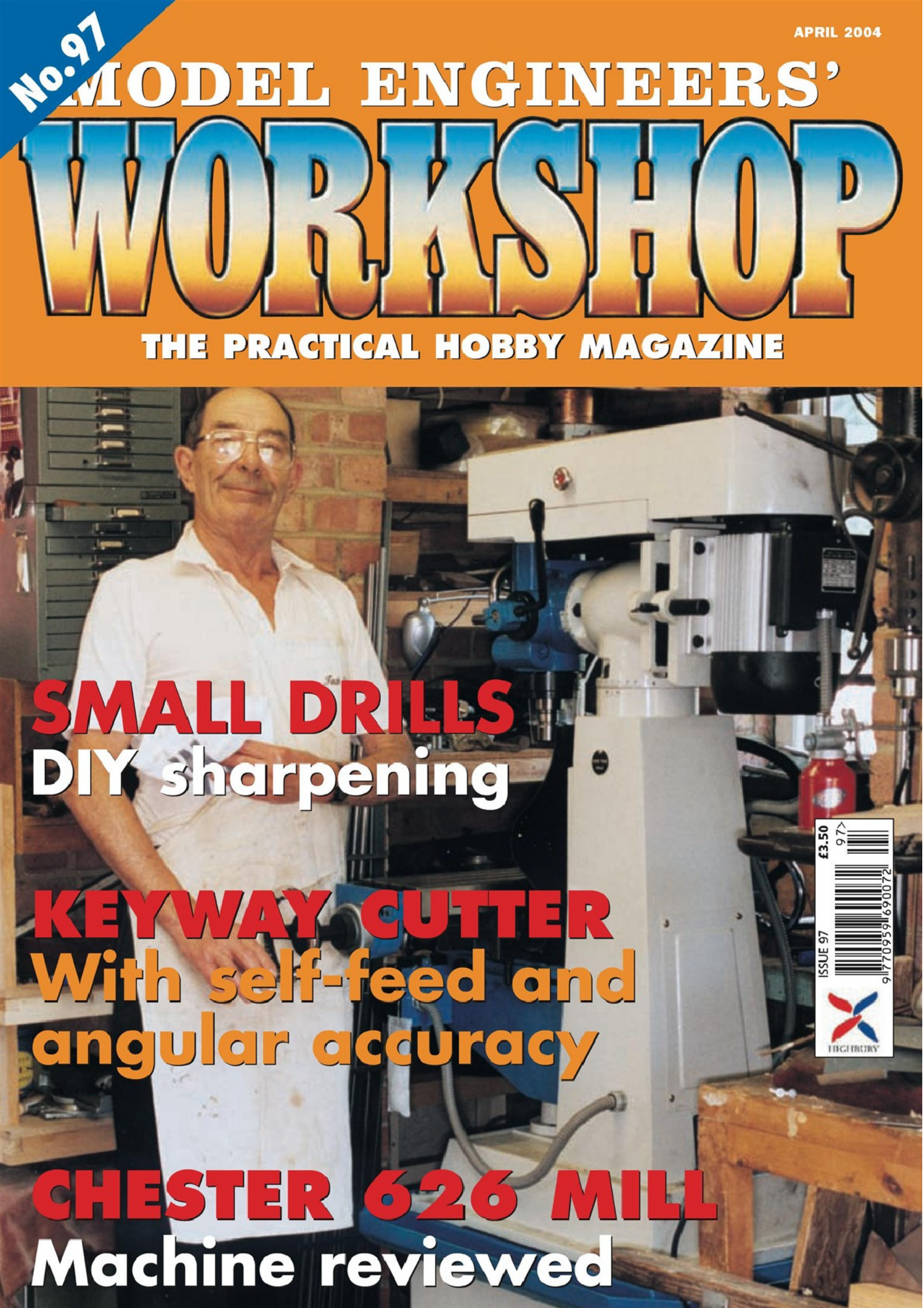


No.97

APRIL 2004

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

A man with glasses and a white shirt stands in a workshop, smiling. He is positioned in front of a large, white and blue machine, likely a mill. The workshop is filled with various tools and equipment, including a workbench and a fire extinguisher.

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Contents

11

On the Editor's Bench

Dave Fenner's commentary

12

Drilling Projects (1)

A tapping guide and screw fixture

16

How's Mike

Assessing the accuracy of micrometers

20

Improved Access to the Minicraft MB850 Lathe

A simple modification for enhanced convenience

22

Musing about ... the Wishbone

— and a DIY version to sharpen small drills

27

Link Up

Readers Sales and Wants

27

Next Issue

28

Mk. 3 Wire Eroder (3)

Completing the mechanical construction

34

Keywaycutter (1)

Go easier on your lathe with this device
for internal keyways

39

Trade Counter

New items from suppliers

41

Going Round The (South) Bend

— and a quick change tool system.

48

The Chester 626 Turret Mill

Assembly and first impressions.

51

Bench Project

Taking a lesson from industry

52

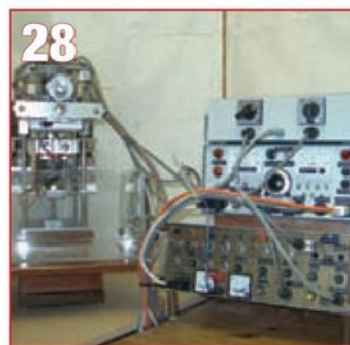
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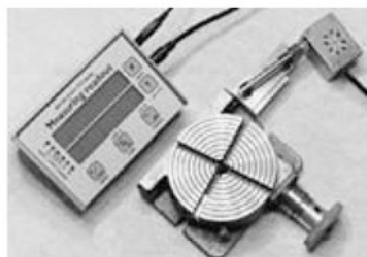
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GLR	8
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Home and Workshop	IBC
I M Service	61
J A Crew	4
Machine Mart.....	7
Metals on the Web.....	4
MEW subs new.....	59
Model Eng. Services.....	4
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Warco.....	5
Welding Centre	8

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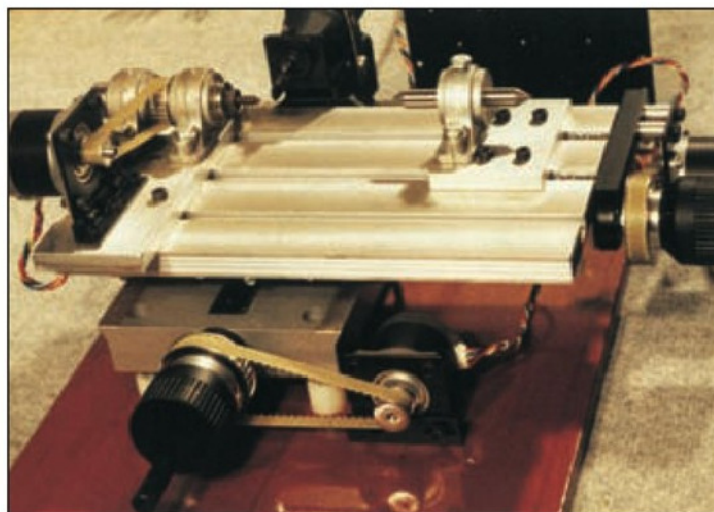
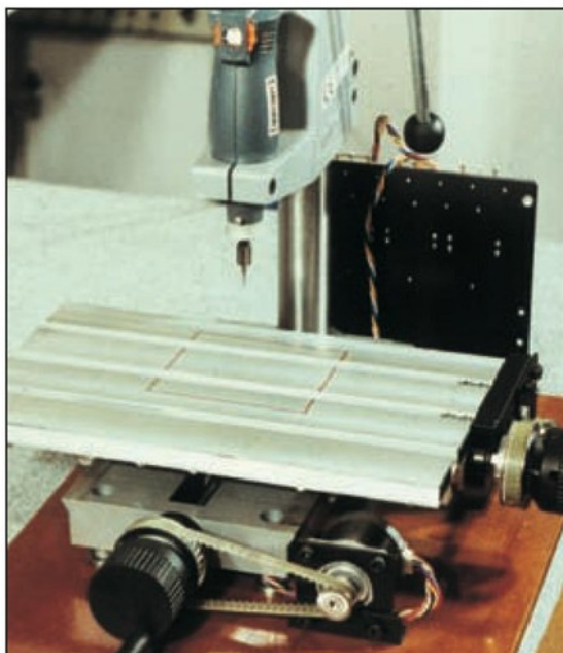
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**Atmospheric Forge & Heat Treat Oven
• Goodman & Holmes • £12.35**

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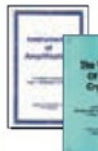
Aircraft Welding • 1942 • Elzea • £13.70

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



Change Gear Devices • 1903 • Perrigo • £7.15

The author looks at twenty-nine patents for lathe gear change devices taken out between 1854 and 1903; he had ignored 135 other less practical ideas. This doesn't mean that all the ones he does consider are "normal" but they are all of interest. There is not much of practical use in this book, but it is a fascinating treasure trove of information for anyone interested in the development of machinery. 81 pages. 36 engravings. Paperback.



**The Voice of the Crystal How to build
working radio receiver components entirely
from scratch • Friedrichs • £12.30**
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homemade tubes, transistors and more
• Friedrichs • £16.30**

The first book is, as its name implies, about building essentially crystal sets completely from scratch, in particular not using any commercial electronic parts of any kind. Pete Friedrichs describes the way in which he approached this in an easy-to-follow way, his approach being as much mechanical as electrical - although there are some horrible equations and formulae at the back of the book. The second book follows on this theme, involving the construction of amplifiers, microphonic relays, transformers etc., all from scratch. What really interests us about these books is not so much the fact they tell you how to make a radio and listen to sounds from the other side of the world, but the intellectual curiosity and pig-headedness that the author used to make the parts from jam jars and other scrap, when everyone told him it couldn't be done. These books really stir up the brain box! 185 & 297 pages respectively, full of drawings diagrams and photographs. Paperbacks.



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• 1844 • The Penny Magazine • £11.90**

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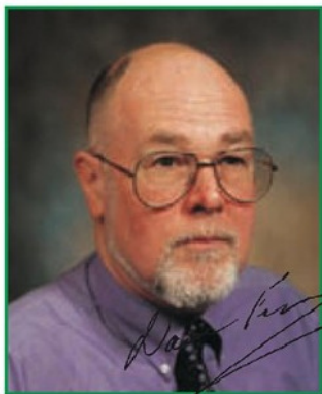
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LATHES Emco Compact 5 CNC Bench Lathe, 1ph, Indexable Turret, Monitor, Chuck £1650.00 Emco Compact 5 CNC Bench Lathe, 1ph, Chuck, Toolpost £1750.00 Denford Oroc CNC Bench Lathe, 1ph, Manual £1450.00 Denford Easturn PWC2 CNC Centre Lathe, 5" x 20", Manual, Toolpost, 1ph £2200.00 Hardinge KL-1 Lathe, Multifit TP, Chucks, Collets, Light, Coolant, 3ph, VGC £2750.00 Boxford ME10 5" x 22" Gearbox, Power C.F. Stand, Tooling, Single Phase, VGC £2100.00 Boxford 125TCL Computer Op Bench Lathe, OCTP Manual, 1ph £1000.00 Lorch AVIK Lathe, Collets, Comp. Slide, Paint stripped off Cabinet for repair, cheap machine for restoration £ 350.00 Boxford AUD 4" x 18" Lathe, Tooling, New single Phase Motor Fitted £1250.00 Boxford AUD 5" x 22" Lathe, 3 & 4 Jaw, OCTP, Catchplate, Manual, 240 Volt 1ph, VGC £1850.00 Boxford CUD 4" x 18" Lathe, 3 Jaw & Toolpost £ 500.00 Boxford CUD 4 1/2" x 18" Lathe, Tooling, 1ph £ 950.00 Myford M17 3 1/2" x 18" Lathe, Industrial Cabinet, Tooling, 3ph £1000.00 Myford Super 7, 3 1/2" x 18" Cabinet mounted lathe, 3C Gearbox, Chucks etc £1500.00 Myford Super 7 Bench Lathe, Tooling £1000.00 Myford Super 7, 3 1/2" x 18" Lathe, Cabinet, Tooling, 1ph £1000.00 Myford Super 7 Lathe & Tooling £1250.00 Myford M17A 3 1/2" x 18", Bench Lathe, 1ph £1250.00 Myford M17 Bench Lathe £ 400.00 Colchester Triumph 2000 Gap bed 7 1/2" x 50", Tooling, 3ph £2750.00 Colchester Student RH, Gap Bed, 3 & 4 Jaw, Travelling Steady, Coolant, Collet Chuck, 3ph, Well Looked After, VGC £1500.00 Colchester Bantam 2000, 6 1/2" x 30", Tooling, 3ph £2350.00 Colchester Bantam 1600 5" x 20", Tooling, Coolant, OCTP, 3ph £1450.00 Colchester Bantam 800 5" x 20", Basic Gearbox, 3 Jaw, Toolpost, Drill Chuck, 3ph £ 750.00 Colchester Student RH, 5" x 25", Tooling, 3ph £ 950.00 Colchester Master 2500 6" x 40", Tooling, 3ph £2350.00 Colchester Master 2500 6" x 40" Gap Bed, 3 & 4 Jaw, OCTP, 3ph £2350.00 Harrison 1.5 1/2" x 40" Gap Bed Centre Lathe, Tooling, 240 Volt Single Phase £1450.00 Harrison M250 Centre Lathe, 5" x 20", Tooling, Light, Coolant, 3000RPM, 3ph £1400.00 Harrison M250 5" x 20" Lathe & Tooling £2500.00 Harrison M300 5" x 40" Centre Lathe, Tooling, 3ph £1500.00 Harrison M300 5" x 25" Centre Lathe, Tooling, 3ph £2250.00 Harrison M300 6" x 40" Gap Bed Lathe, Copying Att, Tooling, 3ph £2750.00 Harrison 140 5 1/2" x 25" Gap Bed Lathe, Tooling, 3ph £21450.00 Harrison 15A 1 1/2" x 25" Gap Bed Lathe, Tooling, 240 Volt Single Phase £1450.00 Harrison 15A 1 1/2" x 25" Gap Bed Lathe, Tooling £ 850.00 Harrison 15 5" x 25" Lathe, Tooling, Coolant, Manual, 3ph £ 750.00 Britan Reposition Lathe, Collets, Bar Feed, 3ph £ 500.00 Taylor Capstan Lathe, Cut off Slide, 3ph, 2HP £ 750.00	DECKL Deckel S0 Engraver Cutter Grinder, Bench Mounting, Collets, 3ph, VGC £1250.00 Turner 6" Width X 16" Heavy Duty Belt Linisher, Spare Belts, 3ph £ 500.00 Dormer Model 108 Drill Grinder, Bench Mounting, 1/8" & 1 1/4" Cap, 3ph £ 475.00 Taylor Hobson Model G Engraver Cutter Grinder, 1ph £ 450.00 Husker Jig Grinder, Well equipped, 3ph £2750.00 Clarkson MK 1 Tool & Cutter Grinder, 3ph, No Tooling £ 250.00 Eagle Hand Op Surface Grinder, Mag Chuck, 3ph £ 600.00 Jones & Shipman 540 Surface Grinder, Mag Chuck, 3ph £1650.00 Jones & Shipman 540 Surface Grinder, No Chuck, 3ph £ 850.00 R.H. Trim Tool Grinder, 3ph £ 200.00 Elliott 8" Pedestal Grinder, 3ph £ 75.00 Duplex Toolpost Linisher, 3ph £ 125.00 Ezrel Rotary Filing Machine, 3ph £ 250.00 Canning 2HP Polishing Spindle, 3ph £ 350.00 Samand D.E. Tool Grinder, Lapper, Coolant, Light, 3ph £ 125.00	SHAPERS Apex M8 Toolroom Slitting Machine, 3ph, VGC £1600.00 New Wonder Bench Top Die Filer, 1ph £ 175.00 Alma 1A Shaper, 3ph, VGC £ 325.00 Main Gear for Alma 1A Shaper & Box of other Spare Parts £100.00 Main Gear for Elliott 10M Shaper £ 75.00	BOXFORD SPARES AND TOOLING Change Gears (Also Fit Southbends) 16T, 20T, 24T, 28T, 32T, 36T, 40T, 44T, 48T, 52T, 56T, 60T, 64T, 68T, 72T, 76T, 80T, 84T, 88T, 92T, 96T, 100T, 104T, 108T, 112T, 116T, 120T, 124T, 128T, 132T, 136T, 140T, 144T, 148T, 152T, 156T, 160T, 164T, 168T, 172T, 176T, 180T, 184T, 188T, 192T, 196T, 200T, 204T, 208T, 212T, 216T, 220T, 224T, 228T, 232T, 236T, 240T, 244T, 248T, 252T, 256T, 260T, 264T, 268T, 272T, 276T, 280T, 284T, 288T, 292T, 296T, 300T, 304T, 308T, 312T, 316T, 320T, 324T, 328T, 332T, 336T, 340T, 344T, 348T, 352T, 356T, 360T, 364T, 368T, 372T, 376T, 380T, 384T, 388T, 392T, 396T, 400T, 404T, 408T, 412T, 416T, 420T, 424T, 428T, 432T, 436T, 440T, 444T, 448T, 452T, 456T, 460T, 464T, 468T, 472T, 476T, 480T, 484T, 488T, 492T, 496T, 500T, 504T, 508T, 512T, 516T, 520T, 524T, 528T, 532T, 536T, 540T, 544T, 548T, 552T, 556T, 560T, 564T, 568T, 572T, 576T, 580T, 584T, 588T, 592T, 596T, 600T, 604T, 608T, 612T, 616T, 620T, 624T, 628T, 632T, 636T, 640T, 644T, 648T, 652T, 656T, 660T, 664T, 668T, 672T, 676T, 680T, 684T, 688T, 692T, 696T, 700T, 704T, 708T, 712T, 716T, 720T, 724T, 728T, 732T, 736T, 740T, 744T, 748T, 752T, 756T, 760T, 764T, 768T, 772T, 776T, 780T, 784T, 788T, 792T, 796T, 800T, 804T, 808T, 812T, 816T, 820T, 824T, 828T, 832T, 836T, 840T, 844T, 848T, 852T, 856T, 860T, 864T, 868T, 872T, 876T, 880T, 884T, 888T, 892T, 896T, 900T, 904T, 908T, 912T, 916T, 920T, 924T, 928T, 932T, 936T, 940T, 944T, 948T, 952T, 956T, 960T, 964T, 968T, 972T, 976T, 980T, 984T, 988T, 992T, 996T, 1000T, 1004T, 1008T, 1012T, 1016T, 1020T, 1024T, 1028T, 1032T, 1036T, 1040T, 1044T, 1048T, 1052T, 1056T, 1060T, 1064T, 1068T, 1072T, 1076T, 1080T, 1084T, 1088T, 1092T, 1096T, 1100T, 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ON THE EDITOR'S BENCH

On the Grapevine

Chingford and District Model Engineering Club have been in touch to advise that their old website is no longer maintained, although a number of links are still active. Their new, enlarged website can be found at www.cdmecc.co.uk or using the full URL: <http://myweb.tiscali.co.uk/cadmec>

The most recent Bristol SMEE newsletter includes a description of what was clearly a most interesting talk on pattern making given by Joe Nemeth. One of the books recommended is "Wood pattern Making" by H McAslin. It is also noted that many small foundries have closed due to the high cost of meeting the latest Health & Safety requirements, and that much foundry work is now undertaken overseas, such as in Poland etc. As the EEC progressively expands it will be interesting to see if other governments enforce what should be "Harmonised legislation", pushing yet more manufacturing to the far east, or will it continue to be caricatured by "The Germans make the rules, the French Italians and most others ignore them, while the British introduce yet another layer of bureaucracy to enforce them".

Development in progress

A conversation with John Stevenson (Nottingham) revealed that he has been working on a "semi cnc" hobbing system. The idea was earlier advanced by Brian

Thompson (Scunthorpe) who has exhibited his set up at one or two shows, but, like many others I have managed to pass by without appreciating what was being demonstrated. In essence Brian's system moves forward from the concept described by Eric Rumbo in MEW issue 75, and uses a rotary encoder with step up drive to generate 4000 pulses per revolution of the hob. These are taken to a black box which performs a dividing function, and outputs a stream of pulses to drive a stepper motor which in turn rotates the workpiece at the appropriate speed. Selector switches on the black box allow any particular number of gear teeth to be chosen instantly, and prime numbers are not a problem. Brian's initial work was at "Modelmaking" scale using a vertical slide on a lathe, and was directed at straight cut gears. John has moved things up in size, currently to a Victoria horizontal mill, and has successfully utilised the table angular adjustment to work on helical gears. He hopes to transfer the concept to a Bridgeport or similar. It is to be hoped that an exhibit from one or other of the gentlemen involved will be on show at Harrogate, and this time I'll make a point of a close inspection. I will also indulge in a little arm twisting to see if the system may be written up later in MEW.

Out and About

One of the clubs of which I am a member, (Monklands Sporting Car Club) holds its AGM in February in the conference room at the Summerlee Heritage Museum (Coatbridge). In previous years, I have managed to arrive for the meeting with little time to spare, however on this occasion determined to arrive an hour early to have a quick look round the museum, which concentrates on industrial heritage. The first pleasant surprise was that admission was free, and as the central belt of Scotland had been spared the blizzards experienced overnight further north, it was possible to take a brisk walk in the sun around some of the outdoor exhibits which include "Workshop items" such as 1890 Bending Rolls, 1894 Plate

Edge Planer, a Radial Arm Drill, and a Vertical Bandsaw, and transport items including electric and steam locomotives, and stationary steam engines.

Moving to the indoor area one finds a number of workshops recreated from the past (the brassfounders, the tinsmiths, the general engineers) with most of the machinery set up with belt drive from overhead lineshafts, and frequently in operation. Looking at these machines of yesteryear, it is hard not to see how easy it would have been to sustain serious injury given the multitude of exposed gears, belts and other unguarded parts.

For any MEW reader visiting the area, I would thoroughly recommend spending some time at Summerlee. We tend to think of our modern lathes as "All singing, all dancing", but a careful look at some of the pre 1900 equipment shows features such as Vee bedways, and powered cross feed. What has changed dramatically is the method of drive, as the availability of electricity and the development of compact electric motors, displaced the steam or gas powered overhead line shaft and its associated flat belting.

Course and Club at South Kent College

Information has recently arrived concerning a hands on course and model engineering club at this college in Ashford, Kent. Participants in the ten week course will have access to a range of workshop equipment which includes twenty lathes, six mills, (vertical and horizontal), and both surface and cylindrical grinders. As the smallest lathe is a six inch swing, the facilities on offer clearly represent an opportunity to push forward with that "Larger project". Whilst attending, depending on their level of experience, those involved may either take full advantage of expert tuition on hand, or get on with the pet project, requesting advice as and when needed. Following on from the course, participants are then able to join the college "Club" for continued access to the workshop. The next course should commence in the evening on Monday 5th April, and for the benefit of those travelling direct from work, the college boasts home cooked food in the refectory, so a "pre session" meal may be enjoyed at reasonable cost.

Cost of the ten week course which will probably be repeated four times a year is £120.00 plus any material required. Further details may be obtained from Colin Humphrey, Engineering Lecturer, South Kent College, Jemmett Road, Ashford, Kent, TN23 4RJ phone 01233 655 531, or Pauline Grant on 01233 655 514.



Brian Thompson operating his hobbing system.



This early shaper at Summerlee is very similar in design to the well known and somewhat smaller Adept

DRILLING PROJECT

1

Harold Hall offers advice on using, and a couple of useful projects for the drill.



1. Testing that the drilling machine table is accurately set.

Long term readers of the beginners projects series will no doubt be surprised to find that at this stage we have entered into the subject of drilling, considering this would have been more appropriate as the first to be aired. This I agree, but at the commencement I could not come up with a project that was substantially drilling. It was whilst having switched, temporarily, my allegiances to woodworking that I came up with what I considered a good subject for the drilling machine but more about that later.

Drilling is probably the operation that will come most easily to the newcomer to the metal working workshop having probably handled the obligatory DIY electric drill. However, this can be a disadvantage as it may lead to complacency thinking that there is little to learn.

The machine

Five things will need considering when obtaining a drilling machine, cost, workpiece capacity, floor or bench mounting, drilling capacity, speed range. The drill must also be considered in relation to the other machines in the workshop. If a milling machine is either in place or planned, then one may choose a smaller capacity drill.

Cost will be for many a major consideration with the choice being between relatively cheap imported machines, industrial quality machines or a second hand machine. In the first category there is quite a wide range of machines available, but do steer clear of the very small machines as these are likely to be too limited, unless of course the user is only into very small work. They may

though be of use as a second machine for delicate work, ref 1. At the other end of the scale come the industrial quality machines and if the cost is of less concern then these are the ones to go for, they are though much more expensive.

Workpiece capacity really equates to distance of chuck to table surface and drill spindle to column. The latter has a bearing on table size and this is probably of greater significance as a larger table makes for easier working. Regarding the work table these normally come in two shapes, round and square, the latter is preferable as it gives a greater surface area for a given size of machine.

Floor or bench mounting, whilst having a major effect on available drill to table dimension, is probably a question for possible positioning in the workshop. A normal design of drilling machine produces, due to the rear mounting of the drive motor, a rather deep machine. This can result in the need for a deep bench and a floor mounting machine may be found to be preferable.

Floor mounted machines do tend to be top heavy, and if not bolted to the floor, then some form of added stabilisation is needed.

When considering drilling capacity do not be fooled by drill chuck capacity these are two quite separate things. The ability of the chuck to hold a 12mm drill does not mean that it will be able to drill a 12mm hole in steel as this will be equally dependant on motor power and lower speeds being available.

Speed range is crucial to the sizes of drills and material types being used. For working mild steel with a 12mm HSS drill, our professional counterparts may work

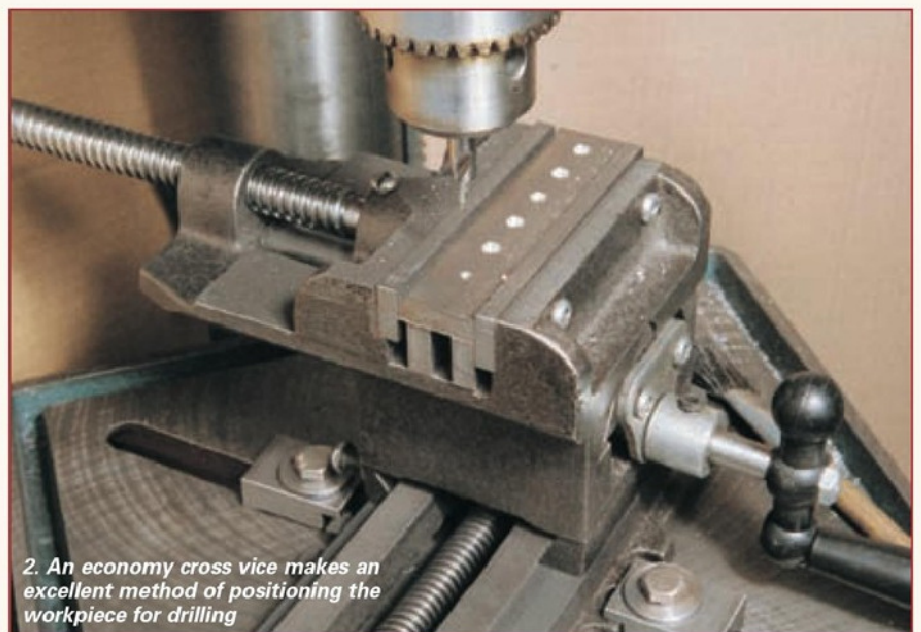
with surface speeds of up to 80ft/min giving a spindle speed of over 600 rpm. We however may wish to drill tougher steel or use home made carbon steel countersink cutters, and hence it may be beneficial to have a lowest speed of say 250 rpm. At the other end of the scale 2500 rpm will cope adequately with drill sizes in the order of 2mm. Over this range aim at around 8 to 10 speeds, more will be of limited benefit. Do however, check that the speeds available are reasonably evenly spaced over the range, as my machine has a substantial gap in the middle going from 680 to 1170 even though the machine has 16 speeds; a ludicrous situation. It is a case of do as I say and not as I do.

The accessories

The main accessory needed is a drilling vice as holding the workpiece by hand is unacceptable on safety grounds unless the drill size is small and the workpiece large. Drilling vices are not that expensive so choose the largest that is compatible with the size of the machine table. The very cheapest do have rather inferior jaws so if possible purchase something a little better. However, the cheapest (around £10.00) would be adequate for much of the work likely to be undertaken.

When drilling larger holes, say 6mm plus, firmly bolting the vice to the table is advisable for safety reasons, for this some T nuts and bolts will be required. Whilst the machine table is likely to have open slots do not just use bolts with nuts and washers, T nuts are much easier to use.

Other items that will be needed are angle plates and vee blocks, these of



2. An economy cross vice makes an excellent method of positioning the workpiece for drilling

course being shared with other machines in the workshop.

Of course drills will be required and here the question is imperial, metric, number/letter or all, and how small the interval between sizes should be. My advice would be to go for metric size drills. The reasoning is that they are regularly available in increments of 0.1mm (0.05mm from some sources), whereas the imperial drills go up typically in increments of 1/64th or about 0.4mm.

Having chosen your measurement standard, imperial or metric, go for the sets with the smallest increments, typically 1 to 10mm by 0.1mm with a few larger sizes, say up to 12mm by 0.5mm increments.

One excellent safety feature which I favour, is the addition of a foot switch.

Initial setting up

The newcomer may believe that the machine will come ready for use, this though may not be the case and the machine needs checking to see if it is accurately set up. For the vast majority of the machines supplied it will be found that the table has a facility for tilting left and right enabling work pieces to be drilled at an angle. This though makes it necessary to check that for normal working the table has been set correctly.

The above adjustment makes possible the setting of the table left and right but manufacturing tolerances may result in an error back and front. Here, it may be found that some machines feature provision for adjusting this. If fitted, a screw, just under the pivot screw enables very small adjustments to be made to the height of the front of the table, thereby providing the necessary adjustment.

To check the adjustment set up a dial indicator as shown in **Photo 1** and check the readings, left and right, and front and back, endeavouring to get within 0.1mm if checking at around 75mm radius. Better would of course be nice but it can be a tedious operation.

The drilling Operation

Having marked out the workpiece with the position that the hole is required, centre punch at this point, this will assist the drill to start in the required position. For better accuracy, some practitioners advocate the use of two centre punches. The first ground to an acute point is used to give a light impression, whose position with reference to scribed lines can be checked with a loupe. The second conventionally ground punch may then be used, slightly off the vertical, to correct the position of the impression, and then enlarge it. With larger drills though the size of the punched impression may still not provide a reliable starting point and the hole should then be started with either a smaller drill, or a centre drill.

Safe working

Drills installed in commercial situations are generally required to be fitted with chuck guards. This is presumably to prevent loose clothing becoming caught, and

3. Using the M8 tapping guide to tap a hole in the screw holding fixture.



pulling the operator towards the drill. However while this must be considered to constitute a risk, it is also noted that the presence of the guard frequently obscures the view of the job, thus creating a secondary risk.

Accidents during drilling operations are indeed relatively common, almost invariably due to complacency on the part of the operator and are almost totally accountable to one of two situations. First, and probably most easily understood, is that the turning motion of the drill can cause the part being drilled to rotate at speed if the part is not securely held. The possible consequences of this are obvious and potentially severe. Secondly, and probably less obvious, is the effect of the drill breaking through as the hole is completed. At this point the part will attempt to run up the drill spiral rather than fully completing the hole. Again grip will easily be lost and the part rotate, this time though above the work table with even greater potential for serious injury. A similar situation can arise when using a larger drill to open up a slightly smaller hole. One further potential source of injury

arises from the rotating swarf, particularly if the left hand is holding the work.

It is essential because of the above that all drilling operations be carried out with appropriate caution. However, to say that all drilling should take place with the part clamped to the machine table, either directly or whilst held in a vice would be making a rule that is bound to be broken. Drilling operations can therefore be loosely divided into three categories.

1. Holding the part by hand whilst being drilled.
2. Placing the part in a vice, whilst holding the vice by hand and.
3. Clamping the part, or a vice in which it is being held, to the drilling machine table.

There are of course no hard and fast rules as to which method should be used other than to say that if in doubt move up to the next more secure method.

Method one should be limited to parts that are sufficiently large to be held securely by hand and only for small drills, say up to 4mm diameter. Using a vice without clamping this to the machine table

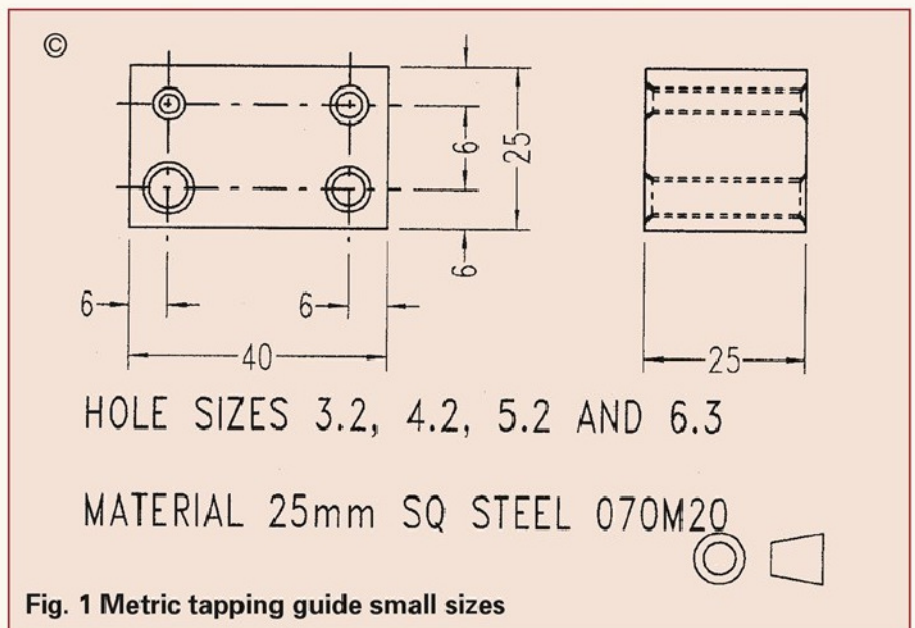
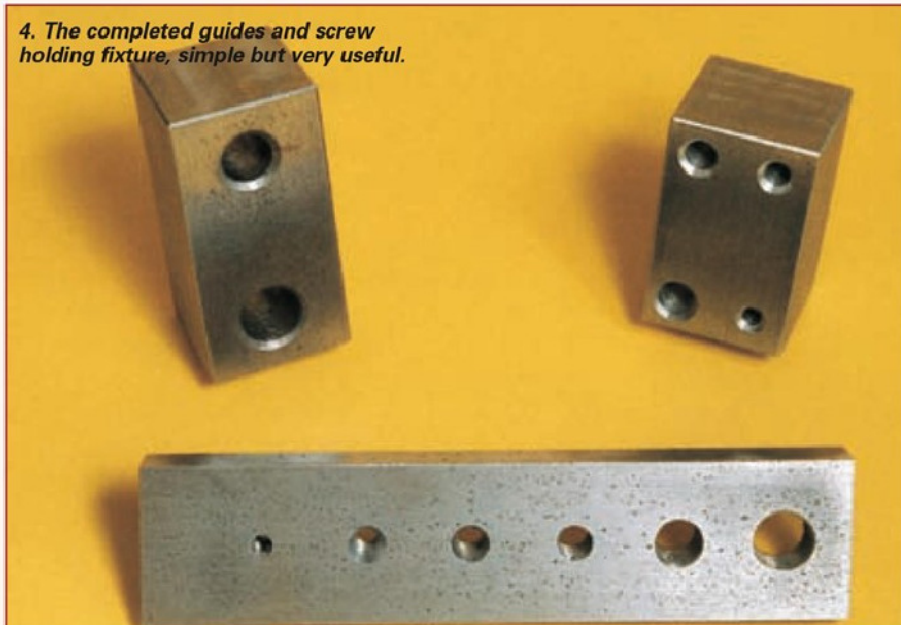


Fig. 1 Metric tapping guide small sizes

4. The completed guides and screw holding fixture, simple but very useful.



will in part depend on the size of the vice being used, obviously the larger and heavier the vice the safer the option. I would say no larger than 6mm diameter should be drilled in this way with a medium size vice. Anything larger, then the part itself, or the vice in which it is being held, should be firmly clamped to the machine table.

