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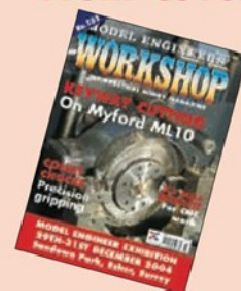
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Front Cover



This Herbert 2D Capstan
features a Crawford Mutibore
collet chuck. Peter Rawlinson
discusses various systems and
their attributes on page 12

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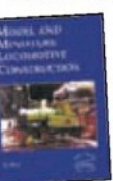
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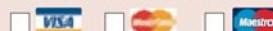
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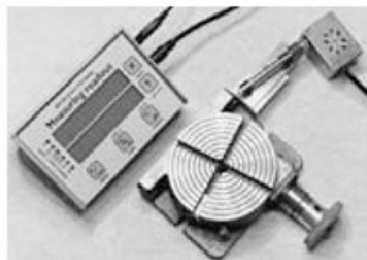
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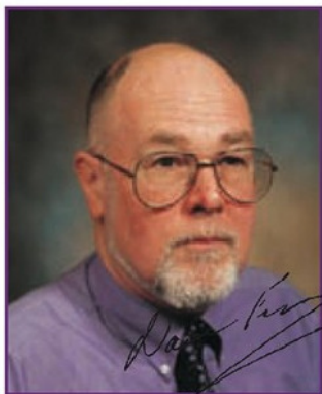
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Model Engineering at Bangor

Thanks go to Bran Bardsley for letting us know that the Coleg Menai of Bangor, North Wales intends holding Model Engineering evening courses. For further information please telephone Student Services on 01248 370 125

And next the information police?

In a week when the reopening of the Diana memorial (complete with barricade and "Paddle police" was humorously covered by at least one TV channel, I also happened to read a tabloid account of the court appearance of eight suspected terrorists. Whilst we all want a secure and peaceful environment, some of the information given caused me a measure of disquiet. One was said to have had two notebooks with information on "explosives, poisons and chemicals", and another with possessing an extract from a bomb making guide.

Recent correspondence to "Scribe a Line" has touched on some of the chemicals used for metal colouring. If my recollection is correct, certain chemicals used in electroplating processes can be pretty toxic. Way back in my primary school days, we learned (outwith school) that a mix of potassium chlorate and sulphur would go bang when struck with a hammer, and that one of sodium chlorate and sugar also behaved in an explosive manner when ignited in a confined space. Interestingly, we were never able to get a bang from a traditional gunpowder recipe, possibly something to do with either the sulphur or the charcoal. One also assumes that pre 1900, Mr Diesel conducted experiments with coal dust etc. which lead to explosive outcomes, or we would never have had the diesel engine.

Being a simple mechanical engineer, I have no appreciation for legal niceties, but do wonder if the authorities have shepherded us on to a slippery slope. It seems it may already be an offence to indulge in or even just hold the information for some types of amateur chemistry; how long before the same applies to the possession of plans for items of model artillery. Many model engineering societies of long standing include the word "Experimental" in their full title. What forms of experiment are

ON THE EDITOR'S BENCH

already or will become illegal activities? Do we look forward to a time when we will have to start burning textbooks on chemistry, physics and engineering, unless they are held under lock and key, in a secure approved university library? By way of contrast, industry continues to bemoan the standards of literacy and numeracy amongst school leavers.

In the Workshop

After a grass cutting session, my wife wheeled in the small rotary mower with the comment, "It just stopped on a heavy clump of grass, and it seems to be stuck". Initial examination confirmed that the engine was indeed partially seized. A closer look showed that the lower part of the crankshaft which carries the blade, (about 22mm diameter) was visibly bent; when eventually removed, the end was a good quarter inch out of line. In addition the torsional impact had sheared the drive key at the blade end, and partially sheared its opposite number at the flywheel end.

Historically, this mower was obtained very cheaply at an end of season sale, so thoughts of following the Briggs & Stratton instruction to renew a distorted crank were instantly put to one side. The question was "Could it be bent back to shape". To find out, the home made hydraulic press was unearthed and dusted off to have a go. I have commented before that I do have a large scrapbox. The press was made up some years ago using the pump and 10 ton ram from a "Portapower" car body repair kit, mounted in a fabricated frame, welded up using a bit of I beam, uprights from a jack leg cabin, and some channel section.

Ideally the shaft would have been mounted in a couple of Vee blocks to ensure stability. As an alternative, I made a Vee shaped top tool and settled on flat blocks below. In an endeavour to avoid marking the shaft, strips of aluminium were placed on the steel blocks, the aluminium also serving to shift the load line closer to the web. This arrangement was only partially successful as the aluminium was squeezed out of the way like butter. Mark two set up used copper strip, the thinking being, that as it distorted to conform to the round shaft, it would also work harden. This combination did work, and after some dozen or so applications of the best part of the ten tons available, the shaft did once again look straight when sighted against a straight edge, and was very few thousandths adrift when rotated in the lathe. One concern was of course that the shaft would simply break, however that did not happen, and there was no visible evidence of surface cracking. Had this been the case then the item would have had to be

scrapped due to the likelihood of a surface crack developing during operation into a fatigue fracture.

The proof of the pudding came later when after a partial reassembly, the shaft rotated freely in its plain bearings, and after reassembly the engine again burst into song. With any luck (and the avoidance of large clumps) we can look forward to a few more years of service from the machine.

74th Model Engineer Exhibition

As noted in the last issue I would again encourage readers to enter items of workshop equipment for this forthcoming exhibition. In contrast to the various classes of models, where the items are based on existing prototype designs, workshop equipment is an area where originality of thought and design can be a dominant factor. The loan category offers an avenue which avoids the pressure of competition but can still bring a range of exhibits to a wide audience. In this context the philosophy behind a workshop item may then spark off a train of thought in spectators' minds which then prompt lines of further work on return to the workshop.

The exhibition will run from 29th to 31st December opening from 10am to 5pm on the first two days, and 10am to 3pm on the third. Along with the editorial staff from senior sister magazine "Model Engineer", I expect to be present for the duration of the event, and aside from enjoyment of the show content, also look forward to renewing friendships and making new acquaintances.



Home built hydraulic press comes in handy for pressing bearings and straightening crankshafts.

COLLETS AND COLLET CHUCKS



1. Home made collet chuck for Myford seven.

This article is primarily based on my own experience over the years with particular emphasis on the collet systems that are in current use in my own workshop. I have to say that earlier in my career, I really had no liking for collets, and indeed was pretty well ignorant of their attributes, until I used a "Ward" turret lathe many years ago. They do say that it was the "Ward" that won the last war. These machines are no longer made but the "Ward" 2A was a good lathe that used a plain steel spring type collet and these could be obtained to hold round, square or hexagonal material. It was on this lathe that I found the beauty of using collets.

When I owned a "Myford" I was given a set of 15 collets but there was no chuck, so the next task was to make one to fit the lathe; this was done and of course, as it was finished on the lathe mandrel it is extremely accurate. These were used for many years but they were slow to open

Peter Rawlinson discusses the merits of several types, and introduces a variety of accessories.

and close with the threaded closer. I had decided to obtain a larger lathe at that time and they were put in the cupboard and forgotten, it was some time before they came to light again and were put to use mounted on the dividing head (which has a "Myford" nose). The Heading photo shows this chuck with a couple of collets.

Nowadays, I have a set of "5C" Collets in various sizes from $\frac{1}{8}$ in. to 1in. and 1.5mm to 28mm in plain circular types, these being supplemented by a very few square and hexagonal types. I use them wherever possible for work up to 28mm diameter on my own lathe. To operate these I purchased a light industrial chuck system from "Acrovu Ltd" some years ago which has given me faithful service ever since with the "5C" collet system. A pair of these collets is shown in **photo 2** and the lathe chuck in **photo 3**. **Photo 4** gives some idea of the wide range of sizes of different collet systems, the smallest being for use in a "Dremel" electric tool and my largest being a "5C".

Collets can usually be obtained in two grades of precision, the normal for general engineering and turning and the high precision ones for grinding or special parts in a second operation. The collet is on the whole more precise than a three jaw chuck and in industry is much faster in use for changing over of parts. It also has the added advantage of not marking the part as it's gripping force covers a greater surface area than a three or four jaw chuck. This is because generally speaking the collet grips over a greater angle. (Some types such as the "ER" may also be designed to grip over the full length of the collet, although this is not possible with all collets due their design.

One of the drawbacks of collets is the gripping range of an individual collet. Many conventional spring collets are

intended for a specific bar size, which is fine for volume production. However **Fig 1** shows what happens if a 5C type collet is not used on the exact size that it is made for. The Heel/Toe contact does not give a good support to the material. However in **Fig 2** it is apparent that the "ER" type collet closes in a different manner and grips over the length of the jaws, and over the full range of its adjustment.

5C collets and accessories

5C collets are threaded on the outside for the closing (Typically using a pull tube) and also on the inside to allow the use of an adjustable stop. Again, I have made some of these as shown in **photo 5**. The length range covers from 5mm to 150mm, and diameter down to 3mm. They are particularly useful in second operation work, and allow tight tolerances to be held on axial length. The leading dimensions of a 5C are given in **Fig 3**, and it should be noted that there is also an external keyway of about $\frac{1}{16}$ in. wide and $\frac{1}{8}$ in. deep running along part of the parallel shank.

These 5C collets can also be used in a number of fixtures that I have. The square and hexagonal blocks shown in **photo 6**, accommodate a collet and can be used to hold in a vice, or on the magnetic chuck of the surface grinder or even in the milling machine. These then allow the part to be rotated to present either 2,3,4 or 6 faces to the tool and can therefore allow the easy machining of squares or hexagons etc. Fixture similar to these have become available within the last year or so from some of our regular suppliers at advantageous prices.

The next is the simple indexing fixture illustrated in **photo 7**, which can be set



2. Two "5C" collets.



3. 5C collet chuck in lathe.



4. Collets come in a wide variety of sizes.

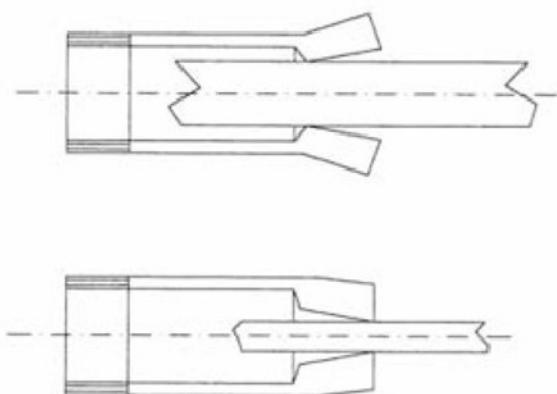


Fig. 1 Heel and toeing

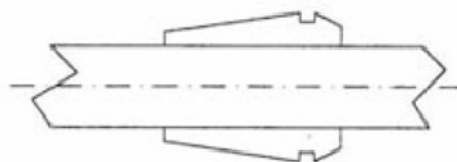


Fig. 2 ER type collet grips full length of collet

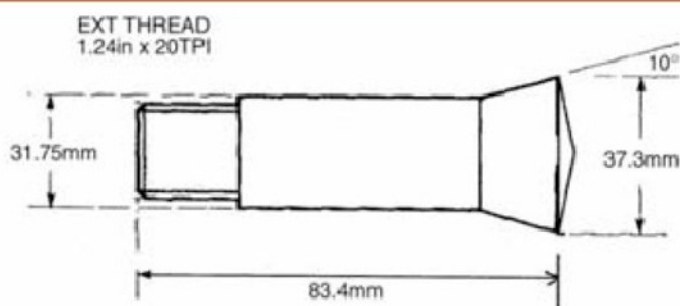


Fig. 3 Outline dimensions - 5C

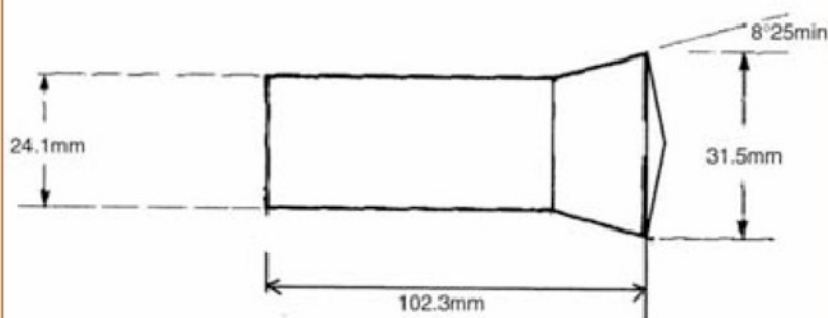


Fig. 4 Outline dimensions - R8

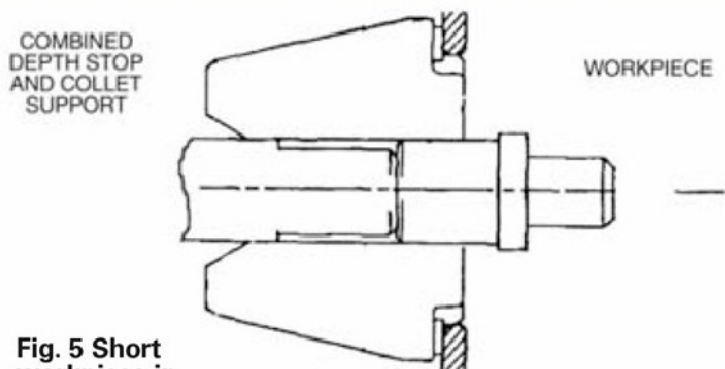


Fig. 5 Short workpiece in multisize collet

quickly to any one of 36 divisions, or at 1 degree intervals by moving a pin. This device is described in some catalogues as a "Spin Indexer", and I have found it very useful for keyways etc.

Another device worth a mention, is the complex indexing unit (photo 8) which is much more robust and is more appropriate to large batch manufacture. It can be set up for a specific number of

©

stops and is operated on a ratchet principle. This unit will also take my three and four jaw 6in. lathe chucks as it has a large accurately ground and screwed nose. This can also be used on the mill to hold the work either the vertically or horizontally, depending on the way it is mounted.

Emergency collets

There is also a series of collets in the 5C range that are supplied soft, and can be bored to suit the specific operation that is required; these are usually called emergency collets. Beside these there is also a range of 5C collets that have a large disc on the front and are usually available up to 6in. dia. these can be machined out to hold large (up to say 5½in.) but usually thin work pieces and photo 9 shows one that has been used on a number of jobs, the last being to make some double headed pennies (old type). Of course, once used these can only be machined out to a larger size, I do believe however that a replacement disc could be fitted as some of these are bolted into place.

Of course the actual changing of a collet size does take a little time but I find to change between a 3 or 4 jaw chuck and my collet set up takes only between 2 to 3 minutes and this also covers the fitting of the required size of collet. However it may also depend on which "Chuck" system is available for the collets, (changing the chuck on an industrial capstan may take half an hour or so). The unit that I have is a good industrial one that uses a lever at the rear of the head stock and which is so arranged that it is possible to release the grip while the spindle is still rotating. This is particularly relevant to bar feed work on capstans and automatics, as after parting off one component, the bar can be advanced to a length stop without stopping the machine. It would also speed up second operation work but would nowadays probably be frowned on by the HSE. I never do this myself, as I prefer to keep all my fingers intact, and where they belong.

As can be seen the "5C" collet is a versatile and worthwhile system. Individual collets can be obtained for about £ 9.00 new, and at about £4.00 - £5.00, secondhand. There are also two other series of collets of similar style, these are the 3J and the 16 J, which have maximum material sizes of 1½in. dia. and 1¼in. dia.

5. Home made depth stop fitted to 5C collet.



Myford collets

Myford have a dedicated collet system for the "Seven" series lathes which feature a number two Morse taper that fits the bore of the head stock. Collets are available from $\frac{1}{8}$ in. to $\frac{1}{2}$ in. by 32nds, and from 3mm to 12.5mm by $\frac{1}{2}$ mm increments. They are closed and opened by a special closer which uses the mandrel nose thread for the closing action, see **photo 10**. Advantages of these collets include the reduction of overhang and the inherent accuracy. A disadvantage for volume work, stems from the axial movement of the collet (and hence workpiece) during tightening.

However there is also a lever operated unit (**photo 11**) that operates in a different manner via a lever at the front of the headstock. This chuck is of the "Dead" length type, in other words the material is not moved axially as the collet grips, and can be operated with the spindle revolving. Thus this type is more suited to repetition bar work, where the material may be fed to a stop then gripped. The maximum size is $\frac{1}{2}$ in. or 16mm rising in either 0.5mm or $\frac{1}{8}$ in. increments.

E R collets

This is a relatively modern type, used regularly for both tool holding and work



6. These collet holders aid machining squares and hexagons, are also a boon for cutter grinding.

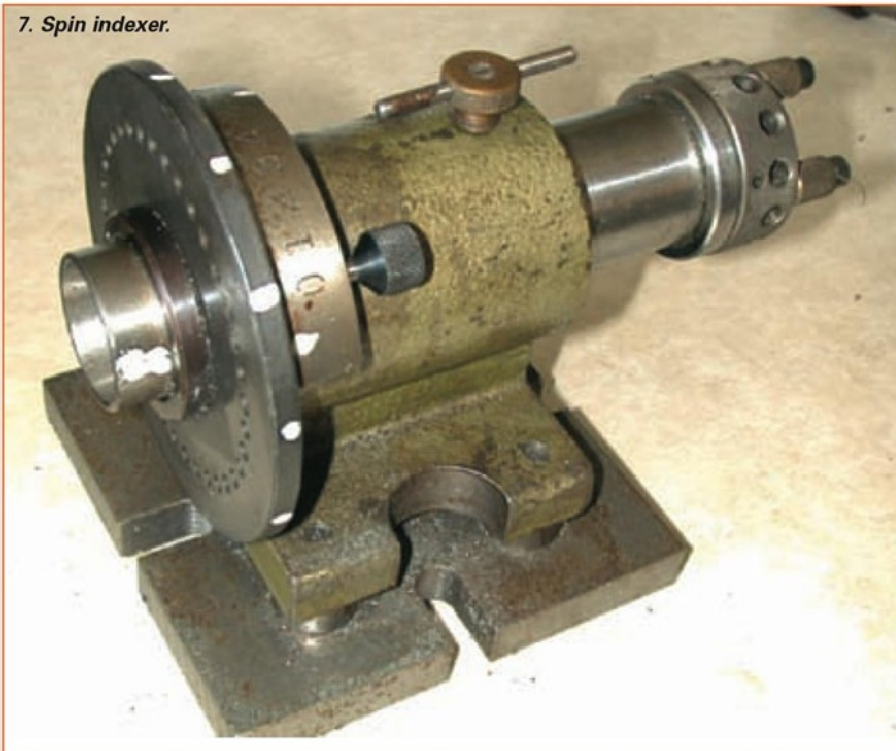
holding. As shown in **Sk 2**, they can grip over the full length. They are also not limited to a specific size, but cover a particular "collapse range", which for many is one millimetre, although some of the smaller ones cover 0.5mm.

There is a number of series starting at the ER8, 11, 16, 20, 25, 32, 40, and 50. They cover a total range of 0.5mm. to 32mm. but with the smallest going down as small as .02in. dia.(ER 8) The family is geometrically similar, all having cone half angles of 8degrees and 30 degrees. To give a good range though, the series "ER 32" starts at 2mm and goes up to 20mm.in 1mm. increments. I now have a mixture of 16, 20, 25 and 32. but I would have been better concentrating on the larger size first as the field of sizes cover

all that I would have wanted over the years. These are again manufactured in two precision levels and the normal that is available is to DIN 6499 which gives a run out of 0.02mm. at a distance of 40mm.on a diameter of 10 - 18mm. However there are high precision collets made that exceed this by a factor of four. By comparison, these collets on the same size bar and over hang give a run out of 0.005mm. They may also have up to 16 jaws and give a remarkable gripping power.

If you are a long term reader of this magazine you may remember that my C.N.C.Mill, and C.N.C.dividing head used these collets in the "ER20" size. This then gave a very flexible way of not only mounting the cutters but also in the mounting of the piece part that was to be machined.

7. Spin indexer.



8. Complex dividing device here shown positioned vertically.





9. Large diameter "emergency" 5C.

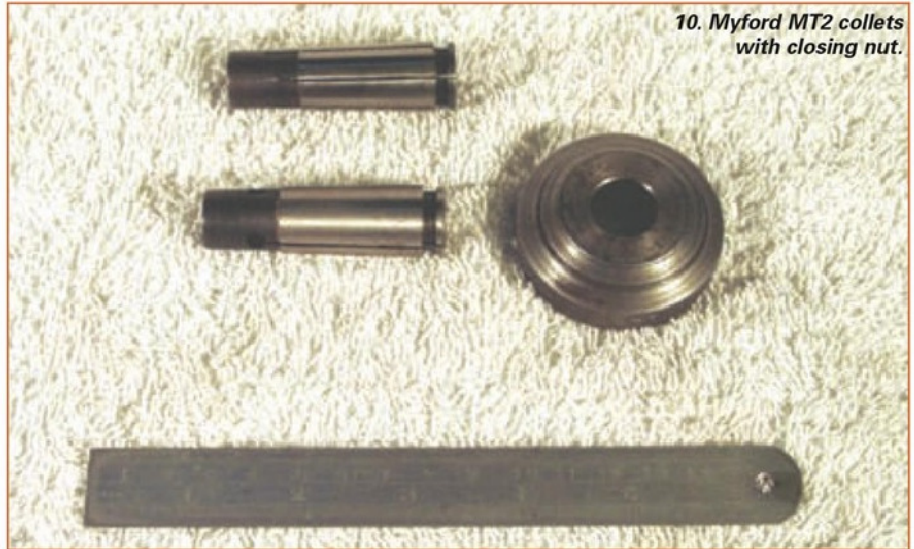
I also use the "ER32" for holding cutters for regrounding in my "Quorn". To this end I have plain shanked mandrels for all sizes, these have a shaft diameter of 25mm. This I also find useful because I can hold odd sized rounds in the lathe by using the "ER" holder shank held in a 25 mm. dia. "5C" collet.

Clarkson collet

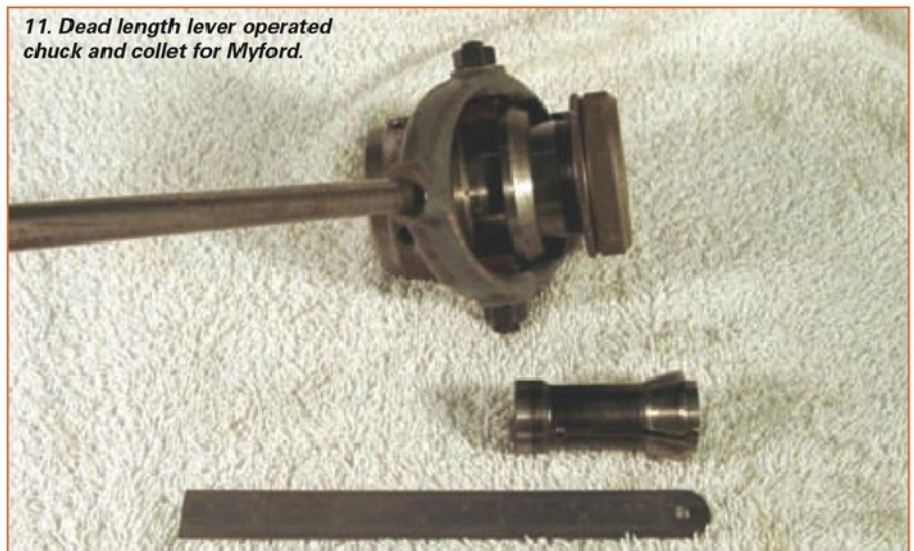
The number of types of collets used in the world today is considerable and many machine tool manufacturers design systems to suit their own tools. But there are a number that will be known to most of us amateurs. These must start off with the Clarkson milling collet chuck (photo 12) which uses four collets for metric and four collets for the imperial sizes of cutter. Of course they also make a larger but similar chuck for the 1in. & 1½in. shanks, however this is of limited interest to most amateurs.

Tapping collet

The next type of collet is the family of tapping collets. In the case of the large set each collet has a machined square cut into the collet to match the tap which helps to drive the tap, but in the small 8BA to 0BA tapping chuck, the drive is carried out by a grub screw onto the side of the tap. These tapping chucks have full torque adjustment and can therefore be set to slip before the tap should break. This breakage of course, is a considerable problem in the mass production of cars etc. and the machine tools used on these applications are fitted with very sophisticated systems



10. Myford MT2 collets with closing nut.



11. Dead length lever operated chuck and collet for Myford.

for the measurements of the torque and give a warning of this to the controllers. The possibility of a broken tap in say an engine block or gearbox housing would cause a considerable cost to the manufacturer.

Photo 13 shows a tapping attachment that is used on the pillar drill and has a reversing system, it turns clockwise from above when cutting the thread and the

pressure is downwards and turns in reverse when "Pulled" upwards and automatically unscrews out of the thread. These can be obtained in very large sizes and we used to use these for tapping 25mm thick mild steel plate with an M30 thread.

Home made collet

A type of holder that could be called a collet that I have used in the past is home made and used to hold square or hexagonal material. These are simply tubes of steel bored accurately for the (size across flats or corners) size of material to be turned and having a machined slit down the full length. These can then be



12. Clarkson chuck and two matching collets to the right.

13. Auto-reverse tapping head and chuck.





14. R8 collets.

held in a three jaw chuck or in another collet. They are easy to make and can solve a problem if proper collets are not available or too costly for the job in hand.

R8 collets

The next type that would be of interest would be the "R8", (popularised by Bridgeport as the spindle fitting in their turret mills. These are shown in **photo 14**, and the leading dimensions given in **Fig 4**. The R8 recess may be used to locate a Clarkson chuck, or to accept R8 collets. This of course gives a much reduced overhang to the cutter. R8 collets are size specific and are not used for many other purposes as the "R8" housing is not widely used on other applications. For milling applications, an advantage over a Morse taper arises because the R8 will generally require only a light tap on the drawbar to release.

CDBX 1

This general coding seems to be used by Crawford Collets to cover a wide variety of sizes in a general pattern geometrically similar to the 5C (size specific, external thread for drawbar, cylindrical location, tapered nose). The smaller ones are probably used mainly in the horological industry. I was fortunate enough to buy 10 of these small collets at a boot sale (**photo 15**) and it was these that the mill used originally to hold the cutters, but when the price was checked it was found that the cost of these collets was in the region of £45 each. I therefore decided to remake the main shaft of the mill, which now uses "ER" type collets. These are available at a much reduced price and can be found for about £10.00, so you can see the reason for the change.



15. Small (but costly) collets.

Single and double angle collet

Also worth a mention is the single angle type collets and these are shown in **Photo 16**. These can be used to hold either work or tools and are usually found as a part of a milling collet chuck system.

Double angle collets are (**photo 17**) available in five series (30, 20, 10, 18, and 40) covering a range of diameters from 1.5mm to 25.5mm. Again these are principally used for toolholding.

Multisize and multibore collets

To digress a little, some years ago, I fitted out a "Herbert" capstan lathe with Pratt Burnerd "Multisize" collets; the cost of the chuck and a set of eight collets was at the time in the region of £1500.00. Each collet was basically a set of six hardened steel blades set radially into a slotted steel holder, and each was made to cover a 1/16" size variation. As six gripping blades are used, the same collet may be used for both round and hex. material. It may also be noted that these collets can be used in any of four



16. Single angle collets.

chuck types, (two each of manual and power operation). Of the manual types, the LC is a lever operated dead length chuck which can be operated with the spindle in motion.

"Multibore" collets are available from Crawford Collets, these being manufactured in a segmented form, and also have a collapse range of 1/16". Older types feature compression springs and retaining rings, while more modern variants use a bonded rubber arrangement. Both Multisize and Multibore types are used frequently on commercial bar feed set ups, where the full length of the collet is used for gripping. It is possible to use them to grip short work, but it is then recommended that a plug made to workpiece diameter (and which may incorporate a depth stop) is located at the rear of the collet (see **Fig 5**) to ensure that the gripping surfaces remain parallel to the axis.

I hope that this little excursion into collets is of interest. For me they fall into the category "Once used always used", and I would thoroughly recommend their use. As stated before I am happy to help out but phone only please.

Peter Rawlinson. Charing, Kent.
01233 712158.



Table 1 ER collet leading dimensions

Type	Range (mm)	Diameter (mm)	Length (mm)
ER8	1 - 5 x 0.5	8.5	13.5
ER11	1 - 7 x 0.5	11.5	18
ER16	1 - 10 x 1	17	27
ER20	1 - 13 x 1	21	32
ER25	1 - 16 x 1	26	35
ER32	2 - 20 x 1	33	40
ER40	3 - 26 x 1	41	46



17. Double angle collets.



18. Multisize and multibore collets.

KEYWAY AND PLANE CUTTING SYSTEM using an ML10 Lathe

Peter Wilton raids the scrap box and produces a versatile accessory. He concludes with comments on ML10 dividing.

Background

W J Hughes - 'Building The Allchin' handbook, (where would we be without it?); fig. 9,10 shows his jig for the planing of the compensating centre using a ML7 lathe. The ML7 is both longer and stronger than the ML10, but I figured that a similar setup could be made to work without undue stress to my ML10.

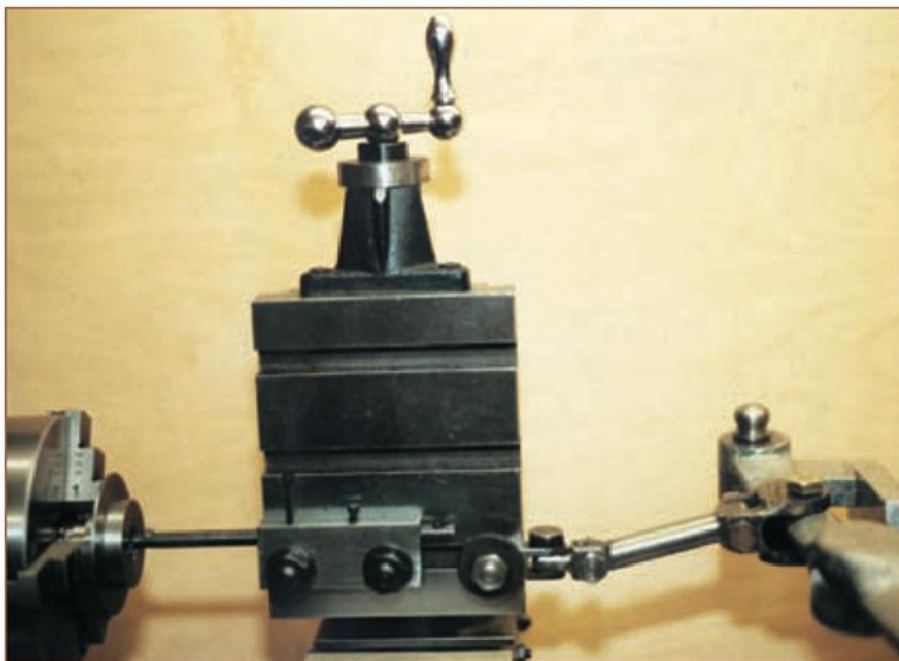
The first item required was a 'Sky hook' to form a pivot for the operating handle. Part of the manufacture of this took place at Lea Manor, Luton Tech. College, where coincidentally Ted Jolliffe, a former editor of the sister publication also attended. When told what it was to be, his response was roughly translated as "What on earth is that?" (only those aren't quite the words he used). His doubting comments spurred me into action with even more resolve to make the thing work. It was very pleasing to find that it did at the first trial.

