, and it can be deepened with the standard one, also in **Fig.2**.

Another useful punch is the one with the reduced point; it is easier to see exactly where the point is. **Photo 5** shows the reduced point centre punch and another of my collection.

Why use a centre punch?

A good question, and for a graphic answer have a look at the last sketch in **Fig 2**. It shows an enlarged view of the chisel edge at the point of any drill. The trouble is that it isn't a point at all. If a drill came to a point it would fall in half. The chisel edge

5. Two favourite centre punches.

6. A drill just starting to cut, note the small shiny flat where the chisel edge does not cut.

is a core, which goes all the way up the cutting part. The punch mark allows the chisel edge to fall into place, and the cutting edges to start cutting. **Photo 6** is of a partly drilled hole; notice the shiny bit in the middle where the chisel edge has been rubbing. If you still have doubts, try to get a ½in. drill started without a punch mark. About half of the power used to drive a drill is absorbed in driving the chisel edge, a good reason to use a pilot drill. Some drills are seen nowadays ground with a sort of "sub point" so that the chisel edge is very much reduced, and, in fact, forms further cutting edges.

Drill construction

Fig 3 shows the details of a twist drill. The point angle shown as 59deg. each side can be thought of as 60deg. There are so many variables that approximately 60deg. is quite good enough long as the lengths marked X and Y are equal. As for the rest, without lip clearance it would not cut. 8 to 12deg. is enough, any more would make the cutting edges too weak. If the lip clearance is right, the angle from web to cutting edge will be about 120deg.

Like any cutting tool, a drill must have rake and clearance. Rake is the angle of twist, usually about 30deg. for general use, but it can be more for different materials like the soft and ductile ones, or less for the hard and brittle ones.

Other features of the drill are not so obvious. There is a cutting land which is a

7. A short drill which has had the web thinned.

strip left when the body is machined. It stands proud and makes sure that the drill does not rub. Another even less obvious one is longitudinal clearance, which means that the drill is nominal diameter at the point, but decreases very slightly towards the shank. It is a very small amount, about 0.0007 in. per inch of length. Like the body clearance, it helps to stop the drill rubbing and is of little practical interest, but if ever you have to drill an accurate hole with a standard drill, choose the shortest one you can find, grind it super-accurately and use a pilot drill, so that there is just a small amount of material to take out. It may work.

It raises another problem which is shown in **Fig 4**, the shorter a drill gets, thicker the web. As the web is the core of the drill, and hence the chisel edge, this means that the edge gets shorter and the cutting efficiency reduces. Thus we need to consider reducing the web; it is one of the modifications which sometimes have to be done.

Drill modifications

When the drill web gets too thick it can be ground back to thin it, **Fig 4**. As long as the grinding follows the flute angle and an equal amount is taken off each side, the drill will cut well. It is more essential for the larger drills. For any under ¼in. it is probably not worth the bother and it is doubtful if most of us would have a grinding wheel with a sharp enough corner to get into the flute. (You might manage with one of the "Mini Tools"). **Photo 7** shows a drill which has had its web thinned.

Backing off the rake

Drilling some materials can be a bit dodgy because of the kick when the drill breaks through. It happens especially with hard brass, the 60/40 type which comes off in a rasping shower when cut. I have been damaged by this, see **photo 8** for the scars. So I'd like to add my two penn'orth to the comments from Mr. Robin Beare, who, some issues back, telephoned and wrote to the editor with a reminder to be careful when drilling. He is a surgeon who has seen some of the injuries. My experience was not so drastic as some but

8. Two scars, the result of careless drilling.

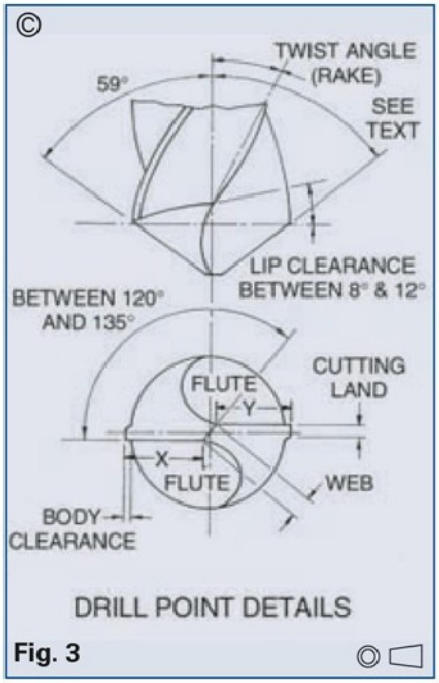


Fig. 3

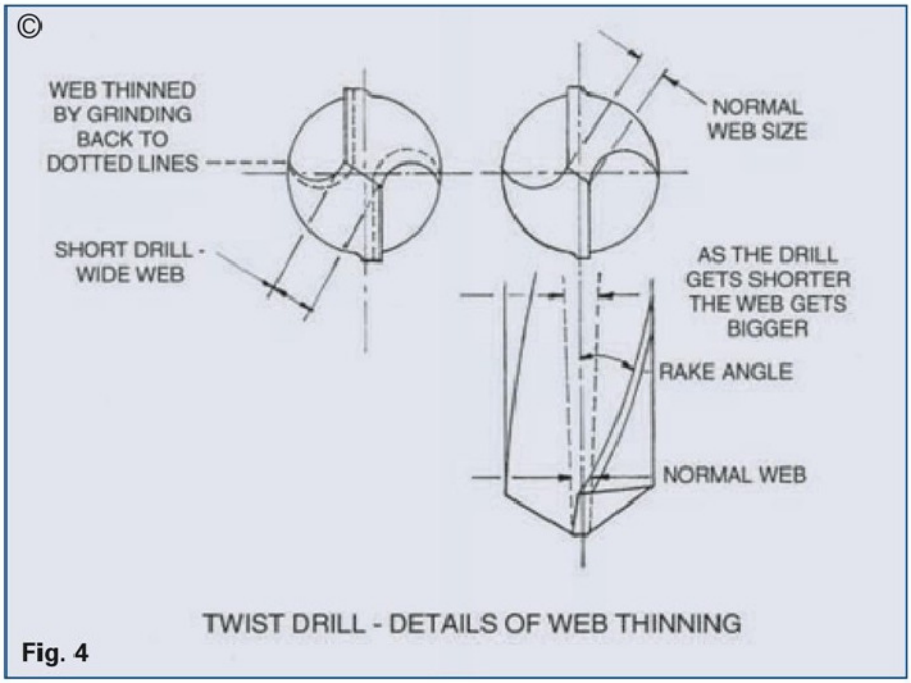


Fig. 4

9. A drill which has had the rake backed off to stop it jumping.

it is a happening I'd rather not repeat. I had four blocks to drill with a ½in.hole. Three of the blocks were 70/30 brass, which machines beautifully, the fourth and last to be drilled was 60/40, it shot up the drill, whizzed round, taking the unclamped vice with it and inflicting the cuts shown. I learned several important lessons in one go back in 1949. The remedy for work, which is likely to jump up the drill, is to reduce the rake angle. **Photo 9** is of a drill, which has been modified in this way, and **photo 10** shows it being done on a smaller drill using a diamond hone. It does not need a great deal of flattening in the smaller sizes, just enough to reduce the rake angle to zero for the first ¼in.or so.

Long series drills

Photo 11 shows a standard drill and a long series one for comparison. They are the same except that they have a different cutting length. In the example photographed, the long series one also has a smaller rake angle than the standard one, making it suitable for the harder and more brittle metals. The long ones are used for deep holes and where the drill has to reach a long way. They will clog up easily with swarf and need constant clearing.

Home-made long series drills

These can be made by silver soldering a standard drill into a mild steel extension. The drill shank is turned down to a spigot, which is a close fit in a drilled hole in the extension. Drill shanks are left soft and turn easily. The hole in the extension should be drilled a bit deeper than the length of the spigot and do not forget to cut a small slot at the bottom of the hole to let the air out, or the solder will not penetrate and the drill will keep popping out when the air expands. Bury the business end in damp sand when soldering to limit any heat effect. A long series drill can sometimes be the only way to do some jobs. I once had to supervise a student who had to make a tube 12in. long with a bore of ⅝in. and an outside diameter of 1in. It was not an easy job and the lathe had to have two steadies, one at the drilling end and one

10. A smaller drill having its rake reduced. Photo-Pauline Loader.

further up the bed. It took a long time, with much withdrawing of the drill to clear the swarf. Because the bore and the outside diameter had to be concentric, the job started at 1¼in.diameter and was finished by turning between centres.

Core drills

These are worth a mention because they are good for opening up holes, which have been punched, forged or cast into the material. Such holes are rarely truly round and an ordinary drill would jump about. Because a core drill usually has three flutes, it will find a true centre of rotation. They cannot drill a hole from the start, only open one up.

Some improvisations

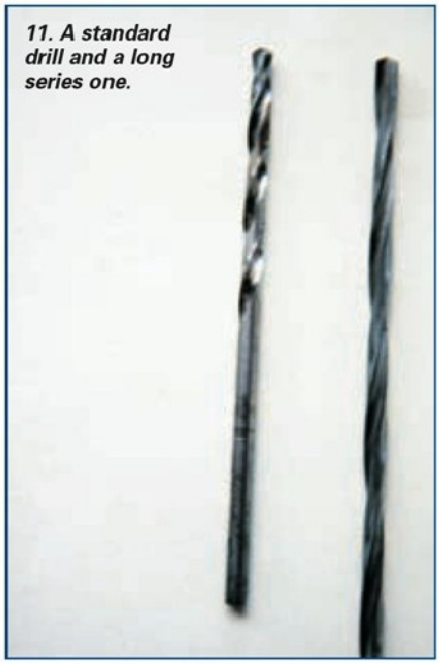
If a drill is needed and you do not have the precise size to hand, the problem can sometimes be solved by making a "D" bit, or if this is not the answer, a drill can perhaps be modified. If the size needed is slightly smaller, the lands can be rubbed down by holding the drill in a lathe or drilling machine and using a stone or diamond hone like a file. It will only be suitable for very small amounts. Some thin oil or paraffin will help and the drill should be discarded or put in a special box so that it will not be used for its original marked size. It is a technique only used as a last resort, I have known it used, but it was to reduce the drill by a few thousandths only.

Drilling oversize

The more realistic among us will say that you only have to use a drill straight out of the box to get an oversized hole. If the amount of oversize isn't too much the problem can sometimes be solved by grinding the drill slightly one-legged with one cutting edge a bit longer than the other, it means that the dimensions marked, 'X' and 'Y' in **Fig 3** are ground unevenly. It needs a lot of fiddling about to get it right and the drill must be re-ground to the right shape afterwards.

Flat bottoming

This sometimes has to be done to seat a screw or bolt. The hole is drilled to depth first, then the drill is ground off flat and the cutting edges given a bit of clearance. Re-grind it when finished with. My advice would always be to use a slot drill) it is a lot easier.



11. A standard drill and a long series one.

Sharpening

A nicely sharpened drill will need very little pressure once it gets going, an equal amount of swarf should come up each flute and when the hole is finished there should only be a small burr. When I was an apprentice, I was lucky to have a succession of apprentice masters who showed me how to grind a drill and made me practice frequently. They made practice a time filler for any of those times between one thing and another when I was not, in their view, gainfully employed. They were quite good at commenting on my efforts in various scathing terms. One of them compared my skill to that of a Patagonian peanut picker. It took a long time to learn but I got there in the finish, but it is a good reason for investing in a drill grinding attachment. The trouble with drill grinding is that it is a compound movement, the drill is held with the cutting edge at 90° to the wheel surface, it is given a twist to the right and the shank is lowered at the same time. Drills smaller than about ⅛in. can be held against the wheel at the right angle and ground without bothering about the fancy twisting. Life really gets interesting when drills of the very small diameters have to be sharpened. Do not bother with any grinding wheel, however fine because the minute the drill touches it, one of two outcomes is likely. Either it will snap, or if you are lucky, it will stay in one piece, but in an instant you will have ground all the way across both edges. Use a fine India stone or diamond lap and an eye glass to see what you are doing. I found this out the hard way when I had broken the last No.80 drill in the stores and had to find a way of sharpening it. A No. 80 is 0.0135 in. dia. and once I could deal with that one, I felt ready to tackle any drill.

Some of the pioneers

We owe a huge debt to all those who worked on the ways and means of drilling. Some of the names live on, like the Morse family who put the twist in the drill to

12. A component marked, boxed and centre punched ready for the drilling.

13. Where the holes do not fit the box, they are punched over.

14. With the holes corrected, the drilling can be finished.

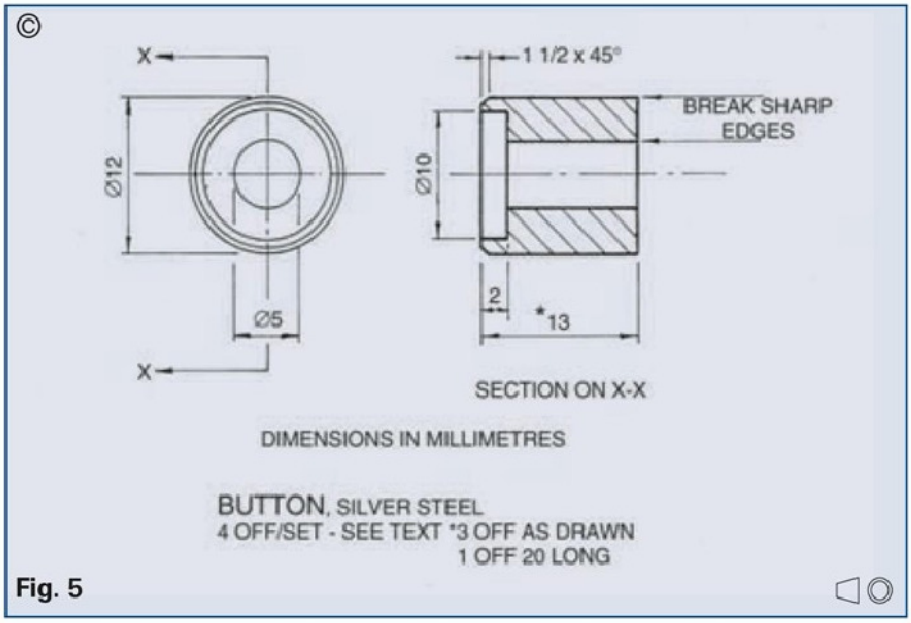
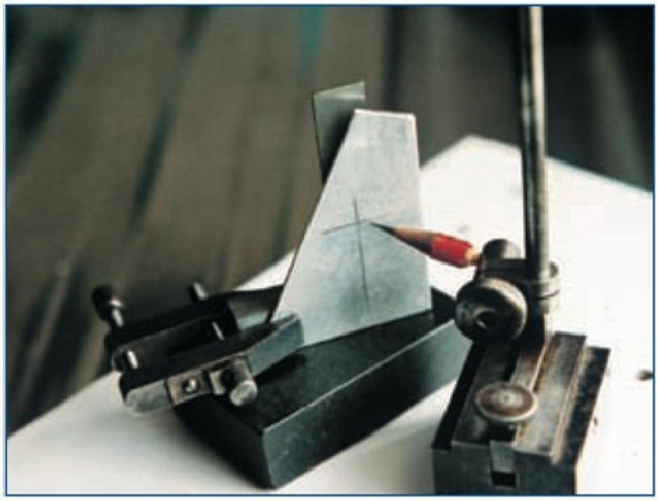


Fig. 5

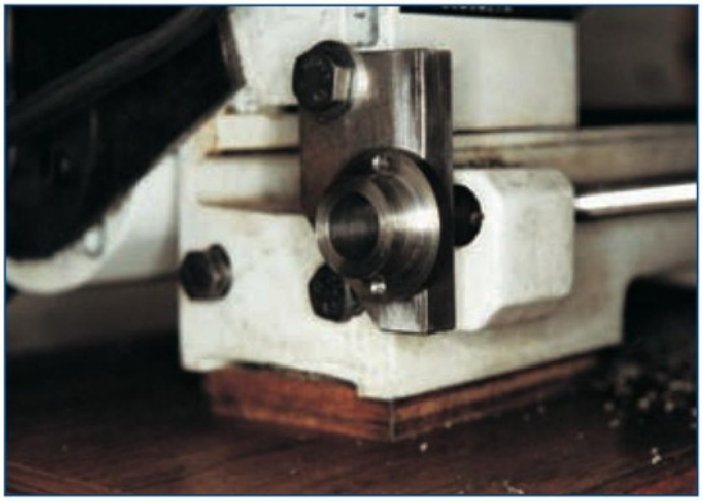
make it cut easier. They were also involved in the development of the taper, which has their name. Another famous name is J. R. Brown of the machine tool builders. He found out how to adapt a milling machine to mill a helix and thus machine the twist. So treasure your drills, a lot of skill and thought has gone into the making of them. Putting holes in the right place touches on some of the more precise positioning techniques, which can be useful. There is a couple of old methods, which are within the scope of a reasonably equipped home workshop. One way is easy but a bit tedious and called 'boxing'. The other one needs a bit more tackle and is 'button boring'.

Hole boxing

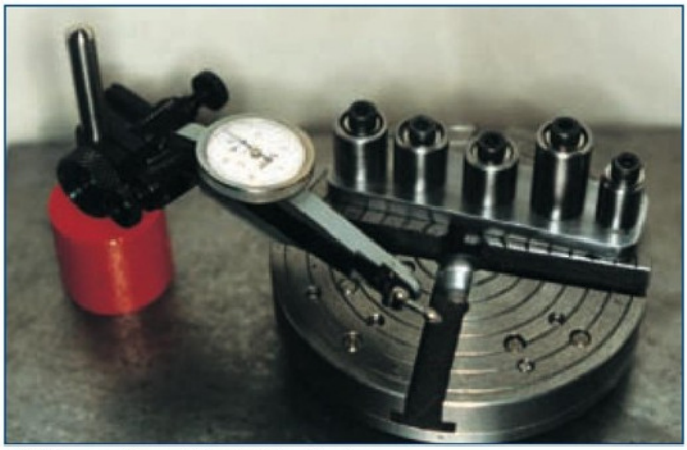
This method could be thought of as a primitive version of jig boring. It needs a vernier height gauge, surface plate, drilling machine and a selection of drills. The process is simple. The hole centres are accurately marked with the height gauge and surrounded by a box which outlines the hole diameter by marking the radius from the centre line in four positions. With the marking out done, the centres are centre punched as accurately as possible, **photo 12**. The holes are started with a drill about ⅛in. smaller than the size needed. The drill MUST NOT cut its full size and by looking closely at the hole outline and how it fits in the box any error can be seen. **Photo 13** shows the corrections. Correcting is done by using a nice sharp centre punch and moving the centres the way they must go. The drill is then encouraged to move in the required direction. The result is shown in **photo 14**, quite close enough for most uses.



15. Marking out using a pencil to limit damage.



16. The bracket which was button bored.



17. The equipment for button boring.

18. Setting a button in position. Photo by Pauline Loader.

An example of boxing

In the 1950's I was working on a ground radar installation, we were a small team of designers, engineers, draughtsmen and, at the bottom of the heap, four or five of us called, "research and development craftsmen (special)". The special was important, because it meant a bit more money. The job was held up for a component, which, because of the tolerances and other features, had to be jig bored.

There was a long wait for jig boring, so I suggested to the charge hand that it could be done by other methods. I thought of using a vertical milling machine and using slip gauges and stops to coordinate the hole positions which were quite a few and tightly toleranced. Because our little gang was detached from the main workshop and there was a bit of friction between us and the rest of the organisation, a milling machine was not available. So I had a go, using a drilling machine and the boxing system. I wondered if I had opened my mouth before the thought had cleared my brain and I was very aware that it was the first time I'd tried the method in anger. It turned out well, as accurate as the average jig bored ones. The charge hand made one or two remarks about the main workshop and their jig borer. The remarks grew in the telling until the bosses were extremely miffed. They retaliated by getting the charge hand a rocket for not going through the proper channels, well, it was a government establishment I was working for. It is a method, which you will only come across once in a blue moon, like another old-fashioned one which can be useful called button boring.

Button boring

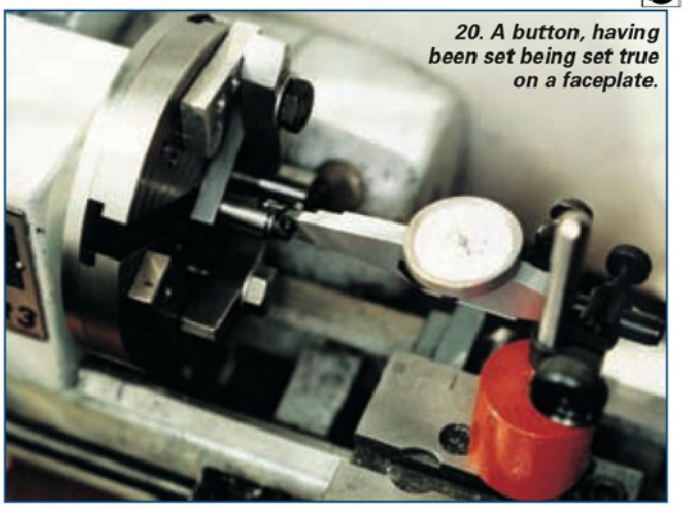
This is another way of positioning holes accurately and one I used when I made a bracket for a hand threading attachment for my Unimat. The bracket is the one shown in **photo 16**. I wanted the hole through the boss and the one for the bolt to be accurately pitched and button boring was a good way of getting the positions right. **Photo 17** shows the buttons and the small dial test indicator used for the setting. **Fig 5** gives the dimensions for the buttons which are not difficult to make from standard silver steel. I used 12mm. because I had some handy but any suitable size will do, as long as it is clean and burr free. The 5mm hole allows a 4mm cap head screw to be a sloppy fit so that the buttons can be moved about for setting. Notice that those shown in photo 17 have one button longer that the rest. This is for when more than two buttons are used and it can be difficult to get the dial indicator to register on the third. The small one on the end is one I made for another awkward setting job. The reason why they are screwed to a keeper plate is because the screws are good at vanishing. I have had to use sets with only a couple of the original ones left and have to hunt for the rest.

Setting the buttons

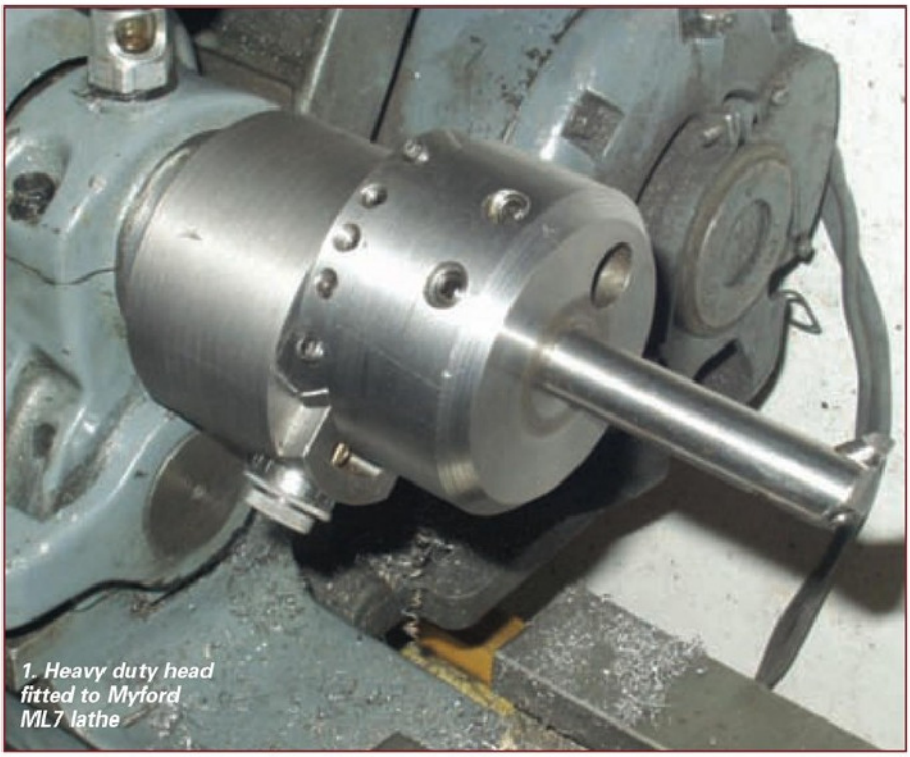
The hole centres are marked out and drilled and tapped to suit the locking screws. Lightly countersink the tapped holes so that the buttons will sit flat on the work. When the locking screws are just nipped, the buttons can be moved by tapping with a piece of wood dowel or something soft. Distances from the datum surfaces to the buttons can be set in several ways. **Photos.18** and **19** show two methods. That shown in **photo18** is fairly easy and just needs a flat surface and two datums at right angles. I used the machining table off the Unimat with a fence on the one edge and an accurate strip clamped on the other one. Some blocks, like those in **photo 4** were set to the right dimensions and the button pressed up to them. If slip gauges are available the job will be very accurate, I used what I had and for the last little bit I used a feeler gauge, which can be seen in **photo 18**, held in my right hand. **Photo 19** shows a better way, which employs a bit more equipment. The work is clamped to a universal vee block on a surface plate and the button positioned by comparing the height of it with the bar clamped to the height gauge nib. The height gauge is set to the dimension needed and when the dial test indicator zeros on button and height gauge nib, you have won and can transfer the work to a lathe faceplate, **photo 20**. Set it running true and drill or bore the hole. Second or other holes are done the same way.

Remember to set the button furthest from the datum first, so that the next one can be set without interfering with the first. When the buttons are positioned, make sure that they are really tight so that they do not move when they are tapped about. Both boxing and button boring are ancient methods used by toolmakers in the past. Both techniques can still be useful.

19. An alternative method of setting a button.



20. A button, having been set being set true on a faceplate.



1. Heavy duty head fitted to Myford ML7 lathe

TWO HEADS BETTER THAN ONE? (2)

In this second instalment, Will Bells describes the second, heavy duty boring head.

The previous article in issue 106, dealt with the light duty head, the design of which employed a round and keyed slide, thus avoiding the need to machine dovetails. This more robust device follows the well trodden principles of many a propriety product, but, assuming the use of a vertical mill, it's not too difficult to make from stock materials. It's accurate, robust and, most importantly, it's an enjoyable project.

2. Milling pocket in body

Heavy duty boring head

This design uses vee slides, so the slideways really must be machined at the same setting, ideally using a vertical milling machine, to get an even movement. I dare say it could be made on a lathe equipped with a suitably skilled operator and a vertical slide but check capacities before committing yourself to this route.

I used cast iron for the Body, which is a nice material for slideways and bearing surfaces because of its inherent lubrication properties. The Body diameter is 75mm with a total travel of 40mm (20mm each side of centre). As designed it takes 16mm diameter boring bars located in two positions on the face and an additional one on the side for maximum coverage. This gives a theoretical capacity of around 100mm diameter and up to 250mm if needed by use of the side hole or the extension attachment.

I made mine to screw directly to my ML7 spindle nose, which is why it's so long, and additionally made a Morse taper 3 adapter to fit my mill. This arrangement can be tailored to the individual's needs, and the Body reduced in length as required. Care must be taken however to ensure any shank connection to the Body is by means of a sizeable screw thread - I would not recommend a plain taper connection due to the high torque potential, and the possibility of encountering interrupted cuts.

As most of us are amateurs with modest workshops, some of the following methods are convoluted in order to impart accuracy by stealth. If you have more professional means to make such components to fine tolerances, I'm sure you will tackle a number of these steps differently.

Construction Notes

Body

This is machined from stock cast iron bar, ideally cut to length by the supplier. This component is not subject to excessive tensile stresses so the inherent lubrication properties and ease of machining cast iron appealed to me. Mild steel could be substituted if preferred.

Because the Leadscrew Nut is drilled through the Body after partial assembly to ensure accurate alignment with the Leadscrew with the minimum of effort, the Body is only partly completed at this stage.

Suggested Machining Sequence:

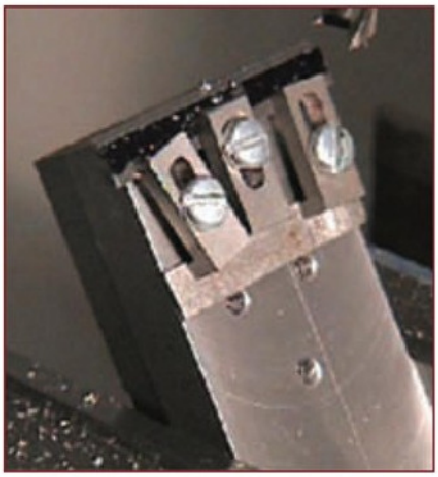
- Hold bar in chuck and face one end.
- At same setting, rough turn outside diameter for half its length, leaving, say, 1mm oversize.
- Reverse in chuck, rough turn remaining diameter, face end and complete screw register details.
- Hold in milling machine vice and cut vee shears with dovetail cutter and complete Leadscrew pocket details (**Photo 2**)
- Drill 8mm hole for tommy bar.

Do not complete dial location details yet.

Leave the diameter unfinished at this stage as it is skimmed whilst part assembled to trim the Gib Strip and to aid concentricity and balance. Cutting the internal thread to match the lathe spindle is best done before machining the arbor. Cut the thread first, extending it right to the faced end so that it can be checked on the lathe nose by removing the chuck whilst still holding the part. The counterbore diameter is the accurate part of the ML7 spindle location and can be machined once the thread is a known good fit.

Assuming a mill is used, transfer to a machine vice to cut the slideways and clearance channel for the Leadscrew. This is theoretically best done with a vee block

3. Boring location holes for bars



4. Milling the angle on the gib strip

held between the jaws and the work, but I admit to just holding directly with the vice. Be careful to position the mismatched diameter so that it is clear when holding. The slides are symmetrical on this part.

Set the slide dials to zero on the centre of the Body and work outwards from there, rough machining with an end mill before swapping to a 60 degree cutter to complete the shears.

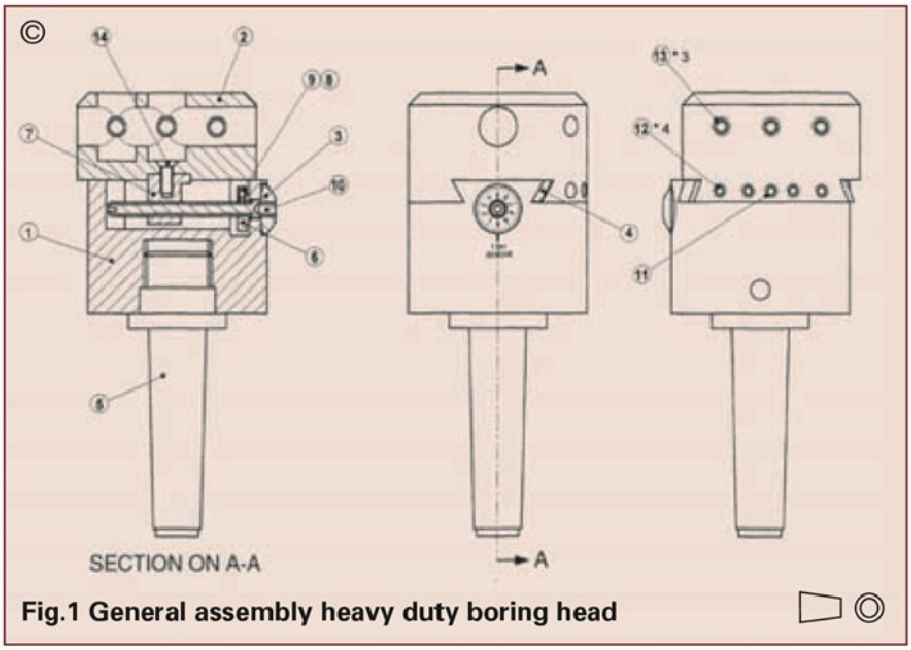


Fig.1 General assembly heavy duty boring head

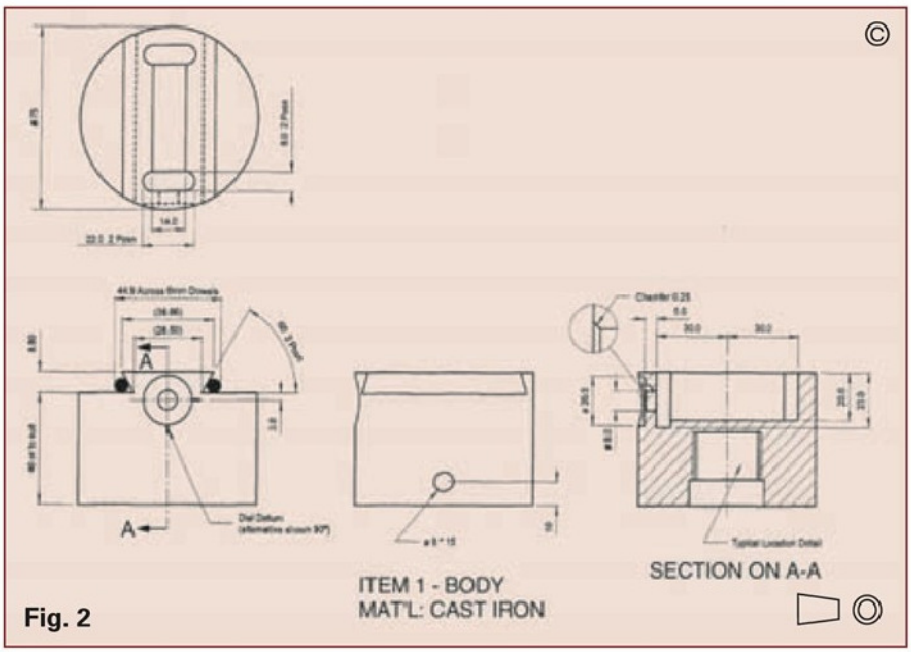


Fig. 2

Take a finish cut off the top surface (this is a clearance face when assembled) with the dovetail cutter, and then zero the vertical dial. Now cut the angles, ensuring the final cut each side is taken with the height setting untouched. Make sure your head is truly vertical to avoid any machined height difference. Without altering the set up, machine the channel for the Leadscrew and Leadscrew Nut to move in. The only critical point is to machine the 8mm slot at the dial end carefully. Use a slot drill in stages and finish off with full length cuts with an end mill to get a vertical and smooth face for the Leadscrew Collar to run against.

