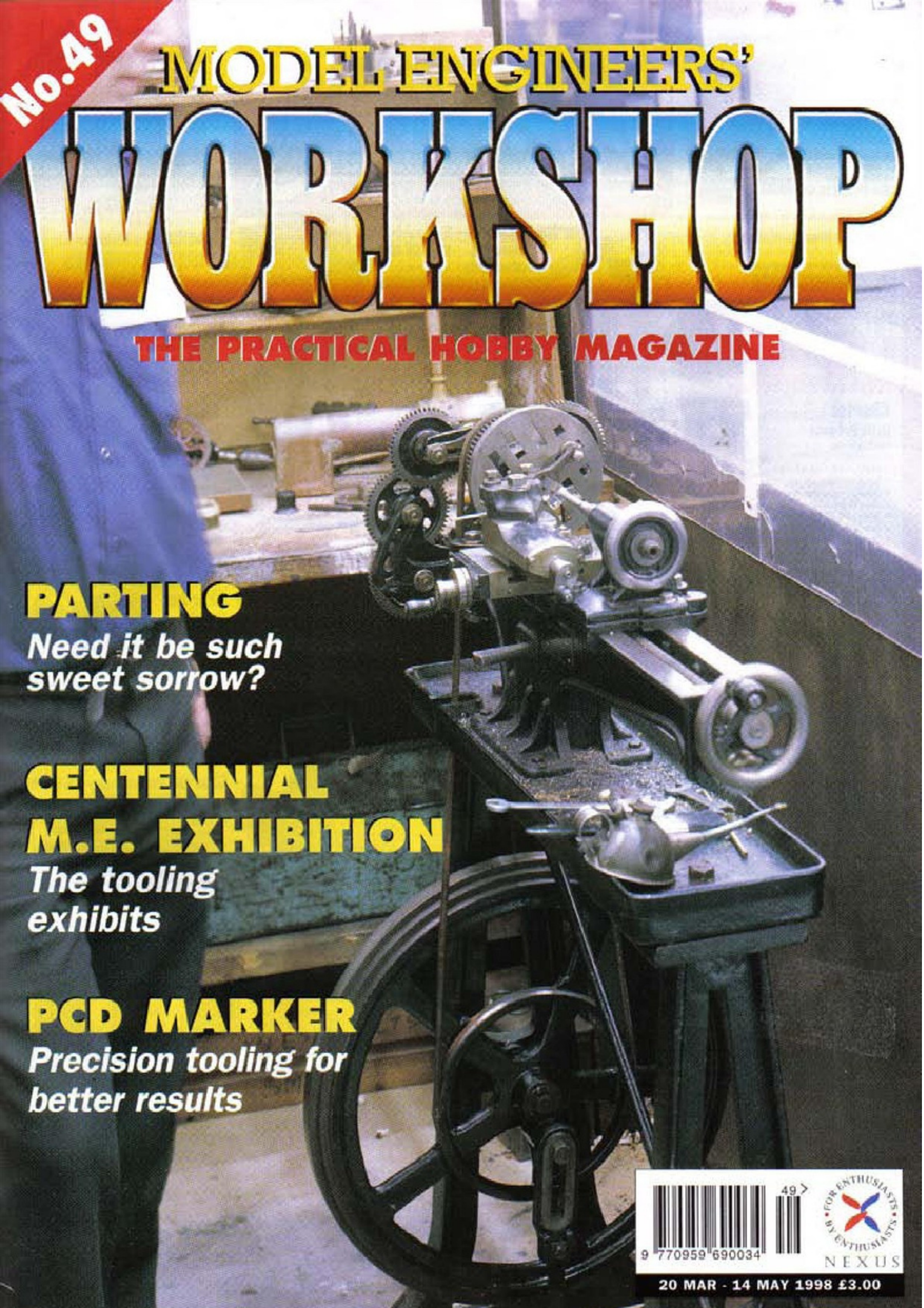
No.49

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE



PARTING
Need it be such sweet sorrow?

CENTENNIAL M.E. EXHIBITION
The tooling exhibits

PCD MARKER
Precision tooling for better results

49
9 770959 690034
NEXUS
FOR ENTHUSIASTS BY ENTHUSIASTS
20 MAR - 14 MAY 1998 £3.00

Published by
Nexus Special Interests Limited
Nexus House, Boundary Way,
Hemel Hempstead, Herts HP2 7ST
Tel: 01442 266551
Fax: 01442 266998

EDITORIAL

Editor
Geoff Sheppard

Group Editor
Ted Jolliffe

PRODUCTION

Designer
Minh Huynh

Production Executive
Theresa Davis

Printed By
St. Ives plc (Andover)

Origination by
Derek Croxons

SALES

Group Sales Ad's Manager
Dianne Farnham

Midland and Southern Area Sales
John Furlong

Northern Area Sales
Denise Barrow
Nexus Media Ltd
Carrington Business Park
Manchester Road
Carrington, Manchester, M31 4YR
Tel: 0161-776 4460
Fax: 0161-777 6524

Classified Ad's Sales
Kelly Helsey

MANAGEMENT

Divisional Managing Director
Tony Debell

Business Manager
Stuart Cooke

Circulation Manager
William Pearson

SUBSCRIPTIONS

SUBSCRIPTIONS: Nexus Subscription Services, Tower House, Sovereign Park, Lathkill Street, Market Harborough, Leicestershire, LE16 9EF.
7 issues UK £18.65, Europe & Eire £26.00, Sterling Overseas: £27.00 (surface-mail) £32.50 (air-mail), US$ overseas $43.00 (surface-mail) $53.00 (air-mail)
Cheques payable to Nexus Special Interests Ltd.
USA Subscription Agent: Wise Owl Worldwide Publications, 4314 West 238th Street, Torrance, CA 90505-4509 USA. For Visa/Mastercard orders in USA telephone (310) 375-6258 Fax (310) 375-0548. Pacific Time: 9am-9pm Weekdays 10am-6pm Weekends.

Model Engineers' Workshop is published Bi-monthly plus an extra copy in November. Subscription price is £43.00, ($53.00 air-mail). Periodical postage paid at Rahway NJ.
Postmaster send address corrections to *Model Engineers' Workshop*, c/o Mercury Airfreight International Ltd., 2323 Randolph Avenue, Avenel, NJ 07001.

NEXUS

CONTENTS

Issue No. 49

Editor: Geoff Sheppard
Nexus Special Interests, Nexus House, Boundary Way, Hemel Hempstead, HP2 7ST, tel. 01442 266551

SUBSCRIPTIONS AND BACK ISSUES HOTLINES:
ORDERS:
01858 - 435344
ENQUIRIES:
01858 - 435322
LINES OPEN 9am - 6.30pm

On the cover

During the recent M.E. Exhibition continuous demonstrations of turning on a treadle lathe were carried out in the West Wilts SME replica Edwardian workshop. Demonstrator was Mike Harmsworth. He reports that he spent more time answering questions and chatting than actual turning. Our look at the show starts on page 52. (Photo: John Jolliffe).

In industry there are literally hundreds of types and designs of grinding wheels for special purposes. Here we show a selection such as might be found in the well equipped home workshop. Find out their characteristics and how to get the best use from them starting on page 20.

ON THE EDITOR'S BENCH

In this issue we carry a report by our correspondent 'Condor' on the workshop equipment seen at the recent International Model Show at Olympia. This event, which of course incorporates the long-standing Model Engineer Exhibition marked the opening of Centenary year celebrations for *Model Engineer* magazine. January 1st. 1998 saw the publication of Issue No. 4058, one hundred years to the day since Percival Marshall launched *The Model Engineer and Amateur Electrician*. In the intervening years, only a handful of issues have failed to appear, due to industrial action taken on a nation-wide scale. Even total demolition of the editorial offices by bombing during the 1940s failed to interrupt publication, and a few traumatic episodes under a variety of owners following the death of 'PM' were survived due to the existence of a loyal readership and the efforts of a number of supportive contributors.

A look at the Centenary issue is very encouraging. Apart from a few delightfully nostalgic items, three excellent articles are by particularly youthful contributors, one of whom has used computer generated drawings and illustrations to explain, with outstanding clarity, the manufacture of some useful soft chuck jaws. On other pages there is an instalment of the constructional series on the building of a 1:20 scale version of the 'No. 2' beam engine at Crofton, while Martin Evans celebrates his 40 years association with the magazine by introducing his latest miniature locomotive *Centenary*.

Congratulations to Ted Jolliffe and Mike Chrisp for steering the magazine towards its next milestone.

Turning now to the Exhibition, the centre piece as far as model engineering was concerned, was the Centennial Village, where great efforts had been made to depict the history of model engineering over the hundred years. The team had succeeded in assembling a number of outstanding collections which, for a variety of reasons, we are not likely to see brought together again. As always, the Society of Model and Experimental Engineers (who also celebrate their centenary this year) had been most supportive, and their stand and workshop were as busy as ever, with members and friends from all over the world 'clocking in' to participate. I find the social gathering to be one of the most important parts of the Exhibition, and enjoyed the opportunity to meet readers of and contributors to this magazine. I can now count quite a few as personal friends, and look forward to meeting more each year.

One aspect of this concentration of effort on the 'Village' was, I feel, some reduction of support for the traditional Competition and Loan sections, where although quality was, as always, extremely high, quantity had suffered. It seems that there may be a natural limit to the energies available to make these things happen. I was particularly disappointed by the support given to the Workshop Equipment categories. There was only a small number of exhibits, fortunately all of high standard, and to those who did make the effort I would offer my sincere thanks.

I am trying to understand the reasons for this scarcity of entries. In recent years, we have not seen a design for a major piece of equipment which has caught the imagination of those who enjoy adding to the capabilities of their workshop by building for themselves. Looking back over the years, we have seen items which have been built by the hundreds. One of the first was the *M.E.* High Speed Sensitive Drilling Machine, designed by Edgar Westbury back in 1941, and for which castings are still available and sold in small numbers. Later came Westbury's 1/2in. capacity Light Vertical Milling Machine, which really 'took off' when the design was re-worked in conjunction with Arnold Throp of Dore Engineering. This new version, now known as the 'Dore-Westbury', was of a simplified construction and easier to make on the type of equipment likely to be found in the amateur's workshop.

I suppose that the next landmark item was the Quorn Tool and Cutter Grinder. Designed and made by Professor Dennis Chaddock. It is said that this came about through the need to be able to sharpen the variety of small milling cutters required for the manufacture the components of the miniature V8 B.R.M. engine he was building. It immediately became popular with those who had no access to a means of sharpening end mills and slot drills, and many have been built. No exhibition is complete without another high-quality example of this outstanding design.

The other major contributor to this list of what could be considered to be 'classic' designs was, of course, George Thomas. Again, the stimulus was a model engineering project under construction, this time a 3 1/2in. gauge 'Pacific' locomotive, *Papyrus*. Every time he came to a stage of the construction for which he did not feel adequately equipped, he would stop, consider the problem from first principles and then design something with which to do the job properly. The result is a legacy of ingenious and practical designs, together with detailed descriptions of how to go about making them. I can vouch from personal experience that following the instructions always seems to end up with a satisfactory result. My only criticism has been that his methods were, on occasions, slightly over-elaborate, and an experienced worker could short-circuit some of them. However, the beginner could set off, confident that observance of the instructions should guarantee success. The irony is, I understand, that the locomotive never did get finished.

Outstanding among 'G.H.T.'s designs were the Universal Pillar Tool and the Versatile Dividing Head. Both items continue to be made in large numbers.

What is the reason for the popularity of the devices mentioned above? It is probably because, at the time, there was not a piece of equipment commercially available which met a perceived need and which complemented the other equipment already available. This was often associated with size, because even the smallest industrial equipment was usually just that bit too big. The instant that mill/drills of a size suitable for the home workshop became readily available, the popularity of home-built machines of a similar size began to decline.

No industrial manufacturer has considered the home workshop market to be sufficient to introduce a small ready-built tool and cutter grinder, though there are other self-build designs which now challenge the Quorn. The 'Stent', the 'Kennet' and the 'Worden' are examples of these, but Ivan Law who now has the prototype Quorn in his care says that although, on the majority of occasions, he will use his Kennet, there are still certain jobs only the Quorn will tackle successfully. Similarly, I have not yet seen a commercially available dividing device which is quite as versatile as G.H.T.'s design, particularly when used in conjunction with our smaller lathes and milling machines.

Where do we go from here? What is the next development in home workshop capability which is not catered for by a really suitable piece of commercially available equipment?

Is it the manufacture of more complex shapes? Do we foresee the need to machine more exotic materials? Are model engineers seeking greater dimensional accuracy and surface finish? Does speed of production really matter in our environment?

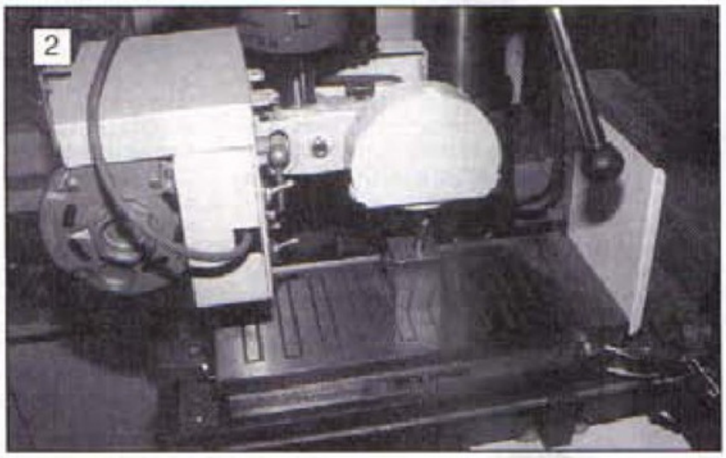
We have a number of talented contributors who, I am sure would not be able to resist the challenge of devising the next 'classic' design, given some indication of the need. What do you, the readers, think?

The close of *Model Engineer's* centenary year will be marked by the opening of the next Olympia exhibition. It would be nice to see examples of new pieces of equipment which will provide the model engineer with the capability of producing Gold Medal winners appropriate to the next century.

SURFACE GRINDING WITH THE QUORN

An increasing number of contributors suggest that surface grinding would improve the tools and accessories which they describe. Philip Amos shows how the Quorn wheelhead can be used to produce acceptable results on smaller items

Spindle clamp.



General view of set-up showing truing diamond, wheelguard and effluent shields.

Introduction

In Reference 1 Professor Chaddock briefly alludes to the possible use of the Quorn for surface grinding. There is about a page of text and two photos. Thus, some investigation and reading between the lines is required to bring this concept to fruition.

Concept

The essential idea is to suspend the Quorn wheelhead from the quill/spindle of a vertical milling machine or drill/mill. In my case, the latter is the smallest of the well known Taiwanese machines and is designated RF 15. Its main dimensions that relate to this exercise are:-

(i) Table size 470 x 160mm with three Tee-slots 355mm long.
(ii) Table movement 320 x 135mm.
(iii) Max. distance, spindle nose to table 400mm.
(iv) Spindle stroke 100mm.

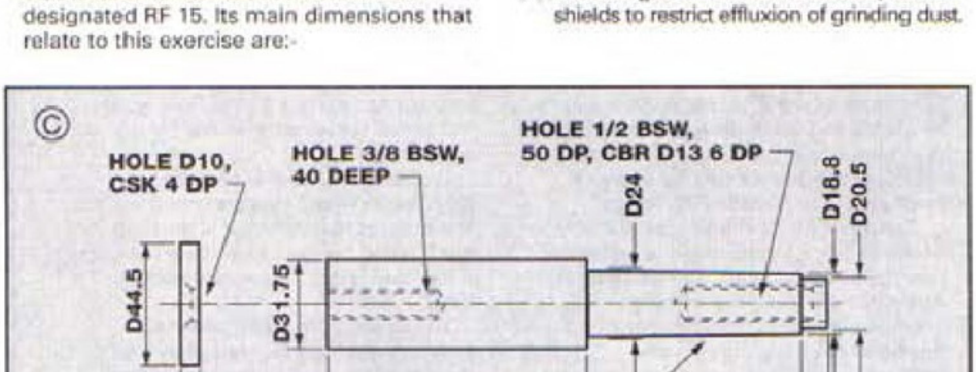
Requirements

(i) Means of attaching the Quorn wheelhead to the drill/mill spindle.
(ii) Means of preventing any rotational movement of the spindle.
(iii) Means of holding the workpiece.
(iv) Means of truing the grinding wheel.
(v) Guarding of the wheel and belt, and shields to restrict effluxion of grinding dust.

These requirements are discussed below.

Attachment

This is effected by the use of a short spigot of 1 1/4 in. dia. Grade 316 stainless steel having a 3MT shank on its upper end incorporating a 1/2in. BSW hole for use with a drawbar. The lower end is tapped 3/8in. BSW to allow a retaining plate of mild steel to be held on by a countersunk socket headed screw. The existing Quorn wheelhead collar clamps directly on to this spigot, and the plate prevents accidental dropping during any adjustments **(See Drawing 1)**.



DRAWING 1
MOUNTING SPIGOT & RETAINING PLATE

Spindle lock

Because of the circumferential backlash in the driving splines of the spindle, locking must be applied directly to the spindle itself. The drill/mill has a clamping collar on the quill which carries the normal depth stop. Another clamping collar on the spindle, joined to the quill clamping collar thus conveniently provides positive spindle locking. The chamfer on the clamp provides clearance to the motor shield **(See Drawing 2 and Photo.1)**.

Holding the Workpiece

Substantial workpieces can be held in the milling vice in a conventional fashion. However, thin pieces present a problem. In Reference 1 it is suggested that a mounting block be used in the milling vice, and that it be first ground in position. The thin article is then attached to this block by adhesive or double sided sticky tape. At times, operating in this way can get quite exciting!

Some time ago, I was fortunate to be able to purchase a secondhand but unused 'Eclipse' magnetic chuck (AXS 614) which is 350 x 150mm in size. Although this will fit on the drill/mill table, it completely covers the Tee-slot portion, leaving only the 'wells' at each end of the table protruding. Therefore, to provide a means of clamping, two auxiliary brackets were made as shown in **Drawing 3**. These were each attached to the drill/mill table with 3/8in. BSW hex. head screws into holes tapped into the table at the front and back of the wells. When the magnetic chuck is not in use, these holes are filled with brass grub screws in order to prevent collection of swarf. The normal magnetic chuck clamps rest on the lip of the chuck and on the end of the drill/mill table, and are tightened with 1/2in. BSW hex. head screws into tapped holes in these auxiliary brackets.

The magnetic chuck provides an excellent means of holding ferrous workpieces.

Truing the Grinding Wheel

A block of mild steel 40 x 40 x 54mm was ground top and bottom, and then drilled and reamed 3/8in. dia. at 15 deg. to the vertical **(see Drawing 4)** - to accommodate the diamond holder already acquired for truing Quorn wheels. A transverse hole was drilled and tapped 1/4in. BSW, and a brass cheesehead screw used to lock the diamond holder in position. The block was then secured on the magnetic chuck and the table moved so that the diamond point was vertically under the grinding wheel axis. The grinder was switched on and the quill of the drill/mill was carefully lowered till a spark showed that the diamond was just in contact with the wheel. At this stage the quill was locked and the table very cautiously traversed from front to back and return. The quill was unlocked and lowered 1/2 division on its scale (= 0.0125mm) and a further traversing cut taken. This procedure was repeated several times until it was observed that sparking occurred right across the face of the wheel. The grinder was then switched off and the entire periphery of the wheel examined. It was found to have cleaned up uniformly, so it was concluded that the truing operation was complete. The wheel was then manually dressed with a Norbide dressing stick to make it ready for use.

Guarding

The sheet metal belt guard used for normal Quorn purposes was found to be satisfactory in this case also, as was the top cover of the motor. However the normal wheelguard was not an appropriate shape. The original wheelguard, fabricated to match that shown in Reference 1 (as a casting) had been discarded in favour of an improved pattern described in Reference 2. This discarded guard was cut back, as shown in **Drawing 5**, to provide ample clearance underneath, and a new side cover was made from 3mm steel plate and attached to the guard with 3 x 3/16in. BSW mushroom head screws through lugs brazed on to the cover. This new side cover is attached after the wheel is in position (**Photo 2**).

The direction of rotation of the grinding wheel is anticlockwise i.e. the bottom of the wheel is moving to the right, discharging its effluent away from the motor.

A simple vertical shield of 24 BG (0.63mm) galvanised steel sheet, with stiffening folded edges was attached to the end of the magnetic chuck to intercept grinding effluent and, in particular, to shield the operator's hand when winding the longitudinal traverse handle.

Similarly, a piece of 24 BG galvanised steel sheet with three edges folded down was attached to the front of the drill/mill sub-table with two 3/16in. mushroom head screws, to shield the drill/mill cross-ways from grinding dust. The front to back depth of this shield is 86mm, limited by encountering the front to back traverse handle at the front of travel. When wound fully back (135mm), some of the cross-ways would be exposed, so a paper extension is used, held on to the shield with masking tape; this paper extension rides over the traverse handle but it does prevent the grinding dust falling on the ways. These two simple sheet metal shields have not been drawn, but can be clearly seen in **Photo 2.**

Grinding Dry

It is really not practical with most home workshop drill/mills or vertical mills to provide a flood of coolant, so the grinding must be done dry.

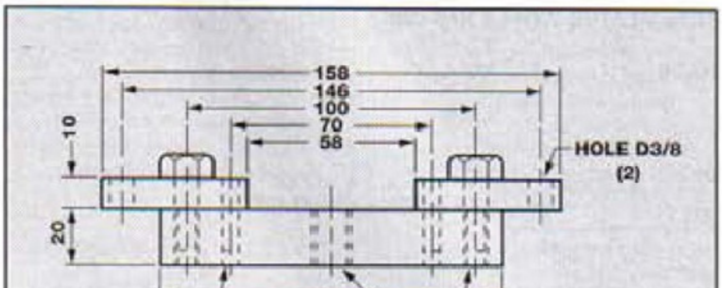
Setting up

Although not immediately obvious from the photo in Reference 1, close inspection will show that the head of the drill/mill is angled to the left by about 45 deg. as it must be in order to position the Quorn in a suitable configuration to allow operation, i.e. to locate the grinding wheel sufficiently far back to just overlap the rear of the magnetic chuck when the table is in its most forward position.

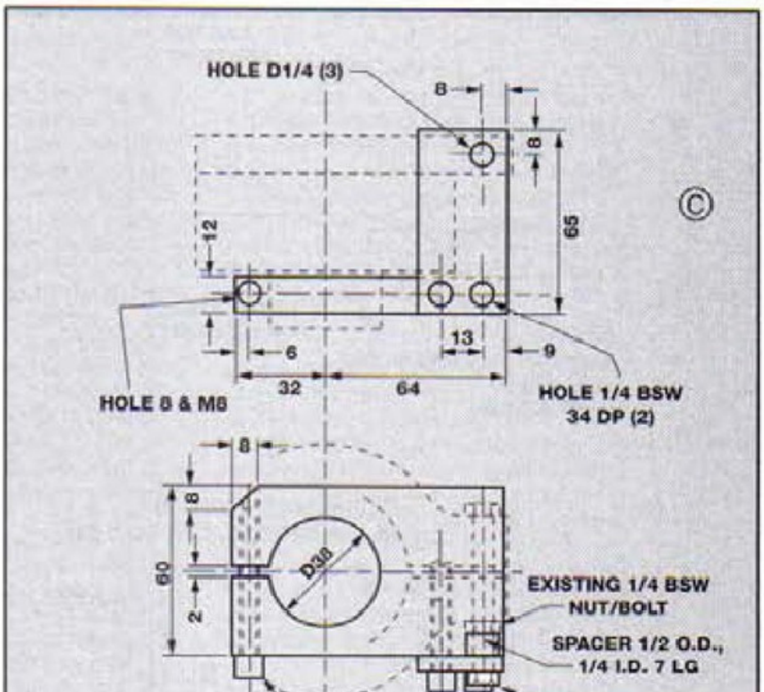
Initially, the drill/mill head should be set at its upper height limit above the table to allow easiest access - firstly for getting the magnetic chuck on to the table, and secondly for getting the Quorn wheelhead on to the special spigot for mounting. Both these items are heavy and so no unnecessary obstruction should interfere with moving them into place.

Some care must be taken to line up the grinding wheel so that it is parallel to the table longitudinal movement, and the spindle is then locked. The wheel is then trued and dressed as described above.

The top and bottom surfaces of the magnetic chuck are ground flat and

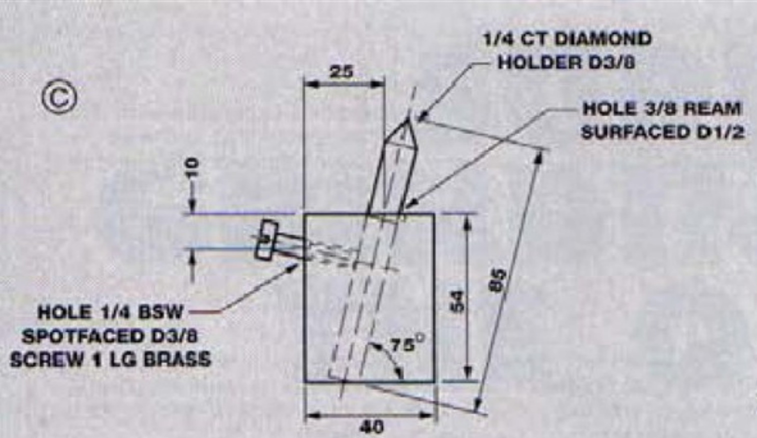


DRAWING 3
BRACKET



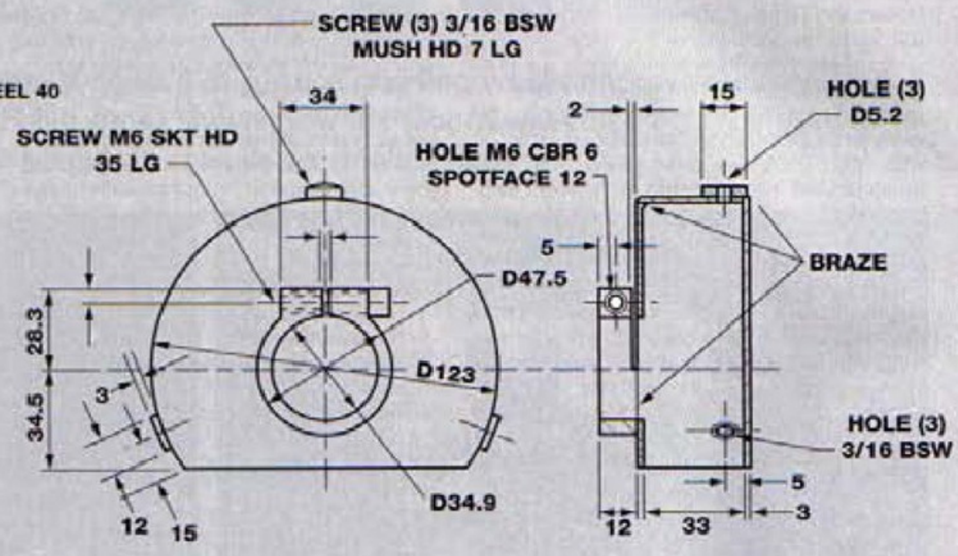
DRAWING 2
SPINDLE CLAMP

©



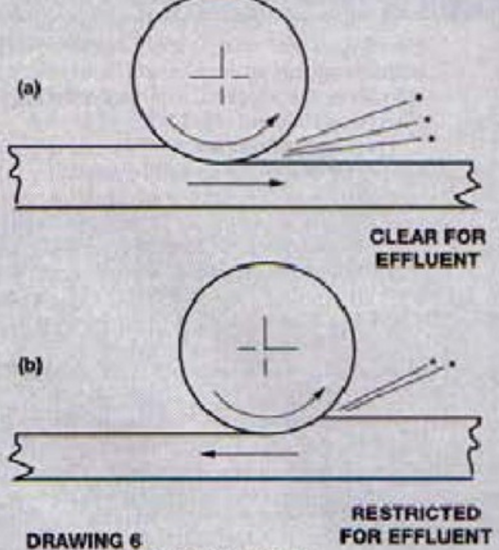
DRAWING 4
DIAMOND BLOCK

MATERIAL: M/STEEL 40

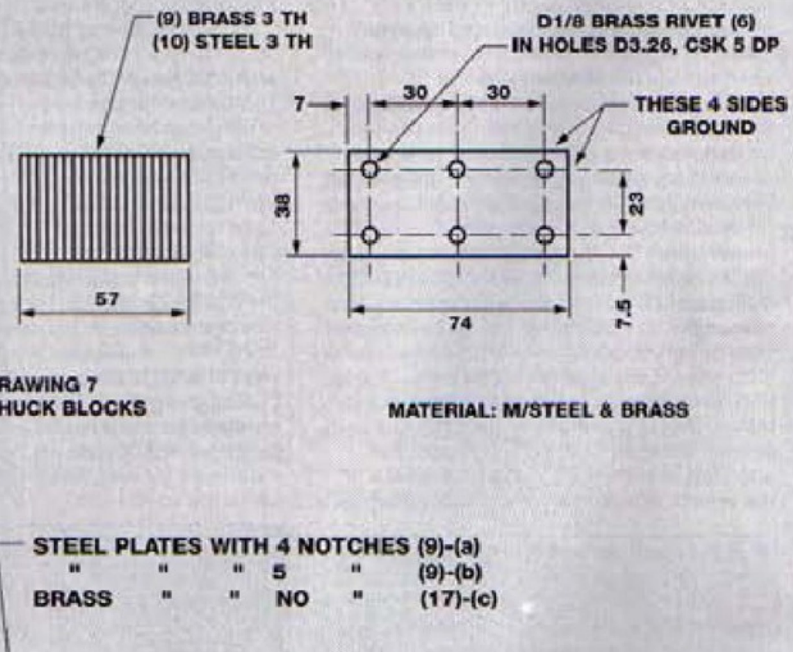


DRAWING 5
WHEELGUARD

MATERIAL: M/STEEL

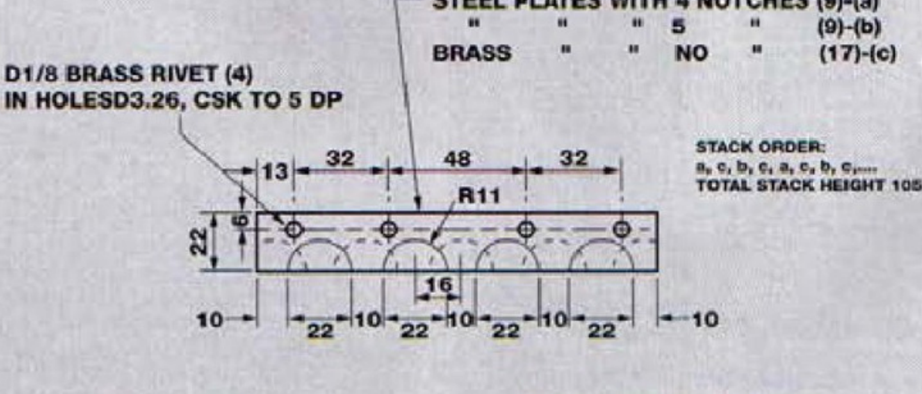


DRAWING 6
SURFACE GRINDING MODES
(a) CLIMB
(b) OPPOSING



DRAWING 7
CHUCK BLOCKS

MATERIAL: M/STEEL & BRASS



DRAWING 8
ADAPTOR PLATE

GROUND TOP & BOTTOM
MATERIAL: M/STEEL & BRASS

parallel during manufacture. The manufacturer recommends that the top surface be given a skim grind when it is first installed on the machine on which it will be used, and for accurate work this is essential.

However with the Quorn on my drill/mill set-up, this is not a practical possibility (even with the several modifications described below) as the magnetic chuck length is 350mm and the table travel is only 320mm.

Workpiece Dimensions

With the normal maximum 4in. dia. Quorn grinding wheels and the wheelhead bracket tilted to the maximum i.e. against the wheelhead collar stop, it will be found that the bottom of the motor mounting plate projects lower than the periphery of the grinding wheel. This limits the longitudinal travel of the work to the distance between the wheel axis and the motor mounting plate – about 135mm. The front to back dimension is limited to the available traverse in this direction – also 135mm.

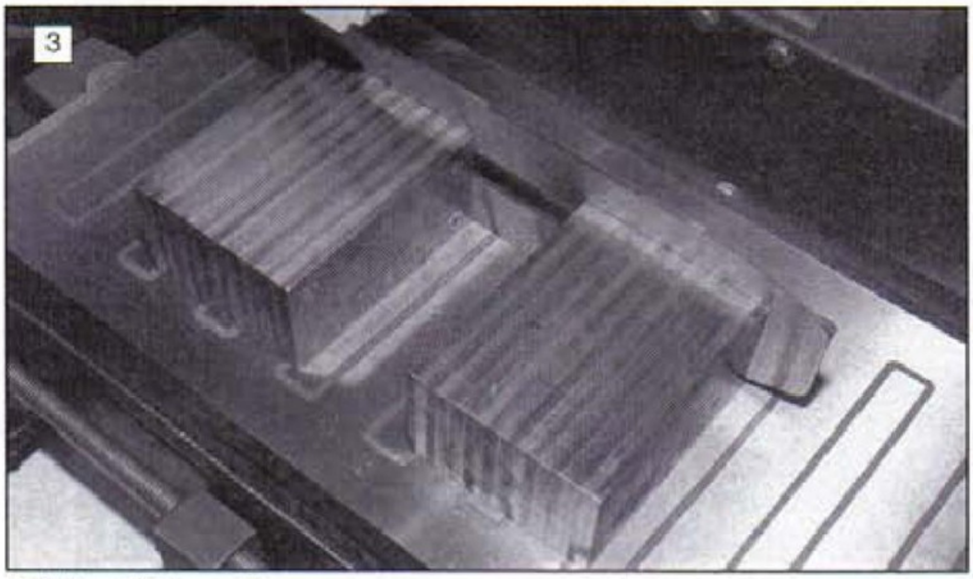
To date, I have not needed to use any larger dimensions than these, but should that need arise, it would seem possible to use the next standard size grinding wheel (6in. dia.), provided that the spindle speed is reduced appropriately. My normal Quorn spindle speed measured by stroboscope is 4800 rpm. Most of the 6in. diameter wheels I possess are marked for maximum speeds of around 4000 rpm. Thus, a smaller motor pulley of diameter $^{4000}/_{4800} \times 2^5/_8$in. $= 2^3/_{16}$in. would be necessary. A new wheel guard would also be required to accommodate the larger wheel.

In my case such a wheel would allow the work to clear the underside of the motor mounting plate by 8mm; the longitudinal dimension of the workpiece could, in this case, be increased to 220mm.

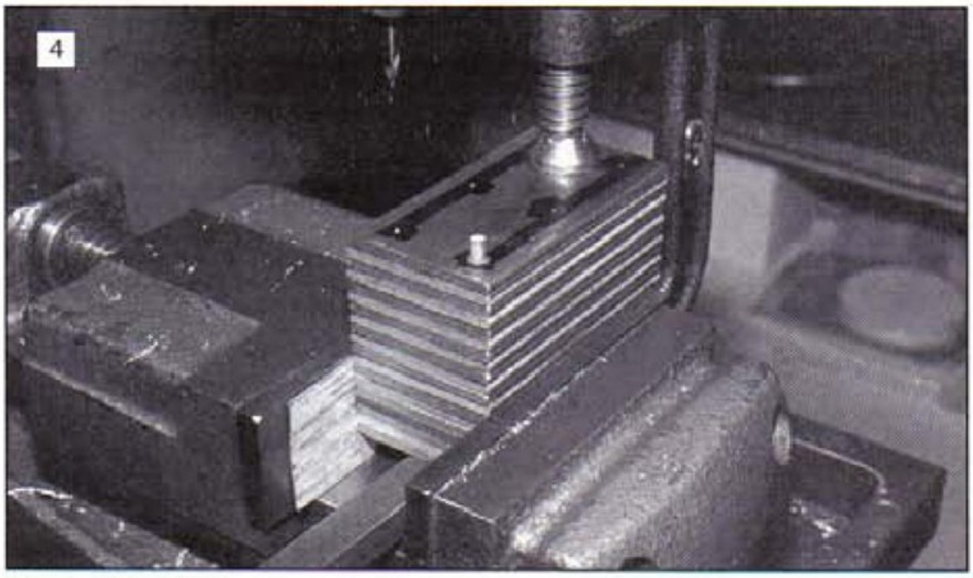
In cases where the front to back workpiece can be reduced, a somewhat greater length could be ground. For this set-up the drill/mill head is turned only 9 deg. to the left instead of 45 deg. In this mode, the axis of the grinding wheel is over the right hand end of the magnetic chuck when the table is at its extreme left position and it is 36mm short of the left hand end when the table is at its extreme right position. Thus the longitudinal dimension which could be ground would be 350 - 36 = 314mm. For this length, the front to back width that could be ground is reduced to 80mm from the previous 135mm. However, if one is prepared to clamp the magnetic chuck to the table cantilevered forward to overlap the front edge of the table by 65mm, it is possible to then grind 314mm long by 135mm wide.

Technique

With the chuck switched off, use a surface gauge to determine the highest point of the workpiece above the chuck. Remove the surface gauge and magnetically clamp the workpiece in place. Hopefully this will not rock the workpiece so that another part becomes the highest point; however this will become evident in due course.



Grinding a blade on edge.



Drilling Chuck Blocks.

Lower the drill/mill head so that the quill travel will allow the grinding wheel to easily reach the workpiece, then clamp the head in position. Start the grinding wheel. Now lower the quill very carefully, with the grinding wheel axis and centre line above the already determined highest point of the workpiece, until it just sparks.

Traverse the table longitudinally so that the grinding wheel passes over the workpiece and beyond. Traverse the table front to back about half the width of the grinding wheel (in my case 7.5mm = 3 turns of the traverse handle for a 13mm wide wheel) and traverse back longitudinally over the workpiece and beyond. Repeat until the whole workpiece has been covered.

Stop the wheel and examine the workpiece. It will be easy to see where grinding has taken place and where not.

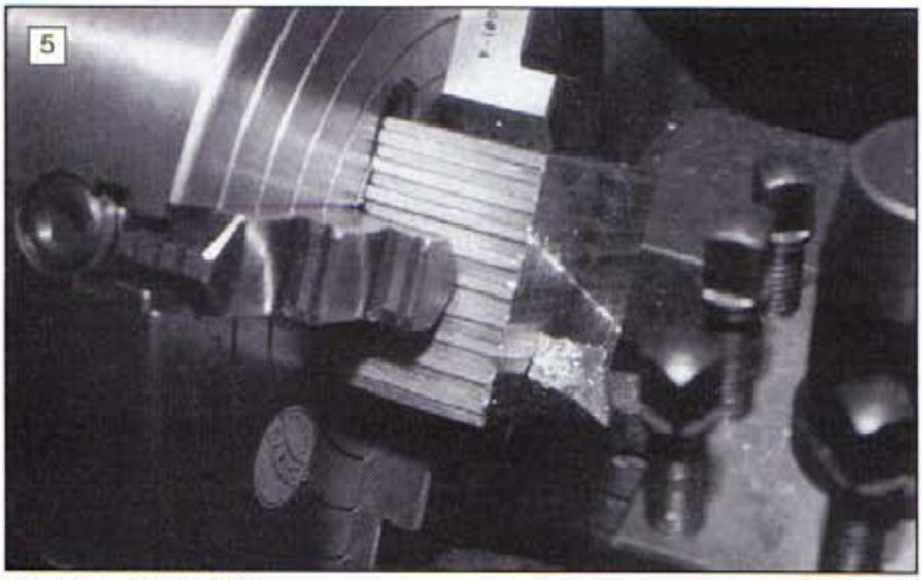
Remember that grinding is a finishing process and not a bulk metal removal activity. A heavy grinding cut might be 0.025mm while a finish grinding cut might be 0.010mm.

Reference 1 suggests the use of the Quorn height adjustment or the drill/mill down feed for setting the cut, but the former is really not practicable. e.g. on my Quorn, the adjusting screws are $^5/_{16}$in. NF (24 TPI) and the grinding wheel axis almost twice as far out as the adjusting screw. It can be shown that to produce 0.025mm height change of the wheel requires the adjusting screw to turn 4.4 deg. – an almost impossible thing to judge without calibration.

My drill/mill feed is marked in 0.025mm divisions, so that one of these divisions is a roughing cut, and a half is a finishing cut. Of course, with deflections in the various members of the machine, play, effects of clamping and the like, it cannot be guaranteed that 0.025mm set on the dial will produce this exact movement, but at least that is the starting point.

After several cuts over the workpiece, it will eventually show that grinding has occurred all over it. A final finishing cut at an unchanged setting should 'spark out', giving a fairly fine uniform finish.

For long items there is a lot of handle turning involved and the grinding occurs in two travel directions. This bi-directional processing is also the normal case in commercial surface grinders, but these have the advantage of flood coolant to flush away the grinding effluent. The cuts taken are so small that there is little tendency for the wheel to grab the workpiece in the 'climb' direction. In fact, in practice this seems to be the easier direction for the machine! - perhaps because of the clear passage to the right for effluent - **(see Drawing 6)**. Anyway, the



Machining Chuck Blocks.

volume of sparks and the noise of slowing down of the motor speed enable the operator to adjust the rate of longitudinal traverse to the conditions at the time. The motor should not be allowed to slow down, so the traverse rate must be reduced to avoid this.

Awkward Shapes

A number of methods of magnetically holding awkward shapes are described in References 3 and 4. Of these, most relate to commercial mass production activities, but two can be of interest in the home workshop. These are the use of Chuck Blocks and of Adapter Plates.

(a) Chuck Blocks

If a workpiece has some protuberance on its underside, it cannot be satisfactorily clamped directly to the magnetic chuck. In this case, the workpiece can be supported on a pair of parallel bar magnetic fixtures called Chuck Blocks. These comprise stacks of alternate magnetic (steel) and non-magnetic (brass) plates, held together with non-magnetic (brass) rivets **(Drawing 7)**. The stacks are machined and ground so that four sides are at right angles and parallel to close limits. They lead the magnetic flux up from the chuck into the workpiece. They can also be used to help support narrow workpieces on edge on the chuck (see **Photo 3**). These items are available commercially, but a pair cost about a third of what I paid for my chuck; so I decided to make my own - see below.

(b) Adapter Plates

For thin workpieces, a finer pole pitch of a magnetic chuck produces better adhesion. An Adapter Plate is made up of interleaved brass strips and special section steel bars **(Drawing 8)**. These are arranged so that alternate steel strips pick up magnetic flux for opposite polarity poles on the chuck. This results in closely spaced north and south poles — in effect a finer pole pitch than that of the chuck itself. Commercially, these adapter plates cost about a third more than I paid for my chuck!

To date I have not felt a need for such a device as the magnetic chuck seems to hold thin pieces quite adequately for grinding. It may be less satisfactory for milling. If in the future a need does develop, I will make a simplified pattern as described below.

Typical Jobs

I. Truing diamond holder

The holder for the truing diamond needs to sit firmly on the magnetic chuck with no possibility of rocking. The top of this holder was ground; it was then up-ended so that its bottom could also be ground flat and parallel.

2. Chuck Blocks

A pair of chuck blocks was made, each from a stack of ten steel plates and nine brass ones. These plates were of material 40 x 3mm and 75mm long. These were riveted together, each with six $^1/8$in. dia. brass rods with countersunk heads being formed on each end and filed flush **(see Drawing 7)**.

The plates were held together with a G-clamp and in position in a vice while the four corner holes were drilled $^1/8$in. (this requires a long series drill) and then No. 30 to allow free passage of the $^1/8$in. dia. brass rods. After each hole was drilled, a rod was inserted to ensure that it would go in and to guard against any minor transverse movement of any plates in the pack. The holes were slightly countersunk at each end. The brass rods had been previously annealed and their ends were hand riveted over, filling the countersinks. The two centre holes were then treated similarly. Finally, all twelve rivet ends were filed flush (see **Photo 4**).