The system described herein was devised in order to cut the various keyways in the gear pinions of my 1½in. Allchin, also to plane the compensating centre bevel gear bearing surfaces. Essential to the design was an accurate cut, easy setting of cutter position and nil cost, the scrap box doing its job to the full. I like to think that those parameters were met and offer these notes to those others who like me have an ML10 and limited resources. The indexing facility is not essential to keyway cutting but it certainly makes life easy.

Components required

Handle Pivot (alias Sky Hook)

Fig.1 and photo 2, do, I think, convey sufficient information for similar ex scrap box manufacture. The primary design requirement was to produce the power



1. Complete system installed on ML10

stroke through the lathe centre line but not to throw too much twisting strain on to the tailstock, this has limited the cutter bit stroke length to about 2.5in. for keyways and 1.5in. for planed surfaces 1.0in. wide. That's plenty for Allchin purposes. The only reason for the offset pivot plate was to cope with the handle whose 'eye' was below the centre line.

Handle

Illustrated in Fig. 2, and again ex scrap box and chosen for the already shaped handle at one end and the eye at the other. O/A length of 15in. gave a nice 6:1 lever advantage. It would be feasible to use hardwood for this item.

Linkage

Ref. Fig.3 and photo 2. My items here were crude in manufacture but effective. If time permits I'll make a respectable set of universal couplings one day. The requirement here is to transfer the power stroke to the vertical slide, which is mounted, on the cross-slide, yet accommodate the horizontal and vertical slide movements. The linkage clamp to the lathe vertical slide may be set in any of the Tee slots to allow for the cutter bar height variations.

The limitation in planing width to 1in. is a by-product of the length of the link and

the universal couplings. An O/A length of 7in. may be preferable.

Tool holder

Refer to Fig. 4. A simple block of MS bored out to take a ¼in. commercial boring bar with two ⅜in. holes for Tee bolts. I milled the back face to give a small tenon which locates in the slide's tee slot thus preventing tipping of the bar during the stroke (if too big a cut is attempted)

Setting up and operation

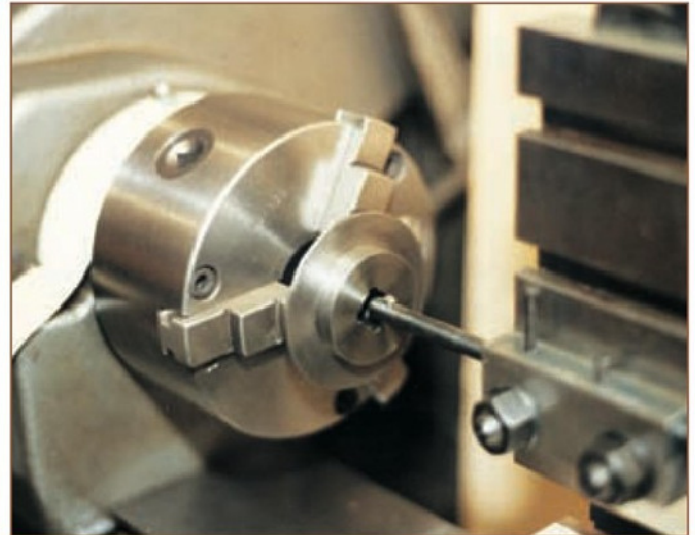
See photo 3. The cutter may be set to cut in any plane but I found that use of the vertical slide as the cutter depth control came easiest. The cross-slide allows accurate centring of the bore where the keyway is to be cut; lock the cross-slide once centring is complete before commencing the cutting action.

Care is necessary in obtaining a truly vertical cutter bit; my way was to remove the cutter bit from the toolbar, insert a blank piece of tool steel long enough to put against a Try-square resting on the lathe bed; tighten the toolbar clamp screws and replace the cutter bit.

It wasn't easy making cutter bits of the correct widths and truly square ends but it is well worth the time to get things just



2. Handle and Linkage components



3. Cutting a vertical keyway

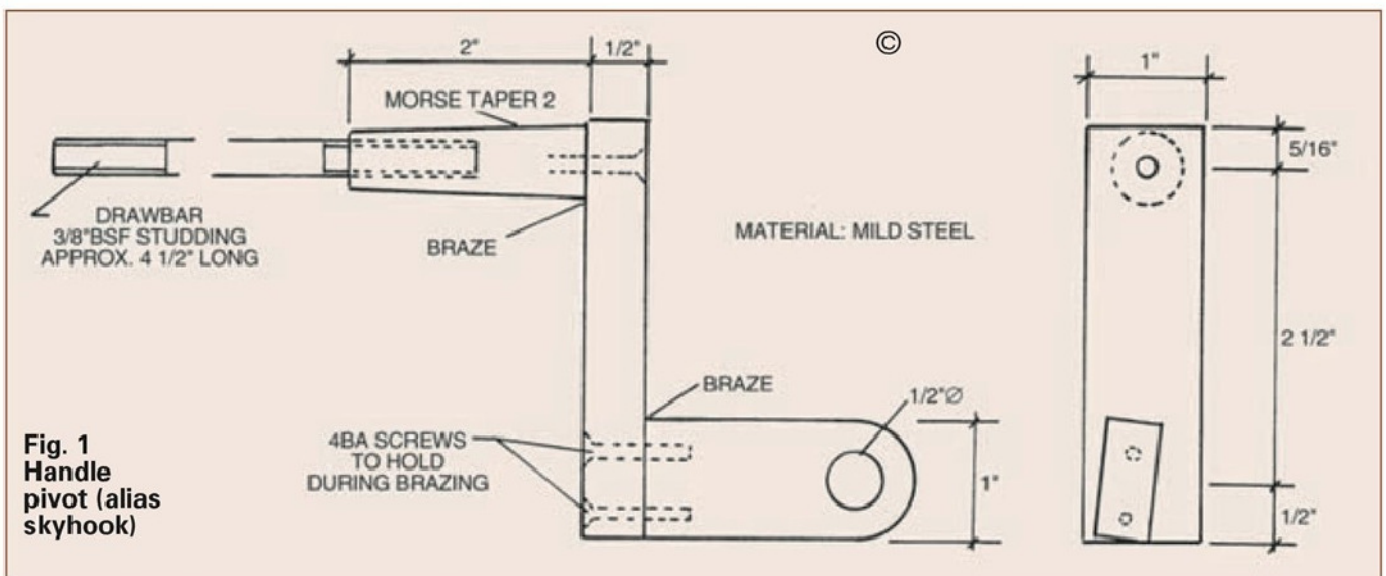


Fig. 1
Handle
pivot (alias
skyhook)

right. I'll confess that the first keyway I cut did look a bit drunk. My toolbar uses round bits; it would be easier if a square tool holder was available.

Planing is done using the cross-slide to control the width of cut, the depth of cut still under vertical slide control. See **photo**

4. where the compensating centre bevel gear bearing surfaces are being cut.

Depth of cuts was held at 2 thou per stroke, the last setting given several strokes to take up the slight give in the toolbar. Four 1/4 in. keyways were cut in a cast-iron gear pinion in just 15 minutes.

Dividing with an ML10

I had made a mandrel for the ML10 some time previously. The acquisition of a 60 tooth gearwheel at my club (Bedford MES)

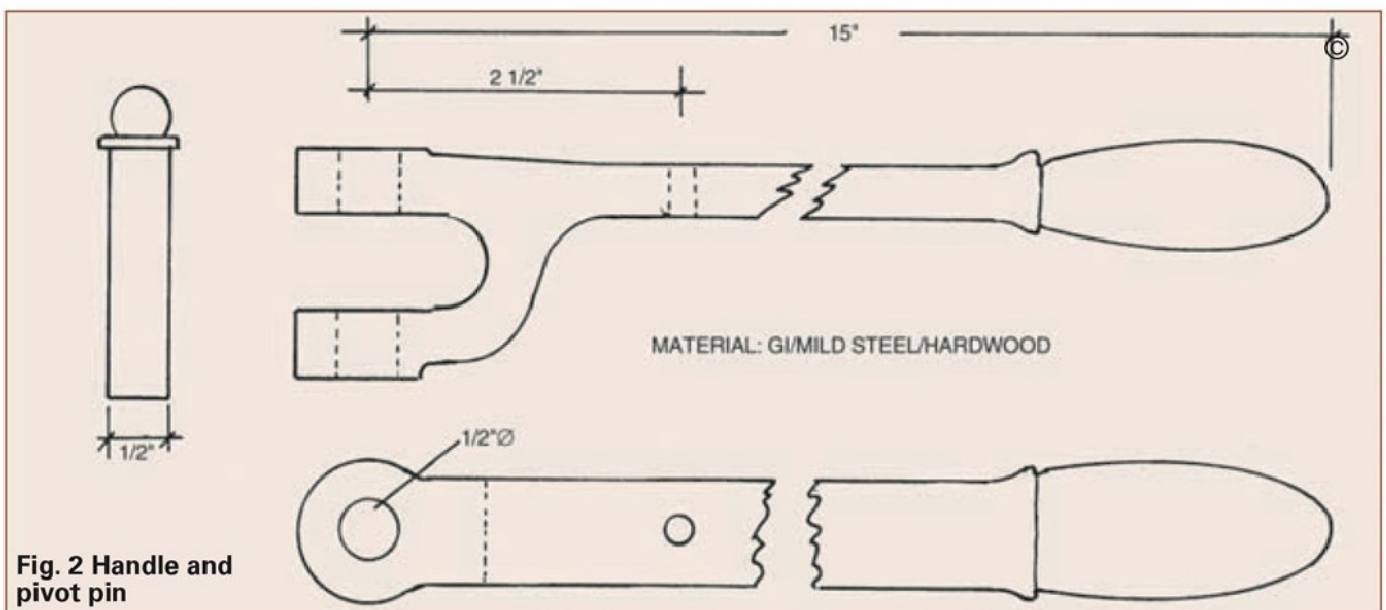
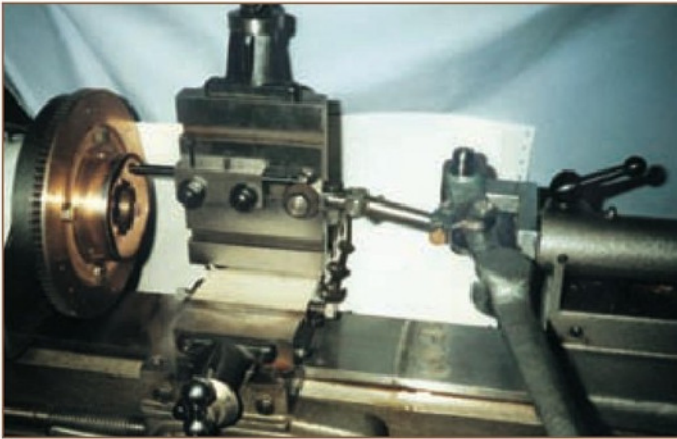
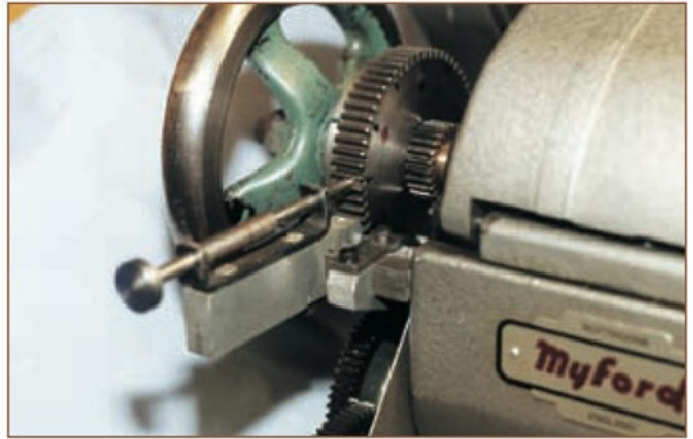


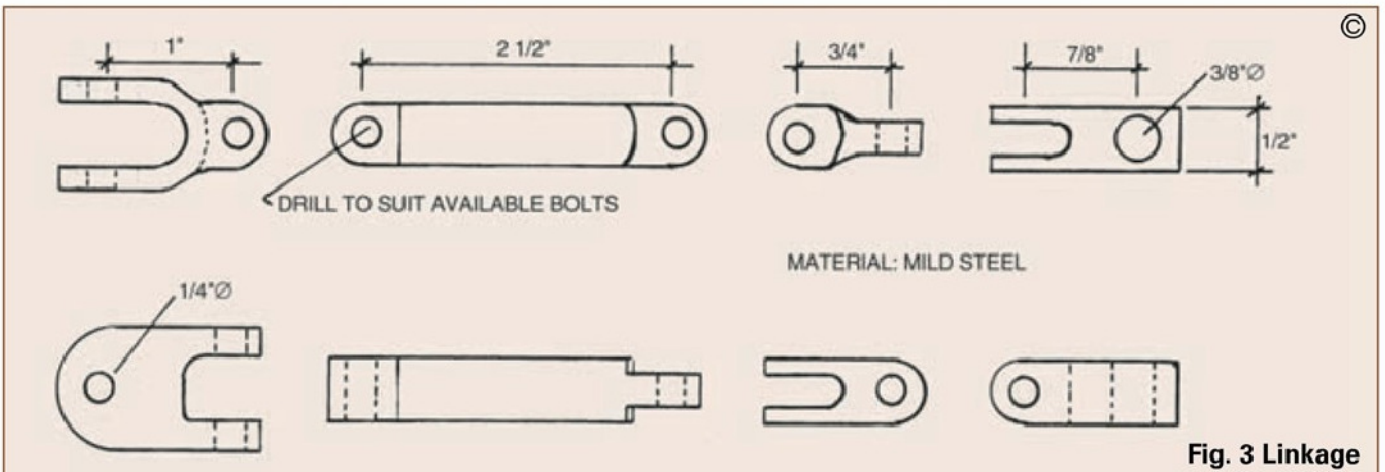
Fig. 2 Handle and
pivot pin



4. A planing operation



5. Dividing unit assembled on lathe

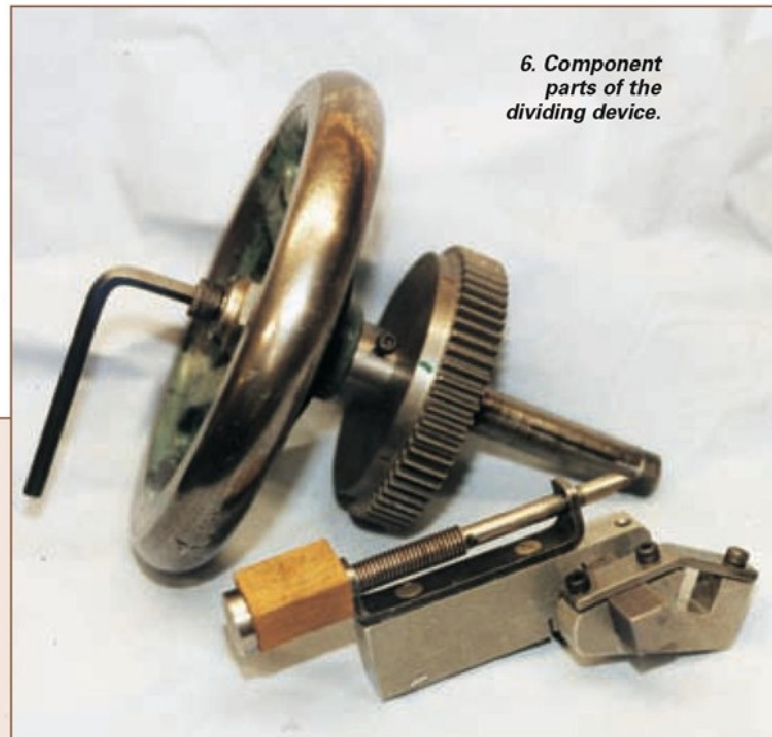


sale gave rise to the dividing system as shown in **photos 5 and 6**.

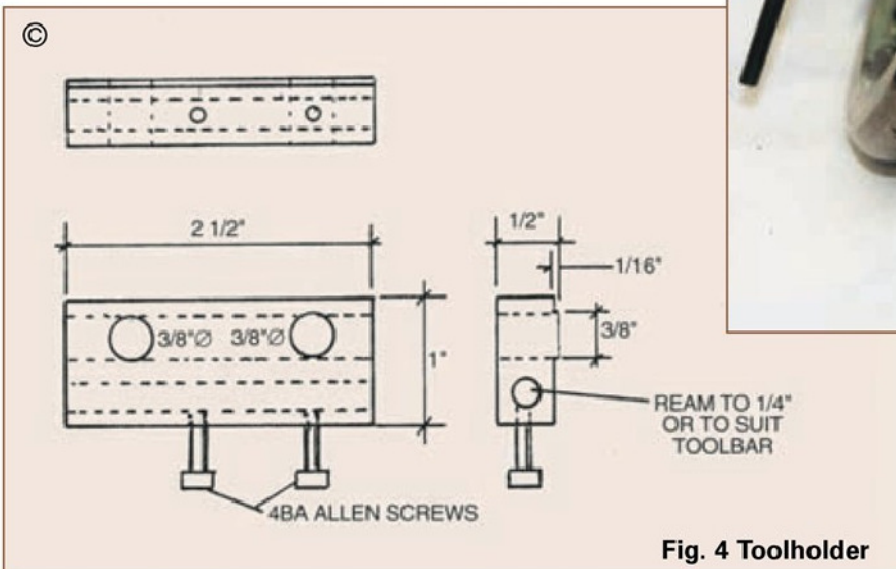
Mounting the detent holder on the change-wheel cover fixture has proved to be firm enough. The detent tooth has a notch cut so that on rotation of the detent through 90 degrees the detent slots over the gear tooth instead of the between giving division to every 3 degrees. Fortuitously the gear wheel needed a bush to fit the mandrel shaft. The bush was keyed to the gear wheel; a shoulder providing space for an Allen headed 4BA locking screw which is used to lock the gear wheel bush to the mandrel after the item in the lathe chuck is positioned

(detent already engaged), a process which gives quite accurate results.

I have not sketched the mandrel or detent items; the photos will hopefully speak for themselves. The mandrel basics have been well publicised in the past; the detent holder will rely on what the odds and sods box offers. It would be necessary to measure



6. Component parts of the dividing device.



the angle of the change-wheel cover fixture with respect to the centre height of the division gear of each lathe. Being Myford, they are probably all the same, but there is nothing like "checking on the job" The little wooden block has a slot in it; when placed over the detent plunger it holds the detent out of engagement.

ROTARY TABLE

2



After having dealt solely with the body in the last issue we commence with the other major component, the table, then go on to conclude the article by detailing most of the remaining items.

Table (Item Q) Fig 4

The table casting is provided with reduced diameters on the rear for the smaller diameters, file four flats on the larger to enable it to be held by a four-jaw chuck. Place the part in the chuck and adjust the outer diameter to run reasonably concentric and the outer face true. If you find this difficult, do not worry, so did I. However, with a little encouragement from a soft faced hammer the outer face eventually ran as required. I felt that the security of this arrangement was a little suspect and so used a tailstock centre for added support. This is unusual for something so short but should not be overlooked!

Machine the outer diameter, **Photo 14**, followed by the face and the groove in the outer diameter. Reverse in the chuck and set the outer diameter to run true and machine the two diameters, **Photo 15**. Ignore the tolerances on the drawings and make the larger diameter a close, almost tight, fit in the hole in the body already made. As the rotary table will probably be called upon to machine parts when it is rotating, curved slots typically, any clearance could cause a problem. If eventually the fit is considered too tight then a little work with a scraper will loosen the fit.

In the same way as the diameter needs to be a close fit so also there should be no end float. To achieve this, first make the larger diameter a little on the long side,

say 0.005in. Fit a saddle stop and with the lathe stationary fit the body over the table. Bring the saddle up to the saddle stop and using the top slide bring a lathe tool up to the thrust face on the inside of the body. Move the saddle back and remove the body. Note carefully the top slide dial reading, then wind the top slide back and then forward, to remove backlash, bringing it to 0.0005in. short of its previous reading. Then, with the saddle against its stop, face the end of the larger diameter. If eventually this turns out too tight then the inner thrust face on the body can be lightly scraped.

As will be seen later the $\frac{1}{16}$ in. hole can be used for holding a plug for centralising parts for machining. For this reason it needs to be concentric with the bearing and is being bored at this stage to achieve this. Do not rely on a drilled hole as it may wander and its size will doubtless be oversize. Drill smaller than $\frac{1}{16}$ in. and bore to size. Reverse once more in the chuck, setting the table to run reasonably true and cut the rings that are an aid to positioning items on the table, **Photo 16**.

The drawings call for the table to be calibrated in 1 degree divisions. However, I considered that this would create divisions that would be too close to read with ease, so chose 180 divisions at 2 degree spacing. I must confess that I also liked the idea of reducing the work involved. The lining tool I use automatically chooses when to produce long, and when short, lines but even so one needs to concentrate on the task in hand, one false move and it would be a case of skim the outer diameter and start again. **Photo 17** shows the calibration taking place. Do set the outer edge of the table to run true (hence the four-jaw chuck being used) as any error will vary the position and depth of the lines being cut and therefore their appearance.

Harold Hall concludes his account of building the CES kit

Cutting the tee slots

Clamp the body on the milling machine table and place the table in this, using an additional clamp to hold this in place. Using a slot drill of the appropriate size mill a slot across the table taking it, in stages, to the full depth of the eventual tee slot. Follow this by milling the arms of the T using a tee slot cutter. Place a small piece of masking tape, or similar, against the table's calibration and make a temporary datum mark. Loosen the table's clamp, but not those for the base, rotate the table through 180 degrees and repeat the slotting operations. My photographs, **Photo 18** and **Photo 19**, show that I cut both slots with a slot drill prior to making the tee slots. The above sequence will though avoid having to accurately set up the table position for cutting the second tee slot. I could not find a supplier who listed a tee slot cutter of the size published on the drawing though I did not search extensively as I had almost made up my mind to make my own. I eventually did make a cutter, and the exercise will form the basis of a future MEW article.

Cover plate (Item R) Fig 5

Mark out a piece of sheet steel, using a pair of dividers, with the diameter required for the cover plate. Rough cut this to shape using a bench shear, jig saw or other device and file to shape and size required, or use a disc sander. Check it against the recess in the bottom of the body. Leave the drilling till later.

Worm wheel (Item D) Fig 6

You probably think that the rotary table is not yet ready for use, well that is not quite the case. Make a locating plug with diameters of $\frac{1}{16}$ in. and $\frac{1}{8}$ in. and with the end of the larger diameter centre drilled with a small centre drill. Place the $\frac{1}{16}$ in. diameter in the hole in the table and the worm wheel over the larger diameter and clamp in place using the tee slot in the rotary table. Now with the body clamped to the milling machine table and a centre drill in the drill chuck, use the X and Y movements to align it with the centre drilled end of the $\frac{1}{8}$ in. diameter. Traverse one of the table movements by 0.500" and centre drill the worm wheel. Using the table's calibration rotate the table through 120 degrees and centre drill the second, repeating the operation for the third, **Photo 20**. Remove from the rotary table and open up the holes on the drilling machine. Eventually, use the worm wheel as a

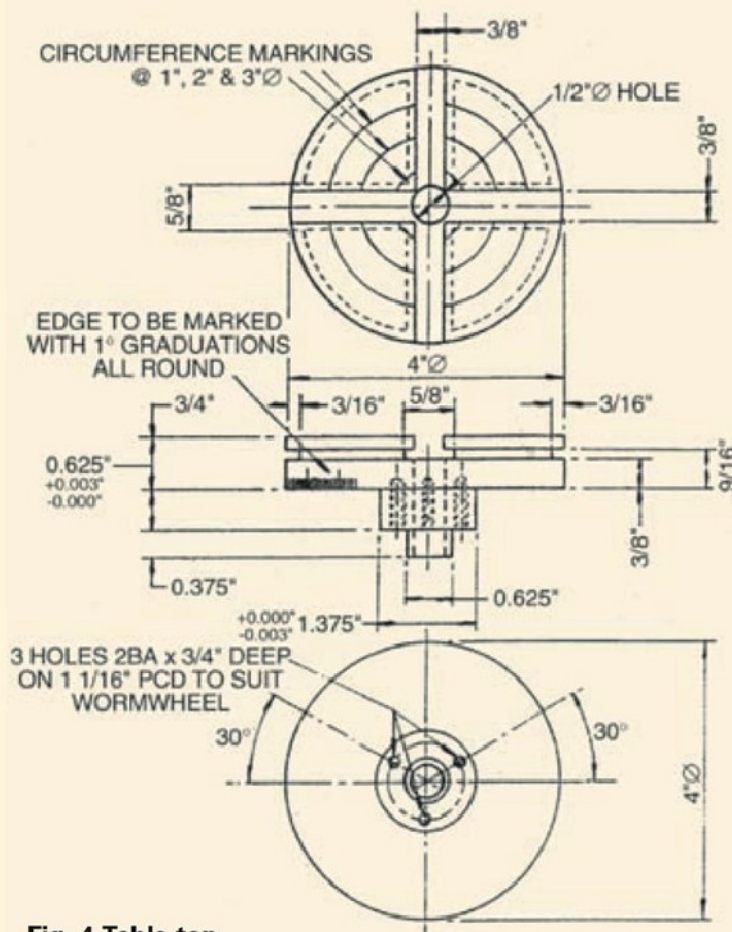


Fig. 4 Table top (Item Q)

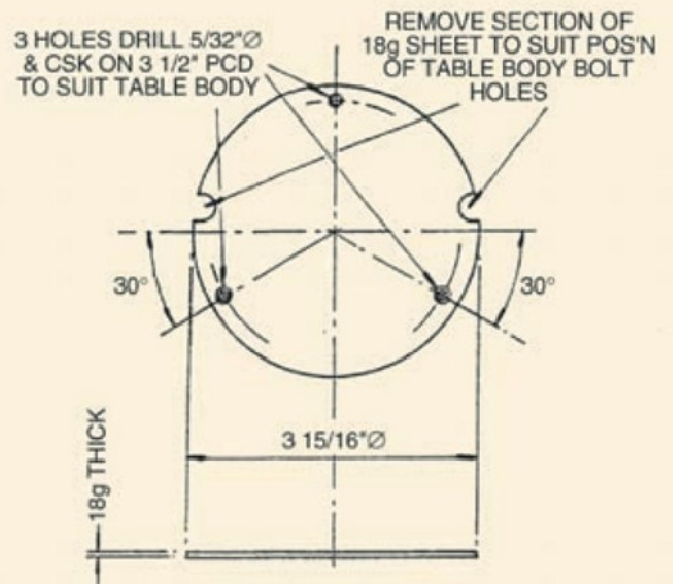


Fig. 5 Base cover plate (Item R)

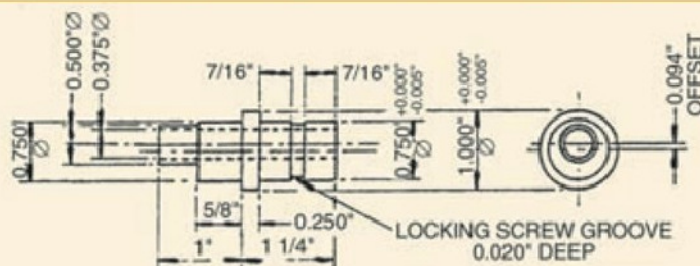


Fig. 7 Detail of eccentric spindle (Item B)

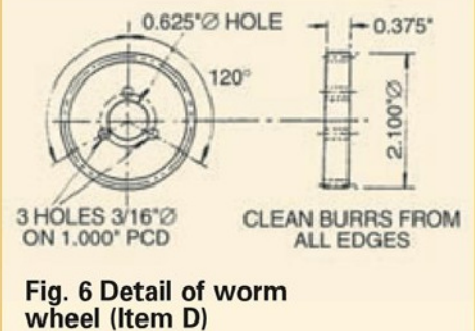
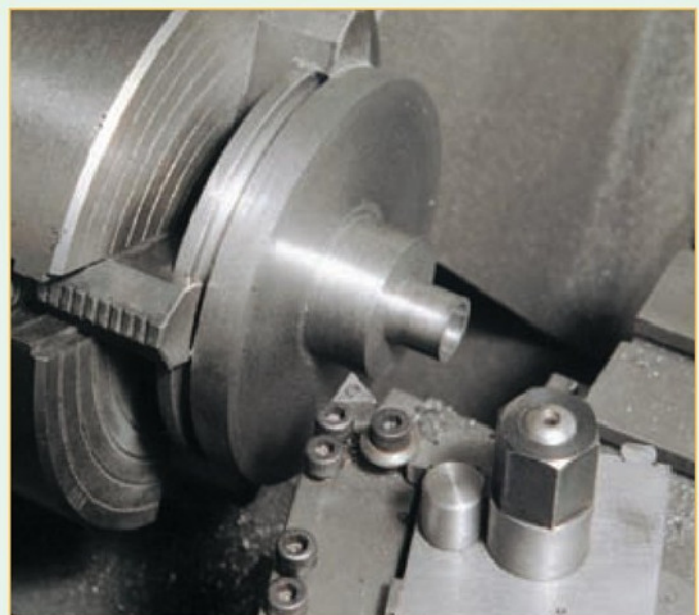


Fig. 6 Detail of worm wheel (Item D)



14. Rough machining the outer diameter of the table.



15. Turning the bearing and worm mountings on the rear of the table.

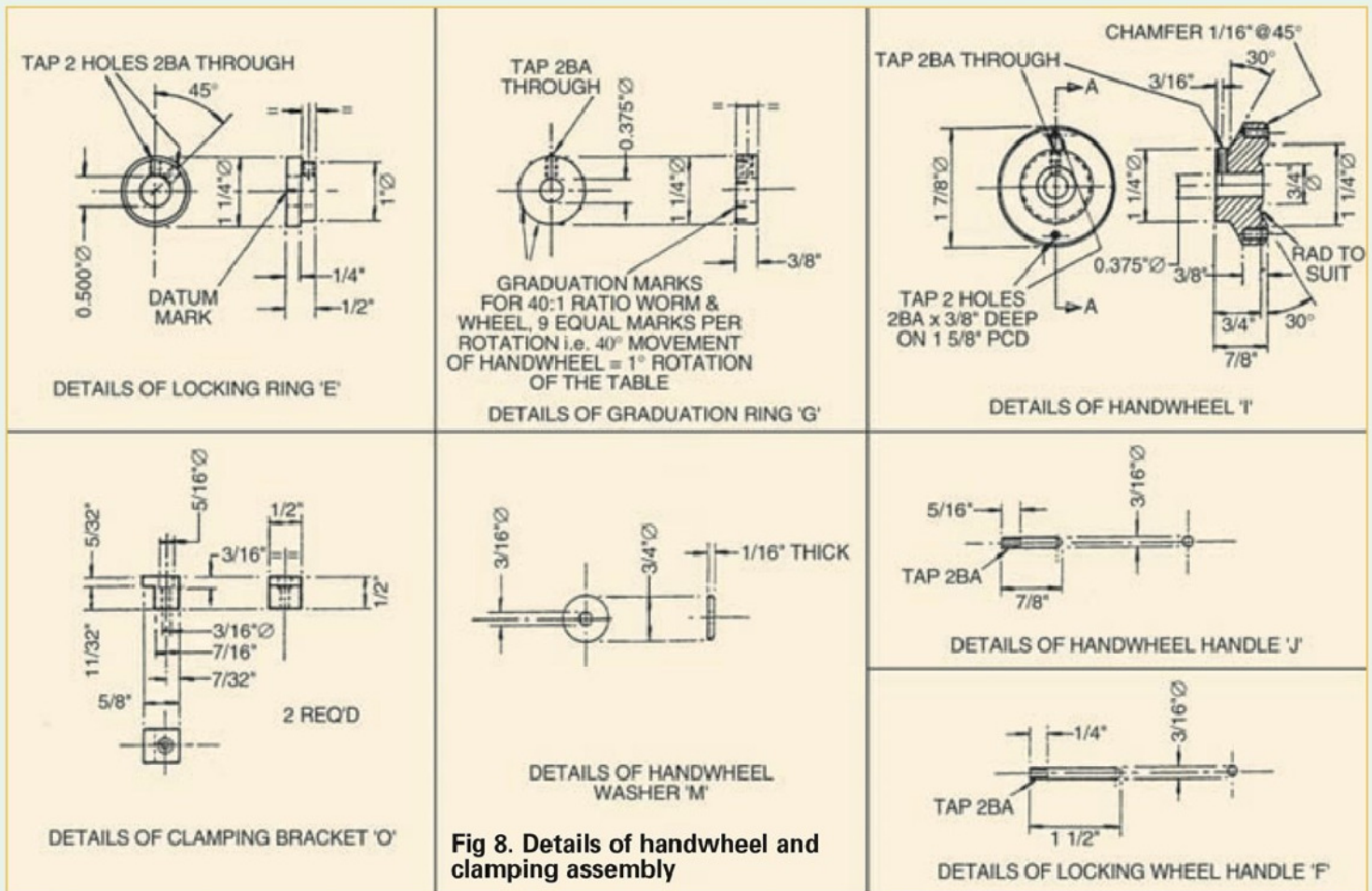


Fig 8. Details of handwheel and clamping assembly

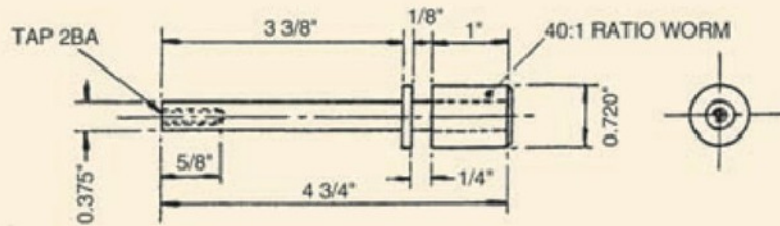


Fig 9 Detail of worm spindle (Item A)

