No.98

MAY/JUNE 2004

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ISSUE 98

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Published by
HIGHBURY LEISURE Publishing Ltd,
Berwick House, 8-10 Knoll Rise,
Orpington, Kent BR6 0PS
Tel: 01689 887200
Fax: 01689 886666

HIGHBURY LEISURE PUBLISHING LTD
is a Highbury House
Communications plc company

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Polestar (Colchester)

Origination by
Atelier Data Services

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SUBSCRIPTIONS

8 issues UK £28.00, Europe £33.50,
US Airmail $54.00, RoW Airmail £36.00
UK SUBSCRIPTIONS AND BACK ISSUES:
Highbury Leisure Subscription Services, Link House,
8 Bartholomew's Walk,
Ely, Cambridgeshire CB74ZD
Tel: 01353 654422 Fax: 01353 654400
Email: leisure.subs@highbury-wyvern.co.uk
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USA SUBSCRIPTION AGENT:
Wise Owl Worldwide Publications,
5150 Candlewood Street, Suite 1, Lakewood
CA 90712-1900 USA.
For Visa/Mastercard orders in USA
Telephone (562) 461 7574. Fax (562) 461 7212.
Email: info@wiseowlmagazines.com
Web: www.wiseowlmagazines.com
Postmaster send address corrections to:
Model Engineers' Workshop
c/o Mercury Airfreight International Limited
365 Blair Road, Avenel, NJ 07001, USPS 010876
CANADIAN DISTRIBUTION:
Gordon & Gotch Periodicals
(Toll free 1 - 800 - 438 - 5005)

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Contents

See page 57 for our special subscription offer!

Front Cover

A drilling machine is a near essential piece of workshop kit. Harold Hall describes a second drilling project on page 16.

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► See Dick Stephen's article in issue 98 of MEW ◄

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18.	***SLOT DRILL SET (THREADED SHANK)*** [1/8, 3/16, 1/4, 5/16, 3/8, 7/16, 1/2] or (m/m 3, 4, 5, 6, 7, 8, 10, 12 m/m]		*£20 EACH SET*
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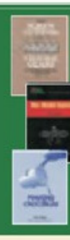

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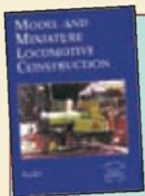

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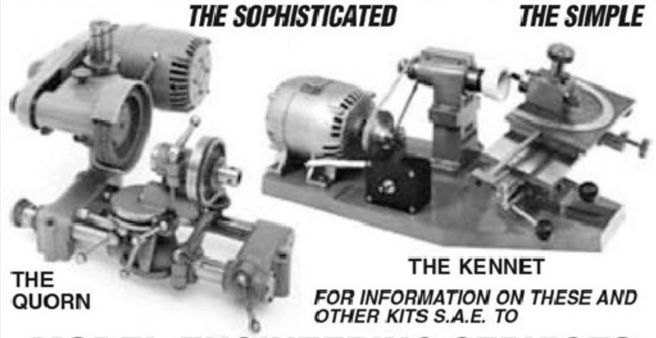

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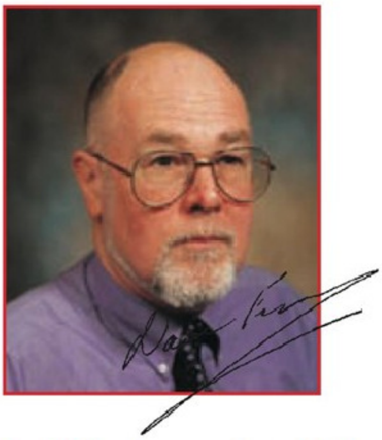


ON THE EDITOR'S BENCH

Is life too short?

Recently I returned a phone call to Alan Timmins, and in the ensuing 52 minutes he berated me firstly for one aspect of the coverage of the Model Engineer Exhibition (issue 96). He had noted the photo of the dividing head which I described as "by Ian Cornish" and was upset because in his view this implied not only "made by" but also "designed by" whereas Alan claims to be the originator of the design and believes he should be publicly credited. So, for the avoidance of misunderstanding, the dividing head built and exhibited by Ian Cornish, was in fact designed by Alan Timmins.

For future clarification, information given on exhibits will normally be that which is presented alongside the item. If the design origin is included then it can be publicised, if not, then I make no claims for an encyclopaedic knowledge of ME equipment of the last century, and will therefore not specify.

He also proceeded to bend my ear at some length concerning the pinion cutting mill described in MEW some eight years ago, as in his view this was a close copy of a device which he had earlier co-designed.

Now, on the one hand I can appreciate Mr Timmins' point of view, it does the ego no harm to have one's design work acknowledged, and if he is in business to make and sell clock making equipment, then plans for home constructed versions represent unwelcome competition. Of course if there is ever a volume market for such things, then no doubt the Chinese will have a field day.

On the other hand, the model and amateur workshop fraternity works to a large extent on DIY versions of shared ideas, designs, techniques and sometimes of commercial equipment; if a design for a gadget stands the test of time, then the true origin may well get lost over the period.

My thoughts then rambled back through some of my own design activities over the last thirty years. Major works for the MOD may not be discussed, but commercial projects have included underwater hydraulic equipment used in mine hunting, and a more recent machine for applying stopping paste to the heads of pins prior to heat treatment. This latter caused quite some head scratching to give consistent doses, and to achieve the required cycle speed.

I did in fact once design a four inch rotary table, and produced patterns. Like a dividing head, it is really nothing more than a set of reduction gears held in accurate engagement by a housing, with provision for location of work, clamping to machine, and carrying a graduated handwheel or division plate. Another club member sourced castings from his local foundry, and a number were made by fellow members.

Now, if at some time in the future, I start pontificating to the effect that "someone has made one of these to my original design", please administer a perfunctory clip round the ear, then remind me that inflated egos are easily punctured and that life is too short!

Articles by Philip Amos

As reported in issue 95, I, along with many others was extremely dismayed to hear that Philip had sadly passed away. Philip had compiled a number of articles for MEW before becoming ill, and latterly, although his level of fitness had allowed only short sessions in the workshop, he had nevertheless continued to write, so that several are held on file. A recent letter from Mrs K Amos has confirmed her kind permission to publish these, and I am most indebted to her for that consideration. Philip's description of improvements to the Le Count Mandrel which he described in an earlier article, will be found elsewhere in this issue.

Out and about

February provides the opportunity to visit Model Rail Scotland at the SECC, Glasgow. As always the layouts were to an extremely high standard, with great attention to detail on the many aspects of scenery as well as locos and stock. It also provided a first hand appreciation of the latest offerings from Hornby, including the live steam OO gauge Mallard, actually announced last year and marketed in time for Xmas. Now live steam in small scales is not new, but has tended to be either spirit or meths fired, with attendant difficulties for remote control. Hornby have adopted a different approach. Power is supplied at 17volts via the track, and feeds an "immersion heater" in a tender mounted boiler. Steam passes through a flexible pipe to the loco, in which are housed a complex arrangement of electrically powered valves, whistles, and superheater. Once charged with water and oil, the loco is placed on the track, and takes about 7 minutes to raise steam. Thereafter it can be driven with control over speed, direction and whistle for some 20 to 30 minutes. Truly a successful partnership of British design and technology married with far eastern manufacturing expertise.

A tale of two taps

Faced with the prospect of lengthy machining sessions on Bentley cylinder heads, I decided to award myself a break and make a little more progress on the Stuart Triple started around 1979. Examination of the main cylinder casting reminded me of one of the reasons for lack of progress; a 7BA tap broken off flush with the surface, a misfortune out of sight and out of mind for some 25 years. A call for assistance to Jim Brown soon saw the tap removed using his spark eroder.

Various other parts of the Stuart were then tackled, and it was for the attachment of the crankshaft balance weights that a 7BA tap was again brought into play. Now whether the cack handedness arose as a result of many years of using nothing smaller than M5, or as a result of working on too late too cold, I don't know. But certainly the same mistake happened again, and in the best Murphy fashion, flush with the surface. A second SOS call would have caused a degree of embarrassment, so alternative solutions were considered.

As the crank was already finish machined and I believe of brazed construction, heating to anneal the tap was not an option. I then remembered the test using a carbide drill on hard gauge plate and wondered if a similar approach might work. At both Harrogate and Donington I had bought a few small carbide burrs/cutters from JB Tools. One of these measured about 2mm diameter and was therefore worth a try. The crank was set up in the mill and positioned with magnifying glass. The cutter was fed down gently to establish a witness mark (checked with the glass) and then more firmly. At one stage it did try to wander, but this was corrected by backing up and progressing more gently again. After drilling through the length of the tap, the thread was found to be untouched, but the end of the cutter had become badly chipped, perhaps on breakthrough, but at the low price paid, these cutters may be considered disposable. It is hoped that this approach may be of use to others.

Just rewards

Other readers will no doubt join me in congratulating Alex Gray, whose restored motorcycles were featured in Issue 93. At the recent Scottish Motorcycle Show, both the Matchless and the Carfield each won their respective classes against stiff opposition from both sides of the border.

MACHINE TO
USING EPO

1. Machining base for Myford grinding machine tailstock.

John Feeney discusses the use of modern materials which can offer easier rebuilding, lower slideway friction and enhanced performance.

Historical perspective

The traditional manufacture of machine tools used sliding surfaces of cast iron on cast iron or steel. This system was probably used for over 100 years from the 1850's to the 1950's or later. While originally both surfaces were left soft (the sliding surfaces were machined and scraped to fit) from the 1950`s the use of slideway grinding machines allowed the bed ways to be hardened after initial machining so that only the mating slide needed to be finished by scraping.

Likewise alignment of other components, headstock/tailstock, was by machining and/or hand scraping as necessary. All these methods of manufacture were highly skilled and time consuming, and while relatively low speeds and feeds were used the friction and damping properties of this type of oil lubricated surface were acceptable.

However, as performance increased and both higher cutting and traversing speeds were used the relatively high co-efficient of friction of oil lubricated cast iron on cast iron needed more power to achieve this. Plain lathe spindle bearings were largely replaced by ball races, roller races or combinations of both types. Even so until well into the 1970`s or later high precision toolroom lathes used special plain bearings for the spindle; this was (is?) also common practice for both workhead and wheel bearings for cylindrical and surface grinding machines.

Finally when CNC machine tools appeared in the 1960`s there was even greater need for higher traverse speeds (rapids) for non-cutting moves in the work cycle.

Friction and damping

Consider the diagram in **Fig. 1**. For a block of mass W on a smooth surface a force F is required before it can be moved. At this point the force F just exceeds the friction force f and the block continues to move as long as the force F is maintained. With many combinations of surfaces the force F required to start the movement of the block is greater than that required to maintain motion so the velocity increases until equilibrium is reached. This situation occurs with an oil-lubricated cast iron on cast iron surface.

By measurement it can be shown that f = μW for a given surface, hence μ can be calculated; values vary from about 0.05 for brass on ice to almost 1 for rubber on concrete. These are *kinetic* coefficients of friction; a larger force of friction generally exists just before the object begins to slide. The co-efficient of friction in this case is the *static* co-efficient of friction. The value of the *kinetic* co-efficient of friction (μ) for the type of system being considered varies with the sliding speed; typical values for cast iron/cast iron and cast iron/plastic are shown in **Fig.2.**

For the cast iron/cast iron system the static coefficient of friction is 0.25-0.30; once sliding starts the kinetic co-efficient of friction takes over and decreases with sliding speed down to about 0.04 at a sliding speed greater than 10m/min. where full hydrodynamic conditions occur. For the cast iron/plastic system the static coefficient of friction is very low, usually less than 0.05 and while the kinetic coefficient of friction which takes over is greater, typically about 0.1, it remains fairly constant up to where hydrodynamic conditions take over again.

This different type of behaviour is of no great significance with the small manually operated machine tools used by model engineers but, for instance moving a six foot milling machine table with a 50 kg dividing head is another matter, and many turret milling machines now use "plastic" slideway coatings. The surface characteristics of these metal/plastic combinations also leads to good mechanical damping, particularly when compared with roller type guideways.

Low friction "plastic" for sliding surfaces

I think that "plastic" slideway coating was first used in the early 1960's. Originally this was by attaching strips or blocks with screws or adhesive followed by conventional machining; I seem to remember seeing photographs of a large planing machine being reconditioned and

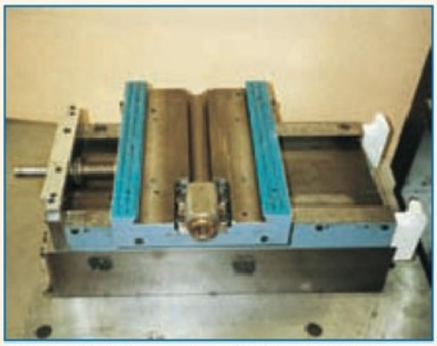
2. Finished machined tailstock.

3. Tailstock with Perspex cover plate.

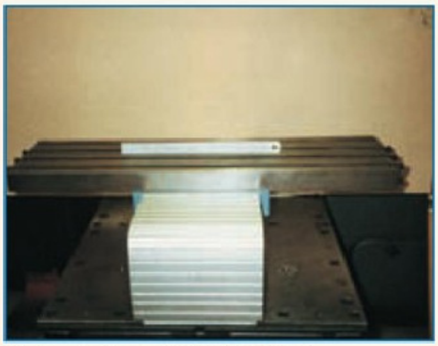
4. As photo 3 with low friction resin injected. Note two "blobs" of resin showing position of holes used to inject the resin.

OL BUILDING
OXY RESINS

5. Balance for weighing out small quantities of resin and hardener.



6. Low friction resin with "cast in" oil grooves. Part of a CNC milling machine under construction.



7. As photo 6 with table fitted.

fitted with solid plastic strips on the slideways. One brand name for this type of material is *TURCITE*. I am not completely certain of the supplier but believe it may come from Busack + Shamban. However it is still often used and referred to in adverts for machine tools.

The next development took place in the 1980's with the availability of liquid/putty resin systems, most using two part epoxy resins with added fillers including bronze and/or PTFE. These are now used extensively in the manufacture of new machine tools and give both better performance and lower cost of manufacture. As well as the lower friction they were also found to improve wear and prevent seizure in the event of loss of lubricant.

A further major advantage of these resins was that with suitable fixtures the slideway surface could be moulded to size so that no additional work was needed to complete a slide assembly, in fact I believe that the resin can be moulded against the opposite slideway (e.g. a hardened and ground lathe bed) provided a release agent is used. In all cases only one side of the slideway is coated and this is the one which not exposed in use. For a lathe this is the under side of the saddle and tailstock; for a conventional milling machine it is the under side of the saddle which runs on the knee and the top face in which the table runs. The vertical slide is also often coated as is the spindle housing on both vertical and horizontal machining centres. I am not sure if these types of coating are used on surface or cylindrical grinding machines, although I can't see why not.

These resins are available in three grades; a thick non flowing putty grade, an injection grade and a pourable grade. More details later.

Plastic resins for location

As well as their use for low friction slideways, other varieties of epoxy resins are used for the accurate location of machine tool elements. They have high compressive strength, typical values being 100 to 150 N/sq.mm (around 15000 lbs/sq. in.) and are available in the three grades mentioned earlier. They are used extensively in the manufacture of machine tools. For example the alignment of a tailstock quill. (See **Fig. 3**) The tailstock casting is rough bored oversize by about 5mm to take a sleeve which contains the quill with its internal taper. The tailstock is clamped to the lathe bed with the quill and sleeve held in place by a mandrel in the lathe headstock spindle. Keep plates are clamped around the sleeve to seal the annular gap into which resin is injected. Alignment to within a few microns can achieved (approx. 0.0002in.)

Other uses include alignment of the vertical columns to the base on machining centres, positioning of spindle bearing sleeves in milling machine heads (See **Fig. 4**) and location of dowels and keys. In the photographs, the black resin is a

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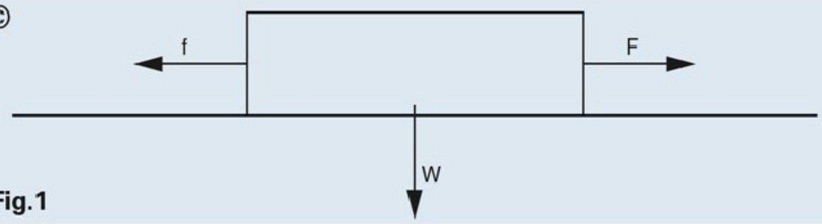
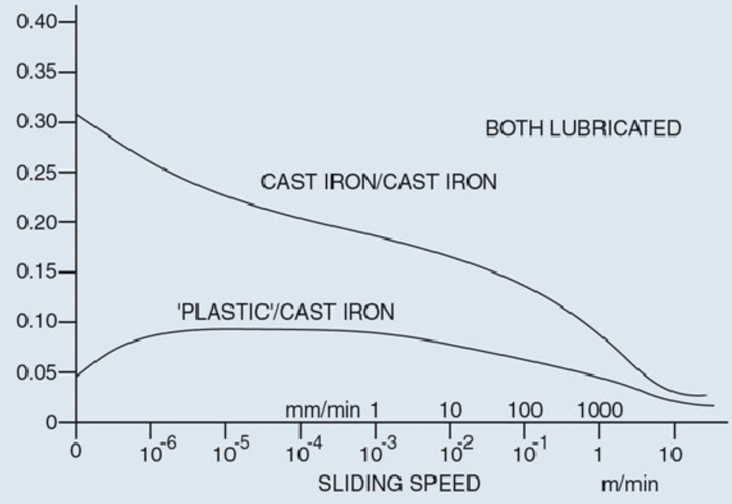


Fig.1



FOR THE LUBRICATED CAST IRON/CAST IRON SYSTEM THE STATIC CO-EFFICIENT OF FRICTION IS 0.25 - 0.30

Fig.2 Co-efficient of friction against sliding speed

8. Boring the end bearing brackets for feedscrew bearings on CNC milling machine table.

9. End bearing bracket showing clearance round the ball race.

location type, while the blue is the low friction material.

Uses in Model Engineering

The main use for these materials is likely to be in the repair/re-building and re-furbishment of machine tools. These will mainly be lathes and milling machines although the methods to be briefly described are generally applicable to any machine tool.

Lathes

One of the most common faults with a used lathe is wear of the bed / saddle. The usual procedure is to re-machine the bed and refit the saddle and tailstock. The difficult part of the job is restoring the vertical alignment so that centre height, leadscrew and feedscrew positions are maintained. It is also quite a difficult job to realign the saddle in three planes, particularly with a "V" bed lathe. The use of these resins makes for a much easier job; an outline of the procedure is listed below.

1. Check the position of the saddle on an unworn part of the bed (usually near the tailstock end). As the saddle will also be worn it may be difficult to measure this accurately; however it may be possible to compare it with a new lathe of the same type. Measure the height of a machined surface above the bed with a depth micrometer, measuring at the front and back and left and right to give four dimensions. It is unlikely that these will be the same, I suggest you note them all.
2. Check the height of the tailstock by measurement over the extended barrel using a height gauge on the bed or a dial gauge set to a metal block of similar height, both placed on the bed. You can check if the base of the tailstock is worn by measurement of the centre height using a ground bar fitted into the spindle taper or by measurement over a turned bar of known diameter.
3. Re-machine the bed. The best method is to have it re-ground; this is particularly applicable to machines like the Myford ML7`s with their flat bed and removable headstock. It is more difficult with a "V" bed lathe and even more so where the headstock is integral with the bed. It is possible to hand scrape the bed if it is not hardened but this calls for a great deal of skill and experience.
4. Machine the underside of the saddle sliding surfaces, take off about 3mm. This must be a rough surface to allow the resin to "key" and make a strong bond. The resin manufacturers recommend a depth of cut of 0.3 / 0.5 mm with a high feed rate (1 mm /rev.!!) I found it difficult to achieve this; in the end I used a single flute slot drill inclined at 30 deg., a feed rate of 300mm/min. and spindle speed of 300rpm. A possible alternative would to drill a series of small holes (say 1.5mm dia.) over the sliding surface after machining.
5. Devise a method of fixing the saddle onto the bed in the correct position. For a Myford it should be possible to fit two bars that clamp across the cross-slide the outer ends of which have jacking screws bearing on to the bed. Jacking screws will also be needed to obtain square alignment across the bed. Adjust until the saddle is aligned correctly, making sure all the jacking screws are locked.
6. If using the injection grade of resin (see later) make end covers to retain the resin. Gaps can also be sealed with self adhesive foam rubber as the pressure used is quite low.
7. Remove the saddle complete with preset jacking screws and place on one side. Clean the lathe bed thoroughly and apply the release agent.
8. Calculate the volume of resin required in mls. and multiply by the appropriate factor and mix the resin as per instruction.

Note. Resin is supplied in amounts

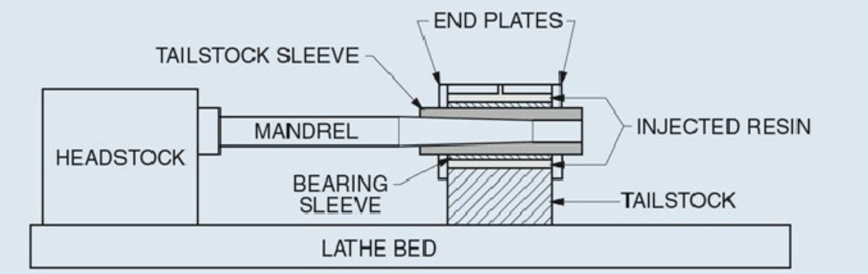


Fig. 3 Aligning a tailsock barrel

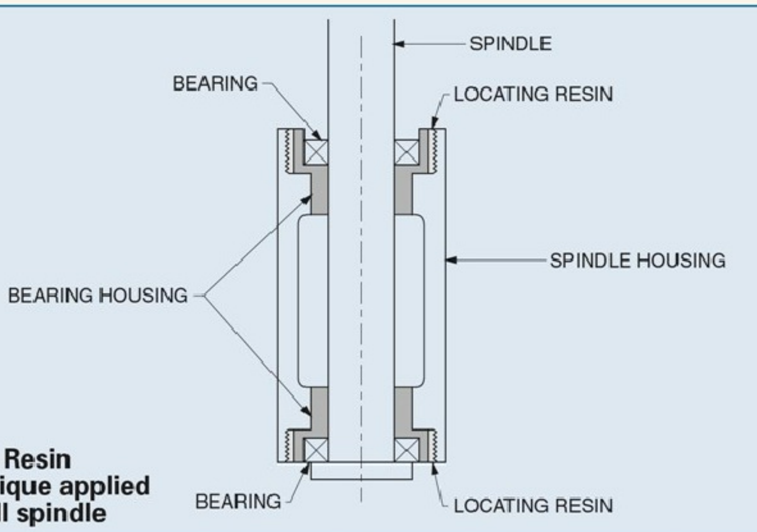


Fig. 4 Resin technique applied to mill spindle

10. Ball race "centralised" by the feedscrew, then clamped.

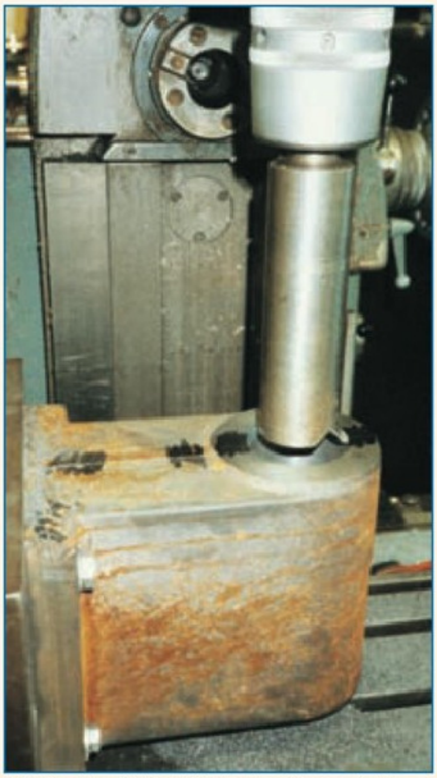
from 0.1kg. to 1kg with the correct amount of hardener. However, even 0.1kg may be too much for some jobs and the larger sizes are more economical to buy. If you have the means to weigh to ~0.1g (**photo 5**) it is possible to mix smaller quantities. I usually buy 0.2 / 0.3kg. and mix between 20g and 100g.

The next step depends on which of the resin grades has been chosen.

9. For the spatula method apply the resin over an area slightly more than that of the saddle sliding surfaces and of greater thickness, replace the saddle making sure it is pressed down against the stop screws and place some weights to keep it in place. Leave for at least 24 hours, remove the saddle and trim away the excess resin.

10. For the injection method first place and secure the saddle on the bed, weights will probably be satisfactory. Mix the resin and pour into an injection tube, push the cap into the tube. The resin is injected using a "mastic" gun used for applying mastic and sealants. Again leave for at least 24 hours before removing the saddle and trimming off the excess resin.

11. If required cut oil grooves into the resin.



13. Boring CNC milling machine spindle housing.

11. Gap around ball race filled with locating resin.

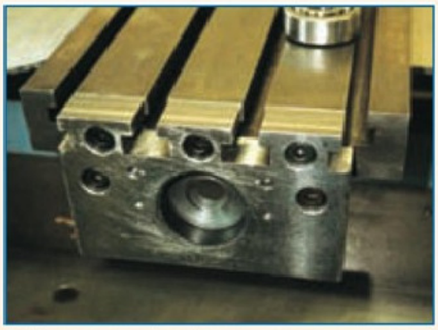
Milling machines

It is probably more complicated to recondition a milling machine in that you need a second, probably larger one to re-machine the slideways. Also, apart from small mill/drill machines the knee or cross slide will be too big and heavy for the average model engineer to handle. However, similar methods to those described for the lathe can be used but I suggest that the injection grade of resin is used, especially if dovetail slides are involved.

One aspect where I have found the locating resin useful is for alignment of the table feedscrew with the nut and its end supporting brackets. To start with, fit the nut to the saddle so that it is parallel to the slideway in both planes. This is easier if the nut is cut into a rectangular block so that it can be aligned against machined, flat surfaces.

Mark out the position of the feedscrew on the bearing brackets and machine about 6mm greater than the bearing diameter (I am assuming the use of ballraces but the same procedure could be used for plain bearings). **Fig 5** and the photos give more detail. Fix the brackets to the table (with the table, feedscrew and bearings in place) and wind the table to one extreme of travel. This will centre the screw and associated bearing. Clamp that bearing in place, wind the table to the other end of the travel. Again the screw will align the bearing. Clamp the second bearing in place. Now remove the brackets from the table and place them flat on the bench so that each recess surrounding the bearing is uppermost. Mix the appropriate amount of pouring grade resin and fill the recesses. Allow to cure for 24 hours.

A more complicated solution would be to make steel bearing housings and bond these into the brackets so that replacement



2. The assembly after cleaning up- bearing removed.

of the bearings would be easier. I have also used the locating resin to fit bearings into a vertical milling machine head. Again the drawing and photo's give more detail.

Summary

This short article shows how commercially available epoxy resin systems can be used by the model engineer to both repair and make machine tools. In many instances the machine tool performance is improved and /or repaired for a fraction of the cost of spare parts, even assuming that they are available.

I have used resin supplied by M. Buttkereit Ltd. whose details are given below. They also supply all the accessories needed such as release compounds, mixers, injector tubes and sealing strip.

A second supplier of similar resins is also given.

I cannot give any firm prices for these resins but they seem to range from about £15 to £25 for 0.2kg. depending on the grade selected; larger sizes are slightly cheaper but don't buy more than you need as they have a fairly short shelf life of just a few months or so. These prices were current as of Nov. 2003, when made my last purchase.

Suppliers

M. Buttkereit Ltd.
Unit 2, Britannia Road. Sale, Cheshire.
Manchester M33 2AA
Tel: 0161 969 5418 Fax: 0161 969 5419

PES(UK) Ltd.
Unit 1, Watling Close, Sketchly Meadows Business Park , Hinckley, Leics. LE10 3EZ
Tel: 01455 251251 Fax: 01455 251252

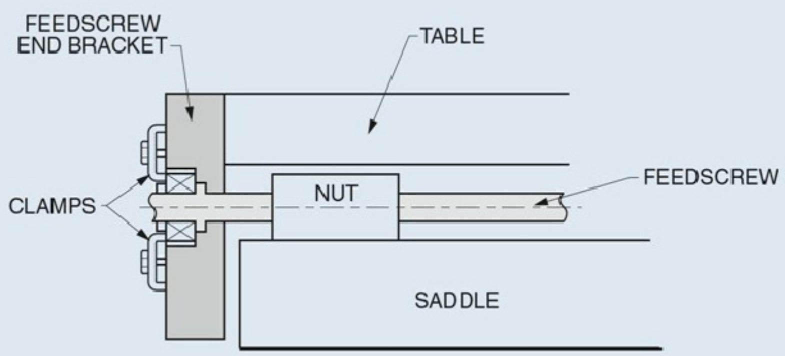


Fig. 5 Centring up table feedscrew bearings

DRILLING PROJECTS

Harold Hall talks us through making a further most useful accessory, the sash clamp.

2

1. An accurately positioned side fence ensures that the machined face is at right angles to the side face.

In this the second project, we deal with the engineer's sash clamps. These will find numerous uses, typically for holding larger parts on the milling table, in this case two clamps will prove especially useful and I would therefore suggest that two should be made. As may be seen from the drawings, the design makes extensive use of two sizes of stock material (25 x 12mm and 50 x 10mm bright mild steel flat) so that many of the components might be produced with little more than a drilling machine. It may also be noted that while this mini series has been penned with particular reference to a drill, underscoring the point that much can be achieved with modest equipment, many of the operations may equally be accomplished on a mill.

Manufacture

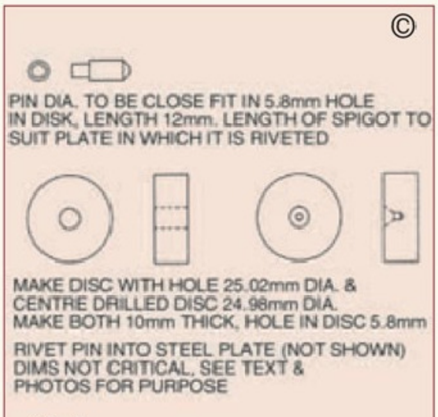
Parts 6 to 10

Cut sufficient pieces of metal to make parts 6 to 10 and machine one end of each as shown in **Photo 1**. The piece of metal seen to the right is a fence set accurately upright using a square off the machine table. This is used to position the part making sure that the machined face will be at right angles to the part's side. Then, using a parallel to position the part, the second end is machined as shown in **Photo 2**. By fixing the down feed all parts will be the same length. It can be seen that the cutter had for some reason become quite blunt between photographs 1 and 2 as there is a large bur on the part not present in photo 1, a candidate for the endmill sharpening fixture described in the milling projects series. The ends of the bar (part 8) had to be machined using the side cutting edges of an endmill as the part was too long to set upright for machining. Of course you may wish to exercise your sawing and filing skills to achieve the same result.