The block edges were now faced square and level in the four jaw chuck in the lathe (**Photo 5**) - and finally the pair were ground together on all four edge sides (**Photo 6**). Measurement showed them to be parallel in both directions within 0.055mm on the worst sides and down to 0.025mm on the best sides.

During this activity the grinding wheel became loaded with brass and had to be regularly dressed with the Norbide dressing stick to clear it.

3. Adapter Plate

The normal available travel cited above of 135mm equates to just over four pole

Grinding Chuck Blocks.

pitches (each 32mm) on the magnetic chuck. In the transverse direction, the poles are 110mm long. These dimensions determine the length (138mm) and width (105mm) of the plate assembly **(see Drawing 8)**.

The downward pointing 'teeth' correspond to the pole width (10mm) and these are spaced with gaps of 22mm. If these gaps are semi-circular, their height is 11mm, and so the overall height is conveniently 25mm or so.

Hence the raw material is 25 x 3mm steel and brass section - 18 steel pieces and 17 brass pieces. Half the steel pieces have the teeth offset half a pitch i.e. 16mm.

The gaps to produce the 'teeth' may be roughly cut out on a bandsaw - 64 of them will take some time. They would then be flycut in packs of nine in the drill/mill to form the 22mm diameter semicircles.

A lot of careful drilling for the four rivet holes (140 holes) would be needed to precede the riveting of the pack together. The top and bottom surfaces of the pack would then be milled flat and parallel, with the pack held on the magnetic chuck. Finally, the top and bottom would be ground flat and parallel.

As this project is somewhat daunting, it will not be undertaken until a specific need arises.

Conclusion

As Professor Chaddock remarks in Reference 1, the whole concept cannot be regarded as a substitute for a commercial surface grinder, and it does not produce comparable results. Nevertheless, it is a most useful enhancement of capabilities in a home workshop, and is commended as such to readers already possessing a Quorn and a drill/mill.

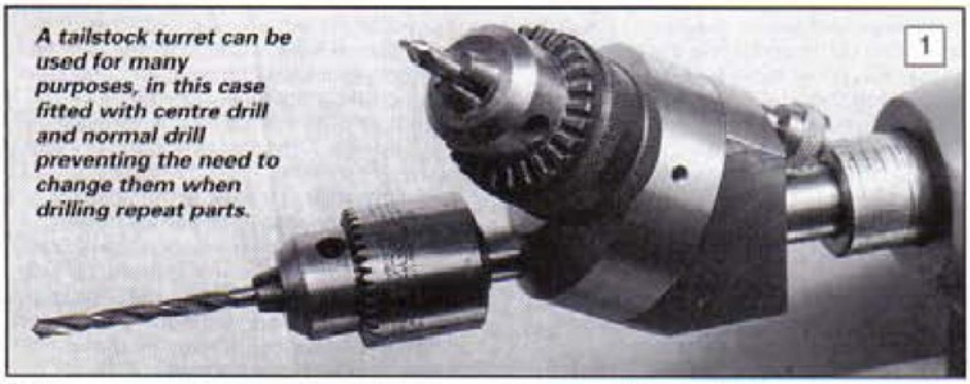
References

1. *The Quorn Universal Tool and Cutter Grinder* - Professor D.H.Chaddock, pp 125 - 127.
2. *Driving and Guarding the Quorn* - Philip Amos, *M.E.W.* Issue 43 p. 34
3. *Permanent Magnet Chuck Users Handbook* - Eclipse.
4. *How To Get The Most From Magnetic Workholding* - Eclipse.
5. *Quorning It With A Myford* - Ed Cloutman, *M.E.* Vol. 176 No. 4019 p 172.

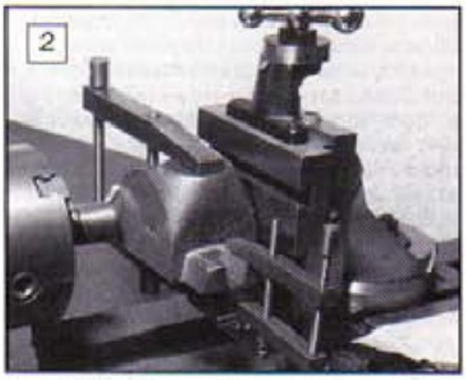
A BEGINNER'S GUIDE TO THE LATHE

PART 14

Harold Hall brings his long-running series to a close with brief notes on a number of items which will give the beginner the capability to aspire to greater things



A tailstock turret can be used for many purposes, in this case fitted with centre drill and normal drill preventing the need to change them when drilling repeat parts.



A vertical slide greatly assists in carrying out milling operations on the lathe.

It is a measure of the versatility of the lathe that, after such a long series, there are still many accessories and processes left which have had little or no mention. It would though be wishful thinking that the subject could ever be completely exhausted, and in any case the series is aimed at the beginner, so there are some legitimate omissions. I have come therefore to the point where I must attempt to bring the series to a conclusion.

To do this I am giving a brief mention to a few of the remaining items which, while not initially fitting into a beginner's activity, he or she should be aware of for future consideration.

Filing rests (Ref. 1)

These assist in the production of flats, (e.g. a single flat, a square or a hexagon) on a part which has been previously turned and is still held in the chuck of the lathe. It is, of course, used with the lathe mandrel stationary. They are not perhaps used so much now that more workshops possess milling machines, but this method can still be worthwhile, as it may be quicker than setting up the milling machine for the task in hand.

Dividing (Ref. 2)

Dividing is frequently carried out while using the mandrel of the lathe to hold the workpiece. Examples of use would be to divide by six to produce a hexagon when using a filing rest, or perhaps some higher number in order to cut a gear, using a separate milling spindle for the gear cutter.

Indexing the mandrel can be achieved by a variety of methods, most of which are devised by the user of the lathe. The following are the methods most frequently encountered:-

1. A series of holes around the backplate of the chuck.

2. The bull wheel of the backgear train, if suitably placed.

3. A changewheel mounted on to the mandrel at the changewheel end.

These require some form of detent to be mounted, at a suitable position, from the structure of the lathe. A greater number of divisions is possible by employing a division plate and a wormwheel engaged with either the gear in 2 or 3 above.

Another method is to employ a dividing head, probably mounted on the cross-slide or vertical slide, and for the milling cutter to be mounted in a chuck on the mandrel of the lathe.

Batch production

If making parts in batches, then any of the following three items will help to speed up the operations, and in some cases improve consistency between parts.

Tailstock Turret (Ref. 3)

If a number of identical items is to be drilled, this would necessitate continuously changing centre drill and drill for each one made. The tailstock turret (**Photo 1**) would eliminate the need to repeatedly change drills.

Saddle/cross slide stops (Ref. 4)

These enable parts to be made to the same dimensions without the need for careful measuring and/or memorising leadscrew dial readings, the stop having been set whilst making the first part. In some cases, more than one stop can be mounted into a turret, so that more than one position can be set up. **Sk. 1** shows a simple example of a single saddle stop.

Mandrel backstops (Ref. 5)

Sometimes it is necessary to machine features which have to be positioned relative to that part of the workpiece which is inaccessible within the chuck jaws. A simple example would be facing the second end of a part to give a precise length. This requires the part to be removed from the chuck to measure its length and then returned to the chuck for further machining if necessary. Although this is not a major problem for a single item, if a number of identical parts is to be made, a backstop within the chuck would enable subsequent parts to be located accurately in the chuck, to enable them to be machined to precisely the same length using the leadscrew dial readings or a saddle stop.

Ball turning attachment (Ref. 6)

The most likely requirement for turning ball shaped objects is to make the traditional type of machine handle, but in a

Another use for the vertical slide.

few cases there will be more demanding requirements, such as for a ball joint. Attachments for ball turning are mostly home made, and many designs for these have been published.

Mandrel Handle (Ref. 7)

Many of the cheaper lathes do not provide slow speeds, say in the order of 30rpm, although some do have slow speed attachments which can be purchased separately. However, a handle for turning the lathe mandrel manually is one way out of the problem, one of the most likely uses being thread cutting, especially if up to a shoulder. The handle is fitted to the mandrel at the changewheel end, often achieved by the use of an expanding spindle which fits into the hole through the mandrel. An example is shown in **Sk. 2**.

Vertical slide

The versatility of the lathe is really exhibited when it is used for milling operations. The main problem is that for maximum capability, the workpiece needs to be traversed in three axes relative to the cutter. For the normal lathe, with the cutter mounted in the headstock chuck, movement will be limited to two axes, those provided by traversing the saddle and the cross slide. To overcome this limitation, a vertical slide is used to give the third axis of movement. Whilst there are limits to the size of workpiece which can be accommodated, with a little thought, quite large items can be machined. **Photo 2** shows a large casting having a face flycut.

Milling head

Another way of overcoming the absence of movement in the third axis is to add a milling head to the lathe. This is most often fitted using a special mounting on the rear of the lathe and converts the machine into a small mill/drill. The saddle and cross slide provide the movement in two axes and the down feed on the milling head the third. Photo 2 in Part 1 of this series (Issue 36 Page 56) shows an example of this set-up.

There is obviously a financial advantage in not having to buy a complete mill/drill, but of equal if not greater importance for those with smaller workshops is that space for a milling machine is not required. This will perhaps allow the installation of a larger lathe than is possible with a separate lathe and milling machine set up.

Milling/drilling spindle (Refs. 7 & 8)

This is a light duty spindle which can be used for light milling and drilling, usually on a workpiece mounted in the lathe chuck. The spindle is mounted on the cross-slide, top-slide or even the vertical slide. Such spindles are normally driven via a lightweight belt from a remote drive motor.

For drilling purposes only, an electric pistol drill can sometimes be pressed into service.

The lathe as a power source

For some, it may be lack of available space, for others, lack of finance, but using the lathe as a means of driving some other machine can advantageous. The device is normally mounted on the bed of the lathe and picks up its power via the mandrel chuck. Machines that I have seen employing this approach are a band saw (Ref. 9), fretsaw (Ref. 10), slotting machine (Ref. 11), circular saw table, filing machine, and jig saw. No doubt others also exist.

Tool post grinder (Ref. 12)

Surface finishing by grinding is a method used widely in industry, where accuracy and/or a fine finish are a requirement. Only rarely used in the home workshop, but in a few cases (such as finishing the bores of internal combustion engines), it is a desirable facility. A tool post grinder provides this, and is an economical alternative to a fully functional cylindrical grinding machine, which seems to be almost non-existent in the context of the home workshop.

Centre finder (Ref. 13)

When setting up a workpiece which has a centre punch mark which has to be set to run true, some aid to achieving this will be very helpful. There are two methods that are commonly employed, one which requires the use of a dial test indicator. The other employs an arm which is pivoted nearer one end than the other and thus has the effect of amplifying the error. **Sk. 3** illustrates the two methods. A perfect example of how a desired end result can be obtained from the simplest of ideas can be seen in Ref. 13.

Coolants

The use of coolants and lubricants almost fits into the essential category and, having left it to the end, will endeavour to cover it in more detail. Of all the subjects in this series, I must confess that this is probably the one on which I feel least able to write as, in common with many home workshop owners, I attempt to get by with the minimum of equipment and materials.

Most readers will be aware of the process of applying a coolant/lubricant to the workpiece in the area in which cutting is taking place. Ideally, this would be a continuous flow delivered by a pump, but unfortunately this is only practical on a lathe mounted in a reasonably large drip tray, as the coolant has to be collected for re-use. This facility is normally only available as an extra for medium size lathes and above, but of course the user could have a tray fabricated for any lathe if considered of sufficient importance.

The purpose of the coolant is in fact twofold, being used as both a coolant and a lubricant. Taking first the action as a coolant, for this to be effective, a substantial flow is required to carry away the heat being generated by the cutting process. The primary reason this is to prevent the cutting tool from overheating at its cutting edge and, as a result, becoming prematurely blunt. Without a drip tray and suds pump this will not be possible

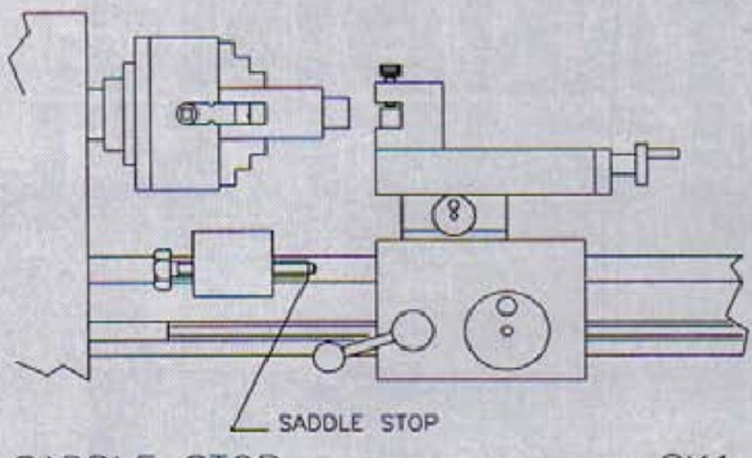
The rate of heat generation will depend on the rate of metal removal and is therefore more of a problem for the commercial workshop where high production speeds are required. Provided that machine speeds and feed rates are kept to a moderate level, the need for continuous coolant flow is not that important, a fact seemingly is confirmed by the relatively small number of home workshops in which the facility is used.

The absence of a suds pump does not mean that work has to be carried out dry, though many workshop owners (particularly those with workshops in the house) do just this. Dry swarf is much more easily picked up by a vacuum cleaner. Treading swarf and a film of suds oil into other parts of the house can make one unpopular! The absence of fumes generated from hot cutting oils will also be welcomed. I make these points to indicate that the use of a coolant/lubricant is not absolutely essential.

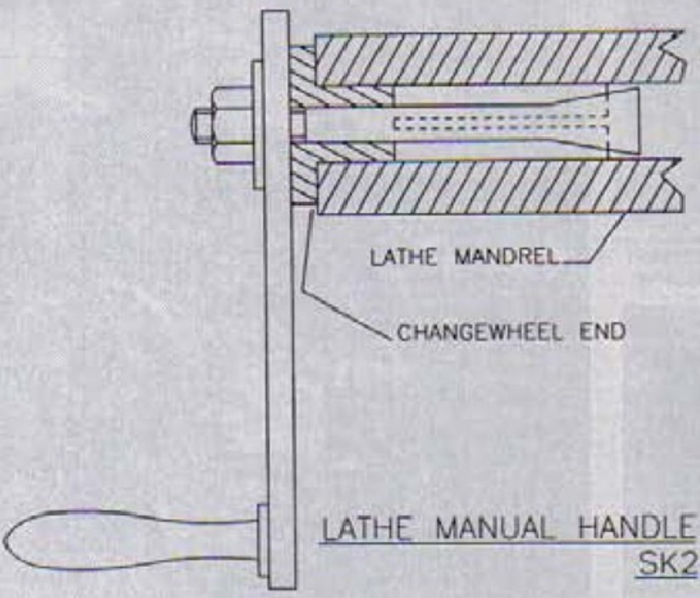
Some authorities on the subject would say that if a continuous flow is not possible, then an intermittent application, say by brush, is totally taboo. The reason for this is that it may cool the cutting tool suddenly, making cracking of the cutting edge a possibility. The lesson to be learnt here is that without a continuous flow, speeds and feeds should be kept low, so as to avoid the possibility of the tool overheating to an extent which makes this a possibility.

We now come to the subject of the coolant acting as a lubricant. Assuming that a light film applied to the workpiece will lubricate the cutting action, then the result must be to reduce friction, thus also reducing heating effects, though by no means as much as achieved by a continuous flow. Under some conditions, such a film of lubricant will improve surface finish. I would like to carry out a comparative test to be more sure of my facts on this one, as I have frequently started to make a dry cut and then applied a small amount of lubricant, the result being an improvement in surface finish. I also find that the swarf produced changes its character.

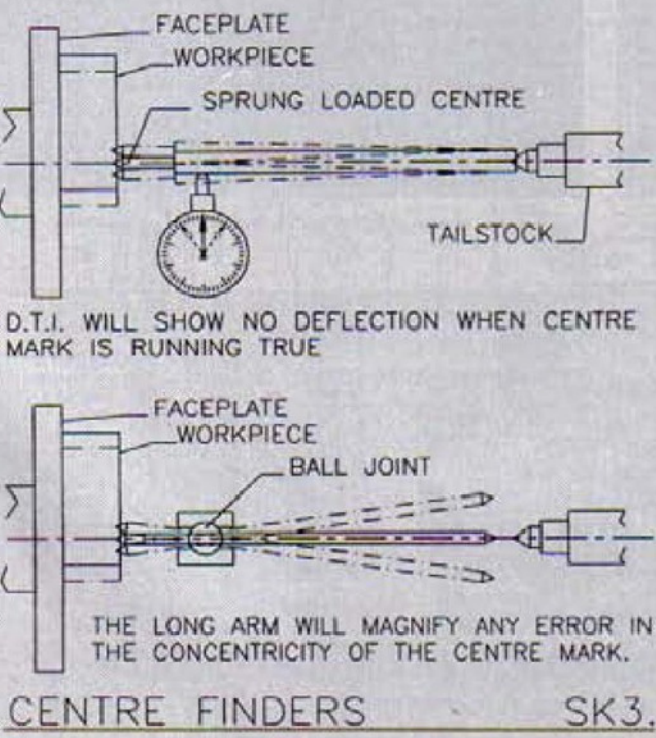
I am also unsure as to how a light film of oil actually gets to the cutting edge. My theory is that it probably does not, but rather that it lubricates the tool a short distance from the cutting edge, allowing the swarf to move away more freely, thereby aiding the finish. My advice would be to apply the lubricant to the part



SADDLE STOP. SK1.



LATHE MANUAL HANDLE SK2



CENTRE FINDERS SK3.

frequently, using a brush or a simple drip feed, and if this results in hot fumes rising from the workpiece, then I suggest that the speed and feed rates are too high.

Recommending a cutting fluid is not easy as there are so many. However, for the home workshop, compromise is again the way forward. For most of the materials we use, basic soluble oil will be good to very good. This includes free cutting steels, brass, copper and aluminium. For demanding applications, silver steel, stainless and the like, use a soluble or non-soluble fluid with extreme pressure additives. Suppliers of these do not recommend them for free cutting materials, but I suspect that this is a question of cost, rather than suitability, as they are more expensive than the basic soluble oil. For the small amounts used in the home workshop, cost differences would be small, and hardly worth attempting to use both types. It would be helpful to have more specific information on this subject.

A Final Comment

Having now arrived at the end of the series I find that it has amounted to 14 parts. In view of its length, I do hope that it has been of benefit to many readers. If you have stayed the course then many thanks, for it will have made my efforts worthwhile. Where the dividing line between a beginner and an experienced lathe user is, is not easily defined, but if you feel that any significant point has been omitted then I would be more than happy to hear from you. If sufficient comments are forthcoming, perhaps the editor would permit a page or two in a future issue by way of an appendix to the series.

References

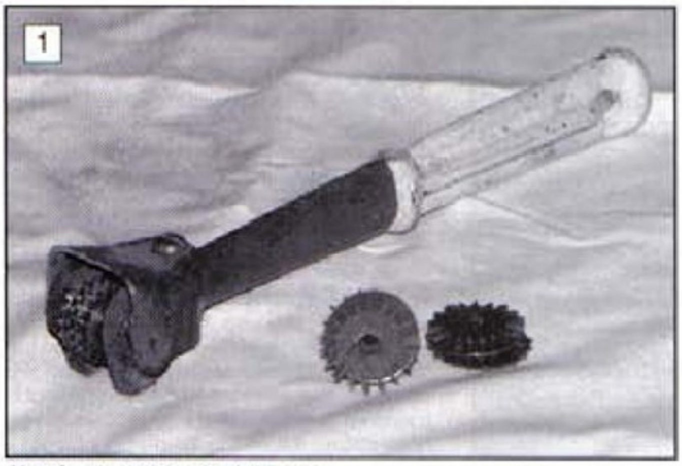
The following are, in most cases, only a selection of the articles published in *M.E.W.* on the particular subjects. Titles do not always highlight the subject.

1. *A Calibrated Filing Rest*—Issue 44 Page 12. *A Simple Filing Rest Issue*—Issue 34 Page 27.
2. *Saddle Stop and Index Arm*—Issue 26 Page 60. *Cross Slide Bracket for an Electric Pistol Drill*—Issue 28 Page 45.
3. *A Three Way Tailstock Turret*—Issue 22 Page 33. *Tailstock Turret*—Issue 28 Page 59.
4. *An Adjustable Lathe Stop*—Issue 37 Page 55. *A Four Way Carriage Stop*—Issue 25 Page 41.
5. *A Lathe Back Stop*—Issue 10 Page 22.
6. *A Ball Turning Tool*—Issue 26 Page 52.
7. *A Releasable Mandrel Handle*—Issue 29 Page 68. *Cross Slide Bracket for an Electric Pistol Drill*—Issue 28 Page 45.
8. *Light Duty Drilling/Milling Spindle*—Issue 27 Page 32. *Milling/Drilling Spindle for the Lathe*—Issue 17 Page 14.
9. *Lathe Mounted Band Saw*—Issue 9 Page 37.
10. *A Fretsaw Attachment for the Lathe*—Issue 28 Page 48. *A Lathe Mounted Fretsaw*—Issue 18 Page 18.
11. *A Slotting Device for the Myford S7*—Issue 30 Page 62.
12. *A Toolpost Grinder*—Issue 18 Page 63. *A Toolpost Grinder*—Issue 4 Page 70.
13. *A Centre Locating Tool Issue*—46 Page 43. *A Centring Device for the Lathe*—Issue 6 Page 16.

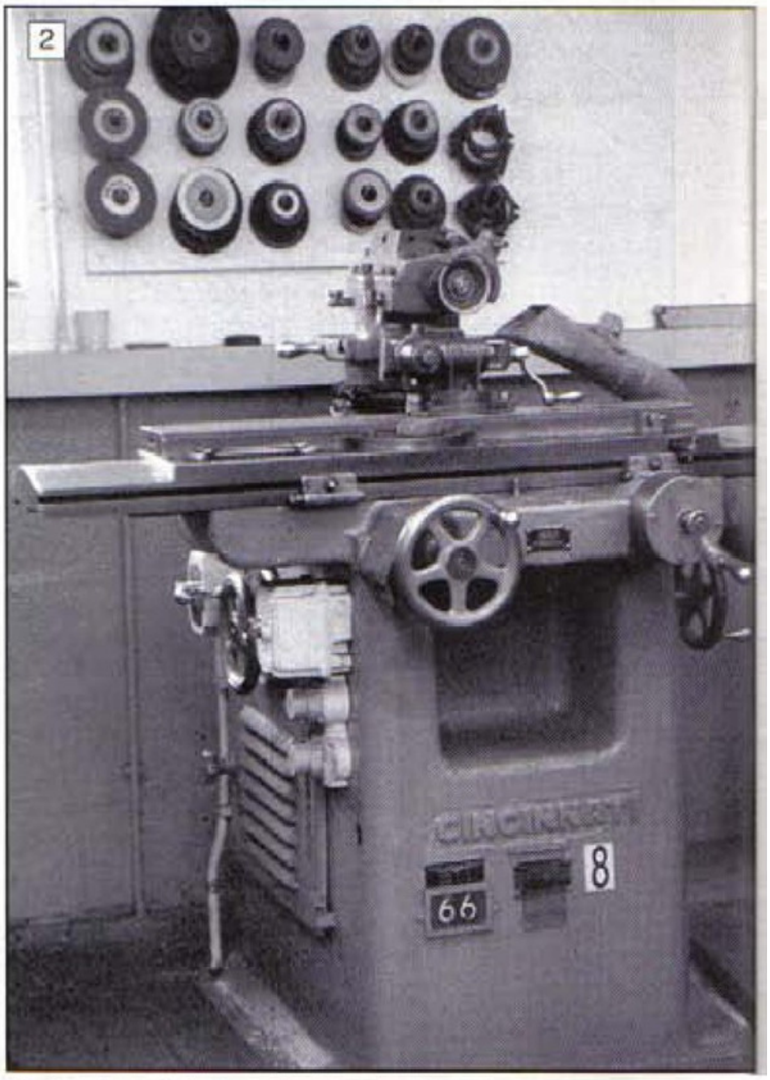
UNDERSTANDING GRINDING WHEELS

PART 2

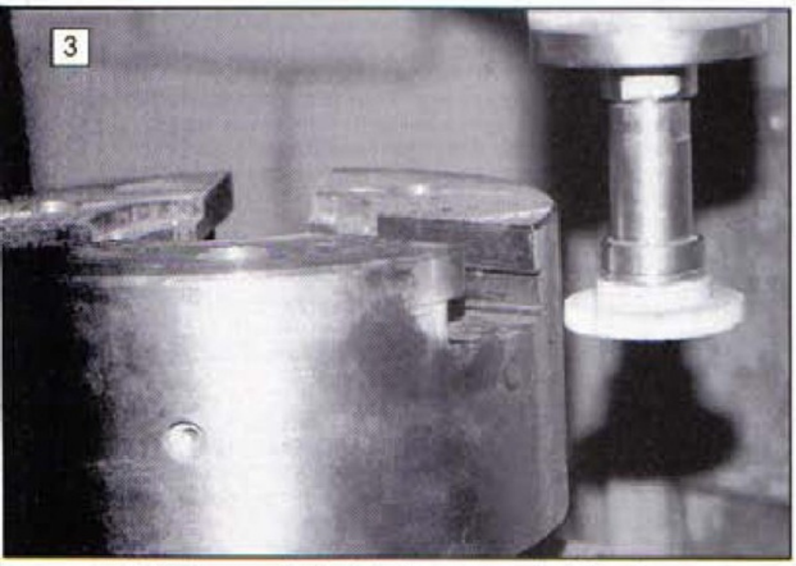
Alan Jeeves continues his survey of abrasive wheels and their application



Huntington type wheel dresser.



Tool and cutter grinder and a selection of wheels.



Wheel on a vertical grinder (may cut on both faces).

Selection of Wheels

When choosing grinding wheels, consideration will have to be given to such matters as the material which is to be ground, the quality of finish required, the type of machine on to which the wheel is mounted, the speed (rpm) at which it will be run and the amount of contact with the work. A few carefully selected wheels will probably suffice for all the work the amateur encounters, whereas the professional user will require an extremely comprehensive range comprising many shapes, sizes, and grades. It is, useful to have a sound knowledge of grinding wheel selection in order to work safely and more economically.

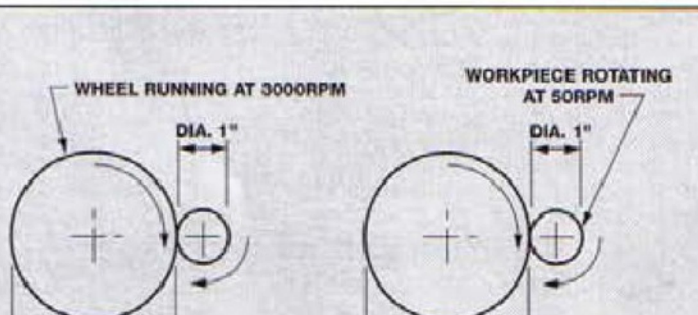
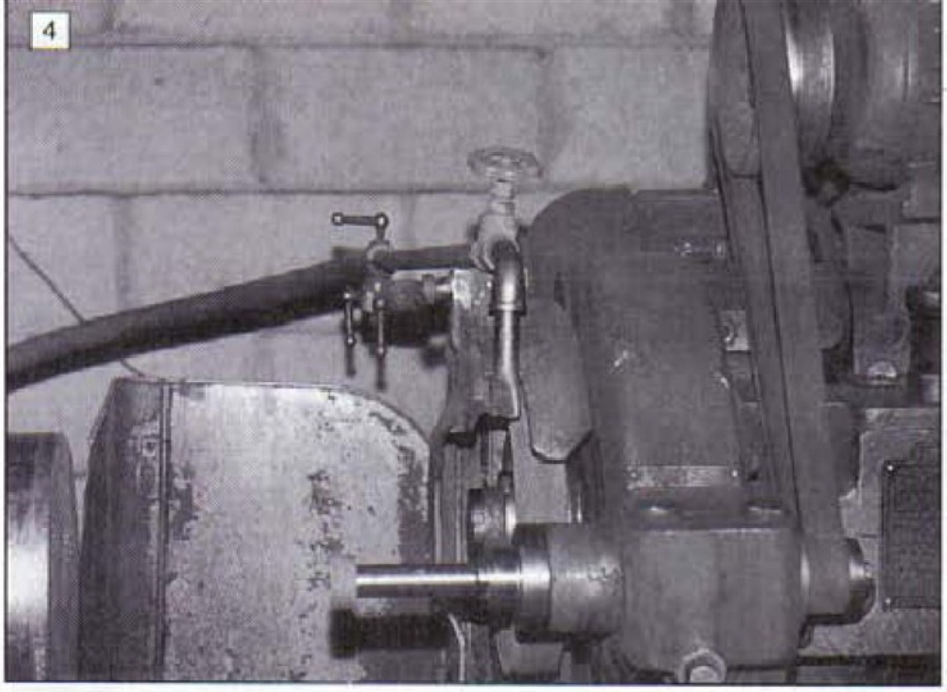
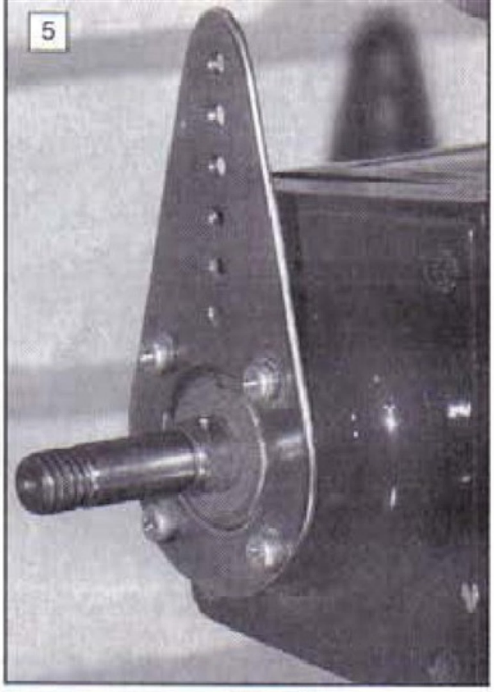


FIG. 1. CUTTING SPEEDS


A bore grinder.


The spindle of a grinding machine.

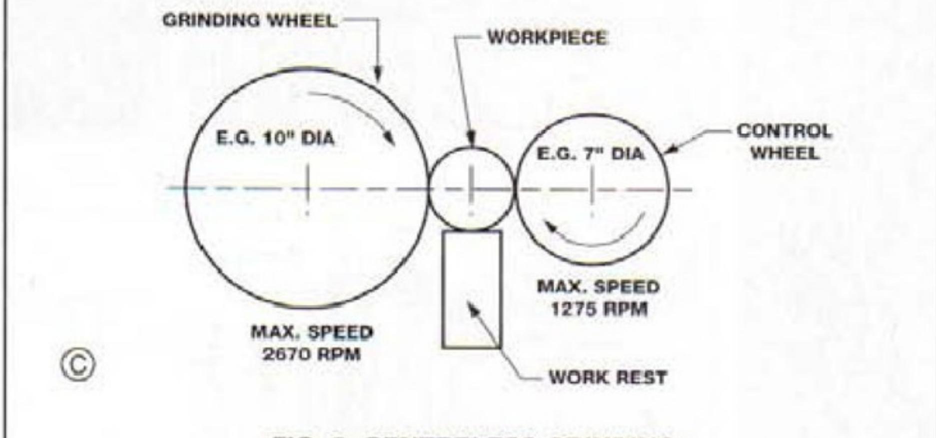


FIG. 2. CENTRELESS GRINDING

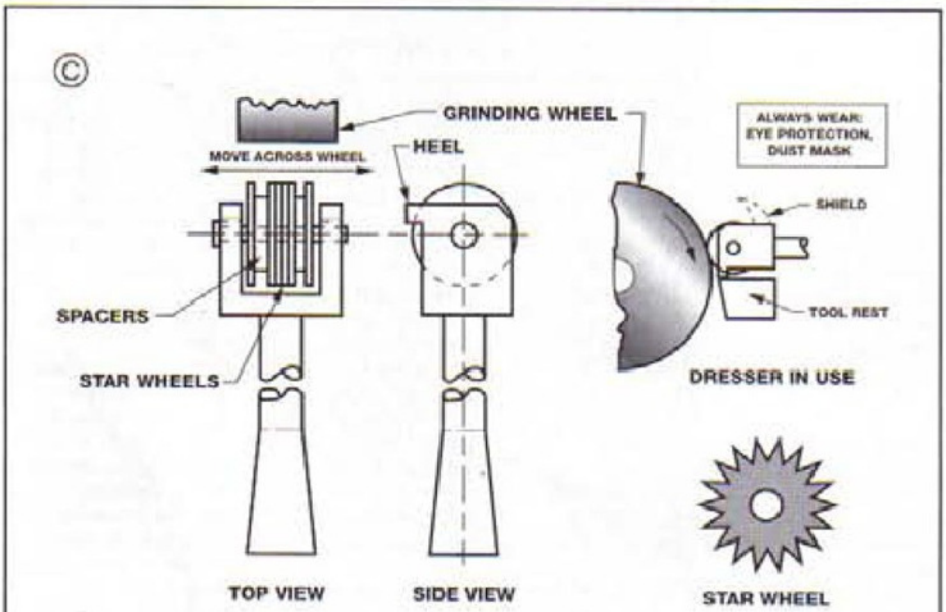
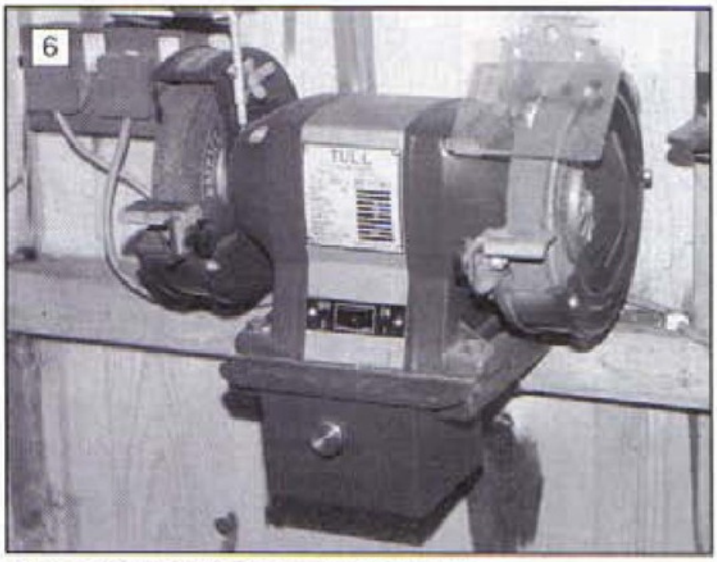


FIG. 3. 'HUNTINGTON' TYPE WHEEL DRESSER

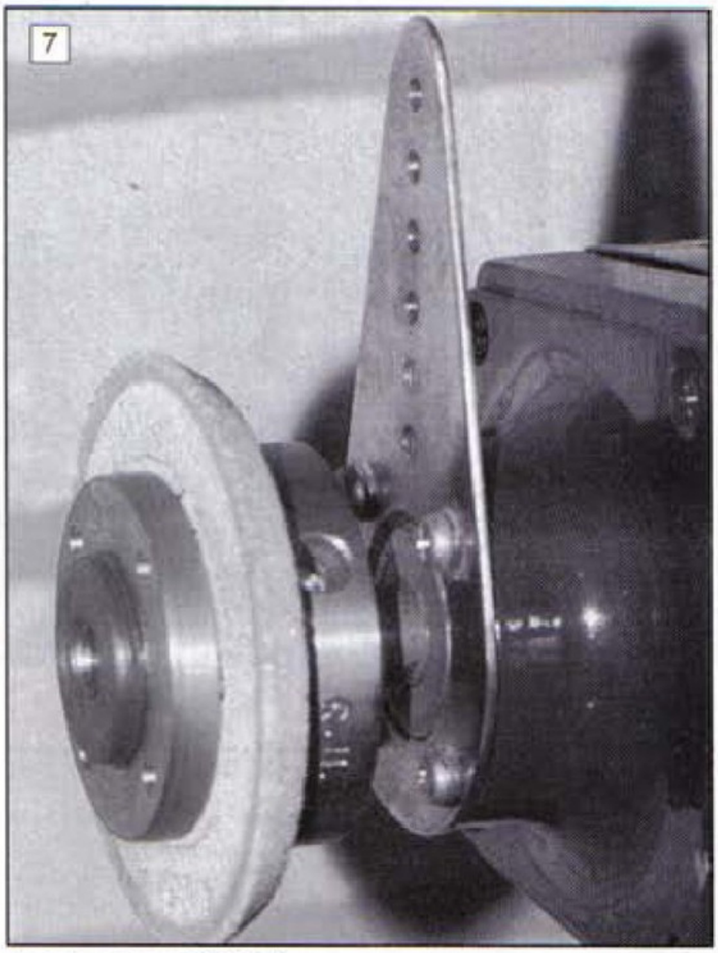
We have, so far, looked at bench grinding wheels, and a couple of good examples of general duty wheels have been suggested. In addition to these Bauxilite wheels at least one silicon carbide wheel will be essential, in order to cope with tungsten carbide tools. This kind of wheel is often called a 'green grit wheel' and, conveniently, its colour gives an immediate indication of its application. If a bench grinder is used with a Bauxilite wheel at one end and a green grit wheel at the other, then a reasonable recommendation for the green wheel (for general duty) is C-60-J-V, which is a medium soft wheel suitable for both roughing and finishing (masonry drills may be sharpened on such a wheel). With the currently low cost of small imported bench grinders, it may be found to be beneficial to have two machines - one for Bauxilite wheels and one for green grit wheels.

The wheels for use on the tool and cutter grinder are much smaller in diameter than those used for bench grinders. 100mm is a common diameter for cup wheels and other shapes, but some of the smaller machines (especially the 'self build from castings' type) use proportionally smaller wheels. These can sometimes be difficult to obtain in sizes below 50mm dia., but specialist suppliers to the model engineering world are known to stock smaller versions.

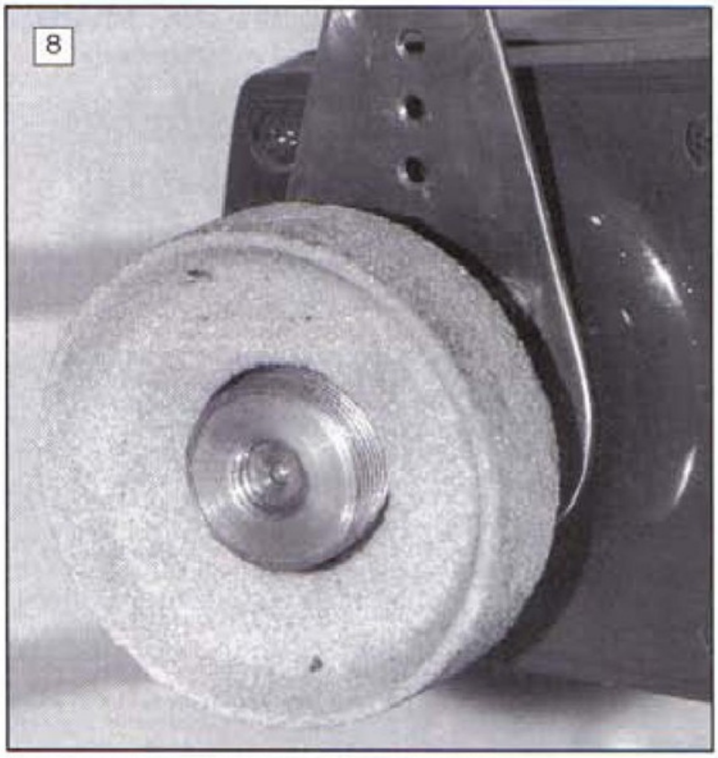
The ordinary Bauxilite abrasive is not normally used for tool grinding. A refined form of Bauxilite which contains a high proportion of pure aluminium oxide, which causes the grains to be extremely friable, is preferred and this abrasive is known as 'white Bauxilite' (identified by the pre-fix WA on the label). White Bauxilite tends to cut cooler than ordinary Bauxilite, which is a great advantage when sharpening carbon steel tools, and it is also sympathetic to HSS cutters. As a consequence, the majority of Bauxilite wheels stocked for cutter grinding use are white in colour. This type of wheel will not, however, 'touch' tungsten carbide tools, so a silicon carbide (green grit) wheel will have to be used for this material.



Flange mounted wheels on a bench grinder.



An arbor mounted wheel.



An arbor mounted wheel without retaining nut.

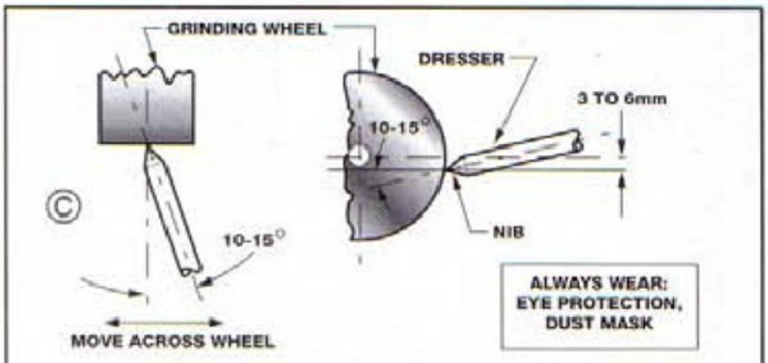
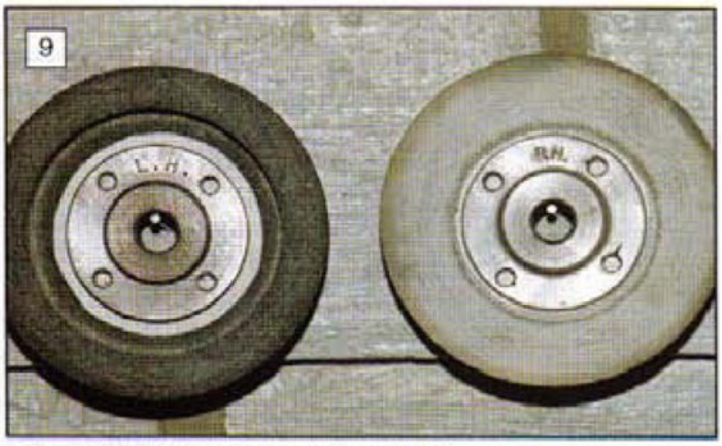


FIG. 4. DIAMOND DRESSER IN USE

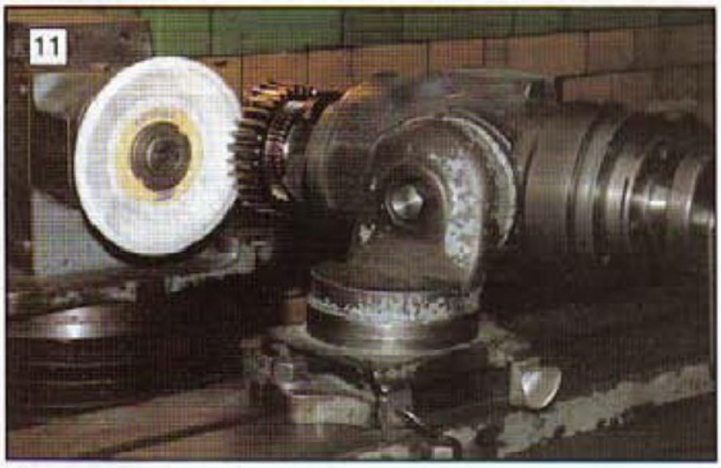
The white wheel is also greatly favoured for surface grinding work, where cutting is apt to generate much heat, and this wheel is particularly suited to applications where no coolant is provided (dry grinding). Another type of wheel often seen on the surface grinder is a pink wheel, which has similar qualities to the white one. It is made up of Bauxilite abrasive and is normally pre-fixed 'MA' or 'DA' on the label. When selecting surface grinder wheels it is particularly important to consider the type of machine for which it is intended. If the straight wheel is mounted on a horizontal spindle and cuts on the periphery, the rules are quite different to the vertical spindle, where the cup wheel is fitted and cuts on the face. Clearly, with the latter, the wheel contact will be greater than that with the straight wheel, which influences the choice of wheel. The straight wheel will need to be of a finer and harder abrasive than the cup wheel, in order to let the grains break away more frequently, thus allowing new, sharper ones to cut the work. Two working examples of wheels for grinding the same hardened steel component are:- straight wheel WA-46-H-V, cup wheel WA-24-H-V, which illustrates this rule.