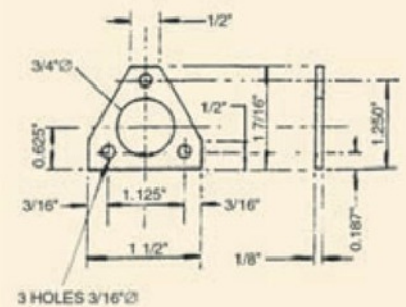
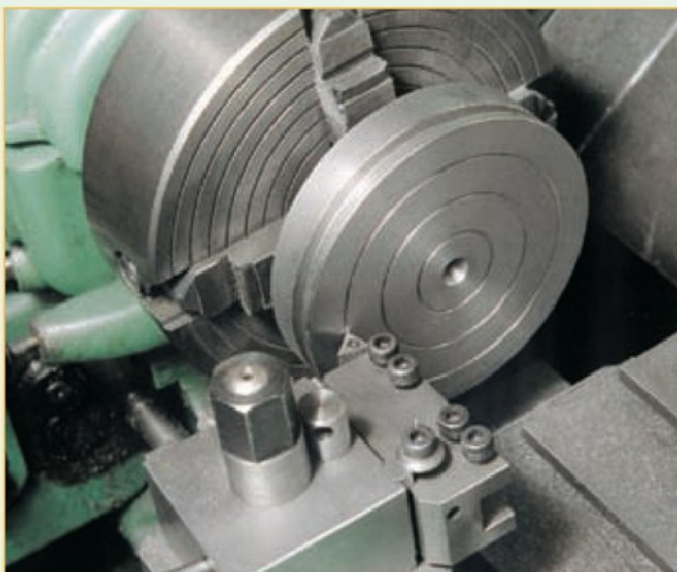
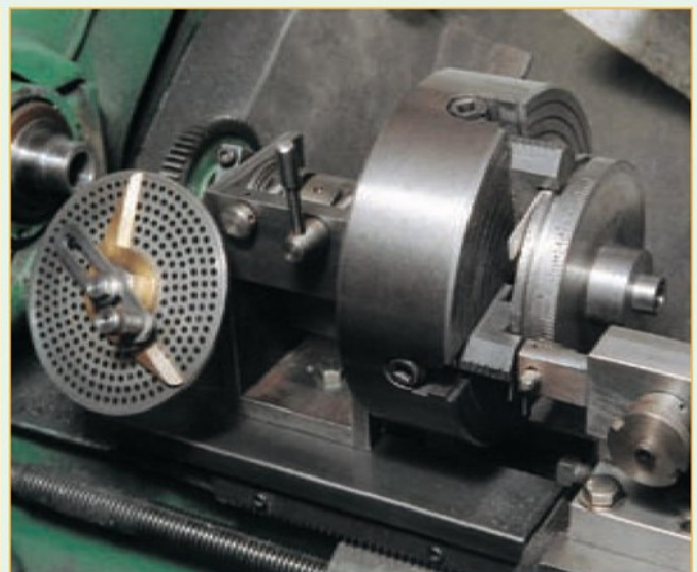


Fig 10 Worm spindle retaining plate (Item C)



16. Turning the table rings.



17. Calibrating the table.



18. Milling the centre portion of the tee slot using a slot drill.

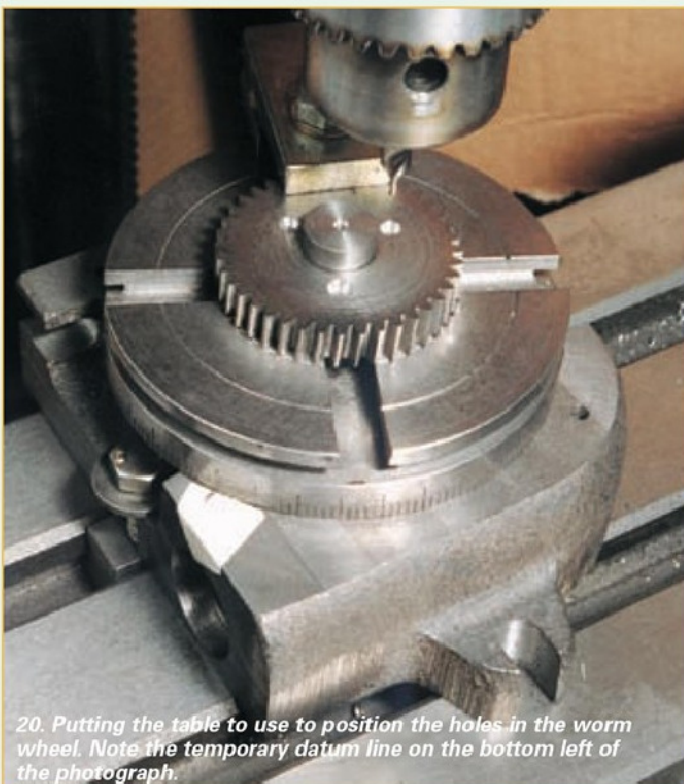
template for drilling the worm wheel mounting holes in the table. Leave the rotary table in place for the next component.

Cover plate drilling

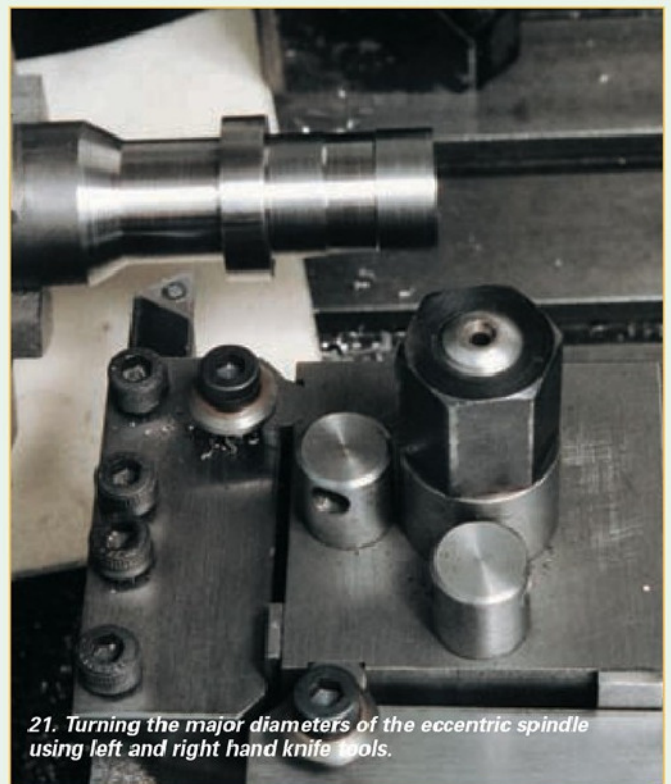
Remove the plug from the centre of the rotary table and place two strips of double adhesive across the table. Mount the cover plate on this and as it is only $\frac{1}{16}$ in. smaller than the table, centralising it is no problem. Traverse the table a further 1.250in. ($1.250\text{in.} + 0.500\text{in.} = 1.750\text{in.}$ as required by the $3\frac{1}{2}$ in. PCD quoted on the drawing) Very lightly drill the cover plate using the end of the centre drill; do not go too deep as you do not want any drilled

holes in your new rotary table. Rotate the table through 120 degrees and mark the plate again, repeat for the third position. Remove the plate from the table and centre punch the marks prior to drilling on the drilling machine. At this stage use a 4BA tapping size drill. Use the plate as a template for drilling the holes in the base, then countersink the holes for the 4BA countersunk screws. It will not be necessary to open up the holes with a normal clearance drill as the countersink will do it for you. As the plate is so thin you will also need to very lightly countersink the tapped holes in the body. If as suggested above you have made the cover plate recess concentric with the table then you will need to rotate the plate

19. Milling the arms of the tee slot using a home made tee slot cutter.



20. Putting the table to use to position the holes in the worm wheel. Note the temporary datum line on the bottom left of the photograph.



21. Turning the major diameters of the eccentric spindle using left and right hand knife tools.



22. Using a dial indicator to set the eccentric spindle to give the required offset.

from that shown on the drawing to find a suitable position for the three holes. Do take care not to break into the bore for the eccentric spindle.

Eccentric Spindle

(Item B) Fig 7

Place a length of 1in. diameter steel in the three-jaw chuck and of sufficient length to turn both 0.750in. diameters using left and right hand knife tools, the 1in. length being at the outer end, **Photo 21**. Ensure that the 0.250in. dimension is just smaller than the depth of the counterbore in the body as the part must rotate freely after assembly. Having done this turn the locking screw groove and skim over the 1in. outer diameter.

Now fit the four-jaw chuck and fit the part gripping it on the 1in. length. Adjust chuck to provide the 0.094in. offset, **Photo 22**. Do take note that the indicator reading must be twice this value, that is 0.188in. to give the required offset. Turn the 0.500in. diameter followed by making the bore.

Handwheel

(Item I) Fig 8

This is supplied as a short length of cast bar and requires turning to shape. Place in the three-jaw and turn the outer end producing the angled recess and a clean outer face together with the chamfer. Reverse in the chuck and produce the 1¼in. diameter and the sloping face, followed by the 0.375in. bore.

Graduation Ring

(Item G) Fig 8

Turning this is relatively straightforward but do ensure that the two faces are parallel. Mount on the dividing head and make the graduation marks, generally as

23. The complete set of parts, minus hardware, ready for assembly.



shown in **photograph 17**. Make a parallel mandrel with internal thread and screw to hold the part.

If you have not made or purchased a dividing head, then mount in the lathe and use a suitable changewheel located at the rear of the spindle. (Peter Wilton's article elsewhere in this issue describes such an arrangement.

Worm Spindle

(Item A) Fig 9

I am assuming that the kit purchased will be the one with the worm and worm wheel included, if so, all that needs doing is to mount the worm, suitably protected, in the three-jaw and with the outer end supported with the fixed steady, drill and tap 2BA as per drawing. If you wish to make the worm drive yourself there have been numerous discussions on the subject in past copies of MEW, see References below.

Remaining parts and operations

There are few minor operations, typically drilling and tapping, still to carry out on the parts already described and I do not intend to elaborate on these. There are also a number of small parts depicted in **Figs 8 and 10** still to make but these need no detailed explanation, **Photo 23** does though show the full extent of the parts that make up the rotary table.

Assembly

Give the parts a final clean up chamfering sharp edges where appropriate and making a small radius on the ends of the fixing slots on the body. Remove as much roughness as can be done with ease from the unmachined areas of the casting and give these a number of coats of paint.

Final assembly is easy but the method of removing the end float in the worm spindle assembly may not be immediately

apparent. The worm and wheel assembly drawing given in the first section of the article, shows that there is a screw (L) in the end of the worm spindle which at first would appear to be there to fix the handle, this is not so. The screw actually takes up the slack in the assembly and when end float is reduced to virtually nil the screw (K) in the hub of the handwheel is used to lock the handle in that position. Screw L cannot therefore be fully tightened as it will prevent rotation of the worm.

Worthwhile?

Even before the rotary table was completed I began to realise the usefulness of the device, having used it for the holes on a PCD in both the worm wheel and cover plate, also using it for the worm wheel of the 6in. table. Without a doubt therefore these are going to be very useful additions to the workshop and would recommend their construction to any who do not already own one. The fact that each one is also a very interesting project is a bonus.

The larger table

As mentioned at the start of the article the 6in. table is virtually identical to the smaller one, having, from a design point of view, only one major difference. The arrangement of small clamps engaging the groove round the edge of the smaller table is replaced with a tapered groove round the table's spindle on the rear of the table with tapered end pins and socket screws for clamping. For those who are conversant with the Myford Super 7 it is identical to the method used for securing the top slide in the cross slide.

The larger rotary table also has no provision for removing the end float in the worm and wheel assembly as the handwheel clamps firmly against a shoulder on the worm spindle. The assembly must therefore be manufactured with the prevention of end float in mind. To do this, make all parts in the assembly with the exception of the graduation ring

and assemble these. Measure accurately the distance between the locking ring (E) and the handwheel (I) and make the width of the graduation ring slightly less than this dimension.

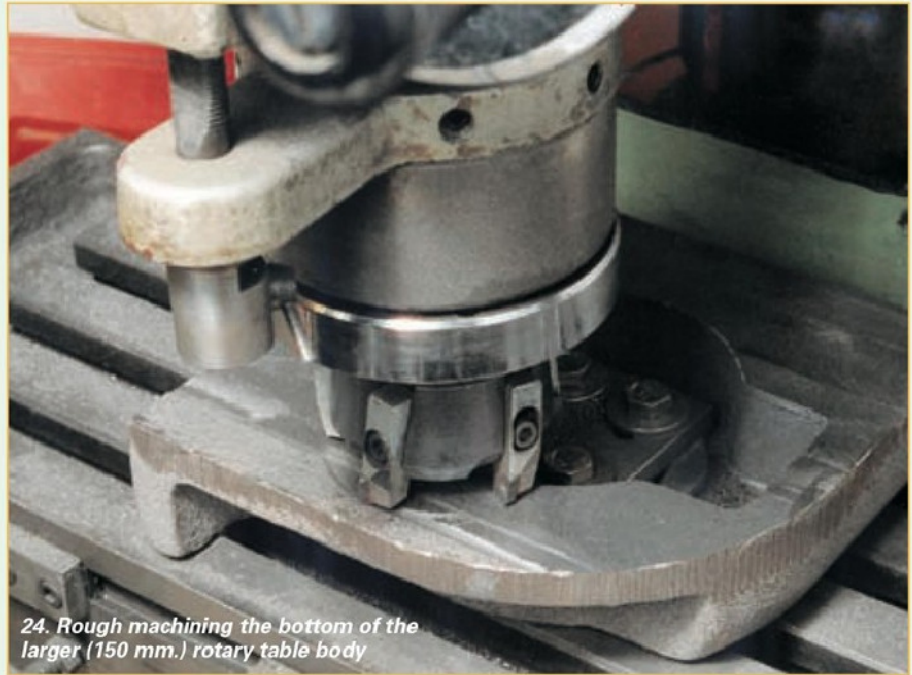
Providing you are using a 3½in. lathe or larger you should have not have a problem with the table though there will not be a lot in hand for the chuck jaws if using a 3½in. lathe. The body will though need a slight change in method compared to the 4in. table unless a larger than average milling machine is available. To machine the underside of the body set the body only about two thirds across the table. This will permit the face cutter to take a first roughing cut of about quarter the width of the cutter. Continue to make further cuts of a similar width as far as the cross feed will permit. At this point unclamp the body and move it over on the table so that the rest of the base can be rough machined, **Photo 24**.

Having machined the bottom of the body in two stages will mean that flatness of the machined area cannot be guaranteed. Centralise the body on the table and finish the bottom taking a very light finishing cut of say 0.1 mm. To do this is will be necessary for the initial cut to be wide, probably almost the full width of the face cutter. I would not have recommended this at the roughing stage but with the limited depth of cut for finishing it can be tolerated, even though not ideal.

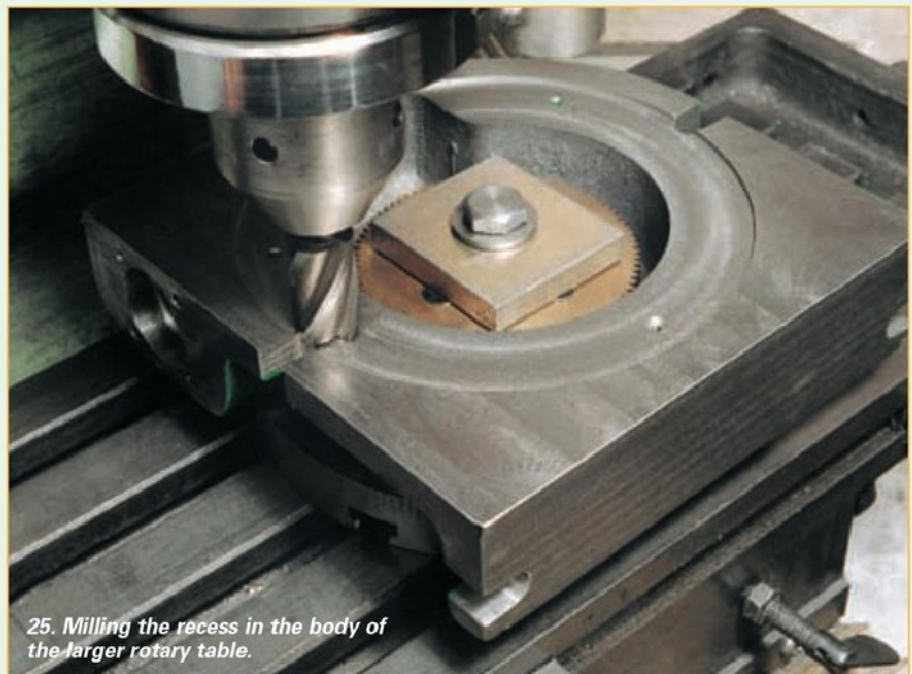
Machining the recess for the cover plate at first appeared a major problem as the width of the gap on the Series Seven was not sufficient for the part to be mounted on the faceplate. However, the following method, albeit unconventional, produced a perfect result with relative ease.

Assemble the table, body and worm wheel, mounting the assembly "table down" on the milling machine table. Use a single fixing stud through hole in the table so allowing the body to rotate on the table. Fit a small end mill and bring this down so that it just touches the bottom of the body and with the end mill running carefully rotate the body by hand. Set the table such that the resulting circle shows the 155mm diameter that is to be machined away. To make the mark more prominent the endmill can be lowered by say 0.02mm. and the process repeated two or three times. Marking the base with marking blue will also aid visibility.

Dismantle the assembly and mount the body only on the table and, using the largest end mill available, mill the 2mm deep recess stopping just short of the 155mm diameter. This is rather tedious but a larger end mill makes it easier to follow the circumference. Now reassemble the three parts and return to the milling machine table as in the first instance. Set the end mill just short of the 2mm depth already machined and bring it close to the edge of the roughly made recess. Rotate the body by hand bringing the recess up to the 155mm diameter in steps of about 0.1mm. Two aspects do though need strict compliance with. First, and absolutely essential, rotation of the body must oppose the rotation of the end mill. Second, adjusting depth of cut should be done whilst the cutter is in the space created by the fixing slot and no cut being taken, **Photo 24** (taken after the part was



24. Rough machining the bottom of the larger (150 mm.) rotary table body



25. Milling the recess in the body of the larger rotary table.

finished). This will prevent the cutter snatching at the body whilst one hand is being used to adjust the depth of cut. This may seem a rather dubious method but I found it easy and without any problem and producing an excellent result. As can probably be seen from the photograph I did lower the end mill to just touch the recess and rotate the body followed by moving to the inner part of the recess to repeat the process giving a near perfect result. Having successfully completed the job, it does occur that a lever arm might have been clamped to the work to give better control of the rotation, and to move the hands further from the cutter.

The larger area of the 6in. rotary table will certainly make mounting larger workpieces easier and extend what is possible. If you have the machines big enough to machine the larger components the little extra cost would be well spent. However, the smaller table is ideal for

smaller parts and a useful acquisition. I, for one, am already wondering how I have managed without such a device thus far.



References

A Power Traverse. *MEW* issue 14 page 62.
Free-Wheel Hobbing a Worm Wheel. *MEW* issue 78 page 19.

Supplier

The College Engineering Supply,
2 Sandy Lane, Codsall,
Wolverhampton, WV8 1EJ
Phone 01902 842 284
(To whom thanks are due for permission to publish the drawings)

TRADE COUNTER

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

Plugs, Sockets and Switchgear

Boost Electrical Engineering who have been manufacturing a comprehensive range of high quality single to three phase converters for fifty years have further improved their support to small workshops. They now stock and supply a comprehensive range of machinery switches and electrical power connectors (plugs and sockets to you and I). Details of their range can be found at www.boost-energy.com where they have a simple to understand explanation of the different sorts of plugs and sockets and how to choose between them. Their rapid access web site also includes a high quality selection of the most common motor control switches (on/off; reversing; speed selection; etc.) for both single and three phase machines at very reasonable prices, including a worldwide delivery service.

Small Spray Gun from ASA



In terms of its size, the Grifo from Anglo Scot Abrasives fits between an airbrush and a full size spray gun. It is supplied as standard with a 100ml cup, but larger 250ml and 500ml are also available. In addition to these gravity feed cups, quick change side fitting cups are also available. These have screw on lids and would make life easier on those small jobs involving both primer and top coat. I have not, as yet, tried the gun in earnest, but blowing through some neat thinners did confirm an even circular spray pattern, and that the gun is light and convenient to use.

Costs are :	Gun with 100ml cup	£24.99
	250ml Cup	£6.99
	500ml cup	£8.99
	Side fitting cup set	£8.99

The company may be better known for its wide range of abrasive blast equipment, and for the amateur, the TTK1 bench top cabinet model, (450mm x 450mm x 450mm), would probably be the most relevant. This is supplied in kit form, requiring plywood sheets to complete. This is then complemented by a range of abrasive media which ranges from the aggressive to relatively gentle. **Anglo Scot can be contacted at 5 Bolton Road, Ashton in Makerfield, Wigan, Greater Manchester, WN4 8AA, phone 01942 270 729 or email john@ansco.fsnet.co.uk**

National Motorcycle Museum – Warco donate lathe

When the tragic news of a devastating fire spread through the motorcycle community in September 2003, a devoted band of volunteers faced the huge task of saving what remained of the exhibits. Unique motorcycles, including "Slippery Sam", a works racing Triumph, winner in 5 consecutive years of the TT, from 1971 to 1975, were damaged by the flames. Three of the five halls at the Museum were ravaged by fire and water.

Volunteers soon began the task of equipping workshops to fashion parts for the damaged motorcycles. Among the suppliers of machine tools approached for a quotation for the supply of a lathe was Warren Machine Tools.

Roger Warren, Managing Director of the family firm which has been supplying machine tools for nearly 30 years, said, "When we were approached to quote for the supply of a lathe, we felt extremely honoured to have been asked, but at the same time, desperately wanted to play our part in the restoration work. We immediately offered to donate a WMT500 lathe to the Museum and were delighted when our offer was accepted. In no time our truck was heading up to the Midlands to make the delivery. Both of the engineers on my staff are keen classic motorcyclists and we are proud to be associated with the Museum".

The Museum itself will re-open in early December 2004, 20 years after its original opening in 1984.



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FIRESIDE READING

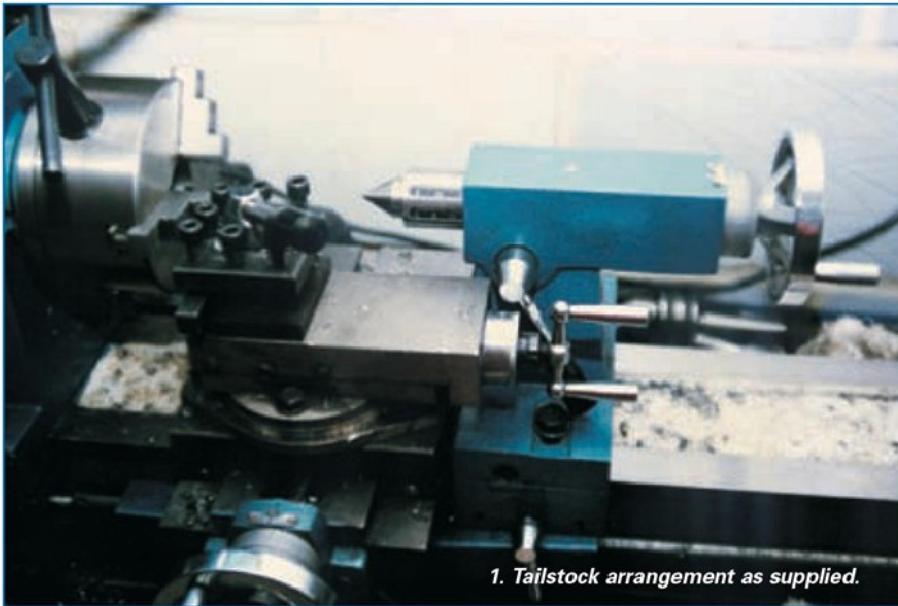
For Stan Bray, retirement is anything but a life of leisure. His latest book "Milling", is hot off the press and covers exactly what it says on the jacket, but is naturally aimed very much at the amateur rather than industrial operator. Ten chapters in order are entitled :- Types of Machine, Installing a machine, The Milling Table, Holding the Work, Setting-up Aids, Cutters and Cutter Holding, Cutting Fluids, Division, Cutting Metal, and Sharpening Milling Cutters and Milling Problems.

Within the initial section, consideration is given to milling in the lathe, horizontal machines, and the various forms of small vertical now available. Treatment of the Milling Table includes discussion on damage repair, table stops, slide adjustment, power feeds, and DRO's. The book is well illustrated with clear photographs and a number of dimensioned line drawings, particularly relating to workholding devices.

Published by Crowood Press, "Milling" in 190mm x 250mm format, is available from reputable booksellers (ISBN 1 86126 680 4) price £19.95.



TAILSTOCK MODIFICATION FOR a Clarke Metalworker



1. Tailstock arrangement as supplied.

Several years ago, Harold Hall's feature entitled 'A Beginners Guide to the Lathe' (Issue 36) highlighted the points that should be considered when purchasing a lathe. This was the situation I found myself in a little later on, and finally purchased a Clarke Metalworker as shown in photograph 6 of the above article.

This machine is a quick and easy way of setting up a home workshop for anyone like myself, who has limited time to look for suitable second hand equipment. It also represents good value for money. However, any machine built down to a budget is certain to have limitations, of which the tailstock is one in this particular lathe.

The tailstock

When turning a long component it is usually essential to use a centre to support the rear of the work. But with the Clarke Metalworker this is no easy task as the tailstock casting is flush with the end of the saddle and the barrel extension is only 40mm. By placing the tool on the right hand side of the toolpost it is possible to use a centre and turn right up to the end of the workpiece, but this creates a problem at the chuck end.

The other shortcoming with the tailstock design (shared with quite a number of other machines) is the lack of the support for the tag on a No.3 Morse taper sleeve. Any jam resulting in drill spin could damage both the internal and external tapers.

Design consideration

It was decided that a redesign/rebuild of the tailstock was a high priority but this had to be undertaken within certain limitations, principally that all the machining had to be carried out on the machine itself. The first observation was that the bed of the machine is symmetrical around the centre of the axis and the tailstock has an overhang at the rear of the casting. It was therefore decided that this body casting would be reversed on the machine bed which would gain a 55mm overhang across the saddle.

On close examination it was found that this casting is parallel bored 35mm dia. for its entire length and by simply drilling one hole to locate the anti-rotation key and drilling and tapping one hole to locate the handwheel bearing the entire assembly could be reversed. (See photographs 1 and 2).

However this alone would not be enough as it would also be necessary to move the barrel lock to the other end of the casting and there is insufficient material to take the 25mm hole required. It was therefore decided to bolt a block, as shown in Fig. 1, to the side of the casting to facilitate this drilling.

The barrel of the tailstock has a threaded insert held in place by the fact that it is a light push fit and has a single grub screw used as a Dutch dowel. As it is intended to provide support for the tag on a tapered sleeve it is necessary to remove

Trevor Palmer describes his improvements to a popular budget machine.

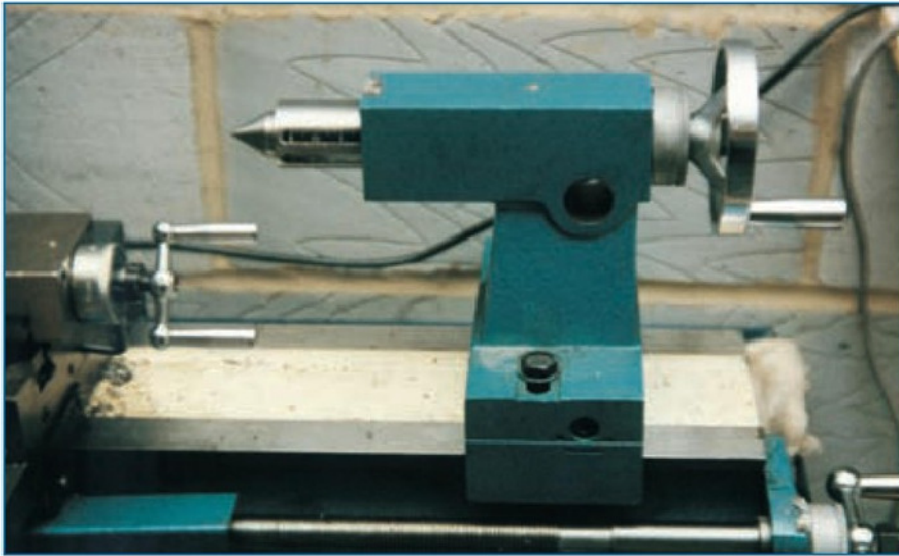
this insert and re-bore the barrel to fit the new insert as shown in Fig 3. By making the insert project out of the back of the barrel and using a bearing block Fig. 2, secured to the rear of the casting, it is possible to increase the stroke of the barrel by 20mm simply by manufacturing a new lead screw. This component created the first design problem. The internal thread is 12mm by 1.75 pitch (according to the scale on the dial), which would make it a standard M12 left hand thread, but a left hand M12 tap is something I do not have access to and the Metalworker will not cut a left hand thread without modification. (A later project?) I had to think again.

The key to stop the tailstock barrel rotating is only supported by a 4mm diameter spigot and as the object of this part of the modification is to provide support to stop a drill spinning in the barrel, any jam could result in this 4mm spigot acting as a shear pin. Should this pin shear and the barrel rotate, with a left hand thread the drill would be forced further into the workpiece, assuming the handwheel did not also rotate. By changing this thread to a standard M12 (Right Hand) any such problem would force the drill out from the workpiece, which is much more desirable. A right hand thread is also much more easily manufactured.