The advantage of methods one and two is that it is easy to align the drill with the centre punch mark and is the only reason for adopting these methods. When securely clamping the part the following procedure will be necessary. With the part on the machine table and all necessary clamps fitted but loose, lower the drill and align the punch mark with the end of the drill. Use the down feed to hold the part in position whilst lightly tightening the clamps, then raise the drill and fully tighten the clamps, finally, recheck alignment and drill. This may seem a tedious operation but must be considered essential practice where larger holes or more difficult materials are being machined. I confess to having little experience when it comes to materials

other than free cutting steels but I do know that materials such as copper or brass can be even more likely to grab the drill and pull the workpiece from your hand, even at small sizes.

A possible alternative would be to obtain one of the cross vices that have become widely available in recent years, **Photo 2**. These are inexpensive and as a result relatively crude, but nevertheless accurate enough for most of the drilling work likely in the home workshop. With one of these in place there would be little use even for method 1, except when the size of the part was greater than the capacity of the vice.

These vices permit easy and accurate alignment of drill and centre punch mark. They do also have dials on their feed screws, albeit basic, which may in a few cases enable holes to be drilled without the need for marking out. Holes would though require to be started using a centre drill or stub drill as, except with very short drills, a more accurate result may be obtained compared to starting with the jobber drill alone. There is a variation on the theme of using a cross vice but one that is much

more expensive and would in most cases rule out the option. I will though briefly comment on it later in the series.

Speed selection

Having arrived with our part in position on the table we have to decide on a speed for the drill to run. Again, as when considering turning and milling, speed is inversely proportional to the size of the drill being used. However, in the home workshop there are no hard and fast rules and limits are set by the rigidity of the machine for larger drills and the fragile nature of the small drill sizes.

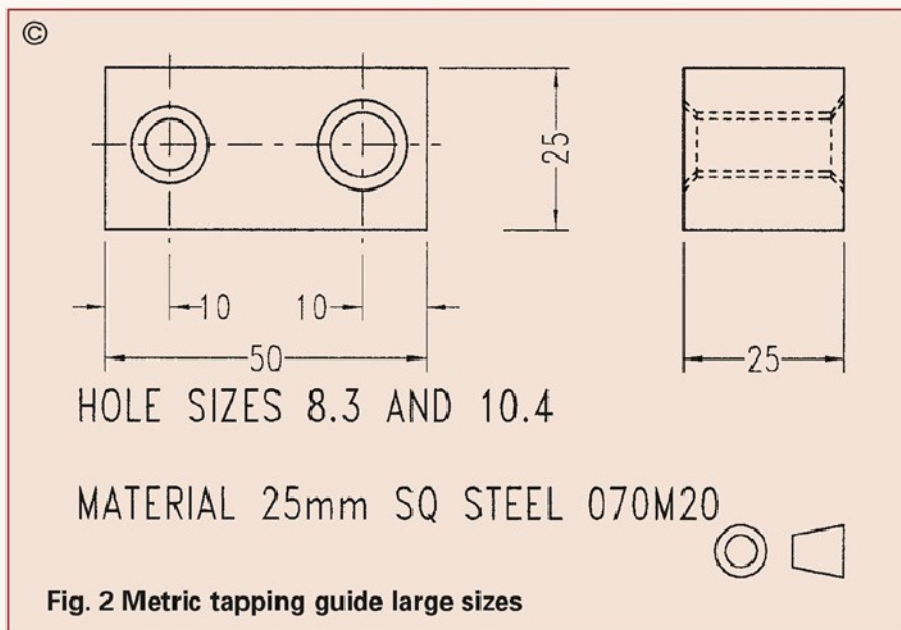
If you find this difficult to understand it is worth considering drilling a 12mm hole at a relatively low speed and high feed rate. It is though only the cutting edges at the extremities of the drill that are at 12mm, in the centre there is the equivalent of say a 3mm drill also running at the same speed and feed rate. In theory therefore a 3mm drill should function adequately at the same speed and feed rate, it has though a cross section of only one sixteenth that of a 12mm drill and as a consequence is much weaker; the feed rate would therefore need reducing dramatically. This would make manual feeding difficult and drill breakage would be highly likely. To overcome this, small drills must run at a sufficiently high speed to make manual feeding a relatively easy operation. Take note that feed is the forward movement of drill per revolution, if the drill is running fast it will be easier to keep feed rate small enough to avoid undue load on the drill.

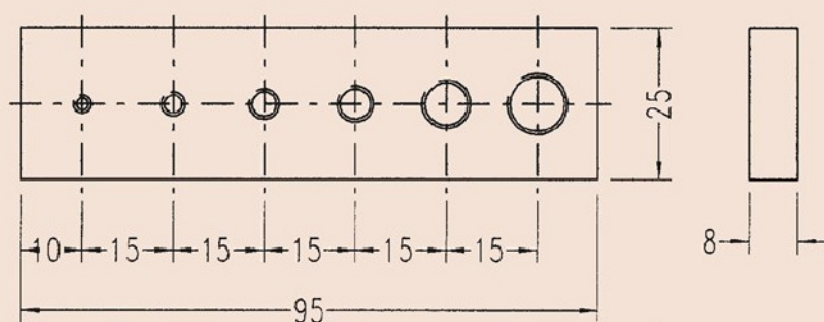
As a guide, and this is all it can be, start with 250rpm for a 12mm drill which equates to 3000 rpm at 1mm. 250 rpm is considerably less than speeds used in industry and it will I am sure be found possible to increase this in many cases. However, at the smaller sizes, speeds of even 3000 rpm are unlikely to be available in the home workshop unless a small high speed machine is available so it will be a question of using the highest speed available and ease off on the feed rate.

Another problem with the average home workshop drilling machine will be robustness and power available. This may result in it being necessary to drill larger holes in two stages, first with a smaller drill and finishing with a drill of the required hole size. Again there is no hard and fast rule as to the size of the first drill but should be small enough to ensure that the larger drill still has some work to do, I would suggest the first drill should be around one quarter to one half the size of the eventual hole. If too large, the larger drill, with little work to do, will attempt to draw itself into the workpiece rather than having to be forced in using pressure from the down feed.

Hole size accuracy

Even new drills may produce holes that are larger than the drills declared diameter due to normal manufacturing tolerance. All manufactured parts are made to a tolerance and drills are no exception, so an over size hole does not indicate a faulty drill. Permitted tolerance is $-0 +0.1$ mm at 3mm drill size up to $-0 +0.18$ mm at 18mm drill size. These tolerances should give adequately





HOLE SIZES M3, M4, M5, M6, M8 AND M10

MATERIAL 25mm X 8mm STEEL 070M20

Fig. 3 Metric screw fixture

sized holes for all normal applications. Less than perfect sharpening will exacerbate this. **SK 1** shows how the hole size will be determined by the longer lip. Home workshop resharpening may lead to a similar fault as amateur methods are unlikely to be as accurate as those in industry.

Even so, providing the error is not excessive, the oversize hole should not be a problem in the vast majority of cases. Holes for eventual reaming may result in a problem and, just possibly, holes for tapping may result in unacceptably weak threads if the holes are appreciably oversize. In the latter case though there is a fair scope for variation unless the fastening is to be stressed near to its maximum.

Greater accuracy can be achieved by first drilling with a drill only just smaller than the hole size needed then completing the hole with a drill of the required size. This though should be attempted with utmost care in view of the drill attempting to spiral through the hole already drilled, as discussed earlier. If attempted the workpiece, or the vice holding it, must certainly be bolted to the machine's table. Feeding the drill will also be difficult due to the backlash in the machine's down feed. The method may be better confined to drilling in the lathe where the backlash of the tailstock is small and even this can be overcome by partially tightening the tailstock's barrel lock.

The projects

We now come to the two projects to develop our drilling skills, the first, two very simple items that will be of help in reducing the length of screws and tapping holes true to the surface being tapped. These provide drilling experience over a wide range of hole sizes.

The second is an item that will give more experience in drilling larger holes and positioning them with greater accuracy. The idea came to me when I started, for a break from the metal working workshop, on some quality woodworking projects. I was gluing up some relatively narrow boards to make a table top and for this was using the obligatory sash clamp (or cramp in woodworker speak) for the exercise.

Doing this, it occurred to me that a small version may have uses in the engineer's workshop and provide some drilling experience for a beginners project. These will call engineer's sash clamps. I also felt that two of these would make a suitable method of holding larger workpieces on the milling machine table. As a result, I am suggesting that two are made.

Tapping guide

I will describe the process based on the metric size guides shown in the drawings (**Figs 1 and 2**) but no doubt other sizes will be necessary for other thread forms. Cut the two pieces of 25mm square steel, one 40mm and one 50mm long, and mark out the positions of the six holes and centre punch. Even at the smallest size drill the part should be held in a vice as the part is too small to be held safely by hand. However, with a reasonably large and heavy vice it should be safe to drill the four smaller holes with the vice hand held. Do take note that it will be necessary to change the speed between the smallest and largest drill.

When drilling the holes for the M8 and M10 guide it will certainly be necessary to clamp the vice to the table. Some vices, though called drilling vices, have limited facilities for bolting to the drilling machine table and are therefore inadequate for this method of working; more about that in the second project. Finish the guides by generously chamfering the holes with a countersink. The purpose of this is to clear any burrs round the drilled hole being tapped or, more likely, burrs thrown up during the tapping operation itself. Take note that many taps for metric and unified threads have a greater outside diameter than the nominal thread size, so a 4.1mm hole will be insufficient to clear an M4 tap. This is because the OD of the female thread is slightly over the nominal diameter.

Screw holding fixture

Very briefly, to use this device (**Fig 3**), thread a nut on the screw to be shortened and run the screw into the

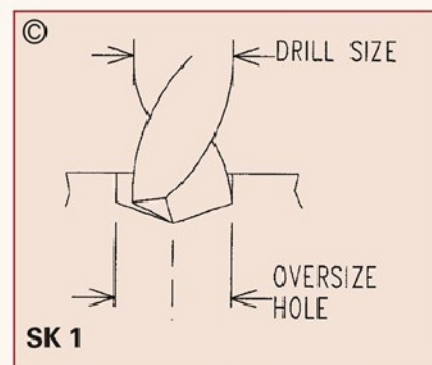
appropriate hole. Lock the screw in position so that if the screw is cut off against the other side of the fixture the screw will be the length required. Loosen the nut and run the screw through further so as to file and radius the end. Rotating the screw using a screw driver, spanner, etc. will help in achieving a good radius on the end. Removal of the screw will break away any thin slither of metal on the end of the screw which the operation has created. A thinner fixture could be made for shorter screws.

Cut a length of metal, mark, centre punch and drill the required tapping size holes. As the tapped hole has little work to do a 50 to 60% thread depth will be adequate and make the tapping operation easy on the tap thereby eliminating the possibility of a broken tap, even at the smaller sizes. For details of percentage thread depth and drill sizes see the Model Engineers' Data book page C1 or other appropriate source.

The part itself could be hand held for drilling the smaller sizes but a hand held vice is better for larger sizes and for total safety, should be bolted to the machine table for the largest. **Photo 3** shows the M8 hole being tapped using the appropriate tapping guide ensuring that the tapped hole is square to the fixture's surface. As at the larger sizes both hands will be necessary to turn the tap, the tapping guide will require to be clamped to the part being tapped as shown in the photograph.

For smaller sizes, say M6 and below, it should be possible to rotate the tap with one hand, then, with the workpiece rigidly held in the vice or by some other means, the guide can be held in place using the other hand. If you have a cross vice the position of the holes can be established using the vice's lead screw and its calibrations and then first drilling with a centre drill or spotting drill. This is the method shown being used in **Photo 2**.

Photo 4 shows the completed fixtures and whilst simple, they can be a considerable help in achieving accurate results. In the next issue we get to grips with the sash clamps which will provide valuable drilling experience and show that there are ways of positioning holes other than the common method of rule, scribe and centre punch.



Reference

Modifications to a very low cost drilling machine.
MEW issue 40 page 20.

HOW'S MIKE? (or: On the health of some micrometers)



1. The injured veteran,
aged and worn.

In the Model Engineer of 1973, around about the time when I first had an interest in small-scale engineering, there appeared a series of articles on workshop practice for beginners by Derek Beck and in one of the articles (Ref.1) there was a section "On not buying a micrometer." He had been able to afford a dial gauge or a micrometer, but not both, so he opted for the former. In a letter to "Postbag," Tubal Cain put him right about this, as he had managed for 20 years with only a 0 to 1 inch micrometer that lived in an overall pocket and was after 43 years "...still within 0.0001 in. throughout the range." I had only previously encountered the micrometer in "A" Level Physics practical classes that involved measuring the diameter of piano wire in a device for estimating its modulus of elasticity. That only physics textbooks still called the measuring instrument an "external micrometer screw gauge caliper" was brought home to me when early in 1974 I decided to invest in one and asked for one by this name in a tool shop in Newcastle-upon-Tyne. No one there knew about such an instrument, but they had plenty of "mikes" so I bought my first one, a Mitutoyo 0 to 1 inch x 0.001 inch

micrometer. Not long afterwards appeared an article by W. M. Thomas (Ref.2) that referred scathingly to a 43 year-old micrometer that retained "...an accuracy which it most certainly never possessed on the day it was made."

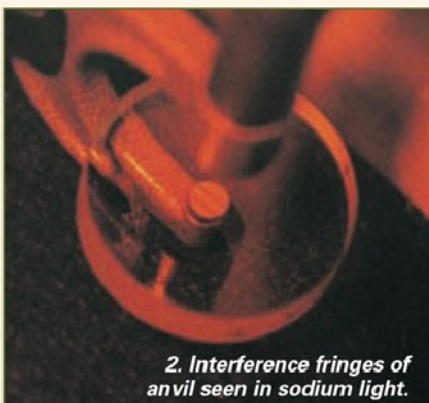
Precision, reproducibility and accuracy

Over the years since then I have acquired many micrometers, usually second hand, because I have come to love precision instruments for their own sakes. It is enough for one to be slightly unusual for me to hanker after it, but since deciding to go metric about seventeen years ago, those that measure in inches have stayed in a drawer and, like Tubal Cain, most of my measuring is done with one micrometer, another Mitutoyo, but a metric one, 0 to 25 mm x 0.01. A lot of the time, the amateur uses his mike as a sort of comparator, to see how much more material to remove from a shaft, for example, for it to fit into a hole that has been measured by the same micrometer

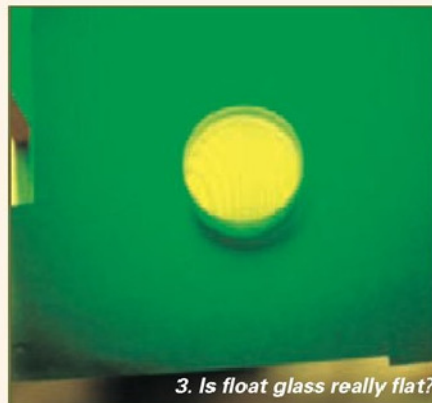
Bill Morris considers the condition and accuracy of a few examples.

with some sort of transfer device like internal calipers. It does not matter whether the hole truly is the, say, 16.04 mm that the mike says it is, as long as the shaft ends up with a diameter of about 0.01 mm less than the hole. However, if my friend in Dannervirke asks me to make a part to fit the hobbing machine that he is building, my 16.03 mm had better be pretty close to his 16.03 mm or we will both be in trouble. In this case, as well as being precise, discriminating between 16.03 and 16.04 mm, the micrometer also needs to be accurate, so that when it reads 16.03 mm, the dimension truly will be 16.03 mm, within agreed limits. A further aspect of precision is that the measurements also need to be reproducible to within similar limits.

Few people will have access to the equipment needed to check a micrometer and most will probably content themselves with occasionally checking that the instrument reads zero when the spindle face is in contact with the anvil, perhaps coupled with a second check over a suitable slip gauge. However, the "humble" micrometer is a remarkably robust triumph of 20th century technology and the methods used to inspect it are themselves of considerable interest, calling for assessment of flatness and parallelism of the measuring faces and calling for some knowledge of assessment of screw thread errors. Over the last few years I have accumulated the apparatus required and I thought it might be of interest to readers to form an idea of how their own instruments might perform, so I recently calibrated three micrometers in various conditions and showing various degrees of wear...



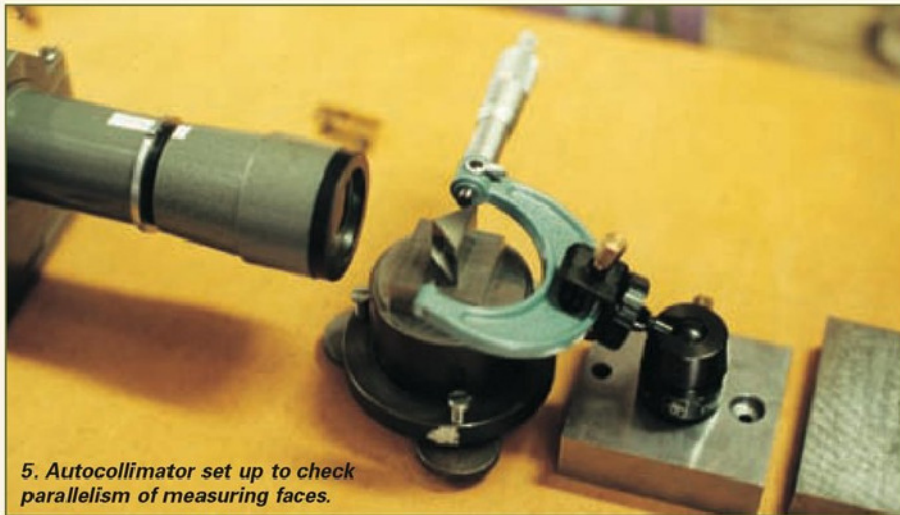
2. Interference fringes of
anvil seen in sodium light.



3. Is float glass really flat?



4. Ball jig used to check
parallelism of measuring faces.



5. Autocollimator set up to check parallelism of measuring faces.

The subjects

Mike 1, the injured veteran

The first was a Brown and Sharpe No. 10, fitted with ratchet stop and vernier, reading 0 to 1 inch x 0.0001 inch. It bears the number of a patent of December 30 1902 and appears in my B & S catalogue of small tools dated 1929 when it retailed for US\$11.75, with leather case available for an extra US\$1.75. I think it is safe to say that when inflation is allowed for, new micrometers have got considerably cheaper. With the writing of this article in mind I went to the local second hand tool shop and asked for the worst and cheapest micrometer that they had. **Photo 1** shows what I was offered for NZ\$10, roughly what it cost when new! I vaguely recall reading once that one should never attempt to measure a shaft's diameter while it is still rotating, but it never occurred to me that anyone would even think of doing so - until I saw the B & S instrument. It has plainly at one time suffered a very nasty accident as there are deep, irregular nicks in the frame at the anvil end and at the bottom of the "U". This must have caused a lot of distortion, as there has been an attempt to correct it by peening the back of the frame. The anvil is jammed in its hole and it is no longer possible to set it to zero. The measuring faces have small corrosion pits in them and the screw had an irregular and gritty feel to it, until I dismantled and cleaned it, after which it no longer felt gritty. Tungsten carbide began to be used in industry only in the mid 20's, so the measuring faces are of hardened steel.

Mike 2, mature and experienced

The second micrometer calibrated is my standard Mitutoyo 0 to 25 mm x 0.01 mm micrometer, bought about seventeen years ago and used so regularly ever since that the maker's name has worn off the plastic grip on the frame. It has not lived in an overall pocket, has been cleaned after use and lives in its box when not in use. It has never been broke, so apart from taking it apart every few years for a good clean and

oil, I have resisted the temptation to fix it by constantly fiddling with the screw adjusting nut and sleeve.

Mike 3, the novice

I did not feel like buying a brand new micrometer for the article, but my 25 to 50 mm x 0.01 mm Mitutoyo micrometer has seen only occasional use so that it is for practical purposes brand new and I chose it to represent the other end of the spectrum from the Mike 1.

There is little point in calibrating the micrometer screw if the measuring faces are not acceptably flat or parallel, as errors here may swamp errors in the screw, so we must first check the faces.

Are the measuring faces flat?

For many applications, it would not matter if the faces were spherical in form and in some applications it would actually tend to reduce alignment errors, but for a general instrument the faces must be flat, so that flat, cylindrical, spherical and, indeed, most other shapes can be measured. If, for example, the spindle face were convex, then the reading would depend on whether the centre or the periphery of the face were in contact with the workpiece. In fact, this is the shape that the spindle face takes with wear, as the periphery rotates, and thus wears, faster than the centre. The anvil face tends to stay flat or wear concave, as the work pieces traverse the centre more than the periphery. B.S. 870:1950 (and amendments) allows an error in flatness of no more than 0.001 mm or 0.000 05 in. If the spindle is left in contact with the anvil it encourages corrosion, so the instrument should be stored with the faces separated.

The simplest way of checking flatness of a highly finished surface is to generate interference bands by use of an optical flat, a piece of glass or similar transparent material that has been worked to a high degree of flatness. Mine is a disc of Pyrex glass worked by the late Garry Nankervill to be flat to better than one tenth the wavelength of visible light, usually taken to mean green light, which has a wavelength of about 0.0005 mm. In use, the flat and the surface being measured are cleaned impeccably of any trace of dirt

or grit and the flat laid (not wrung) on the surface. There are various ways of illuminating the flat, but an extended source like an overhead fluorescent tube will do us. A refinement is to view the flat through a green filter so that only the intense green mercury bands are seen. The light from a sodium lamp is for practical purposes all of one wavelength and is even better.

For our purposes, we do not need to know how the interference bands are generated, but for the interested reader there are many excellent accounts to be found (**Ref. 3**). The undersurface of the flat and the measured surface will usually at first be separated by a fine wedge of air and interference fringes will be seen after a little gentle manipulation and will be closer together the larger the wedge angle. Straight, regularly spaced lines imply a flat surface (**photo 2**, in sodium light) and irregular lines can be thought of as showing a contour map of the surface with the contour lines spaced at one half of the wavelength of the light used. **Photo 3** (in green mercury light) shows that a 40 mm disc of float glass is flat only when considering small areas. As a further example, if the spindle face has worn spherically convex then a series of concentric rings with a central dark area will be seen. We can tell that it is convex rather than concave by applying a little pressure off-centre, when the dark centre will move towards the direction of the pressure. However, it does not matter whether the surface is convex or concave as long as no more than four rings are visible. This will imply that the centre is no more than four half wavelengths or about 0.001 mm higher than the periphery.

How did our Mikes perform? It was not possible to get any reflections from the pitted and scratched steel faces of Mike 1. **Photo 2** shows the perfectly regular and straight fringes available from the tungsten carbide anvil of Mike 2, implying flatness to within a tenth wavelength, or about 0.000 05 mm. Mike three gave a similar picture. Mikes 2 and 3 very comfortably reach the required standard and give a lie to W M Thomas's statement that "It is seldom that a micrometer that has received some use will comply with this standard even when fitted with tungsten carbide."

Are the measuring faces parallel?

The faces on the spindle or anvil or both may not be square to their axes, or if they are, their axes may not be in the same straight line. With such errors, different

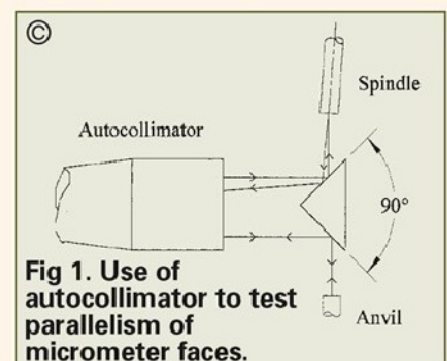
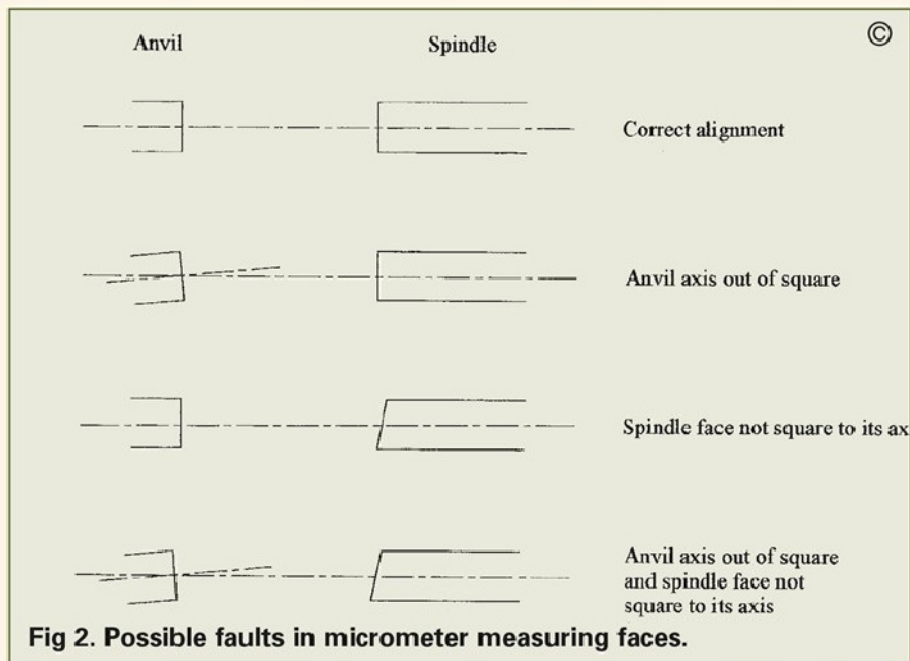


Fig 1. Use of autocollimator to test parallelism of micrometer faces.



readings will be obtained when measuring cylinders or spheres, depending on the parts of the faces in contact with the workpiece. It is just possible that an error of squareness of a face would be cancelled at one position by an error of alignment of the spindle, so any testing method has to take account of this. There are two optical methods of testing and one mechanical; and as Mike 1's faces are not of reflective finish, we had better deal with the mechanical first.

This is the simplest and cheapest. A ball soldered to the end of a piece of wire is used to explore the faces at four places at 90 degrees to each other near the edges, taking precautions to mark the wire at one place so that the same diameter of the ball is always measured, to use constant contact pressure and to fix the micrometer in a holder so that its frame is not distorted by pressure or temperature variations from the hand. With these precautions it should just be possible to check that the instrument is within the allowable tolerance of 0.003 mm or 0.0001 in. If it turns out that the instrument is within tolerance, it is as well to check with a ball of different diameter such that contact is made with the spindle at about 180 degrees to the first position.

Another simple approach is to solder two balls to a piece of angle brass and make a duplicate with the balls at a different spacing, as shown in **photo 4**. The angle makes sure that contact is always made at the same distance from the periphery of spindle and anvil, thus avoiding important cosine errors. It is also a convenient approach to testing larger micrometers.

This is perhaps a good point to digress and write a little about contact pressure. If W M Thomas and Tubal Cain were to be believed, about 25 years ago opinion was unevenly divided about whether to use the ratchet or to develop a sense of feel for contact. Most experienced toolmakers and inspectors, we were told, dispensed with the ratchet, apparently on the grounds that improper use led to inconsistent results. Now that I count myself an experienced user I am prepared to stick my neck out

and say that the ratchet (or friction thimble) should always be used and always used in the same way: the thimble should be rotated via the ratchet slowly until contact is made and rotation continued slowly until the ratchet clicks once. It should not be rotated through one or two turns, as the rate at which it is turned will be inconsistent and result in inconsistent contact pressure. Used as I have described, it is just possible to detect differences as small as 0.0025 mm (0.0001 in) with some consistency, but you should bear in mind that this is right on the limit of permissible errors of the micrometer screw, so we are talking about precision here, not accuracy.

A second method uses optical flats with both faces worked flat and parallel (this adds about 40% to the already-high cost of a flat). The flat is manipulated between the measuring faces until a minimum number of fringes is seen on one and then the fringes counted on the other. There should be no more than ten. One really needs a set of four of these expensive little items of different thicknesses, in order to explore at four different points of rotation of the spindle, but one can get by with two by wringing them to each end of slip gauges; and by this means, the methods can be extended to larger micrometers.

A more general optical method that can be used with micrometers of any size is by use of an autocollimator and a ninety-degree prism. The autocollimator is an optical instrument that can measure very small angles by means of parallel light beams. It is perhaps sufficient to know that it is a telescope that emits a parallel beam of light containing the image of a set of cross wires. If the beam hits a reflector that is at right angles to the beam, the image of the cross wires is reflected back to its source at the focus of an eyepiece. If the reflector is not at right angles to the beam, the reflected image is deflected through an angle that can be measured by means of the wires of a micrometer eyepiece.

Like many setups using fine measuring instruments like the autocollimator, the fiddly practice is often quite different from the nice clear theory, involving much



fumbling and searching for sometimes dim images in semi-darkened rooms, but shorn of all detail, the set up is as shown in **Figure 1** and **photo 5**. The light beam leaving the autocollimator is of parallel rays. If the faces of the micrometer are parallel and the faces of the prism are truly at 90 degrees and all the faces are at right angles to the same horizontal plane, then both reflected images will arrive back at the autocollimator in the same place. If the faces are not parallel, then two images will be seen and their separation can be measured by the autocollimator eyepiece and any variation noted as the micrometer spindle is rotated. Assuming a spindle diameter of about 6 mm, the allowable tolerance of 0.003 mm converts to an angular difference of about .03 degrees or about 100 seconds of an arc, well within the precision capability of most autocollimators. **Figure 2** shows the various possibilities.

By holding Mike 1 up to the light with the faces in contact it was possible to see that they were not parallel to each other. On checking with two of the little ball jigs as

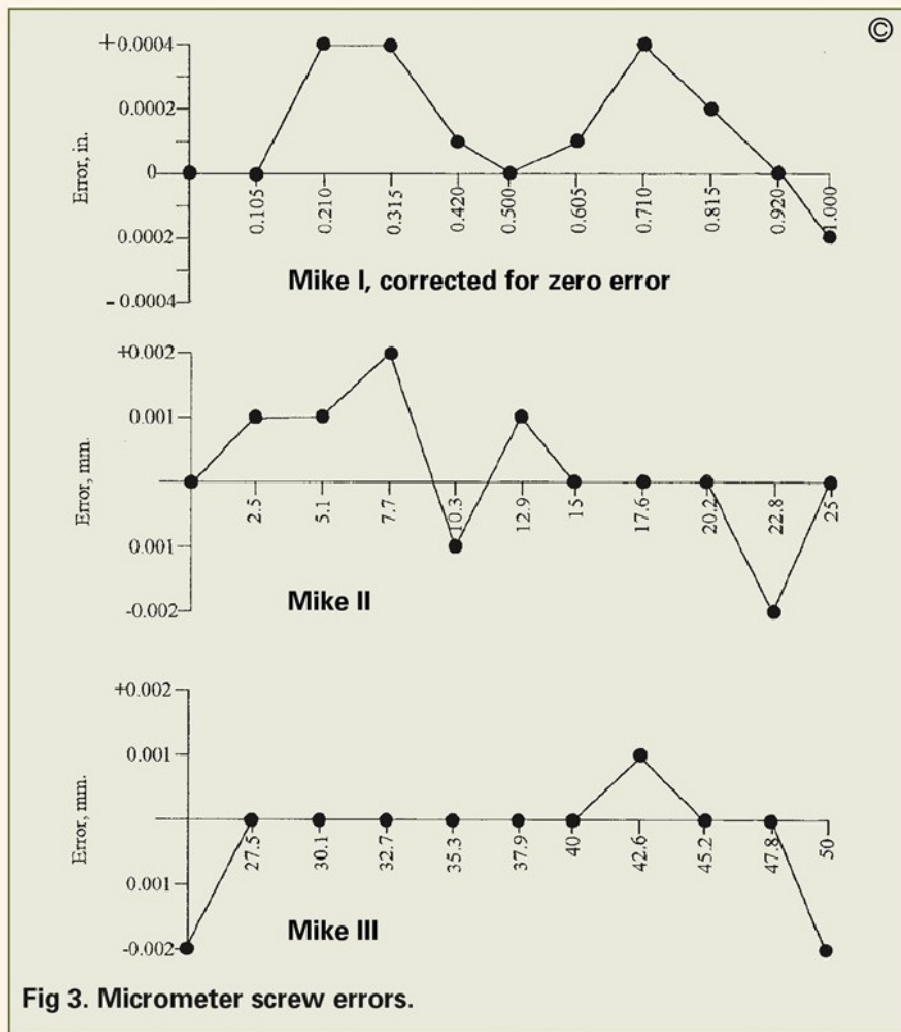


Fig 3. Micrometer screw errors.

seen in photo 4, the results were as in Table I

The differences between successive readings in series (a) and (b) closely parallel each other and the interpretation is that the spindle is badly and sadly out of line with the anvil, by 0.0008 to 0.001 in.

The results for Mike 2 and Mike 3 are much better. The images obtained were rather dim as the only prism in my scrap box with silvered faces turned out to differ from 90 degrees by about 30 minutes. I had to use one with unsilvered faces. Even allowing for uncertainty in reading the images, Mike 2 deviated from parallelism by no more than 3 seconds or about 0.00008 mm. Mike 3 had no measurable deviation.

Calibration of the micrometer screw

The only errors in the screw that are important to the user are pitch errors and these are progressive and periodic. If the pitch of the thread is constant, but longer

or shorter than its nominal value, its error will progress along the length of the thread. For example, if the pitch is 0.26 mm instead of 0.25 mm, the error will be 0.01 mm at the first turn, 0.02 at the second, 0.03 at the third and so on. If the pitch of the thread varies during the course of one revolution, it will show a periodic error that is repeated with each turn of the thread. Common causes are errors in squareness of lead screw thrust bearings, errors in change gear centring and errors in the lead screw itself. These errors are unlikely to be present in the screws of micrometers coming from reputable makers and the commonest source of periodic errors come from errors in centring the micrometer thimble on the spindle. Thus any method of testing must be capable of detecting both types of errors, both at various extensions of the spindle and at various positions of rotation.

Slip gauge manufacturers make up special sets for micrometer testing, but an ordinary set of slip gauges may be used. There are many different series quoted. I used the ones suggested by BS 870: 1950. In making delicate measurements care has to be taken that the gauges and the micrometers are all at the same temperature. The gauges should be allowed to "soak" on a substantial metal plate for at least ten minutes after wringing to their correct length to let them get back to room temperature after handling. It is better not to handle the micrometer frame at all but to clamp it

carefully to a holder of some sort, as shown in the photos. This may seem to some readers to be taking things to the extreme, but the skin temperature of my finger tips on a summer's day is about 35 degrees while the temperature in my workshop is about 25 degrees. If the micrometer frame warmed up to the same temperature as my fingers, it would expand by nearly 0.003 mm (0.00012 in). The measuring faces should be cleaned before use by gently nipping a piece of clean note paper and sliding it out (photo 6), followed by a gentle puff to get rid of any paper fibres, or better still, a sweep with a camel hair brush. The less contact slip gauges have with greasy, sweaty fingers the better, so I use white cotton gloves to handle them and, since I was attempting to estimate the micrometer reading to the nearest 0.001 mm, I used a strong combination of magnifying glasses to read the thimble, as shown in photo 7.

The results for the "Mikes" are shown in Figure 3 and we should not be too hard on Messrs Brown and Sharpe, given that the screw was probably cut more than seventy years ago. The results for Mikes 2 and 3 are a tribute to Mr Mitutoyo's manufacturing skill. Though the errors seem to be of a similar order, note that 0.0004 in. is equal to 0.01 mm and Mike 1's maximum error is actually five times greater than Mike II's.

While Mike 1's errors are well outside the allowable 0.0001 in, if it were used only to measure flat surfaces it would do for model engineering purposes. Unfortunately, the lack of face parallelism introduces errors of up to 1 thou, making it of little use for other than rough work. Mike 2, while not giving results quite as good as those for Mike 3, nevertheless remains comfortably within the permitted tolerance of 0.003 mm after 17 years of frequent use. However, even these good results should warn us against using a micrometer as a measuring instrument when accuracies greater than 0.03 mm or 0.001 in are required, close to 10 times the permitted error of the instrument. With care, it may have sufficient precision to use as a comparator to detect differences of 0.003 mm, but it is unlikely to be able to do so reproducibly. The micrometer is still a marvel of accuracy and precision in these days of computerised laser interferometry. It does not deserve to share a pocket with grit and swarf. It does deserve to be cleaned after use and stored lovingly in its case until needed again to compare and measure to a standard undreamed of 150 years ago.