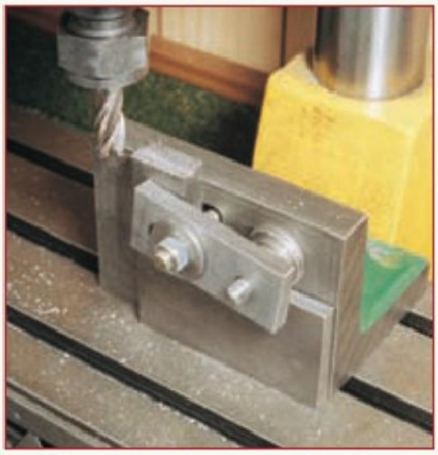
We now come to the clever bit, the method of positioning most of the holes. Make the two setting discs and the locating pin shown in **Sk 1**. The diameter of the pin and the hole in the disc assume that the holes will be pre drilled 5.8mm diameter for eventual reaming 6mm diameter. Make the disc with the hole very slightly oversize, say + 0.02mm and the one centre drilled undersize by a similar amount. The reason for this will be explained later. Rivet the pin into a piece of sheet steel. The piece I used can be seen in **Photo 3**, but as noted later, it would be advantageous to allow a greater width. If the underside of the sheet is lightly countersunk, then the rivetting can be filed off flush so that the sheet will bed evenly on the table.

Place the disc with the hole over the pin and place the other disc against the side of the first disc and lower the centre drill into the centre drilled hole and apply light pressure to hold the assembly in place. Now bring a piece of material, to act as a fence, up against both discs and clamp in place as shown in Photo 3. Here it should be noted that the table should be positioned with a hole or slot under the drill so that it can pass through the sheet without damaging the table.

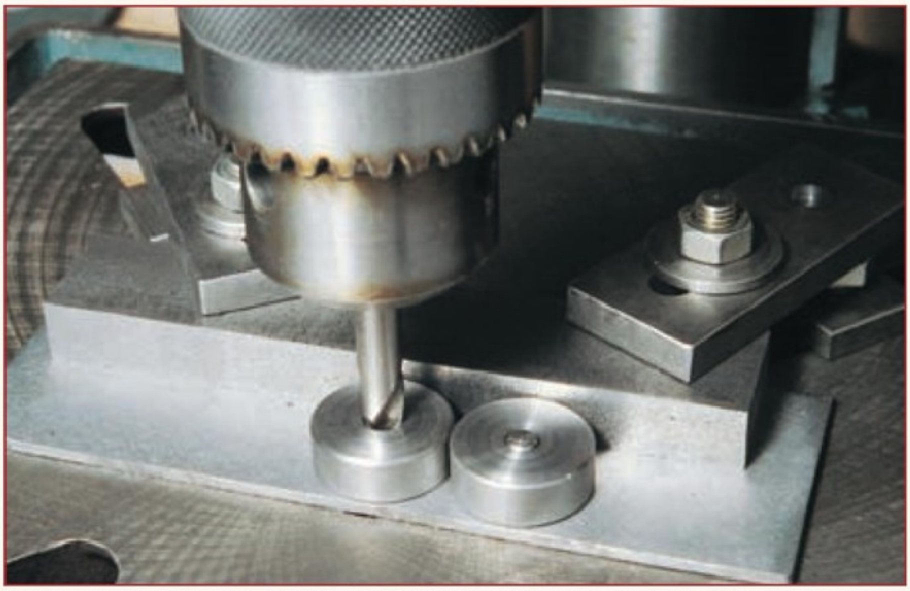
With the disc still on the pin place the first bar against the disc and clamp in place and centre drill as illustrated in **Photo 4**. This ensures the first hole is



Sk.1



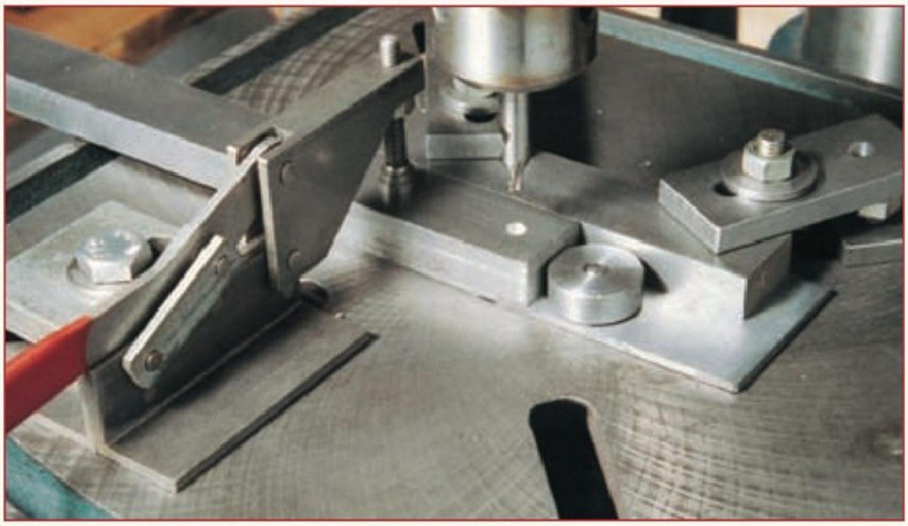
2. With the down feed set and fixed, the parallel will ensure that all parts are the same length



3. The two discs make sure that the holes in the bar will eventually be at the correct centres. The fence ensures that the holes are the correct distance from the side.

12.5mm from the end as per drawing. Follow this by opening up to 5.8mm. Remover the disc and move the bar forward to locate the first hole on the pin and repeat the process for the second hole. Continue centre drilling and drilling additional holes by repeating the process, **Photo 5**. The reason of making the centre drilled disc the smaller is that if larger the drilled hole would be further from the edge and would as a result not locate on the pin. The toggle clamp (Ref 1) seen in the photograph is an excellent method for clamping parts when a number of similar components are to be held, in the absence of one of these an ordinary bar clamp will work equally well, albeit less quickly.

With the disc returned to the pin and a 5mm thick packer in place centre drill the first of the side plates (6 and 9) **Photo 6**. This process makes sure that the hole is 7.5mm from the parts edge as per drawing. Follow this by drilling 5.8mm. Remove the disc, locate part on the pin



4. Using one setting disc only enables the end hole to be positioned.

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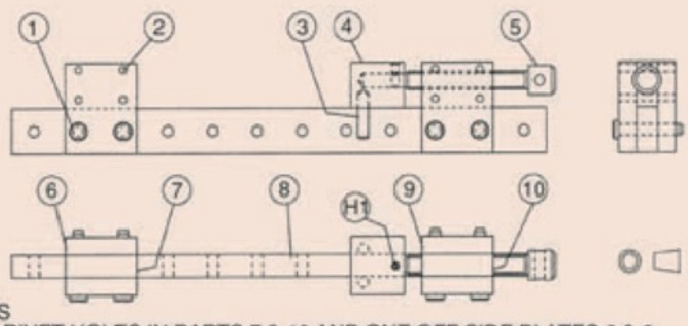

NOTES
DRILL RIVET HOLES IN PARTS 7 & 10 AND ONE OFF SIDE PLATES 6 & 9
ON ASSY. USE PINS 1 & BAR 8 TO ALIGN PARTS
THE QUANTITIES ON THE DETAIL PART DRAWINGS AR FOR ONE CLAMP ONLY
IT IS SUGGESTED THAT TWO CLAMPS SHOULD BE MADE FOR USE IN PAIRS
AS A MACHINE VICE

HARDWARE H1 - M4 x 6 SOCKET GRUB SCREW

Fig.1 Engineers sash clamp - General Assembly

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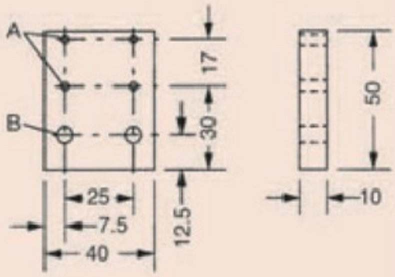
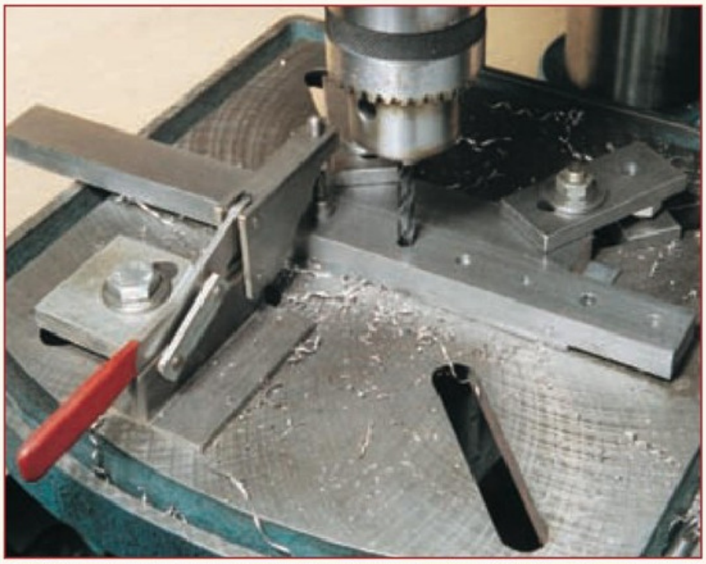


HOLE SIZES
A. 4mm, B. 6mm REAM

MATERIAL
50mm x 10mm STEEL 070M20

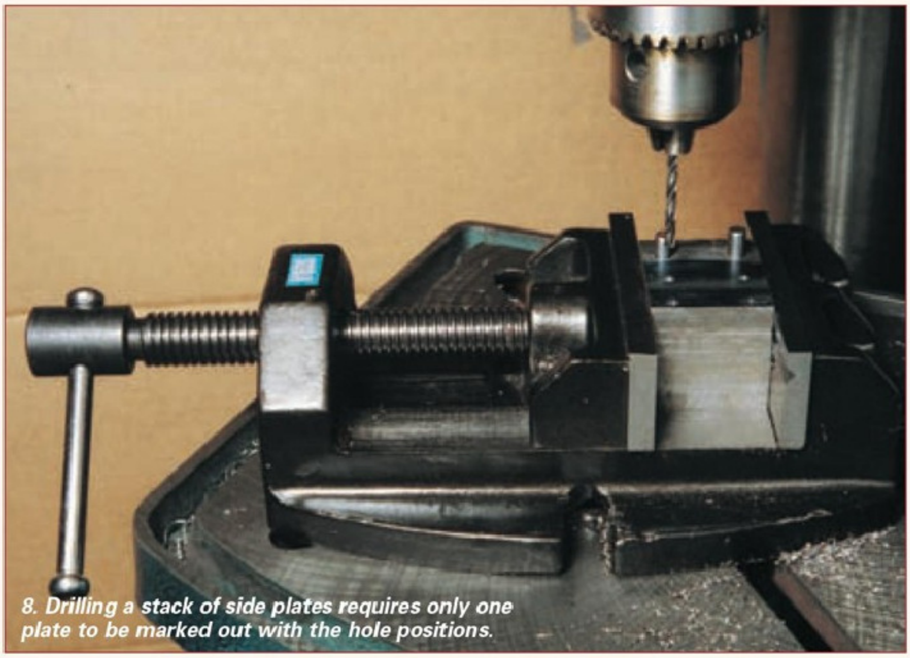
Item 6 & 9 Side Plates
Quantity 4 off



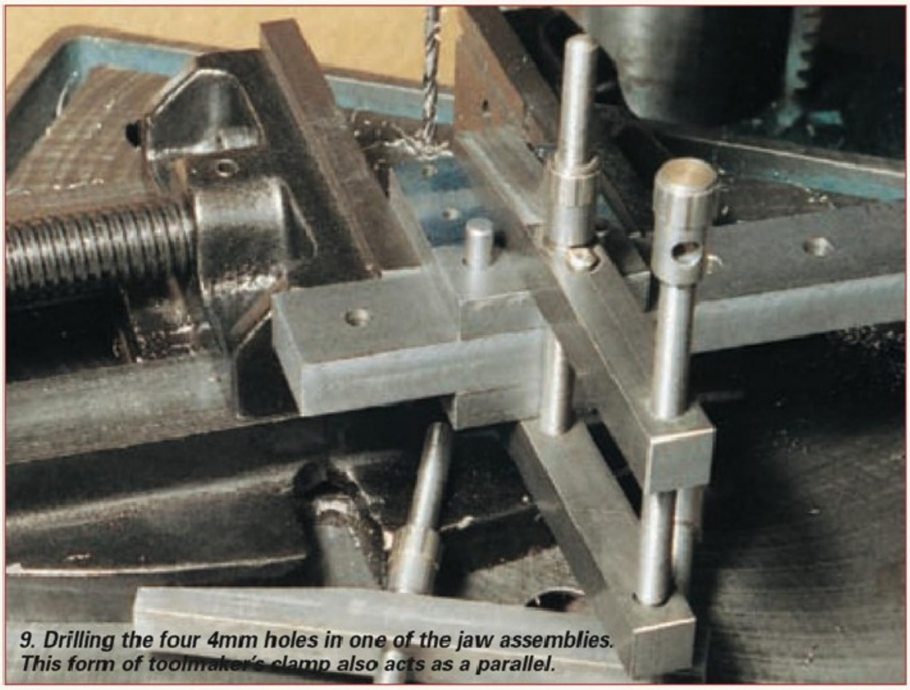
5. Using the pin to locate the bar, holes can be drilled at the required 20mm centres.

6. Drilling the first hole in one of the side plates, the disc plus 5mm packing achieves the 7.5mm dimension.

7. Drilling the second hole at 25mm centres.



8. Drilling a stack of side plates requires only one plate to be marked out with the hole positions.



9. Drilling the four 4mm holes in one of the jaw assemblies. This form of toolmaker's clamp also acts as a parallel.

and centre drill and drill 5.8, **Photo 7**. It can be seen that the part is not clamped but the fence and the additional support added to the left ensure that the part cannot rotate. All that is necessary is to hold the part down firmly, especially as the drill breaks through. This would have been easier had I have made the piece of sheet steel that holds the pin somewhat wider, and in the light of experience, I would certainly advise doing this.

Mark out the position for the four 4mm holes in one side plate only, and with two pins, turned to 5.8mm diameter, stack up with 4 additional side plates and drill the four 4mm holes, **Photo 8**. Set the down feed stop so that the drill only just breaks through the fourth side plate, by this means protecting the vice. You may alternatively place a suitable piece of scrap beneath the work so that the drill can pass through the job but not contact the vice. Do not drill the remaining side plates at this stage. Take note that when drilling deep holes as in this case, especially with smaller drills, it is necessary to withdraw the drill frequently to remove the swarf. The vice seen in the photograph is very well made, even so, not that expensive. However, the single fixing slot on each side gives virtually no scope for lining up the hole position with the drill being used, it is therefore only applicable to hand held use if used on a normal drilling machine table.

The next operation is to transfer the

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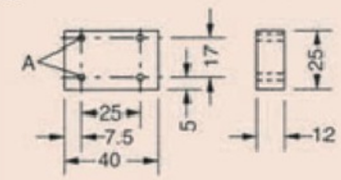

HOLE SIZES
A. 4mm

MATERIAL
25mm x 12mm STEEL 070M20

Item 7 Moving jaw centre piece
Quantity 1 off

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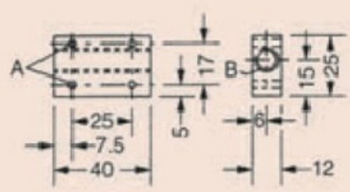
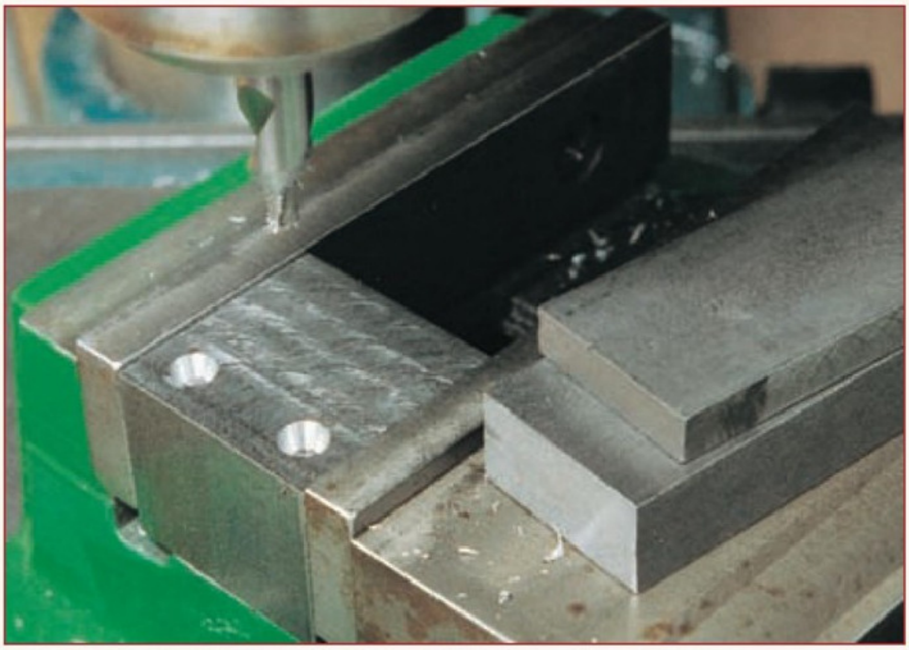


HOLE SIZES
A. 4mm, B. M10

MATERIAL
25mm x 12mm STEEL 070M20

Item 10 Clamp screw carrier
Quantity 1 off



10. Drilling the first hole in the moving jaw.

11. Removal of the 18mm packing enables the second hole to be positioned easily. The vice is of course clamped to the machine table.

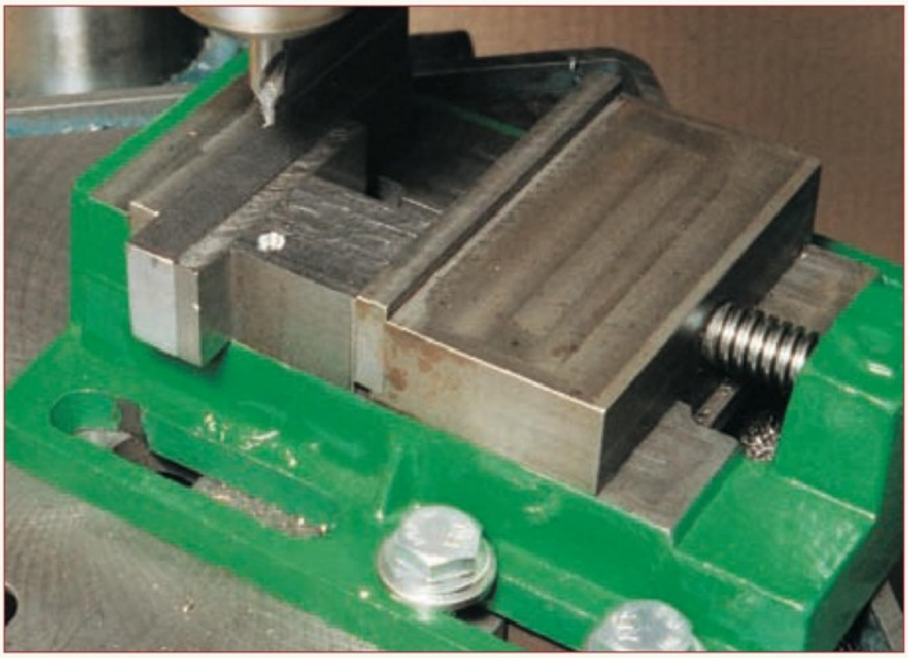
four 4mm holes to parts 7 and 10 and the remaining side plates. Assemble two side plates, lower one not drilled, on to one of the bars (8) using the 5.8mm locating pins and place a centre piece between the side plates. Make sure that the centre piece is in contact with the bar and clamp the assembly together. Drill the four holes as illustrated in **Photo 9**. By using the form of toolmakers clamp (Ref. 2) shown loose in front of the vice it also acts as a parallel to support the assembly. Alternatively, if using a conventional toolmaker's clamp two parallels would be needed. In this case set the down stop so that the drill stops just short of breaking through thereby protecting the parallels, finish drilling the lower plate after dismantling assembly. Repeat for all four assemblies keeping each assembly separate and ensuring that you know which is the outer face of the side plates.

Assembly and fitting

On the outside of the side plates countersink all of the 4mm holes to a little under 6mm make the rivets (2) and assemble. I included a piece of kitchen foil (about 0.04mm) in the assembly to ensure, as I thought, that the finished assembly would move freely on the bar, this though was not the case. Eventually, I found that the 50mm wide material I had used was curved across its width and depending on how it was assembled, convex or concave, it would either move freely or not even go on. Theoretically, as the part is symmetrical, it should be possible to turn over the offending side plates but only very slight differences in hole position would eliminate this possibility. I include this detail so that you can take account of it at an early stage, I eventually used 3 thicknesses of kitchen foil together with a little easing by filing. It may well be that a single thickness from an aluminium Coke or beer can (typically about 0.003in. or 0.08mm) would also work

Part 4

Again we see how holes can be positioned and drilled with minimal need for marking out. Mark out the position for just one of the 6.2mm holes in one jaw and, with the part in the vice aligned with the end of the jaw, line up the centre drill with the hole position, clamp vice in place and centre drill the first hole, **Photo 10.** Note the 18mm packing in the photograph which when removed enables the second hole to be drilled in the correct position, **Photo 11.** It can be seen in photo 10, and some subsequent photographs, that this form of vice, with its long slots, gives plenty of



12. Setting up an upright fence for locating the jaw assemblies for subsequent drilling.

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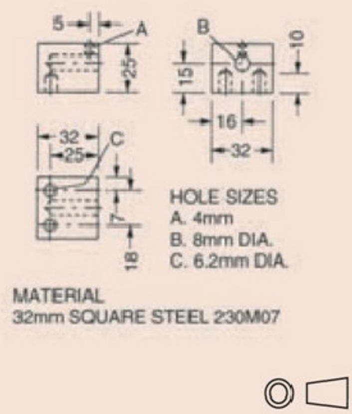
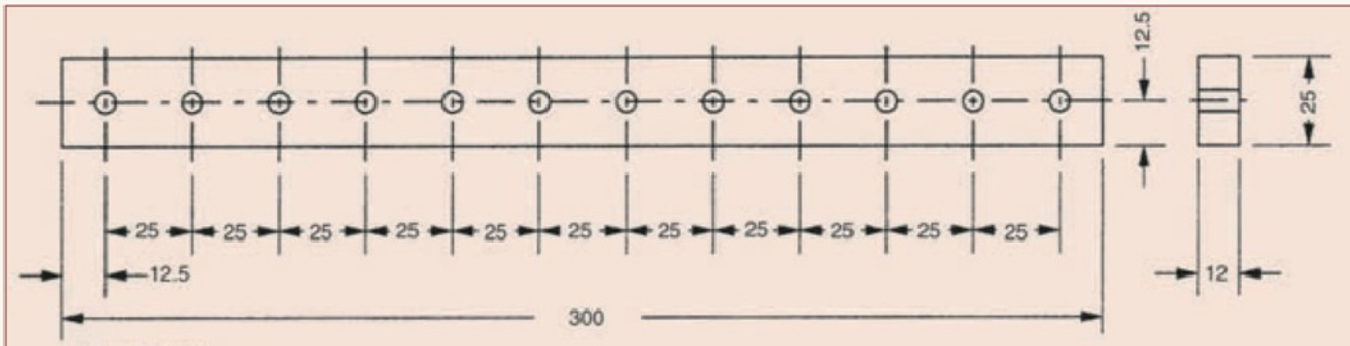


Item 4 Moving jaw
Quantity 1 off



HOLE SIZES
6mm REAM, 12 OFF

MATERIAL
25mm x 12mm STEEL 070M20

Item 8 Bar
Quantity 1 off

scope for bolting it down in the required position. Make the guide pins (3) and fit using a two-part resin adhesive.

Jaw assemblies

Mount a piece of 12mm thick material in the vice ensuring that this is upright, see **Photo 12**. Mark out the position for the remaining hole in just one assembly, clamp to the upright in the vice, line up centre drill and clamp vice in place on the machine table. Centre drill, **Photo 13**, drill, **Photo 14**, and similarly drill hole in the moving jaw, **Photo 15**. This sequence has positioned and drilled the hole in all six parts without any re setting or marking out. Perhaps of even greater significance is that the task will have been completed with a high degree of accuracy/ repeatability.

In the next, and final part of this mini series, problems with making the clamping screw will be discussed together with a few remaining operations.

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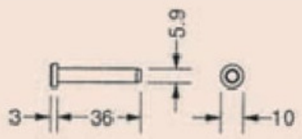

MATERIAL
10mm DIA. STEEL 230M07

Item 1 Pin
Quantity 1 off

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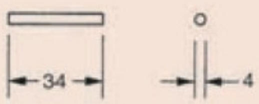

MATERIAL
4mm DIA. STEEL 230M07

Item 2 Rivet
Quantity 8 off

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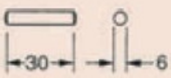
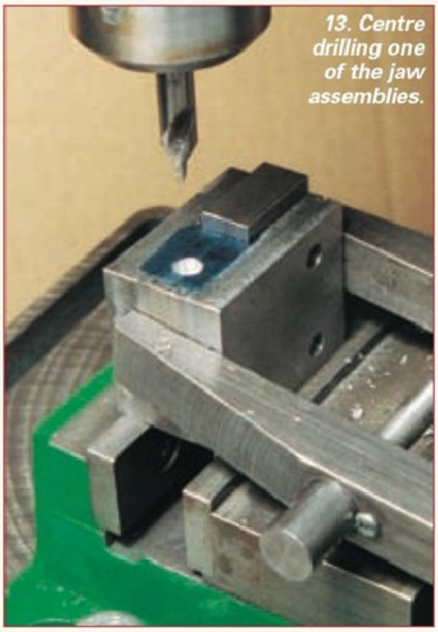


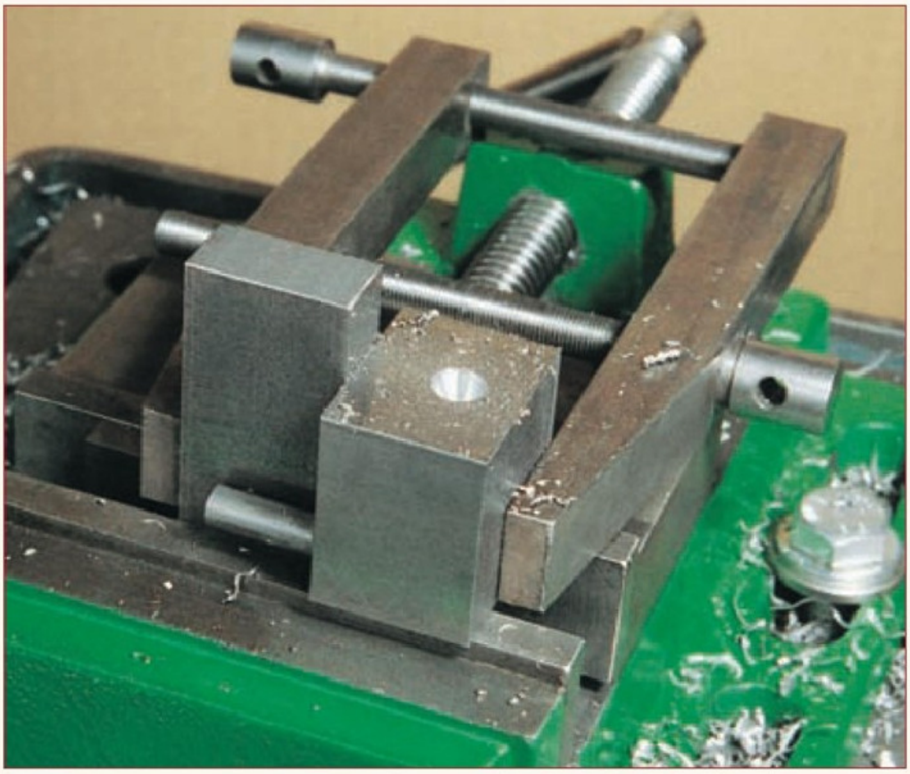
MATERIAL
6mm DIA. STEEL 230M07

Item 3 Guide pin
Quantity 2 off



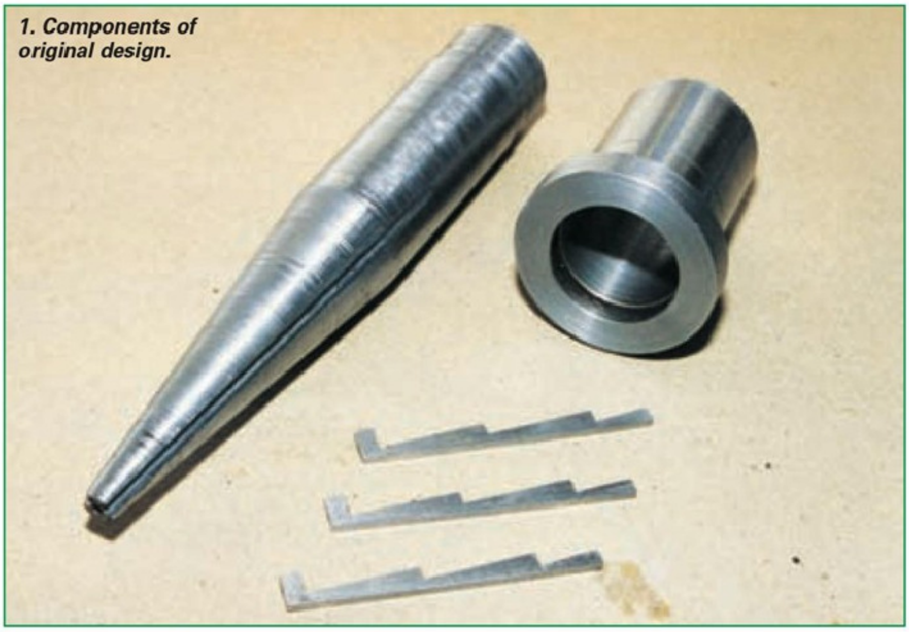
13. Centre drilling one of the jaw assemblies.