Do not machine the Leadscrew bearing hole or counterbore yet, but do drill the 8mm hole on the outer diameter which is to locate a tommy bar for removing from the lathe nose. The diameter for this was scientifically calculated - it happens to fit my three jaw chuck key handle.

Mark out the centre position of the Leadscrew hole in readiness for completion.

Head

Mild steel is used for this component, which stands up better to the constant tightening of screws for clamping.

- Chuck, rough turn half diameter leaving, say, 1mm oversize. Face end.
- Chuck opposite end, complete the oversize diameter and face.
- Machine the side boring bar location hole by boring in the four jaw chuck.
- Machine the two front boring bar holes in the four jaw. (**Photo 3**)
- Hold in milling vice and complete slideways, Leadscrew Nut pocket and drill the M5 clearance hole through the length of the bar.
- Complete drilling of M6 holes. Drill and tap M8 holes.

To machine the slideways follow the same procedure as for the Body. Mark out the positions carefully, ensuring they are correctly orientated to the drawing. Then check the orientation again - this part is not symmetrical. Transfer to the mill and, as before, rough machine and finish both slides without adjusting the vertical setting, then cut the pocket for the Leadscrew Nut with a slot drill. An easy way to drill the clamp holes on a slope is to use the milling machine and counterbore each hole first with a slot drill before starting the hole with a centre drill. Don't tap the M6 holes until after the Gib Strip has been made. The two front boring bar holes could be machined after assembly to ensure accuracy if preferred.

Leadscrew Nut

This phosphor bronze component is fairly straightforward to machine, but must be a good fit to the pocket in the Head because of the subsequent need to repeatedly locate this component accurately and blindly in the Head.

- Cut bar to length and machine all over, ensuring squareness.
- Drill and tap M5 for retaining to Head.
- Machine chamfers.

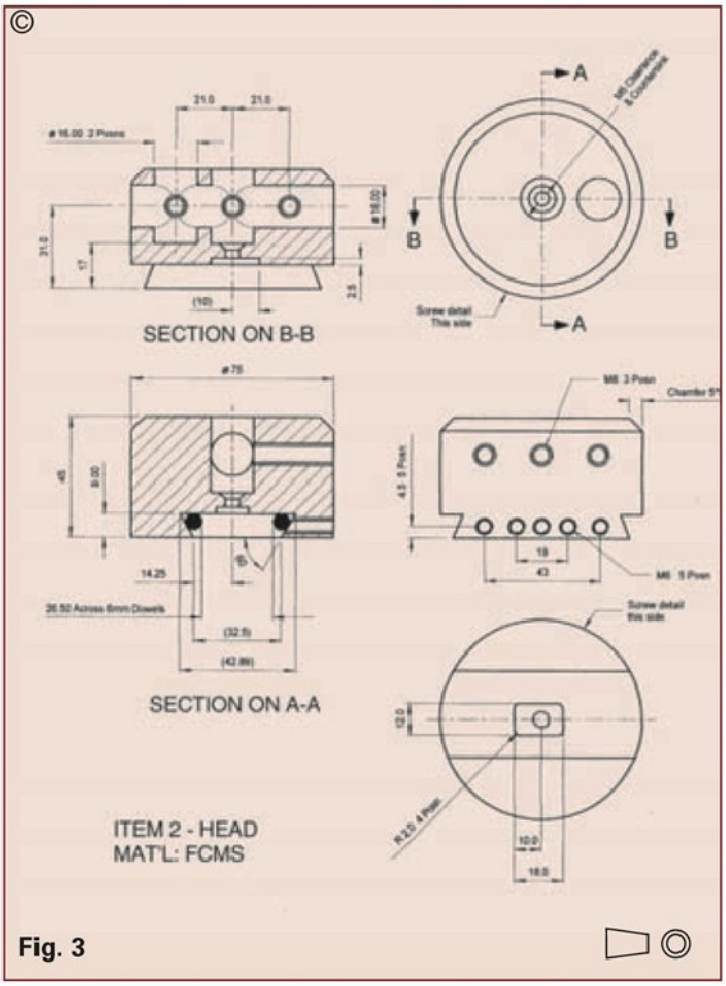


Fig. 3

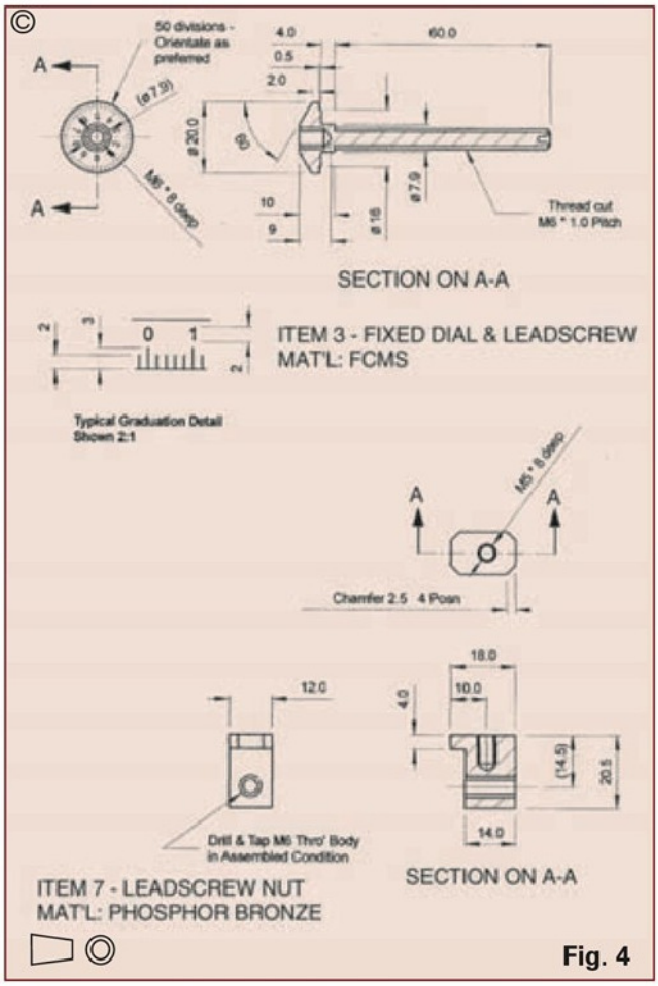
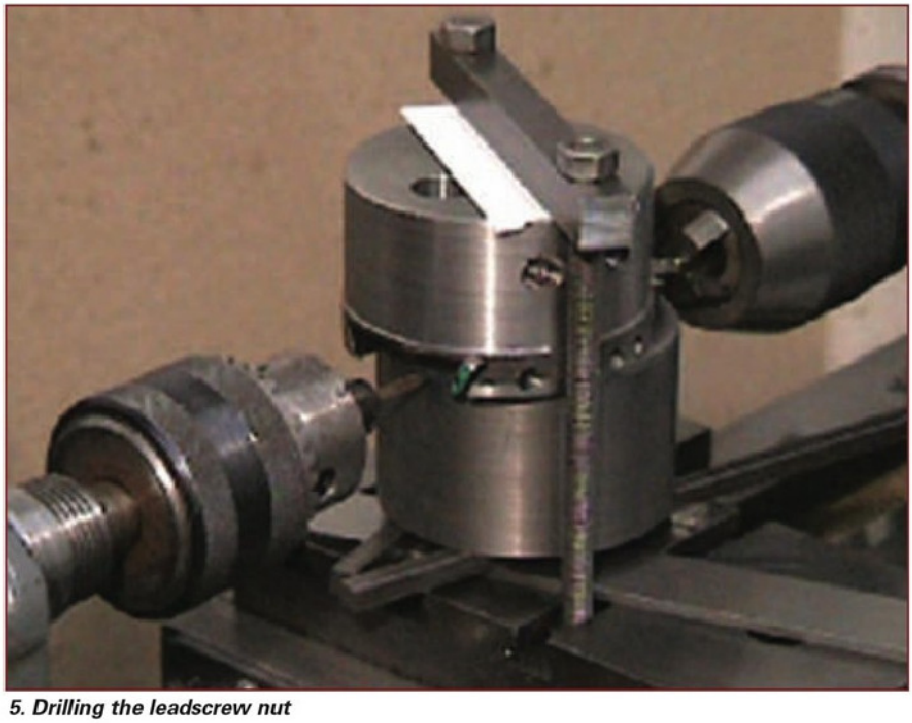


Fig. 4

It's best to machine after the Head to fit it to the pocket, finishing with hand tools if necessary for a perfect fit - the ideal is a slight tap fit which can be pulled into position by the screw. The squareness of the perimeter sides and of the top face is important, so use parallels to accurately set up in the vice. If you want to use an accurate, but more convoluted approach, block up to within 0.5mm, hold in the vice with the locating face uppermost and machine the top face, locating faces and M5 hole in one setting. A slight mismatch on the sides is of no consequence.

Do not machine the Leadscrew hole, which is completed later.

Machine or file the angle on the corners - they are just clearance for the round milled corners in the pocket in the Head. Finally file a slight chamfer on the top edge to act as a lead-in to aid assembly, which is done blind.



5. Drilling the leadscrew nut

Gib Strip

I used gauge plate for this because of its flatness and ground finish, but the material could equally be mild steel, flatted on some fine grit wet and dry paper. The drawings give oversize dimensions on the length to give an allowance for final machining to size after assembly. To machine the angles I clamped onto a location block, which I had previously machined to hold small parts, and held at an angle in the milling vice. See **photo 4**.

To put in the dimples for the adjusting screws assemble the Head to the Body and slip the Gib Strip into position and drill through the untapped holes at five positions. Complete the M6 tapped holes in the Head after this operation.

Leadscrew location details

Pre-assemble the Body, Head and Leadscrew Nut in the following manner:

- Place the Leadscrew Nut loosely into the Leadscrew channel in the Body, ensuring that the orientation is correct.
- Screw the 6mm clamp screws partially into position in the Head, but make sure they do not project below the slide surface
- Slide the Head over the Body so that

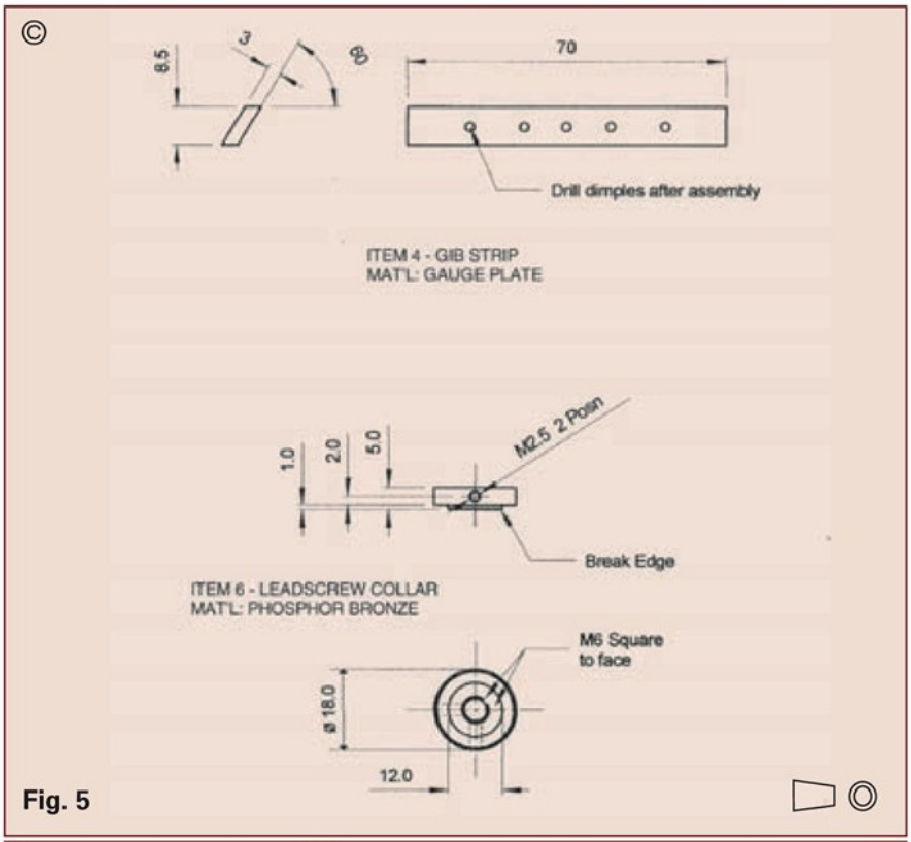


Fig. 5

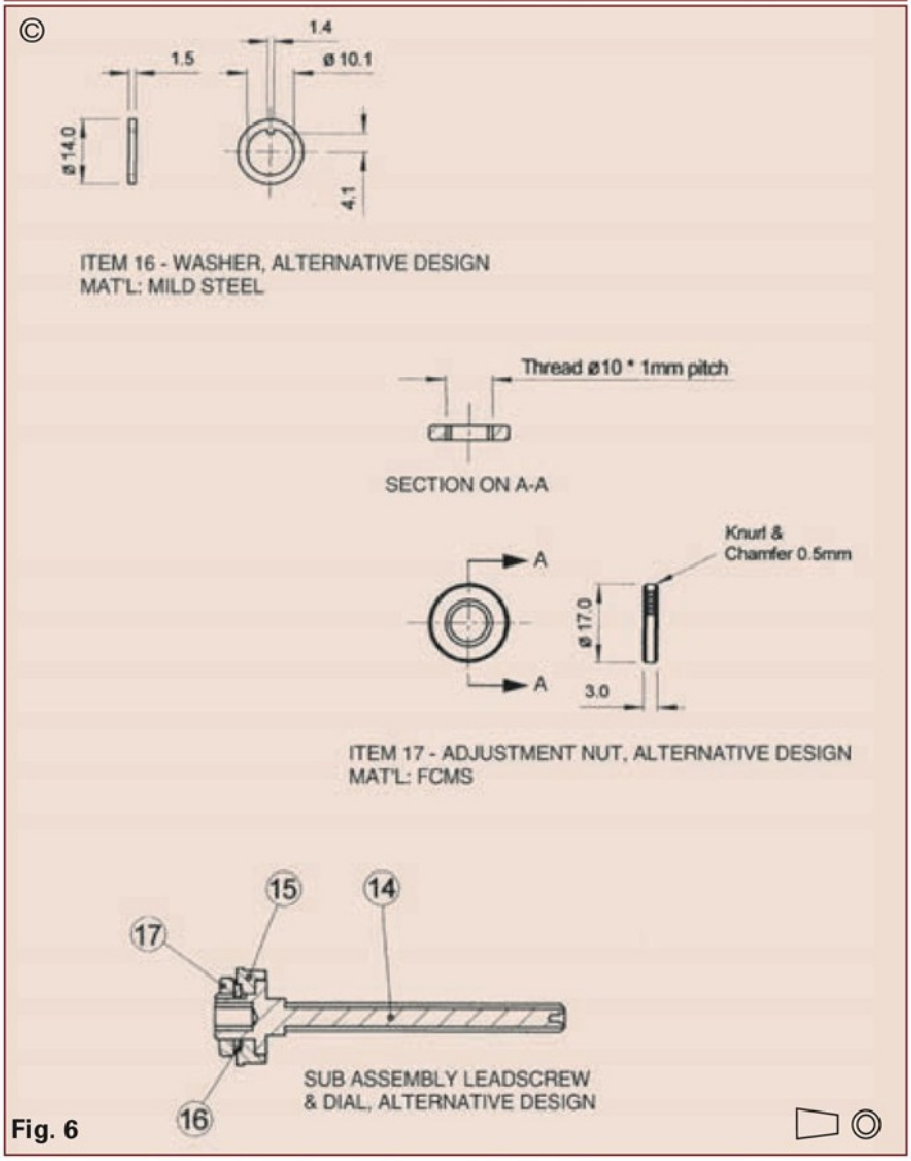


Fig. 6

the nut can be seen through the 6mm clamping hole in the central bore hole.

- Drop in the screw, pick up the Leadscrew Nut and carefully tighten. Ensure this pulls the Leadscrew Nut into position and fully home.
- Slip in the Gib Strip and tighten all the clamp screws with the Head concentric with the Body by eye.
- Screw the Body to the lathe nose (or onto taper adapter if preferred) slacken the clamp screws and clock the Head reasonably concentric, reclamp.
- Now turn the outside diameter and Gib Strip to finished size. Skim front face and chamfer end of the Head.

Remove from the nose (use the 8mm hole on the Body diameter with a bar to rotate), slacken the clamp screws and disassemble to debur all components before reassembling and continuing. Now slide the Head all the way towards the dial end of the Body and re-clamp with the Gib Strip screws. Assuming the lathe is to be used to machine the Leadscrew bearing and counterbore, pack up and clamp to the cross-slide at correct height ensuring the slide ways are parallel in both planes to the bed. Centre drill, then drill through the Body 5mm (see Leadscrew options below prior to this operation and read the notes on taps above) continuing through the Leadscrew Nut. (**Photo 5**) Open up diameter in the Body, and then ream 8mm.

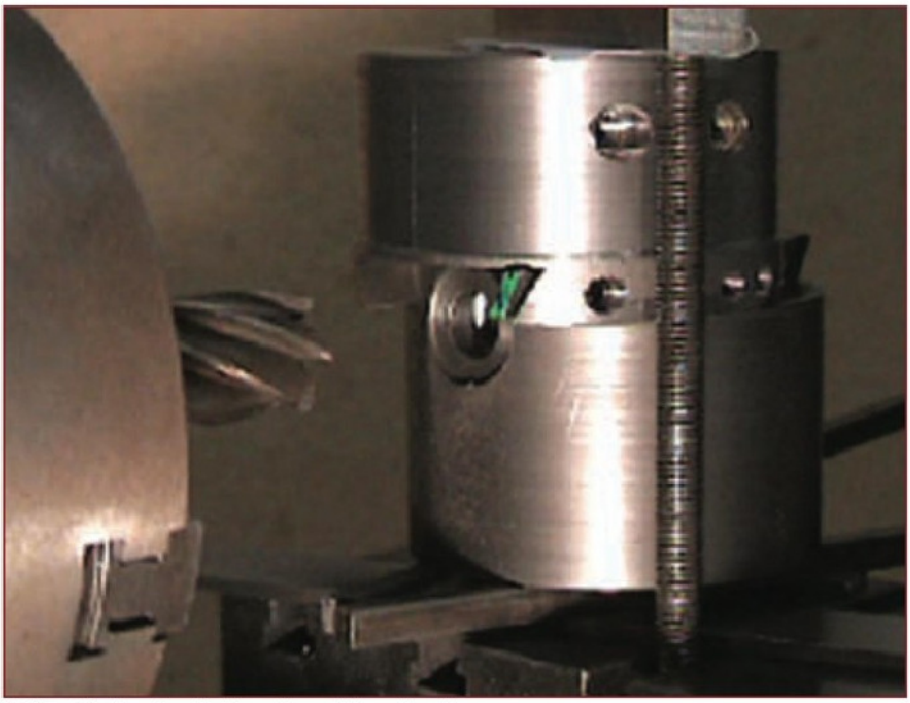
I originally machined the counterbore using a 21mm end mill (**Photo 6**) held in the three jaw chuck with a slow speed and gently cutting to the correct depth, which worked well. This is the advantage of designing – I get to choose sizes that fit my existing capabilities! I guess a suitably shaped tool held in the four jaw would do the job if one were careful, but watch the chatter.

There is a small chamfer on the 8mm bore, which must not be forgotten, and gives clearance without which the Leadscrew could bind. Before finishing, tap the thread in situ, holding the tap in the three jaw chuck and turning the spindle by hand and using tapping lubricant.

Leadscrew

There are two designs included in this article. The first is a plain fixed dial design and the second a more complicated system with the facility to zero the dial during use. Here, I will describe the making of the settable dial version, assuming that my previous comments for the Light Duty Boring Head are directly applicable to the fixed version.

The Leadscrew is machined in a single setting to ensure concentricity throughout. The thread chosen was M6 coarse because it has 1mm pitch which I could finish with a standard die (OK, I didn't own a suitable M8 or M5 tap or die). This means that one full turn of the dial gives 1mm of travel, which is convenient, and 50 divisions on the dial gives 0.02mm travel, or 0.04mm on the diameter for each division. You could make this 100 divisions (which I originally did, but really this makes it too busy) but it's quite easy to set it half way between two divisions without the extra line.



6. Spot facing the dial location with end mill

Alternatives could include, perhaps M5 fine which has a 0.5mm pitch, or, for Imperial users, as with the light duty design, I would suggest that ¼" BSW, which has a 20TPI pitch would be suitable. Those who may wish a finer degree of control might opt for a 40tpi ME thread. Using 50 divisions the movement would then be half a thou per division, hence one thou on diameter.

- Hold suitable length bar in the lathe chuck, carefully face and drill a small centre hole in the end.
- Support with rotating centre and turn diameters.
- Screw cut 6mm slightly oversize and finish thread with a die.
- Thread cut 10mm diameter.
- Hold in milling vice (protect the thread) and mill keyway.
- Cut or part off excess material length.
- Protect thread and hold in chuck to complete M6 screw hole.
- Degrease and tightly screw in M6 grubscrew aided by Loctite Retainer.

The 7.9mm diameter should be a nice free fit in the reamed diameter in the Body, but should not be over tight, as little bit of misalignment capability is useful. Make sure the shoulder which takes the thrust is finely machined square and the root is fairly sharp to avoid clashes when adjusted up. Screw cut the two threads, both of which are 1mm pitch, but leave the 6mm one very slightly oversize and finish with a good HSS Ground die and lubricant, progressively closing the die until a good fit with the Leadscrew Nut thread is attained. Because the 10mm thread will not be finished with a die, the depth of cutting needs to be calculated. Theoretically the tool tip should have a defined flat or radius, which is different for every pitch, and serves to maximise strength, especially under fatigue conditions. Besides the difficulties of accurately producing the radius, this means a lot of tools or a lot of grinding. Worse, if the tip radius is too large, when fitted to the mating thread, the assembly can end up being sized not to the flanks but to the tops of the thread.

Hence, I tend to cheat and use a screw cutting tool having a sharp point with the edge just honed off unless there are special circumstances where I need to take more care or the thread is big - and this is not one of those!

So, touch the point on the outside diameter with a 60 degree tool, and zero

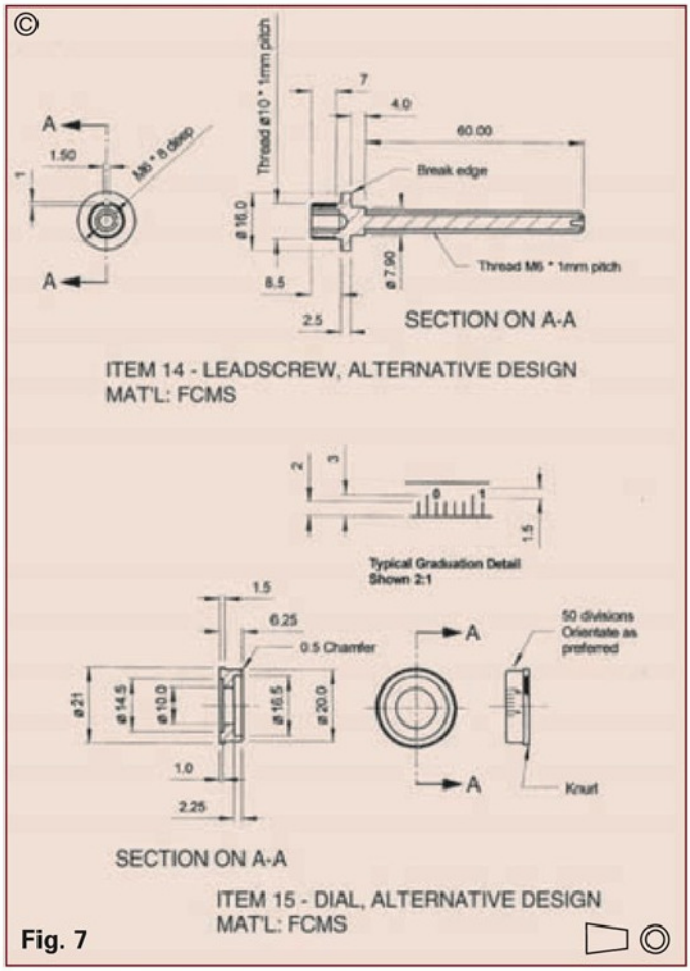


Fig. 7

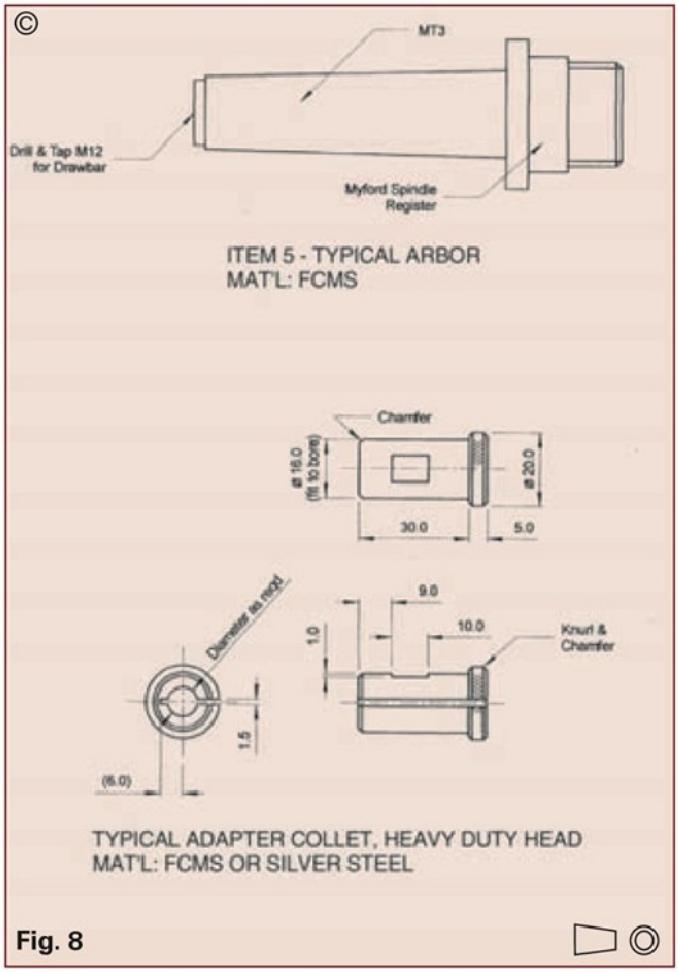


Fig. 8

7. Key components of heavy duty head.

the dial. Using small cuts and plenty of lubricant, feed in to depth (which works out to be around 0.76mm). To help get a good finish on the thread, it is often recommended to set the top slide at half the tool angle and feed in with the top slide only. This means that the tool cuts on the leading edge only. A simpler way for metric threads with a 60 degree threadform, which seems to work just as well for me, is to leave the topslide at zero and feed in square with the cross slide, but, in addition, advance the topslide as well by half the amount. (Strictly speaking the ratio should be nearer 0.577 but half works and is easier on the brain)

Cut the keyway with the mill using the extra length held in the machine vice, and part and carefully debur afterwards.

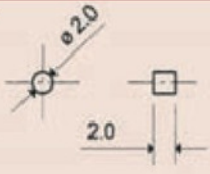
Try to avoid using oil to drill and tap the M6 to minimise contamination for the Loctite and grind a slight groove or flat on the grubscrew to ensure it doesn't want to come back out. This provides the hexagonal socket for adjusting the movement in use with an Allen key.

Locking Collar

- Chuck bar, face, turn outside diameter, knurl and chamfer.
- Drill and bore to size (around 8.9mm diameter).
- Screw cut to match the Leadscrew thread.
- Part to length.

Washer

- Hold bar in chuck and face.
- Drill minor diameter.
- Transfer to rotary table to machine 10.1mm diameter with an end mill.
- Part to size in lathe.
- Finish key detail with needle file.



ITEM 8 - SMALL BULLET
MAT'L: BRASS (2 OFF)

Fig. 9

I used a rotary table to produce the keyed bore then parted off, finishing the key feature with a needle file. Failing that, careful filing out after parting should produce a good enough result. Ensure both sides are nice and smooth; rub against fine wet and dry paper to finish if necessary.

Most importantly, the key should be a good sliding fit in the keyway without rotary movement to prevent the locking ring moving when rotating the dial.

Leadscrew Collar

Again straight forward to make but there is not much margin for error in the retaining screw positions. Phosphor bronze is the first choice of materials, but brass would be a possible alternative.

- 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 M6.
- Part to length.
- Drill and tap M2.5 holes.

Follow the same tapping method as the Leadscrew Nut, ensuring that the smaller diameter face is square to the tapped hole.

Dial

- Hold suitable bar in chuck, face end.
- Turn outside diameters, keeping knurl end nearest chuck.
- Drill and Bore 16.5 and 10mm diameters.
- Knurl and chamfer edges.
- Graduate, then part to length.
- Face and bore 14.5mm, holding on trued mandrel.
- Stamp numbers.

The method used for graduating the dial depends on the level of equipment available. I used the lathe as described for the Light Duty dial. To hold the part squarely and concentrically after parting, turn up a piece of scrap material to a close fit with the 16.5mm bore and hold it in place with two small spots of superglue. Put the adhesive just on the diameter (which is clearance in the assembly) to avoid contact with the working face. It can be separated from the scrap by holding in a vice and gentle tapping off around the edge using a brass drift and scrape off any dried adhesive. Remember that if disaster strikes and too much adhesive is applied, it can be softened by heating to 250 degrees centigrade.

Final assembly

Ensure all sharp edges are removed prior to needing the Band Aid. Clean and assemble as follows:

Place Leadscrew Nut in slot, assemble Head and screw nut into position as previously.

Slide Gib Strip into position and lightly screw clamping screws home.

Slide Head away from the dial end, put a little grease on the Leadscrew Collar face and drop vertically into position. Orientate so that the smaller diameter faced end is in contact with the Body, not the parted face. Assemble Dial, Washer and locking collar to Leadscrew, lubricating the moving faces with a little grease.

Screw the Leadscrew through the Leadscrew Collar and into the Leadscrew Nut. The Leadscrew Collar can be gently prevented from rotating with an Allen key located in one of the screw holes. Drop the brass Bullets into the screw holes in the collar before putting the grub screws in. Tighten the collar to give the Leadscrew a smooth movement without excess axial play. Clamp up grub screws firmly and lubricate the Leadscrew with a little oil.

Remove the gib adjusting screws (the two outside pairs – the middle one is used to clamp the slide), sparingly apply Loctite Threadlock and adjust to the final movement. Leave overnight to cure. The threadlock adhesive chosen should still allow you to unscrew and reposition afterwards.

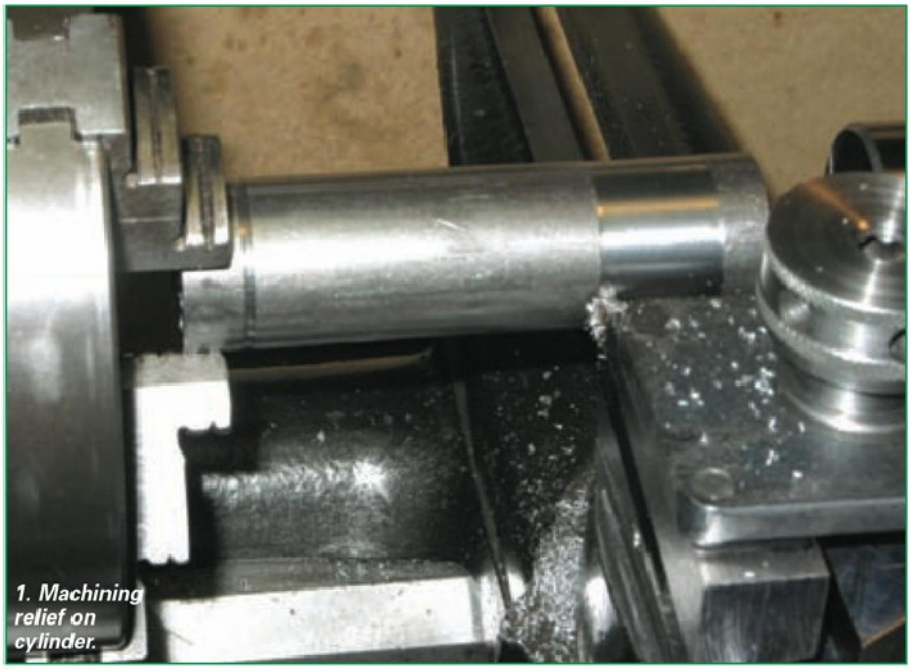
Disassembly is the reverse of the above, however the nut should be pushed out of it's location pocket by partially unfastening the fixing screw and tapping it. Remember to unscrew the Leadscrew first, or it will be damaged.

