

No.122

FEBRUARY 2007

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

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"For the discerning engineer"

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Feed 0,085 and 0,16 mm

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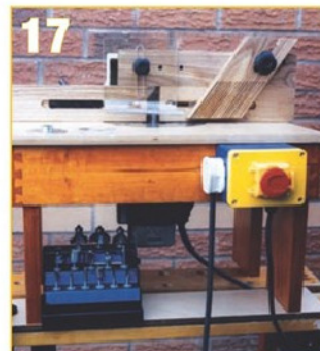
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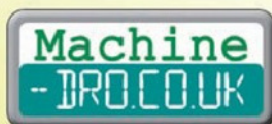
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On the Cover

A Myford Super 7 (and operator) which needs no renovation, unlike that described by Mike Thurgood starting on page 38

See page 57 for our special subscription offer!



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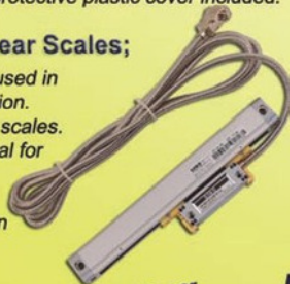
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Vertical Z-axis	280 mm
Transverse Y-axis	150 mm
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Spindle speed r.p.m.	180 - 3000
Swivel range both sides	90°
Tool holder	MT 2Optional MT3 or SK 30
Drilling stroke	40 mm
Work bench	700 x 180 mm

Wabeco produce precision made machines by rigorous quality control and accuracy testing. All lathes and mills are backed by an extensive range of tools and accessories. Wabeco machines are quality rather than far eastern quantity.

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OVERALL HEIGHT 1 1/4"
CENTRE HEIGHT 1 1/4"

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SET OF 5 INDEXABLE LATHE TOOLS 10MM INCLUDING A BORING BAR (8MM)

CODE
XC68

PRICE
£24.95



SET OF FIVE INDEXABLE LATHE TOOLS



CODE	SHANK	PRICE
XC72	1/4	£19.95
XC73	5/16	£19.95
XC74	3/8	£19.95
XC75	1/2	£26.95
XC76	5 X SPARE INSERTS 1/4	£10.00
XC77	5 X SPARE INSERTS 5/16	£10.00
XC78	5 X SPARE INSERTS 3/8	£10.00
XC79	5 X SPARE INSERTS 1/2	£10.00

SET OF 4 INDEXABLE BORING TOOLS SHANK SIZES 8, 10, 12 & 16MM

CODE
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PRICE
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HSS BORING & THREADING SETS INC BORING TOOL & MET/IMP INT THREADING TOOLS



CODE	SIZE	PRICE
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XC71	12MM DIA/16MM SQ HOLDER	£26.95

PARTING TOOL WITH HSS BLADE



CODE	SHANK	PRICE
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XC81	3/4 HIGH 1/2 BLADE	£19.95 £15.00

SET OF 3 8MM TOOLHOLDERS WITH HSS BITS STRAIGHT LH & RH

CODE
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PRICE
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SETS OF 7 INDEXABLE LATHE TOOLS COMPLETE WITH 5 DIFFERENT TURNING TOOLS, A PARTING TOOL & THREADING TOOL



CODE	SHANK	PRICE
XC91	6MM HIGH	£32.00 £29.00
XC92	8MM HIGH	£35.00 £31.00
XC93	10MM HIGH	£39.95 £37.00
XC94	SET 7 INSERTS 6MM	£14.00 £12.00
XC95	SET 7 INSERT 8MM	£14.00 £12.00
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COMPLETE WITH 6 DIFFERENT TURNING TOOLS & A THREADING TOOL



CODE	PRICE
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XC98	SET 7 INSERTS £14.00 £12.00



ALL PRICES INCLUDE VAT & CARRIAGE (UK MAINLAND)

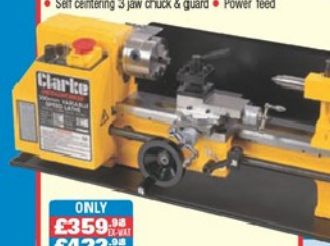
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- Power feed screw cutting facility
- Forward/reverse lathe operation
- Clutch for independent mill/drill operation
- Shown with optional floor stand & tray

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Complete with bolt mountings & feet anchor holes

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20pc Best Budget Buy, 33pc Recommended: Practical Classics

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CB8205	5 Dr chest	38kg	£99.98	£105.73
CB8209	9 Dr chest	38kg	£99.98	£105.73
CB8210	10 Dr chest	30kg	£129.98	£152.73
CB8212	3 Dr cab	43kg	£134.99	£158.61
CB8213	3 Dr cab	43kg	£159.98	£187.98
3 CB8215	5 Dr cab	43kg	£169.98	£198.73
5 CB8217	7 Dr cab	43kg	£199.98	£224.98

MODEL	DESC.	DR. LOAD	EX VAT	INC VAT
2 CB8203	3 Dr step up	38kg	£56.99	£66.99
1 CB8204	4 Dr chest	38kg	£69.98	£82.23
4 CB8206	6 Dr chest	38kg	£96.99	£102.21
CB8205	5 Dr chest	38kg	£99.98	£105.73
CB8209	9 Dr chest	38kg	£99.98	£105.73
CB8210	10 Dr chest	30kg	£129.98	£152.73
CB8212	3 Dr cab	43kg	£134.99	£158.61
CB8213	3 Dr cab	43kg	£159.98	£187.98
3 CB8215	5 Dr cab	43kg	£169.98	£198.73
5 CB8217	7 Dr cab	43kg	£199.98	£224.98

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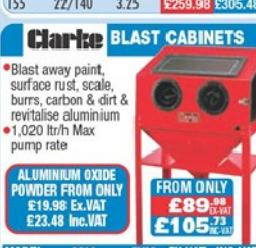
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- Low amp operation - ideal for TIG welding, auto bodywork and thin mild/ stainless steel

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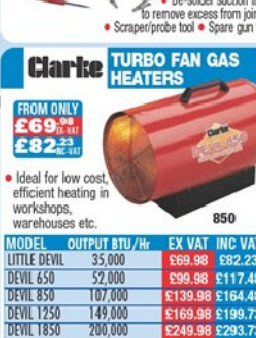
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- He solder suction tool to remove excess from joints
- Scraper/probe tool
- Spare gun tip

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- Ideal for low cost, efficient heating in workshops, warehouses etc.

MODEL	OUTPUT BTU/hr	EX VAT	INC VAT
LITTLE DEVIL	35,000	£69.98	£82.23
DEVIL 650	52,000	£99.98	£117.48
DEVIL 850	107,000	£139.98	£164.48
DEVIL 1250	149,000	£169.98	£199.73
DEVIL 1850	200,000	£249.98	£293.73

Clarke DRILL PRESSES



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- Depth gauge
- Chuck guards

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How (not) to paint a locomotive • Vine • £23.00

The other books we offer on painting models are good, but apart from being more comprehensive as it is considerably larger, this book has one huge advantage for the model engineer - it concerns itself solely with the painting of large engineered (metal) models. In fact the whole book is based around the author's experiences in obtaining the superb finish on his award-winning 7 1/4" gauge LNER B1 class locomotive Bongo; anyone who has seen this model will appreciate the quality of the painting (as well as the engineering), and Bongo is no showcase model, but is steamed on a regular basis. So here you have excellent tuition on not just the painting of the model, the spray guns, paints and techniques to us, but how to build a spray booth, line models out, apply transfers and a fair whack more. This really is well worth putting on your bookshelf. Loads of all-colour illustrations. 168 page hardback.



Fun with Engines and Other Things

• Kouhoup • £14.30

This is the first in a projected series of books containing models designs by the late great Rudi Kouhoup. Here you get the full drawings for a Three-cylinder Radial Engine, a Piston Valve Steam Engine, a Model vertical Steam Engine, Building a Small Steam Engine, a Compressed-Air V-4 Engine and a Revolutionary War Cannon. Anything Rudi designed or wrote was good, but it must be stressed that you only get full drawings here, and a photograph of each model - NO building instructions, so you have to use the old grey matter a bit. 90 spiral bound pages. Card covers.



Metalworking - Book Five • £36.30

Another great series of articles culled from issues of *Projects in Metal* which appeared in 1996 & 1997. The problem for me with this series of books, and the *Projects* ones, is giving indications of contents - the problem for you is not buying all of them, once you have bought one (and we ain't joking!) Here you have 12 articles on 'Techniques', 8 on 'Lathe Accessories', 7 on 'Milling/Drilling Accessories', 21 on 'Shop Improvement Projects' (meaning tools rather than the actual workshop) and 4 'Hobby Projects' (including an Atkinson Cycle engine. All in an extremely well produced, large format hardbound book of 228 pages; good value - or what?



La Tour de 300 mètres • Lemoine • £74.79

When it was completed in 1889, the Eiffel Tower was the highest structure in the world, measuring 300 metres (984 feet), and is now one of the world's most famous structures, having become practically synonymous with Paris itself and receiving more than six million visitors annually. This reprint (at 14.8" x 20.9" and over 4 kgs the biggest book we have ever sold) explores the design and construction of this remarkable building; originally published in 1900 as a large folio by Gustave Eiffel himself in a limited edition of 500 copies, the original was never sold on the market—it was exclusively given and donated by Eiffel. Featuring 53 double-page plates of 4,300 technical drawings explaining the design, including the various lifts, as well as 33 photographs of the construction, the book reveals the complex and fascinating process of building the Tower to life. The drawings will appeal to engineers wishing to model Eiffel's masterpiece (in one-tenth scale just 100' feet high!) but everyone will appreciate this very rare and special book about Paris's glorious mascot. Text in English, German, French, Spanish, Italian, Portuguese, Dutch & Japanese. Hardbound.



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David Curwen's name is best known as a major designer of miniature railway locomotives, but he had served his apprenticeship in the garage trade in the 1930s, then maintained generating plant and steam cars. Along with the late Tom Rolt, he was the only other full-time employee of the Talylln Railway when it first emerged in preserved form although, by then, he had already built some 10 1/4" gauge miniature railway locomotives and subsequently went on to design a whole range of steam or IC powered locomotives up to 15" gauge, including all of the motive power of the present Fairbourne Railway. Whilst not all embracing, this autobiography is written in an easy to read and humorous style, which reflects the man well and, given his place in the post-war miniature railway world, we are delighted he has penned it. 56 A4 format pages, full of B & W and colour illustrations. Paperback.

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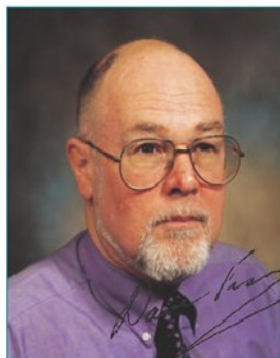
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In the Workshop

Winter work on the Bonneville has been proceeding. After dismantling the top half of the engine, I took the barrels and oversize pistons to Alex Fairbairn, who I came to meet a year or two ago after he had written to *Scribe a Line*. Alex retired some years ago from a lifetime spent in motor engineering, and has a compact workshop in which the principal machine is a much modified Drummond lathe. He also keeps a BUMA cylinder boring machine tucked away for occasional use. In the past, when requiring a rebore, I have simply delivered the engine parts to the company concerned and not witnessed the operation. This was a chance to see such a machine in action.

If one decides to undertake an operation such as this on either a mill or lathe, then much care has to be taken to ensure that the cylinder and machine axes are coincident. The BUMA takes care of details such as this. It even includes a diamond disc on the rear face of one of the drive pulleys and a set of location jigs for cutter sharpening. In addition a supplied setting jig and diametrically calibrated micrometer ensure that the machine can be preset to accurately bore the required diameter. Alex had set up a fine feed, and the result was an excellent surface finish needing no honing.

Work then moved to rebuilding the wheels, as the chrome rims had seen better days, and it was felt that the brake discs would benefit from a light skim. At the time of writing, the front has been completed. The disc was held centrally in a three jaw chuck (internal jaws). Added security was given by a length of M10 studding which passed through the spindle, effectively clamping the disc back against the chuck. It was then possible to machine both faces of the disc at one setting, using a modified tool to reach round to the rear face. The tensioned studding ensured that the work did not "walk"



The BUMA boring machine in action.

ensured that the work did not "walk"

ON THE EDITOR'S BENCH

forwards, due to tool pressure when cutting the rear face.

Before dismantling the spokes, I first photographed then sketched the pattern of spoke lacing. It's another of those things that starts off looking complicated and then the penny drops that it is just a recurring sequence of four. I also built a couple of jigs, generally to the teachings of the "Radco" book. The first is set up using the existing wheel before dismantling, to ensure that the offset is maintained with reasonable concentricity. The new rim is then laced up using this jig. The second is basically a dummy fork to hold the axle so that the newly built wheel can be rotated, and the spokes progressively tensioned whilst checking both concentricity and swash.

Corrections

Two sets of problems arose with the Engineering Plans handbook, republished recently and sold under the **Model Engineers' Workshop** banner between issues 120 and 121, with details of sets of drawings for many of the designs published in **Model Engineer** over the years.

The original intention was to release this for sale only through newtrade outlets. However it was also sent out to all subscribers. To clear up any misunderstanding, I am happy to confirm that the plans special has been supplied free of charge to MEW subscribers, and we hope that many readers will find the information on plans availability helpful, and that it will form the basis of a wide variety of future projects.

Details of a couple of castings suppliers were not updated from the previous version. Unfortunately Norman Spink of Chesterfield died about two years ago, and his business was taken on by:

Blackgates Engineering, Unit 1 Victory Court, Flagship Square, Shawcross Business Park, Dewsbury, West Yorkshire, WF12 7T H www.blackgates.co.uk
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Also **Dave Goodwin** of Rishton, Blackburn has retired. His 2 1/2in. gauge locomotive castings are now available from the National 2 1/2" Gauge Association

The Christmas spirit was clearly flowing a few days too early for issue 121. Page 33 had been set aside to announce the postponement of the **Model Engineer** exhibition, but somehow, an earlier index page found its way in.

Remap

Before Christmas, one of the greetings cards had come in from Remap. Remap,

along with Remap - Scotland and Remap - Isle of Man, provides specialised technical equipment for disabled people, operating through a network of local panels, each panel being composed of health professionals and volunteer technical specialists. The cover picture on the card showed a loco style engine, masterminded by 92 year young MEW reader Frank Langfield to fit in front of a wheel chair. It was produced for a Bristol charity which provides play facilities for disabled children and includes sound effects - whistle, steam and track noises.

Most charitable organisations publicise how many pence from every pound collected actually goes to good causes. Because so much of the value of Remap's work is undertaken by volunteers, they really stand this sort of financial analysis on its head. For every one pound of cash gifted, they reckon to deliver £15 worth of custom made equipment. With Gift Aid this rises to £19.00.

If you would like to donate or otherwise assist, then the contact details are:

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Remap - Isle of Man, Mr D Leoidsson, Whitburn, Shore Road, Castletown, IM9 1BF tel. 01624 825 903

New website

Peter Rawlinson, known to many readers as a regular contributor to MEW, has been in touch to let me know that his new website is up and running at www.model-engineering-books.co.uk

Dates for Your Diary

23 - 25 February, Model Rail Scotland, SECC, Glasgow.

10 - 11 March, Scottish Motorcycle Show, Ingliston, Edinburgh.

14 - 15 April, Large Scale Model Rail, Warwickshire Exhibition Centre, Nr Leamington Spa.

4 - 5 May, pre 65 Trial, Kinlochleven. (Precedes Scottish Six Days Trial)

11 - 13 May, Model Engineering and Modelling Exhibition, Harrogate.

17 - 19 August, Bristol Model Engineering Exhibition, Thornbury Leisure Centre, Bristol.

12 - 16 October, Midlands Model Engineering Exhibition, Warwickshire Exhibition Centre.

LARGE REAR TOOL POST

Manufacture (large post)

Body (1)

Mount the

Harold Hall describes the construction of this Hemingway kit

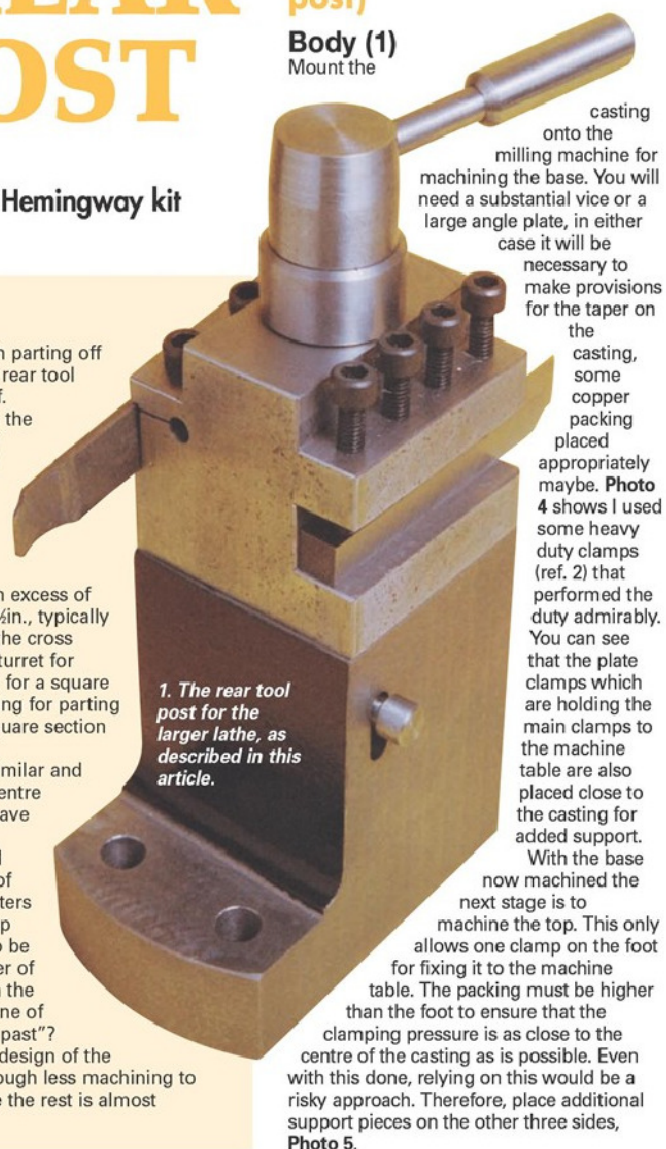
Background

Any home workshop owner who has attempted to cope with parting off with the tool mounted on the top slide, and then obtained a rear tool post, will fully appreciate the benefit of this when parting off. Invariably, the traumas that were present with working from the top slide are very largely eliminated with the tool in the rear tool post. The tool post featured in this article is provided in kit form from Hemingway Kits (ref. 1) and comprises, the main casting, all other raw materials, including hardware. Very detailed drawings are also included, from which just the 3-D General Arrangement and Parts List are reproduced here.

The tool post, **Photo 1**, is for lathes with a centre height in excess of 3½in. The maximum centre height above the cross slide is 3½in., typically therefore a centre height of 5½in. maximum if the height of the cross slide above the lathe's bed is 2in. The design has a rotating turret for fitting two tools, one a traditional parting off blade the other for a square section tool of your choice. If you are now using tipped tooling for parting off then it may be a question of making provision for two square section tools.

Hemingway also provide a smaller toolpost that is very similar and ideally suited for a Myford or any other lathe around 3½in. centre height or a little less. Having made one for my own lathe I have modified the turret to take two square section tools as suggested above. **Photo 2** shows it being used with a tipped parting off tool for larger diameters whilst in the other side of the turret, **Photo 3**, I have a tipped parting off tool for diameters up to about 10mm. The smaller tool is ideal for the workshop owner who often works with smaller diameters and can also be used for machining grooves, tips being available in a number of widths. Actually, **photograph 2** shows the tip more clearly in the rear position. Now having both parting tools available it is one of those cases of "how did I manage without the facility in the past"?

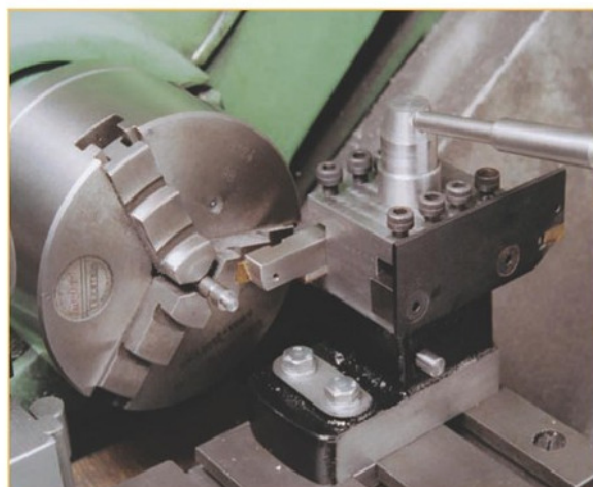
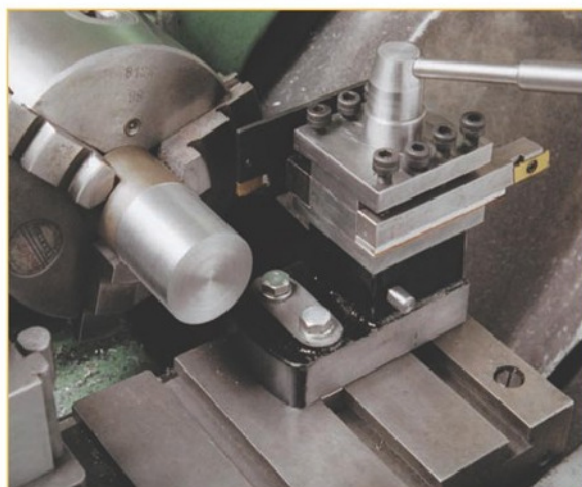
This article illustrates the larger post being made but the design of the smaller follows very closely to that of the larger. There is though less machining to be carried out on the main casting for the smaller, otherwise the rest is almost identical.



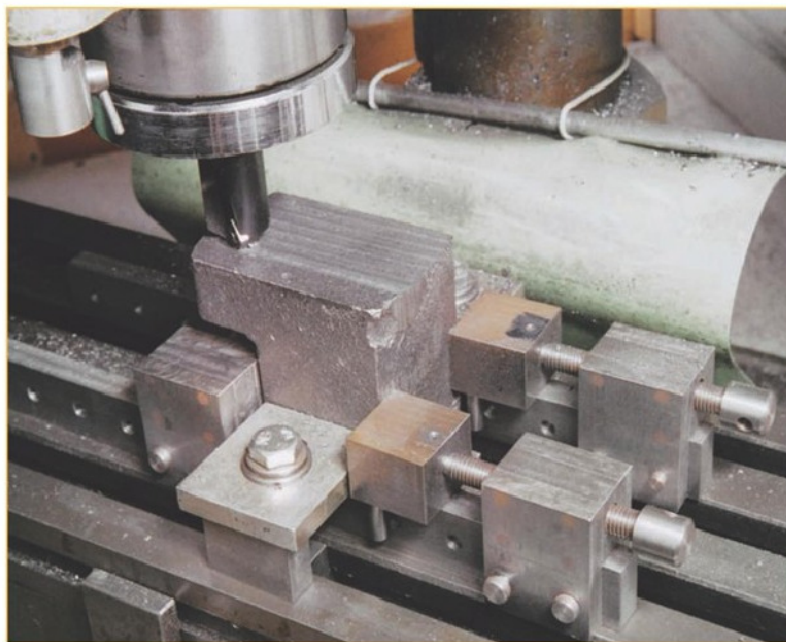
1. The rear tool post for the larger lathe, as described in this article.

casting onto the milling machine for machining the base. You will need a substantial vice or a large angle plate, in either case it will be necessary to make provisions for the taper on the casting, some copper packing placed appropriately maybe. **Photo 4** shows I used some heavy duty clamps (ref. 2) that performed the duty admirably. You can see that the plate clamps which are holding the main clamps to the machine table are also placed close to the casting for added support.

With the base now machined the next stage is to machine the top. This only allows one clamp on the foot for fixing it to the machine table. The packing must be higher than the foot to ensure that the clamping pressure is as close to the centre of the casting as is possible. Even with this done, relying on this would be a risky approach. Therefore, place additional support pieces on the other three sides, **Photo 5**.



2. and 3. The rear tool post for a smaller (3½in.) lathe fitted with two sizes of tipped parting off tools. The smaller suitable for diameters up to 10 mm.



4. Machining the first face, the base.

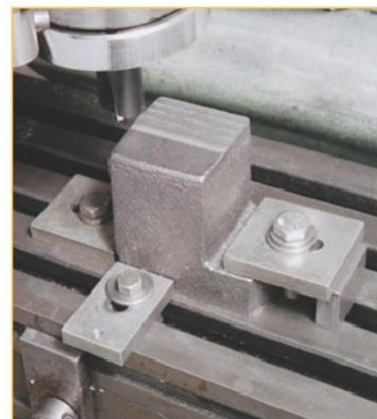
Now, with two parallel machined surfaces, holding the casting becomes somewhat more secure, machine the sides, **Photo 6** and the rear **Photo 7**. Leaving them with a little, say 15 thou, for final machining later. The front face is eventually dressed with a file and painted, you could of course machine it if you so wish.

Next stage is to bore the casting as per drawing. Mark the top at its centre and centre punch. Mount the casting in the four jaw and aided by a centre finder set the centre punch to run true. If you are not conversant with this simple device its internal centre at the tailstock end is sprung loaded to keep it in place at the workpiece where it is set to run true. **Sk. 1** shows the basic construction. If precision is not required, as in this case, then just place a tool close to the centre finder near to the workpiece and adjust the four jaw until the finder appears to remain stationary. Where a more accurate result is

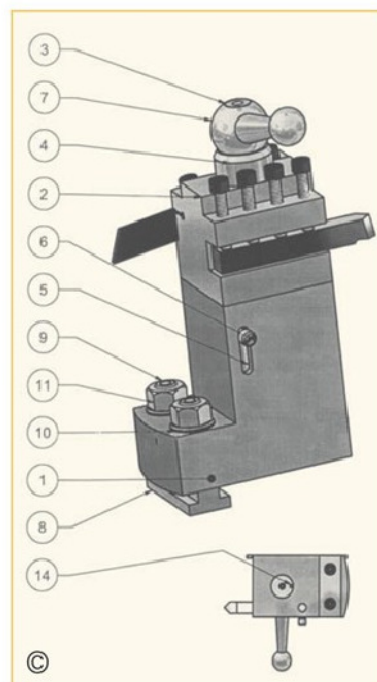
required place a DTI on the finder until there is no deflection of the indicator as the item is rotated.

You will see from **Photo 8** that I added a piece of packing between one jaw and the casting, this to reduce the effect of it being out of balance. Actually, I increased the volume of this but still ran the lathe on the slow side as balance was still not that good.

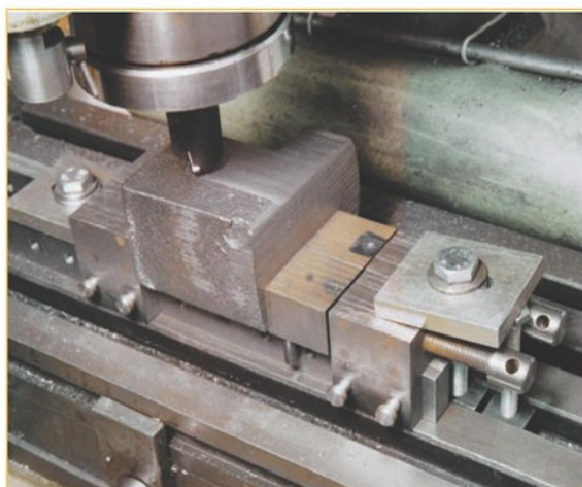
Very lightly skim the top surface to ensure it is running true and drill completely through. The drawing calls for a reamed hole but if you do not have a reamer a drilled hole will be perfectly adequate. Now reduce the height of the casting to suit the centre height of the lathe on which it is to be used and bore 1in. diameter by $\frac{1}{16}$ in. deep. Remove from the chuck and refit, this time holding it on the top of the casting and bore the $\frac{3}{4}$ in. diameter by $\frac{1}{16}$ in. deep bore followed by machining the front of the foot as shown in **Photo 9**. Once again you will need some



5. Machining the top face.



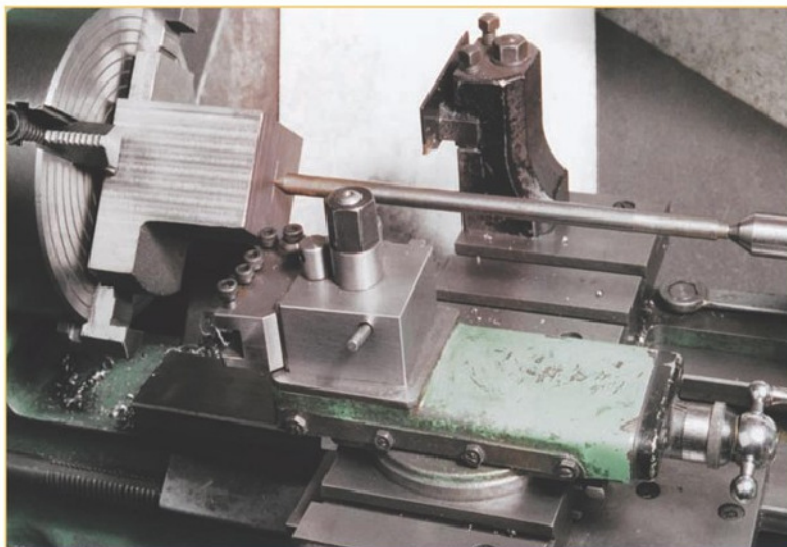
additional weight on the hidden side to establish a nominal balance. Do ensure the chuck is very well tightened, you do not



6. With the top and bottom faces machined holding the casting becomes more secure.



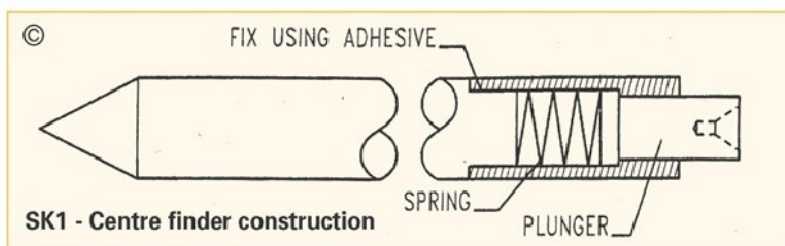
7. Machining the rear of the casting.