If the need arises to grind soft, low tensile strength materials such as cast iron, brass, copper, aluminium, glass, marble, or granite, then a silicon carbide wheel may be found to give the best results, and this is so for all types of grinding (cylindrical, internal, centreless, etc.). Generally speaking, to grind soft materials a hard wheel is required and to grind hard materials a soft wheel is needed. The softer, ductile metals also respond better to a coarser grade of wheel, the finer grades being preferred for the hard brittle metals.

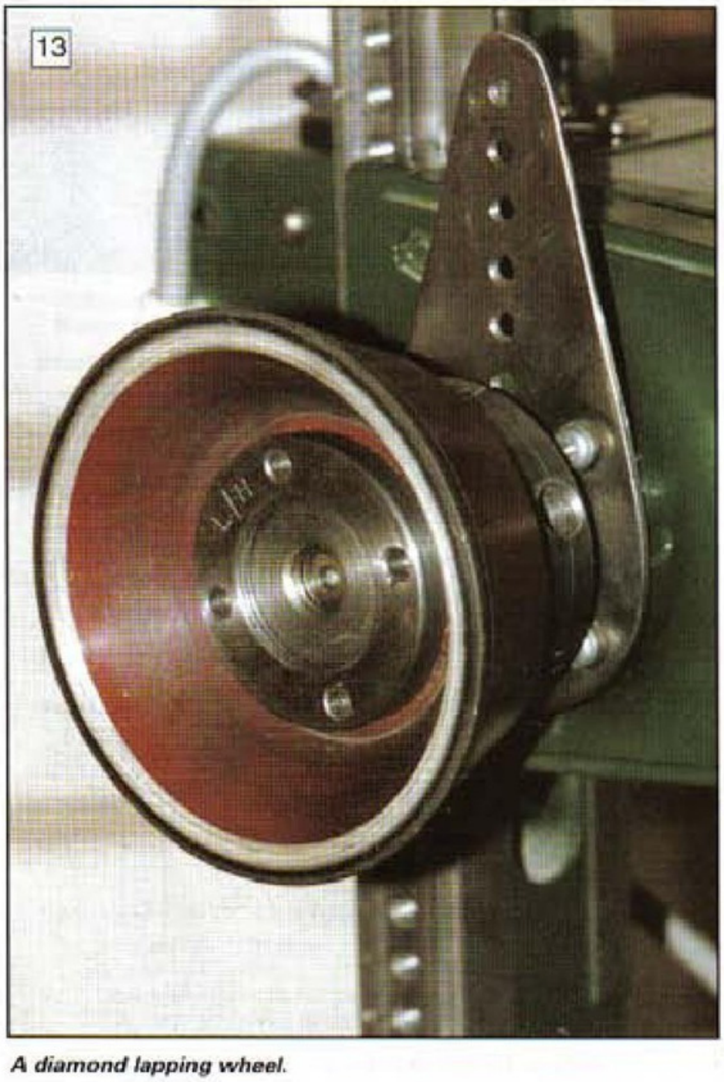
The difference between cylindrical and internal (bore) grinding is that the wheels for the latter will be much smaller than for cylindrical grinding. This, in turn, means that cutting speeds vary tremendously. However, in addition to the wheel head frequently being provided with a selection of speeds, the work head can also be regulated and the cutting speed adjusted, because the work is revolving counter directionally to the wheel (**Fig.1**) The same is so with 'centreless' grinding, except that the work is revolved by a 'control wheel' which can be governed to create the correct cutting speed (**Fig. 2**). Centreless grinding is not likely to concern the amateur too much, but for those who are interested, much the same rules apply to centreless grinding wheels as to those for cylindrical grinding, but the control wheel is quite different. These wheels are always made from Bauxilite and are usually bonded with rubber. They are intended to run at much slower speeds than grinding wheels, and will seldom have a maximum operating speed in excess of 1500 rpm. They are structured with 80 grit (as a rule) and should never be used for any purpose other than control wheels. When grinding larger diameter jobs on the centreless grinder, the centre of the work becomes



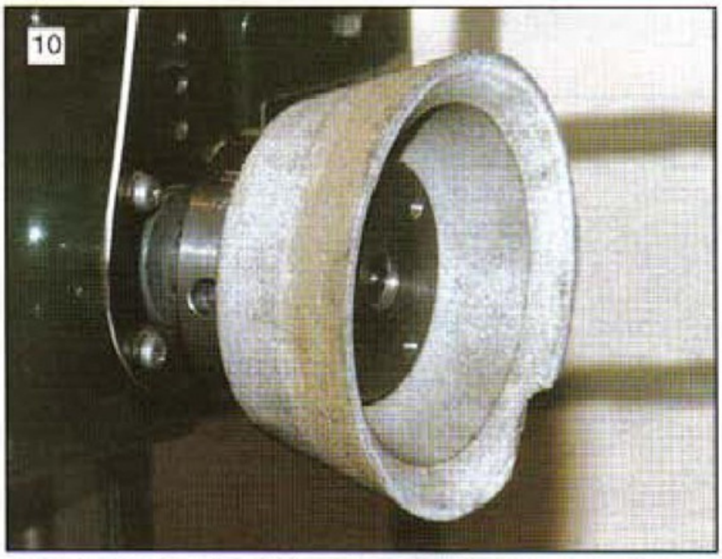
Arbor mounted wheels which are handed.



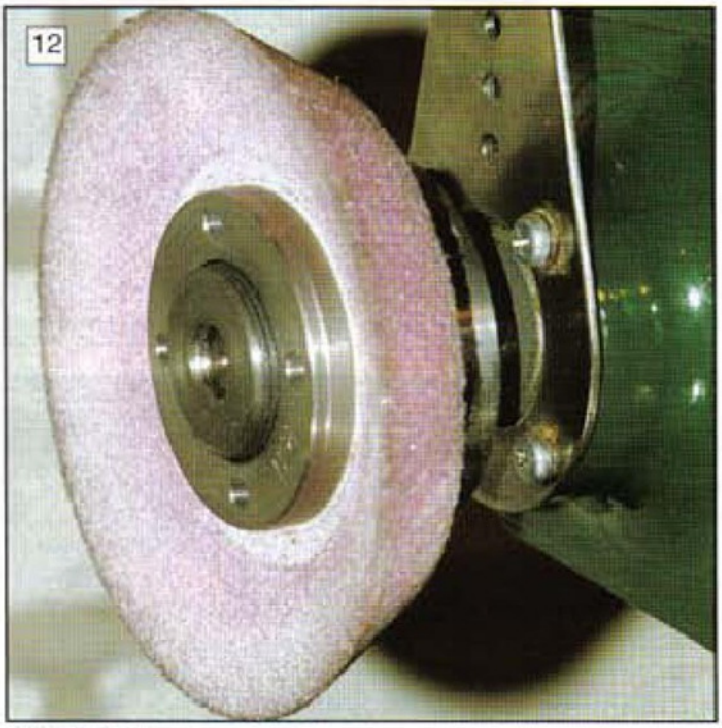
A saucer wheel applied to the face of a cutter.



A diamond lapping wheel.



A wheel which has been damaged in this way must be replaced.



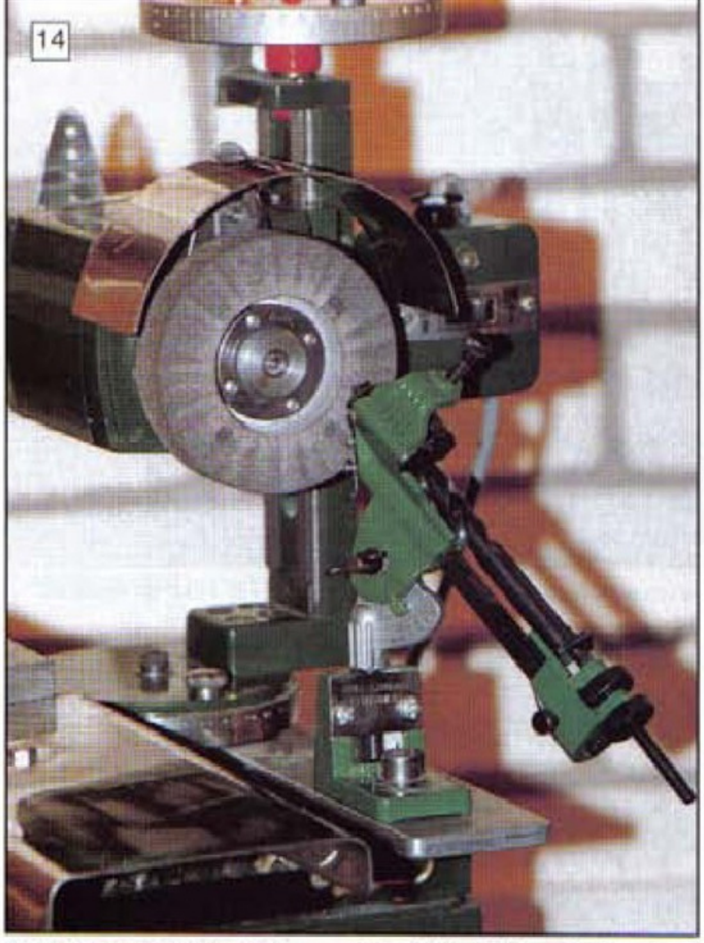
A dish wheel.

"Roebuck" Wheel Dresser

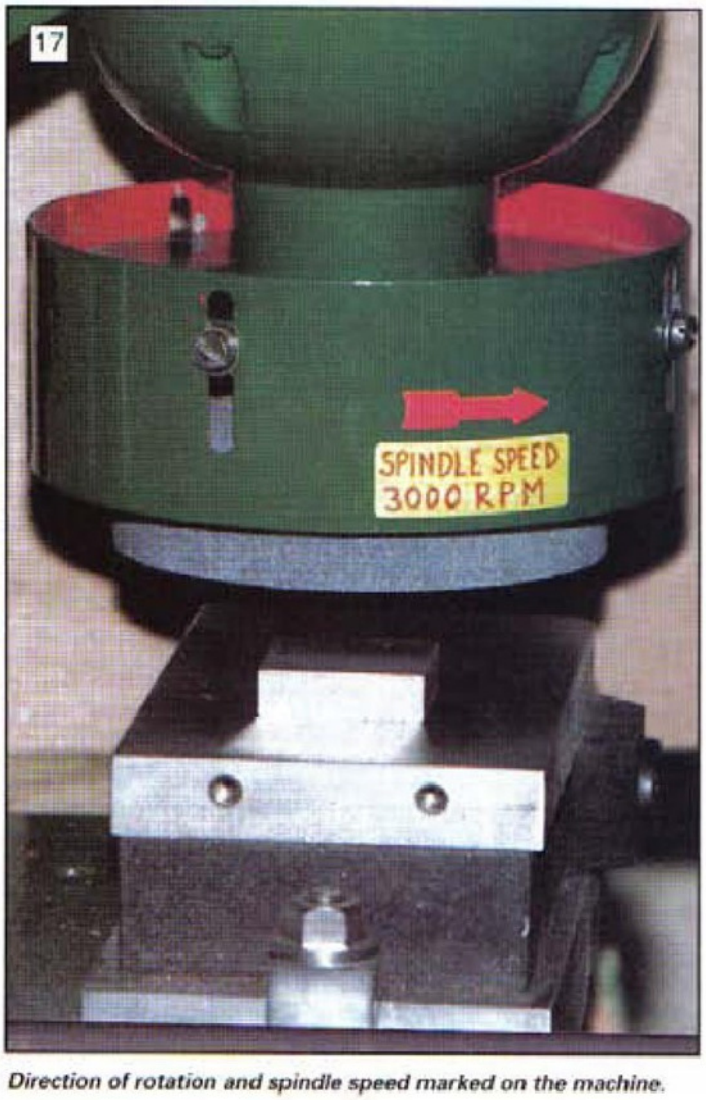
©

much higher than the centre of the wheel. If the job is lowered, the danger of out-of-roundness is present and so the higher centre height can be maintained by using a softer grinding wheel, which effectively reduces the 'contact pressure' of the wheel to the job.

Tables are provided which may be used as a guide for selecting wheels to cope with different applications (Tables 1, 2, 3, & 4). The last of these provides information for those who would like to experiment with thread grinding on such machines as the 'Quorn' tool & cutter grinder. It will be noted that extremely fine grits are specified for this purpose.



A single recessed wheel shown with a drill grinding attachment.



Direction of rotation and spindle speed marked on the machine.

A drill grinding machine which features an almost fully guarded wheel.

Warning signs displayed near a grinder in a factory. The right hand sign indicates that unauthorised persons may not mount wheels in this situation.

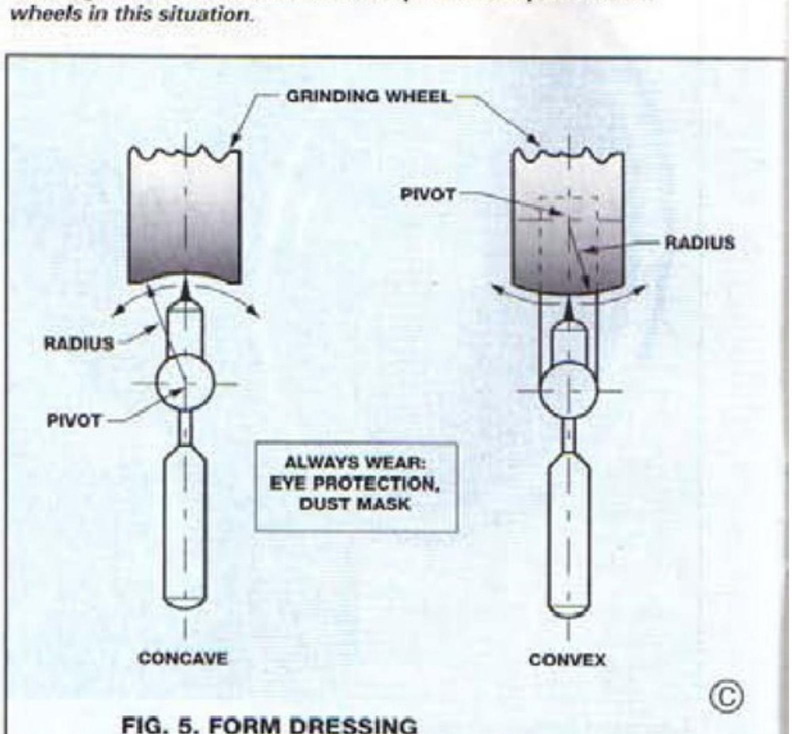


FIG. 5. FORM DRESSING

Mounting wheels

Having selected the most suitable wheel for the job in hand, it must be mounted on to the spindle of the grinding machine. The spindle is first cleaned of all grit, and the wheel is checked for its maximum operating speed. After a visual inspection of the condition of the wheel, it should now be supported by the bore on the fingers and **lightly** tapped with a spanner or similar metallic tool. A clear ring should be heard, indicating that the wheel is sound. If a dull tap rather than a clear ring is heard, it is likely that the wheel is cracked or fractured and it should be discarded. Experience of the ringing sound can be gained with practice, and it is a very reliable way of checking integrity.

The wheel can now be offered to the spindle, which should be a sliding fit into the wheel bore. It should not be forced on, as this can result in the bursting of the wheel if the machine spindle expands due to heat. If the bore of the wheel is greater in diameter than the spindle, e.g. wheel bore =1 1/4in., spindle diameter = 1/2in. (as is often the case), plastic bushes may be fitted, in accordance with the following conditions:-

- Plastic bushes should **not** be used with wheels which are less than 6mm wide or over 50 mm wide.
- Plastic bushes should **not** be used with portable grinders.

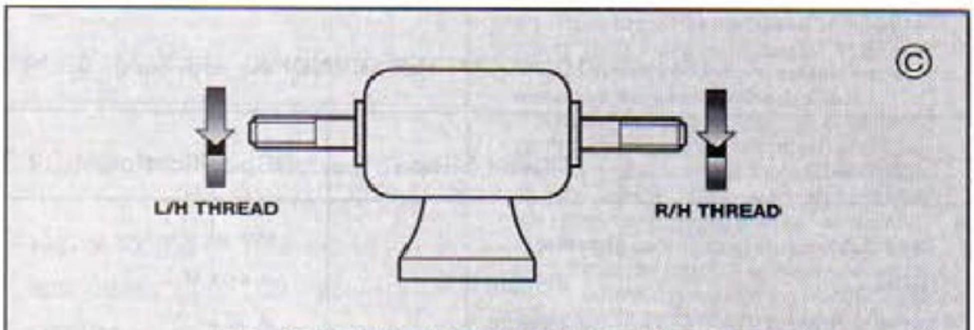


FIG. 6. FRONT VIEW OF GRINDING SPINDLE

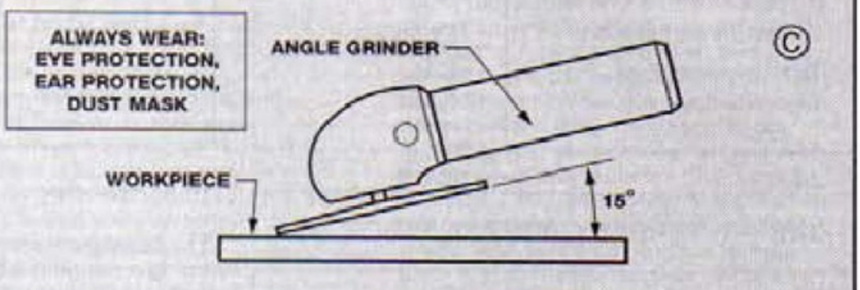


FIG. 7. ANGLE GRINDING - THE CORRECT APPROACH

TABLE 1 GRINDING WHEEL SPECIFICATIONS

Grinding Operation (See Key)	(1)	(2)	(3)	(4)
Material To Be Ground	**Wheel Specification**			
Aluminium	C 46 J V	C 46 J V	C 46 I V	C 36 J V
Brass	C 46 K V	C 46 K V	C 46 I V	C 24 I V
Bronze	C 46 K V	C 46 K V	C 46 I V	C 24 I V
Cast Iron	C 36 J V	C 46 J V	C 36 J V	C 24 J V or WA 24 J V
Copper	C 60 L E	C 46 J E	WA 46 J V	
Steel (soft)	A 46 M V	MA 60 M V	MA 46 J V	WA 24 J V
Steel (hardened)	A 60 K V	WA 60 J V	WA 46 H V	WA 24 H V
Steel (high speed)	A 60 K V	WA 60 I V	WA 46 H V	WA 30 H V
Stainless steel (austenitic)	C 46 M V	C 60 K V	WA 46 H V	WA 36 I V
Stainless steel (martensitic)	A 60 M V	MA 60 L V	WA 46 J V	WA 30 J V

Key to Grinding Operations:-

(1) Cylindrical Grinding
(2) Internal Grinding
(3) Surface Grinding on periphery of wheel
(4) Surface Grinding on face of wheel

TABLE 2 TOOL & CUTTER GRINDING

Operation	Wheel Shape	Specification
Broaches	Cup	WA 60 K V
Drills	Straight	A 46 L V
Lathe centres	Straight	A 60 M V
Milling cutters	Dish or Cup	MA 60 J V
Reamers (sharpening)	Cup	WA 46 L V
Reamers(fluting)	Dish or Cup	WA 60 L V
Stellite tools	Various	WA 46 J V
Tungsten carbide tools	Various	C 80 G V
Taps (sharpening)	Dish	A 60 N V
Taps (fluting)	Form	A 80 N V

TABLE 3 THREAD GRINDING WHEELS

Threads Per Inch	Specification
5 - 6	WA 120 K V
7 - 13	WA 180 K V
14 - 20	WA 220 L V
21 - 30	WA 320 M V
31 - 50	WA 400 M V
51 - 70	WA 500 M V

- Plastic bushes should be fitted to **both** sides of the wheel where the width permits.
- Wheel flanges should **not** touch plastic bushes when fitted; that is to say the flanges should be relieved towards the centre.

The diameter of the wheel flanges should be at least $^1/3$ of the wheel diameter and may be up to $^1/2$ of the diameter. They should preferably be made out of steel, and the inner flange should be keyed or tightly pressed onto the shaft. Some small bench grinders are supplied with both flanges loose fitting and made out of die cast aluminium alloy. It is most advisable to manufacture complete new flanges for this type of machine. Light cast flanges can fracture under operating stresses.

The outer flange is used to clamp the wheel in position on the spindle, and should not be over tightened. The thread should be 'handed' so that it will tighten onto the spindle with its rotation (**Fig. 6**). An arrow indicating the direction of rotation of the spindle should always be conspicuous on the wheel head. **Guards must be replaced before setting the wheel in motion.**

The periphery of the revolving grinding wheel may be very slightly out of concentricity with the spindle, owing to the slight clearance in the bore, and it can now be 'dressed up' in truth with the machine.

Wheel dressing

The usual technique for dressing a grinding wheel correctly is by using either a 'star' wheel dressing tool or an industrial diamond. The star wheel type of dresser is known as the 'Huntington' type (**Fig. 3**) and is highly esteemed in industry for dressing off-hand grinding wheels. It comprises of a holder into which are fitted several (normally 6 but sometimes 4) hardened steel star shaped wheels (rather like the rowels on cowboys' spurs), which are free to revolve. In a tool of a suitable size for use in home workshops, the star wheels are about 25mm in diameter and around 2mm thick. Two plain circular washers are also provided to separate the outer pair of star wheels. The tool is hand held by the robust handle and moved across the periphery of the wheel, removing the dulled outer abrasive grains and allowing a completely fresh cutting surface to be established. In due course, after many dressings, the star wheels may require replacing and a new set is available from the tool supplier. When using this device, the following notes on safety must be heeded.

On surface grinders, cylindrical grinders and tool & cutter grinders, an industrial diamond dresser is employed. As this substance is quite expensive, only a small amount (usually $^1/3$ to $^1/2$ carat) is brazed onto the end of a piece of round mild steel bar of about 12mm diameter and 100mm long. The diamond tip, or nib, is pointed to induce less surface contact (and so less heat). If the nib overheats, there is the possibility that the brazing medium will melt and the diamond will become detached. If a large amount of abrasive has to be removed from the wheel, coolant should be used to disperse heat from the diamond, but they can be used quite successfully dry for amateur work. The pointed nib, after much use, becomes flat nosed and encourages the diamond to become hotter. At this point industrial users will return the dressing tool to the makers to be 're-set' but it is not economical to do this in units of one or two, so the amateur will have either to continue to use his diamond carefully in this condition or replace it.

The small piece of diamond is quite brittle and should be advanced towards the wheel gently. If it is suddenly forced into the wheel, it may fracture.

When purchased, the diamond is normally attached to a holder which is intended to be firmly clamped to the grinding machine, but may also be fixed to a handle, rather like a Huntington dresser, and used freehand.

When in a fixed holder, the diamond should be used as shown in **Fig. 4**, which will reduce the tendency to wear a flat nose on the nib, especially if it can be rotated in its holder from time to time. A special swivelling holder can also be used to form convex and concave radii on the periphery of straight wheels (**Fig. 5**). As a general rule, cuts of only 0.025mm (0.001in.) should be taken per pass of the dressing tool, in order to prolong the life of both the diamond and the wheel. Again, the notes on safety should be adhered to when diamond dressing.

Other types of wheel dresser have from time to time appeared on the market and one such brute from the early 1950s is pictured. It is hand held at each side of a coarse abrasive wheel which dresses the actual grinding wheel requiring attention. It is held at an angle of around 20 deg. to the axis of the machine spindle, and the more it is tilted, the finer will be the dressing.

Wheels in use

The removal of metal stock by grinding differs from other forms of metal removal (turning, milling, drilling) in that only a small amount of material is removed by a single 'cut'. Grinding is used to bring produce a combination of a fine finish and precise dimensions. It is also a practical means of removing metal which has been hardened and can no longer be dealt with using standard turning tools.

The cutting speed of a wheel is normally expressed in feet (of the periphery) per minute or metres per second and a simple calculation will convert spindle speed (rpm) into peripheral speed. Clearly, if the machine has only one spindle speed, then to obtain the correct cutting speed, a precise diameter of wheel will have to be fitted. As long as due regard is given to maximum permissible wheel speed (as marked on the wheel), the correct cutting speed can be realised by varying wheel diameter. Table 4 gives an indication of cutting speeds for different types of grinding.

As the wheel reduces in diameter due to wear, the cutting speed obviously reduces if the spindle speed remains constant. This causes an enhanced rate of wheel wear, which gives rise to the misconception that wheels are actually softer towards the centre. A wheel which does wear rapidly at the correct cutting speed is, however, too soft for the job. On the other hand, a wheel which 'glazes up' frequently is too hard.

TABLE 4 CUTTING SPEED RANGES		
Application	**Ft./Min.**	**Metres/Sec.**
Cylindrical grinding	4900 -9850	25 - 50
Internal (bore) grinding	4900 - 6500	25 - 33
Surface grinding	3950 - 6500	20 - 33
Tool & cutter grinding	4900 - 6000	25 - 30

As a matter of interest, the smallest grinding wheel I have encountered was 2.25mm dia. and the largest was 1830mm diameter.

Notes on portable grinders

Most home workshops will contain a portable grinder of some description, be it an angle grinder, hand grinder (barrel grinder) or a portable drill attachment. The drill attachments consist of either an arbor mounted grinding wheel which is simply gripped in the chuck or alternatively, a flexible drive cable and sheath, driven from the chuck while the machine secured in some sort of drill stand. These types of attachments are seldom provided with guards and in my view do not represent a very good option for model engineers, although flexible drives can be useful as long as sensible safety precautions are observed

Hand grinders which have the spindle parallel with the axis of the machine are a better proposition. Most of these are threaded at the spindle nose and accept grinding wheels which have a nut moulded into them and so can be screwed directly onto the nose. Alas, these machines also seem to be used frequently without guards, but are at least purpose made and are likely to be much safer to use than attachments. By far the most versatile of portable grinders is the angle grinder. This powerful machine can really make light work of metal (or masonry) removal and is to be recommended for 'in-situ' grinding work. They will easily slice through steel bars, though for this application it should be ensured that 'glassfibre reinforced' wheels are used. For general fettling work, to which they are highly suited, the face of the wheel is used, as shown in **Fig. 7**.

In use, all portable grinders should be operated with an awareness of potential danger and with regard to where the sparks are being directed. A fire can easily be started among oily rags and the like. Each spark is a tiny particle of metal, which can embed itself into the surface of non-ferrous metals in the area, causing contamination.

Safety and grinding wheels

A grinding wheel is a particularly dangerous object. Like any other cutting tool, even at rest it can cause injury if a spanner slips and your hand is forced into the sharp, abrasive corner.

It is when revolving at high speed though, that they are at their most hazardous. If you accidentally touch the wheel when it is running, as well as cutting deeply into the hand, a burn is also sustained. This all adds up to the likelihood of serious injury.

When grinding and also when wheel dressing, the eyes should be well protected. The small clear plastic shield which is fitted to some bench grinders is **not** sufficient to provide adequate protection for the eyes. Small particles of abrasive and metal can even come into contact with the eyes even when wearing spectacles, and it should be considered mandatory to use the type of goggles which offer full protection for the whole area around the eyes.

The operations of grinding and wheel dressing both produce quite a lot of fine particles of dust, particularly when using a Huntington dresser. A suitable mask should be worn during all dry grinding or dressing activities.

A grinding wheel should never be run without its guard (or hood as it is sometimes known) being fitted. Arrows should be apparent too, as an indication of the direction of the spindle, as we have seen in **Fig. 6**.

Importance of the Maximum Operating Speed (MOS)

If a wheel is of unknown origin and does not have a maximum operating speed mark evident on it, a very simple formula for calculating its safe speed is:-

wheel dia. x 0 = rpm.

There is then never any danger of this wheel injuring anyone.

(I.E. A wheel of unknown provenance should be consigned to the bin and never run at all, it is not worth taking a chance)

The maximum operating speed (MOS) is stated in rpm on a wheel and is the absolute maximum no-load speed at which a spindle may be run with that wheel correctly mounted upon it. It is sometimes assumed that there is also an additional 'margin of safety' at which the wheel may be overloaded, as the test speed is never as low as the indicated safe operating speed. **This is definitely not so**. True, the wheel is tested at a higher speed than indicated (usually $1^1/2$ times MOS), **but this margin must, on no account be encroached upon.**

When ever any object revolves, a centrifugal force is generated, and this force is proportional to the **square** of the angular velocity. This means that doubling the rpm would create a wheel shattering **quadruple** centrifugal force, so under no circumstances attach a grinding wheel to a motor unless the maximum no-load speed is known, with certainty, to be within the stated Maximum Operating Speed of the wheel.

Care and storage of wheels

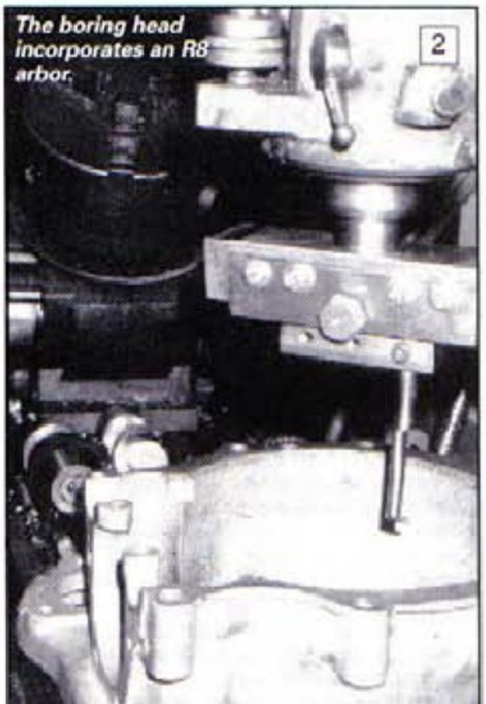
Having gone to so much trouble to select the correct wheels and build up a collection which suits the envisaged applications, great care must be taken if we are to get the best out of them. They should never be thrown in a box or drawer where they are free to knock together. Wheels are better stored in a proper place set aside for this purpose. The larger straight wheels are better stored vertically. A rack can easily be made, with two wooden rails to hold them and stiff cardboard or hardboard discs to keep them apart. If you have plenty of wall space, an area can be designated where wheels can be hung, but it is essential that they are secure and cannot fall off due to the vibration of working machinery. If a wheel accidentally falls on to the floor it should be discarded. If wheels have to be stored in cupboards or drawers, they should be individually boxed or heavily wrapped in newspaper. A wheel should never be rolled about on its periphery.

Mounted points are easily stored in racks which are drilled to accept the arbors. The rack can even be provided with a lid to protect them from heavy objects accidentally being placed on top of them. It is critical that the small arbors on which these miniature grinding wheels are mounted do not become bent, as this will render them useless. This is why, when in use, the 'overhang' of a mounted point (the distance between the collet or chuck and the back of the wheel) should be given due consideration. The greater the overhang, the higher the risk of deforming the arbor.

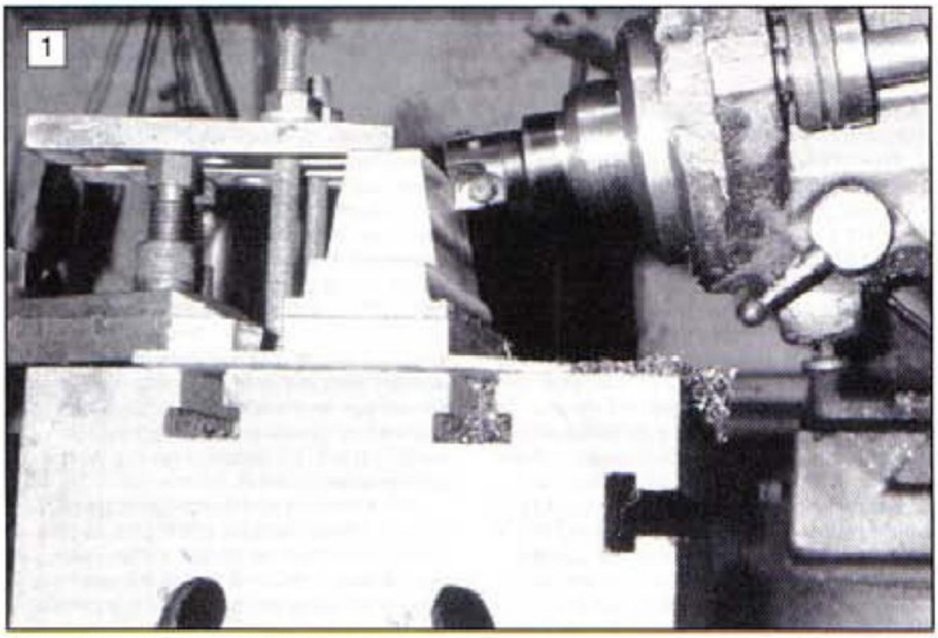
As mentioned earlier, wheel bonds and abrasives are not affected by water or other substances such as oil. Consequently it is in order to use all conventional coolant fluids when grinding. The high speed removal of metal, even in small quantities, can generate a great deal of heat and can easily discolour the surface of the metal, possibly drawing the temper if it has been previously heat treated. Coolant will help here immensely and is an aid to prolonging the life of wheels.

Having discussed grinding wheels fairly fully, it is hoped that the amateur engineer will be able to make more use of the grinding process to obtain greater precision and enhanced surface finishes. By following a few simple rules of safety, he should enjoy a completely accident free association with abrasive wheels, which will serve him faithfully throughout their useful lives.

A BORING HEAD WITH A DIFFERENCE



The boring head incorporates an R8 arbor.



ABOVE: Milling the dovetail slide.

BELOW: Machining the Triumph motorcycle bearing housing.

Wanting to press ahead with the construction of a boring head when tool factors were closed for Christmas, Richard Vaughan of Brecon came up with an alternative design of slideway.

For many years, I had intended to make myself a boring head. Over Christmas 1994, I was reading Issue 27 of M.E.W., which included two differing designs, so I decided to start work on one immediately.

The design brief, to suit my workshop requirements, were as follows:-

1. Large size, to fit a Bridgeport milling machine.
2. Bore size to range from 0.5 to 4in. diameter.
3. To be made from stock materials.
4. To use slide-ways for accurate movement of the cutting tool.
5. Calibrated in 0.001 inch.
6. Easy and quick to make.

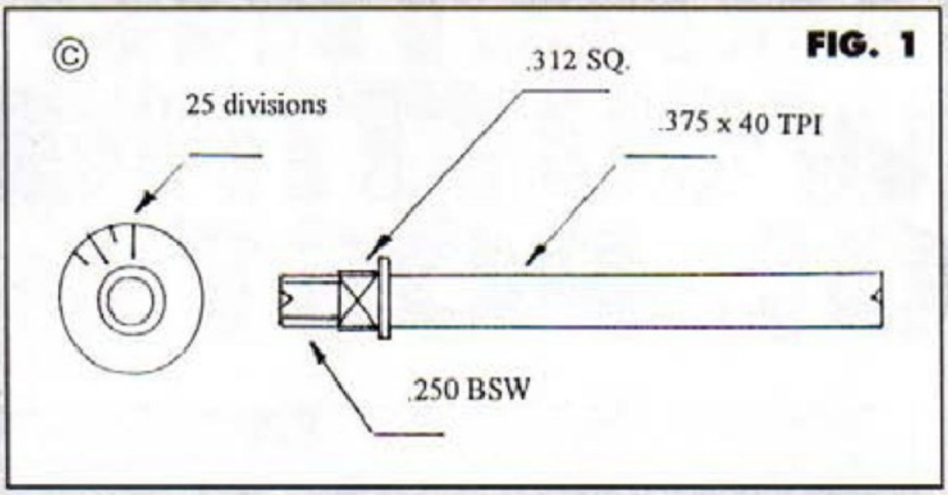


FIG. 1

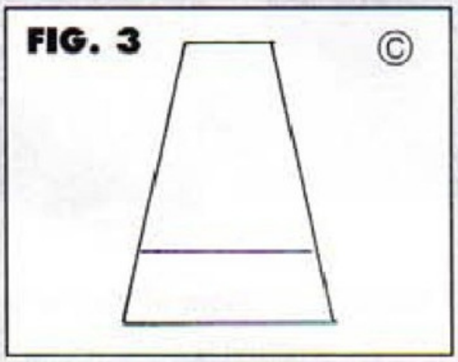


FIG. 3

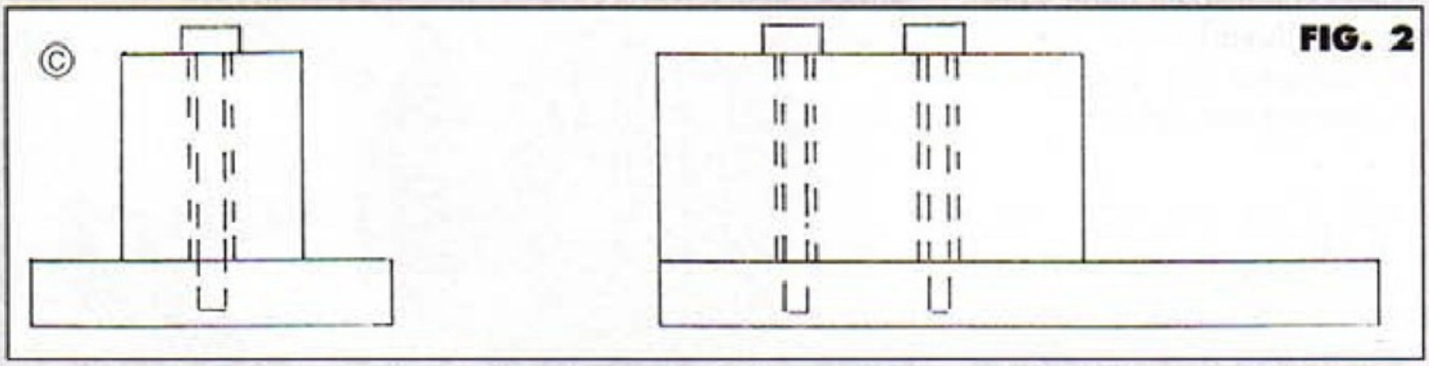


FIG. 2

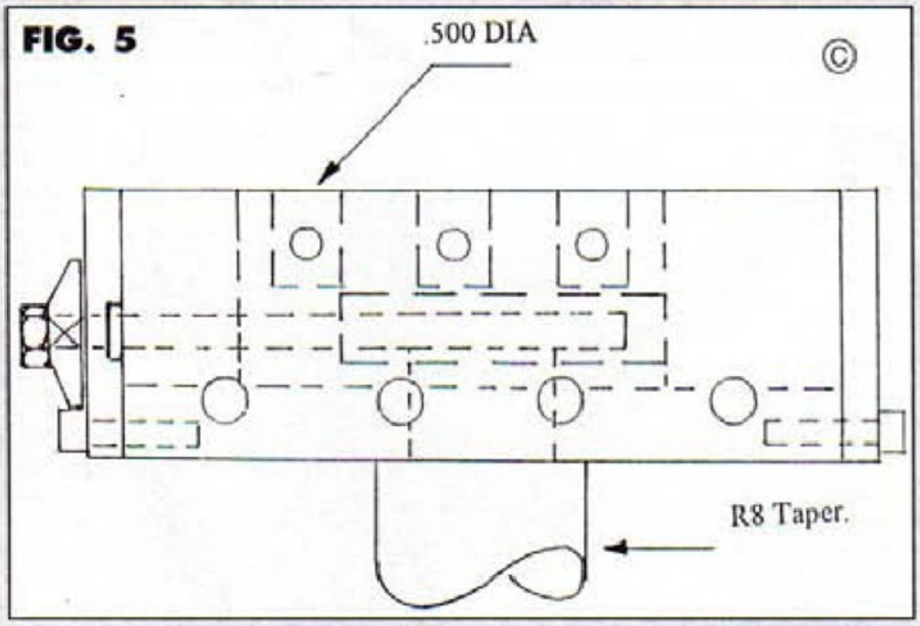


FIG. 5

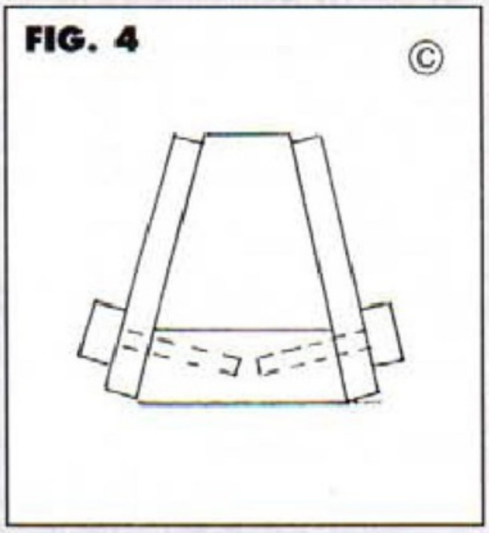


FIG. 4

The largest 40 TPI tap and die set available in my workshop is 3/8in., so this was used for the movement spindle. This later created the problem that a 40 TPI thread requires a dial with 25 divisions on it to read off in 0.001 inch. To mark this accurately, I set the dividing head at the required angle and used the calculation:- 40/ 25 =1.6, so I used one revolution and 12 holes on a 20 hole circle to give the required number of divisions **(See Fig. 1)**.

I now come to the main point of this short article, my method of producing the slideways without the need for expensive dovetail cutters, which I did not have to hand and which were unavailable over the Christmas holidays.

I first temporarily bolted two pieces of steel together **(Fig. 2)**, and then proceeded to mill a 20 deg. angle along the length of both pieces **(Fig. 3)**. I now used Allen bolts to fit side pieces to the larger base piece **(Fig. 4)**, and end pieces were similarly fitted. One end piece was drilled for the movement spindle and counterbored on the inside for the spindle shoulder.

The shorter top piece, which will now slide freely in the fabricated base, was drilled, tapped and counterbored, using the end cap as a guide. The hole for the R8 arbor was then produced and the arbor pressed home. Three tool holes were drilled and reamed and 1/4in. dia. locking bolts fitted **(Fig. 5)**.

I am sure that this method of producing accurate slideways is not original, and many readers may say that the boring-head looks clumsy and unsightly, but it has fulfilled the design brief requirements. The first job the boring-head was used for was opening out the bearing housing of a Triumph motor cycle pre-unit crank case from 3in. to 3.250in.

The making of this piece of equipment has allowed me to return to my hobby of building model traction engines, better equipped and full of enthusiasm, after an interesting break.