References

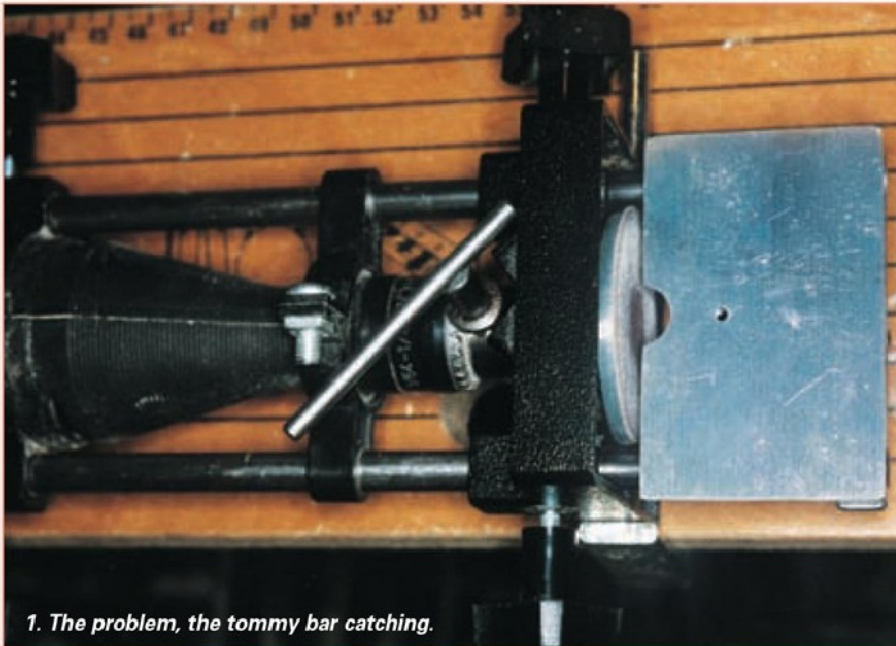
1. A First Affair with a Lathe. Model Engineer 20 April 1973. 388 - 392.
2. Chasing "tenths" with a micrometer. Model Engineer, 17 January 1975. 88 - 91.
3. See for example Harlow, R. and Thompson, T. Fundamentals of Dimensional Metrology. ISBN 0-8273-7126-8, and the much shorter treatment in Anthony, D.M. Engineering Metrology ISBN 0-08-028683-6.

TABLE I

Parallelism of faces, Mike 1

Rotation, deg.	Readings (a)	Readings (b)
0	0.5273 in	0.5145 in
90	0.5268 in	0.5139 in
180	0.5265 in	0.5135 in
270	0.5270 in	0.5142 in

IMPROVED ACCESS TO THE MINICRAFT MB850 LATHE



1. The problem, the tommy bar catching.

Background

For someone interested in making small models and miniatures in wood, the Minicraft lathe kit is a useful piece of equipment. Powered by a Minicraft drill with variable speed controller, it can turn pieces up to 1in. (25 mm) diameter and 9in. (230 mm) long. In addition, the kit contains a flexible drive shaft and a disc sanding facility.

An opportunity to examine and alleviate a problem with fitting the sanding accessory in the space between the drill's nose clamp and the end plate resulted in this simple attachment being made. In the original condition, the tommy bar of the chuck key can only be turned one tooth at a time before it catches on the nose clamp or end plate (Photo 1). The time and effort to insert the key, turn one tooth, remove and reinsert it until the disc is held firmly is frustrating and the process has to be undertaken in reverse to remove the disc.

Given facilities which I do not possess, it might have been possible to manufacture an extended chuck key, however for me, the problem was overcome by making a pair of blocks with a spacer bar to maintain guide rod separation and support while giving full clearance to the chuck (Photo 2). Made from available lengths of imperial sized mild steel, holes are drilled and tapped to suit the Minicraft lathe's metric components. The material for the two blocks and short length of rod required could probably be found by many model engineers in their scrap bin but 300 mm lengths are available from Folkestone Engineering Supplies.

Steel blocks

From 1in. (25 mm) square stock, saw two 1in. (25 mm) long blocks, as sketched in Fig1. I have found that using the woodworkers technique for cutting timber square across the end also works very well when cutting thick steel with a hacksaw. For this, all faces are marked with a scribe and try square and the saw is kept at an angle across the top of the piece being cut. When the top face has been penetrated and reached a depth of about $\frac{1}{8}$ " (3 mm) at the further side, the bar is rotated in the vice and the next face sawn.

With all faces treated, the process continues such that while monitoring the cut on the top face, the partial cut on the further face holds the saw blade true. For those with access to a motorised saw, these arm exercises are bypassed.

To clean up the sawn ends and drill the guide rod hole, place the block nominally central in the four-jaw chuck. Clean up the face, (Photo 3) the amount to be removed dependent on the accuracy with which the end was sawn. With this face cleaned up to your satisfaction, reverse the block in the chuck but this time set it true with a

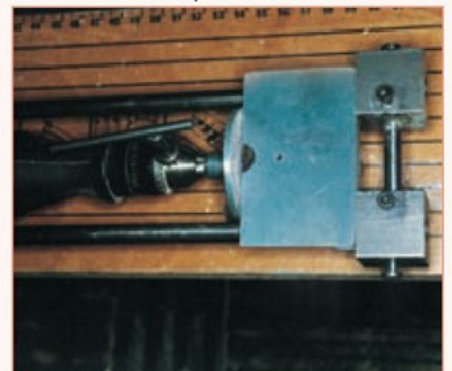
Neil Helsby outlines a simple modification to give more convenient conversion to sanding.

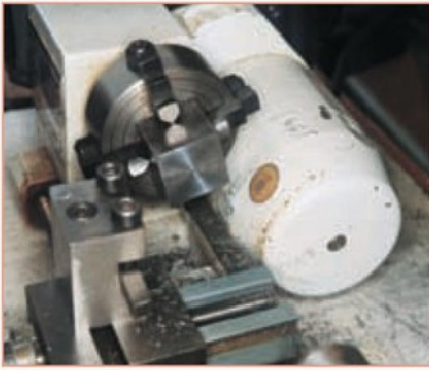
setting gauge or dial indicator. Clean up the face and start the process of drilling the guide rod hole. With the relatively low power of the Unimat lathe, the centre drill (Photo 4) was followed with small steps of drill sizes (Photo 5) up to the final 8 mm hole. Before removing the block, test the guide rod for fit. Mine were found to be a little tight and needed opening out with a fine cut from the boring bar. An 8.1 mm drill would probably have been better, but that is not a size commonly found in workshops. Repeat this process on the second block.

Cross Bar

The cross bar is a 1.75in. (45 mm) length of mild steel rod. To match the lathe guide rods, this should be 8 mm diameter but with only $\frac{1}{4}$ in. and $\frac{1}{8}$ in. stock to hand, some adjustment was necessary. The simplest approach, and the one selected, is to use the $\frac{1}{2}$ in. rod. This is more than capable of withstanding the lathe forces due to sanding. As the chuck on my Unimat lathe only opens to a maximum of 8 mm, the $\frac{1}{2}$ in. (9.5 mm) diameter rod, or at least the ends, would have to be turned down to enable the block to be drilled for the tool rest. Whatever the solution chosen, it is important to align the top of the cross bar with the top of the guide rods. Cut the cross bar to length, reducing the diameter if necessary and cleaning up the ends with a light chamfer (Photo 6). Measure the distance from the top of the block to the top of the guide rod hole and add to this the radius of the cross bar. Using marking blue or felt tip pen, mark the area near the

2. Problem solved, clear access.





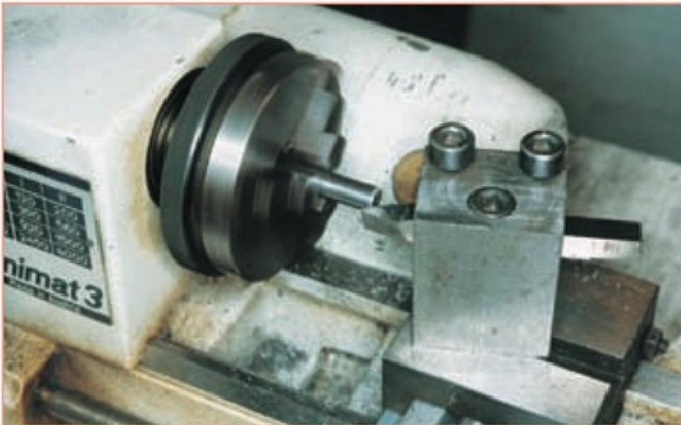
3. Facing a block



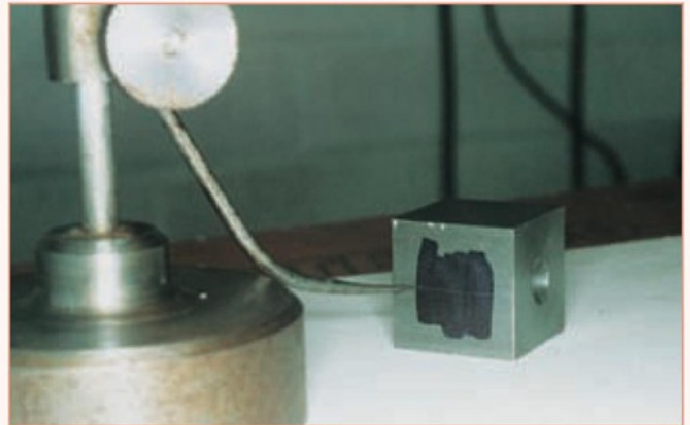
4. Centre drilling a block.



5. Opening up the hole in the block.



6. Chamfering the end of the cross bar.



7. Scribing the centre height of the cross bar.

mid point of each block's face and scribe the cross bar centre point (photo 7).

The cross drilling is next undertaken and it is possible to do this in a pillar drill, (photo 8) although I used the Unimat milling attachment. Place the block in the vice and line up the marked side with the centre drill. Follow this with drills to the diameter required for the crosspiece. Repeat this with the second block, checking that the cross bar slides firmly into position. In a similar way, mark the opposite face of each block such that the holding screw aligns with the centre of the guide rod hole. Mount a block in the vice and after centre drilling, proceed through to the guide rod hole with a 3.3 mm diameter drill, the tapping size for the 4 mm locking screw. Repeat this with the second block. Tap the hole M4 and remove the break through burr in the guide rod hole.

The cross bar is locked in place with 3 mm grub screws. To prepare for this,

mark the block such that the hole will be drilled on the top face of each block above and mid-way along the tool rest opening. On the first block, drill this hole 2.5 mm and tap M3. Before drilling the second block, check that the correct face has been selected as a right-hand and left-hand pair of blocks is required.

The accessory can be painted to match the lathe or left unfinished. If it is left plain, encourage the lathe user to regularly wipe the attachment with an oily rag.

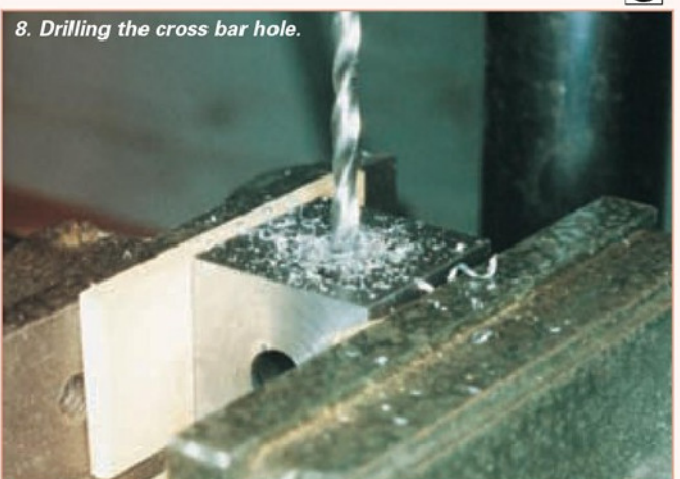
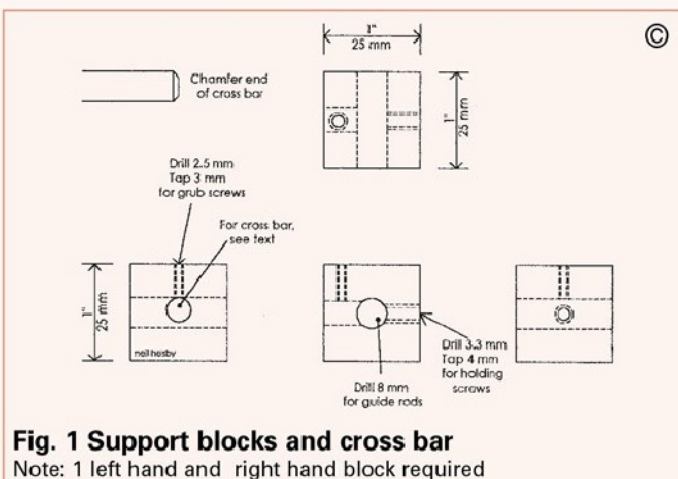
Assembly

For initial setting up, push the cross bar into the two blocks. Remove the Minicraft end plate and slip the attachment onto the guide rods ensuring that the cross bar is the correct way up with the grub screws uppermost. Fit the two M4 locking screws and, placing a rule across the top of the

blocks to ensure they are level, tighten these screws to hold them firmly in place. Fit the two grub screws and tighten these hard onto the cross bar. The assembly can then be removed and replaced readily, the two grub screws firmly holding the assembly together.

To use the attachment, remove the end plate and nose clamp. Push the end plate over the drill body and replace the nose clamp. Slip the new assembly onto the end of the guide rods and tighten the holding screws. Drop the sanding table onto the guide rods and tighten the small knurled knob. Fit the sanding disc, now an easy process, and slide the drill up to the table edge. The sanding attachment is now ready for use, this new arrangement also providing easy access when changing the sanding pad.

An optional refinement would be to fabricate a pair of holding screws with wings. These would make fastening the attachment even more convenient.



8. Drilling the cross bar hole.

MUSING ABOUT... THE WISHBONE



1. The original wishbone could hardly be more simple and effective.

For the benefit of those who have never seen a wishbone, and those who haven't read (or have forgotten) the article in Issue 81 of this magazine, the wishbone can be described as a remarkably simple device that does a very good job of sharpening drill bits. As you know, there are a wide variety of devices to do such sharpening. Where the wishbone stands out from that population of sharpeners is that it allows sharpening of far smaller drill bits than can be handled by any other readily available apparatus. On top of that, it is quick, it is simple, it is inexpensive, and it has negligible (or any) running costs. Surely every home should have one?

Origins: the supplier

As said above, there has been considerable interest in how to acquire a wishbone. The short answer *may* be that you will have to make one. The reasons for that pessimism concerning easy procurement include that the tool merchants (A. E. King (Tools) Ltd., then at 3 Central Parade, Station road, Sidcup, Kent DA15 7DL) who sold me mine, way back in 1982, seem to be no longer available by telephone. From that I suspect, rightly or wrongly, that they are no longer trading. To compound the suspicion that the wishbone may no longer be commercially available, I do not recollect having seen any offered for sale since my purchase those decades ago. If

Following an earlier article on drill sharpening, Trevor Marlow looks at the use of this small tool (believed no longer available) and considers a DIY version.

any readers are aware of a current source they may care to advise via the editor.

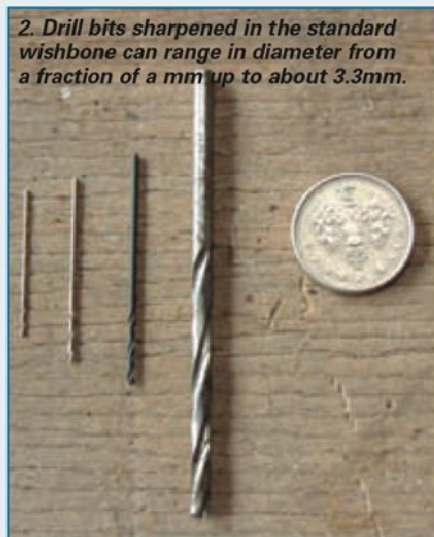
The instruction sheet

The instructions that came with the wishbone were clear and self-explanatory. My own experience was that I achieved almost immediate success. The original comprehensive instruction sheet may be briefly summarised as:

1. Locate the drill using the correct collet in the wishbone so that it protrudes by the correct length (as per gauge), and is set angularly so that the cutting edges are parallel with the arms, and lock in place. (Figs 1 & 2)
2. The wishbone is then held vertically with the drill point towards the operator, and a sharpening stroke effected by pushing the unit away, whilst also progressively tilting to the left. Stop before the wheel crosses the edge of the stone, then lift clear and return to the start position for a second stroke. (Fig 3)
3. Switch round to work on the second edge, and inspect with a loupe, aiming for symmetrical sharpening.

With some familiarity of the device, you may however form the opinion that working in reverse, i.e. having the drill point away from, and drawing the wishbone towards the operator, whilst

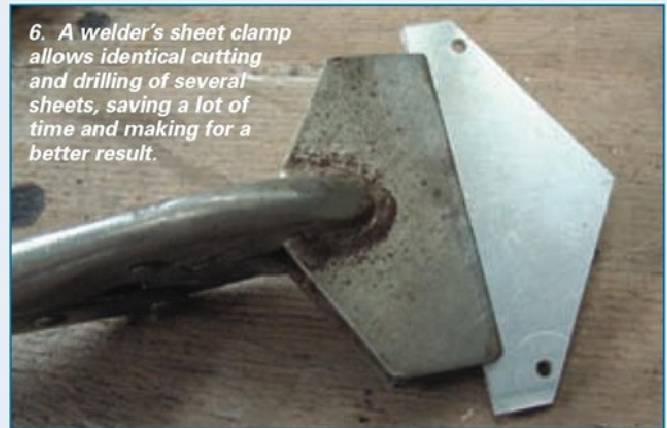
2. Drill bits sharpened in the standard wishbone can range in diameter from a fraction of a mm up to about 3.3mm.



3. The sharpening block as was originally supplied with the standard Wishbone, and the oh-so-fiddly and annoying "setting gauge".



4. Three of the four standard collets. Made in a waxy black plastic, the range allows holding drill bits from the smallest (0.3 mm?) up to about 3.3mm.



leaning to the right, feels a more natural movement.

Does the wishbone enable a perfectly sharpened drill bit?

The answer can be either yes or no, it depends on your standards and requirements. In a typical home workshop situation, the answer is positively "yes". If however we are working to extraordinary accuracy, we will have to admit that, in the final analysis, we can only get it *nearly* right: We will perhaps end up with one of the major cutting edges just a *wee* bit bigger than the other, or we will have removed just a *wee* bit more metal from one of the flanks than from the other. (Note: The design, selection and sharpening of drill bits for particular purposes is *far* more sophisticated than we usually recognise, see e.g. the excellent publications by Dormer).

Hang on now: Why can't I get it exactly right?

Two reasons really. Firstly, there are optical limitations, which limit our ability to compare and assess critical surfaces. Secondly, the removal of metal behind the major cutting edges is dictated by details of your technique during the sharpening stroke, such as by pressure applied to the point of the drill bit and by the several "wrist action" variables.

Considering first the optical limitations, recollect that the special benefit of the wishbone is that it allows you to sharpen drill bits that may have a diameter of just a fraction of a mm. However, therein lies the problem. The teensy drill bit diameter means that the face associated with each cutting edge is, similarly, very small. With those faces being so small, and you not having the eyesight of a seven-year-old, you will need a fairly powerful magnifier (loupe) to allow a close examination. The more powerful the magnifier, the smaller the depth of field, which means that when you focus on any part of the drill bit, only things that are very close in front, or very close behind, will also be in focus. At the same time, your heartbeats and muscle tremors cause that the images are dancing hither and thither. Pull that all together, and the outcome is that you cannot critically examine both flanks at the same

time. The nearest approach to getting round the problem is to slowly rotate the drill bit, so that each flank rolls past your vision in sequence. With a bit of practice, many parts of the surfaces are then reasonably in focus, and you can compare what is just emerging into view with what is just passing from view. The way to enable such comparisons while the drill bit is still in the wishbone is to push the working end of the drill bit through a piece of stiff card. Then, by rolling the knurled "collet driver" between thumb and fingers, you can achieve the best possible examination.

As said above, the second reason for not attaining perfection is the manner in which you remove flank metal (that is, from behind the major cutting edges) when you use a wishbone. The quantity of metal removed, and the locations from which it is removed, are controlled by the details of the wrist-rolling action which makes up the latter part of each sharpening stroke. With that being under manual control, you can never hope to get any two flanks identical in every detail. Some details of the difference will not matter at all, while others may significantly affect the subsequent drilling performance. As said, drill bits sharpened in the wishbone will be fine for any practicable purpose, but they cannot be perfect.

How is it that the wishbone allows a novice to sharpen such tiny drill bits? How does it work?

Seeking to describe how the wishbone works is broadly comparable to trying to describe a spiral staircase without using your hands. The visualisation is easy enough, but coining a description that will not send the reader to sleep is quite tricky. The success of the wishbone hinges on the

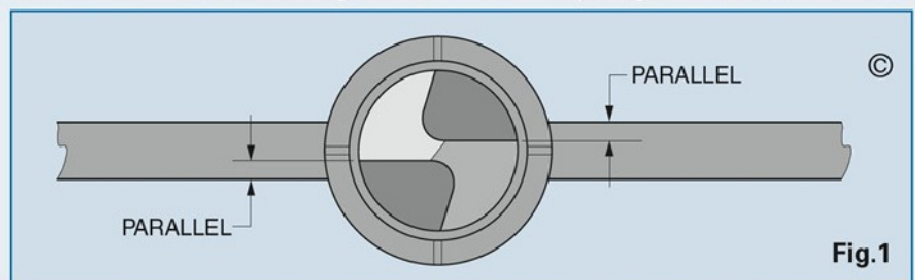
fact that the first requirement in sharpening a drill bit is to get the point angle right. If you set up the wishbone correctly it automatically generates a 118 degree point angle. Having got that angle right, then arriving at the other primary requirement, that there is clearance behind those major cutting edges, does not present any great difficulty. That clearance is provided by the wrist action required in the latter part of the sharpening stroke.

The first bit of the sharpening...

As a starter to understanding the sharpening process, it may help to recollect that if we cut across a cylinder, we will generate surfaces that are either circular (via cuts normal to the cylindrical axis) or elliptical (via cuts made at other angles). Following that, observe that a drill bit is essentially circular, and that if subject to sharpening strokes in the wishbone without any wrist action, then the end of that drill bit will tend to take up such half-elliptical surfaces". The end of the drill bit will in fact tend towards becoming a wedge with an included angle of 118 degrees. The only useful thing about that condition is that the major cutting edges ("lips") are made to be at exactly the right (59 degree) angle.

...and the highly important second bit

A drill bit prepared as above (to the shape of a wedge) is useless because the lack of clearance on the flanks prevents the major cutting edges from making proper contact with the workpiece. The only way to remedy the situation is to provide that clearance, which with the wishbone is brought about by the "wrist action", i.e. the progressive increase of the angle of lean to the LEFT of the wishbone during each sharpening stroke. Note that if it is





7. A finished "Son of Wishbone".
Easy to make, easy to adjust,
easy to use.

allowed to lean to the right, then metal is removed from the cutting edge.

How much clearance?

If your wrist action is such that at the completion of a sharpening stroke your wishbone is still not far from the vertical, you will obviously get a very different clearance contour from what you will get if your sharpening strokes end up with the wishbone not far from the horizontal. It is worth noting that if there is no clearance on the flanks, the meeting point of the two surfaces (the chisel edge) will be at 90 degrees to each major cutting edge ("lip"). That angle (from a lip to the chisel edge) increases with the amount of clearance, and is a very good indicator of the correct amount of clearance. The figure to aim for is 130 degrees, at the same time ensuring that the edges and flanks are symmetrical.

Choosing the abrasive

The abrasive block that came with the wishbone is relatively small, being 113 mm long by 21 mm wide (and 6 mm thick), with that pink colour that suggests that it is made of chrome-doped alumina. It is relatively fine grained, the grain size perhaps being (at a guess) 400 to 600. The wishbone does not however depend on the availability of that original abrasive material. Over the years, drill bits have been sharpened on "wet and dry" papers, on other abrasive blocks, even (the larger drill bits) on well-worn (fine grade) finisher belts. The greater physical size of those alternative surfaces gives the benefit that the leading wheel does not, at the limit of the sharpening stroke, fall over the far edge of the abrasive block. Such a fall can easily happen with the original block since it is only slightly more than twice the working length of the wishbone. When seeking something bigger than the standard block, identification of the best abrasive medium for the teeniest of drill bits is not clear cut. At times past, very fine powder (alumina or silicon carbide) on a hard(ish) surface has

seemed best, but one of the diamond impregnated sharpener surfaces (nowadays more readily available at affordable prices) will probably be better.

Getting a grip...

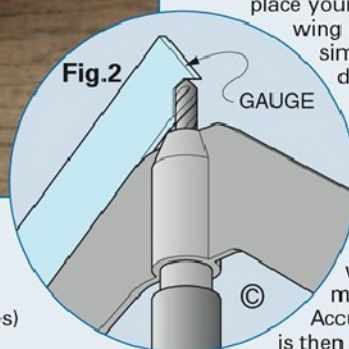
The original instructions suggest that the wishbone is applied with "firm, steady pressure", however experience indicates that there is benefit in keeping that pressure quite light. It will be recalled that success in the sharpening exercise is primarily dependent on getting the areas of the two flanks identical. Sharpening the smallest of drills calls for a very light touch, otherwise it is possible to translate from "flank far too small" to "flank far too big" in only one sharpening stroke. It goes without saying that you use variation of pressure, rather than variation in stroke length, to make the final, fine adjustments in flanks areas. Failure to observe that requirement can, for the reasons set out in earlier paragraphs, result in lack of sufficient clearance behind the major cutting edges (the "lips").

Getting round the fiddly bit

For most of the time, possession of a wishbone will give you a warm glow of satisfaction. There are times however when the warm glow develops into incandescence. That is most likely to occur when you try to follow the setting instructions, and use the supplied drill setting gauge. It is necessary that you achieve exactly the right protrusion and exactly the right rotation at the same time, while the working end of the drill bit is largely hidden behind the shoulder of the gauge! Then, to compound your problems, you discover that the action of tightening the knurled screw (the collet driver) causes the collet to rotate ...! A long time before you approach any degree of success in the complete setting enterprise, you will start to believe that your fingers have turned into telegraph poles. Fortunately, there is a far better way.

Setting up without cracking up

That better way to set up the wishbone hinges on observation that if a drill bit is set to the correct protrusion, and the whole is presented to the abrasive surface, then there is a uniform gap underneath the edge of the wing of the wishbone. It follows from that observation that a regular gap is indicative of correct protrusion. So, if you find a bit of scrap material that is of that thickness that will exactly fill that gap, all you then need to do to set up a drill bit in the wishbone is



place your bit of scrap beneath the wing of the wishbone, then simply ease the drill bit up and down until it contacts the abrasive surface. You still have to get the drill bit into the correct rotational setting, but that is made very easy if you lock onto any part of the drill bit (top or bottom, as available) with a tool such as a

miniature birdsmouth clamp. Accurate setting of the rotation is then easy, by movement of that clamp, as opposed to the clumsiness and inaccuracy if you try to make that setting with fingers. Finally, everything becomes a total doddle when you realise that if you cause the birdsmouth clamp to be butting against the end of the collet, thus locking the correct protrusion adjustment, you then can invert the wishbone and look directly down onto the end of the drill bit while making the rotational adjustment. Do it that way, and you will wonder where your problem went.

Some first thoughts about making your own wishbone(s) ...

The original wishbone seems to have been made by cutting and shaping 1.2 mm sheet metal into those two matching back-to-back shapes as will provide on assembly the two wings, the recesses for the two wheels, also the housing for the collet and the collet locking screw. Those two matching shapes have then been spot welded together, the wheels fitted, and the collet housing threaded.

There are some interesting alternatives to the above construction procedure. By spacing the matching shapes we do not have to form the ends of the sheets into wheel housings. Wheels may be approached as a simple turning exercise, or you might use a couple of washers (e.g. the type used when pop riveting), which have a small ID in relation to the OD.

For those of you who make watches and small clocks, the manufacture of the teeny collets will not present a problem. For the rest of us... aaagh, creating those fine cross cuts! Going back to the drawing board, what we seek to achieve is the accurate location of the drill bit, and this might be in a slot, a vee, or other suitable indentation. The quickest way to make the location slot, I suggest, is by indentation of the shank of a teeny drill, or a length of

fine piano wire, using the force available between the jaws of your bench vice. Such an indented slot would serve to allow holding a range of drill sizes centred on the diameter size of the item that you used as the indenter.

Special drill bits for special purposes ...

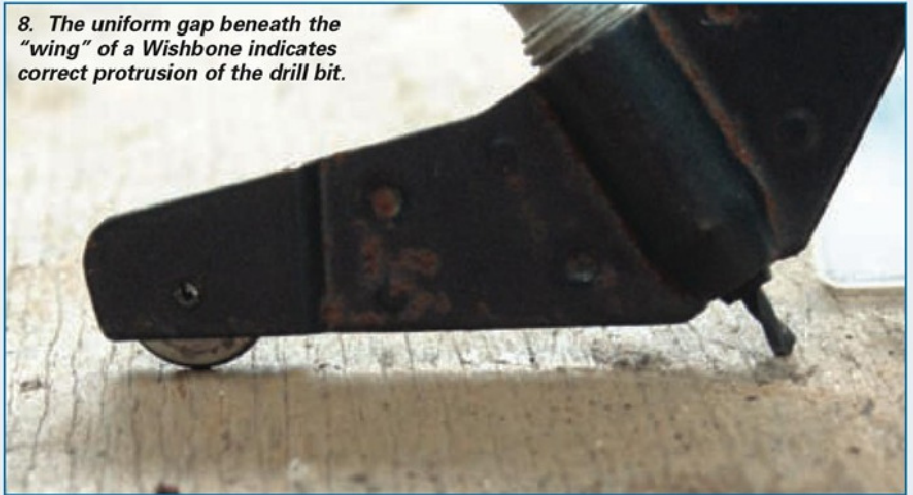
As described earlier, the recognised best value for a general point angle is 118 degrees. Sometimes however, when seeking to drill "difficult" materials or in "difficult" circumstances, best drill bit performance is obtained with different angles.

For instance, re the "difficult" materials, best performance on High Strength Steels, High Strength Stainless Steels, High Temperature Alloys, and Titanium and its Alloys will often follow from a drill bit angle of (say) 135 degrees. As an example re the "difficult circumstances", when drilling thin sheet it is often advantageous to have a drill bit ground to an even larger angle, so extreme that to a casual glance it will almost appear to be flat ended.

A quickie "Son of Wishbone" to get you going...

You may wish to make yourself a quickie "Son of Wishbone", either to satisfy your drill bit sharpening requirements, or simply because you are curious, or to

8. The uniform gap beneath the "wing" of a Wishbone indicates correct protrusion of the drill bit.



serve as a prototype for when you wish to make an all singing and dancing model. Our "quickie model" will be kept as simple as possible. The first thing you need to do is to go through your scrap pile and find some suitable material. Thin sheet aluminium (1 mm, as rolled) is very suitable, being reasonably elastic, moderately soft, and fairly easy to work. If you have a metal-cutting band saw, it makes the following cutting out procedures both quick and easy).

We will base our quickie model on having two sheets, as has the original wishbone. The size of your scrap material needs to be enough to provide a couple of rectangular pieces, each 100 mm by 45 mm. Your piece of scrap material probably has one straight edge on a long side, if not, make such a straight edge.

Marking out...

You now mark out one of those pieces as shown in Fig 4. You may have by now realised that the nice round numbers (30mm and 50mm) have in fact conspired together to give us exactly what is required, viz a 118degree angle.

Cutting and drilling...

From now on, you will be making exactly the same cuts and holes in each of the two rectangular pieces, so you will do a best job if you stack the plates one on top of the other, so that you can cut and drill both at the same time. Firstly, you need to have the sheets properly stacked. So, with the marked-out sheet on top, rest the straight edges on a flat surface. Having done that, slide one sheet relative to the other until, by feel, you are confident that one sheet sits squarely on the other. Now clamp the two sheets together along the top edge. Now, cut away the surplus material without deforming the remainder. (A band saw does it very nicely, whereas some shears will cause unacceptable deformation)

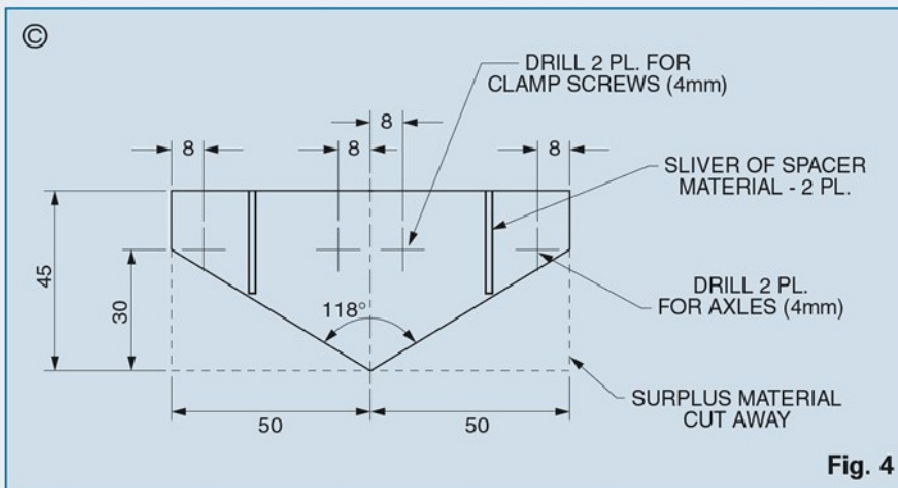
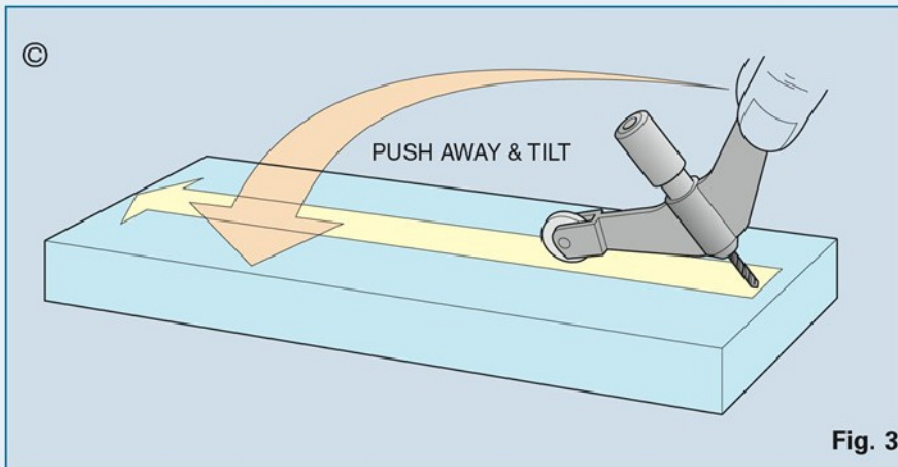
We now need to provide for two things. Firstly, for the wheels at the end of the wings of our "Son of wishbone". Secondly, for some means of positioning and holding the drill bits that we will sharpen.

Nearly done...

(For what follows, we now need 6 off 16 mm diameter pop riveting washers. Prepare each by increasing the bore of the central hole from the "3 and a bit" value up to 4 mm.)

Now, mark off at 8 mm from each end of the remaining scribed line. Centre pop at each of those marks, and then drill a 4 mm hole through each. Release the welder's sheet clamp, then position two of our special washers between the two sheets, one at each "wingtip". At each position, line up the (three) 4 mm holes. Put 4 mm threaded bar (or bolts) through each set of holes, and pull everything together with 4 mm nuts, at not more than finger tightness. (Those washers, that we have just placed between the sheets, will eventually serve as our wheels.)

To make life easy when we come to the positioning of the drill bits, we now make



9. Using a birdsmouth grip (aka "long nosed locking pliers") to set the drill bit protrusion and rotational setting.



a mark at 50 mm along the top edge of the workpiece. Then, since the wingtips are joined, but not tightly, it is easy to prise the sheets apart at the middle of their length (i.e., at about 50 mm) just enough to insert the shank of one of our teensy drills between those sheets.

(Note: When choosing the drill bit that will serve as your indenter, choose a relatively small one, say 1 mm, or a length of 20g piano wire).

With the fingers of one hand, then position the end of that shank to coincide with the tip of the obtuse angle, and with the fingers of the other hand cause the fluted end of the drill bit to coincide with the 50 mm marker that we recently made on the top edge. *(When put into proper position, the drill bit will stay there because of the elasticity in the sheets seeking to restore those sheets to the flat state).*

Now we come to making the indentation that will serve instead of collets. Having carefully positioned the indenter, carefully, position the sheets in your bench vice (at a corner of the vice will probably be best) so that you can compress the sheets down onto the various parts of the drill bit.