8. Positioning the casting using a centre finder.



9. The front of the casting's foot can, if you wish, be machined at this stage.



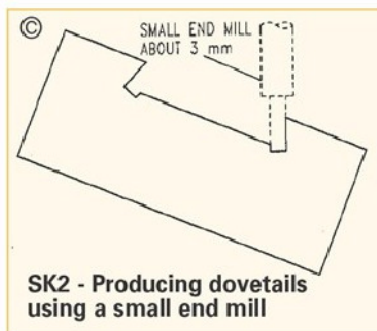
want the packing to fly out once you start the lathe!

Turret (2)

Mount the piece of square steel in the four jaw and set to run approximately true, face the first end. Remove, reverse, refit and start turning the 1in. spigot. As the diameter reduces you will be left with a flat on each side that will get progressively narrower. By observing the width of these you can make small adjustments to the chuck to get it running sufficiently true. Turn until the spigot is a close running fit in the bore on the top of the body. Again the drawings call for a reamed hole but a drilled hole will suffice providing you have made the spigot a fit as mentioned.

Body (1)

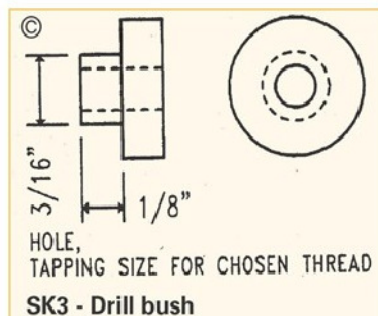
Place a long stud through the body and turret with a nut in the bore at the bottom of the body and one on top of the turret.



Line up the turret with the rough machined body and clamp the assembly together using the nut on top. Having left an extension to the stud at the bottom, use this to clamp the assembly to an angle plate mounted on the milling machine tables, parallels under the turret will ensure it is correctly positioned.

Lower the milling cutter to within a thou or two of the turret and finish machine the body at this level, **Photo 10**. Repeat this for the other side and the rear of the body. Keep the assembly tightly clamped only loosening the nut on the rear of the angle plate to enable it to be turned.

Now set the body up on the table and mill the top surface of the foot as shown in **Photo 11**. I have a set of Little Hogger tipped end mills (obtainable from Chronos ref. 3) that I have converted to 3 Morse taper shanks. The reach of these was only just sufficient hence the stud and nut being set in the recess at the top of the body. If you are using an end mill in a chuck you are unlikely to be able to use this set up. In



this case, mount the body on its back and step the end mill down the foot to achieve the required machined surface.

The turned items

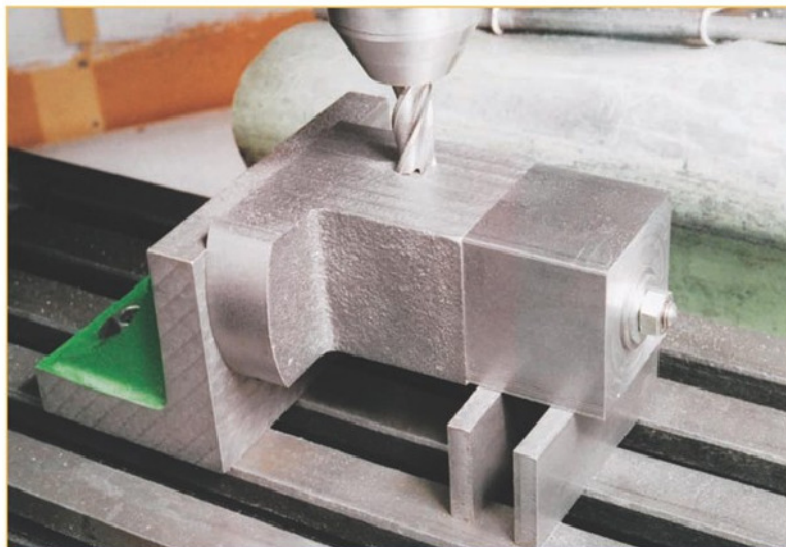
These are all straight forward, ball handle excepted, and need no comments except to say, I chickened out of making the ball handle as photograph 1 shows.

Body

The turret is positioned on the body by means of a spring loaded plunger moving in a reamed hole in the body. Without going into detail but the size of the screw at the bottom of the reamed hole is not ideal for easy manufacture and a larger, say 3/4in. or M10 is preferable. The grub screw can be made by cutting a short length from a screw and sawing a screw driver slot. My explanation assumes you take this approach. However, Hemingway are aware of the problem and may have changed this by the time this gets published.

Mark the position of the hole on the base of the body and after assembling with the turret mount on the Mill drill using an angle plate as shown in **Photo 12**. Using a drill suitable for ultimately reaming the hole, drill through the casting and into the turret, do not ream at this stage. Remove assembly, loosen the turret, reposition this and tighten then return to the mill drill and using the already drilled hole in the body, drill once more into the turret. Dismantle and ream the hole in the body. Unfortunately, the hole in the turret is too shallow for reaming unless you have a machine reamer, if not then carefully open to 3/4in. with a drill.

Now mount the body down on the milling machine table using a square off the table edge and the top face of the body to ensure it is positioned accurately. Place a close fitting piece of 3/4in. material in the hole just drilled and cover the projecting portion with a single layer of thin paper, close fitting on the bar. A piece of adhesive



10. Matching the base to the width of the turret.

across the join on the other side will keep it in place. With a $\frac{3}{16}$ in. end mill running traverse this until it just touches the paper, the rotating cutter may even run the paper off the bar. Raise the cutter and traverse by half the cutter diameter plus half the bar diameter, the cutter will now be central to the hole in the body. Mill the slot as per drawing, **Photo 13**.

Turret

The next stage is to machine the groove for the parting off blade. The drawing calls for the edges for this to be undercut at an angle and the smaller tool post suggests making a mini dovetail cutter for this. Wishing to avoid this I used a very small diameter end mill ($\frac{1}{16}$ in.) to produce a shape as shown in **Sk. 2**. This is not difficult but is not quite as straight forward as may first be thought.

First drill and tap a hole in the centre of where the $\frac{1}{16}$ in. slot for square tooling is to be, M6/0BA suggested $\frac{3}{16}$ in. deep. Now take a piece of rectangular bar, say



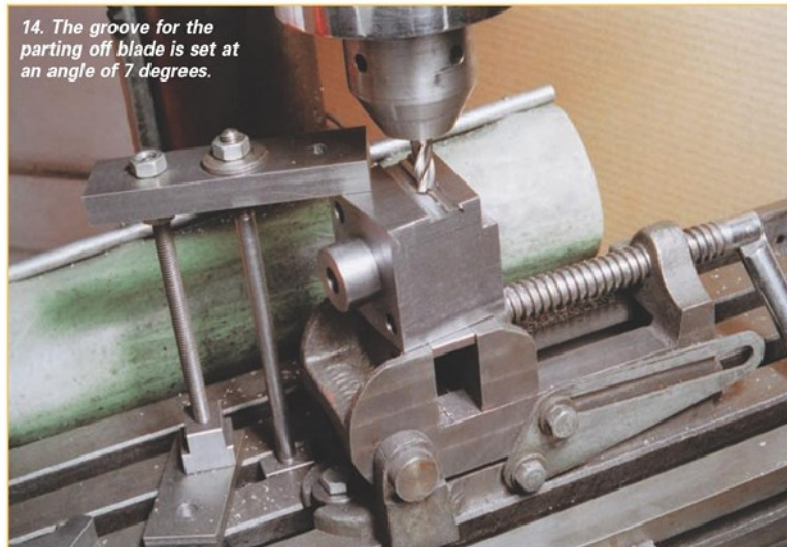
12. Drilling base and turret for the locating plunger.



11. Surfacing the top of the foot for the fixing nuts.



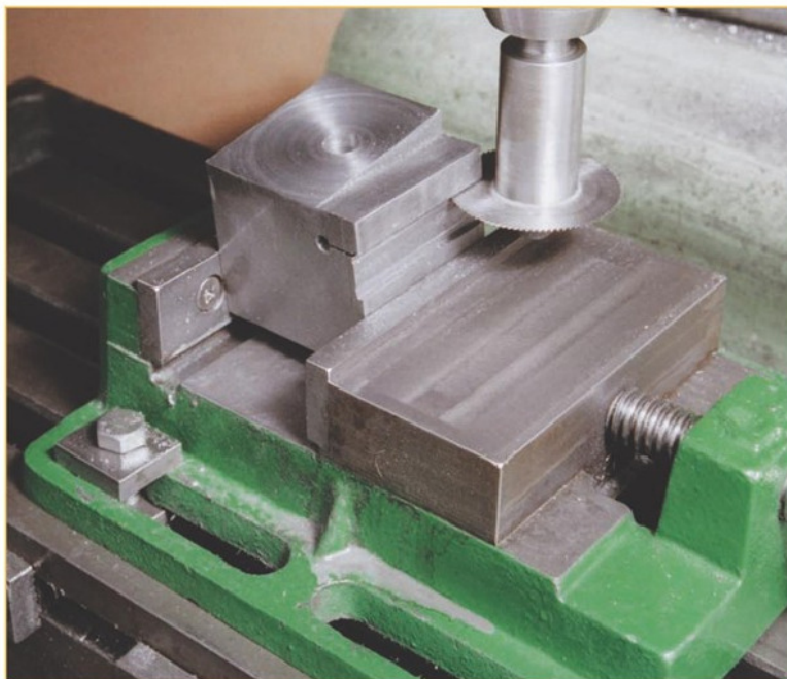
13. Milling the slot for the locating plunger handle.



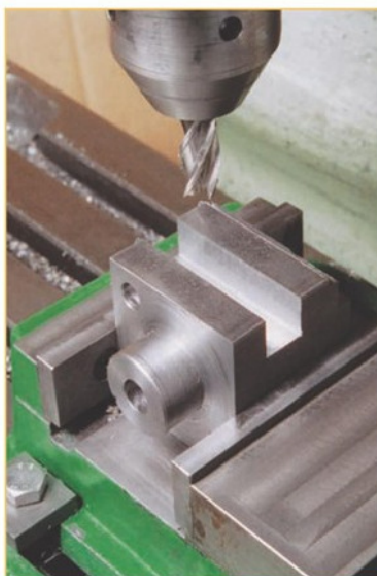
14. The groove for the parting off blade is set at an angle of 7 degrees.



15. Creating the dovetail edges to take the parting off blade.



16. Slitting the turret.



17. Making the groove for the square section tooling.

$\frac{1}{8}$ in. x $\frac{1}{8}$ in. x 3in. long, though dimensions are far from important, and drill this in the centre, clearance for the size of hole just tapped. Fix the bar to the turret and at an angle of seven degrees. Use this to secure the part in a tilting vice, (set level), and mill the $\frac{1}{8}$ in. wide slot as illustrated in **Photo 14**. The bar in the vice is unlikely be sufficiently secure for this operation so add a clamp as in the photograph. You may ask why not just set the vice at an angle of seven degrees on the machine table, the reason is that this would not work for the next operation.

Raise the vice to an angle of eight degrees so as to produce the dovetail shape required using a very small end mill, **Photo 15**. It is necessary to turn the turret, with bar, round in the vice to machine the angle on the second side. Having used the vice in this way the edges of the initial groove were made parallel to the vice pivot and therefore remain parallel to the worktable as the vice is raised to any angle.

As there is very little flexibility for gripping the blade when assembled it is essential that the groove just made is a

very close fit, almost a push fit, on the blade to be used.

After having drilled the hole, eventually on the slit still to be made, fix the turret in a normal milling vice at an angle of seven degrees and machine the top face then slit using a slitting saw, **Photo 16**. This may be an opportune moment to add a word of warning regarding using this form of slitting saw. It is easy to overlook that the saw is much larger in diameter than end mills normally used and should be used at a much lower speed. This is easily done as the saw will cut well, remarkably well actually. However, with the saw being thin, and therefore very little bulk, it will rapidly overheat, become blunt and the effect escalating to an extent that within a few seconds you have a totally irreparable cutter. I know from experience, more than once. Aim for a cutting speed of say 100 feet per min. or less. With a 3in. dia. saw this would give a speed of about 130rpm. Some mills do not have sufficiently slow speeds, hence the modifications by such as Brian Warner and our editor to achieve this. Even at a low speed, it will still cut the turret very easily. Finally for the turret, mill the slot for the square section tool, **Photo 17**, and drill and tap holes still to be made.

Assembly

Now generously chamfer all edges where appropriate and debur others. If you have not machined the front of the body, then file this to remove the worst of the casting's rough surface and give a coat of paint or two. Before final assembly there are two minor actions required. The drawings call for a pin in the base to prevent the centre bolt turning. I clamped the assembly up tight and drilled through the bolt and body and tapped this 4BA to take a long grub screw, easier to remove than a pin if the need arises.

The tapped hole for the plunger handle (6) must be central in the plunger (5). To do this make a small drill bush as per **Sk. 2** and place this in the $\frac{1}{8}$ in. slot in the body and drill tapping size for 4BA, easy!

Dismantle once more and remove any swarf created by the last operations. Generally, clean the parts and assemble for the final time and you have a very worthwhile addition to your lathe.



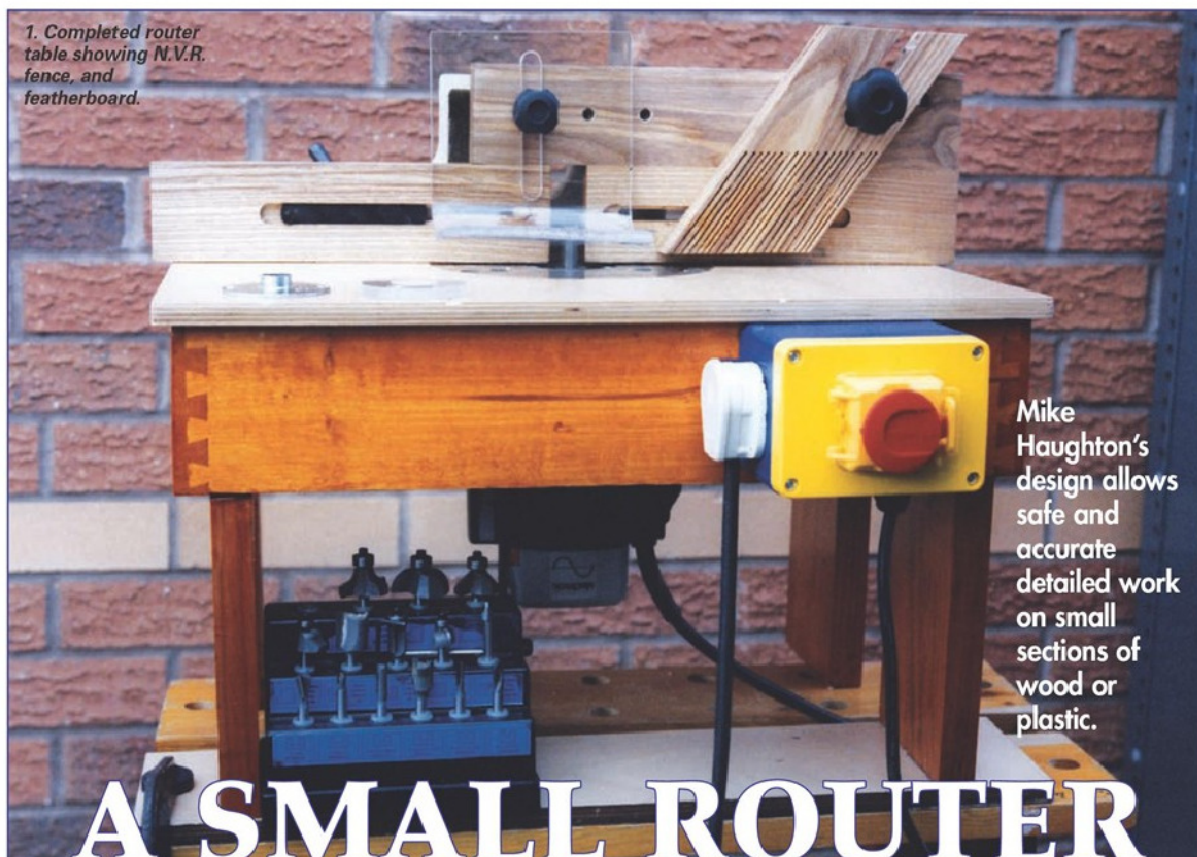
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1. **Hemingway Kits**. 126 Dunval Road, Bridgenorth, Shropshire, WV16 4LZ. Tel/Fax 01746 767739. E-mail info@hemingwaykits.com Website www. Hemingwaykits.com. Kit HK 1070 Rear Tool Post. Kit HK1071 Larger Rear Tool Post
2. **Drilling projects** (Sash clamps) Model Engineer' Workshop magazine, issue 98, page 16.
3. **Chronos Ltd**. Unit 14 Dukeminster Trading Estate, Church Street, Dunstable, Beds, LU5 4HU Tel. 01582 471900. Fax 01582 471920. E-mail sales@chronos.ltd.uk Website www.chronos.ltd.uk

Parts List

Item	Qty	Description	Supplied As
1	1	Body	Iron casting
2	1	Turret	BMS - 2" Square
3	1	Central Bolt	BMS - Ø $\frac{1}{2}$ "
4	1	Top Spacer	BMS - Ø1"
5	1	Plunger	Silver Steel - Ø $\frac{1}{2}$ "
6	1	Plunger	BMS - Ø $\frac{1}{2}$ "
7	1	Ball Handle	BMS - Ø1"
8	1	T Bar	BMS - $\frac{3}{4}$ " Square
9	2	T Stud	BMS - Ø $\frac{1}{2}$ "
10	2	Washer	BMS - Ø $\frac{1}{2}$ "
11	2	Nut - $\frac{1}{8}$ " or $\frac{3}{16}$ " BSF	Complete
14	1	Anti Rotation Pin	Silver Steel Ø $\frac{1}{2}$ "

1. Completed router table showing N.V.R. fence, and featherboard.



Mike Haughton's design allows safe and accurate detailed work on small sections of wood or plastic.

A SMALL ROUTER TABLE

Those of you that do any serious woodworking will already know that a hand held plunge router is very valuable and versatile tool for adding curved details to square edges, creating dovetail joints, copying from templates or making grooves as part of joints or housings. Routers and smaller carbide tipped bits have become much cheaper in recent years, there's lots of choice and there is no reason why one or more of these couldn't be a useful addition to your workshop.

Unfortunately, for the type of work that many of us do, e.g. making clock cases, decorative boxes, dolls houses, toys, instrument cases and scale model making in general, the pieces of timber or plastic being worked are often too small in section to be accurately or safely routed with the hand held router used in the conventional manner. (With the work held steady and the router guided by hand.)

A better solution is to hold the router body stationary, on its side or upside down under a table, and to move the work piece past the cutter by hand supported by a fence, a template and bush, or a cutter with a ball bearing guide.

Commercial Router tables are available, (refs. 1, 2, 3) and are usually the upside down type, often bigger than I think is necessary for model work. Because they have to accommodate a whole range of router styles and sizes from different

manufacturers, they can be quite complex. They are also pretty costly and not usually aimed at smaller, delicate work.

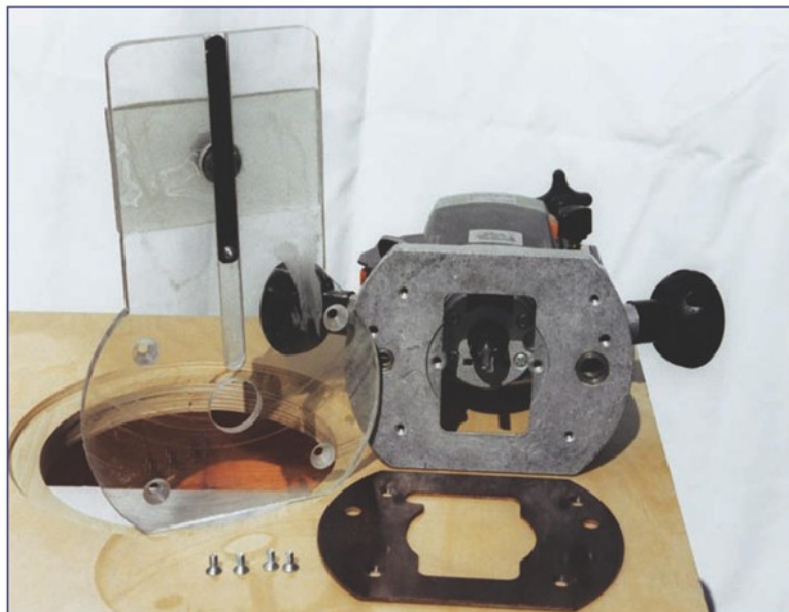
My home constructed small router table, shown in **photo 1**, uses an Elu MOF96E that I have since about 1993. This machine has given me excellent service, but does not seem to be available any more under the Elu brand. Elu and DeWalt are now part of the Black & Decker Empire and a very similar router is still available from DeWalt. Trend also offers a similar Router. The Elu has electronic speed control and a "soft" start.

The following project is aimed at routers using cutters with a $\frac{1}{16}$ in. or 6mm diameter shaft. Larger and smaller routers are available but you will have to change the dimensions accordingly.

Virtually all my cutters are TCT rather than high-speed steel. I find that HSS cutters quickly blunt and burn even when used in softwood. TCT cutters can be used on all sorts of aggressive materials and can be re sharpened with a diamond file provided they have not been left to go too blunt. The biggest enemy to TCT is, of



2. Elu MOF96E router.



3. Router showing original base plate and new circle cutting base.



4. Selection of metal inserts for use with wood.

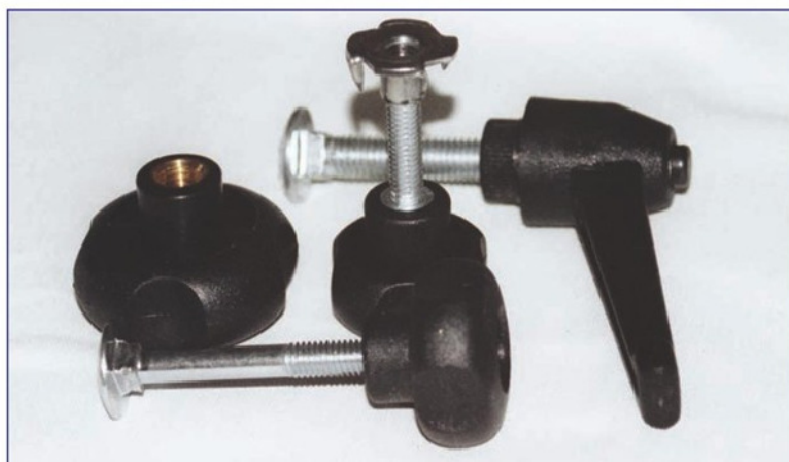
course, dropping and chipping the insert! Unfortunately, there seems to be little standardisation between $\frac{1}{16}$ in. (6mm) routers from different manufacturers, so you may have to adapt what I have done to fit your particular circumstances.

Fine height adjustment

Hand held plunge routers normally have some form of turret of adjustable stops to limit the depth of cut. In operation you

simply push the router body down to the stop and lock the movement.

When plunge routers are mounted upside down under a table this plunge feature is redundant and a fine feed alternative must be provided. These fine feed accessories can be bought or you can make your own. **Photo 2** shows my router with a home made fine feed fitted. As you can see the fine feed that fits the Elu is a long wasted rod and hand wheel that replaces the standard depth indicator. The end of the rod is hollow and threaded



5. Commercial knobs and locking handles.

5mm to screw onto a 30 mm length of 5mm screwed rod fitted to the turret of adjustable stops. Your router may be different but a fine feed is essential for use upside down in a table.

The standard 5mm pitch is 0.8mm, so each turn of the 4 lobed knob is 0.8mm or $\frac{1}{32}$ in., more than sensitive enough.

Router base plates

Most hand held routers have a detachable base of slippery material that should be replaced by a new, bigger, base that fits into a stepped aperture in the router tabletop. I made mine 185mm dia from 6mm polycarbonate. The more expensive manufacturer's router bases are often made from a brown phenolic plastic; styrene resin bonded paper board (SRBP), trade names such as "Paxolin". Cheaper imports tend to use polyethylene or polypropylene for router bases, both are much softer and less dimensionally stable. SRBP sheet is still available, new and surplus, as it is an excellent electrical insulator and quite flat, light and strong. I decided to make new router base plates from polycarbonate, mainly because it's easily available, transparent, tough, slippery and used to make other parts for this project. One downside to polycarbonate is that it scratches very easily, although coated scratch resistant grades are available.

There seems to be little standardisation of base plate design between different manufacturers so there is little point in giving you the dimensions of my base plate. If you look at the Trend Website (3) you will find dimensions of the Trend/Elu/DeWalt "standard". All I can suggest is that you remove your existing base plate, usually just 4 x M5 countersink screws, and use it as a template for new bases.

Photo 3 shows the original base plate removed from the Elu and a circle-cutting base that will replace it. You will need to make several new base plates, as you get into this project.



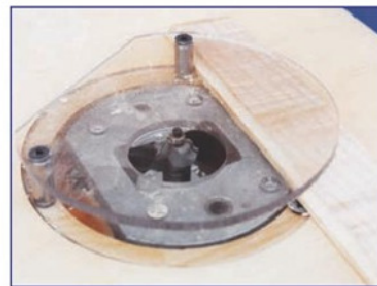
6. Circle cutting base fitted to router - resting on test piece.



7. Transferring hole positions – see text.



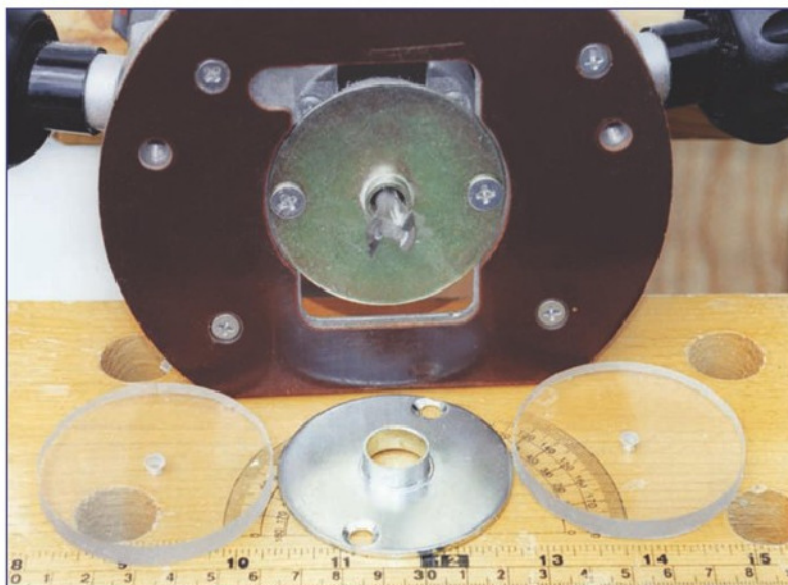
8. Boring polycarbonate sheet with Forstner bit.



9. Showing a bearing guided ogee cutter, starting pin and the form produced.

Polycarbonate

This stuff is very tough and has been used for riot shields because of its impact resistance. It's also used in machine guards, automotive light covers, CD's, DVD's and conservatory roofs. I found a local glass supplier who uses it in "vandal proof" windows and was willing to sell off cuts of 6mm material at a realistic price. The stuff can be worked very like acrylic sheeting (Perspex) and is supplied with tear off sheeting on both sides to protect it from being scratched whilst it is being worked. Polycarbonate can be cut with a band saw fitted with a woodworking blade, routed, drilled, milled, tapped and countersunk like a soft metal. It can also be cold and hot formed. See reference (4) for more information on Polycarbonate sheet and how to work it. Polycarbonate is sold under trade names Makrolon(ref. 5) and Lexan(ref. 6).



10. Here two commercial guide bushes can be seen along with two partially completed polycarbonate blanks.

Safety

Hand held routers rely on two-handed operation to keep hands out of the path of the cutter, which at up to 30,000rpm can do a lot of damage in an instant. In **Photo 1** you can see I have fitted a no volt release emergency stop to allow the router to be left switched on and started / stopped from the front of the table. I found an NVR unit at Axminster (Part Number TNVR) that includes a 13A mains socket so the router can simply be plugged into this. No need to remove the mains plug from the router cable!

As you can see in **Photos 1, 9** and **15** I have made guards from 6mm polycarbonate to keep me away from the rotating cutter. I found bending 6mm polycarbonate sheet very difficult, despite the advice given in reference (4). I experimented with sheet parts placed on a flat baking tray in a domestic fan oven set at 150deg.C. After 20 minutes I could just about bend the sheet through a few degrees. Placing it back in the oven it tended to straighten out again!! I upped the oven temperature in stages over 20 minutes to 200deg.C, at which it was soft, a bit like stiff toffee and could be bent, if I was quick, over the edge of a kitchen worktop. The resulting part contains hundreds of small bubbles, visible in one of the photographs, so I probably over did the cooking! Rather strangely polycarbonate will absorb water at room temperature and this could have been the source of the bubbles. Perhaps a more expert reader could provide a better technique for these bending or flowing operations?