Of course the handwheel scale will read backwards and the handwheel must be rotated in the opposite direction to a conventional lathe, but in my experience this does not create any operational problems. It is no worse than changing to driving a car with the indicator switch on the opposite side of the steering wheel, you soon become used to it.

Manufacturing

It is essential to manufacture the components in the correct order as any operation requiring the use of the tailstock must be conducted before the tailstock is dismantled. The first part of the manufacture is the threaded insert Fig 3. Use a piece of 25 dia. MS bar held in the three jaw chuck. Accurately turn the 24mm diameter followed by the 18mm diameter. A 10.2mm diameter hole is then drilled the entire length and tapped M12 X 1.75 to give at least 20mm of full thread. Reverse



2. - and reassembled in reverse.

the component in the chuck, face and counterbore 12.5mm diameter by 40mm deep. This component can then be used as a thread gauge for screw cutting the lead screw (Fig.4)

The lead screw

Use a piece of BMS 20mm diameter by 135mm long held in the three jaw chuck with a 65mm projection. First turn to 20 diameter the full length followed by 15mm diameter the 12mm and the 10mm diameter for the thread. Do not forget the undercut at the shoulder end of the thread. The M10 thread can be produced either by using a die or screw cut. Reverse the component and preferably hold in a four jaw chuck. I recommend the use of a four jaw chuck because it is important that the 15mm diameter bearing surface is concentric with the thread. If a four jaw chuck is not available use the three jaw and clock and shim as necessary. Having obtained concentricity, the 12 and 10mm diameters can be turned and the lathe set for screw cutting.

Once the change wheels are set for a 1.75mm pitch you are ready to screw cut. However, with this type of machine it is not possible to disengage the lead screw from the saddle whilst screw cutting. The only way to stop is to hit the red button and bearing in mind the overrun, screw cutting up to a shoulder is dodgy to say the least. The answer is to place the tool at

the "chuck end" of the workpiece and to screw cut with the lathe in reverse. In this way the tool moves away from the chuck and becomes a lot easier to control. The machine must, of course, be run forwards to reposition the tool at the start of the thread. But if you stop short and then turn the chuck by hand you should not have any problems.

During the screw cutting operation it would be desirable to support the workpiece with a centre, but I think you will find this difficult, which highlights the reason for undertaking this modification in the first place. Using care, a sharp tool and light cuts a good thread can be produced without the use of a centre for support.

The clamp and bearing block

Both the clamp block and bearing block could be manufactured by turning in a four jaw chuck or by milling. I will leave the choice to the constructor as only he or she knows what equipment is to hand. The choice of materials for these two parts is also a matter for the individual. In my case I used cast iron because I happened to have some. It is also the ideal material as the blocks are to be bolted to a casting. If the constructor uses mild steel for the bearing block (Fig.2) and is not happy using a steel to steel bearing then this component could be modified by simply

boring the block out to 35mm diameter and re-using the original bearing insert. It is part of the fun of engineering, that designs can be modified to suit your own particular needs.

The barrel

It is now necessary to dismantle the tailstock. This is achieved by simply rotating the handwheel until the barrel can be pulled from the housing. To remove the lead screw and bearing housing assembly, simply undo the grub screw on the underside of the housing and pull out the handwheel assembly. Undoing the handwheel nut enables the handwheel, barrel and bearing to be simply dismantled. If your machine is like my lathe, you will find that as well as being a push fit and supported by a Dutch dowel, the threaded insert is also held into the barrel by peening with a centre punch. It will be advisable to drill out the centre punch marks as well as removing the grub screw before driving the insert from the barrel.

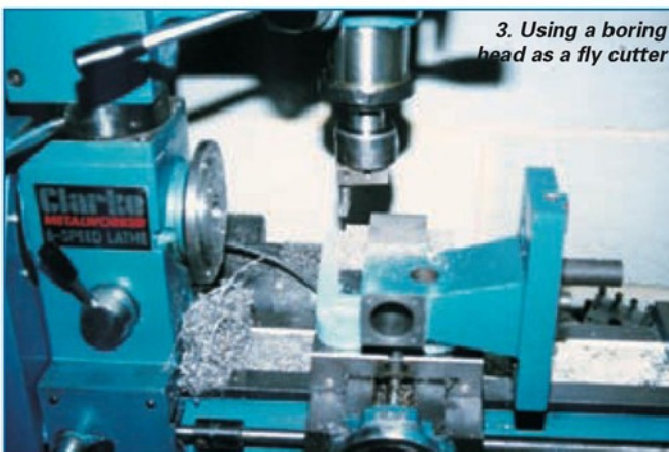
The barrel can now be set up in the lathe and bored 24mm diameter by 40mm deep. It is important to ensure that the barrel runs true and that the finished bore enables the insert to be pushed firmly into place. Remember you only get one chance with this component, so take care.

It is now necessary to remove the top slide assembly and chuck from the lathe. Clamp the three jaw chuck to the cross slide/mill table and use this to hold the threaded insert Fig. 3 whilst the tag support slot is machined. This insert can now be pressed into the previously machined barrel. If due to machining errors this is not a press fit, then I would recommend the use of Loctite.

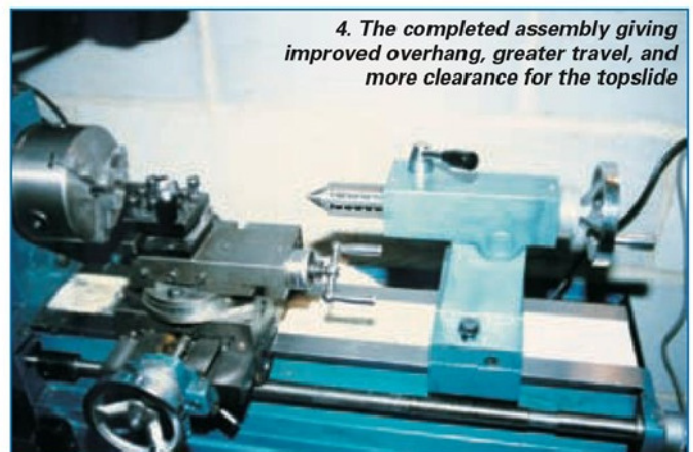
The barrel is then held in the chuck and four holes drilled and tapped M5 into the cylindrical interface between the barrel and the insert. These holes are spaced at 90degrees. Four M5 grub screws can be used to firmly hold the insert in position. Remove the three jaw chuck from the mill table and replace with the machine vice. The lead screw Fig. 4 can now be held in the vice and the keyway machined.

Body casting

The next stage is to attach the clamp block Fig. 1 to the side of the casting in the position shown in Fig. 5. As the block is to be bolted to an un-machined face it is first necessary to machine a flat on this



3. Using a boring head as a fly cutter



4. The completed assembly giving improved overhang, greater travel, and more clearance for the top slide

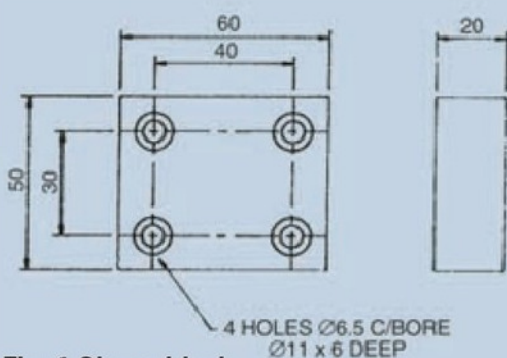


Fig. 1 Clamp block

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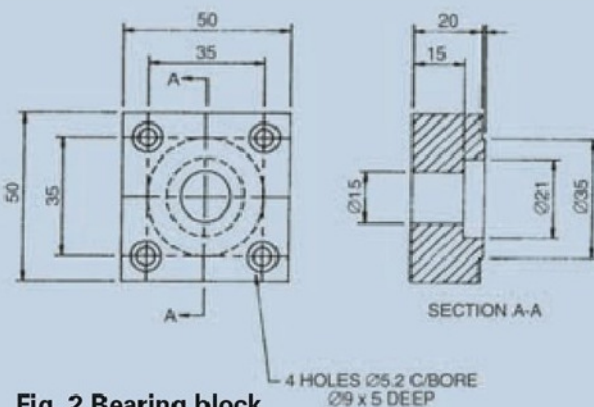


Fig. 2 Bearing block

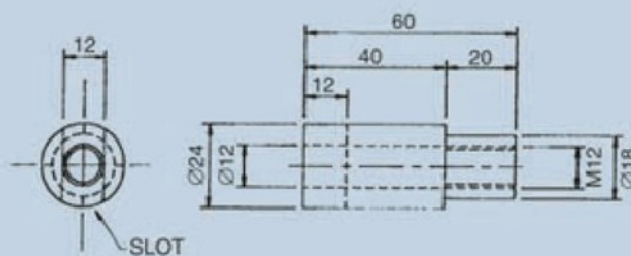


Fig.3 Threaded insert

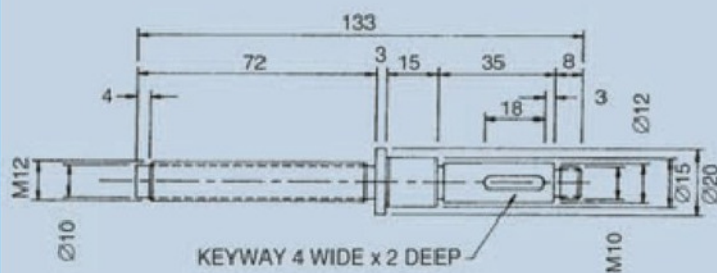


Fig.4 Lead screw

casting. Lay the tailstock casting onto its side and clamp into the machine vice. Using an end mill or fly cutter remove only enough material to obtain a flat surface. **Photograph 3** illustrates the use of a boring head as a fly cutter to obtain a flat surface.

The four block fixing holes can now be drilled and tapped M6 using the centres shown in Fig. 1.

At this stage it is worth rotating the casting by 90 degrees, and removing about 2mm from the underside of the overhang. This operation is not essential but ensures that the overhang clears the lathe top slide in operation.

It is now necessary to clamp the tailstock casting to the machine table to drill the 25mm clamp hole. The easiest way to achieve this is to separate the two halves of the casting. The top half can then be placed on parallels and clamped to the table. The casting should be positioned with the bore parallel to the table travel. This is easily achieved by placing the barrel into the 35mm diameter hole and clocking on to this at each end of the casting by sliding the barrel from one end to the other. The 25mm diameter hole can then be produced. I drilled in stages up to the largest drill in my collection (5/16") and then opened up progressively to 25mm using a boring tool.

Whilst the casting is still clamped in this position the 4mm key support hole is drilled. The hole is only required on the bottom part of the casting, but has to be drilled right through from the top. The unwanted hole through the top of the casting can be tapped M5 and a screw used to stop the ingress of swarf. In service this hole may be considered as a useful lubrication point.

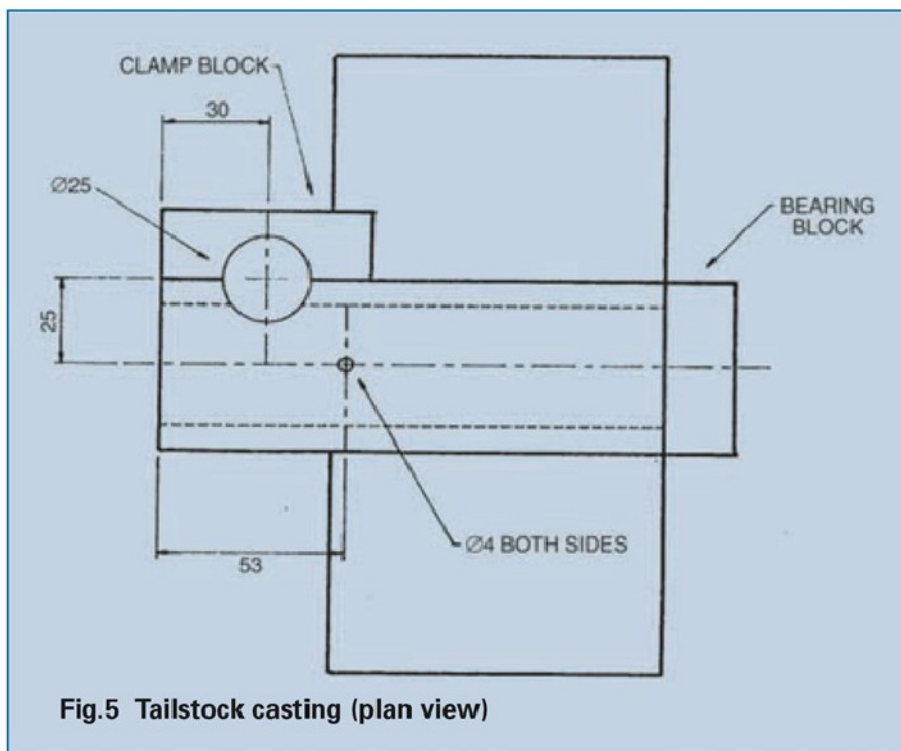


Fig.5 Tailstock casting (plan view)

The last operation is to drill and tap the four M5 holes in the rear (formerly the front) of the casting for the bearing block fixing.

Assembly and operation

Once all the components have been deburred and the swarf removed from the

tapped holes the tailstock can be re-assembled, painted and placed back onto the lathe, as shown in **photograph 4**. Before use it would be advisable to check and adjust, if necessary, the centre to centre alignment. In operation you will find using a centre to be both easy and convenient. Furthermore, the increase of the barrel travel from 35 to 55mm (more than 55% enhancement) is a definite improvement when drilling long holes.



RETROFITTING THE X3 MILLING MACHINE (1)



Rationale

Readers, who have followed my articles on aspects of CNC, will be aware that I have a Wabeco CNC mill in my workshop. These readers will now be wondering why I am retrofitting a Chinese mill when I already have a perfectly satisfactory CNC machine. There are a number of reasons why I am embarking on the retrofit. First and foremost I like to keep myself busy. I generally have a project on the go most of the time particularly in the winter when I cannot go fishing. Secondly there are a number of ideas I want to try out with the retrofit. Thirdly model engineers are showing an ever increasing interest in CNC and would like to retrofit an existing mill but are unsure of how to begin what may seem a daunting project. Though this

series will be principally concerned with the X3 mill, the underlying principles should be applicable, with modification, to the retrofit of any mill.

A CNC mill is only as good as the screws fitted to the machine. For my money, the only satisfactory screws for the long term are ball screws. These may have a certain (very small) amount of backlash but this is not a problem as the backlash with ball screws is constant along the entire length of the screw and should remain constant for a very long time. Acme screws are very satisfactory for hand operation where backlash is not a serious problem. Unfortunately, uniform backlash with new Acme screws rapidly becomes non-uniform, because one tends to use the middle section of the screw more than either end. After this the screw is of little

Dick Stephen describes how he added CNC control to his machine.

use for accurate CNC work. When I stripped the X3 down I was impressed with the quality of the screws. It seemed a pity to scrap them but that is what happened. Having made this decision, the next question was finding suitable ball screws to replace them. The ball screws that are currently available are either precision ground screws costing an arm and a leg or the more affordable rolled screw. The threaded section of both the X and Z screws on the X3 are 500 mm long. I wanted 12 mm diameter by 2 mm pitch screws as I intended attaching the stepper motors directly to the X and Y screws. An arrangement having 2 mm pitch screws and using Gecko 201 micro-stepping drives, provides 10 micro steps per single motor step and thus gives a resolution of 1000 steps per millimetre. There was a further reason for opting for direct drive. The design of the Y-axis of the X3 meant that if I had opted for a timing belt drive I would have had to replace the front screw bearing.

Almost all available ball screws are right hand screws. All milling machines are fitted with left hand Acme screws on the Y-axis, thus a consequence of replacing the Y-axis screw with a ball screw is that this axis becomes opposite handed to the X-axis. For CNC operation this is not a problem, it is simply a matter of changing the sense of rotation of the stepper motor. If the mill will be used as a manual machine this opposite handedness of the X and Y axes is a bit of a bind. To overcome this problem I, together with my friend Tony Jeffree, have designed a "hand operation" unit that drives through the stepper motors. The unit is similar to units found on industrial CNC machines and consists of a hand held box (containing some electronic bits) which connects to the drive unit for the stepper motors. The box is fitted with a single 20 position hand wheel, a range selector switch and an axis selector switch. Rotating the hand wheel clockwise moves the X and Y axes in a positive direction (i.e. with X selected the table moves to the right) and the head down (Z negative). Rotating the hand wheel anti-clockwise reverses the direction. Using the range selector a single rotation of the hand wheel moves the X and Y axes 2 mm or 0.2 mm. Each hand wheel position thus corresponds to a movement of 0.10 mm or 0.01 mm. Full

2. Scraper, flat, and engineer's blue used for slideway improvement.



instructions for constructing this unit will be given at the end of this series. Readers not wishing to construct the unit can still operate the machine by hand by fitting double ended shaft stepper motors.

Selecting the ball screws

The ball screws are the first item that needs to be selected. The pitch of the screws will determine the size of stepper motor required. I searched the Web for suitable screws with little luck. There were lots of screws available; unfortunately the ones available were either prohibitively expensive or the wrong length. The only manufacturer that was able to supply 12 mm diameter 2 mm pitch screw was THK (MBF 1202 nut 500LC7 rolled screw). The

maximum length of screw rod they were able to supply was fortunately 500 mm, exactly what I needed. When I fitted ball screws to my Wabeco I used THK screws and found them absolutely excellent. The standard C7 grade rolled 12 mm 2 mm pitch ball screw has a maximum error of 50 microns for a 300 mm travel. THK have a new design of ball nut for this screw, which features replaceable nylon wipers conforming to the profile of the screw thread to prevent the ingress of all but the very finest dust. The nuts are also self-lubricating. The only lubricant required is a light oil, applied to the screw. If any reader is intending to purchase these or any equivalent ball screws he should not pay more than £145.00 for a single screw and a nut. This may seem expensive, in fact it isn't as these screws will last a lifetime.



3. Detail of scraper profile.

Selecting the stepper motors

Having decided on the screws for the machine the stepper motors can now be selected. Many model engineers I have spoken to on the subject of stepper motors for CNC are of the opinion that one should fit motors as powerful as possible. The consequence of this may be that the motors, and hence the associated drivers and power supply are all larger (and more expensive) than necessary. A complete approach to selecting motors, including accounting for resonance effects is really outwith the scope of this article, but I will describe in detail the steps I followed in selecting the motors for the X3 retrofit. I should note that as my work generally uses small cutters and fine feeds, I have simplified things somewhat and calculated the torque required firstly to move the inertial mass of the table and secondly to overcome the frictional forces generated at the slideways. As my work invariably uses small cutters, I chose to ignore cutting forces.

To understand how to carry out this calculation consider what happens when the stepper motor is initially turned on. The torque generated is used to accelerate the mass of the table from rest to the final velocity. The amount of torque needed to do this will depend on the mass of the table, the magnitude of the final velocity and the time taken to reach this final velocity (determined by the acceleration of the table). In addition torque is also required to overcome friction in the slideways. The initial friction ("stiction") is significantly larger than the friction once the table has begun to move. It is this initial friction that is important when considering the size of motor required.

The mass of the table needs to be estimated first. You can either put the table on the bathroom scales or work it out from the approximate dimensions of the table assembly. The estimated mass should err on the high side.

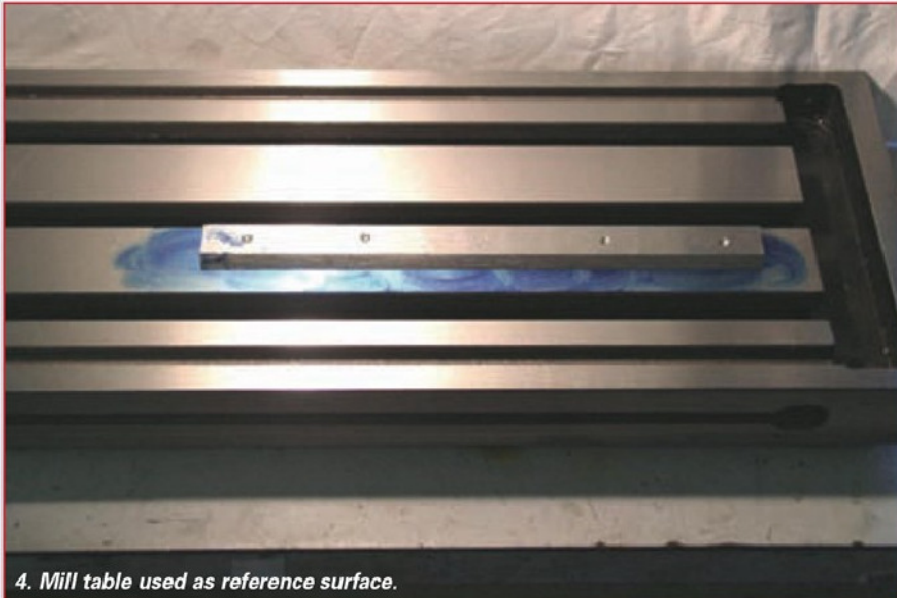
Table dimensions
55 cm x 16 cm x 4 cm

Dovetail assembly 20 cm x 20 cm x 3 cm

Volume of the table = 3520 cm³

Materials required for the complete retrofit

- Ball screws.** (3), Ref. Nut MBF1202; Rolled screw rod 12 mm 2 mm pitch 500 mm long. THK UK Ltd Tel 01908 222159
- Stepper Motors.** (2), 23HSX-206 for X and Y axes. (1) 23HSX-306 for the Z axis. McLennan Servo Supplies Ltd. Tel. 08707 700700
- Oldham Couplers** (4), 25 mm 8 mm bore (2 for each screw) for attaching the stepper motors to the X and Y screws. I got mine from RS-Components stock number 359-6434 A packet of Nylon torque discs is also required stock number 359-7579.
- Timing pulleys** for the Z-axis drive 15 and 30 tooth 5 mm pitch 12 mm wide and a 295 mm long 5 mm pitch 12 mm wide timing belt. HPC Gears Tel 01246 268080.
- Enclosure** for re-housing the electronic motor control unit. I used the following one from RS-Components, Stock number 129-628.
- EN1A mild steel** round rod. 300 mm of 20 mm; 1 m of 15 mm; 500 mm of 12 mm; 300 mm of 10 mm.
- Brass bar.** 1 piece each 70 mm x 38 mm x 22 mm, 100 mm x 32 mm diameter.
- Aluminium.** 1 piece 300 mm x 80 mm x 12 mm. 3 pieces 200 mm x 80 mm x 8 mm. 2 pieces 250 mm x 200 mm x 1.6 mm. 1 piece 300 mm x 25 mm x 12 mm.
- Loctite 326** Structural adhesive. One 50ml bottle. Somewhat expensive (£21) but very useful around the workshop. Produces a very strong joint nearly as strong as soft solder but a lot more convenient. A useful tip. NEVER apply any Loctite adhesive (particularly 603 or 326) straight from the bottle to the work piece. Always transfer the Loctite from the bottle on to a piece of plastic sheet (I use a scrap of Perspex) then use a new toothpick to apply the Loctite to the work.
- Ball races** 3 off 6 mm i.d.
- Assorted Hex head screws.** 3 mm, 4 mm, 5 mm and 6 mm
- Screened cable** 6 metres 5amp 4core for connecting the stepper motors to the drive unit.
- 5 Amp screw terminal block.** Several sections.
- 3 mm solder tags.**
- Gas Spring** (replacement). The standard gas spring fitted to the Z-axis to support the weight of the head stock is non adjustable and does actually over compensate for the weight. The actual weight of the head stock is about 30Kg. The compliance of the correct gas spring should be just enough to support the weight. I replaced mine with an adjustable one. These are widely available. RS-Components supply suitable springs (stock number 686991), unfortunately only in packs of 2 units. I got mine from RS, fortunately I was able to pass the extra one on to a friend. For a supplier contact the manufacturer Arvin Motion Control Tel. 0116 274 3600.



4. Mill table used as reference surface.

Volume of dovetail assembly = 1200 cm³

The density (mass/volume) of steel is 7.8 gm/cm³

Mass of the table
= 3520 x 7.8 = 27.456 Kilogram

Mass of dovetail assembly =
1200 x 7.8 = 9.36 Kilogram

Total mass M of the table assembly =
36.8 Kilogram

The effective inertial load, J, seen by the motor is given by the following formula: -

$$J_{\text{Load}} = M_{\text{Table}} p^2 / (2\pi)^2$$

Where p is the pitch of the lead screw in cm.

The motor for the Y-axis is required to move both the table and the dovetail assembly. If a suitable motor is selected for the Y-axis the same motor will be more than adequate for the X-axis as this motor is only required to move the table. The screw chosen for the X3 has a 0.20 cm pitch (2 mm). Substituting the value of the table assembly the effective inertial load J is

$$J = 36.8 \times (.2)^2 / (2\pi)^2 \\ = 0.037 \text{ Kg cm}^2$$

To proceed further with the calculation the maximum velocity of the table needs to be considered. For most practical model engineering CNC work a maximum table speed of 15 mm per second is adequate. For industrial production work where time is money far higher speeds are frequently used. To calculate the required torque the maximum velocity needs to be expressed in the number of rotations of the screw per second (or radians per sec). To have a linear table speed of 15 mm per sec the 2 mm pitch screw need to rotate 7.5 times per sec. The maximum angular velocity, ω is then equal to

$$\omega = 7.5 \times 2\pi \text{ radians/sec} \\ = 47.12 \text{ radians/sec}$$

Finally the acceleration time to achieve this velocity has to be found. Readers will be aware that I use and very much like the CNC software DeskCNC. One facility of the machine set up procedure is that it enables table velocity and acceleration to be correctly linked.

Earlier I said that the stepper motors would drive the lead screws directly. With a 2 mm pitch and a x 10 micro step drive the calibration factor for the X and Y screws is 1000 steps/mm. A 20 mm/sec velocity then equates to a step rate of 20,000 steps/sec. The Desk CNC software includes a machine set up table which allows the velocity and acceleration to be correctly linked with an appropriate acceleration time, t, in this case 0.017 sec (17 milliseconds).

The motor torque required to this table movement is given by the formula:-

$$T = J \cdot \omega / 10t \\ J = 0.037 \text{ Kg cm}^2 \\ \omega = 47.12 \text{ radians/sec} \\ t = 17 \text{ milliseconds}$$

Inserting these values the required torque is

$$T = 0.01 \text{ Newton metre} \\ = 1 \text{ N cm}$$

This result shows that the torque required to accelerate the table mass is very small and essentially can be ignored. There is a rather simpler way of assessing whether a stepper motor is suitable that is to compare the effective inertia calculated above with the value of the rotor inertia of the proposed motor. Suitable motors should satisfy the condition:-

$$J_{\text{Table}} < \text{Rotor inertia}$$

Table 1 lists the mechanical specifications of a range of 23 frame size MAE stepper motors supplied by McLennans. The last column in the table lists the rotor inertia of the motors. The condition is satisfied for all the motors listed.

Slideway Friction

In addition to accelerating the mass of the table assembly the stepper motors have to overcome the slideway friction. There is no method of reliably calculating the magnitude of the slideway friction. The only simple way to obtain a value for the friction is to actually measure it. I used a spring balance to measure the slideway friction on the X3. There are two components to the friction, the initial starting value as the table accelerates from rest and the value during motion at constant velocity. The initial friction is significantly larger than the friction at constant velocity. For the table assembly (both X and Y) of the X3 the initial friction force was approximately 10 K gm dropping to about 5 K gm once the table commenced motion. When selecting the stepper motor it is the initial friction that is important. The frictional load seen by the motor is reduced by the mechanical advantage of the lead screws. A further factor that determines the frictional load seen by the motor is the efficiency of the screw. For Acme screws the efficiency is of the order of 35%, while for ball screws the efficiency is in excess of 85%. This is another good reason for fitting ball screws. The motor torque required to overcome the friction is given by the formula: -

$$\text{Torque} = (\text{Friction force}) \times p / 2\pi e$$

Where p is the lead screw pitch and e the screw efficiency. For the X3 table assembly the required torque is equal to: -

$$T = 10 \times 0.2 / 0.85 \times 2\pi \\ = 0.37 \text{ Newton cm}$$

Referring to Table 1 all of the motors would be adequate for the mill. In making the final choice you should remember that the torque estimated above does not take into account the forces generated during machining or the additional weight of a vice. Anyone wishing to evaluate cutting force effects might perhaps fit a slave pulley in place of a handwheel and use a spring balance and string method. I settled for motors with a bi-polar holding torque of 163 Newton cm for all three axes. This is possibly a bit over the top as I probably could have got away with motors with a lesser holding torque. I have to admit I like a very good margin of safety in matters such as this.

Dismantling the machine

If you have purchased the cabinet stand undo the bolts that attach the machine to the stand. If possible place the mill in the middle of your workshop. You will need to be able to work all around the machine. In addition you will need to get access to the two hex head bolts that secure the Y-axis nut, from underneath the base. This access is possible if the base is allowed to overhang the cabinet front by about 20cm. There is no danger of the mill and stand tipping over as the centre of gravity of the mill is close to the column when the machine is stripped down.

Begin dismantling the mill. Do this in a very systematic way and lay each part as

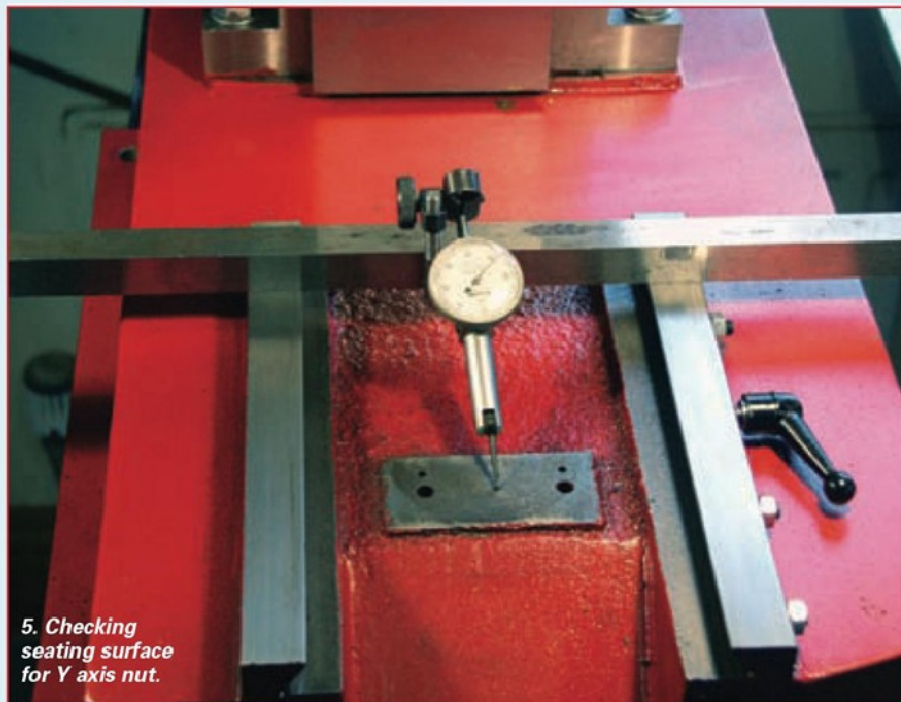
you remove it in an orderly way somewhere that they can be left undisturbed for however long it takes you to complete the project. Remove first the entire table assembly. The head stock can be removed next. Completely assembled the head stock is too heavy for a single person to easily lift. To make the removal manageable, the head needs to be partially stripped down. Remove the motor, access to the screws that secure the motor are under the cover over the motor pulley. The motor will still be attached to the machine by its power cable. To completely remove the motor, the entire electrical assembly for the machine located behind the column will also have to be removed. To do this undo the four screws that attach the column cover to the machine. The entire electrical assembly will need to be removed later and fitted into a separate enclosure. Remove the cast iron cover on top of the head. This will allow you to remove the motor mounting bracket. Finally remove the handle for lowering the spindle. Don't attempt to remove the spindle; re-tensioning the return spring is difficult! Lower the head as far as it will go. Pack the space between the head and the base of the machine with old rags so that when the head is loosened and comes off it cannot drop and cause damage - See **Photo 1**. The dowels that locate the head are tapped for 4 mm screws. You may be able to insert a screw and pull them out. If not you will have to make an extractor. This is no more than a 20 mm length of 12 mm mild steel rod drilled 8 mm to a depth of 15 mm and then with a 4 mm drill for the full length. Thread a nut on a 30 mm long 4 mm screw. Place the extractor over the dowel and screw the 4 mm screw into the dowel end. Tightening the nut will ease out the dowel.