14. Drilling the jaw assembly.



15. The same set up is used for drilling the moving jaw.

IMPROVING A LE COUNT MANDREL



1. Components of original design.

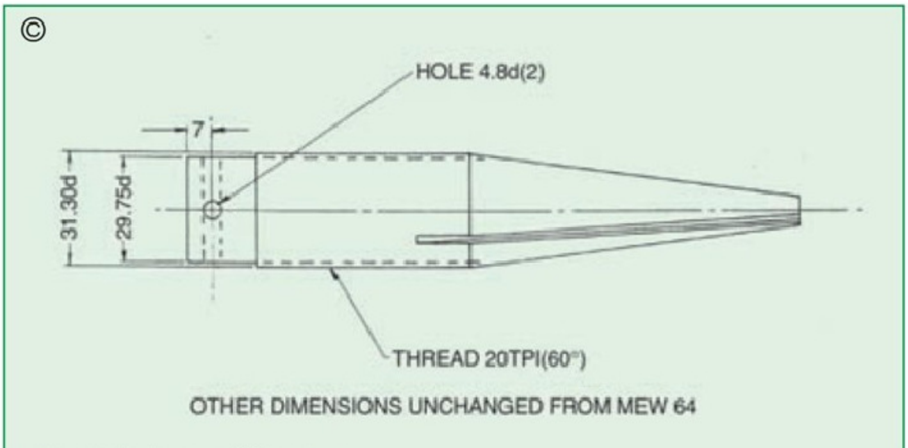
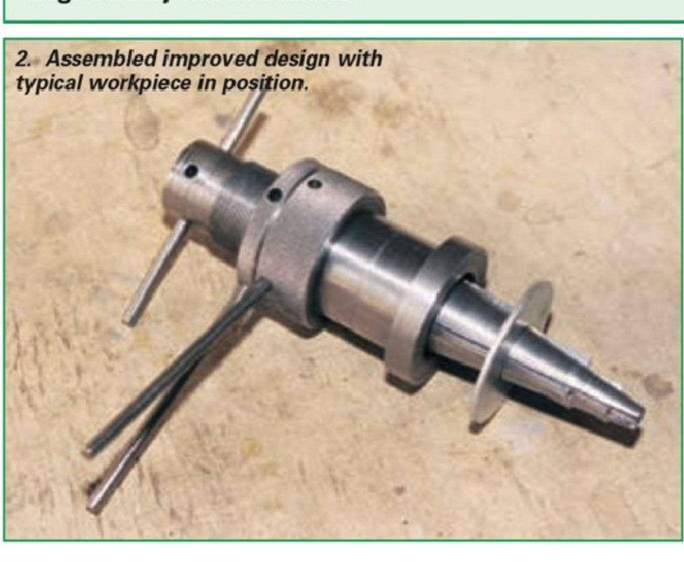


Fig. 1 Body modifications



2. Assembled improved design with typical workpiece in position.

3. Components of improved design.

Philip Amos describes a modification to a useful accessory

In issue 64 of MEW there was presented a description of the design and manufacture of a Le Count type mandrel, along the lines of those illustrated by Ian Bradley and Tubal Cain in photos in references 1 and 2 - see **photo 1**. There was a recommendation in the article that the design could be improved by the use of a threaded body and sleeve, as shown in the Holtzappfel illustration in reference 3. A further article by Mr Hugh Smith, in issue 66 of MEW described a genuine Le Count mandrel, which has no threaded feature but does differ from that given in Iss. 64 principally in that the commercial device employs a 5 degree included taper whereas the version constructed from photographs used 14 degrees. The smaller included angle was described by Mr Smith as giving a "tenaceous grip", whereas it was noted that for the 14 degree arrangement, the gripping power and convenience might be bettered by using the threaded configuration to be described.

Reworking

After some years of occasional use it seemed worthwhile contemplating whether the existing device could be reworked to conform to the threaded configuration. It was decided to proceed and a description of this process is the subject of this article.

Concept

There is no problem in cutting a 20 tpi 60deg. thread on the body of the mandrel,

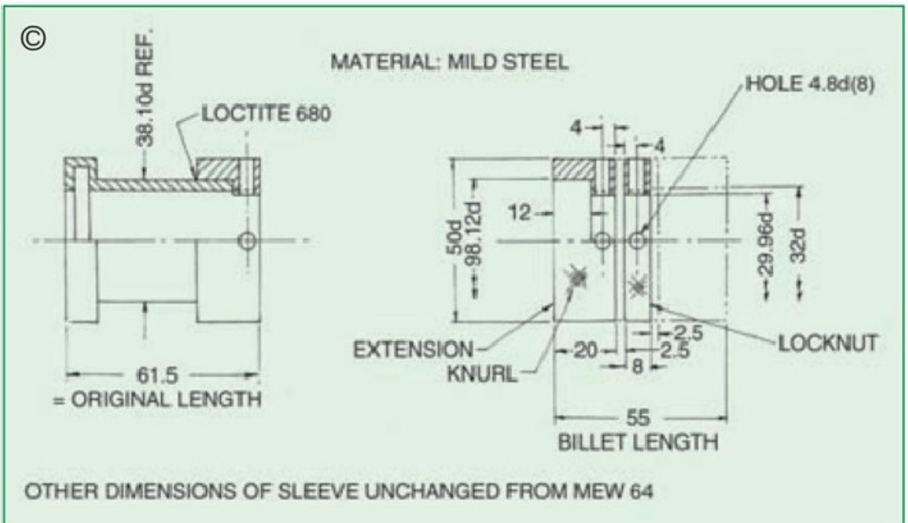


Fig. 2 Sleeve modifications

(**Fig. 1**) but getting a matching thread on the sleeve requires a "metal putting-on-tool" - not usually available in the home workshop. Thus a short piece was removed from the smaller end of the sleeve, and this was replaced with a new sleeve extension attached with Loctite 680 adhesive as shown in Fig. 2. A lock nut and some tommy bar holes in the body complete the work.

Manufacture

The sleeve was lightly held by its large end in the 3 jaw lathe chuck with its outer end supported on a pipe centre in the tail stock. It was grooved almost through, then sawn off with a hacksaw and the end filed flat. The end of the body was skimmed to 29.75mm diameter. The body was then held by this reduced diameter in the 3 jaw chuck and its other end supported by the tail stock centre. The main 31.30mm diameter was then threaded 20 tpi 60deg. for its full length. It was found that this thread raised a burr which increased the body diameter from 31.30 to 31.40mm so this was machined back to size. Two holes at right angles 4.8 mm diameter were cross drilled 7 mm from the end for use of a tommy bar.

A billet of 2 inch diameter bright mild steel 55mm long was faced both ends and turned circular 50mm diameter each end in turn. One end was drilled and bored 12mm deep and 38.12mm diameter so that it would just slide on to the end of the sleeve. The other end was then drilled and bored 24.5mm deep and 32mm diameter to easily clear the threading tool. The axial length between the two counterbores (18.5mm) was then threaded 20 tpi 60deg. (29.96mm minor diameter).

Eight holes 4.8mm diameter were drilled in designated positions for tommy bars and the outside diameter diamond knurled. The sleeve extension 20mm long and the locknut 8mm long were then parted off to length. After deburring the sleeve extension was Loctited in position.

Three tommy bars were made 100mm long from 3/16 inch (4.76mm) diameter bright mild steel.

Photos 2 and 3 show the reworked mandrel assembled and dismantled.

Conclusion

The reworked mandrel is more convenient to use and the conversion effort seems well worthwhile.

References

1. The Amateurs Workshop - Ian Bradley 1950.
2. Workholding in the Lathe - Tubal Cain WPS 15 1987.
3. Turning & Mechanical Manipulation Vol IV - J.J.Holtzappfel 1897

IN OUR NEXT ISSUE

Coming up in Issue No. 99 will be

Centre Square

An easily made marking out aid described by Mike Tierney

Mini Lathe Modifications

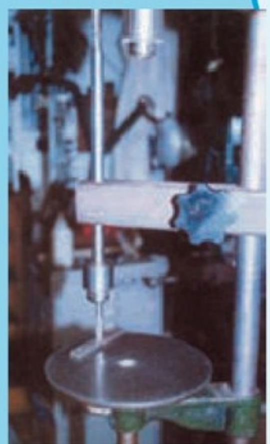
Bob Margolis improves the change gear cover retention.

A Quicker Approach to Ball turning

Ray Newton gives his variation on tool infeeding

A Simple Tapping Attachment

Avoid broken taps with Don Unwin's elegantly simple device



Issue on sale 18th June 2004

(Contents may be subject to change)

KEYWAYCUTTER 2

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

Alan Aldridge concludes the description of his accessory for cutting internal keyways

Ratchet

The ratchet is a two part construction with the inner core in steel or bronze and the outer in gauge plate so it can be hardened. Ratchets can be made in a variety of ways and some time ago I developed a tool post divider to do just this sort of job for ratchet wheels used on a gear cutting machine and which is seen in **Photo 2** making the wheel for the keyseater. This device will be described in a future article.

If the two parts are silver soldered together then the gauge plate will probably harden and cause milling problems. Therefore, cut the plate to rough size, drill for centre and follow up by making the bush an interference fit or add adhesive of the high strength type for the machining operation. Centre the assembly and bore to size and turn the outer diameters followed by dividing the ratchet into the 16 teeth. Ratchet design can be more complicated than just milling a flat but we shall make do with a plain flat and right angled teeth. It would look better if all the teeth were identical but the actual dimensioning is not that critical. Clean up the ratchet and heat to red heat followed by dipping in water or oil, (the latter will give a black sheen to the part) and then temper to straw. Those who used adhesive will have to destroy the joint and clean out any vestige of glue before silver soldering. Those with interference fitting will add just a seal of solder to finally secure the joint as it will be found that the interference grip has been lost in the hardening phase.

Pawls

The arrangement that now appears on the back of the cage is the third attempt and fourth design. It looks about the best all round, though it is still not completely to my liking. In this version one pawl is mounted on a bell crank riding on the bushes at the ratchet and the cage which looks a bit odd as one half of the bearing is moving, the other stationary but is quite acceptable. A second bell crank has a roller end that bears on the other leg of the pawl bell crank that comes through the side wall of the cage. The requirement for a quick action of the ratchet tripping was met by having a rod ganged to the hand lever and threaded so it can be adjusted for stroke and to set the beginning and end of a stroke of the second bell crank with a little lost motion in the set up to overcome the apparent lengthening and shortening of the rod between driver and bell crank.

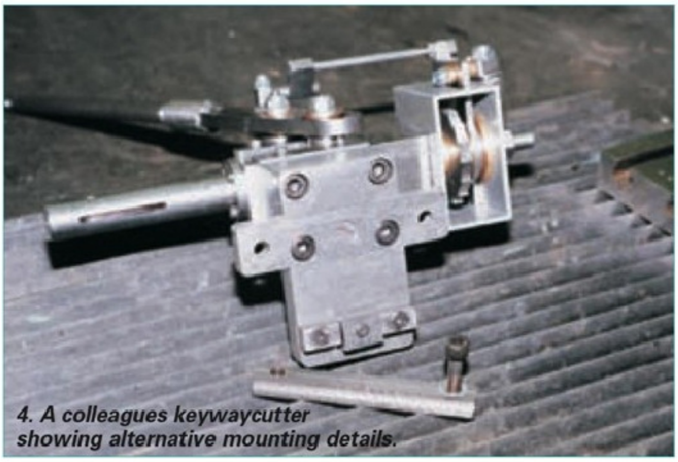
All the wearing surfaces and pins are either hardened gauge plate or silver steel and bronze bushed. The pawls need careful work and the drawing shows them overlong and the angles not detailed as it will only be from the actual fitting work that each pawl will be made to engage and disengage properly. From experience the amount to be taken off at the final fitting stages is minute and really is the difference between dead right and disaster. For both the stop and push pawls there is a variety of ways of keeping the pawls firmly in contact with the ratchet. For the ratchet pawl I used a small holder that has a saw cut across it to hold a leaf spring blade that forms the return spring. The leaf spring is made overlong, glued in place with possibly a sliver of steel to take up the gap and then trimmed to size. The boss is held by a nut and screw at the back of the appropriate bracket or side plate. The stop pawl is mounted on a short shaft with a helical spring mounted on a step and pin pushing upwards. Alternatively one may hunt for a pair of spiral springs but these are quite tricky things to size so they have the correct loading, correct action and do not need too much bending up of the ends. In the drawings the arrangement shown is for a long shaft paralleling the screw shaft on to which the pawl slides and is held by two springs. Other arrangements are possible. A reasonably stiff tension spring will be needed to pull the inside bell crank back to its start point and this will require a short bracket that is bolted to the stop pawl bracket.

Originally I had gone through a series of ideas which became more and more complicated as to how to lift both pawls to rewind the ratchet after each key cutting exercise. The answer in practice is so much simpler as the proximity of the two pawls is such that the thumb and forefinger push down both together to release their hold on the ratchet which is rotated backwards with one finger of the other hand. The corner of the plate cut out may require nicking out and squaring of the bottom or top corners to allow the inside bell crank to fully stroke.

Setting out the rod between driver and bell crank will try one's patience but the idea is to get the pawl to engage the tooth just before the vertical centre line and at the last moments in the travel of the driver so that as little as possible is lost in the actual cutting stroke. The first steps are to get the bell cranks to over stroke the ratchet, that is there is no restriction on their movement in the slot or to the outer crank through touching any metal. Then it is a case of progressively cutting back the pawls. Note that there is an interaction between the pawls that will affect the stroking and though one might see a missed tooth at the push pawl it could be the stop pawl that is causing the problem. The stroking should be restricted to the final 10 mm of blade travel and the cutting blade must be free of the workpiece for the

2. Milling ratchet teeth using toolpost divider.


3. Device located between centres to measure shim thickness.


4. A colleagues keywaycutter showing alternative mounting details.

advance of the blade even if this is so very small. Once the rod lengths have been found, the trial material, a piece of screwed rod, can be exchanged for something much more easy on the eye which has a plain face and not the rippled thread form riding through the bell crank connection.

Blade

Casting around for ways and means of procuring blades for the job it struck me that a composite blade would probably be the better route than purchasing a proper parting tool, which has a mechanical drawback in any case, with the sloping sides losing guidance ultimately in the slot of the arbor. The first blades were made from gauge plate throughout and served well. The blade was shaped to the drawing shown previously but instead of full length heat treatment only the extreme tip was heated to red heat and dipped in water. No tempering was added. The blade, as long as it was not dropped, was normally protected from breakage by being retracted into the slot when stored and the normal cut was tiny and with minimum shock load in relation to what the blade material could take. No relief of the blade was contemplated other than the top rake angle as the depth of cut was too small to warrant any side clearance. The blade could then be ground to give the final cutting edge. If the blade material is not to the correct width for the keyway, say, 3.2 mm for a 3 mm key, then it needs grinding locally at the tip and here a Quorn would be helpful to regulate more exactly the amount each side that was removed. Careful hand grinding was not out of the question but it does require the sort of grinding wheel used on a Quorn with a finer grit than normal. I have used a linisher with a worn belt, in the past, to do exactly this type of work to good effect. The cutting edge should be undercut so a definite rake is applied through the complete cutting process and that would be better ground on a fine wheel followed by stoning. The other end of the blade is finished in a hole which should be a nice fit to the cross pin as should the holes in the arbor. If the arbor slotting has been properly sized the blade will be a firm push fit. The angled underside is approximately to the drawing angle but should be straight and not given any curvature. The cutting forces tend to push the blade back on to the tongue.

By reshaping the blade, wider keyways can be cut with the extreme end of the slot at the blade tip being widened out by milling with no particular size being required, and a blade made of gauge plate but with a brazed on tip of tool steel, or a silver steel, which is ground to size. Going one step further, I now have the essential make up of a broach which can cut several keyways by indexing around 90degrees with each cut or I can cut other more fancy shapes by grinding a form at the tool end. So far I have confined myself to making a 4mm wide key on 16 mm bore but the possibilities are there for internal gear cutting in small bores.

Main body

Unless castings are available a fabricated main body or stand will have to be made, though it will be almost necessary to have a milling machine if the machining work required is only done after the fabrication is made. However, many fabrications are made up of fully machined parts and in pieces of metal the size we are using there is not much likelihood of massive heat distortion as welding progresses. This approach though does need some care with the setting up, as we must get the sliding surfaces on centre line in all planes for which a good flat and true surface will be needed from which to take readings as we proceed. Reference was made earlier that shimming would be provided which would compensate for machining errors and this can go between base plate and the main stand of the frame (**Photo 3**) but it is not there to sort out a dipping angle in the slides.

If the keyway cutter is to be used on the lathe then much of the machining work can be done on the lathe saddle by hacking out the slot and then finishing it with finer cuts to the required accuracy. The slotting once complete could become the holder for the driver block which would then be drilled and bored off the lathe spindle. The main body is in two pieces. To mill out the slot with, probably, a cutter of under the finish size by some 10 mm one can use the dodge of having the base stood on a series of raising bars that will adjust the cutting height to take out the top and bottom faces of the slot. The alternative is to cut the slot on the milling machine to finish size that suits the driving bar and carefully lift it into place on the base parts in the lathe with the slotted holder supported on a mandrel and the driver slung between centres and then measure off the dimension needed for a spacer or a shim between the driver holder and the main body. The mandrel could be the actual arbor turned end for end, set for centre in the four jaw and held on its centre in the tailstock. The drawing shows only certain dimensions but the others can be adjusted to suit material to hand and working arrangements. Those given relate particularly to Myford ML7 and Super 7 lathes with dimensions such as the centre height of the cutting arbor at 53.97 mm, which is the height of the spindle in a ML 7 above the saddle or 88.9 mm if working off the bed. Where the gap is small the two parts could be given a tack by welding while on the lathe, taking necessary precautions to protect the lathe and with the main body completed and held down in its true position on the lathe saddle. With the complete assembly aligned properly the slotted section can be tack welded to the base proper for running in the final welds on the bench. Keep the welder earth lead close up to the welding area. Note that where the machine is used in conjunction with the lathe it will be advantageous to make up the main body with either a key that neatly picks up a saddle slot or with a part that goes between the lathe shears sized to be a neat fit to give the required orientation and eliminate any setting out work. In the latter case the arbor must locate on lathe's centre line. The bolts holding the two parts of the main body together must be free in their holes so that there is a little room to shift the top half around with the driver installed with the arbor between centres so that the key and arbor all line up properly. One will have to half tighten the bolts and tap the top half lightly to gain the correct alignment, then fully tighten down off the lathe. Note that the block is machined underneath to give a small landing all round rather than have a very large area which in all probability would not bed firmly all over.

The position of the driving arm has been set for it to stand vertically which may not accord with all tastes but it does tend to give a reasonably tidy appearance to the machine and is not awkward to use. The lever could be repositioned horizontally but a different arrangement would be required for the link pivoting which could be made up, (instead of from a block) from a pair of vertical plates carrying a short flat with the necessary vertical pin welded to it. The vertical plates

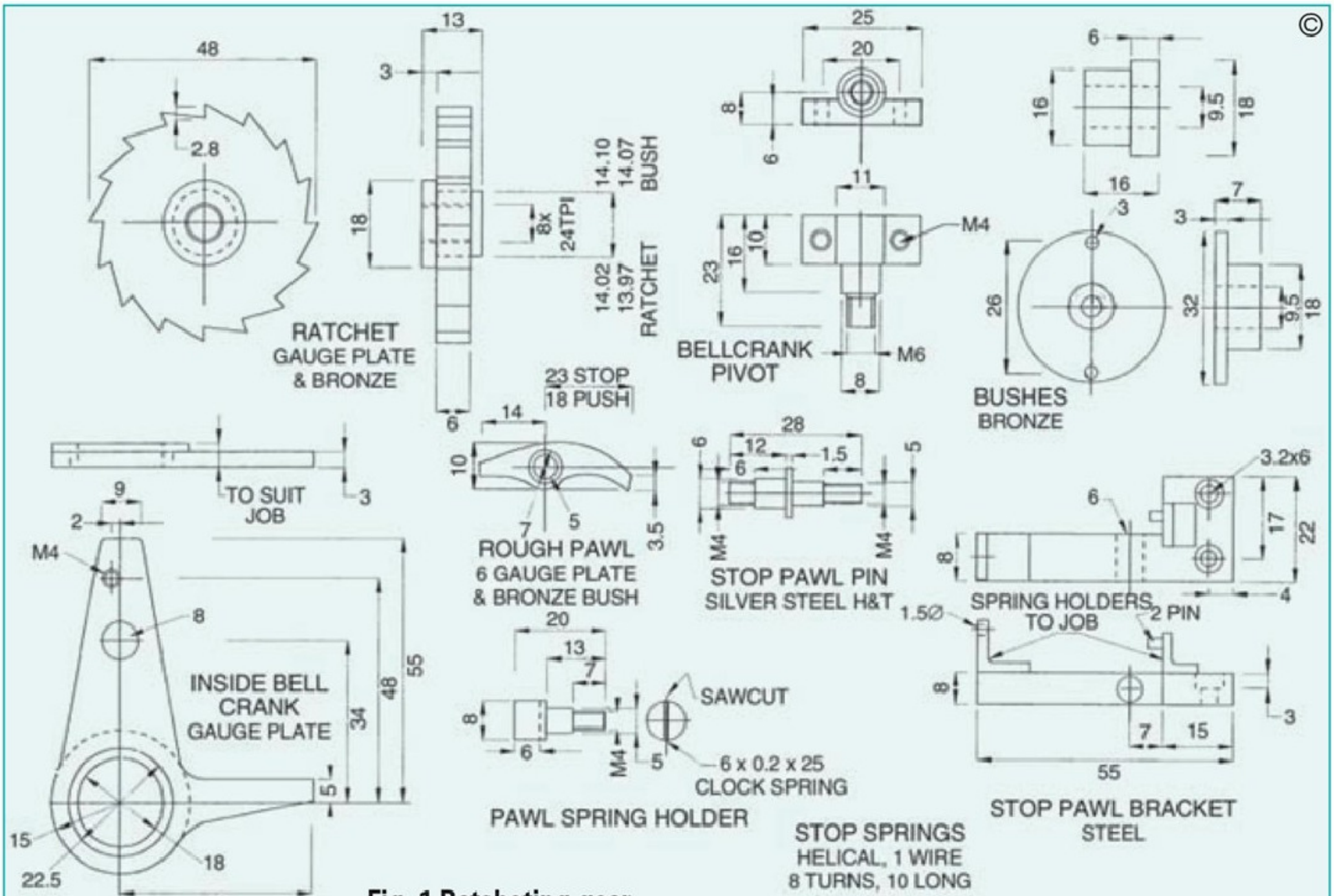


Fig. 1 Ratcheting gear

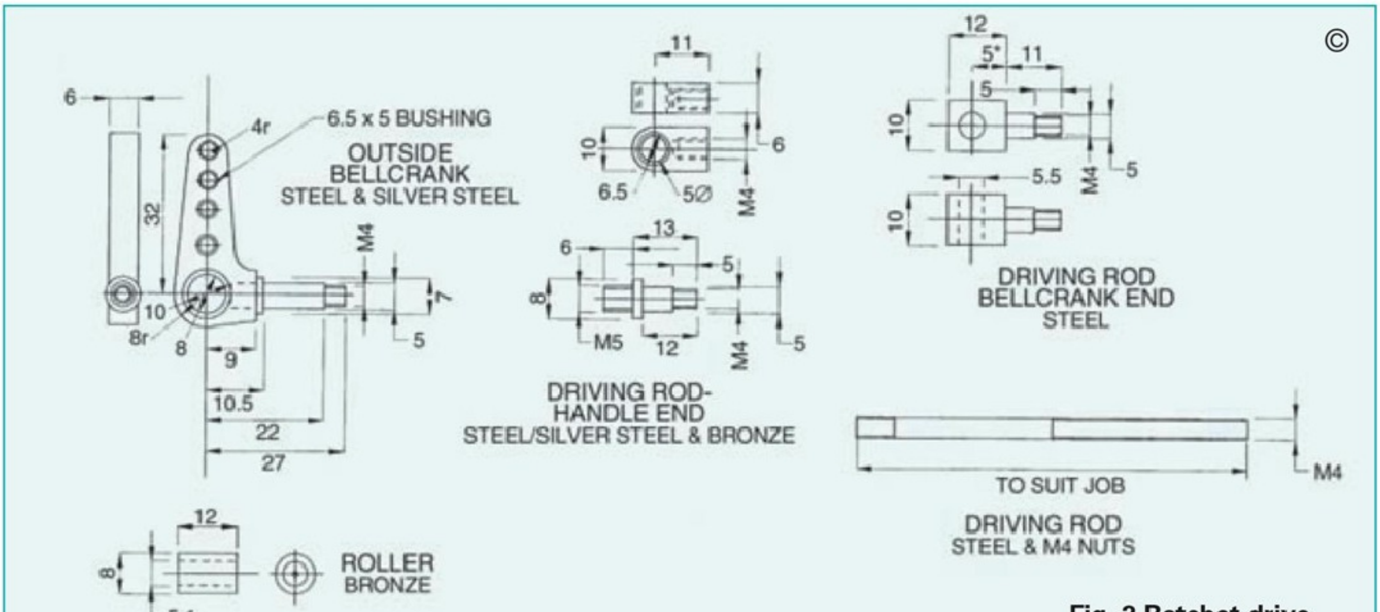


Fig. 2 Ratchet drive

would then be welded to the sliding block.

A club colleague is making the keyway cutter but as he is averse to welding, he has slotted out the base of the main block to take a tight fitting bar which carries the two outrigged clamping bolt holes (**Photo 4**). This modification requires the counter bored holes holding the driver assembly to move slightly back and a third screw is added to locate the bar in the slot for drilling the counter bore bolt holes. In addition it may be observed that he has arranged that the stop pawl operates just by gravity.

Although using the device on the lathe is convenient, the intention in my own workshop was to have the key cutting work done off the lathe. This has been achieved as the base can either bolt down to the lathe bed with an appropriate spacer or be used on a separate platform in the vertical plane with the work pieces loosely set under the arbor and then secured as required. As the forward motion is all self contained there is no need for the machine to sit on the saddle so it can be interposed between saddle and chuck on the lathe bed to cut the odd keyway. This is obviously much quicker and easier to use but even better is a separate machine as it does away with any resetting of the work in the lathe chuck and is the preferred method for key cutting groups of wheels. Several interesting jobs can now be tackled, such as cutting keys in two adjacent bores, as one would have in a crank with two separate pins to very precise measurements for key size and orientation. Built up crankshafts of quite complicated design can now be a very practical proposition with a confidence that the end result will be perfect and taking a

5. The same unit showing modified pawl arrangement.a

fraction of the time necessary for lesser methods. The actual additional parts are not much in quantity or content.

Adapters

Although the model engineer largely has control of the sizes of shafts and housings that he will make and can therefore build up machinery and mechanisms to suit a few sizes to suit available equipment in the shop, like the Keyway Cutter, there will be times when a key slot is required in a size not specifically catered for by an arbor on hand and to extend the machine's usefulness a series of adapters can be made as indicated in the drawing given in the previous article.

This looks to be merely straight forward turning and boring work but for the adapters to work properly the offset of the two circles needs to be accurately set one to the other which can be done by direct measurement, just with toolmaker's button methods as long as there is a biggish difference between arbor and out of size bore diameters and by trial and error, though usually I would frown on this approach. The main large bore plug is turned down to size and the work is then lifted up to approximately right height and a centre put in, drilled out and boring commenced with the bore measured and tested arithmetically till the correct offset is obtained. To make this work proceed smoothly start with a square piece of bar.

The passage of the key cutting blade is arranged by milling out the slot and adding a round hole in the flange section. The adapter does not have to guide the blade in any way, only set the arbor to the bore, but it must be prevented from turning around during operations and this can be done by planting a hole in the wheel corresponding to one in the adapter or some other suitable fixing arranged where additional holes are not permitted, like using an existing grub screw or strongbacks through spoked wheels.

Power driving

The photographs have shown the machine in its original guise but several ideas have run through my head about possible modifications to extend the use of the machine or reduce the effort in working it to near zero. It would be possible to add an extension to the base plate and place a small electric motor on it driving a worm gear box to give a step down ratio of 40 to 1 and then driving an eccentric to push and pull the ram of the machine. A mechanical counter would be added to the main part of the machine driven off the plunger that operates the ratchet wheel so each complete stroke is counted and it would then be possible to be very exact about the depth of the keyway. Some preliminary work over several wheels showed that the actual cut was very slightly less than the anticipated figure and thus by averaging, a more representative figure for the number of strokes to complete a keyway was found. A complete 1.5 mm deep keyway takes no more than two minutes which, with one off keyways, is not much of a motivation to build a lot more parts. However where a stack of 10 or more wheels need keying, the ease of running these through the machine would eliminate any thoughts about alternatives to keyed assemblies which I would naturally favour, but until recently often avoided. It is a fact that once one has a special machine to do certain jobs, the design process tends to take its presence into account and more work can be assigned to it which once was committed to lesser methods. I have seen this repeatedly in industry and it should be just as common in the home workshop. Building up crank shafts with keyed components is one option but there are many others like splining, fitting axles and wheels for locomotives with easy quartering procedures and generally working with keyed assemblies rather than force and glued fits.

Worm and wormwheels

If one can lay one's hands on a small geared motor with a worm box then much of the work is already complete but making a worm and wormwheel is not a major or a problem job as the basic requirements in the workshop are easily arranged. A normal tap run in the lathe chuck and a short mandrel carrying the wheel blank so the latter lies on centre

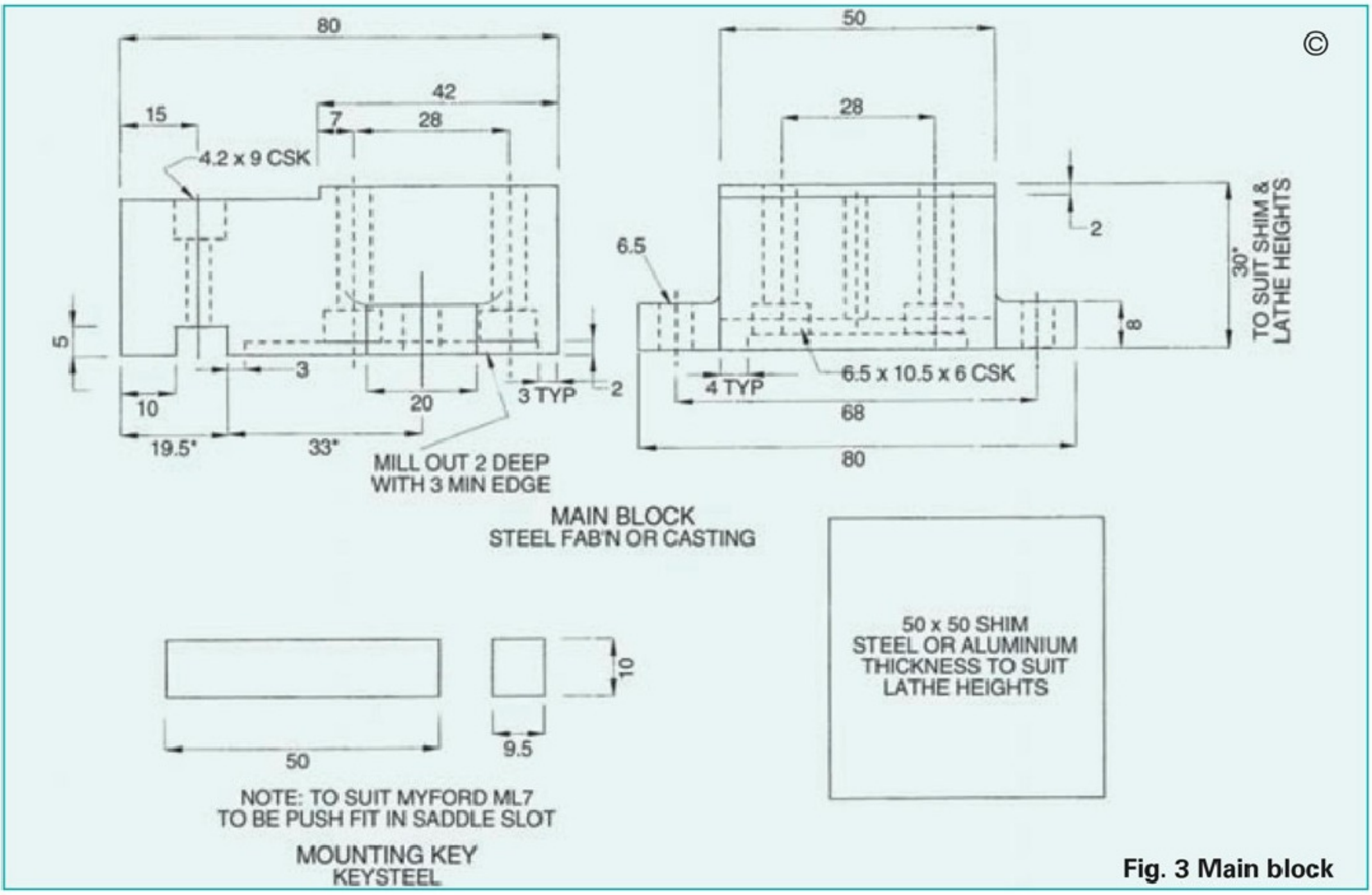


Fig. 3 Main block

line and is free to revolve but also free of any shake on its pin or mandrel is all that is needed. In the absence of an appropriate tap one can make a cutter while making the worm. Both may be made in silver steel and subsequently hardened and tempered. The hob needs to be gashed like a tap, to provide a cutting edge and clear out swarf and to have a short plain length for holding in the lathe chuck while the wheel turns on a well fitting pin on a plate in the tool post. The thread should be to Acme standards. The initial cuts into the wheel look terrible but after a while the shape just appears and the shape must then be gauged to ensure there is full depth engagement to the base of the thread. On the first worm and wormwheels I made by this method I ended up with one tooth less than expected but here 39 or 41 teeth is not a problem. I still cannot see how good looking teeth can carry such an error but such was the case. The depthing of the wheel is critical and has to happen in two stages. The first is to get the diameter of the wheel correct with high precision which is calculated by dividing the pitch diameter by Pi in the following form.

$$\text{Outside diameter} = \frac{(\text{Number of teeth in wheel} + 2 \text{ teeth}) \times \text{pitch of between 2 teeth}}{3.142}$$

It is important to keep to a set size for the tooth depth so the mesh of wheel and worm is right. Standard screw cutting tables will provide all the necessary information. The wheel should be in bronze . One can use the actual worm to check the mesh and it will be right when there is no noticeable catching as the two revolve with each other. If cutting a worm wheel for which the number of teeth is critical, then the wheel could be gashed first using a suitable dividing device, so that the tap or hob has a partial form to follow.