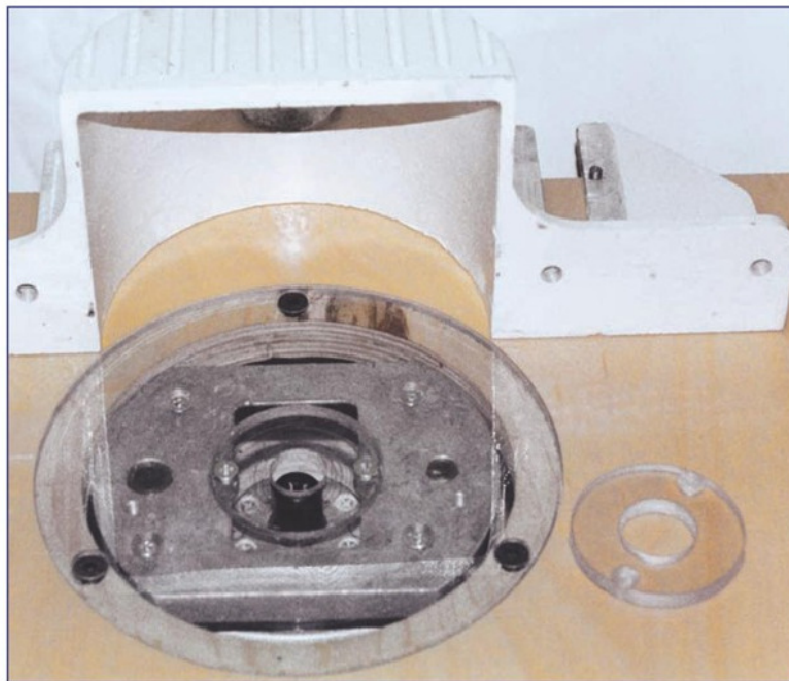
The router table top

The requirement here is for a flat surface that is dimensionally stable, slippery and hardwearing. I chose some 12mm birch 9-ply with a heavily lacquered coating on both sides. The material I used had been part of a library display unit. The top is 350 x 500mm. (14in. x 20in.approx.) To support the top I made a wooden box, 330 x 480mm from 19mm x 90mm softwood, dovetail jointed at the corners, rebated into the top to a depth of 4mm and glued up with polyurethane glue, PU glue.

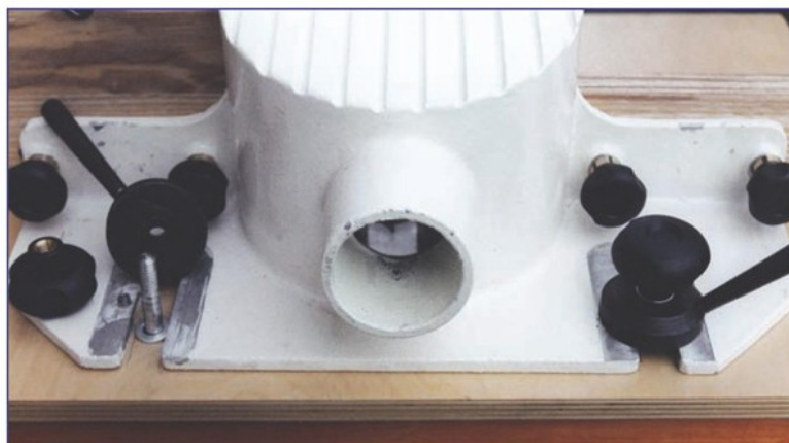
The various parts attached to the top (the fence, base plates, starting pins and bit safety guards) have to be quickly removable, depending on the choice of routing process, so I decided to use 6 and 8mm screwed metal inserts inserted into the plywood. I experimented with two styles of inserts from Screwfix (1) and Axminster (2). **Photo 4** shows an assortment of tapped metal inserts for wood. **Photo 5** shows some of the commercial knobs and locking handles that can be used with them.

The hex drive 6 and 8mm inserts require 13mm wood thickness, 6mm "T nuts" 8mm and 8mm "T nuts" 9mm. After a bit of experimentation I found that the hex drive inserts gave the best results in the ply top and the ash fence attachments.

One consequence of using these inserts and letting the 6mm polycarbonate flush into the top is the requirement to thicken it. However, you can't use too thick a top or the router bit will not go through both



11. One polycarbonate blank fitted, also showing the cast alloy fence.



12. Attachment system combines clamping and adjustment.

pieces of ply from one side when you rout the stepped recess. I think pieces of kitchen worktop would be too thick, unless you had a more powerful router. Another problem with thin tops is that they resonate like a drum and make a noisy machine even noisier. I doubled the top thickness around the 185mm cut out by sticking a second layer of the same ply underneath. Attempts to stick the two ply pieces together with a PU woodworking glue was a dismal failure and I had to remake the joint using epoxy resin.

Remember, if you fabricate a top by lamination, veneer both sides to balance the forces and avoid distortion which can occur over time.

Circle-cutting jig

To cut the polycarbonate table insert and the stepped hole in the tabletop and some base plate adaptors (more on these later) I

made a circle-cutting jig for my Elu router. Although Trend (3) and others, can supply all manner of circle cutting kits and templates for hole cutting, but I decided to make my own. I replaced the supplied phenolic router base with one cut from 6mm thick extruded polycarbonate (Bayer, Makrolon(ref. 5)) with a 95 x 115mm extension on one side to carry an adjustable sliding pivot. **Photo 3** shows the circle-cutting base and **Photo 6** the base fitted to the router and a test circle cut in the birch ply. **Photo 7** shows the phenolic base being used as a template to transfer the countersunk hole locations to the new base. The template is attached to the polycarbonate with double-sided tape. The centering device shown is a tube with a 90deg. point with a drill passing through it.

Photo 8 shows a 25mm woodworking Forstner bit being used to bore the central hole in the jig, a job which it does very nicely.

A 10mm wide by 3.5mm deep slot was

milled, using a regular end mill, in the circle-cutting jig base to accept a 100x10x3mm of steel strip with a silver steel pivot point pressed into it. A second piece of polycarbonate was glued, with epoxy resin, across the back of the slot to provide enough thickness to hold a simple clamp for the sliding steel pivot strip. I have found this circle-cutting jig really useful with the fine height adjustment and this is now my preferred method of cutting circles from 50mm to 200 mm in wood or plastic.

A starting pin

The router table can be used without a fence if you are going to use a router cutter with a ball bearing guide or a guide bush to follow a template. **Photo 9** shows a ball bearing guide mounted at the end of a Roman Ogee shaped TCT cutter. The idea is that the bearing rides on a previously finished surface which can be the wood itself or a template attached to the top of the wood. This technique is a good way of adding a decorative profile but starting to cut at the end of the timber is easier and safer if a starting pin is made. In **photo 9** two of the 6mm countersunk screws holding the router plate to the table have been replaced with 12mm dia. pins turned down to 6mm, threaded and profiled to fit the countersink in the router plate. The pin at the front is used as a pin and both support a Polycarbonate safety guard.

TCT cutters with the bearing mounted on the shaft below the cutter are available, but are less common.

In **photo 9** a piece of ash is shown with a concave profile in one edge produced by the ogee profile. (The ash has been turned over to show the timber removed.) Take care not to run the timber between the pin and the router cutter. The timber is fed from the pin to the outside of the cutter so the timber arrives against the cutter rotation, not with it.

Guide bushings

In **photo 10** the 62mm aperture in the router base around the cutter has been filled with a commercial metal plate with a raised guide bush. This bush can be used to follow a template attached to the bottom of the work piece. Also shown are a larger metal bush and two incomplete polycarbonate blanks to be used to fill the router base aperture. They will be attached with countersink screws and will have different sized holes bored in their centres. **Photo 11** shows two of these completed inserts, one fitted to the router and tabletop.

A router fence

I originally planned to use a piece of aluminium alloy angle as a fence for the router table but nothing suitable was available so I bought a cast alloy fence from Axminster (2), part number 043262. This sand casting shown in **Photo 11** required a small amount of modification before use.

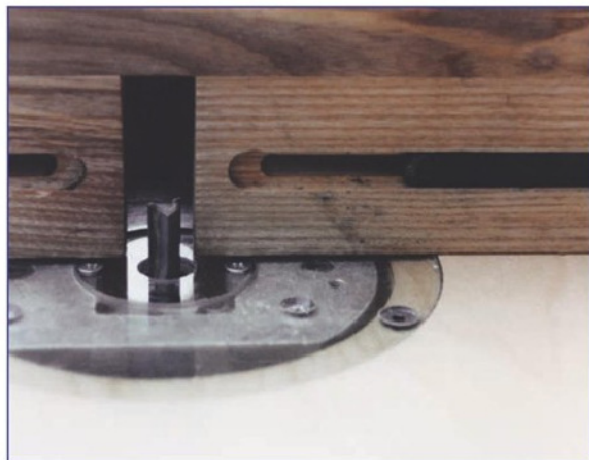
There are 4 x 6mm holes already drilled to fit wooden cheeks to the fence. I opened these holes out to 8mm and



13. Detail view showing the adjustment system.

spot faced the back of the holes for the knobs to bear on when tightened up. This proved to be a mistake as 8mm knobs are too big, so I bushed the holes down to 6mm again! In my example of the fence the cast in pads were not drilled through centrally so the brass bushes helped!

The table mounting slots were widened to 17mm and an area 45mm wide milled around the slots to remove the casting "drag" and provide a flat area for two eccentric handles and clamps to be added. The fence has to be accurately positioned relative to the cutters to set the depth of cut. **Photo 12** shows the handles I made. **Photo 13** one of the handle assemblies in more detail. They have a short slot milled in the base that fits over a short pin screwed and glued into the fence. Two 8mm Bristol handles from Axminster provide the clamping force. Later I replaced these with 8mm plastic knobs as they take up less room. These simple handles working on the pins provide about 25mm movement to the fence. To obtain more movement extra pairs of holes are needed in the top.



14. Wooden extensions fitted to cast fence.

Fence cheeks

These fence linings are made to be adjustable to accommodate different cutter diameters. I made mine from three pieces of native ash 60mm x 22 mm x 260 mm long. All three were put through my planer to ensure that they are exactly the same thickness, smooth and square. The in feed fence, to the right as you face the machine, has an extension glued and biscuit jointed to the top of it to provide support for adjustable polycarbonate safety screens and feather boards. **Photos 14** and **15** show these. Again I used 6mm and 8mm screw in inserts. The ash I used was very tough and it was difficult to drive the inserts in squarely with an Allen key. I managed to break one by over tightening it and was forced to drill the remnants out of the hole and fit a new insert.

A further function of this extension is to block off most of the dust extraction chamber that is an integral part of the Axminster fence casting. Extraction is pretty essential with a router and the fence in question has a 48mm port cast into it. I had to turn an adaptor from polyethylene rod to reduce the port size to fit the 38mm hose I am using for small tools. My extraction

system ends up at 100mm at the point where it hits the fan.

The fences are adjustable horizontally to an opening just larger than the cutter being used and have 12mm wide x 4mm deep slots routed into them to hold the sliding clamping bars and 6mm studs. These bars were fabricated by silver soldering and then chemically blackened. (Selenium)

It's important that you check the alignment of the two fence cheeks (in feed and out feed) with a straight edge. For normal operations they must be exactly in line.

One useful trick you could try is to place strips of paper behind the out feed fence and adjust the out feed to be exactly in line with the cutting edge of a straight cutting TCT bit. This arrangement can be used as a poor man's substitute for an edge jointer. Try it, it works very well.

Feather boards

The purpose of these is to prevent kick back and to push the work firmly down against the tabletop. They are especially useful with thin stock. An adjustable feather board, made from native ash, can be seen in **Photo 15**. This was simply made by running a number of parallel cuts with a band saw along the grain of a piece of ash.

Read all about it!

There is no way I could cover all the router techniques one could use with a router and table in a short article such as this. It's such a versatile machine. If I have whetted your appetite, get one of the specialised books on the subject. (7)

Final thoughts

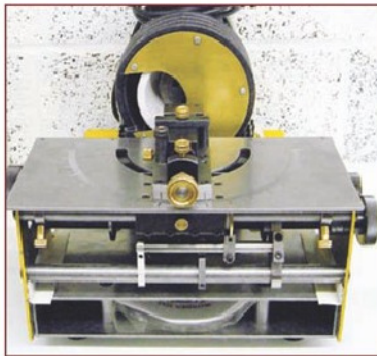
I'm still discovering what can be done with my router table. If I were starting again I would probably make the various Polycarbonate components that required bending from thinner sheet. Thinner sheet would also be of benefit for the table insert, so that less of the TCT cutter length is wasted.



15. Infeed fence has vertical extension to carry feather board and safety screen.

FEEDSCREW TRAVERSE FOR THE WORDEN

Jim Whetren describes an "add on" for this popular tool and cutter grinder.



1. Front view of machine with traverse added.

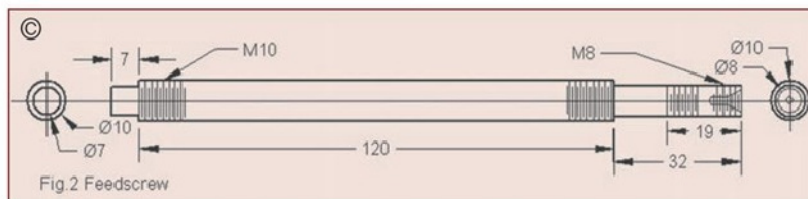
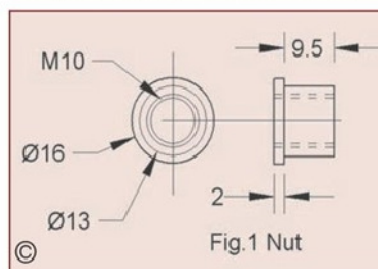
Construction

Nut Fig. 1

Chuck a length of $\frac{1}{2}$ in. FCMS bar with 20mm protruding, clean up the diameter for a length of 15mm and face the end, centre then drill and tap M10. Reduce the diameter to 13mm for a length of 9.5mm, remove the sharp corners and part off at 13mm long. Re-chuck and face the parted end to leave the flange 3mm wide. The nut is made first to gauge the screw thread which must be as close fitting as possible while allowing smooth movement.

Feedscrew Fig. 2

A length of 10mm FCMS bar is faced off



Background

This article describes the construction of a positive lateral feed for the work table of the Worden tool and cutter grinder. A general view of the machine is given as **Photo 1**, which also shows the dust control modification described in Issue 104. It is quite possible that, with a little ingenuity, the concept may be applied to other equipment. When considering how best to achieve this, I came upon a current adjusting screw and nut removed from a redundant arc welder. This screw is 10mm dia. and some 6in. long, of which $4\frac{1}{2}$ in. has a two start 10 x 1.5mm thread. There is a 7mm dia. spigot on the end and the remaining length is threaded M10. This was ideal, as the twin thread allowed a travel of 3mm per one turn of the screw. The 19mm hole in the right hand table side plate was utilised to accommodate a bearing boss for the feed screw, and the spacer bar at the front of the plates was used as a guide bar for the two sliding components and the fixed one. The screw is operated by a knurled hand wheel. This assembly is shown fitted up in **Photo 2**.

The system, as made, provides an instant sliding setup travel of 4in. by the release of a single screw. After locking the screw, a further precise travel of 4in. is provided by the feedscrew. The full table tilt angle adjustment is retained with the traverse engaged, as is fully lifting the table for tool examination. Without the advantage of the two start thread, a standard M10 thread has a pitch of 1.5mm and a $\frac{1}{16}$ in. Whit thread has a pitch of $\frac{1}{16}$ in. Either of these would provide a reasonable feed rate for tool grinding. The drawings have been prepared on a "make from scratch" basis, however some detail differences may be noted in the photographs, which show my unit constructed using the salvaged screw assembly.

and chamfered, and a full depth centre drilled in the end with a BS3 Sloccombe drill. With 40mm protruding, the bar is turned down to 8mm diameter for a length of 32mm. Thread M8 for a length of 19mm, either screw cut in the lathe or use a die. The bar is withdrawn a further 130mm and the end supported with a revolving centre. At 120mm from the previously formed shoulder, feed in a parting tool to a depth of 1.5mm. Withdraw the tool and move it towards the chuck for a further 7mm and feed in again to the same depth. The full diameter is now screw cut at 1.5mm pitch for a length of 120mm. Again a die can be used, starting the thread with a tailstock die holder and finishing the length at the bench if the holder has insufficient travel.

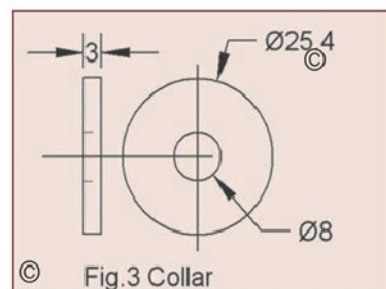
Saw the finished piece from the parent bar using the last groove as a guide. The screw is now held in a collet or with a split sleeve in the 3 jaw chuck, failing this with the thread wrapped in thin material to protect it. With the groove clear of the

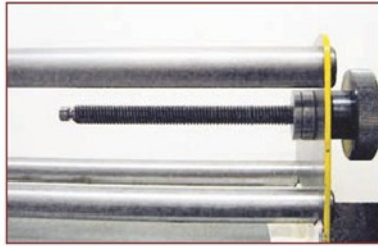
chuck jaws, turn the 7mm length down to 7mm diameter with light cuts and face the sawn end. Use a chamfering tool to break all sharp corners. (Standard 10mm screwed rod could be used instead. Make the nut and take it with you as a gauge!)

Collar Fig. 3

Grip a short (55mm) length of 1in. dia FCMS in the 3 jaw, face the end and break the sharp corner. Form a centre and drill 7.9mm to a depth of 4mm at the drill lips. Part off a full 3mm slice. Use a hand reamer to gradually open up the hole to be a firm twist fit on the 8mm diameter of the screw, or drill 8mm and use Loctite. Fit with the faced end against the shoulder.

With the 7mm dia. end of the screw in the chuck and the other end supported with the revolving centre, take light cuts





2. Feed screw assembly fitted.



3. Screw and nut assembly.

over the parted face of the collar to clean up and leave this face square to the screw, break the sharp corner. The screw is now finished. The sub-assembly is shown in photo 3.

Bearing Fig. 4 &

Lock Ring Fig. 5

Re-chuck the piece of 1in. bar with 25mm protruding and turn down to 19mm diameter for a length of 10mm, chamfer the end and if screw-cutting; form an undercut at the shoulder 1mm deep. Form a thread of 1mm pitch for the 10mm length. (I used 1/4in. UNF as I had a tap and die of this size).

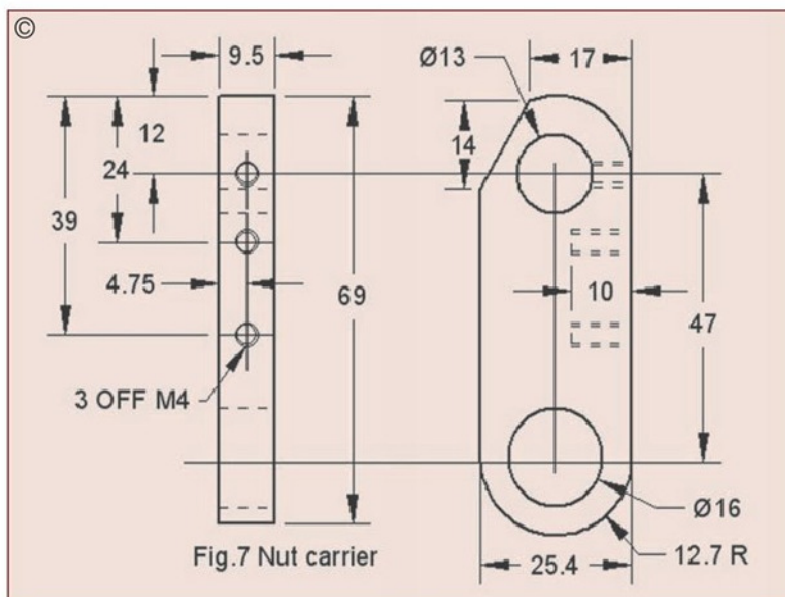
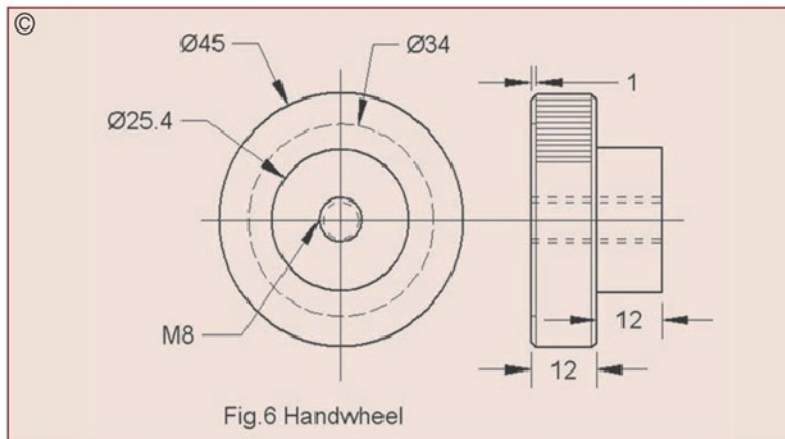
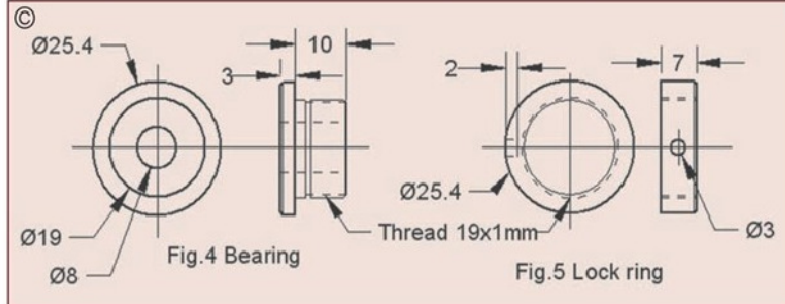
Centre and drill 7.9mm for a depth of 25mm. Lightly countersink the hole and chamfer the outer diameter. Ream the hole 8mm for a good running fit on the screw, clean up the full diameter and part off leaving a flange 3mm wide. Open out the 8mm hole in the chucked piece to tapping size suitable for the thread cut on the bearing, to a depth of 10mm; cut the corresponding thread a good fit on the bearing. Countersink and chamfer, taking a skim over the diameter to clean up, part off a length of 7mm.

Re-chuck the bearing protecting the thread, and face the parted end and chamfer. Reverse and mount the lock ring, leaving the parted face clear of the bearing piece to face and chamfer the ring. The chuck jaws gripping both pieces.

Handwheel Fig. 6

This is made from a 1in. chunk of 1.75in. dia. FCMS, which can just be held in the inside jaws of a 4in. 3 jaw chuck (or alternatively hold in a 4 jaw). After filing off any nibs left from the sawing, push the blank into the chuck until any high spot just touches the face of the chuck, use a square to get the OD square to the chuck face and tighten the jaws. Lightly face to get an even surface then reverse in the chuck, this time pushing firmly against the chuck face.

Face this end and reduce to 25mm dia. for a length of 12mm. Centre and drill through tapping size for M8 and tap the thread. Chamfer the start of the thread and take a final facing cut to ensure the face is



square to the thread. Reverse in the chuck gripping the 25mm dia. It will be found that the large diameter is proud of the jaws which allows a medium straight knurl to be cut with the knurls clearing the jaw steps. When the knurling is completed, form a 1mm chamfer on each side of the knurling.

Set up a round nose tool facing the chuck, and working from the centre, take a 1mm deep facing cut out to a diameter of 34mm. This gives a pleasant appearance to the otherwise large bland face. (Purely cosmetic, otherwise use a commercial M8 plastic knob)

These completed items can now be assembled into the right hand table side plate from the inside using the 19mm hole

provided. A shallow 3mm diameter hole is drilled in the OD of the lock ring to allow tightening; it only needs to be nipped up to hold the bearing piece secure. The screw is fitted into the bearing and the hand wheel screwed on to just lock everything, a 6mm long M8 set screw is loosely fitted and the hand wheel backed off slightly. Gripping the hand wheel, firmly tighten the set screw locking the wheel in place. If, as I found, tightening the set screw slightly moved the main screw, this is easily cured by placing a suitable diameter steel ball in the centre at the end of the feed screw, as can be seen in Photo 4. The wheel should turn freely with no perceptible end float.

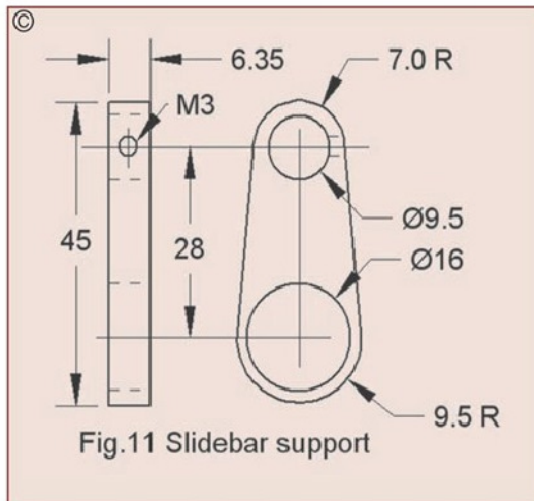


Fig.11 Slidebar support

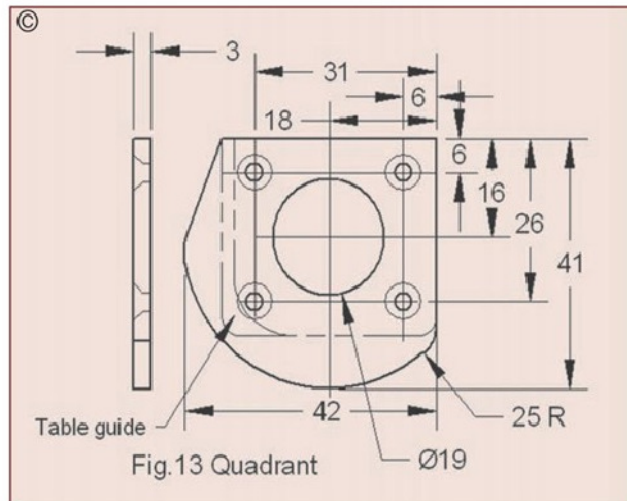


Fig.13 Quadrant

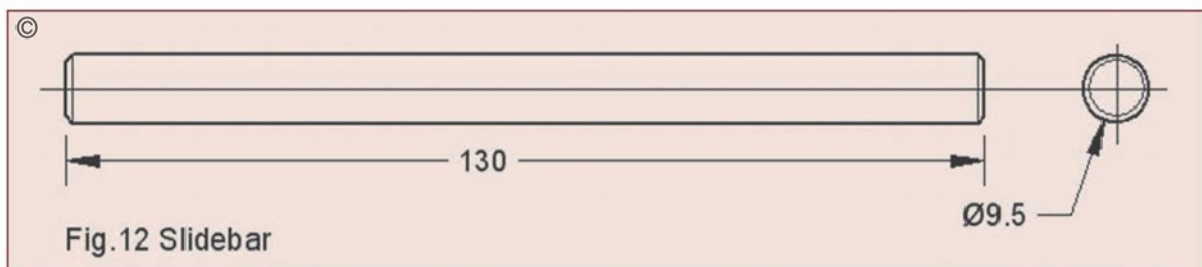


Fig.12 Slidebar

At the end with the large hole scribe a line across the width at 29mm from the end; from each end of this line scribe lines to meet the 6mm radius. With each line set up in turn parallel with the vice jaws of the mill or bench vice, mill or file away the waste to leave the shape in the drawing, rounding the end as before.

At one edge, mark a centreline and an intersecting line at 4mm from the square end. Punch and drill right through with the M3 tapping drill. Open this hole to 3mm to just over half way across the width. This will allow a 3mm tap to reach deep enough to cut the thread. Open up the 4mm hole to 5mm diameter, 3mm deep to accept an Allen screw. A light skim is required along the screw head to remove the knurling and small flange. On this edge, file or mill the small notch to clear the fork as it passes. (Mark from job)

Make the slit across the bottom as per the drawing. A slitting saw gives a neater result, but at this size a junior hacksaw does the job in the time it takes to fit a slitting saw blade. The steady can now be

fitted and when the supported feed screw turns freely, it is locked to the spacer bar with the Allen screw.

Slide bar Clamp Fig. 9 & Drive Fork Fig. 10

Both of these items are made from $\frac{3}{16}$ in. x $\frac{1}{4}$ in. BMS flat stock as per the drawings and require little comment, except to point out that the $\frac{3}{16}$ in. reamed hole in the clamp piece should just break out at the bottom to allow firm clamping of the slide bar when the mounting screws are tightened. The slot in the fork was cut with a suitable end mill in four passes to produce a good sliding fit with the 3mm thick quadrant.

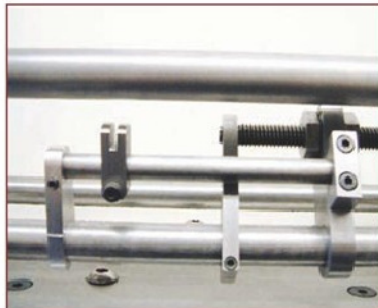
Slide bar Support Fig 11 & Slide bar Fig. 12

The support is made from $\frac{3}{16}$ in. x $\frac{1}{4}$ in. BMS flat stock which is bored and shaped to the drawing using the method of the previous

flat items. The slide bar is a 130mm length of $\frac{1}{4}$ in. FCMS faced and chamfered at either end. These pieces can now be fitted and the free movement of the feedscrew checked throughout its travel. When satisfied, the bar is secured to the steady with a short M3 set screw. The fork assembly is illustrated in **Photo 6** and can be seen in location in **photo 7**.