In the next and concluding article, operational and tooling aspects relating to boring heads, will be considered.

Table of Fasteners Required

Item No.	Description	Qty
9	M2.5 Grubscrew * 4mm, flat end	2
10	M6 Grubscrew * 8mm	1
11	M6 Grubscrew * 16mm	1
12	M6 Grubscrew * 8mm, cone point	4
13	M8 Grubscrew * 15mm, flat end	3
14	M5 Socket head countersunk screw * 12mm	1
16	M8 Grubscrew * 9mm, flat end	1

A KINEMATICALLY M
STAND FOR A SO



1. Machining relief on cylinder.

Jim Wright of Nova Scotia offers a design with added convenience.

A kinematic mounting or coupling is a device which is used when the connection between coupled components must be decoupled and reassembled without affecting the precision of location of sensing devices, usually measuring or aligning instruments. Such a device is used for example in coupling a theodolite or similar device to it's tripod. A well designed coupling also eliminates strain or distortion that may be introduced by clamping devices or by differential expansion within the assembly.

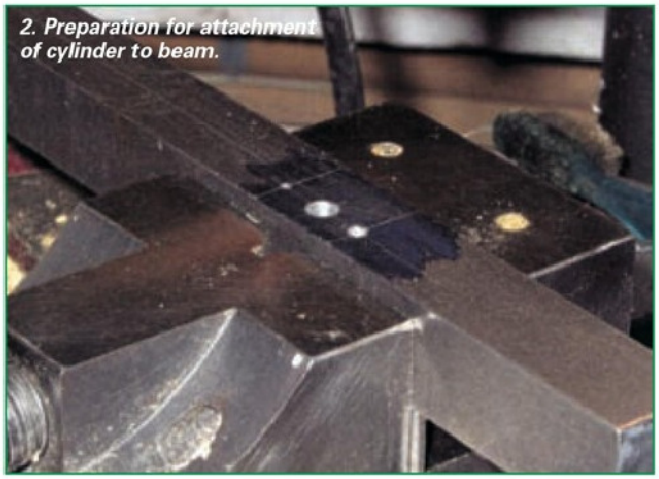
In making a workpiece setup or checking concentricity of a workpiece when chucking or working between centres I have often felt the need for a support which would hold my dial indicator with great rigidity, but yet could be removed from its location and replaced without upsetting the reading, and that would function without resorting to magnetic bases or clamps. In the device I have developed for the lathe I have introduced a degree of lateral freedom normally absent from a coupling of this type in order to allow traversing of the indicator stand along the bed, parallel to the lathe centre line. This is necessary to locate the indicator where it is required on the work and also permits the measuring of taper in the work, or angular setting of a compound slide.

This design can be directly adapted to any lathe that has double 'V' form bedways. For the Southbend, a cylinder of 1.125in. diameter locates between the closely spaced Vee features. For other machines e.g. Colchester, which have one Vee to the rear of the bed and a second at the front, then a variation using a pair of cylinders may be adopted. It might also be applied to a Myford with a different design of location system, employing a larger diameter cylinder making contact with the narrow surface area of the inner chamfered edges of the shears. As these are not are not thought of as precision surfaces, the same degree of accuracy might not be achievable.

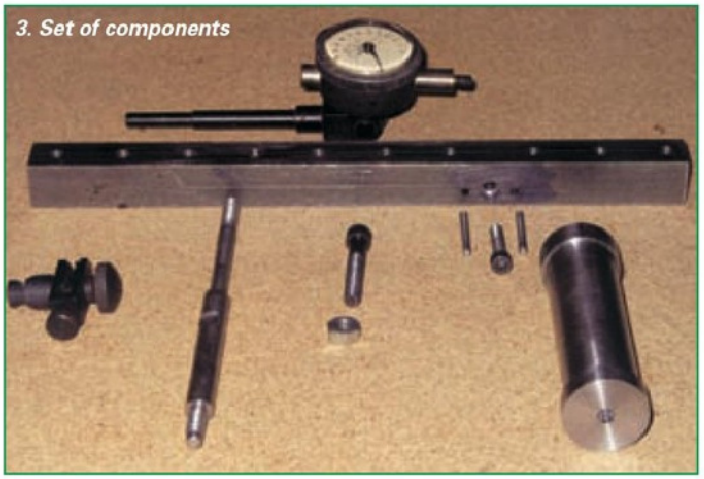
The drawing provided shows that construction is very simple and requires no great precision except that the two cylindrical 1.125in. dia. contacting surfaces should each sit in the 'V', comfortably making contact on the two inclined surfaces without bottoming on a third point. The necessary third point of support is the levelling screw passing through the beam. One improvement, that might be made to improve durability, is to case harden the cylindrical contacts but this I have not done since wear against the 'V' ways would be insignificant with the amount of use anticipated and is not critical to function in any case.

The construction process

My first step was to prepare a piece of 1.125 in. dia. bright finished carbon steel for chucking. This should be about 5 inches long. You may need a steady to support at this length so that the material can be set to run true and concentric at the overhanging end. Face off and prepare a centre in the end of the material whilst supported by the steady. Remove the steady and replace with a centre in the tailstock. With support by the centre and in the chuck finish turn the mid clearance section of the workpiece (**Photo 1**) to the 1in. dia. indicated on the drawing. Polish the two 0.375in. long end cylinders for appearance. Part off the workpiece, clean up and square off the end faces to the 4in. length of the cylinder component. You may

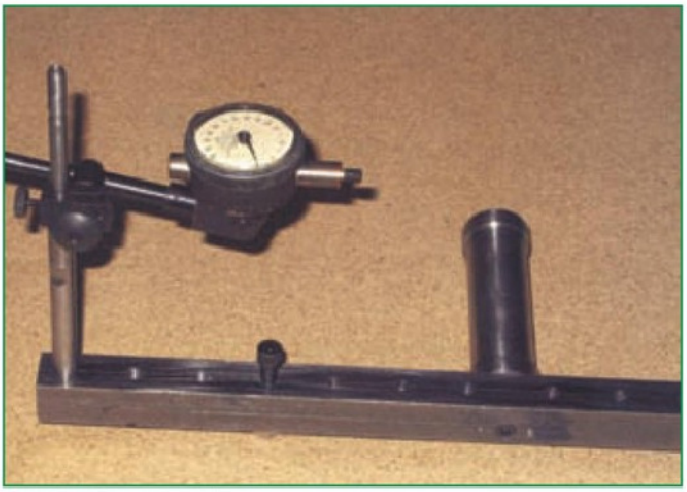


2. Preparation for attachment of cylinder to beam.

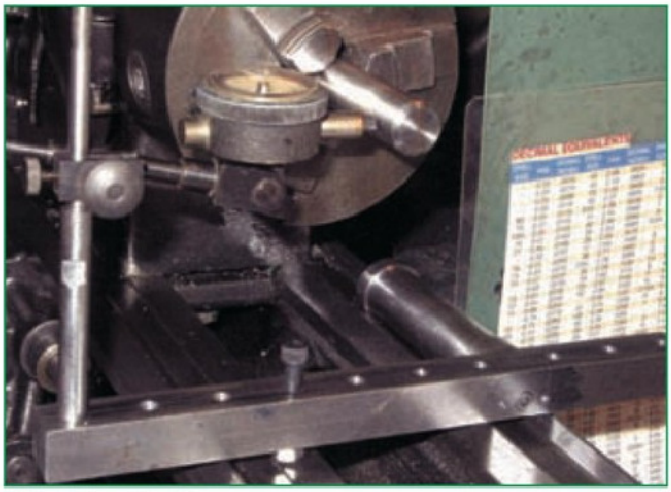


3. Set of components

OUNTED INDICATOR UTH BEND LATHE



4. Complete assembly.



5. Indicator stand in use.

need to replace the steady. Drill and tap the end face of the workpiece for a No.10 ANF or SI equivalent screw thread about 1in. deep. This will be the clamping screw for the transverse mounting beam.

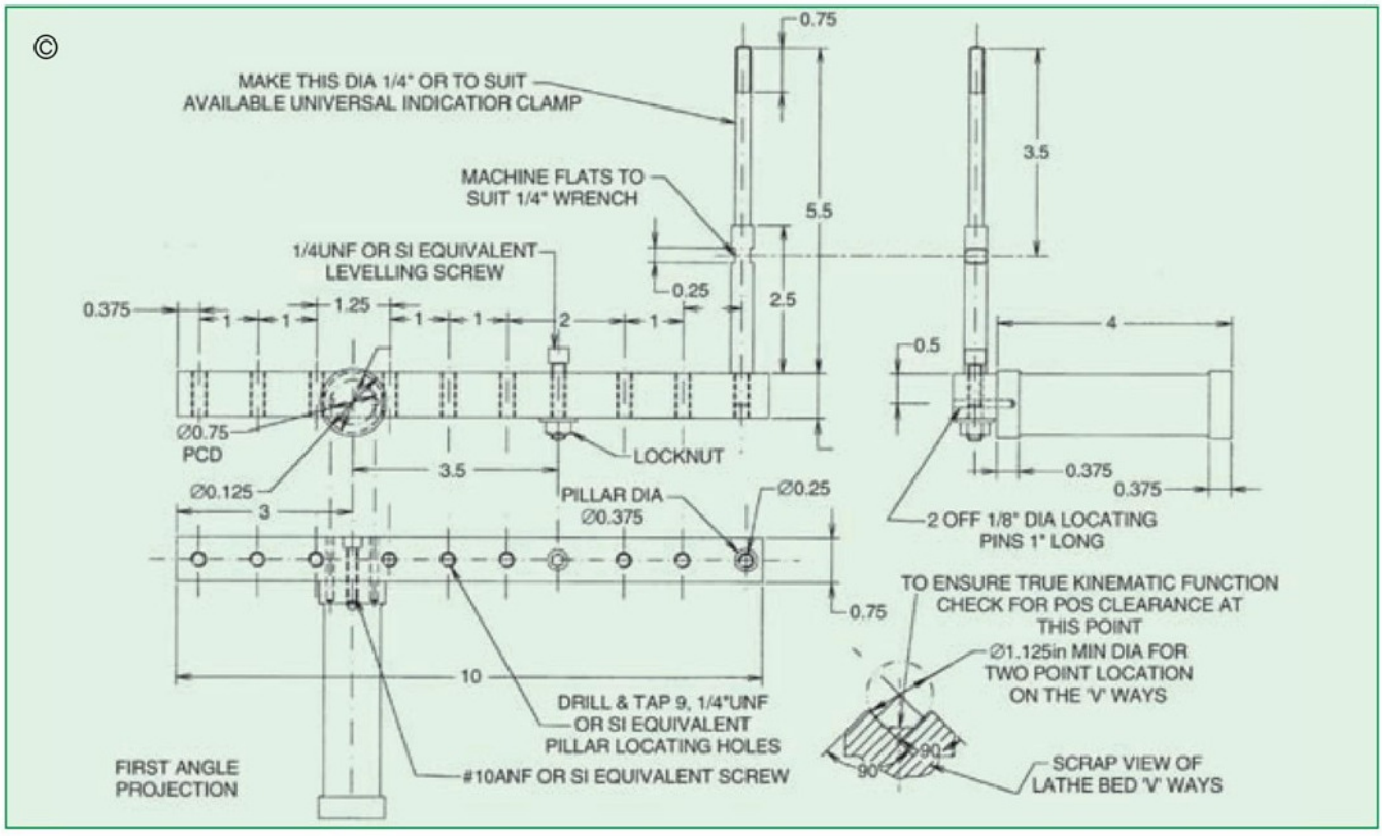
Prepare a piece of ¾in. square bright finished carbon steel bar 10in. long, (**photo 2**).

In the transverse direction through the bar drill and tap 10 holes ¼in.UNF or SI equivalent for the indicator pillar and the level adjusting screw . The level adjusting screw hole should be tapped appropriately.

On a 0.75in. pitch circle around the clamping screw hole in the cylinder component drill two ⅛in. reamer size holes (No.31 or No.32 drill size). Carefully locate the transverse mounting beam on to the cylinder end. Clamp tightly with an Allen screw. Drill through the No.31 or No.32 holes into the cylinder, ream and fit ⅛in. dia. silver steel locating pins. An alternative would be to force fit the pins without reaming since the assembly is permanent. Assemble the cylinder to the beam. Fit the indicator pillar and secure with a nut. Fit an Allen screw as a levelling screw and provide a locking nut.

All that is required now is to fit a universal clamping device for the dial indicator. These are usually readily available as a commercial item or you can make one up fairly simply.

You will find that you now have a very convenient indicator stand for use not only on the lathe but also for use with an adjusting mechanism added, as a comparator on your surface plate or marking out table.



INDEXING HANDWHEEL FOR MYFORD LATHES

Maurice Cunnington of Busselton, Western Australia **describes how to "unfix" the scale on the ubiquitous leadscrew handwheel.**

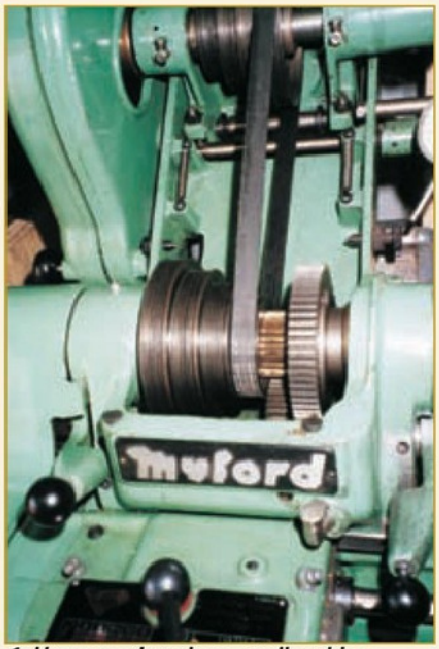
Background

It's over 40 years since I bought my first Myford lathe and for many of those years I had looked at the beautiful leadscrew handwheel and wondered how I could make it indexing or adjustable. For me, the fixed scale is the most annoying feature of the Myford Sevens. How many of us have made a mistake when using the lathe for milling? About a decade ago, I had come back to the Myford, buying a Super 7B, and once again I had started looking and wondering how. The final straw came when I was going to fit poly vee belts and to machine approximately 40 grooves at 93 thous centres with a fixed scale on the leadscrew handwheel was inviting disaster. **Photo 1** shows the finished poly vees, which were later machined with no mishaps.

Over the years I had considered various methods:-

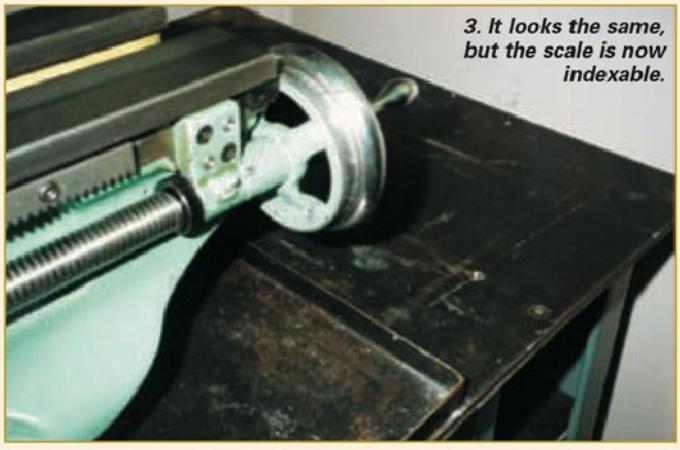
1. Make one out of two, separating the scale from one and machining the scale from the other, but oh the cost!
2. Trepanning the scale off using a curved parting tool.
3. Trepanning it off with a large hole saw but the centre boss of the handwheel would make it difficult.

Looking in a tool catalogue, I noticed long series slot drills of ⅛in. dia with a flute length of ⅝in. and the door opened. I thought I would use a slot drill to get the scale off the handwheel. **Figures 1 & 2** show what I did. It would mean milling a ⅛in. groove ⅝in. deep. So before attempting the handwheel, I took a piece of case iron and tried to machine a groove in it (**Photo 2** shows this). After 40 years of thinking about it, **Photo 3** shows the end result, it doesn't look any different, but it is adjustable.



1. Home made poly vee pulley drive arrangement.

2. A trial run at groove milling.



3. It looks the same, but the scale is now indexable.

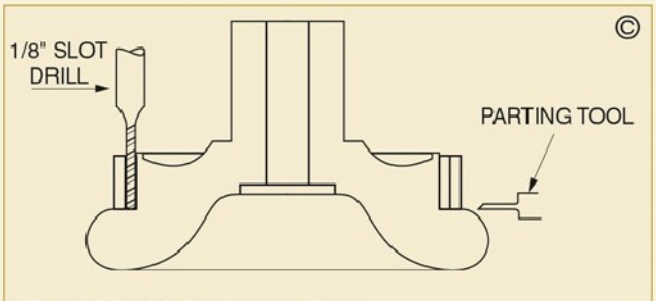
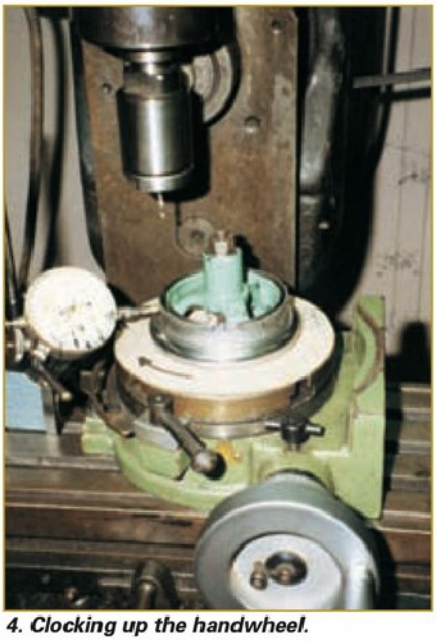


Fig. 1 Machining operations

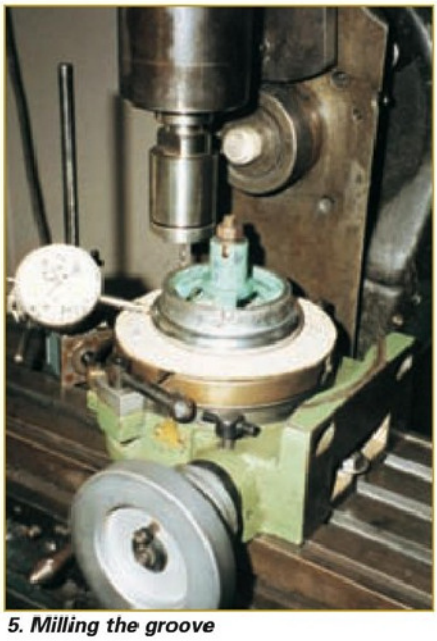
Construction

The first problem was unscrewing the handle from the handwheel and it sure was tight. I first tried the fibre jaws on the vice, then two pieces of wood and finally two pieces of hardboard, called 'masonite' here, and for some unknown reason they gripped the handle better. The handwheel was then set up on the rotary table, located with a piece of card placed under it. **Photo 4** shows it being 'clocked' up on my 70-year-old milling machine, it will be seen that the collet chuck just clears the boss of the handwheel.

The sequence of operations to mill the groove could now commence. The slot

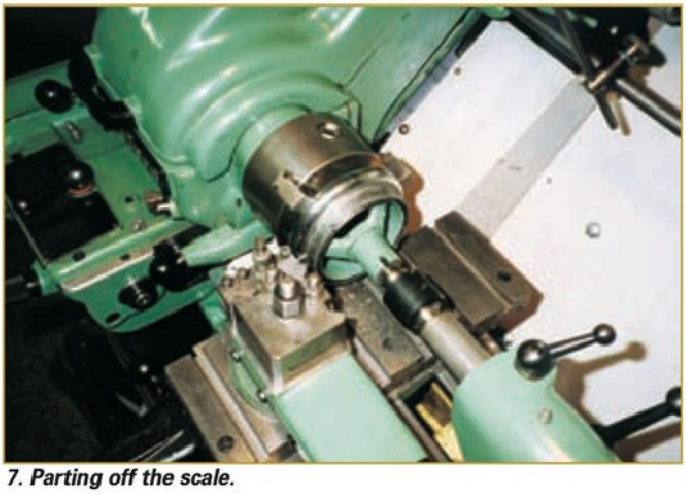


4. Clocking up the handwheel.

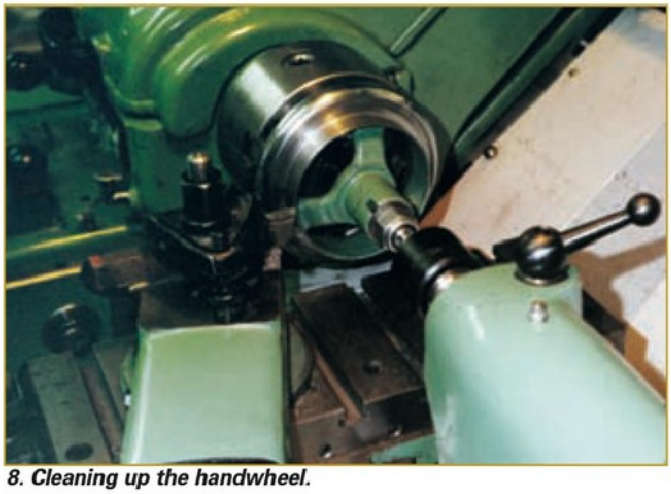


5. Milling the groove

6. Groove now cut to full depth.



7. Parting off the scale.



8. Cleaning up the handwheel.

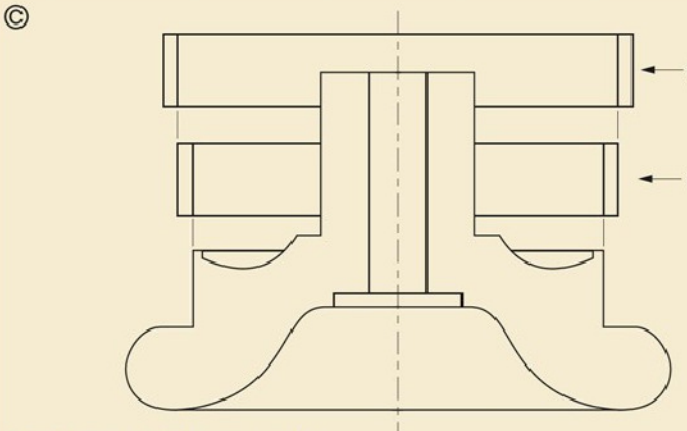


Fig. 2 Exploded assembly

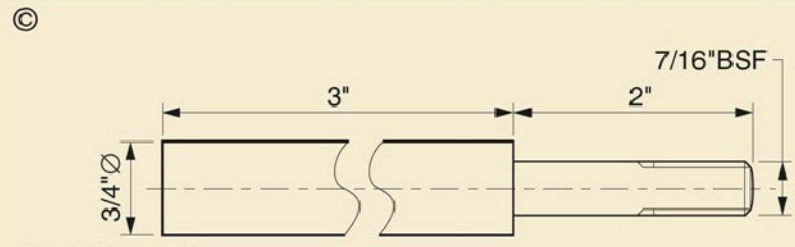
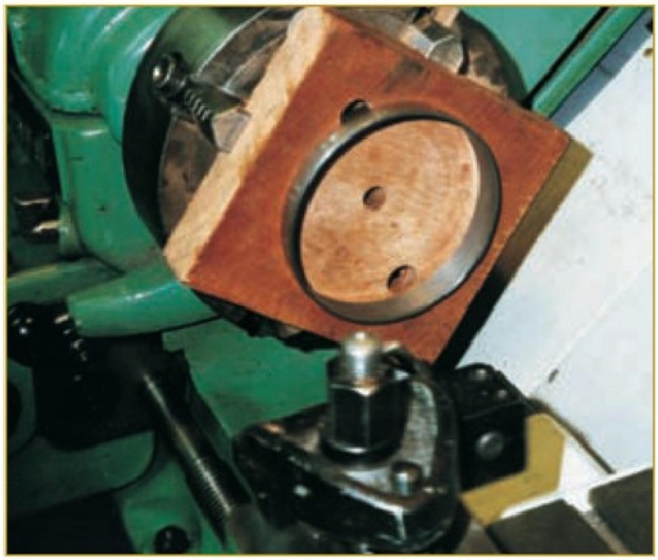


Fig. 3 Mandrel

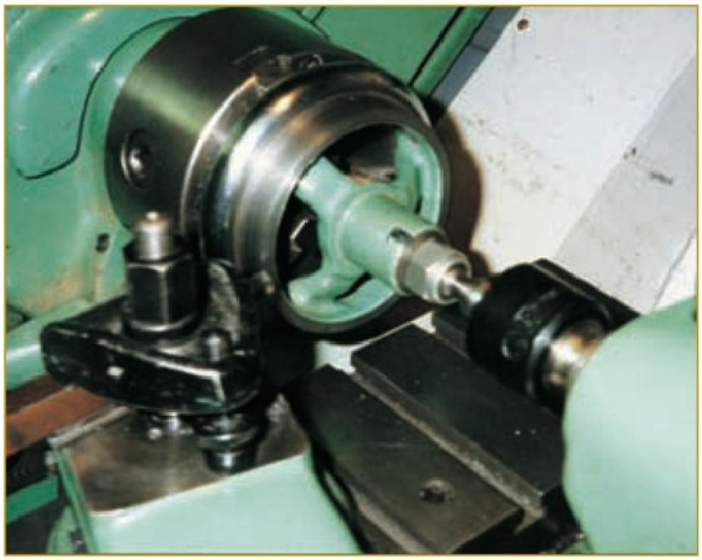
drill was set in the centre of the rim of the handwheel, leaving the scale ring just over 1/16in. wide (**Photo 5** shows this). In my experience, just plunging into metal with a flimsy slot drill invites breakage, so I started by first drilling an 1/8in. dia. hole 5/8in. deep and then putting the cut on whilst the cutter was over this hole. I took 30 thou. cuts and tried to keep the rotary table moving at a constant speed, if you stop it will form a groove in the wall of the groove. After two hours you should have the groove machined, just take it steady and you won't get trouble thanks to Myford's beautiful soft cast iron. **Photo 6** shows the slot drill at full depth. At the end of each cut, blow or preferably vacuum the dust out of the groove.

Grip the handwheel in the 3 jaw chuck with the centre in to steady it and **Photo 7** shows the scale being parted off with a tool 1/32in. wide, filed up from silver steel. Now, handle the scale ring very carefully, if you drop it, you've had it.

Next turn up a mandrel, identical to the righthand end of the leadscrew (**Figure 3** shows this). Mount the handwheel on the mandrel; the surface has to be cleaned up (**Photo 8**). A firm dimension can't be given for this as it depends how well the groove was machined. Don't be worried if the



9. Scale ring located in hardwood fixture.



10. Outside diameter of sleeve being turned to size

metal is thin when you have cleaned it up, there is plenty of metal left, as the spokes of the wheel are not touched.

The scale ring has to be cleaned up in the bore. To do this a piece of hardwood one inch thick is bored out so that the scale ring can be pushed in with the parted edge outwards (see **Photo 9**). Two holes can be seen in the wood. These are drilled half and half on the periphery, and are a safeguard so you can push the ring out, but be careful you don't make the ring too tight to push in. The ring is cleaned up to about 1/64in. thick. Aim for a nice smooth finish and clean up the end that was parted off.

A sleeve is needed bored out to fit the turned handwheel and turned to fit the inside of the ring. I found a screwed pipe socket in a scrapyard for the steel to make the sleeve. It was terrible stuff to turn, but light cuts and patience beat it. The sleeve is Loctited on to the handwheel then put it on the mandrel to be turned for the ring to fit on. Make it so the ring can be turned easily but not too loose.

Photo 10 shows the handwheel sleeve being turned. No fancy locking arrangement is needed, all I have been using for years is a molybdenum di-sulphide compound called 'Never Seize' between the two faces, and this never dries or weeps to cause a mess.

On assembly you will find there is too much gap between the scale ring and the pointer. To correct this, take a cut off the face of the boss on the handwheel. This modification was done over 10 years ago and its surprising how often it is used and how easy it was to turn the poly vee grooves at the correct centres.

TIPPED SLOTTING TOOL

Harold Hall describes a DIY tool holder for replaceable grooving tips

Background

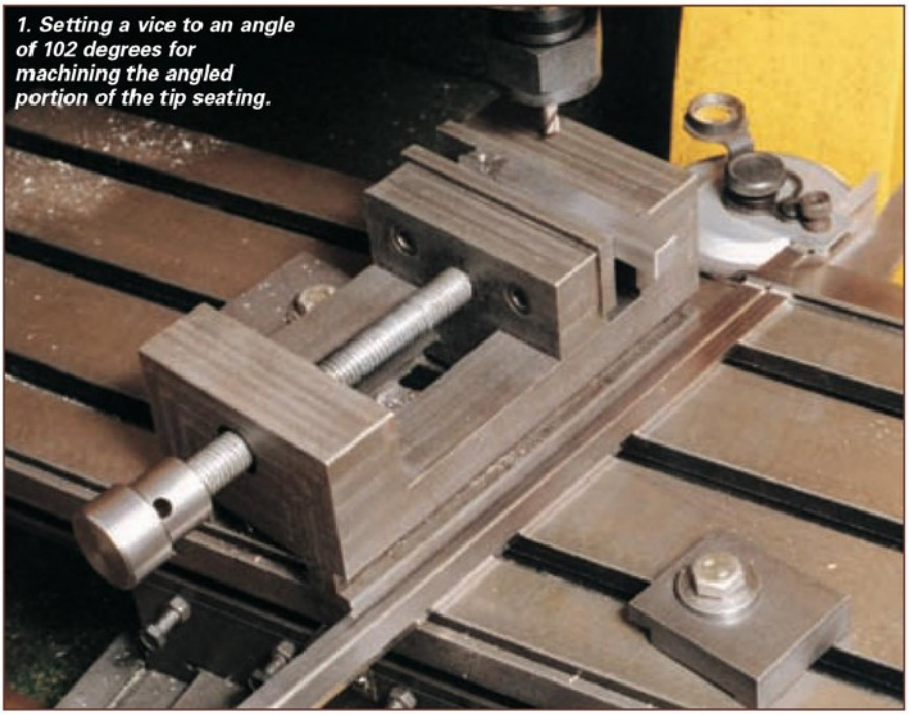
Compared to their use in industry, replaceable tipped tools have been a latecomer to the home workshop, due most probably to them not initially being aggressively marketed to the amateur machinist. Even after suppliers started to address the amateur market, no doubt their high cost has also been a deterrent. Now that cost is less of a problem, due to lower relative costs, they are appearing in greater numbers. However, prices can still be very high, especially the industrial calibre holders. Also, they are still only available in a limited range of types from the majority of suppliers to the home workshop. This probably due to the more specialised types having a price tag that would be a bar for most. Tools for cutting full form internal and external threads are particular examples.

Some requirements can still only be met by hand grinding them from high speed steel (HSS) tool bits due to replaceable tips not being appropriate for some shapes, particularly in the smaller sizes. A typical example might be a boring tool for say 6mm diameter, but see the note below regarding WNT. One such tool that I had not encountered, even in catalogues for companies which supply to industry, were narrow grooving tools and as a result I ground these from HSS.

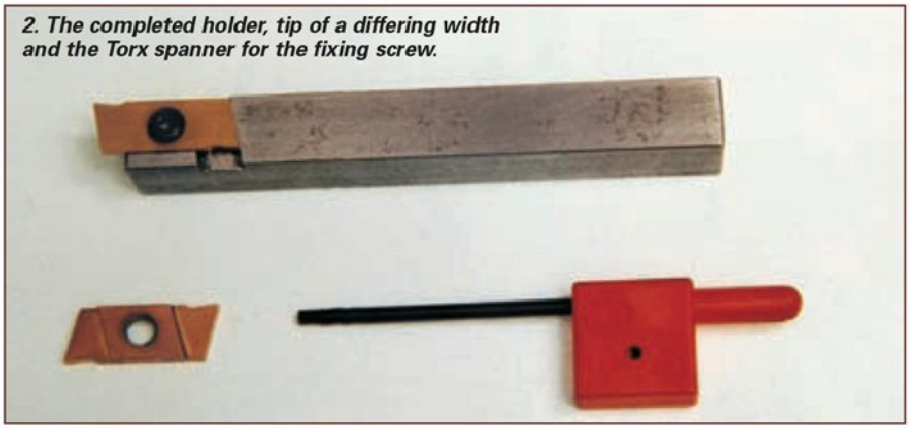
However, having acquired a copy of the J & L Industrial Supply catalogue (ref. 1), I found reference to replaceable tipped grooving tools in a wide range of widths, 11 between 0.5mm and 2.0mm. The grooving tools have a leading edge, which is at 90 degrees to their length, but similar tips which have a leading edge angle of 5 degrees are available for parting off diameters up to 12mm. These are made with widths of 1mm, 1.5mm and 2.0mm and would be particularly useful if the user is into small diameter work, say 5 mm diameter. The 1mm wide tip would especially be an advantage for this application. Incidentally, at this width and at the smaller diameters, mounting the tool on the top slide rather than the rear tool post should be perfectly acceptable.