A box in steel plate has to be made to fit the motor nose and house the bearings to carry the wormwheel shafts and which will depend on the motor to hand. At the drive end of the shaft there is a eccentric which is made with a tee slot in which rides the adjustable crank pin which can be moved and held by a grub screw fixing. I have only moved the eccentric pin once when initially setting up the motorised unit as I always fully stroke the cutting tool through the wheel being slotted, but it is advisable to have the adjustment for the initial phase. The connecting rod is to one's own fancies; the actual force required and the loading in the rod are not very high so a 6 mm diameter is acceptable. The output speed of the eccentric is about 35 rpm but more teeth in the worm wheel will give slower rotation, of course. The motor is only needs to be around 1/10 HP and lies along side the machine with the gearbox furthest away from the machine .

Next steps

Working with the attachment on the lathe is not really a good solution as it requires the individual wheels to be set up in the chuck or, better, on the face plate where they can be aligned not to the jaws of a chuck and dial indicator but to the arbor though some form of raising block is advisable to prevent damage to the lathe. The more appropriate method would be to make the whole Keyway Cutter free standing with a pillared stand so it was a separate machine altogether.

Towards this end there is a stand being made that incorporates the same sort of assembly I have successfully used in a camshaft forming machine and that was itself based on the Quorn round bar bed with two long vertical round bars with top and bottom bridging pieces and a sliding saddle running between them though that feature is again not widely used. The motor and worm box now sit at the top of the columns. The base of the machine holds the columns or pillars and a raising block which is tubular and on top of which is placed the machined table that holds the wheels. The side of the tube is cut to remove swarf occasionally and to allow the full travel of the arbor and cutter. The table is Tee slotted for bolts that will clamp the wheel which is aligned to the arbor only. Various attachments can be made to obtain orientation for quartering, for example, which are first aligned to the arbor and then the wheels can be sequentially placed, clamped and run through the Keyway Cutter for slotting. There is nothing particularly difficult about the stand as long as time is taken to get the pillars parallel and truly square to the base for which a re- read of the Quorn series would make sense.

Though I would have liked to complete the work on the original broaches similar to those that can be purchased, I have come to think that the single point tool has its own advantages for the home workshop, it is certainly easier to make, it does not call for sophisticated grinding techniques, is capable of re- sharpening in a manner not possible with the broach and is fully automatic in operation. One is often asked with machinery construction as to how long the work takes as motivation for manufacture in the home workshop often stands or falls on the time to make the equipment. Bearing in mind that I had to stop from time to time to rethink some of the work, particularly with regard to the ratchet and pawl drives, so there was some doubling of the content, the machine was started on a Monday and complete with hand operation three weeks later to the day with approximately 5 hours given to the project each day. The electric drive came a month later and took three days to build and assemble. The stand looks to be another two to three week job.

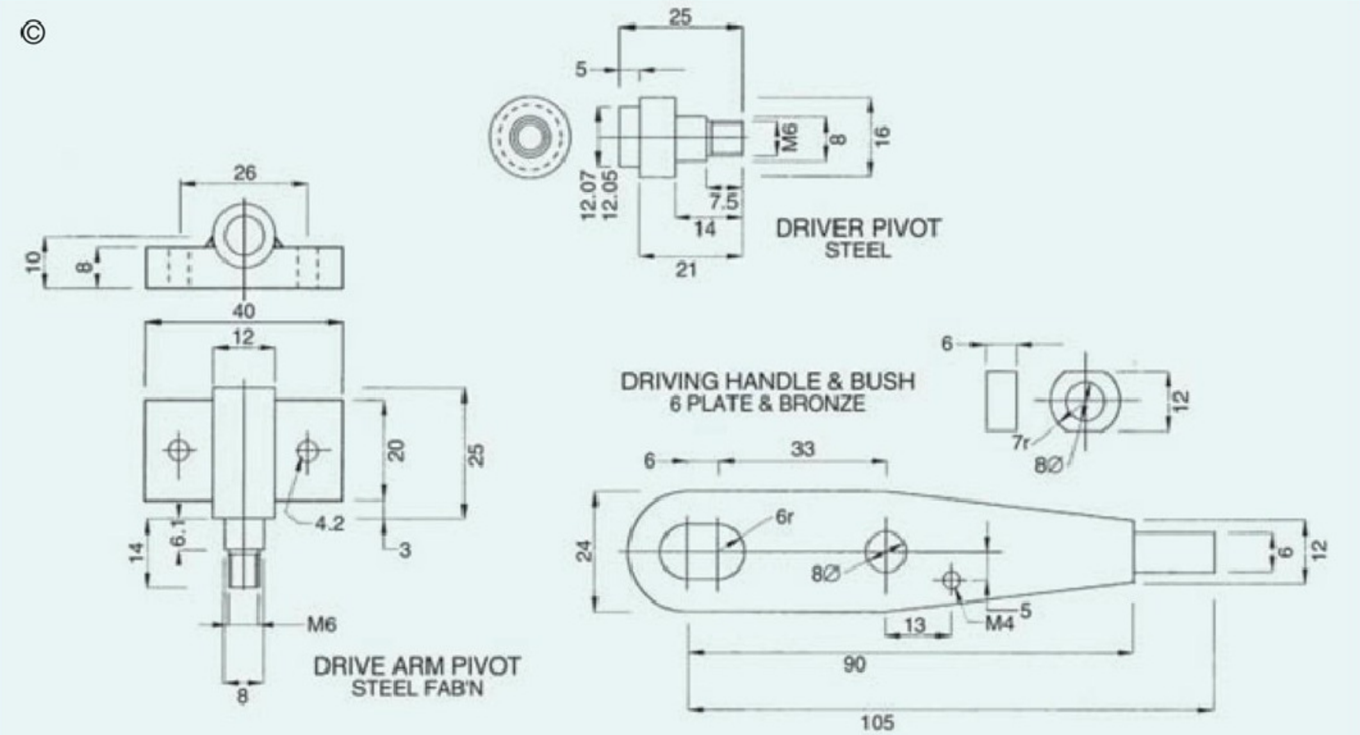


Fig. 4 Driving handle

THE X-3 MILLING MACHINE

Dick Stephen takes delivery of a new machine, and is suitably impressed by Far Eastern design and quality.

1. The X3 Milling Machine

Background

About 4 years ago I purchased a CNC mill having seen it demonstrated at a Model Engineering exhibition. I had been interested in clock making for nearly 25 years and had become tired of cutting out skeleton clock plates and crossing wheels by hand. Over the last 4 years I have become more and more fascinated by the endless applications of CNC not only to clock making but more generally in the amateur workshop. Recently I decided to take my interest in CNC a step further and to retrofit a mill entirely myself. I wanted the result to be a machine that was configured precisely to my own specifications and requirements. I also did not want to invest a great deal of money in the project as at the end of the exercise I intended sell one of the mills. If my retrofit turned out not as I had hoped then I would not have lost too much if I had to sell it.

Which machine?

The first problem was choosing a mill to retrofit. I wasn't interested in any of the small mills that are available, due to the simple fact that one can make small items on a large machine but it is however impossible to make large items on a small one. I wanted a machine with an X-axis movement of 300 mm and a Y-axis of a minimum of 150 mm. The problem with nearly all the machines I looked at was the Z-axis. This had to have a screw feed, but should not have a round column. Most of the imported new machines, mainly of far eastern origin had round columns and rack and pinion feeds. This rendered them, in my opinion, unsuitable. I simply could not see how I would get sufficient accuracy for the Z-axis feed or adequate stability of the head, when movement up and down the column is considered. Eventually I found the X-3. This was the appropriate size and most importantly, in addition to the normal quill arrangement, it had a dove tail Z-axis and a screw feed. It was, like nearly all the mills available, made in China. Chinese machine tools for one reason or another, enjoy in some quarters, a reputation for inferior quality. This has not been my experience. I have several items of Taiwanese origin and frankly they are all excellent and as good or better than equivalents made in Europe. So this last January I took myself down to the Wembley exhibition to have a closer look at the X-3. I spent some time over a careful examination of the machine. The overall finish was good, and in fact, the more I looked the better I liked it.

Several features are worth mentioning. As can be seen from the photo. the stand incorporates a useful lockable cupboard for tool storage, and safety wise, a clear plastic guard is fitted which slides up and down and also hinges forwards. Most purchasers of this machine will no doubt wish to use it as supplied (rather than carry out the CNC conversion) and in this respect, the graduated rule along the front of the table is the sort of detail which makes it much easier to avoid miscounting turns of the handle on long traverses. The spindle power is provided by a 600 watt permanent magnet DC motor driving through a two speed gearbox via a toothed belt. The electronic speed control system includes overload protection and feedback for speed stability. The specification claims a speed range from 100rpm to 2000rpm in high range, and 100rpm to 1000rpm in low, although it seems possible to go well below this.

Arc Euro Trade and the machine in pieces

As luck would have it the X-3 is available from Arc Euro Trade, who are based in Leicester not too far from my home. A further piece of good fortune was that a friend of mine had just started working for Arc cleaning and setting up Arc's machines before they are sent out to the customers.

2. The retaining cap which holds the 3 – 2 Morse taper adapter in place

This is a very important point to bear in mind if you intend buying a far eastern machine. All the machines supplied by Arc (excluding Z1 & X0) will have been stripped down, cleaned and any problems sorted before the machine reaches the customer. The person doing this is also very good at it. When I paid Arc a visit I was able to see an X3 in pieces being cleaned. This allowed me to assess the quality of the construction as well as to take measurements to see how feasible it would be to fit ball screws, which I believe are an absolute must for CNC. The first thing I noticed was the high quality of the castings; the quality of the construction was first class. All parts are screwed and doweled making assembly very precise. In fact I was not able to fault the construction in any way. The head is very solid and heavy being entirely of cast iron construction. To counteract the weight of the head the Z-axis is fitted with a gas spring. (The same sort of device used to counter the weight of a hatchback rear door) The substantial weight and rigidity of the head means that the mill should handle large cutters without trouble. I then examined the X and Y axes. Again here no problems in fact, only plus points. The X-axis screw is supported at both ends. This means that the nut does not have to serve as both a nut and a bearing. This will significantly reduce the wear on the nut and reduce backlash. The Y-axis screw is unsupported at its free end, which is fine with the existing acme screw. When converting to ball screws, a rear bearing will be needed, but this will be a very simple task to fit and that is certainly something I will do when I fit the ball screws. The existing nuts on all three axes are anti-backlash bronze nuts of substantial proportion. Measuring up the space available at all three axes I realised that it would be possible to fit ball screws without having to do any machining on the castings. A very major plus as far as the retrofit was concerned. By this time I had seen enough to convince me that the X3 was a goer and without delay placed an order for a machine with a No. 3 Morse taper spindle. That the machine was an Imperial one mattered little as I was going to replace the screws with metric ones.

Delivery

The mill was duly delivered by Arc, the machine in one crate and the stand in a second. Getting the stand into the workshop was no problem, the mill presented a heavy problem. There was no way that I could have moved the machine into the workshop let alone raised it on to the stand even with another pair of hands. Arc when delivering extremely heavy machines come fully equipped with a mobile lifter to solve such heavy problems. (ARC provides this service by special arrangement only, at extra cost). Readers purchasing this size of machine should therefore make the necessary preparations before placing an order, as carriers will only deliver the machines to your door without installing the machines. If you are unprepared, you could be faced a with bit of tricky installation work requiring specialist lifting gear, rather as Jack Cox outlined in his article in MEW issue 97.

3. Centring microscope in use on lathe

Small mod. and little niggles

I have had the mill for some time and been able to carefully check every aspect of the machine before I take it apart to install the ball screws and stepper motors. As I have already said, the spindle comes with a No.3 Morse taper. All the tooling that I have, has No.2 Morse taper. This has required the fitting of a No.3 to No.2 Morse adapter. **Photo 2** illustrates the way I have done this. Fortunately the spindle comes with a transverse groove into which two drive dogs are secured by 5 mm cap heads which I was able to use to attach the cover piece I made, which retains the No. 3 to No.2 adapter while the No. 2 tooling is removed. Without such a retainer, the chances are that each time the No. 2 tooling is ejected, the adapter comes out with the tool and then has to be separated and refitted. I have been able to find only two aspects of the mill I don't like. The first is the draw bar which is a typical item and a bit crude for my taste. Again this is a trivial problem to solve. I have tapped the hole at the top end of the spindle with a 15 mm by 1 mm pitch thread and made a differential thread draw bar. This will allow a "push" action for tooling removal. I use a centring microscope a lot (**Photo 3** shows this in use on the lathe) and I didn't fancy using a mallet to remove it. The other aspect I don't like is the accessibility of the electrical controls on the side of the column. I guess though, that one would get used to the position in time. Fitting the Z-axis stepper motor will require the electrics to be moved which in turn will allow me to situate them in a position more convenient for my way of working.

Overall

I have checked the set up of the table with a dial gauge. Both the X and the Y axes are set precisely at 90 degrees to the spindle. I could not detect any movement of the dial gauge when traversing along either axes. The concentricity of the spindle, even after the addition of the Morse adaptor is also perfect. The adjustment of the gib screws on the X and Y axes is also very precise and convenient. The Z-axis too, is fitted with a tapered gib strip for ease of adjustment. **Photo 4** was taken during the strip down phase and serves to give some idea of the thickness and weight of the head casting.

In my opinion the X3 mill is an excellent machine very well constructed and at around £1,000 including the stand, superb value for money.

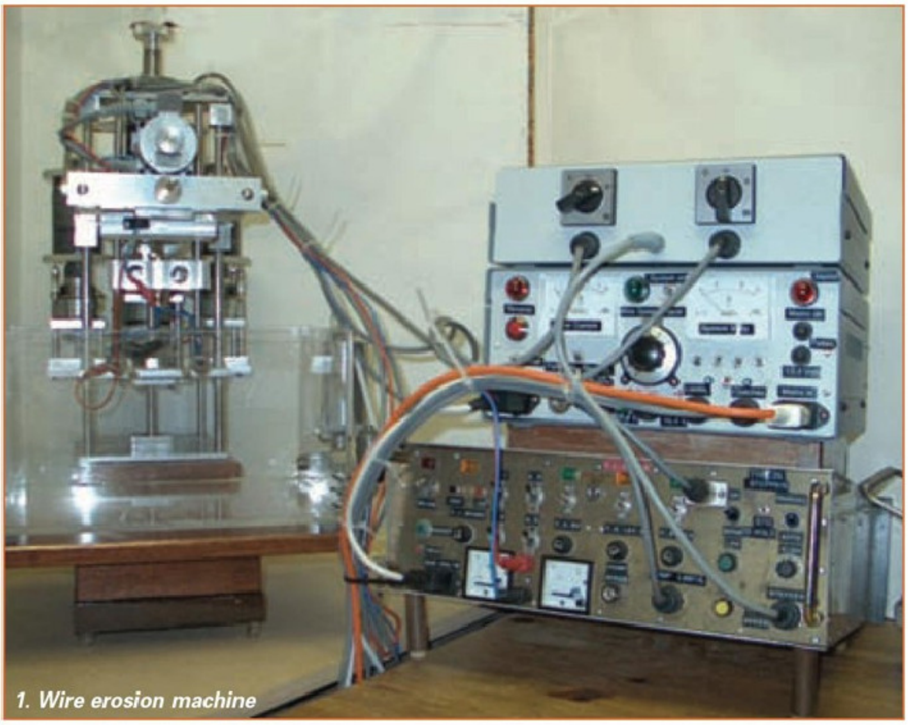
4. The weight of the head casting augers well for the general rigidity of the machine.

Supplier

Arc Euro Trade, 10 Archdale Street, Syston, Leicester, LE7 1NA. Tel 0116 269 5693

See also advert. on page 4.

MK 3 WIRE ERODER (4)



1. Wire erosion machine

In this section Peter Rawlinson deals with the printed circuit boards and electronics

Spark eroder PC board

As a fourth article on the Wire Eroder I thought I would start with the P.C.B. "printed circuit board" which is the basis of the electronics that are required to operate the drive mechanism. This is essentially the same as published in MEW issues 57 and 58 in relation to my original spark eroder, and as a result the description will be kept relatively brief. A detailed test procedure will be presented later which should help to achieve a fully working circuit.

Control circuit

Being a mechanical engineer by background, for the electronic side I have therefore borrowed heavily from other sources and acknowledge these with gratitude. To this end I would like to point out here that the main design of the electronic circuitry and the basic PCB is the work of Robert Langlois of Ontario Canada, and to him I am most indebted. I have also drawn heavily on his test procedures, but have checked these with my own working circuit boards. In addition, the PCB has been redrawn to suit myself and parts available in Britain; I have also incorporated a plug in system which makes for a very much better way of removal for testing etc.

As noted previously, the cost of having these PCB's made commercially in small quantities is completely prohibitive and it was decided to make my own.

Printed circuit board

Before embarking on this, I first read the excellent articles in the M.E.W. issues 26, 27, 33 and 34 by Ray Stuart and a book called "How to design and make your own PCB's. by Mr R.A.Penfold. The method I adopted was described in more detail in an earlier article, and relies on creating a negative, then photographic development of the resist, and hence the need for a UV light box. I gather that other techniques are now available, and that an article on one of these by Chris Fouweather will appear in a future issue of MEW. It is therefore my intention here to merely give a little guidance where I can from the amateur's view.

Please note that the PCB layout is printed full size and the dimensions shown on it must be adhered to or the various components will not fit in the drilled holes. However a negative can be made by taking the magazine to a good copy house who can print it onto film.

I understand the simple way is to do as I did as a child printing photographs, that is to sandwich the negative and the pre - sensitised board between a piece of flat glass and a piece of board, and to the let the sun do the work, however I found that this did not work for me and after a number of abortive attempts gave up, One attempt ended up with no tracks and copper where no copper should have been in other words a negative. I therefore decided that a UV light box was needed, and the price range of £120 to £200 fro a commercial unit (**photo 2**) dictated that I should make my own.

Most parts were unearthed from the scrap box, but a friend contributed a surplus mahogany kitchen drawer, while the plate glass came from the local glazier and the UV light source was found in the Maplin catalogue. This unit was priced at £5.34 + VAT and consisted of: UV bulb of 4 watts, bulb holders, plug, switch, cable, choke, starter, capacitor and case. Five of these were purchased, their part number is MW36P, which is attractive when it is realised that the bulb alone was £ 3.25 + VAT and after completing the box I still

2. A commercial ultra violet light box.

3. Home made UV light box.

4. Mechanism for "Rocking table"

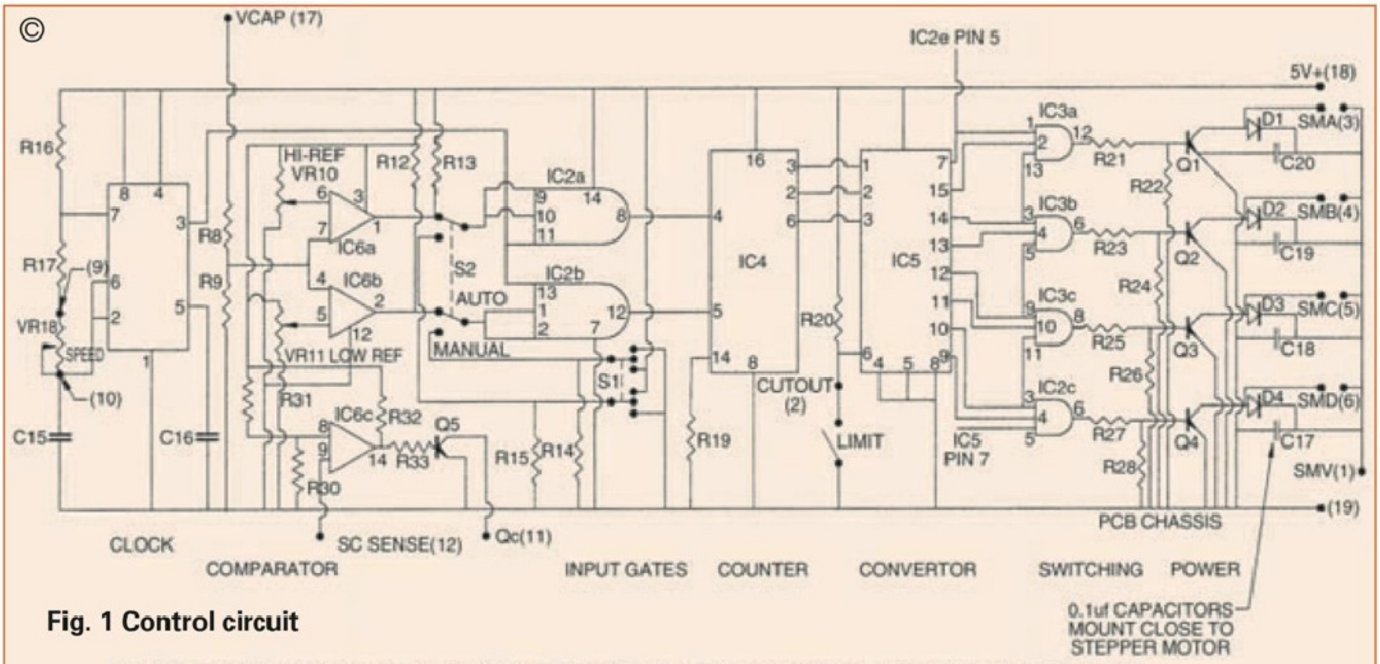


Fig. 1 Control circuit

NOTE: THE PCB CHASSIS MUST NOT COME INTO CONTACT WITH THE SPARK EARTH UNDER ANY CIRCUMSTANCES
SEE SEPARATE DRAWING FOR THE BRIDGE RECTIFIER CIRCUITS, & THE ELECTRICAL CIRCUIT
ALL PART NO'S REFER TO PARTS LIST, CAPACITORS MARKED 'C' ARE 0.1uf CERAMIC FOR DECOUPLING
NUMBERS IN BRACKETS REFER TO POS'NS ON TERMINAL BLOCKS 1 & 2
ALL 5V POWER CONNECTIONS TO THE IC'S ARE DECOUPLED ADJACENT TO THE IC, THESE ARE SHOWN ON THE CONVERTER DRAWING
CIRCUIT DESIGN BY ROBERT LANGLOIS, ONTARIO, CANADA

Safety notes

Do read all the instructions carefully and keep the hands etc. out of the chemicals, also carry out all operations away from "children, animals, and food stuffs." also dispose of as directed on the container or check with the manufacturers.

Also do not expose your skin or eyes to the UV light for more than a few seconds, or better still not at all.

When working with the etch chemical, it is a good idea to wear Marigold or similar protective gloves, and when finished, make sure all items are washed before storage.

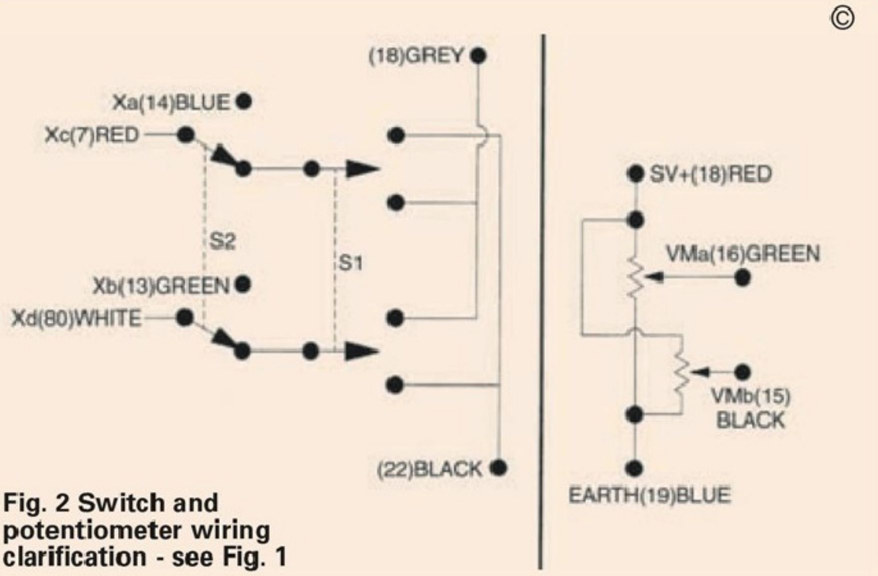


Fig. 2 Switch and potentiometer wiring clarification - see Fig. 1

5. Purpose built etch tank – later version with PCB.

have four switches and four 13 amp plugs and cables for future use.

I do not intend giving a detailed account as it is simple to build, but **photo 3** gives the general idea of the build up and layout of the bulbs and chokes etc. More detail on this may be found in MEW issue 57.

In essence the drawer was divided into two main compartments, the rear one for the chokes and other components, and the forward for the light tubes. This area is covered first by the glass, and then by the foam covered lid. It should be noted that my box will light an area of 115mm x 270mm and I was surprised to find that light does not seem to spread beyond the ends of the bulbs.

This project separately yielded a UV light box worth around £150.00 for an outlay of some £35.00. It works well but a greater spread of light should be possible if the glass to bulb distance is increased from my chosen 20mm. It is also possible that a silver type reflector will give a better spread of light, but this should be of a type as used in the halogen lights. (They have a crinkled surface so that the light is spread evenly). For information, I set the bulbs at 50mm centres.

Board and negative

Following an abortive attempt to use standard board and apply a sensitising spray, I opted for a pre- sensitised board which has a plastic coating that is peeled off immediately prior to use.

My "negative" was printed on an inkjet printer, but problems were experienced with the ink drying; even after weeks it was still "smudge-able". Since then I have received two pieces of helpful advice, first to use thin drawing paper (but being more opaque would increase the exposure time) and secondly to photocopy on to "copier friendly acetate" which solves all the problems. For handling the boards, I have found that a pair of locking forceps works very well.

Exposure

I started out with some trial pieces about 30mm square, and it was found (using film) that a time of 10 minutes was required for the exposure to give

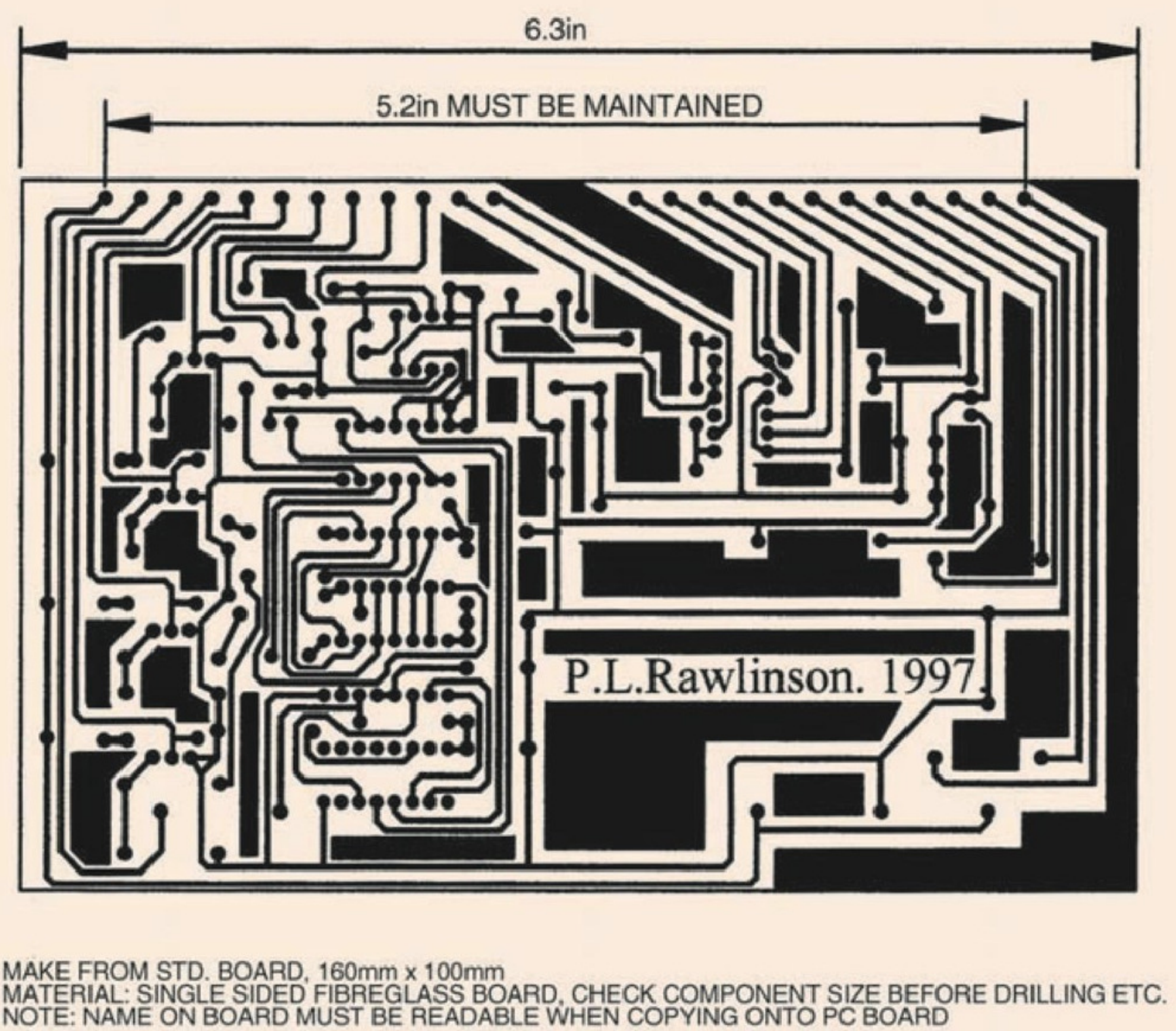


Fig. 3 PC board layout

satisfactory results, but I think now another couple of minutes would have been better, but at least this gives a starting point. After this trial, I went to the full size and no problem was experienced.