With the motor and the electronic control unit removed the Z-axis assembly can now be completely removed. The gas spring must be removed first. To do this the wind the Z-axis nut up as far as it will go. In this position the gas spring exerts no force. The spring is held in position by two 8 mm pegs one screwed into the nut housing the other at the bottom of the base of the mill. With the spring removed the remainder of the assembly comes apart easily.

The Y-axis nut will still be attached to the base. Slide the base forward to overhang the stand by about 20 cm. This will give access to the two 5 mm hex screws that hold the nut in place.

Correcting minor imperfections

It is worth spending some time correcting some of the minor imperfections you will doubtless have noticed as you dismantled the machine. It is really worth getting the slides as good as possible as this reduces slideway friction. The X-axis slideways on my mill were very good, but I felt that the Z-axis slide was not quite perfect. The seating for the Y-axis nut was adequate for an Acme nut but not for the ball nut I used. I decided that the rear surface of the head casting where it is bolted onto the Z-axis slide could be improved. The gib strips seemed to be fine but nevertheless I scraped then perfectly flat and got the



surface really smooth. The difference was amazing, the slides felt so much better.

For this rework, my chosen method is to use a scraper, a test flat and a tin of engineers blue. I was able to borrow a carbide tipped slideway scraper illustrated in **Photo 2**. A very adequate alternative can be made out of an old 20 mm wide flat file. Grind off all the teeth for about 30 mm from the end. Make sure that one face is absolutely flat. Grind a curve (see **Photo 3**) on the end (radius ~ 50 mm) square to the flat face. Heat the end to a cherry red and plunge into cold water with a layer of oil on top. Re-grind the end to sharpen and stone off any burrs on a fine oil stone. Next you will need to make a flat or borrow one. The flat needs to be about 300 mm long 25 mm wide and about 10 mm thick. The easiest material to make the flat out of is fine cast iron, mild steel will also do. **Photo 2** shows the one I was able to borrow. Begin by cutting a 45 deg. bevel one edge and milling one face flat. You can argue the relative merits of fly cutters v end mills; I used a fly cutter using a very slow feed and to as good a finish as possible. You may want to do this before you dismantle the mill! The face of the flat needs to be very smooth and perfectly flat. Remove all machining marks using wet and dry paper on a FLAT surface. The surface of the flat needs to be checked for irregularities. To do this a reference flat is needed. I used as a reference flat, for

truing up the gib strips (see **Photo 4**), the surface of the mill table.

All the slideway surfaces need to be checked for high spots. To do this smear a small amount of the engineers blue onto the surface of the flat. Place the flat on the surface being tested and rub the flat against the surface. Any high spot will be marked with blue. Carefully scrape the blue away, removing a small amount of the underlying metal at the same time. New cast iron scrapes very easily. If you are unsure about scraping and have a piece of cast iron handy spend a few minutes practising scraping until you have mastered the art. Re-apply the flat and scrape again until the surface is quite flat.

The surfaces that require very careful checking are the seatings for the X and Y nuts. As we will be using ballscrews, these seatings need to be both flat and parallel to the slideways. The subsequent lining up of the screws depends to a large extent on these seating surfaces. On my machine the X seating was perfect, the Y not quite so. **Photo 5** illustrates how I checked the Y seating. I attached my dial indicator to a length of 16 mm square ground bar. Moving the dial indicator over the surface of the seating located the high spots. These were marked with blue a felt tipped pen and then scraped.

The next section will cover the reassembly process, fitting the ball screws and stepper motors.

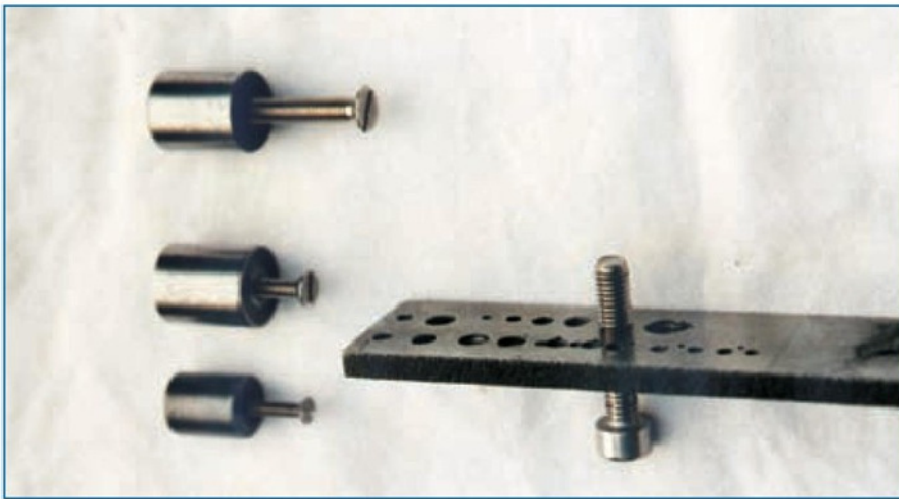


TABLE 1 MAE Motors from McLennan

Mechanical Specification: 1.8 degree high performance stepper motors

Motor type	length	Shaft dia.	No. of leads	Mass	Uni-polar holding torque	Bi-polar Holding torque	Rotor inertia
	mm	mm		Kg	Ncm	Ncm	Kgcm ²
23HSX-102	41	6.35	8	0.5	37	47	0.077
23HSX-202	55	6.35	8	0.7	75	98	0.22
23HSX-206							
23HSX-306	78.5	8.0	8	1.0	125	163	0.34

DRESSING SCREWS



This article outlines two very simple and useful, homemade workshop accessories for the purpose of "dressing" machine screws, to accurate lengths with neat burr free ends. No drawings are given as it is anticipated that the descriptions and photographs will convey sufficient information.

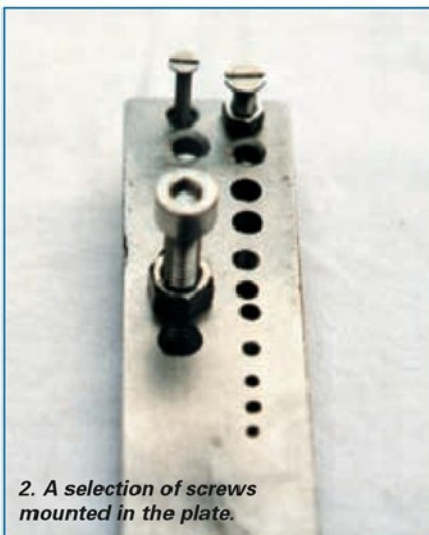
For use with saw and file

The first gadget can be made from a piece of high carbon steel gauge plate $\frac{3}{16}$ in. thick and 1in. wide x 3ins. long. As an alternative to hardenable gauge plate, an annealed file that has had all the teeth and serrations removed by grinding both surfaces on a surface grinder, is a good source of re-hardenable steel. A series of tapping size holes is drilled in the workpiece and each hole tapped to size and thread form. It may be found convenient to make a series of these tools, say one each for B.A., B.S.F., U.N.F., Metric coarse, etc.

When all the holes have been tapped and countersunk on one side of the workpiece, the tool can be hardened by

the normal method of heat treatment, and quenching in water or oil. Once it has been tempered to a medium straw colour, the tool will have sufficient hardness to allow it to be held in the jaws of bench vice and subjected to the sawing and filing actions in the "dressing" process, without damaging the tool. Any machine screws can be secured into an immovable, rigid, position, by using a nut of the same thread size and form to fit the screw that has been located in the tool, on whatever side of the tool is the most convenient and practical to the user. **Photo 2** shows several screws suitably secured.

This is a fast and practical method to use when cutting to size and hand finishing a ready made machine screw. If you do not want to get involved in the heat treatment process, then make the device from bright mild steel or gauge plate. It will save a bit of time, and in home workshop duty will still have a reasonable life. A variation on the theme which has appeared in the past in MEW employs a single row of holes, and a saw cut. It is then possible to compress the tool in a vice, closing the saw cut slightly, and thus locking a screw in place. However my preference was for the form described here.



2. A selection of screws mounted in the plate.



3. Screw in place, locking screw to be fitted.

Stephen Bondfield describes a couple of simple accessories aimed at tyro enthusiasts.

For use on lathe

The second item is made for the same purpose as that described above but the design of this tool enables it to be used to "machine dress" the workpiece, by locating the screw within the tool which is then held in the jaws of a lathe chuck. This device, although more time consuming in its creation and use because each individual screw size has to have a separate and individually made screw holder, is however, a more reliable, accurate and safe method of workholding than simply securing the screw in a drill chuck and using a hacksaw. With the use of this tool, most standard sizes and forms of screw head can be accommodated within the body, provided that the secondary threaded hole is of sufficient diameter to allow for clearance.

Use a piece of silver steel rod a diameter about 10 or 12mm larger than the diameter of the screw head, and approximately 19mm in length. Locate this in the lathe chuck and drill through its entire length the tapping size hole for whichever screw that is to be machined.

Next measure the diameter of the head of the screw to be dressed, and select a drill slightly larger than this which will function as a tapping drill size. Use this drill and counterbore the workpiece for about two thirds of its length. For example, if the screw size to be dressed or cut to length is a 4mm countersunk, having a head diameter of 7.5mm, then the counterbored hole might be drilled 8.5mm (the tapping size for a M10 thread). If the bore is finished with a "D" bit or other means to give a flat bottom, then most effective use of the available length will result. Tap the first hole for a M4 thread for the remaining one third of the overall length of the workpiece. Then tap a M10 thread in the second hole to allow a 10mm screw to be fitted after the first screw (4mm) is positioned in the tool, ready for "dressing". Finish with a plug tap to ensure as much useful thread as possible. The effect of the 10mm locking screw tightened against the screw head of the first, within the tool, will cause it to be made secure during the rotation of the lathe chuck and the pressure of the cutting action of the lathe tool against the workpiece screw when in motion. It may be noted that resistance to loosening might be improved by chamfering the locking screw to give contact over just the central area, however this has not been found to be necessary. **Photo 3** shows a tool with screw located, but locking screw not yet fitted.

This assembly allows accuracy when machining the screw, and prevents any damage that might occur if the workpiece screw becomes loose within the tool.



4. Assembly in place in chuck.

Alternatively a lock nut of the same thread specification as the workpiece screw can be used on the outside, machining end of the tool, in order to fulfil the locking function.

When both diameter holes have been tapped, the workpiece should be thoroughly cleaned and any loose swarf removed. It can then be hardened by heat treatment and tempered to a medium straw colour. This will give it sufficient hardness to allow it to be used repetitively in the jaws of a lathe chuck (Photo 4). A family of three of these tools is shown in Photo 5.

Table 1 gives a guide to a few examples of comparative dimensions between



5. Family of three gadgets.

screw size, tool stock size, counterbore dia. and secondary thread size for the locking screw. The head size diameters of most countersunk machine screws were found to be larger as a standard size than the head sizes of other head forms with the exception of some pan headed

screws. Obviously allowances would have to be made in order to accommodate screw head form diameters other than those listed, and thus the table should be considered as an approximate guide rather than a definitive table of comparative sizes.



Screw	Head dia.	Stock size	C/B dia.	Secondary thread
M3	6.5mm	12mm	6.8mm	M8
M4	7.5mm	16mm	8.5mm	M10
M5	8.8mm	16mm	8.9mm	M10
M6	10.8mm	19mm	11.4mm	½in. UNF

IN OUR NEXT ISSUE

Coming up in Issue No. 103 will be

Wood in the Metalworking Workshop

Harold Hall discusses this non metallic natural material.



Floating Toolholder

Dyson Watkins extends the versatility of an earlier concept.

High Speed Tailstock Drilling Attachment

Tony Jeffree describes a device built by John Stevenson.



Slow Speed for the VMC

A modification from Brian Warner to permit larger cutters.



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(Contents may be subject to change)

SPRINGTIME AT HARROGATE



1. Malcolm Leafe's 1/4 scale Alba 1A shaping machine was judged to be the best piece of workshop equipment in the competition.

This year's Harrogate show (or to give it its proper title, The 11th. Annual National Model Engineering and Model Exhibition) proved to be yet another outstanding event in the tradition we have come to expect. With the assistance of superb Yorkshire spring weather, Exhibition Director Simon Boak and Manager Lou Rex provided us with a three-day package of interest and entertainment in congenial company. One of the highlights was the chance to see Tim Coles' 5in. gauge gas turbine powered locomotive in action in an 'after hours' demonstration.

As in previous years there was an interesting selection of tooling items in both the competition section and on the



2. The accessories to the shaping machine were to an equally high standard.

club stands but, as seems to be the trend these days, club members were reluctant to enter their work for judging. Many of the pieces of equipment tucked away on the club stands were of sufficiently high quality to have won an award, so I would make another appeal for builders to support the competitions at both the Model Engineer Exhibition later this year and the Harrogate event next year.

Competition

As is customary at Harrogate, the Workshop Equipment section covers both full-size items and miniature versions of machine tools and equipment. The outstanding item was one of the latter, Malcolm Leafe's quarter scale Alba 1A shaping machine (Photos. 1 and 2). Not only was the basic machine faithfully

The Harrogate exhibition always features a good selection of tooling. Geoff Sheppard takes a look at some of the items to be seen in competition and on the Club and Society stands.

reproduced, but also a number of items of supporting equipment, including a surface table with marking-out equipment and a bench complete with vice. This delightful model was awarded a First and also the Chester Shield for Best Workshop Equipment. Somewhat larger was Gordon May's vertical milling head for a Centec 2B machine (Photo. 3). Substantially built, this unit uses a combination of belts and gears to translate the drive from horizontal to vertical mode. It was awarded a Highly Commended Certificate.

A similar award was also given to Malcolm Leafe's second entry in the class, a taper turning attachment designed to fit a Sharp & Brown lathe. Also seen in the competition section were Neil Carney's 100mm belt finisher, a retractable screw cutting tool holder and an 'Aid to Jig boring', the last two being made by PJH Bowler (Photos. 4 to 7).

Club Stands

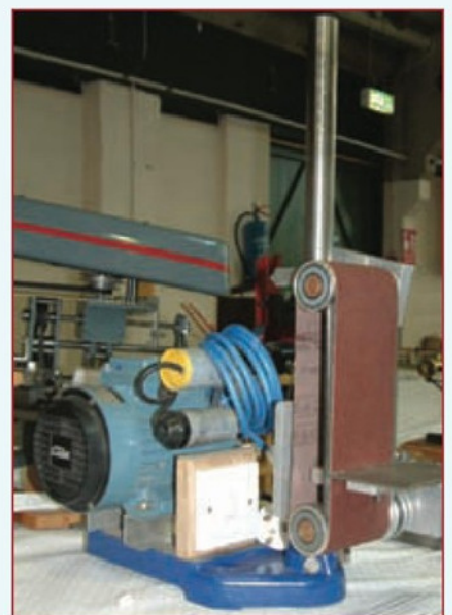
Constructing substantial pieces of workshop equipment often requires considerable time and effort, so it is interesting to see what club members are



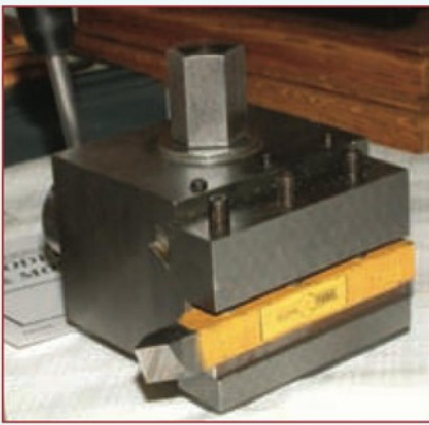
3. Designed to fit a Centec 2B milling machine, Gordon May's vertical head was awarded a Highly Commended certificate.



4. Also Highly Commended was Malcolm Leafe's taper turning attachment for a Smart & Brown lathe.



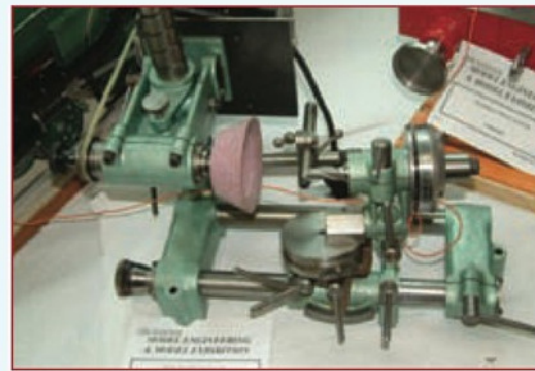
5. Neil Carney's vertical finisher features a 100mm wide belt.



6. The ability to retract the tool rapidly at the end of a cut is a great aid to successful screwcutting. This substantial toolpost was entered by P. J. H. Bowler



7. Also by P. Bowler, the design for this aid to jig boring was found in Guy Lautard's 'Bedside Reader'



8. Martin Dixon of the Leeds Society produced this nice example of a Quorn tool and cutter grinder.



9. The Stent design is also popular, this version being by Peter Fedorof of the Tyneside Society.



10. This 'Kennet' grinder was seen on the stand of the Society of Model and Experimental Engineers

prepared to tackle. As always, tool and cutter grinders were well in evidence at Harrogate, with two Quorns, two Stents, a Kennet and one unit designed by the builder (Photos. 8 to 11). Rotary tables and dividing devices are also popular self-build projects, with two of the former (Photos.

12 and 13) and four of the latter being on view. Two of these (Photos 14 and 15) were familiar items, being to the M.E.S. and Timmins designs respectively, but the one seen in Photo. 16 is more unusual, apparently being to the 'Dividing Head Plus' design by H. J. Turpin, published in Model Engineer in the late 1950s (Volume 105), and often confused with the smaller Potts unit. An ingenious item we have seen previously is the direct dividing device seen in Photo. 17.

Pillar tools and tapping devices have found a place in the home workshop, particularly since the appearance of George Thomas's design. These ranged



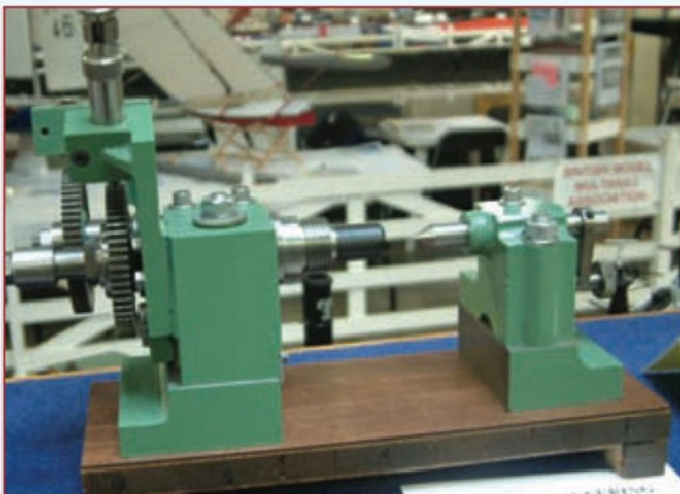
12. A neat 4in. rotary table by John Rhea of the Grimsby and Cleethorpes Society



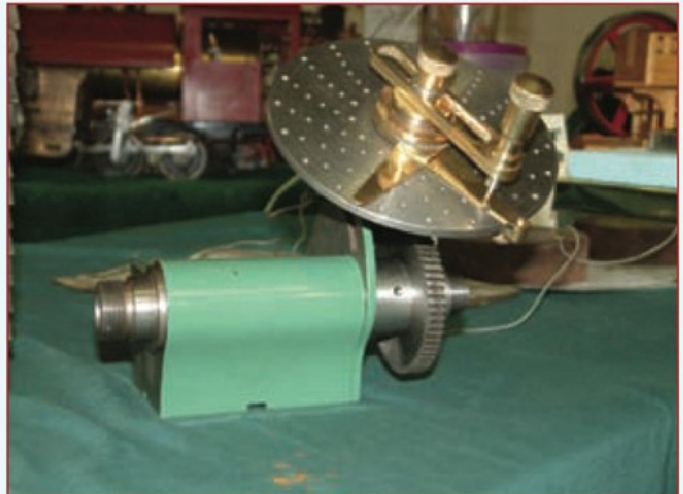
11. Mike O'Dwyer of the Keighley and District Society designed and built this tool grinder.

13. Tyneside's John Boler built this rotary table to the 'G. H. Thomas Plus' design

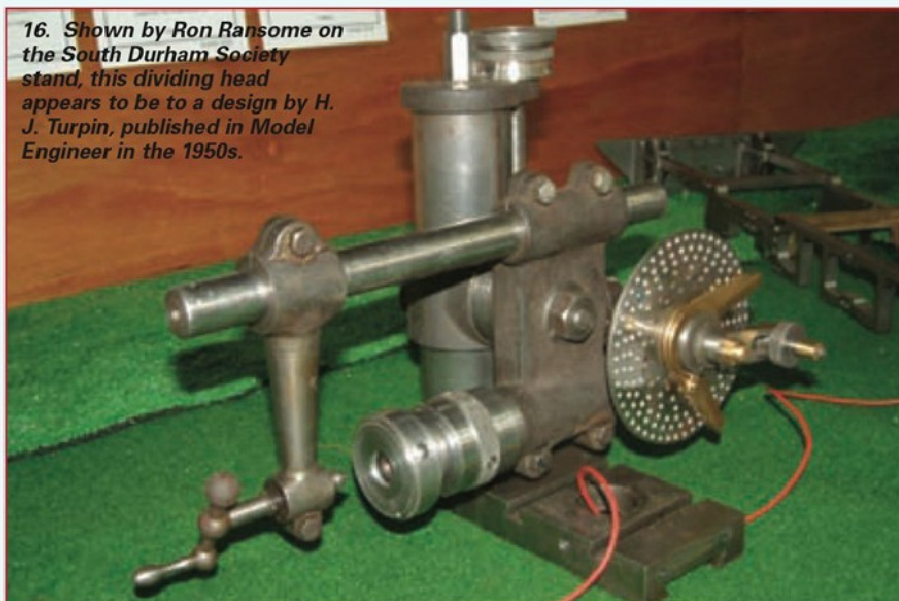




14. Jim Batchelor of the Bradford Society used M.E.S. castings for his dividing head.



15. Alan Timmins designed the dividing head built by John Thompson of Scunthorpe



16. Shown by Ron Ransome on the South Durham Society stand, this dividing head appears to be to a design by H. J. Turpin, published in Model Engineer in the 1950s.



17. A neat direct dividing device by John Matthews of Grimsby and Cleethorpes.

from the very simple (Photo. 18) to the complex (Photo. 19).

Gear cutting is a task attempted by the more ambitious model engineer, and we

are now seeing variations on the simple dividing head and form cutter approach (Photos. 20 and 21). The more conventional approach requires form

relieved gear cutters that some constructors prefer to make for themselves, rather than rely on commercial items. Two examples of relieving tools were available for study (Photos 22 and 23).

Many of the Society stands featured examples of the hundreds of small tooling items made by model engineers each year, but one most unusual item which qualifies as an item of tooling was seen on the Gas Turbine Builders' stand (Photo. 24).



18. A simple tapping device by Edwin Hughes of Leeds



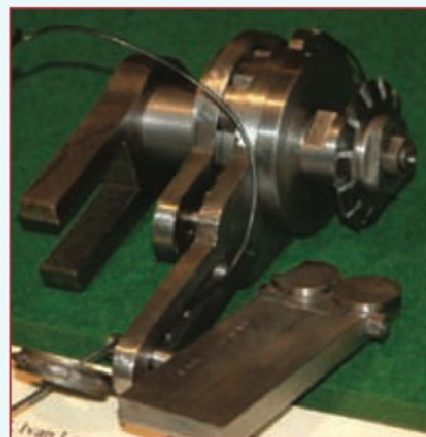
19. Stan Wade's sophisticated pillar tool was displayed high on the Bradford stand, not in the ideal place to get a good photograph.



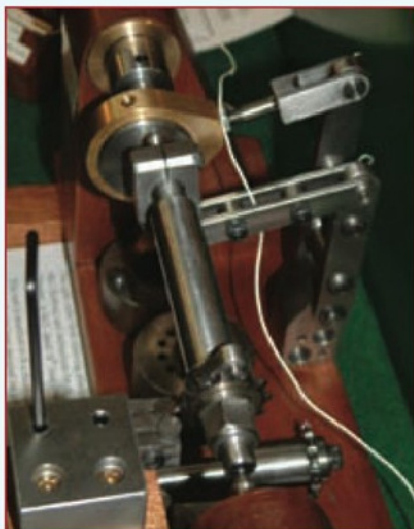
20. This gear hobber, was by Spenborough's Peter Kitchen



21. Bryan Thompson of Scunthorpe has taken rather a different approach. He has built an attachment for a milling machine on which the gear blank is driven relative to the hob by a stepper motor. The hardware was available for inspection, accompanied by a video presentation showing the device in action.



22. Alan Hopwood has made a relieving tool to the 'Eureka' design by the late Professor Chaddock. This was seen on the York Society stand.



23. Mike Sayers of Pickering is building a 1/8th scale version of the engine of his 3 litre Bentley. This form relieving tool was used in the manufacture of cutters for the helical gears in the turret of the engine. The design is based on one published in Model Engineer in June 1949.

24. Used in the manufacture of miniature gas turbine engines, this dynamic balancing machine was to be seen on the Gas Turbine Builders' stand.



FOUR WAY TOOL POST

Colin Golding suggests an "angled slot" approach.

Background

A number of eagle eyed readers had contacted the editor after seeing my toolpost which happened to appear in a couple of photos relating to my article on the centre finding microscope (MEW Iss 98 p44). He in turn suggested a description, and hence this article. The background was essentially that I was fed up with the usual tool holders for tool-bits on the lathe - clamps, with packing shims, the old fashioned "boat" type, the time wasted in changing regularly used tools - and never getting the centre height exactly right, I decided to design and make a simple four way tool post to fit my elderly (1945 vintage) Atlas 5in. lathe. It needed to be easy to make without any special tools, versatile, to suit 3/8in square bits, and have angled slots to allow adjustment for precise centering. In fact, two were made - the first having slots that were not angled, (and tool-bits needed packing) the angle feature being an afterthought improvement based on usage. They are non-indexing.

Basic Design

Photo 1 shows the two tool posts side by side, the left one having level slots 1/4in. wide x 1/4in. deep, the right one with slots angled at 10 deg. to horizontal and 1/4in. wide x 1/4in. deep. In other respects they are similar. The basic parameters of design apply to both but the exact dimensions depend on the specific

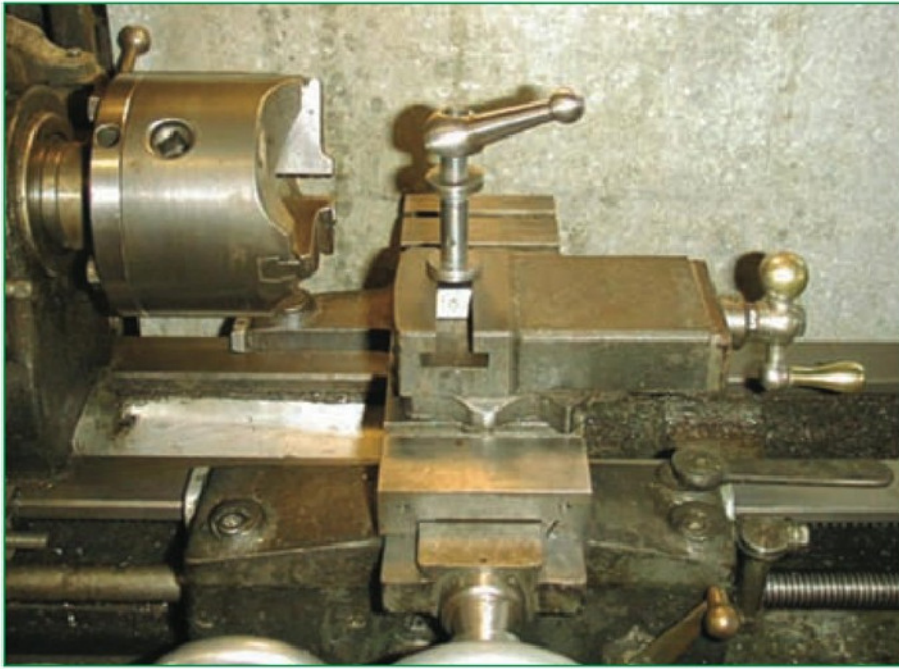
machine for which they will be used. In particular, the distance from the lathe centre-line to the top surface of the compound slide, will need to be considered. The Atlas is 1 1/4in. (0.8125in.) and has a land 2in. x 3in. wide. The Myford ML7 is 1 1/4in. (0.6875in.) with a land of 2 1/2in. square.

The Atlas, and others, has a Tee slot in

the compound slide top surface and the clamp pillar and Tee nut are shown in Photo 2. On the other hand, the Myford has a screwed pillar fitted from underneath. Photo 3. Dimensions of each are shown in Sketch 1A and 1B respectively, together with a proposed design (1C) for one for the Myford, (although I have not made one of these) All makes of Lathe will differ - the largest I have dealt with has a land 4in. square and a land to centre height of 3 1/2in. Still the same considerations apply. As a point of interest, I fitted a Myford "Long Cross Slide" to my Atlas because of it's Tee slots, which mine did not have, and this makes a slight difference to the original land to centre height. Sketch 2 shows dimensions of the tool post pillar, Tee nut

1. The two toolposts, angled slots (and milling error) visible on right.





and ball handle. A $\frac{1}{4}$ in. spacer is also shown. This needs to be faced down in thickness to position the ball handle at a suitable working angle. The Myford does not need these.