Tooling Direct (ref. 2) also supply the same system but in a smaller range of sizes. They do though list similar tips but for threading having 55 degree and 60 degree internal angles. The illustration in the J & L catalogue also shows tips for basic turning, a grooving tool with radiused end, and even an internal grooving tip, all in the same format.

WNT (ref.3) are becoming better known on the industrial scene, and their leaflets include the Precitool range (still relatively expensive) and a variety of solid carbide miniature boring and internal grooving tools.



1. Setting a vice to an angle of 102 degrees for machining the angled portion of the tip seating.



2. The completed holder, tip of a differing width and the Torx spanner for the fixing screw.

Making a holder

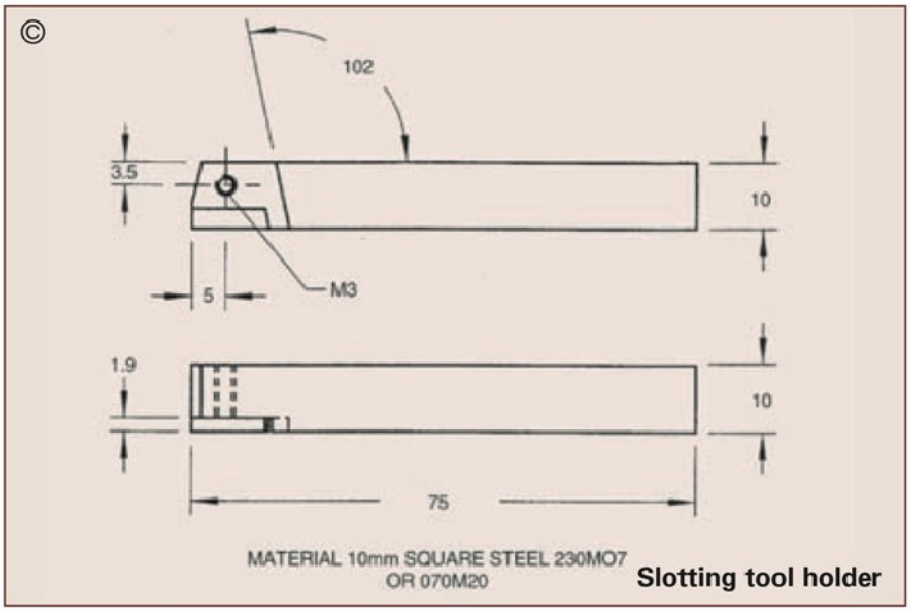
All the grooving tips available in the range considered here, ("Interstate Mini-Thin System") are to the same basic size so only one holder is required. Whilst this is so, making more would be very easy having set up for the first. A holder for each tip width envisaged would therefore be a good idea and feasible if one is making ones own. As a comparison, two commercial holders could cost as much as a budget milling cutter chuck with collets; it is difficult to understand why this should be. The sketch shows the dimensions for a holder having a 10mm square shank. You may though wish to change cross section and or length to suit your requirements. The tip seating would of course have to remain the same.

Cut a length of steel and finish the ends. Cover the side at one end with marking blue sufficient to position the fixing screw and mark out the edge positions of the tip. Drill and tap the hole for the fixing screw, temporarily fix one of the tips in place and carefully scribe round the two edges with a sharp scriber. Using a 3mm mini mill running at a high speed set the depth to 1.9mm and carefully machine up to the longitudinal line. Watch the band of marking blue as it decreases in width as you progressively work towards the marked line. As you approach the point that the blue band will be finally machined away make only small adjustments, say 0.05mm. Stop machining as soon as the blue line ceases to exist, but do not machine away the scribed line. A magnifying glass will help to check the results, but DO NOT UNDER ANY CIRCUMSTANCES do this with the machine running. If you decide to make more than one holder repeat the complete exercise because if you work to the machine dial readings you may end up with a poorly fitting tip due to a variation in the position of the tapped hole

Set the vice to an angle of 102 degrees as shown in **Photo 1.** A tool makers vice with parallel sides, as in the photograph, is easily set to the required angle as can be seen. This is often not the case with other forms of milling vice. Using the same approach as above, now machine up to the angled line. Do this with the 3mm mini mill and still set at 1.9mm deep. Machine right across the tool holder to prevent leaving a radius made by the cutter, which would foul the tip.

You may find that the countersink of the fixing screw provided projects through the tip by a small amount. If so the tapped hole in the holder will need lightly countersinking. Otherwise, lightly chamfer all the edges and the holder is complete, **Photo 2.** You may for a professional finish oil black them, or use one of the propriety blacking products.

It is unlikely that it will ever be the case that replaceable tipped tooling will serve all our workshop needs, but this is one more requirement that can be wiped from the list of "grind them myself" tools.



Slotting tool holder

Suppliers

Ref 1. J & L Industrial Supply. 7 Pacific Avenue, Wednesbury, West Midlands, WS10 7WP telephone 0800 66 33 55.
E-mail sales@jlindustrial.co.uk
Web site www.jlindustrial.co.uk

Ref 2. Tooling Direct Ltd. 533/537 Lichfield Road, Aston, Birmingham, B6 7SP telephone 0121 327 1952.
E-mail toolingdirect@btinternet.com

Ref 3. WNT United Kingdom Ltd. Sheffield Airport Business Park, Europa Link, Sheffield S9 1XU
Freephone 0800 073 2073

Note the Torx fixing screws are not included with the tips and must be ordered as a separate item.

A COPYING ATTACHMENT FOR THE WARCO 300/2 LATHE/MILL

Alan Barrett describes his attachment seen earlier at Sandown Park

Background

1. The attachment (earlier version with QC toolpost) in operation.

About two years ago, I decided to make a chess set for my grandchildren, and as soon as I looked at the shapes required, it was obvious that some form of profiling would be required. This led to designing a copying attachment for my Warco 300/2 lathe/mill to produce the various pieces, probably in quantities of 2 up to 16.

After several attempts, the attachment is now in use, albeit with a few drawbacks which I will elaborate on later. The idea of this article is to explain how it was produced, how it can be used, the methods I used to produce the various parts and thus enable anyone else to follow my example. Any improvements or suggestions will be gratefully received. The design should be capable of being adapted to other lathes, providing there is enough cross slide movement.

Since it has been in operation, I have made several changes in the design and found a whole range of uses, which I had not thought of before. The latest is the production of a tapered thread which was required for a repair on an adapter.

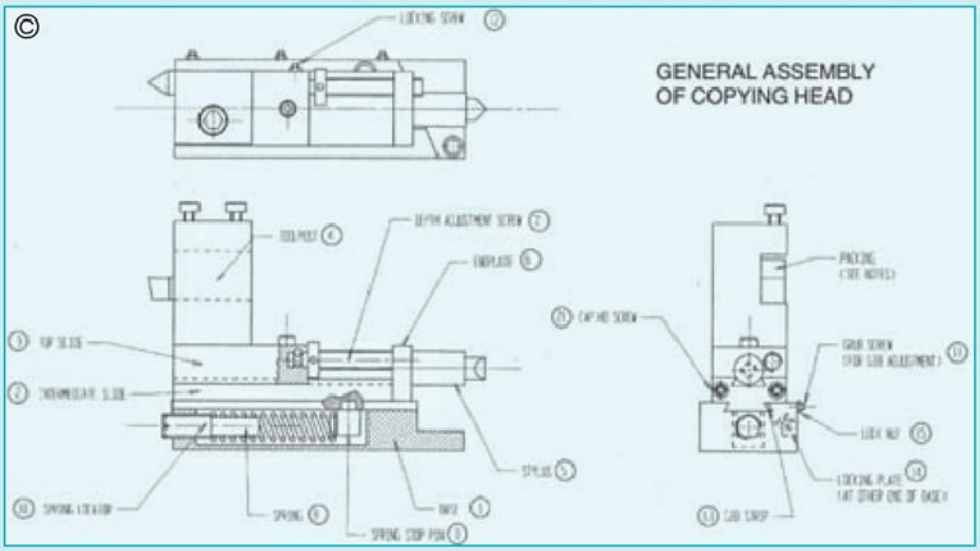
In its original design, there was too much movement in the device to allow a reasonable depth of cut and good surface finish. I therefore decided that there must be a locking system of the upper slide when cutting, removed when returning to the starting position. I also moved the gib strip to the other side for more rigidity when cutting. Because of backlash problems, I was also cutting the profile when returning to the starting position, so modified the device to enable me to remove the stylus on the return (see **Photo 1**) However, this proved troublesome as I could not guarantee accuracy, so I have recently reverted to a fixed stylus, and remove the template instead

Another change was the toolpost. You will see in photo 1, a quick change toolpost which I produced some years ago for an older lathe I had at the time. It came from issue 26 of Model Engineering Workshop. The problem was that it tended it create too much leverage when in use leading to chatter and poor surface finish. This was because the tool was mounted about 45mm from the centre of the slide, and the slide being only about 15mm wide.

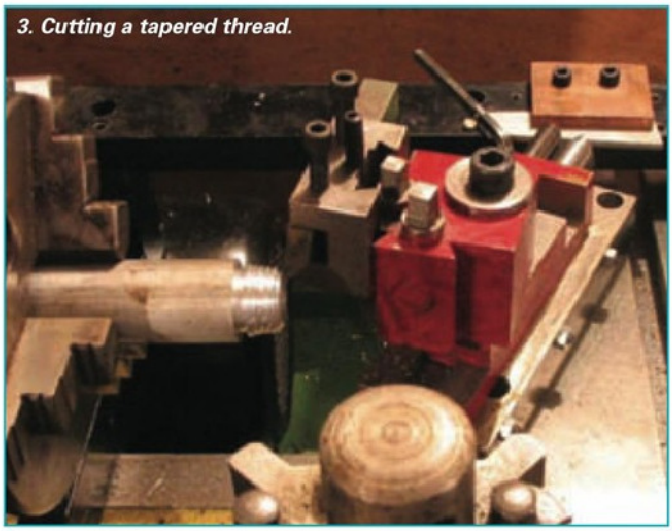
I should also point out that the device was made entirely from my scrap bin, so material choice and size were limited, and dictated by what was available. My range of taps and dies is mainly imperial, but I had a stock of M5 cap head bolts so standardised on these where I could.

Ideally, the main base unit should have lugs fitted (or incorporated) so that you do not have to disassemble the top slide to attach it to the cross-slide, and similarly assemble it after bolting it down. Unfortunately, I did not have a piece of steel large enough for this and hence it now resides on the rear of the cross slide almost permanently to avoid this problem. The alternative is to place a lug on each side and weld it in position. (this is shown dotted on the base drawing **Item 1**)

When not in use, I remove the front two clamps to take away the template assembly, leaving the slide and head in position at the rear of the cross slide. As the lathe has an extra long cross slide, there is plenty of space to do this, and it saves a lot of time setting up. Most of the manufacture is straightforward so I have only elaborated on what I feel are the important parts. I should also note that the methods noted are to suit my facilities, others having access to other machinery may wish to adopt alternative techniques.



2. Spotting through on the pillar drill.



3. Cutting a tapered thread.

Item 1 Base Unit

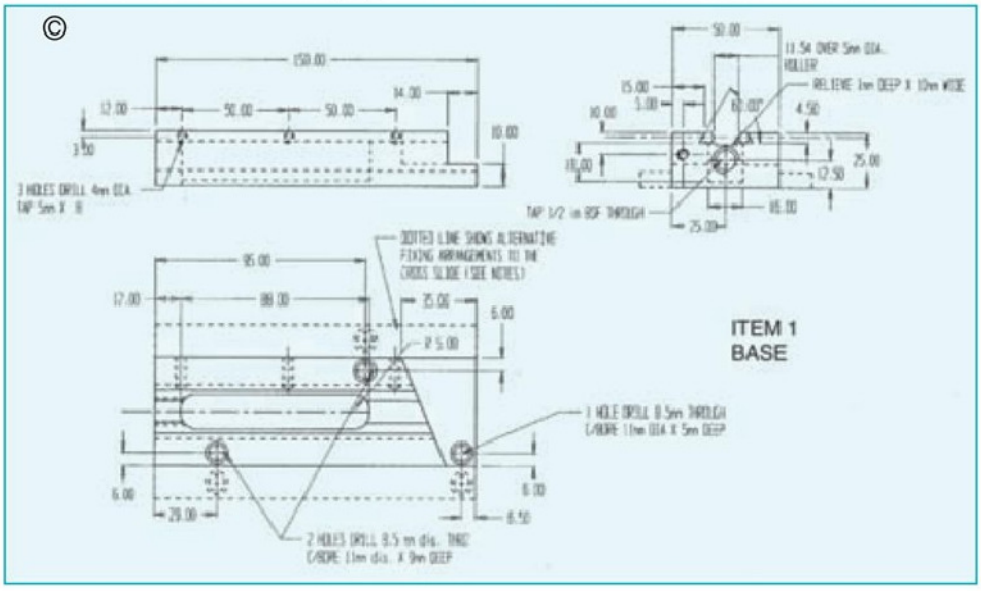
The standard method I use is to block up each part to size first, select a datum face which is used against the fixed jaw at all times, then proceed from there. The fixed jaw is clocked up with a DTI to ensure datum accuracy. I use the vice at right angles to the lathe bed as this gives more control over the feed rate. It means that you need some form of length control on the saddle, so I place a block of aluminium, made for this purpose, on the bed and use length blocks to control the position. On the later version of the Warco 300/2 there is a feed handle on the leadscrew so it would be better to set up the vice parallel to the lathe bed.

In this case, after sizing the base, I cut away the rear angled section, then using a 14mm diameter end mill, cut the dovetail slot to 20mm, leaving the actual dovetail until later.

The central pocket 88mm length by 16mm wide was then roughed out and finished with a 10mm slot drill. Whilst I had this cutter in the machine I also cut out the relief 10mm wide by 1mm deep down the middle of the slideway. The clamping holes were then marked out, drilled and counterbored.

A 60 degree dovetail cutter was then used to produce both of the angled sides of the slide at the same setting. I used 5mm dia. silver steel rods as rollers to measure the dovetail. The dimensions had been carefully drawn up in a CAD package to provide the necessary accuracy as I like to confirm my calculations. Finally the remaining holes were drilled and tapped. This was carried out on a pillar drill, rather than on the lathe.

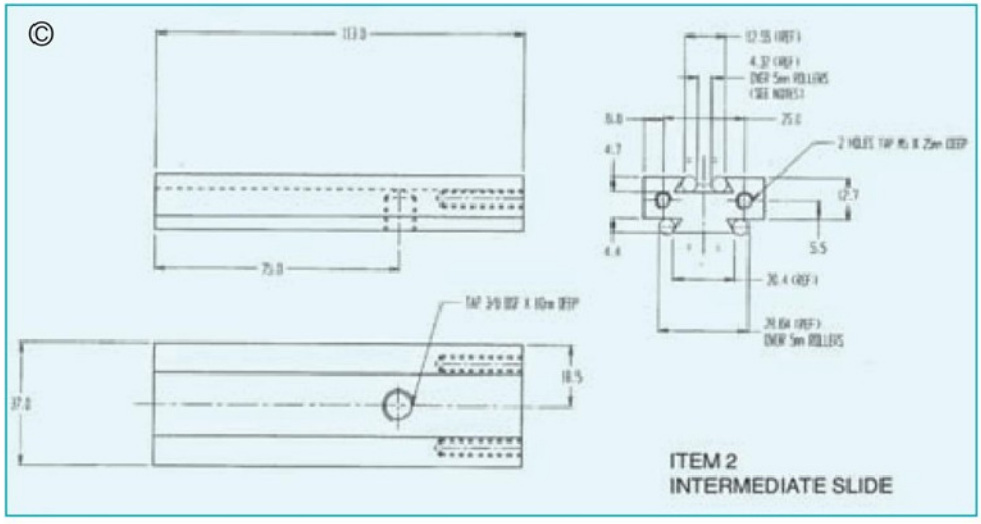
As you can see from the drawing, I would have preferred to use a larger piece of material, or welded lugs for the clamping to the cross slide, but as I have no welding facilities and could not find a large enough chunk of metal, I had to compromise. In reality it is not a serious problem as I leave the tool holder and slide at the rear of the machine most of the time and simply remove the template holder.



Item 2 Intermediate slide

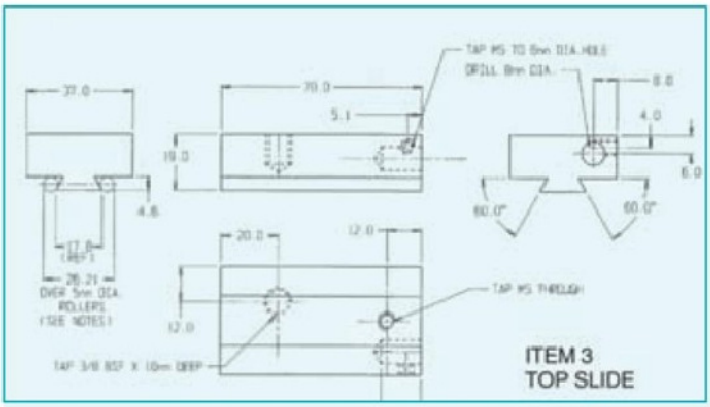
This was blocked up in the normal way, the top dovetail cut out as before using a 10mm slot drill to clear the centre then a dovetail cutter to finish to size. In this case, the size is critical as there is no gib strip on the top slide and a good slide fit is essential between the two mating parts.

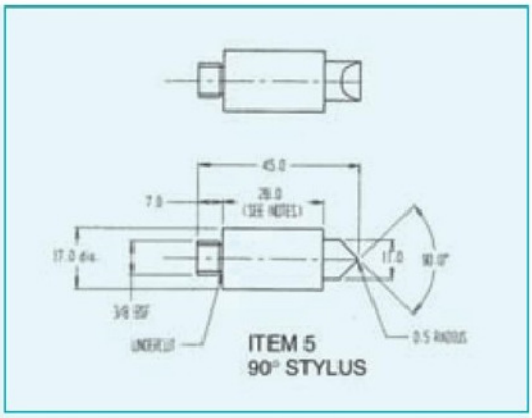
The slide was then turned over, keeping the same edge against the fixed jaw as a datum to ensure that the two dovetails are parallel and the second outer dovetail roughed out with a 10mm slot drill, followed by the dovetail cutter. Finally the holes were marked out, drilled and tapped on the pillar drill.

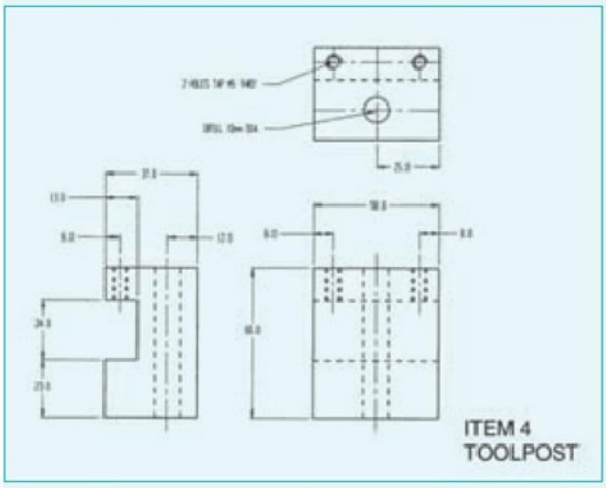


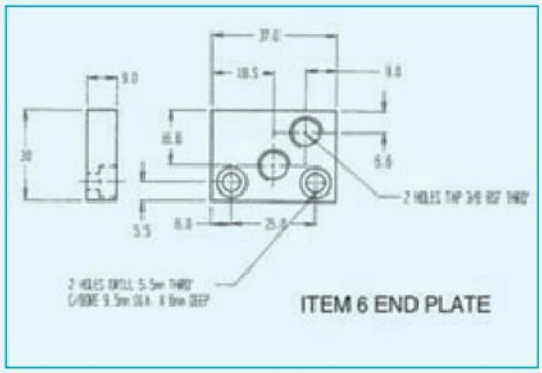
Item 3 Top slide

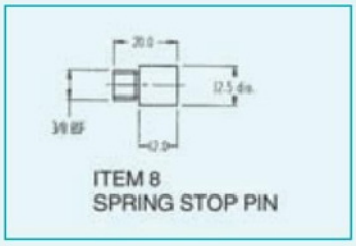
This was produced in the same way as the intermediate slide by blocking up, roughing out with a slot drill and finishing with the dovetail cutter. The main difference this time was to ensure that a good slide fit was obtained with the intermediate slide. I checked the size regularly with the rollers, but several 'air' cuts were used to get the right fit. At this

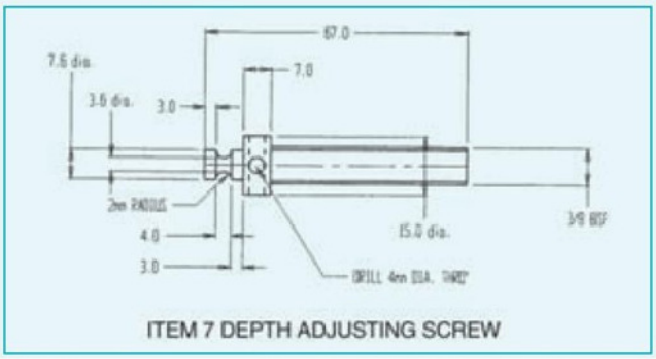












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stage you can fit the two slides together for checking purposes.

The other holes were then drilled and tapped, with the exception of the 8mm hole which was drilled on the pillar drill at a later stage, after the end plate had been fitted to the intermediate slide, so that you can spot it through the assembly to ensure that it lined up accurately (**Photo 2**)

Item 4 Toolpost

As previously mentioned, this was added at a later date because of the chatter problems caused with the original quick change toolpost. It was blocked up in the usual way, then the 24mm x 13mm slot removed, before drilling and tapping the other holes.

The depth for the tool (24mm) appears to be very large, but this is to enable you to turn the lathe tool upside down to cut right hand tapered threads. If the tool is left in the usual position with the lathe running in reverse, you cut a left hand thread. The need for this change became apparent recently when I was attempting to cut a tapered thread and realised that the toolholder was nearly out of the top of the body (**Photo3**) Experience in use shows that a better finish can be obtained with the tool inverted but I have not studied the reasons why.

Item 5 Stylus

Whilst there is a drawing provided for the stylus, this is an item which may require several different versions. The stylus shown was the second one produced, the first one shown in **photo 1** was intended to have a quick release mechanism, and whilst it worked to a degree, led to chatter and inaccuracies. The variations on the solid stylus will be the angle on the tracing end and the length required to give a reasonable working distance in which to operate.

I have found that the 28mm length is fine until you start cutting tapered threads and turn the toolpost to half the thread angle so that you feed down one side of the thread. This means you have to turn the toolpost and this moves the tool closer to the work, so I had to produce another stylus 12mm shorter. Before cutting the 90° angle on the front face, screw the stylus into the end plate and mark the top so the you can get the angled face vertical when it is assembled

Item 7 Depth adjusting screw

This is the screw which feeds in the tool to increase the depth of cut. If you use the cross slide, the tool position does not change as the template simply keeps the tool in the same position, but increases the pressure on the template.

I intended to make the screw from hexagonal bar to be able to use a spanner to adjust it. However, as I had no hexagonal bar, I put two holes at right angles in the 15mm diameter and used a tommy bar to adjust the cut.

As the thread is ⅜in BSF, it has a pitch of 0.05in, hence one turn of the screw feeds the tool in 0.05in. However, if the assembly is set at 30° to the cross slide (The standard fitting) it will only feed in 0.043in. Therefore turning the screw about 45° gives a feed of 0.005in, which is quite adequate. If the assembly is set over to 45°, the radial distance travelled will be 0.028in.

Turn the screw thread first, then holding the thread in a split nut clamped in the three jaw chuck, turn the rest of the screw. The cross drilling was carried out on the pillar drill, using a vee block with aluminium packing to protect the thread where it was clamped.

Item 9 Spring

This was a bought out item. I tried several different springs, each 10mm diameter, to see which gave the best results. The first

4. Milling the gib strip using a sacrificial block.

5. Assembly set at 30 degrees.

one was a die spring, but this was too strong and resulted in the stylus cutting into the template, rather than following it.

The next one was very light, and did not have sufficient strength to hold the stylus on to the template. This surprised me as I assumed that once cutting commenced, the cutting force would keep the stylus on the template. Eventually I settled on the current spring which has a wire diameter of 1.5mm.

Item 10 Spring locator

This was produced at one set-up, turning both diameters, then cutting the thread (with a die). It cannot be made until after you have decided on which spring to use as the internal diameter of the spring determines the location diameter. The size is not critical as it only has to keep the spring in position whilst assembling it and holding it there during copying. The screwdriver slot was produced by using a hacksaw. If you aim for more of an exhibition finish, you may choose to cut this with a slitting saw.

Item 12 Locking screw

The production of this is identical to that of item 10, as it is only a smaller version of the same profile. Its function is to lock the depth adjusting screw to the top slide, but allow rotation. A lock nut is used (Item 15) to keep it in place.

Item 13 Gib strip

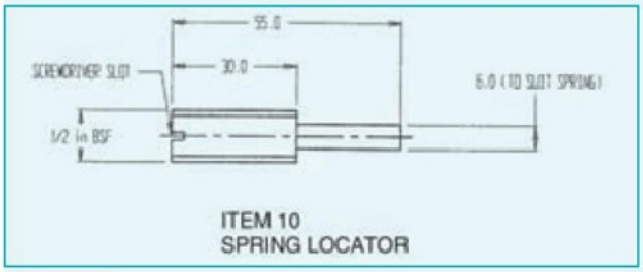
This item proved to be the most difficult to produce. The problem was not only maintaining accurate size, but holding it during machining. It is made from 4mm brass strip 10mm wide. The problem I had was that it is 120 mm long, and my vice jaw is only 75mm long, so 45mm is flapping outside the jaws. I overcame this by using a 'sacrificial block'(i.e. a piece of material which can be used as a support, but cut away where necessary, then thrown away) with a toolmakers clamp. (**Photo 4**) If the gib strip is made from steel, it could be ground to the 4mm thickness, but I had this 4mm brass, so used that. (I do not have a surface grinder anyway).

To set this up, you must clock up the fixed jaw in the normal horizontal position first, then tilt the vice to 30°, grip the block and the gib strip material, then clock up again to ensure that the gib strip is parallel to the cutter. I managed to scrap two strips before obtaining the required accuracy because I did not get the strip parallel.

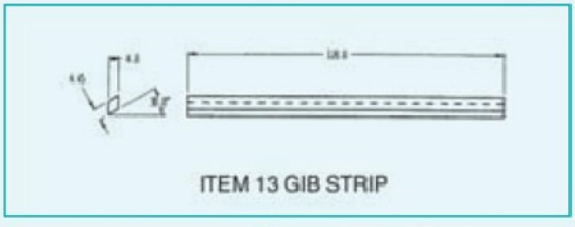
As you can see from **Fig 1**,there is not a lot of material left to clamp on (just under 3mm) when the 30° top face has been cut, then turned over. The cutter used was a 6mm slot drill, which has to be positioned so that it cuts the gib strip, but not the vice jaw. In other words it is lined up just clear of the vice jaw and cuts into the sacrificial block.

Item 14 Locking plate

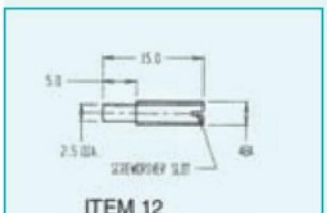
This is made from any scrap of sheet, simply to keep the gib strip in position. In practice, in the year that I have used the



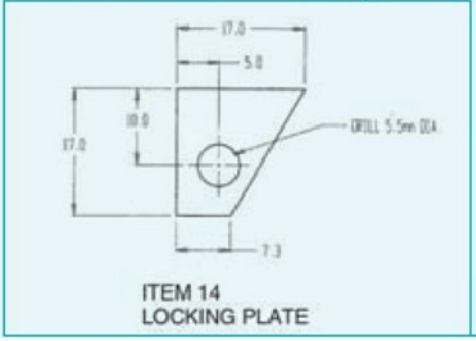
ITEM 10
SPRING LOCATOR



ITEM 13 GIB STRIP



ITEM 12
LOCKING SCREW



ITEM 14
LOCKING PLATE

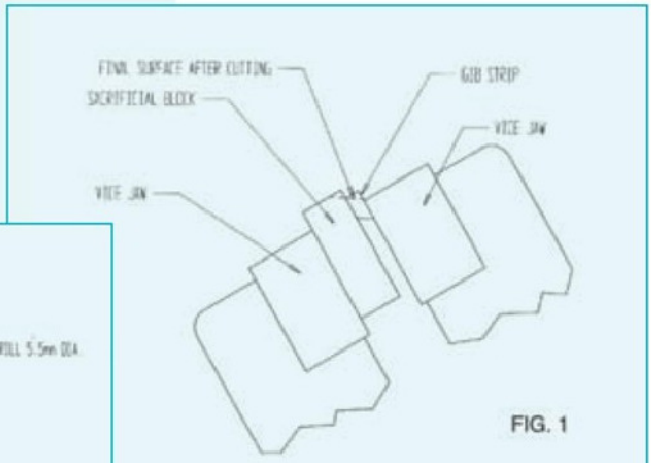
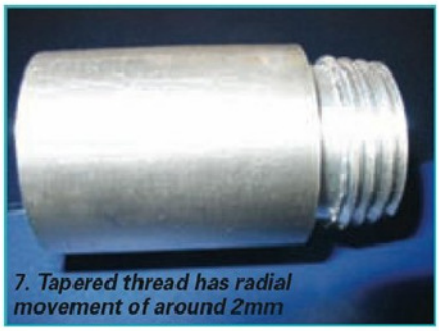
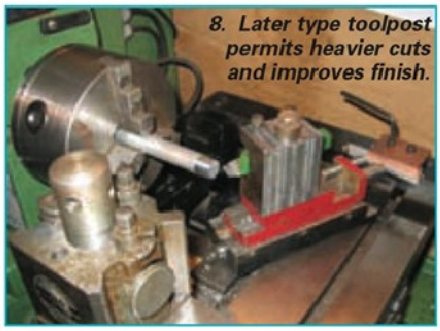


FIG. 1

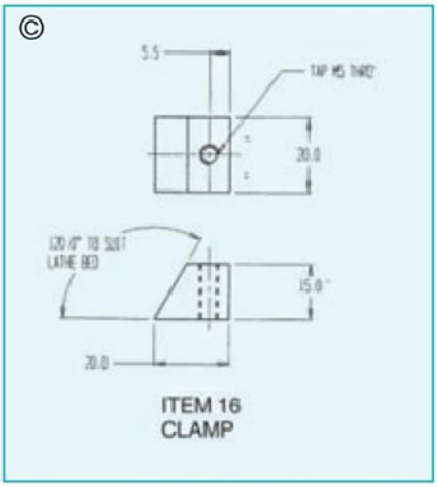
6. Assembly set at 45 degrees.



7. Tapered thread has radial movement of around 2mm



8. Later type toolpost permits heavier cuts and improves finish.



attachment, the gib strip has not moved without the plate in position, but over a period of time it could do so.

Item 16 Clamp

As I was worried about damaging the lathe bed when clamping the template holder to it, I decided to use aluminium alloy parts wherever the attachment was in contact with the lathe. The manufacture is straight forward, simply blocking up to size, then cutting the 120 degree angle. I made several measurements of the lathe bed angle and as the fixture clamps securely in the same position each time, I am confident it is correct, but it is advisable to check the angle for yourself.

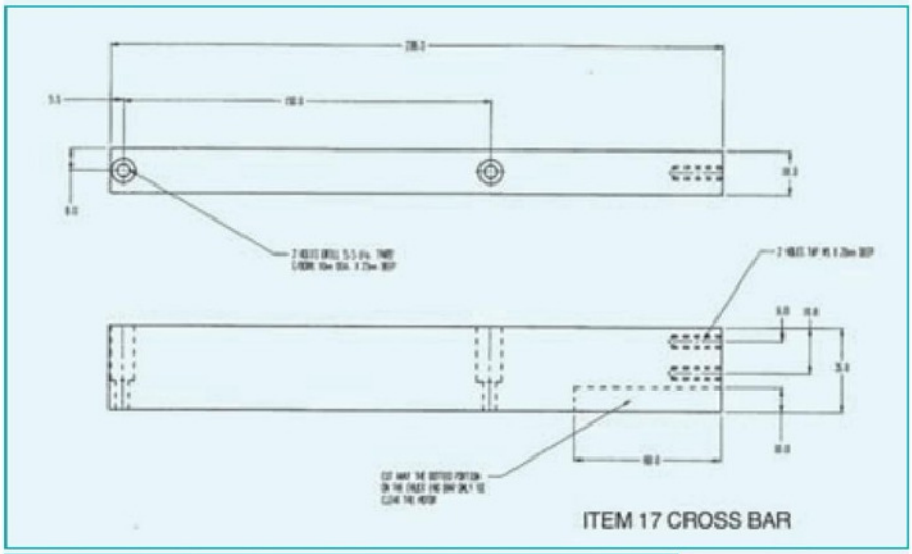
Drill and tap two clamps, but leave the other two undrilled until you can spot through on assembly. This is necessary if the cross bars are to be rigid. In the first instance, I produced three correct holes, but one did not actually lock onto the bed and produced a rocking element to the template bar. The solution was quite simple. If it does not clamp onto the bed, remove a small amount from the top edge until it does.