6. A Dremel fitted to the mill via an adapter for accurately placed small holes.

Developing

Follow the directions given with the developer being used, as they can vary slightly. The temperature can be maintained by putting the dish of developer into another dish of hot water, and topping up the outer dish from a kettle. A soft haired brush may be used to gently stir the chemicals over the board. This agitates the fluid and helps to clear the sensitized surface which has been degraded by the chemical action. The board will soon look like the negative, with the tracks still covered and bright copper showing at all other places. Now take the board out and inspect carefully. If it is satisfactory, rinse

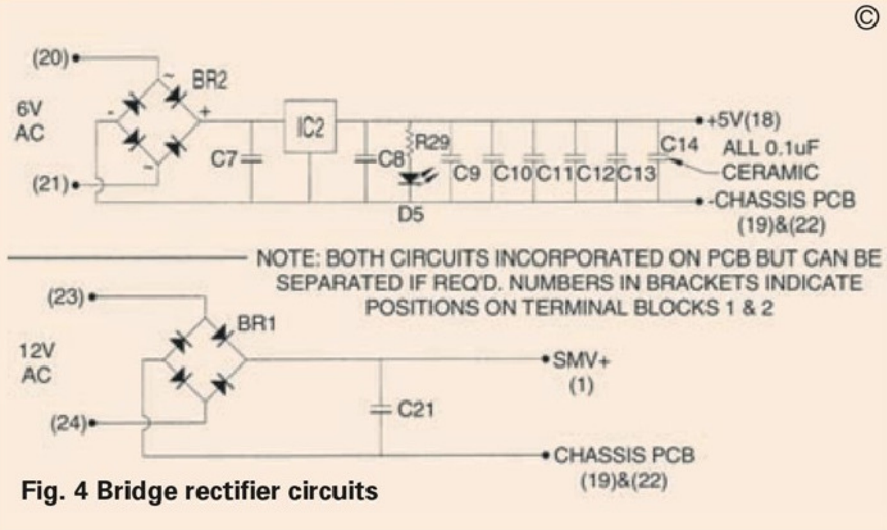
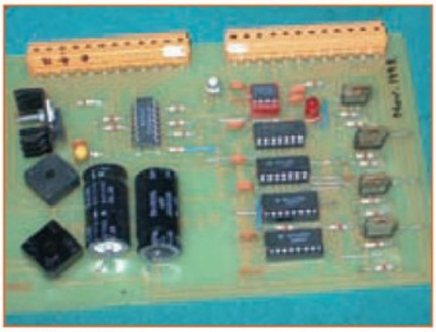


Fig. 4 Bridge rectifier circuits



7. The PC board now populated.

thoroughly under running water to stop the chemical reaction.

Etching the board

The chemical used is basically ferric chloride obtained from Maplins as PCB etch powder part No MC49D, which is economic and easy to use. Mix as per the instructions and use at 45 deg. C. As with the developer, I used an outer tank refilled as necessary to hold the temperature. For a thermometer, I used a digital device intended for a fish tank, but a normal glass one would be fine.

Several methods are available to "encourage" the etching process. Originally I used a rocking table system powered by a small geared model motor working at about 20rpm to rock the tank, (the mechanism of which is illustrated in **photo 4**) augmented by the application again of the soft haired brush. I later constructed a purpose built tank (MEW iss.64) which speeds things up considerably, and is justified if a number of boards is considered (**photo 5**). The advice given by Clive Noakes (Scribe a Line MEW issue 67) is also extremely relevant. He advocates supporting the PCB copper side down (for the debris to fall away) and a slightly higher temperature (50deg. C).

Regularly inspect the board during etching and when completed remove from the chemical and wash thoroughly using the "tweezers" and not your fingers. I then cleaned the boards with a "Garryflex" block which I generally use for metal finishing. It is a block of some 70 x 40 x 20mm made up of a rubber compound impregnated with abrasive and available in several grades. The etch resist is removed sufficiently to give a bright copper sheen to the tracks.

The board is then inspected closely to determine if any tracks are missing or conversely if any shorts are apparent. I checked with a magnifying glass and an ohm meter, and found one piece of track about 2mm long missing, which was repaired during the soldering of the components, also two places where the etch had not cleared between the tracks. This is more difficult to solve but I then ground the back edge of a scalpel blade to act as a hook scraper which worked very well. It was also used where solder over ran, and has now been put away carefully with the soldering gear for future use.

Drilling holes

Most holes are 0.8mm but some are larger so check the components first. A small high speed drill like a Dremel or Minicraft

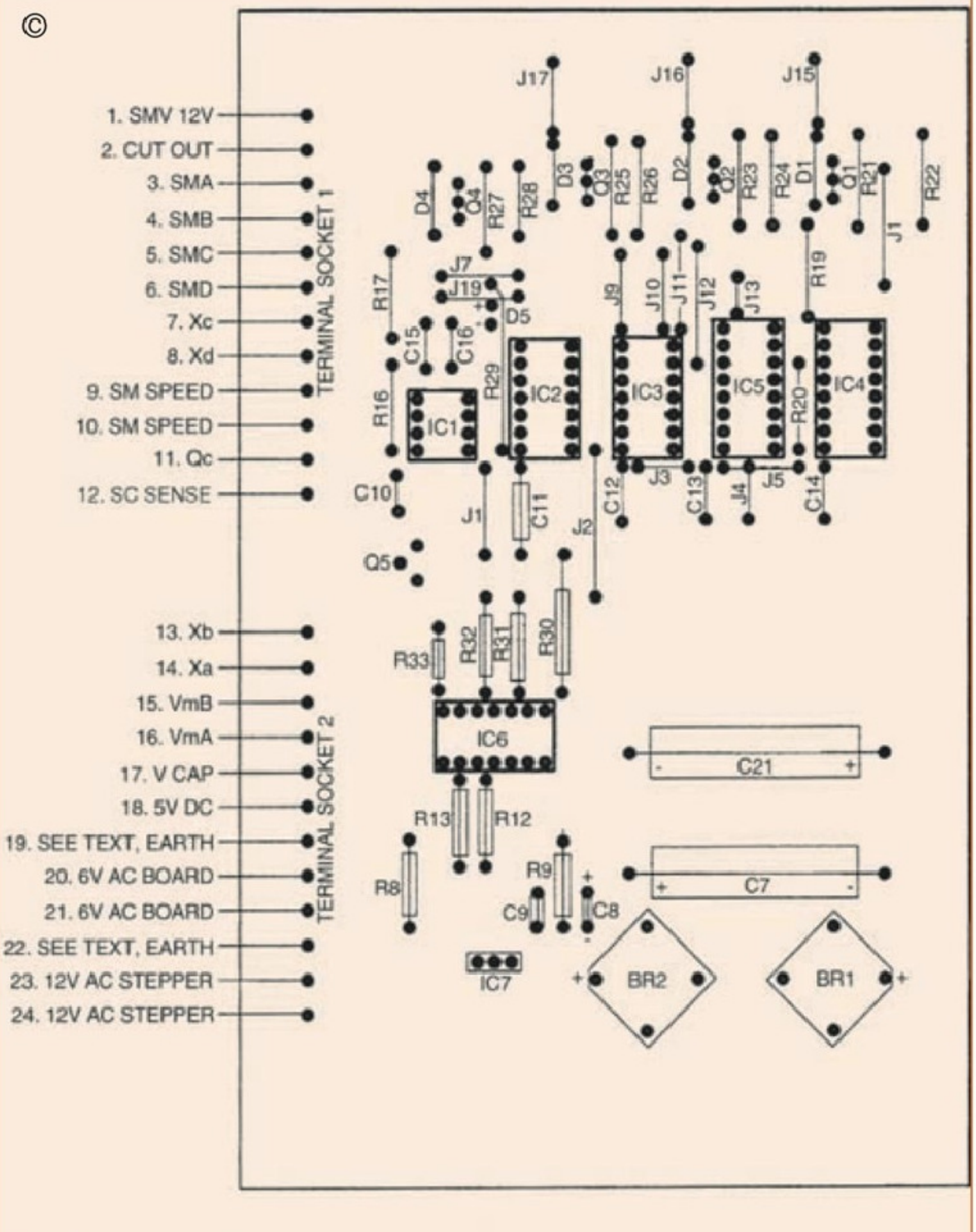


Fig. 5 Component layout

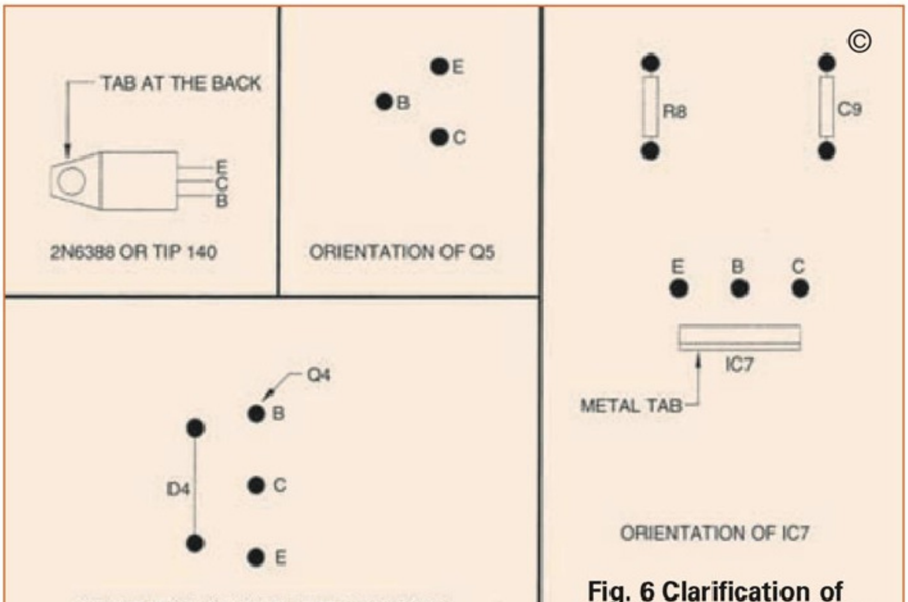


Fig. 6 Clarification of component orientation

PCB Parts List

(Part Numbers are Maplin reference unless otherwise stated)

1. Presensitized Board		FA 63 T		
2. Developer.		YJ38R		
3. Etchant		YX12N		
4. Etch Resist Pen.		HX02C		
CHIPS (IC's) & Transistors				
5. LM555	(IC.1.)			
6. SN74LS10	(IC.2.)	YF08J		
7 SN74LS10	(IC.3.)	YF08J		
8. SN74LS193	(IC.4.)	YF81C		
9. SN74LS138	(IC.5.)	YF53H		
10. LM339N	(IC.6.)	UH31J		
11. LM7805CT	(IC.7.)	AV16S		
12. TIP 140	(Q.1. - Q.4.)	426-830	4 off	Farnell
13. 2N2222	(Q.5.)	UH54J		
DIODES				
14. IN4002	(D.1. - D.4.)	QL74R	4 off	
LED				
15. Red 5v.LED	(D.5.)	CK46A		
RECTIFIERS				
16. 6.amp.x l00v	(BR1.& 2.)	BV 706-929	2 off	Farnell
STEPPER MOTOR				
17. 12v.x48.step		575-653		Farnell
SOCKETS				
18. 8.Pin DIL		FJ63T	1 off	
19. 14.Pin.DIL		FJ64U	3 off	
20. 16.Pin.DIL		FJ65Y	2 off	
21. PCB.Terminal Sockets 12.Way		NE55K	2 off	
22. PCB.Terminal Plug. 12 Way		NE27F	2 off	
23. Barrier Strip		423-497		Farnell
24. Cable Supports		389-555		Farnell
RESISTORS				
25. R8.	100K	Q100K	1 off	
26. R9	4.7K	Q4.7K	1 off	
27. R12-R17,R19.-28, R32 & R33	1K	Q1K	19 off	
28. R29.	470.	Q470.	1 off	
29. R31 & 37.	10K	Q10K.	2 off	
30. R30.	2.2K	Q2.2K	1 off	
31. R34.	100.	Q100.	1 off	
Use following for initial set up				
32. R35,R36.	4.7K	Q4.7K.	2 off	
33. R37.	10K	Q10K.	1 off	
34. R38.	1K.	QIK.	1 off	
POTENTIOMETERS				
35. R10 & R11.	10K Lin.0.2.Watt.	JM7IN.	2 off	
36. R18.	100K.Lin.0.2 Watt.	JM74R.	1 off	
CAPACITORS				
37. C9-20.	0.1.uf 50v.	BX03D.	14 off	
38. C7&21.	1000.uf. 50v.	ATI9V	2 off	
39. C8.	20uf. 50v.	WW73Q.	1 off	
SWITCHES				
40. S1.	DPDT Toggle (On-On)	FH00A.	1 off	
41. 52.	DPDT.Toggle (On)0ff(On)	FH03D.	1 off	
42. S3.	Micro.Roller. SPST.	FH95D.	1 off	
43. P1.	6.Pin.Sockets.	HL36P.	2 off	
44. P2.	6.Pin Plug.	HL37S.	2 off	
45. Cable.	8.core cable.	XS19V.	4 Meters	
46. Heat Sink.	TO220.	KU51F.	1 off	

Plus all ancilliary Parts:
Nuts, Bolts, Spacers, Solder, Hook-up Wire, Knobs, Etc.
Many of the above parts will have equivalents available from Maplins, Farnell or Electromail.

is ideal, and can be mounted to a mill or drill via an adapter (**photo 6**). One useful tip is to make use of a fence, fixing one axis and allowing the board to slide on the other. This makes manual positioning considerably easier

Precautions

Make sure the soldering iron is earthed and use only a maximum of a 25 watt iron.

- Earth yourself. (A wire round the wrist to a water pipe is all that is needed.)
- Keep the iron on the component for a maximum of 3 Seconds.
- Use a heat sink and short out the pins where possible. Use ordinary tweezers with an elastic band on them so they will stay closed.

Population

I also made a simple MDF jig to hold the board, and soldered components in the following order:-

1. Jumper leads
2. Resistors
3. Sockets
4. Capacitors
5. LED's
6. Diodes
7. Rectifiers
8. Transistor
9. Power devices

Many components have to be orientated in a specific direction, and it must also be remembered that the components are fitted to the "non copper side of the board" so beware the mirror image effect.

- **Diodes** have a silver band. This goes to the right of the board (output sockets at top).
- **LED.** Flat to left of board.
- **Rectifiers.** Positive DC. pins to outer edges of board.
- **Chip sockets.** These have a notch at one end, Nos. 1, 2, 3,4, 5. to the Left.
- **Nos. 6.** to the top of the board.
- **Output transistors.** Metal plate to the bottom of the board.
- **Voltage regulator.** To the left of the board.

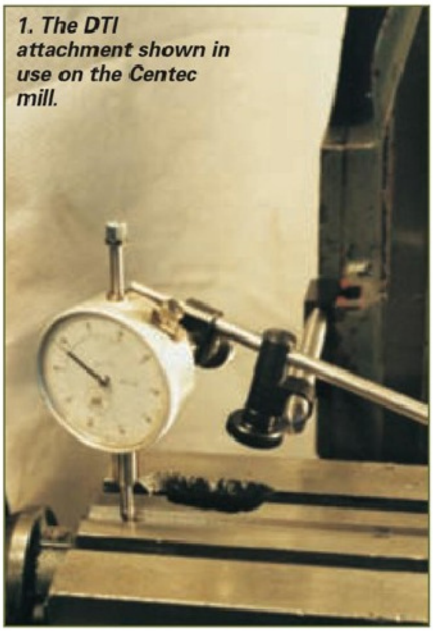
After a trial population of the board, I removed all parts bar the jumpers. These were then held in place with a piece of foam rubber, the board turned over and the solder applied. The ends were then trimmed and the joints inspected with a loupe. A similar approach is followed for successive groups of components. If a transistor or component is damaged then cut the item off above the board and deal with each wire individually, this will help to obviate damaging the track on the PCB. This should now complete the building of the PCB (**photo 7**) and all will be ready for testing, for which a detailed procedure will be given in a later article.

I shall as always be happy to help where possible but phone only please, and I will not ring back for obvious reasons.

Peter Rawlinson. Charing, Kent.
Tel: 01233 712158.

ACCESSORIES FOR A CENTEC

John Slater describes his DTI holder and adjustable work stop.



1. The DTI attachment shown in use on the Centec mill.

Oh! Woe is me

I'd been on one of my frequent workshop visits to my mate David; seeking as we usually do solace comfort etc., and this time a ⅝₂in. woodruff cutter. When I related my tale of woe, what did I get, no solace or comfort but; "I couldn't do with your scrap rate, 50% way too much!" Knows how to wound does David. He's a proper machinist is David - earns his living working a boring machine on piece work. And to cap it all, he didn't have a cutter either.

Here's my tale of woe. I'd been attempting to make some additional Dickson type tool holders for specials to hold round tool bits (I know about the vee type of Dickson holders, but they won't do in this case). My "production" method revolved around cutting the T slot first; end milling the slot then undercutting using a woodruff cutter. However my cutter was ⅛in. thick. This meant two passes at different heights. Now how it happened I'm not sure (I'm tempted to blame anyone but me, I guess it must have been brain fade) but some how I went up with the feed on the miller vertical head instead of down! Lots of naughty words were said at this point as the second item of a batch of two was scrapped. Hence the visit and comment by David. Is it only me, or does everyone else suffer these momentary lapsed that result in scrap? You never seem to read of these things in the magazines so I guess it must be me!

2. The completed attachment shown without dial gauge.

There has to be a better way

A ⅝₂in. woodruff cutter would have solved the problem nicely (perhaps). The more I thought about the problem and the causes I became more convinced that I needed to be able to monitor the feed movement in a more tangible way than relying on juggling with the feed dial and remembering to add or subtract the readings.

I have two magnetic base dial indicator stands but find that both are very inconvenient to use with my milling machine a Centec 2A (the one with the very small table and knee adjustment at the rear of the machine). (*Some Centecs feature an uncounterbalanced, uncalibrated lever feed at the rear –Ed.*) I'm always juggling for space and can never get the magnetic base set rigid enough to read accurately. However running up the side of the body of the Centec is a T slot that originally carried the knee height stops. Yes I realise now that I could perhaps have prevented my mishap by using the stops but I still needed some way of setting them and the location of my machine makes it very difficult to read the graduations on the knee movement.

A dial gauge holder

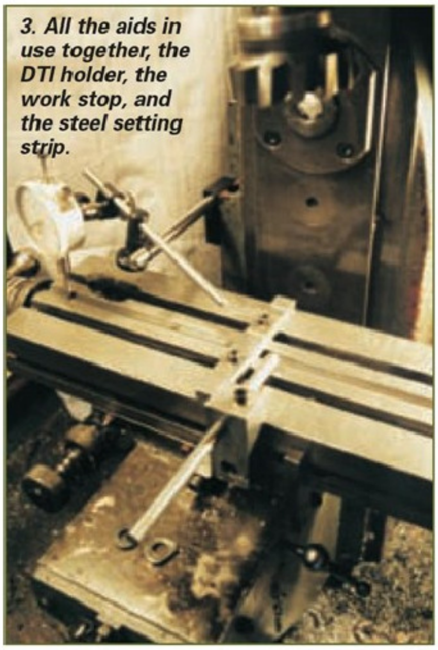
So here is a little exercise in machining and tool making that will enable you to fit a dial gauge firmly to your Centec and maybe avoid the high scrap rate I once had. The general concept is shown in the photographs and it is possible that with modification the idea may be applied to other machines. The body (**Fig 1**) was milled from a rectangular block that was lying around; the key is not essential but does help to locate the item in the T slot and the three tapped holes offer maximum flexibility for the location of the indicator post. I counter bored for the socket head cap screw but it again this is not really necessary.

The indicator post (**Fig 2**) has a cross hole for a tommy bar although two spanner flats or a hexagon filed or milled would be perhaps more professional. The length of the indicator post may be considered a little short however the table of my miller is only 4½in. wide.

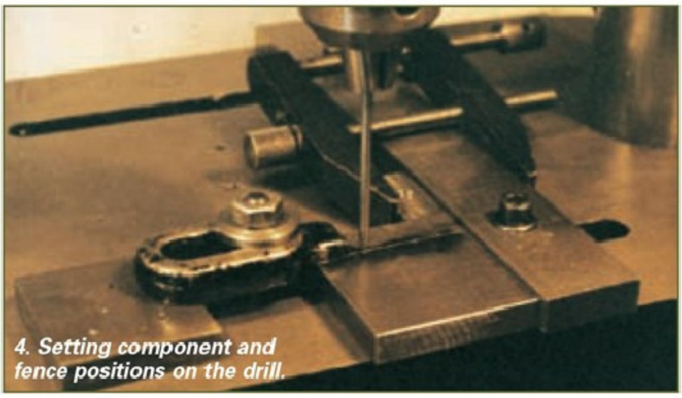
The indicator clamp (**Fig 3**) could also be left with square ends but I think the round ends look and feel much better. I drilled the holes first then located the clamp on a piece of round material and proceeded to mill a series of flats tangential to the finished round finally taking off the remaining corners with a fine file to finish the item.

The clamp was left at this stage and the sleeve (**Fig 4**) completed including the taper. Whilst I had the top slide set for the angle I turned up a tapered D bit from silver steel. I use Shell Garia H neat cutting oil when turning silver steel and it works really well. This was a tip I picked up from reading the books and articles of the late George Thomas which I have found to be a veritable mine of good information. The flat was filed as usual and the whole D bit hardened using soft soap to prevent scaling and give an indication that the correct temperature had been reached (the soap fuses). The D bit was then used to finish the tapered bore in the clamp. It may be noted that the taper feature is often not present on commercial DTI clamps, but I feel it is worth the little extra effort as it contributes to the rigidity and avoids the need to over tighten the knob. A Tee nut from one of the standard stops may be used, but a sketch is also included in the work stop described below.

The remaining items are fairly simple plain turned items that should not give cause for concern, although judging from



3. All the aids in use together, the DTI holder, the work stop, and the steel setting strip.



4. Setting component and fence positions on the drill.

5. Having set fence and stops, multiple parts are drilled with repeatable accuracy.

some past comments in various magazines knurling can sometimes present problems. I like to have straight knurling on items that I have to twist and diamond knurling on items that I have to pull. So the knob has straight knurling. I start off with the knurl at a slight angle to the work so that the left hand leading corner is closest to the work. Overlap the knurl on to the work about ⅓ of the knurl width. Then with the lathe in moderate back gear feed in the knurl until it begins to form the pattern. Once the pattern has formed, rack the lathe carriage towards the headstock a little so that the length of the knurl is increased. Repeat racking to and fro until the knurl is full depth and the right length. Use plenty of coolant to wash away the debris and remember that knurling is actually forming the pattern by a sort of swaging action so you have to give the material time to swell into the peaks and troughs of the knurl pattern. You should end up with a sharp crest to the knurl (look at it through a jeweler's eye piece). There is quite a deal of force needed to produce such a knurl pattern so I usually arrange things so that I put the knurl on first and use as stiff a work piece as possible and tailstock support.

No room at the top - use a work stop

I do not use a vice on my miller mainly because there is insufficient headroom. So all my set ups involve clamps etc. David

6. Work stop and fence used to prepare parts for drilling

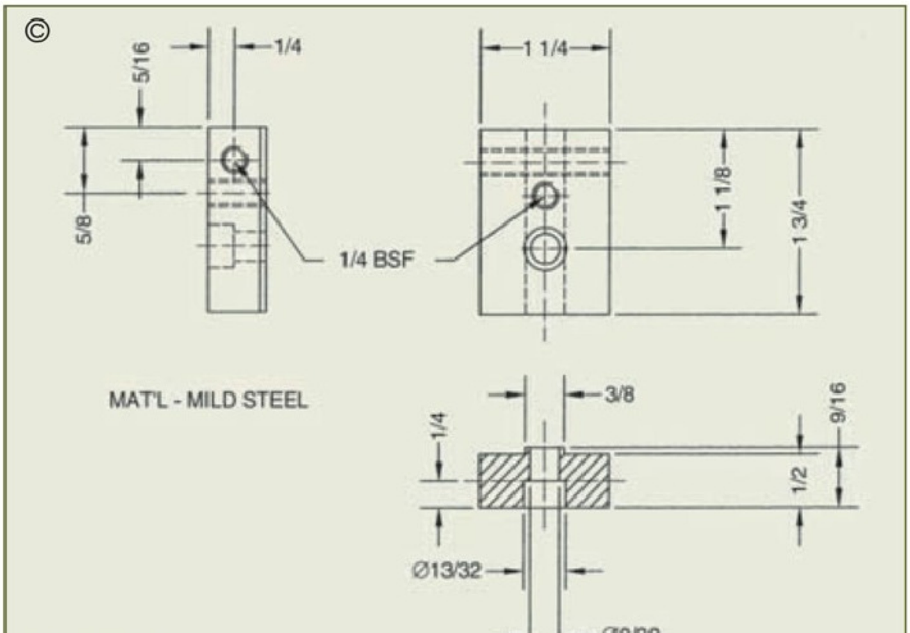


Fig. 1 Block

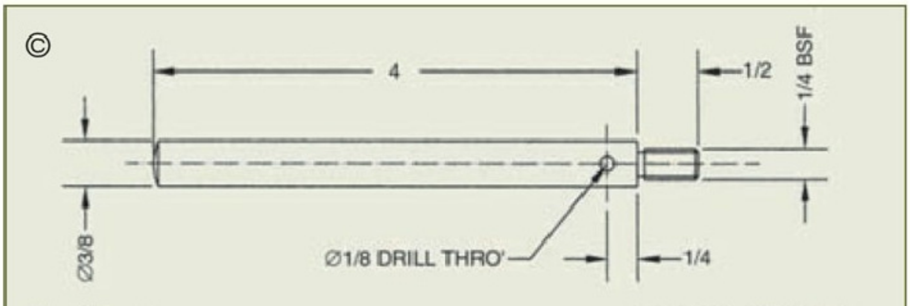


Fig. 2 Post

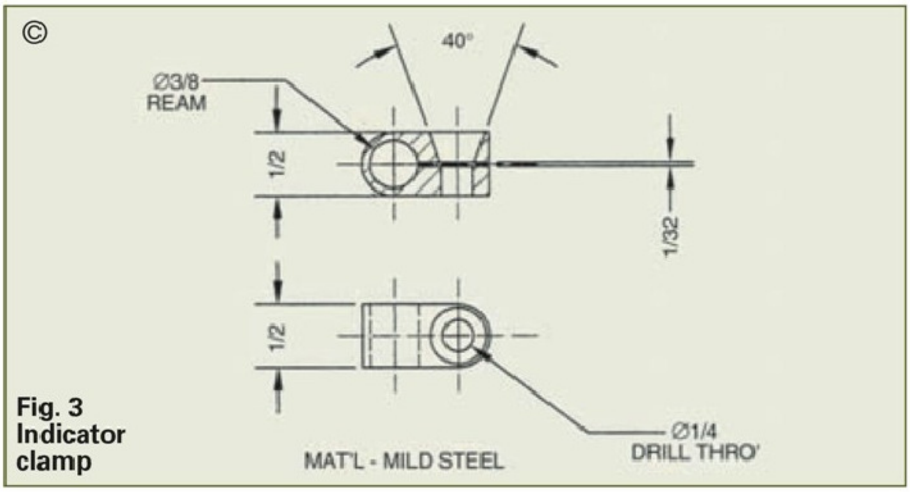


Fig. 3 Indicator clamp

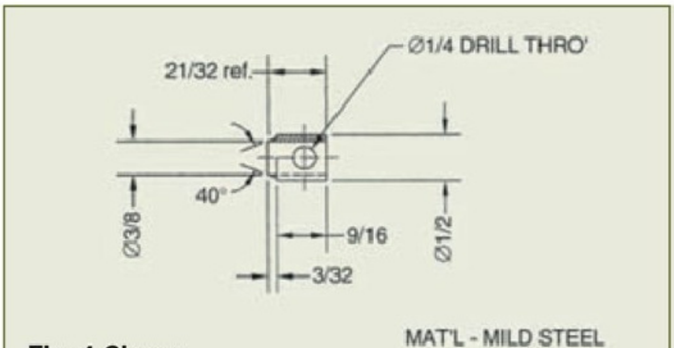


Fig. 4 Sleeve

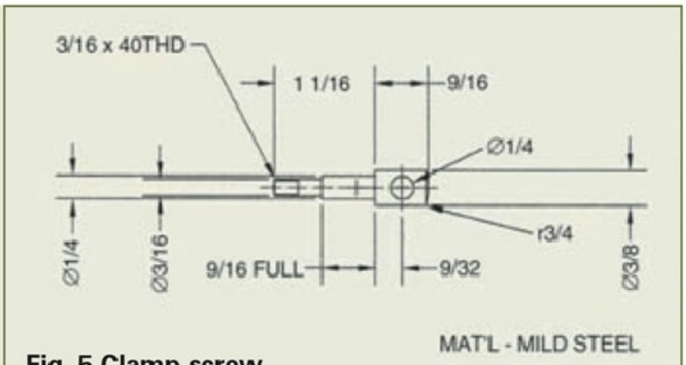


Fig. 5 Clamp screw

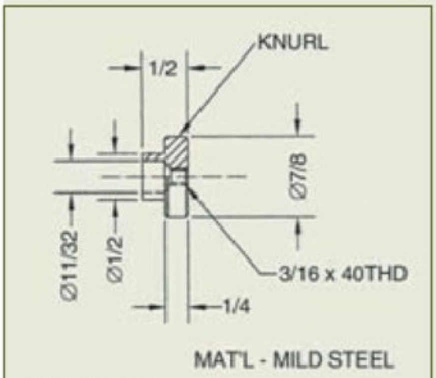


Fig. 6 Knob

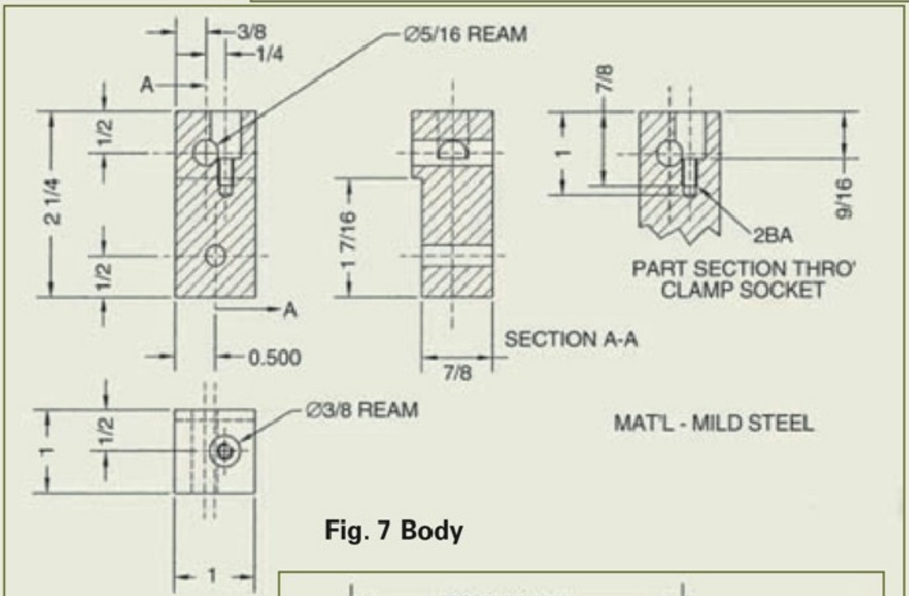


Fig. 7 Body

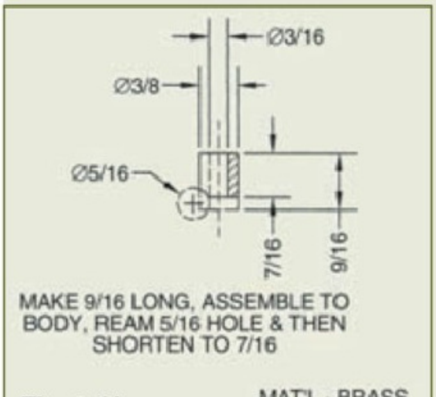


Fig. 8 Clamp

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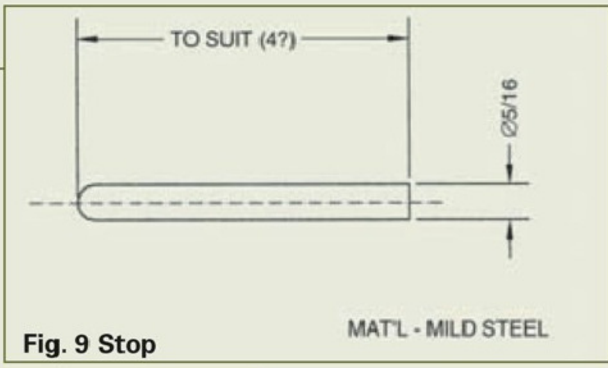


Fig. 9 Stop

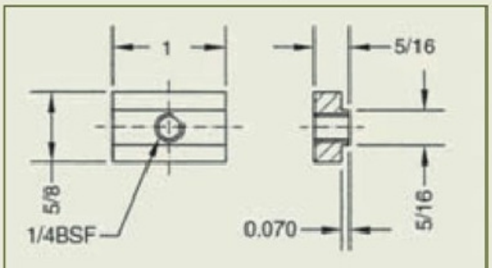


Fig. 10 T Nut

keeps on to me about a vice. He uses them but then he's got plenty of headroom on his machines. So another small item that helps me to reduce my scrap rate is a work stop for which the drawings are shown in Figs. 7 to 10. This is attached to the front tee slot on the Centec (very handy that tee slot).