(Note: Do not over-indent. Increase the compression until you estimate the remaining local gap between the sheets to be about half the drill bit diameter, i.e., about 0.5 mm if you are using a 1 mm drill bit, and leave it at that. Do it that way, and your indented groove will then allow easy location and a firm grip on a wide range of sizes of small drill bits).

(Note: You will find it advantageous to then reverse the drill bit (i.e., put the working end to emerge at the obtuse angle) and repeat the compression, since you then will have a better impression, everywhere free of flute profiles).

After compressing onto the drill bit, you will find that we have lost the clamping force that previously was exerted by the sheets onto that drill bit. That isn't a problem, because we now make provision to hold any drill bit firmly in position. To do that, we mark out 8 mm at each side of the centre of our remaining line. We centre pop at those marks, then drill 4 mm holes. We put threaded bar (or bolts) through those holes, then put our special washers (and nuts) on each side. Finally, everything is pulled together by tightening (only lightly) on the 4 mm nuts.

Adjustments...

A final detail is that we need to put a thin (about 2 mm thick) sliver of any convenient material "inboard" from each wheel, so that the clamping force that we put onto our drill bit does not cause the side sheets to press on the "wheels", thus preventing their free rotation. These may either be retained by friction, or perhaps by a touch of epoxy.

When you are about to start sharpening a drill bit, the nuts that locate the drill bit need only be lightly tightened (because the clamping effect is very efficient), and the nuts holding our "wheel axles" need to barely contact the sheet materials. (So that the pressure is carried by our aforementioned "sliver of material", and the wheels are free to rotate).

Let joy be unconfined

Insertion of a drill bit takes only a few seconds. For protrusion adjustment, the easiest way is to put "Son of wishbone" on a flat surface and judge how the gap varies from drill bit to "wheel", then adjusted by easing the drill bit in and out until the gap is uniform. Lock that protrusion in position using a birdsmouth clamp or similar tool, and use that tool to rotate the drill bit to the correct rotational position (as shown in Fig 1 above). Lightly tighten the drill bit locking nuts, and you are ready to roll.

And finally, should faults and failures happen...

All experience supports the expectation that drill bits sharpened with a wishbone will provide satisfactory service. Perhaps not quite as good as a brand new item, but in a hobby workshop you might be hard pressed to tell the difference.

So, on those rare occasions when there are faults and failures, and a drill bit does

not perform satisfactorily, it can be a bit of a mystery, and it is useful to have a clue as to where the fault may lie. An oversized hole, for instance, will suggest that the lips of the drill bit are not of equal size, or that the chisel edge is not central. As a variant on that theme, lips not being equal can lead to a tapered hole. If a drill bit breaks, one possibility is that (despite your efforts) it was not sharp, with another strong candidate being that you have not provided sufficient clearance behind the lips, or simply applied too much feed. If the drill bit wears, there are several candidate causes. You might for example be working at too high r.p.m, or you might be using a poor lubricant, or you might not be using enough lubricant, or the lubricant might not be getting to where it will be beneficial. Or, you might be using entirely the wrong drill bit, such as one where the helix angle is too high. Or, it might be entirely the right type of drill bit, but one that has at an earlier time been irrevocably ruined by use on brick, stone or concrete. If you do get problems, then besides looking hard at the drill bit, look equally long and hard at all the aspects of possible materials changes and the set up of the drilling operation. The lesson of history is that your problems may well not be caused by the condition at the working end of the drill bit, but lie elsewhere.

Since you can make any "Son of Wishbone" in such a short time, you may choose to make one for each point angle that you might ever need. For drilling aluminium try increasing the 30mm dimension on Fig 4 to 50mm, and for plastics and magnesium, increase again to 70mm. This will of course require larger metal blanks.

Given half a chance, a wishbone will enable you to sharpen any teensy drill bit to such a standard that the drill bit itself will hardly ever be the cause of problems. In that light, the message must surely be that you have to get yourself a wishbone, whether by theft, or by purchase, or by making your own. As said at the outset: surely every home should have one, but since they are so easy to make, surely every home should have several!



10. The "Son of Wishbone" in use, at the start of a sharpening stroke. The degree of tilt (to the left) is progressively increased during the stroke.

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- For sale Two Micrometer heads, one large barrel, one small barrel, £5-00 each. Dial indicator £10-00. Record Engineer's Vice, No3, £10-00 Please phone 01708 720 355 (Romford)
- For Sale Aztek 1000S airbrush unused and with instructional videotape £12-00 plus postage. Phone 01286 678 584 (Caernarfon)

WANTED

- Wanted Autosketch version 3. Have manual etc but mislaid original discs. Will swap ver.7 please email Eric Greig at e.greig@absamail.co.za
- Wanted English Electric 3ph motor 1/8hp, 1400rpm, 0.38amps full load, 50cycles, flange mounted. (To power table on Centec 2A). Please phone J Hawkes on 01274 492 482 (Bradford)
- Wanted Secondhand casting machine as used exclusively for the spin/disc casting of low fusing lead/tin & pewter alloys which use rtv rubber moulds. A melting pot with very accurate readout would be an essential companion. A used model as made by Alec Tiranti would be excellent. Failing all this does anyone own a Tiranti caster and is willing to send me a copy of the user handbook for me to build my own. Thank you. Email skyshot46@aol.com
- Wanted a) Drawings and Instruction Booklet as supplied with the Dore Westbury Mk. 2 milling machine construction kits. b) 12mm collet for Clarkson "S" type milling chuck. Please phone 01603 811 199 (Norfolk)
- Wanted a copy of "Model Engineer's Workshop" issue 92. Please contact Mr Les Hitchings on 0161 480 8165 (Stockport)
- Wanted information, copy of handbook, and parts for Colchester Bantam lathe. Please contact Mr Ken Nunn, at 4 South Lodge Drive, Fornham St. Genevieve, Bury St. Edmunds, Suffolk, IP28 6TQ, or phone 01284 704848
- Wanted back copies of "Model Engineer" and "Model Engineers' Workshop", also books on engineering e. g. Victorian, Edwardian. Must be cheap or free to student. Please write to S. Hall, 23 Kensington Ave, Normanby, Middlesbrough, Cleveland, TS6 0QQ
- Wanted Any advice on setting up Kennedy Mini Hacksaw. Please phone 01302 531 790 or email chin.yeung@scanrope.no

IN OUR NEXT ISSUE

Coming up in Issue No. 98 will be

Machine Tool Building using Epoxy Resins

John Feeney discusses the use of modern low friction materials that can give better than new performance on a rebuilt machine



Improving a Le Count Mandrel

Philip Amos offers a modified version of a useful workholding device.

Ornamental Turning for Model Engineers

John Edwards considers the Eccentric Chuck



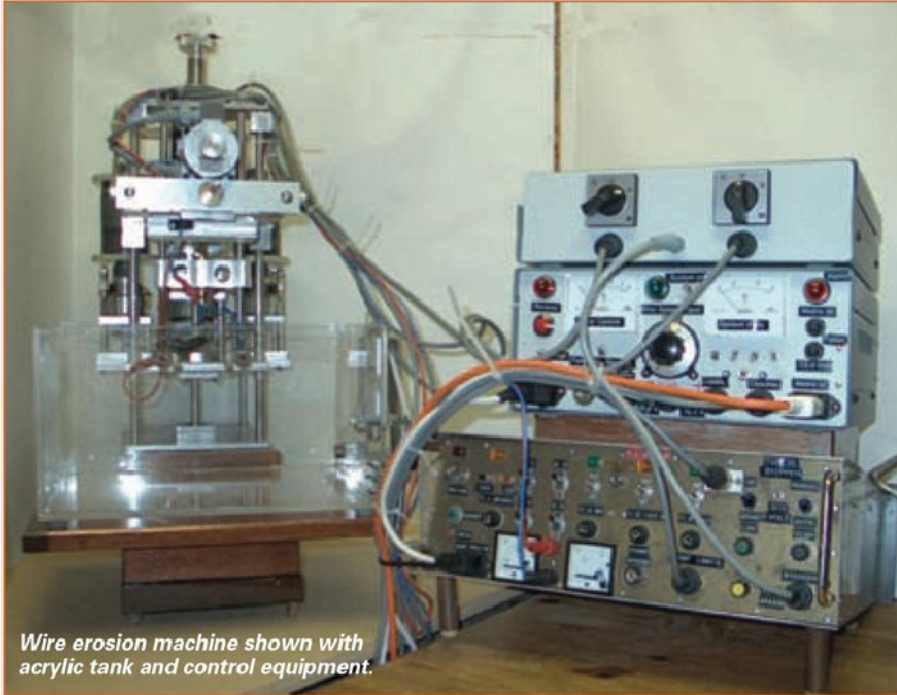
Drilling Projects (2) Engineers Sash Clamps

Harold Hall gives details on making these clamps, which will find countless applications in the home workshop.

Issue on sale 7th May 2004

(Contents may be subject to change)

MK. 3 WIRE ERODER (3)



Wire erosion machine shown with acrylic tank and control equipment.

Up & down - principle of vertical movement

This is, as stated in the first article, accomplished by rotating the shaft in a chosen direction and at the same time turning the nut in the same direction by a percentage of the of the rotation of the shaft. Thus the linear movement of the nut to the shaft will be reduced, and in the wire eroder the components which achieve this are the main hollow shaft and the hollow inner shaft that we have previously discussed. The components relating to this section are given in **Figs 1 to 6**.

We then come to the simple or complex (depending on your viewpoint) part of the spool direction reversal system. In this case it consists of a 24 tpi threaded shaft. I have chosen this pitch (in fact wherever

this $\frac{3}{16}$ in. dia. is used I have used the same pitch) as I had a tap for this size, and screwcutting of internal threads of this diameter ($\frac{3}{16}$ in. dia x 24tpi) is not my idea of fun. I therefore start by screw cutting and finish using the tap. The external is a different matter and this was fully screw cut, but I did use a replaceable carbide tip of the correct thread form. I gave up grinding my own many years ago and can recommend them as they have a very long life and three cutting edges; I have not thrown away a tip yet. The nut that runs on this shaft is made from bronze and is pressed into the hollow shaft.

We come next to the most awkward part, that being the "Power take off bush". This is made of bronze and is threaded on the outside, it is also incorporates a keyway for a fixed key made from 4mm square key steel but machined down to 3mm thick. This key runs the full length of the bush and is screwed into place using

Peter Rawlinson concludes the description of the mechanical construction of this intriguing machine

two No. 6 BA C/S Socket screws. Normally I would not use this system of a short key moving in a long slot due to the wear but to use the opposite and correct system made the diameters of the bushes and the driving shaft much larger and this then complicated other parts. There is also the problem of retaining the long key and although I have used this method in the past on a heavy tunnel excavator (modern jargon "TBM" or tunnel boring machine), I would feel that the correct way would be to use a splined shaft but this is not really for the amateur.

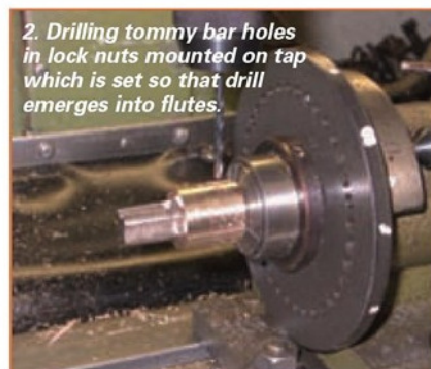
I am using a steel to steel sliding interface which is also not ideal and the fitting of a bronze key would be better but (touch wood) there has been no problem so far. The main outer shaft has been drilled and tapped to fit a grease nipple so that an oil gun can be used once in a while, and by fitting in this place it allows lubrication of all of the sliding and rotating bearings, also the "Lift" thread..

The first article mentioned my use of a key way broach and I said that I have one size only and I use it where ever I can but before I had this broach I cut these keyways with a shaper and before that I used the Lathe, I made up a stiff boring tool with a $\frac{3}{16}$ in. square tool bit set at Right angles to the centreline of the lathe this was then fed through the bush using the saddle hand wheel as the driving force, the key way depth being increased by increasing the depth of cut by a few thou on the "Y" axis. A passable keyway can be cut this way but it does take a little time.

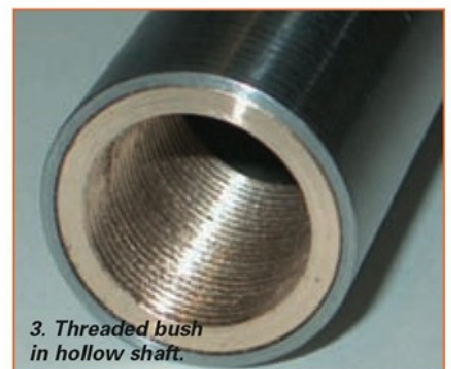
Bearing are pressed into place, but may be Loctited if required, but then extra care must be exercised to stop the fluid entering the bearing or it's seal. I have a small bottle of thixotropic Loctite, (No 243.). This is intended for locking nuts, and is a very thin liquid that sucks its way into



1. Cutting the keyway in the shaft



2. Drilling tommy bar holes in lock nuts mounted on tap which is set so that drill emerges into flutes.



3. Threaded bush in hollow shaft.



the joint using capillary action. This is very useful, but requires care, and I use the system used in the 007 film "You only live twice" (when the girl is poisoned, by allowing the poison to run down a string) I let the liquid run down a thin wire to it's exact position, and although it is intended for use on nuts it seems to work well on the fitting of bearings.

Gears, and pulleys

These all have to be fixed to their respective shafts and in order to save space I have

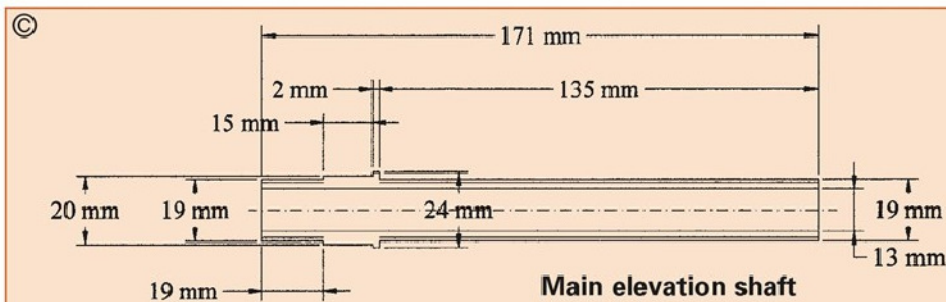


used the type "T" pulley which has no boss. The grub screws on these pulleys are positioned in the root between two teeth, and seemed to be M4 but I replaced these with the next size up namely M5 which are more robust, and to my mind, a better solution. The gears are also fixed in this way and again I use an M5 grub screw on them. Here it is worth explaining the method of drilling these gears, it would be difficult to simply drill and tap these due to the small space between the teeth and so I set the gear up in the mill and use a slot drill to counterbore down to the root of the teeth. This is then followed by centre drill, tapping drill and tap.

This of course takes out a little from the 9.53mm effective width of the gear which may lead to premature wear on these

teeth. But I think that it will be quite some time away, and not really a great cause for concern. However if the gears are to be cut specially for this machine there is plenty of room to make them say 15mm wide. The various pulleys and gears are illustrated in Figs. 7 to 11.

Most of these components will require a machining operation, whether for bore size or fixing method. Workholding for these merits a few words, as it is generally not possible to rely on the 3 jaw chuck. Flanges on pulleys are frequently not "true", and it can be problematic to achieve accuracy if gripping by these. Using the 4 jaw independent chuck takes a little longer but delivers the result. I generally drill to a size say one mm under finished size then bore and finally ream. If reamers of the correct



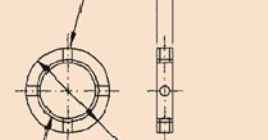
Main elevation shaft

1 off. Mild steel. Screw cut.
Thread 3/4" x 24 Tpi.

Material:- Bronze. 2.off.

3mm.Dia Holes.

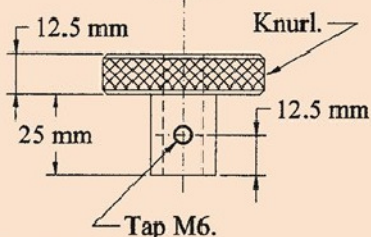
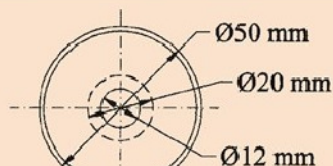
5 mm



Ø26 mm

Tap 3/4" 24 Tpi.

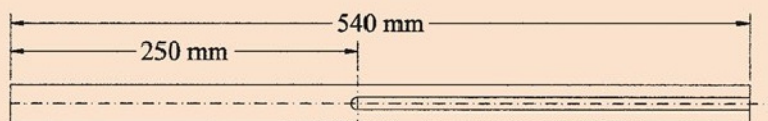
Lock nuts
(main shaft & power bush)



Handwheel

1 off. Aluminium.

Fig. 1 Main shaft parts



Through shaft.

12mm Stainless steel. Keyway. 4mm wide x 3.5mm deep.



7. Brake disc and spring.

sizes are not available then accurate boring will be required. In one case the gear is bored and threaded, and again it would be best to firstly screw cut it and then finish using a tap. If a tap is used without the screw cutting first, then the thread (courtesy of Mr Murphy), could and often does "Run off".

A brief word concerning the timing belts may not be amiss. In order to achieve a reduced width needed, a single belt was split in two using a craft knife.

Clutches and brakes

The clutches are as mentioned before made by a company called KEB and their catalogue is very explicit on the fitting and use these clutches. They are designed for use on a 24 volt power supply but work very satisfactorily on the 16volts used here. These clutches have also been used



8. Main clock and anti-clock drive clutches.

to also "Power" the brakes, which were found to be necessary to maintain the correct tension on the wire, as the residual friction in the system was too small. The components associated with the clutch and brake arrangements are given in Figs. 12 to 15.

The clutches have to be set up with an air gap of 0.2mm or 0.008in. between the rotor and the armature, but there must be a running fit between the central hollow shafts (forward/reverse pulley). There is a flat circular spring which is riveted to the armature and this in turn is (in my case) screwed to the drive adapter [spool drive] (using M3 countersunk socket screws) or in the case of the "forward/reverse" pulley to the two flanges. When energised the armature is pulled against the rotor which gives the drive and this stretches the spring. When de-energised, the spring lifts the armature clear of the of the rotor cutting any drive completely with the

exception of the small amount of friction in the bearings etc. I have used this movement of the armature to carry out the braking, by making a new armature which is 23 mm bigger in diameter. This then allows a brake pad to be positioned above it such that when the clutch is de-energised the brake is applied and when energised it is released. Thus the brake is effected by the flat spring, and the pressure can be adjusted by the set up of the springs and stop nuts on the brake support studs. This refers to the spool drive only.

The brake pad, as said before, was cut from an old table mat (it had to be old or I should have been in trouble). This was ideal as it already had a good hard board backing so it was overall about 3mm thick, and only required three countersunk screw holes in each of the two spool brakes for fixing to be ideal. (The rest of the table mat is now in the workshop.)

Small parts

The small pulleys were machined from steel and were fitted with 5mm x 20mm x 5mm. sealed ball bearings, but if I had not had these already to hand I would have used plastic bushes. It is interesting to see this machine operating and it has been found that during the actual cutting operation the steel in the vicinity of the cut takes on a very even but thin coat of rust so if I were rebuilding again (Heaven forbid) I would replace these lower two pulleys with either plastic or brass. The power is fed to the cutting wire by tips similar to a Mig welding plant, made from copper with a No.60 hole for the wire. These also act as a guides, and are screwed to small aluminium brackets, which are isolated from the remainder of the metalwork by fitting nylon insulators as a press fit as shown on the drawing.

Tip

One small tip comes about by my having to strip and rebuild the machine a number of times and during this it was found that the tightening of the grub screws were causing an uplift crater at their positions on the shafts. As the parts were all a snug fit a problem arose in that sliding parts off the shafts became almost impossible. To solve this, flats were machined on the shafts or rods at the marked places. This not only solved the problem but also gave a better surface for the grub screws to "bite" into.

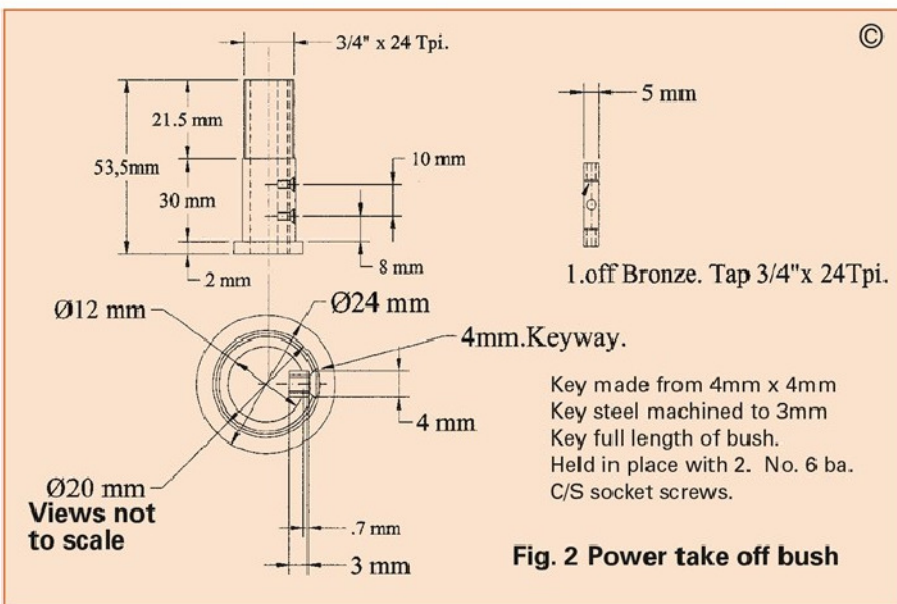
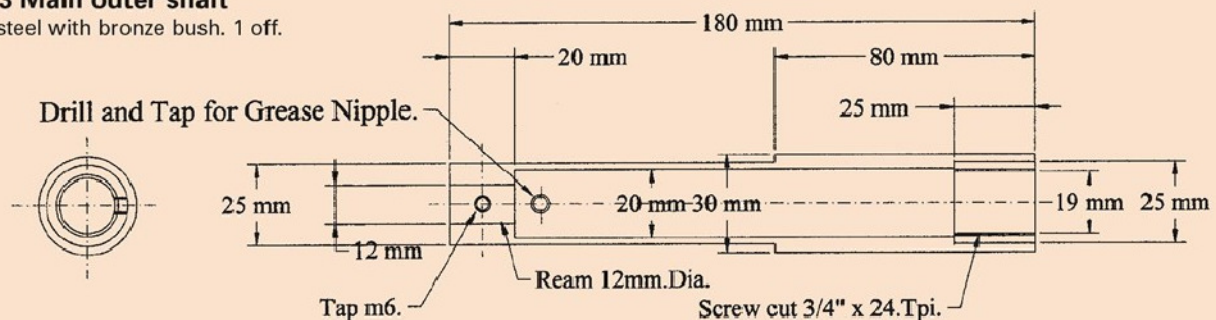


Fig. 2 Power take off bush

Fig. 3 Main outer shaft

Mild steel with bronze bush. 1 off.



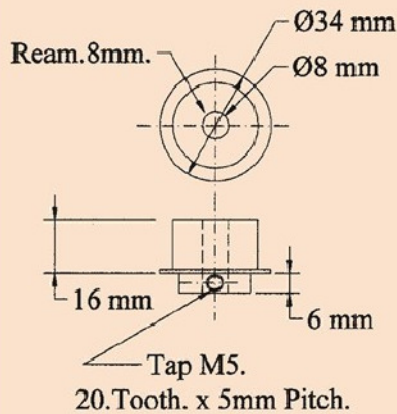


Fig. 4 Motor pulley 1 off.

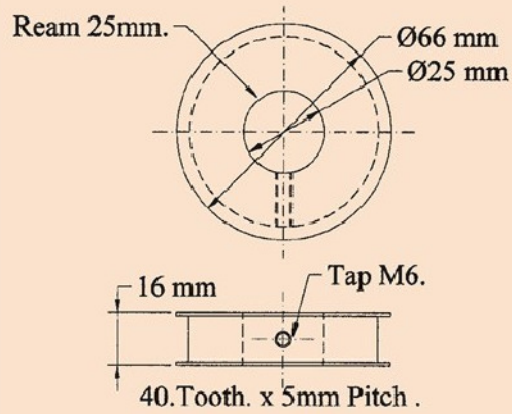


Fig. 5 Main shaft pulley 1 off.

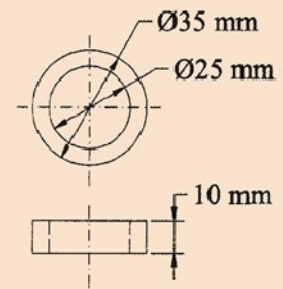


Fig. 6 Spacer
Mild steel. 1 off.

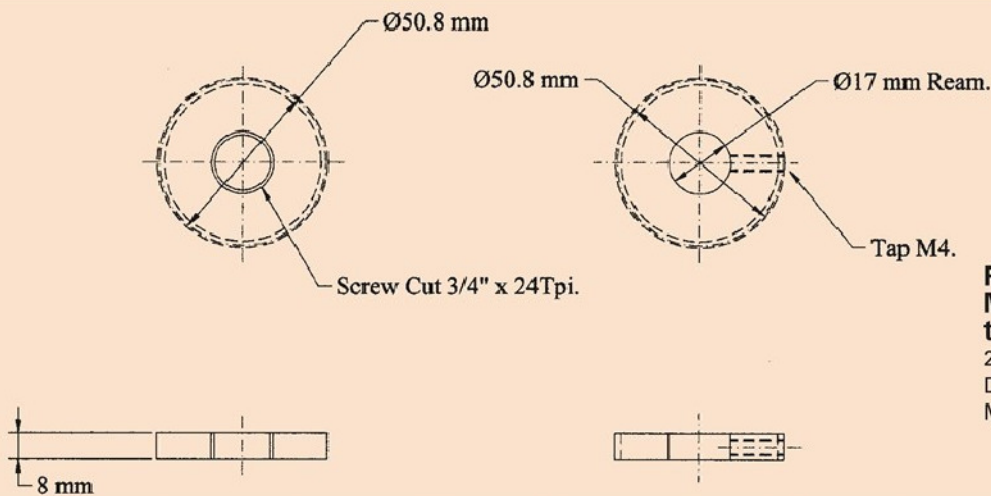


Fig. 7 Modifications to gears
2 off. 48 tooth x 24 DP 2" PCD.
Material mild steel

©

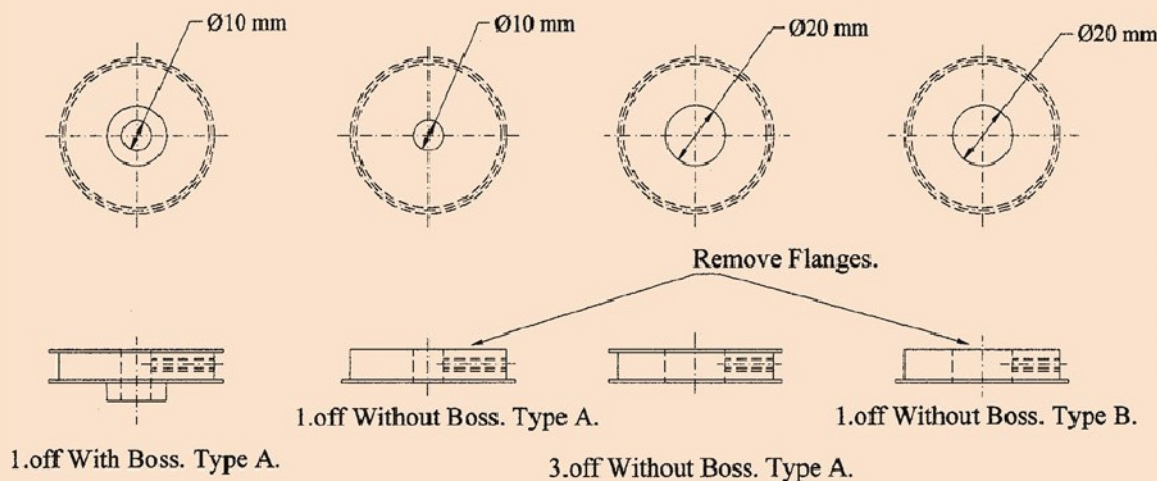


Fig. 8 Modifications to pulleys

Type A = 24 tooth.
5mm pitch. for
6mm belt.

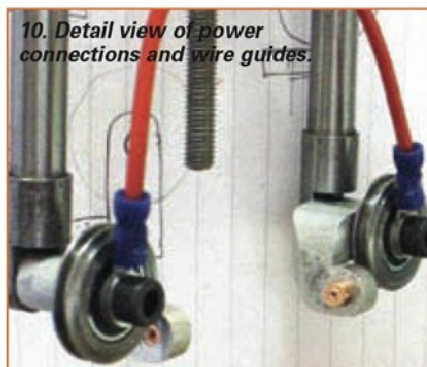
Type B = 30 tooth.
5mm pitch. for
6mm belt.

All tapped holes
M5 into root of
tooth

All holes bored
and reamed



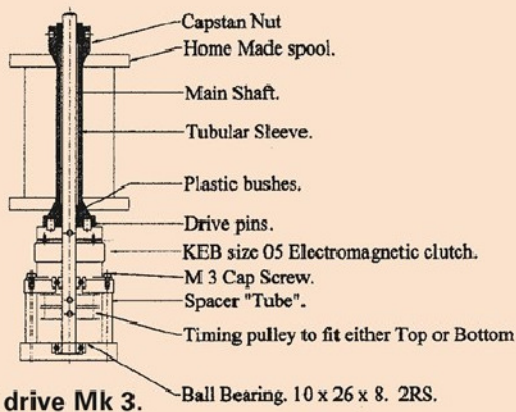
9. Limit switch bar complete.



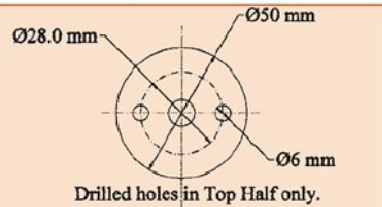
10. Detail view of power connections and wire guides.

The spark voltage is still transmitted to the rest of the metal work, but this is indirect and causes no trouble, if any other builder wishes to obviate this, all pulleys can be made from plastic.

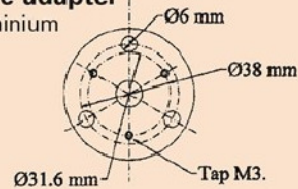
During the finishing of the machine I decided that the electric's which had not been used for a few months should be checked and realised it would be a simple thing to have an additional part that would be used for standard spark erosion duties so a bracket (Fig. 15) was made that would hold a small drill chuck. This bracket is held in position by the two bolts that would generally hold on the two lower pulleys,



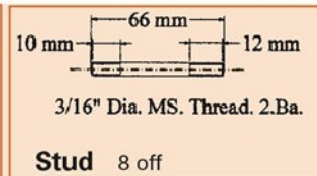
Spool drive Mk 3.



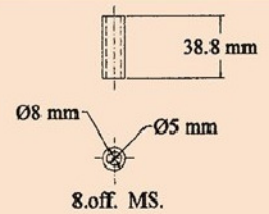
Drive adapter
Aluminium



Tap and Drill Bottom Half only. 2.off.



Stud 8 off

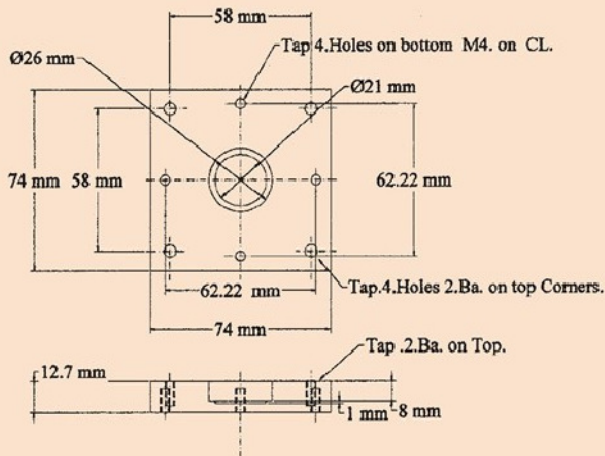


8.off. MS.

Spacer tube

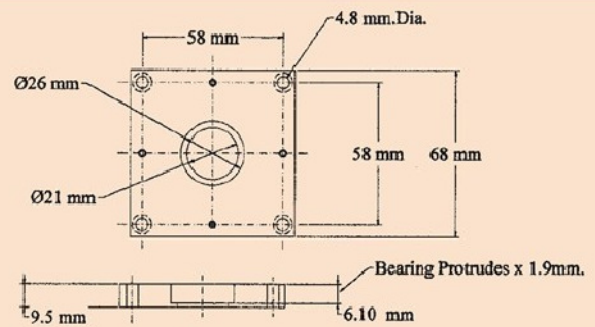
Fig. 9 Clutch mounting parts

©



Base.

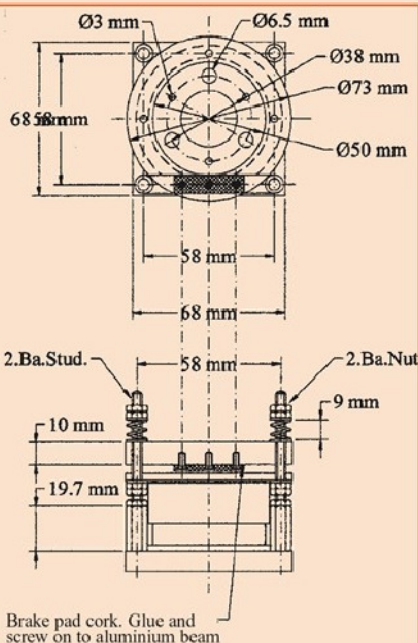
Aluminium. 2 off bearing. 10 x 26 x 8mm. 2RS.



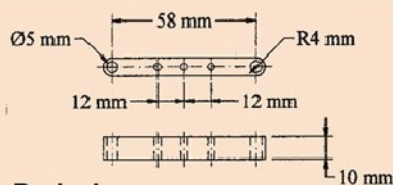
Clutch mounting plate.

Aluminium. 2 off bearing.

Note!! Will require 2 NO. 26 internal circlips. Bearing. 10 x 26 x 8mm

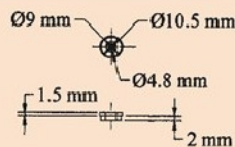


Brake pad cork. Glue and screw on to aluminium beam



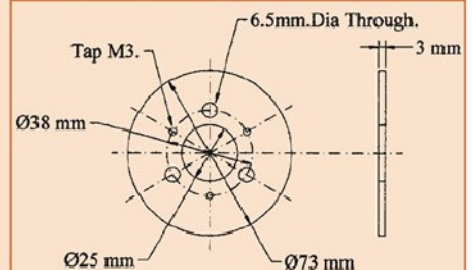
Brake beam.

2. off. Aluminium.



Spring centring washers.

8. off. Brass.

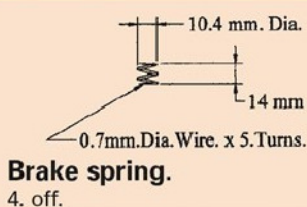


New disk for the KEB clutch.

2. off. Mild steel. Ground finish.

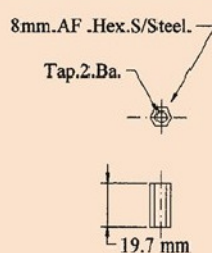
Fig. 10 Brake parts

©



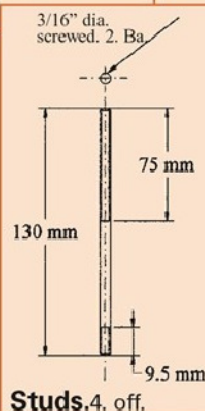
Brake spring.

4. off.



Spacers.

4. off.



Studs.4. off.



Brake pads.

4. off.

and is a matter of moments to swap between wire or tool. This also incorporates a built in tube for the pumped electrolyte.

Tank

I am not going into the wood work or the building of the "New" tank as I have done an article for the "Model Engineer" on the building of Acrylic (Perspex) Cases. This tank now incorporates a small pump and the filter designed and published in M.E.W. Number. 68. The inclusion of the pump was for the straight forward spark erosion but I have found that the cut using the wire

is greatly improved and cuts out the possibility of the metal particles from bridging the cut "Gap" above the wire, which was happening with regularity without the continuous flow of electrolyte passing over the wire. A special bracket is now incorporated in the design and I use model aircraft silicone fuel line as it is very flexible, but a fixed copper pipe is used at the delivery end.