A RETRACTING SCREWCUTTING TOOL POST

Victor Elsendoom of Voorhout, Holland decided that he needed a helping hand while cutting threads in the lathe, so he designed this elegant retracting tool holder

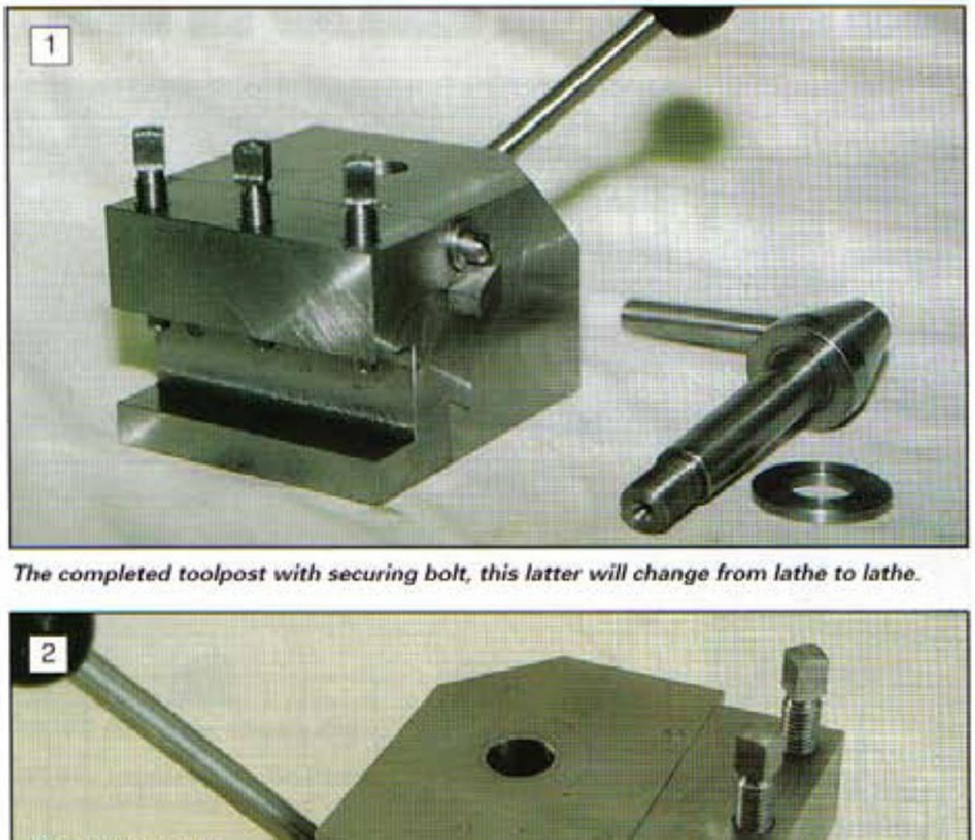
While thread cutting on the lathe, I always feel that I am one or two hands short! At the end of a cut I have to put the machine in reverse and at the same time withdraw the tool-post by moving the slide. At the moment the cutter is at the starting point again, I have to put the slide in its new cutting position. Not an easy job to do!

The toolpost described here enables me to withdraw the cutter by means of one handle and, with the same handle, to bring it back to its original position. The toolpost was designed for a relatively large lathe, but scaling down for smaller machines can be done easily.

The toolpost consists of two main parts which fit together with a dovetail (Items 4 and 5). The block 4 will be mounted on the lathe with one bolt. The position of that bolt depends on the mounting arrangements of the particular lathe, so this bolt hole is not shown on the drawing.

Sliding tool holder

The project starts with the production of the sliding tool holder (Item 5). Use material that is about 5mm oversize, which will allow for surface milling when assembled with Item 4. By doing it in this way, the positioning of the dovetail, which will be milled first, is not critical. Start by milling away both corners, using an end mill, so that a T profile is created, making sure that the depth on both sides is the same. Replace the end mill with a dovetail cutter while keeping the component in the same position. Take light cuts, since forces on the cutter will increase rapidly when you move deeper. Keep clear of the bottom by 0.5mm **(see Fig. 1)** and leave it like this until you have the other side in the same form. Stop milling when there is just a sharp edge on the top at both sides, then lower the cutter until a light cut is taken from bottom as well as from the dovetail side. Keep the mill at the same depth setting and move to the other side. By proceeding in this way, the depth of the dovetail is exactly the same on both sides. With the same cutter, take a light cut along the top of the dovetail, and in this way you will have the best guarantee that all surfaces will be parallel.



The completed toolpost with securing bolt, this latter will change from lathe to lathe.

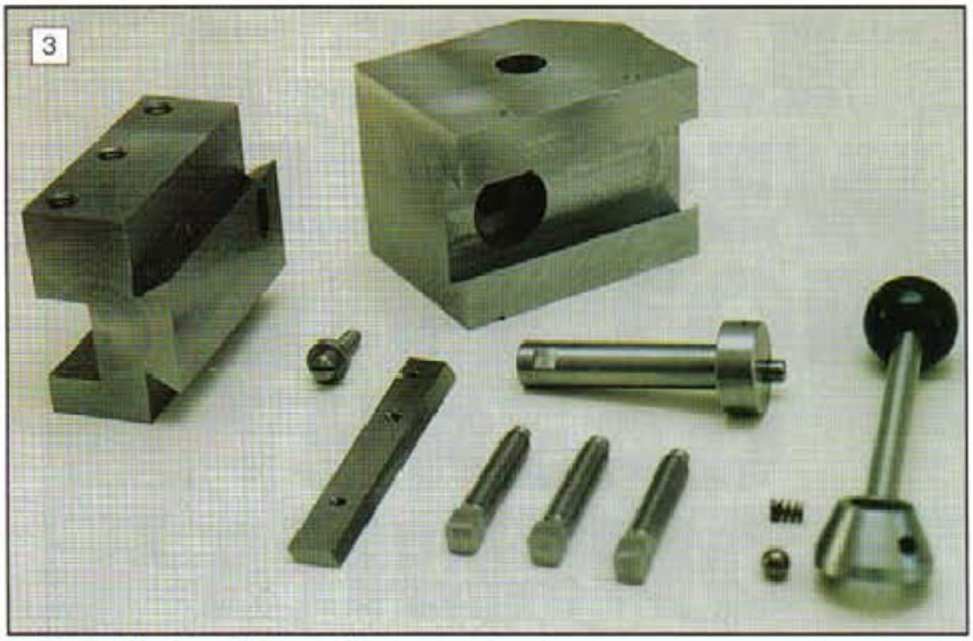
Flicking the lever on the left of the picture will retract or advance the tool as required. Note the square headed screws, a much better proposition than the more commonly used Allen screws.

Mounting block

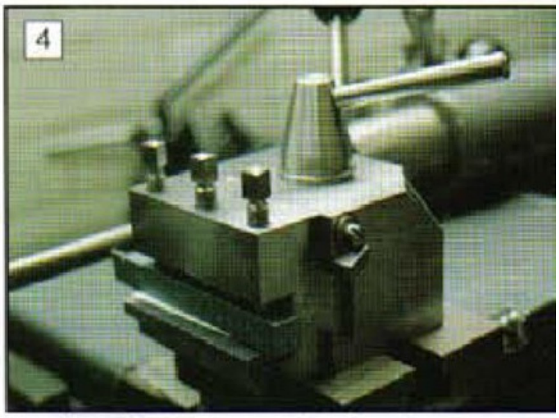
The next component to produce is the mounting block (Item 4), the first operation being to mill a groove 26mm wide. Now, rotate the vice, complete with the block, until it is set at an angle of 1 in 100 **(see Fig. 2).** This can be done with the help of a dial gauge. Replace the end mill with the dovetail cutter and machine one side carefully. Before going any further with Item 4, it will be necessary to fit the gib strip (Item 6) into position, so this should be prepared next.

Gib strip

The wedge shaped gib strip should be made out of good quality blank steel (6mm x 14mm), first forming the 60 deg. angle on one of the short sides. The easiest way to do this is to use the dovetail cutter, running this along this side **(see Fig. 3).** The length



The assembly stripped down to its component parts.



of the gib should be 95mm.

Assemble the gib strip in the mounting block with two M4 screws, the hole positions for which are shown on the drawing. Make sure that the angled edge of the gib is in contact with the bottom of the slot. It will now overlap Item 4 on all the other sides.

The mounting block now has to be clamped in the vice of the milling machine once again. Make sure that the all sides of the block run parallel to the axes of the machine, checking with a dial gauge. Mill the top of the gib strip down until it is flush with the mounting block, and then the dovetail (female slide) can be milled. Make sure that during milling of the sides there is clearance at the bottom (say 0.5 mm). Bring both sides to a sharp edge at the top. The groove should still be too small to accommodate the male part of the dovetail, so now bring the cutter down to the bottom of the groove and mill it out until the male slide of Item 4 just fits.

The difficult work is now done!

Mark the hole in which the crank will be placed from the dovetail side. Centre the hole and clamp the block in the four jaw chuck to drill a hole of 11.8mm dia., reaming it to 12mm. Counterbore the hole to 24mm for a depth of 10mm to house the disc of the crank.

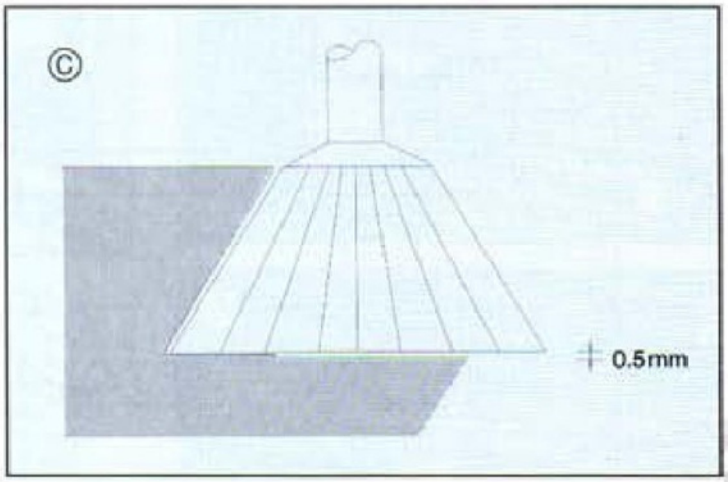
Assemble the slide (Item 5) in the mounting block (Item 4), together with the now wedge shaped gib strip. Put the parts firmly together by tapping the gib strip with a plastic hammer. At the front, there should be a difference in position of 8.5 mm between Items 4 and 5 (Item 5 sits 8.5mm back). Make a centre punch from 12mm silver steel, using this to mark Item 5 via the 12mm hole in Item 4. This gives the location of the 14.5mm x 6 mm slot into which the crank pin will engage. The marked centre is used to set Item 5 in the correct position on the milling machine, so that the slot can be formed with a slot drill. Make sure that the centre of one of the slot end radii is positioned exactly on the centre line of the mounting block, otherwise there will be a chance that the slide can be pushed away completely (end point too high) or that the slide will move towards the workpiece as the tool is first withdrawn (end point too low).

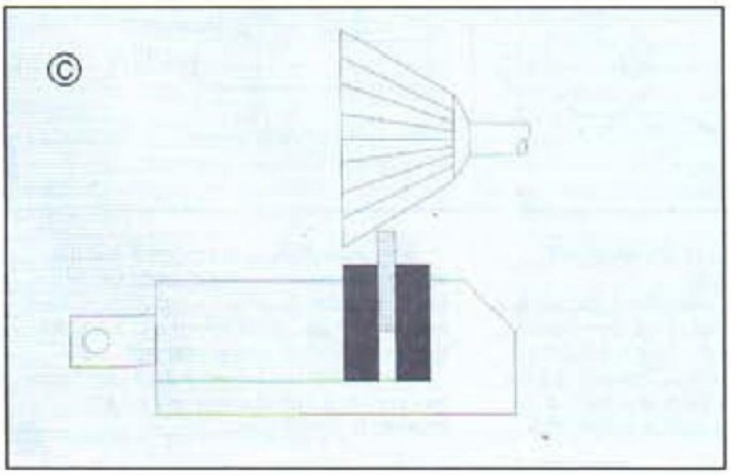
Crank and crankpin

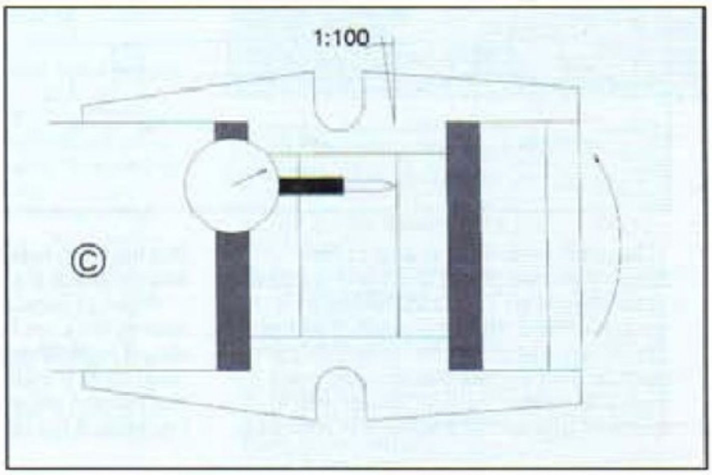
The crank and crankpin (Items 3 and 3a) are simple turning jobs and don't need any description other than to emphasise that Item 3a must be perfectly square on Item 3 and that the shaft must be a good running fit in the 12 mm hole in the mounting block, otherwise the slide will not move smoothly.

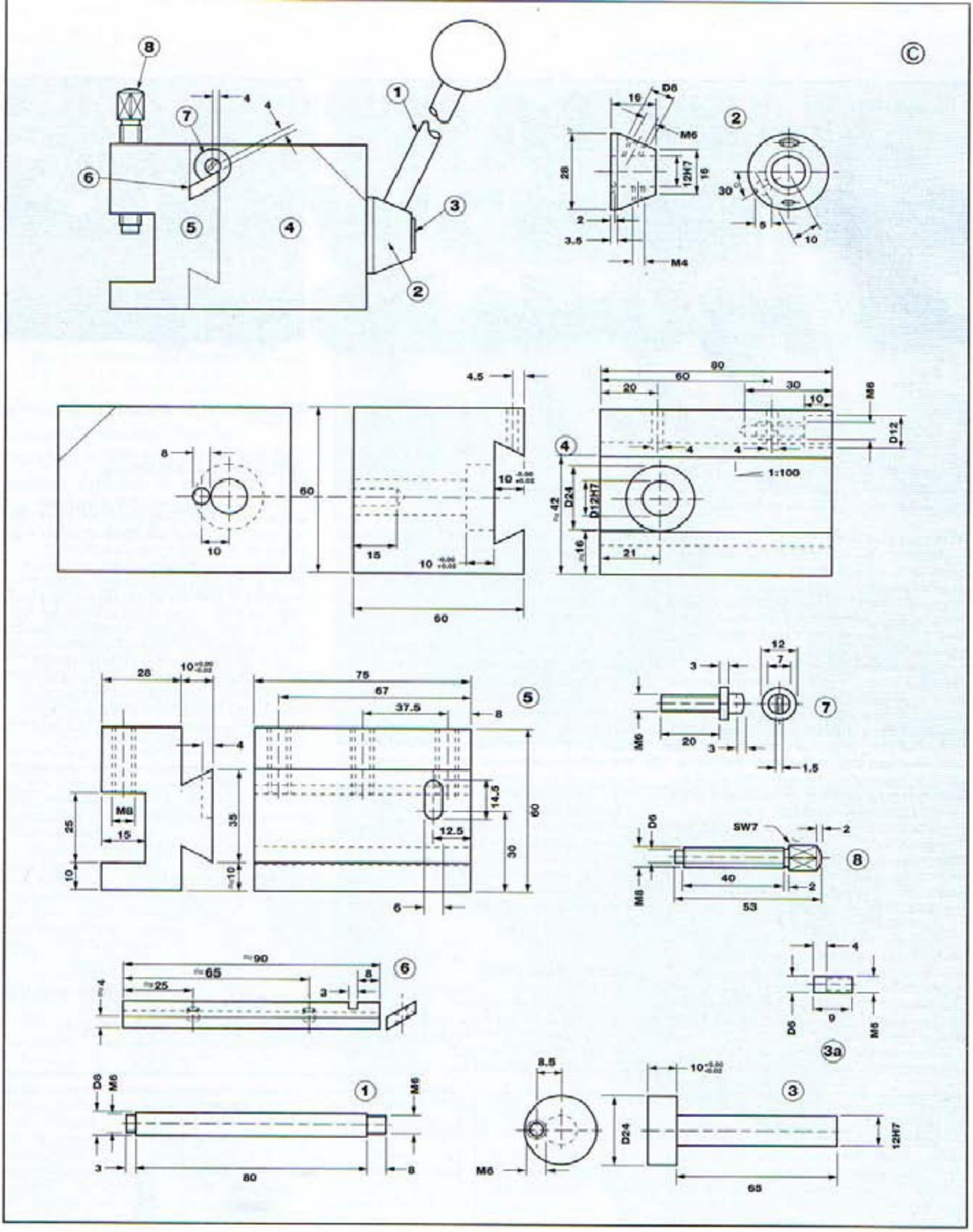
Finishing the assembly

The only other thing that may need some clarification is the positioning of the gib strip. Put Items 1, 2, 3, 3a, 4, 5 and 6 together. By moving the slide (Item 5) backwards and forwards with the handle (Item 2) the gib can be worked into the slot (remember that the side is tapered at 1 in 100). As soon as the gib is in as far as possible, the position of its slot is marked on it. This slot has to accommodate the adjustment screw (item 7). Mark the gib in such a way that there is enough room for adjustment, forward as well as backwards, without the adjustment screw leaving its housing. The slot in the gib strip can be sawn by using a slitting saw.









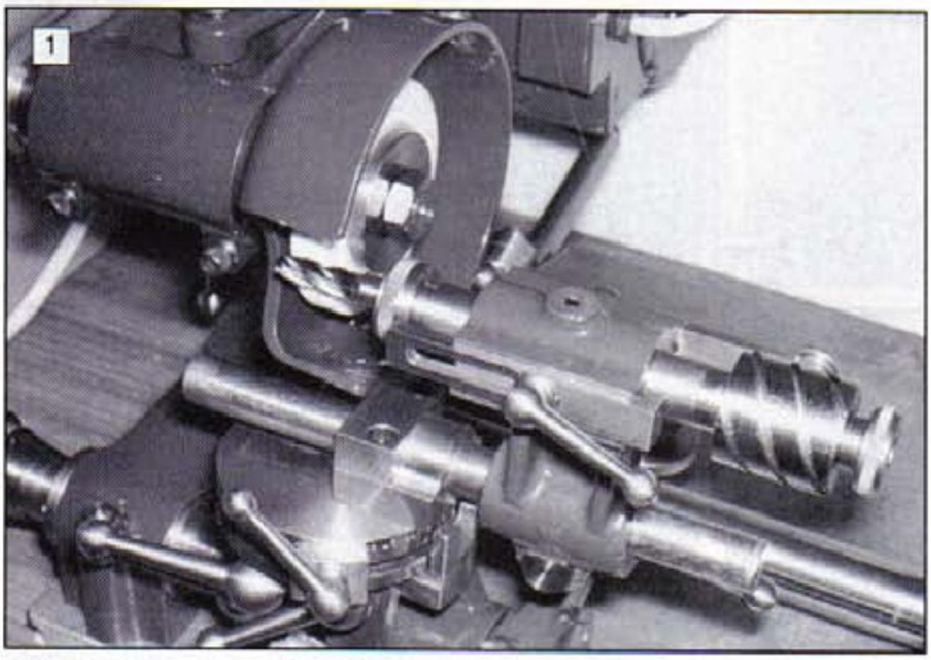
In order to locate the slide in the forward and backward positions, a detent consisting of an 8mm ball carried on a spring is fitted. Mark the position of the 8mm hole and drill 6mm deep. Bring all parts to their correct position and mark Item 2 by giving it a light stroke with a hammer (mark both positions in this way). Drill the 8mm hole to a depth which will accommodate the spring.

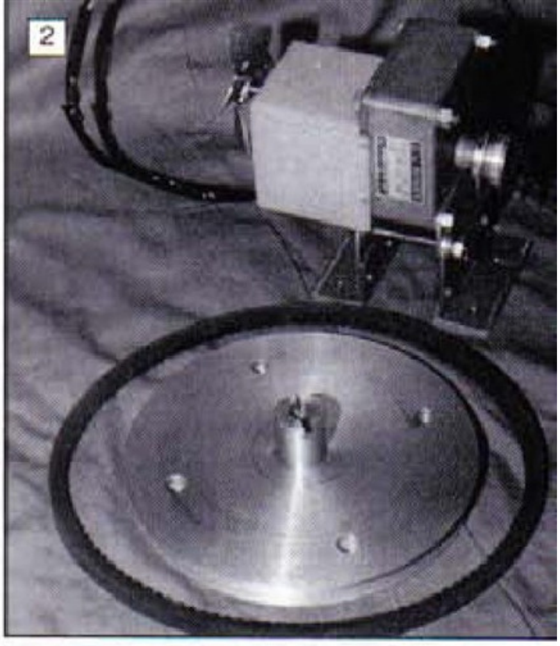
When all items are assembled, the top and bottom faces can be milled flat, then Item 5 should be removed and a light cut (0.3mm) taken off its bottom surface. This will ensure that this part will slide freely and not rub on the toolpost mounting surface of the lathe.

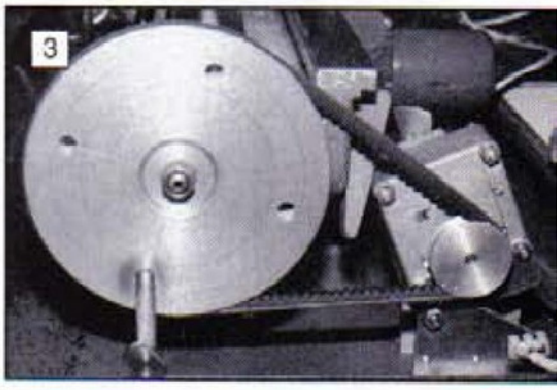
When everything is put together and the slide moves smoothly, the gib strip can be cut to the right size. To close the top of the toolpost, two 4mm plugs can be turned and fixed into the two redundant screw holes with Loctite.

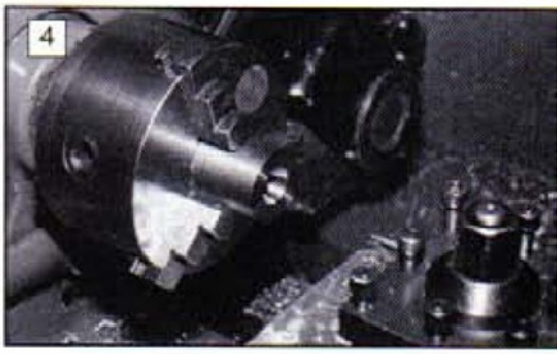
The toolpost has proved to be a very handy tool and I had a lot of enjoyment when making it. Good luck!

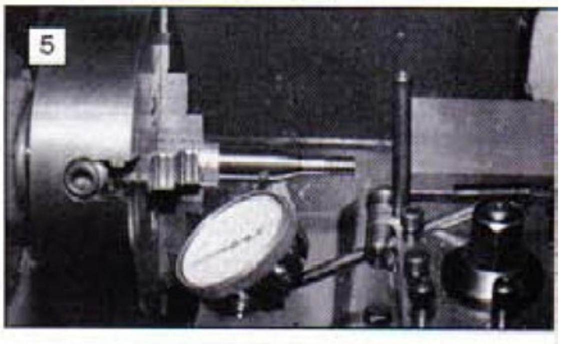
A SIMPLE LEADSCREW DRIVE FOR THREAD MILLING











Machining coarser threads can appear to be quite daunting, especially as lathe changewheel teeth are at risk if conventional methods are used. David Machin describes how he devised a set-up for thread milling

It is said that necessity is the mother of invention and it was certainly true in the case of my need for a leadscrew drive for making the hobs on the Quorn Tool and Cutter Grinder. The idea of a hob for guiding the grinding of end mill cutters is the ingenious idea of the late Professor D.H.Chaddock, designer of the Quorn. He published in *Model Engineer* a series of excellent articles on the construction of the grinder, and later a book, which I believe is still available (TEE Publishing). Castings and materials for the machine are available from Model Engineering Services.

Briefly, the idea is that the end mill to be ground is mounted on one end of a shaft and the hob on the other. The shaft is part of the spiralling head attachment – really an alternative workhead. The hob has helical grooves machined on it, these grooves having the same helix length as that of the cutter. A detent pin is positioned to engage the grooves and thus guide the cutter correctly past the grinding wheel. Obviously, a different hob is needed for each size of end mill. **Photo 1** shows a 5/16in. cutter being ground using the hob with the longest helix. The making of this hob will be seen later.

To make these hobs is a screwcutting job, but rather a special one, because the pitches needed are very long. They are so long that, in all cases, the leadscrew is revolving faster than the workpiece. To attempt to screwcut in the normal way would almost certainly break teeth on one or more of the change wheels due to the strain on them caused by the large ratios needed to achieve the large pitches. What

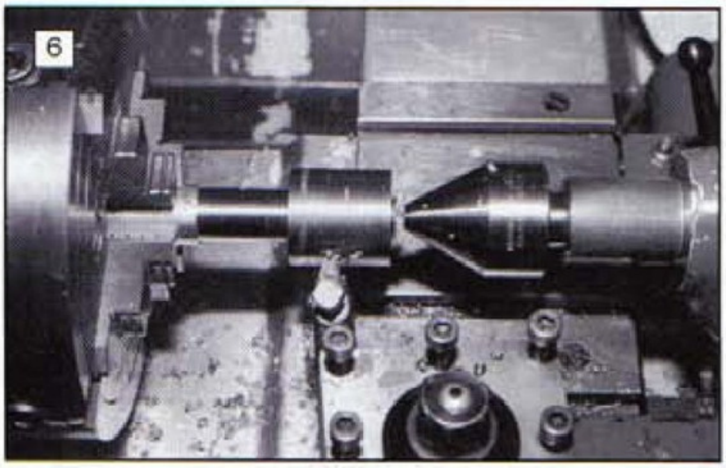
1: The Quorn spiralling attachment showing a hob in use.

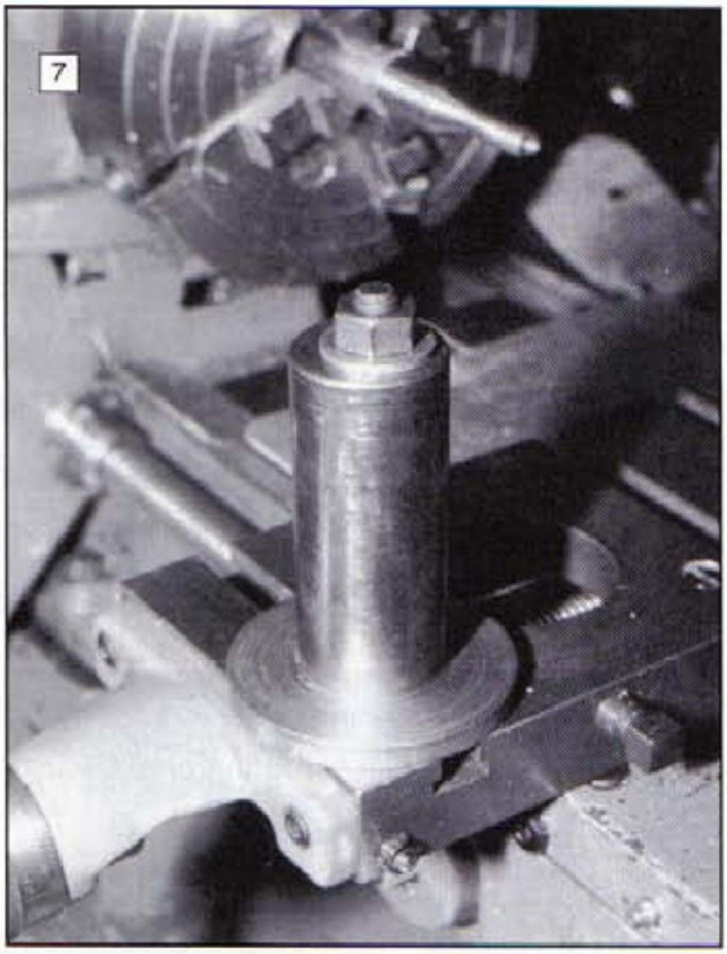
2: The motor, pulley and belt.

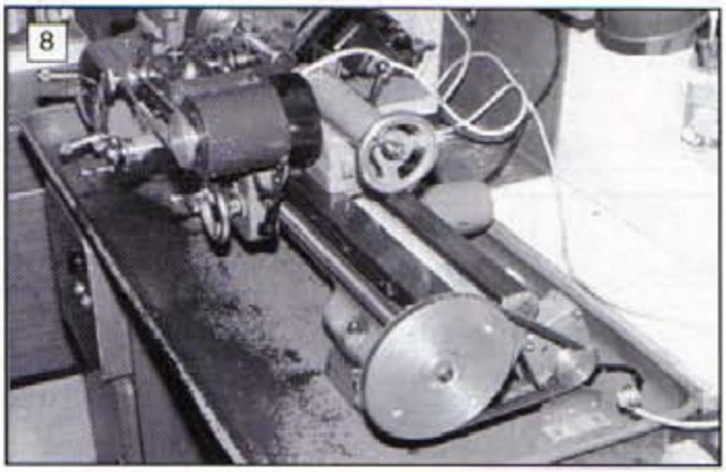
3: The motor installation. Note the wooden wedge and the drive handle.

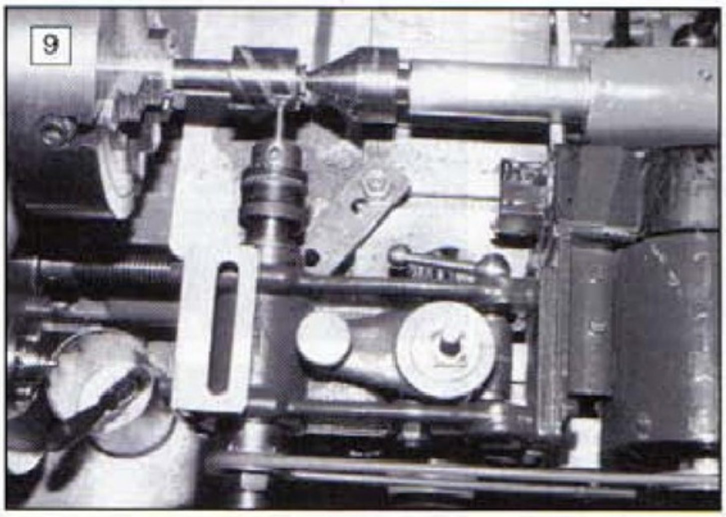
4: A hob blank is machined.

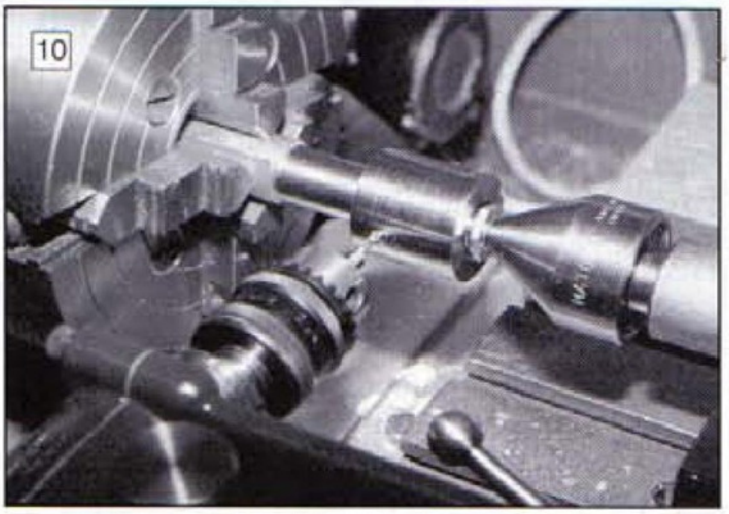
5: The spiral attachment shaft is set true in the four jaw chuck prior to milling the hob.











6: The hob blank, mounted on the spiral attachment shaft is trued on the outside diameter.

7: The tool post by which the Quorn head is mounted on the lathe.

8: The complete spiral milling set-up.

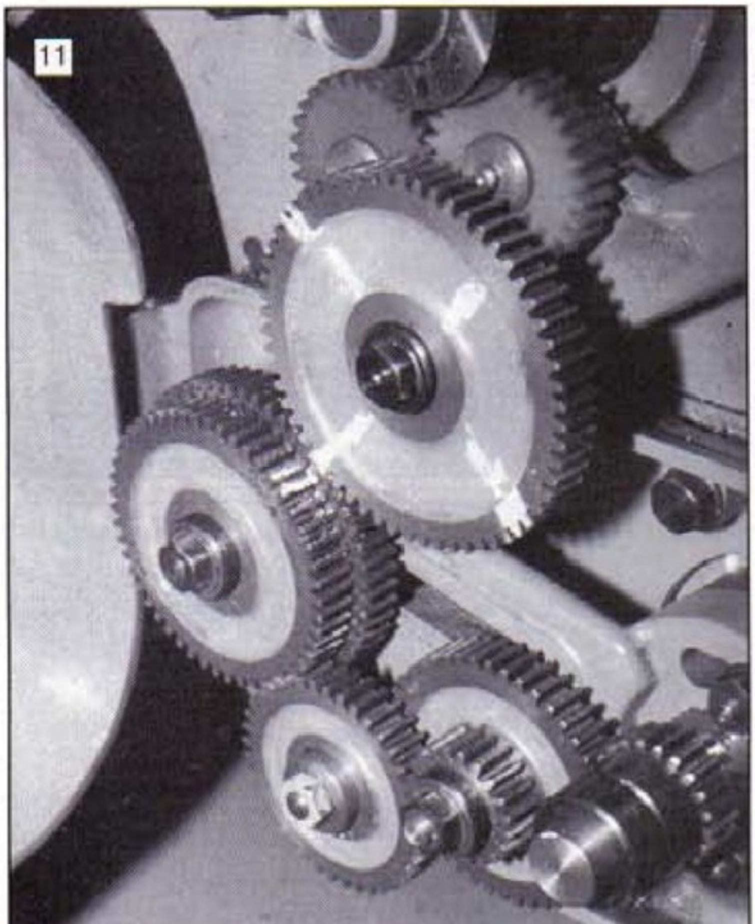
9: A close-up of the machining arrangement. The drill chuck is not the preferred arrangement, so only light cuts are possible.

10: The first cut.

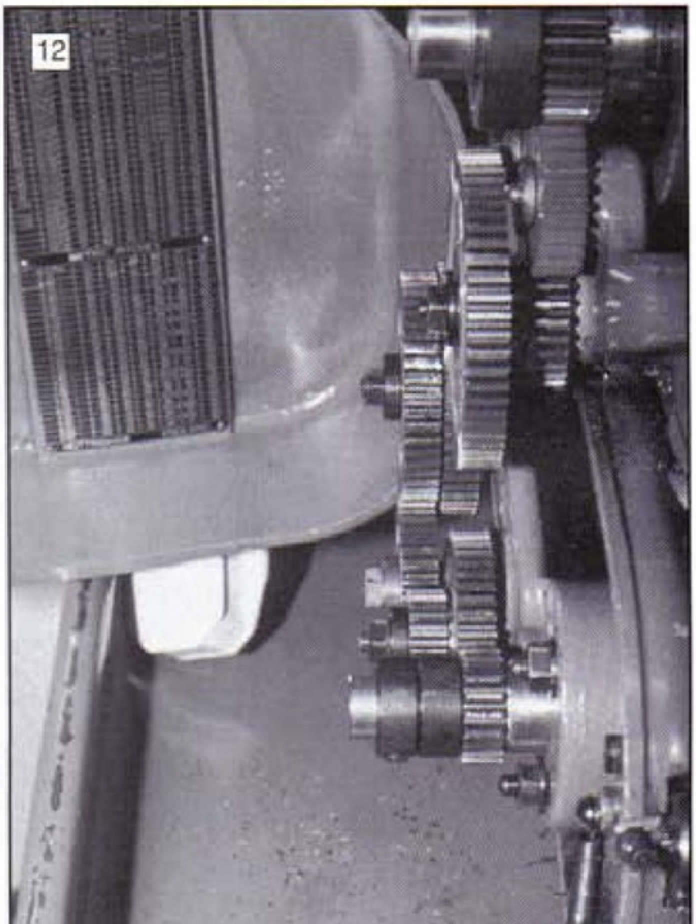
is required is to drive the leadscrew and to mill the grooves. The Professor shows how this can be arranged, using an overhead belt drive and worm and wheel to achieve a suitable speed and feed, with the wheelhead of the Quorn itself used to do the milling. The former, though an excellent system, was, I thought, a wee bit complex. Then I remembered that I had a small motor and gearbox unit which I had been hoarding for years. This came out of an old photo-copier. Could this be used? Would it be powerful enough? Would the speed and feed be acceptable? As will be seen, the answer to all these questions is yes.

Drive motor

Photo 2 shows the motor - a shaded pole type. It has a lamination thickness of 1.187in. (30mm) and the gearbox output shaft is 8mm dia. The maker's plate showed a motor speed of 2681rpm, and a gearbox output speed of 30rpm, at a torque of 6 kg-cm. A further reduction in speed could be obtained by a pulley and belt. The pulley diameters used resulted in a speed of 8.33 rpm at the leadscrew, and this would also produce an increase in torque. To assess the torque requirement, I did a simple (and crude) experiment. A gear train was set up on the Myford, of the type to be used to make one of the hobs (there was a difficulty here, but more of this later). The tumbler reverse was engaged so that the lathe spindle would be driven by the leadscrew. Additionally, the half-nuts were engaged, so that the carriage too would be driven. Using the leadscrew handwheel, I moved the handle to the three-o'clock position and placed



The changewheel set-up. Note the chalk marks used for re-setting.



Another view of the gear train.

weights on it until the handle moved and started to turn the leadscrew and lathe spindle and to move the carriage. The weight (in kg) was then multiplied by the distance (in cm) from the centre of the handwheel to the centre of the handle. This gave an idea of the required torque value, it being recognised that more torque would be required to meet the actual thread milling load. I must admit that *I cannot now remember what the* calculated value was, but I do remember that it was quite a bit less than the geared motor output. The additional torque to be provided by pulley and belt reduction would increase the margin of available power, so this encouraged me to go ahead with the project. The only snag was that the gearbox output speed was fixed; the Professor's system had a variable speed capability. However, in the interests of simplicity and speed of manufacture, I felt that this was acceptable.

The plan now was to mount the motor and gearbox on the lathe drip tray, to obtain a suitable belt, to make up the necessary pulleys to match the belt and to arrange for engagement and disengagement of the drive. At the drawing board, a simple system was worked out, including the length of belt required.

The belt was the first purchase. This was a Goodyear FAI Auto J 0 AVO 713. The last three figures are the outside circumference of the belt in mm. Readers may be surprised at the choice of so hefty a belt; its transmission power is far greater than is needed. However, I knew that I could buy an M section belt of almost any length cheaply and 'off the shelf' from my friendly car spares shop (he stocks them in length increments as well as by car part number). I next made some patterns and castings to produce the pulleys, and after these were machined (to 1.875in. and 6.75in. dia. respectively), I could then do a trial fitting. In retrospect, a wooden pulley mounted on a metal boss would be just as effective.

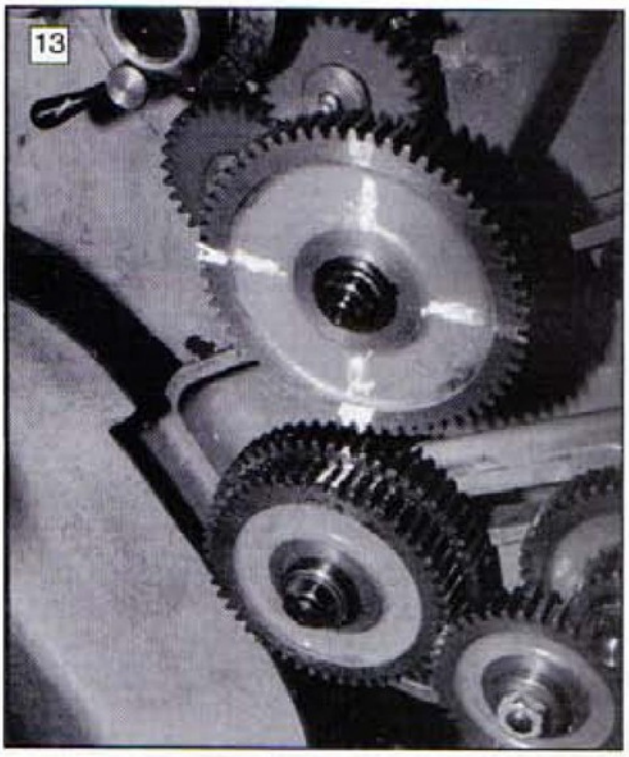
Motor mounting

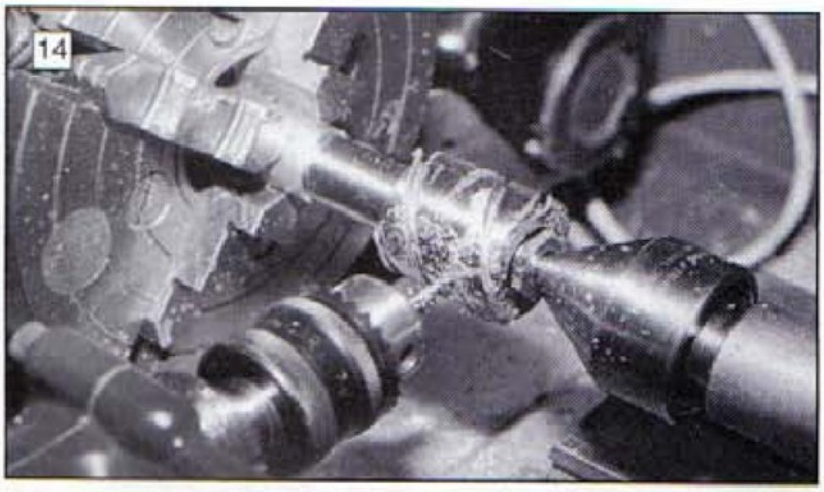
On the basis of the trial, I could now confirm dimensions and make some parts to hold the motor in position. Two pieces of aluminium alloy angle were screwed to the drip tray using 4 x 2BA screws. I used a pistol drill to drill the tapping size holes, and the drip tray is quite thick enough to take an adequate thread. Pieces of alloy plate were riveted to these angles and to this assembly was mounted the motor and gearbox, which were arranged to pivot. This pivot gave a means of adjusting the belt tension and a simple means of engagement and disengagement of the drive. A slotted link (for use with suitable screws and nuts) was then made to hold the belt tension, much in the same way that the alternator drive belt on a car engine is tensioned. This later proved to be a mistake, in that it took too long to change the adjustment between one cut and the next. A toggle arrangement would probably be a better method, but by way of a quick and easy solution, I used a simple and crude - but effective - wooden wedge! **Photos 2 & 3** will, I hope, make all clear. I have not included any drawings, since any motor and gearbox purchased is bound to be different dimensionally.

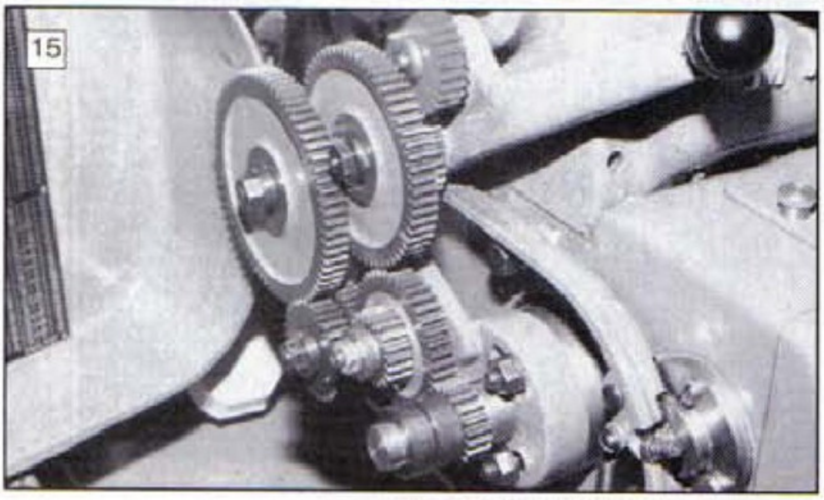
I now had a means of driving the leadscrew, with instant disengagement of drive to facilitate easy winding back of the carriage for the next cut. The winding back was facilitated by a (crude) handle *arrangement into a tapped hole in the* pulley, as can be seen in **Photo 3**. I could now make the hobs.