The parts are not too complicated to make, none of the sizes are critical and I used what came to hand. I used the cotter style of clamp because it is positive and does not bruise the stop rod. The drawings indicate how I made this, but an effective part could probably be produced by turning and filing. Alternatively, you could use just a 2 BA screw bearing directly on the rod to do the same job but do have a flat on the rod so you can move it easily after clamping.

The photographs show both the dial gauge mount and the work stop on my Centec. No! I didn't pull the T slot out on the table. That was done by a previous owner and I've not got round to repairing it yet (If anyone has a spare table I'd be interested). You will also see that I use a strip of steel as a straight edge fence bolted to the table to locate parts. This simple device does speed things up and is a boon to location once it is set square to the table traverse. I've also included some photographs of a similar device on the table of the drilling machine together with an improvised work stop held by a toolmakers clamp. **Photo 4** shows the set up phase for drilling the work piece with two holes places symmetrically about the centerline of the job and **photo 5** shows the drilling progressing to drill hole number two completing the first one of a batch of four items.

After making these items my scrap rate has dropped dramatically much to my and David's pleasure (Shhh! don't tell any one but I also hear that very occasionally David also makes some scrap). I hope that they and the straight edges may help to reduce your scrap rates.

ENHANCING THE PEA

Tony Jeffree comments on commercial accessories for the Peatol Lathe, a machine popular among enthusiasts for small scale work.

1. The various items in the "Flipper" kit

I have recently acquired two after-market accessories aimed at the Peatol lathe (made by Taig in the USA), and other small lathes such as the Sherline. Both are aimed at making tool changes quicker and easier on these machines; one has a low-tech, low-cost approach, and the other is a more conventional "Quick Change Tool Post" design. Both of them have their merits and their own particular appeal.

The Peatol/Taig lathe has a simple tool post machined from 1in. square aluminium, with a yellow hard-anodised finish. There is also a rear tool post, conveniently anodised black to allow the two to be quickly distinguished. Fixing is achieved by means of a single central cap head T-bolt and nut, allowing the tool post to be fitted/removed by means of a hex wrench. The basic Sherline tool post is very similar, although it differs in height from the one used on the Peatol/Taig. In many ways, this arrangement provides the user with a "poor man's QC tool post" as extra tool posts are cheap to buy; if you buy as many posts as you have frequently used tools, you can simply leave the tools ready shimmed in the tool post, ready for use. For many of us who are users of these small lathes, that is a most satisfactory solution.

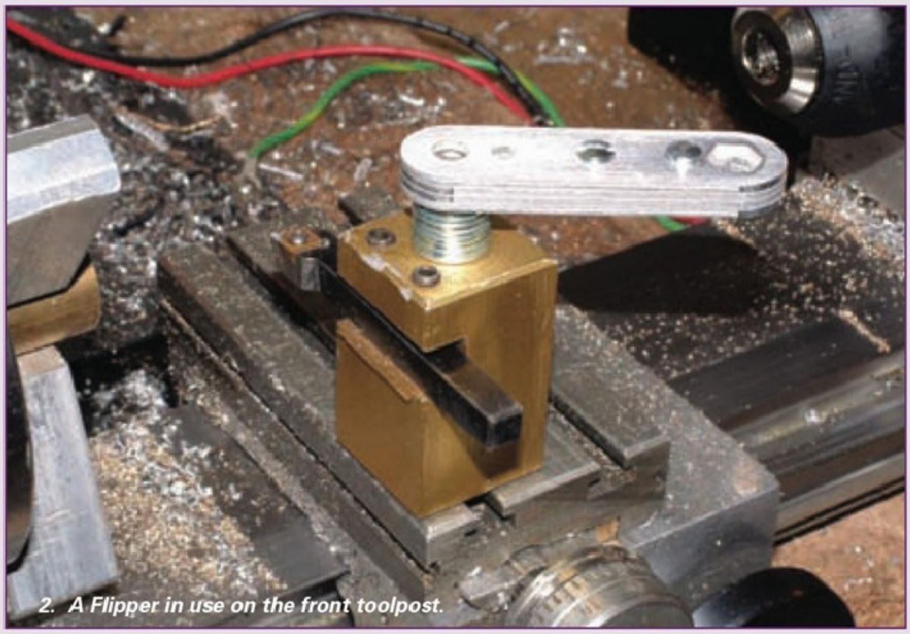
However, the two products reviewed in this article offer additional "features" that may be interesting to some users.

The "Flipper"

This accessory is a neat, low-tech solution to the "Where did I leave my Allen key?" problem. This is a perennial problem to users of lathes that have cap head screws for the various fixtures and fittings. Whenever you want to make an adjustment, the particular wrench you need to fit that screw is usually hiding somewhere on the bench, often directly under your nose. As can be seen in **Photo 1**, what you get for your money is 16 pieces of stamped-out aluminium sheet, four long T-bolts, a bunch of steel washers, and eight short screws/nuts. Each of the Aluminium stampings has a round hole at one end, and a hexagonal hole at the other; the hex hole is just the right size to fit over the hex head of one of the long T-bolts. Taking four of the aluminium stampings, you pass the bolt though the round hole in one of the stampings, then two more form a "pocket" for the hex bolt head, and the fourth stops the bolt falling out. The stack of four is then screwed together with two of the short screws/nuts. The result is a long T-bolt with a handy handle attached to the bolt head.

This assembly simply replaces the standard fixing bolt for the tool post; the T-nut is re-used, and the washers are stacked under the bolt head to adjust the effective length of the T-bolt and also to raise the lever above any obstacles such as the cap screws used to clamp the tool bit. The final finishing touch is to work out which way round the nut has to be to ensure the lever ends up in the right position when tightened; it is a smart move to mark the edge of the nut facing the operator once this has been done, so that next time you fit the tool post the nut goes into the T-slot the right way round.

Photo 2 shows the "Flipper" fitted to the standard Peatol/Taig tool post, and **Photo 3** shows it attached to the rear tool post. The "Flipper" does its job very well; removing and re-fitting the tool post is much quicker than with the standard cap-head screw. All in all, "Flipper" is a worthwhile and inexpensive enhancement. The $29.95 kit provides sufficient components to convert four tool posts with the Flipper locking lever.



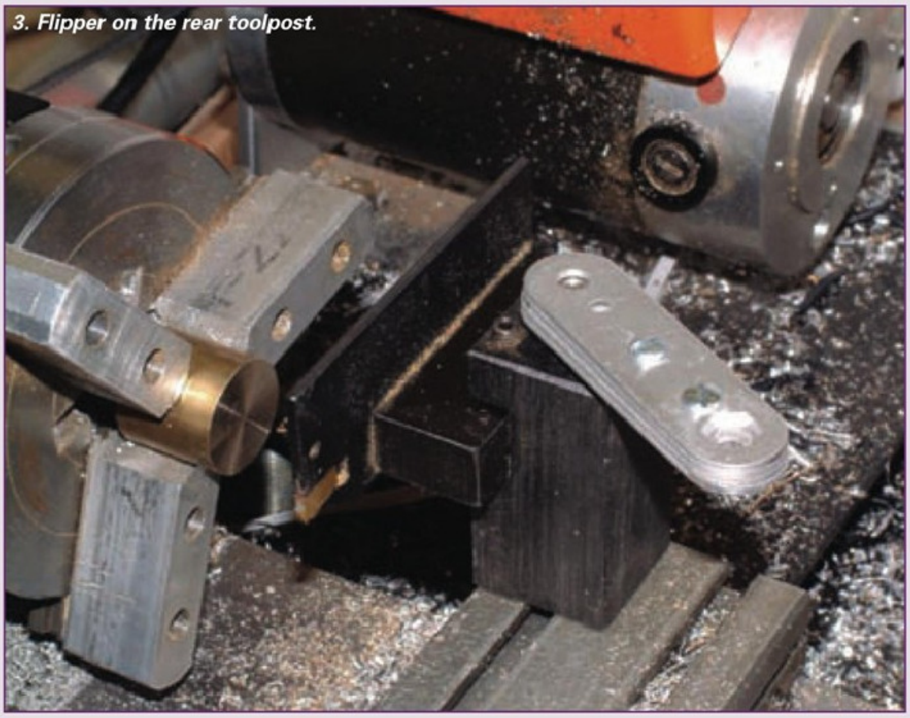
2. A Flipper in use on the front toolpost.

The Kenbo QC toolpost

This is a rather more conventional solution to the quick tool change problem, although the design is different from the more common "Dickson" style toolposts. **Photo 4** shows the components as supplied; the middle component on the bottom row is the tool post itself, the other five items are tool holders to fit the tool post. The colour of the hard-anodised finish makes certain that these holders won't easily blend into the swarf on the workbench!

Four "ordinary" tool holders and a cutoff tool holder were supplied to me; I

ATOL/TAIG TOOLPOST



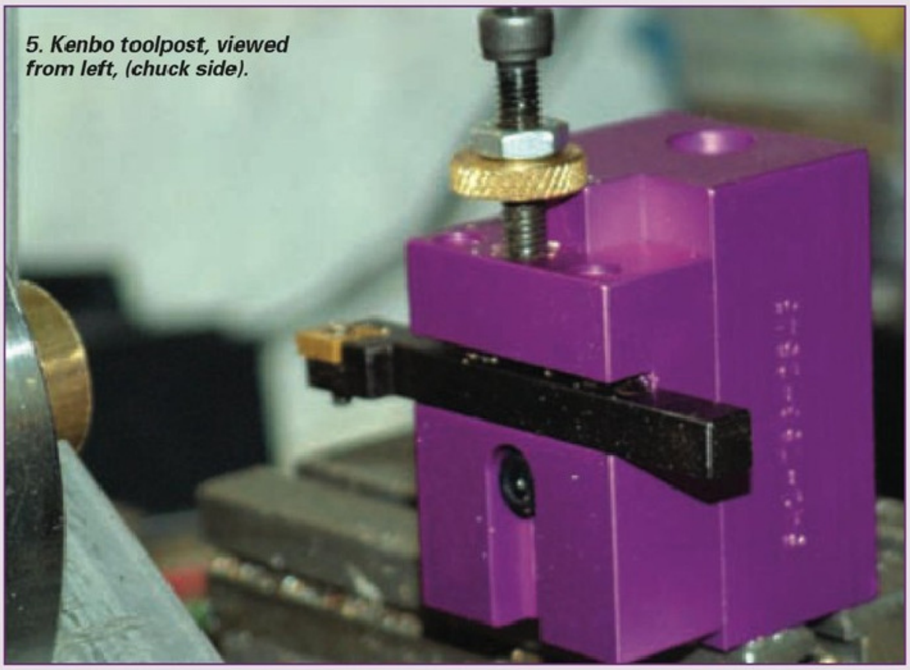
3. Flipper on the rear toolpost.

4. Kenbo toolpost and five toolholders.

understand that the kits now include a boring bar holder as well, the all in cost of the toolpost, four "ordinary", one part off and one boring bar holders being $100. The boring bar holder clamps into one of the four ordinary tool holders; essentially it is a piece of aluminium bar bored and set-screwed for the boring bar shaft, and with a ¼in. wide flange to fit the tool holder slot, so these could be added by the user if necessary. In the case of the smaller indexable tipped boring bars, the ordinary tool holder will actually do the job as it stands.

Each tool holder has the usual arrangement of adjusting screw with knurled nut and locknut to adjust the cutting height of the tool, and two separate cap screws to hold the tool bit itself. I found that it was necessary to Superglue the adjusting screws in place to ensure that once the height has been fixed the adjusting assembly stays put. **Photos 5 and 6** show the tool post in operation on the lathe. The post is held by a single T-bolt, as with the conventional Peatol/Taig holder. The fixing screw for the tool holders can be seen in **Photo 5**; this clamps the holder against a slight dovetail in the post for a rigid and repeatable setup.

The tool post works very well, is good value as QC tool posts go, and looks the part; however, I have to say that it really isn't any quicker to remove/fit a tool than with the standard Peatol/Taig tool post, as the locking screw is yet another cap-head screw, and, being situated at the left of the tool post, it is not in an ideal position to make life easier by adding an operating lever. The real advantages seem to be the ease of height adjustment, avoiding the need for shims, and that you can remove and re-fit a tool, knowing that its cutting edge will be back where it was the last time you fitted it. This could be useful when a machining operation requires different tools to be used in sequence. There is a further advantage that, because the tool post is wider than the standard Peatol/Taig tool post, the tool can be made to overhang the cross-slide at the right hand side, which is very useful when machining up to the end of a workpiece with tailstock support.



5. Kenbo toolpost, viewed from left, (chuck side).

Suppliers

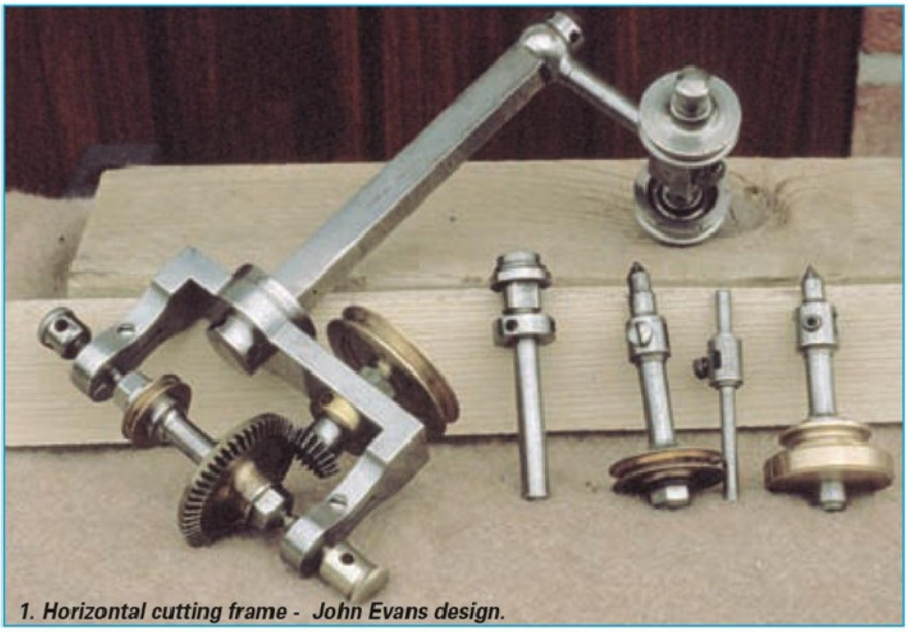
These items can be ordered from suppliers in the USA.

Flipper from the eMachineShop, telephone No. +1 201 447 9120 email frog@machineshop.com, website http://www.emachineshop.com/frog/flipper/htm

The Kenbo toolpost from Kenbo, telephone No. +1 541 753 2543 email kenbo@proaxis.co, website http://www.kenbo.org/

6. Toolpost from above also showing use of soft jaws.

ORNAMENTAL MODEL ENG


1. Horizontal cutting frame - John Evans design.

John Edwards continues his discussion of OT accessories and considers the eccentric chuck

Answers to Queries

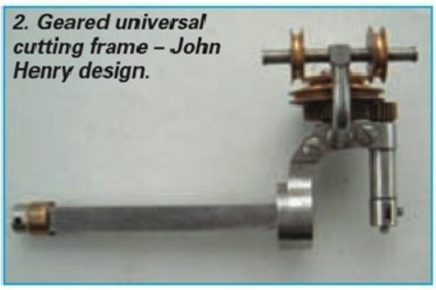
In my last article (issue No.94) I described a Horizontal Cutting Frame (HCF) with limited angular adjustment and I stated that for full universal angular movement an additional double pulley would need to be fitted to control the driving band which would otherwise slip off when an angle of more than, say, 15degrees in either direction is set. A reader wrote to me enquiring about the design of such an addition. There are several types; the earliest was designed by John Evans who mounted the extra directional pulleys on the rear end of the shank (**photo 1**). John Evans' grandson, John Henry designed a geared Universal Cutting Frame with the directional pulleys on the side (**photo 2**). Holtzapffel adapted the original HCF design and mounted the pulleys on a swinging arm on top (**photo 3**). An adaptation of one of these types could be fitted quite easily to the cutting frame described in issue No.94.

George Birch produced an improved version of the geared type (of which **photo 4** is a modern copy made by S.O.T. member Tony Brooks) and the latest type, based on an American adaptation, has a continuous belt instead of gears, the belt running from the vertical drive pulley, under two jockey pulleys either side and then around the horizontal toolholding pulley **photo 5** (made by S.O.T. members Mike Bain & Tony Brooks).

Other readers have asked about driving belts for ornamental lathes and cutting frames. I use Polycord, a flexible plastic round belt made in Switzerland, which may be joined end-to-end into a loop by heat. I use 6mm diameter for driving the lathe headstock and either 3mm or 4mm for driving cutting frames from the overhead. Several engineering suppliers stock it (e.g. B.B.Engineering Services Tel: 07976 539675) or it can probably be obtainable through specialist retailers of horological equipment. Typical prices are 4mm @ £3 per metre and 6mm @ £5 per metre.

Another reader enquired about speeds of running the lathe and the cutting frame. I cannot be precise; speeds for modern lathes are generally known (provided neither the original motor nor drive ratio have been changed). Antique ornamental turning lathes were designed for foot power and my mentor, the late Roger Davies, used to say they should not be driven faster than one could treadle them; about 1,000 r.p.m. These lathes have hardened steel spindles running in plain hardened steel bearings so they must be well-lubricated at all times or they will over-heat and seize up. However, such bearings have been used successfully in high speed applications and I see no reason why they should not be run at up to, say, 2500 r.p.m. provided they are not overloaded.

In respect of cutting frames the speed depends on the type being used, the radius of the cutter and the material being cut. A drilling spindle, having a cutter of small radius, may be run like a power router at anything up to, say, 30,000 r.p.m. However, particularly when cutting wood, there is a risk of burning at very high speed. Also, there is a risk of over heating and damage to the bearings unless they are perfectly adjusted and lubricated. I tend to run a drilling spindle at what sounds comfortable, probably between 5,000 and 10,000 r.p.m. and I check frequently that the bearings are not running hot. Horizontal (or vertical or universal angle) cutting frames make slashing cuts and I run these considerably slower; again judging the speed by ear as to what sounds comfortable, probably as high as 5,000 r.p.m. for a short radius cutter and maybe as low as 1000 r.p.m. for a cutter running at, say, 2" radius. Similarly, with the eccentric cutting frame, where the cutter describes a circle on the workpiece; when set at very low radius I run these quite fast but probably not more than 5,000 r.p.m. as they have large, heavy heads that are not always perfectly balanced. At larger radii, I run them considerably slower, maybe around 1,000 or even 500 r.p.m. The spindles may tend to flex slightly if too heavy a cut is attempted and the tool will vibrate and


2. Geared universal cutting frame – John Henry design.


3. HCF as adapted by Holtzapffel.


4. Geared frame made by Tony Brooks.

TURNING FOR GINEERS (2)

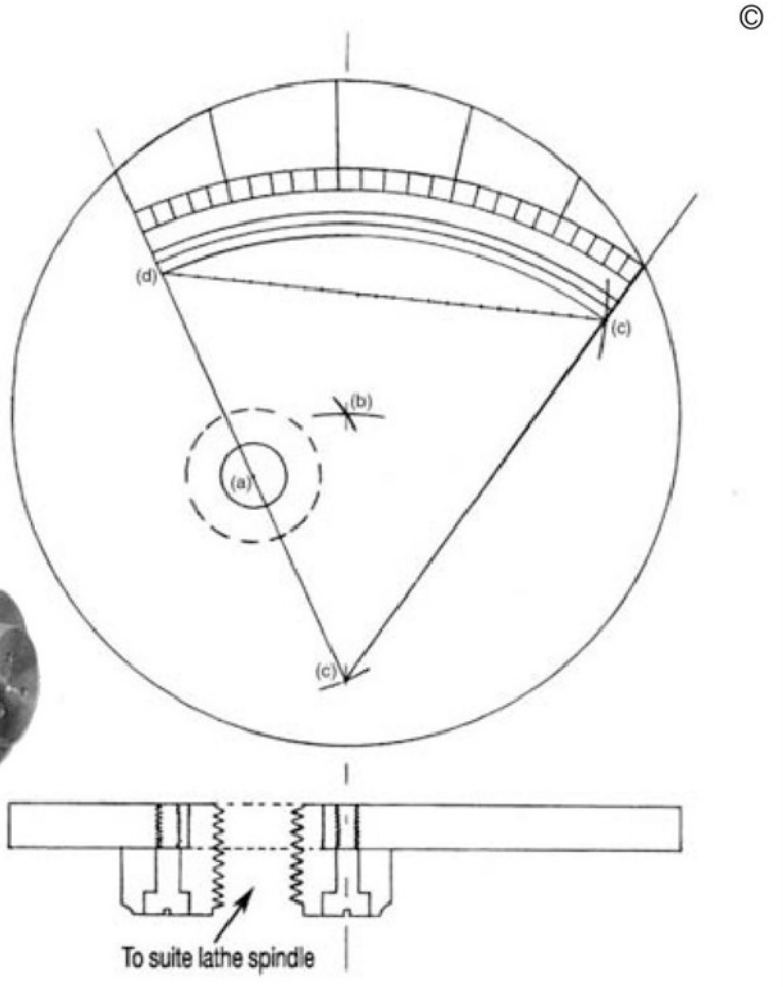
sometimes dig in, thus spoiling the work and risking damage to the tool. Experience will enable the reader to avoid these problems by advancing the tool in to cut smoothly and gently and listening to the sounds of speed and cutting. For ornamental turning the cutter should be as sharp as it can be and the rate of penetration should be quite slow. This causes the material to come off in fine streams or flakes and produces a highly polished finish. Any attempt to improve the finish with abrasives will end in disappointment as the crisp edges of the cuts, essential to good O.T., will be destroyed.

The Eccentric Chuck - How big should it be?

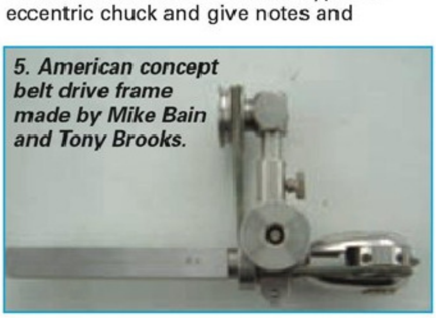
To do ornamental turning of any significant size a lathe with a centre height of 5in. or more is desirable. For 5, 6 and 6½inch lathes, Holtzapffel made the Eccentric Chuck with a radius of 3in. and maximum eccentricity of 2.5in. The foundation plate of the larger Rectilinear Chuck has a radius of 4.75in. when in the neutral position, but the sliding eccentric plate has only a 2½in. radius so it does not extend beyond the radius of the foundation plate until its eccentricity exceeds 2.25in.; its maximum eccentricity is 4in. in one direction and 2in. in the other. When fully extended either of these chucks will almost touch the bed of a 6½in. lathe and any workpiece of more than 3in. radius will touch the bed before the chuck is fully extended.

But this is not the whole problem: in some applications it is necessary to place apparatus between the bed and the workpiece; for example, the centre of rotation of a spherical slide-rest has to be directly beneath the workpiece when used to turn, say, a ball with eccentric segments like a peeled orange. So, if your lathe has less than 5in. centre height, you may need to make a scaled-down version of the chuck or, you might consider fitting raising blocks.

In this article I shall describe both the conventional and the modern types of eccentric chuck and give notes and drawings to describe the construction of the modern type. This project is quite simple and the result should satisfy the casual ornamental turner. However, the conventional type, with its sliding eccentric plate controlled by a leadscrew and its fine worm and wheel adjustment, is far superior. So, for those who prefer to undertake the more difficult but rewarding task of constructing the better chuck, notes and drawings will follow in a later article.



Drawing 1 Foundation plate



5. American concept belt drive frame made by Mike Bain and Tony Brooks.

General Description – conventional type

The Eccentric Chuck (illustrated in **photos 6 to 9**) is a work-holding chuck that fits on the lathe spindle and gives the facility of moving the workpiece eccentrically in relation to the axis of the lathe. It has a back plate, or foundation plate, a sliding or eccentric plate and a front plate, or 'nosewheel'. The workpiece is mounted on the nosewheel and, with all three plates in alignment, is turned truly circular. Then the eccentric plate may be moved to a chosen eccentricity within its range and this has the effect that the centre of the workpiece is moved along a slide, away from the centre or axis of the lathe spindle. It is then possible to make cuts on the workpiece based on its new eccentric centre. The nosewheel may then be rotated and fixed in a different orientation to obtain another new eccentric centre on which cuts may be made. In this way it is possible to make cuts or patterns at any place on the surface of the workpiece within the range of the chuck, i.e. multiple centre turning without the need to remove the workpiece from the chuck.

Primitive Eccentric Chucks were first illustrated in "L'Art du Tourner" by Charles

6. Eccentric chuck – front.

7. Eccentric chuck – with slide extended.

8. Eccentric chuck – rear view.

Plumier (1701). Significant improvements were made by Holtzapffel and others throughout the 18th and 19th centuries and the end result was almost as perfect as could be desired. However, the construction of this conventional type of chuck is quite complex and to make one will take some considerable time and effort. There are simpler, modern alternatives that are easier to make but these are less versatile in use.

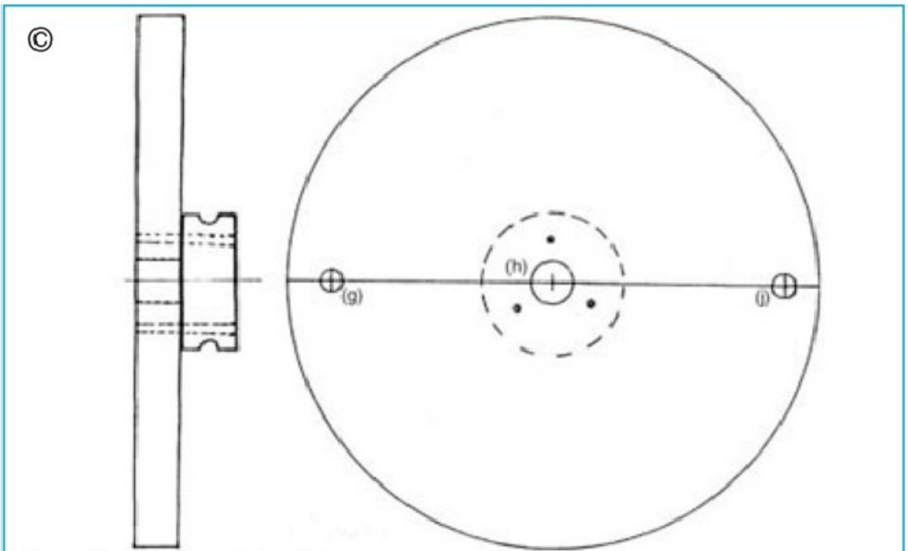
Description - modern type

One modern commercial example is shown in **(inset drawing 1)**; its foundation plate has a bolt near to its edge on which the eccentric plate pivots and swings in an arc, being fixed by another bolt that may enter one of a series of threaded holes in the foundation plate; a spigot fixed in the eccentric plate, locates in the centre of the nosewheel which may be rotated upon it and fixed to it at any angle (or sector position) by a clamping bolt or bolts.

This type has several disadvantages, the main one being that each movement of the eccentric plate, being an arc, puts the workpiece on a different plane to its previous position; whereas if, as in the conventional chuck, the movement were to be effected by a centrally sliding eccentric plate, all positions would be in the same plane. This, therefore, requires a means of compensation. One way to do this would be with a flat section machined on the edge of the nosewheel so that it may be aligned with a spirit level; another would be to drill a hole into the edge of the nosewheel and make a height gauge that will sit on the bed of the lathe with a detent at centre height to locate precisely in the hole, so that after each change in eccentricity or sector position the nosewheel may be re-orientated to the 'horizontal' position. When changing either the eccentricity or the sector position, the chuck should be set with the nosewheel horizontal and the lathe spindle should be held in position by the index and division plate. The nosewheel may then be released and, to change the sector position, the index is moved to the required new point on the division plate, the nosewheel is then re-set to horizontal and locked; or, when changing the eccentricity the eccentric plate is released, swung to the new eccentricity and fixed then the nosewheel is re-set to horizontal and locked.

The second disadvantage of the modern type of chuck is that the choice of eccentricities is restricted to the positions of the threaded holes by which the eccentric plate is fixed, whereas if, as with the conventional chuck, the movement was controlled by a leadscrew, it could be set at any eccentricity within its range. Also, it is difficult to calculate the positions for the threaded holes so they will give meaningful changes in eccentricity because they are on an arc and the distances between them are greater than the changes of eccentricity they effect. A third disadvantage of some versions of this type of chuck is that the workpiece has to be removed from the chuck, or the chuck from the lathe spindle, before its eccentricity or orientation may be adjusted.

I apologise for this lengthy explanation but I hope it will make readers aware that the modern chuck, although simpler to make, is far less convenient to operate than the conventional type.