Quadrant Fig. 13

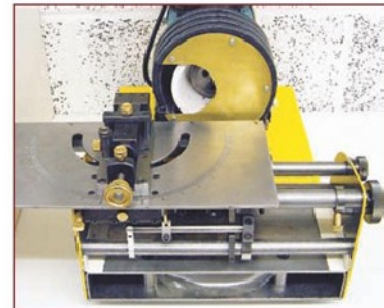
Cut a 2in. square of 3mm thick sheet steel or brass, mark out as the drawing including the 25mm radius and bore the $\frac{1}{4}$ in. (19mm) hole first. This will allow the plate to be accurately located on the end of the table guide with a stub of bar to locate the two straight edges and mark where the material has to be cut away. If the holes in the plate are drilled M3 tapping size, the plate can be re-located on the bore with the stub of bar, and the top edge accurately aligned with the top machined face of the guide by pressing the side of a set square stock against the



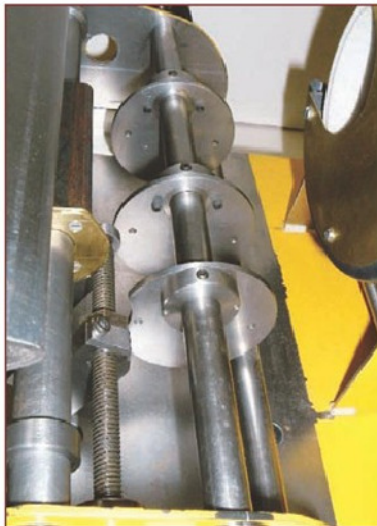
7. Fork assembly in position on machine.



8. The guide is relieved by filing to give clearance for the fork.



9. Working to the left of the wheel.



10. "Some relieving of the right hand table eccentric is required".

pieces. Drill one hole at the right angled corner and tap this, opening out the hole in the plate to 3mm will allow it to be secured with a screw to check all is well. Should something go wrong, this hole can

be opened out a bit more to achieve the desired result. With the plate firmly screwed in place, the other three holes are then spotted and the drilling and the tapping completed. The holes in the plate are opened up and countersunk. (Students of the late GHT's school will achieve this by accurate marking out and drilling direct. I'm not that good –hence the Mickey Mouse method described. (A large flat washer, with the right angle sawn and filed could also be used.)

It can be seen from Photo 8 that some relief must be filed on the end of the table guide to clear the fork. This would be best marked out from the job on assembly.

Using the Fine Feed

Most of the time, the nut is roughly in the middle of the feedscrew. The fork is loosened and the table slid to the start position for the initial setting; the fork is locked and the tool feeding performed with the handwheel. It is only necessary to slacken one screw, (M4 Allen screw or 10mm dia. knurled screw) to reposition the table, thus keeping to a minimum the amount of knob twiddling. The quadrant and fork method of engaging the feed allows unrestricted tilting of the table.

The maximum distance from the standard tool-holder to the left hand side of the wheel is 25mm. Photo 9. Due to the space occupied by the traverse components this is reduced to 12mm to the right hand side. However, as most tool grinding will take place from the left this shouldn't be a problem. There is sufficient room to grind a turning tool from the right.

And Finally!

To allow free passage of the table when set at angles below five degrees, some relieving of the right hand table eccentric is required, (Photo 10) again check in situ. Due to the fit of the nut bracket on the spacer bar, any slop in the feed thread may cause the bracket to rock, locking it. This can be cured by inserting the reamer and tilting it in the longitudinal plane of the bracket and taking a small scrape from either side, thus preventing the edges of the bore from digging in. This would appear to spoil the precision fit, but observation shows that the precision contact is only required at the sides. This situation was only found when the part was initially assembled alone; when the slide bar and steady are also fitted, any tendency to rock is eliminated.



A NOVEL HYGROMETER

Harold Hall describes a simple piece of woodwork which may prove useful humidity alert.

Background

Both I (issue 103 page 12) and Jack Cox (issue 109 page 26) have expressed reservations regarding writing a woodworking article for an essentially metalworking publication. Another common feature was the emphasis on how timber will vary in size as its moisture content varies, very little along the grain but appreciably in the other two plains. It was with this in mind that I was reminded of a simple Hygrometer that relies on this characteristic.

It is appropriate for this magazine, as the finished item may well prove a useful indication of the workshop's changes in humidity and hence propensity for rust formation. It would also be possible to make a more decorative version for display in the house where it could be an interesting talking point.

The principle

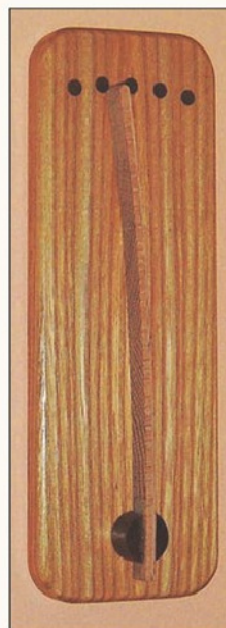
Photo 1 shows the finished item. In this, the thin wooden vane is made of two pieces of timber glued side by side but with the grain in the one at right angles to the other. As the moisture content of the timber varies with the surrounding humidity one side will not change in length whilst the other does causing the strip to bend.

The timber

All timbers will exhibit changes in dimension but some more than others, those with the greatest change will bend the most. You may of course like to make strips of a number of species and compare results. However, Oak will be a good choice as this has a greater change in dimension than most common timbers.

Manufacture

Making two very thin pieces then gluing them together would be next to impossible as the side with the grain at right angles to the length would very easily break. Avoid this problem by making two thicker pieces, glue them together and then reduce the thickness on both sides to give a strip about 4 mm thick. Dimensions are of course not critical but I would suggest 10 mm wide and 200 mm long. What is essential though is that strip with the grain lengthways should be thinner than the cross grain strip due to the it being much more resistant to bending. I would suggest approximate thicknesses of 1mm and 3mm. Use an epoxy resin adhesive, as a water based one will not be suitable for obvious reasons. As



it is unlikely that you will have a board 200 mm wide for the cross grain side, this will have to be achieved by gluing two or more pieces together. For greater sensitivity, a vane longer than 200 mm will of course deflect more.

Ideally, the timber should be seasoned at the mid humidity level so that the vane is straight when in the mid position, bending to the left and to the right as the humidity level reduces and increases. This though may be difficult to ensure and some curvature of the vane may have to be accepted in the mid point.

The fixing for the vane is a piece of dowel, being a close fit in the base board but not glued. This enables the dowel to be rotated for centralising the top end of the vane between the maximum and minimum situations.

Finishing

If you are making a unit for display in the house then you will wish to varnish the base board. However, the vane must not be varnished as this would prevent it quickly responding to humidity changes. Also, as it would be logical for it to swing to the right with increase in humidity, its left side should have the cross grain.



A NEW ANGLE ON BENDING

Paul Prince of Aviation Metalcraft charts the evolution of the Warco Magnum Bender from prototype to production.

For the last 15 years I have been running Aviation Metalcraft, an engineering company specialising in the design, and manufacture, of high quality metalwork kits and components for homebuilt and vintage light aircraft; everything, from a simple control surface hinge, to a complete tubular steel fuselage – ready for fitting-out. For the majority of aircraft homebuilders, it is the production of the many, frequently complex, metal fittings that proves to be difficult. There is also the question of time to consider. If funds permit, it is generally far quicker to engage the assistance of specialists to help the project along, which is where Aviation Metalcraft can play a significant part.

One aspect of this niche manufacturing business is the production of precision bends in high strength aircraft specification alloys, which are accurate in location; of defined bend radius, and with a high quality finish and definitely, without any signs of cracking, creasing or crimping. When sets of identical parts are required – for instance control surface hinges – then repeatability becomes an important additional issue. This generally means that some type of forming tool, or press tool, is required to produce matched sets of parts.

The majority of the heavier gauge components in a homebuilt aircraft are likely to be found in the undercarriage and wing attachment fittings. There is seldom a need to produce a bend greater than 6in. (150mm) in width, and $\frac{1}{8}$ in. (3mm) thick material is about as thick as it gets. The material that is most frequently encountered by the homebuilder is SAE 4130N – an American specification chrome molybdenum steel with a tensile strength of 40 ton/sq.in. in the normalised (N) condition. Before the advent of the monocoque chassis, 4130N was also used extensively in the production of racing car chassis. Today, it is still used in the

construction of kit cars and specials, motorcycles and some cycle frames – in fact anywhere where a lightweight high-strength component is required. In addition to its high strength, which is not diminished after welding, it can, if desired, be heat treated to achieve higher strength and hardness. For the model engineer who requires a high strength alloy, 4130N is definitely worth a look at. It can be obtained in small quantities in sheet, bar, rod and tube form – including a limited range of streamline sections from PFA Metals (Ref.1) (Usual Disclaimer). As far as I am aware, 4130 steel, in all its various forms, is only available in imperial sizes.

For years, I had been looking for a 'universal' bender that could meet these requirements. I use the word universal with caution, because there will always be parts which cannot be made on any so called 'universal' machine. And, in these cases, I frequently resort to making a dedicated form/press tool. Many years ago I found a bender that I thought might go some way to meeting the specification and purchased the machine direct from the manufacturer. This product is shown in **Photo 1**. Whilst it could bend $\frac{1}{8}$ in. thick 4130N, the radius formed was of questionable and, frequently, variable quality. In addition, but most importantly, there was no provision for changing the bend radius – I was stuck with the crude 'radius' formed on the edge of a piece of angle iron that doubled-up as the work 'hold down'. In addition to these limitations, it is also extremely difficult to set up the work accurately relative to the hinge line and the bend radius. With no other machine available on the market I decided it was time to start from scratch, and design one that would fulfil all of my requirements.

From a production perspective, it is usually more cost effective to buy a ready-made tool or machine, rather than to manufacture in-house. So, before looking at the design in more detail, it is worth taking a brief look at existing machines on the market, and considering their strengths and weaknesses. There are numerous ways of bending sheet material. The techniques and tools which are most frequently encountered by both amateur and professional alike are:-

1. Sheet metal folder

The traditional sheet metal folder is designed to make long bends in relatively thin material. The machine I was looking for would be designed to bend shorter lengths, but much thicker section material.

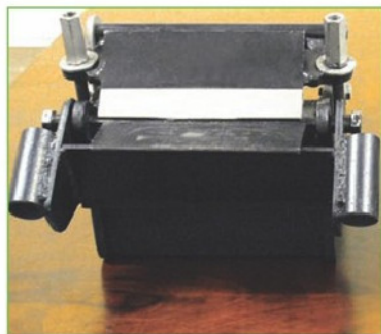
2. Bending / forming blocks

This is a technique that will be familiar to most model engineers. Firstly let us consider a simple bending block. The required radius is created on the edge of a suitable piece of material; this could be hardwood, a densified wood such as Permal or Jabroc, aluminium or steel. The part and bending block are placed in a vice and the part tapped over with the aid of a drift – again of appropriate material. (To avoid bruising the component, the drift should be softer than the work piece). The advantage of this technique is that it is versatile and all manner of parts can be formed, even curved bends requiring a certain amount of shrinking or stretching. The block can incorporate tooling buttons or other features to locate the part, making it possible to produce a batch of identical parts. I use this technique extensively and, over the years, have amassed a large quantity of this type of tooling.

The down side to this method is that it is invariably component specific and each tool can take a considerable time to produce. **Photo 2** shows a form tool manufactured from steel to form the tapered, flanged lever seen in the assembly to the rear of the photograph. This assembly forms part of the Comper Swift aileron control gear. **Photo 3** shows a form block which makes bends in part of a control surface hinge.

3. The Flypress

The flypress is a common sight in a sheet metal workshop. They are used for a variety of tasks including punching holes, forming and bending. Although I possess a large flypress, I seldom use this approach



1. The bender used earlier.



2. (right) Blank, form tool and fabricated assembly.



3. Form block allowing four components to be handled together.

for bending or forming parts. It is often too difficult to locate the part accurately relative to the bending die. If you have dozens of parts to make, then the trial and error set-up approach of making minute adjustments to the 'nest' or locations can be justified. Once set, the actual production run can proceed at a fair pace. For even higher volume production, a die set would be made which includes both the punch and die in a single unit. Location for the blanks is also incorporated. An additional benefit of the die set is the quick set-up and tool change times. For low volume production, this is precisely the problem. If there are only two parts to bend – and they are handed left and right, as they frequently are, the chances of getting each bend 'spot-on' first time, is, to say the least, remote. A recent article in MEW (ref.2) discusses a number of tooling options when using the flypress.

4. Bend, roll and shear machines

Next, let us take a look at the bend, roll and shear, 3 in 1 style machines. These have been around for a number of years now, and are available from many machinery suppliers, in a range of sizes. I bought a small 12in. version specifically to form some thin aluminium components. So far, I have only used the bending facility, but the limitations for me are threefold. Firstly, the material thickness which this type of machine can handle is limited to about 1mm in mild steel (probably a little less when using 4130N and, secondly, but most importantly, the lack of work positioning aid(s) relative to the bending blade is a limitation – a simple back stop is generally all that is provided. Thirdly, the bending blades have an incredibly small fixed 'radius' that can be thought of more as a knife-edge, rather than a nice smooth radius. **Photo 4** shows a close up of the blade. This is fine of course for producing crisp bends in thin brass, aluminium and steel – which is of course what they are designed for – but of little use in producing parts for an aircraft. Without wishing to overstate the point, the one requirement of every bent component used on an aircraft is that the bend is of good finish and known radius. This minimises the risk of a fatigue failure occurring along the bend line.

I have searched the internet many times to see if I could find my ideal machine, without success. So it was time to design and build the machine myself. The starting



4. Blade and Vee of 3 in 1 machine.

process for all projects is the specification, or "wish list": what features I must have; and which are less important, and what methods can I use to make it?

The maximum capacity of the machine has been defined. It should be capable of bending a 6in. wide piece of $\frac{1}{8}$ in. thick 4130N steel. For this, one would typically need a $\frac{1}{8}$ in. or even $\frac{1}{4}$ in. radius to create the bend without the material cracking. (Tip; to reduce the likelihood of cracking, all bends should ideally be formed at 90 degrees to the 'grain' – which is always in the direction of rolling and, on 4130, is indicated also by the printed information which is repeated on each sheet). This will deal with most of the heavier fittings that are typically found on the undercarriage of a light aircraft. At the other extreme, it should be capable of bending delicate 22SWG steel or aluminium alloys, for which a radius of 0.020in. might be more appropriate. This defines the upper and lower limits of the machine. (Note, the 3 in 1 style machines can produce acceptable bends in 20 and 22g steel or aluminium).

In general, unless otherwise specified on the designer's drawings, an inside bend radius equal to the thickness of the material is the minimum acceptable when bending steel. Aluminium alloys are more prone to cracking and are, typically, formed with a greater radius.

After a well-defined bend radius, the most important requirement is the ease and accuracy of setting up the work piece in the bender – something I find hard in a flypress or 3 in 1 style machine. Here, I felt something akin to a machine tool type 'T' slotted table could be used. I consider the slotted table 'Eureka' moment No 1! – or, why hadn't I, or anyone else for that matter, thought of it before and applied it to this type of machine. A slotted table would also permit the use of standard fixturing and clamping kits which would greatly ease set-up. Some form of magnetic hold-down capability, similar to a magnetic chuck, might also be highly desirable. This would later turn out to be 'Eureka' moment No 2! For steel components this would permit some delicate lateral shuffling of the part relative to the bend line, but would hold the part down, freeing up both hands for doing up nuts and bolts etc.

Considering the power source, one could use: hydraulics; some form of screw-jack principle, or, levers. From experience gained using the American bender, I knew that I could bend 6in. x $\frac{1}{8}$ in. 4130N by using suitable levers, so long as the machine is bolted to an immovable object,



5. Assembled parts of bender showing tab and slot construction.

and the levers are of adequate length. I have always used the American machine bolted to the table of my Warco A2F milling machine with great success. It would, of course, be preferable to bolt it to a substantial bench, which should be bolted to the floor.

The final requirement of a bender is the ability to produce an accurate 90-degree bend. This is perhaps stating the obvious, however, as anyone who has attempted to bend 4130N will know, it is incredibly tough and 'springy', and must be over-bent beyond 90 degrees to achieve a perfect 90 degree bend.

Magnum bender specification

- Maximum material size 6in. (150mm) wide x $\frac{1}{8}$ in. (3mm) thick 4130N steel
- Radiused interchangeable bending bars
- 'T' slotted, removable work sub-table
- Magnetic hold down incorporated in the work sub-table
- Sensitive and fine adjustment of the bending die relative to the pivoting beam and work piece.

The machine construction concept

What production methods to use? Build it from castings, fabricate from steel plate, or a mix? I do not have the luxury of being able to spend hours machining parts from castings, let alone justify the time taken making the patterns. I needed a quick and accurate technique. I settled on a fabricated machine with all the major components being laser cut from grade St 37 mild steel plate. I use laser cutting regularly to produce components and special tooling, and I know how to get the best from the process. Laser cutting companies are able to work directly from files created by most CAD systems, which also fits in nicely with my design methods. To make the whole machine self-jigging for welding, I adopted a tab and slot approach, which is clearly seen in **Photo 5**. Once the design was completed I plotted the parts out full size, which enabled me to check the fit of part 'A' against part 'B' – this won't show up minute errors, but it will show up gross errors, such as a missing hole or slot. All was well, and I was satisfied that the parts were, as far as I



6. Laser cut components of main frame.



7. Components of bending bar assembly.



8. End view of bending bars.



9. The Warco Magnum Bender (photo courtesy of Warren Machine Tools Ltd).

could tell, fault free. **Photo 6** and **Photo 7** show the major laser cut components of the machine frame and pivoting bending bar assembly respectively.

Bending bars

The bending bars were machined from mild steel using an adjustable angle plate on the milling machine. For the prototype machine, the radii were all hand formed with constant reference being made to radius gauges. Each radius was finished with the aid of a purpose made scraper with a matching female radius. The scraper was made from gauge plate, and hardened but not tempered. The technique worked surprisingly well. On the production machines the radii are machined and polished before being hardened and tempered.

The Magnum Bender is available with either metric bending bars with radii of 1,2,3,4,5,6mm, or imperial with radii of 1/8in., 1/4in., 3/8in., 1/2in., 5/8in. and 3/4in. Sets are also available individually to upgrade a metric machine to imperial and vice versa. **Photo 8** shows a set of metric bars 'end-on'.

If one of the standard bending bars will not do the job, it is possible to 'adjust' the bending bar radius upwards by first bending a piece of steel shim of appropriate thickness around a standard radius, such that the thickness of the shim, plus the existing radius, produces the new desired radius. The shim can be held in place with double-sided tape.

Magnum bender operation

1. Start by selecting the correct bending bar to suit the material. In general, use

a bend radius equal to the material thickness.

2. Wind the adjusting screws at the rear of the machine back. Place the bending bar roughly in position on the machine.
3. Lift the operating levers until the pivoting bar is approximately 90deg. to the universal slotted plate.
4. Place the work piece or a piece of material of equal thickness vertically against the pivoting bar. Using the two adjuster screws to the rear of the machine, move the bending bar forward until it just touches the work piece. If the work piece is narrow, use two pieces of material at each end of the bending bar to ensure that the edge of the pivoting bar is parallel to the pivot line.
5. Lower the operating levers.
6. Remove the bending bar and place the work piece on the bed of the machine – if it is steel, the rare earth magnets will hold it in place. Replace the bending bar and fit the clamp bolts loosely. Push the bending bar back against the adjusting screws and tighten the clamp bolts.
7. The work piece may now be bent by raising the operating levers.

Taking the bender to market

From prototype to production can be a long and tortuous path with many a pitfall along the way. On seeing the bender, a number of my customers had asked if I would make similar machines to aid in completing their metalwork. In the first 6 months after producing the prototype a further 4 were completed for customers.

As it happened they were each building a full size replica of the 1930's Comper Swift racing and record breaking aircraft (Ref.3) A complex machine given its diminutive size.

For series production what I needed was a suitable manufacturer and distributor. Enter Warco. I have used Warco machinery and tooling, almost exclusively, ever since setting up Aviation Metalcraft. Quality, value and service abound, and it is always a pleasurable experience doing business with them. Warco was, therefore, my preferred choice. I approached Roger Warren (MD), and discussed a manufacturing and distribution arrangement for the bender.

Roger could see the potential of the bender, not only in the aviation sector, but also to a much wider audience of model engineers and educational users. A licensing agreement was drawn up, and the rest as they say is history. The Magnum Bender is now being manufactured in the Far East and marketed worldwide under licence by Warco. For readers of MEW in the USA and Canada, Aircraft Spruce and Speciality have been appointed as distributors.



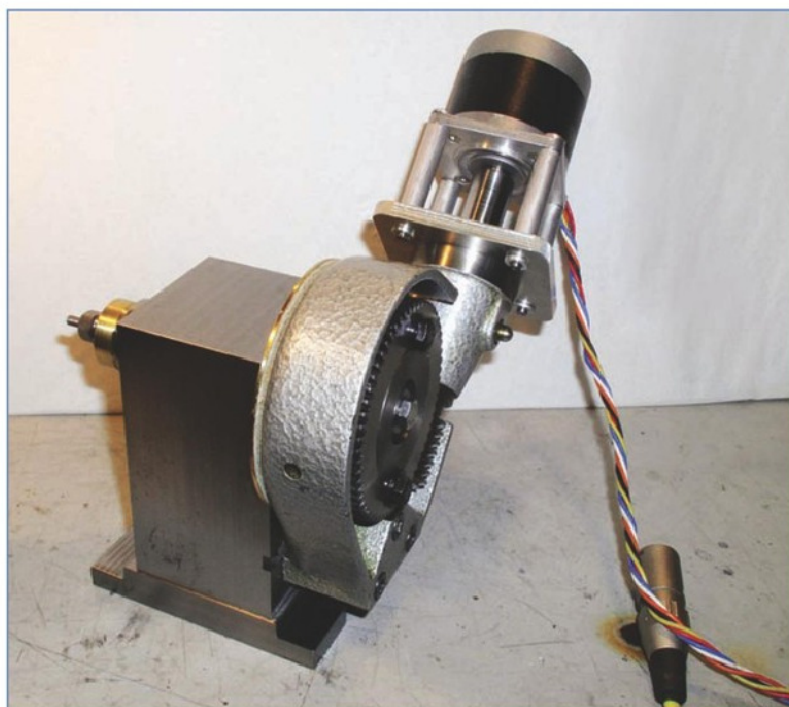
References

1. PFA Metals (A division of Winged Aviation)
Winged Aviation House
Stone Circle Road
Round Spinney Industrial Estate
Northampton NN3 8RF
Tel 01604 670810 Fax 01604 670831
sales@winged-aviation.co.uk
2. MEW Vol. 117, P46 Bending tools for use in the fly press Mike Tiernay
3. Comper Swift Technical Article by P Prince, **Aviation Metalcraft**
<http://www.aviationmetalcraft.co.uk/comper-swift.htm>

Suppliers

Warco, Fisher Lane, Chiddingfold,
Surrey, GU8 4TD
Tel 01428 682929 Fax 01428 685870
www.warco.co.uk warco@warco.co.uk

Aircraft Spruce and Speciality
<http://www.aircraftspruce.com>



the assembled CNC dividing head and
Photo 2 all the component parts.

Materials Required

The body

For the body of the unit, see (Fig 1), you require a block, when finished, 80mm x 80mm x 100mm of either mild steel or aluminium alloy. I used mild steel as I had a piece available. If I had used aluminium, then my preference would have been to fit a sleeve for the spindle to run in. This sleeve can be made of mild steel, brass or bronze; you will need a piece 90mm long and 25mm diameter. I simply drilled and finished the hole in the block with a reamer for my spindle. The bearing for the spindle needs to be parallel with a nice smooth surface finish. The maximum speed of rotation of the spindle is never likely to exceed 2 or 3 revolutions per hour, so wear is unlikely ever to be a problem! I have suggested a height for the block of 100mm, which will enable wheels of 200mm diameter to be cut.

The base

For the base, (Fig 1) a piece 10mm thick x 120mm x 80mm is needed. This can either be mild steel or aluminium alloy.

The spindle

For the spindle (Fig 2) you will need a piece of mild steel bar 25mm diameter, 140mm long. I suggest using EN1A leaded mild steel rather than ordinary mild steel as it is much easier to get a fine finish with the leaded variety. As the spindle rotates so slowly (one revolution for each wheel!!) it is unnecessary for the spindle to be hardened.

The worm and wheel

Many readers may have a worm and wheel available, which can be used for the project. I used the one from the dividing head that was supplied with my lathe. It is important that the worm and wheel has no backlash at all. I use the wheels I cut for precision clocks. For minimum engaging friction as the wheels mesh the tooth spacing must be constant. This is only possible if the worm and wheel have no backlash. Precision 60:1 worm and wheels are available from HPC Gears (Tel 01246 268080). If you are buying a worm and wheel I suggest a 1.25 Module. Make sure the wheel you order has a boss. The wheels come with a 12mm bore. HPC will for a small extra charge supply the wheel with a 16mm bore and a keyway. Get a hardened bore type worm. The bore type is easiest to use as this allows you to fit your own shaft for connecting to the stepper motor.

Worm wheel shaft and shaft housing

For the worm wheel shaft housing (Fig 3) you require a piece of 40mm x 40mm mild steel 50mm long. The worm wheel shaft runs in 8mm id 14mm od ball bearings set into the mild steel housing. The worm wheel shaft (Fig 4) is made of silver steel rod 12mm in diameter.

GEAR CUTTING USING CNC

Dick Stephen describes a lightweight stepper driven dividing head intended for clockmaking.

The major advantage of CNC is that it removes the tedium out of lot of repetitive tasks in the workshop. I have a Wabeco mill fitted with CNC which I use for clock making, my principal occupation since I retired. Until recently I used the CNC mainly for profiling skeleton clock plates and crossing out wheels. Cutting the teeth of the wheels was done on the lathe using a dividing head and hand feeding the cutter. Recently I made a skeleton clock with a large great wheel having 384 teeth. I managed to scrap the first wheel because I missed one hole when advancing the dividing head and only noticed the mistake when I cut the final tooth and noticed that it was a bit thin. At this point I decided there had to be an easier way to cut wheels, which was less prone to error, than doing it by hand.

Round that time, I had seen in the Horological Journal and Model Engineers Workshop adverts for electronic division units. Having CNC already available I did not see the point in duplicating what I already had by purchasing a ready made unit to do the divisions. I also had a very

accurate dividing head with a precision 60:1 worm and wheel that attached to my lathe. The big advantage of cutting gears on a lathe is that it is that machining the blank to size, boring the hole for the arbor collet and cutting the teeth can be carried out in a single operation thus ensuring concentricity. The easiest option would have been to replace the division plates with a stepper motor operated by the CNC drive unit. This would have still required the cutter to be traversed by hand. To achieve full automation I needed to construct a dividing head, using the existing worm and wheel, that could be fitted to the CNC mill.

The only thing I did not have to hand was a suitable stepper motor to drive the worm and wheel. Fortunately a friend had one he did not want which fitted my requirements precisely. With all the components available all that was needed was a suitable design. The only possible snag with the idea was maintaining concentricity. This was the most important parameter in the design of the spindle of my CNC dividing head. Photo 1 illustrates

Worm wheel mounting

plate

Fig 5a illustrates the worm mounting plate and Fig 5b the worm housing bush. The stub arbor on the side of the housing fits into a bronze bearing set in a 6mm aluminium alloy plate attached to the main body. The worm shaft housing can rotate about the stub arbor. This allows the depth of the worm and wheel to be adjusted as well as enabling the worm to be swung free of the wheel for assembly. For this mounting plate a piece of 6mm x 120mm x 140mm aluminium is required.

Stepper motor mounting

Fig 6 illustrates the mounting of the stepper motor. I used a size 23 motor for my dividing head. A piece of aluminium 6mm x 60mm x 60mm and a length of free machining aluminium rod 10mm diameter 300mm long will be needed to make the mounting bracket.

Additional items

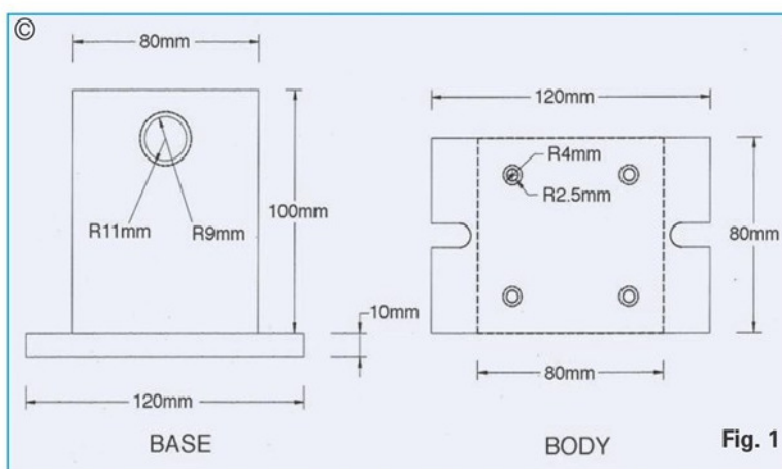
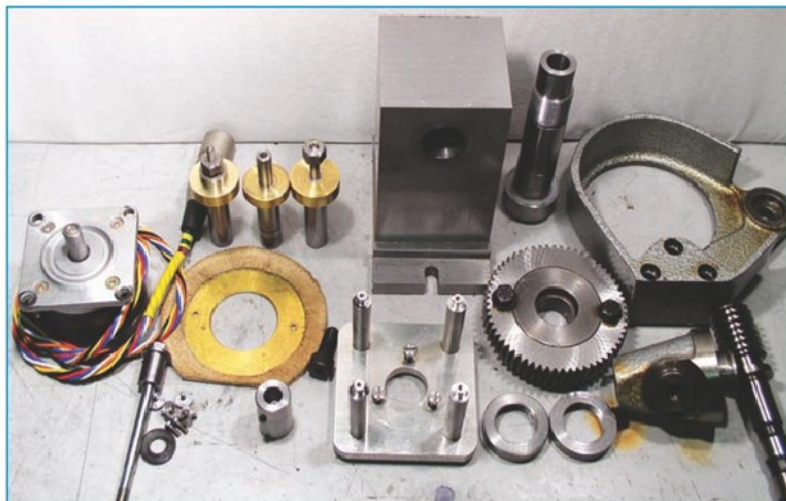
In addition to the above you will require the following :-

1. 2 off, 8mm i.d. 14mm o.d. ball races.
2. A short length (~25mm) of bronze 25mm diameter.
3. 1 length of 12mm diameter silver steel rod.
4. 1 length of 10mm silver steel rod for mandrels.
5. An Oldham coupling for coupling the worm shaft to the stepper motor. Oldham couplings are available from RS Components.
6. A 23 frame size stepper motor. Mine has a holding torque of 98 Newton cm. Stepper motors are available from McLennan Servo Supplies Tel 08707 700 700 or Arc Euro Trade 0116 260 5805
7. A strip of 1.5mm thick aluminium sheet 30mm wide and 300mm long to make a shroud to shield the worm and wheel from swarf, (Fig 5c).