Materials and construction

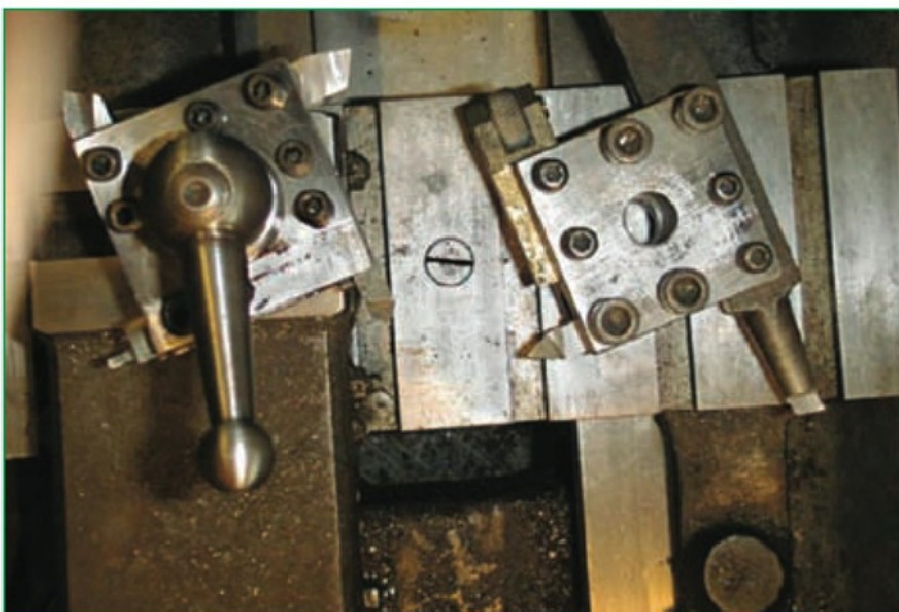
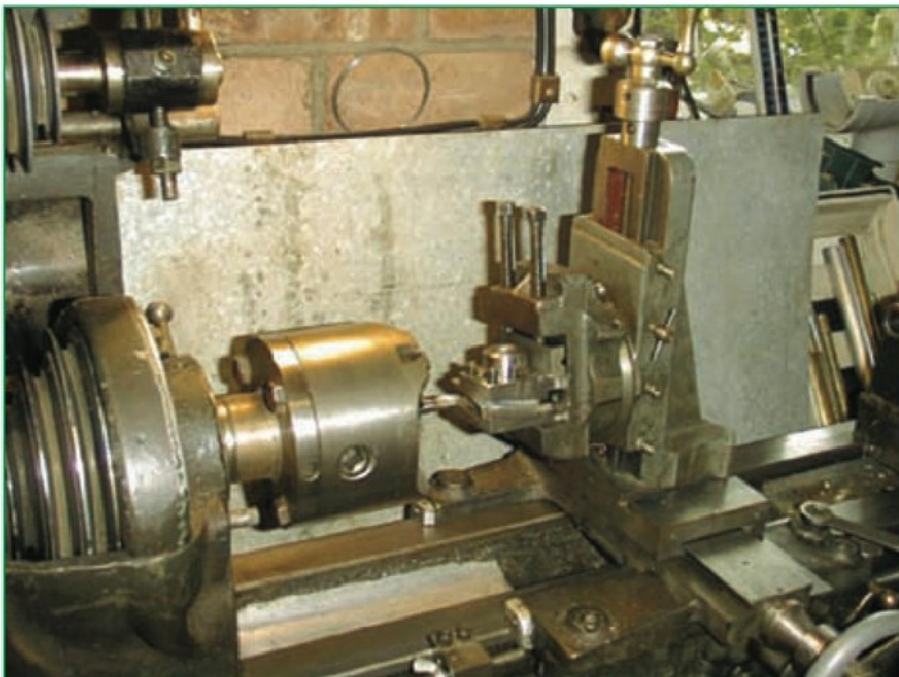
All materials are basic mild steel with no special heat treatment. I started with a piece of 2in. square bright bar, 2in. long. (Use $2\frac{1}{2}$ in. square for Myford and - on reflection - I would use $2\frac{1}{2}$ in. on mine if I was doing it again) Don't make the Tee nut too tight in the slot and I found a 'tommy' bar hole in the pillar was necessary to tighten it up and avoid it unscrewing from the nut when unlocking the ball handle to index the tools. When cutting one of the tool-bit slots, I made the mistake of milling all the way across. This intersected with the slot at 90 deg, which left the front of the adjacent tool unsupported. See **Photo 1** right hand view.

Most of the machining operations need no explanation but I will say that I did not have the luxury of a milling machine when I made these two tool posts and I had to use the lathe's vertical slide. See **Photo 4**.

Usage and tips

Having two - four way tool posts allows both to have regularly used tools fitted, on centre, and time is saved by changing the whole tool post instead of changing individual tools.

Another useful tip is shown for the Myford design. I would drill and ream a $\frac{1}{4}$ in. hole along one side to allow the use of a round boring bar. To achieve the correct centre height most simply, the unfinished tool post is locked in position on the lathe and the cross slide moved to the desired position and firmly locked. Then, with drills mounted in the lathe chuck, start with centre drill, then use progressively larger drills to open up the $\frac{1}{4}$ in hole, finally reaming to size. By this means the hole will be exactly on the lathe centre height. I



TOP LEFT

2. Topslide and Tee nut arrangement on Atlas lathe, showing also the "Taylor" three jaw chuck.

TOP RIGHT:

3. Myford topslide has captive pillar.

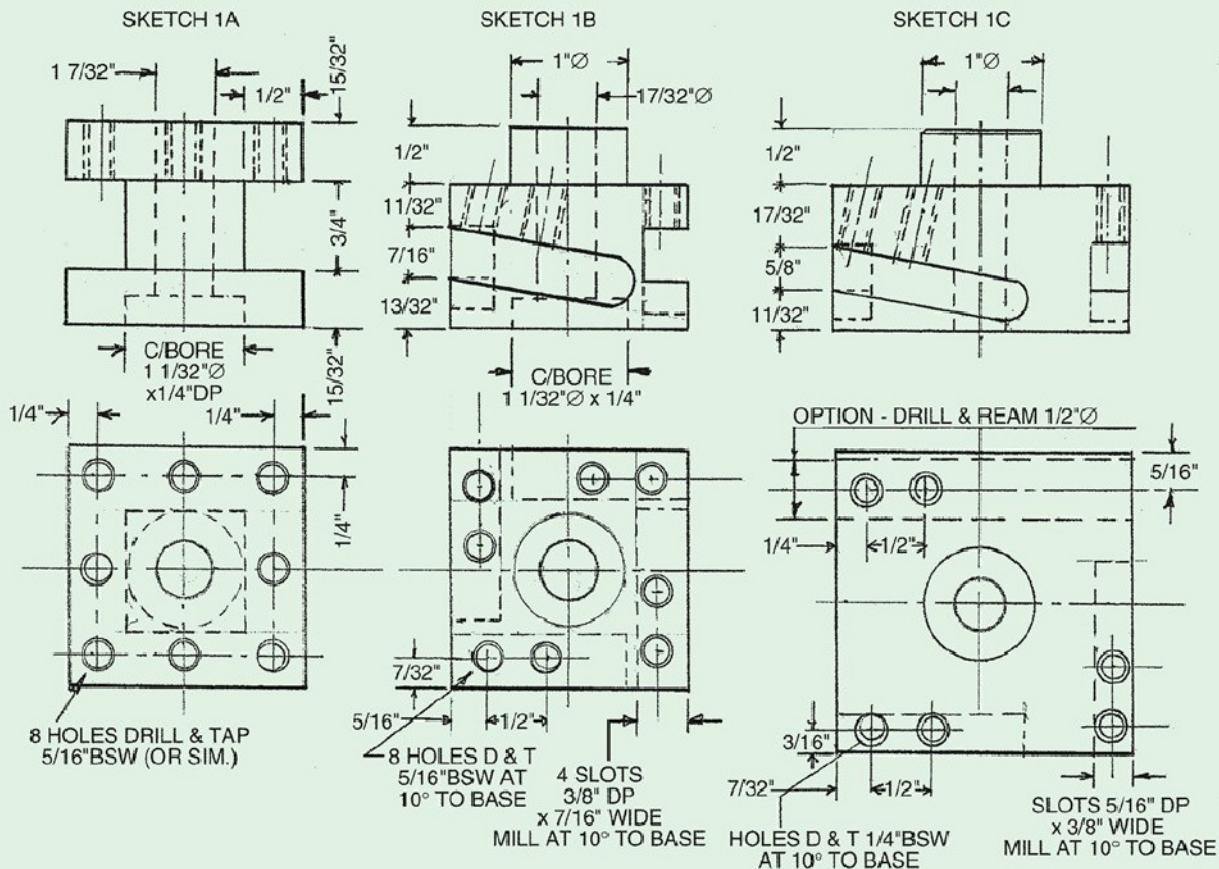
CENTRE:

4. Milling on the Atlas using the vertical slide.

BOTTOM:

5. Two toolposts, one in place, both loaded with tools.

©



Sketch 1

have made one of these boring bars from silver steel and find that using it in this hole saves packing and time as careful preparation of the cutting edge (before hardening) will position it exactly on centre every time.

One thing I never ever do is to part-off from this tool post - always using a rear toolpostand I haven't broken a parting tool in many years!

Consider the tools you use regularly. My selection for the angled tool post is:-

- a) round nosed roughing
- b) finishing knife edge
- c) undercutting
- d) double sided 45 deg chamfering.

(Remember, the front clearance angle - normally about 5 deg.- will need to be increased by the angle of the slot to base.)

It pays to grind some tools at an angle in order to be able to get close to the chuck or shoulder without hitting the jaws - probably about 10 deg will suffice. For the one with level slots, my selection is:-

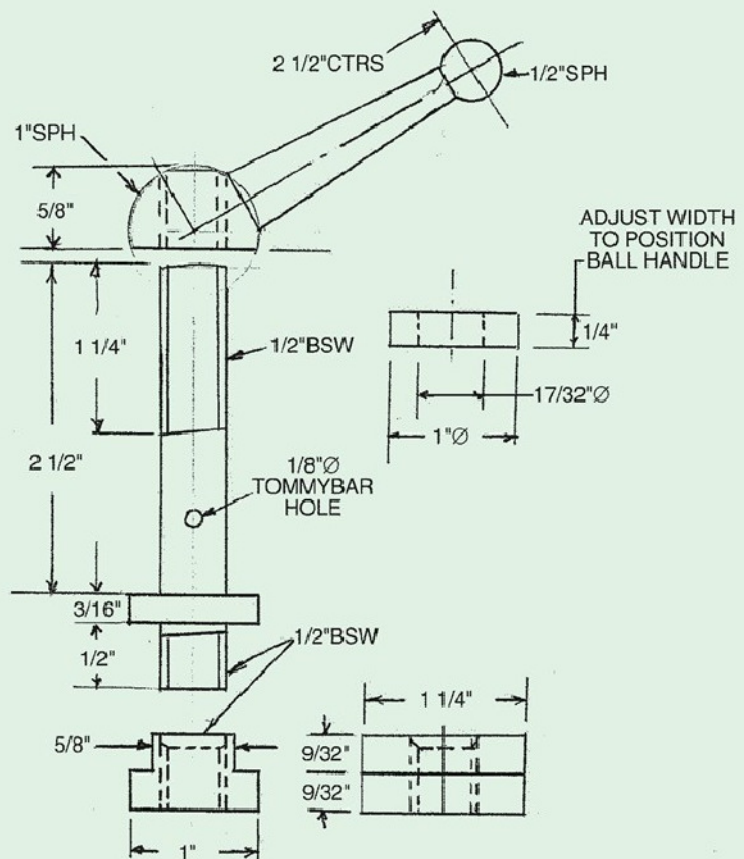
- a) a boring tool
b) medium knurling tool
c) screw cutting tool. **Photo 5** shows both tool posts with tool bits fitted.

Conclusion

Quite simple. Once made, you will never go back to a single tool post again. Happy turning.

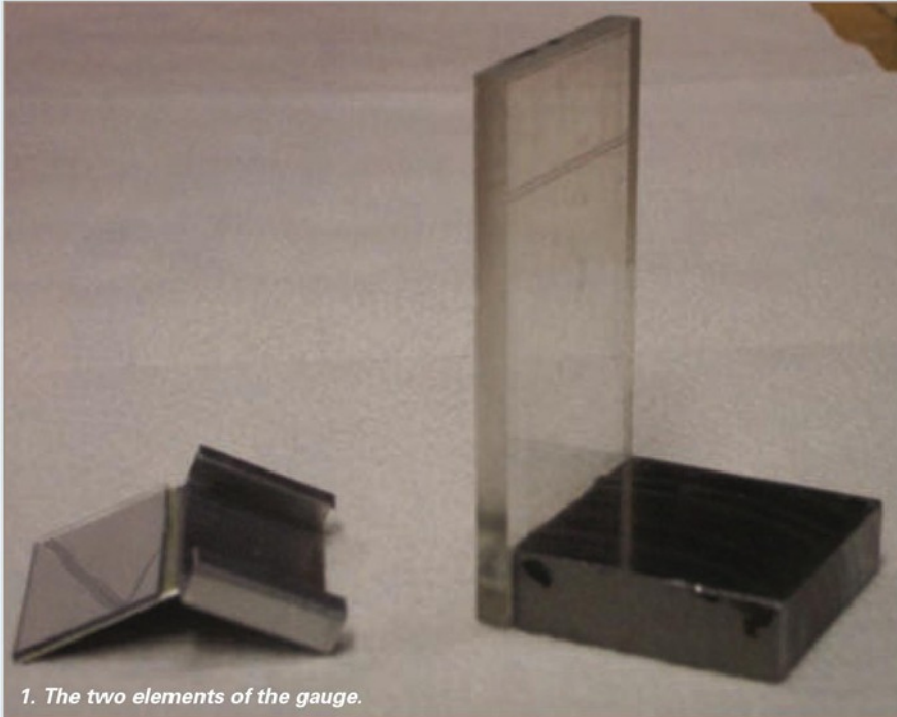


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Sketch 2

LATHE TOOL HEIGHT GAUGE



1. The two elements of the gauge.

Background

All, or nearly all, workshop enthusiasts have a height gauge for setting the height of the cutting tool on the lathe centre, or an equivalent for use on a horizontal milling machine. Indeed a very good traditional gauge was described by the late Philip Amos in MEW issue 88. For myself until recently, the gauge consisted of a piece of stock with flat end faces that are accurately turned to be at right angle to the length, and of the correct length to offer to the tool to set this to lathe centre height. This stock piece works just fine when used carefully but it has one disadvantage which we all combat in a variety of different ways. It is necessary to get the eye lined up with the two pieces being compared. This usually involves stooping or crouching down and swinging the lathe tool holding device round so that the tool can be compared with the height of the gauge which itself is sited on a suitable, and often limited, surface of the cross slide. Some people work from the lathe ways which can make comparison easier but again tool holder rotation is often still necessary. Not too bad if a quick change tool holder is used as these hold their adjustment when the holder is swung round but not so good with the cheaper American style (boat shaped) holder which is often used.

Better Mouse Trap

Recently, I discussed this matter with a friend of mine, Jim Wright, over a cup of char in his kitchen and out of this came an idea for a "better mouse trap". It is just as good as the usual height gauge but has two additional advantages. Firstly, it is not necessary to wriggle around nor bend the aged back in order to see what is going on. Secondly, it will function just as well when the gauge and the tool or any other reference point are separated. I don't know if this has been done before but I have not seen it described in any publication. The two parts of this are shown in **Photo 1**. That on the right consists of a base and a vertical sight gauge made of a piece of $\frac{1}{4}$ in.

Perspex with two lines, one on each surface, both at exactly lathe centre height when standing on the appropriate flat surface or the lathe ways. The reason for the two lines (as will be seen later) is to overcome any parallax error inherent in lining up two items in what ever application. The second part, on the left, consists of a mirror mounted on a simple slide which fits onto the sight gauge and can be adjusted vertically. The slide holds the mirror at 45deg. to the vertical. (The images on the mirror in **Photo 1** are a reflection of something when I took the photo, not cracks in the mirror). No dimensions are given as these will depend on the machine tool being used. In my

Ted Wale employs optics to improve ergonomics.

case, for my 10in. Southbend, the Perspex was $3\frac{1}{2}$ in. x 2in. the mirror 2in. x 1in. and the lathe centre height $2\frac{1}{4}$ in. (all approximate) when the gauge is used standing on the cross-slide. My version uses $\frac{1}{4}$ in. Perspex, and this has proved entirely satisfactory, however as always with the benefit of hindsight, it occurs that thicker material (giving greater separation of the sight lines) might convey even better accuracy when the tool is some distance from the gauge.

In **Photo 2** the device can be seen standing on the cross slide and the tail stock centre offered up to it. Note the reflection of the centre in the mirror and this is seen from the normal operator's position without any straining around nor crouching. A clearer view of what is happening is seen in **Photo 3** which is a directly overhead shot of the same set up. Note how the tip of the centre sits directly on the two lines in the reflection: these lines are brought together by moving the eye (or in this case the camera) so as to make the lines merge into one and so remove any parallax between the centre and the gauge. This adjustment has not been done perfectly in this photo as the two lines can be seen to be separated by a small amount which helps to illustrate the operation.

The above describes in some detail the setup of this better mousetrap. In **Photo 4** is seen the most used application of this. A lathe tool has been painted white with typist's Snowpake to make it stand out more clearly. It is offered up to the gauge onto the line on the outboard side. In **Photo 5** is seen the reflection in the mirror with the two lines superimposed on the object. (The two faint shadow lines above the image are some aberration and can be disregarded). It can be seen how easy it is to adjust the tool height.

Remote gauging

This gauge has an additional advantage which is seen in the last two photos where the objects, centre and tool, have been moved away from the gauge and, in addition, while the centre is still at the correct centre height, the tool has been raised a little above centre height. In **Photo 6**. I made the viewing position slightly in error so that the reference lines are separated: it is virtually impossible to tell that the tool is at the incorrect height and that the centre is at the correct height. However, when the eye position is adjusted, as in **Photo 7**, to superimpose the two reference lines

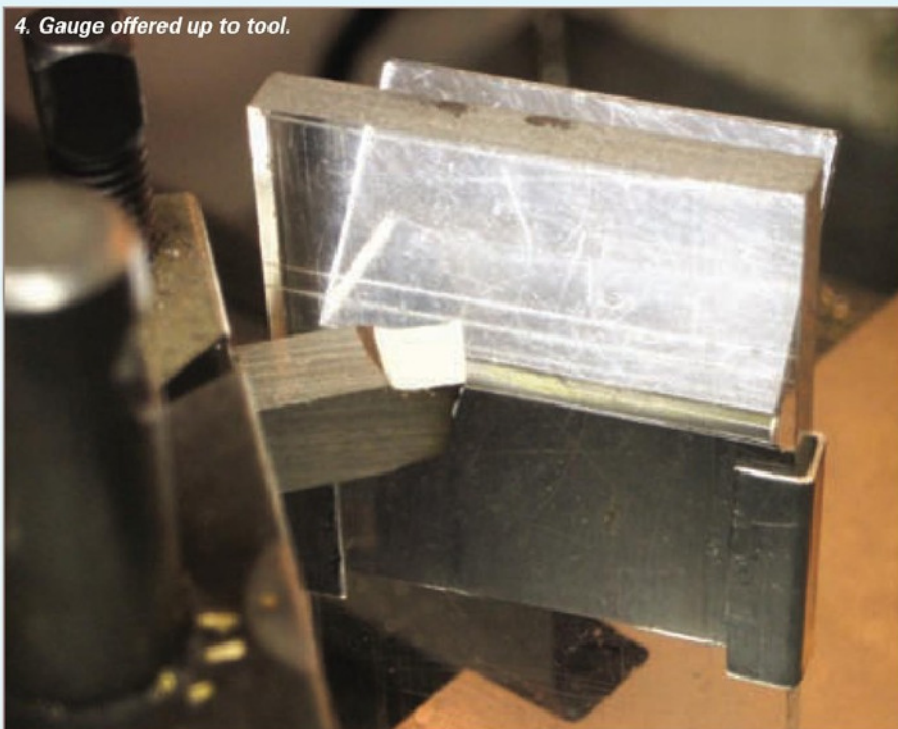
2. The gauge set against the tailstock centre.



3. Overhead "operators" view, lines and centre coincide.



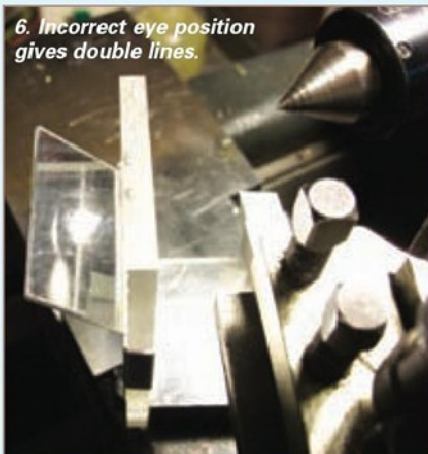
4. Gauge offered up to tool.



correctly it is easily seen that the tool is too high.

This ability to view the tool from a distance and still make out accurately whether the height is correct or not is very

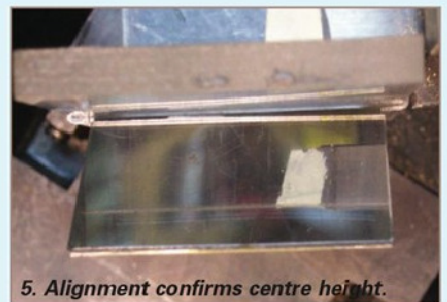
6. Incorrect eye position gives double lines.



convenient. As mentioned in the first paragraph there are times when it is not a good idea to release the tool holder in order to rotate it into a convenient position for height measurement. A careful set up for a piece to have a good finish is one case. Another is a careful set up when a small diameter is to be turned. A combination of these two requires very careful tool height positioning.

Setting four jaw

Another occasion when this gauge proves its worth is when a piece is to be set up accurately in a four jaw chuck to continue machining and it is important that the centre be accurately placed. Suppose that the point which is to be the turning centre is recessed into the body of the piece part. Also this centre is not necessarily the centre of the previous turning. Then it may be impossible to place a centre measuring stock piece or centre so as to set up this



5. Alignment confirms centre height.

new centre in a simple manner using a DTI. Of course it can be done, machinists have been doing it for years when they have had to do so, but it is not easy. With this better mouse trap it is easy to set up this remote reference point so that it is the centre of turning.

As several of these photos show, it is easy to view the images in the mirror from the normal operator's position, or near to it, simply by adjusting the position of the gauge and the mirror. It is not necessary to manoeuvre the eye into some awkward position to get an accurate view. That really is a help.

Conclusion

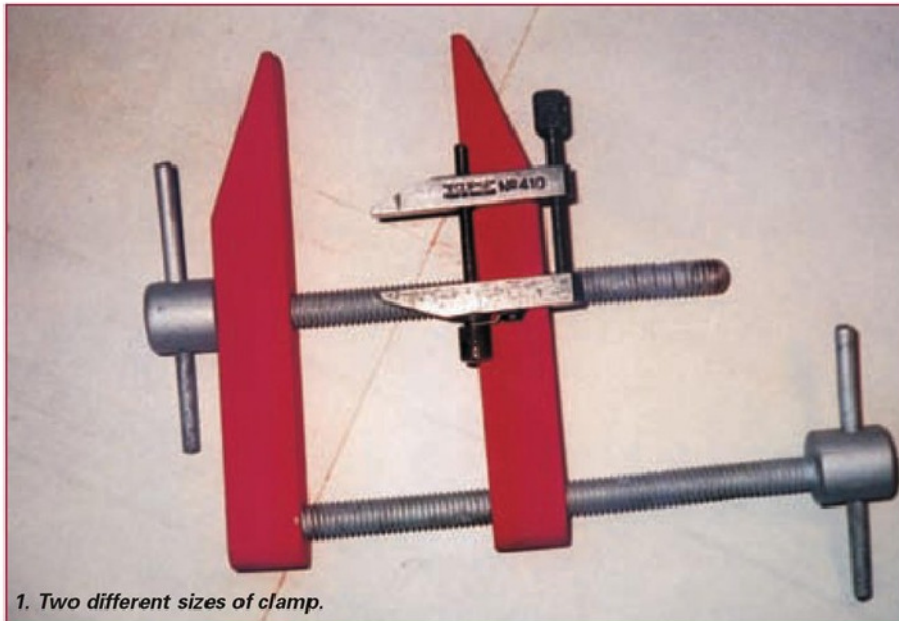
I have found this design of gauge to be very useful. It saves the back, it improves accuracy, and it saves time.



7. Correct height, tool remote from gauge.



TOOLMAKERS CLAMPS



1. Two different sizes of clamp.

In most hardware shops there are such a variety of clamps that making your own would seem rather pointless, but sometimes you need those special clamps that don't obstruct the area you're trying to work in. Then the "Toolmakers Clamps" are usually ideal for most clamping problems. You can purchase well-known brands of toolmakers clamps from most reputable Engineers Tool/catalogue shops, but they're not cheap. So why not make your own, they are simple to produce and a useful addition to the workshop; and making is an excellent project for the beginner.

Photo 1 shows two different sizes of clamps (usually made as a pair). The smallest clamp being a commercially manufactured item. The other one home made. You may have noticed a clip attached to the top face of the small clamp. This little gadget is to hold the one

half of the clamp in position, as there is no thread in that hole to secure the pin. It will also prevent the screwed pin from falling out, if the clamps were separated, when trying to squeeze that extra capacity from the clamps, which would undoubtedly result in a lost or damaged pin. The homemade clamps have no such refinements. But have included the bracket as a separate item, if you want to add it to the project.

Materials

Photo 2 depicts the materials and some of the tools used for manufacture of the clamps: Items 1 & 2 were made from 20mm square bright mild steel (BMS): The screwed pins are made from M10 screwed rod, with a 25mm dia boss drilled and tapped M10. These are then positioned on the ends of the screwed rods, and held in

Aiming at the tyro, Mike Tierney describes how to make your own.

place with Loctite. They are then drilled and reamed for a 5mm dia silver steel pin for belt and braces retention, and to act as tommy bars. The component details are given in **Fig 1**.

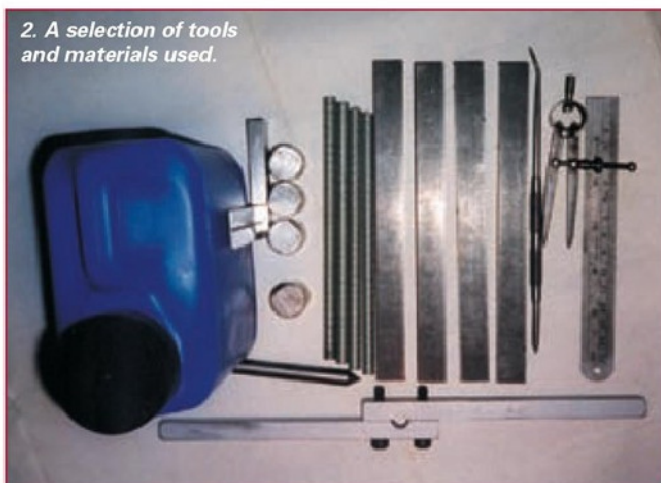
Item 1

With Items 1&2 cut to length, mark off the hole positions for the screwed rod, in Item 1. First wash the surface with marking blue, or use a felt tip pen. Scribe a line in the centre along the length of the bar, see **Fig 2**, and two lines across the bar, one 12mm in from one end of the bar and the other one, at 70mm centres. Drill the two holes through 8.5mm dia, and tap M10. Before tapping the two holes, you will need to transfer the positions of these holes through into the other half of the clamp item 2, with the 8.5mm drill. Clamp the two halves together, and support in the drill vice, see **Fig 3**. Spot through with the 8.5 drill to a depth of 2mm, or just passed the lip of the drill.

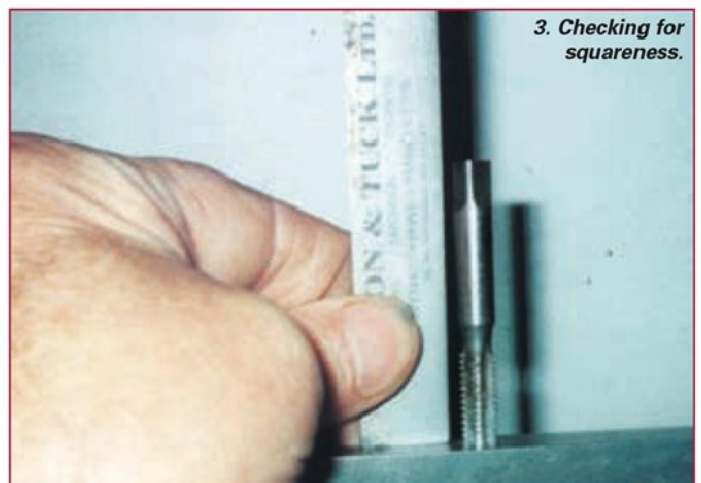
Remove Item 1 from the vice, and drill Item 2 one position (see drawing) only, straight through with a 10.2mm dia. clearance drill. The other hole is drilled (at the end of the bar) to a depth of 5mm.