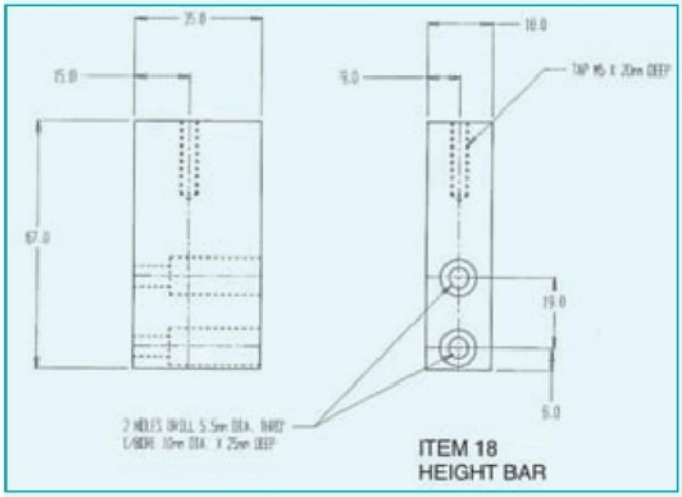
Item 17 Cross bar

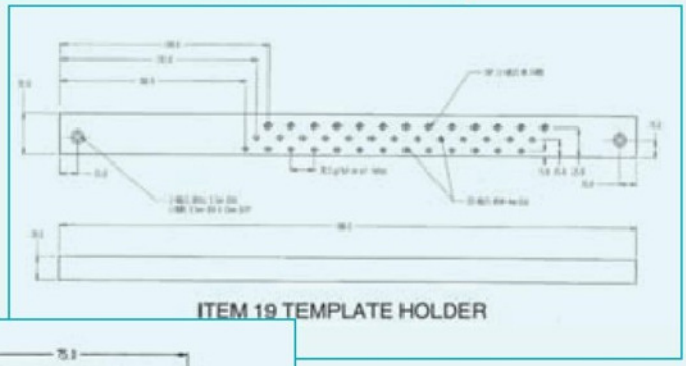
The manufacture of these two bars is straight forward but the left bar has a cut-out to clear the drive motor of the lathe. I decided to keep everything as common as possible so the tapped holes for the height bars are identical, which means that they could be interchangeable if required. There is no reason why items17 and 18 should not be welded together if you have welding facilities.

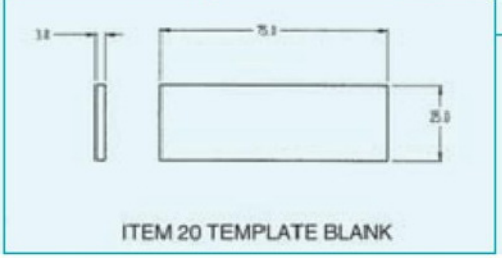
Item 18 Height bar

These were one of the last items produced and again, manufacture is straight forward;









but I left extra material on the top of the 67mm length so that I could assemble them to the cross bars and check both the level and the height relative to the template bar when assembled. For the same reason, I did not drill and tap the M5 holes until I could assemble them on the lathe, clock up the template holder, then spot through.

Item 19 Template holder

This was made from a piece of BMS 35mm x 20mm which I had in stock, so the only machining required was to drill and tap the holes. Its size is not important, but it must be at least 450mm long and rigid. I started by marking out and drilling the two 5.5mm diameter holes which are used to clamp it to the height bars then counter-boring them 10mm deep.

The holder was placed in the vice on the lathe and the 4mm holes drilled and reamed. I machined them on the lathe because they locate the template and need to be parallel to the front face. You need to be careful when positioning the vice to ensure that you can produce all the holes at one set-up, and also ensure that the vice is square to the saddle. Using the same set up, I drilled the M5 tapped holes as well.

Item 20 Template blank

The shape and size of this is entirely dependent upon what shapes and their size you intend to produce. I had about 6 pieces of 3mm aluminium plate of this size and they have been all that I required up to now. I thought the aluminium would wear, but as the quantity produced of any shape has been under 12, this has not been a problem.

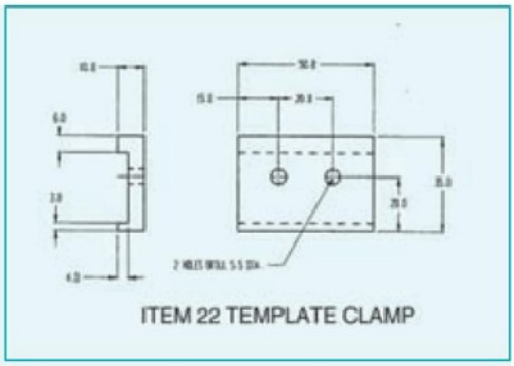
Future developments could be putting centres on the template holder so that if I need to cut a Morse taper, I could put an existing taper up and use it. Because I was careful in the production of the holes on the template holder, the template blank rear edge is regarded as datum and the profile marked out from that, ensuring accuracy.

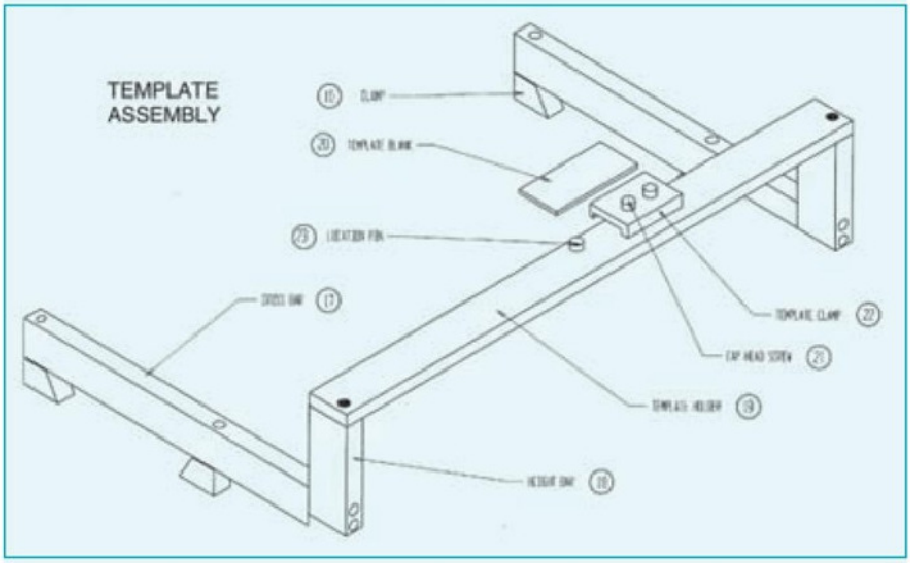
Item 22 Template clamp

As with the template blank, the size of this is dependent upon the shape being produced. If a long template is required, two clamps would be used. To date I have only made one clamp so this problem has not arisen.

Assembly

The first assembly to complete was the toolholder and slides as this defined the height at which the template holder needed to be set. It is advisable to lubricate all the surfaces at this stage to ease movement. Clamp the base to the cross slide using two bolts and tee bolts in the front and left side holes, using the left hand tee slot on the cross slide (**Photo 5**). This sets the assembly at about 30°. If the two holes on the right side of the base are used, it sets the assembly at about 45° (**Photo 6**).





The intermediate slide is then put in place, item 8 (spring stop pin) screwed in, the end plate bolted on, the gib strip inserted, and adjusted with the three grub screws on the left hand side. These are locked in position with lock nuts. The spring is now fitted to the spring locator and this screwed into the base. This should move the intermediate slide to the rear of the base. Screw the spring locator in until it is nearly flush with the base. Now fit the top slide to the intermediate slide, fit the depth adjusting screw, push the slide onto the end of the screw and fit the locking screw and lock nut. This assembly should now move freely when rotating the screw. Screw in the stylus.

Clamp the cross bars onto the lathe bed in approximately the correct position and with the template holder placed on the height bars. Check that the stylus is in the correct position relative to the template. If any adjustments are needed to align the height of the template relative to the stylus, now is the time to do this. Spot through one end of the template holder and drill and tap the left hand end (Chuck end) height bar. You probably need to remove it from the cross bars to do this.

Bolt the template bar to the left hand height bar and then, using a dial indicator, line up the template bar parallel to the lathe bed, clamp it in position and spot through. All that remains is to complete the assembly by bolting on the template clamp and fitting a lathe tool on centre height in the toolpost.

Using the attachment

As you can see from the drawings, there is a wide variation available on the template holder for the position in which you can place the template. Its position is determined by the length you require to cut and where the profile is on the workpiece. The attachment has a total slide movement, depending on the closed length of the spring of approximately 15mm. This is the maximum difference in radius that you can cut. However, the position of this 15mm, relative to the centre line of the machine has a range of about 40mm, depending upon where the toolpost is positioned. In most cases the total movement, particularly for tapers, is not very great. On the example (**Photo 7**) the 10° thread it was only 2mm over a length of about 11mm.

Place the workpiece to be machined in the chuck leaving slightly more out of the chuck than normal to allow for clearance. Screw the attachment toolpost to the back of its movement to clear the workpiece. Set the tool in position at the end of the cutting position, clear of the workpiece, and determine the position of the template on the template holder so that the finish point of the profile is correct. This is important as if the tool is travelling too far along the workpiece, and runs off the template, it will cut a parallel diameter. I usually have a taper or cutaway at the chuck end of the template to ensure that the tool physically clears the material and gives me space to stop

the machine without the tool rubbing on the workpiece.

Move the saddle so that the tool is in position to start cutting, clamp up the template against the location pins and move the cross slide so that the stylus contacts the template. Continue moving the cross slide until enough movement is possible of the toolpost to cut your profile. Adjust the toolpost so that the tool is taking its first cut and clamp up the top slide. This is important as there will be too much movement in the attachment if the top slide is free, with a resulting chatter and poor surface finish. Always lock up the tool slide when taking a cut. At the end of the cut, carefully return the cross slide to the starting position, unlock the top slide, feed in the tool, and clamp up the slide. Repeat this process until the profile is the correct diameter.

If you have problems back cutting the profile on the return to the starting position, remove the template at the end of the cut to allow the tool to stand clear of the workpiece, return the cross slide to the starting position, refit the template and then you are ready for the next cut. This was the reason that I was careful in using location pins on the template holder, to ensure accurate repositioning of the template at any stage.

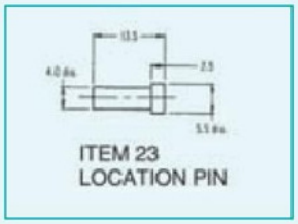
You will see from **Photo 3** that I leave the Allen key for clamping the top slide in position whilst cutting. This acts as a reminder to clamp up the top slide. The drawings supplied are for the latest version, as shown in **Photo 8**, which has a fixed 90° stylus and works well on most components, but there are occasions where the 60° stylus is required. The attachment works well where the profile increases in diameter towards the chuck. There are limitations in cutting curved profiles due to interference of the stylus onto the shape. **Fig 2** shows how this can occur. **Figs 2** and **3** show a template for a machine handle and how to overcome the problem by stopping the cut at the start of the interference. This means reversing the component for a second operation, using the same template.

It should be noted that to cut a tapered thread, the template only has to be a straight taper of the correct angle. It does not require a thread form as this is provided by the combination of tool form and leadscrew feed in the normal way. Typical examples are shown in **Fig 4**. You will see that the chess piece is quite different from the template because of the stylus and cutter interference. This was produced with a 40° stylus. The profile created several problems as I needed a lighter spring and had to modify the shape to get a successful profile. Where the stylus has to reduce the profile, it lays almost parallel to the template so I reduced the angle of the stylus to 40° and still needed manual assistance to achieve a cut. As I stated at the beginning of this article, this design is really made for increasing diameters and reasonable curves. The resulting shape differs from the template and allowances must be made for this variation. Fig 4 shows a selection of shapes for which the attachment has worked well. Producing this article has made me look more carefully at the design, and I have overcome many of the original problems that appeared. Of course, design is an evolutionary process, and each component produces different problems, but that is the pleasure and the challenge in design and manufacture.

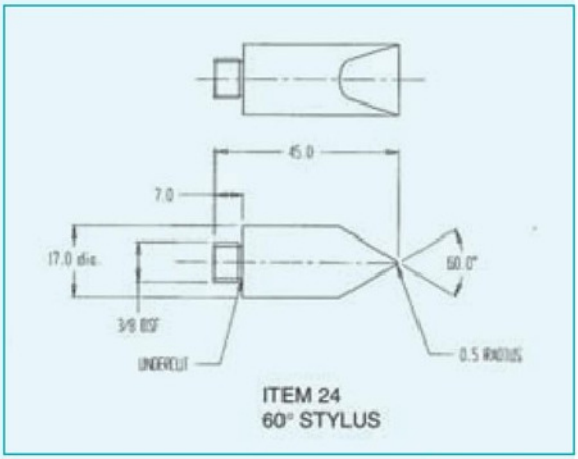
TABLE1 PARTS LIST FOR COPYING ATTACHMENT

(All dimensions in mm's unless otherwise stated)

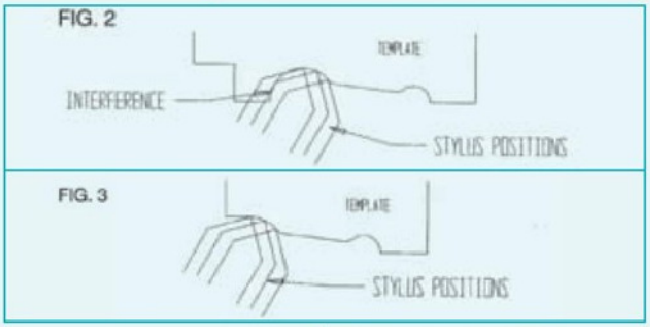
ITEM NO.	No OFF	DESCRIPTION	MAT/L	ACTUAL SIZE
1	1	BASE	BMS	50 X 25 X 150
2	1	INTERMEDIATE SLIDE	BMS	18 X 37 X 113
3	1	TOP SLIDE	BMS	19 X 37 X 70
4	1	TOOLPOST	BMS	37 X 50 X 60
5	1	90°STYLUS	BMS	Ø17 X 45
6	1	END PLATE	BMS	9 X 27 X 37
7	1	DEPTH ADJUSTING SCREW	BMS	Ø15 X 67
8	1	SPRING STOP PIN	BMS	Ø 12.5 X 20
9	1	SPRING		Ø 10 X 75mm LG
10	1	SPRING LOCATOR	BMS	Ø 1/2in X 55
11	3	GRUB SCREW		4BA X 1in LG
12	1	LOCKING SCREW	BMS	Ø3.6 X 15
13	1	GIB STRIP	BRASS	4 X 10 X 120
14	1	LOCKING PLATE	BMS	1 X17 X 17
15	4	LOCK NUT		4BA
16	2	CLAMP	AL.ALL	15 X 20 X 20
17	2	CROSS BAR	AL. ALL	18 X 35 X 236
18	2	HEIGHT BAR	BMS	18 X 35 X 67
19	1	TEMPLATE HOLDER	BMS	20 X 35 X 500
20	1	TEMPLATE BLANK	BMS	3 X 25 X 75
21	17	CAP HEAD SCREW		5mm X 25mm LG
22	1	TEMPLATE CLAMP	BMS	10 X 35 X 50
23	3	LOCATION PIN	BRASS	Ø5.5 X 13.5
24	1	60° STYLUS	BMS	17mm ø X 45

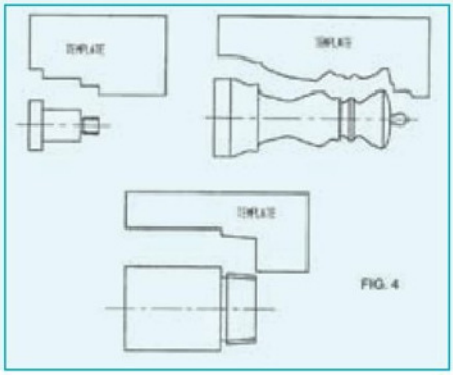


ITEM 23
LOCATION PIN



ITEM 24
60° STYLUS





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TRADE COUNTER

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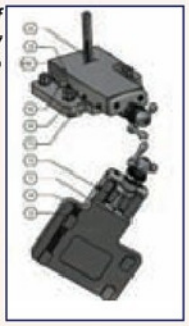
New topslide kit from Hemingway



A 3-D drawing of the Hemingway topslide

As with many apparently novel items, this one has its roots firmly in the past. Back around 1971, a more robust design of topslide was proposed for Myford Seven lathes by J.A. Radford in an article in Model Engineer. Hemingway now offer a kit of parts to build this device, which conveys a number of advantages compared with the standard article. Mounting is by the saddle tee slots, and it is intended to be set accurately at 90degrees, which it is reckoned caters for the vast majority of turning work. (The original can be substituted in a minute or so when an angle setting is needed.) The castings are also shaped so that the tool can be brought closer to the centreline with less overhang, and avoid interference with the tailstock. **Hemingway can be contacted by phone on 01746 767 739 or at 126 Dunval Road, Bridgnorth, Shropshire, WV16 4LZ**

News from Arc Euro Trade

Larger stepper from Arc Euro Trade.

As a sales tool, the new web site is already proving its worth, by giving customers not only the opportunity to view the latest catalogue items on line, but also place orders. Credit card information is secured by encryption, and for customers who prefer not to transmit such details via the internet, phone or fax may be used as an alternative.

On the new products front, following the success of the small stepper motors and drivers, larger chunkier versions have now arrived. The motor weighs in at 5.25Kg and yields a holding torque of 6.5 Nm on a rated phase current of 4.2A. The driver requires a supply voltage of 24 to 80 volts DC and gives output current adjustable up to 7.8A. Microstep settings are available from 2 to 256 pulses/step, and a measure of short circuit protection is designed in. These steppers and drivers now present an opportunity for low cost refit on professional sized machinery. **Arc Euro Trade are on 0116 269 5693 or at www.arceurotrade.co.uk**

... and from Chronos

The smaller of two tailstock dieholders from Chronos

Historically, to be shown "how", raw beginners would either seek assistance at the local club, attend one of the "hen's teeth" college classes, or consult a book. DVD's are now available which take you step by step through machine set up followed by various lathe operations. One of the series is based on the Taig/Peatol lathe, while another illustrates work on the Mini lathe supplied in the UK by Warco, Chester, Clarke etc. The first runs for two hours and costs £26.95, while the second runs to four hours for a cost of £34.95. Other disks are devoted to other topics.

New items of tooling include a couple of tailstock type dieholders, one for 13/16in. the other for 1in. In each case the holder runs on a 3/4in. shaft stepped down to 3/8in. for easy holding in a smaller chuck. Price for each is £12.22. All Chronos prices include VAT and UK mainland carriage. **Contact Chronos on 01582 471 900 or www.chronos.ltd.uk**

Cable from DivisionMaster

DIY CNC enthusiasts may have found that the cable specified by Dick Stephen for connecting stepper motors to their drive electronics (four core screened) is readily available only in large reels. Shorter lengths are now on offer from Tony Jeffree at DivisionMaster priced at £2.25 per metre, inclusive of VAT and postage. **Contact DivisionMaster Ltd, 11a Poplar Grove, Sale, Cheshire, M33 3AX, 0161 973 4278.**

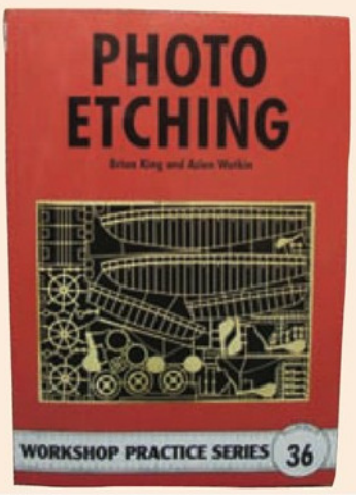
Fireside reading

Photo etching, metal etching, or chemical milling is a process that will be well known to readers as applied to the production of printed circuit boards. Those with an interest in O gauge or smaller railways, and in marine modelling will probably also have encountered it as a means employed by kit manufacturers of producing delicate parts in thin metal sheet whilst avoiding the need for expensive press tools.

This informative book talks you through the process, dealing latterly with two production avenues, preparing the artwork and using a commercial etching company to do the chemical bit, or doing the whole job at home. Ten chapters are entitled: Introduction; Uses, advantages, and limitations of photo etching; Preparation of artwork using the drawing board; Producing artwork using CAD; Component design; The maths bit; Sheet layout; Etching at home; Industrial etching; Handling and assembling etched parts.

Brian King is an acknowledged expert (gold medal winner) on marine modelling and the examples given throughout the book are naturally oriented towards this sphere of interest. However the detailed knowledge imparted would be equally applicable to small, thin sheet parts for any branch of model or amateur engineering.

This book is the latest addition (No 36) to the Workshop Practice Series published by Special Interest Model Books, runs to 112 pages and is priced at £6.95. The format is their usual 210 x 148 mm, which allows for good-sized clear photographs and drawings. It is obtainable from good booksellers or **Highbury Leisure Customer Services (01689 886 660)**



TIG WELDING OF AL ALLOYS IN THE H

Trevor Marlow concludes his assessment of the process.

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.

Next to Godliness

All parties agree that aluminium and its alloys have to be scrupulously clean prior to welding. Popular ways to reach that condition include brushing with a stainless brush, abrasive blasting, preserving "factory fresh" surfaces, and wiping with (or immersion in) various organic or alkaline liquids. The mechanical methods (stainless brush, abrasive blasting) will certainly provide a clean surface. The most convenient procedure in the home workshop is to use the stainless steel brush, because you then do not have problems with airlines or have aggressive fluids slopping about. When trying to get intricate shapes really clean, the stainless brush is less useful, at which times my own favourite method is to immerse the aluminium (or alloy) in a fresh 10% (or so) solution of sodium hydroxide. When freshly made, the solution is quite warm, which causes that the metal will start to gas freely in a few seconds. Allowing the reaction to continue for a further minute or so results in a lightly etched surface. Immersion of the object in a water butt or large bucket, in which the workpiece surfaces are lightly brushed with a domestic paintbrush, results in removal of any films of sodium hydroxide or corrosion product. Blowing dry with a hot air blower then results in all surfaces being at a surgical level of cleanliness.

CAUTION

The sodium hydroxide pellets are freely available, at modest cost, from your local ironmonger. However, please be very careful both with those pellets and with any solutions that you may prepare. Follow the mixing instructions to the letter. Protect your eyes with a full face visor. Remember that the hydroxide solution will dissolve certain containers or their lids!

Getting it together

You have put a lot of effort into matching your surfaces and getting all surfaces scrupulously clean. Is there anything else you can do? Yes, often there is. You can apply modest forces that will trivially deform the parts of the workpiece but will cause the points of contact to be where you wish to start welding. As illustration, consider the edge-on welding of two rectangular plates. If the two plates are just placed side by side, it is rather unlikely that a point of contact exists at the position where you wish to start your run of weld. Consider however if you apply modest force via substantial clamps across each end of the line of contact. Despite the plates being reluctant to deform in response to such forces, they will deform sufficiently for the points of contact to move to the ends, near the clamps. At the first generation of weld pools, then if there is any justice in this world, those pools should run together. After that, the subsequent welding is fairly easy, not least because the clamping forces provide ongoing benefit as the weld pool moves all along the line of welding.

Why should you apply "modest forces via substantial clamps"? The reason is that you then get full pooling benefit without gross deformation. To get the picture, consider the inverse, what would happen if you applied the clamping forces via long springs. When the aluminium got hot it would creep and creep and creep. If instead of that we use very stiff clamps, the aluminium will creep just a little, then there will be very little clamping force to cause any further movement.

If you have tears to shed, prepare to shed them now

Having made such effort in preparation, and having fastidiously set up the machine, it would then be rewarding and gratifying if the end product turned out to be a tidy and consistent weld. There is therefore all the more reason for distress when you examine the weld and find that it is far prettier than it is functional. The reason is that there is far less penetration than is suggested by visual examination of the crown of the weld. The weld looks good, but isn't. For the reason why you get such poor penetration you have to look all the way back to the nature of the arc as determined by the mix of polarities and the features dictated by that mix of polarities, such as the size of the tungsten electrode and the way that the end of that electrode has to be ground. The settings made at the machine give the operator a choice between best oxide dispersal and best penetration. The trouble is that, even if you set up for the least oxide dispersal that you think you can get away with, the corresponding penetration is still far less than you expect, far less than the penetration that you will have come to expect with DC TIG.

There isn't a good or effective way round the problem. By increasing the switching frequency it is possible to make a narrower arc. By moving the electrode even nearer to the surface of the weld pool it is possible to have a more concentrated arc. By lingering a little, there is more opportunity for penetration. The hazards associated with such desperate measures, such as a probability of contaminating the

LUMINIUM AND ITS OME WORKSHOP 2

electrode or having cataclysmic melting, will be obvious. You will get rather better penetration with lots of practice, but the poor penetration remains as a major deficiency of the AC method. It has all manner of ramifications, for instance, the need to use "weld preps" on relatively thin material, which is a serious detraction from the convenience and value of welding as a casual joining method.

Something very nasty lurks in the shadows ... and it is following you!

Once you have evolved working practices that allow your weld pools to run together and that lead to tolerable penetration, you might then reasonably hope to be able to make some reasonable autogenous (i.e., without filler) welds. And so you will ... but only sometimes. More often than not, you will fail. Not because you are slow on the uptake, have shaky hands, or haven't done sufficient preparation. You will fail simply because you have wandered into a minefield, an area where your reasonable hopes are, more often than not, destined to be dashed.

Your first awareness of this big family of problems will come when you seek to make autogenous welds in aluminium of impeccable provenance, new material that you have purchased from your local supplier. Your heart will swell with pleasure when the two pools meld into one, leading to further gratification when you progress that pool along the junction of the two pieces of parent material. Hang on though, what is happening in the darkness behind the arc? The material that solidified earlier looks somehow, different to the material that is in process of solidification, immediately behind the arc.

When you have finished the welding, there then is better opportunity to see what it is that is "somehow different". The difference, you find, is that the solidified material has cracked down the centreline of the weld! What you could just make out in the shadows was a thin black line, a crack, meandering through the bright new surface, following the progress of the torch. On examination of the crack, one thing is immediately obvious, that for any engineering purpose, such a weld is totally useless.

11. If you seek to weld aluminium alloys without adding filler, you will often get cracking like this. Silicon-rich filler alloys provide an almost total cure, but the associated need to "prep" the edges and feed the filler is tedious and unappealing.

Centreline cracking, - Can I avoid it?

The cracking is caused by things that happen as some aluminium alloys cool down. Yes, you can avoid it, but only in a roundabout way. To get the picture about the cause of the cracking, visualise a typical butt weld, at the time when it is still a pool of molten alloy set against a solid backing. Heat is lost in all directions, but mostly into the solid material. In consequence, the pool of alloy starts to solidify from the boundary with the solid material. The new solid does not however advance on a smooth and regular front. Rather, it advances as crystals, which grow preferentially away from the heat sink, periodically throwing off side branches as they go. Eventually there has to be a crunch time, when the crystals growing from one side meet the crystals growing from the other. On meeting, they blend and stick together in an orderly fashion. In a word, they cohere. In some alloys that is it. Everything solidifies and cools down without incident, and we have a nice, usable weld. In other alloys however, things are different. Recollect that the crystals are growing because everything is cooling down. It follows that, since everything is cooling down, everything is contracting. Such contraction is no problem before the two sides have met, but after the coherence the further contraction starts to generate stresses, which extend across the coherence boundary.

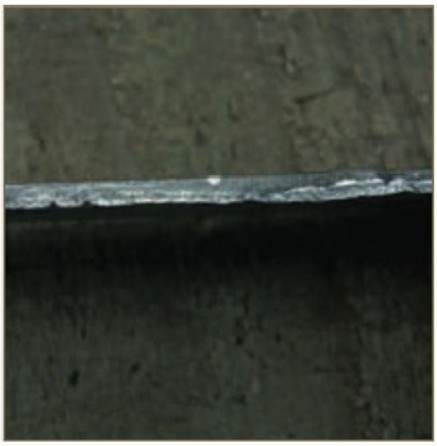
At that point, a detail of the solidification processes becomes rather important. That detail is that, although the primary crystals have met and cohered, the spaces between and around those primary crystals are still full of molten metal. Such a mix, of crystal fronds and liquid, has little or any capacity to deform under a tensile stress ... but it is that selfsame mixture which has to sustain the contraction stresses! The result is that the mixture fails to support the stresses, and we have our centreline crack.

Why do some alloys crack and others do not? The key feature is the range of temperature between the coherence and everything becoming fully solid. The bigger that temperature range, the bigger the contraction stresses that have to be endured. So, the bigger that temperature range, from coherence to full solidification, the more the tendency to cracking.

What dictates the size of this temperature range, for any particular alloy? As might be expected, the amounts of the different alloying ingredients are the dominant factor, but it is also important how quickly the metal is cooling. At typical cooling rates, the biggest range of temperature between cohesion and solidification is found in alloys containing about 0.5% silicon, so such alloys are very prone to cracking. *(Note: At very slow cooling rates, the most crack-prone alloy should be at about 1.5% silicon. It is the high cooling rate, which pulls the figure down to about 0.5%).*

The fact that the worst situation is at about 0.5% silicon gives an immediate clue how to get round the problem. Either reduce the silicon content to a lower value, or increase it to a higher value. The former

12. Here, surface tension has been coaxing the two pools to merge into one, but then disaster has struck, caused either by too wide a gap or by locally oxidised surfaces. From whatever cause, the surface tension causing the edges to pull apart has overcome the surface tension tending to cause one pool. Sometimes the situation is recoverable if in the early stages (when you first notice that the weld has stopped advancing) you provide a deft dab of filler. If it gets to this stage however, your best bet is to start again ... tomorrow!



13. An autogenous (no filler) weld might look quite OK, but if you examine the reverse side you will often find that the penetration is poor or non-existent. Flexing in a manner to open the root gap will often cause the weldment to fail, allowing visual confirmation of how little penetration had been achieved.

14. If you do not have the correct thickness of filler wire for the thicker jobs, your attempts to provide sufficient filler will be rather like trying to fill a bath with a teaspoon. Worse, you will experience problems with the thin filler rod getting too hot too quickly, making it difficult to add material to the weld pool. A partial remedy, useful only until you can get the proper filler rods, is to assemble three rods into a triangular cluster. You hold that cluster together at the far end with a bit of sticky tape, and hold it together elsewhere by a sliding spring, or whatever else is handy and suitable. You then get something like three times the filler feed rate and, more importantly, you can provide that filler into the weld pool.

15. There will be the usual poor penetration on the bottom leaf of a lap weld, but if the top leaf is then melted onto that liquid surface, the poor penetration will not matter, and the resultant weld cross section will be acceptable.

course, seeking to reduce the level of silicon, is not too rewarding. It is easy to increase the level of an alloying element, but difficult to reduce the level. Also, the "tendency to cracking" curve, while centred on something like 0.5% silicon, extends quite close to the 0% value, making it difficult to get below the cracking zone. The latter course, increasing the silicon, is on the other hand totally easy and totally rewarding, hence the popularity of the 4043 filler alloy with about 5% silicon. There then is further potential benefit from the filler alloy with about 12.5% silicon, which has little or any range of temperature between coherence and full solidification, is very fluid, and is even known to "heal" such cracks as might form.

Success or failure can hinge on a detail, trivia and miscellany

When welding unrestrained objects, such as two pieces of light strip resting side by side on a welding plate, it can be observed that the first part of the weld run will usually not crack. Fairly obviously, the trivial strength in the first solidification has been sufficient to move the light strip. However, as the early weld cools, that availability of relative movement is soon lost, and we see the onset of cracking. Hence, the term "restraint" can infer either (or both) *remote* influence (such as our strips being clamped onto the welding plate) or *local* influence (such as the restraint offered by the weld you have just made). If we intend to use randomly sourced material (i.e., we do not know what it is) then it is inevitable that some of it will be the nominally pure material, i.e., all aluminium. We may note in passing that by blending 8 or so parts of that pure material with 1 part of the popular 4030 filler alloy, we can arrive at a mixture that is slap bang in the middle of the brittle (circa 0.5% silicon) constitution. Perhaps poor penetration, which in other respects is a big downside, might in this respect be useful, since it means that there cannot be much dilution (by filler) of the weld metal. The degree of dilution varies, by the way, from one weld type to another, so when starting with entirely the same materials, you might get good fillet welds (not a lot of dilution) but get cracks in some of your butt welds (greater dilution causing that weld metal to approximate to the constitution of the parent metal).

(Note: While the cause and cure of solidification cracking is normally thought of in terms of silicon contents, it cannot be special to silicon, since for example Al-Cu-Mg-Zn alloys are also susceptible. Some of the phenomena are explicable but seeking to understand the reasons for all such phenomena leads to a dull pain behind the eyes, and awareness that you are generating more questions than answers!