The construction

When I constructed my dividing unit I was able to use much of the original dividing head that was supplied with my lathe. The design that I am describing here is based on the design of my original lathe unit.

Begin by constructing the main body and base of the unit. The dimensions of the body and base are shown in Fig 1. The precise dimensions are not critical or in other words use what you have or can get. It is however important to ensure that the sides of the body are all precisely square one to another. The upper and lower surfaces of the base must also be parallel to each other. To cut accurate wheels the blank must be precisely at right angles to the table, as well as at right angles to the X-axis, of the mill. The base needs two slots cutting as shown in Fig 1 for T-bolts to secure the unit to the mill table. The length of these slots has not been shown, as this will depend on the spacing between the T-slots in the table of your mill. After I had made my base and attached it to the body, I realised it would



have been much better to have attached the base as shown in the drawing. By then it was a bit late! Next drill and tap the holes in the base for the 5mm cap head screws that attach the base to the body.

The hole for the spindle should be bored in the body next. If you are using aluminium, this hole may be opened out to 22mm in diameter to accommodate a bronze sleeve for the spindle. If you are using mild steel for the body a bronze sleeve is not strictly necessary. In this case the hole should be 18mm in diameter. The diameter of the hole is again not critical as the bronze sleeve or the spindle will be finished to fit the hole, whatever its precise final size. I bored the hole in the body of my unit using a 4-jaw chuck in the lathe. The block was fixed in position in the chuck. The hole must be exactly at right angles to the front and back faces of the block. Check, using a dial gauge, the block is set correctly. Begin by drilling a 6mm pilot hole through the block. Expand the size of the hole using drills of increasing size up to 17mm (or 21mm) if you have appropriate drills. If not use the biggest drill you have and finish boring the hole using a very sharp boring tool. The final cut need to be no more than .05mm. Use suds and run the boring tool 3 or 4 times through the hole without altering the setting on the final cut. This should ensure that the hole has the same diameter all

along its length. The aim is the best possible surface finish if you are going to use the hole as the bearing surface.

If aluminium has been used for the body a bronze sleeve bearing should be made next. The dimensions of the bearing are shown in Fig 2. Again the precise dimensions are not critical. The bearing should be a close but not tight fit. The internal finish should be as good as possible. I would make the bearing just slightly longer than the body so that when the spindle rotates it does not bear against the aluminium surface. The bearing is secured in the body with Loctite bearing fit or if you do not have any of this, a small amount of 5 min epoxy will do just as well.

The spindle

The dimensions of the spindle are shown in Fig 2. The dimensions shown are appropriate for the 1.25 module 60:1 worm and wheel supplied by HPC Gears (if you are sleeve the spindle needs to be 3mm longer to accommodate the length of the sleeve). If you are using a different worm and wheel some of the dimensions will need to be changed.

Begin by drilling and reaming a 6mm hole (or any similar size hole for which you have a reamer) for the draw bar. Now drill

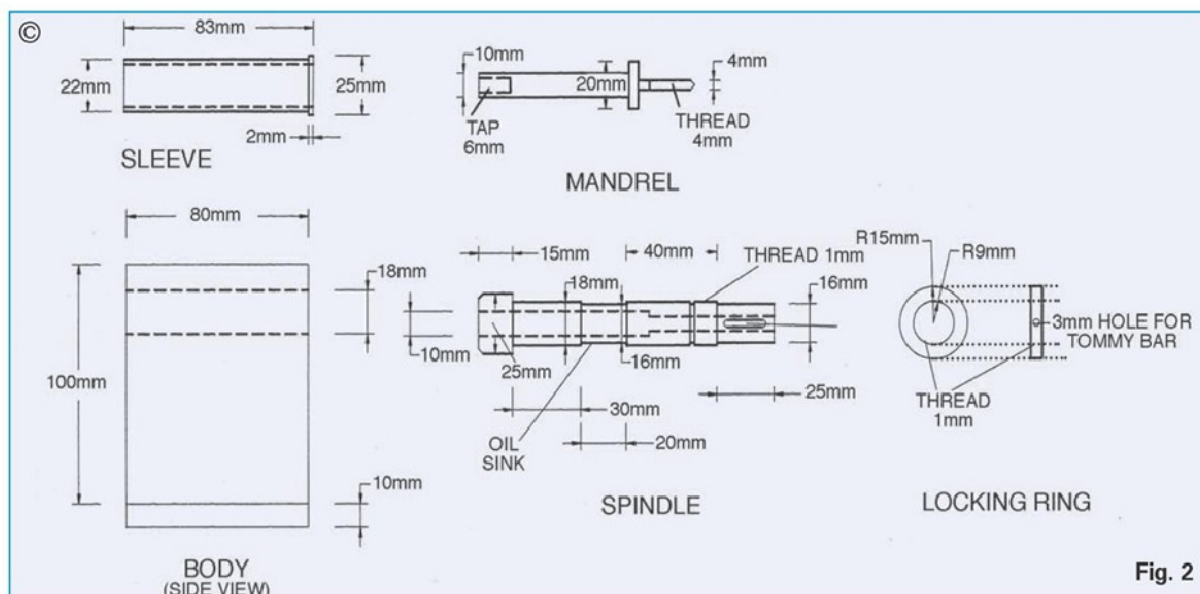


Fig. 2

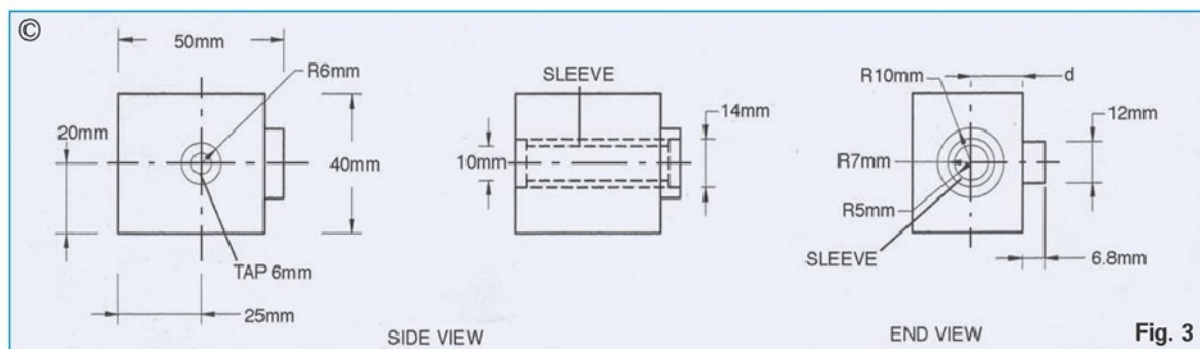


Fig. 3

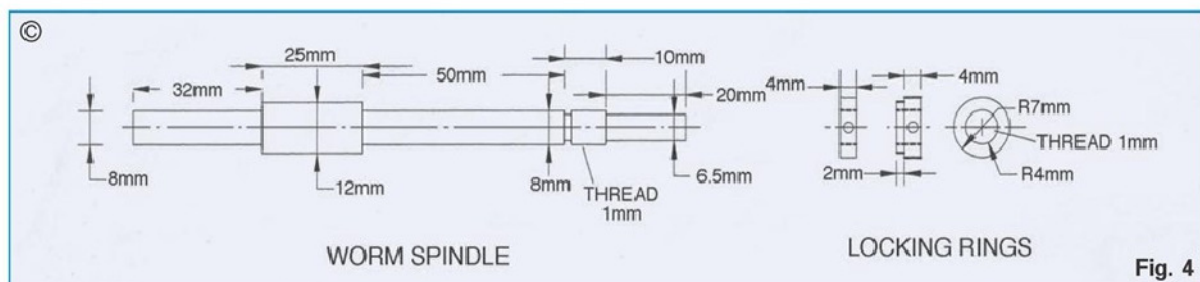


Fig. 4

and ream the hole to a depth of 75mm to 10mm (or any similar size hole for which you have a reamer) for the mandrel. The hole wants to be the diameter of readily available silver steel rod, which is used to make the mandrels on which the wheel blanks are mounted. Clean all swarf out the hole. Wipe some light oil on a length of the 10mm silver steel rod and check that it fits snugly in the hole without any detectable sideways play.

Proceed now to machine the rest of the spindle. To ensure absolute concentricity the spindle blank should be turned between centres. The end of the spindle can now be threaded 1mm (or any convenient fine thread). Measure the width of the key way in the wheel and mill a slot for the key in the end of the spindle as illustrated.

Finally make and thread 1mm (or any convenient fine pitch thread) the two

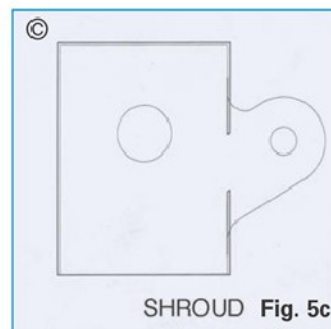
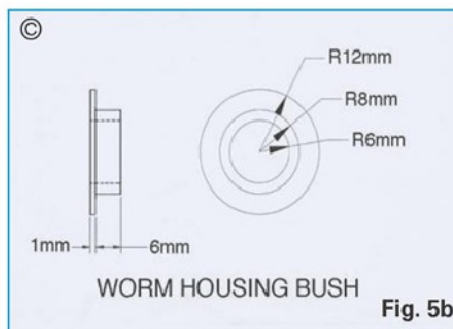
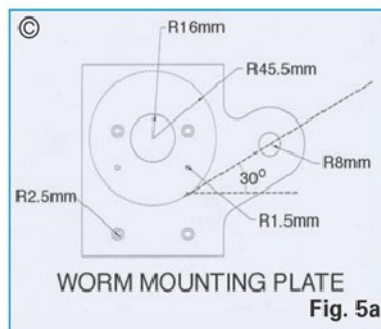
locking rings that secure the spindle in the housing. Fit the spindle in the bearing in the body and check that it rotates freely without any axial or sideways play. The degree of axial play is adjusted by tightening or slackening the two threaded locking rings.

The mandrels

A typical mandrel is illustrated in Fig 2. These are made from 10mm silver steel rod. I made 3 mandrels to accommodate wheel blanks with 4mm 5mm and 8mm centre holes. The end of the mandrel is drilled and tapped 6mm for a draw bar. I used a 6mm bolt for my draw bar. A 20mm diameter back support for the wheel blank is attached to the 4mm section with Loctite.

The worm mounting plate

The worm mounting plate that attaches to the body of the unit next. Fig 5a shows the position of the hole in the plate through which the main spindle projects. Mark the position of the centre of the hole. Set a pair of dividers to exactly 45.5mm, half of the sum of the pitch circle diameters of the worm and wheel (the dimension CTS in the HPC catalogue). With the centre of the spindle hole as centre scribe an arc on the plate as shown in Fig 5a. Now scribe a line tangent to this arc as shown. A bronze bush is set into the plate at the position shown into which a peg on the side of the worm spindle housing fits.



The easiest way of precisely drilling and boring the holes in the plate and cutting it out is to use CNC. Readers wishing to construct the unit are welcome to contact me by e-mail and I will send them a .dxf file of the plate. My e-mail address is given at the end of the article. Position the plate with the spindle in the centre of the hole and mark the position of the screw holes on the body. Drill and tap the holes for the screws. Secure the plate to the body. Now drill 2, 3mm holes for register pins. These register pins will enable the plate to be accurately re-positioned after the plate has been removed.

The 16mm diameter hole for the bronze bush is bored in the plate next. Finally the bronze bush can be made. The dimensions for the bush are shown in Fig 5b. The bush will be secured later in the plate using High Strength Loctite. Finally cut the plate to the shape shown in Fig 5a.

The worm bearing assembly

The layout of the worm assembly is illustrated in Fig 5a. Before commencing to make this, the precise distance "d" of the axis of the worm shaft from the mounting plate must be determined. Fit the wheel onto the main spindle. Now measure the distance from the plate to the centre of the perimeter of the wheel. Note this measurement, which determines dimension "d" in Fig 3. The worm spindle is the first part that needs to be made. The dimensions for this are shown in Fig 4. As the worm spindle runs in ball races there is no need for this to be hardened. As before I suggest you use EN1A for this spindle. The construction should present no problems, however, if your lathe is not equipped with collets the shaft will have to be turned between centres to ensure concentricity.

The worm bearing housing is made next. Set the block up in a 4-jaw chuck. Turn the block to length (50mm) and face off both ends. Scribe a line equidistant from two opposite edges and a second line $d + 5.8\text{mm}$ from an adjacent edge (see Fig 3) (note, the value of d must be reduced by 2mm if you are using a sleeve for the spindle). The intersection of these two lines marks the centre of the hole for the worm spindle bearing. Set the block up in a 4-jaw chuck centred on the intersection of the two scribe lines. Drill and ream a 14mm hole through the length of the block. If you do not have a reamer use a suitable boring bar. This hole needs to be accurately sized for the two 8mm by 14mm ball races on which the spindle

runs. Finally turn down the end of the housing to a diameter of 20mm for a distance of 6mm. This is for the plate for attaching the stepper motor.

Next a sleeve that is set in the hole you have just bored should be made. This sleeve is 14mm in diameter and 43mm long with a 10mm diameter hole. The sleeve is secured in the hole in the bearing housing 3.5mm (the width of the 14mm ball races) from each end using Loctite. This method of fitting the ball races at either end of the housing ensures that the two bearing will be precisely lined up and is a lot easier than trying to accurately bore recesses at either end of the housing.

In Fig 3 you will see that a 12mm diameter stub arbor 6.8mm long is turned on the side of the spindle bearing housing. This stub arbor fits into a 12mm bronze bush set (see Figs 5a and b) into the plate against which the bearing housing is secured by a 6mm cap head screw and washer. This arbor should be turned next. Grip the bearing housing in the 4-jaw chuck and accurately centre the housing. Turn down the side of the housing to 12mm diameter, making the peg exactly 6.8mm long. This will leave the distance from the turned face of the housing to the centre of the worm shaft equal to $(d-1)\text{mm}$. Adding to this the 1mm thickness of the flange of the bronze bush leaves the centre of the worm spindle the desired distance "d" from the surface of the plate.

Attaching the stepper motor

The stepper motor is coupled to the worm shaft using a device called an Oldham coupling. These devices allow for a degree of misalignment of the worm shaft and the motor shaft. In addition the coupling provides bi-directional shaft rotation with zero backlash. An Oldham coupling consists of a metal hub attached to each shaft and a nylon torsion disc that joins

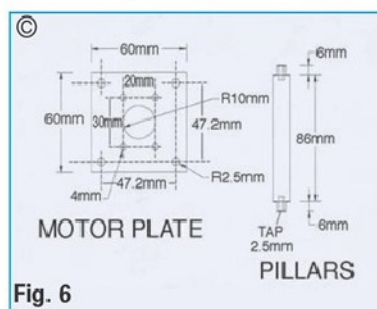
the two hubs. The shaft of the suggested stepper motor is 55mm in length and diameter 6.35mm (1/4 inch). Why is it after years of metrication things are still produced with some dimensions metric and others Imperial? Bizarre). You will need to purchase two 1/4 inch hubs for the motor shaft and worm shaft.

The dimensions of the plate and the positions of the holes for the pillars and the screws to attach the plate to the worm spindle housing are given in Fig 6. The holes, particularly for the pillars and the 20mm diameter hole must be drilled with as much precision as possible. The pillar holes must be accurately placed on the circumference of a circle centred on the 20mm hole. The Oldham coupling can only accommodate a certain degree of misalignment. I drilled the holes in my plate on my mill, which is fitted with a digital readout. It is likely that readers who are contemplating making the dividing unit will already have CNC and if they don't have digital readouts already fitted will be able to use CNC to position the holes. The holes in the worm spindle housing were not indicated in Fig 3. To mark the position of these holes fit the plate onto the end of the housing and use the holes for the 4mm cap head screws to mark the position of the holes to be drilled. Having marked the position of the screw holes drill them 3.6mm and tap 4mm.

The pillars should be made next. The length of the pillars should be 1mm longer than the length of the motor shaft (55mm) plus the length of the worm shaft extending beyond the end of the housing (30mm). The pillars using the suggested motor will then be 86mm in length plus a further 12mm (overall length of 98mm) for the ends of the pillars that insert into the plate and the motor. Start by cutting off four 100mm lengths of the 10mm diameter aluminium rod. If you have collets for your lathe this will make turning the pillars a lot easier. If you don't the pillars will have to be turned between centres to ensure adequate precision. Drill and tap the ends of the pillars for 2.5mm screws (or equivalent). I used the left over aluminium rod to make eight washers for the screws. Drill a 2.5mm hole in the rod and part off eight 1mm thick washers. These look so much better than those one can purchase.

The shroud

The worm and wheel needs to be protected from the fine particles of swarf that are produced during the cutting of gear teeth. Brass causes a particular problem as the swarf is almost like dust and seems to get everywhere. To obtain



the minimum backlash between the worm and wheel the two need to be quite tightly meshed. Any swarf on either the worm or wheel will make them bind and lead to errors in the tooth spacing of the wheel being cut. To minimise the ingress of swarf a shroud needs to be attached all around the stepper mounting plate. The shroud is made from the length of 1.5mm aluminium strip bent to conform with the outline of the plate as illustrated in Fig 5c. It can be attached to the edge of the plate with 2mm (or equivalent) screws. That completes the construction of the dividing head.

Using the dividing head to cut wheels

Before the dividing unit can be used it is necessary to calibrate the CNC drive system. The easiest way to describe this will be to explain the calibration of my unit.

The stepper motor suggested for this unit and the one I used are 1.8 degree or 200 steps for a full rotation. I use a X10 microstep drive unit thus giving me 2,000 steps per revolution. The worm and wheel has a 60:1 reduction. The total number of steps required for one complete rotation of the spindle is then $2,000 \times 60 = 120,000$ steps or dividing by 360 gives 333.333 steps per degree.

I use DeskCNC software, which allows more than one machine set-up to be stored. Before I fitted a 4th axis driver to my unit I saved a machine set-up called

gear cutting with the Y-axis set to 333.333 steps permm (in reality degrees) which I used to drive the dividing unit stepper motor. I was able to do this since the leads to the steppers on my mill plug into sockets attached to the motors. I have an aversion to locking an axis of the mill and then applying power to the stepper. If the motors on your mill are permanently wired in, it is worth fitting plus and sockets to all three of the motors. The X-axis drive is used to move the gear cutter. The Z-axis motor is left unconnected and the axis is locked after the height of the cutter has been set. The disconnected Y-axis is also locked after the depth of cut is set.

G-Code programming

Programming the dividing unit is simplicity itself. I use DeskCNC software, which uses G-code to control the stepper motors. The DeskCNC has the facility to write and edit ones own G-code programmes. To illustrate the procedure of generating a G-code routine for dividing, suppose a 90 tooth wheel is to be cut. The first step is to calculate the angular separation of adjacent teeth. For a 90 tooth wheel this is $360/90$ degrees or 4 degrees. Next the distance the cutter has to traverse has to be estimated. For a wheel with a thickness of 1.5mm a traverse of 10mm is adequate. Finally the cutting speed has to be decided, 40mm/min is a reasonable cutting speed. The G-code routine can now be written to cut the first tooth, it is

```
F40
X-10
X0
Y4
```

Let us analyse each step in turn. The first line instructs the computer to set the feed rate at 40mm/min (the feedrates in DeskCNC are set in mm/min). The second line instructs the computer to move the table a distance of 10mm to the left along the X-axis from the start position. The third line moves the table back to the start position. The last line instructs the dividing unit (Y-axis) to rotate 4 degrees. Everything is now set to cut the next tooth. The next three lines of code are as expected

```
X-10
X0
Y8
```

The same three lines are added incrementing Y by 4 each time to cut the remaining teeth. For a 90 tooth wheel I increment Y until up to 120 (30 teeth) and then stop. The programme is then run two more times to cut the remaining 60 teeth. The segment of code is saved on a floppy disc for use later whenever a 90 tooth wheel needs to be cut. For any other division the number of teeth required is divided into 360 and the resulting value used to increment the "Y-axis". If you are able to write computer programmes or know someone who can it is a very simple job to write a programme that will automatically generate the G-code using the input parameters feed rate, X-axis traverse and the required number of teeth.

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IN OUR NEXT ISSUE

Coming up in Issue No. 123 will be



ER32 Collet Chuck

Harold Hall describes building a version for the lathe



Turning Tools for Beginners

Bob Loader discusses tool materials, shapes, and sharpening



The Quoin and other Pushers

A review of compression devices from Philip Amos

Clamp On Straight Edge

Malcolm Leafe offers a metalwork project for woodworkers



Issue on sale 9th March 2007

(Contents may be subject to change)

Background

The CentreCam described in a previous article had been designed and built around a Logitech QuickCam Express webcam. These are low cost 640 x 480 pixel devices that are readily available from a number of suppliers. It did establish the principle and together with bespoke software written by the author proved to be very useful. The previous article did identify one problem and in this article this is addressed.

The lighting problem

The main difficulty encountered was that of illumination. Because the camera is close to the work piece it tends to shield attempts to apply external illumination using the normal workshop lighting arrangements. It was difficult to achieve uniform illumination and because the light was generally projected low down from the side of the work piece, it gave rise to many extraneous glints and a one-sided bias. Additionally, the overall light levels changed significantly when one moved around the workshop because of variable shielding of ambient light.

Various low-level settings of the webcam driver software were tried. The Logitech software allows user setting of exposure, gain, brightness, contrast, hue, saturation, sharpness, white balance and gamma correction. It also has a low-light boost mode and an auto mode for brightness and contrast adjustment. Combinations of all of these were tried to reach an optimum result under different conditions and with different materials – aluminium, brass and steel. Whilst the system was certainly functional and usable, better illumination would clearly improve it.

Possible solutions

Many commercially available optical alignment systems do have built in illumination, as do microscopes and workshop projector systems. Historically, these have used small or miniature low-voltage incandescent light bulbs. However, there is general tendency in the area of scientific instruments to move towards light emitting diodes (LEDs). These are semiconductor devices that emit light when they pass a current but because they have no filament are inherently reliable. They are also very efficient and therefore do not get hot. Originally, LEDs that emitted red light were only available. Since then manufacturers have developed LEDs that emit blue, green, yellow, infra-red, UV and white light.

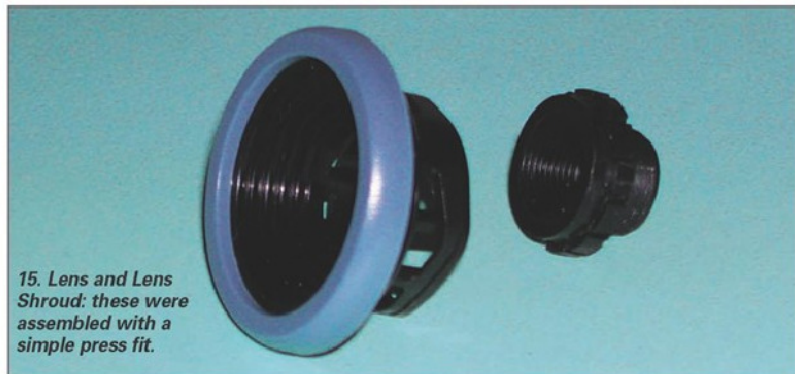
LED illumination

It was decided to try using white LED illumination with the CentreCam. A 5 Volt source is conveniently available on the webcam circuit board that is derived from the host computer. The magnitude of current being considered here is well

CENTRECAM

2

Mike Trethewey improves clarity by adding illumination



within the capabilities of this supply. To achieve a uniform illumination a ring of six LEDs was considered. The maximum light output from a single LED is more than adequate for this illumination job but by using six, symmetrically placed around the camera lens, driven with a very low current, it was hoped that a more uniform source would be achieved.

The electrical circuit for the LEDs is shown in **drawing 1**. It is very straightforward; each LED has a series resistor and they are all placed in parallel across the supply. The value of the resistor determines the current in each LED and this is chosen to adjust the light level. According to the LED specifications a current of 20 mA gives the maximum light output. This was tried and it was found to be far too bright. Eventually, resistor values of 10 k Ohms were selected giving LED currents of 100 μ A; this is 200 times lower than the maximum.

Resistor values

The calculation of resistor value to achieve a required current is a straightforward application of Ohms Law. This states that the resistance, R , is given by:

$$R = V/I$$

where V is the voltage across the resistor and I is the current flowing through the resistor.

The voltage across the resistor is derived from the power supply voltage ($V_+ = 5$ V) and the forward voltage drop of the LED (V_F). The white LEDs used by the author have a forward voltage drop of 4 V when the current is 20 mA. This will be slightly lower with lower currents but the relationship is not linear and 4 V can be assumed for design purposes. (Note that, different colour LEDs and different manufacturer's LEDs have different forward voltage specifications; for example, red LEDs are typically 2.5 V.)

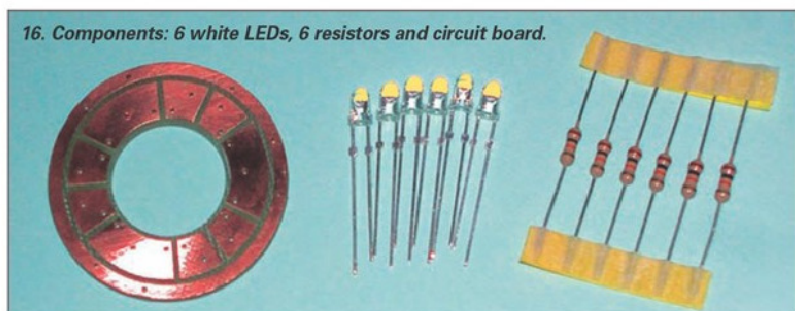
The voltage across the resistor is given by $V_R = (V_+ - V_F)$

and the required resistor is therefore $(V_+ - V_F)/I$

Substituting the appropriate values for this project we have

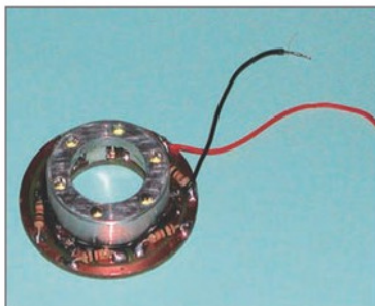
$$R = 5.0V - 4.0V/100 \mu A = 10k \text{ ohms}$$

The power dissipated by this resistor is very small ($\sim 100 \mu$ W) and therefore miniature (including surface mount resistors) can be used.

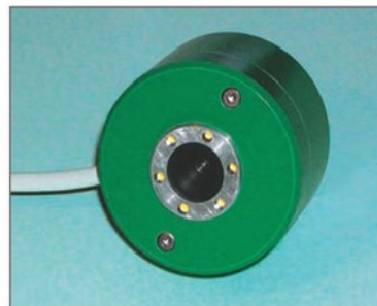




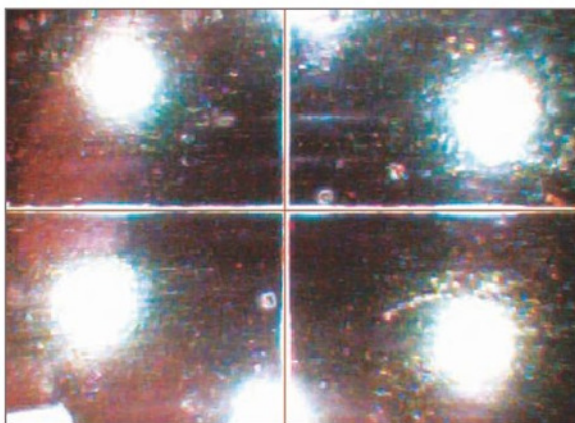
17. Assembled Circuit Board: note that the components are mounted on the copper track side of the board.



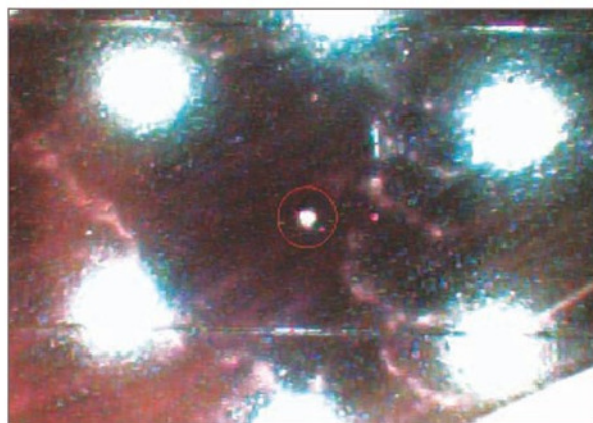
18. Assembled Circuit Board with Support Ring.



19. Lighting Ring Integrated in CentreCam Unit.



20. Scribed lines on blackened brass.



21. Centre pop on blackened brass.

Construction

A drawing was prepared to show how a small circuit board with the necessary support components and LEDs could be fitted to the CentreCam (**drawing 2**). In this new layout the lens shroud was removed (actually, this had already been removed as discussed in part 1) from the lens (**photo 15**) to provide room for the LEDs. Conventional wire ended resistors were used; small surface mount components are available but they tend to be more difficult to buy in small quantities and much harder to solder into place because of their small size. Space is limited between the camera lens support spider and the top of the camera housing.