Banjo hang-ups

This article should now be complete; but as I mentioned earlier, the changewheel set-ups on the Myford were not as straightforward as those on the Professor's machine. This is because the change wheel banjo slot will not allow the last driver gear in a train to get close enough to mesh with a 20 or 21 tooth gear mounted on the leadscrew or gearbox input shaft, so an idler gear has to be inserted in the gear train. Any gear will do; it has no effect on the ratio, of course, but it does reverse the direction of rotation, which simply means adjustment of the tumbler reverse − no big deal! Also, I had a gearbox on my lathe, the construction of which I described some years ago. Fortunately, I had kept the full set of changewheels and I could still use these for the (very) compound trains required for the hobs. Moreover, by use of the gearbox, I only needed three changewheel set-ups







13: The gears are disengaged by moving the banjo when it is required to index the hob through 90 degrees.

14: The finishing cut.

15: The gear train used for the $^3/8$in. hob.

to cut seven hobs - for example, I could use the same set-up for $^1/16$, $^1/8$, and $^1/4$in. hobs since I could use the gearbox at three different pitch settings. It should also be pointed out that to work normally, my gearbox has to have a 2:1 reduction in the drive from the lathe spindle to the gearbox. This means that it is possible, with a 1:1 ratio, to cut a thread of 3.5 TPI at the 7 TPI setting. Not that for a second would I recommend it unless you are thread milling!

Changewheel set-ups

With the Editor's permission, I will give the changewheel set ups that I used for the hobs for any interested readers:-

For $^1/16$, $^1/8$ and $^1/4$in. hobs at the gearbox pitch setting of 40, 20 and 10TPI:-

60/21 x 50/21

An idler gear of 55 teeth is fitted between the 50t gear and the 21t gear.

The pitch produced by this train at the 10TPI setting is 1.3605in.

For $^3/32$ and $^3/16$in. hobs at the gearbox pitch settings of 16 and 8 TPI:-

40/21 x 45/21

An idler gear of 55 teeth is fitted between the 45t. gear and the 21t. gear.

The pitch produced by this train at the 8 TPI setting is 1.020in.

For $^5/32$ and $^5/16$in. hobs at the gearbox pitch setting of 14 and 7 TPI:-

60/55 x 50/20 x 45/21

An idler of 40teeth is fitted between the 50t gear and the 20t gear.

The pitch produced by this train at the 7 TPI setting is 1.6697in.

For $^3/8$in. hobs at the gearbox pitch setting of 8 TPI:-

60/30 x 70/30 x 35/20

An idler of 40 teeth is fitted between the 35t. gear and the 20t gear.

The pitch produced by this train is 2.0416 in.

Note that for the last two trains, a third gear spindle assembly had to be made, since the standard Myford changewheel set has only two. Also, for the last train, I had to use two 30t gears. I borrowed one from a friend. (Thank you, Frank!).

Machining a hob

For interested readers, I have taken some photos of the $^5/16$in. hob being made. **Photo 4** shows the embryo hob. The outside diameter has been machined a little oversize and the bore has been completed, along with the internal taper turning. **Photo 5** shows the spiral attachment shaft being gripped truly in the four jaw chuck. **Photo 6** shows the hob mounted on this shaft using a 'hollow' nut to secure it in position. This is to allow a centre to support the hob. The outside diameter is being machined to size. **Photo 7** shows the 'toolpost' mounted on the cross-slide, ready to take the wheelhead from the Quorn. **Photos 8 & 9** show the whole set up. **Photo 10** shows the first cut being taken. Not having an 8mm collet, I used a drill chuck to grip the cutter, which meant less rigidity. Also, I used steel for the hobs. This all added up to having to be content with small cuts: 0.005in. per pass.

Photos 11 & 12 show the changewheel set-up. Note the use of chalk marks for later resetting. To cut the next helix, 90deg. from the first, the 60t gear has to be moved through a quarter turn whilst the banjo is moved down out of mesh. First, to preserve accuracy, one of the quadrant chalk marks on the 60t gear is being lined up with the single mark on the 50t gear before disengagement – the leadscrew handwheel is used for this. Please remember that, once the first cut has been taken, neither the tumbler reverse nor the half nuts are disengaged until the hob is finished, or the 'thread' position will be lost. The banjo nuts are then slackened to allow the whole banjo to move down (**Photo 13**). The 60t gear is then revolved a quarter of a turn, the quadrant moved up to re-mesh the gears and the nuts retightened, taking care to mesh in exactly the right place. **Photo 14** shows the last cut being taken.

Photo 15 is of the $^3/8$in. hob changewheel set-ups and is included for any readers who wish to attempt this (very) compound gear train. There is only just enough room for the gears to fit!

Other applications

Of course, this method of driving the leadscrew and milling threads has other applications:- cutting helical grooves of large pitch for head elevation on the column of a vertical miller or for a focusing system on a lens barrel are two such applications. I'm sure that you'll think of plenty more.

FROM THE PLANS SERVICE

WE 26 A Small Swivelling Vice

This issue of *Model Engineers' Workshop* features a cover-mounted 'extra' in the form of a drawing which is an abridged version of one which is usually offered through the Nexus Plans Service

A reader of *Model Engineer*, Syd Pipe, purchased a small vice which had been manufactured in Japan. The vice could be clamped to the bench and was capable of being swivelled in both the horizontal and vertical planes and therefore proved to be a versatile addition to the workshop. He found, however, that although the concept was good, the design and manufacture were not up to expectations as the working clearances were too large and the unit was too small and too weak to be practical. He therefore resolved to design and make a more robust version.

Having made the patterns for the castings and completed a vice, the design proved popular with others, who requested castings. He therefore thought that it would be worth writing an article for publication, and this duly appeared in *Model Engineer* in 1983, in four parts. The description was comprehensive, giving instructions on pattern making for those who have never attempted this part of the job before, and also giving a number of hints and tips on machining set-ups and tooling. It is assumed that castings were never available commercially in the U.K. as the designer lived in Australia.

The description commenced in *Model Engineer* Vol.150 No. 3702 (1 April 1983) and continued in Nos. 3704, 3706 and 3708. The drawings were included in the Plans Service as WE 26 and contained all the details mentioned above, shown on two sheets. Our cover-mounted drawing is an abridged version of these and, together with these pages, contains details of all the components and the patterns required for the cast items. We have no knowledge of a current source of castings, so if any reader is planning to make the patterns, the Editor would be pleased to hear from them, as this could be of help to other potential constructors.

The design

The vice has a capacity of around 1in. with a jaw width of $2^1/2$in. A short base casting, which can be screwed to the bench, houses the spigot of a tee shaped post casting which can be rotated through 360deg. about the vertical axis. The spigot can be immobilised by means of a powerful lock of the floating pad-bolt type.

The post casting is bored horizontally to house the jaw assembly and its clamping mechanism. This whole assembly is also free to rotate through 360deg. and can be secured in the desired position by a second pad-bolt lock.

The design provides two sets of jaws, one plain and the other accommodating vee grooves. The top faces of the jaws are relieved at 5 deg. from the clamping faces to allow the vice to be used for bending springy material, such as stainless steel, through a right angle, when a measure of over-bending is necessary.

The clamping screw employs a $^3/8$ in. BSW thread, and a $4^1/4$in. long sliding handle is specified. A nylon thrust washer is used to transmit the clamping force to the outer jaw.

Construction can be achieved using a $3^1/2$in. lathe equipped with a vertical slide, together with a bench drilling machine. Patternmaking should present no particular difficulties if the suggestions made in the article are adopted. A selection of these is reproduced here. In summary, this small vice would make a useful addition to any workshop in which small benchwork is undertaken.

THE MODEL ENGINEER PLANS SERVICE

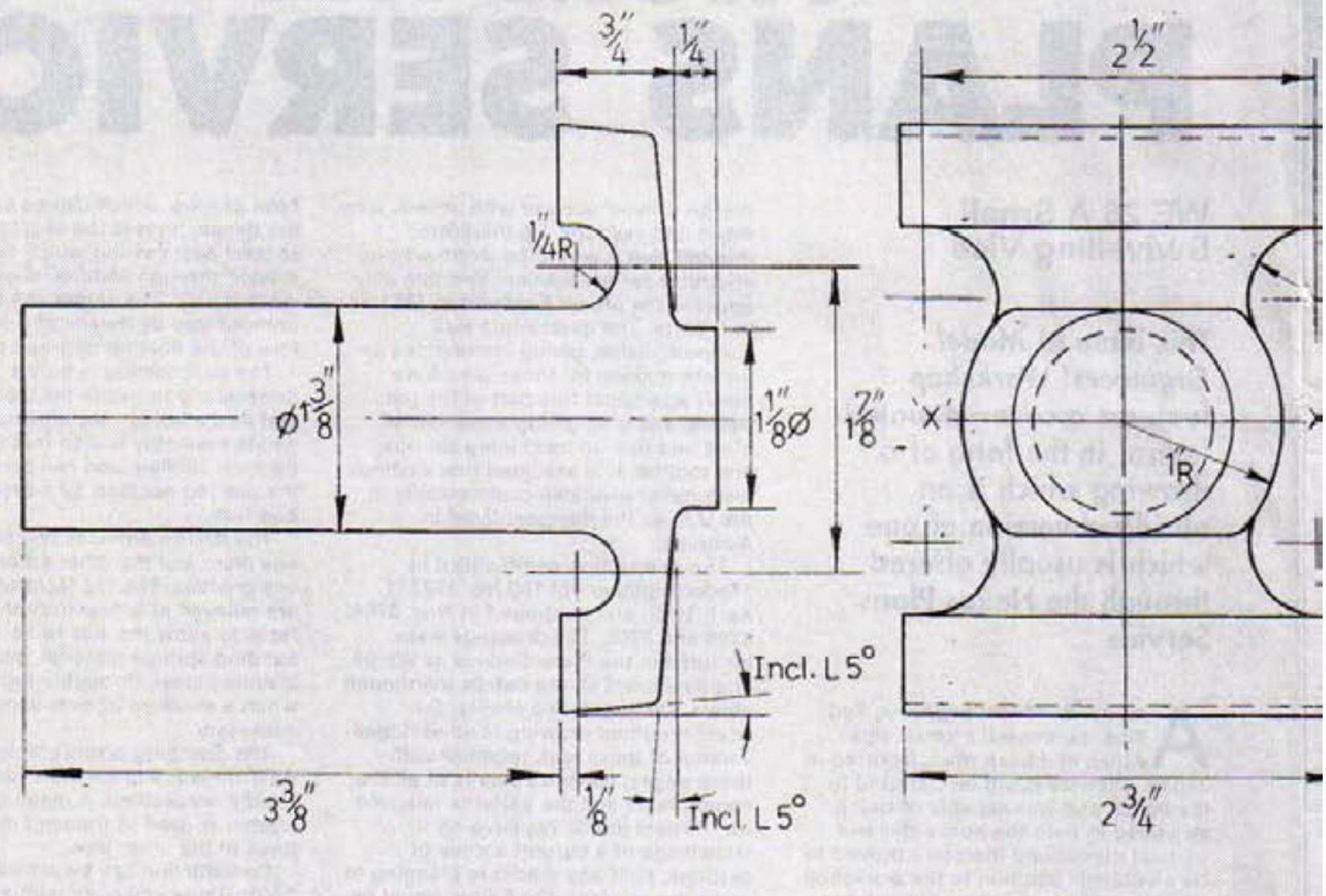
The Plans Service has been in existence for nearly as long as long as *M.E.* and during that time not only do fashions change but expectations also. Just 18 months ago, the total number of model plans available through the Plans Service amounted to nearly 9500 and, if individual sheets of locomotive and traction engine designs were taken into account, a lot more than that.

Many of the drawings had lain dormant for years and showed none of the vital signs demanded if further investment was to be made in them. Rather than destroy drawings that form a part of model engineering history, Nexus has made arrangements for continued availability of these drawings through an alternative supplier.

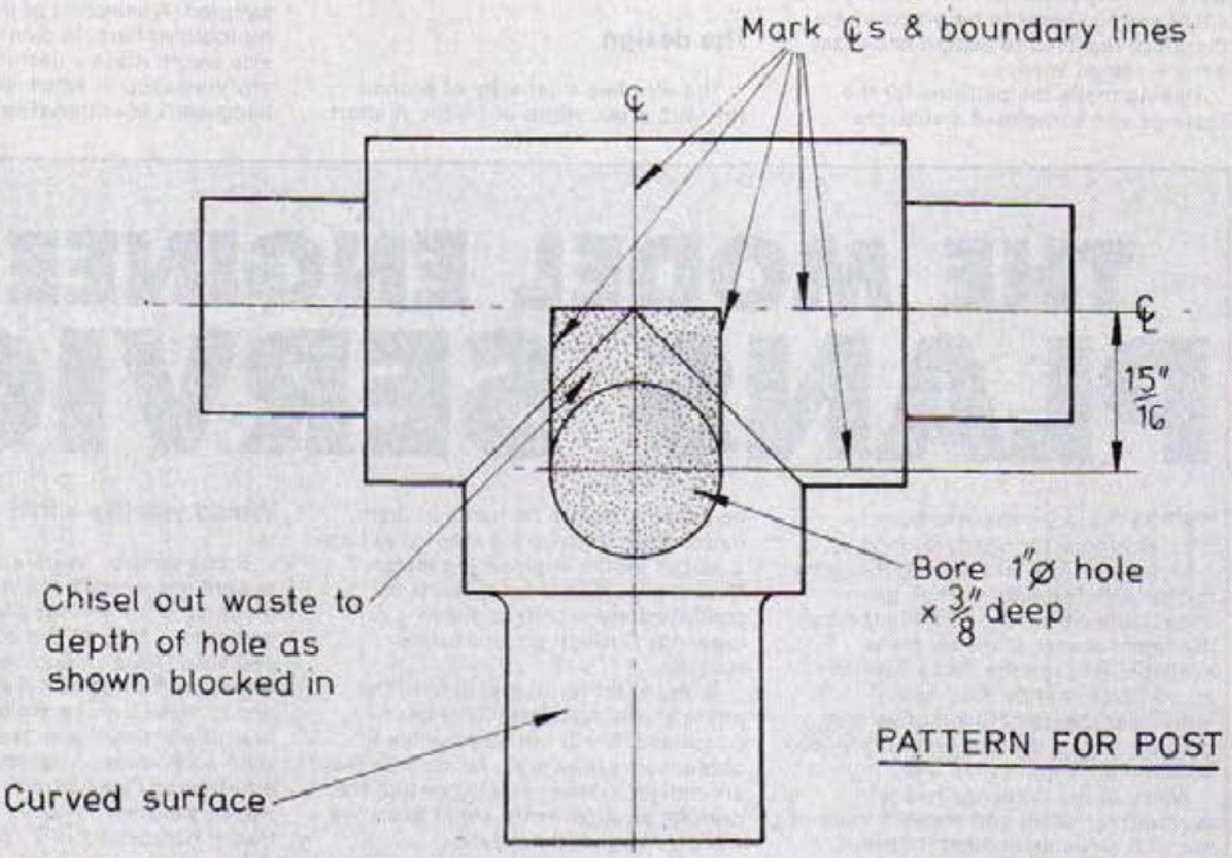
In the short term, that is until the physical arrangements have been concluded, it will not be possible to obtain some drawings. As soon as they are moved to their new home and the printing arrangements are in place we will give you all the details.

Would you like a list?

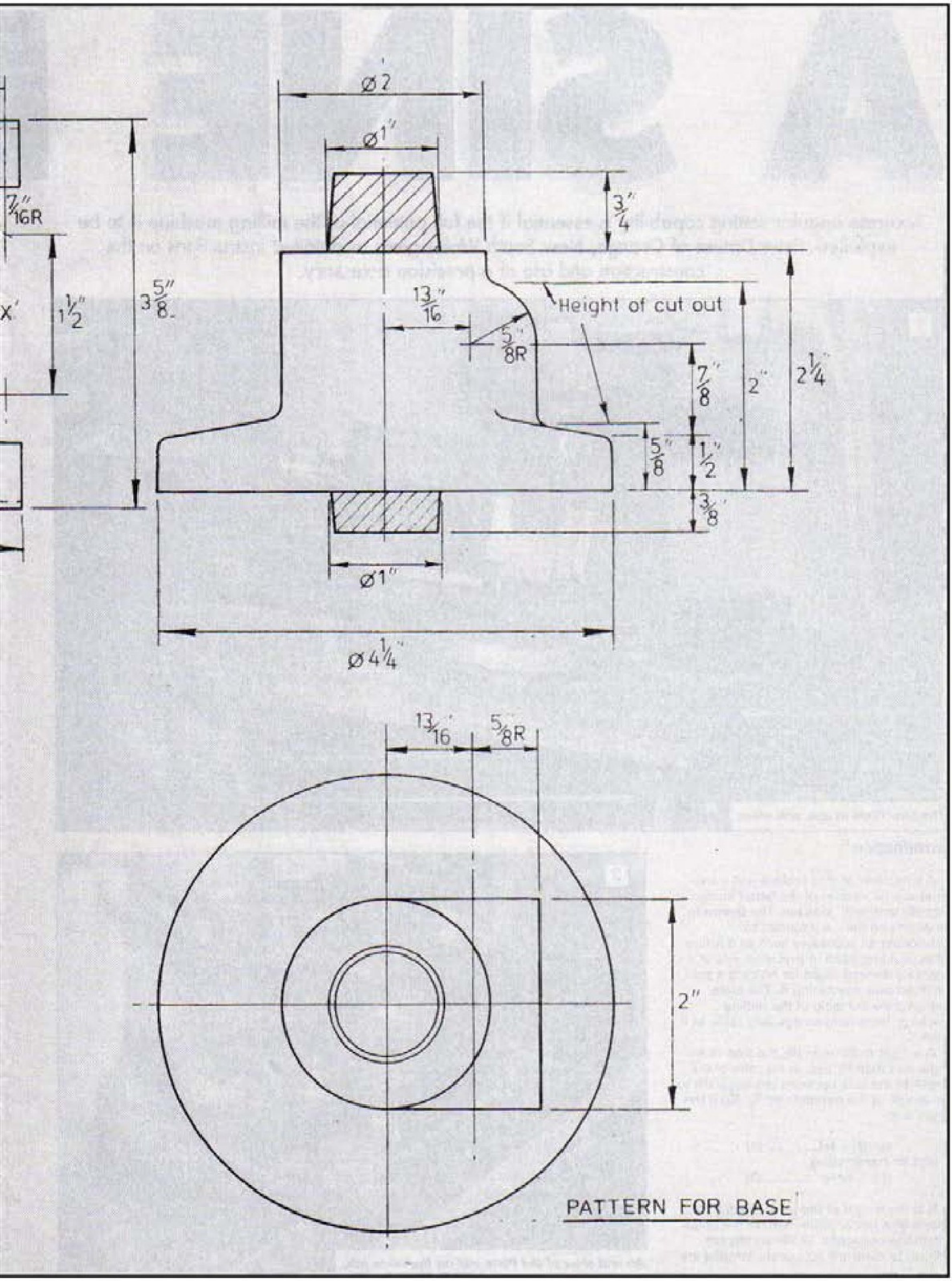
Some unlucky readers may have missed one or both of the cover mounted plans listings given away free with issues *M.E.* 4053 (Locomotives) and 4055 (Traction Engines and Workshop Equipment) If you would like one of these listings, which include 50 new *Model Engineers' Workshop* plans, send a stamped addressed A4 size envelope to Plans Service, Nexus House, Boundary Way, Hemel Hempstead HP2 7ST.



PATTERN FOR OUTER JAW

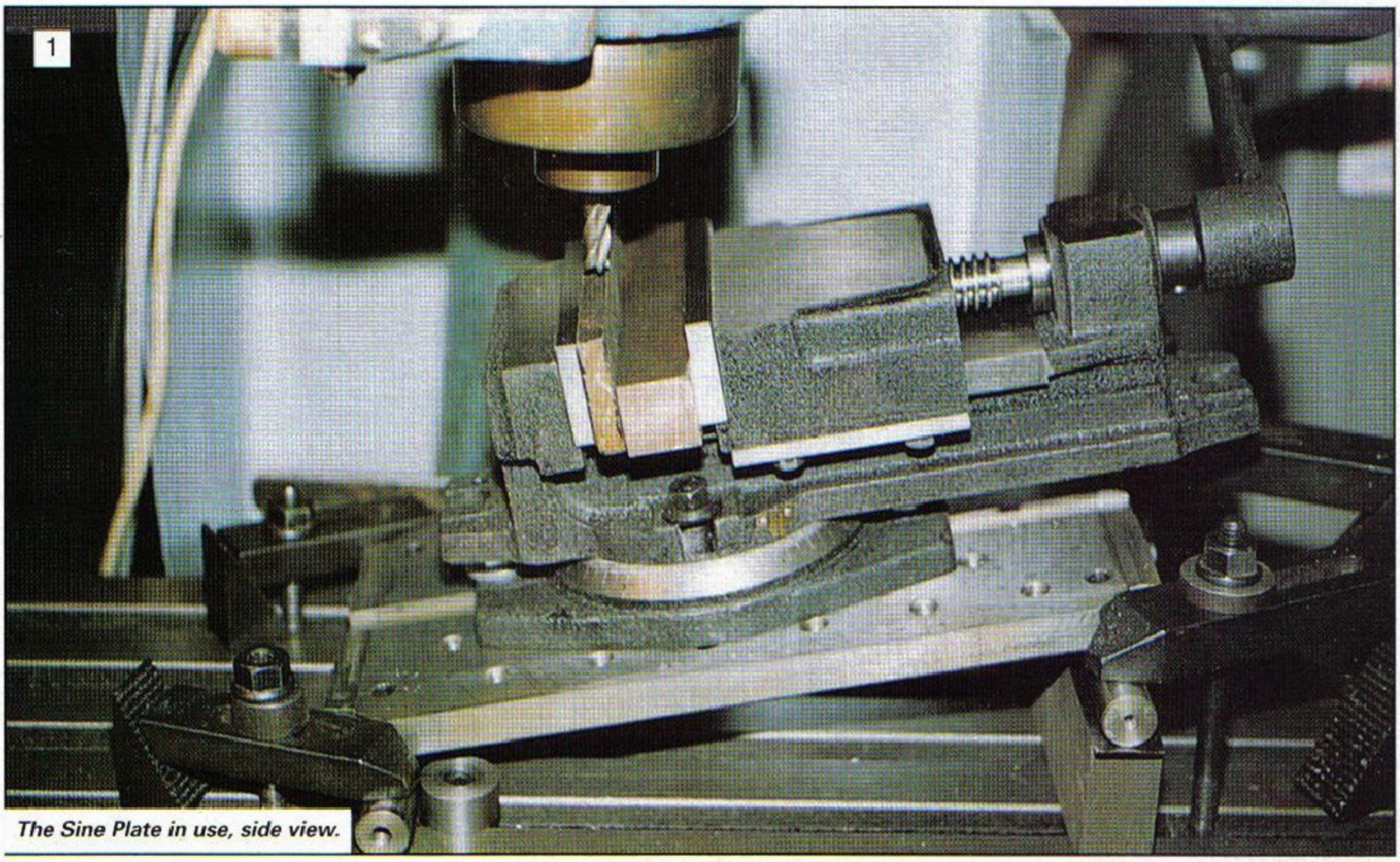


PATTERN FOR POST


Ø2
Ø1″
3/4″
7/16R
X′
1 1/2″
3 5/8″
13/16″
5/8″R
Height of cut out
7/8″
2″
2 1/4″
5/8″
1/2″
3/8″
Ø1″
Ø4 1/4″
13/16″
5/8R
2″
PATTERN FOR BASE

A SINE P

Accurate angular setting capability is essential if the full potential of the milling machine is to be exploited. Peter Dawes of Orange, New South Wales gives us detailed instructions on the construction and use of a precision accessory.



The Sine Plate in use, side view.

Introduction

A sine plate or sine table is just a two-dimensional version of the better known 'one-dimensional' sine bar. The device to be described here is intended for positioning an accessory such as a rotary table, dividing head or precision vice at a precisely defined angle for holding a part while actually machining it. The plate clamps onto the table of the milling machine, becoming an auxiliary table as it were.

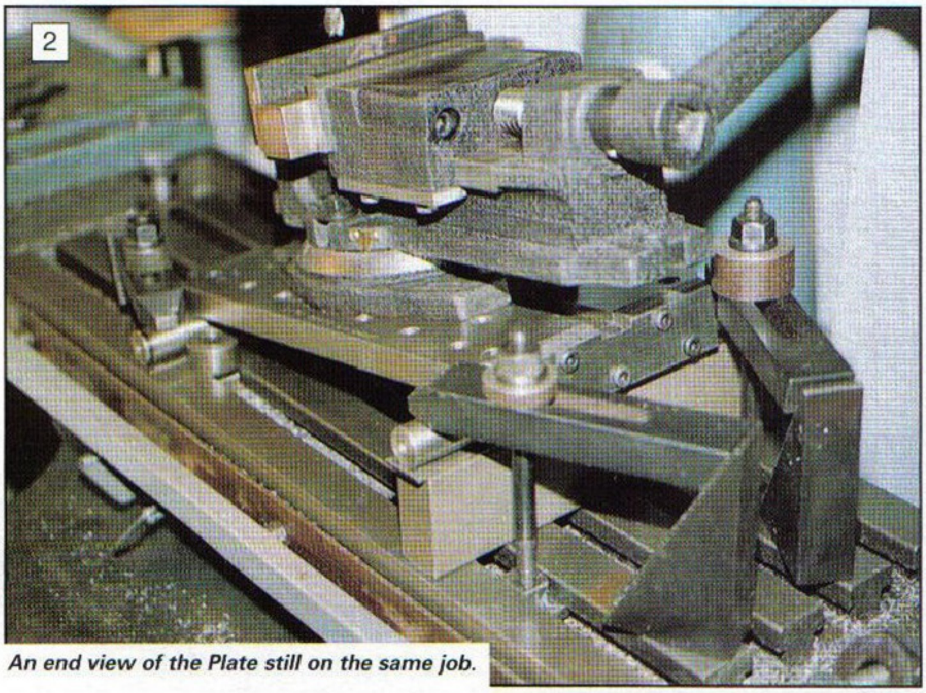
In a right angle triangle, the sine of an angle less than 90 deg. is the ratio of the length of the side opposite the angle (H) to the length of the hypotenuse (L). So if the angle is ø:-

$\sin(\varnothing) = H/L$..............(1)

and on transposing,

$H = L\sin(\varnothing)$...............(2)

H is the height of the stack needed to raise a sine bar or plate to make the angle ø with the horizontal. While angles are difficult to measure accurately, lengths are



An end view of the Plate still on the same job.

PLATE

easy, so the beauty of the sine bar is that it produces extremely precise angles from just two easily measured lengths.

A 4in. precision machine vice such as the Taiwanese model No. V104 (currently A$169 which converts to about UK £80, + local sales taxes) would be an ideal accessory for use with the plate described here and is the one shown in the photos. A guide bar should be fitted to its base to allow quick setting of the vice parallel to the sine table.

While intended as an accessory for a milling machine, the plate can also be used for marking out or it can be clamped to a drill press table for angle drilling.

Units

A mixture of Imperial and metric units has been used in the article. I make no apology for this because steel now comes in metric sizes, but the cap screws were Imperial, and the traditional length of a sine bar is Imperial. My silver steel was also Imperial, so it isn't easy.

Range

The sine plate provides unmatched accuracy for small angles, but it's less useful above 30deg., where other methods (such as the adjustable angle plate) are preferable. Because the angles are derived from units of length that can be measured very precisely, they are highly accurate, unlike devices that depend on engraved angle scales. Very precise wedges can be milled with the device. It can be used with a dividing head to set very accurate helix angles for gears—far better than the graduations on a tilting Brown & Sharpe dividing head for example. Similarly, it is probably the only way to mill long slow tapers such as gib strips for taper dovetails. These must be extremely accurate or they don't bear evenly along the length of the dovetail. To give an example, my lathe cross slide happens to have a gib strip with a taper of 0.694 deg. To set that angle on a 10in. sine plate I would use a stack height of 0.1211in., which I can get exactly with an accurate 3mm packing strip and a 3 thou shim.

Dimensions of the table

There are several criteria that dictate the length and width of a sine table. The plate described here was designed to suit a Taiwanese mill/drill similar to an RF40, but comments along the way will explain how to adapt it to other machines.

It is difficult to find a way to bolt the plate itself on to the milling machine table, so it has to be clamped via its 'round bars'. This then is what dictates the maximum width of the plate.

Width

There must be enough space down each side of the plate for the hold-down fingers to hold the round bars (see side view photo). My milling machine table is 210mm wide ($8^1/4$in.) so a convenient width is 150mm because that's also a stock black steel width. The plate should be about 50mm less than the width of your own table.

Length

The maximum length is determined not so much by the milling machine table length as by the maximum length you can mill around in a single positioning of the job. This is to avoid having to accurately reposition the plate while milling the ends and the guide slot. The plate length is therefore best determined by the ability to machine around it in a single pass, although there is nothing to stop a builder repositioning the plate during the milling if he is prepared to go to the trouble of realigning it accurately.

Sine bars are traditionally 10in. long because, in the days before electronic calculators, this was convenient for calculating the thickness of the packing blocks. You looked up the sine of the angle in tables and just shifted the decimal point one place to the right. I settled for a 10in. plate, but builders might prefer to make it 300mm or a fractional size. With the ubiquitous electronic calculators the length doesn't matter. All you require is an accurate measurement of the length L (which should be permanently stamped on the plate). Then you use the pocket calculator to multiply the sine of the required angle by that length according to formula (2) to get the required stack height,

but remember that the longer the plate, the higher the stack for a given angle. Thirty degrees on a 250mm (10in.) sine bar requires a stack 125mm (5in.) high, and that is a reasonable upper working limit in practice for this particular plate.

Another criterion that determines length is the length of the longest Vernier caliper to which you have access, because it is absolutely necessary to accurately measure the finished length of the plate to a 0.001in. (0.025mm).

The third point to consider is whether your accessory devices have locating bars under them. If they do (and they certainly should have) you will cut a guide slot in the top of the plate parallel to the sides, to accommodate that bar and this should be done during the same positioning of the plate as for truing the ends, to ensure absolute parallelism.

Accuracy considerations

My plate came out at 10.000 ± 0.001in., so the uncertainty for an angle of 30 degrees is better than ± four one thousandths of a degree, plus any error in the stack height. I don't possess slip gauges, so I make the stack packs from such ground stock and clean BMS bars as I have on hand and such as I gradually accumulate. To avoid cumulative errors in adding up the thicknesses of the various bars, the actual final height of the stack is measured with the Vernier height gauge, so that measurement also has about ±1 thousandth tolerance. An alternative method of measuring it is to use an internal micrometer under the ends of the round bar.

The nature of the particular job will dictate what accuracy is required. Most model making jobs will be more than adequately satisfied by a stack accuracy of ±10 thou (0.3mm) and that should be easily achievable. A tapered gib strip will be one of the most demanding jobs, and is one where you must aim for the highest possible accuracy.

An adjustable parallel

A useful accessory is an adjustable parallel with a range of 12-25mm (say $^1/2$ - 1in.), but I haven't built or designed one at this stage. Ideally it should be made of tool steel. A long one is not likely to be commercially available, but can be relatively easily made using the sine plate itself to mill the two wedges.

A useful trick for setting heights below the minimum thickness of such a parallel is to add a bar slightly thicker than the minimum height of the adjustable bar, under the low end of the sine table. This cancels out the thickness of the adjustable bar as far as the angle is concerned, but its exact thickness must be subtracted when measuring the stack.

To give an example of its usage, suppose an angle of 13.6 deg. is required. That means a stack 0.235in. high, which is less than the minimum thickness of the parallel, so a 0.5in. bar is put under the lower end of the table. The parallel is then 'miked' to 0.235 + 0.5 or 0.735in. thick. Making due allowance for any other pieces added to the stack, the difference between the two ends (0.735 - 0.5 = 0.235) is the 'effective' height of the stack.

Surface grinding

All the parts for the sine plate are surface ground for accuracy, for ease of construction, and for appearance. Silver steel is specified for the round bars, so these will already be ground to close tolerance and they will also be both stronger and harder than mild steel. A really professional job would have hardened bars, but that would require cylindrical grinding after heat treatment.

Round bars - inside or outside?

Before proceeding further, I need to mention that the more conventional way of making a sine bar or plate is to have the round bars outside the corner angles at each end, or at least at the lower end. Mine has the round bars inside. I chose this because it is easier to make the plate. Builders may choose the conventional method and machine the plate accordingly, but they will have to start with a much thicker plate and mill a rebate in it, or they will have to fasten pieces to it at the end to form an outside corner to locate the round bars. The method you elect to use dictates the length to which to machine the plate.

Outside bars do have one advantage, and that is they allow a much greater tilt to the plate without the end of the plate fouling the mill table. With angles of up to 30deg. it is not a problem with inside bars, as long as the top edge of the lower end piece is bevelled as described. In any case, adding a packing piece under the lower bar and an equal one under the upper bar always overcomes that problem.

Materials and tools

All steel bar stock is black mild steel, and must be sawn, not guillotined. Guillotining deforms the ends of the steel and will cause immense difficulties, possibly wrecking the project. I was able to obtain black steel sawn accurately to size, and within a degree of square. The accuracy of the cuts of course dictates how much machining allowance to leave.

The plate requires the following materials:-

1). One piece of black mild steel plate 16mm thick x 150mm x 275mm long (to finish to 10.750in.). Builders may need to allow more for finishing, depending on the source of supply.

Note that the finished machined length of the plate must end up as 10 in. plus one diameter of the round bars used, so it is going to depend on the exact diameter of your own round bars. In the alternative design with 'outside' round bars, the plate is made differently, but I don't propose to detail that version.

2). Two pieces of 12mm black mild steel flat, 32mm wide by 130mm long for 'end pieces'.

3). 14 cap screws 1/4in. BSW x 3/4in. long (or M6 x 20mm if available). Also two cap screws 5/16in. diameter for the stop buttons.

4). 16.8in. of 3/4in. round silver steel to cut into two pieces 8 3/8in. long, approximately. They only need to be as long as the table is wide, or perhaps slightly longer. The diameter is not critical, but needs to be measured accurately to calculate the length to which to machine the plate. The two pieces should be cut from the same bar. Silver steel ('drill rod' in US parlance) is usually within 0.0005in. of nominal diameter. While you could also use ground mild steel, the cost is not that much lower and it is softer. Do NOT substitute 1/2in. dia. silver steel. The round bars need to be quite substantial.

5). Two pieces 25mm long of 25mm x 6mm flat bar, and two pieces 25mm long of 16mm x 6mm flat black for making tee nuts.

6). About 35mm of 1.125in. or 32mm round bar, or a diameter to suit your own table slots - for 'stop buttons'.

7). Two old power hacksaw blades or some thin gauge plate 8 3/8in. (215mm) long x 25mm wide x 2 or 3mm thick, to make a pair of hardened steel packing strips. If using power hacksaw blades they should be the hard-all-over types. Friends supplied me with old HSS blades, and a colleague ground them to 0.050in. ± 0.001in. At a pinch you can use a pair of identical steel rules - the thicker the better.

8). Assorted bars and shims of 25mm width, in various thicknesses all 8 1/4 - 8 1/2in. long (or equal to the width of your own table) – to make packing bars (See 'Height packing bars -The poor man's Jo blocks' - below).

Tools

A milling machine and large end mill, 1/2 - 3/4in. diameter. The sine plate is essentially a milling machine accessory, so a milling machine is taken for granted. A vertical mill, such as a mill/drill is the best type for milling around the edge of the plate. On a horizontal mill, the plate could be mounted on edge on a big angle plate.

A Vernier height gauge. While a simple surface gauge can be used for the marking out, it is not as convenient. In any case, the stack height cannot be measured accurately without a Vernier height gauge, or at least an internal micrometer. You can, of course, measure the stack by adding together the thickness of its component parts, as is done when using Johansson (Jo) blocks, but this will result in a cumulative error depending on the number of pieces in the stack and on the error of each individual measurement. Proper Jo blocks are measured in millionths and ground optically flat, so are immune from this problem.

A 12in. Vernier caliper to measure plate length.

Bluing solution

A large angle plate 6 x 4in. approximately, and G-clamps.

A surface plate or a piece of heavy plate glass.

Counterbores for 1/4in. and 5/16in. cap screws.

Concentrated hydrochloric acid for descaling. It's usually supplied in 5L plastic bottles. Dilute for use down to about 15%. **don't** substitute other acids for hydrochloric and don't use it to pickle copper.

Descaling

All black steel is descaled according to the method described by Peter Lukey in *Australian Model Engineering*, No. 63, Nov./Dec. 1995, page 16. Taking due safety precautions, dunk the pieces in a bucket of dilute hydrochloric acid for about a quarter to one hour depending on the freshness of the acid. The black scale flakes off and leaves the steel clean and with a light grey colour. It's now ready for machining and/or surface grinding.

Construction

Start with the plate proper. Pack it up on the mill table on a pair of parallels and align it accurately lengthways. Position it so that the cutter can travel right round it in a single clamping. Mill down the two long edges. The exact width isn't important.

Next mill the two ends such that the plate is exactly 10.750in. long, or if the round bars happen to be some different diameter, make it 10in + exactly one of your own bar diameters. Measure the length accurately with the 12in. Vernier caliper. If you make a mistake, it doesn't really matter, as long as you measure the length accurately and stamp the plate with that length, in whatever units you prefer. You can use the scientific calculator to easily calculate the stack height required for a particular angle by using formula (2).

Next, without repositioning the plate, mill a slot in the centre, lengthways, of a width to suit the locating bar on the devices that are to be mounted on the plate. The slot should be about 4 - 5mm deep, again to suit the bar. My mill has 16mm wide tee slots, so I made the slot 16mm wide to be a close but free fit on the bar.

Remove the plate now and saw off each of its corners, about 12 x 12mm at 45deg., and finish smooth by filing. This is to allow the hold-down fingers to angle across from an adjacent table slot to get a grip on the round bar as shown in the end view photo. That completes the main machining on the plate.

Next come the two end pieces, made from 32 x 12mm bar. Cut two end pieces to the same length as the width of the ends of the plate, bevelling the cut about 25 - 30 deg., as shown on the drawing. Clamp the pieces on edge on the mill table against a piece of 25mm BMS square, or hold in the precision milling vice and mill both edges straight, square and parallel. The pieces don't have to be exactly equal in width because we select one edge (the top) to be a reference edge and take all future measurements from that. That finishes their machining for the time being.

If you do not have access to surface grinding facilities, try to locate a local machine shop which will do the job for you, and send them the three pieces for attention. Thickness is not important on any of them, but flatness is. The surface finish doesn't have to be mirror-like, unless you particularly want it so. It will take longer to do and will cost more. A medium fine finish is OK.

While the parts are away being ground, work on the two 'round bars' and the two 'stop buttons'.

Round bars

Cut two pieces of 0.750in. dia. silver steel, 8 3/8in. long (or to suit your table) from the same piece of stock. Face the ends and break the sharp edges slightly.

Blue a narrow strip down each bar and scribe a line down it by putting the bar in the self-centring chuck and scribing a line with the lathe tool through the blue. Call this line No. 5.

Optionally, you can also drill and tap the ends of the round bars 5/16BSW for cap screws to add extra stops or fastenings should they ever be needed. (The photos show that my round bars have been so tapped, but so far I haven't needed them). These holes are not shown on the drawings.

Stop buttons

Make two short round 'buttons' that will lock in the tee slots of the table with 5/16in. cap screws. The buttons must be somewhat wider than the table slots to lock on the surface and must be wide enough not to need washers. Since my mill has 16mm wide tee slots, I used some 1.125in. round bar stock. Chuck the bar, face the end and turn enough of the outside diameter to a clean finish to make two buttons. Don't remove it from the chuck until both pieces have been parted off.

The buttons must not stand higher off the table than the clearance available under the Sine Plate when it is in position, but must also be somewhat more than half the diameter of the round bars high, so that they contact the lower round bar on its diameter. That makes them about 5/8in. long ('high') for nominal 3/4in. round bars. Centre drill the bar and then drill axially to a depth of about 25mm and to a diameter that is the clearance size of the spigot of the 5/16in. counterbore you are using. Part the piece off carefully to length, so that the end remains square with the outside and so that it doesn't need further machining. Repeat for a second button.

Chuck a button and counterbore it for the 5/16in. cap screw, which should end up flush with the top of the button. Repeat for the other button.

Tee nuts

Now make two tee nuts to go with the buttons. I chose to fabricate these rather than machine them out of solid, but that is optional. Cut off two pieces 25mm long of 25 x 10mm or 6mm flat black or bright bar stock (assuming 16mm wide tee slots). Also cut two pieces of 16 x 7mm flat black or bright bar, also 25mm long. Roughly bevel one edge at both ends of each of the four pieces by grinding. This is to create a vee groove for welding them together at the ends. Place in the vice with the 16mm piece centred flat on the 25mm piece so that the vee grooves are lined up. Weld the vee in the ends without getting any weld metal around the corners. Clean up on the grinder and file away any metal that encroaches into the rebates on the sides. You end up with 25mm long nuts with a rebate down each side.

Mark the centre of the flat face of each piece and drill 1/4in., square to the surface. Tap the holes 5/16in. BSW.

That finishes the buttons, but make them to suit your own tee slots by using the same method with appropriate bar stock sizes and tap to suit your cap screws.

Marking out

Making this sine plate is very much an exercise in marking out, so with the surface grinding finished, blue the plate on both ends and on what will be the top face (the one with the guide slot) down for about 3/4in from each end. Blue one face of each of the two end pieces also. All dimensions across the width of the parts are referenced to the centre line of the part, so that actual width doesn't come into it.

Start with the plate itself. Measure accurately the thickness of the plate (=T) and halve it in order to get the height of the centre line for locating the row of holes for the cap screws which hold the end pieces. Scribe a line on the ends of the plate to mark this centre line by laying the plate flat on the surface plate and scribing across with the height gauge. Call this line 1.

Also scribe a line across the face of the two 'end pieces' at the same height while standing them on edge. This is line 2. This edge becomes the top edge and also the reference edge. It is the edge that is to be next to the side of the plate with the slot in it (or top face).

Scribe another line on the end pieces referenced to the top edge, at a distance equal to the thickness of the plate (T) plus 0.375in. (half the diameter of the round bars). This is the place where the round bar will contact the plate and so is the centre line for the screws to be put into the round bar. (This can be line 3).

Stand the plate on end, supported by the angle plate with a clamp to hold it, and scribe across what is to be the top face of the plate 0.375in. up from the surface plate. This is again the exact centre of where the round bar will touch the plate. This is line 4. Repeat on the other end.

Mark the centre of the plate and that of the two end pieces, width-wise, and reference all cross measurements along all the lines to these centre lines.

Mark a cross line in the centre of the round bars across line 5 (the one that was scribed at the time they were cut and faced).

Two cap screws on each end hold the round bar to the plate. Three cap screws fasten the round bar to the end piece, and another two cap screws fasten the end piece to the plate. This makes a very strong assembly, provided that the screws enter the round bar exactly on diameter.

Now, create four sets of cross lines, repeating for both ends of the plate:-

Scribe two cross lines along line 1, so that they are centred 1.125in. from the centre line.

Scribe three cross lines across line 3, one in the centre and one on each side, 1.75in. from centre.

Scribe two cross lines on the top face of the plate across lines 4 at 2.125in. from centre. These are for the screws that bolt the round bar to the plate.

Scribe three cross lines on the round bars, one in the centre and one on each side 1.750in. from centre, to correspond with those on line 3.

The odd spacing of the screws is only to ensure that none of the holes intersect. The spacing is not critical otherwise, although builders using a different plate width will need to redesign the hole spacing.

Centre punch all cross points and start the drilling with a centre drill. Centre the round bar under the drill and drill the three holes on the cross lines that intersect line No. 5. Drill these No.8 for 1/4in. BSW cap screws, but don't let the drill break through to the other side. If the screws turn out to be too long you may have to shorten some of them. Tap the holes 1/4in. BSW. Repeat on the other round bar, using a good cutting oil such as Rocol Ultracut (TM) while tapping silver steel, and clearing the chips frequently.