As we have seen, the cause of much cracking originates in phenomena that are, (if we seek to remain autogenous i.e. using no filler) for the most part beyond the control of the welder. It is a situation where the material that is last to solidify is called on to undergo tensile deformations and stresses (generated by contraction in the material all around), and that last-to-solidify material does not possess the properties that are being called for. The detail of what happens and why it happens is dictated by the chemical constitution of the material that we are attempting to weld. Our scrap "aluminium" or "ali" might well be something like 99.5% pure, or it might well contain significant and deliberate additions of things like silicon, magnesium or manganese. For instance, if you order sheet aluminium you will probably be provided with cold-rolled 99.5% pure material, but if you order extruded forms (box, strip etc.) then you will probably be provided with a heat treatable material such as Alloy HE30. HE30 contains Si at 0.7 to 1.3%, Mg at 0.6 to 1.2%, and Mn at 0.4 to 1.0%. The significance of the two constitutions (99.5 Al and HE30) will become clear when seen in the context of **Fig. 3**, which seeks to depict graphically the information given above, that around 0.5% Si, the material will be very prone to crack upon solidification.

So, where might batches of 99.5% Al be on such a curve? Might they perhaps be anywhere, offering explanation of the very variable incidence of cracking in such materials? As to the cracking of the alloys such as HE30, at 0.7 to 1.3 Si etc., then we might conclude that they will be very prone to cracking, not far removed from the worst possible constitution. *Think about it. A soft and weak metal has been turned into a much more useful material by controlled additions of other elements, but those controlled additions are then the cause of much cracking when we seek to use our improved material for useful purposes.*

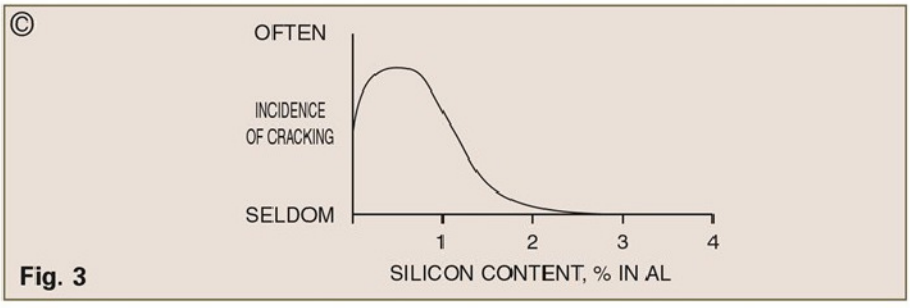


Fig. 3

So, what is the bottom line? Can I weld Al consistently and usefully?

The bottom line, unfortunately, contains a lot of detail. It seems fair to say that a lot of autogenous (no filler) welding is unwise enterprise, and likely to end in tears. Equally, if the "no filler" condition is removed, then you might then make a lot of nice crack-free welds. The reason for the benefit is that appropriate fillers will contain a lot of Si, often 5% or 12%, the presence of which can drag the pool constitution away from the "cracking zone" which, as we have seen, is somewhere around the 0.5% Si value.

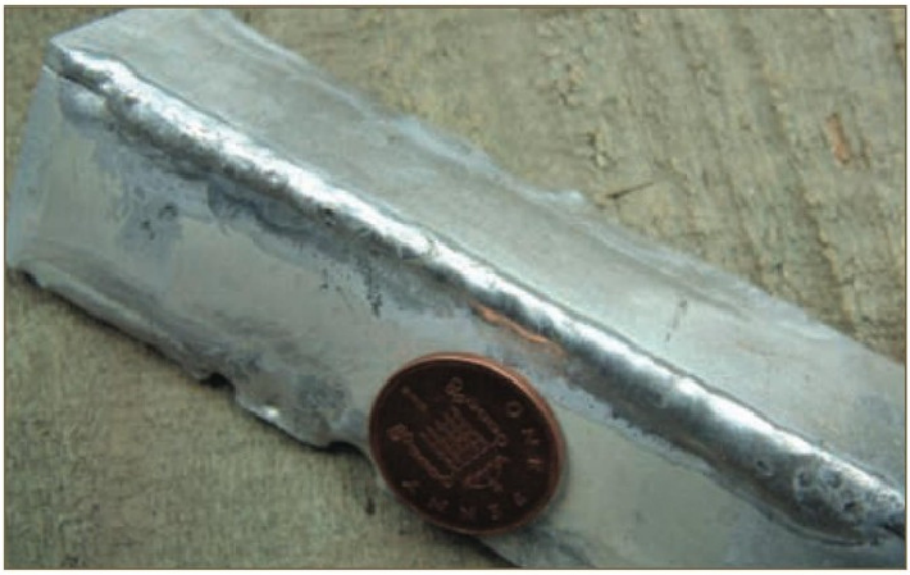
A small number of aluminium alloys are, by common consent, deemed unweldable. The identities are well documented, but the reasons why they are unweldable are seldom or ever provided. It is very relevant to observe, for the remainder, that most scrap will have needed to be strong for its original purpose, and hence will contain the deliberate additions of Si, Mg, Mn etc. that make autogenous welding so dodgy.

Choosing your filler materials: Some best bets for welding common alloys

The identification of a best filler material must be that provided by a consensus of experienced opinion. Often, good reasons for the choice are apparent. Sometimes, the choice is a bit puzzling. As example, it is perhaps a little puzzling that, for welding "pure" Al, relatively pure filler materials (1080A or a 1050B) have been recommended. The broad consensus seems to be that for all the common Aluminium-Magnesium alloys, you can use one filler, identity 5056A. The Aluminium-Copper alloys will be very prone to crack along the centreline of welding if you seek to use matching filler. The appropriate remedy seems to be to fill with the 12% Silicon alloy (4047).

Aluminium-Magnesium-Silicon alloys (heat treatable, they are often used for window frames) are also very prone to crack along the centreline of welding if you seek to use matching filler. The recommended filler material in that case is the 5% silicon alloy (4043). Al-Zn-Mg alloys are a bit special in that, while like any other aluminium alloy they become soft and weak near the weld, they can recover strength by natural ageing. If you wish to retain that virtue in the weld metal, it is possible to do so, but you need to obtain special filler wires.

Because of the properties necessary in a good casting alloy, such alloys are often weldable without any problems. Indeed, the advice from some authorities is that all castings are weldable. The applicability of such advice to automotive (car, motorcycle) wheels is a bit puzzling. Such wheels appear to have been cast, presumably under pressure, and yet a favourite material for such wheels seems to be the 2024 alloy, which has the reputation of being one of the two least weldable alloys. All very strange. It may be relevant (the poor weldability) that repaired wheels often look great until you inflate the tyre, at which time the weld will frequently fail, causing a piece of the wheel to become a projectile.



16. The welding of corners seems to go smoothly, with less cracking than would be experienced in making butt welds in the same material. It is not entirely unexpected, in that each of the two plates can bend (in one plane) more easily than if it was a component of, say, a butt weld. We have as always to remember however that appearance will be deceptive, with material being much weakened and penetration far less than is suggested by the appearance of the weld.

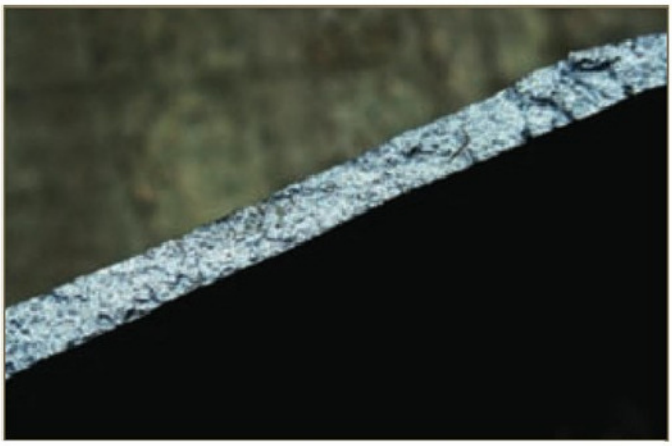
Setting up the bells and whistles

For starters in the setting-up procedure, we need to be sure that the welding torch carries the correct electrode for AC welding: If you examine the electrode and find that it is colour-coded red, that means it is a thoriated electrode, which is right for most DC, but is not suitable for AC welding. For AC welding you need either white or grey coding, representing pure tungsten or zirconiated electrodes. Which of those is best for aluminium is a bit esoteric, with various opinions involving questions of conductivity, resistance to contamination, and more. Your best bet: use zirconiated until someone persuades you otherwise. *(A useful mnemonic for remembering those colour codes is that rust is red (iron) whereas aluminium and its oxide are, if anything, white or grey, the colour coding of the appropriate electrodes.)*

Having identified the material for the electrode, what about the dimensions (i.e. diameter) of that electrode? A reasonable mnemonic for that situation is "For thinnest locally available material, use thinnest locally available electrode". What that reminds you is that immediate local availability (of sheet etc.) usually starts at 1mm, and the thinnest electrodes off the local shelf will be 1.6mm. So, for starters, for 1mm material select a 1.6mm electrode. For 2mm material, the next electrode size would be 2.4mm. The "home workshop" man might find those two electrode sizes sufficient, but for very thin stuff it is possible to get 1.2 mm electrodes, and for thicker stuff the availability extends to 3.2, 4.0, 4.8 and so on.

So much for a choice of electrodes. What about a choice for current? Different parties will suggest different values, but a reasonable starter value is something like 40 amps per mm of material thickness. Very conveniently, that lends itself to the mnemonic "One amp per thou' of thickness".

What then about the diameter of filler rod? A mnemonic for that starter choice is "Have the same diameter in each hand". In other words, choose the value of filler wire diameter to be the same as the value you have already chosen for the diameter of the tungsten electrode. As illustration: if you have chosen a 1.6 mm electrode, then choose a 1.6 mm filler rod. Having the correct thickness of filler rod is more important than it might appear at first sight. The reason is that, to prevent oxidation on the surface of the rod, you feed it from opposite the torch, keeping it in the stream of argon. If on one of the bigger jobs you try to make do with rods that are too thin, the radiant heat from the arc and the high temperature of the argon cause the rod end to melt before you have the opportunity to feed it into the weld pool. Having melted, it is then also a bit oxidised, and is from then on quite reluctant to meld into the weld pool. That difficulty can be compounded by the fact that you can have difficulty getting the filler to reach the weld pool, if it is dribbling away quicker than you can feed it. It is best to get the right rods, but if that isn't practicable or warranted, you can prevent the premature melting by clustering three rods into an equilateral triangle, putting a wrap of sticky tape around one end of the cluster to prevent longitudinal movement, and holding the cluster together by a sliding guide made out of a piece of tubing or small spring,



17. Hot cracking usually occurs where there isn't a lot of material, such as where poor penetration has led to a pathetic bridge across butting edges. However, if the material is prone to cracking, it will happen in any situation where thermal contraction leads to tension, even where we have managed full penetration.

18. It is beneficial to use powerful clamps to facilitate assembly, but with those clamps being carefully adjusted so as to apply very little force. Then, the stiffness of the clamps prevents excessive creep during the period when the parent metals are at elevated temperatures, while at the same time the welds are not subject to the tensile forces which, if the clamp was absent, would cause cracking.

see **Photo 14.** It must be stressed that these mnemonics give approximate starter values. If you then judge the current to be too high, or the filler too thin, or whatever, then follow your intuition and change to the better values.

Besides the problem of getting sufficient penetration, there can be a problem in getting things hot enough. In round terms, the thermal conductivity of aluminium is about three times the value for iron, which means that, even though you only have to raise it to a fusion temperature of about 660deg C, the heat may sink away quicker than you can supply it. On small jobs there is no problem, since small jobs soon get hot overall, and there then is very little heat sink. On massive jobs however, you may need to supply preheat, usually to about 180deg C or thereabouts. You will find that a powerful "hot air paint stripper gun" is ideal for that preheat purpose, far better and more convenient than anything you start with a spark igniter or with matches.

Another of the causes of heartbreak in aluminium welding is cratering at the end of a weld run. To avoid such cratering, the trick is to gradually back off the current and backtrack to solidified metal. The change of current can be done entirely manually, or on "bells and whistles" machines, the gradual changes in current can be pre-programmed.

The welding and the alloys, miscellany and snippets

For general home workshop welding, the arc length will be about 3mm. If you are trying to do something really special, you may need to work at a lot less than that value. Being mindful that the tungsten electrode must not be allowed to touch the weld pool or the filler rod, you will appreciate that the limits of your capability are thus largely dictated by your tremors and heartbeats. You will have best control if you are sitting comfortably and the heel of your hand is supported at a comfortable height on a block of wood or something similar, something that maintains the hand at a constant height wherever that hand is, along the length of the weld. Supporting the heel of the hand means that only the tremors in the hand remain. Body and arm tremors are largely eliminated.

Because of the HF start facility that is common on the AC machines, there is less need to possess an auto-darkening helmet. However, if you are using one of the cheaper scratch-start machines, such a helmet makes starting so much easier. The only thing you have to remember is to initiate the arc with the ceramic shroud laid on its side.

The welding starts by forming the pool or pools, as appropriate to the particular job. The filler is fed into the forward edge of the weld pool, always keeping it within the cloud of inert gas, to minimise oxidation. That stainless wire brush, so useful for preparing surfaces, can be equally useful for refreshing a surface prior to further runs of weld.

Proceeding at a cracking pace

As described earlier, one of the more distressing characteristics of some aluminium alloys is that they crack down the weld centreline as they cool, making your best efforts a total waste of time. Such cracking is actually one of a *family* of cracking phenomena, those others often being far less obvious than gross centreline cracking, but of equally serious consequence. As example, in such as Aluminium-Magnesium-Zinc alloys, low melting point constituents can occur in the heat affected zone of the weld, leading to "liquation" cracking when everything else has solidified. As if that failure spectrum was not enough, some of the higher strength alloys can suffer SCC (Stress Corrosion Cracking) if, in subsequent service, they are allowed to be exposed to remarkably innocuous substances, some even cracking on exposure to the atmosphere!

The loss of strength of aluminium and its alloys due to welding and brazing temperatures is a major detraction from their value as engineering and construction materials. Clever strategies to get round the loss of strength include making the material particularly bulky where you intend to weld, or situating the welds in regions that will not see high service stresses. Work hardened material is rendered much weaker, by the welding temperatures. Heat Treatable Al alloys can be re-strengthened by solution treatment, quenching and ageing, but often it will not be practicable to carry out such thermal treatments on an assembly. Some filler metals both prevent solidification cracking and provide a heat treatable deposit that has properties broadly akin to those of the parent. Some parent metals will restrengthen naturally over course of time, without need for any thermal treatment to bring that about. Some alloys are not normally welded because, for them, there isn't a filler that gives "like parent" properties and prevents solidification cracking. Some high strength alloys suffer liquation cracking , so they too are not normally welded. Conversely, alloys that are rather less strong may be weldable because they suffer less liquation cracking. What a complicated world we live in!

A few thoughts in closing

To keep everything in perspective, we need to observe that there are many situations in industry where aluminium and its alloys are TIG welded with success and great benefit, either by expert operatives or robotically under controlled conditions. The reasons for that success include that there is great care to select a material with best weldability and there is great effort to optimise the welding parameters. Success and reliability may only follow measures that are not practicable in the home workshop, such as the use of argon/helium mixtures instead of pure argon, to combat the problem of poor penetration.

Having observed that others can do far better than we can, it is also relevant to examine the manner of fabrication chosen for a modern passenger aircraft. In that technology, when there are several hundred lives at risk, and there is no room for compromise, have you ever tried counting

the rivets? There are thousands upon thousands, the majority not obvious because all surfaces have been levelled and burnished. If after appreciating the effort and cost required to make that sophisticated structure, we then are mindful that the rivets themselves are not always without problems (insidious corrosion, difficult to prevent and to detect), we can begin to appreciate the reservations regarding welded aluminium joints that must be felt by the plane makers.

Being mindful of what Boeing deem to be best, we can return to the topic of what might or might not be appropriate to the home workshop. To recap, we have examined AC TIG for welding aluminium and its alloys in the home workshop, and have discovered that, for the enthusiastic amateur, it has several big downsides. It is a major disappointment that, unless you add filler, you probably cannot (because of centreline cracking) weld pieces of metal chosen casually from your scrap pile. The discovery that the natural level of penetration is a mere fraction of that usual in DC welding raises all manner of spectres. As example: in situations where you only have one-sided access, such as welding pipework, can you ever be sure that you have sufficient penetration, or are you being fooled by a pretty surface?

As to the tricky task of avoiding catastrophic melting, we can perhaps look at it in several ways. It is hardly the fault of aluminium that it is so difficult to visually estimate its temperature. Equally, we must ask whether it is fair to harshly criticise the novice operative if two molten pools refuse to meld, if we are mindful that it has taken the skilled operative a long, long time to acquire the necessary knowledge and dexterity to make it look easy. A more subtle situation presents itself when the operative seeks to use manipulation and judgement to arrive at best penetration. How easy to over-cook things and end up with an embarrassing puddle! The poor penetration leads us into the tedium of needing to "prep" relatively thin materials. Then there is the improbability of getting to know the detail identities of your raw materials, and the near-impossibility of getting to grips with all that data on the alloys of aluminium. In the light of these difficulties, and the damage done to your piggy bank if you choose to buy an AC set, we have to ask the big question. Is such a purchase a good idea?

Different persons will have different ideas. To swing you round to my way of thinking, consider the following. When you TIG weld an anonymous aluminium alloy, it will be odds on that you will need to add filler, and it is odds on that you will choose to use the 5% silicon material. Next, consider how, should you choose to braze that anonymous alloy, with your propane torch or whatever, you will probably use the most popular brazing metal ... which is the same 5% Silicon alloy! *(Note: In industry, for their many and varied brazing processes, they tend to use braze metals with higher silicon, in the range about 6.5 to 13 per cent.)*

Let us now compare the joints that you will have made by the two processes. In both cases, the nearby parent material will have suffered a serious loss of strength. Remember that our welded joint could only be welded where we could get at it. The degree of penetration, and hence the value of the weld, can only mirror the fastidiousness in preparation, the shrewdness in choice of preset parameter values, and the level of manipulative skill. The brazed joint, on the other hand will, since it involves use of an efficient flux, provide us with an efficient bond everywhere. The skill requirement is marginally more than is usual for brazing steels etc., but still not a lot. The necessary equipment, you probably already possess. The downside is the need to remove the flux after completion.

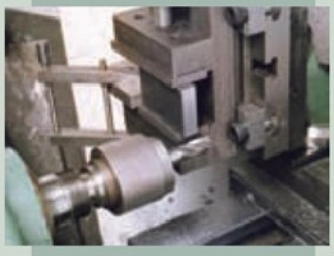
So, in total, I remain totally enthusiastic about TIG in the home workshop, but only the everyday DC version. The AC/DC machines can be things of beauty in their own right, and can be quite invaluable in industry, but I suggest that in the home workshop you will not obtain benefit to match the higher order of cost. The fault does not lie with the sets themselves, but with the behaviour of aluminium alloys and with the fudges that have been necessary to arrive at any form of TIG welding for aluminium. There is a crying need for a technological break through, which when it comes will probably be a better way to disperse the oxides, at the same time restoring the lost penetration. It may not happen within your lifetime, so for now I suggest that your best option is to buy yourself a nice DC TIG set, practice your brazing of aluminium alloys with the 4043 and the Saffire flux, examine what is possible with aluminium wire in your MIG set, and leave the bulk of your money in the little pot pig.

IN OUR NEXT ISSUE

Coming up in Issue No. 108 will be

The Lathe Only Workshop (1)

New series in which Harold Hall shows how much can be done with just one main machine.



Sheet Metal Etching

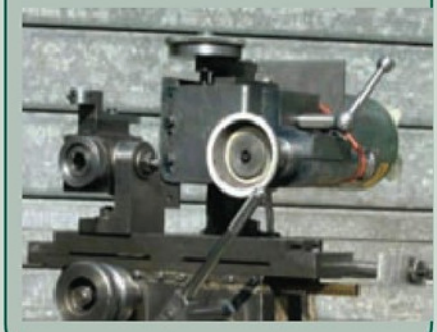
Delicate parts produced with zero cutting forces. John Purvis tells how.

Off-Centre Tailstock Device

Cut tapers without disturbing the lathe with this accessory from Peter Rawlinson.

Stent Modifications

Giles Parkes describes changes to this popular machine.

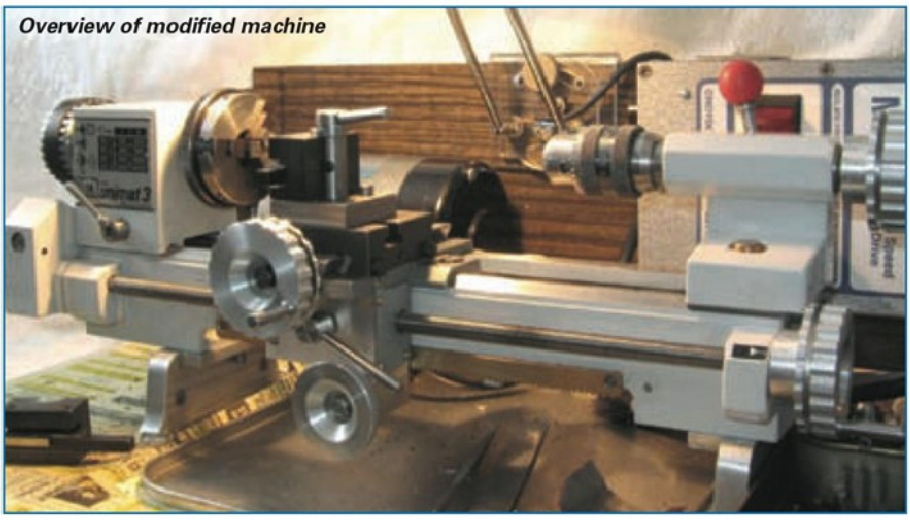


Issue on sale 29th July 2005

(Contents may be subject to change)

UNIMAT 3 SPLIT NUT LEAD SCREW CLUTCH

Maurice Rhodes presents a time saving modification for this popular machine.



Overview of modified machine

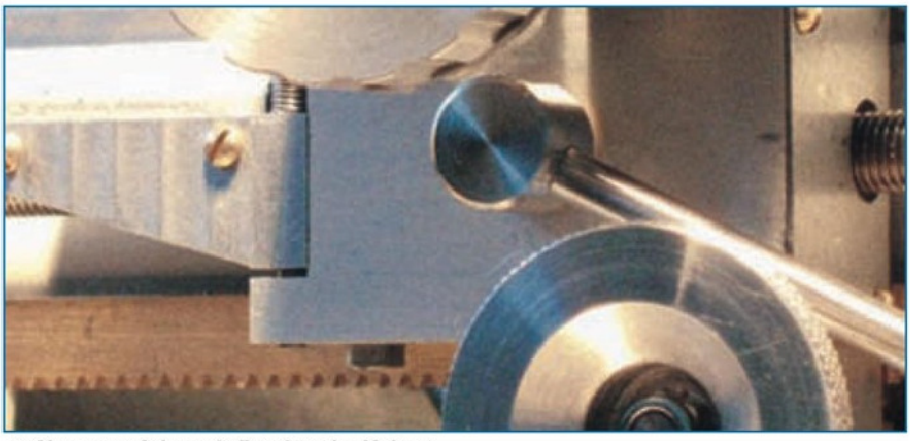
Some years ago, after the purchase of my Unimat 3, it soon became apparent that winding the lead-screw was time consuming, whenever the saddle needed to be moved, and without up-setting the cross slide setting, to make room for the micrometer or whatever to measure the work being turned. Some way of releasing the lead-screw nut would therefore, be a great advantage in saving time and also unnecessary wear to the machine. An idea based on a system similar to that used on the bigger lathes began to form, and a "mock-up" was quickly made to prove that the idea could be adapted in some way for the Unimat. A problem then emerged and the "mock-up" was put to one side, and winding the handwheel for the purpose already mentioned, continued until recently. Whilst looking for one of those items that is used "once in a blue moon", the prototype re-surfaced; the obstacle which had led to it being put to one side was suddenly solved, and before long the project began to take priority. With the unit fitted (**photo 1**) the saddle takes seconds to move well away from the headstock whenever required and as an added bonus, the backlash in the nut has been restored to as good as, if not better than, new. In designing the modification, one problem to be overcome, concerned the limited space between the lathe bed and the leadscrew. At ⅜in there was just enough clearance for the new nut housing and still retain sufficient strength. To allow access to the new rack and pinion handwheel, it is necessary for the lathe to be raised on mounting blocks of about one inch in height. In fact, this was something that had been done much earlier, soon after my machine arrived, so that anything, which was dropped accidentally and fell under the bed, was easily retrieved.

It is an advantage if a second lathe is available to help with the modification, but this article has been prepared on the basis that the job can be accomplished using the lathe to be modified, together with its mill/drill attachment. The procedure will therefore require the saddle to be removed and re-fitted three or four times, for marking and drilling etc. Although the text relating to the fitting of the nut carrier unit, appears to be a step-by-step guide, the intention is to hopefully minimise the number of times, the saddle has to be removed and replaced, under these circumstances.

Initial components

By removing the swarf guard measure the angle of the nut block (this can be done without removing the saddle), and will be in the region of 93 degrees. From a piece of mild steel 1in. x 1in. x ½in. saw away the excess and mill to the dimensions in the support bracket drawing. Drill two holes for the locating pins and at the same end, the fixing hole (No 31 initially) and likewise that for the screw above the lead-screw position, leaving the third to be drilled when fitting the main body.

For the nut carrier, cut two lengths of mild steel ⅜in. x 1.5in.in length and a little wider than the finished width of the jaw; saw away the middle portion of the end of each piece, and mill the opening to a good but not too tight fit over the mounting bracket. Cutting such an amount as this from the centre will most likely have caused the sides to splay outwards, and now the extra width can be used for correction. Clamp the two pieces together



1. Close up of the unit fitted to the Unimat

2. Using the drilling attachment.

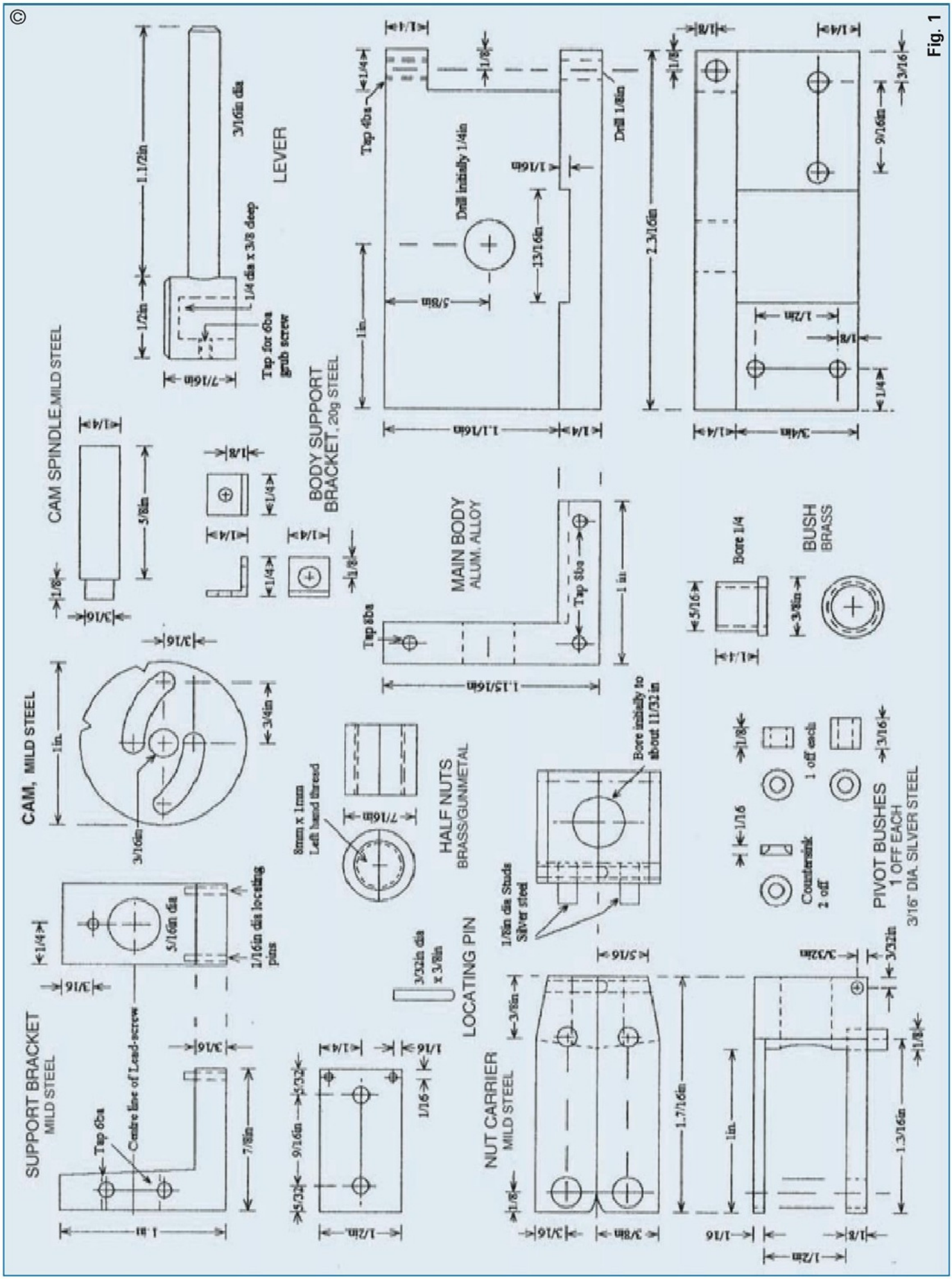

©
LEVER
3/16in dia
1.1/2in
1/2in
1/4 dia x 3/8 deep
Tap for 6ba grub screw
7/16in
CAM SPINDLE, MILD STEEL
5/8in
1/8
3/16
BODY SUPPORT BRACKET, 20g STEEL
Tap 4ba
Drill initially 1/4in
Drill 1/8in
1/16in
13/16in
5/8in
1in
1.1/16in
1/4
2.3/16in
1/8
9/16in
3/16
1/2in
3/4in
MAIN BODY ALUM. ALLOY
Tap 8ba
1.13/16in
BUSH BRASS
Bore 1/4
5/16
3/8in
CAM, MILD STEEL
1in
3/4in
3/16in
8mm x 1mm Left hand thread
7/16in
HALF NUTS BRASS/GUNMETAL
Bore initially to about 11/32 in
1/8in dia Studs Silver steel
1/16
Countersink 2 off
1 off each
PIVOT BUSHES 1 OFF EACH 3/16" DIA. SILVER STEEL
SUPPORT BRACKET MILD STEEL
5/16in dia
1/16in dia locating pins
Tap 6ba
Centre line of Lead-screw
7/8in
1.1/8in
3/32in dia x 3/8in
LOCATING PIN
NUT CARRIER MILD STEEL
5/16
3/8in
1.7/16in
3/32in
1.3/16in
1in

Fig. 1

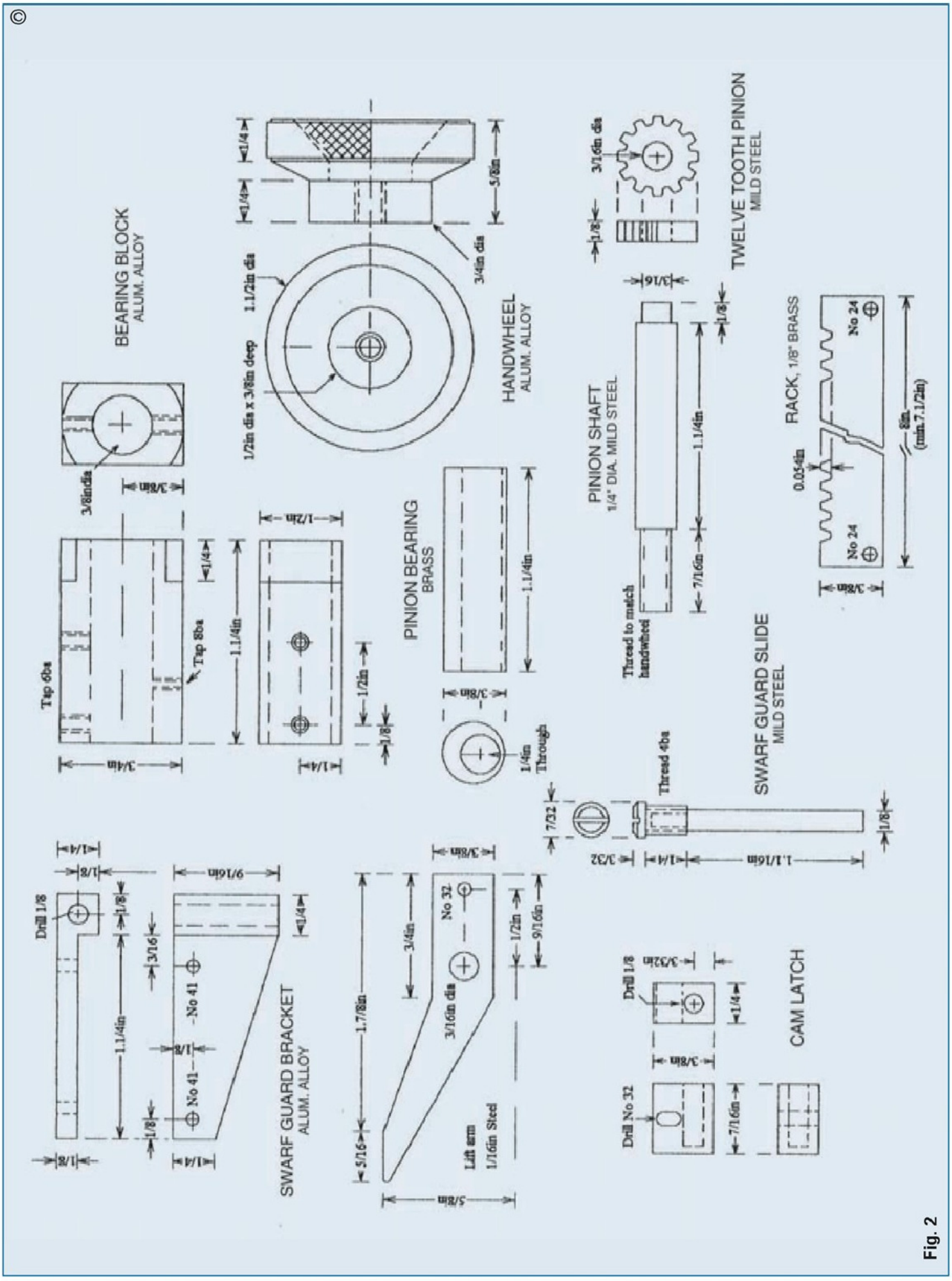

BEARING BLOCK
ALUM. ALLOY
HANDWHEEL
ALUM. ALLOY
PINION BEARING
BRASS
PINION SHAFT
1/4" DIA. MILD STEEL
TWELVE TOOTH PINION
MILD STEEL
RACK, 1/8" BRASS
SWARF GUARD SLIDE
MILD STEEL
SWARF GUARD BRACKET
ALUM. ALLOY
CAM LATCH
Tap 6ba
Tap 8ba
3/8in dia
1/2in dia x 3/8in deep
1.1/2in dia
3/4in dia
5/8in
1.1/4in
1/2in
3/8in
1/4in Through
Thread to match handwheel
Thread 4ba
7/16in
3/16in dia
No 24
No 32
No 41
Drill 1/8
Drill No 32
Lift arm
1/16in Steel
1.7/8in
1.1/16in
0.054in
8in (min.7.1/2in)