It was decided that the components could be fitted on a small circular circuit board that sat on the lens support spider

and a small aluminium ring to support the LEDs could be mounted on top. A drawing of the circuit board is shown in **drawing 3** and component with this board are shown in **photo 16**. Again, no dimensions are given; it is left to the reader to adjust these to suit the camera and components used. Great care must be taken to ensure the support ring does not short any of the electrical contacts. It should sit firmly onto the zero volt regions of the circuit board but not the other copper tracks. Alternatively, it could be made from an insulation material (such as nylon).

The board was cut to shape on the lathe. Three pieces of board were sandwiched together and then cut to size (inner and outer diameters). The reason for using three was that it prevented tearing of the centre board and therefore a very clean edge was achieved. The outer two boards were sacrificial although in practice

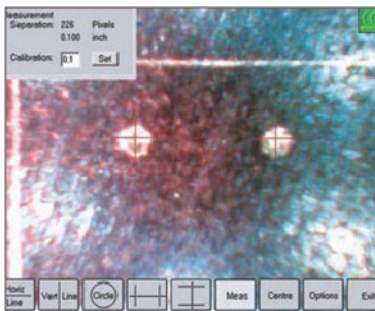
they were probably usable. This technique may not have been necessary especially if a higher speed lathe were available.

The circuit board was not etched, as is the conventional way. It is very simple and therefore easy to mill with a 0.8 mm endmill. This proved to be very successful. The board was assembled as shown in **photo 17** and **photo 18**. Note that the components are mounted on the copper track side of the circuit board; this allows the board to sit firmly on the lens support spider. After some additional removal of metal from the inside of the housing it was successfully fitted to the original CentreCam (**photo 19**).

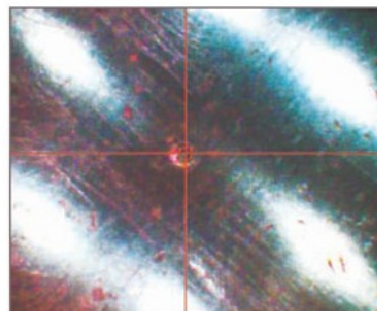
The final wiring does require connections to the Logitech webcam circuit board. This is straightforward but great care must be taken when soldering the power supply wires to the board. Gaps between tracks are very small and it is all



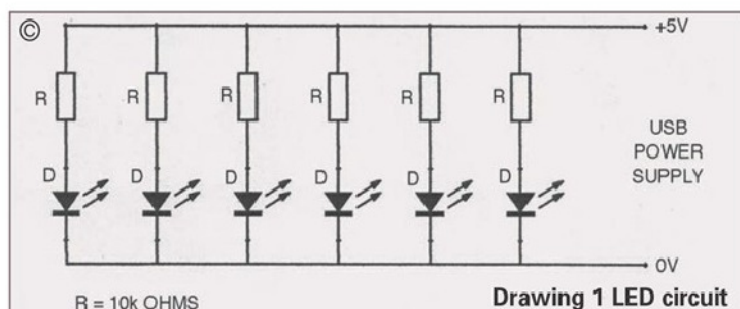
22. Alignment to a hole on a plain brass work piece.



23. Measurements on blackened rough mild steel.



24. Alignment to a centre pop on aluminium.



Drawing 1 LED circuit

too easy to bridge one of these accidentally. It is a good idea to check the connection with an eye loupe or magnifying glass before powering up the device.

If the reader is going to embark on this form of illumination it is important that:

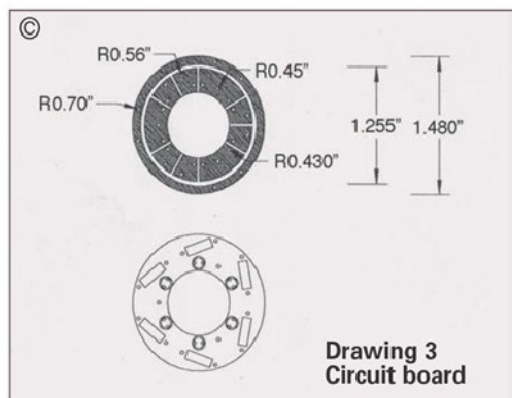
1. only resin flux cored solder is used,
2. the webcam is disconnected from the computer before soldering, and
3. visual checks are made afterwards to ensure no short circuits.

Most computer USB ports are protected against short circuits so it is unlikely that any damage will be done to the host computer, but they are likely to damage the webcam.

In use

The LED illumination certainly made a difference. Most importantly it made the illumination more consistent and avoided the need for fiddling around with the external light source – a huge benefit. More consistent lighting meant that one set of camera settings (gain, exposure, brightness etc) was adequate for all materials.

However, the discrete sources of light within the LED were very noticeable. Although the light is projected in a cone bright spots are apparent. This does depend on the material and surface finish of the work piece. A mirror finish makes this very apparent. However, we do not often work with mirrors and materials like brass can be blued. In any case, the point on the screen of interest is the centre not the periphery. It is easy to ignore the brighter spots and concentrate on the region of interest. Some practical examples of the CentreCam in use are shown in photos 20 to 24.



Drawing 3 Circuit board

Measurement accuracy

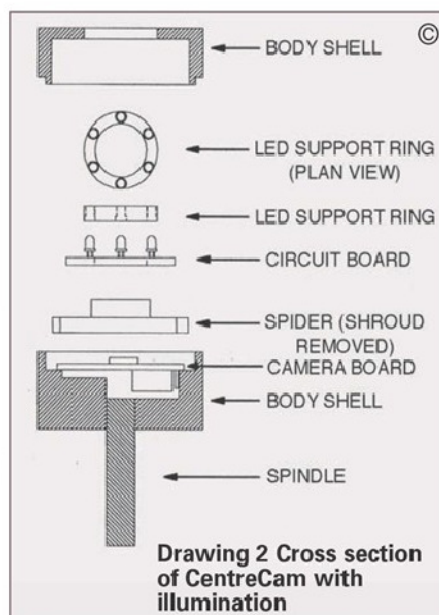
To round off it is worth commenting more on the use of the CentreCam for measurements. These can be performed in two ways: firstly by direct measurement from the camera image, and secondly by using the milling table X and Y scales. The first method is limited to the field of view of the camera and to its calibration accuracy. In the author's case the field-of-view was chosen to be 0.64×0.48 inch. The measurement accuracy is determined by how well the calibration is performed and if the camera height is disturbed how accurately it is restored. If the calibration is carried out at one height setting and then reset to a different height setting the error is function of the lens field of view angle. If, as in the author's case, a 90 degree field-of-view lens is used then a 1 thou error in height setting will lead to a 2 thou error in distance measurement. That is there is a 2:1 magnification of error. Clearly, height setting is very important. If a standard rule is used for calibration (see photo 8, part 1) then its thickness must be allowed for by resetting the height of the camera above the work piece surface.

If measurements are made using the second method then the CentreCam is only being used as an alignment reference and its calibration and height setting is unimportant (provided it is focused). In this case it is the accuracy of the milling table's X and Y scales that are important.

Height gauge block

If measurements are to be made with the field-of-view of the camera then clearly the height of the camera above the work surface is critical. To aid the setting and resetting of this height a simple height gauge block was made. This is a cylindrical block of length made to the exact height setting with a cut-out with clearance for the lens assembly. No drawing or dimensions are given here because the actual design will depended very much on the reader's camera housing and the chosen focus height.

In use, the gauge block is placed on the work piece and the camera body brought down to sit on top of it. The quill readout is zeroed and the block is removed. It is then only a simple matter to return



Drawing 2 Cross section of CentreCam with illumination

the camera body to the exact height when required. This gauge block prove very useful and as a bonus also proved a stand on which to rest the CentreCam when not in use.

Conclusions

The inclusion of an LEDs light source has improved the usability of the CentreCam. The illumination is more consistent and although the six LEDs are reflected to give peripheral spots these are easily ignored. If anything the light source is too bright, so increasing the value of the LED series resistors may be desirable but the author has not tried this. Consideration has also been given to using some form of diffuser or filter to reduce the spot effect. This may lead to a future modification in the future.

Components

All of the electronic components can be sourced from Maplins, RS Components or Farnell:
 6 off White LEDs, NSPW310BS, 2mm, 60deg. angle of view.
 6 off 10 k Ohm, 0.6 W metal film resistors.
 1 piece of copper clad board, single sided.

Websites:

www.maplin.co.uk
rswwww.com
uk.farnell.com

Software

The CentreCam software is available to readers. To obtain a copy please contact Mike Trethewey by email at miketreth@mistral.co.uk or via the web site www.miketreth.mistral.co.uk.

RENOVATING A MYFORD SUPER-7

Mike Thurgood discusses making the top slide assembly, work on the carriage, the motorising assembly, the headstock assembly, making a new tray and raising blocks for the cabinet stand.



37. Machining the tool platform on the top slide casting.

Top slide feedscrew assembly

Getting back to the subject of the top slide feedscrew: first the Acme threaded length of the old cross slide feedscrew spindle was cut off below the adjusting collar and just clear of the damaged part of the thread: this shortened the spindle to the required length. A $\frac{1}{4}$ in. diameter hole was drilled in the adjusting collar end of the spindle to a depth of $\frac{7}{16}$ in. (~ 11 mm).

The cut feedscrew was next turned down for about $\frac{3}{16}$ in. until it was a light push fit in the $\frac{1}{4}$ in. diameter hole in the adjusting collar piece. The two parts were then silver soldered together. So now I had a "new" feedscrew for the proposed new top slide assembly. The reconstituted feedscrew was shown earlier in **Photo 10**. The odd length of Acme thread seen in that photo is the short length that was cut from the original longer feedscrew – I really don't know why I included that bit in the photo! Because the original steel micrometer dial had been damaged at its graduated end, as was shown in **Photo 4** in **Part I**, I decided to replace it with a new one rather than make one. No doubt the damaged one will come in useful for

something else at sometime or other. Never throw anything away!

My main reason for buying the micrometer dials rather than making them is that my number punching is not up to a very good standard – it really requires a proper jig to achieve optimum neatness, which I have never got round to making.

Top slide assembly

This was absent altogether. To buy one or not to buy, that was the question - with apologies to Will Shakespeare. There wasn't really any problem about machining a new one because I had machined a complete top slide assembly for my first Super-7 a long time ago using CI castings imported from Britain. At the same time I took the opportunity to incorporate the 360 degree rotation capability because the original design was identical to that on early Myford ML7 lathes. This earlier conversion required the large diameter hole to be bored through the cross slide. It gave me perfect service for many years, including producing my thread-cut Acme feedscrew and matching bronze nut, threaded with an Acme tap obtained from Tracy Tools Limited.

Because I had already made the feedscrew - see above - it only required the two castings to be able to get on with the job. Once again I got Pex Foundry to cast the items for me in SGI. In any case,

the cost-effectiveness of getting castings made here wins hands down. But of course the whole exercise was only cost effective for me because I was able to do the machining myself, otherwise the story would have been quite different. The foundry who cast the cross slide for me had polyurethane patterns made from the top slide and its base which I temporarily removed from what was then my daily working Super-7.

These polyurethane patterns are packed in a mould box and left *in situ*. In this way two matching halves of the mould box are not required because the pattern is literally consumed in the casting process.

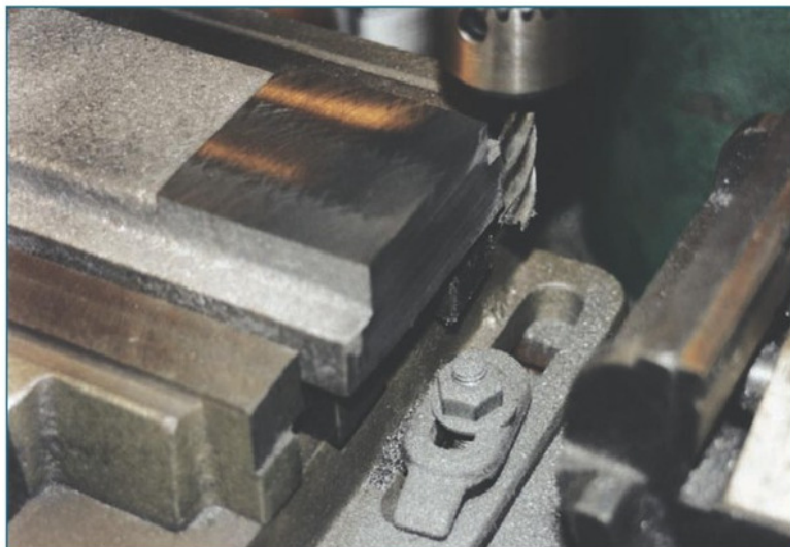
The disadvantage is that it's a once-off process, but it makes life far easier for the foundry moulding shop. But since I am not intending to go into the business of making cross or top slides, I decided on the same route, which avoided the necessity to make recoverable wooden patterns.

Interestingly, some other items which I had the foundry cast for me later for a totally different job, and for which I made recoverable patterns in wood, cost considerably more. This was because of the additional work and time that was necessary to mould the sand in two mould boxes so that the two keyed halves were separable for removing the pattern. An interesting point to remember.

No photo was taken of the raw castings. Some of the machining operations are shown in **Photos 37 to 40**. **Photo 36**, in the



38. Machining one of the edges on the top slide casting.

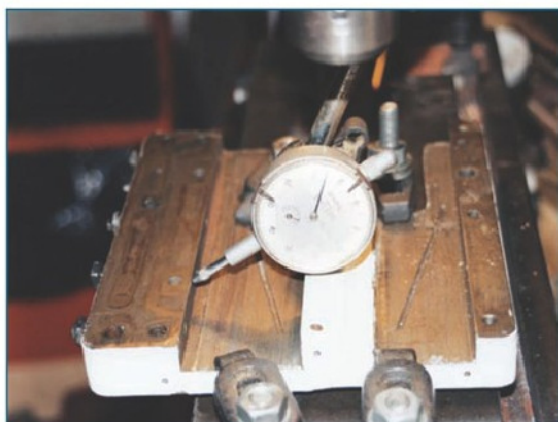


39. Machining the front edge of the top slide casting. Although the vice jaw nearest the camera is gripping against an unmachined edge of the casting, the other machined edge is hard against the fixed jaw of the vise. Therefore the casting is located squarely.

previous instalment, showed the completed cross and top slide assemblies mounted on the now working lathe with an adjustable tool holder mounted on the topline. I will refer to these tool holders again later.

Carriage assembly

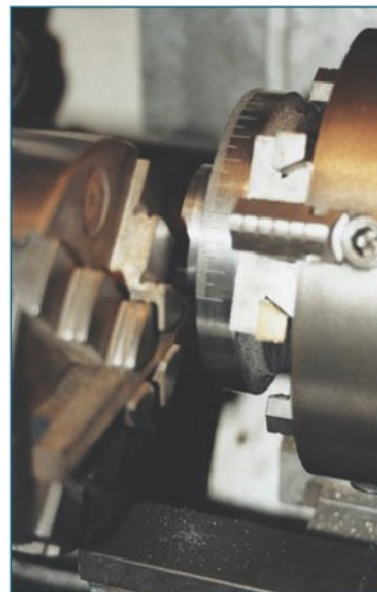
There wasn't a great deal wrong with the underside of the saddle itself. Its front bearing surface was checked for straightness along its length using a dial gauge – see **Photo 41**. Other wearing surfaces were very evenly, but lightly, worn and therefore they didn't require any work on them. However, the upper surface wasn't so good. Thus the previous cross slide had quite badly and unevenly worn down the faces of the apron on which it rests and slides. It was so bad, in fact, that the level was below that area on which the travelling steady is bolted. This depression is visible in **Photo 42**, where it can be seen along the uppermost surface in the photo.



41. The cut-outs under the apron which slide along the flat latheways on the bed were checked with a dial gauge, set up as shown in this photo. No serious uneven wear was detected.

The veeways looked as though they had for some reason been ground by hand, giving them a rough and uneven finish, such as would be obtained using emery paper. Not very precise at all. The apron was set up square on the mill/drill table as accurately as was possible using a dial gauge, and very light cuts were taken along both vees with a 45 degree dovetail cutter – see **Photo 43**. At the same time the horizontal surfaces were also machined – using the end faces of the dovetail cutter – to exactly the same depth on both sides of the apron. Machining these two surfaces to one width of the dovetail cutter was adequate because there was no obvious reason to go wider than the sliding surfaces on the new cross slide.

One can only guess at the reason for this amount of wear to have occurred. Certainly I never had such wear either on my Myford ML7, which I used for around 30 years, nor the first Super-7. Maybe highly abrasive swarf, possibly from a ceramic, or emery dust or even sand, was responsible. But, just as in the case of vehicle engine



40. This photo shows the degree graduations being marked on the circular ring of the base casting for the top slide, using the Sparey changewheel dividing head – out of the photo, to the right.

crankshafts that require regrinding, one doesn't normally bother to enquire why the wear has occurred. The only consideration is to get the job done. No doubt wear on aprons is considered to be perfectly normal, the remedy being to have it remachined, with no other thought about why an unexpected amount of wear has occurred.

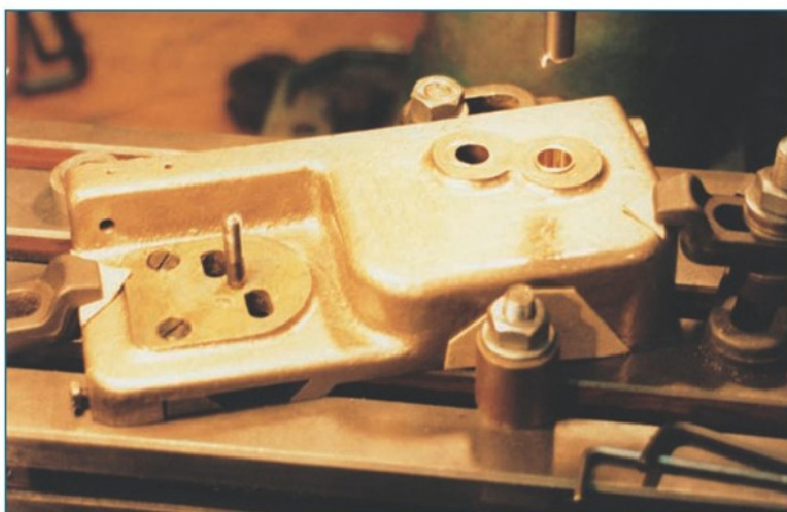
One of the grease nipples in the carriage had been broken off leaving just the threaded stem. This was removed by inserting, and lightly tapping in place, the five sided tip of a small taper reamer of the sort used to make taper holes for small taper pins. The nut, bolt and eccentric washer which are used to clamp the saddle to the lathe bed were missing – I machined replacements for them. The badly worn oval hole in the apron was drilled oversize and fitted with a phosphor bronze bush, and bored to give a small clearance for the new hand traverse pinion



42. This photo shows the upper face of the apron. The original machined surfaces on both sides of the veeway along which the cross slide engages had both been quite badly worn below the original level. The surface on the headstock side – ie with the two slotted screws in the mounting holes for the travelling steady – had the worst wear, which can be discerned in the photo. The piece of cardboard is obscuring the apron on that side closest to the camera – there was some reason for putting it there for the photo, but I can't remember why!



43. This photo shows the apron mounted upside down on the mill/drill table and how it was set truly square, using the dial gauge along a vee way as a datum. A straight edge was first placed along the vee groove to check that it was straight, and hadn't been worn to an uneven shape. It hadn't been. The vees were very lightly skimmed with the dovetail cutter, which was lowered sufficiently to provide clean surfaces to an identical depth on both sides, against which the top slide bears. The part-circular marks from the dovetail cutter can just be discerned on the right. The width of the slightly depressed re-machined surfaces were made slightly wider than the corresponding surfaces on the new cross slide.



44. The apron casting is shown here, still mounted on the mill/drill table, after finishing the re-boring of the hole for the new hand traverse pinion arbor, and into which the phosphor bronze bush has been fitted.

arbor – see **Photo 44**. The centre distance as provided by Myford's was 1.02in.

The original knob on the carriage handwheel had been lost and replaced with a rather odd-looking turned down length of hexagon steel rod, now rusty – this can be seen in **Photo 4** in part 1. A new stainless steel handle was turned to a more acceptable shape and fitted, but because the $\frac{1}{2}$ in. BSF thread in the handwheel rim had been damaged, the thread die was set to cut a slightly larger diameter thread in the hope that it would provide a suitably tight fit – it did, in fact, although the opportunity was taken to Loctite it as well.

Lathe motor – single phase - and rotary switch

The single phase capacitor start motor was manufactured in South Africa by Femet to comply with a South African Bureau of Standards national standard. Its output is rated at 0.37 kw (nom. 0.5 HP) at 50 Hz. The output shaft is $\frac{1}{2}$ in. diameter, perhaps unusual for a fractional HP motor which might be expected to measure $\frac{1}{4}$ in. diameter (or its metric equivalent nowadays, of course). After cleaning and

repainting it I had the motor checked that it was in good working order and that there were no reversing problems. The motor is a little noisy, even though new bearings were fitted, but the noise level is tolerable. The firm who did this job for me insisted on giving the motor another coat of paint!

Readers may recall I mentioned in an earlier part of this series of articles that the only leads going to it from the reversing switch were the two for the mains supply plus the earthing wire. It has to be assumed, therefore, that the previous owner had no requirement to be able to reverse the motor.

An important safety item that required to be dealt with was replacing a missing threaded plastic cover for the terminal end of the starter condenser. Because I didn't propose to reproduce the thread, instead I turned a disc from a piece of 6 mm thick rigid PVC with a flange, to be a light push fit in the end of the cylindrical condenser shell, and stuck it in place with PVC adhesive. When I had the motor checked I had the barrel-type reversing switch checked at the same time. I didn't know how its internal rotary contacts had been arranged, but they were completely unrepresentative of anything that could be used for reversing. I was told that it was scrap! Actually what they were telling me was that the cost of the manpower to dismantle it, etc, would far outweigh the cost of a new switch. So the \$1000 question was: did I really have to buy a new one?

To find the answer to this question I dismantled the switch, which wasn't any problem. There were five wafer discs in it, three with two wafer contacts, the other two with three. Three of the wafer discs were recoverable, but two were totally ruined because of burning of their phosphor bronze wafer contacts by electrical arcing. (These switches are often used as on/off switches as well as providing the reversing function, and when used in the on/off mode progressive burning of the contacts obviously occurs after long usage). The main structure of the switch was in good order, and three of the wafer discs were in perfect condition. These three wafers provided sufficient contacts to be able to reassemble them in such a way to provide a reversing capability, but I definitely wouldn't attempt to use such a switch again in an on/off mode. The damaged wafers were discarded. A lesson on this one is, I suppose, why throw things away if they really are recoverable?

Motorising assembly and headstock belt guard

There were no broken or cracked components here. The spring-loaded roller and plunger assembly in the countershaft support bracket – which retains the headstock cover in the open position – had become stuck but it worked perfectly again after removing, cleaning and oiling. But there's an unfinished tale about this plunger which I will deal with later.

All the covers were carefully examined to see if there were any cracks or other damage to them. They were all found to be



45. The belt guard required the cutouts nearest the camera to be built up and smoothed to remedy the rough way that they had been enlarged with a hacksaw, as was shown in Photos 17 & 18. This photo shows it after painting.

in sound condition, and even the untidily enlarged cutouts in the headstock belt cover to provide more clearance for the swinghead hadn't caused serious damage to it – I will deal with these cutouts in more detail later. That there was nil or minimal damage to these components was very surprising in view of the way that other parts of the lathe had been maltreated.

One of the countershaft oil cups in the swing head assembly was missing. It had, in fact, fallen out of its housing and was found stuck in dirt and oil in the swing head assembly. Both oil cups were cleaned of the grease which had been incorrectly used at some stage, and they were refitted to the countershaft bracket on reassembly. The major blemishes were the cutouts in the headstock belt guard which provide clearance for the bearing ends of the swing head assembly. These had been enlarged, but very roughly, as was shown earlier in Photos 17 & 18.

In addition, the extra cutouts weren't quite symmetrical on the two sides. Because the increased size of these cutouts wasn't excessive, rather than attempt to replace the missing metal I decided to clean up the edges, ensuring that both sides were symmetrical in the process, and then re-model the missing originally cast-in beading using Pratley Steel Quickset epoxy resin. However, these rough cutouts weren't the only problem with this belt guard. As was seen in Photo

5 in Part I it didn't seat down properly on the rubber buffers in the headstock front edge. In fact, the cut out on the RHS which is intended to clear the front taper bearing housing on the headstock was, in fact, fouling it, thus preventing the cover from seating down. However, the cutout on the LHS wasn't causing any such trouble.

The belt cover certainly didn't look as though it had been bent out of shape, and no adjustment of the hinge bracket would offer sufficient compensation to make it fit without setting it badly out of its proper location. There was no alternative but to file this cutout larger until it provided the necessary clearance over the front bearing housing. Luckily the work described above to remodel the edges to the enlarged cutouts didn't, in my opinion, spoil its appearance, and the variation from the original would be most unlikely to be noticed except by having an original belt guard alongside to compare it with. Photo 45 shows it finish-painted, white on the inside. Photo 46 was taken before the belt guard finally fitted properly over the front bearing housing and on to the PVC buffers in the headstock. However, this photo does show that I had now reached the second significant stage in the renovation of this lathe. Photo 47 shows the belt guard in close-up, and it can be seen to be fouling the front bearing housing. But after filing off at least 5 mm round the far edge of the cut-out, it finally fitted in position to my satisfaction – see Photo 48.

The enlarged cut-outs in the belt guard are adequate to prevent any contact with the swing head when it is moved to release the belts. A useful point this, because the swing head on my first Super-7 always clanged against the belt guard when the belt tension was released. However, that was most likely a function of having fitted a longer belt than recommended. (There was a story about this belt, which I will discuss later).

Headstock assembly – its removal and replacement

When I renovated my first Super-7 I decided not to remove the headstock casting. The reason for this was, as I naively thought, to save myself the work of having to realign it on its machined bed on reassembly. I needn't have worried because I found out with this second lathe, having removed the headstock, that its location is pre-determined by two machined axially oriented vertical locating faces. These two faces are held together with two set screws which are screwed through the front edge of the bed flange at the lathe head, just above where the gearbox is mounted.

Alignments

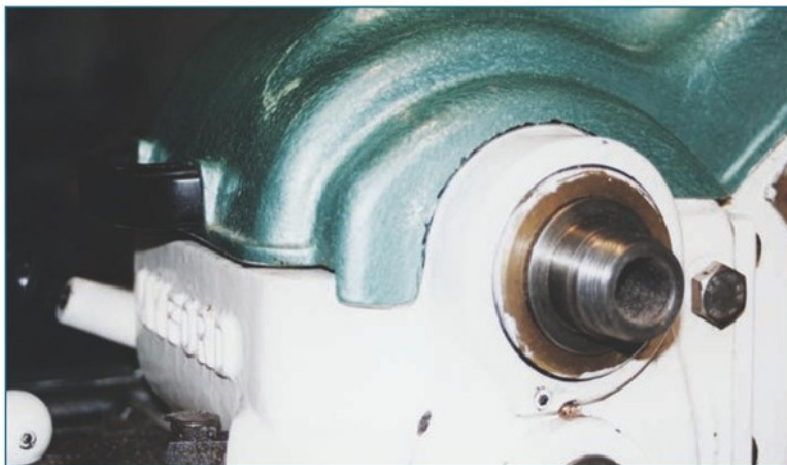
Apart from the alignment of the mandrel in the headstock being required to be truly parallel with the longitudinal axis of the lathe bed, clearly the exact transverse location of the mandrel with that axis is not critical. Proper longitudinal alignment will ensure true parallel overhung turning from work mounted in a chuck. What is critical, of course, is that the axis between the mandrel and the tailstock centres shall line up exactly with the longitudinal axis of the lathe bed, and be the same vertical height from the bed along its length. Only in this way can between-centres turning come out truly parallel. And that alignment is achieved by carefully adjusting both the transverse position and height of the tailstock by shimming, if the latter is necessary.



46. The tailstock end of the newly painted lathe, partly assembled. The stage when this photo was taken was the second milestone in the renovation work on it. However, the belt guard was not yet properly fitting - - -



47. - - - as can be seen in this photo, where the cut-out at the front over the front mandrel bearing housing is fouling it, preventing the guard from properly closing down on to its PVC buffers. The cut out on the other side was clear.



48. After filing off at least 5 mm from the rear of the cut-out, the belt guard eventually seated down properly on to the headstock PVC buffers. Unfortunately, I left black felt pen markings round the edge of the cut-out which make it look as though I have left it rough! And what remained of the Hammerite light green paint I successfully caused it to completely gel and become useless by putting in lacquer thinners instead of Hammerite thinners. So be warned!



49. The 2 mm steel plate for the cabinet tray is shown partly cut. The reader's attention is drawn to the very hi-tech anti-vibration methodology applied to facilitate hacksawing – thus there's the broken concrete block and the crab clamps at each end of the steel plate to attach it firmly to the rustic garden table.

There is also a crab clamp across the end of the cut which acted as a cutting screech-damper and to stop the strip bending downwards as the cut progressed and, of course, it eased handling the narrow strip of steel as the other end of the cut was being reached. The other hi-tech feature is associated with the cup of coffee, viz using heat conductivity to cool it down quickly whilst I was getting my camera.

Thus these faces are pushed together hard in contact prior to tightening the headstock mounting socket screws. Obviously it is very important on re-assembly to ensure that no paint or grit particles get trapped between these mating faces, or between the machined underside of the headstock casting and its bed, otherwise parallelism will be lost with the axis along the lathe bed.

So there was no big deal at all with this component – except undoing the socket headed screws for the first time!