The next sections of this series will cover the electric's and electronics but if you have a spark eroder already, then the majority of the parts will be to hand. The only electronics will be two small kit

packages one of which is built completely and the other must be soldered together, but this should not cause problems even for relative beginners, as I have now built four of these and all worked first time with no problems.

I am as usual happy to help where I can, but telephone only please. However an Email with any queries before a call could be helpful. Again I will not ring back for obvious reasons.

Peter Rawlinson. Charing Kent 01233 712 158. Email Piprawli6@aol.com

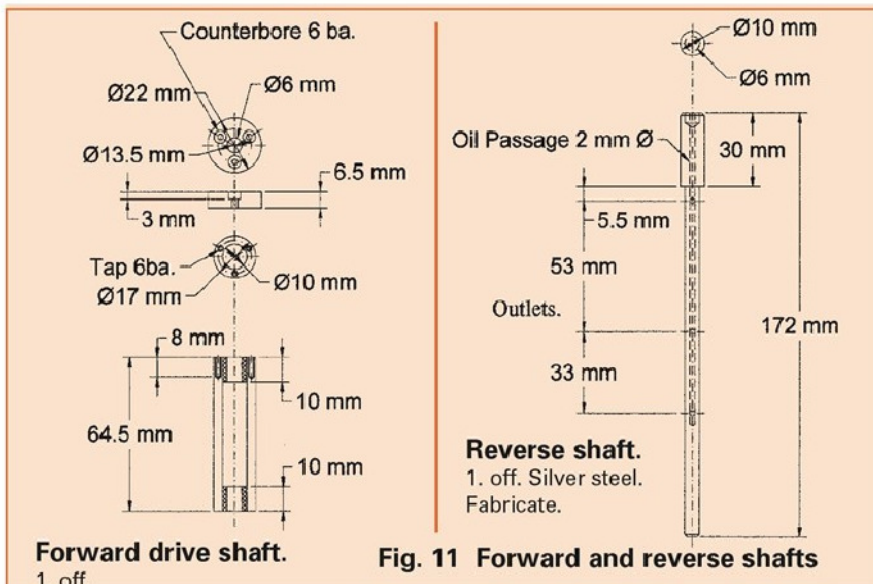


Fig. 11 Forward and reverse shafts

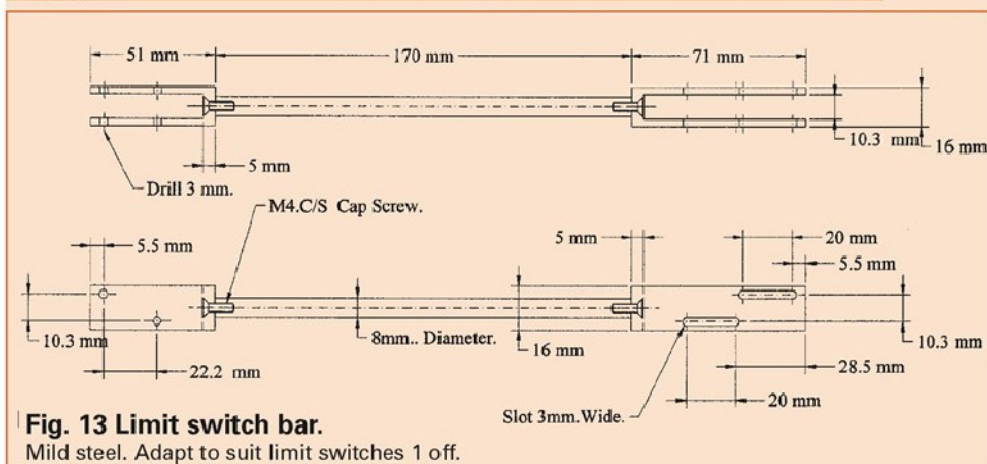


Fig. 13 Limit switch bar.
Mild steel. Adapt to suit limit switches 1 off.

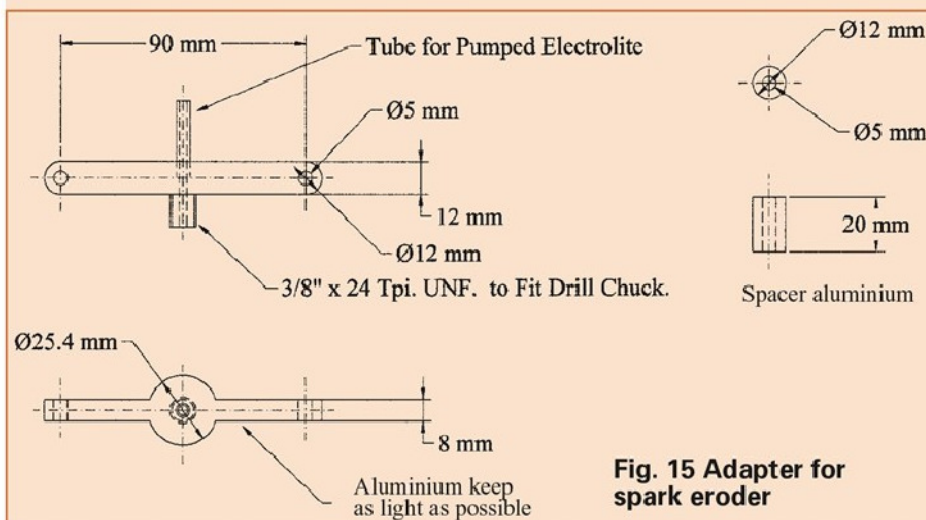
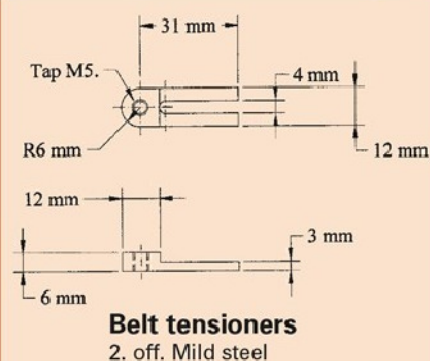


Fig. 15 Adapter for spark eroder



Fig. 12 Thrust washer to maintain 'air' gap in clutch. PTFE or similar. (Oilite) 2 off required.



Belt tensioners
2. off. Mild steel



Modified countersunk cap screw
Used to fit 5mm x 16mm x 5mm Deep grooved ball bearing with 2 seals.
2 off. required.

Also required. 1 No. ball bearing 3 x 10 x 4mm 2 ZR.

Fig. 14 Belt tensioner and screw

KEYWAYCUTTER 1



1. Cutting a key with the device fitted to a Myford ML7

Background

With a gear cutting machine and some other projects regularly presenting wheels and bores needing the cutting of internal keyways, the traditional methods of racking to and fro the lathe saddle with a tool set in a holder was increasingly found wanting. The loads involved are fairly heavy, applied via a long torque arm, so that even with reasonably light cuts, the forces so generated create the risk of damage to the lathe. This really determines, for me, that an alternative system is an imperative. The building of a special unit to take most of these forces out of the lathe proper can take the form of a separate racking unit mounted on the lathe bed or the unit could be a separate free standing machine which would avoid breaking down lathe setups.

Two further problems arise with simple lathe set ups for keyway cutting. The first is that of finding the dead centre of the bore, on paper easy, in practice not always so. The actual depthing of the key needs careful watching as on some of the longer work I have found, to my cost, that the tool is bending away with a tapered finish to the keyway without any hope of measuring to the back of the work while key way cutting is proceeding. This is especially true in smaller bore work where the arbor carrying the tool cannot be effectively supported against side thrusts. Pulling the cutter rather than pushing does eliminate some of these problems but still leaves much to be desired.

The setting of the tool for successive cuts which is normally done with the cross slide dials does not really give adequate sensitivity, and measuring accurately the very small increments for each cut proves to be difficult, especially if more than two wheels are to be tackled one after the other. For instance, it will be soon found that forcing a cutting tool through a bore with no more than 0.025 mm [0.001in.] advance is very heavy work and that has to be repeated 64 times for a small key. It would be preferable to reduce the cut to near half this, not easily set repeatably. If one has as many wheels to be keywayed, as I have, then it is little wonder why I loathed the job so much as to seek an efficient alternative, and the General Arrangement of the device is shown in Fig 1.

Consideration of Broaches

I have regularly seen broaching machines at work on numerous highly precise operations, but actually did not know too much about the niceties of design. The tools themselves are deceptively simple, but I could not see any quick and easy way to make a broach in the accepted industrial manner even for a simple keyway cutter. Failing to find a reasonable methodology and one that was affordable with proper broach arrangements as seen in books I started looking at improving the standard

model engineering approach and came up with an interesting if not novel variant of the usual cutting tool that would lie on dead centres of an arbor by design and without any aligning, be capable of being moved exactly to certain increments of measurement so that very good control of depth, centring and cutting forces for keyways could be achieved.

In industrial broaches the amount of cut per tooth is usually about 0.06 to 0.12 mm [0.0025- 0.005in.] which I know to be too heavy a cut on the ML7 using hand methods. Adjusting for reduced cut per tooth, is not easy because of the smallness of the dimension and the lack of precision

Alan Aldridge offers a solution to producing internal keyways, which is kind to the lathe and includes self-act controlled feed

available to the average modeller. In a continuous broaching operation it would require a great deal more teeth and a longer broach length than the industrial tool. However, if I could halve that the usual depth of cut tooth to tooth and be sure at all times that the feed was exact, easily applied to a guaranteed depth, then very good keyways to a fine tolerance and finish should be the order of the day. In a proper broach it would require increments in the tooth height over some 40 to 48 teeth, about 0.03 mm cut per tooth, which would be the absolute maximum cut for the sort of depth of keyway I use, which is almost invariably 3 x 3 mm size, that is 1.5 to 1.6 mm keyway depth. It is here that the standard sort of broach becomes something of a headache in the amateur's work shop as the spacing of the teeth is critical and the limited depth of the teeth make the preferred shaping and machining procedure of grinding almost impossible.

Photographs 2 and 3 show of attempts to make broaches to this pattern using a threadcutting technique. These make use of one holder for machining, and a second for operating, each being constructed in a similar way to the arbor described later. These broaches have been used quite successfully short term on aluminium. As a matter of interest one of the limiting factors in making a broach work is the containment of the swarf as it is cut and it will surprise just how much space is required ahead of the cutting edge to accommodate the cut material. It is for this reason that broaches tend to be much longer than might appear necessary as the individual tooth must hold all the swarf generated by the depth of cut times the length of cut and in any keyway that volume needs to be multiplied by at least five, to be sure that the teeth do not clog. Cutting aluminium with a 10 mm length and a thou cut to each tooth fills the teeth solid with a 6 mm spacing between teeth and a 1.5 mm maximum depth as might be seen in one of the broaches (**photo 4**) which has been blinded by compacted swarf.

Back to single tooth

An easily hardened and ground edge on a single cutting tooth would appear to be the starting point in the home workshop and if one could find some way to reliably raise the cutter for the incremental cuts required that did not depend on manual adjustment, preferably automatic, actuated by the back sweep of the mechanism, (a bit like the feed on a shaper) then we would be satisfying most of the requirements for good keyway cutting. The machinery to do all this has to be simple



2. Making a broach by screwcutting. The blade is shown partially inserted in the machining arbor.

which is a tall order but a gadget that will perform the necessary task has been made and gives very good keyways, to correct depth throughout, because of the very limited but repeatably advanced cut on each stroke. The concept overcomes the centre finding problem, and its rigidity ensures keyways are cut to the correct width and depth.

The machine depends on two well known mechanical details, the first is an inclined plane which, in this case, is formed by the cutting tool having a canted underside resting on a driving tongue so that as the latter moves forward it will lift the blade. The tongue, in turn, is pushed forward by a feed screw and ratchet mechanism. If we choose to have a 24 tpi thread then one complete turn will give approximately 0.042in. (approximately 1 mm) travel and if the inclined plane is at



3. The broach blade located in the operating arbor. The depth of cut can be seen increasing from left to right, and the inclination is maintained by the dowels.

20° then the actual lift will be about one third of this travel. If the ratchet is geared to provide 16 stations then each sweep of the driving arm of the machine will automatically advance the cut by

$$\frac{0.042\text{in.}}{3 \times 16} = 0.000875\text{in. [0.02 mm]}$$

For even finer feed increments, the angle might be reduced, the thread changed for more tpi, or the number of ratchet teeth increased.

Ratchets should be fairly familiar mechanisms to many model engineers as they form the basis of many a lubricator so we have the basis of a machine that needs only low force to drive it and absolutely no brain power apart from knowing when to stop cutting. The actual machine design treads well worn paths so there is not likely to be anything too complicated or fancy in its construction, added to which is a means of changing the arbors carrying the cutter so several different keyways can be cut for diameter and key size, using cutters that can be made from proper tool steel (say by grinding an old parting tool). The time taken to cut the full depth of keyway will be about 50 strokes of the driving arm, say, a minute or so. Now I am very definitely interested.

As the work progressed with design and manufacture the simplicity of the original concept was partly satisfied but other thoughts materialised to make the machine a little more flexible but also a little more complicated in manufacture. For instance, there is strictly no need to have



4. Although the incremental cut per tooth is only 0.05mm, it may be seen that some gullets are blinded by swarf.

the arbors orientated to the machine holder in such a fashion that the cutting blade stands truly vertical but if one wants to cut multiple keyways, or splines, then it would be a decided advantage to have that feature together with a simple form of indexing, which requires some extra jiggling or templates.

Much of the description of the machine is applicable to the plain broach with multiple teeth and a fixed blade and one could make broaches, as shown in the photographs, this way. I made three satisfactory and some other not so very good fixed blade broaches before embarking on the single point tool, and these have been used fairly extensively. However their shortcomings show themselves fairly quickly and though making and changing blades is not difficult it is the force required to drive them that is the last straw. It either needs hydraulic power or a hefty thump with a hammer to drive them through.

Arbor

Looking at various ways and means of achieving not just an arbor to support the tool but to have the slot dead on centre and any of the follow on equipment running on fixed planes it is apparent that the first imperative is to maintain the centre line through the arbor and all other data has to be referenced to it. If the round bar which is the arbor, is centred and the centres are kept throughout the machining operations then we retain the datum. The alternative is to make up a bar or machine



5. Milling the arbor.

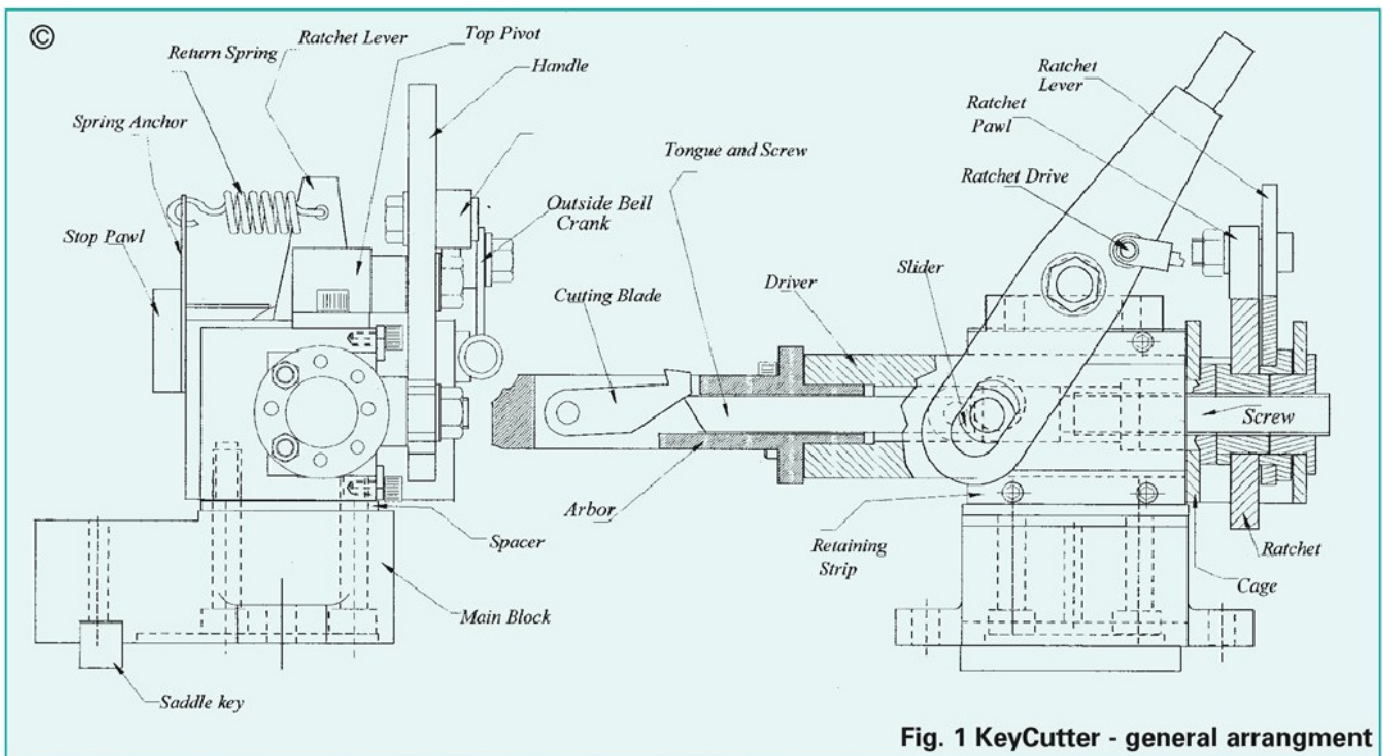


Fig. 1 KeyCutter - general arrangement

6. Arbors are given a final touch with a file before silver soldering.



the tool slot and later find the centres. The method described may look a little odd but it works extremely well in the amateur setting and has been proven to be highly effective. It is the method employed for the broaches in the photographs and the keys cut by them are dead on line in as much that with the mating shaft keyway a tight key fit without any slack, has been obtained, first time, on each occasion.

The arbor (Fig 2) is rough machined after facing and centring both ends to around 1.5mm above the final size at both ends except the stop flange or collar which can be finished to 28mm. The arbor is then mounted in the machine vice with aluminium slips either side (photo 5) to grip the arbor and protect the vice as milling proceeds. With care, the arbor can be milled on the vertical slide with the bar strapped down to the Tee slot at the ends and in the middle. The milling reduces the bar until the flat is 1.5 mm below the centre line. In the machine vice and milling machine the micrometer can be set in at each end to test the round to flat dimension. A depth mike or a vernier would be required on the vertical

slide. I would reduce the dimension until it is within about 0.025 to 0.05mm of size and later finish with a fine file to exact size. Filing can be done with the arbor once again between centres in the lathe, (photo 6). The ratchet end of the arbor needs to be reduced further with a sunken slot at the same depth, no more than 8 mm wide and equidistant from the sides spaced to drawing though there is a little latitude on the lengths. Note that the depth of the slot has to be a finite dimension, no filing to size is really possible and therefore any allowance left on the other milled surfaces has to be taken into account and the width of the slot must be 8 mm and equidistant from the top and bottom edges of the bar. I would like the slots to be almost without any working clearance.

The arbor will be completed by a closer which is a piece of 12 x 8 bright bar but the actual size is not important as long as it will come outside the final diameter of the arbor when fixed in place. The bar needs no machining at all. Make up the following small parts not shown on drawings: a pair of offcuts 3 mm thick,

possibly of the blade material, to act as spacers in the slot and a partial flange to complete the 30 mm diameter collar, which can be over size in diameter and width but should be a snug fit to the closer bar. Before putting the closer into place permanently, have the tongue and its slide available and fit the various parts together with several dummy runs until everything runs smoothly, especially at the change of section in the arbor.

Lay the closer over the arbor and dress the length so it drops in and there is space to get silver solder, down deep into the ends. The offcut blade will prevent the clamp from closing the slots. Clamp the closer to the arbor, it does not have to lie square, and silver solder the lot together. Lay the complete arbor on the closer face which acts as a reference for the slot position and site the cross drill hole in the drill press for the tool pivot. Start with milling a small flat so that positioning becomes that much easier and follow with a centre drill and open out to the required size, 4 or 5 mm nominal.

Offer up the arbor to the centres in the lathe (photo 7) and turn the outside diameters throughout, down to the final housing and driving end diameters less 0.025- 0.035 mm and parallel throughout. The collar is dressed to around 28 mm and 4 mm wide. The arbor should then be a running fit to the wheel bores and thus will provide some support to the cutting tool preventing it from apparently sagging under load. As there is an intermittent cut the start needs to be taken carefully. Turn the arbor around and part off as drawing to remove the driving end centre. The driving end diameter should be set to a common size for all tools, and held to fairly close limits, so that the plugging in of the tooling does not have any shake and, secondly, there are no extra bits and pieces required for setting up. A 16 mm arbor would be similarly approached but the starting diameter would be 17 or 17.5 mm and any other sizes would be adjusted on a similar basis. The smallest diameter so far tackled is 8mm, still with a 13 mm driving end, but this also required a modified tongue section. Do not part off the end of the driving portion yet on the 13 mm arbor, as it will be required to set out the machine base. The 16mm or any other size can be parted off to length. Photo 8 shows a 13mm arbor after turning.

Driver

The driver, shown with its holder in Fig 3, is a squarish bar that runs in a guideway in a stationary block bolted down to a base plate or to any suitable machine. The front end of the driver picks up the arbor on two pins so that the correct angular orientation is maintained. The wheel is then located to the arbor to give the final positioning of any keyway. A drill jig which fits either arbor or driver, ensures that the orientation is consistent. Ideally this would be from gauge plate, but I have succeeded quite well with plain mild steel.

The block is offered up to the chuck and centred for drilling the through hole then bored on centre line as shown on the drawing. The driver is machined all over; mine was actually hand scraped to get the best running surface possible. The driver must have a stub shaft onto which can be

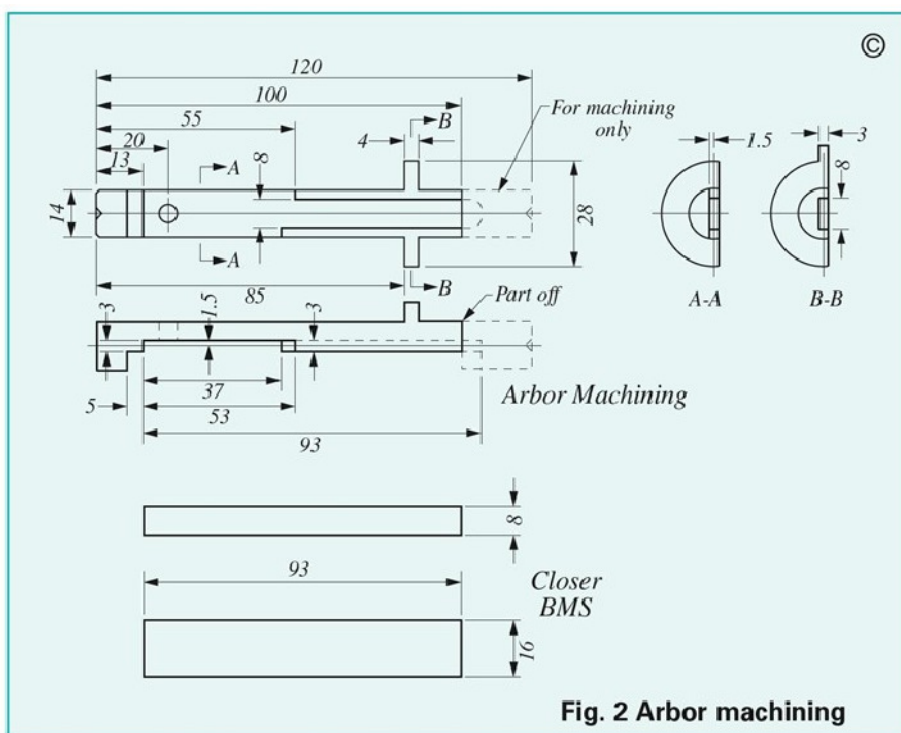


Fig. 2 Arbor machining

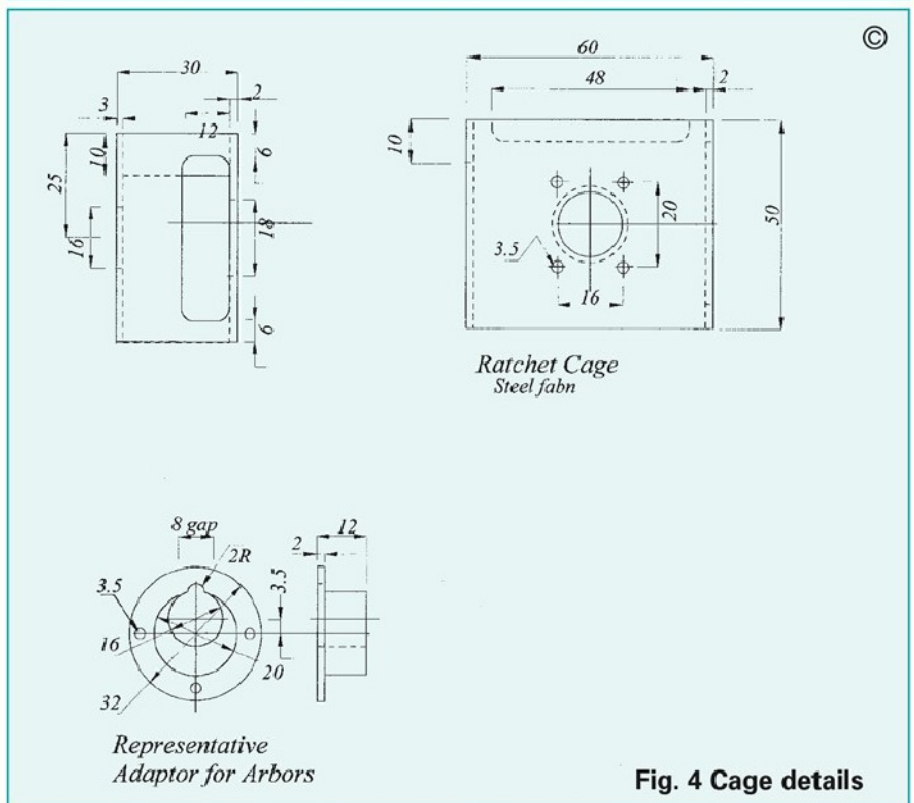
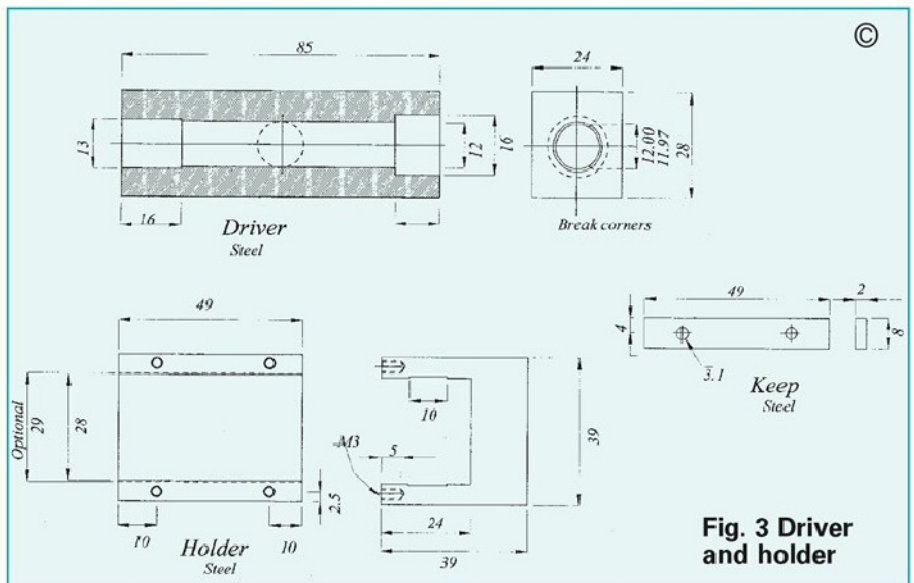
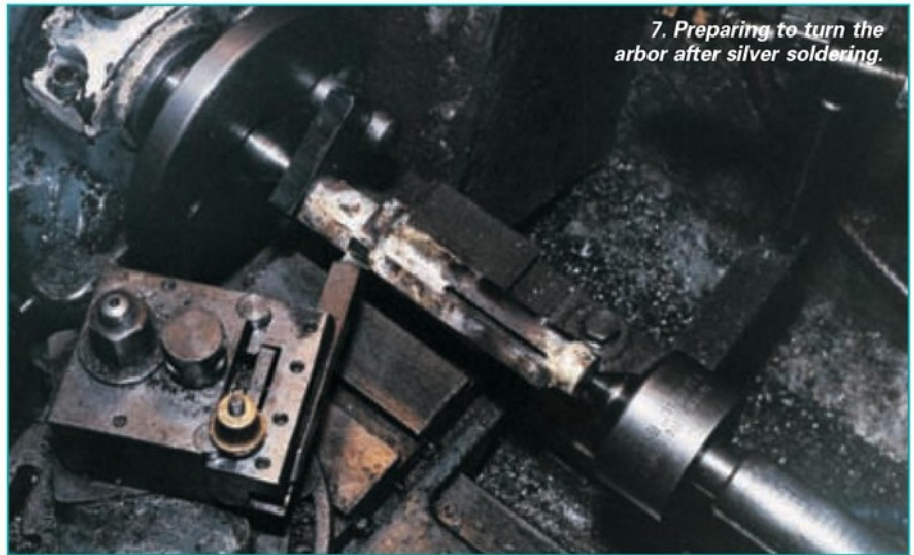
coupled the driving arm and this takes the form of a plain steel turning which is force fitted to the driver itself. The dimensioning on the drawings shows the amount of interference required. It could be silver soldered in place but I would, personally, avoid adhesives. I actually reamed the hole and from the known reamer cutting size gave the shaft a 0.07mm interference.

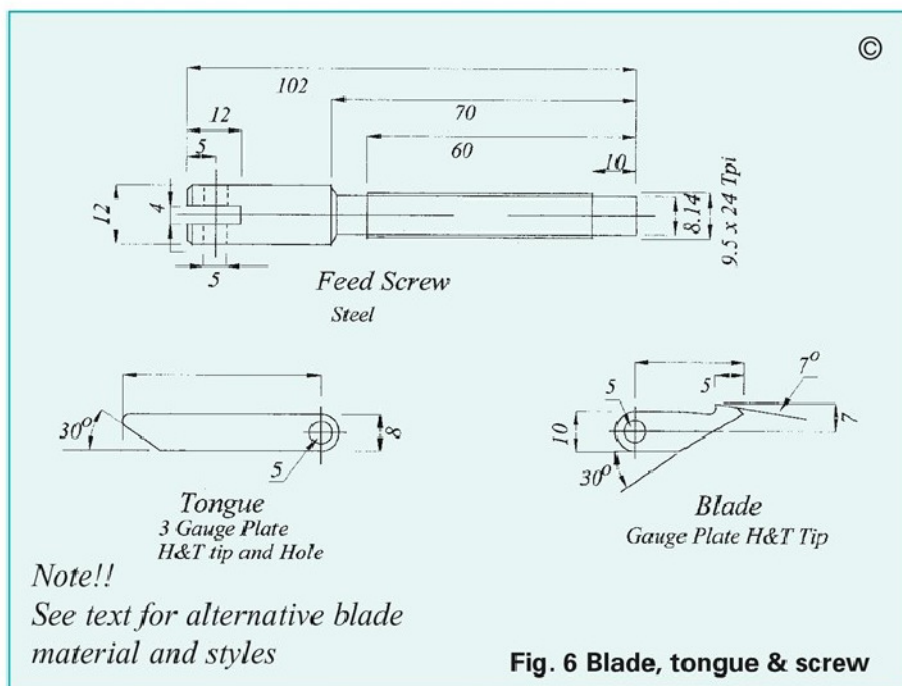
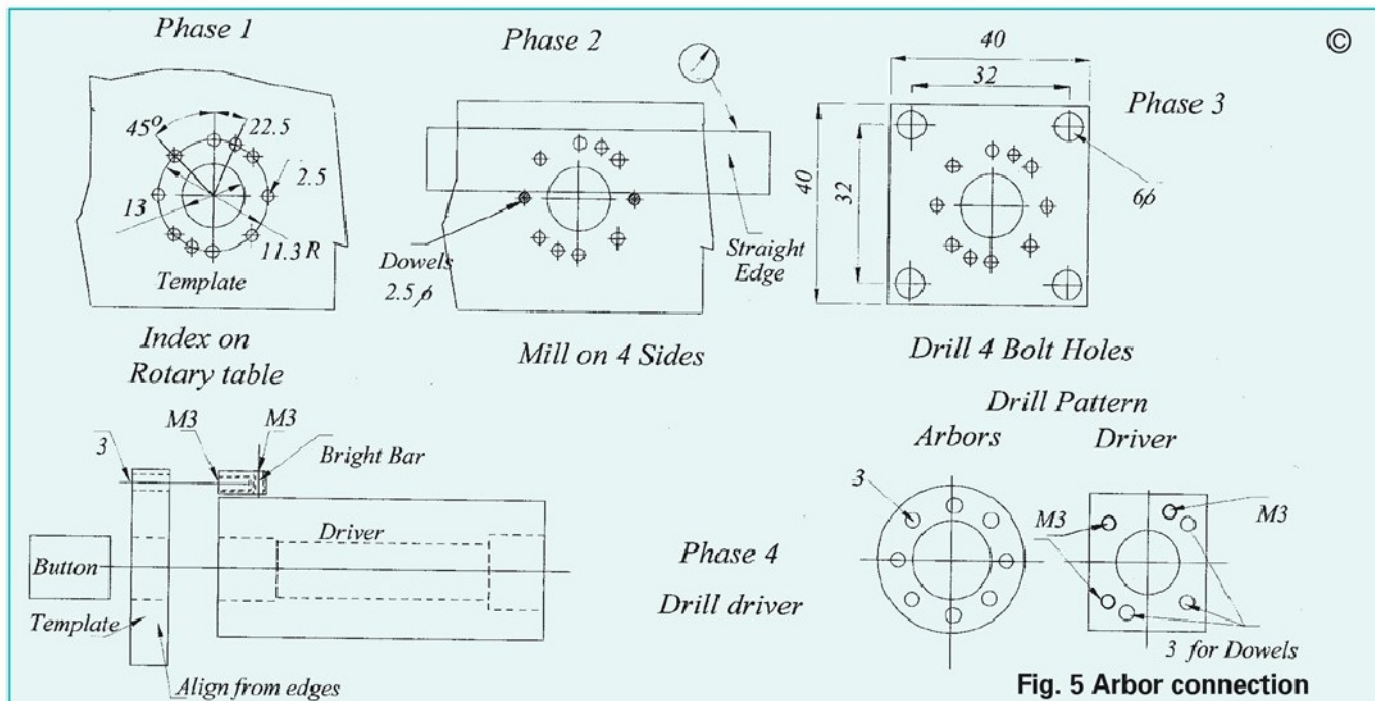
Cage

At the rear end of the driver there is a cage (Fig 4) which houses the ratchet and this can be fashioned out of square tube or machined from plate or solid. The cage contains two bronze bushes brazed into place that carry the screw that drives the cutting tool height adjusting mechanism and to maintain the ratchet wheel horizontal position. Once the cage is fabricated it should be set up in the four jaw to drill and bore the two holes that carry the bushes to ensure satisfactory alignment. The threaded spindle is made to a reasonable fit to the hole right through the driver. The cage is bolted on to the driver bar but could be brazed or welded on. The bronze bushes will be added at the machining stage but the larger or thicker of the two is used to position the cage on the back of the driver and the other needs to be slimmed down to position the ratchet with the merest amount of backlash. Before any setting of the detenting system the screwed shaft must be made to turn freely in the bushes and the driver bore.

Angular orientation

The arbors have to not only slip easily into the holder but must be retained so that they do not stick in the bore they are cutting and pull out. A secondary requirement could be that the arbors should be orientated in a certain way though for plain one off key ways the wheel can be turned around in the lathe, for example, to provide any particular angular rotation of hub to arbor required. However, if one can cut one slot with ease why not look at cutting several or even two opposite each other which then calls for something a little more fancy, unless the angular move is made by the headstock. Therefore when setting out the holes in the ends of both the driver and the arbor collar something which is machine divided will be necessary. Once the various bits and pieces are made, pushing through 8 or more holes in the arbor collars is not a chore. Nominally with a 3mm cutter the maximum number of slots that can be cut for a spline in 16 or 20mm diameter hubs is eight, so the basic requirement would be to divide in eight holes on a rotary table but it is possible to spline larger diameters for larger numbers of slots with the 16mm arbor, for instance, and this would be catered for by having two extra holes at 22.5deg. (giving an added subdivision) and the remainder at 45deg. The sketches given in Fig 5 show the various phases that are required to set out the holes. The template should be gauge plate though plain steel can be used. At the back of the plate is a scrap piece of plate that bolts with M3 screws on to the plate with a dash of adhesive and





through the arbor so that there is the minimum of lost motion in the screw assembly. There will be some fitting to be done which is going to be awkward but by no means impossible, with Swiss files working down a hole to clear out any fillet formed by the silver soldering. The tongue must be the first consideration as it has to work in the 3 mm slot and one might make it very long to start with so one can size up what is required mating with blade and the screw. The loads on the pins are not unduly high and a 4 mm hardened silver steel pin will be quite satisfactory. Pins must be just shy of the width dimension so they do not scrape along the slot sides. The end of the tongue bearing on the under side of the blade needs to be given a rounded end and hardened locally at the end and the pin hole.