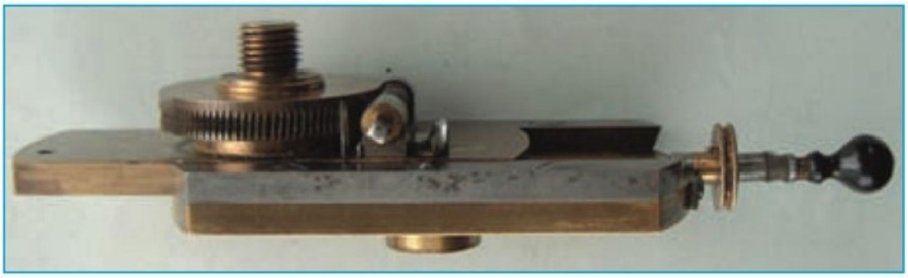
Drawing 2 Eccentric plate

If you decide to make the simpler, modern type, I would suggest a few alterations to the design shown in in the photo. First, if the boss (or backplate) is placed to one side of the foundation plate and not in its centre, a greater maximum eccentricity can be achieved in relation to the size of the chuck. Second, a curved slot instead of screw-threaded holes would allow for finer adjustment of eccentricity. Third, a means of setting the chuck to the horizontal plane, for which purpose I suggest a hole drilled in the side of the nosewheel for a detent mounted on a height gauge.

Construction – modern type

The three plates, foundation, sliding and nosewheel may be circular. The only critical dimensions are that the radius of the eccentric plate plus the extent of eccentricity should not exceed the centre height of the lathe. Dimensions given in the drawings will suit a lathe 5½in. centre height; giving up to 2½in. eccentricity. The same dimensions are suitable for a 5in. lathe but not more than 2in. of the eccentricity can be used.

The foundation plate may be made from a 7½in. diameter casting, like a backplate with a boss 1.25in. off-centre or, fabricated from joining a plate and a short cylinder that will form the off-centre boss. The plate is chucked by the boss and the surface turned flat. Then it is clamped with its newly turned surface to a faceplate with the boss rising from the centre so the back surface and the boss may be faced and the boss turned truly circular. The plate is then again chucked in reverse being held by the boss in the 3-jaw chuck and the surface is skimmed true and a pilot hole (a) (**drawing 1**) is drilled at the centre of the boss. Then two short arcs are scribed from the pilot hole, one at 1.5in. radius to find the centre of the plate (b) which is then centre-punched, and the second arc of 2.5in. radius from (a) to about 0.5in. from the edge of the plate. A third arc of 3in. radius is scribed from (b) to cross the one from (a) and this point (c) is centre punched. (c) will be the 'pivot point'. From (c) a line is scribed through (a) to the far edge of the plate and on that line the point (d) is found at 5in. radius from (c) and centre-punched. From (c) and from (d) two arcs of 5in. diameter are scribed to cross at (e) and two lines scribed, one from (d) to (e) and one from (c) through (e) to the far edge of the plate, thus forming an equilateral triangle with two extended sides. The left side is the 'minimum line' which will indicate the central or neutral position and the right side is the 'maximum line' which will indicate the maximum eccentricity of the chuck. The top line of the triangle (opposite the pivot point) is then divided and marked at

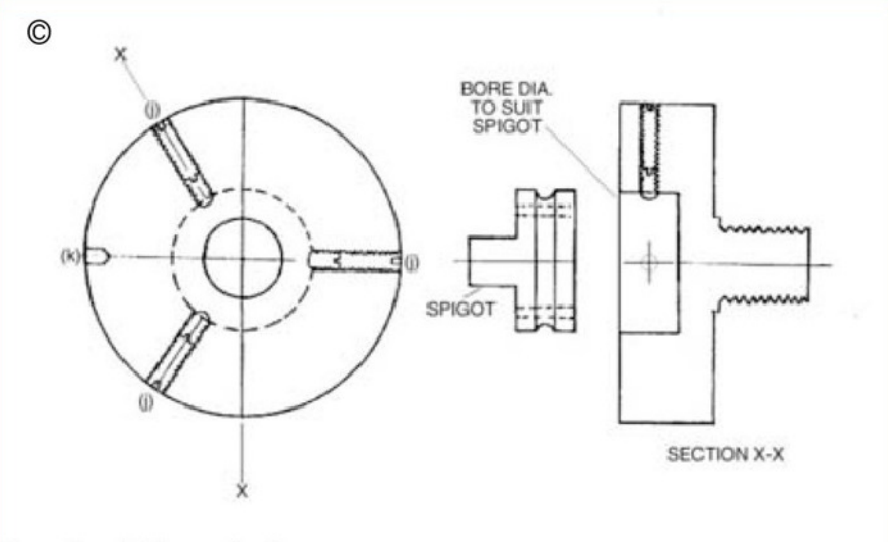


9. Eccentric chuck – side view.

intervals of 0.2in. From the pivot point (c) five long arcs are scribed each joining the two extended sides of the triangle at radii of 5, 5.125, 5.25, 5.5 and 5.75in. From the pivot point across each of the 0.2in. marks, a line is extended and scribed deeply where it crosses between the 5.5in and 5.75in. arcs. These deeply scribed lines will indicate the amount of eccentricity in 10ths of an inch between the minimum and the maximum. The point on the minimum line where it crosses the 5.125in. radius arc is centre-punched and a 0.25in. dia. hole drilled and this is repeated at 0.25in. intervals all along the arc with the last hole on the maximum line. When all the holes are drilled the arcuate slot is milled or filed out from end to end. Of course, if you have capable milling facilities, you may choose to produce the slot entirely by milling.

The eccentric plate may be made from flat stock turned to 6in. diameter. It is centre-punched, a 'datum' line is scribed deeply across the centre from edge to edge (**drawing 2**) and a short arc at 2.5in. radius from the centre is scribed lightly across one end of the line and the crossing point (f) centre-punched. This will be the 'pivot' point. From (f) another short arc is scribed across the line near the opposite edge of the plate at 5.125in. radius so as to cross the line (at g) which will be the 'fixing' point and this is also centre-punched. Holes are drilled at both (f) and (g) and tapped (say, 0.25in. BSF, 0BA or 6mm) and the foundation and eccentric plates are joined by a bolt passing through a washer and then through the pivot point of the foundation plate and screwed into the pivot point on the eccentric plate. A second bolt, without washer, is screwed into the 'fixing' hole of the eccentric plate to pass through the milled arc of the foundation plate and assembled with a washer and nut to hold the plates together lightly so that the eccentric plate may be swung from one end of the arced slot to the other. Any slight imperfection of the slot may be corrected by filing. The datum line on the eccentric plate will indicate the amount of eccentricity by its relative position to the deeply scribed lines on the arc of the foundation plate and to facilitate accurate reading of the position it is advisable to extend the datum line across the edge of the eccentric plate. Now, with the datum line on the first mark and the two bolts tightened, the two plates are aligned in the neutral position with the centre directly over the boss of the foundation plate. With the assembly screwed firmly on to the lathe spindle, a central hole is bored in the eccentric plate into which the spigot (h) will be silver-soldered and pinned. After this the spigot is skim-turned so as to run perfectly true.

The nosewheel may be made from a solid block or, like the foundation plate, from a casting or, fabricated from two pieces. The only essential is that the spigot hole runs truly in line with the copy of the spindle thread (or other means of fixing to the workpiece). The spigot hole is bored and lapped to fit the spigot on the eccentric plate, then 3 holes (j) (**drawing 3**) are drilled and tapped at equal intervals around the edge of the nosewheel and a fourth hole, (k) midway between two others, is drilled for the detent which will enable the nosewheel to be aligned to the horizontal position. Socket screws are fitted in the three tapped holes so that the nosewheel may be fixed firm and true on the spigot. The socket screws are then slackened slightly and the nosewheel rotated so that the screws



Drawing 3 Nosewheel

11. Holtzapffel chuck features detachable backplate.

scratch a ring all the way around the spigot; then, after removing the nosewheel, the eccentric plate is mounted on a faceplate with the spigot running perfectly true. A groove is then turned around the scratched ring. Some may choose to make the groove with tapering base diameter to encourage the nosewheel to abut firmly against the eccentric plate.

Three short brass screws are made so that, when the nosewheel is replaced on the spigot, these screws may be screwed down into the socket screw holes until they all locate in the groove, thus preventing the nosewheel from coming off but not tight enough to prevent it from rotating. Then, when the socket screws are screwed down tight onto the short brass screws they will lock the nosewheel in place and, because the brass screws are soft, the groove will not be damaged by successive adjustments.

In this position the outer edge, the face and the screw-thread of the nosewheel are turned true and, using the division plate scribed with either 96 or 120 divisions which will indicated the orientation of the chuck to the datum line on the eccentric plate.

The chuck will be considerably out of balance but the segment of the foundation plate beyond the maximum line may be sawn off and beyond the minimum line holes may be drilled and tapped so that a series of weights can be screwed to the back of the plate to compensate for the amount of imbalance.

If your Eccentric Chuck is to be used on more than one lathe you might consider making a separate detachable backplate, like that on the conventional chuck sold 'off the shelf' by Holtzapffel (see **photo 11**).

The next article(s) will provide drawings for the construction of the superior conventional type of Eccentric Chuck and, will proceed to examine features of the Eccentric Cutting Frame.

A SIMPLE PRIS
FINDING M

1. Completed Centre Finding Microscope

Colin Golding describes an easily constructed accessory for use on the mill, lathe or pillar drill.

Background

Fed up with "Sticky Pins", "Wigglers", or "Wobblers", for trying to position a carefully marked out workpiece accurately, on centre in the machine for the next operation, I figured there must be a simple device using elementary optical principles, cheap and easy to make with the average facilities and expertise possessed by the model engineer. **Photo 1** and the accompanying drawings show what I ended up with; no magical accuracy is required; it works well and is a delight to use.

The prism

I started by making the prism - not as daunting a task as might first be expected. I made it from Perspex, since this has excellent optical qualities, is easy to machine, and with care and patience, polishes easily to give an acceptable finish. It does not require the high quality finish of a "professional" optical instrument.

The prism is a 60 deg type and must first be cut out of ½in. thick Perspex to the heavy outline shown. Faces a, b, c, should then be machined, either in the lathe vertical slide or in a milling machine. The angles should be set carefully, though extreme accuracy is not required. Use a VERY sharp cutter, running as fast as practical, with light cuts and a very fine feed. Use some neat cutting oil while machining.

Polishing should be carried out by moving the workpiece in one direction by hand over the abrasive or polish, using plenty of lubricant, light, slow strokes. Start with 600 grade wet and dry, laid on a flat surface with plenty of water. When the machine marks have been removed, lay a sheet of soft paper on the flat surface and apply some Bluebell or Brasso to the paper, and move the work over it as before. Next (with a fresh piece of paper) do the same thing using Perspex polish if available, or Solvol Autosol, and finally, furniture polish such as Pledge or Sparkle or similar.

To produce the telescope spigot diameter, I gripped the sides of the prism between the angled faces of 2 jaws of the 3 jaw chuck (**Photo 2**). Perspex machines easily and it is not necessary to tighten the chuck too hard, thus no damage will result to work or chuck. The finished prism may be seen in **Photo 3**.

The spacer and side plates

Next the spacer - made from ½in. brass (aluminium would do). Two important points to watch:-

1. the thickness must be about 5 thou thinner than the Prism thickness.

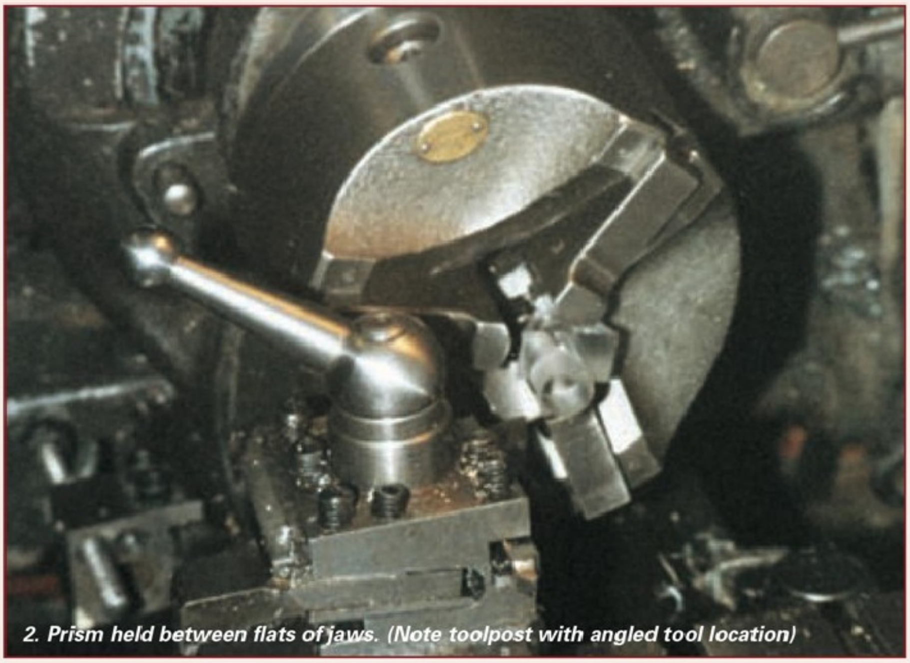
2. Don't try to machine, drill and tap the shank yet; this will be done later, so just leave it rough.

The side plates are next. These are made from ⅛in. brass and, when cut to shape, are clamped together with the Spacer correctly positioned and drilled right through No. 34 drill, then no 28 drill through one side and the spacer, leaving the second side to be tapped 4 B.A. Having done this, assemble with an additional central dummy spacer and tighten up the four screws. Then mount in the 4 jaw chuck using only two of the four jaws (**photo 4**). A 60 deg screwcutting gauge will assist in setting the angle (which is not critical) and centralise with the aid of a surface gauge and scriber point on the four corners of the side plates. The shank can now be turned, drilled and tapped. Again, gripping the work by only two of the jaws may not be best practice, but worked perfectly for me as the turning operation was carried out carefully.

Tubes and lenses

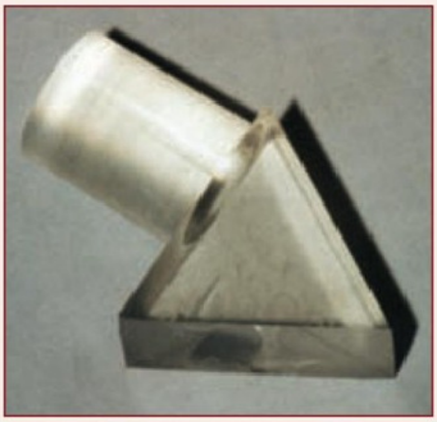
The telescope tubes need no real explanation. I used a piece of ½in. diameter bore imperial copper tube turned down on the outside to fit inside diameter of a piece of metric (15 mm bore) copper tube, but any alternative method will do.

The eyepiece lens came from a watchmakers loupe. It needs to be about 4in. focal length to focus on the lower face of the target lens - though this may depend on whether the user wears spectacles. The target lens is made from ¼in. thick Perspex made to fit tightly between the side plates and then drilled through for the two ⅛in. pins.



2. Prism held between flats of jaws. (Note toolpost with angled tool location)

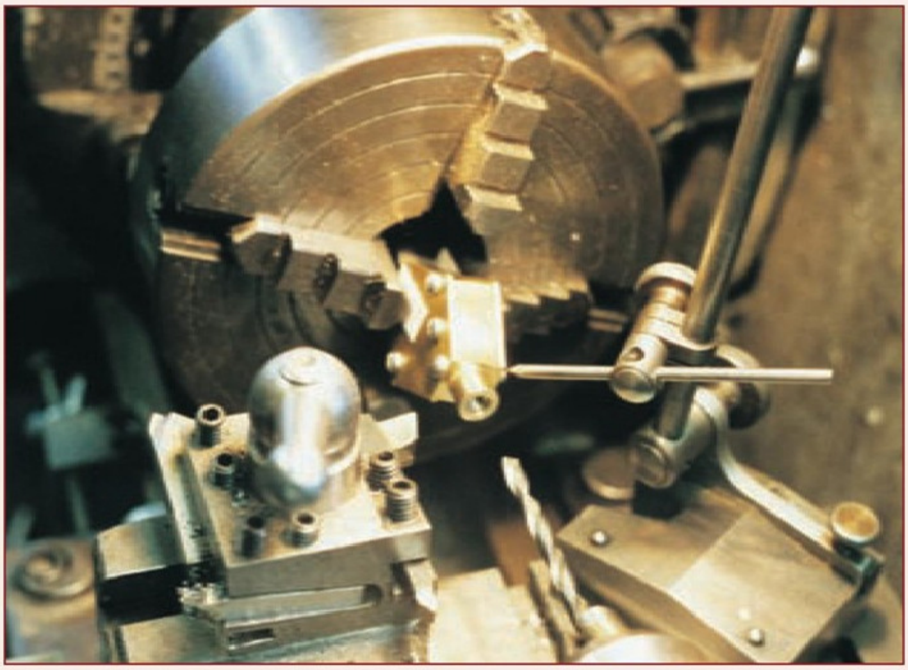
MATIC CENTRE ICROSCOPE



3. Completed prism

Assembly

This is straightforward and needs no detailed comment, however the insertion of a smooth, shiny piece of aluminium cooking foil between the spacer and the reflecting face of the prism will improve its reflectivity.



4. Assembly with dummy spacer held between two jaws of four jaw chuck.

Calibration

This procedure is carried out as follows:-

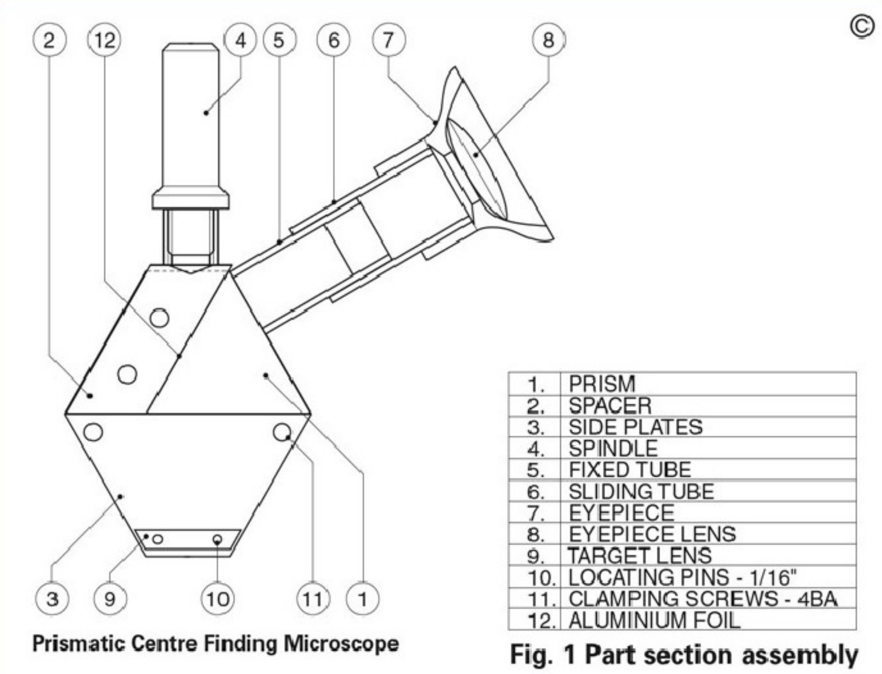
1. Make the two steel calibration pegs ensuring true concentricity, the first with a very sharp point, the second with a very sharp edged female centre. The point was 60 deg included angle, the circle also 60 deg but with a centre drilled hole to ⅛in. dia. first.

2. Clamp a piece of material to the drill or mill table, drill and ream a hole to give a close fit of the pegs.

3. Without moving the material or the machine table after drilling, remove the drill and fit the now finished microscope into the drill chuck. Lower it on to the first calibration peg so that it JUST TOUCHES the target lens (**Photos 6 and 7**). This will make a small indentation on the Perspex which will be perfectly concentric with the shank/machine centre. Repeating with the second peg will add the circular mark (**Photo 8**).

Operation

When in use, it is important to have the target lens as close as possible to the workpiece upon which you are centering in order to avoid parallax error. To do this, I use a thin piece of card on the work and allow the target lens to rest on it, lock the quill, focus the telescope, then remove the

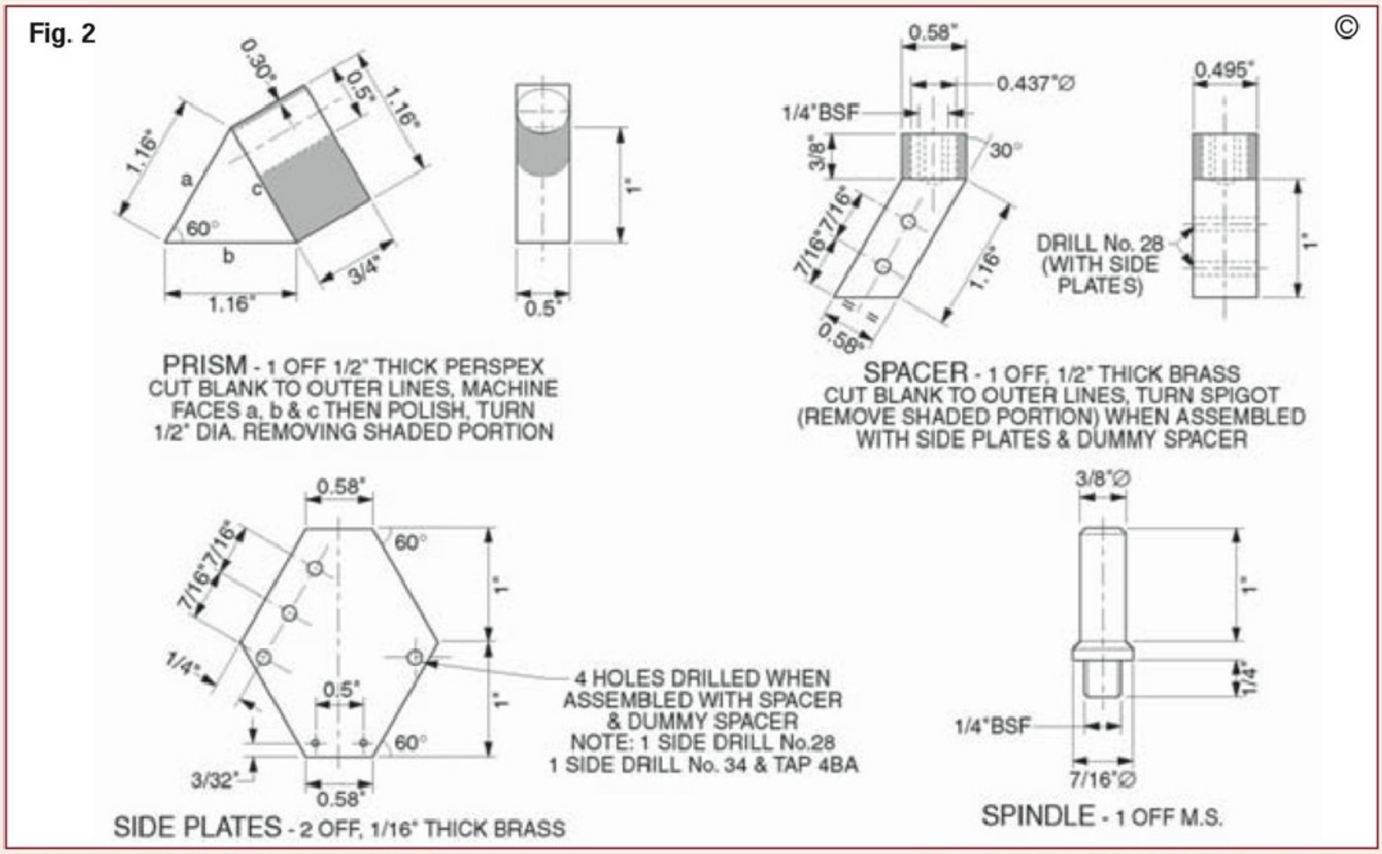


1.	PRISM
2.	SPACER
3.	SIDE PLATES
4.	SPINDLE
5.	FIXED TUBE
6.	SLIDING TUBE
7.	EYEPIECE
8.	EYEPIECE LENS
9.	TARGET LENS
10.	LOCATING PINS - 1/16"
11.	CLAMPING SCREWS - 4BA
12.	ALUMINIUM FOIL

Fig. 1 Part section assembly

5. The component parts ready for assembly.

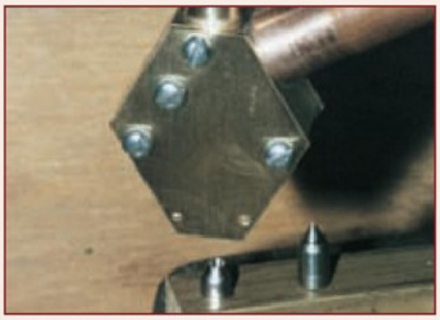
Fig. 2



6. *The quill is lowered so that the target lens is marked by the calibration pin.*

card. This way, the target lens is protected and the gap is minimised. Also you will soon become used to the fact that you need to move the work being centred in the opposite direction to what you expect!

I hope other readers will find this Centering Microscope as useful as I do.



7. Close up view, as Photo 6

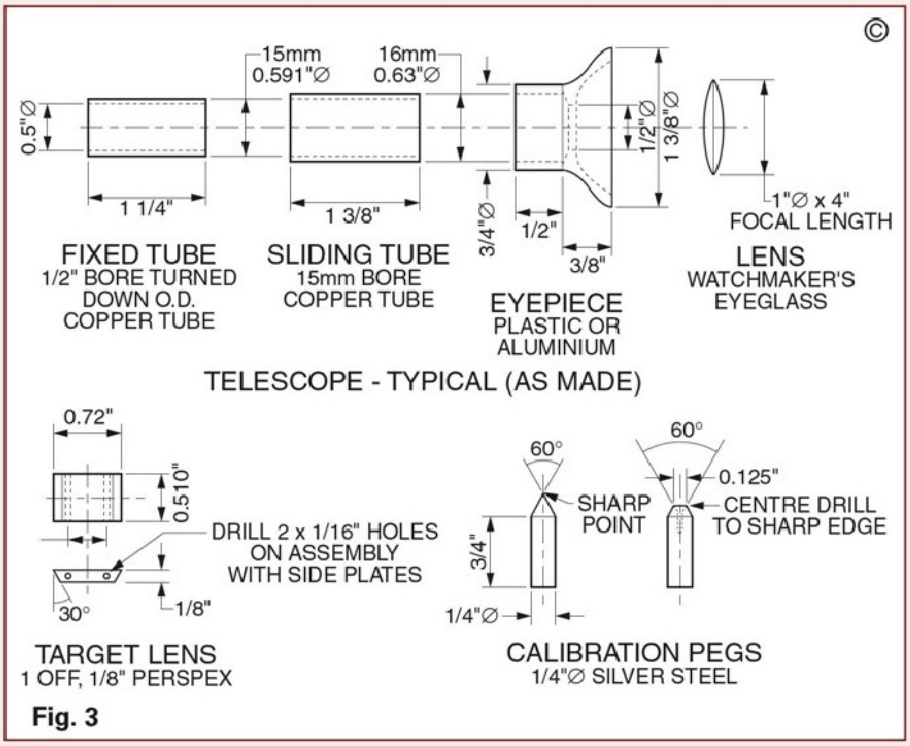
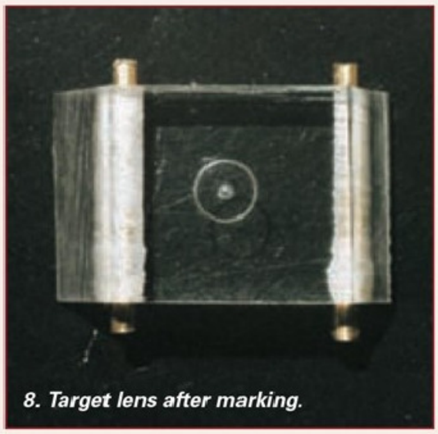


Fig. 3



8. Target lens after marking.

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.

When they're gone they're gone

A selection of cutters from Clarke

Clarke Engineering has acquired a job lot range of imperial sized milling cutters and is therefore able to offer these at bargain prices. The quality of the cutters (which are 8% cobalt M42 industrial grade, and better than "common or garden HSS") has been proved out in Clarke's own works at Rackheath, and as a model engineer himself, proprietor Steve Clarke is confident that others of the fraternity will find the range most interesting. Prices are quoted including post and VAT, so what you see is what you pay.

Four types are included, slot drill threaded, end mill threaded, and FC3 throw aways in both short and long series. The size ranges should suit many model engineering applications, with slot drills and end mills from ⅛in. to 9⁄16in. and FC3's from 1⁄16in. to ¼in. The photo. shows a representative sample, and **a full priced list of these cutters and other tooling products can be obtained free of charge by phoning 01603 722023 until 4pm or 01603 426 522 after 4pm**. The Clarke Engineering advert also appears elsewhere in this issue.

New Range from Engineer's Toolroom

The CY1220GH lathe from The Engineer's Toolroom

Proprietor Reg. Pugh trained as a toolmaker and is therefore a touch selective about what he chooses to sell. Two new lathes have been added to the range and these really are toolroom type machines. Both are fully geared head lathes, and features include such items as hardened bedways, D1 Camlock chuck retention, coolant system, halogen worklight, 3 and 4 jaw chucks etc. The CY1220GH and CY1230GH models give 6in. centre height and 20 or 30in. between centres, while the CX1340GH and CY1340GH are 6.5in. centre height and 40in between centres. The CX machine gives great capacity for a low price (£2295-00 delivered) while the CY series offers greater sophistication for prices starting at £2290-00 including delivery and depending on location, installation as well. For the enthusiast working with larger components these machines must represent a viable brand new alternative to similarly sized and comparably priced second hand equipment. **The Engineers Toolroom can be contacted by phone 01443 442 651, fax 01443 435 726, or at Unit 28 Enterprise Centre, Llwynpia Road, Tonypandy, CF40 2ET. The website is www.engineerstoolroom.co.uk**

Blast Cleaning Equipment

After seeing the recent "Blast Box" article Anglo Scot Abrasives proprietor John Whalley wrote in to let me know about the range of equipment they offer, including blast cabinets, guns, media, compressors, and paint spray guns. Although primarily a supplier to industry, some items are aimed at the amateur market, in particular the TTK1 (450mm x 450mm x 450mm) blast cabinet kit and the Grifo Minispray, whose size and capacity place it between an airbrush and a full size gun. The range of abrasive blast media covers not only a variety of "aggressive" grits but also glass beads and walnut shell/oilstone grain for delicate surfaces. The full catalogue may be obtained by sending two first class stamps to: **Anglo Scot Abrasives, 5 Bolton Road, Ashton in Makerfield, Wigan, WN4 8AA**

Latest Catalogue from Tilgear

Running to over 300 pages, this "book" is a veritable Aladdin's cave of goodies aimed at both metal worker and woodworker. For someone like me with sketchy knowledge of woodworking, it is also a source of education regarding those many items I just did not know existed. For convenience it is divided into twenty-two product groups commencing with "Inspection, Measuring and Layout", progressing through such headings as "Drilling, Turning, Milling", and concluding with "Oldham Router Cutters". While the range is wide, items have been carefully selected to give a choice of quality and price.

Catalogues (and helpful advice on stock items) are available free of charge by telephoning or writing. This will also put you on the mailing list for the periodic special offers lists. As much of the business is by mail order, the company can now accept payment by most of the major credit/ debit cards. **Tilgear can be contacted by phone on 01707 873 434 or at Bridge House, 69 Station Road, Cuffley, Herts, EN6 4TG**

QUICK TIP

From Mr George Winspur

Many workshop activities would be easier if we were a little taller, e.g. drill table at high setting or some filing and sawing jobs in the vice. On these occasions, I slip on a pair of clogs and get an instant height increase. There is an incidental advantage in that this form of footwear is reckoned to be particularly good on cold, hard floors.