Lathe tray

In deciding to make a new tray rather than buy one I took into consideration the cost,

and particularly the cost of importing such a bulky item. But, as I mentioned in an earlier part, the sheer challenge to me was a most important factor! I decided to make it the same thickness as the tray supplied by Myford's, ie from nom. 2mm mild steel plate, copying the typical Myford design of an elongated octagonal shape with sloping edges. The standard Myford Super 7 tray is very firm, and it provides good holding points when moving the lathe around on its stand. And so was this tray very strong after the edge joints had been brazed.

The required shape for the tray was marked out on the steel plate, including the narrow triangular pieces to be removed at the eight corners to allow for a ~60 degree bend to form the edges of the tray. 1/16" diameter holes were drilled at the

roots of each of the eight corner butt ends, both to facilitate cutting out the narrow triangular pieces, and bending the edges afterwards. **Photo 49** shows the piece of steel plate partly cut to shape, the last edge being removed with one of those extremely useful Eclipse plate hacksaws which I must have bought 45 years ago in Woking. I have never seen another one like it. Although I have used it very infrequently, how vital it has been on those rare occasions! The crab clamps seen at each end of the plate are anchoring it to the garden table, whilst the smaller one, second from the left, is mounted across the beginning of the cut. This is to prevent the smaller cut strip from bending downwards as the cut progresses, particularly as the other end is reached. It provides an excellent "spare hand"! The heavy piece of concrete was there helping to stabilise the plate.

But by far the most important item that is seen in the photo is, of course, the cup of black coffee. And it's in a genuine Hornsea Pottery mug, bought in Lancaster as a set of six at least 22 years ago. I can't prove it – their logo on the underside gradually washed off years ago. Only two of them left, now. The heat extracted by the steel plate gave it a quick cool. Thus everything is used to its best advantage – otherwise known as opportunism! Once this strip had been cut from the plate the corner vees were marked off and cut out. The last task at this stage was filing the edges smooth.

The next process was bending the edges to give the final required shape. These were bent by clamping in a large-jawed vice along the marked edge line and pushing or pulling hard, depending on which way round the tray had been mounted in the vice. The edges were bent a little at a time and in increments slightly less than a jaw width, thus advancing in overlapping stages. This sequence was repeated until the required angle, uniformity and straightness, were achieved.

The eight corners were rounded off, and the butt joints closed up as far as was practicable by tin-bashing with a copper mallet against a 4in. diameter piece of round cast iron bar held in place at each joint. The result, seen in **Photo 50**, was far neater than I had dared to hope when I started out on this task, and only quite narrow gaps were left at the eight butt joints, as can be seen in the photo, ready for welding or brazing. The odd-shaped piece of plywood seen at the back of the tray in **Photo 50** was used as a template to get the angle of the sloping edges reasonably uniform along their length. However, I can't explain why there is a rubber mallet in this photo because I exclusively used the copper mallet to form the corners.

I then moved on to brazing the eight edge butt-joints. I refer to brazing them because this is exactly what I did, not silver soldering. To silver solder would have probably required two propane torches, one of very large capacity (which I do not have) in order to get the surrounding metal up to the required temperature – and second smaller one for the actual silver soldering. I had considered electric arc welding but I knew from past experience that my brilliantly untutored technique would have resulted in large holes "appearing" in the 2 mm steel plate, so I rejected this technique before I even started.



50. The cabinet tray with the edges bent to their required angle, and the corners at the eight butt joints slightly rounded for appearance and to close up the butt joints.

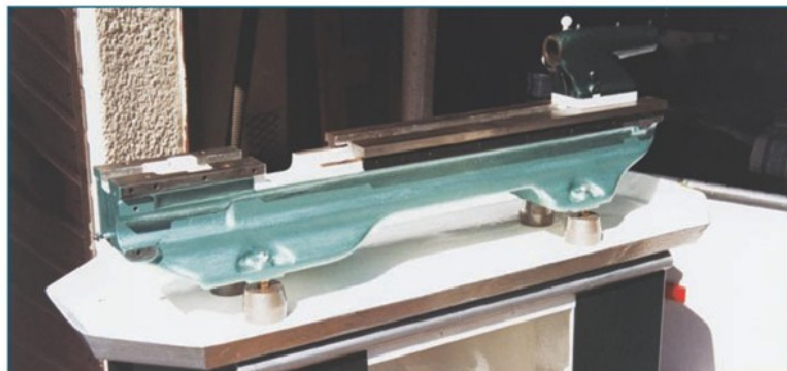
But without any oxy-propane or oxy-acetylene equipment, how was I going to get the job done? Have it welded professionally? I thought about it, but I eventually did the job by carbon arc brazing. As this is a subject about which I hadn't read anything at the time, a description of the technique may possibly be of interest to readers. I will report in some detail on what I found out, purely by trial and error, of course, later along with notes concerning the finishing work on the tray. The finished brazed tray was left outside in a rainstorm, which very effectively cleaned off all flux residues. I seem not to have photographed it at this stage, but it was shown finished, painted, and mounted on the cabinet stand in **Photo 25** earlier, which is reproduced here as **Photo 51**.

I had intended making a coned outlet at one end of the tray to take a connection to a future coolant pump, and silver solder it into position. Although I drilled the drain hole for the intended fitting, I painted the tray in such great haste that I forgot all about the coning and brazing jobs! However, because I didn't intend to spoil the new painting I left the hole as it was. I will need to think about fitting a suitable connection later, if it is ever required. I would most likely consider a flanged fitting now, attached to the underside of the tray with countersunk screws.

Carbon arc brazing

I was considering getting the job welded professionally when I remembered that I had a carbon arc brazing attachment for use with an electric arc welder that I had imported from a British supplier a considerable number of years ago, but which I had never previously used. I don't remember who the supplier was. I had bought an arc welding transformer of Italian manufacture many years ago in Britain when I reconstructed a road trailer. With this unit went the usual welder's helmet. The carbon arc brazing unit is shown in **Photo 52**.

I understand that there is nothing new about the unit – only its unfamiliarity to myself. (I believe they were popular for



51. The finished cabinet tray mounted on the lathe cabinet.

automotive repairs in the UK before changes to the MOT rules.) I used the welder's helmet with its standard ultra violet absorber window for eye protection against the intense carbon arc light source. There was perfectly adequate light from the carbon arc to see the work. Although I can make no claim that my arc welding is very proficient, my silver soldering with a propane blowtorch is at least quite reasonable – most of the time! So, the question now was: what is it like brazing with a carbon arc? Frankly, I hadn't a clue, and I knew absolutely no one else who had used such equipment who could offer any advice.

It was obvious by observing through the helmet glass that the hot plasma produced by the electric arc moves in the preferred forwards direction, as in the case of a gas torch, ie away from the apex of the two carbon electrodes. The electrode clamps are arranged so that the electrodes point to one another at about 45 degrees, as can be seen in **Photo 52**. One of the electrodes is mounted on a sliding guide, the movement of which takes up the shortening of both electrodes. Thus as the arcing process consumes both electrodes at more or less the same rate – they are the same diameter – only the sliding electrode requires to be adjusted by moving it closer to the fixed electrode with a finger. I assume that the very hot gas plasma acts as a reducing micro-atmosphere.

I adjusted the current rating to a fairly low level, which appeared to be

satisfactory with the 2 mm thick steel plate I was brazing, and I found that I didn't need to make any further current adjustment. Or perhaps I should be more scientific about it and say that, if any current adjustment up or down could have provided some advantage, I didn't try it so I don't know the answer.

I had bought four lengths of flux-coated brazing rod of Afrox manufacture (they are the South African offshoot of BOC) about ten years previously. However, the molten globules of the brazing metal seemed to prefer to spit and explode into a shower of smaller globules rather than adhere to the steel plate, leading to a somewhat rough-looking finish. (I found out a considerable time afterwards that absorbed moisture during the long period in storage basically caused the problem. The brazing rods should first have been heated in an oven to dry them out).

The rough brazed finish of my first attempt would have required a lot of smoothing. Luckily, as it turned out, due to my initial inexperienced brazing technique and the spitting globules, I ended up with only some of the joins completely brazed over with lots of small globules of the brazing metal in the tray, and no brazing rods left. I therefore went to the Afrox Depot in nearby Paarden Island and bought a 1kg packet of brazing rods and a 500 g jar of brazing flux. Back on the job, I was now getting a much better brazed finish, so much so that I quickly ran the torch over what I had previously done to improve its appearance.



52. This is the commercially made carbon arc brazing unit. The rod to which the left carbon electrode is attached is gradually moved towards the other carbon electrode as the two are consumed by equal amounts.

TRADE COUNTER

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

At the Midlands Exhibition, a number of our regular suppliers were in attendance, some with new products on display.

Warco

On the Warco stand at Leamington Spa were displayed a number of new items, and amongst these, Roger Warren drew my attention to the latest variants of two machines. The very popular Mini Lathe is now supplied with a lever locking tailstock, and touch pad control panel incorporating a digital tachometer. The latest version of the Mini Mill is equipped with a larger, wider table giving increased travel, a more powerful varispeed 550watt motor, metal handwheels and a spring loaded counter balance for the head. The Warco CNC milling machine, was also on display, and here was demonstrated by Eric Offen, an enthusiast well known to i.c. engine enthusiasts



The latest version of the Warco Mini Lathe



Warco CNC mill based on the WM16 machine



New Mini Mill has larger table and travel

Tracy Tools



Tracy's latest catalogue, now printed in red, comes with their humorous illustrative sheet of special bolts and includes their many useful lines in cutters tooling and equipment, frequently at prices which the competition find hard to match. They are also now prominent in the supply of thread repair kits, (www.unithread.com) for which a separate order line operates – 01803 559 595. Kits contain everything needed to restore a stripped internal thread; new tapping size drill, oversize tap, wire inserts, and insertion tool.

Notable items from the main catalogue include boxed sets (wooden boxes) of taps and dies, covering all the thread systems we are likely to

need. Also, special end mill sets giving cutting diameters of $\frac{1}{16}$ in. $\frac{1}{8}$ in. $\frac{1}{4}$ in. and 1in. priced at £33-30. What is interesting here is that all four sizes share a $\frac{1}{16}$ in. diameter threaded shank which fits the smaller series Clarkson and similar milling chucks, which are used by many home workshop enthusiasts. Also featured is the $\frac{1}{16}$ in. dia. indexable carbide tipped endmill, intended for milling to square corners, but which I have also found extremely useful as a boring bar. Again, this tool, priced at just £12, has a Clarkson type threaded shank, again $\frac{1}{16}$ in. diameter. The prices quoted above include VAT and UK postage. The Tracy Tools main website is www.TracyTools.com and their telephone contact number is 01803 833 134.



Chester



Chester's latest line up includes the new 'DB' variable speed series lathes starting from £495 inc vat & delivery to UK Mainland.

Features include:
Variable speed,
Digital speed display,
Fully equipped with accessories, Offset tailstocks (for taper turning), Hardened & ground vee beds

They have also announced new showroom facilities for their much valued southern based customers. These will be at TPH Machine Tools in Rainham, Essex which is close to junction 31 on the M25, just a few minutes from the Dartford Tunnel and close to both Railway

and London underground stations.

Both TPH and Chester have been working successfully together in the Industrial market for over 18 months and have developed a fantastic working relationship. The new facility is now open to Model Engineers who are welcome to visit where they will see a most comprehensive range of machines on show. Both Chester and TPH feel this will be greatly advantageous to Model Engineers based in Southern areas as this will save the long drive to Chester or having to wait for one of the London Model Engineering exhibitions. We believe this once again underlines Chester UK's commitment to the Model Engineer. **TPH Machine Tools have been trading since 1923 and can be contacted by telephone on 01708 523916, email machines@tphmachinetools.co.uk and website: www.tphmachinetools.co.uk**

Arc Euro Trade

At the Midlands Exhibition, the CNC conversion of the X3 mill was being demonstrated by John Stevenson, who had a hand in designing/specifying the conversion kit and is involved in manufacturing some of the kit components.

The latest catalogue includes new C0 lathe which bears strong similarities to the Unimat 4 but is currently being offered at an introductory price of just £111. Despite the diminutive size (and price) of such machines, they are capable of serious work. Anyone who doubts this might refer to various articles in *MEW* by Bob Loader, or Stan Bray's book *"The Compact Lathe"*. Accessories for and modifications to the Unimat, which will probably also work on this lathe, have also been described in *MEW* from time to time by Maurice Rhodes. The leading particulars are swing over bed 110mm, spindle/tailstock bore 10mm, spindle/tailstock screw M14x1. The list of accessories includes items such as fixed steady, two way toolpost, and autofeed attachment.

At this sort of size, a lathe might be housed in a purpose made box similar in size to that needed for a sewing machine, and used (with care and senior management approval) in a domestic setting. Is this the next best thing to a lathe in a brief case; do we look forward to the genuinely portable laptop lathe for use on train or plane?

How (not) to paint a locomotive



and line it out
and build a spray booth
and apply transfers
and more.....

Christopher Vine

FIRESIDE READING

Visitors to the 2004 Model Engineer Exhibition could not fail to be impressed by the 7 1/4 inch gauge model, "Bongo" of an LNER B1 locomotive, which in fact won for Christopher Vine, a gold medal and the Charles Kennion Memorial Trophy. In

the preface, the author notes that the process of painting, lining, and reassembly of Bongo took two years of frustration, mistakes, and wrong directions, then that the dearth of published advice together with encouragement from MEX chief judge Ivan Law, prompted him to put pen to paper. The reader thus gains from Christopher Vine's experience, and can thus avoid the many pitfalls. Very often, superbly constructed models are let down by a lesser standard of paintwork and finishing. This work offers a route to obtaining a quality finish.

The book is presented in thirteen sections. Ten chapters cover: Introduction, Equipment, Paint, Preparation, Spray Painting, Hand painting, Fixing Blemishes, Lining, Transfers, Looking After the Paint. These are followed by a Summary, and two Appendices, the first giving a very useful list of suppliers, the second a glossary of terms.

One of the most important pieces of advice (even if one of the most basic) concerns record keeping. With the many variables involved in the painting process, it is essential to maintain a detailed record of the parameters employed in order to either repeat success or avoid added failures.

Much useful information is presented on matters such as procedures for preparation, varieties of paint, simple techniques for workholding, and rectifying problems. The author is also able to draw on personal experience to report on these areas, also on items such as spray guns, lining tools etc. Although aimed at the modelmaker, the techniques will be equally applicable to detail work on cars, motorcycles stationary engines etc.

Interestingly, the book has been published by the author (as opposed to placing it in the hands of a publishing company), and the result is as well finished as Bongo. It is in hardback form, contains 168 pages, 130 excellent colour photos and 30 diagrams. It is available from model engineering book suppliers TEE Publishing and Camden Miniature Steam Services. Alternatively, it may be ordered directly from the author; send cheque / postal order for £20.00 plus £1.50 P&P to C Vine (MEW), PO Box 9246, Bridge of Weir, PA11 3WD, Scotland. The ISBN is 978-0-9553359-0-7.



1. Completed micrometer adjustable tooth rest.

Design criteria

During my initial trials, I found that considerable problems were encountered due to the arrangement of the tooth rest. In particular, the blade had to be:

1. Correctly angled to match the cutter.
2. Adjusted precisely with reference to the cutter and grind wheel centre line heights.
3. Flexible enough to "spring" over the teeth.
4. But also stiff enough to withstand the pressure of the grinding without movement.
5. Capable of being adjusted within an awkward confined space.

The angling is done by grinding the top edge of the blade, and therefore a number will be required. The adjustment of the height is "fiddly" and takes time.



2. Unit dismantled showing the component parts.

ADJUSTABLE GRINDING TOOTH REST

Peter Rawlinson describes an accessory to aid setting for cutter grinding

Background

I do not intend this article to be one on grinding tools as that topic has been dealt with by others better qualified than myself. It does however introduce a device that I have found very useful in that it gives micrometer height control when setting the position of a cutter to be sharpened. This in turn means accurate control of the primary and secondary clearance angles created when grinding the flutes of endmills etc..

Some years ago I was given a "Clarkson Mk.I", tool and cutter grinder, similar to that used by Shelley Curtis in his recent article (MEW Issue 120). I then proceeded to recondition the machine but for some time allowed it to unproductively gather dust. Later I started to explore the uses to which it could be put. For me and I believe many others, the principal requirements centre around sharpening end mills and slot drills with some added use for side and face cutters. I have since started to use the machine for circular wood saws, but that is another story,

Solution

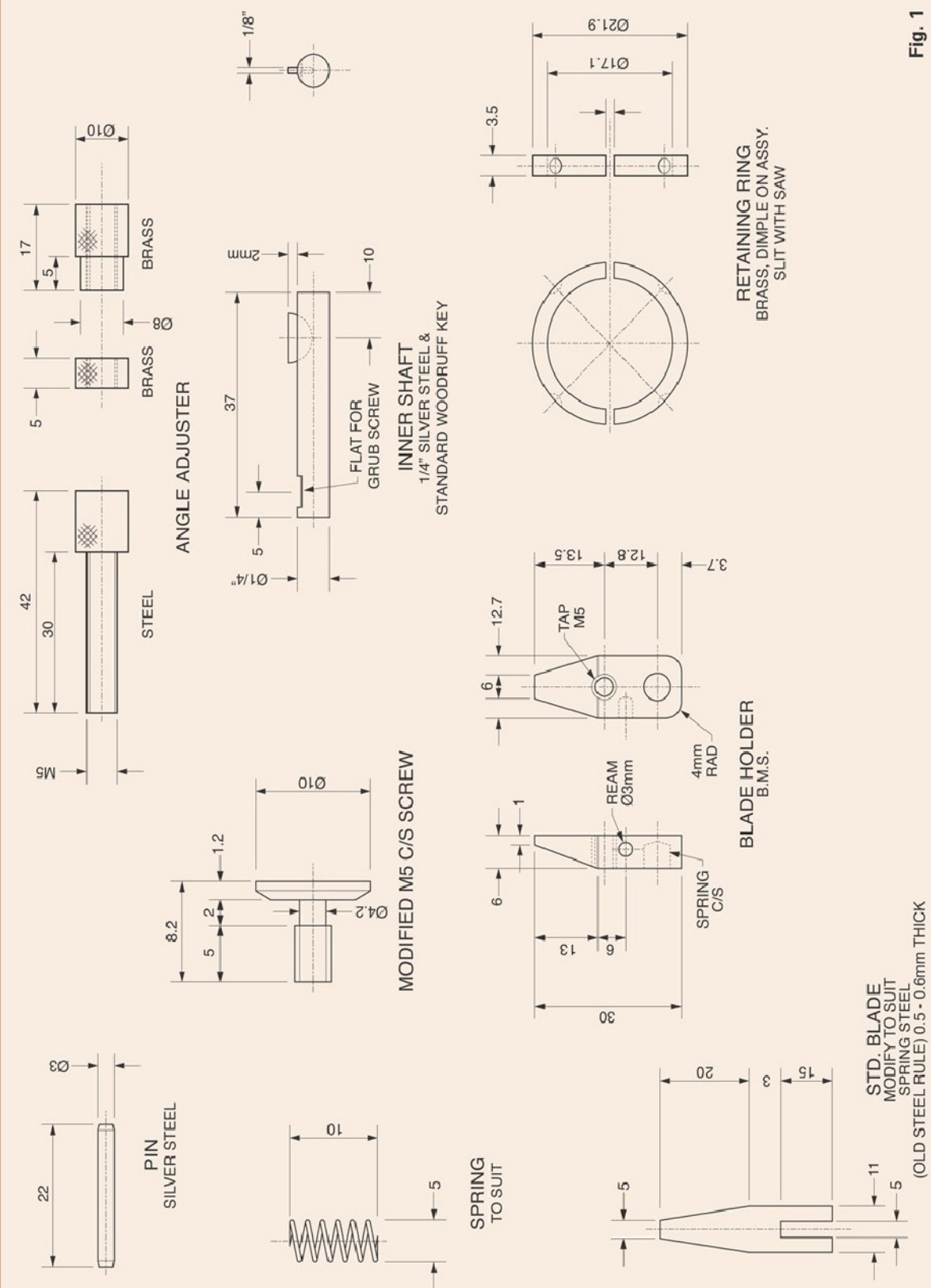
After much deliberation I came up with the device shown in **photo 1**. This solves all the problems mentioned but is limited to cutters of approximately 40mm. dia. At greater diameters, the cutter hits the adjusting screw, however with a little further design I feel that this size limitation could be overcome.

The "blade holder" as I will call it has also been fitted with a horizontal adjustment which makes it easier to adjust the position of the blade over a range of cutter sizes.

The blade fork holder is the most complicated part to make, and here as always I cheat to some extent, and chuck a piece of bar some 30 mm, longer than required. This is then threaded, bored and reamed. It can then be removed, held in the mill by the extension section, milled, drilled, and the keyway cut. This is taken right through to clear the woodruff key fitted in the inner shaft, to get the holes etc at 90 deg. I would hold this part in a chuck on a dividing head which allows a precise set up, and accurate indexing. Next, set the part up in a vice and mill the flat, remove and return to the lathe and start the part off operation. At about half diameter, change to a chamfering tool, add the chamfer, then complete the parting off.

The adjuster cap is best machined by holding a long piece of steel, knurl first, turn knurling away, face, counterbore, drill, and tap. Then, as before, part off part way, chamfer, finish parting off. By following this sequence, in this way all features are machined concentrically. Do not drill the holes at this time.

The main shaft is best machined from an over length piece of bar which will



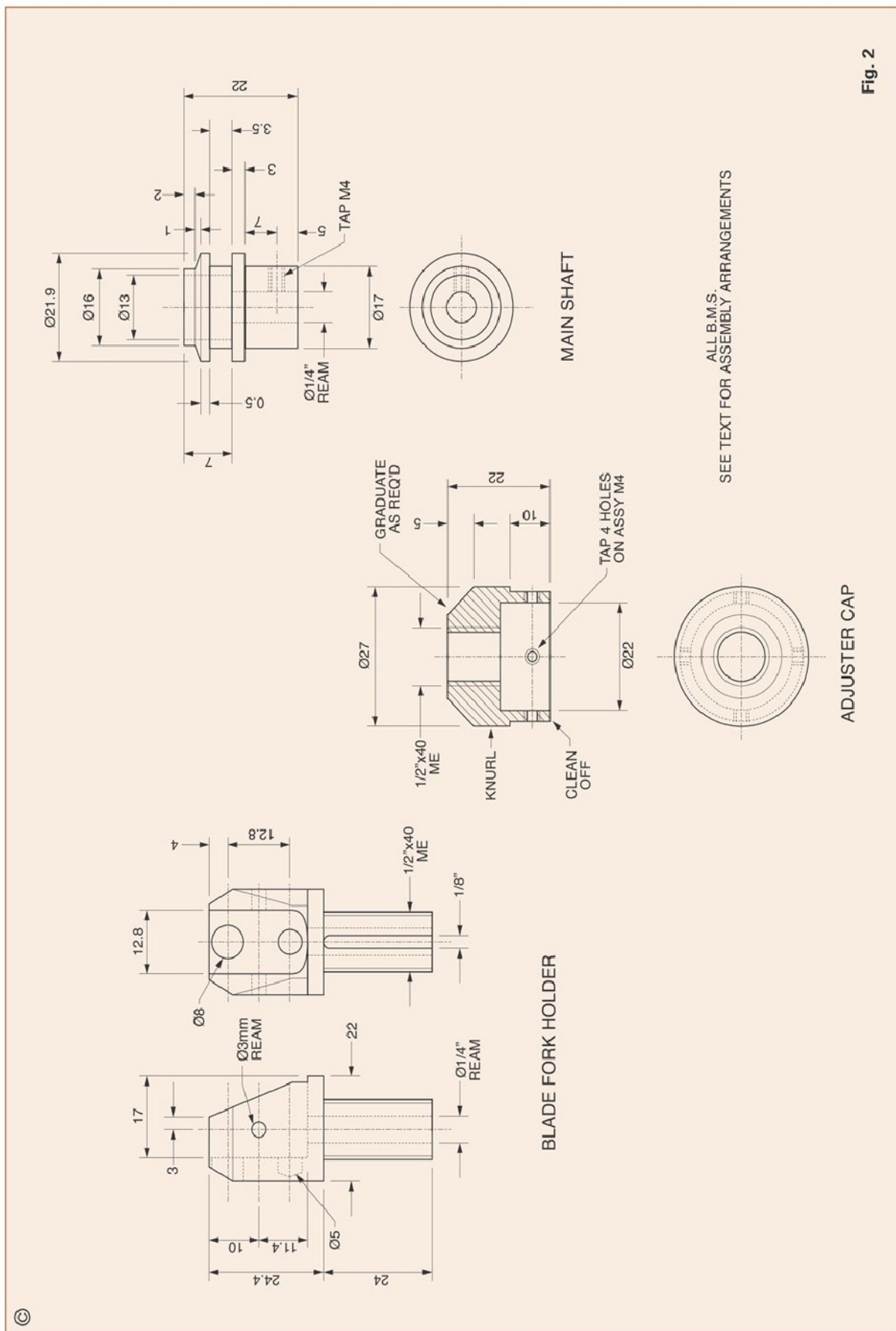


Fig. 2



3. Partly assembled rest.

again ensure concentricity which is most important on these parts.

The inner shaft is straightforward, if no cutter is available for the woodruff key, a parallel key may be used but it must be held captive in the shaft.

The retaining ring is turned from a longer length of (preferably) brass or bronze and parted off. It is worth taking care here to ensure that the ring fits neatly in the width of the groove. Excess clearance will give rise to vertical "backlash", which might make adjustment less sensitive. It is then split using a junior hack saw or may be cut by machine typically with a slitting saw.

The blade holder is small and fiddly but straight forward; the adjuster boss should be turned as a press fit into the main body, or alternatively Loctited in place.

The blade is held in its holder by a modified M5 countersunk screw. I used one of the socket head variety. The modifications are first to turn away part of the conical underside of the head to create a flat surface to butt against the blade, and second to shorten to length leaving a

flat end which will contact the angle adjuster.

Assembly

To assemble first fit the retaining ring into its respective slot in the main shaft. Place the cap over the top, clamp in position and using a tapping size drill, (3.3mm on No 30) drill through the cap and deeply into the brass ring. Mark the positions of the ring in relation to the cap. Strip apart and tap the holes in cap M4. Fit inner shaft into main shaft and lock into position. Now fit the brass ring into the main shaft fit top cap and grub screw together and fit lock nuts. Slide the "the blade fork holder" on to the inner shaft and screw on using cap.

You may need to make up an adjustable support bar, but the design will depend on the grinder that you have. The one I have made for the Clarkson Mk. I is shown.

In the end I found that an old 12in. x 1/2in. steel rule was ideal for the blades as it



4. The major sub assemblies.

could be cut and filed to suit. Also, it may be possible to use old hacksaw blades, as the spring loaded pivot arrangement means that the flexibility is no longer a crucial issue.

The photographs show various set ups of the unit which are all straight forward. It has proved easy to use and makes life very simple. It would also be possible to make an adapter to suit the "Quorn" grinder or by reducing the diameter of the main shaft it could be made to fit directly on to the existing blade clamp.

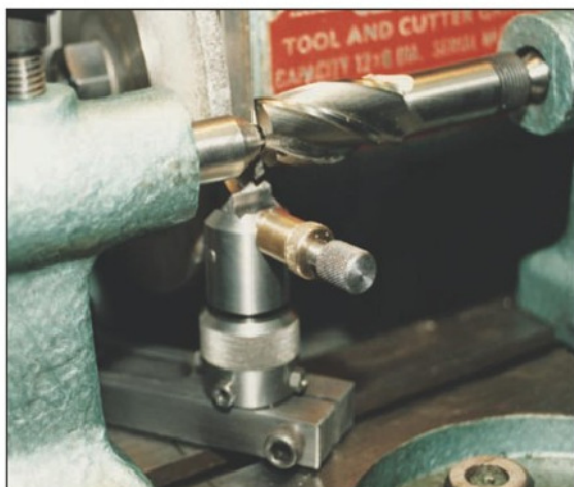
I hope that the device described will prove beneficial to those who build it, and if I can be of help I shall be pleased to assist; but phone only please and I will not ring back for obvious reasons.

Peter Rawlinson, Charing, Kent.
01233 712158.

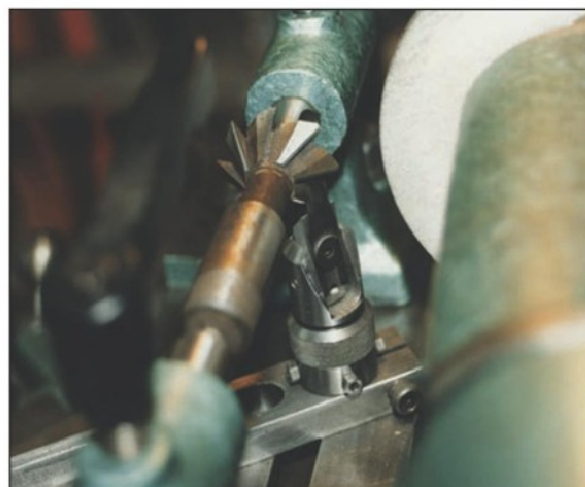


Supplier

Folkestone Engineering Supplies,
62 Canterbury Road, Hawkinge, Kent,
CT18 7BP
Metals.
Phone 01303 894 611



5. In use, set up for sharpening the helix of standard end mill.



6. Set up for sharpening dovetail cutter.

WORKSHOP EQUIPMENT AT LEAMINGTON SPA



This was my first visit to an exhibition at the Fosse, (I had previously attended the event at Castle Donington) and the initial impressions were: good availability of sensibly priced local accommodation, then, on arrival, plentiful level parking. Once inside, the quantity, standard, and variety of exhibits to be seen on trade, club and competition stands did not disappoint. Brief comments on some of the trade exhibitors may be found in "Trade Counter".