Bolt the round bars to their end pieces via these three holes.

Drill the total of four holes in the two ends of the plate No.8 for about 1in. deep. Tap 1/4in. BSW.

Open out all holes in the top of the plate to the clearance diameter of the spigot of the cap screw counter-borer. This was 17/64in. in my case. Counterbore the holes so that the cap screws will be just below the top of the plate. Do the same to the three-hole row in the two end pieces. The remaining two holes in the end pieces can be fully or partly countersunk – builders can please themselves about those.

Lightly chamfer the edges of all holes with a 90 deg. countersink and assemble the end pieces and round bars with cap screws, as far as is possible so far. That should be every screw except those in the top of the plate.

Place the whole assembly on the drill press table and finish by drilling the holes in the round bars off the holes already drilled in the top of the plate. Start the holes with the same clearance drill (e.g. 17/64in.) to ensure that the tapping drill will be centred, then continue with the No.8 tapping drill, again not quite through to the other side. Again remove the round bars from the end plates and tap all holes.

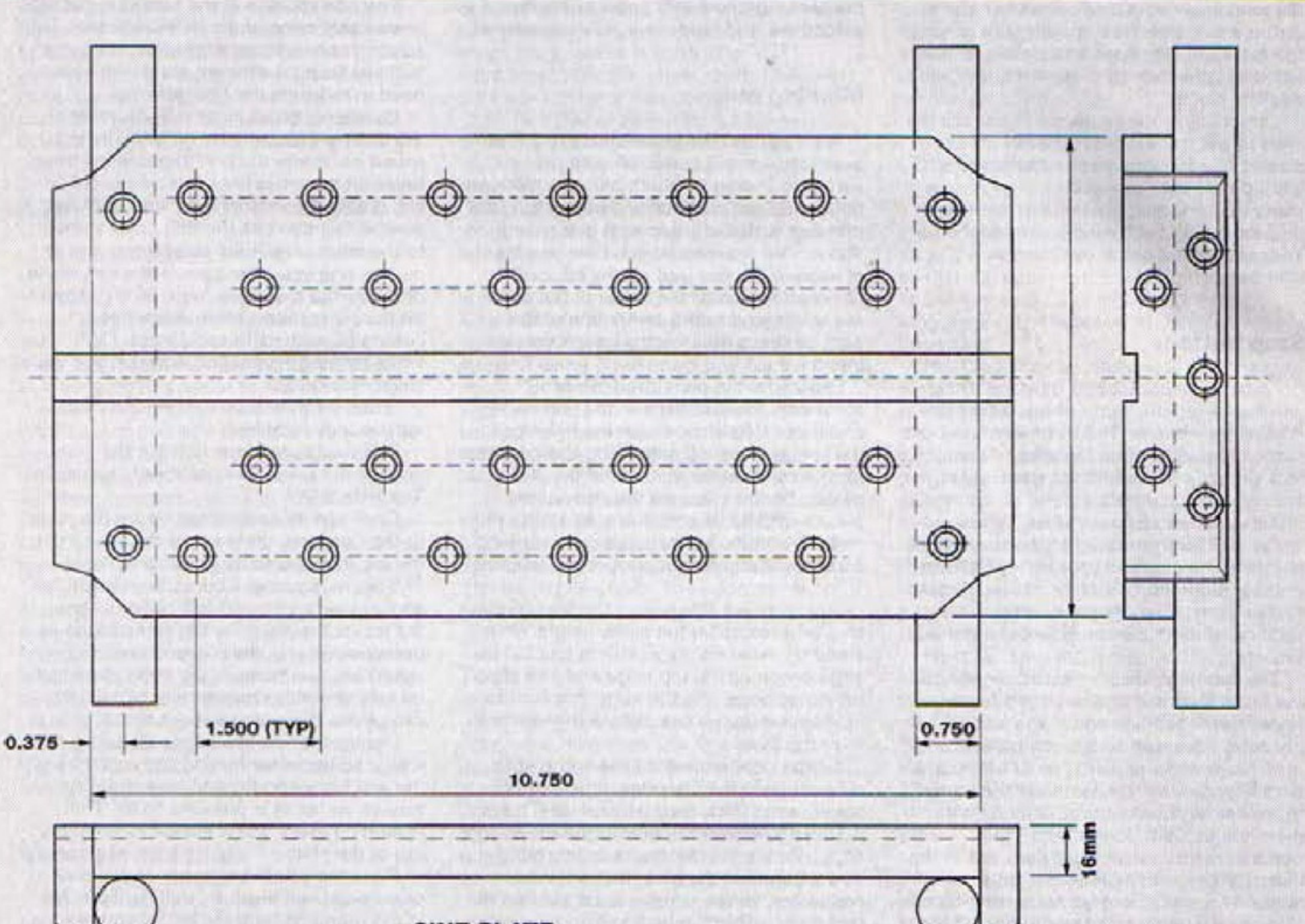
The plate itself can be drilled and tapped with a pattern of holes for hold-down bolts as shown in the drawing. I drilled two staggered rows of 3/8in. BSW. holes each side of the slot, spaced about 1.5in. apart, but how you do this is optional. Lightly countersink the entrances of all holes with a 90 deg. countersink.

The final job is to bevel the bottom outer edge of what will be the end piece at the **low** end of the sine plate. This is to allow the plate to tilt up without the end piece hitting the table top. Bevel the edge right across at about 30 deg., stopping just short of hitting the heads of the cap screws.

The final assembly should be carried out by pulling all the screws up sequentially in stages, finally tightening them all up hard. This is to 'settle' the parts in their most 'comfortable' positions. It's similar in principle to tightening up wheel nuts on the car. Stamp the length of the plate somewhere (L=10.000in. or whatever), and the sine plate is finished.

Height packing bars - the poor man's Jo blocks

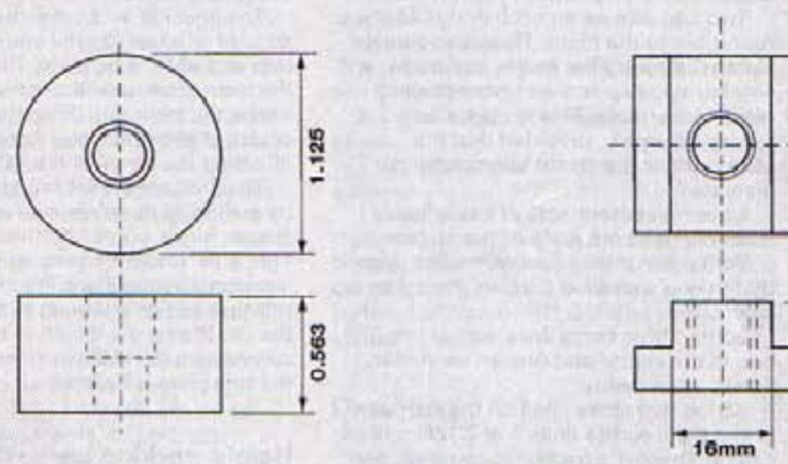
Normally, a sine bar is used with high precision Johannson blocks wrung together to make rigid block. Apart from



SINE PLATE

SINE PLATE NOTES:

1. ALL STEEL FLATS GROUND BOTH SIDES - MED. FINE FINISH
2. ALL HOLES INTO ROUND BARS TAPPED 1/4in WHIT.
3. ALL SCREWS IN SINE PLATE 1/4in CAP SCREWS
4. ALL HOLE ENTRANCES CHAMFERED
5. WORK HOLES IN PLATE TAPPED 3/8in W WITH LIGHT COUNTERSINK
6. SLOT IN TOP TO FIT GUIDE (LOCATING) BARS IN ACCESSORIES



BUTTON & NUT

1. DRILL/TAP NUT FOR 5/16in W CAP
2. COUNTERBORE TOP FLUSH FOR HEAD

©

the practical difficulty that I don't have any, they are generally too short to span the width of the plate and I wouldn't want to use them as clamping blocks anyway. I suggest using such packing bars as are available, whether ground or unground, and measuring the final stack height with the height gauge.

Any working surface in direct contact with a round bar should be a hardened surface, so it's important to make one pair of hardened steel strips to put under the round bars, to prevent them bruising the table and the mild steel stacking pieces. If making only light cuts with light clamping, they may not be needed, but should always be used if heavy machining is intended and if the plate must be bolted down hard. They must be of equal thickness, and if possible of some convenient round-number thickness, such as 0.05in. or 0.1in. or 2mm because you must subtract their thickness from the stack height as measured by the vernier height gauge. Having one under each end of the plate means they have no nett effect on the angle.

All bars should be 8 1/4in. long (or equal to the width of your own mill table). Make an assortment, ranging from 2 thou shims up to 4in. x 1in. thick bars (100 x 25mm). Descale them and very carefully linish them. Use shim stock for the very thin ones. The ideal set is a series that doubles in thickness at each step. That gives close to the minimum number of pieces from which all possible combinations can be assembled. In Australia it's possible to buy black metric MS bar in 1.5, 3, 6, 12, 25, 50, & 100mm, all by 25m. That makes a good set, and adding a 10mm and a 32mm bar would improve it again. I have never contemplated making a full set of ground bars, but I will be making various pieces (always in pairs) over time and as particular jobs demand. An adjustable parallel would save making a lot of the smaller in-between sizes.

Stamp the thicknesses on thick strips and engrave it on thin strips with a spark engraver or other type of hand engraving tool. That way it' s easy to assemble a stack close to the required thickness.

Linishing

The linisher is the poor man's surface grinder, so machine any bars to appropriate size then linish to finish the surface. I accepted whatever figure they 'miked' at and stamped them accordingly. That meant they would usually add up to slightly less than nominal size, but the difference is easily made up with shims.

I recommend making all bars in identical pairs because then they can also be used on the mill table as parallels for packing up work to precise heights. I also happen to have made a large table to replace the cross slide on my 6in. lathe to allow work to be bored in the lathe. Setting heights on this can only be done with parallels because there is no vertical slide in this configuration, so having assorted bars in pairs is particularly useful.

Whenever you are having some pieces ground, always put in a pair of parallels for the same thickness. It will cost very little more. On the other hand, grinding many pieces to specific thickness is prohibitively expensive unless you can do it yourself in your own shop.

Martin Cleeve's gauge bars

Those wanting to go further into the making of gauge bars for the home workshop can read the two articles by Martin Cleeve in *Engineering in Miniature*, (Vol. 1 Nos. 9 & 10, January 1980, starting page 277), but be warned, his series is based on stock sizes of BMS bars in fractional inch sizes that were available in the U.K. His set was designed specifically to make up fractional sizes in $^1/64$in. increments with just two blocks. He mainly used them as scribing blocks for marking out on the surface plate, and he claimed that they are faster and more accurate than using a ruler and surface gauge. I think I would agree with that, however they could not possibly be as versatile as a Vernier height gauge, and builders in Australia will certainly have trouble buying Imperial fractional sizes of BMS.

Using the sine plate

Start by positioning the stop buttons on the table as widely apart as possible - two or more slots apart. Position them to the left hand end of the table if the plate is to be tilted up to the right. They should be placed so that the job proper will end up roughly in the centre of the milling table. Use an engineer's square to set them accurately square relative to the edge of the table and lock them. Place the sine plate over the buttons, with the inside of the left round bar hard up against the left side of the buttons. This is how the plate is aligned parallel to the table.

With a scientific calculator, find the sine of the required angle. Multiply this by the exact length of your own plate in order to find the height of the stack required. Work in the same units in which your plate and bars are specified.

Assemble the stack according to the simple rules below and put it under the right hand round bar. Always check that the plate is hard up against both buttons before tightening the hold-downs. When the plate has been finally tightened down hard, another one or two 'stop' clamps should be put hard up against the outside of the low end round bar, to prevent any slippage under heavy side pressure. This effectively grips the lower round bar on all four sides at both ends.

If the end piece on the lower end of the plate hits the table at high angles, add a 3mm packing strip under it and an identical strip under the high end, and remember that you have to disregard this extra thickness when measuring the stack height, or you will end up with an error. This piece would normally be a hardened strip.

Stack assembly

When assembling the stack, there are seven easy rules to follow:-

a) Clean the surfaces of the pieces carefully.

b) Avoid thin shims that are creased, because their effective thickness will be pressure-dependent.

c) Use strips that are at least equal in length to the width of the mill table and not less than 25mm wide.

d) Sandwich thin shim strips between thick strips top and bottom.

e) Compress the stack fully with the clamps before attempting to measure its height.

f) Always use equal thickness hardened steel strips under the two round bars when clamping the plate down hard. Subtract this thickness from the stack. Their presence at both ends means they have zero effect on the angle.

g) Finally, for the highest accuracy, measure the stack height over the bars, and at both ends. If the measurements differ take the mean, then subtract the bar diameter. Alternatively, just measure to the top of the stack itself.

Conclusion

I drilled and tapped a pattern of holes in my plate, as shown in the drawings—and that suffices for most jobs, but users can drill and tap their plate wherever a job demands it.

A couple of holes will be required in the centre of the guide bar groove and spaced 150mm apart if using the swivelling 4in. precision vice, model V104, mentioned in the Introduction and shown in the photos.

I recommend using the same size bolts as used for the usual milling machine hold-downs, so that everything is standardised. My hold-downs are $^3/8$in. BSW studs, flanged nuts, and tee nuts, so I am able to use them interchangeably on the mill, the sine plate and the lathe cross slide table. However, $^5/16$in. cap screws are required with the buttons because the heads of $^3/8$in. cap screws are too thick for the height of the buttons.

The hold-down fingers are improved if there is a small vee groove on the faces where they contact the round bars. Since the hold-downs are at an angle, the groove has to be cut accurately to that same angle. A groove is more important on the lower bar of the sine table than on the upper one.

Overhang

The plate is completely flat on top, so if a part is longer or wider than the plate, it can overhang as necessary. Engineer's clamps or G-clamps can be placed around the sides of the plate to hold things. The thick $^3/4$in. round bars on the Sine Plate are an advantage here because they give plenty of clearance underneath. A thin gib strip longer than the plate can be accommodated by supporting it on a suitable narrow substantial bar of the same or longer length and allowing the combination to overhang.

PARTING

"Such Sweet Sorrow" opined The Bard, and many turners, both amateur and professional have had reason to agree with him. Here, Geoff Sheppard reviews the process and looks at some developments in tooling which are making it somewhat less fraught

A traditional form of one-piece forged parting tool. This example has seen better days and has long been 'retired'.

I suppose that I must have first encountered parting off during my time in the metalwork shop at grammar school, where we had a solitary early Myford lathe, an ML2 if I recall correctly. As no horrendous incident remains in my memory, my first attempts must have been reasonably successful. Not so was a later one during apprentice days when working on the centre lathe section of the Basic Training Workshop. I forget the precise nature of the job, but the workpiece was quite substantial, and the parting cut was a deep one. The tool was a large one-piece example of the forged type shown in **Photo 1**, and with a generous coolant flow operating, I set to with enthusiasm. Well into the cut, I must have let my attention wander and the result was a good, old fashioned dig in. Almost forty-five years on, I can still hear the noise created as the tool fractured, a sound which I can only describe as a loud 'UNK'. Hastily stopping the mandrel, I glanced round guiltily, sure that everyone in the shop, and especially the instructors, would have heard it. Much to my surprise, the general hubbub carried on, though I did sense that my colleagues on adjacent machines were studiously averting their eyes, as is only decent on such occasions.

The tool hadn't broken off completely, but the blade portion was hanging down, attached only by the last few thou. Fortunately, the cabinet alongside the lathe contained another parting tool, so a trip to the large tool grinder, ostensibly to touch up the cutting edge, provided an opportunity to despatch the casualty to the swarf bin and no-one was any the wiser!

Only a few weeks later, the cartoon reproduced on page 50 appeared in the pages of *Model Engineer* (a magazine which was already a firm favourite with our little group) and generated a few pointed remarks aimed in my direction. I have retained a keen interest in the science of parting ever since.

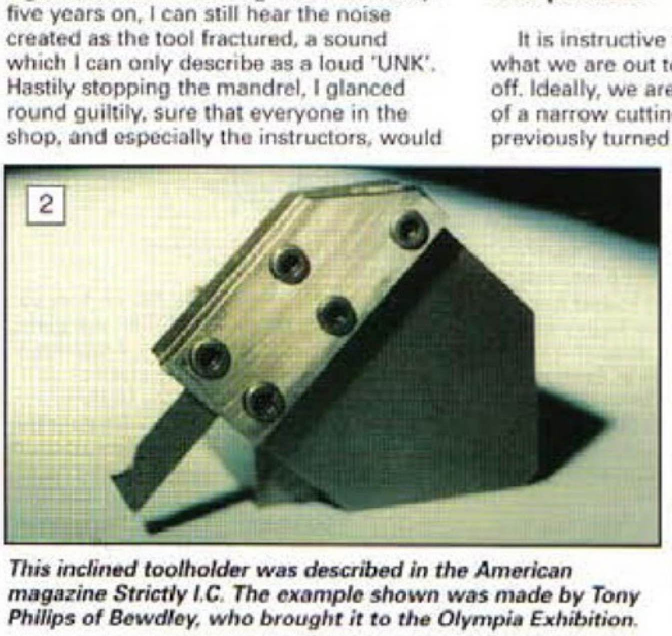
Over the years, almost every contributor to these journals has had his twopennyworth on the subject, so I may as well have my turn. My excuse is that there do seem to have been some recent advances in tooling which appear to make the task easier.

The process

It is instructive to first try to understand what we are out to achieve when parting off. Ideally, we are aiming to use one pass of a narrow cutting tool to separate a previously turned workpiece from the stock material in the minimum time and with the minimum waste of material. We would like the parted face of the workpiece to have an accurate flat end, with good surface finish as it is not always easy (and a waste of effort) to re-chuck the job to take a finishing cut. It may also be an advantage if the face of the stock material has a good finish, as this may save work on the next component.

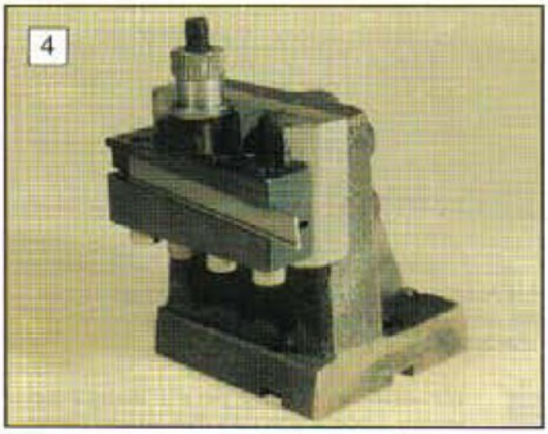
From the above, it is possible to envisage the parting cut as two facing operations, one occurring on each side of the tool tip. There are, however, important differences as the chips formed at each face are still joined together, and the formation of this single chip results in high cutting forces and substantial loads on every element of the system. For those wishing to understand the process more fully, I can do no better than to refer them to the Sandvik Coromant publication *Modern Metal Cutting* (Ref. 1).

Keeping the width of the tip to a minimum is an important factor in avoiding chatter. With conventional parting tools, the width of the chip is, at minimum, the same as that of the groove, with the resultant danger of jamming in the groove and damage to the face of the workpiece. Many writers on the subject have expressed the opinion that it is the jamming of swarf in the groove which causes most of the difficulties experienced when parting. There do seem to be two 'modes of failure', one being the aforementioned 'dig-in', where flexibilities and excessive clearances in the lathe mandrel, slides and toolholding system allow the tool to deflect towards the job under the action of cutting loads, and the other being seizure between the tool tip and the side faces of the groove being cut. The latter is associated with heat

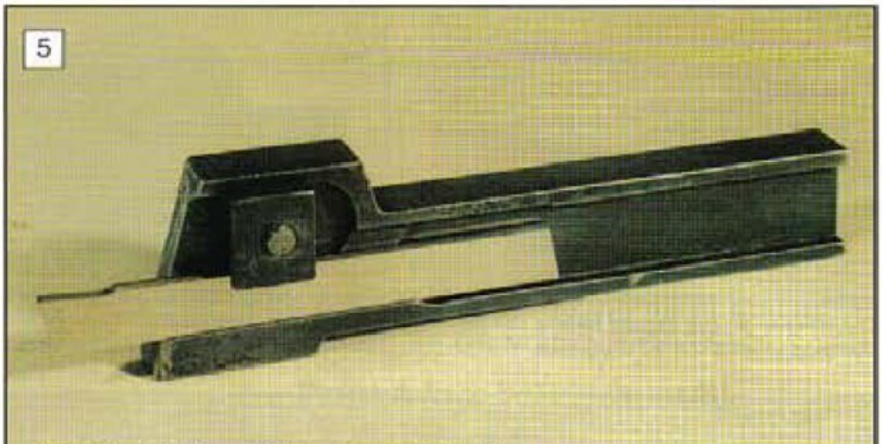


This inclined toolholder was described in the American magazine Strictly I.C. The example shown was made by Tony Philips of Bewdley, who brought it to the Olympia Exhibition.

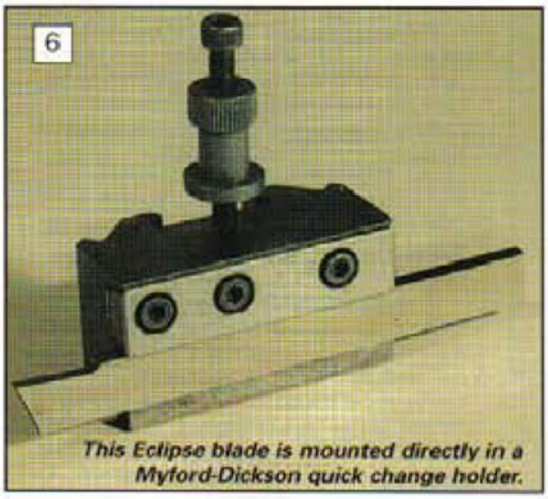
Also shown at Olympia was this new rear parting toolpost assembly recently introduced by Myford Ltd.



A Churchill Empire tee blade mounted in a 'Wellsborough' quick change toolpost assembly.



An Eclipse blade and holder from Niell Tools.



This Eclipse blade is mounted directly in a Myford-Dickson quick change holder.

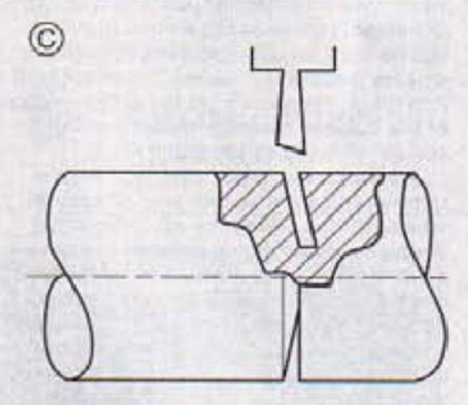


FIG. 1. POTENTIAL EFFECT OF AN ANGLED CUTTING EDGE

generated by excessive friction between tool blade, workpiece and chips.

The 'Pip'

It seems inevitable that, as the parting tool nears the centre of the workpiece, the forces acting on the last, small section of the metal will become more than the material can stand. It will shear, resulting in a small 'pip' being left behind, and it seems that this is always left adhering to the detached section (the 'job'), with the result that an extra operation to remove it is entailed. The most usually recommended method of avoiding this problem is to grind the cutting edge of the parting tool at an angle, so that it will sever the material cleanly, close to the job.

This method does, however, suffer from two major disadvantages. Firstly, due to the inherent lack of stiffness in the blade section of the tool, the forces acting on the inclined tip will tend to drive the blade to the right (**Fig.1**) resulting in a concave face to the workpiece, if not in fracture of the blade. Secondly, the chip generated by this form of blade will have a greater width than that of the groove being cut, encouraging the tendency to jam. Perhaps a better solution is to use a square-ground tool for the majority of the cut and to introduce the angled version for the last stages only. Judging the change-over point will be an interesting exercise! Arranging that the pip remains on the stock material does have the advantage that it can be removed simply by continuing the in-feed of the tool.

An associated problem is the matter of support for a longer, heavier workpiece. The use of the fixed steady is frequently recommended, but employing the support of the tailstock centre is a much more contentious issue. Although suggested by some, the majority of opinion is that this could lead to a major catastrophe and should be avoided at all costs. Again, it may be sensible to support the work in this way while the majority of the parting groove is being formed, but to detach the centre well before the breakthrough.

Avoiding the 'dig-in'

Many theories as to the origins of the 'dig-in' have been advanced over the years, with flexibilities in the system usually being held to blame. Earlier articles included diagrams which showed the workpiece climbing over the tool tip, due to deflection of the mandrel and clearance in the bearings. Having in the past owned one or two of the lathes dating from the period, I can understand that this was a valid concern. Advertised (new) at around 5 guineas (£5.25 in today's terms), these machines featured scantlings that ensured that deflection was built in.

The usual exhortation was, of course to ensure that all unnecessary clearances were eliminated, and the same advice holds good today, but there was little that could be done about the fundamental shortcomings of the machine. Modern lathes, in the main, seem to be much more substantially built, so these problems should be of lesser significance.

Surprisingly, one of the methods suggested for overcoming some of the problems was to introduce more flexibility in the shape of a sprung tool holder (Ref. 2), but here the design of the holder ensured that deflection took the tool tip out of engagement with the workpiece. A more recent design, published in an American magazine (Ref. 3) features a solid tool holder, but the geometry of this is arranged to give similar characteristics (**Photo 2**).

The rear mounted parting tool

The majority of writers agree, however, that mounting the tool in an inverted position to the rear of the mandrel makes for a more reliable parting operation. Movement due to flexibility in the toolholding system will automatically take the tool out of engagement with the workpiece, as Harold Hall recently explained in his series on lathework (Ref. 4). A further point is that gravity will help the chips to drop clear of the groove, so obviating the tendency to jam.

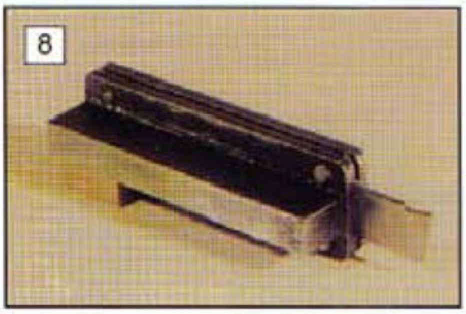
Many designs of rear parting tool holder have been described over the years, and commercial examples are also available (**Photo 3**). One of the most popular designs of self build attachments is that from the drawing board of George Thomas (Ref. 5). Drawings and castings for this are available from both Messrs Reeves and Hemingway.

One of the hazards of a permanently mounted rear tool is, however, that knuckles can be at risk when working close to the chuck. Toolholders of the rapid change type, which accurately re-position the tool on replacement (**Photo 4**) can be an advantage here.

Tool geometry

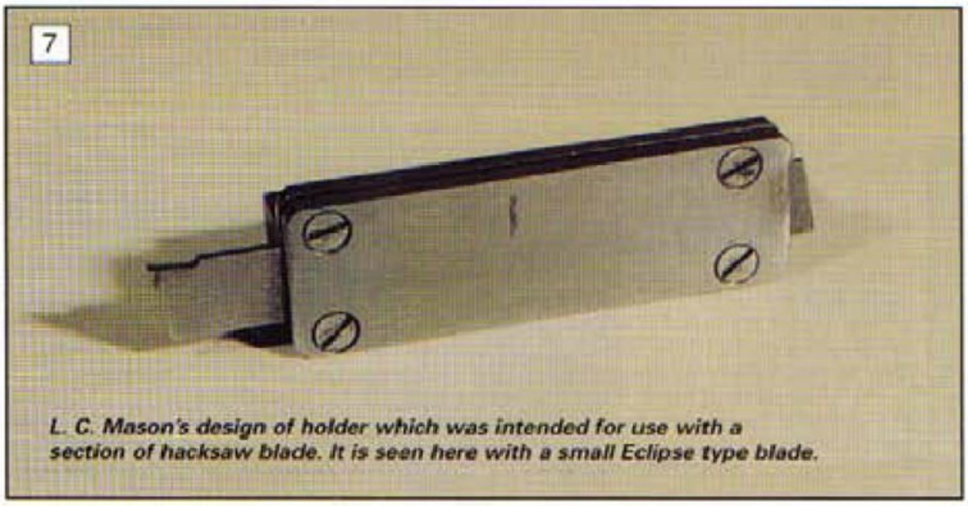
(i) The conventional parting tool

The first parting tool which most of us will have encountered is that shown in **Fig. 2** and **Photo1**. If ground from a solid chunk of forged tool steel, it is time-consuming



The tongue on the Mason holder can be clamped in a variety of toolposts.

The clamping arrangement featured in this holder allows the blade to be pivoted to the desired top rake angle. The front clearance angle is adjusted accordingly. The toolholder was kindly loaned by L.A. Services, and the blade by Tracy Tools.



L. C. Mason's design of holder which was intended for use with a section of hacksaw blade. It is seen here with a small Eclipse type blade.

to make and wasteful of material. It is mounted in the toolpost, with the tip at centre height and the blade at right angles to the lathe centre line.

The dimensions of the blade will be determined by a set of compromises. We have seen that we would like the tip to be as narrow as possible, but as the length must be sufficient to deal with the diameter of the work to be parted and conventional wisdom (challenged by later developments) says that it must taper from front to back in order to provide relief on each side, the width at the neck is the controlling factor. As always, when the subject of tool angles is discussed, there are as many variations as there are writers. There does, however, seem to be reasonable agreement over this relief angle, as too small a relief can result in rubbing when wear occurs at the sides of the tip, and too large an angle can allow swarf to penetrate the space, causing damage to the parted face or even jamming. The preferred angle seems to be between $1\frac{1}{4}$ - 3 degrees.

The resultant maximum tip width is of the order of $\frac{3}{16}$in. where the longer blades are concerned. At the other end of the range, $\frac{1}{16}$in. to $\frac{5}{64}$in. is specified and for intermediate sizes, $\frac{3}{32}$ - $\frac{7}{64}$in. is appropriate.

The thickness of the tool (in the vertical direction) should be the maximum which can be accommodated, as of course, it is this dimension which resists the cutting forces, which put the top surface in tension and the bottom in compression. The limit is the distance between lathe centre and the top surface of the top-slide. The side clearance angle now comes into play, as this reduces the width of the bottom surface even further. Again, the range of preferred angles is $1\frac{1}{4}$ - 3 degrees.

The front clearance angle should be kept as small as possible, in order to maintain maximum support for the cutting tip, 5 deg. being commonly recommended, but the late Martin Cleeve (Ref. 6) suggested that only 1deg. could be used if the finished tool is set exactly at centre height.

The general advice on top rake angles seems to be to follow the angles appropriate to the material for a knife tool, but George Thomas (Ref. 7) was of the opinion that a compromise angle of 7 deg. is suitable for most materials. Interestingly, many of the published designs of toolholder feature a top rake within a degree or so of this figure. The angle should be faired back to the top surface in a smooth curve, so that the chip can flow away from the cutting edge, so further reducing the risk of jamming.

(ii) The parting blade

A logical step in the development of the parting tool was the introduction of the narrow parting blade which could be secured in a substantial holder. A typical example of this is the well-known 'Eclipse' brand (**Photo 5**) from the long established tool maker, James Neill of Sheffield. Such blades are available in a range of widths and heights, with holders to suit (**Photos 5 & 6**). They can be obtained with a bevelled cross-section (i.e. a constant taper from top to bottom) or with hollow ground sides (**Figs. 3 & 4**). Care must be taken to select the appropriate holder for the section.

The top and bottom edges of the blade are bevelled to ensure that the holder can exert a firm clamping action, and it is therefore necessary to grind away this bevel to ensure a flat top to the tool over the cutting length. New blades appear to be supplied with this already incorporated, but the point needs to be borne in mind when the length has been substantially reduced by successive sharpenings.

The introduction of this type of blade seems to have shown that relief along the length of the blade is not strictly necessary, as they are parallel along their length. George Thomas (Ref. 8) wondered whether this relief is merely to take care of slight errors in the mounting of the tool or to ensure that the blade is not wider at the back than at the front.

Considering this, a further point to be watched is that, if a significant top rake has been ground into the tool, sharpening by grinding the front face will lower the cutting edge and will consequently reduce its width, due to the tapered form of the blade. This will make the cutting edge narrower than the section of the blade immediately behind the top rake (**Fig. 5**), leading to problems when parting larger diameters.

The major problem with the design of this combination of blade and holder is that it constrains the height of blade which can be used, and as we have seen, blade height needs to be maximised to resist cutting forces. Numerous designs of holder which avoid this constraint have been described over the years, typical of these being L. C. Mason's version (**Photos 7 & 8**, Ref. 9) which was intended for use with a length of hacksaw blade as the cutting tool, but can be used equally successfully with the smaller proprietary blades. The offset built into these designs allows the bottom edge of the blade to protrude below the top surface of the lathe top-slide.

An alternative type is that sometimes referred to as the 'Armstrong' (**Photo 9**), which has the additional advantage that the blade clamp, being conical, can be pivoted so that the top surface of the blade can be inclined. This allows a top rake to be applied without grinding the blade, and a corresponding adjustment of the front clearance angle means that no thinning of the cutting edge takes place when the blade is re-sharpened.

(iii) The Tee-section blade

A further development of the narrow parting blade is the tee-section version (**Fig. 6**) in which the width is significantly reduced, in a parallel form, for about the lower 80% of the section, and the remaining wider portion is hollow ground on top and sides. A well-known example of this type is the 'Empire' brand from the Empire Tool Co., USA., which are also manufactured in the UK by J. J. Churchill of Market Bosworth. They require purpose-made holders which will locate this particular blade section in the correct position, and as Churchill's products are aimed at the larger industrial machine, Bob King of Wellsborough Engineering has developed a range which will suit the smaller machine. These are marketed on his behalf by L.A.Services of Bramcote, Warwickshire.

The relief and hollow grinding on the sides of these blades obviously play a

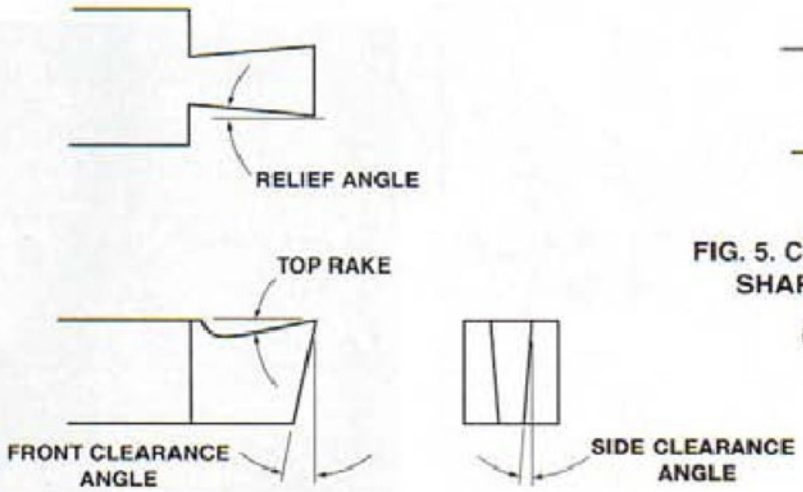


FIG. 2. CONVENTIONAL PARTING TOOL

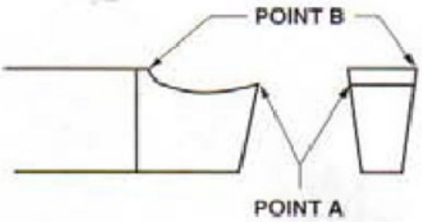


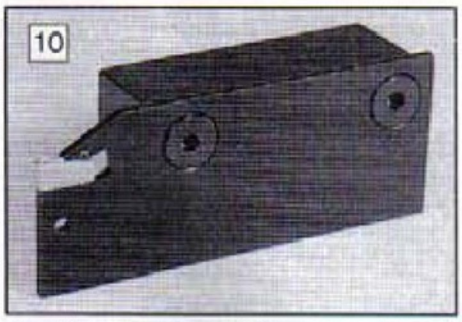
FIG. 5. CUTTING EDGE NARROWS AS BLADE IS SHARPENED BY GRINDING FRONT FACE

(Point A falls below Point B)

FIG. 3. BEVEL SECTION PARTING BLADE

FIG. 4. HOLLOW GROUND PARTING BLADE

FIG. 6. TEE SECTION BLADE



The Greenwood parting tool is based on a Sandvik Coromant silicon carbide insert.

large part in reducing friction between tool and workpiece, but the manufacturers also claim that the hollow ground top surface collapses the chip so that it will not rub on the sides of the groove, further reducing friction and heat generation. The modification of a flat-topped blade by grinding in a small concave depression was suggested in an article on this topic in an early issue of *M.E.W.* (Ref. 2).

I recently had the opportunity to test one of the Empire blades, held in of Bob's holders which was mounted on the rear toolpost illustrated in **Photo 4**. I was using a 7.5mm high blade (5mm, 12mm and 17mm blades are also listed) to part off a piece of steel of unknown specification (ex the scrap box), but it definitely wasn't free-cutting mild steel, being decidedly tough and difficult to plain turn to a decent surface finish. The recommended maximum depth of cut is about equal to the blade height, e.g. 15mm dia. for a 7.5mm blade, but my test piece was nearer 20mm dia. The suggested mandrel speed for mild steel of this diameter is about 200 rpm, so I tried the next higher speed on my Super 7, i.e. 290rpm.

With drip can coolant feed in operation, parting was simplicity itself. No sign of chatter or dig-in, and a comfortable 'natural' hand feed rate was soon established. Swarf came away in tight curls, with no sign of jamming in the groove. An experimental interruption of the coolant feed soon gave signs of impending seizure, so the feed was hastily restored. The whole process lacked drama (unlike some parting operations I have undertaken!) and the parted slice fell away cleanly, but still with a pip.

Examination of the parted faces revealed an excellent surface finish, except for a very small section where the incipient seizure was evident. I can thoroughly recommend the use of this type of parting blade, but do keep the coolant flowing.

(iv) Tipped tools

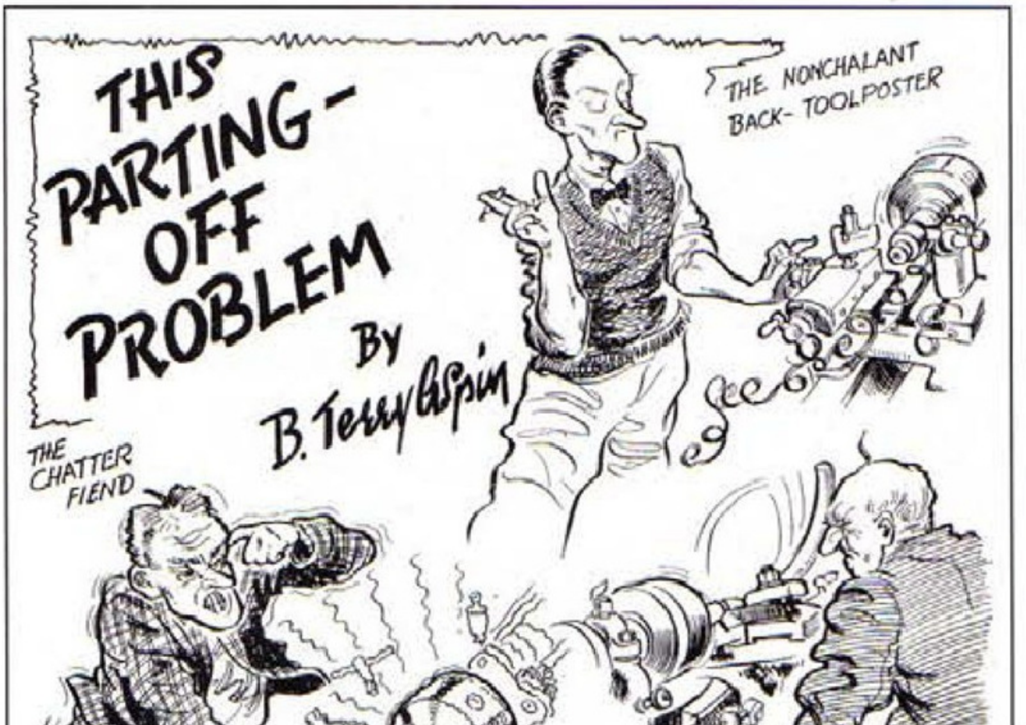
The use of parting tools with cemented carbide tips, either permanently bonded or detachable has been commonplace in industry for some time. The majority of these tools have, however been too big for the smaller lathes of the sort commonly found in the home workshop. The situation has recently changed with the introduction by Greenwood Tools of Bromsgrove of a Sandvik tungsten carbide tip in a spring-blade clamping holder of proportions suitable for use in the amateur's lathe (**Photo 10**). I first encountered this tool at a local model engineering exhibition where a demonstration workshop had been established. One of the tools had been loaned for evaluation, and was receiving what can only be described as 'rave notices'. Subsequent personal experience has only served to confirm these impressions and letters received from other delighted users indicate that this tool is providing a real advance in parting technology.

My own testing was carried out both with the tool mounted in a Myford-Dixon holder on the top-slide of my Super 7 and in Bob King's rear toolpost. In both configurations, the overhang is a little more than ideal, but the tool has been designed so that it can also be used in a four tool turret and so needs adequate clearance to allow the turret to be rotated. The clamping tongue can be modified with little difficulty if desired.

Testing was carried out on the same 'difficult' piece of material used for evaluating the tee blade, but this time at a diameter of $1^1/4$in., a dimension made possible by the 20mm maximum reach of the tool. After tentatively increasing the cutting speed with manual feed, I found that, with the tool at the rear, I was able to use the top 'normal' mandrel speed (i.e. lower countershaft speed) of 615 rpm, which equates to a cutting speed of 200 ft/min. I then engaged the power cross-feed at the lowest rate and watched the tool sail through the material, leaving an excellent finish on both surfaces. Lubrication was again by drip can, and the chips were of a similar appearance to those generated by the tee section blade, falling clear in a similar manner, the top surface of the titanium nitride coated tip also having a concave form.

Costs

It is perhaps somewhat pointless to quote costs in an article such as this because home workshop owners are



Reproduced from 'Model Engineer' Vol. 110 No. 2767 5 June 1954

renowned for trawling through the surplus and secondhand markets and coming up with incredible bargains. Additionally, whereas an industrial customer will go straight to the tool factor for his supplies, most of our fraternity will consider which components can be made within the workshop before seeking commercial items. The following prices are therefore quoted just as an indication of the comparative costs of the newer and the more traditional systems.

A current catalogue lists a standard 3/8in. forged parting tool in 5% cobalt at £26.65 including VAT (somewhat more than I can ever recall paying for one). The smallest (1/16 x 5/16in.) hollow ground Eclipse blade is listed at £13.28, with a suitable holder at £76.30, but one of the major model engineering suppliers stocks these at a significant discount and also quotes lower prices for other makes.

The Empire Tee section blades are obtainable at between £12 and £18 depending upon size and the corresponding special holders (dovetail fitting) cost between £20 and £26. The Wellsborough rear toolpost (without holder) is listed at £49. The 'plain' version of these items will be somewhat cheaper, at £59 complete.

Turning now to the tool featuring the cemented carbide insert, the RRP is £59.80, but Greenwood Tools are offering it at £35.88, with replacement tips currently costing £6.77.

From the above, it can be seen that my 'ideal' set-up, consisting of a Sandvik/Greenwood parting tool in a dovetail holder mounted on a Wellsborough rear toolpost would set me back about £100, which would necessitate serious plundering of the workshop fund.

However, changing poets, I think that Keats may have had the right description of any of these modern parting tools now on the market - "A thing of beauty and a joy forever"!

REFERENCES

1). Modern Metal Cutting - a practical handbook - AB Sandvik Coromant, S-811 81 Sandviken, Sweden ISBN 91-97 22 99 - 0 - 3 (Available from Greenwood Tools)

2). M.E.W., Issue 3, Page 30 - Parting off made easy, Ted McDuffie.