The screw thread is machined between centres to 24 tpi or 1 mm pitch necked down at the front to give a place for the tool to run into while withdrawing. Ultimately the end will be milled to give a 3 mm wide slotting for the tongue section. I am inclined to reduce the outer end as well to the bottom diameter of the thread (thread depth 0.0255in - 0.647mm).

The end of the screw that protrudes beyond the ratchet cage could be used to carry a stop collar which will give the required depth to within about 0.15 mm, and eliminate counting each stroke. I have made a short shaft fitted with a key to act as a go gauge for each arbor size.



The concluding section of the article to be published in the next issue will cover the ratchet feed system, and consider avenues for potential future improvement.

above them are two more screws which are used for setting. The plate is divided on a rotary table or dividing head and in the next phase, two of the opposite holes are fitted with tight fitting dowels. By tightening the screws at the top to tip the template left or right it is possible to get the template to stand exactly square to the driver as indicated by the feeler and parallels and dead on the driver centre as the template is held to the driver by a tight fitting round pin. Once set, the 2.5 mm holes are spotted and then drilled as shown in the Drilling Pattern for the driver. It looks very curious but gives all the positions that are required. The holes can be tapped and opened out for the dowels, normally only two dowels are placed in the driver at the 45° marks. In my case the dowels are machined to 2.5 mm at the outer ends to allow gripping with a pair of pliers. The arbors are drilled 3 mm only

but it is necessary to get the arbor slot dead upright and for this the template is fitted back over the driver the dowels will be moved around to one side and the lot set up taking care to ensure that the various items are correctly lined up and squared to each other. The template has been drilled and tapped with two M4 screws to hold the template to arbor for the drilling operation. At all times one of these screws must be tight.

Tongue and Screw

This is the heart of the design along with the blade, and these components are illustrated in Fig 6. The tongue is a single piece of plain steel or gauge plate which has a pivot at one end and the sloping face at the other. The hole is for a cross pin that holds the tongue to the screw that drives it. The material must just slide in the slot

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.

New catalogue from Arrand

These days, when so much of our home grown manufacturing industry is in decline, it is encouraging to have positive news from a UK supplier of precision tooling. My first recollections of seeing the Arrand name date back some 25 years to adverts in Model Engineer, when members of our society purchased a flycutting head and a boring head, each being highly delighted with their acquisitions.

Today's catalogue displays a far more extended product range which starts with a variety of indexable tipped tooling, both for lathe and mill, ranges of boring heads, includes counterbalanced flycutters, endmill holders, ER collet chucks and arbors, and even a small milling spindle. For anyone contemplating repetition work on a centre lathe, the quick change tailstock tooling system will no doubt prove to be of interest, and potentially a useful timesaver.

To obtain a free copy of the catalogue, either telephone 01664 454 566 or write to Arrand, The Forge, Knossington, Nr Oakham, Leicestershire, LE15 8LN.



From J A Crew, a digital caliper promotion and a new catalogue



It is not so long ago that I parted with around £55-00 for a "cheap" 150mm digital caliper. Prices have fallen further, and J A Crew now offer the instrument shown in the accompanying photo for just £24-95 plus £2-50 p&p, packaged up with a free copy of their new catalogue (normally £1-50). The caliper comes in a substantial moulded padded plastic case (featuring piano style hinge, rather than usual modern flexible plastic) with instructions and battery, and carries the usual buttons for on/off, inch/mm, and zero. Imperial reading is to 0.0005in, and metric to 0.01mm, with the main components being manufactured from hardened stainless. A series of quick checks over a number of gauge blocks (up to 100mm) showed a correct reading at each stage, so accuracy has not been sacrificed for price.

In a sense, it might be suggested that the Crew catalogue takes over where Whiston left off. In addition to tools fasteners and materials, there is

much to interest the experimenter in terms of electrical and electronic components and also equipment at "surplus" prices. J. A. Crew & co. may be contacted at Watery Gate Farm, Chipping Campden, Gloucs. GL55 6QU or phone 01386 841 979

New Extended Toolholder from Chronos

Chronos now have in stock a new extended toolholder for their MFQC1 Quick Change toolpost system which suits the Myford ML7, Super 7 and similar sized lathes. They are very useful in that they are 3.5in. in length, and provide extra clearance from the block, giving a rigidity improvement in many turning situations. The new toolholder will also match Toolmex/Bison toolposts of similar design. As may be seen from the photo, the holder is hardened and ground on all external and working surfaces. Price is £26.95, and Chronos may be contacted by phone on 01727 832 793, by email to sales@chronos.ltd.uk, or at Unit 8, Executive Park, 229/231 Hatfield Rd. St. Albans, Herts, AL1 4TA



News from Boost

Boost Electrical Engineering who are manufacturers of single to three phase converters, and suppliers of inverters and other products such as forward/reverse switches etc. have recently changed ownership. The new owners have restructured Boost as a limited company and Tony Barton, the previous owner continues as technical director. They have moved into expanded premises which have been refitted purely for Boost, and have completely revamped their product range.

Boost are the only manufacturer of phase converters in the UK who will supply across the entire power spectrum from small 1/2-hp/0.4-kW to 40-hp/30-kW machines. They have been in continuous production since before 1957 and guarantee their products for both performance and as having the best price. Details of their range can be found at www.boost-energy.com or by contacting them directly where they are happy to advise customers. They continue to be owner-managed by David Sharman who, like Tony Barton, is a hands-on professional engineer.

The company may be contacted by phone on 0118 903 4881, fax 0118 903 4882 or at Felix Farm, Howe Lane, Binfield, Berks. RG42 5QL, or by email to david.sharman@boost-energy.com

Spring supplier

Thumbing through one of the trade magazines recently I came across the previously unseen name of a Swedish based spring supplier - Lesjöfors, and promptly requested a copy of their catalogue. Surprisingly, it includes automotive springs as well as the expected compression, tension, torsion and disc, together with gas struts, and raw material such as grades of Inconel, Hastelloy, and Nimonic. The downside is that at present their minimum order value is £50-00, but it is understood that the company has plans to introduce a credit card charging scheme within the next six months which will improve the efficiency for handling small orders and allow a review of the minimum charge.

The company can be contacted by post to Lesjöfors Springs (UK) Ltd, Warhurst Rd, Lowfields Business Park, Elland, W Yorks. HX5 9DF, or phone 01422 377 355 Their website is at www.lesjoforsab.com

New Catalogue from Machine Mart



Machine Mart have announced their latest catalogue which features 285 new products and 727 reduced prices on a range of products which includes power tools, hand tools, metal and wood working equipment, construction, garage, workshop and gardening equipment and much more. The new catalogue will be high on the priority list for both DIY and trade users, and can be obtained free of charge either by calling in to any of the forty seven Machine Mart Superstores nationwide, by phoning the request line on 0845 450 1855, emailing sales@machinemart.co.uk or visiting the website www.machinemart.co.uk.

At the time of writing, I have not yet seen the new catalogue but certainly have found the previous version a source of much bed time reading. The metalworking section contained a wide selection of drills, and bandsaws, together with lathes and mill/drills. After completing the car trailer last year, I consulted the Machine Mart catalogue, and treated myself to a set of the heavy duty ratchet tie downs with wheel straps, which should ensure that the car being carried remains correctly perched.

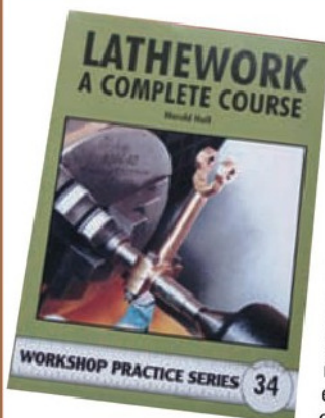
Slick Distribution from Bede

Run by father (Barry) and son (Andrew) MacPherson from their Jarrow premises, Bede Tools and Machinery have built up a solid reputation for supplying quality machinery at sensible prices, and have now sold in excess of one thousand lathes. Having a client base which includes many model engineers in turn means that Saturdays at the premises are almost unofficial club meetings, complete with coffee and biscuits.

With much of their business coming from the southern counties, it made sense to examine and optimise transport arrangements. For machines which can be fastened to a pallet, the Palletline system offers rapid delivery at competitive cost (e.g. less than £40.00 to Surrey). Palletline is apparently an organisation set up by hauliers in cooperation which certainly seems to "deliver the goods" in all senses.

Coupled with their policy of showing VAT inclusive prices, this means substantially reduced oncosts compared to some competitors. **Bede can be contacted at Unit 35, Royal Ind. Est., Jarrow, Tyne & Wear, NE32 3HR**
Or phone 0191 428 6575 or email bedetools@yahoo.co.uk

Fireside Reading



Since I took over as Editor from Geoff Sheppard, I have received numerous calls from readers enquiring as to which backnumbers they would need to purchase to have the complete series of articles "Lathe Projects for Beginners" by Harold Hall. In fact, the series ran through seventeen issues, and as many have found, backnumbers are not always easy to obtain. I am therefore confident that many newcomers to the hobby will share my delight at the publication of "Lathework, a Complete Course", by the same author, which is closely based on the seventeen articles. In conversation, Harold is disarmingly self deprecating about the depth of his knowledge of machining processes, claiming to be essentially self taught since retirement. (His background had been in complex electrical control systems.) For me, the strength that this conveys is the ability to explain, with great clarity, particularly areas which many old hands would tend to

gloss over or omit, forgetting that the novice lacks the same experience.

The book is divided into thirteen chapters, which offer a staged progression for the complete novice, covering all the basic techniques required for the many projects described, which include; mini surface gauge, precision square, between centres test bar, hole gauges, distance gauges, tailstock die holders, precision tapers, screw jack, mill/drill spindle, and milling cutter chuck. Project and process descriptions are augmented by clear photographs and line drawings.

For the novice, this book offers the opportunity not only to develop practical skills but also to create a range of useful workshop tools and equipment, which may also be of interest to many experts. "Lathework, a Complete Course" is published by Special Interest Model Books (ISBN 1-85486-230-8) price £7.95 from reputable booksellers.

Also of interest to amateur workshop enthusiasts, but on a totally different topic, "Atmospheric Forge and Heat Treat Oven", by William T. Goodman and Robert W Holmes is a concise book devoted to a single project. Published by the well known David J Gingery concern, the book is very much American in style.

The end result of the project is a gas fired furnace with the potential to reach 2500 degrees F. in around two and a half minutes from start up. As there is no electrical connection, this is a device which could be used for "metalwork in the middle of nowhere". A clear list of materials is given, along with advice on suppliers. In fact ready made parts are available from an American supplier. Successive chapters take the reader step by step through a logical build process culminating in final assembly and firing up. The facilities required to produce one or two of the heavier components for the forge tend to the "medium fabrication" rather than model making, and thus for these, many of us would probably either invoke the assistance of a local engineering shop, or avoid bending 1/4in. plate by welding up individual flat sheets.

Unless you manage to fall over a good second hand unit, small furnaces can be expensive items, and therefore this book offers a low cost route to acquiring the facility. **The book is available in this country priced at £12.35 post paid, from Camden Miniature Steam Services, Barrow Farm, Rode, Frome, Somerset, BA11 6PS or phone 01373 830 151**



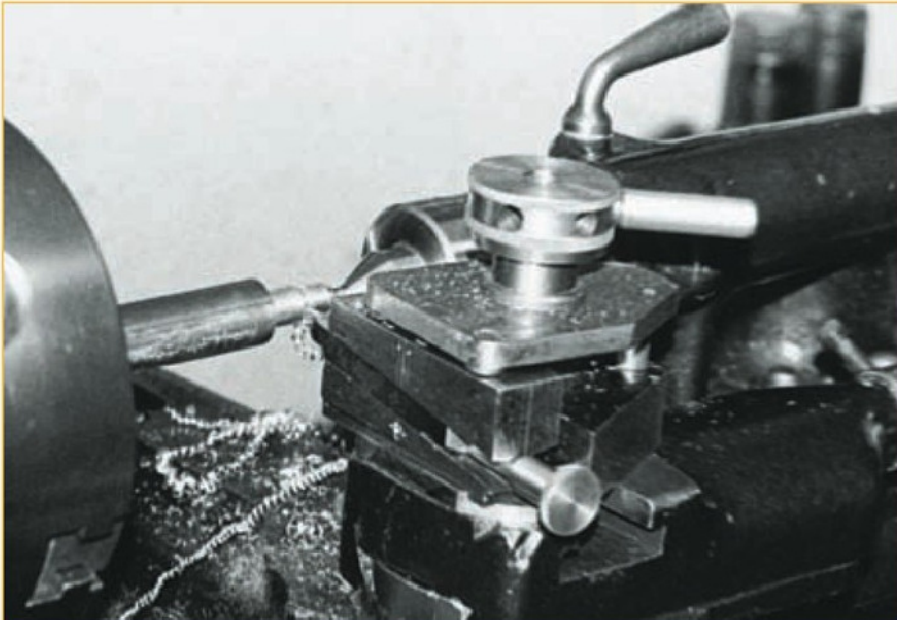
Convert scanned drawings to CAD with new Scan2CAD v7.

Regular readers will recall the review by Stan Bray of the earlier version of this software in MEW issue 89. Softcover has now released Scan2CAD v7, an improved version of the raster to vector converter which allows CNC users to turn scanned drawings and outlines into accurate DXF vector files for editing in any PC CAD program, such as AutoCAD 2004, LT or similar, as well as CNC and other design programs.

It is claimed that by extending Scan2CAD v7's drawing element recognition to include dashed lines, lined hatch patterns, B-splines and arrow lines, etc, and by improving its overall conversion accuracy, Scan2CAD v7 now offers CNC users the least expensive way to achieve the most accurate professional quality conversion results with scanned drawings.

Scan2CAD v7 is available in two versions, Regular (£179.78) and Pro (£297.28), and an evaluation program can be downloaded from: www.softcover.com. As with the earlier versions, Regular works with black and white, while Pro has colour capability along with a number of added features.

GOING ROUND THE (SOUTH) BEND



1. Progressive turning of elevating screw.

A few years ago I received a letter from the General Secretary of the Institution of Mechanical Engineers. It was to advise me that since I had been paying corporate membership fees for fifty years I was to be relieved of that expense for the rest of my life! Needless to say this was welcome news in a small way and which provided me with lots of food for thought. Did this letter signal the end of my "mechanical" life or was it possibly a new beginning? It set in motion a wave of nostalgia, including a memory of the very first lathe on which I took instruction. This is where the South Bend came in. The manual instruction workshop at the secondary school that I was fortunate to attend in the UK in the early 1940's was doing double duty as a training school for machine tool operatives badly needed for the war effort and had been equipped with an excellent selection of American machine tools. During the day the school used the workshop for its manual instruction periods but during the evenings the trainees, ladies mainly of course,

descended on the workshop to learn the rudiments of metal cutting. For me the highlight of our day in the workshop was carrying out an exercise on one of the small bench lathes. We had a row of four or five South Bends, Lend-Lease equipment I believe, brand spanking new and resplendent in their glossy grey paintwork.

In Nova Scotia, older used South Bend lathes in good condition are as scarce as hen's teeth. The better examples were to be found in sales of trade school equipment being displaced by modern cad/cam equipment or simply being dropped from the schools inventory as the demand for practical technology training diminished. It seemed that the nearest I could ever get to owning one was to listen to a group of my friends congratulating the latest lucky owner in a quietly gloating kind of way. I could of course have bought a new one for several thousand dollars. But that's not the way of it in retirement when nostalgia is the motivation and impecuniosity the limitation! I had seen a number of excellent examples in sales and

Jim Wright of Nova Scotia describes his approach to a quick change tooling system for the well known South Bend lathe.

in second hand showrooms in England but the complications of arranging export, taxes and duties etc., during a holiday visit were just a little too much. And the prices asked were very high compared with used equipment in North America.

However, about a year ago my luck was in. A friend put me on to one which he thought might well suit me. In the time it took to make a telephone call I was on my way to see it. I was surprised to find that the slideways showed little sign of wear, the gearing systems appeared to be in excellent shape and I could detect very little clearance in the spindle journals so I made the deal. The lathe was fully equipped with a taper turning attachment and a set of spindle nose collets. A final bonus that satisfied my nostalgic proclivity was the discovery of the cast-in information on the bed proclaiming that it was a "War Production Standard" version. It was a nine inch (or 4½ inch in the UK) bench top model virtually identical with one I had met as a teenager.

Within a week the lathe was a pile of castings on my garage floor. Having assembled the castings into a working entity and having done some more comprehensive checks to confirm that I could work with acceptable precision, I set about improvements that I felt essential. My first improvement was to design and build a toolpost that I could work with easily and quickly. The intention in this presentation is to describe the design and fabrication of this toolpost and to provide what might be a practical and interesting project for the home workshop.

I had always disliked the American pillar' or 'rocker' style toolpost which came with the lathe although it is quite functional if you have patience and can accept a lot of fiddling with tool geometry. But this type of toolpost has significant flexibility and susceptibility to vibration,



2. Cutting screw thread of elevating screw



3. Elevating screw



4. First step in marking out, item 9.



5. Marking out 60 degree datum faces.

which I wished to avoid. I was also frustrated with the time it took to change and reset a tool since I was producing very small complicated components for a gauge one locomotive which required very precise setting of toolpoint height for good results. Speed and precision of tool setting for production of miniature screw threads could also be improved if a suitable datum could be built in to the toolpost design. These thoughts led me to a set of desirable performance requirements.

Design and performance requirements

Toolholding system

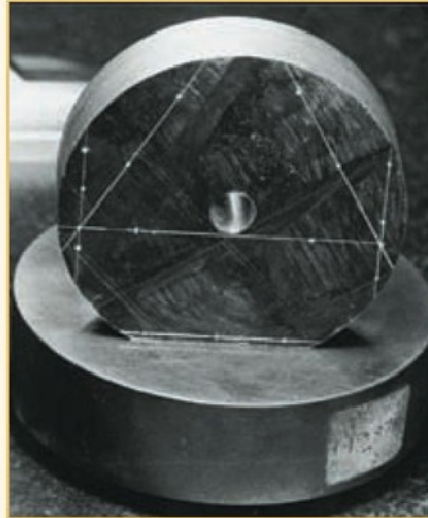
In use, the toolbit, for a range of applications, should be accommodated in a common holder or toolblock which should be very quick and easy to interchange. Whilst cemented carbide cutting tools are excellent in use they are expensive and less convenient to manage in the home workshop. Sometimes cemented carbides are an advantage when cutting into chilled surfaces of iron castings or in use in high productivity environments but are certainly not essential in the home workshop. For the home workshop the conventional square section high speed steel or cobalt toolbit is my personal preference. It also allows complete flexibility in choice of tool geometry. Therefore the toolblocks should accommodate this type of bit.

Toolbit regrinding

Tool geometry should be easy to create and manage. By this I mean that the angles which are important to the cutting process should be easy to maintain. In particular the rake angle or top rake surface should not require regrinding when resharpener and should reset precisely with ease when changing tools. Design of the toolpost system must enable sharpening of the toolbit cutting edges to be performed by grinding the clearance faces only.

Setting for screwcutting

When screwcutting, the toolpost base should provide a built-in datum to enable precise angular presentation of the toolpoint to the work. This would avoid 'fiddling' with screwcutting gauges in awkward situations.



6. Markout of item 9 complete.

Rigidity of the toolbit

Cutting loads should be taken as directly as possible through to the bed slideways eliminating as far as possible cantilevering or overhang of the toolbit. This helps to avoid chatter and poor surface finish.

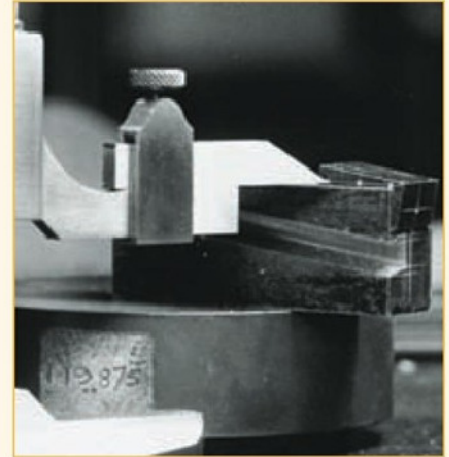
Accommodation for a range rake angles

The basic toolblock design should have the capacity within its dimensions to accommodate several rake angle variations with a toolbit length of two to three inches.

The question was, could I produce a toolpost system easily and cheaply that would meet my requirements? I suppose I could purchase one but I expect it would cost about the price I paid for the lathe!

Some remarks on the cutting process

It might be worthwhile and interesting to the home workshop operator or amateur machinist to have some of the background



7. Ramp block set up for marking out in ramp pocket.

to the cutting process discussed. Generally speaking, if a hard material is brought into contact with a softer material the harder will penetrate the softer. In fact the measure we use for 'hardness' is a measure of the extent to which a material resists penetration. Hardness is often defined quantitatively by measuring the penetration of a spherical or diamond shaped penetrating device forced into the surface in question. This implies that provided we can apply enough force and that relative hardness is in the correct order, displacement of the work material (cutting action) can be achieved with the most primitive tool geometry. But that is too much of a simplification. We must also provide for good surface finish, achievement of dimensional tolerance and the economics of the process of stock removal. It is for these reasons that a great deal of time and money has been spent researching the geometry and dynamics of metal cutting. (Nevertheless, the most successful production/design engineer is still the one who largely eliminates the need for stock removal!)

For our purposes the geometric elements of the toolpoint that should be considered are the angle of the raked surface, sometimes called the "top" rake,

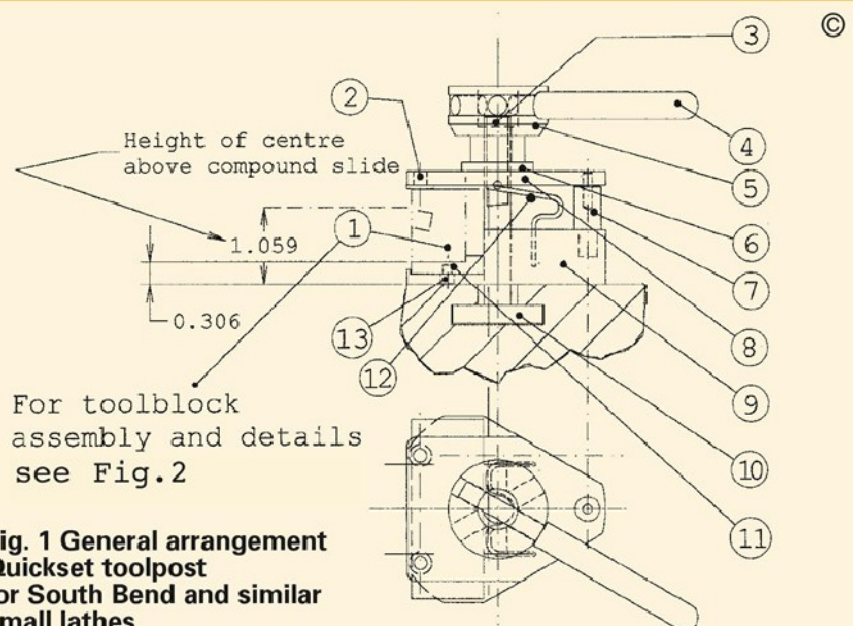
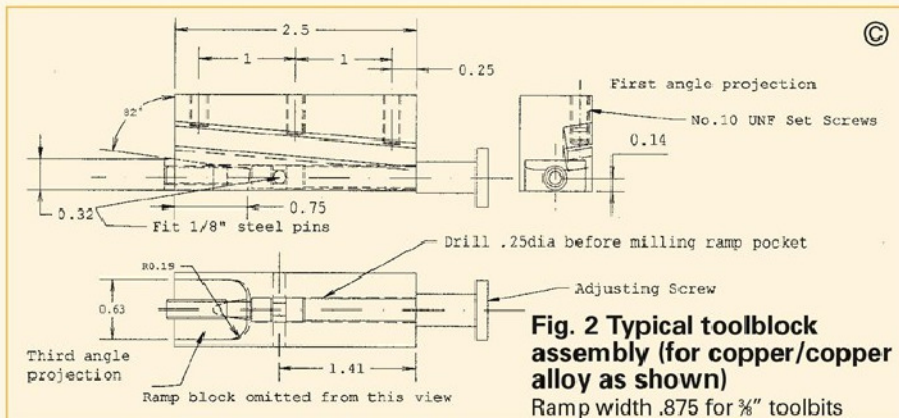
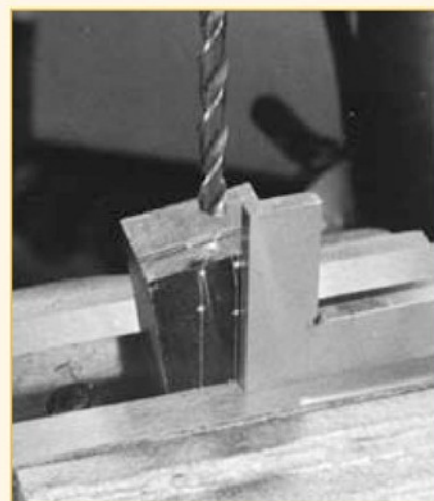
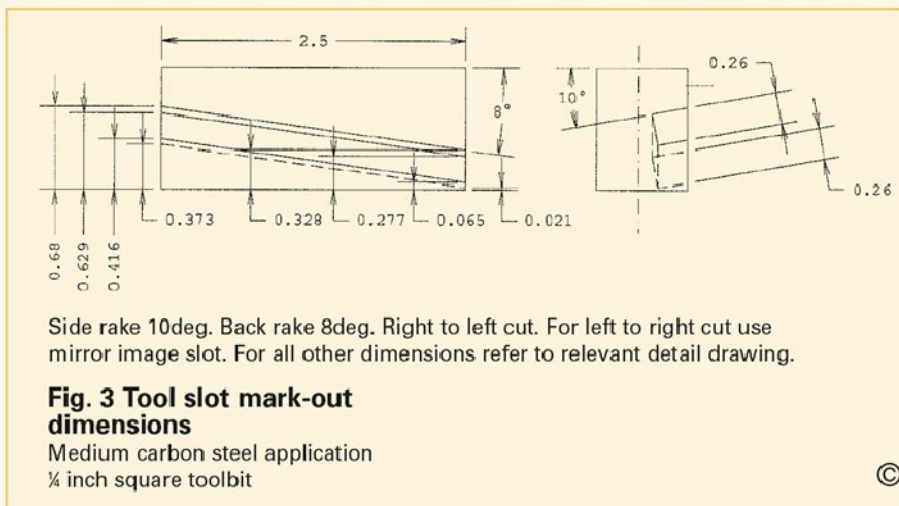


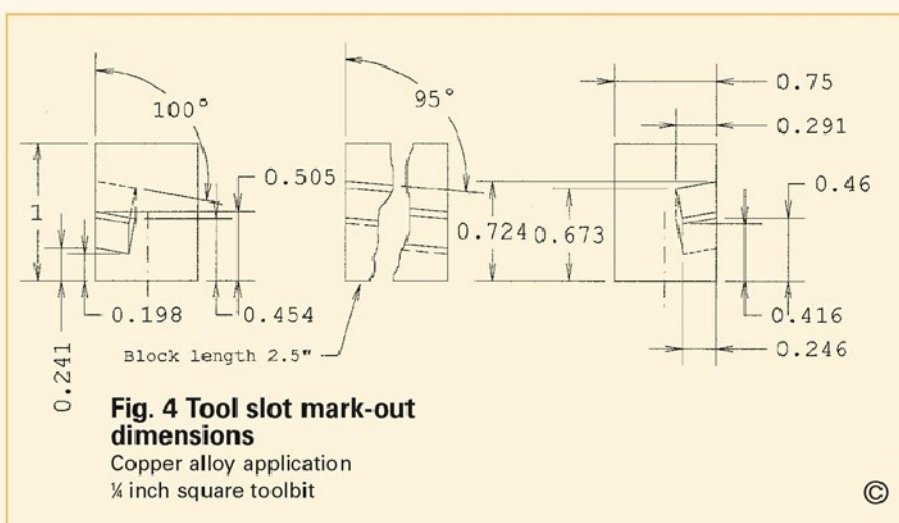
Fig. 1 General arrangement Quickset toolpost for South Bend and similar small lathes



8. Centre drilling in preparation for through drilling of tool slot.



9. Realigning toolblock for through drilling of tool slot.



the clearance or end relief angle between the tool face presented to the work and the work itself, and finally the end and side cutting edge angles. The end relief angle which is usually about 5 degrees, is not critical but it does affect the wear rate and strength of the tool tip. At the point where the cutting edges intersect the intersection is rounded off to form a nose. This nose radius has a bearing on surface finish, and is a matter of operator preference to suit the work being carried out, as are the end and side cutting edge angles.

The question arises, which size of tool bit ($\frac{1}{4}$ or $\frac{3}{8}$ in.) should one use? I have provided dimensions for four toolblocks at the $\frac{1}{4}$ in. size and an example at the $\frac{3}{8}$ in. There is also a packing plate required for use with the $\frac{1}{4}$ in. toolblock. In the case of

typical work on a 9in. lathe, the area of tool rake surface exposed to the chip (simplified as feed x depth of cut) is always small enough to permit the use of the $\frac{1}{4}$ in. square size. However if the combination of load and speed load is high, heat generation can reduce the life of the cutting edge. This can be ameliorated to some extent by taking advantage of the greater heat transport capacity of the $\frac{3}{8}$ in. sq. tool bit. Cooling of the toolbit can also be improved by using a cutting coolant. This is rather messy in a home workshop environment and in my work I have never used a coolant as such! To improve finish I do however use a cutting lubricant, which is an entirely different story!

The rake angles I have selected for the design of the tool blocks are

recommended by the Machinability Data Centre, Cincinnati (1980) as is the rest of the tool geometry described.

The drawings

Separate arrangement drawings are provided for toolpost assembly (Fig 1) and for a typical toolblock assembly (Fig 2). To clarify the dimensioning of the toolblocks, detail slot dimensions are shown on a separate drawing for each of the different $\frac{1}{4}$ inch toolbit rake angles and for a typical $\frac{1}{4}$ inch toolbit (Figs 3,4,5,6). If you have a CAD programme, blocks for other toolbit rake angles can be very quickly drawn up using the toolpoint position as a datum or starting point. Note that the toolpoint projection from the toolblock is nominally 0.6in. which effectively locates the tool slot in the toolblock. The toolblock drawings provided are for copper alloys, medium carbon steels and for a zero rake block for screwcutting or experimental work.

I would point out that the toolpoint datum is set relative to measurements taken from my 9in. South Bend; i.e. the centre height and compound slide height. Any other lathe (except the 10in. South Bend) would probably require adjustment to the 0.139in. depth of the toolblock platform. (Item 9 on Fig 7.) To facilitate this adjustment I have included a set of

Fabrication

Dimensional tolerances are not shown on the drawings because fits and clearances are not critical to function provided they are appropriate. A modeller can decide in the workshop how close he wants to work to nominal dimensions. One dimension that should be treated with care is the 60 degree angle of the reference faces in item 9 which define the screwcutting setting. It should also be borne in mind that the range of tool centre height adjustment is limited by the ramp dimensions (on **Fig 2** and **Fig 10**) and this limits the tolerance accumulation available for a convenient range of centre height

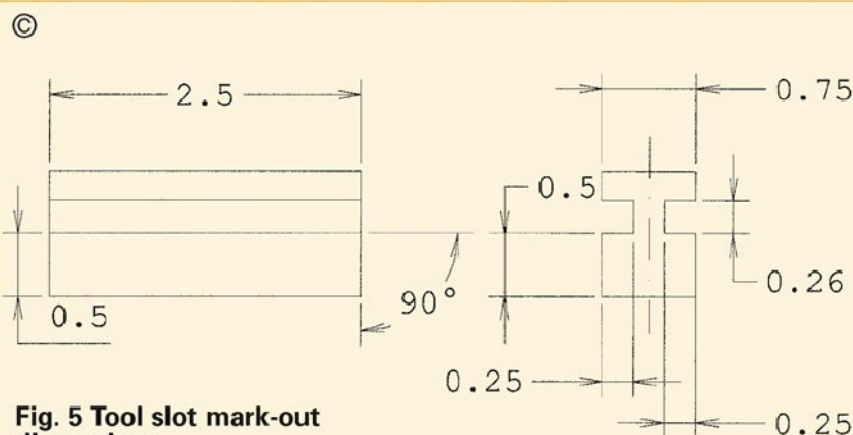


Fig. 5 Tool slot mark-out dimensions

Screwcutting application
1/4 inch square toolbit

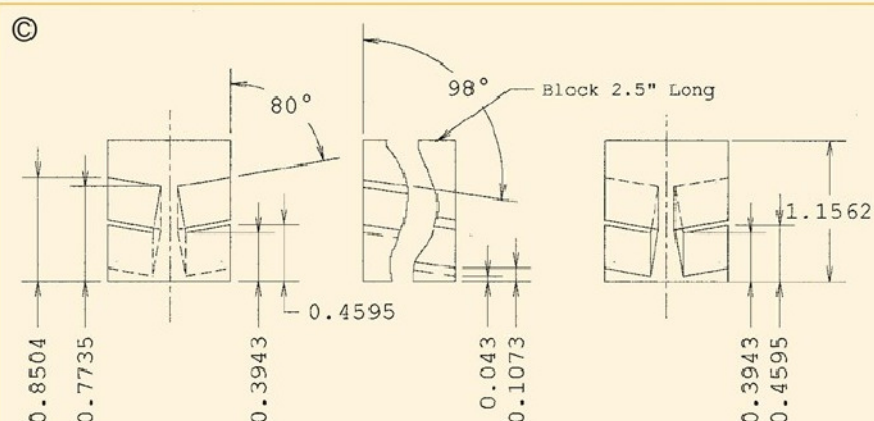


Fig. 6 Tool slot mark-out dimensions

Medium carbon steel application
3/8 inch square toolbit

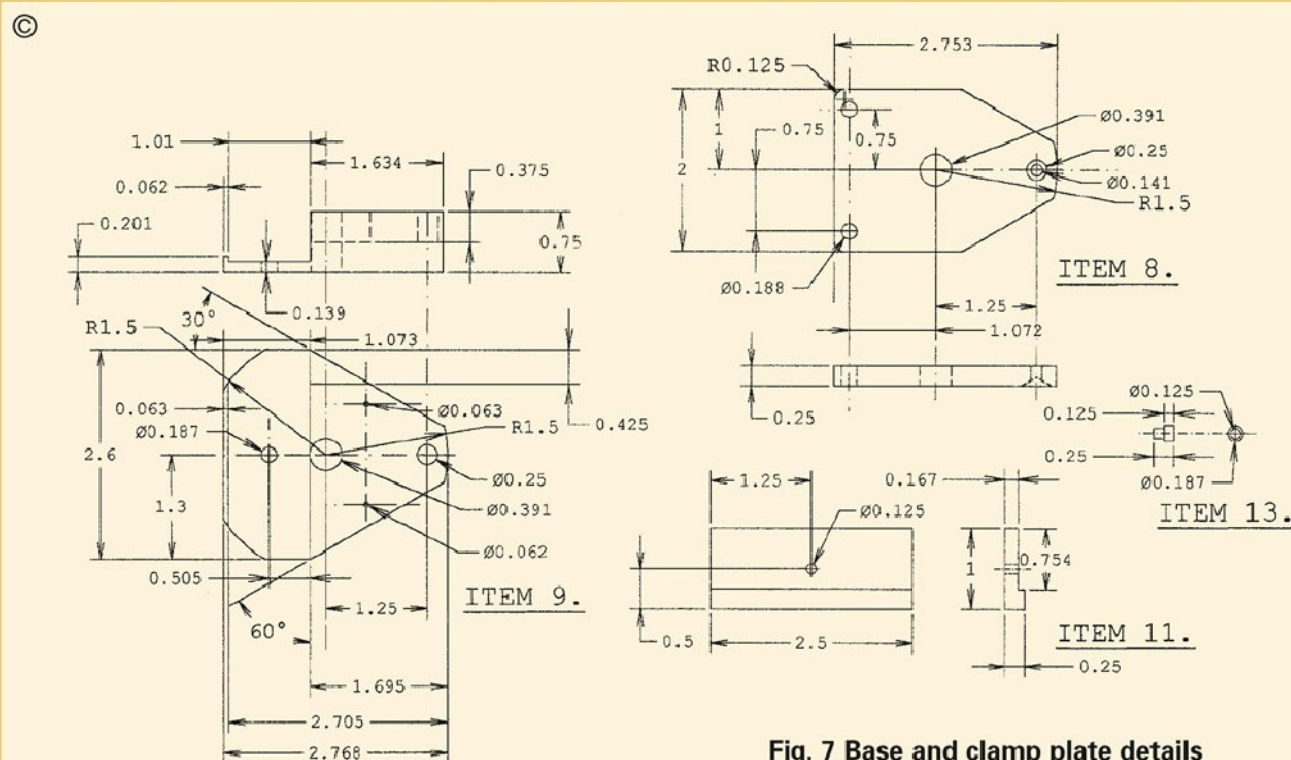


Fig. 7 Base and clamp plate details

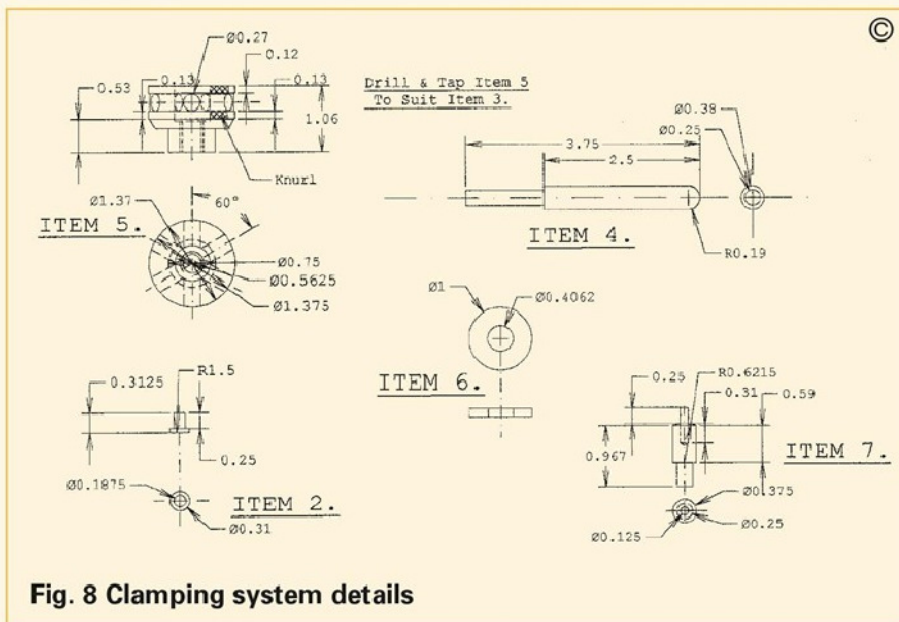


Fig. 8 Clamping system details

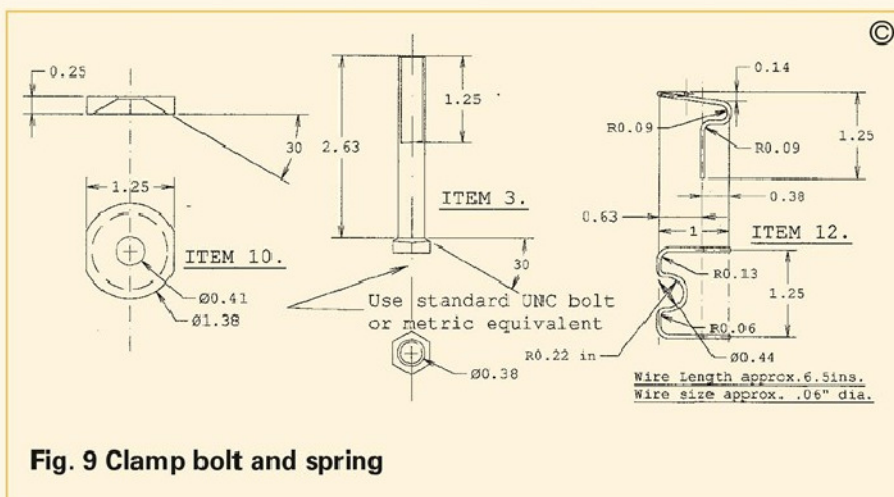


Fig. 9 Clamp bolt and spring

adjustment. I suggest working within a plus or minus 0.003in. range.