Avoiding damaged threads

To protect the start of any thread from accidental damage. All tapped holes should have the first thread or so removed from the start of the tapped hole. This can be done by opening up the start of the hole with the "Size Drill" that is, a M10 tapped hole will have the start of the hole



2. A selection of tools and materials used.



3. Checking for squareness.

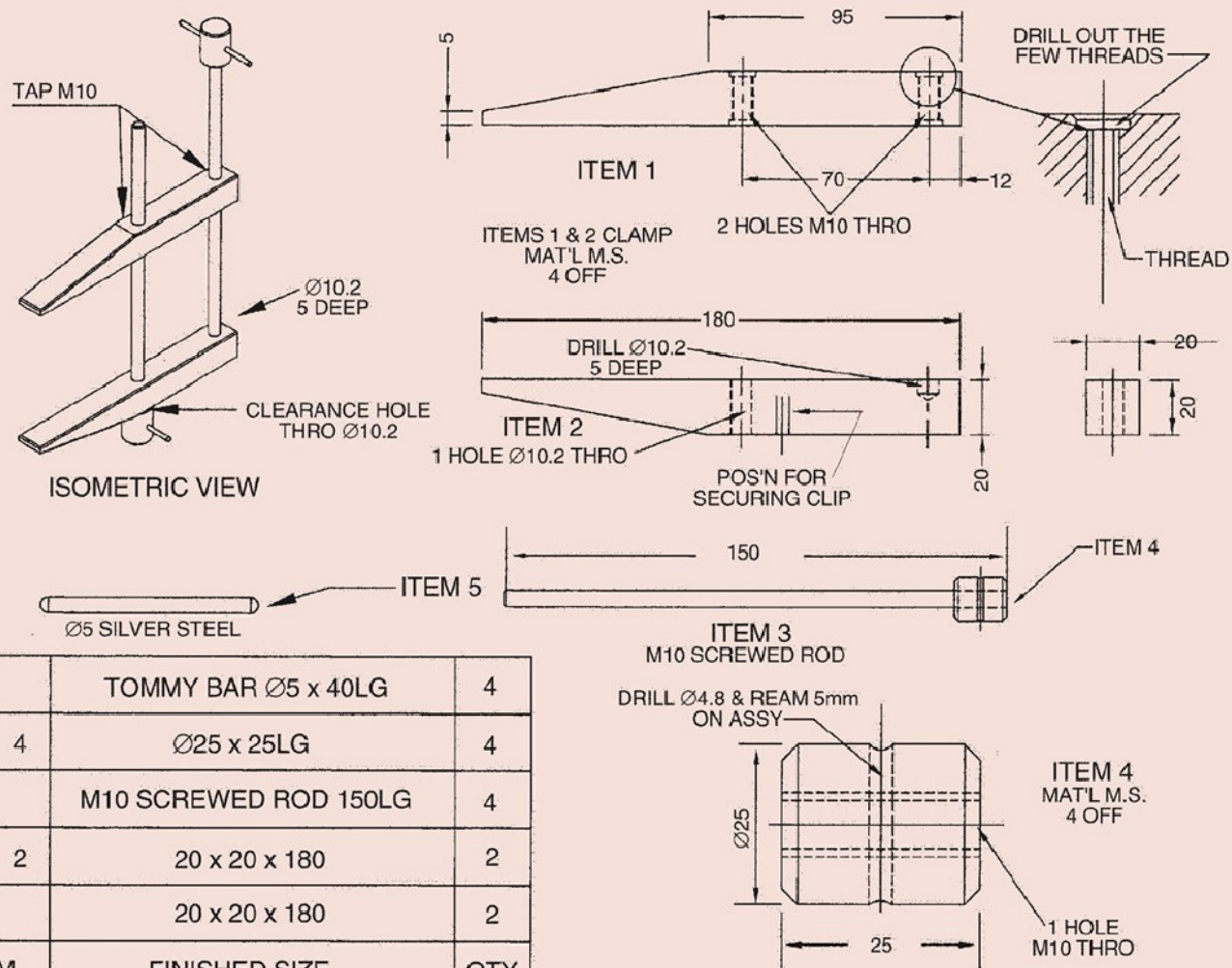


Fig. 1 Components

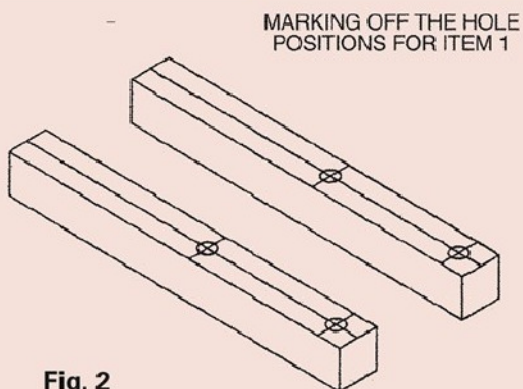


Fig. 2

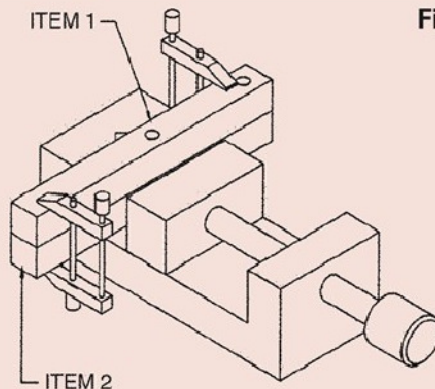


Fig. 3

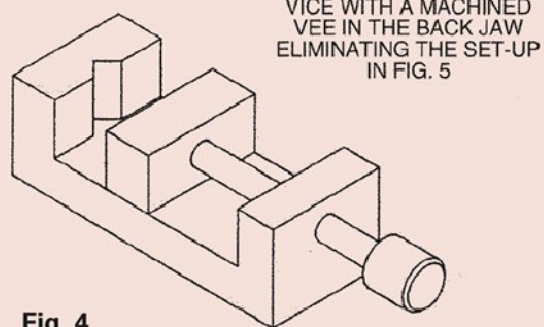


Fig. 4

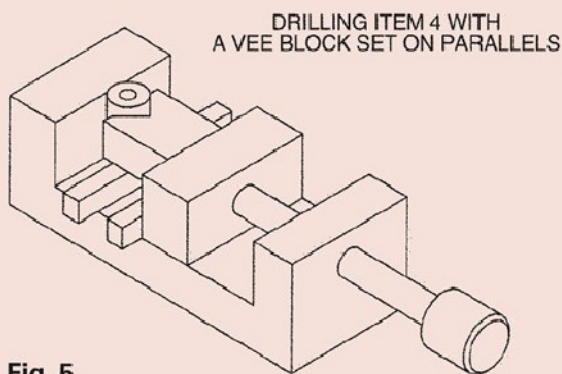
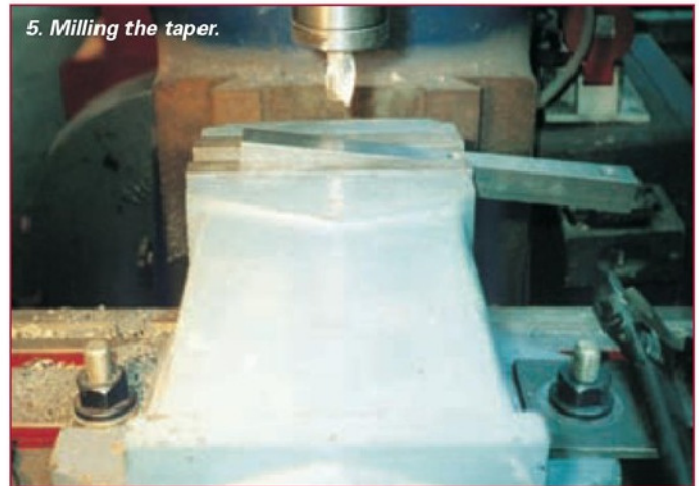
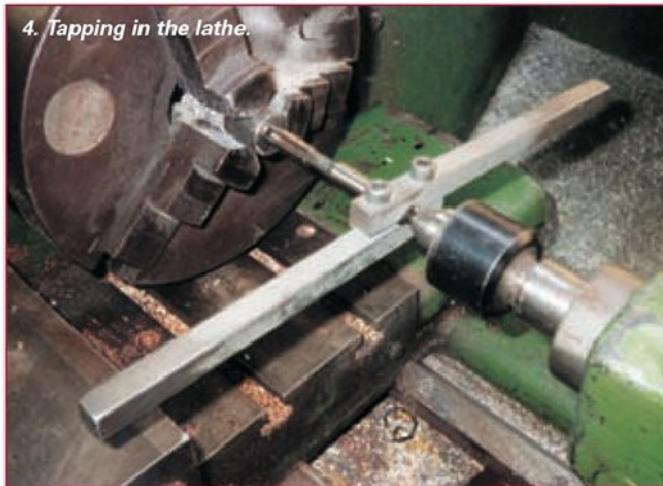


Fig. 5



opened up with the 10mm drill deep enough to remove the first one or two threads, see **Fig 1**. A few enlightened engineers remove the first threads by counter sinking the edge of the hole. That's ok, but it's usually due to bad habits and/or laziness that the incorrect procedure is used; so try to use 'good workshop practice' by doing things correctly. The "opening up" may be left until after the tapping, but is better done as a first part of

the drilling sequence. Do please be careful when opening up the hole as the drill may snatch, and leading to damaged fingers if the job is not clamped down to the table.

Tapping

The 8.5mm dia drilled holes in Item 1 will now require tapping M10. – If you are an engineering beginner, and have little knowledge of tapping holes by hand, then

here are a few tips: discard any old taps that have been given to you unless you know them to be fairly new and not chipped or blunt. Also (although not strictly necessary for this exercise), that you have all three taps, that is, first, second and third tap. The first tap has a long taper; the second tap has a shorter length of taper, and the third tap (usually known as the "Plug tap") has no taper which allows a full thread to be cut to the bottom of a blind hole. The holes will have to be tapped square: to do this you will require the aid of a small square. If you don't have one, then use the end of your 6-inch rule, see **photo 3**. (The 6 inch Rule comes in very handy when trying to square up taps, in places where the square won't fit.) Start with the "First tap" keeping sufficient pressure on the tap to bite into the metal, turn the tap wrench in a clockwise direction, do so a couple of times to make sure the thread has started. We must now check the 'squareness' of the tap in the hole with the aid of a square on each side of the tap. Any correction to the tap can be made by pulling or pushing the tap in the required direction, at the same time turning the tap to bite further into the hole. Keep checking the tap at stages as you go through the hole. Finish with the other two taps.

An alternative method for starting the tap square is to make a simple guide. The detail will depend on the contents of your scrap box, but basically all you need do is to drill a 10.2mm hole through a piece of flat material about 19mm thick. Place this over the hole to be tapped and clamp in place. It will then guide the tap and hold it square.

Item 3

The screwed pins, Item 3 were cut from a one-metre length of M10 screwed rod. These are easily cut to length with the aid of a hacksaw. Being careful not to damage the thread, (use soft jaws if you have them) hold the screwed rod in the vice. With some 160mm protruding from the side of the vice cut four lengths (if you intend to make a pair of clamps) 150mm long. A pair is advisable, as at sometime you'll need that extra hand!

Item 4

It will be clear that Item 3 is a sub

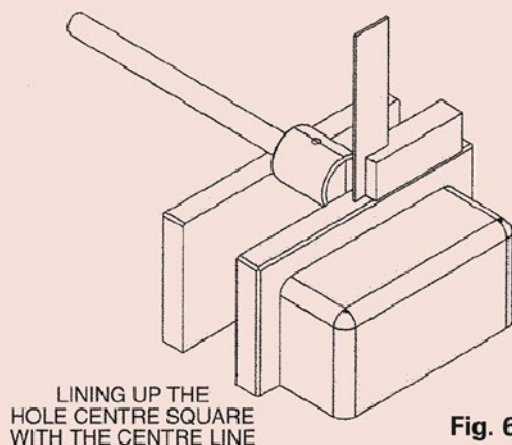


Fig. 6

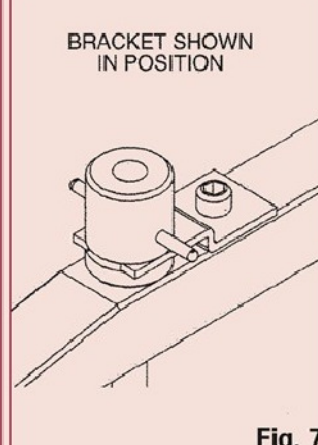


Fig. 7

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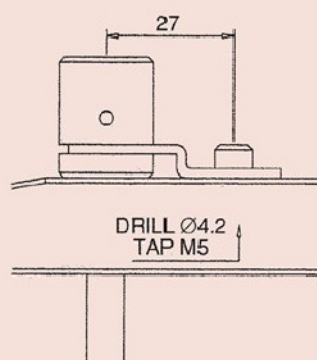


Fig. 8

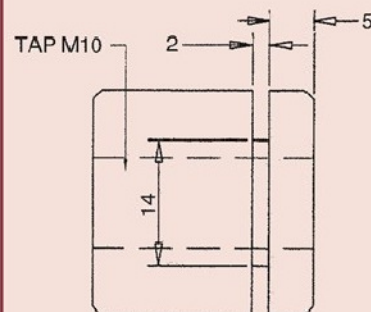


Fig. 9

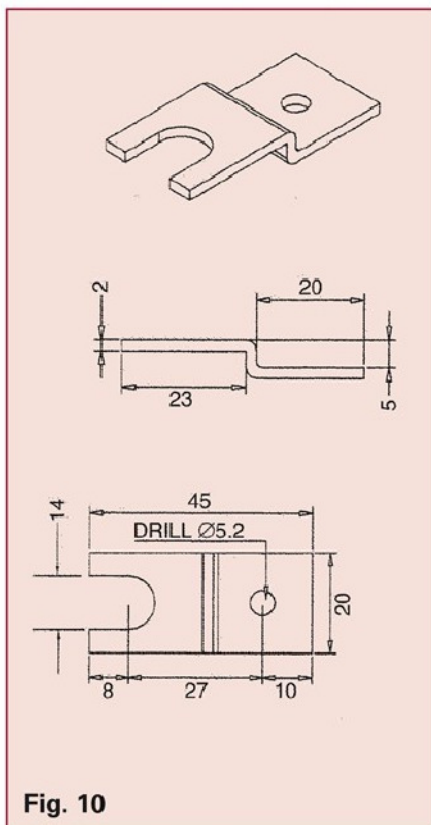


Fig. 10

assembly built up from the threaded rod and Item 4. As this article is aimed primarily at the beginner, this was considered an easier and quicker method to produce the part than turning from solid and screwcutting. Item 4 is a part of the sub assembly, and is manufactured from a short length of 25mm dia. x 25mm long mild steel bar. If you have a centre lathe, then cut these off slightly longer, and face up in the lathe. While set-up for this operation drill through 8.5mm dia. and tap M10. If you have no experience of tapping holes on the lathe! Then the procedure is: Switch off the machine. Insert an M10 tap into the hole: (The tap suitable for this method of tapping, must have a manufactured centre on the squared end of the tap, that is the end used for locating the tap wrench) a suitable centre is then set-up in the tailstock, see **Photo 4**. Place a tap wrench on to the end of the tap. Wind

in the tailstock to lightly hold the tap in position. Then turn the tap wrench in a clockwise direction approximately two full revolutions; next, reverse the tap approximately half revolution. This will break the chip and stop the tap from clogging or jamming in the hole. Repeat the process until the hole is tapped through, moving the tailstock centre up each time to maintain contact with the tap.

Without the lathe

If the beginner is not yet the proud owner of a centre lathe, then item 4 can easily be drilled on the workshop drill. If the material has not been cut off on a power saw, then the ends might not be square, in which case treat yourself to an exercise in filing. Once they are ok, then the item can be positioned on parallels in the drill vice. As an aside, for items having off square ends, you might use a drill vice with a machined "V" in the back jaw of the vice see **Fig 4**. Alternatively, depending on the type of vice, the component could be clamped or held as depicted in the illustration of **Fig 5**. Before setting up in the drill vice, we need to mark off the centre for the tapped hole. The best way to do this is to use the centre square (ref MEW iss. 99 p.14). Scribe several lines across the end face of Item 4 to locate the centre, then drill through 8.5mm dia. and tap through M10.

Assembling Item 4

It now remains to assemble Item 4 on to the ends of the screwed rod. Wash out the tapped hole with paraffin, or any other suitable cleaning agent removing any cutting oil left behind. Repeat for the end of the screwed rod, and Loctite both parts together. When cured the two parts can be drilled and reamed through for the Tommy bar, which will finally secure the items together. **Fig 6** shows one set up for drilling the Tommy- bar hole. You will first have to mark off the hole position, this is best done on the bench. First scribe a line along the length of item 4, and one at 12mm from one end centre punch the position, and then scribe a line on the end of the bar in the centre, to line up with the line on top, this can be done with the aid of a centre square. This centre line will

help set up Item 3 accurately in the drill vice, so that the pinhole can be drilled through square and in the centre, this can be done readily with a square or a six-inch rule. Of course if you are equipped for milling then other options are available for this operation.

Drilling the pin hole

First pre-drill the position with a small centre drill, this is necessary as otherwise the drill may skid off in other directions, and you may end up with a broken drill or a misplaced hole. Taking that extra care when centre punching hole centres accurately is well worth the effort, especially on curved surfaces, as the drill will follow the centre pop. A drill will have to be chosen that will leave sufficient material in the drilled hole for reaming, but not to much usually about 0.007inch or 0.18mm. So for a 5mm reamed hole I would use a 4.8mm drill. Sometimes gremlins can rear their ugly head when drilling tight holes for reamers. Just on those occasions when you are trying to leave small amounts of material in the drilled hole for reaming, things will go awry and can result in the hole being drilled over size and therefore leaving no material for the reamer. There are two main reasons why this occurs:-

1. The drill has been ground off centre, and which therefore increases the cutting diameter of the drill. - and
2. the material being ejected up through the flutes of the drill is also dragging/wearing material from the sides of the drilled hole. This occurs to some small extent with all drilled holes.

The solutions are -

1. make sure that your drill is ground centrally. (Whatever size of drill) If you have little or no experience of grinding drills by hand, then use a new drill. Even the experts will find grinding very small drills by hand accurately is very much trial and error. Examine your drills with a loupe to be sure that the cutting edges are of equal length and symmetrical, and
2. the problem here can be over come to

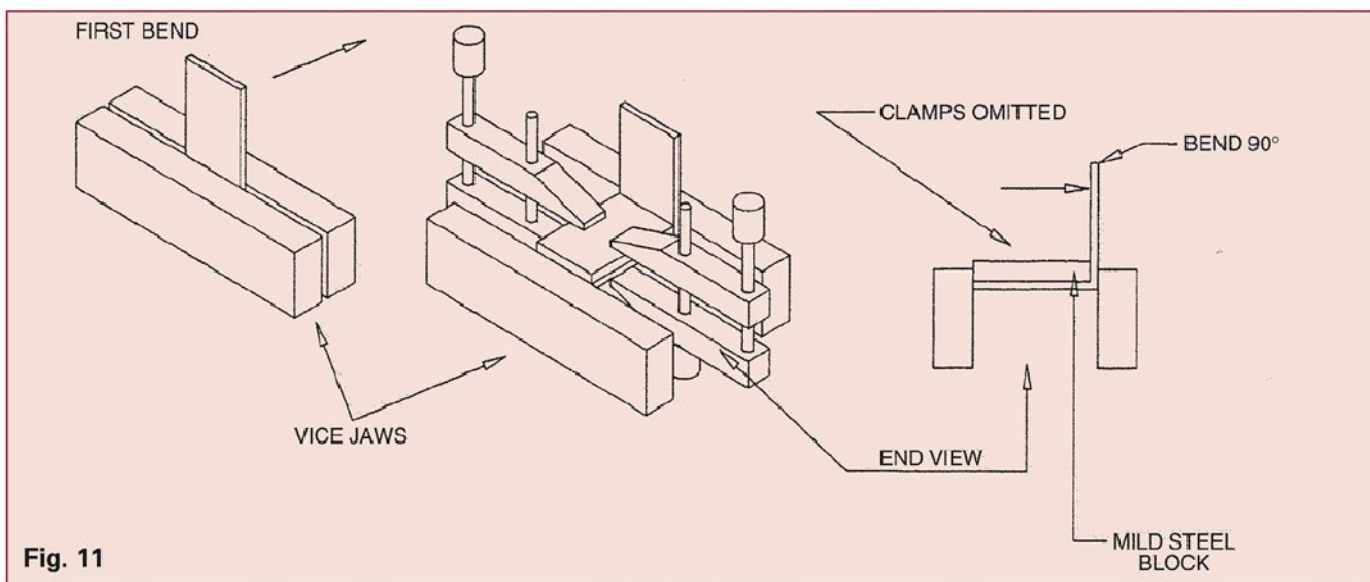


Fig. 11



6. The finished articles (these without tommy bars).

across the centre of the strip to 90 degrees, and then with the aid of a steel block and clamps, the second bend was formed. The bracket could then be trimmed to length.

Drilling the bracket

Mark off the hole centres, and drill through to the hole sizes shown. The 27mm dimension is not critical as the 5.2mm dia. hole is to be transferred on assembly. The 14mm dia. hole might cause a problem for the reader being of such thin material for the size of the drill. As with all thin materials, drill through first with a smaller dia drill, in this case, the 5.2 will do. Then open up with the 14mm drill. If you have one of the "Concut drills" intended for opening up holes in sheet then that would be fine. The conical surface would require a light touch with a round file. It just remains, to hacksaw down each side of the hole, leaving a small amount of material to be filed smooth.

Assembly

Setting the bracket in place and transferring the 5.2 dia hole into item 2, might pose a slight problem, in that, the screwed pin item 3, is rather long and obstructs the set up from being held in the drill vice. One way around the problem, is to either spot through the hole with a hand drill, or to mark the centre of the hole by placing the 5.2mm drill in the hole and turning the drill in a anti-clockwise direction at the same time tapping the end of the drill to make an impression into item 2, repeat this several times (make sure that you have a sharp point on the drill). Remove the bracket, and carefully centre punch the marked position. The hole can now be drilled 4.2mm dia. to a depth of 15mm deep and tapped M5. If the reader has problems clamping the bracket to item 2, that is, no clamps small enough (this is where a pair of small toolmakers clamps are ideal, see Fig 11) then get someone to hold the bracket in place, while you centre the hole with the 5.2mm drill. You could, of course, temporarily superglue the bracket in place.

Simplified version

For those needing a rough and ready clamp made up in much less time, I offer the arrangement shown in Fig 13. Using threaded rod and standard nuts, this avoids making the turned parts, and can avoid the tapped holes.

Conclusion

This project is intended for the engineering beginner; I hope it will be of interest and create a useful addition to your workshop, - Photo 6 shows the completed project. But every tradesmen can and will benefit from well-made tools, whether they are homemade, or commercially manufactured. There is now an abundance of cheap imported tools on the market. (Six million jobs world wide, have gone to China in the last few years) So if you are an engineering beginner building-up your tool kit, and you can afford the best, then buy the best; if not start making, or buy to suit your wallet.

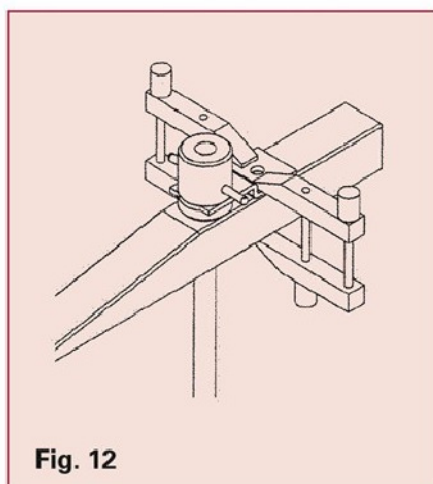


Fig. 12

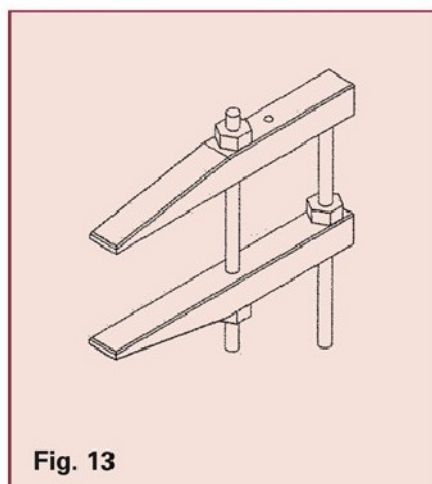


Fig. 13

some extent by double; or even treble drilling the hole, that is, use smaller drills first to remove some of the surplus material, this reduces the amount of material left when drilling with the correct size drill. You may choose to use some form of cutting fluid which will then perform a cooling and lubricating function.

Having drilled through with the 4.8mm drill. We can now ream out the hole. This is best done with a "Hand reamer", as you can check on the amount metal being removed by periodically removing the reamer and checking the hole with the pin. Note that reamers should always be rotated forwards, so do not reverse the reamer when withdrawing from the hole, as it might chip or even break. You should aim for a tight fit to firmly secure item 5, although Loctite could be used here too.

Machining the angles

The taper on the ends of the clamps, allows for greater accessibility when trying to clamp on small areas, and will go where other types won't fit. Photo 5 shows the set-up for machining the taper: The component was set at an angle of approximately 10 degrees. Or you may

choose to scribe a line between the 5mm and 95mm dimensions, and set parallel in the vice, then machine the taper to your scribed line - I used a 20mm dia 'end mill' to machine the tapers. Again, if you do not yet enjoy the luxury of a milling machine, you may either choose to mill on the lathe or to award yourself a few more brownie points for physical exercise and reach for the hacksaw and file.

Adding the bracket

If you wish to include the bracket, I've given two diagrams of the assembly as Figs 7 and 8. Item 4 will have to be modified to incorporate the bracket, that is, a groove will have to be machined around its diameter, see Fig 9. Make the width of the groove slightly wider than the material thickness of the bracket, in this case 2mm. But it may be worthwhile making the bracket first, so that any discrepancies in the bracket height can be adjusted out when machining the position of the groove.

Cut the material off for the bracket (Fig 10) about 60mm long, this will leave enough material on each end of the bracket to trim to size after forming. Fig 11 illustrates the method used for forming the bracket. I first bent the material in the vice,

BACKPLATES AND FACEPLATES FOR D1-3 LATHES

Accessories can be expensive, so Philip Leith made his own

I had purchased a Colchester Bantam lathe at auction about 3 years ago (at the beginning of my model engineering career) but it came with only a 3 jaw chuck. The price of new chucks was astronomical since those to fit a Camlock D1-3 lathe could only at that point be purchased from industrial sources, although they are sometimes available on special offer from sources such as J & L Industrial Supply. The advantage of the Camlock studs approach is that the lathe can be run either forward or reverse with no possibility of the chuck coming off, but it is an expensive advantage.

I bought a D1-3 faceplate and also a 4 jaw chuck from a second hand dealer whilst in London and brought it back home. As my experience with turning grew I noticed that faults appeared when I used the faceplate. The front face appeared to be buckling and when I took a skim across the face, the next day the distortion was back. By then it was well over a year since I had purchased the faceplate and thought it pointless to complain – and anyway I had taken so many skims off this that there wasn't much faceplate left. I determined to make my own...

Photo 1 shows the pattern I had cast. My favourite material for patterns is MDF board and this is simply several layers of board cut on a bandsaw and glued together. The result is much more substantial than the original Colchester



1. Pattern made from MDF used to cast backplate.

faceplate and after feeling its weight in cast iron I cut the flange down somewhat and produced a handier but still substantial piece. The finished faceplate is in **Photos 2 and 3** and shows an improvement on the relatively original lightweight faceplate for the lathe. I also, during the making of the faceplate came across a 5C collet chuck at an auction for £5 and **Photo 4** shows the backplate made before fitting to the collet chuck (in fact, it wasn't 5C – the body was identical to a 5C but there was a different thread which required modification of the chuck, now complete).

Making two gauges

The problem I was faced with when working out how to produce the faceplate is that the D1-3 Camlock is relatively complicated. The general arrangement of the spindle nose is shown in **Fig 1**. It has a very short tapered nose which is set at 7 degrees 7 minutes 30 seconds. The mating part (faceplate/backplate) also has three studs spaced at 120 degrees, screwed in and held in correct angular position by three Allen screws. The positions of these are given in **Fig 2**. When a backplate or faceplate is correctly located on the



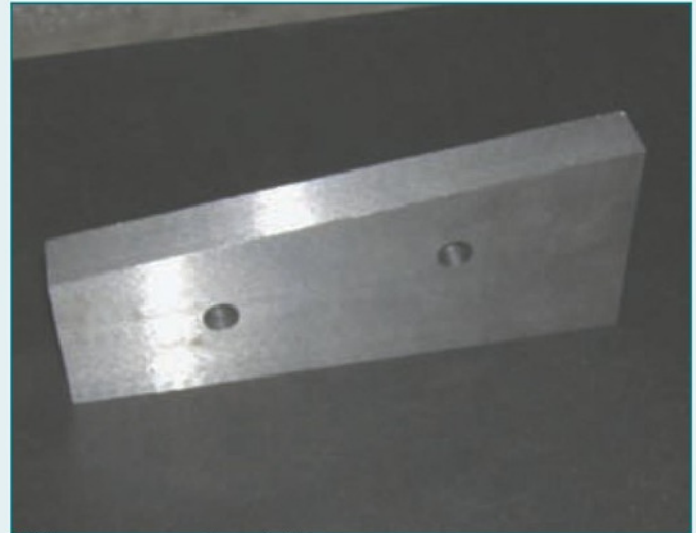
2. Completed backplate showing D1-3 studs.



3. Front view of faceplate.



4. Rear of faceplate clearly showing studs and retaining capscrews.



5. Taper gauge made to 7.125 degrees.

headstock spindle, it is located simultaneously by the taper and by the flat rear face; this calls for careful attention to sizing.

The taper was considered too short to set a tool from on the lathe. I reckoned that I needed two gauges – the first (Photo 5) was one to set the tool for cutting the taper to the required angle on the lathe, and the second was as a fitting gauge to help me get the female hole (in the faceplate) to fit the male nose on the lathe. This is shown in Photo 6. You could do without this second gauge but it would be a much more awkward job if you don't have it.

I made these whilst at evening class where the machinery available included a surface grinder and mill with DRO. I first intended to use the fitting gauge as a drilling jig as well (you can see the holes I started but didn't finish). I have been building a DRO off the web (www.shumatech.com – that's another story) and thought that when it was

complete I wouldn't need a drilling jig in future and used the college mill for the work in hand.

To make the taper gauge, you need a piece of steel. Mine is about 6in. by 3in. by 1/2in. It should have three edges squared off on the mill and surface grinder then the fourth edge is milled to provide the required taper. This is done by fixing the gauge to an angle plate, setting the angle plate on a surface plate and using slip gauges and sine bar beneath the steel blank to set the required angle. To get 7° 7' 30" requires – for a 5in. sine bar – slips to the value of 0.62in. to be inserted. This is not rocket science, but initially it certainly stretched my mathematical abilities. I tried to find a calculator or program which would produce a natural sine in the format specified for the taper but couldn't. It was only when it was pointed out that I should translate this into a decimal that it eventually clicked. So 7° 7' 30" is equivalent to 7° 7.5' (because 30 is half of

the 60 seconds in a minute). Turning 7° and 7.5' into a decimal is easy enough, since there are 60 minutes in a degree:

$$7^{\circ} + \frac{7.5}{60}$$

Which equals 7.125deg. A calculator gave the natural sine of 0.124034 and then, from the formula to calculate height for a given length of sine bar:

Height of slips at one end of bar
= Length of bar x Sine of angle
= 5 x 0.124034 inches
i.e. Height of slips at one end of bar
= 0.62017in. or 0.620in to the nearest thou.

I've discussed this here because I spent some time trying to work out how to deal with what is actually quite a simple mathematical task – handling minutes and seconds – and which I've never seen described in any of the texts which outline sine bar use.

The slip gauges were set under one end of the sine bar, the sine bar held up the blank and the blank was bolted to the angle plate. This meant that the taper gauge was set to the required angle. The top was then milled level and then put onto the grinder for fine surfacing (to help when the DTI tracked over it). You can see the holes in Photo 5 where the gauge was bolted to the angle plate.

With the taper gauge available, I could set the top slide to the correct taper and simply open out the required female part on the faceplate or machine the male part for the fitting gauge. Photo 7 shows the taper gauge in place (excuse the mess). One of the end faces is placed against the nose of the lathe (which explains why they need to be squared accurately) and the other held by the tailstock. A DTI allowed this to be done quite accurately (though each time I did it took up to 20 minutes to get it just right).

Next comes the making of the fitting gauge. I put a slice of 4in. dia. bar steel in the 4 jaw chuck and using a boring tool set by the taper gauge (opposite way around of course to how it will be used to make the female taper) it was relatively simple to produce the desired male taper to size. I used a spare D1-3 driver/catch plate to test

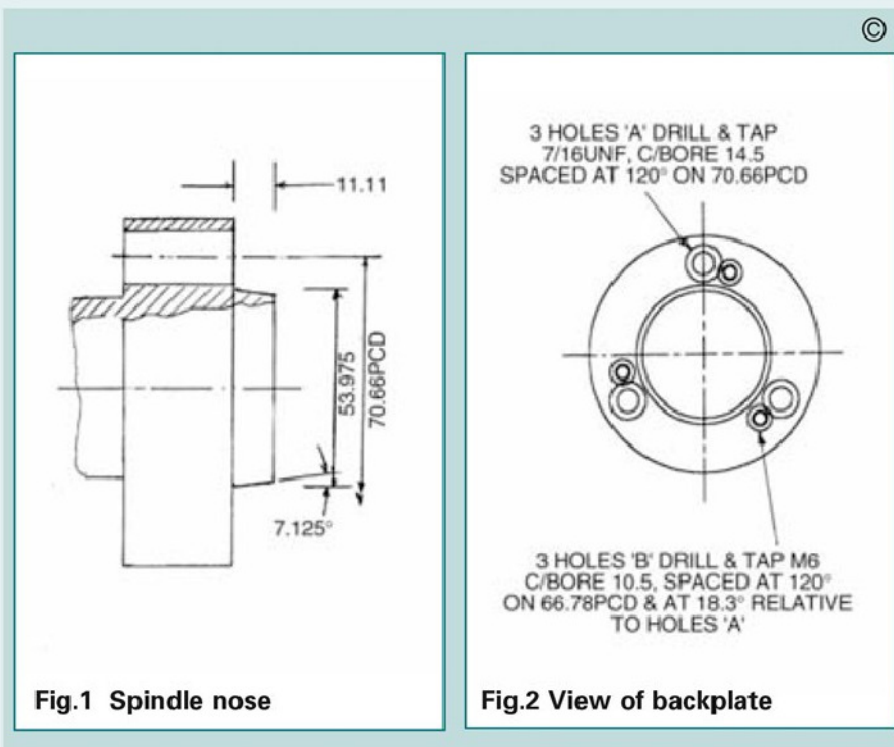


Fig.1 Spindle nose

Fig.2 View of backplate

the accuracy of my male taper. This is perhaps the most important part of all – the fitting gauge must be accurate because the D1-3 nose must fit on both the front face and the taper exactly. However, it can be done – even by someone with as limited skills as this author. If you make the tapered section too small, you simply need to skim something off the front face and then redo the taper. With a fitting gauge, it makes it more convenient and easier to produce the required female taper in any faceplates or backplates you wish to make. It can – like the taper gauge – be used again and again. Hindsight is of course a wonderful attribute, and thinking back, it now occurs that perhaps the fastest way to bring the fitting gauge to size might be to first make the taper a thou or two under. Then place the catch plate on the taper and hold against the flat face. Then measure the radial float and remove 3 times this amount from the face. After a second repeat the fit would probably be acceptable. (the relationship should be close to 4:1 based on trig.)