3). Strictly I.C., Vol. 8, No. 45, Page 29 - Looking for a better cut-off tool?, Bob Ellison

4). M.E.W., Issue 47, Page 42 - A beginner's guide to the lathe - Part 12, Harold Hall

5). Model Engineer, Vol. 142, No. 3532, Page 228 - On parting off, George H. Thomas

6). Model Engineer, Vol. 114, No 2858, Page 363 - Heavy duty parting tools, Martin Cleeve

7). Model Engineer, Vol. 142, No. 3533, Page 277 - On parting off, George H. Thomas

8). Model Engineer, Vol. 142, No. 3535, Page 383 - On parting off, George H. Thomas

9). Model Engineer, Vol. 136, No. 3391, Page 404 - An extra-thin parting tool, L. C. Mason.

SUPPLIERS

J. J. Churchill Limited, Station Road, Market Bosworth, Nuneaton, CV13 0PF. Tel. 01455 290491 Fax. 01455 292330

Greenwood Tools Sherwood House, Sherwood Road, Bromsgrove, Worcestershire B60 3DR Tel. 01527 877576 Fax. 01527 579365

Hemingway, Wadworth House, Greens Lane, Burstwick, Hull, HU12 9EY. Tel. & Fax. 01964 670701

L. A. Services Ltd., Bramcote Fields Farm, Bramcote, Warwickshire, CV11 6QL. Tel. 01455 220340

Myford Ltd., Wilmot Lane, Chilwell Road, Beeston, Nottingham, NG9 1ER Tel. 0115 9254222 Fax. 0115 9431299

Neill Tools Ltd., Atlas Way, Atlas North, Sheffield, S4 7QQ. Tel. 0114 281 4242 Fax. 0114 281 4252

A. J. Reeves Co. (B'ham) Ltd., Holly Lane, Marston Green, Birmingham, B37 7AW. Tel. 0121 7796831 Fax. 0121 7795205 email ajreeves@dial.pipex.com

Tracy Tools Ltd., 2 Mayor's Ave., Dartmouth, S. Devon, TQ6 9NF. Tel. 01803 833134. Fax. 01803 834588.

TEASERS
SOLUTIONS

In Issue 47, we published a couple of photos of devices which were proving a puzzle to their owners. A number of readers from across the U.K. and Europe have identified one of them. Peter Rawlinson describes its use and provides photos of a complete unit

The 'Spike"

In response to your *Teasers* enquiry in Issue 47, I enclose some photos which should solve one of them.

The device which you call a 'spike' is, in fact, a tool which is used for the extraction of Morse taper tools such as drills or reamers, and avoids the use of a hammer.

The problem with the example you show is that there is a piece missing. One photo shows a complete unit, owned by a colleague, and another shows a modern version which is still made by a French company called Fracom. They are still available from the better tool shops.

The missing piece is a second wedge, which fits over the lower one and which has a rack on its lower side (not easy to see). This meshes with a gear cut into the end of the handle.

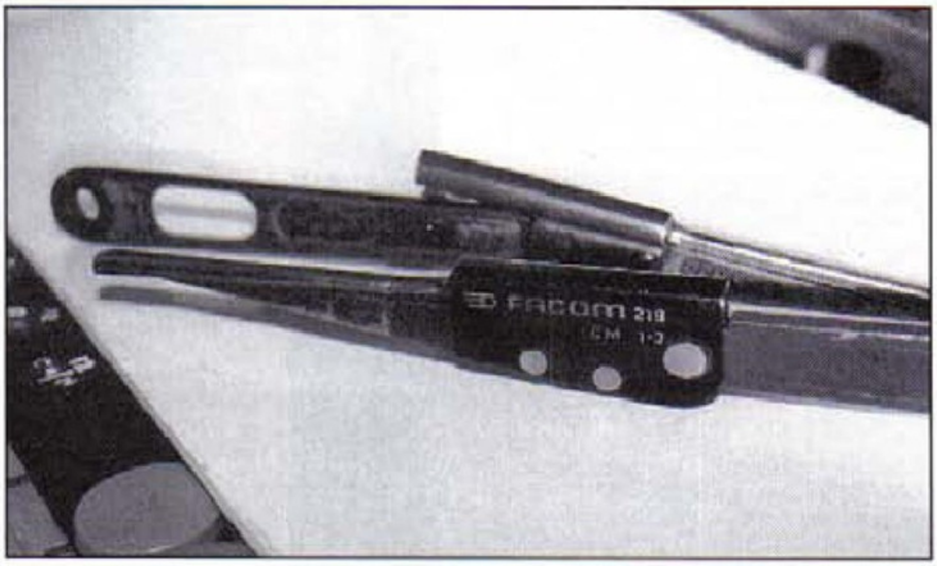
In use, the double wedge is slid into the extractor hole in the Morse taper sleeve and the handle is cranked down. The gear pushes the top wedge along the lower one, producing a considerable force to extract the taper. Its a much more civilised method than beating a taper drift with a blunt instrument!

G. Hamilton of Belfast identified it as a 'Ket' Tangmaster, and sent us a copy of the maker's instruction leaflet. He has one which is unblemished after 15 years' use.

J. Walker of East Yorkshire advises us that the Tangmaster is available from Drill Services (Horley) Ltd. at £28.00 for the 1 to 3MT version and £38.90 for one covering the range 3 to 6MT.

Dr Jurgen Miller of Marburg, Malcolm Purdue of Shaftesbury and N. Fritchley of Nottingham kindly sent us sketches of the extractor, showing the principles of operation.

Thanks to all who took the trouble to respond.



Clamp?

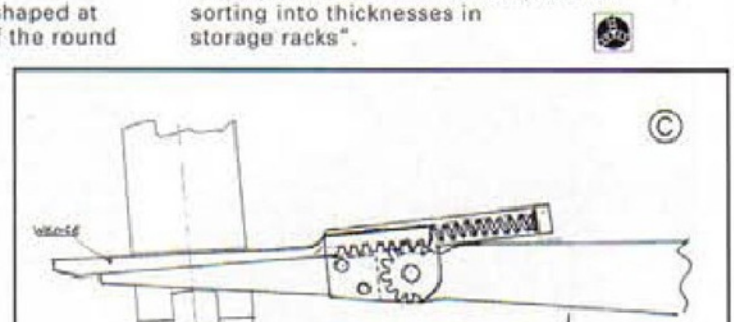
Meanwhile, the other item has brought only one reaction, from Mike Thurgood of Milnerton, South Africa:-

"I am writing about the 'clamp' teaser shown on page 67 of *MEW*, December 1997.

No, I don't possess one, so what I think it may be is purely speculation. However, you omitted an important feature in your description, since without it the device couldn't possibly work. The omission? The two sections of the 20TPI thread are obviously opposite handed.

Because the 'jaws' are shaped at their ends, and because of the round bar seen at the top of the photos, which must be intended to keep the 'jaws' truly parallel and which can be locked with grub screws and, of course, the graduated scaling feature, I would guess that it is a measuring tool, say for a crankshaft journal.

With the counterbores in the 'jaws', into which the adjusting screw will fit, so allowing the device to fully close, coupled with the rounding of the outer edges of the measuring ends of the 'jaws', it could also be used to measure quite small internal diameters. This may not be the case at all, so maybe it might have been used to measure the thickness of metal plate, or to check stock plate for sorting into thicknesses in storage racks".



THE 67th M.E. EXHIBITION

'Condor' looks at some of the tools and tooling and the results of the related competition classes at the exhibition this year.

(Photos: Mike Chrisp)

At first glance this was perhaps not a vintage year for workshop enthusiasts. There was little new in the tooling section. However, wandering around the show it became obvious that several model engineers had pulled out all the stops to contribute items of workshop tooling to the wide ranging displays in the Model Engineer Centennial Village and a few more in the Loan Section.

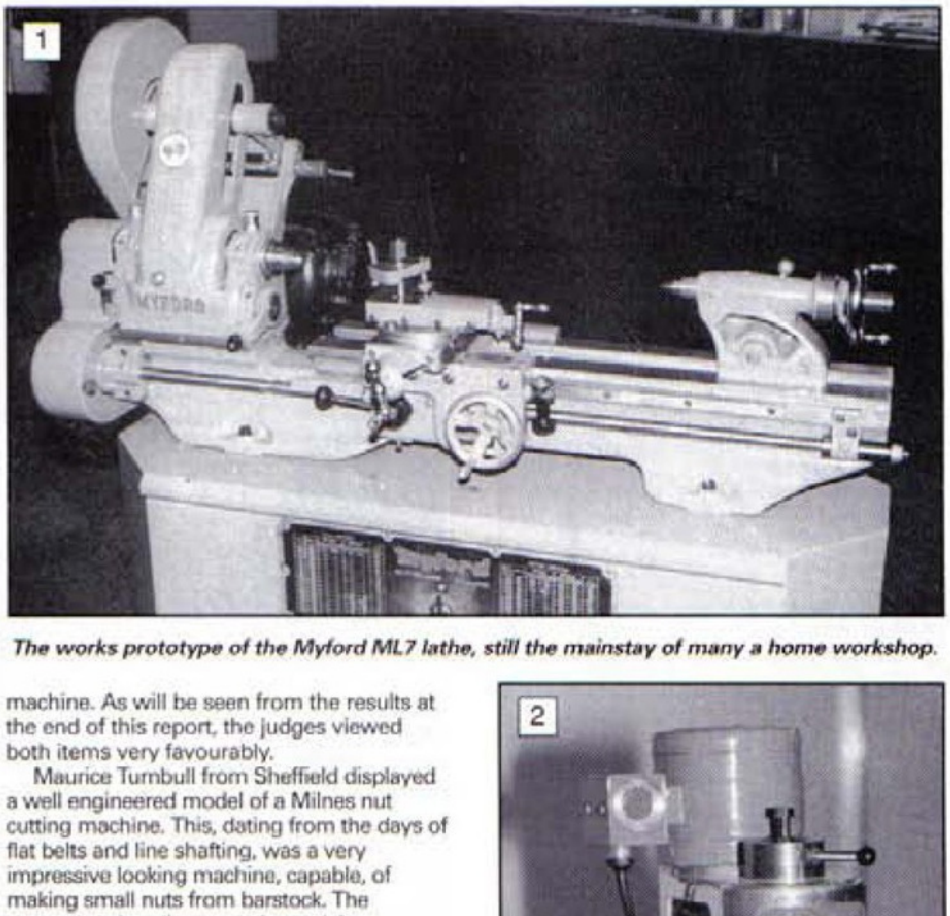
There can be but very few home workshop enthusiasts who have not heard the name LBSC (for any such this was the pen name of L. Lawrence, perhaps among the best known of the model steam locomotive designers).

In his later years he often extolled the virtues of his Myford Super 7 lathe. It was therefore a real treat to find that as well as a large representative collection of his locomotive designs, many built by himself. The present owner had kindly consented to LBSC's own Super 7 lathe being displayed.

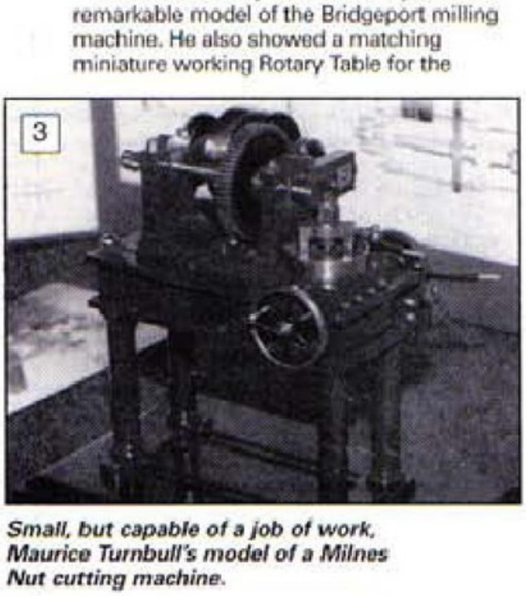
Thanks to the generosity of Messrs. Myford Ltd visitors were able to inspect three more lathes of great interest. Myford have retained their pre-production prototypes of the ML7 and the later Super 7, and displayed both of these machines in the village. There were some differences apparent between these and the production models and lots of visitors spent some time in comparing these with their machine at home.

Many years ago Myford commissioned the building of a scale replica of the famous ML7 lathe. This too was on display in the village.

We have already featured Barry Jordan's remarkable model of the Bridgeport milling machine. He also showed a matching miniature working Rotary Table for the machine. As will be seen from the results at the end of this report, the judges viewed both items very favourably.



The works prototype of the Myford ML7 lathe, still the mainstay of many a home workshop.



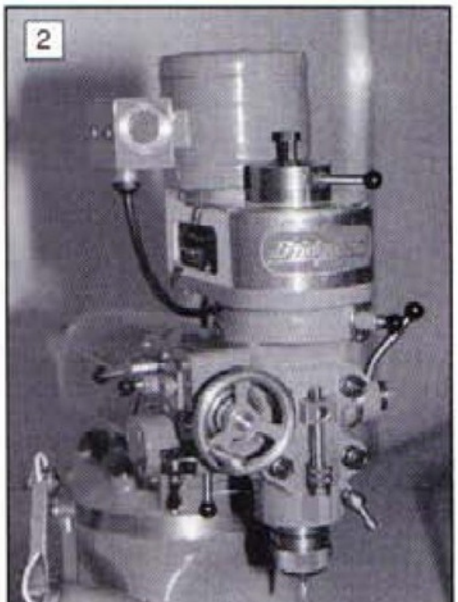
Small, but capable of a job of work, Maurice Turnbull's model of a Milnes Nut cutting machine.

Maurice Turnbull from Sheffield displayed a well engineered model of a Milnes nut cutting machine. This, dating from the days of flat belts and line shafting, was a very impressive looking machine, capable, of making small nuts from barstock. The accompanying diagrams showed the workings of the machine. No castings were used in the construction. the machine was all fabricated.

Last year Alan Cambridge showed his model Hobbies fretsawing machine and wood turning lathe. This year he loaned these machines to the village. He also sent his latest a $^1/2$ size treadle fretworking machine.

One of the stars of the show this year was Mike Harmsworth from West Wilts SME. Mike is the custodian of the Society's collection of Edwardian tools and machinery all housed in a portable garden shed. This was full of period artefacts, chief of which was a 1900s treadle lathe, and set up to replicate an early model engineering workshop. During the show, when not chatting to crowds of visitors, Mike demonstrated the art of treadling a lathe as he turned a two throw crankshaft from a piece of black iron barstock. A section of this workshop graces our cover for this issue.

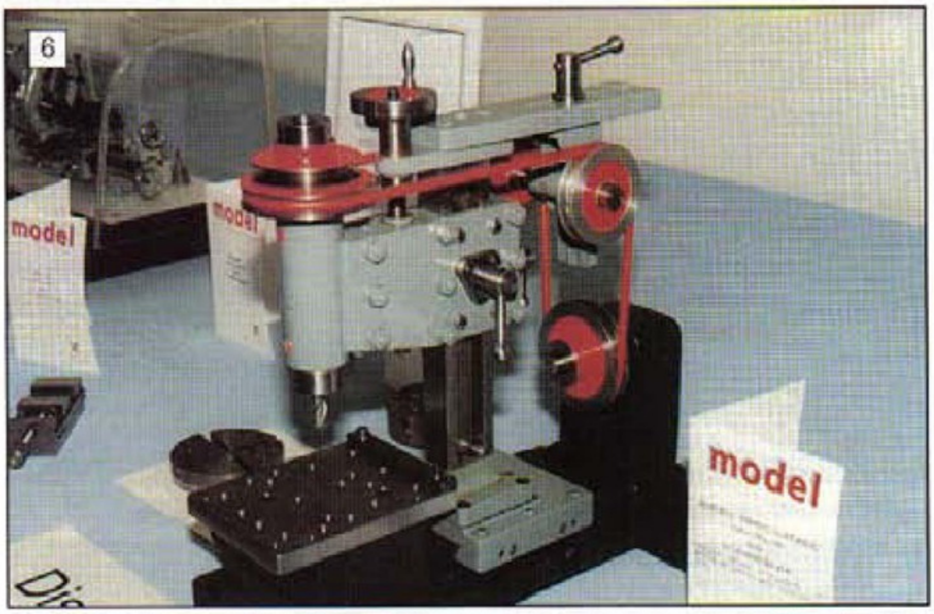
Three other workshops were contained within the village, the ever busy SMEE area, combining meeting point, workshop demonstrations and a small display area. As has become the custom at the show, the demonstrators were hard pressed to get any constructive work done, they spent most of their time chatting to interested visitors, offering advice and information.



A close-up of the head of Barry Jordan's remarkable model of a Bridgeport milling machine.

The third workshop was manned by Alex Price, using machines kindly loaned by

Demonstrating the art of treadling for our photographer. Mike Harmsworth at the West Wilts SME antique lathe.



Len Walker's Micro Mill designed forthe Myford ML10 lathe, the design can be altered to suit other machines.

Chester Machines. The concept here was a 'Workshop in a cupboard' again Alex was hard pressed to make much progress, but certainly demonstrated that one can have a workable shop in quite a confined space. One little story that came from Alex's area was that a lady visitor very much admired the swarf he had collected into a box ready for disposal at the end of the day. Some of it was shiny steel, other, where the machine had been pressed harder was a lovely shade of blue. The lady offered to buy the swarf, claiming it would be good for a project in her hobby. (Stuffed and mounted swarf perhaps?)

Welcome exhibitors were the Society of Ornamental Turners. They had a small workshop with an OT lathe and a selection of turned objects for visitors' inspection. Many were interested in seeing the complex shapes which can be generated by a combination of turning, milling from the slide rest while indexing the headstock, and all the other ramifications of which the well equipped OT lathe is capable.

Thanks to the good offices of Messrs. Warco, Emco Maier, Chronos and Chester Machines it was possible to give an idea of the well equipped 'Workshop of today'. This exhibit was unmanned, but gave visitors the chance to examine some of the latest machine tools at close quarters.

Among the other tools in the village was the collection of tooling made by the late Peter Jones and kindly loaned by his family. These were made to check the accuracy of various items mentioned in his recent *Mechanisation of Manufacture* series in *Model Engineer* magazine. Interesting to see how automatic and semi-automatic machinery developed to meet manufacturing needs, although it must be said that in the main these were for activities of a warlike nature!

More mundane, they used to be used in their hundreds, but are now very rare, was the glass engravers' lathe exhibited and restored by Alan Bourne.

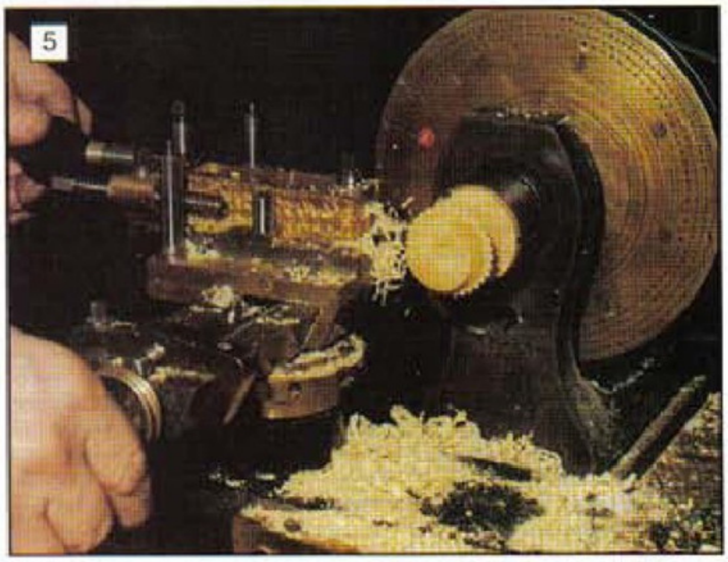
Adjacent to this display we had a model of an industrial tilting table loaned by Peter Rawlinson, together with his bandsaw blade welding machine cum spot welder, which attracted so much attention last year.

A very prolific workman is Peter, he also shoed his self centring vice, the PCD Marker described elsewhere in this issue, a mill/drill centring device used for centring the mill or drill over round or rectangular sections.

It was a treat to get the chance to inspect Fred (Bushy) Robinson's case of miniature carpenters tools again. These are a previous winner of the DOE award. Interestingly, while the coveted cup was in his possession Bushy made a $^1/3$ scale model of this in Silver, then modelled its carrying case, warts and all! He gained a Bronze Medal for this very fine effort.

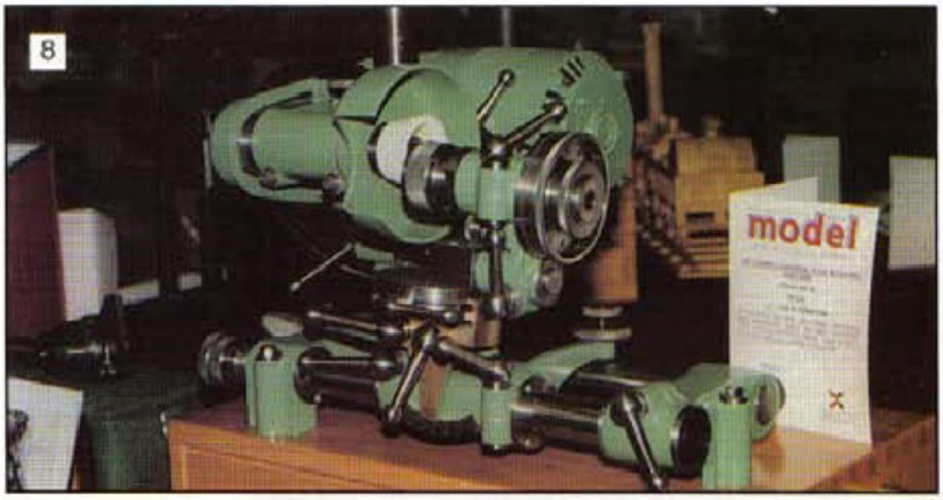
Tubal Cain, a long time contributor to *M.E.* displayed his Master and Slave chuck outfit, which he described in *M.E.* some years ago.

Our contributor Bob Loader displayed a



Intricate patterns being produced on Boxwood on the OT lathe.

Easy on the Variax, but try to generate this shape on a conventional milling machine.



Colin Craxton's award winning version of the Quorn Tool and Cutter Grinder.

Antony Pedley's well made version of the Eureka continuous form relieving tool gained a Commended certificate.

Alex Skinner loaned these historically interesting tools, used by a watch/clockmaker for many years.

Ron Harris demonstrating on the Myford Vertical Milling machine in the SMEE workshop with Derek Brown engrossed in another job close by.

selection of his many items of tooling for the Unimat, together with the *Calivider* which featured in issue 48.

Another nicely made item featured here was Alan Jeeves' Swing Surface Grinder, featured in issue 46.

Len Walker is also a prolific worker, whose articles appear from time to time in *M.E.* and *M.E.W.* He had two items on display this year, his Micro Mill for the Myford ML10, which was described in *M.E.* a few years back, and a more recent offering, a device for retaining vertical table alignment on his drilling machine, which quite coincidentally acts as a steady to the outboard end of the table, thereby stiffening the whole machine. This too was described in *M.E.*

Class A2.
GENERAL ENGINEERING MODELS

Barry J. Jordan
Silver Medal
Model Bridgeport milling machine

Hubert M. Turnbull
Bronze Medal
Nut cutting machine

Barry J. Jordan
Commended
Scale Rotary Table for a model Bridgeport milling machine

Class A5
TOOLS & WORKSHOP APPLIANCES

Colin Craxton
Silver Medal
The Quorn universal tool & cutter grinder

Peter A.Clark
Bronze Medal
Milling machine accessories

Peter A.Clark
Highly Commended
Setting equipment

Antony Pedley
Commended
Eureka, continuous form relieving tool

Derek P. Winks
Commended
Stand for Black & Decker *Powerfile*

Class A9
GENERAL ENGINEERING CRAFTSMANSHIP

Alan Cambridge
Silver Medal
Hobbies type A1 Fretsawing machine, 1/2 scale

Richard Shepherd loaned a hand operated spot facing tool, made as a first attempt at model engineering. This was made to the Hemingway design.

M.E's. Technical Editor Mike Chrisp staged a small display showing an item made by the Variax machine. This revolutionary machine, a great leap forward in metal machining technology was described in issue 46. It was interesting to see a sample of the work it can produce.

Moving on to the competition entries, we had a very well made example of the popular Quorn Tool and Cutter Grinder by Colin Craxton. This gained a Silver medal.

Peter Clarke is a regular exhibitor, this year he had two entries, a well conceived and executed set of milling machine accessories, designed to upgrade the scope of a small instrument milling machine, gaining him a Bronze medal. His other entry, a series of setting equipment designed to allow easy setting of jigs, tools and fixtures on workshop machinery gained a Highly Commended certificate. Both exhibits were nicely presented on purpose built display stands, backed up with a lot of information.

Anthony Pedley had made a super job of his exhibit, a version of the popular *Eureka* continuous form relieving tool, to the design of Prof. Chaddock and Ivan Law. This was the more commendable because it was made using a tiny Peatol lathe and hand tools. It was awarded a Commended certificate.

Final entry was a stand for the Black and Decker *Powerfile* by Derek Winks. This converts a popular hand held power tool into a machine suited for light use in the workshop, the integral dust bag preventing the spread of dust and dirt from the sanding operations. A Commended certificate was awarded.

A late entry in the Loan Section this year was from Tommy Bartlett of the SMEE. His novel riveting tool allows rivet setting single handed in awkward positions, where it would be difficult or impossible to get with the conventional hammer and dolly closing methods.

Alex Skinner displayed a selection of early clock and model making tools in the Loan Section. These originally belonged to Mr. J.W. Wright (1840 - 1908) a clock/watchmaker in Lincoln. They later passed into the hands of his son, Mr. J.W.R. Wright, (1888 - 1975) who served his apprenticeship at Willands in Rugby. He later set up in business for himself, making a variety of machines. Interesting indeed to have the chance to see these survivors from an earlier age.

Making a welcome return to the Loan Section was Eric Ball's Precision Calibrated Filing Rest for the lathe, a useful tool this, showing evidence of considerable use. It was featured in *M.E.W.* No. 44.

Victor Cole displayed a very nicely made tilting table in a fitted wooden case. The necessary tooling and accessories were contained in a drawer below the main tool.

These then were among the tooling exhibits shown at the M.E. Exhibition.

Perhaps this is not the place to wax lyrical about the remaining exhibits of all disciplines. Certainly the show mounted in the Centennial Village displayed some of the best of contemporary and traditional model engineering in all its many facets.

There were many other attractions, sparkling displays on the pond, many displays of flying expertise in the aircraft hall, the lightning reflexes of the lads on the car racing track, the bargains on the many trade stands, the club stands, this year two operating passenger carrying railways on the balcony, together with several smaller gauge layouts, the models on the regular display stands, in all disciplines, and finally the bustle of people moving round looking at these various offerings and enjoying themselves.

Thanks to all who took an active part in making the show such a success, the organising team, exhibitors, stewards, club members, traders and visitors, we look forward to your participation next year.

LINK UP

- Reader to reader service
- queries
- wants
- Help
- small sales
- & its all free!

Please note that this FREE service is restricted to single items of under £50 value. Items for which a greater price than £50 is asked should be sent to our Classified Advertisement Dept. Tel. 01 442 266551.

FOR SALE

● Small metal cutting bandsaw (two wheel) with five spare blades £50.
Tel. 01708 720355

● Free to good home! Two Moore and Wright micrometers. A 3 to 4in. (weight 325 grams, defective ratchet thimble) and a 6 to 7in. (weight 725 grams).
A. M. v.d. Maal, Schubertlaan 27, 7333 CS, Apeldoorn, Holland. Tel. 055 5341186

● Archer Quick-Change tooling:- 3 off Chucks, Model 1202, 12 off Adapter Type 1222, 5 off Adapter Type 1212, 6 off Adapter Type 22, 6 off Adapter Type 12. I am open to offers for the lot, but would exchange for a small adjustable boring head for use on a Centec mill
J. McEvoy, 47 Wilton Crescent, Upper Shirley, Southampton, SO15 7QG. Tel. 01703 324574

● Myford tee slotted long cross-slide £50 o.n.o.
Tel. Paul on 01625 576709 (Macclesfield)

● Helix Jacobs Gear Hobbing machine, single phase. Built 1996. Some hob making equipment. Cheap to good home.
A. Craven. Tel. 01352 711512 (Flints.) Anytime

● For Myford Super 7 Lathe: following conversion to S7B, I have the following seven surplus change wheels for sale - 20t (x2), 25t, 38t, 65t, 70t, 75t. Almost new condition, £50 o.n.o. the lot, or will split. Very many thanks to all those who were kind enough to answer my request for information about the Acorn Tools 7in. Bench Shaping Machine. Your help and advice were very much appreciated and I am extremely grateful to all.
Tel. 01373 832681 (Wilts) (evenings/weekends)

WANTED

● Would Dave from Farnborough please ring again about the C.V.A. lathe parts.
Gordon, tel. 01460 64376

● A copy of the book *Tool Making Hints and Tips* by R. Hutcheson, 1945/54, pub. Percival Marshall.
W. Carlow, 31 Kirkton Crescent, Cardross, Dumbarton, G82 5PH. Tel. 01389 841661

● *Model Engineer's Workshop* Nos. 1 to 38, cash or exchange for workshop equipment or *Woodworker* magazines.
Tel. Paul on 01625 576709 (Macclesfield)

● For a Zyto 3 3/8in. lathe: Change wheel cover, original manual (or photocopy), accessories. My Zyto has its original screwcutting chart - send SAE for a photocopy.
Tony Jeffree, 11a Poplar Grove, Sale, Cheshire, M33 3AX. Tel. 0161 2823824

● Many thanks for the response to my request for back numbers of *M.E.W.* I now have a complete set. I would still like to purchase unmachined castings for 11/2in. Allchin (not boiler). Also complete sets of drawings for *Titfield Thunderbolt* and *Canterbury Lamb*, both in 31/2in. gauge.
Joe Lloyd, 3 Leafield Avenue, Longwood, Huddersfield, HD3 4TW. Tel. 01484 654557

● For Viceroy TDS 1 lathe, 28 tooth tumbler reverse gears, 38t stud gear, 24t stud gear and 38t spindle gear.
Tel. (any evening up to 2200hrs) 01329 230992 (Fareham)

● Handbook for Elliott Omnispeed 20/1650 lathe (buy or copy), also *Building the Heisler* by Kozo Hiraoka.
Tel. Roland on 01623 636343 (Evenings) 0115 9478798 (Day)

● A back toolpost for a Myford ML7.
Tel. 01835 863063 (Roxburghshire)

● I wish to purchase Issues 2 and 3 (Autumn 1990 & Winter 1990/91) of *M.E.W.* Your price paid.
J. Walker. Tel. 01964 533032 (East Yorks)

● For Myford Super 7 Lathe—240V single phase electrics to fit in place of three phase system. Does anyone want to go the other way? Any help with parts etc. would be welcome. Will purchase or can offer numerous items for swap or PX.
J. McEvoy, 47 Wilton Crescent, Upper Shirley, Southampton SO15 7QG Tel. 01703 324574

● Does anyone have a copy of a manual for an Arboga EM825 Mill Drill which they would allow me to photocopy please?
Tel. 01673 828568 (Lincs)

● I am looking for a manual/handbook for a Raglan Little John lathe, for copying or purchase. Also, I am interested in original tooling, such as the 4 jaw independent chuck, taper turning attachment, vertical slide, threaded backing plates, etc.
Colin King, Tel. 01430 441725 (East Yorks).

IN OUR NEXT ISSUE

Coming up in Issue No. 50 will be


1


2


3

1. A MAGNETIC VEE BLOCK

This useful accessory is the result of research carried out by Peter Rawlinson

2. A SELF-ACT FOR THE MILLING MACHINE

Stan Wade devised a system based on a windscreen wiper motor for his Sharp milling machine. It could be adapted for use on other machines

3. A BANDSAW DAMPER

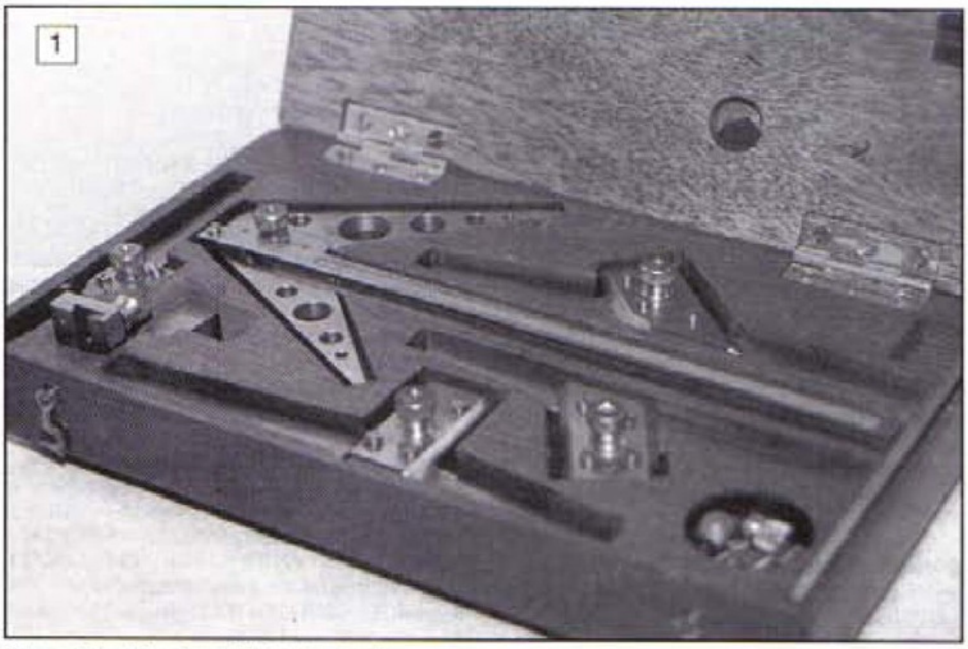
Shelley Curtis feared the consequences if the blade of his universal bandsaw broke, so he devised a simple damper

ISSUE ON SALE 15 MAY 1998

(Contents may be changed)

P. C. D. MARKER SET

Marking hole positions on a pitch circle can be a time-consuming process. Peter Rawlinson has devised this marking instrument which eliminates most of the measuring



The original Design (Mk. 1 Version).

Cross section of the Mk. 1 Rule.

Cross section of the Mk. 2. Rule.

This tool came about through laziness. Having marked out many flanges of all sizes and shapes over the years, I had always thought that there must be a better system than the old one of using dividers, which takes an inordinate length of time, not to mention that which must be added if the flange has a central hole which must first have a blank fitted. Now, I know that toolmakers will use an indexing or rotary table, or even a CNC mill, but there are many applications where this degree of accuracy is not warranted, and for the one-off's, the time required to set a machine up is not worthwhile.

During one of these one-off marking out exercises, I started thinking seriously of how it could be done in a simple and quick manner. I had, on a number of previous occasions, thought about the problem, but another more pressing job had always come up, so it had been dropped. However, on this occasion, nothing else was on hand, so I began to make some progress.

My first thoughts were to use a 'centre square' and a standard square, but it was found to be difficult to hold these together. It did occur, however, that if the centre square had a guide parallel to its rule edge, this problem could be solved. It was a start.

Second Thought:- if the square were to be a sliding attachment, it could be clamped into place, and if it were to be extended either side of the rule, then it would make marking out even more accurate.

It is difficult, looking back, to decide on the exact series of events which led to the design of the tool as it is now. I was asked by the Production Manager of one of the biggest English tool manufacturers how I had come up with it. Even verbally (easier than writing) it was difficult to give a clear answer, but his next comment was nice to hear, "If you had come up with this 100 years ago, everyone would now have one in his tool kit". As it is, we must go with the times and not get too big a head! As with all my designs, I am happy for any individual to make a set for himself, but for any other requirements, contact should be made via the Editor.

To continue. It was a simple step to add the 45deg. and 30deg. arms and then to come up with a locating position for the dividers. The tool has taken two forms, the first being the more complicated but more versatile. The second will be easier to make.

The first is shown in **Photo 1** and has the locating groove machined into the top surface of the rule (see **Photo 2** which shows the cross-section). In **Photo 3** can be seen the cross-section of the 'production' model, while **Photo 4** shows an overall view.

Photo 5 shows the only additional feature that the Mk 1. has over the Mk 2, which is an attachment for marking such things as keyways from the end of the shaft. I will now concentrate on Mk. 2.

How to use P. C. D. Marker Mk. 2

Before detailing the method of manufacture, it may be helpful to understand how the device is used in practice. **Photo 4** shows the instrument on a disc which covers a flange, with a line drawn using the main rule, from point 'A'. The rule has also been subsequently fitted with the 90deg. arm. The unit is rotated around the circumference of the flange until the 90deg. arm is parallel to the line drawn from point 'A' and at the same time, the arm is slid along its guide until perfect alignment is achieved with the original line. If a second line is now drawn along the rule, it will be at 90deg. to the first.

That is all there to the basic principle of the tool. By adding arms of 45deg. and 30deg., the following divisions can be obtained:-

2, 3, 4, 6, 8, 12, 16, & 24.

Photo 6 shows the 45deg. arm fitted to the rule and being used to mark out the 45deg. line. This routine can be continued to give eight equi-spaced points, and when replaced by the 30deg. arm (**Photo 7**), a series of lines at 45, 30, or 15deg. increments can be constructed, as shown in **Photo 8**. Further divisions could be achieved by adding extra arms of say 5 & 10deg., but I have found the three arms to be quite adequate, so far.

Drawing a pitch circle

Under normal circumstances, on a plain disc, one would centre-punch at the intersection of the lines and use a set of dividers to scribe the diameter. However, as discussed above, if the flange has a hole in the centre, then a plug or bung will have to be fitted flush, in order to create a surface on to which the centre can be marked. This can take a long time, as different plugs will be required for the various hole diameters encountered.

The P. C. D. Marker has a way round this, built into the 90deg. arm (and in the others, if required). It is simply a location which will accept the point of the divider, positioned such that when the arm and the rule coincide with the previously scribed crossed lines, it is directly over the centre point, from which the radius can be struck. This saves considerable time, and indeed I estimate that the tool can save some 10 to 15 minutes on a one-off flange with eight points, not forgetting the improved accuracy.

Manufacture

My first prototype was made from mild steel, and Mk 2 was made from unhardened gauge plate. Hardening can be undertaken if required. My first was made by clamping in many ways but it was somewhat time consuming, so when I subsequently decided to make a batch of four, a series of jigs was made. For a single unit, these are neither necessary nor worthwhile. It can be completed quite easily just by taking a little more time.

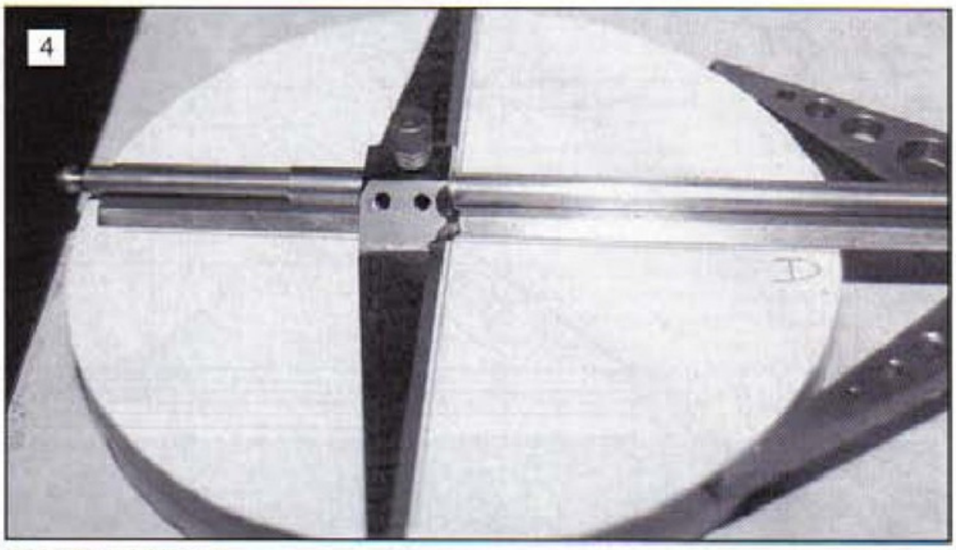
The Rule

Made from gauge plate, 15 x 3mm, and machined on the scribing face, the groove, and the chamfer all at the same setting, this part can be clamped down on a packer, but I suggest that it is clamped directly to the machine table with the scribing face over a Tee slot, so that the cutter can drop below the surface of the table. Good and accurate edges are required to both the groove and the scribing edge, as these will determine the overall accuracy.

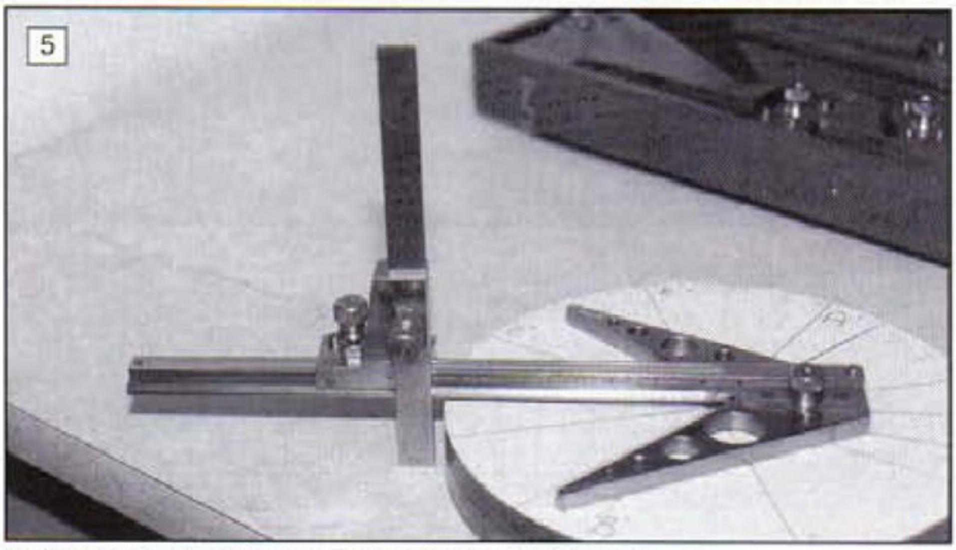
The Guide

Made from silver steel, 6mm dia., it has a ball machined on the end to ease the mounting of the various arms. It is much easier to put a close fit bore onto a ball end than onto a square ended shaft, and the bore can be rotated around the ball, to align with the shaft. This system can be seen on the shafts of some of the older magnetic dial gauge bases.

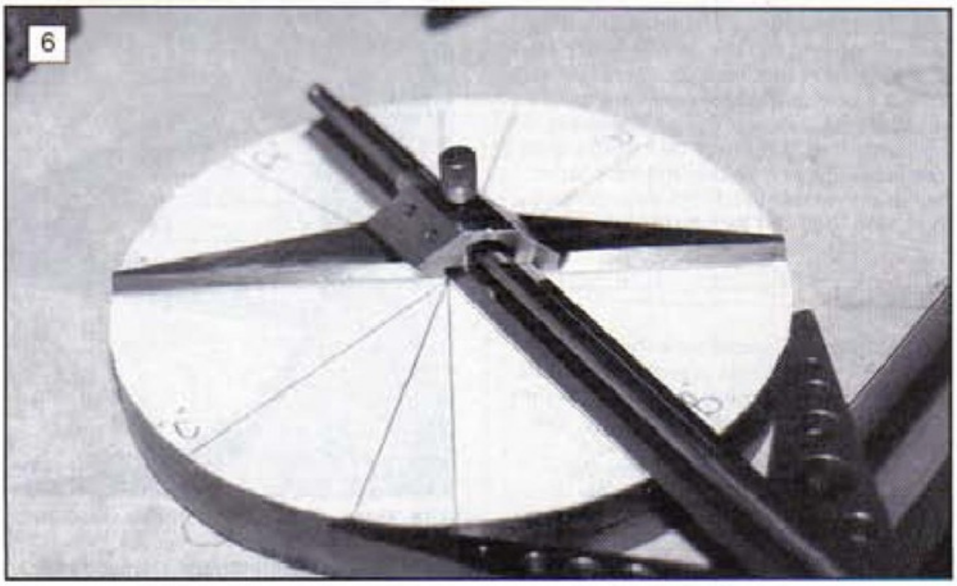
As an aside, I would thoroughly recommend making a ball turning tool. I made one from a design published in *Model Engineer* many years ago. It saves all the hand work, and mine will, by varying the height of the tool, allow concave machining for handles.