Probably the most challenging component is the tool tip elevating screw, (Fig10) which requires careful planning to produce the several diameters, the screwed portion and the axial locating groove on this rather slender component

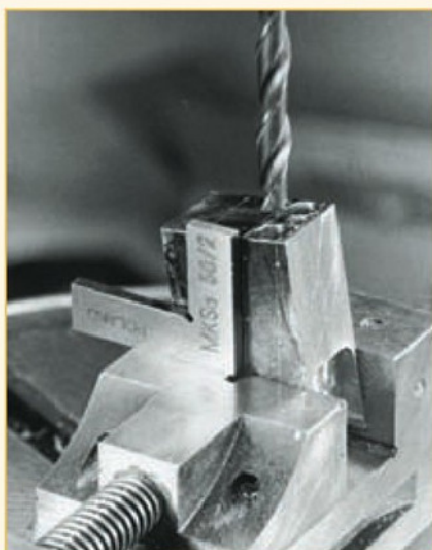
(photos 1, 2 and 3). My method is to work progressively along the workpiece, reducing each diameter in turn for the shortest practical length to retain maximum stiffness as work progresses. A tailstock centre is also necessary for support, particularly when cutting the screwed portion.

In preparation of "sculptured" pieces like the toolpost base, the toolblocks and the ramp blocks, marking-out is a skill to be exercised carefully. Precise marking-out to provide cutting guides and setting lines for clamping in the angle milling vice or even on a sine table is an important requirement. I personally make great use of scribed lines as a check on any setting before making a cut. **Photos 4, 5, and 6** show preparation of the toolpost base item 9. **Photo 7** shows the marking out of a ramp block by setting it up in the finished ramp pocket.

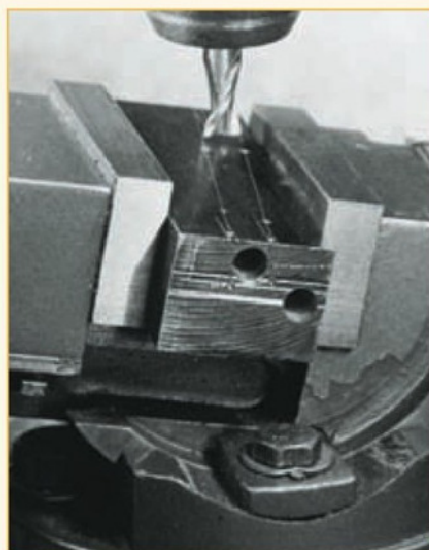
The main body and the toolblocks require a significant volume of metal removal to prepare the toolblock locating groove and the toolbit slots. I try to minimise the amount to be removed by the milling cutters by drilling out as much material as possible. It is a good exercise in precise drilling and saves a good deal of wear on expensive end mills. I find it much easier and cheaper to sharpen twist drills than milling cutters! **Photos 8 and 9** show a toolblock in preparation for drilling, firstly setting the block end surface horizontal for centre drilling and then setting the block at the back rake angle for through drilling. **Photo 10** shows completion of the drilling process for a double slotted block.

Aligning the tool slot at it's correct compound angle for milling is a little tricky. I find that the spirit level in the protractor head of my combination square is quite sensitive enough to make the setting which I check before machining by traversing the endmill along the scribed markout line as in **photo 11**. Use a feeler gauge to check the run of the cutter edge along the line. **Photo 12** shows slot milling in process. Of course, if you really enjoy hand crafting you could saw, chisel and file to finish after drilling! Or a shaper could be used for the whole process.

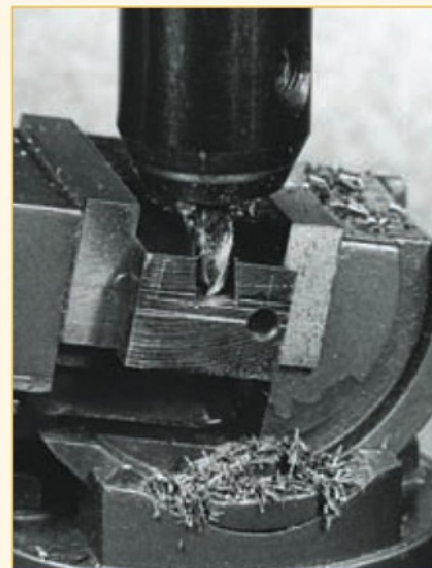
One dimension that is fairly critical is the 60 degree angular dimension of the thread angle setting surfaces on item 9 and their angular relationship to the toolblock locating surfaces. This affects the precision of setting the tooltip alignment when screwcutting. I found that this requirement was easily satisfied by the straightforward end milling methods described, **photo 13**, followed by a minor



10. Tool slot drilling completed in double sided toolblock.



11. Checking compound angle setting for milling of tool slot



12. Tool slot milling in progress.

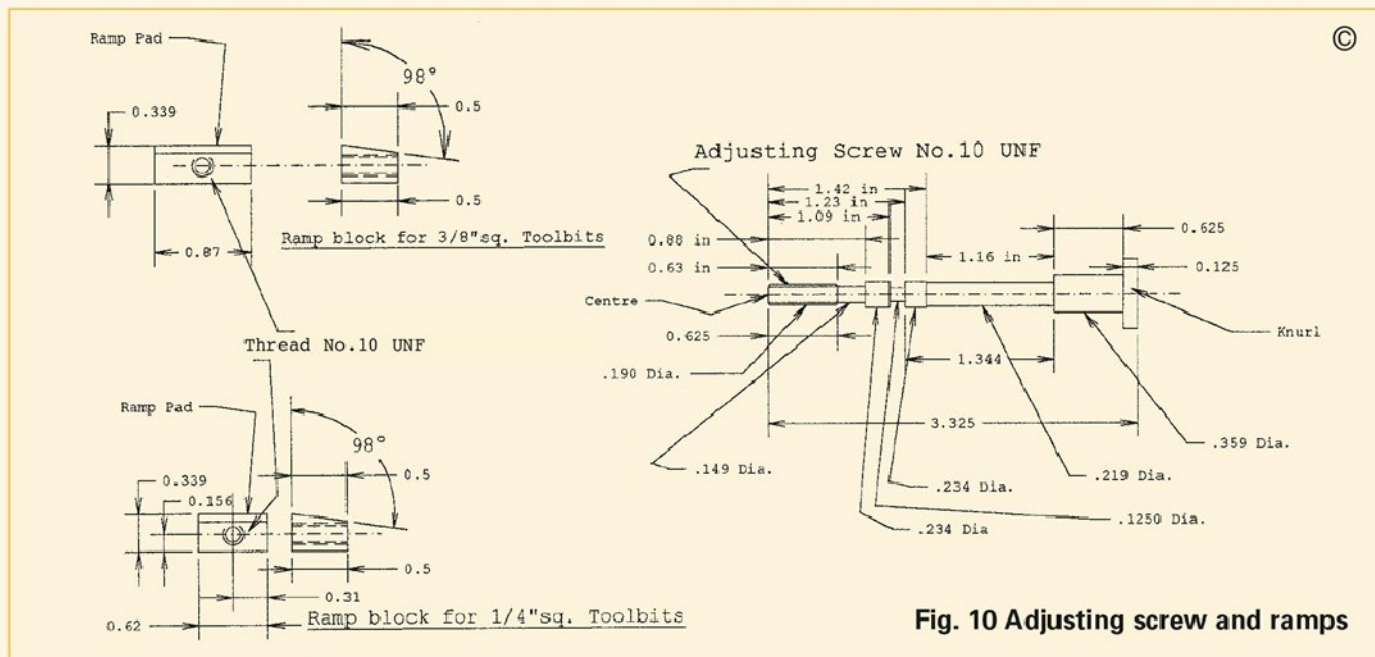


Fig. 10 Adjusting screw and ramps

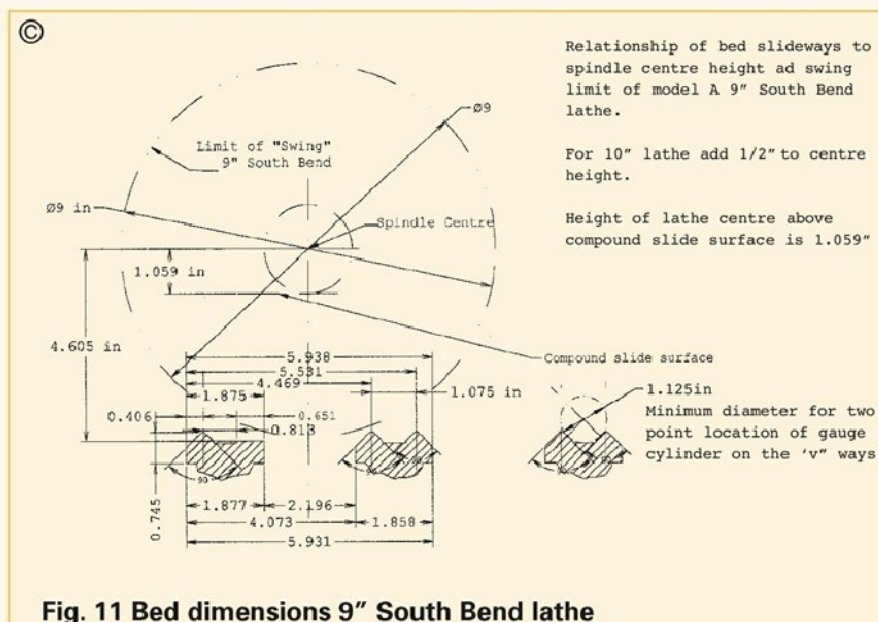


Fig. 11 Bed dimensions 9" South Bend lathe

adjustment with file and scraper. For checking angles when filing or scraping I always use a precision vernier protractor. To ensure that toolblock changes are quick and easy I provide a spring support, (item 12) for the toolblock clamping plate (item 8). The spring dimensions are shown in detail but some adjustment to ensure effective operation may be necessary.

Assembly of a toolblock

Ensure that the ramp blocks (Fig 10) are a comfortable slide fit and are well bedded over their whole width in the ramp pockets in the base of the toolblocks. Assemble the elevating screw (Fig 10) into the toolblocks checking that the axial locating groove aligns satisfactorily with the $\frac{1}{16}$ in. driving pin holes. Fit the pins, one each side. Make sure the adjusting screw rotates freely with a small clearance under the head. Lock the pins by centre punching around the hole or by some other appropriate method such as Loctite.

Finally draw the ramp block into it's slot noting that clearance in the screw hole allows for vertical movement of the ramp, screw and block during tool tip height adjustment. The toolblock is now complete.

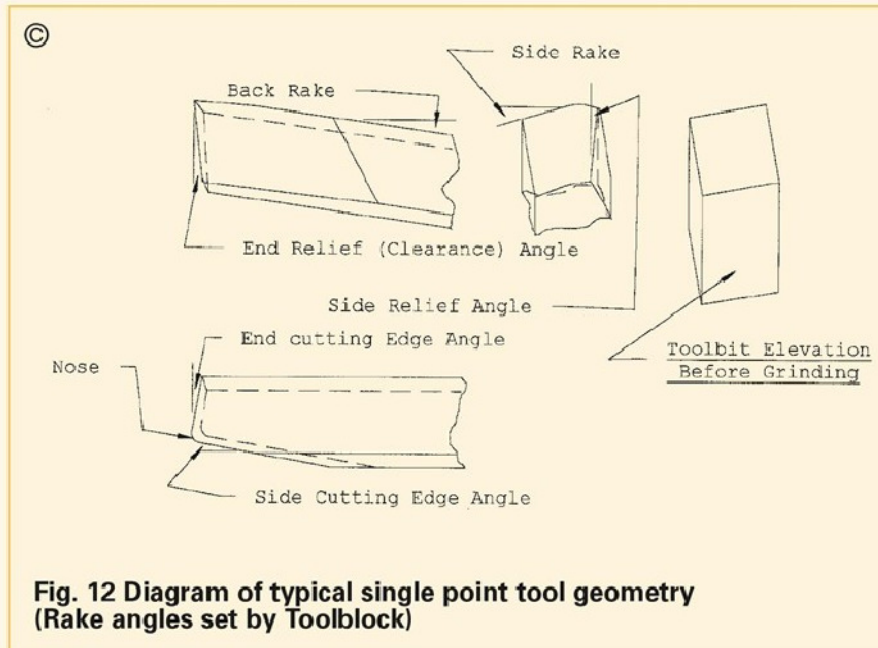
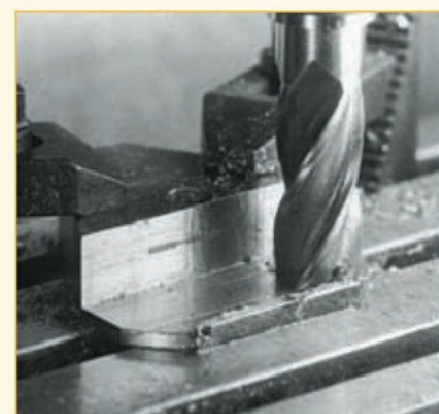


Fig. 12 Diagram of typical single point tool geometry (Rake angles set by Toolblock)



13. Endmilling item 9 to form toolblock locating surfaces.



14. A set of toolpost components.

Assembly of the toolpost

Photo 14 illustrates a set of components. The general arrangement drawing (Fig 1) is self explanatory and few comments are required. For easy and quick operation the spring (item 12) should be made as close to drawing detail as possible and then adjusted to support and balance the clamp plate (item 8). The clamp bolt (item 3) should be connected to it's articulated head plate (item 10) by means of a roll pin or similar to facilitate handling and prevent rotation.

Set-up for cylindrical turning (Photo 15)

Since the toolpost base can be rotated through 360 degrees the toolblock can be set up right or left of the clamp bolt. This provides facility for working close up to the tailstock centre on the right or to the chuck jaws on the left.

Set-up for screw cutting

For convenience in setting the toolpost base on the compound slide to the correct thread angle, setting or datum surfaces angled at 30/60 degrees have been provided on the toolpost base. To take full advantage of this facility a setting line or lines is required on the top surface of the compound slide, (photo 16). To scribe these lines set the compound slide at your preferred screwcutting feed angle (I use about 29 degrees to clean up the flank of the thread as cutting proceeds), install a scriber either in the chuck or a tailstock fixture so that a line can be scribed on the compound rest surface as the saddle is traversed under the scriber point.

Alternatively set up the toolpost with the screwcutting bit, (photo 17), using a conventional centre gauge against a workpiece in the chuck, the setting lines then being scribed on the compound slide top surface using the setting surfaces of item 9 as a guide. Use a mark out fluid on the compound slide for better delineation. Place a light centre punch mark near each end of the line for easier location of the line then scribe heavily over the original line.

When preparing to cut a thread set the base datum surface to this line to provide correct orientation of the tool tip. The setting line is indicated in photo 17.



15. Setup for cylindrical turning.



17. Setup for marking datum lines on compound slide.



16. Screwcutting datum lines on compound slide face.



18. Jig used to generate 60 degree toolpoint on screwcutting toolbit.

Tool grinding

One of the objectives and merits of the toolblock system is that the rake surface angle is set permanently by the toolblock and does not require regrinding. The cutting edges are re-sharpened by grinding only the clearance or relief surfaces. A good procedure is to use a surface generating method by means of a simple jig and guide plate system I have developed, (photo 18). The illustration is of a 60 degree screwcutting tooltip. This method is quite precise but a person can easily grind off the ends of his fingers at the same time! A colleague of mine, Ted Wale devised and built a tool grinding jig, featured in issues 83 and 84 of MEW, which may well overcome this problem.

The toolpost in use

The toolpost is conventional in use except for it's increased speed and convenience and needs little comment. Clamping of the toolbit in the tool slot by means of the

No.10ANF set screws should be reasonably tight to ensure that the clamping load applied by the clamp plate (item 8) is effectively transferred to the toolbit and through the toolpost base (item 9) to the compound slide casting. I have found that I can clamp the toolblock quite tightly enough by hand using the knurled nut (item 5) even though provision has been made for a tommy bar. A typical set of toolblocks is shown in photo 19.

Conclusion

Although there are many alternative systems available for holding a toolbit, I have found this to be the most precise, convenient, rigid and fast operating of any I've tried on a small lathe. It has the further convenience of providing a top rake almost unaffected by re-sharpening and has the simplicity of sharpening or regrinding the cutting edges by regenerating the just the clearance faces using a simple hand held jig on the shop grindstone platen.



19. A typical set of toolblocks.

THE CHESTER 626 TURRET MILL



1. Time for a "cuppa" and a sulk

Jack Cox samples the delights of added capacity for the workshop.

the machine and start playing with it immediately after delivery, it's a bit shattering. The delivery man had other things to do, and left fairly smartly, leaving me to my own devices. Fortunately, a very beefy friend and neighbour, who also happens to be a professional mechanical engineer, lifted the stand off the machine case (by himself), thus allowing me to remove the packing-case surrounding the machine. On completion of this exercise, with a very heavy machine sitting in the middle of my garage floor, and my normally cosseted MGB sitting outside, I decided that I was having a nightmare, and sat in front of the machine and sulked for a while, hoping that I would soon wake up (Photo. 1).

Background

Having just taken delivery of a brand-new Chester 626 Turret Mill, after thirty-four years doing my best with vertical slides on my Myford ML7 and Super-7 lathes, I'm beginning to wonder how I managed without this beautiful piece of engineering dominating my workshop, and which I am currently drooling over. But I'm jumping the gun a little, it wasn't all sweetness and light to begin with.

I am in the fortunate position of having knowledgeable friends, who were able to advise me about the attributes a good general-purpose machine should have, for example, a head that would swing and tilt, a knee with a large vertical movement in addition to the normal lever 'drilling' facility, and a sensibly long travel on its horizontal slides. This disposed of a few of the smaller devices I'd been idly looking at (and contemptuously dismissed as 'toys' by my advisers, but no doubt ideal for the worker in smaller scales), and finally settled me on the Chester machine, which, in addition to the foregoing attributes, had the facility of a graduated handwheel on the quill which could be engaged as desired as a fine vertical feed. Despite being mentally a little intimidated by the stated size of the machine, I duly ordered a 626 by telephone. The guys up there were very friendly and helpful, but didn't tell me (because I didn't ask, I daresay), that there was a bit of a difference between 'delivery' and 'installation'. Needless to say, I'd mentally expected the latter.

Delivery...

The machine duly turned up on the day, in the charge of one guy with a kind of manually-operated fork-lift device. Unfortunately, due to a fairly recent spot of major surgery, I couldn't be of much assistance, but finally we managed to get the thing up the driveway and into my garage / workshop, where I had my first chance to contemplate my purchase, well, the packing cases anyway. My first shock was when I noticed that, rather than the machine being on its stand, the stand was sitting on top of the machine. Now all this is very sensible when one thinks about it but, to the goof who expects to walk up to

...and Installation

By pure coincidence, I had a 'phone call from our editor on another matter and, during conversation, mentioned my predicament. It was he who advised me on getting hold of a 'garage or engine crane' to get the job done. This was a new one on me, I'd never heard of such a device. It turned out however, that another good friend of mine, who also happens to be a car technician, actually owned one. More or less at a stroke, my problems disappeared, via the capable hands of three good mates and one garage crane (Photo. 2). From then on it was the pure pleasure of playing with a brand-new machine (Photo. 3).



2. Many hands (and a garage crane) make light work

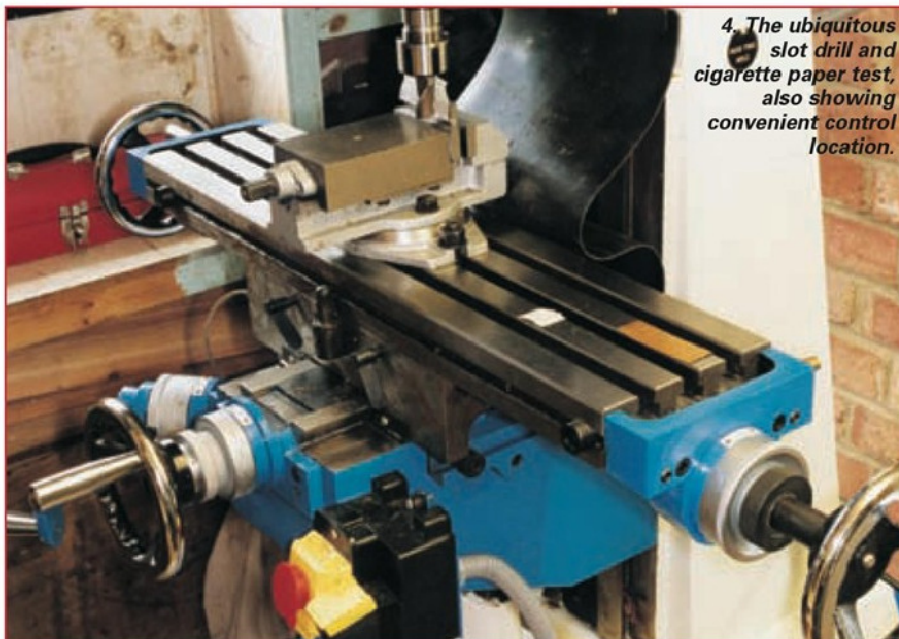


3. It's the next best thing to Christmas

Accuracy

Although an electronics engineer (retired) by profession, I have always had an interest in mechanical engineering and workshop practice and, with the equipment at my disposal, was able to check out the machine reasonably comprehensively.

One of the trickiest checks perhaps is that of spindle run-out, largely because it is somewhat indirect, i.e. bung a ground bar of known diameter into a collet and check that. All very well if the bar is dead straight along its length; not so good if one can see flashes of daylight when it's rolled across a surface plate (which is what happened with all the silver steel rod in my collection). I preferred to put the probe of my Verdict (which is graduated in half-thou's and, due to its dial size can be read to tenths reasonably well) into the tapered bore of the R8 collet chuck and check that. Answer: 0.0007in. Total Indicated Reading. OK by me. There is of course another test which may be performed to similar effect, that of milling a smooth parallel surface with the flank of a slot drill, and then using the ubiquitous Mark.1 cigarette paper on each cutting edge of the slot drill in turn (Photos. 4 and 5). Although less accurate than a clock reading I suppose, it is nevertheless good to see (and hear) both edges in contact with the work, and after all, that's what it's all about. I was highly impressed with the 0.0002in. reading I got over the entire 14½in. available longitudinal movement and the 6in. crosswise movement, and even more so with the 'rotational' reading (Photo. 6), as the machine has a tilting head facility, and I expected to have to fool around with this a little bit to get the column dead perpendicular to the bed, but clearly, the guys at Chester had done this for me. Incidentally, the bronze shim in the photograph is only to allow the dial indicator to bridge the gaps; all readings were taken direct on the bed. The vertical movements of the quill and the knee were very difficult to check accurately, largely due to the necessarily indirect methods needed (i.e. something fairly long held in the collet, and which got in the way of the



4. The ubiquitous slot drill and cigarette paper test, also showing convenient control location.

knee movement). I persuaded myself that I had about 0.0005in. on the quill and 0.001in. over the full travel of the knee, but I wouldn't argue the point. In any case, all-in-all, I was, and still am, well pleased with the machine. The speed-change system on the drive belts (Photo. 7) is really rather neat, including a lockable spring-loaded plunger arrangement which is difficult to describe but readily understood once seen and used.

The imperfections

That's not to say that there aren't a couple of 'naughties' here and there. Perhaps the worst was that the R8 sleeves (two of 'em, one for a drill chuck and one for a collet set) were extremely stiff in the bore of the spindle, and had to be really wound in and given a fair clout to get them out. Being somewhat inexperienced in terms of milling machines (I'd been brought up on Morse tapers, and had never seen an R8 sleeve before, much less used one), I thought this was normal, but fortunately, my experienced advisers were to hand and immediately disabused me of the notion. I ended up putting the sleeves in the lathe and ring-lapping about three-tenths off the diameter of the machined ends. All is now well, the sleeves can be pushed in by hand, and need only a light tap to break the taper on removal (and accuracy has not suffered). Whether the real problem was a slight oversize of the two sleeves, or

a slight 'undersize' inside the bore of the machine, I do not know and in any case, no way was I going to try messing about with the latter! I also had a little problem trying to lock in the top handwheel for fine vertical feed. This is done by means of a knurled knob immediately to the left of the wheel (Photo. 8). Winding it in engages the handwheel, winding it out reverses the process. The knob was decidedly stiff, and I began to believe that there was something wrong, but my rather beefier mate applied a little more grip and sorted matters. Nevertheless the adjustment remains stiff. Slightly worse, is the fact that, when the handwheel is engaged, there is significant vertical backlash in the system, in that, if the handwheel is made to move the quill downwards, and then the hand-lever is operated, there is free movement. This means that, for a fairly stiff action (as mine is), there is a possibility of putting on a feed with the handwheel, and then subsequently getting a little more than one bargained for, and this did happen to me on one occasion. It has to be said that this is a common factor across many machines which feature similar quill down feed arrangements. And on the other hand, with the Chester, it is possible to use the knee control to put on a very fine vertical feed, half a 'thou at a time if need be, and, due to the weight of



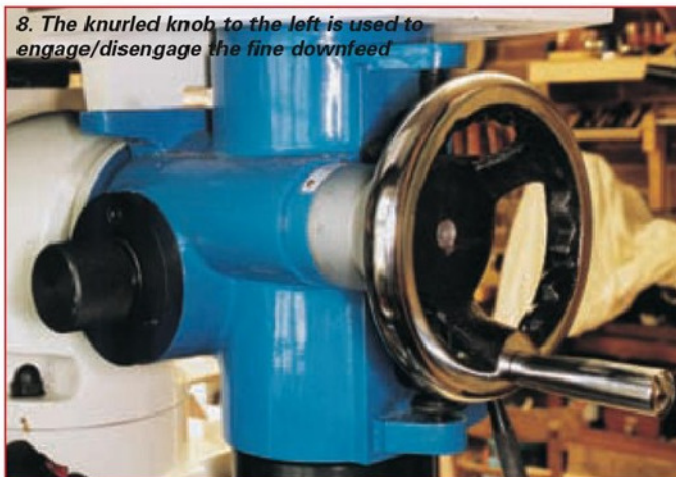
5. Close up of the R8 test



6. Checking squareness of head.



7. Belt changing is easy, and the guard includes safety cut out



8. The knurled knob to the left is used to engage/disengage the fine downfeed



9. The locking lever fouling the casting.

the moving part, one can forget all about backlash. This is in fact the way I have learnt to prefer using the machine for fine vertical setting.

Another small niggle was occasioned by the fact that the top hand lever could not be locked, as the locking lever fouled the column casting (**Photo. 9**), before applying sufficient locking pressure. A bit of head-scratching was necessary here, but eventually the problem was solved by unscrewing the handle, removing the locking bolt, and adding a home-made copper washer to the assembly (**Photo.10**). As a small extra point, the plastic apron protecting the vertical slide was split

slightly on arrival; I mentioned this to Chester over the 'phone, and a replacement arrived almost by return, with no quibble.

The only remaining moan I have is with the handbook. It is a constant source of puzzlement to me that, even for high-quality equipment (of all types) the handbook or instruction manual is poor, to say the least. Much of this seems to stem from the fact that quite a lot of gear comes from the Far East these days, which is generally fair enough as regards the equipment, but can be a bit of a let-down as regards instruction. Much of the problem arises from use of English, e.g.

"the name of the supplier can be found printed on the backside" is the best one I've seen over the years but, more seriously, things can get downright incomprehensible. The 626 handbook does, in places, fit the latter category, in my view, not least because it really ought to answer a lot more (quite reasonable) questions than it does.

Experience to date

Having had the machine in use for just over two weeks, at the time of writing, I have only a couple of fly-cutters and a part-made boring head to show for my learning-curve but, as an example, **Photo.11** shows an angled slitting-saw cut made through one inch square steel, with a beautifully smooth finish, and also allowing use of both resultant halves, despite being attacked from both sides, due to saw diameter. I did mention earlier that the size of the machine bothered me a bit, but I should have remembered that 'big' can also mean 'sturdy' and 'chatter-free' etc.

Being somewhat inexperienced in the use of milling machines, I suppose I ought to admit that my opinions aren't necessarily worth all that much, although I have used my two metalworking lathes for milling and gear-cutting operations for many years. However, I do have a couple of friends, both of whom have extensive toolroom experience of all types, and their views on the machine coincide with mine. On balance, I consider it to be very good value for money, and I am personally well pleased with my purchase.



10. Adding a washer effected a simple cure.



11. The piece of 1 inch square steel sliced from both sides

BENCH PROJECT

Pat Addy casts an eye over industrial kit, and suggests a quick assembly approach.



1. Bench frame for 10ft. bench from standard materials

Problem and Solution

Good benches are the basis of any workshop. They need to be strong and rigid. The traditional woodworkers bench is made of good quality timber and obtains its strength and rigidity through its mass and joints. This makes it expensive, heavy to move and impossible or at the least time consuming to disassemble. Many workshops are dual or multi purpose e.g. they share space with the family car. There is also the thought in these days of conservation that maybe good quality timber should not be used on an item that is basically utilitarian. Man made products possibly have a lesser impact on the planets resources. The following outlines a project that is economical, uses mainly man made products, stores easily and can be assembled and disassembled in a matter of minutes. Above all it is strong, rigid, versatile and can be easily modified as needs change.

The original use of this product came about because of an urgent need for an extra 100 metres of bench space in an engineering factory. Some of the benches needed to be lower than the standard bench height. The existing benches were of welded 2in. steel tube, which were good but also expensive, made to order hence a

time delay, heavy and difficult in a move.

The solution was to use standard industrial racking. This is readily available both new and second hand. The second hand cost is relatively low and the product with a little thought is extremely adaptable. The racking is extremely strong and is capable of supporting many tons.

The original benches were frames with standard kitchen counter top fitted. This gave benches of 10 feet in length. The only tools needed to assemble the frames were a hacksaw, two spanners, a screwdriver and a drill.

Description

The racking verticals have holes spaced on a 3in. centre therefore the height adjustment is easy. When not in use the units can be disassembled to two end frames, three or four cross rails and a top. Weight, except for the top, which will depend on the material used, is fairly low so could be transported to a remote site easily. An average end frame weighs less than 20lb. Assembly time for the end frames and cross rails is probably two minutes and involves no tools. The product allows for a continuous run of benches to be made. Anyone with youngsters who are interested in woodworking or engineering could produce a bench of the correct height, which could grow by two inches using the normal leveling techniques, and then by any amount by replacing the four uprights. All other parts would be reused. It takes about twenty minutes to assemble a pair of ends from cut and drilled material.

As can be seen from photo 2 cutting end frames to an appropriate height is quite straightforward, and from there on, assembly/dismantling requires just the spanners for the lock bolts. Photo 3 illustrates a set of non scratch nylon feet made to avoid damage to a delicate floor. These are also visible in photo 1.

I have used the concept to make the following list of items:

1. Benches
2. Drill stand.
3. Circular saw table with side extensions which can be fitted and aligned within a few minutes.
4. Router table.
5. OHS stand
6. Band saw stand.
7. Chop saw stand - this is similar to the OHS stand.
8. Belt sander stand
9. Portable thicknesser stand with height adjustable, extended in feed and out feed tables.
10. Dovetail jig stand with raised back table to support longer pieces of timber.

By using brackets made from angle or solid material, it is also quite



2. Details of locking ends and hole for lock bolt

straightforward to include under-bench additions such as suspended cupboards or tool cabinets. If it is required to arrange height adjustment within the three inch increments, this is also easy to incorporate using brackets and screwed feet.

Other creations have included more obscure items such as stands for plastering, stands for decorating and a barbecue stand. Currently I am designing a full sheet (8ft. x 4ft.) panel saw around the racking. Again, this needs to be easily dismantled for storage and transport.