Fig. 2

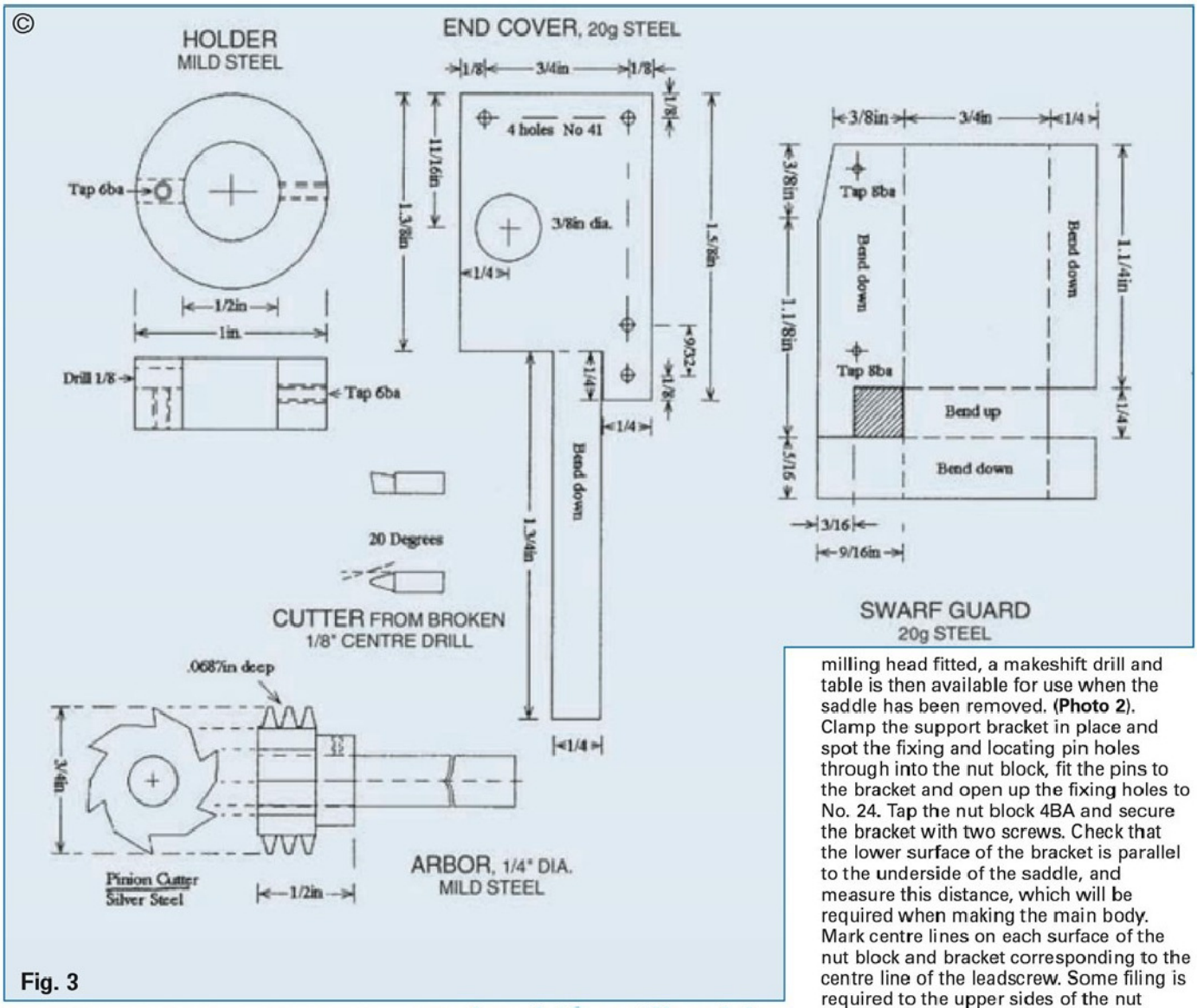


Fig. 3

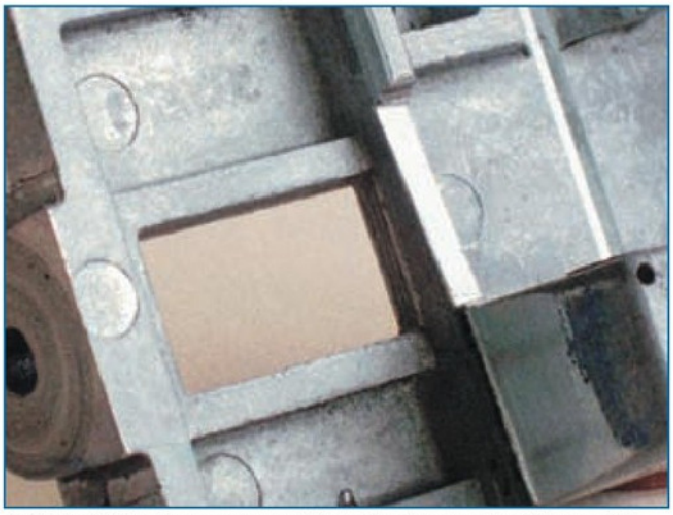
face-to-face and drill a hole through for the locating pin, you may find that a couple of spots of superglue helps in these situations to hold the parts temporarily in place before clamping. Later, the parts can be easily separated with a tap from a light hammer, or a little gentle heat. Drill the pivot holes No 43 for the time being, and complete the carrier except for the bore for the half-nuts.

Makeshift mill table

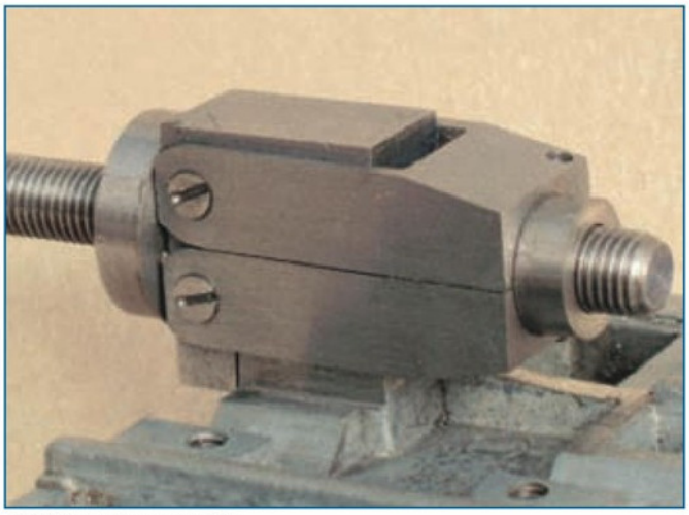
Loosen the screw located under the lead-screw bearing and remove the lead-screw, bearing and handwheel together. Remove the two front screws and gib strip from under the saddle and loosen the other two screws, then lift off the saddle. Fit the milling table (or a piece of plywood directly on to the lathe bed, using a slip of card between for protection, with the milling head fitted, a makeshift drill and table is then available for use when the saddle has been removed. **(Photo 2)**. Clamp the support bracket in place and spot the fixing and locating pin holes through into the nut block, fit the pins to the bracket and open up the fixing holes to No. 24. Tap the nut block 4BA and secure the bracket with two screws. Check that the lower surface of the bracket is parallel to the underside of the saddle, and measure this distance, which will be required when making the main body. Mark centre lines on each surface of the nut block and bracket corresponding to the centre line of the leadscrew. Some filing is required to the upper sides of the nut block to make it the same width as the bracket; there is also a little to be removed from the inner web of the saddle to allow the top jaw of the nut carrier to open fully **(Photo 3)**.

Reassemble to make more parts

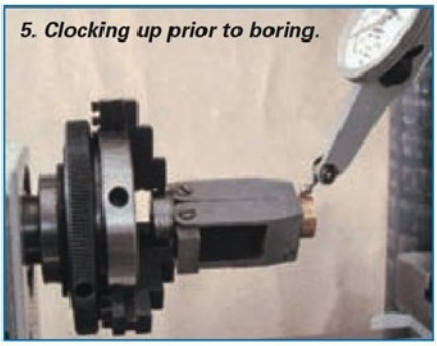
Remove the bracket and replace the saddle



3. Material has been removed from the inner web of the saddle.



4. Nut carrier assembly



5. Clocking up prior to boring.

6. Unit built up ready to fit to lathe.

etc. on the lathe for normal use.

Position the nut-carrier jaws, onto the support bracket and drill the pivot holes No 43, tap the bracket for 6BA screws, then drill the 5⁄16in hole for the lead-screw. Open up the pivot holes in the nut carrier to 3⁄16in. (reamed), and mount into position on the bracket. Transfer the centre line from the bracket and on to the nut carrier. Remove the carrier assembly, and replace the saddle on the lathe. Set the carrier jaws in the four-jaw chuck to bore lengthwise about 13⁄32in. dia. to take the nut halves. (A couple of spots of Superglue to hold the two halves together may help here; again, a tap with a light hammer or some gentle heat will release them when required). In the three jaw chuck, turn a piece of 1⁄2in round brass to make a collar about 1⁄4in in length with a hole as close a slide fit to the lead-screw as possible. From a piece of 3⁄8in dia. mild steel, make a chucking piece, with an 8mm left hand thread through the centre.

Saddle off and on once more

Remove the saddle again, and fit the bracket/nut carrier assembly to the nut block; thread the chucking piece onto the lead-screw, and feed the screw through the nut block followed by the brass collar, then using a little epoxy resin, tighten the chucking piece against the support bracket, enough to obtain a good bond, without creating a locknut effect, (leave access to the fixing screw and remember to grease the lead-screw Fix the brass collar to the free end of the closed nut carrier (**Photo 4**). When cured remove the screw and carrier unit and set the work up in the lathe using a D.T.I. on the brass collar (**Photo 5**). Replace the saddle etc., and with a boring tool, widen the bore for the half-nuts to a little more than their diameter and then remove the remainder of the brass collar. It may be an advantage to proceed with the rest of the components at this point, so that they are to hand after completion of the next stage. Once again remove the saddle, mount the nut carrier assembly onto the nut block, and feed the lead-screw through. Mix more epoxy resin and with the usual precautions for bonding those surfaces which are to be stuck and those that aren't, secure the half nuts in place and leave to cure.

The main body is made with an inside measurement equal to that taken earlier, and a centre line will need to be transferred from the nut block, to mark the position of the bush. Mill the portion in the base of the body if required, to clear the cam. Drill a 1⁄4in.hole and fit the cam and shaft. To make certain that the cam opens and closes the nut carrier properly; any adjustment should be made before enlarging the hole to take the bush. Drill and tap for the second fixing hole through the underside and into the support bracket. Further support for the main body, is gained at its forward edge by the small body support bracket, which is secured to the body by the swarf guard slide and then by the 8BA screw to the saddle; similar support to the rear, is from the end cover.

Assembling the latch, is a tricky operation and a clear plastic bag big enough to put your hands into, to do this operation, will prevent the ball and spring from escaping when a failed attempt occurs. A 1⁄4in wide strip of "Tin" formed to the shape of the block, can be slipped over the block to retain the ball, until fitted in place on the body. Two notches in the cam plate are required, in the open and closed positions, and are marked off from the job. The cam slots should be filed so that nut carrier is fully closed before they reach the end of their travel. **Photo 6** shows the unit minus the swarf guard ready for mounting on the lathe.

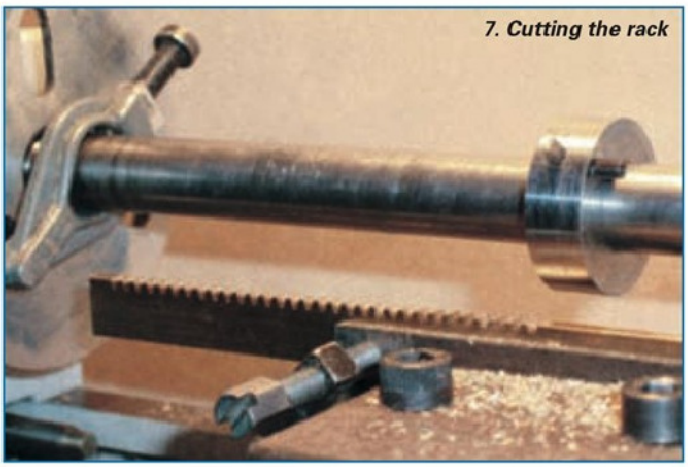
Rack and pinion

Cutting the rack on the limited space of the Unimat requires a combination of saddle and cutter movement. An angle plate made from a piece of scrap will hold the rack blank with its lower edge directly on the cross-slide surface, and in an upright position (**Photo 7**). Four or five teeth are cut, before rewinding the saddle and moving the cutter holder to a new position. As a near approximation, two and half turns of the hand wheel was used for tooth spacing, and although not the correct amount, it is close enough and a convenient figure to work with. Similarly the shape of the cutter may not be a true shape for meshing with the pinion, but a rack, which is quite adequate for the job, was made using these two combinations. Make the cut starting from the back of the lathe, winding the cross-slide towards the front. When the workpiece nears the lathe dog, rewind the saddle and reposition the cutter, the blank or both as required. Check that the position for the fixing holes are suitable before drilling.

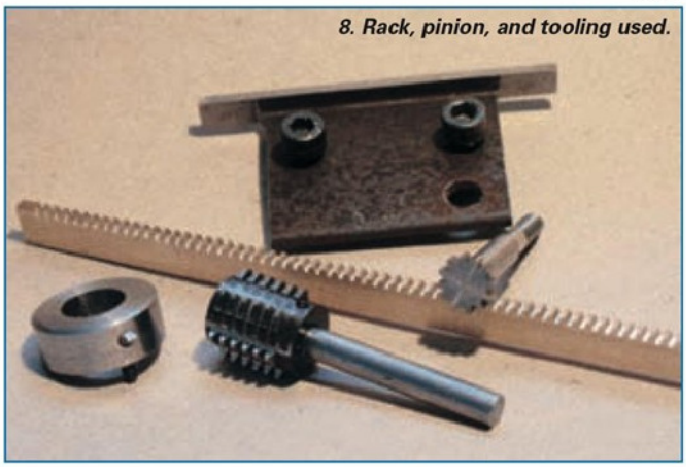
To cut the pinion, the method proposed a number of years ago by Rex. Tingey was adopted. A "hob" is made from a length of 3⁄4in.diameter silver steel about 1⁄2in.long with a 1⁄4in bore and a hole drilled and tapped for a 4BA securing screw. Secure the piece to the arbor and using a tool with a profile similar to that used for cutting the rack, cut three grooves to a depth of 0.0687in.and which, when compared with a thread gauge will produce spacing at 10 t.p.i. Mill along the length of the blank to produce the profile of the teeth; finally harden and temper. (**Photo 8**). From mild steel turn a blank for the pinion, secure it to the pinion shaft and turn it down to 0.545 diameter. Then the dividing head with suitable division plate can be used to cut the twelve teeth.

An eccentrically bored bush is used for adjusting the amount of engagement of the pinion with the rack. The offset does not have to be any specific measurement; a slip of 20g scrap between one of the jaws and the brass blank, before drilling the bore should suffice. The bush is locked in place by the 8BA screw in the bearing block. The handwheel is screwed onto the pinion shaft and secured with a locknut. The automatic swarf guard which also lifts the felt wiper for the lead-screw is optional, and could be replaced with a simple cover without the felt

When satisfied and prior to fitting the unit to the lathe, run a drill or reamer through the nut block to remove the thread, fit the rack to the lathe and finally adjust the pinion.



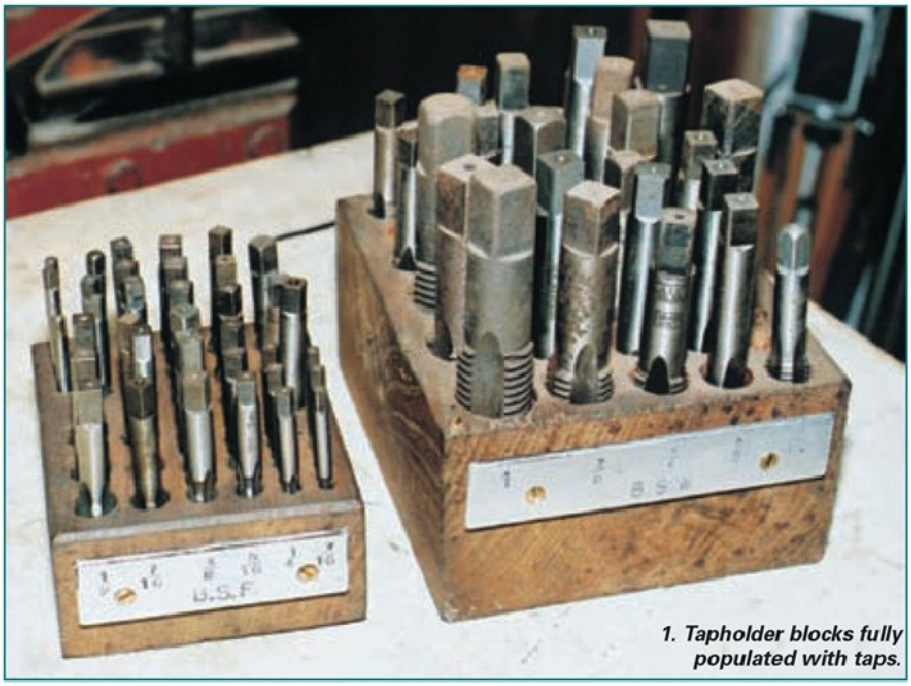
7. Cutting the rack



8. Rack, pinion, and tooling used.

SOME IDEAS ON TOOL STORAGE

Amhlaoibh Hennessy describes some of his solutions



1. Tapholder blocks fully populated with taps.

Background

When I began, a half century ago, to collect a set of tools to suit my needs, I was a bachelor without a fixed base. My tools were accommodated in a haphazard collection of tin, wooden, and cardboard boxes. As time passed, this became less and less satisfactory , and I began to exercise the grey matter to find better systems. I came to the conclusion that there are four principles that must be observed:

1. The tools must be protected from damage;
2. The tools must be ready to hand, especially if of frequent use;
3. It must be easy to select the required tool from a set, without any rummaging or shuffling.
4. The tools must be easily returned to their correct storage place after use.

You might add a fifth, for tools of infrequent use:

5. You must know where to find it.

A friend once put the matter in this wise: "If you can't lay your hand on a bodger when you need a bodger, then, even though you may own two bodgers, you ain't got a bodger". In this article, I will describe the storage systems I have devised for screwing tackle and lathe change wheels.

Taps, dies, tapwrenches and dieholders

Over many years I have accumulated taps and dies in BSF, BSW, ME, BSP, BSB, UNF , BA, Metric, and Metric Fine threads. Now, keeping taps loose in a box is not conducive to preserving sharpness. Taps and dies can be bought in boxed sets but the boxes have to be big enough to accommodate the accompanying tapwrenches and dieholders, and are awkward to handle in a small and congested workshop like mine. Furthermore, if you have tackle in several different thread systems as I have, you don't need a multiplicity of tapwrenches and dieholders.

I began with the taps, and made holders from wooden blocks drilled to take the threaded part of the taps with a little clearance for comfort. Hardwood is best, but not oak (the tannin in oak reacts with iron). Offcuts from hardwood doorframes, salvaged from a skip, provided many of mine. **Photo 1** shows one block holding taps in BSF and BSW from ⅜in. to ½in., and another holding taps from ⅝in. to 1in. **Photo 2** shows the latter block empty to show how the holes are arranged. By grouping sets of taps on opposite sides of the block, and working across in size increments, it has been possible to make best use of the available space. For the larger holes I did not always have a drill to give the necessary clearance, but a hole can be "reamed" out a little as follows: take a short length of ½in. rod, split one end for an inch or so with a hacksaw, and put a short length of coarse emery cloth in the slit; chuck the rod in the drill, lower the end with the emery cloth into the hole to be reamed, switch on, and work the "reamer" up and down in the hole until the desired clearance is obtained. I made the labelling plates from aluminium strip, marked with number punches, and filled the numbers with black paint. The surplus paint can be wiped off with a kitchen towel while wet, and a final polish with fine emery cloth when the paint had dried finished the job. To prevent rusting, I soaked the holes with 3 in 1 oil, and no rust has appeared in over twenty years of use.

2. One block, less taps to show hole arrangement.

3. The dieholder "cabinet".

4. Two of the dieholder shelves.

5. Aluminium extrusions are used as holders for small tapwrenches, angles for larger.

6. Dieholders are also located by holders from aluminium angle.

Then I considered die storage. I assembled all my dies on a table and moved them around like chessmen while waiting for inspiration. Eventually I came up with the idea of a little chest of drawers, or rather a chest of shelves, as shown in **Photo 3**. The shelves are made from what I call "soft hardwood" which can be readily obtained from woodworking or D.I.Y. stores. The stuff I used was 5½in. x ¾in. I found that all my dies could be accommodated on eight shelves. **Photo 4** shows two of the shelves. I have left a projecting tab on each shelf, in one of four different positions. The shelves are arranged so that the tabs come in two diagonal rows as shown in **Photo 3**, enabling any shelf to be withdrawn easily. The shelves run on lengths of ½in. x ½in. x ⅛in. aluminium angle, which are fixed by small countersunk screws. Making due allowance for operating clearances, it was now possible to make up the carcass: in my case, the sides were made from the same stuff as the shelves, the bottom and top from 9 mm MDF and the back from 6 mm MDF. The parts are held together by long thin nails. Of course, many other and doubtless better forms of construction are possible.

The dies need to be laid out carefully on each shelf. I have found that if they are laid out in size order (not the O.D. of the die) it is easy to identify any required die and it is not necessary to label the recesses. I arranged its dies on each shelf in turn, and drew an outline of each die on the wood. I then marked the centre of each recess, and began the drilling of the recesses. Using a piece of waste shelf material, and with the appropriate flat-bit in the chuck, I set the drill to give the necessary depth for the largest O.D. of die, and then drilled all the recesses of that size, repeating the operation for the other die O.D.'s. An ordinary set of flat wood bits did the job. It remained to cut grooves with a woodworker's gouge to enable the dies to be lifted out using two fingers. These grooves may be seen on **Photo 4**. The last operation was to make labels from aluminium to identify the inhabitants of each shelf. These I fixed with epoxy: they could also be fixed with small screws or even tacks.

Photos 5 and **6** show my tapwrenches and dieholders, mounted on the inside of the doors of the stand on which my lathe is mounted. They are carried on brackets made mostly from aluminium angle: the tee-wrenches are carried in brackets made from aluminium section left over from an ancient double-glazing system (waste not, want not). I also have tailstock dieholders for all my dies.

Change wheel storage rack

Many years ago I bought a Logan lathe which had seen a fair amount of use. The set of change wheels was not complete, but I found suitable wheels from time to time in scrap-yards and was able to adapt them to fill the gaps. As well as completing the "official" Logan set, I added wheels of 21 and 42 teeth, which enabled me to cut metric threads. I did not stop there: I kept on accumulating wheels in a range of dentitions with an idea of making a dividing device some day. That has not happened yet but I was left with a large collection of wheels, which had to be sorted and shuffled every time I needed to set up a gear train. There had to be a better way. Applying the four principles enunciated above, I decided to provide a storage system for the essential wheels only, and to have a dedicated space for each wheel. The result is the device shown in **Photo 7**.

Logan change wheels are 16 D.P., 7/16in. wide, and proceed in tooth multiples of four. I assembled the wheels I wished to

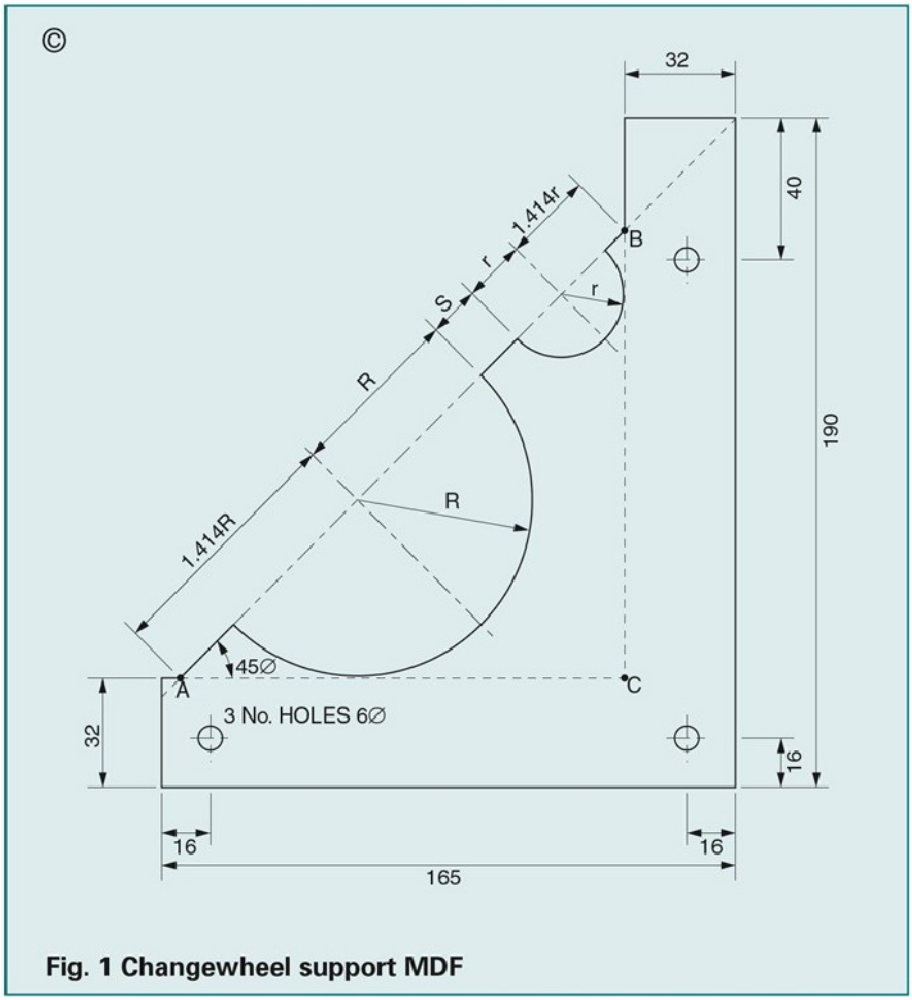
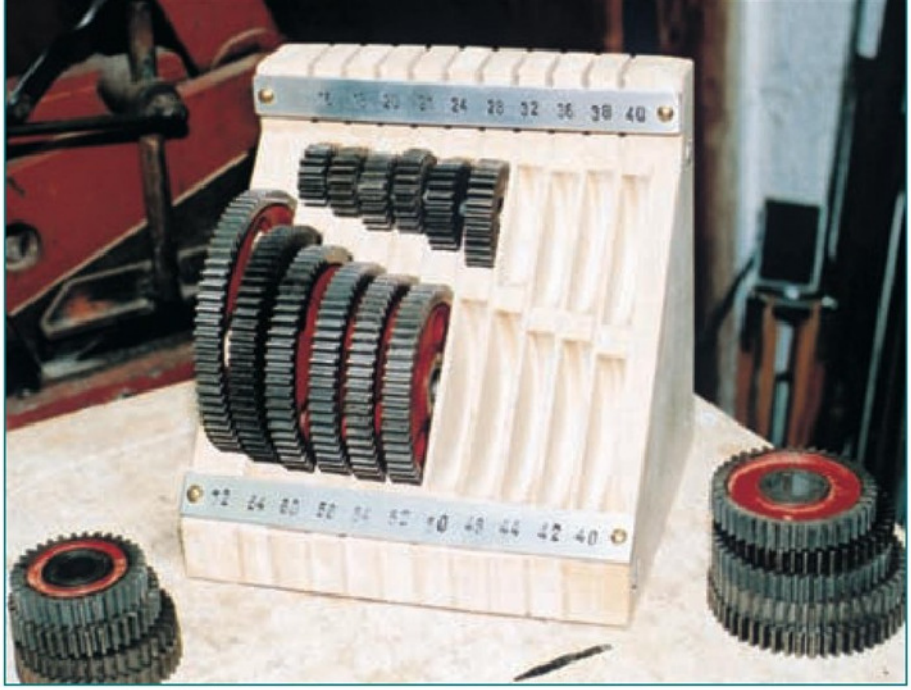


Fig. 1 Changewheel support MDF



7. Changewheel holder.

include, and arranged them in pairs the sum of whose teeth came to 80 or a little less. There is a 72 tooth wheel which I left unpaired. I drew up a list of the wheels in four columns: No.of teeth; O.D. plus 1 to 2mm; r = half of second column; and r x 1.414. I then drew up a diagram as Fig. 1 showing two semicircular pockets, the centres being on a line inclined at 45 degrees. The diameters of the pockets are to suit a pair of wheels from the list. R is the radius for the lower wheel of the pair, r the radius for the upper one. Now consider the horizontal line AC. If the centre of the lower pocket is fixed a distance of R x 1.414 from A, the bottoms of all the pockets will touch the line AC, and when the wheels are placed in the pockets the fronts of the wheels will touch a vertical line through the point A. Similarly the wheels in the upper pockets will touch the line BC and a horizontal line through B. Allowing a reasonable space S, (I allowed 12 mm), the corresponding upper pocket can be set out and the position of the line BC can be established. Then the overall dimensions for the pieces and the positions of the three holes can be fixed.

These pieces were cut from 12mm MDF, which comfortably accommodated the wheels. Dividers were cut from 3 mm hardboard to the same outer dimensions but of course without the pockets. The two end pieces were also from 12mm MDF and without pockets. I made a template from thin stiff card to the outline of the dividers to facilitate marking out the pieces. The MDF I cut into strips 165 mm wide on which I marked out the outline of the piece and the line AB. From my list I was then able to mark out the positions of the centres for the pockets, and I noted down the required diameter. To ensure against errors I struck out the pockets with a compass.

I cut the pockets out as complete circles while the material was still in the form of long strips, which made holding easier, using the tool shown in **Photo 8**, which is adjustable for radius. I think mine came from Tilgear; Chronos also list a similar one. It is possible to fit a longer cross-bar which enables hole to be cut a little larger than the tool can handle in standard form. When holes of large diameter are being cut, it is wise to proceed with a very gentle feed. When the cut has reached about half the depth, the work can be turned over and finished from the other side. This gives a cleaner hole. A breathing mask should be worn for this operation as a lot of MDF dust will be raised and breathing this is not healthy.

I then completed the cutting out of all the pieces, and on one piece I marked the positions for the three holes for the 6mm screwed rods which hold the parts together. I then set up a simple jig on the table of my drill (**photo 9**). It consisted of two strips screwed to a piece of MDF forming a right angle into which the pieces could be located. Having set it for one of the holes on the marked piece, the hole could be drilled and the other pieces were then placed in the jig in succession for drilling.

8. Cutting circles.

Repeat for the other two holes. I counterbored the holes in the end pieces deep enough to "bury" a nut and washer. I then assembled the parts on three pieces of 6 mm threaded rod, cut a little oversize and finally cut to size when all was tightened up. Two aluminium strips carrying the tooth numbers finished the job.

This rack has been a pleasure to use as any wheel can be got at instantly, and equally important, there is a great incentive to return wheels to their proper place. **Photo 10** shows the change-wheel rack and the die chest installed on a shelf. On the shelf above can be seen some of the rest of my wheel collection.