Moving onto the faceplate itself, with the tool set and the faceplate rear facing the tool (either on a 4 jaw chuck or another lathe) it is possible to open out to the correct taper. The fitting gauge can be used to test the size. Remember that male and female tapers on the lathe nose and faceplate/backplate must fit perfectly, and that contact must also be made with the flat face.

Holes for Camlock Studs

The next step is to produce suitable holes for the Camlock studs and this is where a DRO or rotary table is almost essential. There is a standard for Camlock studs thread sizes but it doesn't seem to be universally applied. Apparently some studs are M10 but mine were $\frac{7}{16}$ in. UNF. Since the body of the Camlock stud ($\frac{7}{16}$ in.) goes into the faceplate for a few mm, there are two diameters for the hole required for each stud – on mine a 9.9mm hole for tapping $\frac{7}{16}$ in. UNF and a 14.5mm hole for the stud body.

The studs are held in place by M6 socket head cap screws. These require a 5.2mm hole for tapping and a 10.5 mm hole for the cap screw head. The only problem in producing these holes is that the one for the cap screw head will break into the stud hole and if you try to use a drill for this, it will cause some bending of the drill towards that hole and loss of accuracy. I found it necessary to open the cap screw head hole out with a milling cutter.

The holes for the studs and the holes for cap screws are on different PCDs:

70.66mm for the stud
66.78mm for the socket screw.

Without access to a DRO or rotary table, I'm not sure how easily these features could be set out with the required degree of accuracy. Using calculated X-Y coordinates, the DRO also makes it easy to set the required angle between the stud hole and the socket screw hole of 18.3deg. I dealt with the three stud holes first and then moved on to the three holes for the cap screws.



6. Completed fitting gauge



7. Using the taper gauge to set the topslide angle.

When putting the studs in, you may have to screw them in or out in order to correctly engage with the cams in the lathe nose. With the studs in place, the faceplate can be mounted on the lathe and the witness mark (to ensure that it is always replaced in the same location stud-wise) put in with a few taps of a chisel or centre punch.

Getting studs

Studs are available through industrial sources like Rotagrip (who handle genuine Pratt Burnerd parts), and cost industrial prices. I discovered that RDG Tools also supplied them (see **Photo 8**). These are quite cheap but do not appear to be as hard and they are missing a machined semi-circular feature on each side of the stud which is in the standard (BS4442-1:1969). However, they are cheaper and do work. My next step, given time, will be to work out a jig which allows studs to be machined. In

discussion with others it has been suggested that suitable materials for studs might include silver steel (hardened and tempered back a bit to avoid brittleness), also En19 and En24, both alloy steels, which can be suitably heat treated or obtained in the "T" condition. (i.e. already heat treated to around 55-65 tonf./sq. in.). But any further advice is welcome at philipleith@netscape.net.



8. Detail of Camlock stud.

MOVING $\frac{3}{4}$ TON LATHE SINGLE HANDED



1. Jacked up and ready to roll.

Dick Gays outlines his approach to machine relocation

When the lathe was pulled on to the rails in front of the garage by mini hoist, the length of rail it was on had to be crow barred up on to blocks and then levered sideways above some edging stones to line up with a narrow passage. (Photo 1) SWMBO would not have approved of my moving the edging stones and damaging the flower bed.

The motor cover and electrical input box were removed to change the lathe from 50mm wider than the passage to 25mm narrower, making progress to the back of the house possible. Photo 2 shows the wide end of the tapered passage

The journey here is down hill so the mini hoist is used to limit the speed of travel and to act as a brake when the previous rail section is moved ready to be the next section.

The next obstacles were slewing the track round towards the steps and then aligning the track with the steps, not an easy task single handed. (Photo 3) Lengths of wood under the rails make slewing the track easier and prevent scrape marks on the patio.

Fortunately the steps were downwards, the mini hoist being used behind the lathe again, to control the descent and act as a brake whilst the spare piece of track was moved forwards in readiness. (Photo 4) Crossing the soggy lawn was easy going though the wooden sleepers under the track sank well in.

More track slewing was required to line up with the workshop doorway, then it was a simple case of lay another length of track, pull and the job was done. (Photo 5).

It took about 4½ hours to move about 100 feet, laying the track as it went. That works out about 0.004 miles per hour, but there were leaves on the line...honest.



2. The wide end of the tapered passage.

For a few years my Colchester Student lived in extremely cramped conditions in my garage, but last January it was moved to a new workshop at the bottom of the garden.

There a number of obstacles to overcome on the way, like a passage 50mm narrower than the width of the lathe, two corners to be rounded, steps to be descended and a very soggy lawn to cross.

Since my options for moving it were limited to what I could make and my own muscle power, it was decided to send it by rail. Two full lengths of 50mm x 50mm angle, later used on another job, were first cut in half and welded to spacers to make the rails at the correct "gauge" in a "toes in" configuration. This meant I had two sections of rail, 3 metres long, which could be bolted together at either end. Two short bits of angle exactly the width of the lathe had short stub axles welded on, and were bolted one at each end of the lathe. Four nylon wheels were turned, 40mm wide, 70mm diameter. These were a free fit on the stub axles, only the rail flanges stopped them falling off.



3. Slewing round and aligning the track.



4. Descent controlled by mini hoist.



5. Safe arrival at destination

Scribe A Line

Dr D B James of Glan Conwy writes:

Re. making gear wheels without machine tools

If you read "Gears from the Greeks" by Jones, you will discover that they could make gear wheels with 440 teeth. If they had machine tools they must have all rusted away by now. If you read "The Mathematics of Plato's Academy" by D H Fowler, you will find they thought mainly about whole number ratios, and clearly if you had a wheel with 113 teeth meshing with one with 355 teeth, you could calculate π pretty well. But the book makes no mention of technology. Were the philosophers all "snobs", and all the "technology" done by slaves? Christian Huygens had two astronomical clocks built; was it easier to make two than one? Did it make sense to clamp two wheels together, chase the teeth, move them on a few teeth and repeat and so remove the periodic errors.

Perhaps other readers may be able to answer my queries from their own practical experience or other avenues of research.

Chris Fouweather writes:

Re making pcb's

Since writing the article published recently, I have found some paper which is perfect for making pcb's and is very cheap. It contains no clay and is ideal for our purpose. It can be obtained from www.ctsdirect.co.uk email sales@ctsdirect.co.uk order code 4CCA4130 size A4 price £6.99 for 250 sheets. They also do it in A3. It is much easier to use than photographic paper and could not be cheaper.

Ted Fletcher writes:

Before buying expensive "Esso Nutto 44" oil for your lathe (which is actually

hydraulic fluid) visit your local ship chandlers, agricultural tractor dealers or earth moving equipment company who may stock the Shell equivalent, with a clean an empty 1 litre plastic container and pay rather less.

Ted Wale of Nova Scotia writes:

Re Knurling

With reference to Garry Wooding's letter on knurling I completely agree with what he says and with our editor's note to it. I also have found that starting with a deeper cut yields a good started and finished job. I also think that Garry's proposal that the wheel slips and adjusts itself to the first set of valleys is the most sensible answer to "Why does the same knurling wheel cut clean knurls over a wide range of workpiece diameters?" I have often wondered about that without giving it much serious thought. BUT I strongly suggest that this is not the real nor complete answer. For years I owned and used the simple two wheel tools that mount in the tool holder and are forced into the workpiece by cross slide pressure. On my original little Emco this worked poorly if at all and certainly strained everything in the attempt. When I progressed to the 6in. Atlas things were better but it still felt horrible. I now own a 10in. heavy duty Southbend (my pride and joy) and even on this the forcing of the knurling tool into the workpiece is an insult to the machine. The force required for a 5 thou knurl is apparently many times that needed for a 50 thou cut in stainless steel. In addition, unless everything is wrung up dead tight the tool is liable to finish up tilted to the workpiece.

Two years ago I was faced with project that required an amount of knurling. It was at this point that I seriously considered the

Mr Tom Bartlett of Swanley writes: Drill sharpening with a Lapping or Honing Jig

I really don't think that model engineers should let their drills get into such a state that they need grinding, whether it be done freehand or on any grinder. There is the danger of drawing the temper through overheating. There is an alternative method, that is to make a jig that can hold the drill rigidly so that both facets can be sharpened on an oil stone at one setting

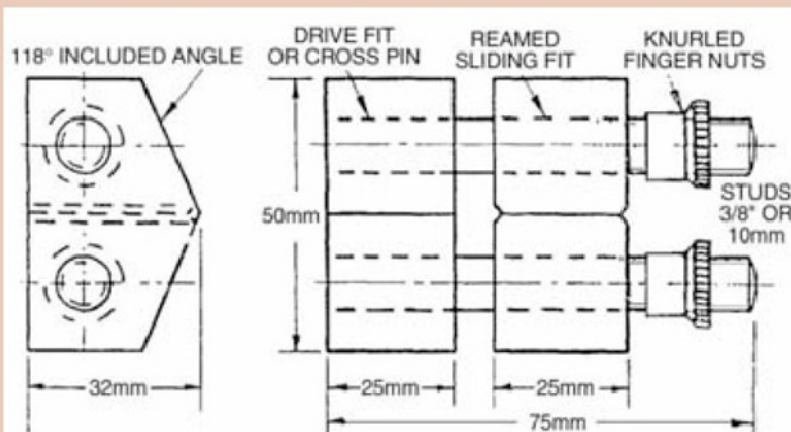
Use a large oil stone as used by carpenters, lay it on the bench and slide the jig with the drill protruding slightly. The drill needs to be rotated prior to clamping, so that a small amount of clearance is formed. The precise setting may call for a little trial and error. This will produce a superior cutting edge. Keep sliding until the jig touches. Some oil on the stone will help prevent grooving. Deal with both facets equally.

To construct the jig, machine two steel blocks 50mm x 32mm x 25mm. Clamp them together with Loctite adhesive whilst they are drilled to take two 3/8in. rods. These must be set parallel, and the bores accurately formed so that one block can slide without slack. The rods should be retained in one block, and fitted with knurled clamping nuts.

Two principal operations remain. You can either drill a small hole through the centre, and then separate and file to form the Vees, then machine the main angles. Or you may choose to create the angle surfaces first, followed by cutting the Vee. Either way, it is necessary to ensure that the centre line of the Vee is coincident with the apex of, and bisects the 118degree angle to ensure accurate and even lapping of the drill edges.

For small drills, a smaller version using perhaps half inch plates would suffice.

We would also thank Mr Brian Bach of Longfield, who also provided descriptive information and drawing for the same device.



Colin Golding writes:

Close up of the makers plate on the Taylor chuck



Other readers may be interested in a little more information on the three jaw chuck shown in MEW iss 98 page 44. The accompanying photos convey the essential details of the device, manufactured by Chas. Taylor. The principal feature is that the jaws do not slide radially perpendicular to the axis, but at an angle. The scroll instead of being flat with a square thread is coned inwards with a buttress thread. In spite of its fair age, I find this to be still an exceptionally accurate chuck. I have found some information concerning the company on the internet, but otherwise have little knowledge of the Chas. Taylor company or its other products, perhaps others may be able enlighten us.

The component parts, note the angle of the thread on the jaws.

problem (for the first time I regret to say) and the solution was obvious - take that strain off the cross slide! Over the years there have been many designs published in many magazines for a knurling tool that is only positioned in the tool holder and in which the pressure to cut the knurl is supplied by a clamping action between two (or three) wheels. This loading is internal to the knurling tool and throws no load on to the tool holder whose sole function is to position the knurling tool on to the lathe centre line(approximately). The latest version that I have seen is in our own MEW iss. 72-April 2001- and the article is by the same Gary Wooding would you believe. This was the one I made in a few hours and with very few small changes so that it suited both my 6in. and 10in. lathes. The end result is clean deep knurls simply made first time, good control of the start and finish positions, depth of the final knurl only limited by the depth of the teeth on the cutting wheel and no strain on the cross slide. It drops into my quick change tool holder, already set up, in 15 seconds.

Why did I wait so long to do what is

obviously basic good machine practice? I strongly suggest that all model makers(as well as machinists) should take the little time that it takes to make one. This is certainly a lot less than repairing the lathe that uses it.

Dr. John Ponsonby writes:

I have just received issue 101 of MEW and have read Dick Stephen's article describing his "Speed Increaser" device. It seems to me his Fig 1, showing the gear train, is in significant error. The "ring wheel" which is the driven wheel, is shown rotating clockwise. This will make the "planet wheel", whose axis is fixed in position, also rotate clockwise. The "sun wheel", which is on the output shaft, will therefore rotate anticlockwise and not as shown. Thus his device reverses the direction of rotation. He doesn't remark on this in his text. To use the device with conventional milling cutters therefore requires one to be able to reverse the direction of the mill spindle.

Possibly the >£1000 commercially

available device that he sought to emulate doesn't have this reversing feature and therefore must contain something other than his simple "fixed planet" epicyclic gear train.

Dave Fenner comments: As Dick Stephen is on holiday I have not been able to contact him for additional comment. I believe that his machine would already be fitted with a reversing facility, useful for tapping. Our thanks to Dr Ponsonby for correctly pointing out the error and omission. The commercial device is believed to be a simple epicyclic arrangement but utilising fixed annulus - rotating planets, and hence no reversal between input and output. In this respect it bears some similarity to the gear train described by Richard Bartlett in MEW issue 85.

Tom Cowing of Hexham writes:

When faced with a need to produce a small thirteen leaf pinion, and not having a suitable gear wheel. I persuaded a computer literate friend to print off a large pie chart with thirteen equal divisions. This was glued to a disc which was in turn fitted to an adapter in to the rear of the headstock spindle. The large diameter ensured that any error was minimal. Others may find the technique useful for division work with awkward numbers.

LINK UP

Would readers wishing to make use of this facility please note that the maximum total value of items accepted for a 'For Sale' entry is £50.

To advertise goods of a greater value, please contact our Classified

Advertisement Department. Please indicate clearly if an item is intended for Link Up.

FOR SALE

- For Sale: Set of 9 Myford lathe tools, boat type with 4 boats, all in very good condition £40. Please phone 01723 362 537 or write 114 Scholes Park Road Scarborough

WANTED

- Wanted: Issue 87 of MEW. I have every other issue except this, resulting from a subscription mix-up. Sensible price paid. Greg Widin email: gpwidin@comcast.net
- Wanted: Instruction / maintenance manual for Amolco milling attachment. Photocopy costs etc. gladly reimbursed. Please phone 01793 524 153 (Swindon)

Issue 100 Competition Winners

Judging by the volume of entries, the competition feature was well received by readers. Entries were received from many different parts of the world, the international nature of MEW being underscored by winning entries which were received from Australia and France as well as the UK. We congratulate the following lucky winners, and trust that the items they choose will give them great pleasure for many years to come.

Arc Euro Trade Competition

M. Bernard Fargette
Reims, FRANCE

Camden Competition

Mr. Peter Harrison
Rugeley
Staffs

Folkestone Engineering Supplies Competition

Mr. Robin F. Smith
Lynwood, W. AUSTRALIA

Hemingway Kits Competition

Mr. John Chamberlain
St. Helens, Merseyside

Myford Competition

Mr. P Andrews
Spalding, Lincs

Newton Tesla Competition

Mr. Peter Evand
York, Yorks.

Warco Competition

Mr. Bernard Towers
Norwich, Norfolk

TO HELP YOU GET THE BEST FROM THE MODEL ENGINEER EXHIBITION

These notes are written purely for guidance. Full information is contained in the Competitors' Information booklet which is sent to every entrant as part of the information package. If you have an item and are unsure as to the Class into which it should be entered, leave that section blank and we will take care of it. The Judges have the right to move any competition exhibit into another class if they feel that by doing so its chances of gaining higher marks or a more appropriate award are improved.

If the item is offered as a Loan exhibit please indicate this by writing Loan on the form in the box identifying the Class. Loan models are not judged but carry all other privileges associated with competition entries.

Part built models are particularly welcome in the Loan Section; visitors like to see work in progress, and entry does not preclude the item being entered in competition when completed.

The classes listed below are those associated with mainstream model engineering.

Club exhibits

Where a club is exhibiting, each model should be entered on a separate entry form and clearly identified as a club exhibit by entering Loan/Club in the class section box. This ensures that we have a full record of all models on display during the show and facilitates matters of administration and insurance.

Additional forms

If you do not wish to deface your copy of the magazine we are happy to receive photocopies of the entry form, one for each model. We will be pleased to send out extra forms if required, so if you know of a modeller who is not a reader of one of our magazines but who you think may wish to participate, please advise them to contact our Exhibitions Office, or simply photocopy the entry form for them.

The success of the show depends largely on the number of models on display. Your work could well be the stimulus which inspires someone else to start in the hobby. There can be no doubt that this event is our showcase on the world of modelling in all its aspects. Every modelling discipline needs more and more participants, and it is by displaying not only the crème-de-la-crème, but also examples of work of a more achievable standard, that people are encouraged to join into the wonderful world of modelling, in whatever aspect.

We look forward to seeing a sample of your work at the show!

COMPETITION CLASSES

Engineering Section

- A1 Hot air engines.
- A2 General engineering models (including stationary and marine engines).
- A3 Internal combustion engines.
- A4 Mechanical propelled road vehicles (including tractors).
- A5 Tools and workshop appliances.
- A6 Horological, scientific and optical apparatus.
- A7 General engineering exhibits — not covered by the above

Railway Section

- B1 Working steam locomotives 1in scale and over.
- B2 Working steam locomotives under 1in scale.
- B3 Locomotives of any scale, experimental, freelance or based on any published design and not necessarily replicas of full size prototypes, intended for track duties.
- B4 Scratchbuilt model locomotives of any

scale, not covered by classes B1, B2, B3, including working models of non-steam, electrically or clockwork powered steam prototypes.

- B5 Scratchbuilt model locomotives gauge 1 (10mm scale) and under.
- B6 Kitbuilt model locomotives gauge 1 (10mm scale) and under.
- B7 Scratchbuilt rolling stock, gauge 1 (10mm scale) and under.
- B8 Kitbuilt rolling stock, gauge 1 (10mm scale) and under.
- B9 Passenger or goods rolling stock, above 1in scale.
- B10 Passenger or goods rolling stock, under 1in scale.
- B11 Railway buildings and lineside accessories to any recognised model railway scale.
- B12 Tramway vehicles.

Marine Models

- C1 Working scale models of powered vessels (from any period). Scale 1:1 to 1:48
- C2 Working scale models of powered vessels (from any period). Scale 1:49 to 1:384
- C3 Non-working scale models (from any period). Scale 1:1 to 1:48
- C4 Non-working scale models (from any period). Scale 1:49 to 1:384
- C5 Sailing ships and oared vessels of any period - working.
- C6 Sailing ships and oared vessels of any period - non-working.
- C7 Non-scale powered functional models including hydroplanes.
- C8 Miniatures. Length of hull not to exceed 15in for 1:32 scale; 12in for 1:25 scale; 10in for 1:16 scale; 9in for 1:8 scale. No limit for smaller scales.
- C9 For any model boat built from a commercial kit. Before acceptance in this class the kit must have been readily available for at least 3 months prior to the opening date of the exhibition and at least 20 kits must have been sold either by mail order or through the retail trade.

Scale Aircraft Section

- D1 Scale radio control flying models
- D2 Scale flying control-line and free flight
- D3 Scale non-flying models, including kit and scratch-built
- D4 Scale flying radio controlled helicopters

Model Horse Drawn Vehicle Section

- G1 Carriages & other sprung vehicles. (Omnibuses, trade vans etc.) Wagons, carts and farm implements. Caravans.

Junior Section

- J1 For any type of model, mechanical or engineering work, by an under 14 year old.
- J2 For any type of model, mechanical or engineering work, by an under 16 year old.
- J3 For any type of model, mechanical or engineering work, by an under 18 year old.

All entries will be judged for standard of craftsmanship, regardless of the modelling discipline, i.e. a boat will not be competing

against a military figure. Providing a model attains sufficient marks it will be awarded a gold, silver or bronze medals

Model Vehicle Section

- K1 Non-working cars, including small commercial vehicles (e.g. Ford Transit) all scales down to 1/42.
- K2 Non-working trucks, articulated tractor and trailer units, plus other large commercial vehicles based on truck-type chassis, all scales down to 1/42.
- K3 Non-working motor bikes, including push bikes, all scales down to 1/42.
- K4 Non-working emergency vehicles, fire, police and ambulance, all scales down to 1/42.
- K5 Non-working vehicles including small commercial vehicles (e.g. Ford Transit). Scale from 1/43 or smaller.
- K6 Any available body shells including Concours, in any scale or material, to be judged on appearance only.
- K7 Functional model cars/vehicles which must be able to move under its own power of any type. Can be either free-running, tethered radio controlled or slot car, but must represent a reasonable full size replica

DUKE OF EDINBURGH CHALLENGE TROPHY

Rules and Particulars

1. The Duke of Edinburgh Challenge Trophy is awarded to the winner of the Championship Award at the Model Engineer Exhibition.
2. The trophy remains at all times the property of Highbury Leisure.
3. The name of the winner and the date of the year in which the award is made will be engraved on the trophy, which may remain, at the discretion of Highbury Leisure in his/her possession until required for renovation and display at the following Model Engineer Exhibition.
4. Any piece of model engineering work will be eligible for this Championship Award after it has been awarded, at The Model Engineer Exhibition, a Gold or Silver medal by Highbury Leisure.
5. No model may be entered more than once.
6. Entry shall be free. Competitors must state on the entry form:
 - (a) That exhibits are their own bona-fide work.
 - (b) Any parts or kits that were purchased or were not the outcome of their own work.
 - (c) That the model has not been structurally altered since winning the qualifying award.
7. Highbury Leisure may at their sole discretion vary the conditions of entry without notice.

COMPETITION RULES

1. Each entry shall be made separately on the official form and every question must be answered.
2. Competition Application Forms must be received by the stated closing date.

LATE ENTRIES WILL ONLY BE ACCEPTED AT THE DISCRETION OF THE ORGANISERS.

3. Competitors must state on their form the following:
 - (a) Insured value of their model.
 - (b) The exhibit is their own work and property.
 - (c) Parts or kits purchased.
 - (d) Past not the outcome of their own work.
 - (e) The origin of the design, in the case of a model that has been made by more than one person.

NOTE: Entry in the competition can only be made by one of the parties and only their work will be eligible for judging.

4. Models will be insured for the period during which they are in the custody of Highbury Leisure.
5. A junior shall mean a person under 18 years of age on December 31st in the year of entry.
6. Past Gold and Silver medal award winners at any of the exhibitions promoted by Highbury Leisure are eligible to re-enter their model for the 'Duke of Edinburgh Challenge Trophy.'

Past winners at any of the exhibitions promoted by Highbury Leisure will not be eligible for re-entry into the competition unless it has been substantially altered in any way.

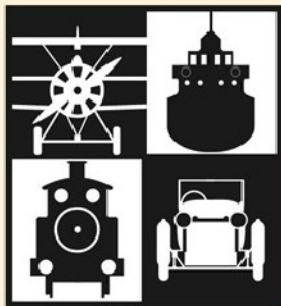
7. Highbury Leisure reserve the right to:
 - (a) Transfer an entry to a more appropriate class.
 - (b) Describe and photograph any models entered for competition or display and to make use of any such photographs or descriptions in any way they may think fit.
 - (c) Refuse any entry or model on arrival at the exhibition and shall not be required to furnish a reason for doing so.
8. Entry into the competition sections is not permitted by:
 - (a) Professional model makers.
 - (b) Anyone who has a financial interest in the direct supply of materials and designs to the public.

NOTE: If unsure, please contact the Competition organisers, prior to the show.

9. The judges' decision is final. All awards are at the discretion of the judges and no correspondence regarding the awards will be entered into.
10. Exhibitors must present their model receipt for all models collected at the end of the exhibition and sign as retrieved.
11. The signed release for each model must be presented to security staff when leaving the exhibition complex with display model(s) after the close of the exhibition.

IMPORTANT NOTE PLEASE MAKE COPIES, INCLUDING PHOTOGRAPHS, OF ALL INFORMATION RELATING TO YOUR MODEL, AS Highbury Leisure WILL NOT ACCEPT LIABILITY FOR ANY LOSS.

CLOSING DATE 17TH DECEMBER 2004



THE MODEL ENGINEER EXHIBITION

Please return completed form to:
Model Engineer Competition, The Leys,
Church St., Twyford, Bucks. MK18 4EU

ENTRY FORM - COMPETITION & LOAN MODELS

ENTRY NO.

OFFICE USE ONLY

CLASS	ENTRY NO.

PERSONAL DETAILS (Please print)

Surname Forename(s) Age

Address
.....
.....

Post Code Home Tel: Daytime Tel:

Model Club or Association

Have you entered before? (Y/N)

Do you purchase or subscribe to a Highbury Leisure magazine? (Y/N)

How many years have you been a modeller?

Mail Order Protection - please tick this box if you would prefer not to receive mail from other companies which may be of interest to you ☐

MODEL DETAILS - PLEASE TICK BOX IF MODEL IS FOR LOAN ☐

Entry Class (competition entries only)

Model Title (to be used for catalogue and display card)

Model Description

Model Scale Length Width Height Weight

Type of construction

Parts not made by you and commercial items.....

Have you supplied a photograph? (Y/N)

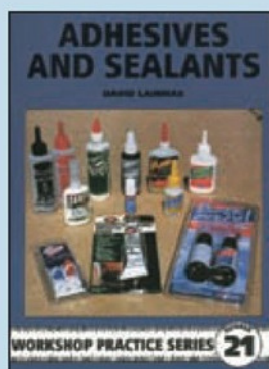
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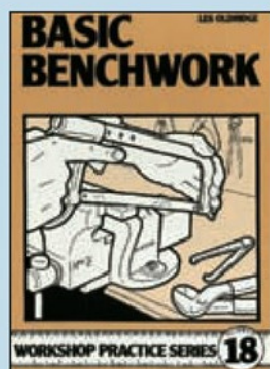
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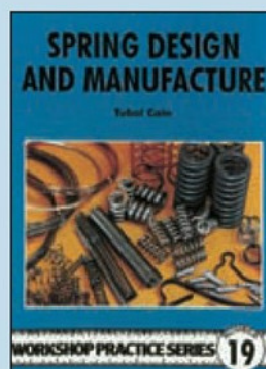
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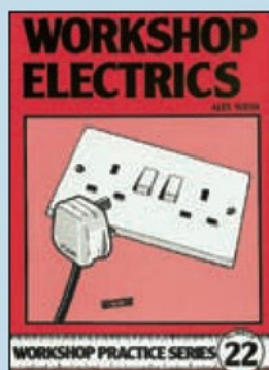
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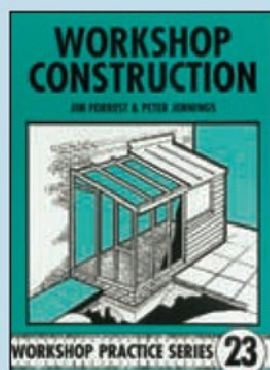
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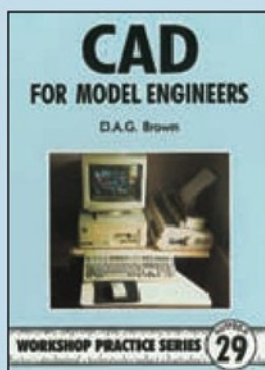
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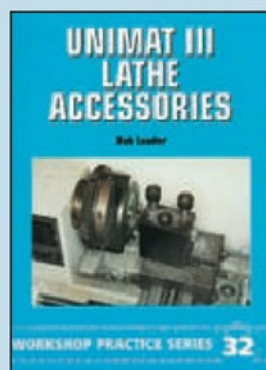
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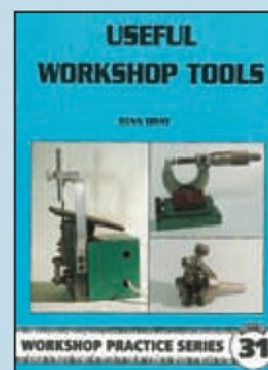
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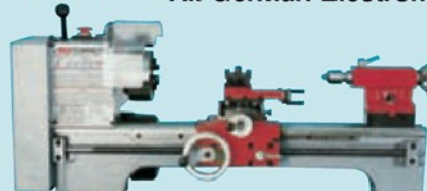
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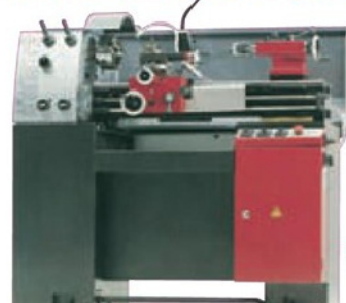
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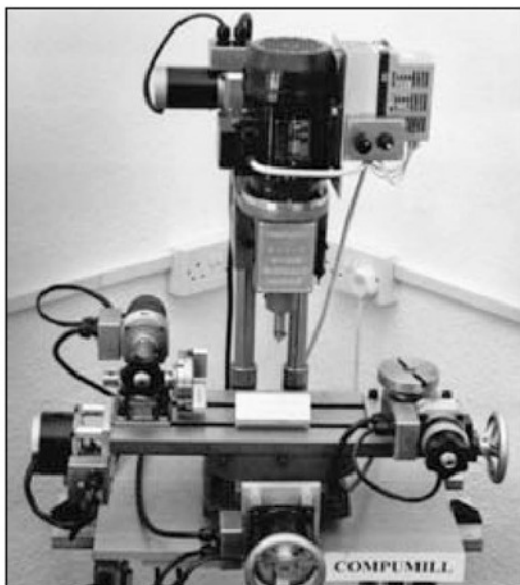
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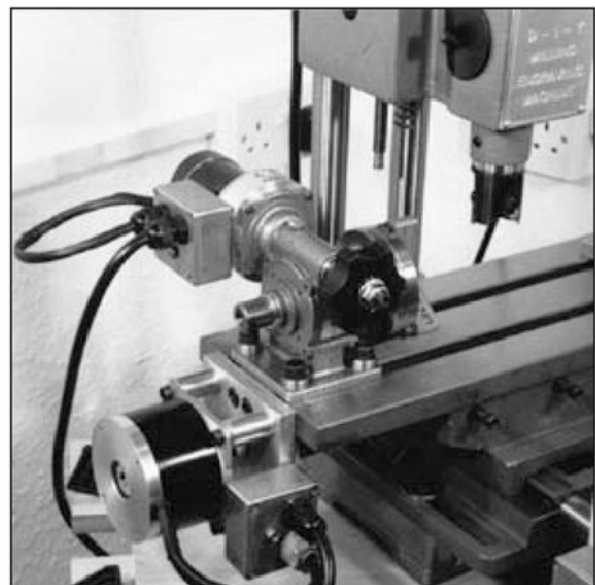
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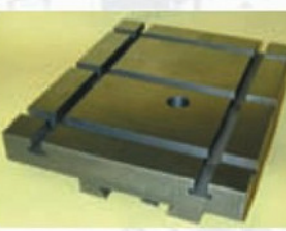
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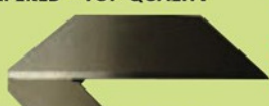
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