Workshop equipment exhibited

One of the first items to catch my eye looked familiar, (photo 1) and although I had not previously seen it "in the flesh", the description, drawings and photos had crossed my desk. This was the 4/6 facet

drill grinding jig designed and made by Les Riley, described in his article published in MEW issue 112, pages 24 – 27. A couple of larger drills were shown with the exhibit, a testament to its effectiveness.

Philip Arnold of the Grantham and District Model and Engineering Association seems to be one of those people I envy for their prodigious output of quality work. When I first spied his freelance watchmakers lathe (Photo 2), I thought at first it was the one on display last year. Not a bit of it, on checking back against the pictures taken by Tony Jeffree at the previous Midlands Exhibition, it was clear that this was a very different machine. Mr Arnold had also produced a number of other exhibits, the six inch scale Drummond round bed lathe shown in photo 3, the six inch scale Drummond M type lathe (photo 4), which gained second prize in the workshop equipment category and the freelance dividing head (photo 5).

The Grantham stand boasted quite a

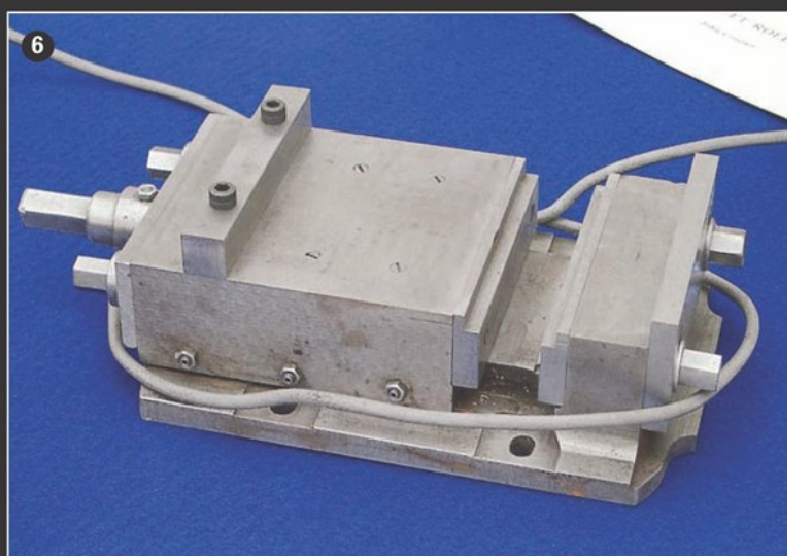
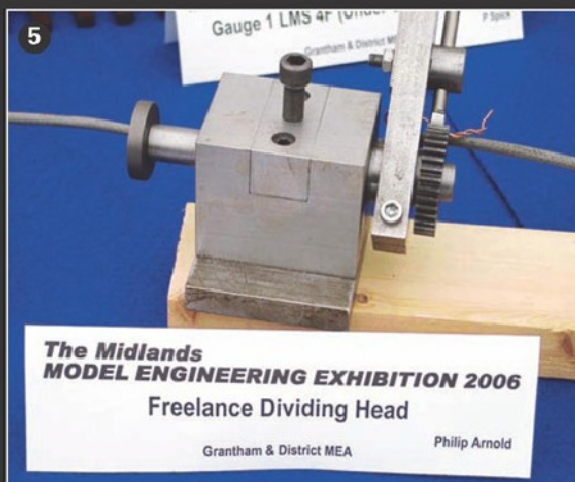
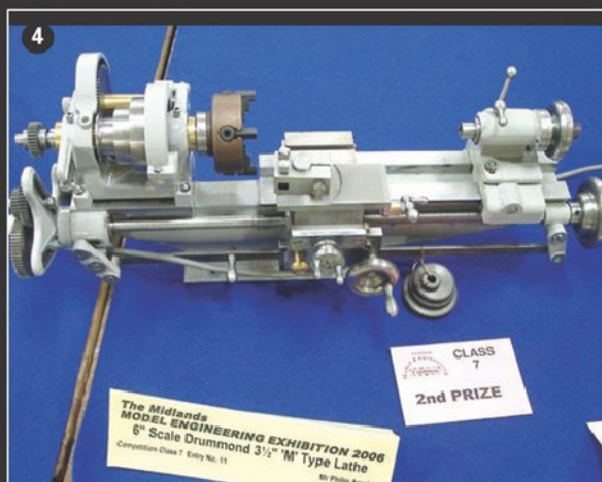
After missing out in 2005, Dave Fenner made the trip to the Midlands show in October 2006.

number of items of workshop kit produced by other members. From amongst these I offer a brief selection. The modified milling vice from Mr P. Spick (photo 6), appeared to have two altered features. First the original jaws had been cut away with a step. This sort of mod. is sometimes seen in industry to ensure repeatable height location of work. The other alteration however I had not seen before, viz. the addition of supplementary jaws for gripping work wider than the nominal capacity of the vice. Kevin Wade's arbor press (photo 7) was accompanied by various automotive oil pump components and an invitation for more to join the Grantham College sessions on Thursday evenings. From the descriptive note, it is clear that an impressive selection of equipment is available there, for use by participants. Two items had been brought along by John Crozier, the bending rolls, (photo 8) and the torch holder (photo 9). Photo 10 shows an automotive brake pipe flaring tool capable of producing two stages of flare, along with a sample of completed pipe.

Several examples of the Quorn tool and cutter grinder were on display, notably those from Martin Gregory, (photo 11), D.W. Waldram, (photo 12), and David Shrimpton (photo 13). Of these, that by Martin Gregory embodied a number of departures from the classic D H Chaddock design, and yes, Martin has been invited to describe his modifications for these pages.

On the Birmingham Society stand, the exhibit described simply as "Tooling" by David Piddington (photo 14) deserved close attention. Many of us run into storage and space problems, and the tool



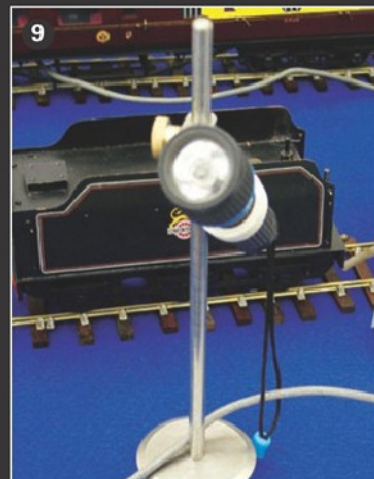


box and contents showed just how a standard box (in this case a Clarke chest from Machine Mart) may be effectively modified by ingenious use of MDF lining and trays, to store numerous items in a small space. Contents on display were an own design five inch rotary table, a headstock dividing attachment to the George Thomas design, a dividing head

again to GHT design for use with either the rotary table or the headstock attachment, a three jaw chuck, and a tailstock both for use with the rotary table, the latter to the teachings of GHT but with a spacer to give equal centre heights. One of the photographs in the box lid also showed two trays omitted from the display. These would normally contain: a pair of vee

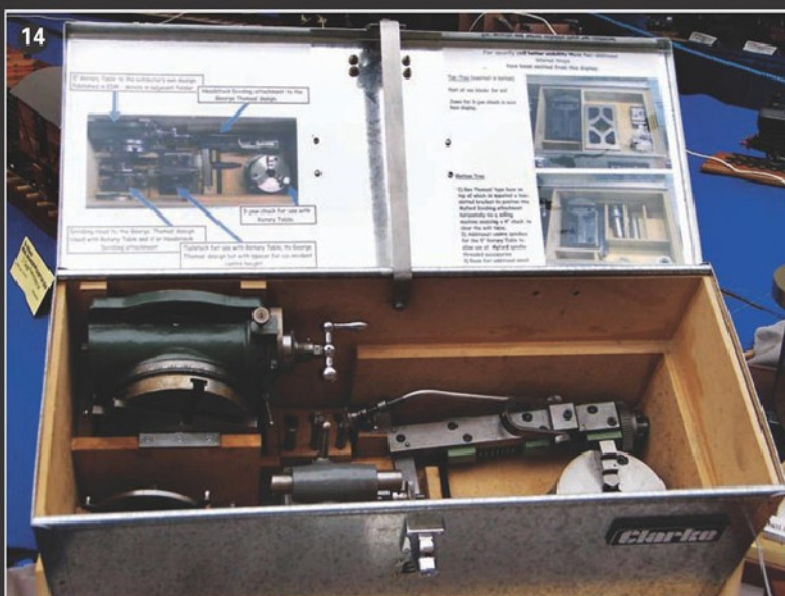
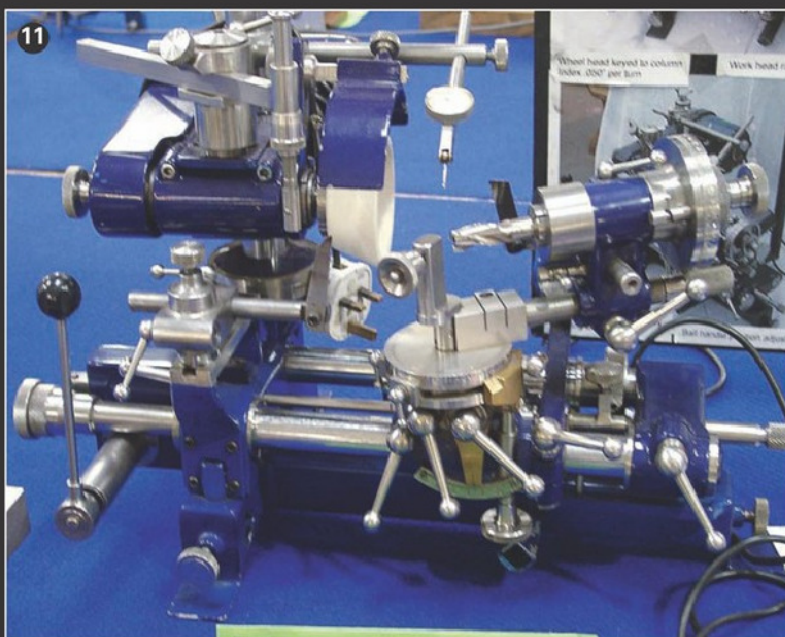
blocks, alternative chuck jaws, a tee slotted base for mounting a Myford dividing head on a mill (giving clearance for a four inch chuck) and a selection of spindles for use with the rotary table enabling the use of Myford threaded attachments.

Following on with the "division" theme, two other noteworthy exhibits were the compact dividing head (photo 15) from





Chris Hallaway, and the six inch rotary table built from College Engineering castings by John Godfrey (photo 16). The latter had been modified to fit a Dore Westbury mill, and fitted with an adjustable cursor. The former weighed just 8 pounds, used a Myford 60 tooth changewheel, and featured adjustable friction dials on both the main and handwheel spindles.



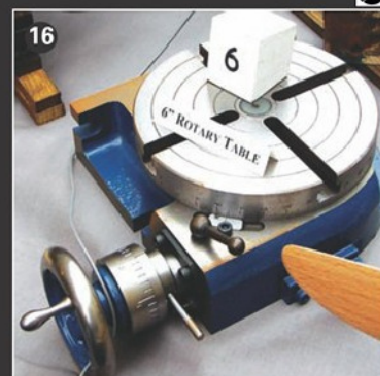
Young Engineer

A particularly encouraging point was the "Young Engineer" category which was supported by no less than twenty three entries from some nine entrants. As one might expect, these represented in the main, relatively straightforward projects such as plumb bobs, engineer's squares, and scribing blocks, but were executed with fine craftsmanship. One hopes that these young engineers will progress into the profession, and that they will also continue to develop their practical skills.

SMEE

Regular exhibition supporters SMEE were in attendance, occupying a workshop area located in a corner of one hall. Members were available to offer advice and demonstrate particular operations. When

not delivering a lecture on CAD design, Derek Brown manned a lathe kindly provided by Chester UK, while Giles Parkes demonstrated gearcutting using the hobbing method.



Scribe a Line

Peter Rawlinson writes:

Continuous Ink Supply (C.I.S.) is a system that is to me relatively new, and is applicable to many of the ink jet printers that people using computers have on their desks. The systems that are available obviate the need to continually change (and buy) very costly OEM print cartridges or even the more reasonably priced compatibles.

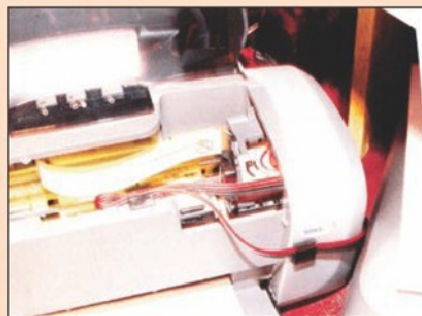
In the case of most printers, the existing cartridges are replaced with a set of special cartridges which have a silicone flat multi-tube attachment that goes to a set of ink tanks outside the printer. These tanks hold a minimum of 100 ml of each colour of ink. Like the originals, the replacement cartridges also carry electronic chips but unlike the originals, these are resettable, although I have not found this to be required as long as the tanks are kept topped up. The levels are easily seen and refilling quite straightforward.

Even when buying ink in 100ml bottles the cost is of order of £3 and if bought in larger quantities the cost reduces dramatically (1.4 L total of 4 colours around £20 plus)

Having tried unsuccessfully to reduce printing costs with a laser printer, I have recently invested in a new duplex ink jet printer and have fitted this system. Thus far, it works very well and although these are early days, I see no reason why there should be problems. For those readers who have printers which have "Travelling Cartridges" this arrangement can also be accommodated by using kits which are supplied with longer multi pipes that can be set to travel with the print head.

For anybody who wishes more information and is on the internet. Go to. - "Ebay" Type in CIS EPSON. The screen will come up on which you can select and click on "Signal Inkjet" who have a good site. I have found that by using this system I can reduce the costs of my own publications enormously, so that I am able to pass these savings on for future buyers. Volumes 1, 2, 3 are now £16 + p&p, vol. 4 £20 + p&p and vol.5 £8 + p&p.

The systems are available for many of the makes of printers so check that it is made for yours and that it is compatible to your model. I hope this information may be of help to other readers, who are welcome to phone me on 01233 712 158 if more detail is needed.



Peter Parry writes:

I have just been reading Mike Haughton's interesting article on buying engineering items on eBay. There is one thing he mentioned which might be worth expanding, especially if someone is contemplating spending a lot of money purchasing an item.

In his section on "PayPal or Plastic" Mike mentions that Credit Cards offer a greater degree of protection than Debit cards or cheques on purchases. This is certainly true of purchases made directly from web sites or shops. However, it is not the case if payment is made through PayPal as most eBay purchases are.

The usual "Section 75" protection afforded by the 1974 Consumer Credit Act to credit card transactions does not apply to payments made through electronic fund transfer services such as PayPal. http://www.ombudsmanandfsa.info/case_studies/wi-03.htm is the reference if you are interested.

Some card issuers still provide customers with a degree of protection for such third party purchases in their own T&C's but not all do so and it isn't statutory protection.

Brian Thomson writes:

I read Mr Haughton's article (MEW issue 119) on his experiences with the Chester UK 626 milling machine with some interest because I bought one last year and I have not used it enough yet to assess its capabilities or its accuracy. I was reassured

to see that he is quite impressed with the machine.

I have to disagree with him, though, on one point which is that you need a crane and at least two people to get the machine off its pallet and into the correct position in the workshop. This point seems to have been made at an earlier time by a Mr Cox but I did not see that reference.

I got my 626 off its pallet and into the corner of my garage (which is also my workshop) and this is how:

Like Mr Haughton's, my 626 was delivered on a pallet on a pallet truck and was wrapped in bubble wrap. I had it dumped in the middle of my garage with plenty of room all round and considered, with some dismay, what to do next. I thought of an engine crane but I didn't think I could get the machine into the corner of the garage using one (because they have those long, splayed-out legs to keep them from overbalancing) and spending £45 plus delivery and collection charges just to lift the machine off its pallet seemed over the top. Then again, if you hire a crane for a day or two you have to wait for it to arrive and then do the job to a fixed schedule. I prefer to do things to my own timescales. I sat and stared long and hard and I saw the way!

By lifting the pallet a small amount (using a trolley jack) I was able to put blocks underneath the top face of the pallet directly beneath the machine itself so as to take the weight of the pallet. I was then able to remove some of the slats in the top surface of the pallet. By moving the blocks to a slightly different position I was able to remove some more slats and then I could

get the blocks under the machine itself through the gaps in the pallet.

It was, then, just a matter of dismantling the pallet from around the machine until the machine was left sitting there on the blocks on its own. This dismantling process was hindered by the fact that a sheet of plywood covered the whole of the top of the pallet. Fortunately, it was very thin and not difficult to rip apart. To balance that, the process was helped by the main elements of the pallet being bolted together rather than nailed.

Having got rid of the pallet it was an easy matter to lift the machine at the front and substitute slightly smaller blocks then do the same at the back and then again at the front and so on until the machine was finally resting on 25mm steel rollers (bits of steel gas pipe and a Land Rover half-shaft). At this point I could roll it easily into the corner.

By this time, of course, I was using a lever and a block of wood as a fulcrum to lift the machine rather than the trolley jack but it takes little effort to tilt such a machine with a 600mm crowbar. Having put the machine into position, I replaced the rollers with blocks of wood to level it. It now rests about 20mm off the floor so it is a very easy matter to tilt each side in turn (I can't get to the back any longer) and replace the blocks with rollers if I want to move it.

It took me about 2½ hours, working on my own, to do all this and there wasn't any real manual effort involved.

There are safety issues to be considered such as:



Robert MacKay of Sutherland writes:

I read in a recent issue of **MEW** that you had received a complaint in connection with your motorcycle lift, regarding the lack of a safety device to provide for hydraulic failure. The accompanying photos show my home constructed lift – in particular the details of the safety prop and the front wheel clamp. In my case, as a flexible hose is used to connect pump to ram, there may be a higher risk of sudden fluid loss than with your car jack arrangement.

- Never lift the machine more than an inch or so without putting something underneath that will stop it coming down too far if something gives way. As you raise the machine higher, increase the size of whatever you have put underneath. (As an aside, I do this even when I jack the car up to change a wheel. As soon as the car is high enough, the spare wheel goes under the sill. As soon as the original wheel is off, it goes under the sill in place of the spare. If the car is going to fall off the jack, it isn't going to fall far!)
- Don't push blocks around under the machine by hand - use a stick.
- Put replacement blocks under the machine before you remove the originals.
- When gradually reducing the size of the blocks do it very gradually indeed.

I don't think there was ever any chance of my machine tipping over (it is very stable on its base) but if you are worried about it, attach three or four ropes from the top of the machine to various places in the workshop. I hope this information will be useful for other people in a similar position.

John Stevenson writes:

In reply to Bob McGillicuddy who pointed out the free web site at <http://www.homeworkshop.org.uk> and asked for more information I can supply the following comments.

For quite a few years a guy called Chris Heapy used to have a very good web page with links to projects and

workshop ideas. Part of this web page was devoted to running a free adverts page which was very well received by people with home workshops. I must admit I bought and sold a fair amount of equipment on these pages with less hassle than sites like Ebay.

Three years ago, for some unknown reason, his web page declined and the adverts dried up. Charles Ping from Surrey and I tried to contact Chris to see if we could help out or carry on with the page as it was too useful to allow to die. We had no reply so took the steps to set up a new page at the address above. This site is run completely free of charge for both buyers and sellers. It is actually run by the advertisers, no adverts, no web page, we are only caretakers. We take the forms as they come in, check them for spam, spurious adverts and copy them to the visible page you see. The page is open for buying and selling anything workshop related, equipment, plans, models etc.

Adverts stay up for a month or until a remove advert form is received, there is no limit to how many months you can post, it just requires being resubmitted.

There is a links page for traders and people with commercial interests. We accept adverts from traders provided they are not too blatant or pushy but we won't accept adverts pointing to auction sales. Neither will we accept adverts in all capitals as on the internet this is equivalent to shouting and is bad English anyway.

The page isn't automated, we have to vet the forms and post them on. As we both work full time this usually takes place twice or three times a day but never at a specific time. Usually everything catches up daily.

Mr T Ellis writes:

I would be very grateful for some advice from one of your experts.

I have a 12 volt cordless drill and I was wondering if it would be possible to operate it using a 12 volt car battery charger. My idea was to use an old battery, strip out the insides and connect a flex into it to join up with the charger, giving me a 12 volt mains powered corded drill.

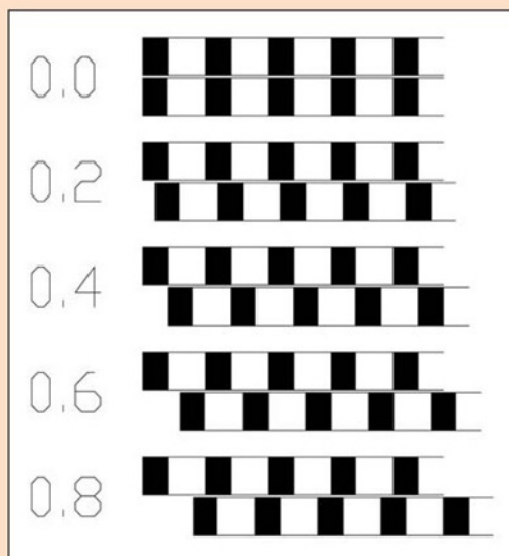
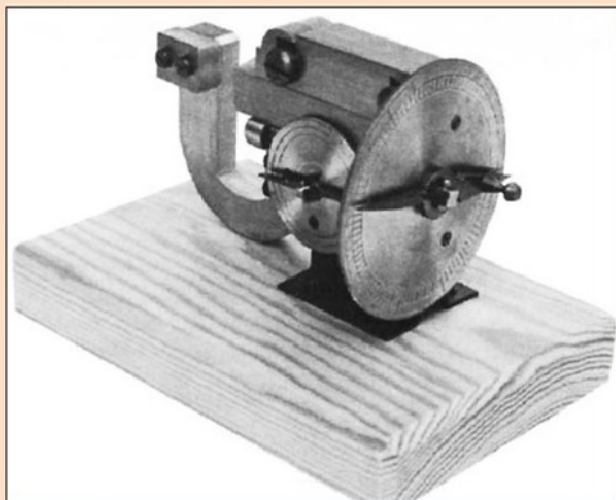
Is this a practical idea?

Dave Fenner comments:

I hesitate to present myself as an "expert" on electrical matters, but would offer the following thoughts. The traditional car battery charger was basically a transformer feeding a rectifier, and the transformer was designed with a characteristic suitable for its intended job. In the past I have measured open circuit voltages of up to about 27 volts on a nominal 12 volt charger. This then falls to a level suitable for charging, when it is connected to a battery and current is delivered. The charging current would be typically up to about 4 amps unless the charger is substantial.

This raises two questions. First, the high open circuit voltage. This will presumably fall when the motor is energised. Second, is the charging current sufficient to power the tool? I do not have any data on cordless drill currents, but a power of around 50 watts looks small compared to a typical mains Black & Decker. My own approach would be to have the charger feed a 12 volt battery (maybe ex car) which would deliver higher current. What do others think?

Prof Joerg Hugel writes:



In MEW 120, p. 22 I've read the interesting article from Bob Loader. Probably also other readers may tell you that he has confused the nautical mile and the metre. This is one ten millionth of an earth's meridian from the equator to the pole. In addition, since 1983 the metre is no longer defined on a wavelength standard but on the velocity of light. But this is not the reason for this note; I would like to offer some additional information on micrometers. An early example if not the oldest that has survived is found in the science museum in London, it is said to have been made 1772 by no less than James Watt who was an instrument maker in Glasgow before he went into the steam business. The accompanying photo shows a replica which was made as part of an educational project by the German Museum in Munich (Deutsches Museum). The drawings and a description in German is available from there. (ISBN 3-924183-37-6). Another interesting piece of information may be an alternative principle to the Vernier to read scales between the marks; common to both is the fact that the alignment of two marks can be judged very accurately and also two equal distances under identical conditions are easily seen as such. The simple principle is shown in the accompanying figure. I know this principle was shown to me when I was a student but I cannot remember the detailed circumstances. The width of the marks should be 0.4 times their distance apart and must be manufactured with clean and precise borders. Here, ultra fine lines are not the right selection for a precise scale.

Bill Brading of North Shore City, New Zealand writes:

Other readers may be interested in a setting up aid for the vertical milling machine.

The need for this little accessory arose when I had to make a number of adaptor blocks for a friend to fit new air filters to a classic car. The blocks required a polygonal outer profile and a set of radial mounting holes all referenced to the bore.

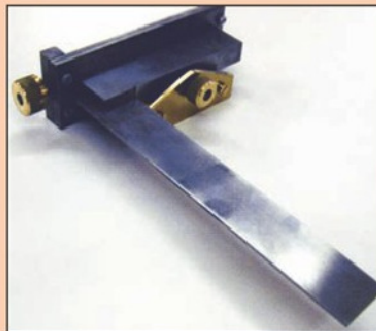
After boring, the job was set up gripped by its bore on the rotary table on the vertical mill. It was now necessary to set one reference face at right angles to the x-axis with the rotary table set to zero. My Myford VMB machine has a rectangular column so it seemed that the obvious way would be to hold a square with its stock against the column whilst tightening the chuck – except that this is a three handed job.

The photographs show the fixture that solved the problem. It consists of a quarter inch thick steel plate with two 3/8 inch square bars fixed to the back. One of these bars has a small recessed rebate allowing the plate to be clamped against the V of the column guide. The other has a clamping screw. On the front is mounted a brass bracket which can hold the square also clamped by a brass screw. Photographs show the device in isolation, and assembled with the square.

Since making this I have found it most useful for marking out the crossings on clock wheels just prior to machining them at the same set up on the mill as a further photo makes clear. Obviously this fixture can only be applied to machines having a square vertical column unfortunately.



Bill Brading's setting aid.



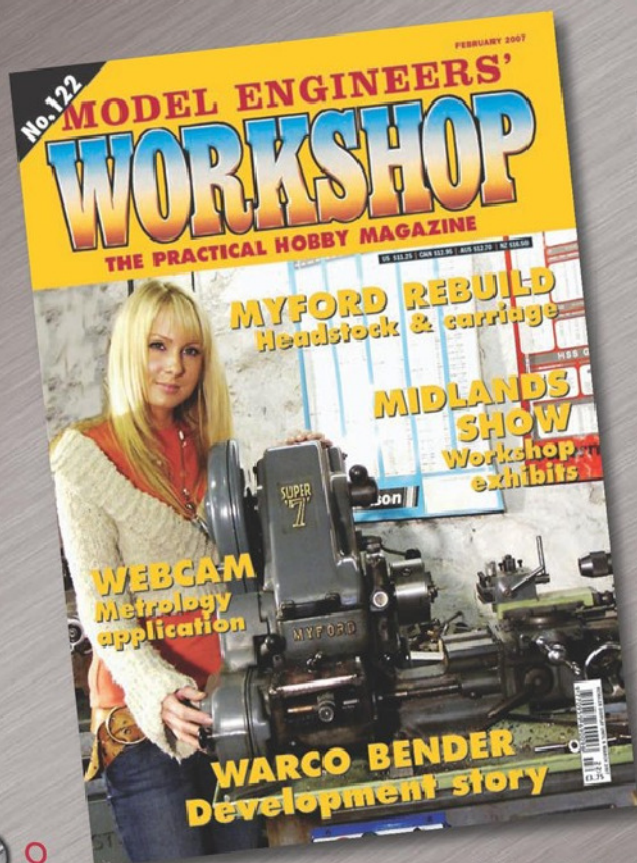
Device fitted with square.



Assembly in use on VMB mill.

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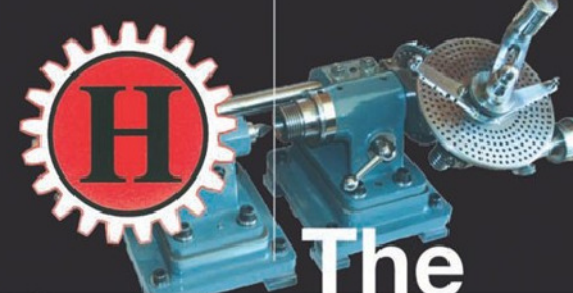
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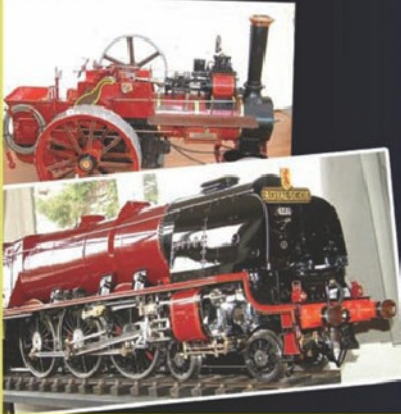
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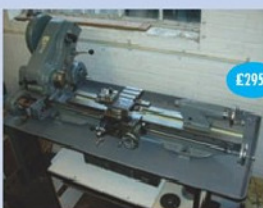
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MAX. FACE MILLING CAP. 63MM
TABLE SIZE 700x180MM
SPINDLE TAPER MT2
RANGE OF SPEEDS 50-2200RPM
MOTOR 1HP
DIMENSIONS 670x550x860MM

DB8V LATHE

£695.00



DISTANCE BETWEEN CENTRES 400MM
SWING OVER BED 210MM
SPINDLE BORE 21MM
RANGE OF SPINDLE SPEEDS 50-2000RPM
MOTOR 3/4HP
DIMENSIONS (LxWxH) 1050x560x570MM

DB10V LATHE

£895.00



DISTANCE BETWEEN CENTRES 550MM
SWING OVER BED 250MM
SPINDLE BORE 26MM
RANGE OF SPINDLE SPEEDS 50-2500RPM
MOTOR 1HP
DIMENSIONS (LxWxH) 1150x700x570MM

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DB11V LATHE

£1195.00



DISTANCE BETWEEN CENTRES 700MM
SWING OVER BED 280MM
SPINDLE BORE 26MM
RANGE OF SPINDLE SPEEDS 125-2500RPM
MOTOR 1HP
DIMENSIONS (LxWxH) 1390x700x630MM



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