A saw and cutter rack

I have a modest collection of slitting saws and small milling cutters, which have also been stored in a higgledy-piggledy fashion. On looking at my finished wheel rack, I realised that a similar rack would accommodate these. I sorted them by diameter and thickness, and also took note of the fact that cutters, such as slitting saws, which cut only on the periphery , could be placed in a pocket with other similar ones. Side and face cutters, on the other hand, required private quarters to avoid damage to the teeth.

MDF is available in thicknesses of 3, 6, 9, 12, and 18mm. By using these, sometimes in combination, I was able to work out a system of pockets to hold all my cutters. I have not included a photo since it looks very like the change-wheel rack except that the pockets are not of uniform width. Again, I am happy with the result.

9. Jig on drill table for repeat drilling.

10. Effective use of space is a necessity in the small workshop.

Scribe A Line

Mr Guy Smith writes:

In reply to Mr. W Pendreigh's problem, outlined in issue 104, 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.

Mr Graeme Laing of Sandringham, Australia writes:

I refer to the query posed by Mr. W. Pendreigh, Scribe a Line *MEW* issue 104. I imagine that Mr. Pendreigh has deduced that the adjustment of the "long connecting screw" is critical to the operation of his milling machine's variable speed drive box, however it's hard to accept that, even with this adjusted to the most ideal position, the metal-to-metal contact of the steel ring to the split-pulleys would result in acceptably consistent operating speeds.

You may have been advised by other readers already, that most of the currently-available automatic transmission scooters of Asian and European manufacture use a constantly-variable drive system similar to that of Mr. Pendreigh's milling machine except for:

1. A V-belt (of a similar cross-section to the current steel ring) is used as a driving medium
2. The adjusting screw is deleted, and a compression spring ensures that the lower split pulley halves remain in satisfactory contact with the drive belt.

In order to provide the constantly-variable ratio facility, the splined shaft of Mr. Pendreigh's diagram (which I assume to be a rack-and-pinion control of the top pulley half) is replaced, in the system as utilised on these scooters, by 6-8 balls or rollers operating on ramps which, as they move out under the influence of centrifugal force cause the moveable half of the top pulley to slide along the drive shaft towards the fixed half. The resulting wedging action causes the v-belt to move out to a constantly-increasing diameter, which is permitted by the v-belt wedging the moveable half of the driven pulley away from its fixed half, against the resistance of the aforementioned spring.

It seems to me that, depending on the layout of the machine, it may be practical to

1. Replace the steel ring with a suitable v-belt, and
2. Remove the adjusting screw and fit a suitable spring to the driven pulley.

Eric Parker writes:

I have just re-read Mike Haughton's progress report on the Chester Craftsman lathe. Regarding to Mr. Haughton's comments on "Electrics", with my similar lathe I have found another question mark with the electrics. When I stop the machine I get a loud crack, almost as if someone is behind the machine letting off party poppers. I wonder if anyone else with one of these machines has got this problem.

Reg Pugh, proprietor of Engineer's Tool Room replies: It was naturally of concern that Mr. Parker should not be completely confident of the reliability of his machine, so arrangements were made to visit him in Yorkshire and assess the problem first hand. The noise reported turned out to be the click of the centrifugal switch within the single phase motor, which closes as the revs fall after switch off. For readers who may not be conversant with the workings of single phase induction motors, the function of the switch is to ensure that start and run windings are energized at start up, then to disconnect the start windings as the motor approaches rated speed.

Dick Stephen writes:

I use Turbocad for all the drawings for my CNC work. For a number of years I have used version 6 and have found it very satisfactory. Recently I upgraded my computer to one using Windows XP and at the same time upgraded my version of Turbocad to version 9. It is necessary to use the filleting facility extensively for all one's CNC work. I had no problems filleting with version 6. With version 9 I have had endless problems filleting. In frustration I contacted IMSI and eventually managed to elicit a response from them. IMSI certainly do not get high marks for their customer relations. IMSI have informed me that there is a problem with the filleting routine (i.e. it doesn't work properly!) in versions 8 9 10 and 11. Apparently V 11 can be fixed with a download patch. If you are having problems with these versions of Turbocad my advice is to do as I have done and revert to version 6 if you can get it. It seems to work fine with Windows XP.

Steve Bachanek of Thunder Bay, Ontario, writes:

I have very much enjoyed Harold Hall's article "*Taps and Dies, Choosing and Using*" in *MEW* 104. As always, his articles are of great detail and usefulness to home shop machinists, and written in a comfortably readable form. One footnote to the article could be the difference in nomenclature of tap forms on the two sides of the Atlantic. The U.K. describes them as Taper, Second, and Plug/Bottom. In the U.S. and Canada the same ones are Taper, Plug, and Bottoming respectively. Obviously some confusion could result from the quite different meanings of "Plug" if a reader were to order a tap from a catalogue on the other side. Recently I needed a costly tap for an obsolete thread used on an old lathe. It was available from a U.S. supplier under their specialty tap list and was apparently made in the U.K. The catalogue stated it was supplied only in the Plug form. But which "Plug"? It turned out to be a U.K. "Second"

Grant Notley from New Zealand writes:

I have noticed in some of the relatively recent correspondence on 'single point' thread cutting, correspondents appear to rely on leaving the half nuts engaged and reversing the lathe each time to take another cut. However, it is possible to cut threads without a thread dial and without reversing the lathe, simply by dis-engaging (and re-engaging) the half-nuts. The secret is to ensure that the rotational positions of the chuck, the lead screw, and the start position of the saddle, are always exactly the same at the start of each cut.

My elderly (pre WWII) Myford only came with change gears, but I can still cut any thread the change gears will give, without reversing. Since the chuck is 'screw on', this process also eliminates any problem of unwinding the chuck. (I don't have a reversing switch - so it's a bit academic anyway!)

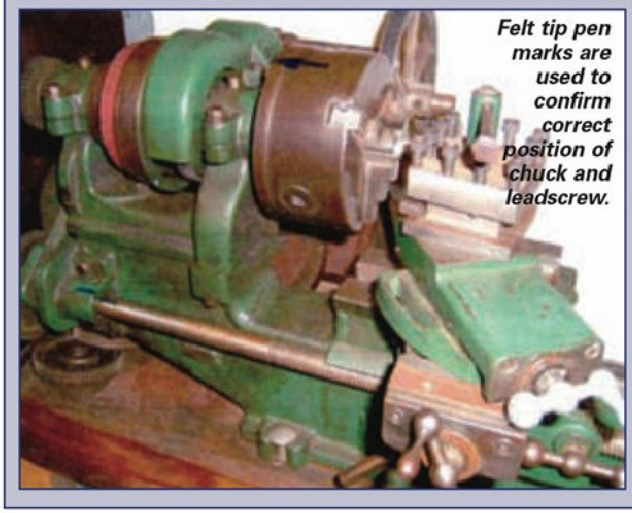
If possible, first set the cross slide dial to zero, (or mark it with a felt tip), with the tool tip just touching the work piece, before moving the saddle back the ¼ inch or so clear of the end of the work piece. Engage the half nuts. It may be necessary to slightly adjust the position of the saddle to get a 'clean' engagement.

Also, I swing my top slide over to half the included angle of the thread, to make resetting the cross slide easy. While not absolutely necessary, if not, it becomes necessary to remember the reading for each preceding cut.

Lay a (roughly) rectangular 'stop' block on the bed, in contact with the back face of the saddle and then bring the tailstock up so that the base also contacts the spacer. The 'stop' block can be any material, wood, plastic or metal of any size - its function is simply to provide an identical point to start from each time and to keep the tailstock clear of the top slide. If the tailstock centre is being used to support the end of the work, it may be necessary to experiment a little with the length of the block to ensure the full depth of the thread can be cut.

Lock the tailstock in place. With the lathe and tooling all set to go, mark the position (rotational) of the chuck and lead screw, with a felt-tip pen or similar, each against a reference mark on the headstock and body of the lathe, so that they can be lined up each time, before taking a cut. (See photo) Start the lathe and take the first (trial) cut, just scratching the surface. Disengage the half nuts at the finish of the thread and at the same time rapidly reverse the cross slide screw, to pull the tip of the cutting tool clear of the work. This needs a bit of practice, but only needs be half-to-three-quarters of a turn or so, just to pull the tip of the toolbit clear. Stop the lathe. Use a screw gauge to check that the thread is the right TPI.

Rewind the saddle back against the stop and then reset the cutting tool to take the next cut, by moving the cross slide forward to zero and then using the topslide to advance the toolbit for the next cut. (The depth of cut will depend on the material being cut, the size of the job, the rigidity of the lathe and whether the cut is at the start of the job or nearing the end).



Felt tip pen marks are used to confirm correct position of chuck and leadscrew.

Rotate the chuck forward, either by hand or under power, until both the chuck and the lead screw marks, together, line up with their respective start points. This is important - they must both line up. At this point, it should be possible to re-engage the half-nuts cleanly.

Start the lathe and take the next cut. Repeat until near full depth. The usual 'check and proceed cautiously' now come in to play! After a little practice, it should be possible to cut a thread without stopping the lathe until close to finished size.

I was taught this technique as an apprentice, in the mid to late 50's. Also before I wrote this, I checked an 11 TPI thread – worked fine!

However, if the TPI of the thread being cut is an exact factor or multiple of the lead screw TPI, all the above is totally unnecessary, you can 'drop-in' at any point. E.G. on my Myford with an 8TPI lead screw, 2, 4, 8, 16, 24 or 32 TPI are a doddle.

Also, I haven't checked, but I suspect 12 TPI also falls into this category. I will try to answer any questions, but may have to renege if it all becomes too much. My e-mail address is:- grant.notley@xtra.co.nz

designated as "Plug" for the U.S. catalogue.

Hugh Castellan of Rugeley writes:

Ref your note in issue 105 on spark plug electrodes. May I suggest two possible methods:

1st a small roller box.

2nd a shell endmill with a 0.0625 hole down the middle. Shell mills were much use in the past by model engineers and my late father owned several. They can be home made if you like.

Ketan Swali of Arc Euro Trade writes:

Correspondence has recently appeared in sister magazine "*Model Engineer*" on bearing related topics. As our business origins are in bearing supply, I felt that some information might be of interest to readers of *MEW*.

First, drawn cup needle roller bearings. One of the key issues with drawn cup needle roller bearings is that they gain their support from their housing. So, you do need a press fit – no Loctite type products. If for example, you were to put a correct size diameter shaft through the bore of the bearing before you fit the bearing into the housing, it will probably be a slightly loose fit. However, you have to make the housing about 0.0005in. smaller for cast iron/steel and up to 0.001in. smaller for softer materials such as brass, than the bearing manufacturer's nominal outside diameter specification of the bearing, and then press fit the bearing in the housing. These are not to be used as exact measures, but more as a general observation and guidance. Once the bearing is in the housing, you will find that the shaft does fit properly, as the cup is compressed, moving the rollers inwards. This procedure is especially important with drawn cup needle roller clutch bearings used in lubricator drives, to avoid slippage over a period of time. Rubber sealed (to keep grease in and dirt out) drawn cup needle roller bearings are available, in many sizes, as shown in our catalogue.

Moving on to the subject of Chinese mini-lathes. Readers may be aware that we sell the C3 mini-lathe, which is of the same family. The issue has been raised regarding chattering due to deep-groove ball bearings being used in these lathes. It must be noted that not all such lathes are affected and an improvement is readily available. Deep groove ball bearings size 6206 are used by manufacturers of these lathes because these are cheaper to use than 30206 – Taper Roller Bearings which were originally used in this family of lathes. Even today, the headstock casting of these mini-lathes is designed to accept the wider taper roller bearings. In order to fit them you may simply have to add or skim a spacer on the shaft before fitting the taper roller bearings, depending on which of about five factories, the mini-lathe came out of.

The issue of chattering with the deep groove ball bearing 6206 depends on where the bearings originated. One of the best bearing factories in China operates with Russian and Japanese production machinery, as they also produce for a Japanese bearing manufacturer. Their inspection procedure separates out standard clearance "C0", looser fit "C3" and even looser "C4". Perversely, C2 is tighter than standard. Other factories may have other less demanding inspection policies and hence achieve lower costs. All these mini lathes are built down to a price, and bearing quality will vary slightly.

Martin Smith writes

The six scrapers described by Martin Smith

Detail view of the cutting edges of two scrapers.

How I enjoyed Bob Loader's article in issue 105 of MEW! I had noticed too in the 100th issue the fact that scraping was still alive at Myfords in the capable hands of Mr. McKechnie. However it was Bob's reminiscences of his days as an apprentice which brought back to me the experience I had as an apprentice at Alfred Herbert Machine Tools in Coventry back in the early '60's. In those days we were first put through the Apprentice Training School on joining at the tender age of 15. One of the first 'fitting' exercises was to file a 1⅛th inch cube to a 1in. cube, square and to a thou! After achieving the near impossible the exercise was then to scrape the cube to a 20 spot count on at least two faces.

After passing out from the ATS, and selecting a trade in the manner of the army tradition of "you, you, and you, Turning.....you, you, and you, Milling", it was a case of out on the shop floor for me as a 'Universal Miller Apprentice'. The upside was that after passing through all the various disciplines within the ATS we were all (well mostly all!) capable of turning our hand to any small job involved in making special bits of tooling or whatever. Once, for me, this involved making a small fixture for a 'fitters return', this being when two parts of a machine would not fit together as intended and a slight 'bodge' was called for. The Fitting Chargehand would come to the milling section to get a modification made to one part or the other. My fixture (designed on a proverbial fag packet), needed to be scraped, so I went up to the Fitting Section to get it done. "Weren't you taught that in ATS?" well I had to admit "Yes, but I haven't got a scraper!" Within minutes a tried and trusty scraper was found and with the words "Let's see you do it then" ringing in my ears I was busy scraping away for the rest of the day 'Off Section'. This was a bit of a treat for an apprentice, the office girls up that end of the factory were a change from the ones we saw at the other end! (Herberts main shop extended for about 36 bays, the largest m/c tool factory in the western world we were told)

The upshot of all this, was that I was presented with the aforementioned scraper and still have it to this day. It was made in house and is marked up as a 'Supercut J26 BA 186 AH 2'. The front end was a tool steel referred to as 'Magic', which I believe was a Herbert trade name for cobalt tool steel (bit like M42). Since I still do a little scraping from time to time may I add to Bob Loaders article with the comment that a 'big scraper' (in terms of length and width) is far easier, in my opinion, to get to grips with the 'feel' of scraping. I well remember being told that a scraper is just a single toothed file! The accompanying photographs show my current collection of scrapers. In the main picture, from top to bottom, they are:

1. A proprietary Sandvik inserted tip carbide scraper (part 062-25) fitted with a 25mm wide K10 grade tip. Picked up for a song at the Midlands M.E show at Donington a few years back.
2. An 'Eclipse model 99B' 8in. flat scraper.
3. My A.H Ltd 'Magic' scraper, with a 1¾in wide by 12in. long blade.
4. My home made inserted tip carbide scraper (made from an odd triangular piece of TC I found and mounted in a strip of ⅜in wide black flat steel strip.
5. My late father's half round bearing scraper, dating from the 1930's and made from an even older file! (ex-Armstrong Siddeley)
6. Again, my late father's three square scraper dating from the mid 1920's (ex-Coventry Ordnance Factory) from yet another even older file!

The interesting feature on the 1930's half round scraper is the way it is hollow ground on the underside, and the way the edge makes for a slight positive cutting rake. It is a treat to use, but needs care, as it can easily 'dig in' but then again bearing bronzes need a sharp edge if the scraper is not to 'slide over' the top.

As for Bob's comments on finish to achieve, I have always found that a scraped surface is its own beauty, and is best performed at 90 degree cuts to one another. The other point that will be apparent to the new comer to scraping is the silky smooth finish that is imparted on any surface. It seems that the act of scraping modifies the 'lay' of the surface of the metal and in this ensures a faster 'bed in' of components with less initial wear, and hence providing for longevity of component service.

The act of scraping for 'oil retention' is to my mind dubious at best, I often feel that the only good a 'diamond scrape', as often seen on Tom Senior mills, can lead to is apprehension and anxiety on the part of the owner when the frosting starts to disappear! In many cases it is little more than decorative patterning. Then again, I can never hope to emulate the concise rows of neat crescents on those Tom Seniors so it may just be jealousy!

One last point, I was also taught to sharpen a scraper in the fashion as illustrated in Bob's article, however there is a slight twist (pun!) to my teaching, in that I was taught to twist the blade of the scraper to an angle of around 10degrees (anti clockwise as viewed from the handle end). This imparts a 'nose' rather similar to a twist drill, the cuts being made mainly for a right-handed person on the left underside of the blade. The twist would need to be clockwise for a left-handed practitioner. How do others sharpen their blades? Diamond laps are, by the way, compulsory for carbide blades!

Happy scraping, and no scrapping!

I am aware of many customers who have deep groove 6206 ball-raced mini-lathes and have no problem with chattering. At the same time, there is a number who buy 30206's in pairs from me to cure chattering, and/or before putting a bigger chuck on the lathe, and/or to get a higher precision result. My general advice is to see how you get on with your mini-lathe with the standard 6206 bearings fitted, as they are designed for "general" hobby use. If you want to have higher precision or heavier capacity, then consider changing to taper roller races.

Yateley Hampshire writes:

Ref Tailstock modification for a Clark Metalworker. Issue 102 MEW. I would like first to endorse Richard Wilson's comments in issue 103. You preach (rightly enough) health and safety, but, oh dear, that chuck key that was left in. Shame on you editor. Also, using a right hand thread to work the tailstock isn't wrong but you just don't do it. Seriously, it is not very difficult to internal screw cut a left hand 12mm x 1.75 pitch thread, particularly considering the original components are there to use as screw gauges. I have actually carried out this mod. on a Warco WMT 300/1 lathe/mill with total success, the tail stock being virtually the same. The threaded insert 40mm dia. was increased to 50mm long, moving the tang slot by 10mm. This increased the tail stock movement from a mediocre 30mm to 55mm. This alone was well worth the effort. What are Dutch dowels? I suspect what the author means is, when the tailstock sleeve was bored out to receive the threaded insert, it was pressed in, then three holes were drilled parallel to the axis, 120 deg, apart at the

intersection of the two components, tapped out M5 thread and M5 grubs screwed in. I assume this is Dutch doweling.

I would also like to comment on Mike Brennan's letter in issue 104. Point A. There is 60mm difference when the tailstock is reversed. The tailstock itself can be moved back along the bed (by altering the stop) by 15mm. The "clamping point "is moved 60mm not 120mm (5ins). Point B. Considering the overloading on the tailstock bolts, I think Mike is exaggerating just a mite, For example, if a 25mm hole is to be drilled, on a lathe of this size it is logical to first centre drill, then follow with a 12mm, perhaps a 20mm, then size. This would in no way over exert a lathe of this calibre. Lastly if it is surface finish that is required there is always a boring tool! As Dave Fenner pointed out, since the position of this centre line remains unchanged in this arrangement, there is no change in the bending moment applied to the tail stock assembly. It was always a problem getting close enough to the chuck to drill with short or small drills, I tried using drill extensions, but a certain amount of sensitivity is lost. By being able to go in, the extra couple of inches makes all the difference in the world.

Mike Smith of Crediton, Devon writes:

Re. Myford Super Seven Gearbox

The other day I decided to renew the feed nuts on my Tom Senior Major and the cross feed on the Eagle Surface Grinder, these all being 5 TPI left or right ACME threads. Knowing my Myford S7B (with gearbox) would only cut down to 8 TPI, I went about sorting out the change wheel gearing to achieve 5 TPI. Now the Myford is of the very early variety that is to say drip feed main bearing and gearbox with the external gearing on the right behind a cover.

The tumbler I have is a 12 tooth and all documentation I could find stated that it should be 24 tooth but the 12 tooth tumbler had cut many accurate threads in the past. I then contacted Myfords to check and seek clarification, I was told that the 12 tooth is a fine feed tumbler to be used with change wheels and not to be used with the gearbox, it should be a 24 tooth. So back to the workshop to check the lathe and my maths. On further investigation I have discovered that there is a ratio difference through the box between the early and later gearboxes. The difference is in how the output shaft of the gearbox is coupled to the leadscrew, this is explained as follows:-

Older Gearbox before s/n QC2501 pre Dec.1956

The output is taken off the upper shaft on the right hand side of the box to a 18 tooth gear coupled to a 36 tooth free rotating pinion which in turn is coupled to a 18 tooth gear mounted on the leadscrew (1:1 ratio between gearbox output and leadscrew).

Newer Gearbox after s/n QC2500 post Dec.1956

The output is taken off the upper shaft on the left hand side of the box to a 26 tooth gear and coupled straight to a 52 tooth gear mounted on the leadscrew (2:1 ratio between gearbox output and leadscrew).

The consequence is that if the newer box requires a 30/24 tumbler gear, the older box needs a 30/12 gear to keep the ratio between headstock spindle and leadscrew correct. If the newer tumbler arrangement is fitted to the older gearbox this gives an extended upper range of 4 to 7 TPI to those previously available providing you only take light cuts .

The metric pitches chart inside the change wheel cover is also different from the newer version depicting the correct gears for the differing ratio. The 30/12 fine feed tumbler Myford part A1974A/1 is intended for use with the non gearbox S7's and this is the same tumbler that was fitted to the early gearboxes.
This observation has been passed to Myfords to assist in providing others with the correct information.

David Hall writes:

I refer to the ingenious solution given by Jim Smith (Scribe a Line issue 104) to the problem of raising and lowering a heavy drilling machine table. Other readers may be interested in my own answer to this problem utilising a car scissor jack.
This has served me well for the past 20 or so years.

Use of a car scissor jack eases vertical movement of the drill table.

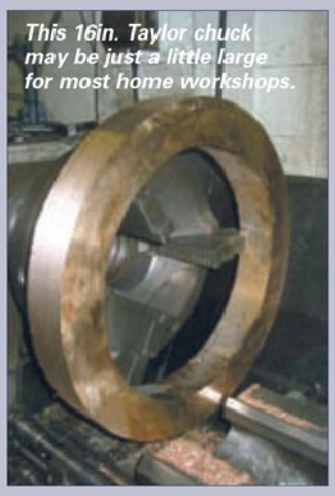
Mr M S Meredith writes

I have followed with interest the correspondence in the recent issues of MEW on the products manufactured by Messrs Charles Taylor & Co Ltd. I run a small general engineering business started by my late father over 80 years ago. In its heyday with some 74 employees and numerous centre lathes from 7½ in. to 15in. centre height, all the lathes were fitted with Taylor chucks of various sizes.

When ordering a new lathe my father specified that the machine be supplied without a chuck, which he would order direct from Taylors.

He considered them to be superior to the usual flat radial scroll chucks, saying that the Taylor chuck with its conical shaped Vee thread scroll was the only chuck having a ground scroll. I cannot vouch for this, but must say that they have immense gripping power and strength as shown by the length of the top bar on the chuck key supplied by the makers. We still use a 35 year old 16in. Taylor chuck on a more modern Colchester "Mastiff" 12½ in. centre height lathe, and the accompanying photograph shows it holding a large phosphor bronze ring prior to roughing out work. It is still very accurate and always preferred when heavy machining is to be carried out. I was sorry to learn that Charles Taylor no longer exist, being unable to compete with the cheaper products from the far east.

As a relative newcomer to MEW, I always look forward to each issue, also readers' solutions in overcoming problems with machining in the home workshop.



This 16in. Taylor chuck may be just a little large for most home workshops.

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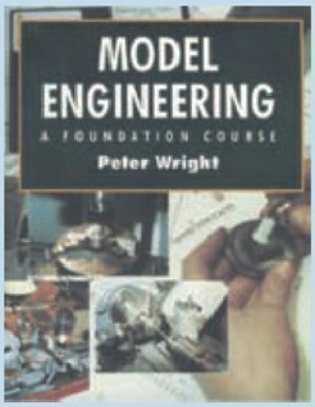

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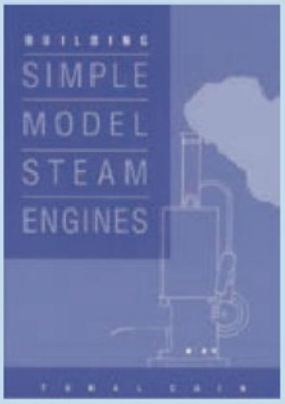

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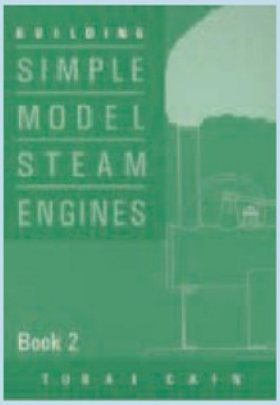

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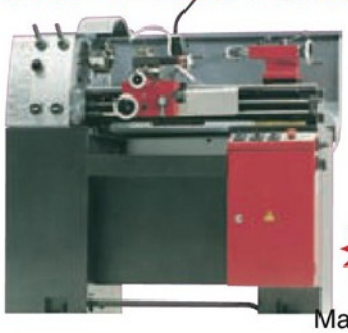

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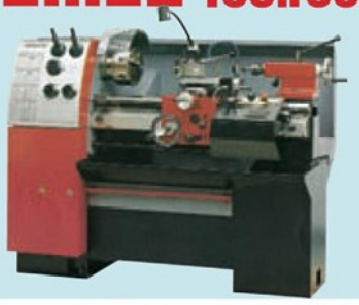

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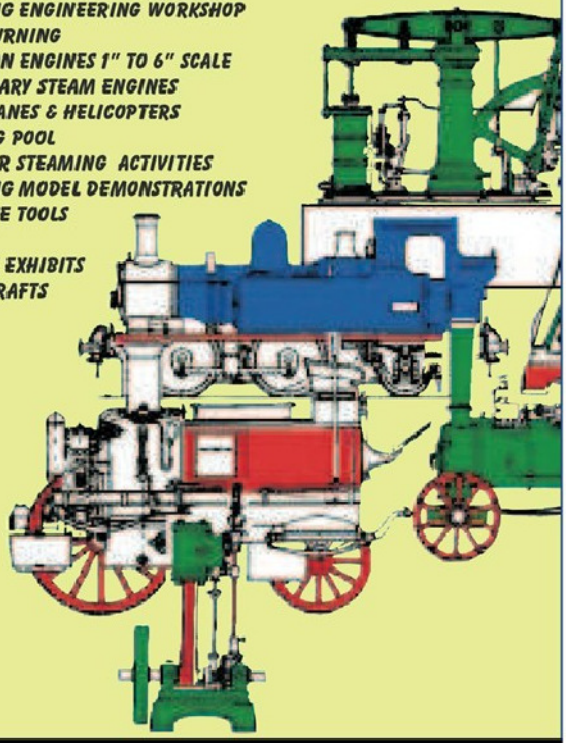

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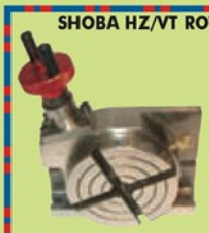

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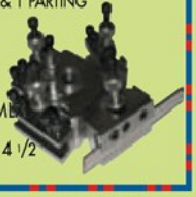

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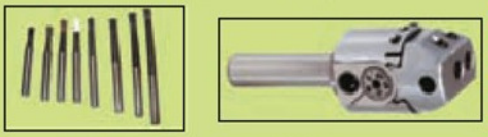

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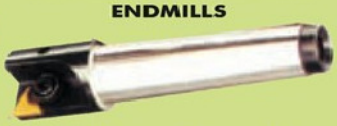

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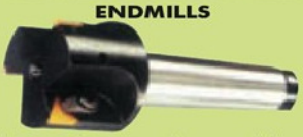

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N5	1/4 x 3/8 - 1/2 - 3/4 - 1	24.65

ALUMINIUM ROUND F/C

P1	3/16 - 1/4 - 5/16 - 3/8 - 7/16 - 1/2	10.25
P2	5/8 - 3/4 - 1	17.70

PHOSPHOR BRONZE ROUND

Q1	1/8 - 5/32 - 3/16 - 1/4	09.45
Q2	5/16 - 3/8 - 7/16	24.00

SILVER STEEL 1 X 13" OF EACH

S1	3/32 -1/8 -5/32 -3/18 - 7/32 -1/4 -9/32 -5/16 -3/8 - 7/16 - 1/2	20.40
S2	3mm - 4mm - 5mm - 6mm - 7mm - 8mm - 9mm - 10mm - 12mm	18.00

ALUMINIUM FLATS

R1	1/8 x 1/2 - 1/8 x 1 - 1/4 x 1/2 - 1/4 x 1 - 1/4 x 1.1/2 - 1/4 x 2	14.28
R2	3/8 x 1/2 - 3/8 x 1 - 3/8 x 1.1/2	11.87
R3	1/2 x 1 - 1/2 x 1.1/2 - 1/2 x 2	18.00
R4	1/2 x 2.1/2 - 1/2 x 3	21.15

METAL FINISHING PRODUCTS

NICKEL PLATING KITS Bright 0r Black Electro Plate on to: **Copper - Brass - Iron - Steel** Welded Brazed or Soldered Joints
"TEK-NICK" Workshop Kit £59.50 + £6.50 carr. **"TEK-NICK"** Mid-Tec Kit £115.00 + £7.00 carr. **"TEK-NICK"** Maxi-Tec £180.00 + £7.50 carr.
Instructions with all kits. Replacement components available

"KOOLBLAK" Simple immersion at room temperature. Permanent heavy duty blacking for **Steel - Iron - Cast Iron**
Creates an integral, professional finish with no dimentional change. A superlative black oxide finish on steel.
"KOOLBLAK" Starter kit £30.00 + £6.50 carr. **"KOOLBLAK"** Workshop kit £48.50 + £7.00 carr.
Instructions with all kits. Replacements available

"TECHTRATE" Steel blackening in salts. Gives an uniform Jet Black finish or on a polished surface gives a Blue/Black finish.
The solution operates at 141C / 285F Ideal for - Tools, Fasteners or Fittings. £37.60 + £06.50 carr.

"ZINCFAST XL" Produces a bright zinc deposit on **Steel & Iron.** For **Car & Motorcycle** components. Zinc is highly valued as a rustproof finish, suitable for all types of fasteners.Instructions with all kits - Replacement components available. Workshop kit £76.50 + £6.50 carr.

"CASE HARDENING POWDER" This case hardening compound gives an acceptable depth of hardening to steel components
250gms £12.00 + £2.00 Carr. 500 gms £18.00 + £3.00 Carr. 1000gms £30.00 + £6.50 carr.
DRY ACID SALTS 500gms £8.50 + £3.00 carr. - **COPPER SULPHATE** 500gms £7.95 + £3.00 carr.

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7.1/4"G	1366	0-6-0	3.1/2"G	Molly	0-6-0
5"NG	Dholpur	2-8-4	3.1/2"G	Cant. Lamb	0-4-0
5"G	Butch	0-6-0	3.1/2"G	Petrolea	2-4-0
5"G	Chub	0-4-0	3.1/2"G	Iris	0-6-0
5"G	Simplex	0-6-0	3.1/2"G	Doris	4-6-0
5"G	Springbok	4-6-0	3.1/2"G	Rainhill	0-2-2
5"G	King John	4-6-0	3.1/2"G	Heilan Lass.	4-6-2
5"G	Dean Goods	0-6-0	3.1/2"G	Rob Roy	0-6-0
5"G	2251	0-6-0	3.1/2"G	Miss 10 to 8	4-4-0
5"G	Firefly	2-6-2	3.1/2"G	Juliet	0-4-0
5"G	Mogul	2-6-2	3.1/2"G	Virginia	4-4-0
5"G	Peggy	0-4-0	3.1/2"G	Maisie	4-4-2
5"G	Twin Sisters	0-6-0	3.1/2"G	City of Truro	4-4-0
5"G	Pansy	0-6-0	3.1/2"G	P.V. Baker	0-6-0
5'G	Tich	0-4-0			
5'G New	Combpyne	4-4-2T	Radial Tank - L.S.W.R. 415 Class		
5'G New	Nine Elms	0-4-2	L.S.W.R. A12 Class with Beyer Tender		
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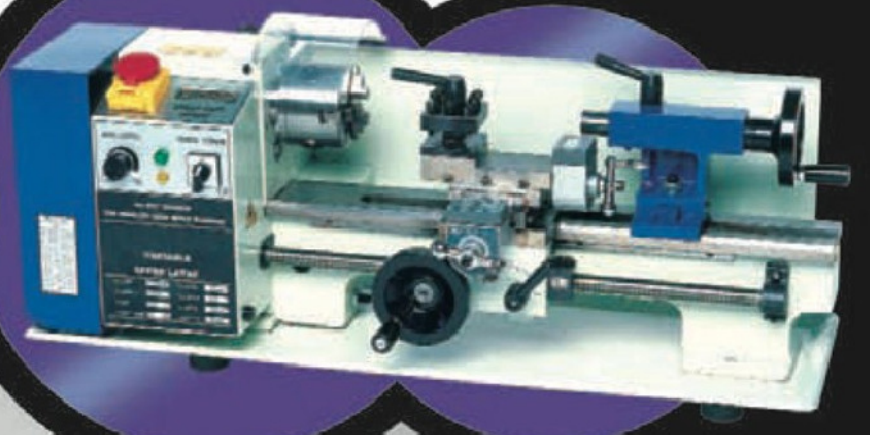

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