The Mk. 2 unit in use.



Marking keyways with an attachment fitted to the Mk. 1 unit.



Mk. 2 fitted with the 45deg. Arm.

Vee Base (Fig. 1)

This has to be cut from plate, which may be mild steel or gauge plate. The angle of 90deg. is not critical, but when the

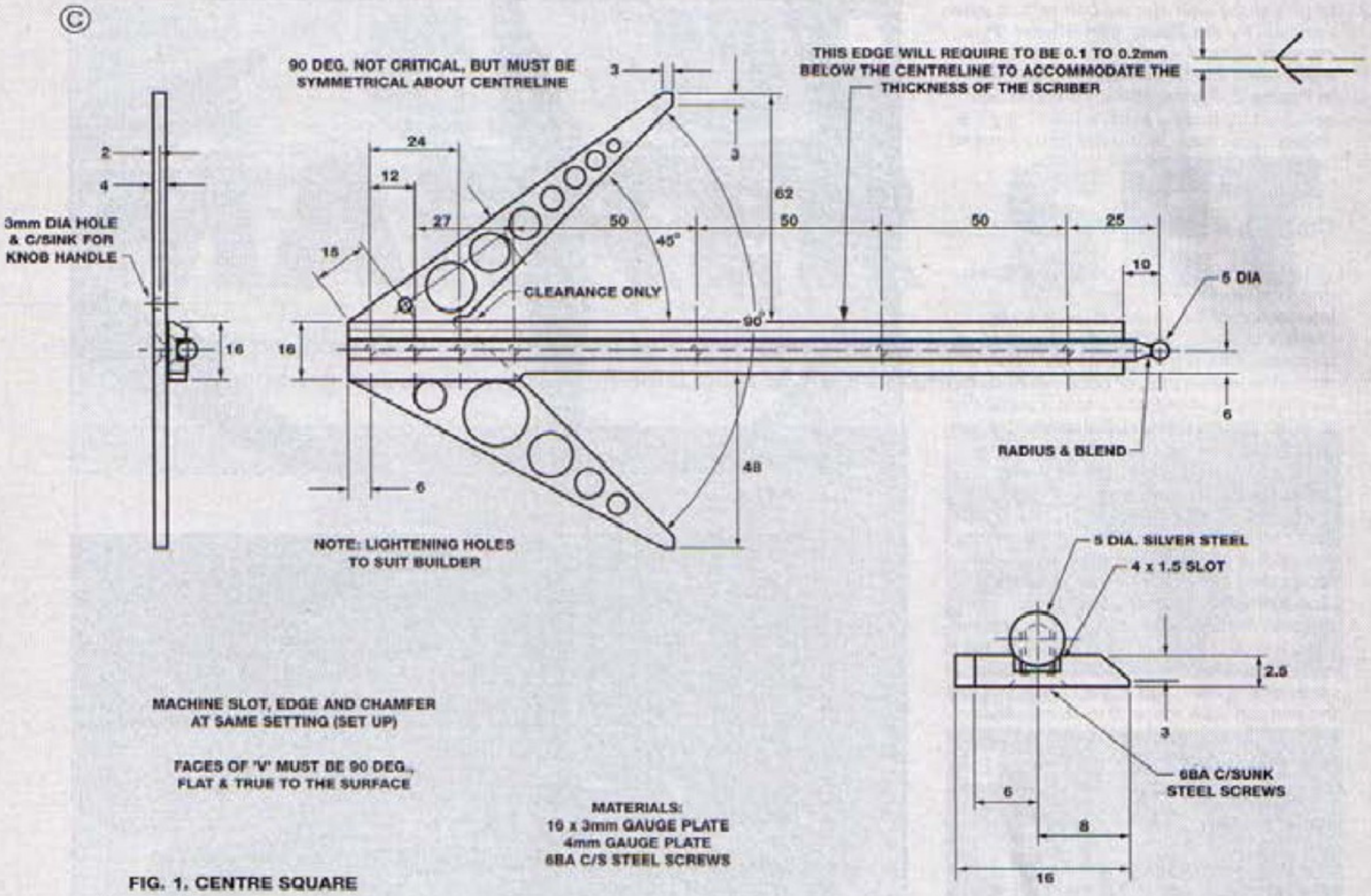


FIG. 1. CENTRE SQUARE

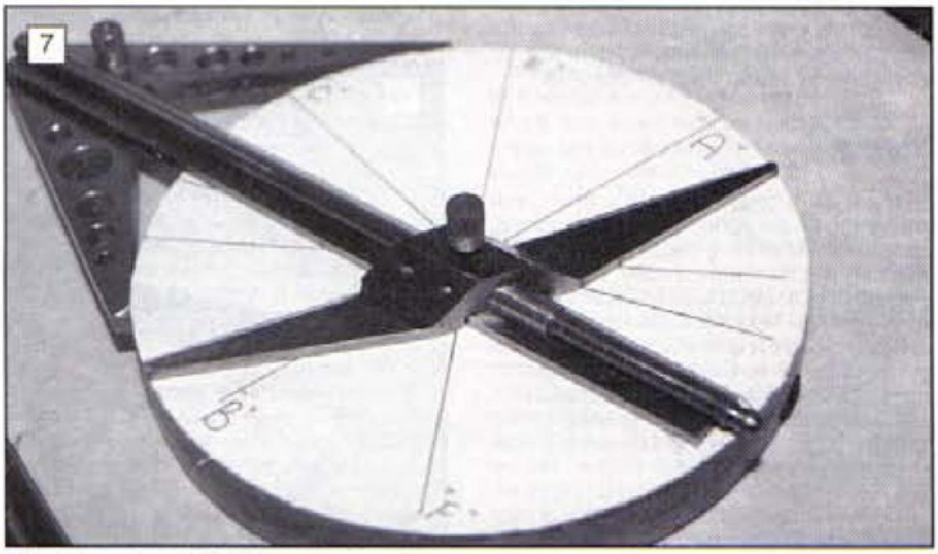
Rule is set up on this Base, the angle must be bisected exactly (more about this later). The internal angled faces should be accurately machined and finished off by draw filing and the use of Wet & Dry. Here it is important that both faces are flat and true, otherwise the tool may vary in accuracy on different flange diameters.

Lightening holes may be incorporated if required. They make the unit look 'right', but are not essential. If not done properly, however, they can look terrible.

Assembly

Drill, tap and countersink the holes for the first 4 x 6BA holes (counting from the ball end) and assemble using countersunk Allen screws. Clamp the Rule to the Vee Base, in its correct position, using a minimum of two toolmakers clamps.

To check that the rule is correctly positioned, turn a piece of material say 4in. dia. to face the end square. Hold this in the vice and blue or copper sulphate this end surface – I have found that thick-tipped marker pens work well. Place the Centre Square on the machined face and scribe a light line. Rotate the Centre Square through 180deg., and if the Rule is in the correct position, its edge will line up exactly with the scribed line. If not, reposition the Rule, scribe another line and check again. When the correct position is



The 30deg. Arm is fitted in this view.

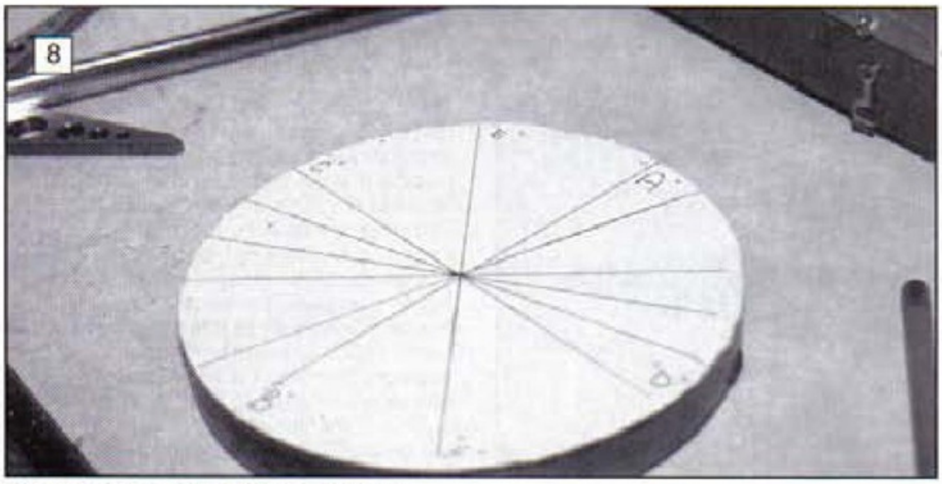
reached, finally tighten the clamps fully and again recheck.

Drill, tap, countersink and open up the holes for the securing screws and attach. Even at this late stage, slight adjustment is still possible. If the error is angular, then loosen and rotate. If the scribed line is 'below' the rule line, then draw file and use Wet & Dry to give the clearance. This surface must remain flat (see **Photo 9**).

If all is correct, then finally polish using Wet & Dry and fit the handle. Spray with a little WD40 to prevent rust.

90 degree Arm (Fig. 2)

The arms (**Photo 10**) are the most awkward parts to make and should be tackled slowly and carefully. First, machine



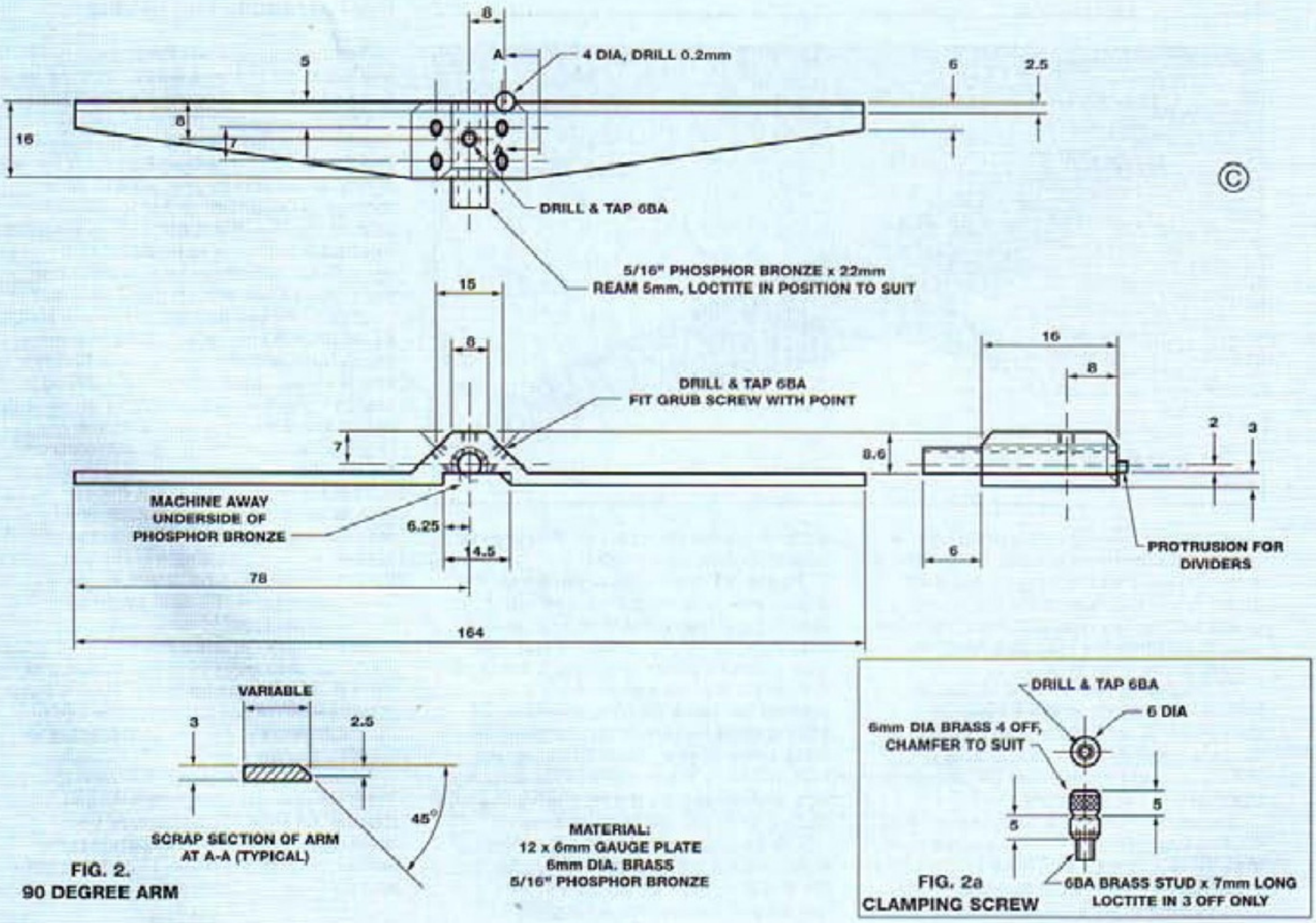
Showing 90, 45, 30, & 15deg. divisions.

away all of the excess material, other than the groove on the underside. Creating the protuberance which forms the divider point location will mean milling away a considerable amount of material from the front edge.

Before the next step (if carried out on the milling machine) check that the machine quill is square to the surface of the machine table. This can be carried out by using a dial gauge on an arm mounted in the spindle. With the probe of the dial gauge bearing against the table, the spindle is rotated and the gauge readings noted at 90deg. increments along and across the table. These readings should all be exactly the same; if there is a variation, then acceptability will depend on the exact reading and the length of the arm. 0.1mm on a 150mm arm could be tolerated, but the same reading on a 50mm arm would not. Far better, however, to obtain an equal reading at all points, and to work as closely to zero tolerance as possible.

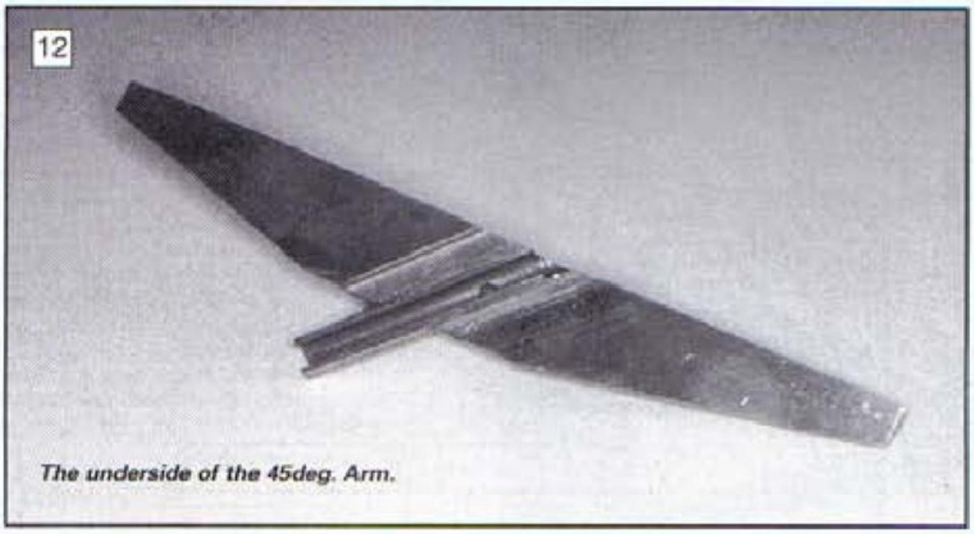
All this effort is required because the next step is to accurately face the 'reading face' of the arm and to drill, bore and ream the hole for the inserted bronze tube, which of course must be at right angles. The hole must also be parallel to the underside of the arm and be correctly

Underside of the Centre Square.



The 90deg. Arm.

The underside of the 90deg. Arm.



The underside of the 45deg. Arm.

positioned in relation to the underside, so that the undersides are flush. To this end, I would advise that the height from the underside of the Rule to the top of the Guide be checked first, and this dimension used to position the hole and, later, the groove in the underside.

Fit the previously bored and reamed bronze tube, which would be best as a light press fit. Loctite can also be used, but the tube must not be a heavy fit, as distortion could occur when the groove is machined in the assembly.

The next job is to mark off, drill, and tap the five 6 BA holes in the top and sides of the arm (see **Photo 4**). Those on the sides are fitted with pointed nose grub screws, which give a small amount of adjustment on to the guide. The top hole accommodates the brass clamping screw, which doubles as a handle.

Photo 11 shows the underside of the 90deg. arm with its groove. I would recommend that when this is set up for machining, it is held in such a way that access can be obtained to check the fit of the Centre Square without having to remove the piece from the machine. Milling must be carried out carefully, and a scrap piece of 6mm steel fitted into the tube will help. When close to the finished size, de-burr and try the fit, continuing with caution until a good fit is obtained.

The next operation seemed, at first sight, to be a very difficult set-up, but in the end proved to be simple and easily carried out, namely the drilling of the divider point centre. This is carried out using a 'wobbler' and Digital Read Out or a dial gauge. First set up the assembly, which must be square to the table travel, using a dial gauge for accuracy, and clamp down to the table on parallels so that clearance is available underneath, giving clearance for the wobbler ball.

Line up the rule in the normal way on the 'Y' axis using the wobbler and dial gauge then offset the rule away from the centre by an accurate amount and lock in position. This offset is needed to give access to the working face of the arm.

Repeat the above on the 90deg. arm, but on the 'X' axis. Do not however move it away, but lock the table travel. Move the 'X' axis back into its centre position, using the dial gauge again, and lock. Spot using the smallest centre drill and drill 0.2mm (0.008in).

45 and 30deg. Arms (Fig. 3 & 4)

The 45 and 30deg. Arms (**Photo 12**) are very similar and the basic procedures are the same, but here the hole through being at an angle requires a different approach. Machine the front edge first; the arm must then be set at the correct angle, either by the use of a sine bar and dial gauge or similar. A slot drill is then used to level off the area through which the bore is to go, and it is then centre drilled, drilled, bored and reamed to fit the bronze tube. All other operations are the same.

Final assembly and testing

Testing is simple but time consuming and is carried out by a similar method to that used for checking the Centre Square.

Check once again that the Centre Square is correct, then scribe an accurate line. Fit the 90deg. arm and scribe a line at 90deg. Check this by revolving the tool through 180deg. and checking the arm against the line. If it is not correct, then the front edge will have to be adjusted by draw filing, but please bear in mind that the surface must end up true and flat.

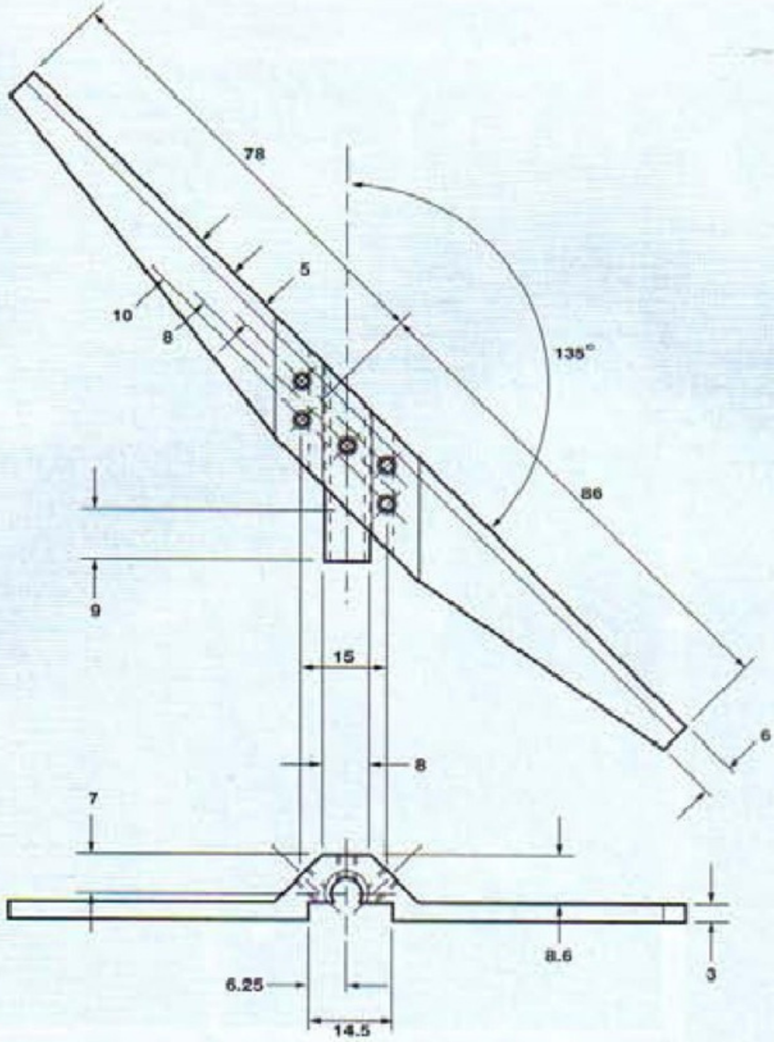
When satisfied that this is correct, scribe an accurate 90deg. line and replace the 90deg. arm with the 45deg. arm. Scribe a line at 45deg., then rotate to the 90deg. line and check, again correcting as necessary. When this arm is to the required accuracy, then repeat the process for the 30deg. arm.

The above is read quickly, but can be time consuming to carry out, as drills and reamers can wander even when the drilled hole is corrected by single point tool boring before reaming. It will, in the end, be worthwhile, as the time saved by using the completed tool is substantial.

At the sizes depicted, the tool is very useful for diameters between 30mm and 150mm. It can be used below 30mm, but it may be worthwhile to reduce the size of the P.C.D. Marker if the requirement is to work in smaller sizes.

Designing and making this instrument has been an interesting exercise and the tool can be used for a variety of other marking out tasks, such as parallel lines across the end of a circle. I hope that you find it of use.

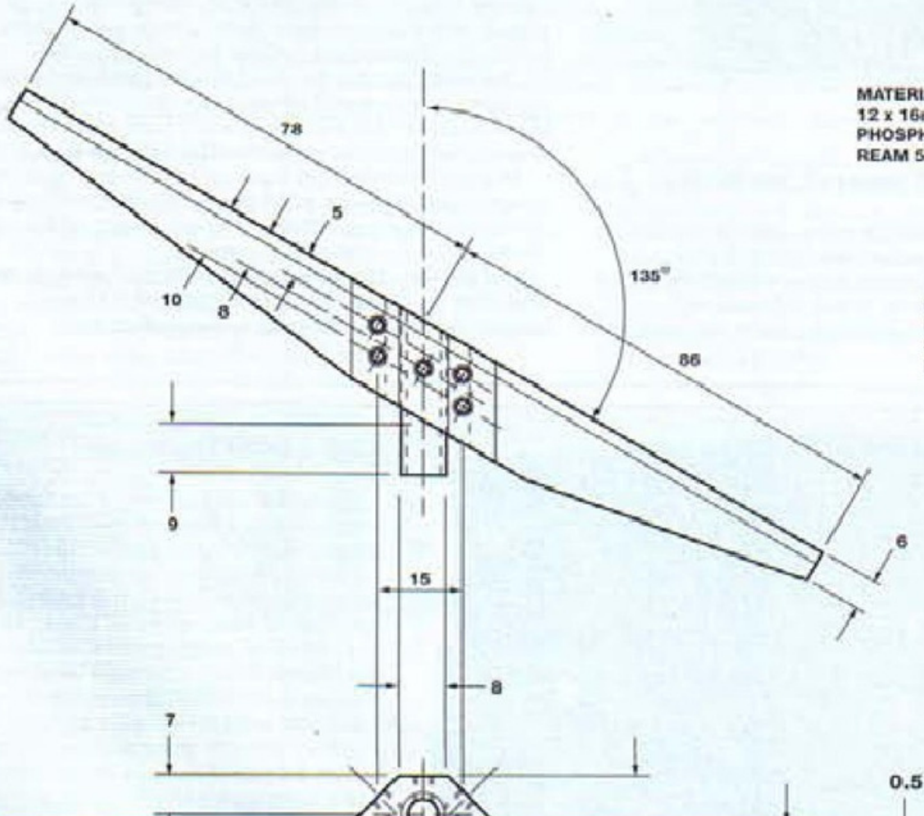
©



MATERIALS:
12 x 16mm GAUGE PLATE x APPROX. 170mm LONG
PHOSPHOR BRONZE 5/16" DIA. x 36mm, REAM 5mm

NOTE:
ALL OTHER DETAILS AS 90 DEG. UNIT
DIVIDER POSITION MAY BE ADDED IF REQUIRED
SEE FIG. 2a FOR PINCH SCREWS

FIG. 3.
45 DEGREE ARM



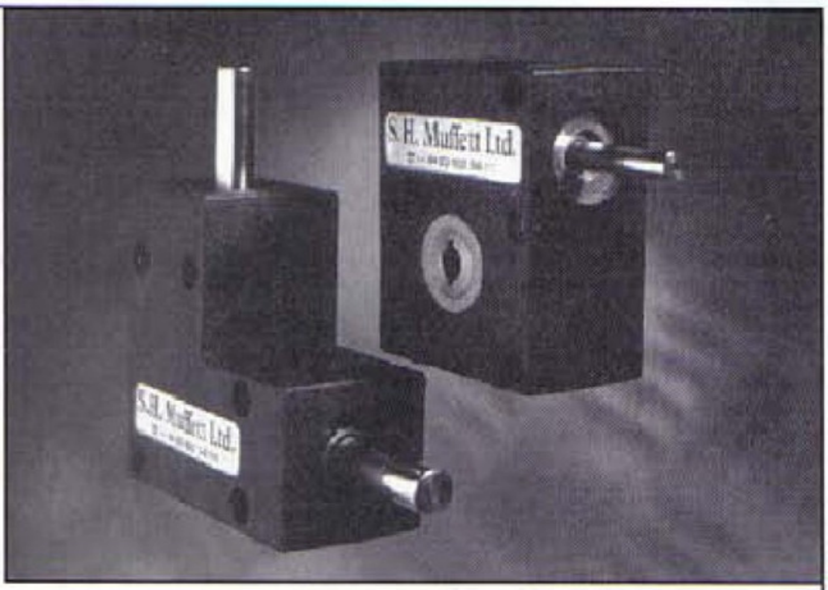
MATERIALS:
12 x 16mm GAUGE PLATE APPROX. 170mm LONG
PHOSPHOR BRONZE 5/16" DIA x 30mm
REAM 5mm

NOTE: ALL OTHER DETAILS AS 90 DEGREE UNIT
DIVIDER POSITION MAY BE FITTED IF REQUIRED
SEE FIG. 2a FOR CLAMP SCREWS
DRILL & TAP HOLES 6BA, DRILL SIZE 2.3mm

©

FIG. 4.
30 DEGREE ARM

TRADE COUNTER



S H Muffett Ltd extend their range of gearboxes

S H Muffett Ltd of Tunbridge Wells have long been renowned for their extensive range of gears and gearboxes, many of their products having been specified for model engineering projects over the years. Two new gearboxes were launched at Drives and Controls, which took place at Telford Exhibition Centre between 10 - 12 March.

The new units are both plastic case types, the PL2 being a bevel gearbox and the P2 being a worm reduction version. The former features steel and plastic moulded bevel gears in a glass filled nylon case. It incorporates a versatile fixing arrangement, which makes it suitable for a wide range of applications.

The worm gearbox houses a polished steel worm and a phosphor bronze worm wheel, available in a wide range of ratios. It has a double-ended input shaft and a bore which receives the output shaft, eliminating the need for a coupling.

Muffetts have also just published a new catalogue, which now runs to over 350 pages and not only includes a complete list of products and custom services, but also a technical section giving in-depth advice on product performance.

S H Muffett Ltd., Woodbury Park Road, Tunbridge Wells, Kent TN4 9NH Tel. 01892 542111 Fax. 01892 542117 email: sales@muffett.co.uk Website www.muffett.co.uk

High quality toolchests

Many visitors to the Olympia Exhibition were impressed by a range of traditional toolchests displayed on the stand of H. Fine & Son Ltd. of Wembley, Middlesex. Included in their Salmens range of products, these are available under the established trade marks of 'Union' and 'Neslein' in a variety of configurations which range from a five drawer version, through seven and eight drawers to an eleven drawer model, many of these also incorporating a tray top.

Constructed of wood and featuring high quality fittings, they have lockable front panels and a carrying handle.

Fine's catalogue also contains a wide range of hand tools, tool carriers and bags, workbenches and a comprehensive range of oilstones and slips.

H. Fine & Son Ltd., Victoria House, 93 Manor Farm Road, Wembley, Middlesex HA0 1XB Tel. 0181 9975055 Fax. 0181 9978410

Eurotherm Drives for 400V operation

A major advance in the control of motor speed on home workshop machinery has been the introduction of Frequency Inverters which will operate from 220/240V single phase ac supplies. These are used in conjunction with a three phase motor which can be connected for 230V operation, normally delta connected. A number of the suppliers of machinery who advertise in these pages are now incorporating these units into their products, and such devices can also be purchased from electrical equipment suppliers such as Power Capacitors as add-on systems.

Although such facilities have long been available for use with equipment working at 400V, they have historically been just the lower end of ranges up to several hundred kilowatts. This has meant that they have been carrying a large control overhead, necessary for the higher power, more sophisticated applications, but an overkill for 90% of low power installations. The costs associated with this sophistication have often been prohibitive.

Eurotherm Drives of Littlehampton, West Sussex have now introduced a 400V variant of their 601 Series range of inverters, covering the range 0.37 to 2.2kW, a power range previously associated with 230V inverters. They can operate on ac supplies from 380 to 460V and include the operator and programming controls featured in the 230V systems. Each unit also includes an internal dynamic braking switch for applications requiring rapid deceleration of the motor or involving high inertia loads.

RFI filters meeting EMC Class A emission levels are built in as standard.

Eurotherm Drives, New Courtwick Lane, Littlehampton, West Sussex BN17 7PD Tel. 01903 721311 Fax. 01903 723938

Power Capacitors Limited, 30 Redfern Road, Tyseley, Birmingham B11 2BH Tel. 0121 7082811 Fax. 0121 7654054

BW Electronics - New address

BW Electronics, manufacturers of digital position readout (DRO) systems suitable for the type of machine found in the home workshop, have moved from their former Bedford address. They are now settled in premises in Corby Glen, Grantham, and have extended their range of instruments which all use a similar measuring method based on an extending stranded stainless steel wire. This method allows adaptation to both linear and rotary measurement, so systems suitable for use on lathes, milling machines and rotary tables are available.

In addition to descriptive leaflets and price lists, BW can also supply an Application Note, which explains how these units can be used to best advantage.

BW Electronics, 12 Mussons Close, Corby Glen, Grantham NG33 4NY Tel./Fax. 01476 550826 Website: www.bwelectronics.co.uk

New catalogue from Chester UK

Chester UK have a new illustrated 60 page catalogue available, covering their entire range, from heavy duty lathes and milling machines to the smaller items of tooling and instrumentation.

Although the majority of home workshop owners would have some difficulty in accommodating the larger items (for example, a vertical lathe with a 1400mm diameter table or a horizontal borer which will accept a workpiece weighing 8000kg.), much of the machinery is tailored to the needs of the amateur, with all the necessary accessories and tooling also listed.

The Chester team attend the majority of the major model engineering exhibitions, or their catalogue can be obtained direct from their Waverton base.

Chester UK Ltd., Unit 8, Waverton Business Park, Waverton, Chester CH3 7PD Tel. 01244 336100 Fax. 01244 336036

The Hemingway catalogue

Since the retirement of Neil Hemingway, some months back, the new owner of the business, John Corlyon, has been compiling an impressive new catalogue. This is now available and comes in loose leaf A4 format in a ring binder. Literature and drawings will, in future, be supplied in this standardised format, the drawings coming in transparent sleeves, so that they can be used in the workshop, then returned to the binder for storage.

Castings and materials for a wide range of workshop equipment are listed in the catalogue, the designs coming from, among others, such famous names such as George Thomas, 'Duplex', Tubal Cain and Charles Tidy.

Many of the items have been the subject of constructional articles in *M.E.W.* and *Model Engineer* and we hope to feature more in the near future.

Hemingway, Wadworth House, Burstwick, Hull HU12 9EY Tel./Fax. 01964 670701

SCRIBE A LINE

Welding cast iron

From T. D. Walshaw, Kendal, Westmoreland, Cumbria

Your correspondent Mr. Pettengell may be quite sure that his exhaust manifold is 'sand cast'. Until relatively recently (to a chap of my age) virtually all cast iron was cast in sand moulds. However, he does not tell us the nature of his problem! Sand cast iron CAN be welded, though with great difficulty, and the best people to advise him are the British Oxygen Co., Ltd. It is the technique that matters, and no 'hi tech' devices such as MIG will remove this necessity.

However, 60-odd years ago the Suffolk Iron Foundry developed a means of repair of castings known as Sif-Bronze, now known as 'Bronze Welding', specifically for the repair of iron castings. I have successfully repaired cylinder blocks, cylinder heads, and even exhaust manifolds with this method. The work still needs pre-heating, but as the filler material is more ductile than iron there is much less risk of cracking. It is, of course, a flame welding method, not electric arc.

Your other correspondent in Link-up, Mr. Green, asks about the Pallas machine. These, together with a number of others (Progress, Denbigh, Victoria, etc.) came together under the Elliott Company during the post-war years. The last address I have is Elliott Machinery Co. Ltd., Victoria Works, Willesden, London NW10 6NY. Suggest consulting the Directory at the local library.

From F. J. Arnold, Upwell, W. Norfolk

With regard to Mr Pettengell's cast iron welding query, he is facing a nearly impossible task. Cast iron articles that have been subject to prolonged heat lose all semblance to the material when new, all that remains seem to be the impurities of the original. I have met this condition in new castings that have been cast from the end of a melt and have included the dross, and also in grates from central heating boilers.

He might stand a chance with oxy-acetylene fusion welding by puddling the weld with the filler rod. Do not attempt bronze welding as it will not tin as the burnt metals and non-ferrous metals are 'short' when hot.

Regarding sand cast iron, the majority of castings are cast in sand, and it is the inclusion of impurities that are not weldable, not the casting. Two identical castings from the same source will show this - one will weld quite well, the other not at all.

May I say that I am not a metallurgist, but have been welding since I was seventeen and am now 72 years of age. For the greater part of my working life I was a self-employed blacksmith-welder.

From D. T. Bartram, Caernarfon, Gwynedd

I refer to the request for assistance with cast iron welding by David Pettengell in M.E.W. No. 48.

I have successfully welded cast iron on several occasions using the oxy-acetylene process which gives a weld deposit of identical nature to the parent metal. This process was always recommended by my welding tutors as being the best method for repair of cast iron.

Welding rods of cast iron are available from British Oxygen Co., as is the cast iron welding flux, although I have also used bronze welding flux for this purpose when the cast iron flux was not available. The broken casting should be well cleaned to remove rust and corrosion products from the area to be welded. The joint edges should be ground to form a vee to allow proper penetration by the welding flame. The parts must be held in proper alignment, but not clamped so rigidly that expansion and contraction will produce excessive stresses and result in further cracking. Preheating is required to minimise stresses and prevent rapid cooling which will cause hard, brittle welds. Apply flux to the joint and heat to welding temperature. The welding rod is heated and dipped into the flux to transfer more flux to the joint and keep the rod clean as the weld proceeds.

Cast iron melts in a different manner to steel, and bright star-like spots may be seen on the weld pool surface showing that the temperature is correct. The welding rod is added to the pool with a puddling or stirring action.

The casting should be allowed to cool as slowly as possible to minimise contraction stresses and formation of hard material. Covering with a thick layer of ashes allows slow cooling. I have also reheated smaller items in the Rayburn fire to red heat and allowed them to cool in a bucket of ashes.

Preheating may be carried out with the welding torch for small jobs or a large propane torch or charcoal fire for larger items. Provided that the heating and cooling have been adequately controlled, the weld deposit should be a grey cast iron which is machineable. It is likely that the joint face on the manifold will require skimming after welding.

The Welding Department in the local Technical College may be able to help. There are also welding companies who specialise in the repair of castings by welding and also by mechanical 'stitching'.

Andy Nichols of Chelmsford also enquires about shield gases for MIG welding. Pure argon is essential for welding aluminium, but is considerably more expensive than the argon mixtures normally used with steel. These mixtures have been developed to give good weld profiles on mild and stainless steels. If a universal shield gas is really necessary, pure argon would be the best to try for all three metals.

I hope that these comments will be of use to your readers.

As always, readers of M.E.W. have rushed to help someone in trouble. The above represent a sample of the replies received and which have been passed to David Pettengell.

In addition, John Nicholls of Uxbridge recommended the services of Angell & Williams (Peckham) Ltd, quoting an interesting article by E. G. Donaldson of The International Meehanite Metal Co., which appeared in the journal *Maintenance Engineering* back in February 1975.

Gerry Collins of Brighton drew our attention to an article by Dick Butcher, published in *Australian Model Engineering* (Nov/Dec 1997) entitled *Locomotive cylinder repairs on the NSWGR.*

Offers of help and information have also been received from Michael Hill of Warwick, D. W.Davis of Reading and Steve Vincent of Axbridge, Somerset. Thanks to one and all.

Drive belting suitable for the Unimat

From Dr.L.G. Wood, Horley, Surrey

I have been an avid reader of your journal since its inception and have taken special interest in the articles by Bob Loader, the latter by reason of the fact that I own a Unimat 3 lathe.

After experiencing drive belt breakages on a number occasions, I visited Messrs. Mountains at Hays Bridge Business Centre, Brickhouse Lane, South Godstone, Surrey RH9 8JW (Tel. 01342 844088 Fax. 01342 844385)

They supplied me with a small quantity of Polycord an extruded circular cross section polyurethane cord, available in 1 to 12mm cross section versions in 1mm increments. A suitable length of the 5mm version was cut and the ends joined with a hot knife, making a belt which has served me well since July 1995. (I was advised to allow the bond to develop for 24 hrs. before using the belt).

I am sure that Unimat users in the UK will find the above source of belts more convenient than the Campbell Tools Co. in the USA.

Needless to say my only connection with Messrs. Mountains is as a very satisfied customer.

Little John lathes and motors

From Colin King, Brough East Yorkshire

I have been donated two 'LJ's' in bits and several motors. The latter are all Cromptons of various ages and I want to use one for metal polishing, but the spindle rotation needs reversing. Do I have to use a reversing switch or can it be simply rewired?

I used to see 'LJ's' at school and at a friend's grandfathers and all did not use the original forward/stop/reverse switch in the cap. I have an original switch and an external stand-mounted switch that I can fit, but would like to keep the lathe as original as possible (I was, after all, taught to respect my elders). Is there something I should know about the original switch? Does it break easily? Is it dangerous?

Drain cocks—LBSC's method

From David Turner, Derby

The photo of the drain cock in the article on taper turning (M.E.W. 46) reminded me of a description by LBSC (may he rest in peace) of drain cock production in a 1930s Model Engineer. His method was to set the top slide to the angle required, machine a taper on a piece of silver steel from which he made a 'D' bit reamer to shape the hole in the cock and then machine the moving part of the cock at the same setting. He then machined just the taper on a supply of further cock plugs for use in the future. They were put away safely with the reamer until they were required.

Comments on two other items in the same issue:-

Of course paint brush cleaning white spirit should be re-used, but remember that the varnish component of the paint will not sink to the bottom with the pigment. always give the brushes a final rinse in clean spirit (which can then go to make up the losses from the dirty bottle).

Rex Galway asks why knurls always fit on the surface being knurled. They don't with me! On the second rotation of the work, the engagement is sometimes half a pitch out. When this happens, I reduce the diameter by about five thou., say 0.1mm. The aim is, of course, to reduce the circumference by half the pitch of the knurl.

TECHNIQUES ON SHOW AT THE BRITISH HOROLOGICAL INSTITUTE

STAN BRAY

went along to the 1997 Open Weekend at Upton Hall, and discovered lots to interest the home workshop enthusiast

The annual Open Days at the British Horological Institute are always eagerly anticipated, 1997 was no exception.

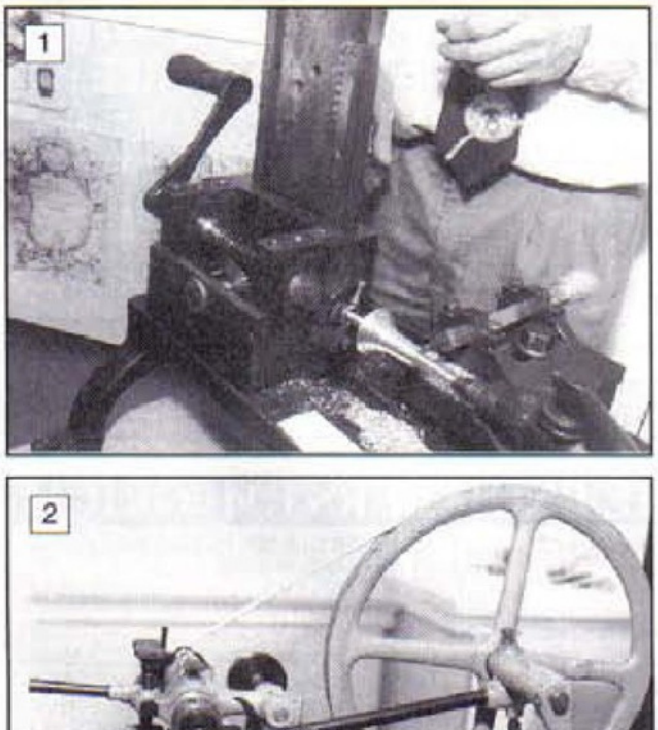
The theme this year was watch and clock making of bygone days. A great deal of old, primitive and simple machinery was on display and being demonstrated. This did not mean that modern equipment was forgotten this too was also on display with demonstrations., including a number of ultrasonic cleaning machines. In all there were some ten or so areas, each specialising in a particular aspect of horology. There was a continuous programme of lectures on various aspects of the subject. It is really quite fascinating to go along and see clock and watch repairing from very early times, right up to modern day electronic items.

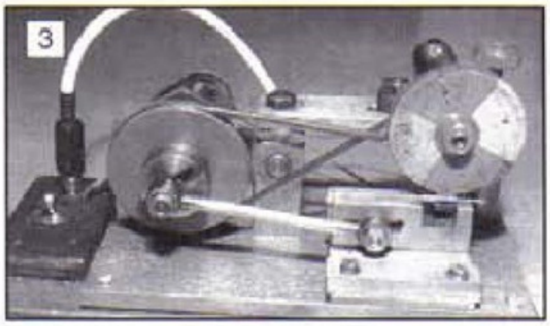
Surprisingly this year was the large number of model engineers who I recognised or who recognised me. I learnt that many had started making clocks after having spent years constructing other types of models, several of these were eagerly watching the many demonstrations of various techniques and garnering as much information as possible on how to do things.

There were hundreds of clocks on display and for 1997 particular attention was given to bracket and tower clocks. There were numerous trade stands and a Watch and Clock Fair which was of more than a passing interest, here was a chance to buy, sell or swap equipment and to get some of those odd little items that are difficult to acquire.

The magnificent house owned by the Institute, is itself worth a tour; the entrance hall with its lovely staircase and landings on which are displayed many long case clocks makes an imposing start to any visit.

I spent much longer at the event than I originally anticipated, a measure of the enjoyment and interest which it aroused.





1: An early fusee turning machine. Rotated by hand, the tool is also pressed into the work by hand, relying on the expertise of the operator to machine to the correct depth.

2: A 19th century Swiss wheel cutting engine.

3: A simple pinion polishing machine built by John Lynam, demonstrating how equipment for clock making need not be complicated or expensive.

4: A wheel cutting engine. Built by Arthur McDonald and designed by George E. Lloyd-Jones.

5: The magnificent stairway and entrance hall at Upton Hall.