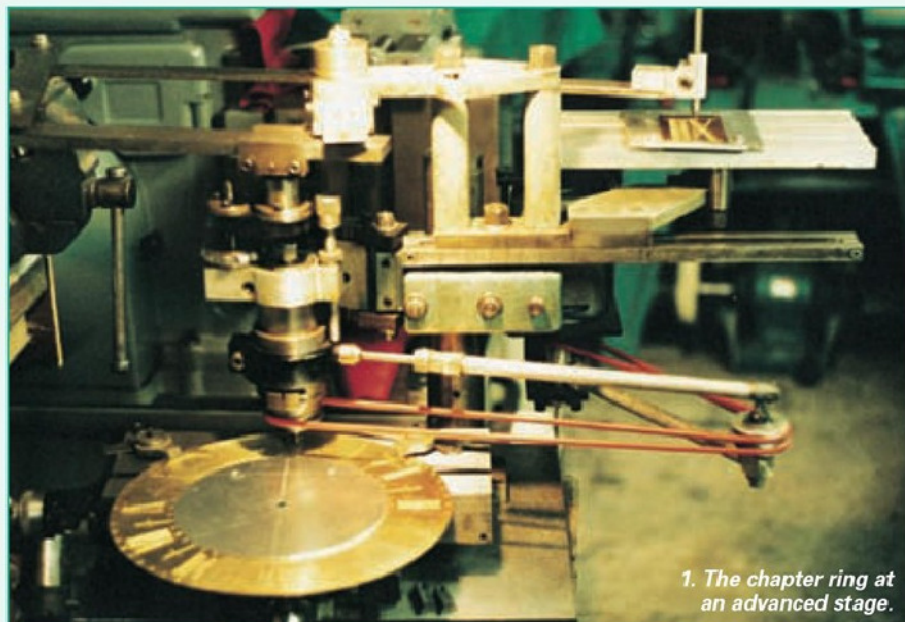


3. Fabricated non scratch nylon feet



4. 'On site use for two end frames and two horizontal rails to give a 9in. lift by 10ft. long temporary platform for a plastering job

ENGRAVING ROMAN NUMERALS



1. The chapter ring at an advanced stage.

Background

My interest in engraving machines began many years ago when I lived in Lancashire and an old friend named Dave Burton who owned a precision engineering works in the Blackpool area showed me a machine his father had made, together with copy produced with the assistance of 3in. letters and numerals fabricated from $\frac{1}{8}$ in. welding rods, half submerged in Plaster of Paris. Once the plaster had set, the metal was removed and the remaining indentations guided the machine's stylus to engrave permanent $\frac{1}{8}$ in. copy in brass using a 4/1 ratio.

A primitive and unsuccessful attempt to replicate this machine did not destroy my interest, and it was not until several years later that I read a series of articles in *Model Engineer* by Mr. D. J. Unwin. In them I found a detailed and dimensioned description of an Engraver he designed to attach to the overarm of his horizontal miller, thereby using its compound slides. I modified his design and made a self contained machine with its own compound table, taking the precaution of using multiple ballraces at every joint to ensure minimum friction and to eliminate free play.

Copy in brass and nylon is available in a staggering variety of styles and armed with a small supply of taper shank cutters which I sharpen on a small grinding machine I made and dedicated solely for this purpose, the machine has for years and years produced work indistinguishable from that available commercially.

The project in hand

My current project is the construction of a long case or grandfather clock, and as the movement was completed and placed on test, my thoughts turned to the difficulties of making a presentable chapter ring (the circle with hour numerals for these uninterested in clocks). Whilst there are various ways of doing this on the lathe, and it may also be noted that beautifully etched and silvered rings can be purchased very reasonably, my thoughts turned to the possibility of using my engraver.

The problems I faced were threefold. Firstly as my Roman figures needed to be

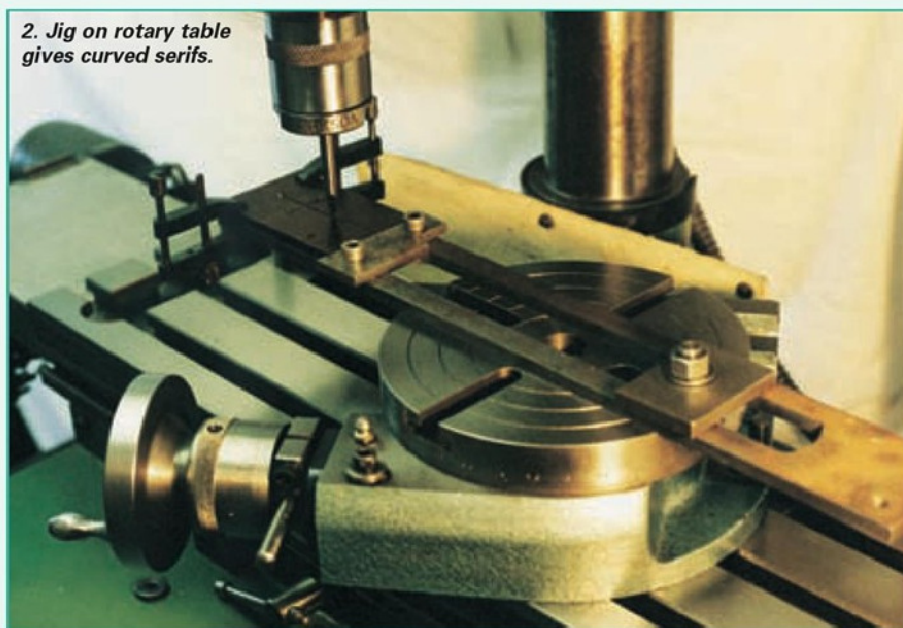
John Crammond talks us through his technique.

1.25in. high, I would need copy at least 2.5in. tall using a 2/1 reduction. Engraving with a 1/1 ratio is a practice I find unpleasant as there is no mechanical advantage, and the pressure needed to guide the stylus increases the danger of jumping out of the grooves in the copy. Secondly Roman numeral copy is not to my knowledge commercially available and although engraving suppliers will make whatever you want, to special order, I'm sure the set that I needed would be prohibitively expensive. Lastly there was the problem of what to make my copy out of. Brass is ideal but expensive, aluminium a possibility, even hard wood such as apple or pear was considered, but as I had a supply of paxolin, 2in. wide 5mm thick in three foot lengths, I decided to use this, bearing in mind that it is a laminated substance, so that the hazard of dust must be taken seriously.

Geometry

Roman numerals when used on clock faces are usually compressed sideways otherwise there would be very little space between some of them, and I settled on thick strokes of $\frac{1}{8}$ in. width with a gap of $\frac{1}{8}$ in. between them where required. The included angle of the V was to be 18degrees, and the strokes of the X would cross at 30deg. So with the basic dimensions decided and bearing in mind that the copy needed to be twice the eventual engraved size, 12 blanks 2in. wide and 3.25in. long were marked out with the numeral outlines, and the centre lines of

2. Jig on rotary table gives curved serifs.

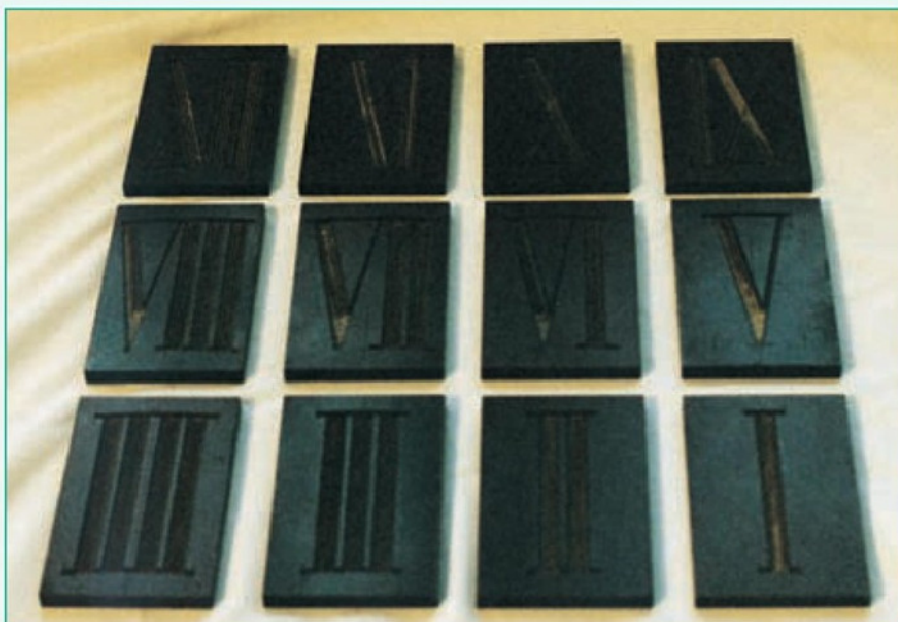
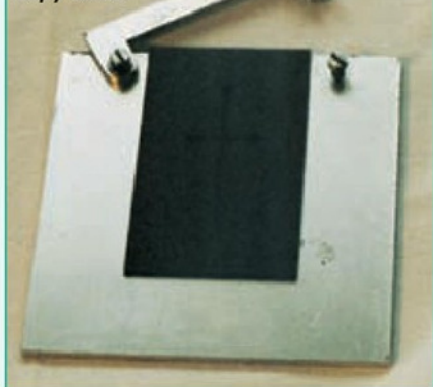


each blank scribed together with the positions of top and bottom serifs. These positions must be identical on each blank to simplify the eventual engraving on brass. Isn't it ironic how far removed we get from our original goals with the production of jigs and fixtures. I now found myself having to make a jig to hold the blanks to make the copy to cut the numerals. Phew, have I missed anything? A slight complication arose in that the serifs were not straight lines but curved to the radius of their positions on the Chapter Ring, so I decided to mount the jig on a rotary table as shown in **photo 2**.

Method

To produce a numeral a blank is placed in the jig which simply consists of a length of 2in. x 0.25in. bright steel with a ledge bolted at right angles and against which a blank is located and held firmly with two small toolmakers clamps. The jig is set to the required radius on the rotary table and the long side of the blank set parallel to the X axis of the milling machine using a dial indicator. The rotary table's micrometer dial is set to zero, and with the aid of the mill's compound table locate the cutter (for which purpose I used a 60deg. included engraving cutter) on the blank centre line at the position of the top serif; lock the X & Y table movements and rotate the jig to a starting point of the top serif. Lower the cutter to penetrate 0.060in. and using the rotary table only traverse to the finishing point. Lift the cutter and zero the rotary table again. Remember to zero from the same direction each time, otherwise due to the minute clearances between worm and wheel you will get tiny angular discrepancies which will spoil the copy and consequently any work produced from it. Unlock the X axis table movement and relocate to the bottom serif where you repeat the operation. With the rotary table again zeroed move the lifted cutter to over the starting point of a long stroke using X and Y movement, and proceed to cut from top to bottom serifs using of course the X lead screw, being extra careful not to compromise either serif. For the wide strokes $\frac{1}{16}$ in. on the chapter ring will require $\frac{1}{16}$ in. on the copy, so four traverses of 0.060in. will give you the required width and leave narrow troughs for the stylus to follow. Vs & Xs are done in a similar fashion. Be careful with the angular settings of the rotary table. I chose to cut the thin lines first on the Vs and last on the Xs. You'll soon get the idea and the pile of

4. A simple holder to clamp to the copy table



3. Set of copy numerals at twice size.

completed numerals will quickly grow, as shown in **photo 3**.

As almost all engraving machine copy tables are designed to accommodate 1.25in. copy a simple holder as depicted in one of the **photo 4** will be needed to clamp to the engravers copy table. Mine was made in a few minutes out of $\frac{1}{16}$ in. alloy. It helps to keep everything square as it can then be positioned easily with the aid of a square against the edge of the copy table. The heading photo shows engraving nearing completion on the Chapter ring, and **photo 5** the end result before graining waxing and silvering.

Unforeseen problems

You may think that the actual engraving went without a hitch. Not so. I took the precaution of trying out the copy on one or two pieces of scrap brass first, and found that on the wide strokes very thin tram lines at full height were left between the multiple grooves which would have shown through the wax filling. This was due to my own carelessness in not checking the tables of cutter depths and widths. The problem could have been easily resolved by using a wider cutter. However I wanted to avoid the need to be constantly changing cutters and decided to remove the tram lines by slight movements of the engraving machine's own table, remembering of course to return to the original setting at the completion of each wide stroke.

My second discovery was that paxolin was not a good choice for copy material, as the sides of the four grooves in the wide strokes were quite fragile and great care was needed to ensure that the stylus did not wander off course.

Other applications

Engraving machines are quite versatile and as a result of the increasing use of computer controlled varieties capable of producing any kind of script programmed on their discs, old fashioned machines

using separate copy are now appearing quite cheaply on the market. Whilst they are not intended for heavy work, within reason they will faithfully reproduce whatever you have copy for. Good examples are the cam covers of a V8 BRM engine once made by a very well known engineer which he showed me on one of his visits to the Lake District. He proudly informed me that they had just been made on Tony Walshaw's machine; many of you will know of Mr. Walshaw as a wonderfully gifted engineer responsible for superb Merlin engines and many other breathtaking examples of his skill. These cam covers were perfect miniatures of the full size ones which I was very familiar with having worked with these engines during the sixties. Engravers are therefore capable of much more than marking cups plaques and dog collars.

I'm sure that most of us have experimented with number and letter stamps, and all of us will have muttered under our breath as despite the greatest care our straight line of letters has somehow gone slightly skew wiff. Engraving machines produce straight lines of lettering of even depth and without the need to flatten down the bruised metal disturbed by punching.

So if you have room in your workshop and a few pounds to spare, have a look round to see what's on offer, alternatively you could make a machine like mine, but do think about it. Engraving is a branch of engineering seldom discussed in our magazines, yet it's end product is to be seen all around us.



5. The end result before graining, waxing, and silvering.

Scribe A Line

Wiley Seipel writes by email:

In the Scribe A Line section of MEW No. 95, Malcolm White mentions that he's having trouble with his knurling. Maybe this will help. When we knurl something, we really aren't concerned much with exact diameters, we're just trying to give ourselves a better surface to hold on to or turn. If we have to fudge a little one way or the other to get those pretty diamonds that we all desire, it won't hurt at all since we're actually extruding the metal and the final size isn't what the print called for anyway.

Knurling is much like gear cutting. We need to have the correct outside diameter for the pitch that we're cutting so that we get the right number of teeth on the gear. To figure the pitch on your knurling wheel, count the actual number of teeth on the wheel and measure the diameter. Now we just figure the circumference using the formula $(\pi \times d)$ and then divide this by the number of teeth on the knurling wheel to give us the pitch. $(\pi \times d)/T$. As an example, if our knurling wheel is 0.75in. diameter, and it has 51 teeth then our pitch for this wheel is $(\pi \times 0.75)/51$ which equals 0.046199892in.

Now we need to figure out how many teeth this knurling wheel will try to cut on our given diameter. Once again we figure the circumference of the piece that were working on using the $(\pi \times d)$ formula, then divide this circumference by the pitch of our knurling wheel to see how many "teeth" this wheel will try to cut on this piece. Let's say we're working with a piece 0.812in. diameter. Using our formula $(\pi \times 0.812)$ for the circumference give us 2.550973235. If we now divide this by our pitch (0.046199892) we see that this knurling wheel will try to cut 55.21599996 teeth on the 0.812in. diameter. This means we're going to get overlap on the knurl and not those pretty diamonds. In order to get those diamonds, we need to reduce the actual diameter of the piece enough to get rid of the partial teeth. That's pretty easy. All we have to do is drop the decimal and figure our diameter to cut 55 teeth.

Back to our circumferential formula, only this time we know how many teeth are

going to be cut on our diameter. We want 55 teeth to be formed by our 0.75in. diameter knurling wheel which has 51 teeth of its own, so the formula is $(55 \times 0.75)/51$. This gives us an actual diameter 0.808823529in. By cutting our piece 0.003in. smaller than the print dimension we have eliminated the partial teeth and prevented the overlap. Now we can have those pretty diamonds every time.

Jim Cox of Grantham, writes: In reply to CE Hartland P51 Dec/Jan Releasing J6 taper

The J6 taper of the No2 Morse taper adapter enters a blind J6 tapered hole in the back of the drill chuck. This part of the drill chuck is not hardened and can easily be drilled through from the front end – a $\frac{1}{16}$ in. hole in this position does not damage or degrade the accuracy of the chuck.

Using this hole the adapter can be driven out directly with a $\frac{1}{16}$ in. dia. drift. However it is much gentler and more effective to hydraulic it out by first filling the cavity with heavy engine oil and then driving a close fitting plunger into the hole with a single heavy blow.

This is more effective than a direct blow because the surface area of the end of the J6 taper is greater than the area of the end of the $\frac{1}{16}$ in. plunger. The ejection force is multiplied by the ratio of these two areas.

Mr R. A. Skinner of Glasgow, writes:

With reference to the question raised by Mr C. E. Hartland in MEW Issue 95, I had a similar problem a couple of years back and give below my solution, as best reconstructed from rather limited diary notes.

The chuck was a quite good second-hand unit but on an arbor of a size that I could not use. There was no significant space at the rear face of the chuck in which to insert conventional chuck

wedges, and the chuck did not overhang significantly beyond the arbor OD to allow a drift to be used through a hole. Therefore, as advocated by Tubal Cain (p. 40 in WSP 12), I drilled through the base of the chuck and tapped this hole M10 for a "jack-out" (forcing) screw. However the M10 Allen grub screw could not release the chuck within what I felt was a reasonable torque for the tapped hole. I therefore packed the cavity within the chuck with thick grease and oil, endeavouring to leave as near to zero air within the space as possible. Screwing in a plain grub screw did not work. However, on wrapping the grub screw with a few turns of PTFE tape moulded in, and then screwing in the grub screw it was able to disengage the chuck, presumably because the PTFE tape was able to reduce the leakage around the grub screw stem enough to allow a sufficiently high pressure to be developed within the grease filling. Whether this acted purely on the opposing end faces, or whether some "pressure seepage" occurred to encourage expansion of the outer taper is not known. I do however understand that a related hydraulic technique has been used in connection with fitting/removing bearings, and on a larger scale with the removal of ships propellers.

I hope something along these lines may be of assistance to other readers.

Editorial note:

We are grateful to a number of other readers who also sent in their suggestions for chuck removal which generally followed the methods published. In particular, Mr L Porter of Chorley, and Mr D Mace of Liverpool

Ted Wale of Nova Scotia writes:

The article by Philip Amos in issue 95 on travel stops has finally prompted me to write about a problem that I see in so many of these things. There have been quite a few articles on these in MEW and ME over the years. I need to set up something along these lines on my 10in. heavy duty Southbend. Now that is a lot of power in the traverse and in the cross slide. Ideally I would like stops in both directions.

The difficulty that has always worried me is that when the carriage approaches the stop one has to stand by to take the drive off and finish the traverse by hand until the carriage gently nestles against the stop. If one doesn't do this then something has to give when the carriage or table reaches the stop and it is going to be something that one does not wish to strain. Anyway the cut goes on even after hitting the stop so the purpose is defeated. Also, when interrupting the cut, there is nearly always a mark on the finish where the traverse has been interrupted in going from power feed to manual feed. There is an obvious solution when the lathe has a power trip button and I saw one of these stop trip systems written up. (That is fine- if it is repeatable).

On my 6in. Atlas I fixed micro-switches on a bar across the front of the bed very similar to photo #3 in Philip Amos' article and I use them to trip a power relay in the



Don Bonny of Harvey, Western Australia, writes:

I enjoy reading MEW with articles by Bob Loader on how to beat the system and of times gone by, also the photos of models made by people with skills I could never hope to achieve. My hobby is restoring stationary engines (barn engines) which need new parts made, but not to micron tolerances. To lift these engines and fly wheels I have made a floor crane from scrap with a safety winch. The accompanying photos give the general impression. This may be old hat to many, but was used on some agricultural machinery in W.A. and works well. The idea is shown in photos, and the key mechanical feature is that the handle shaft is threaded and when wound up tightens the clutch plates and winds up being held by the ratchet. When the handle is wound out the clutch plates release and the load lowers until the plates tighten on thread and the load is held. In fact you have to wind the load down. The photo shows a rotary hoe suspended. The advantage is the boom does not move, the load lifts in straight line, and no hydraulic leaks. The rotary hoe was given to me in a box of parts less engine. The engine used is a Robin 7hp with a 2:1 reduction which ideally replaces the original Mark 40 Villiers which was 4hp at low revs having a huge 386cc capacity.



With regard to clutches I have used V slip belts for over 50 years and found the system cheap and effective. Being involved with farm machinery all my life this type of clutch is very common in agriculture. I have always wondered why industrial engineers have not used this system more, almost if it is not pure enough. From my first lathe (4 in 50 years) I have always used the V belt clutch. My far east lathe has been adapted for a V belt clutch as single phase motors seem to object to constant turning on and off. The criteria for belt clutches is for the guides to hold the belt the right shape when tension is released. Belt companies will have this information.

motor circuit. This is alright but not accurate as the time for the motor to stop depends on the cut being made at that time. Have other readers any ideas to overcome this problem and produce an accurate, repeatable stop- to be easy to set up would also be nice.

George Winspur writes by email:

Regarding the chuck removal problem aired previously, my own similar chuck was modified as recommended by Duplex by the tapping of an axial thread which allows the chuck to be removed by a forcing screw. Obviously, this was done before the taper shank was fitted but I think it could probably be done now and would solve Mr Hartland's problem. The other aspect of the modification is that the JT end of the taper shank I also tapped in a smaller size so that a retaining screw can be fitted through the chuck.

The main point of this modification, of course, is to guard against the chuck coming off the taper when the drill catches.

None of this helps the perennial problem of scored drill shanks but I am getting better results with the modern type of keyless chuck which I think has carbide

inserts in the jaws. I notice one contributor has fitted a Vertex chuck to his Chester Craftsman. In view of the disadvantage he identifies, however, it wouldn't do for the tapping operation I am suggesting! Are these chucks self-tightening in some way as the corresponding advantage? One type as fitted to a cordless power drill is hand tightened until it clicks whereafter it seems to grip well without further tightening. Another disadvantage is the greater length of the keyless chuck.

Moving forward and reading Peter Foyle's interesting article in issue 96 sent me back to the letter by Mr Campbell to which he referred, to your editorial note to this, to the earlier article you referred to by Peter Rawlinson and to my own index of relevant material.

Mr Campbell asked whether any reader had modified a Myford by the incorporation of a dog clutch as described by Martin Cleeve. I cannot remember anyone having done precisely this but note that in an article in ME 144 3598 at p 1407 Martin Cleeve referred tantalisingly to a prototype single-tooth dog-clutch mechanism he had devised for the Super 7B, the details of which he was unable to divulge!

However, in ME 144 3599 at p 1510 in the course of a long and interesting letter N G Savill pointed out that a simple hand

operated clutch of this type was described by E K Dennis in ME 3222 for 11 April 1963. I can't comment further because I lack this issue but no doubt someone has it and could help Mr Campbell on this point.

Finally, I noted that Martin Cleeve's article also elicited a letter from David Urwick whose Metalmaster incorporated a dog-clutch based on the Exe lathe; coincidentally, the Metalmaster was featured in MEW issue 74, the same issue that contained the article by Peter Rawlinson.

As a general observation, whatever means plain or fancy are adopted for arresting the motion of a screwcutting tool, it seems clear that the amateur's lathe needs some means of stopping the saddle with precision. It is interesting that Myford do not provide this as standard whilst Drummond and others on their more primitive machinery did.

Mr Maurice Gibbs of Grantham writes:

Having read the article in a recent issue of MEW by Bob Margolis concerning the capabilities of the Warco Mini lathe, may I

make a plea on behalf of those who lack the ability to do so, for the more knowledgeable readers of MEW to come forward with designs for useful adjuncts directly tailored to the size and limitations of the machine: such as for dividing purposes; gear cutting, including those for clocks; together with any other items of equipment that would come within its scope.

It is easy enough to suggest that drawing dimensions can be modified to suit any size of machine, but not everyone possesses the confidence to do so, however competent they may be in other matters, and the publication of drawings such as I suggest, would be more than welcome by those who come within this category.

Changing the subject completely, it would be welcome information to many, if someone possessing one of the small vertical mill/drills has succeeded in designing a reliable, easy to make, powered constant rate downfeed mechanism for controlling the spindle movement of their machine, for use when carrying out boring operations etc. and might describe this in the pages of MEW. I am sure that every owner of one of these machines would welcome the advantage of having such a facility with the greatest of pleasure.

Editorial comment:

Machines of far eastern origin have advanced greatly in popularity in recent years, and are therefore in use by a significant proportion of readers. Prospective authors of articles

concerning attachments, modifications etc. for such equipment are most welcome to make contact.

Mr Trevor Deary of Norwich writes:

I would like to make contact with any reader of the magazine who may have worked for one of the big arms companies. For many years I have studied the finishing process known as "Browning". Although I do have written instructions from several arsenals, I have never made contact with anyone who has actually carried out the process.

Several things puzzle me in respect of how this labour intensive treatment was adapted to mass production. If anyone can help, I would be delighted to hear from them.

Harold Hall of Berkhamsted writes:

It was while reading the editor's comments (issue 91 page 11) regarding comparative values of second hand machines, manual v CNC, that I became inclined to write this letter. Several items later also prompted me, but Mr McLatchie's letter (issue 95 page 51) gave me the final push.

Reading that manual mills hold their value better than their CNC counterparts was of little surprise and was prompted to

consider my experience in industry. Pre electronics, users of control systems would reasonably understand their workings and in the event of a failed component would replace it with an alternative to hand. One relay works much like another, even if physically larger and has to be bolted some place else.

Electronics however brought about a major change, printed circuit boards had to be instantly interchangeable with the user carrying stocks of every specific board. Now as we know, computers, televisions, etc., become rapidly obsolete and impossible to get repaired. Industry is also affected in a similar way.

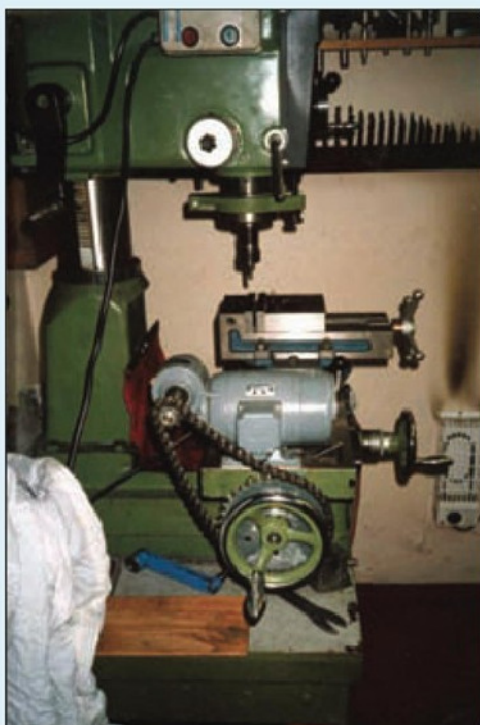
The systems we produced used a multitude of different integrated circuits (IC's) which occasionally one, then another, would cease to be available. If a user of one of our systems had been careless with their spares holding we may find ourselves being asked to provide a spare off the shelf. This initially, we could, but after 15 years probably not. A customer's machine may therefore be shut down just for the sake of an IC costing originally say £10.00. With no interchangeable device available little bits of circuitry were lashed together and hung from the original like Christmas decorations.

Now you may think I am talking of small systems. No! These were large printing machine drives and even larger paper making machines, total motor load, say 3000 KW. Its control system costing some one million pounds and the total cost, machine, building, etc. perhaps 100 million. Now with that situation you would

Jonas Beausang of Sunne, Sweden writes:

The home made self feed shown in the accompanying photos, for a common Taiwanese mill/drill is very simple to make. The only problem may be to find a suitable electric motor. The one I have used is German and marked EMW. Groschopp und Co. It is 70watt and 0 - 90rpm. With wormgear, variable speed, and forward/reverse switching for left right/feed. I thought if could find one then so could you. The photos will convey the information better than the proverbial thousand words.

It doesn't take too much room. I use two sprockets, 9 teeth driving 40 teeth and a motorcycle chain. A bicycle chain would also work. The unit is placed above the left hand feed handle, and has been in use now for around four years. The hand feed may be operated by first slackening off the small sprocket, and this could be an area for improvement, but even in its present form, it works well.



think we could do some arm twisting to get the IC manufacturer to come up with the goods, but no go.

Why am I making these comments, well it is a warning to those who are tempted to purchase machines with complex computerised controls. If you are into modern technology and accept these problems, as we do with our computers, and are reasonably wealthy, then go ahead it is certainly an interesting arm of our hobby. If though you only wish to increase your productivity do tread carefully and ask yourself how long-standing a firm (and their suppliers) are you attempting to do business with and what is their spares policy?

For the many home workshop owners who have no desire to keep up with the times in this way, no fear, you will be in the majority for a long time with manual machines being available for a long time yet. With a little care your machines will still be going strong in 100 years time, an electronic system will probably have gone through at least five reincarnations.

In defence of Mr Mc Latchie's local electronics firm, electronics is a very wide ranging discipline. I for one having been an engineer on the systems above would never dream of attempting to repair the TV.

FINALLY, AND MOST IMPORTANT, if you purchase a piece of complex electronics, either separately or with a machine, do ask for a service manual, or at least a schematic diagram. Requesting someone to fault find on such equipment without one is asking almost the impossible.

Mr C E Hartland of Gillingham writes

Further to my plea for assistance, may I express thanks to all those readers who responded both in print and in letters forwarded to me. The information offered has answered my problems completely. The depth of information, and the ability of some to recall facts from the past are indeed amazing.

Mr David Galer of Bexley writes:

RE - MEW No.95 "Scribe a Line" page 51 "Dragon's Blood"

Mr C E Hartland, of Gillingham, is enquiring about "Dragon's Blood". This reminded me of 50 years ago when I was at The School of Pharmacy studying for my degree. I suspect that the course was still largely based on a pre-war syllabus. It included instruction on the production of pills, which even then were virtually obsolete. Do not be confused with the modern use of the term "pill" it is incorrectly applied to a tablet which is normally produced by compression of granules. The process is very similar to the first stage of sintered glass/metal technology. A pill is made from a mass, similar to dough, which is divided into uniform small pieces; these are then rolled into spheres.

Traditionally pills were coated to give

them more attractive appearance. This usually involved a coating of shellac. I believe that "Dragons Blood" may have been one of the coatings used.

For more detailed information I refer readers to:

- 1 The Extra Pharmacopoeia Vol 1 23rd Edn 1952 Pub. The Pharmaceutical Press
- 2 Textbook of Pharmacognosy by T E Wallis Pub. J&A Churchill 1951 2nd Edn.

These describe Dragon's Blood (Sanguis Draconis) as a resinous secretion on the fruits of *Daemonorops propinquis* and related species. Dull red odourless, tasteless pieces or lumps. Used for colouring varnishes.

I trust that this may be of help. I have no idea from where it might be obtained today.

Mr Jerry Monk writes by email:

May I enlist our readers' help in finding a supplier of "Light Glass", a glass-fibre mat impregnated with premixed resin paste which sets on exposure to UV or sunlight. I bought a tin about four years ago from an outfit called Industrial Tape Solutions up Leeds way, but they have moved and, when tracked down, said they no longer supply it. The tin is remarkably unhelpful, just saying 'Manufactured by Goodville Engineering Ltd.', and a French telephone number. The WWW Web has been no help, and I haven't yet found anyone who speaks French well enough. Light Glass is horribly expensive at about £12 per square foot, but its ability to be moulded into complex shapes and then set in ten minutes, if necessarily masked off into zones, is absolutely invaluable in some circumstances.

My thanks to anyone who can point me in the right direction. My email address is: jerry.m@mail.zetnet.co.uk

Mr John McWilliams writes by email

While I have not yet read through in detail issue 96, I did see a letter on the Denford "Orac" lathe which, when I also saw a report on the ME Exhibition at Sandown by Peter Clark for a micro drilling attachment for a Aciera F1, reminded me that there are other quality lathes in the world other than Myford!

As a fellow user of an F1 (together with Schaublin lathes and milling machines) I wonder if it is not time to seek opinions as to whether owners of such equipment should not start to pool their resources. Aciera have gone (although batches of machines are still made by a small manufacturer) and information about parts, spares etc is probably only held by a relatively small number of us.

I know Peter Clark quite well and perhaps he could be persuaded to share some of his designs with the rest of us through the pages of your magazine. I certainly have a number of the Schaublin and Aciera manuals and a good friend of mine based in the Midlands is probably

the last Schaublin trained engineer in the UK who is still available to sort machines out and provide information. Boley and Leinen equipment probably falls into a similar category. I would be happy to hear from readers with such machines, and if sufficient people appear to have the equipment we might be able to put a website together in order to share knowledge and possibly spares or equipment. I can be contacted by email at john@hobbyhorse.co.uk

Anselm Keogh Writes by email:

This little idea might be of interest to some readers. I made a small extra item for my four jaw chuck - simply a resized T-shaped chuck key. The cross piece is about two inches, the upright about one and a half inches long by 3/16 in. square steel, silver-soldered. I was finding it difficult to use the supplied key when I wanted to adjust the jaw at the back of the chuck because of its long arms, and now find it very useful to use the two keys opposite each other. This gives a better control over the adjusting of the workpiece.

Mr J Jamieson writes by email

I thought other readers might be interested in my experience of making a shell milling cutter for boring the valve passages on an i.c. engine, whilst leaving material for the valve guides. The first attempt was made in silver steel somewhat roughly, the four teeth being cut simply by eye with hacksaw and file. After hardening, tempering and sharpening on a grinder, it was found to clog quickly with swarf, requiring frequent withdrawal. It also lost sharpness quite rapidly. The lessons drawn were that the tooth gaps were too small and too much heat had been applied in tempering.

A second cutter was turned up and again gashed quickly by eye, as before using hacksaw and file, but this time with just two teeth and rather more space for swarf. And to avoid over tempering, this one was hardened but not tempered. First mistake!

This version seemed to cut rather more effectively than the first, and this encouraged increasing the down feed. Second mistake! A loud crack heralded the conversion of the two tooth cutter to a single tooth version, with the crack line following closely a classic 45 degree torsional shear fracture.

After removal and examination the now single tooth cutter was remounted and found to perform even better in terms of actual time to complete a cut. This experience reminded me of the early experiments involving screw propulsion for ships. When part of the multiturn screw fell off, the ship travelled faster.

When making cutters having multiple teeth, sharpening each tooth to a constant projection can present a problem if the spacing (as on these) is not accurately divided out. Opting for a single tooth (more or less a trepanning tool) eliminates the difficulty.

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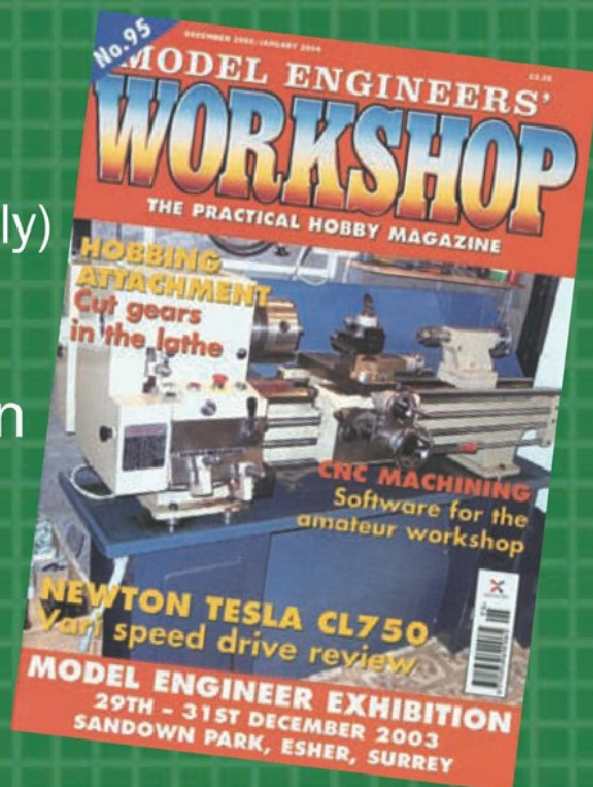
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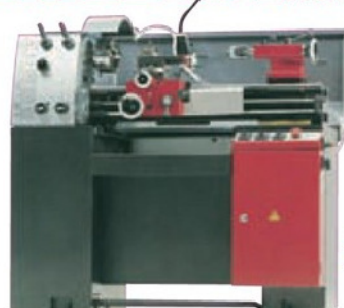
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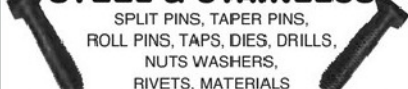
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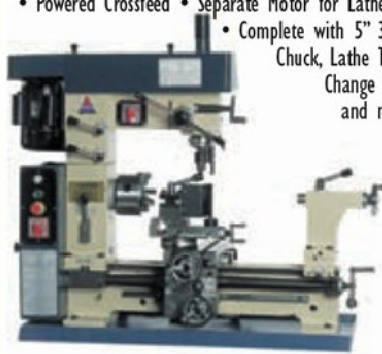
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