WHAT, NO POWER!

The spectre of "Power outage" has cropped up on several occasions recently. Bob Loader gave it further thought.

1. The tools used for the drilling experiment.

During a conversation with our editor, he gave me a problem to think about. "What", he said, "would happen if the lights went out?" Blow the lights, I thought, if they were out so would be the power, an interesting happening to toy with.

Coincidence is a funny old thing because shortly after I was faced with this conundrum, Pauline and I were due to look after my son's house, while our daughter-in-law and two grand-daughters joined him in Japan for a couple of weeks, where he had been working. It was to be for about three weeks and our duties were not too time-consuming. There were two cars which didn't bother us, being non drivers and a pet rat called 'Pooh' which was Pauline's job, apart from being my photography assistant. It was an ideal time to see if it was possible to do much without power, starting with drilling holes. No doubt some people nowadays would swear by the latest breed of cordless power tools, but in my experience these are fine for woodwork, but soon run out of puff when worked hard on steel, and in any case Murphy would probably have ensured that the battery was not charged. Likewise, the old fashioned hand brace always seemed to be a struggle on anything much harder than aluminium.

The tools

Luckily, my Workmate lives in my son's garage these days and it has a vice fastened to it. I took what other tools I thought I'd need and forgot some, including a pot of Vaseline which has many uses. Pauline needed a few odds and ends, so we returned to base, the other side of the city and picked up the extras.

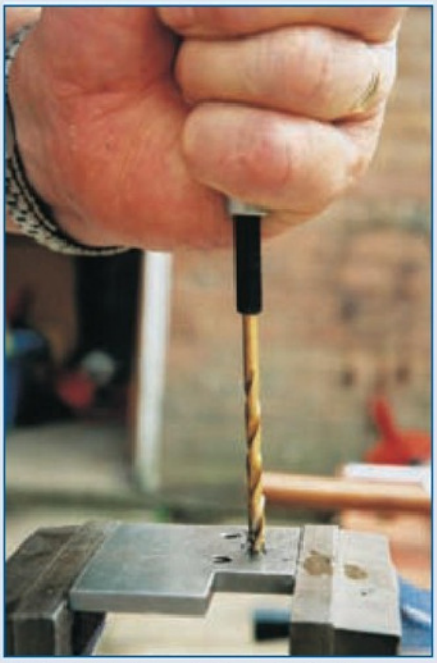
Photo. 1 shows most of the tools I used. The drills with the yellow finish are from a set of sockets, screwdriver inserts and other items, all in a nice fitted case with a universal handle. The important feature as far as I was concerned was that all the bits and pieces had hexagonal shanks to fit the handle. I thought that if a piece of work was held against the front vice jaw and the drill offered up to it with pressure applied by the tightening of the vice, the turning movement could be done using a spanner to fit the hexagon. It worked, see **photo. 2**. So I had the two things I needed, the pressure and the turning. I used a smear of Vaseline on the drill point and started with a 2mm. drill, a small drill will always be easier to get cutting. From time to time the drill bent enough to be a worry, but a lessening of pressure let it straighten up. Eventually the drill would go no further and was obviously against the vice jaw. It was safe enough because at the speed of rotation and the slight pressure it would do no damage. The drill was just poking through enough so that I could twiddle it by hand from the other side to finish off. **Photo. 3** shows this being done with the 3mm drill. All the photos which show both of my hands were taken by Pauline, who is an expert at it, all I have to do is set up the shot and she does the rest, it saves a lot of time and trouble, especially as the camera I use now has no cable release socket and the remote control gadget costs a small fortune.

2. Drilling the initial hole.

Opening up

Once a small hole has been drilled it can be opened up with larger drills and if the steps in size are not too big it will go well. I hit a snag at over 3mm. because my vice only opens to 3¼in. - not enough for the larger drills. I had to use a different set-up, **the one in photo. 4**. A large G clamp was held in the vice and the drill held in the chuck off my ancient Black and Decker. It was easier on the drill because the clamp is one I made a long time ago and is only suitable for light clamping. Another thing I'd forgotten was a tommy bar but my son had some 4in. nails in his garage and the chuck in **photo. 4** is being heaved around with a nail with the tip cut off. I shall have to tell him that he has a pointless nail.

Another tool I used for opening up was my 8in. rat tail file, **photos. 5 and 6**. It



3. Breaking through from the back.

4. Using the larger drill.

helps the drills and at last I had a 5mm. hole drilled through a piece of 3⁄16in. mild steel, **photo.7** shows the result. Once a hole of that size has been made it can be enlarged by various means so I rate the experiment a success. It took a while and a bit of sweat because it was done in the heat wave.

Different materials - different methods

If more equipment is available there are other ways and means. If the metal can be heated red hot, holes can be punched through the thinner sizes using a tapered punch like a blacksmith's hot punch. Softer metals like aluminium can be drilled by the primitive method I used and brass wouldn't be too bad. I have fond memories of my old friend Steamboat the blacksmith punching holes in the most unlikely materials but it takes a lot of skill and experience.

Some synthetics, like nylon, acrylics and polystyrene can have holes burned through by a heated steel rod, all it needs is a heat source like a gas stove. So much for the thermo-plastics, thermo-setting ones like Tufnol are a different thing but would drill by using the vice method, a hand brace or even by twirling by hand. I did toy with the idea of making a simple bow drill but I hadn't got the makings and I doubt if I could have exerted enough pressure on the steel workpiece. The same reason would have ruled out a wheel brace even if I had one to use.

So much for the drilling, - I chose drilling because it is a vital thing to be able to do and probably the most difficult if the tools are limited.

Other shaping methods

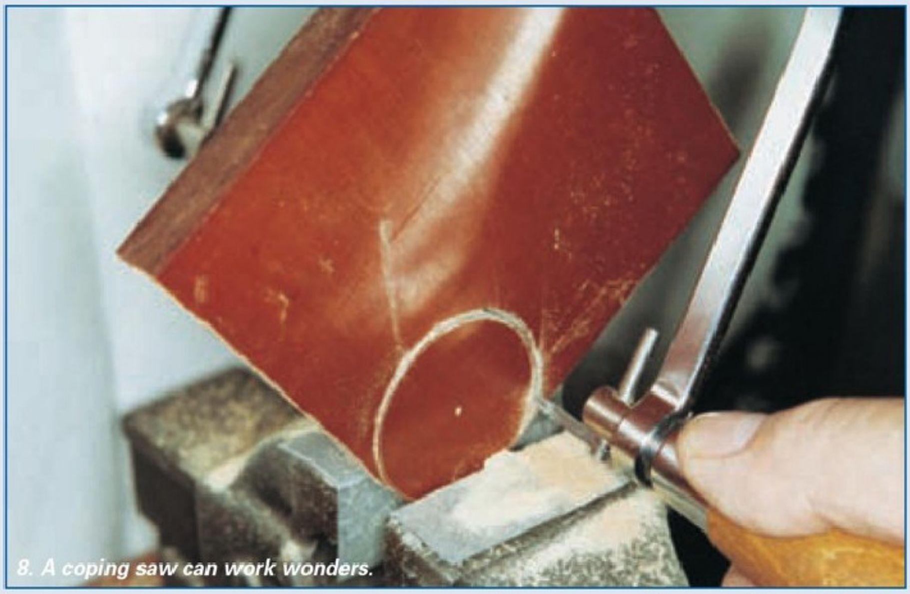
It has always been my habit to do as much of the shaping of components by hand if possible. Apart from being contrary that way, when the metal shifting gear is limited to a small lathe like the Unimat, it is necessary to avoid over loading it. So I have always reached for the hacksaw and a few files first, not forgetting a chisel from time to time. I have dealt with some of the techniques in previous articles. One operation I left out was the shaping of round pieces without using a lathe. It is not as difficult as it seems and is a simple filing exercise to first file the part to a square which has the same size as the diameter of the part. The corners are then filed off to make an eight sided shape, taking care that the measurement across the flats is accurate, the corners are again filed off and when there are no corners left the piece will be near enough round and just need a careful clean up. If the round part has to go up to an edge, the file safe edge will take care of it. The key thing is to keep checking to make the distance from flat to flat accurate. Once upon a time, when craft apprentices had to make a test piece under exam conditions, it wasn't unusual to find such a task.

Do not forget special tools like the coping saw in **photo. 8**, they can be the answer to quite a few awkward shapes, just don't expect too much of them, they are very good for some jobs but remember that they have quite widely

5. The rat-tail file helps the drill along.

6. Close to finished size.

7. The finished 3/16in. hole.



8. A coping saw can work wonders.

pitched teeth and are best for the softer and thicker materials.

Their main use is for cutting shapes which are normally hard to do with ordinary saws. Because the blades are very narrow they can turn corners, as the one in the photo has done. For even finer work I have used a fret saw, not very often but on some very small jobs, it is an option.

Fine surface finish

Should a finish better than fine filing be needed, one answer is to scrape it. My introduction to scraping was a month spent in the toolroom in about 1950. Senior apprentices who were to be instrument makers or tool makers and similar trades all did it. During the month we scraped a small plate about 10in. by 8in. for our own use, to an accuracy of 20 spots per inch which is an acceptable standard and took some doing.

Learning to scrape is a bit of an uncomfortable caper and for the first day or so the arm aches from the finger tips to the shoulder and hands become grimed with a mixture of cast iron dust, engineers' blue and 'raddle', a white lead substance smeared on the plate before blueing, so that the spots would show up better. I finished my small plate in reasonable time and was set to work on one of the tool maker's plates, a fair bit bigger. Tool makers are pragmatic types and hate to see apprentices with nothing to do.

When I'd finished my month I could do a fair job and even manage the crescent pattern of finishing; these days I would need to spend a long time to get the touch back, so I turn chicken and limit myself to doing a chequer pattern on items no bigger than the one in **photo. 9.**

A simple scribing block

While I was sorting out the things I'd need for the drilling experiment, I came across the scribing block shown in **photo. 10**. It dates back to about the same time as the scraping and was made while I was in the toolroom for another month to learn a bit about the tool making business. I had some time left over and the apprentice master I was working with allowed me to make the very simple scribing block. There wasn't enough time to make a super deluxe one, so I offer this as a quickly made but most useful addition for marking out and other jobs.

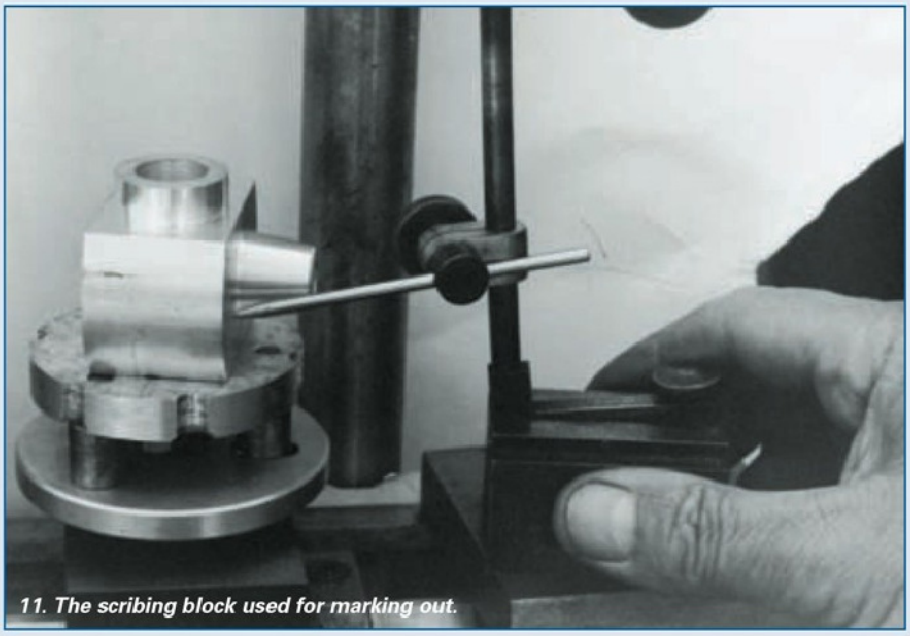
It is good for marking out, **photo. 11** and for holding a dial test indicator, **photo. 12** for the many checking and alignment jobs which have to be done from time to time.

Simple construction

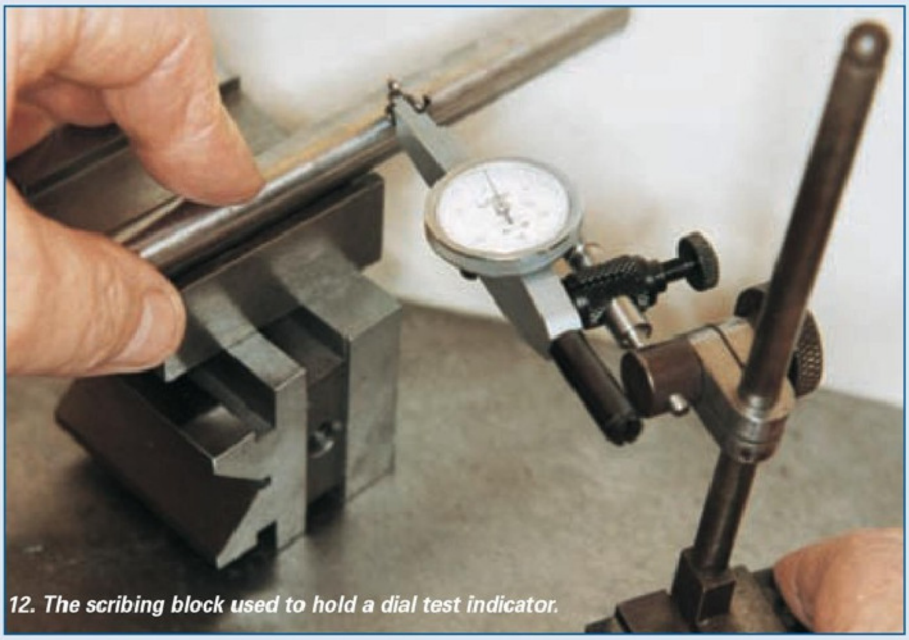
The body looks a bit square and boxy but it is functional. It could be made without the vee in the bottom, just a wide relief slot, leaving a thin land each side of about 1/4in. would be enough. One or two other differences made the making easier than the more conventional pattern. The rocker

9. Scraping a small cast iron block.

10. The simple scribing block.



11. The scribing block used for marking out.



12. The scribing block used to hold a dial test indicator.

was made with the minimum of shaping and the clamp was made to fit a scriber and not cross-drilled for a ¼in. rod to fit as well. To use it to hold a dial test indicator I made an adapter which can be seen in **photo. 12.** It is a simply made piece, a length of ¼in. mild steel with a ⅛in. spigot to fit in the clamp, it can be made any length to suit requirements. I use a short straight scriber, a great long one poking out can be a nuisance; nor can I see why there has to be a bent bit on the other end, I have never found a use for it.

Two things I was advised to do by my apprentice master. One was to use silver steel for the pillar, not hardened, but it is more durable than mild steel. The other was to make the pivot for the rocker by drilling it in the middle ⅛in., countersinking each side to about 7/32in. and using ¼in. steel balls for locating and pivoting. The balls are held in place by a short spring and a grub screw. It has never come loose.

A simple rule stand

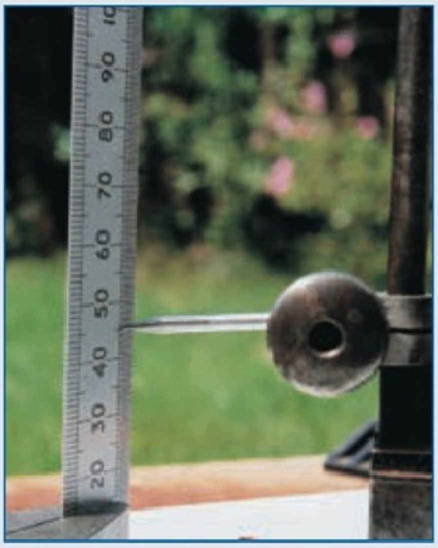
When I need a rule stand, I improvise with the one in **photo. 13**. All it is, is a large toolmaker's clamp, the sort with nothing sticking out at the side. It will hold a rule rigidly enough for setting. Note that the reference surface is a piece of melamine covered chip board, usually quite accurate and flat enough for most marking and setting, but check it first.

An emergency radius gauge

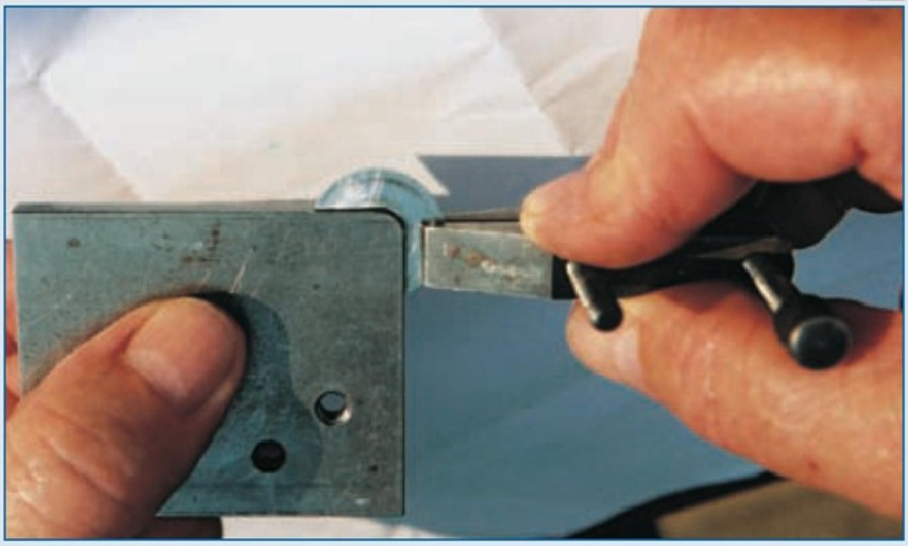
Among the odds and ends I had taken with me to my son's I had nothing to check a radius with but I did have several washers in various sizes. I found one of the right inside diameter, cut it to shape with a junior saw and cleaned it up with a fine file. To make it easier to hold, I used my favourite small toolmaker's clamp. The result is shown in **photo. 14**.

Post script

I wrote at the outset that coincidence was a runny old thing; it stayed with us till the end. Hearing about the huge power cut in America, we rang our daughter who lives in Massachusetts to check if it had caused any problems. It hadn't, but she suggested that I did a similar piece for an American magazine. I wouldn't have the cheek but I did spare a thought for any of them caught without power, perhaps in the middle of a critical operation.



13. An improvised rule stand.



14. A cheap and cheerful radius gauge.

PROFILE TURNING DEVICE

Faced with turning a curved contour, Dave Fenner raided the scrap box and knocked up a quick solution.

1. Bentley Cam Box showing curved profile.

Background and Function

After starting work on the major components for a model Bentley BR2 rotary aircraft engine to the L. K. Blackmore design, I ran up against the question of how to produce the curved contour on the front face of the cam box (**Photo 1**). One solution would have involved using a variation on the radius or ball turning theme, effectively mounting the turning tool on a rigid swing arm. It was felt however that the device to be described offered more in terms of versatility, although subsequent experience suggests that a fine finish may be more difficult to achieve.

In principle the device is a near direct crib of the industrial copy turning devices, but without the hydraulics. These will be well known to older readers with a background in industry. In essence it provides a means of manually guiding a follower and hence the turning tool around a profile plate, (the shape of which matches a part radial section of the job) and allows for radial setting of the tool position. (Axial setting is provided by the lathe topslide.) In my case, the work was to be done on a Colchester Chipmaster (5½ in.) lathe, but with some modification to sizes, the principle can be adapted up or down in size. **Photos 2** shows the attachment fitted to the lathe, with the workpiece chucked for illustration rather than cutting, and the tool position adjusted.

Construction

The build up may be considered by reference to the two bracket sub assemblies, the contour plate, and the various fasteners.

Rear Bracket

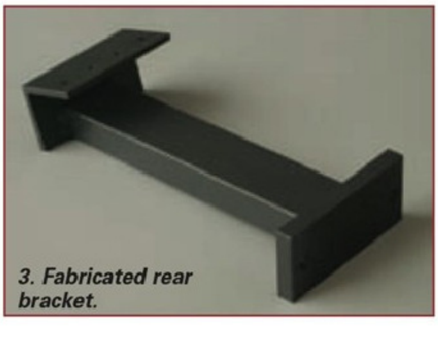
The Rear Bracket (**Photo 3**) is a welded item bolted to the rear of the lathe bed using the Tee slot provided for a taper turning attachment. In my case the Tee bolts were to my usual cheat construction - a short length of M10 screwed rod into a piece of drilled and tapped flat bar, Loctited or welded at the base, and machined flush. (**photo 4**). The bracket is constructed from three components, a 100mm length of 50 x 50 x 6mm steel angle, a 225mm length of 50 x 25 x 3mm steel hollow section, and a 115mm length of 50 x 12mm bright steel flat. The angle and the flat are cut off square, and drilled and tapped as in **Figures 1 and 2**. The hollow section is cut with one end square, and the other at 74 degrees (**Figure 3**).This angle matches the inclination of the mounting surface on the rear of the Chipmaster, and gives a good approximation for vertical positioning of the contour plate. (It may be noted that Myford 7 series and other lathes have a more convenient vertical location face on the rear of the bed, making the 74degree angled feature unnecessary. However the parts would need to be arranged to achieve the correct height.) The three parts are welded up as shown in Photo 3.

2a. Posed photo of workpiece and device from above fitted to lathe.

2b. Same shot of workpiece and device from the front.

Saddle Bracket

This item is built up from three components (**Photo 5**). These parts are very straightforward and the photo and description should suffice. A piece of 0.375in. thick bright mild steel is cut 100mm long by 30mm wide. Holes are drilled to permit bolting to the saddle, in my case spaced at 73mm. Secondly a piece of 22mm dia. bar is cut and faced off to 40mm length, then drilled and tapped M16. (Actually, this was another "cheat". Some years ago I was involved in a contract for making adjustable feet components for bank autoteller machines – several thousand per week. I still have a bag of left overs beside the scrap box. One of these seemed to be just right) This was welded to the 0.375in. plate. Finally, a length of M16 Mild steel screwed rod is cut and faced off to 110mm. This will become



3. Fabricated rear bracket.

4. *"Cheat" Tee bolts*

5. *Saddle bracket assembly*

6. *Profile plate.*

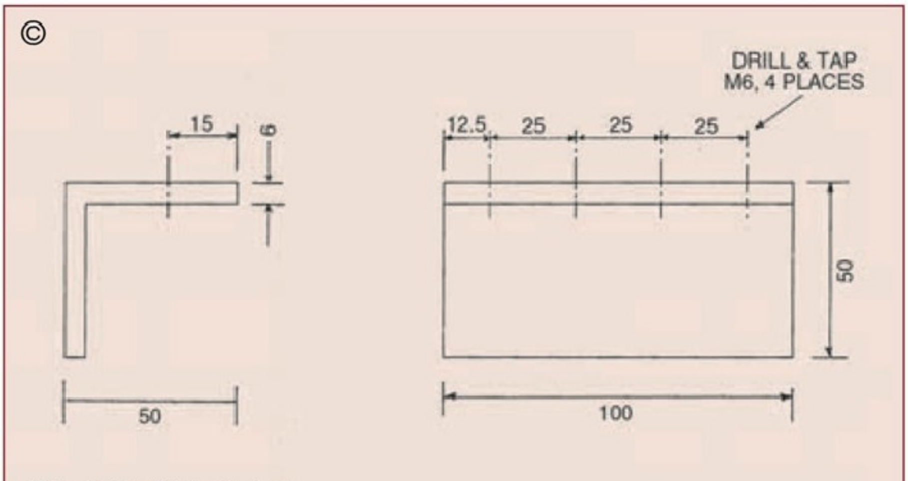


Fig. 1 Angle (mild steel)

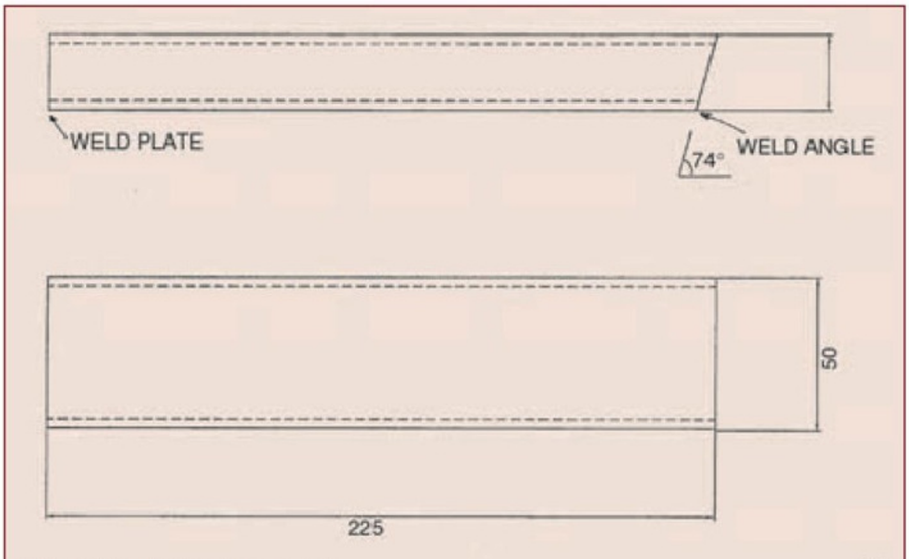


Fig. 3 Arm (50 x 25 x 3 RMS)

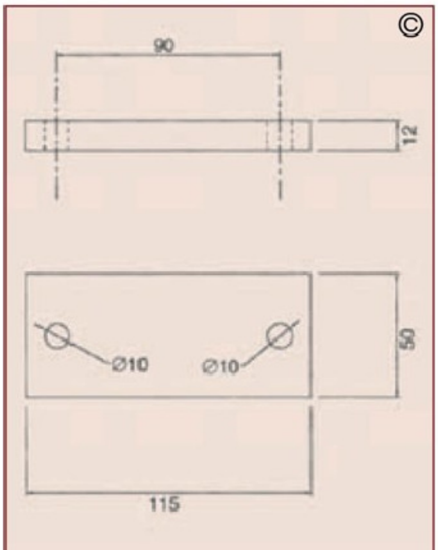


Fig. 2 Plate (Mild Steel)

the adjustable follower rod. One end is turned down to 12mm dia. for a length of 12mm, and the edge of the extremity radiused off so that the radius matches that of the tooltip ultimately to be used with the attachment. The rod is completed by cutting a screwdriver slot in the opposite end. This can of course be machined accurately on the mill – I have to confess to reaching for the hacksaw.

Profile plate

This is naturally specific to the job in hand, and for the application illustrated, the plate was cut from a piece of scrap 3mm steel plate which measured 80mm by 65mm. On this, the part section of the Bentley cam box was marked out, along with a couple of fixing holes to match those on the Rear Bracket. The profile was then sawn and filed to shape with a little powered help from the angle grinder. **Photo 6** shows the finished result.

Operation

The rear bracket is attached by its Tee bolts to the lathe bed, and the saddle bracket to the saddle. The profile plate is then mounted on the rear bracket using sufficient spacers to bring its centreline up to that of the follower rod. With the workpiece mounted in the chuck, it is now possible to establish a tool reference position, and roughly position the rear bracket along the Tee slot and then clamp in position. Now the topslide and follower rod can be adjusted so that the tooltip and the follower rod achieve the correct relative positions on the workpiece and contour plate respectively. Back off the tool a few thou (say ten) in both directions and then proceed to take a series of light axial cuts, the travel on each one being limited by the rod arriving in contact with the plate. Repeating this removes most of the stock. Finally, the tool is advanced by the ten thou in both axes to take a finishing cut, gently guiding the rod around the plate using both carriage and cross slide hand wheels. Any small imperfections are then removed with file or emery.

A word on geometric accuracy

In an earlier issue, readers may recall under Scribe a Line, a letter from Dr J Ponsonby regarding geometric accuracy of ellipses. As regards the device described here, for similar reasons to those noted by Dr Ponsonby, a faithful reproduction of the contour on the profile plate will result only if the end of the follower rod is given a radius to match that on the tip of the turning tool. The exercise described was undertaken some time before the acquisition of the round nosed tool from Greenwood mentioned in Trade Counter (Issue 90). With this tool in mind, it could be worth considering fitting a radiused cup end to the follower rod to take full advantage of capabilities of this form of tool.

Scribe A Line

Peter King from Christchurch, New Zealand, writes:

Mea culpa, mea culpa, I had forgotten that the UK had changed its Patent Act. However what I said still stands in many countries in the world. As far as the UK is concerned, however it is not as free and easy as correspondents have indicated.

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then you are still liable to prosecution by the patentee; so don't try it on in many European countries outside the UK and most others elsewhere.

On a happier note, I found Harold Hall's article on the use of a shaper interesting. My shaper is a vast "Invicta", probably from the Elliott Machine Co. and probably of UK origin. The smallest automatic transverse feed increment on this shaper is 0.005in. (0.127mm) as measured with a DTI. For finishing, I use a HSS round nose tool with a radius of about 13mm. This is honed to a razor edge for bronze otherwise it tends to skid instead of cutting. For cast iron and steel, I use ordinary lathe carbide tools and again a HSS tool with the same radius as the one set up for bronze.

I have had similar problems to John Harris in separating a drill chuck from its arbor. I now have a pair of hardened wedges that do the job very neatly; these were acquired from a dealer in second hand tools. However alas they only fit some small sizes and there is no trademark on them so I don't know the provenance.

Regarding Malcolm Whites problem with drunken threads, I suspect that this may be due to using bar stock that has a very small amplitude 'corkscrew' form rolled into it. I have had this same effect appear when knurling a long length of bar and like Malcolm, also when cutting a long length of thread with a tailstock mounted threading die. If this is the problem, then I suspect that die guides will not correct the problem.

Peter Miller writes by email:

Re: CL300M electrics

May I join in the ongoing correspondence... The fuse in any electrical circuit should never be uprated or operating characteristics changed (slow/quick blow) to stop it blowing - to do so is inviting fire and disaster. The designer will have considered the mechanical, electrical and thermal limitations of the components and materials used and selected the most appropriate fuse to allow the machine to operate safely. If the manufacturer makes an error, he is inviting product liability lawsuits. If you make the changes then any warranty and insurance cover may be void. A persistently blowing fuse is trying to tell you that something is badly wrong - stop what you are doing now. In the case of a machine tool, sharpen or change the tools and take lighter cuts or there is a fault in the machine.

In an electric motor, the current consumed is proportional to the output torque. The majority of the heat dissipated in the motor is caused by the flow of electric current through the windings so more output torque causes more heat to be dissipated in the motor. The shaft mounted fan is designed so at rated speed there is sufficient air passing through the motor to restrict the internal temperature rise to the limitations of the insulation materials used within the motor.

Unfortunately the amount of air moved by the fan varies in proportion to the square of the fan speed. For example at one quarter full speed, there is only one sixteenth of the airflow available - if the motor is required to provide full torque (which electrically it is quite capable of doing) then the motor will rapidly overheat and fail. In these small lathes there is no means of detecting when the motor is overheating other than your nose, at which point it is too late - so always lighten the load on the motor when operating at less than full speed. You are likely to be surprised just how hot the motor will get when run for a time with little load at minimum speed.

Larger industrial variable speed drive systems use over-sized or separate cooling fans when motors are expected to operate at reduced speed for extended periods. Many systems incorporate temperature sensors within the motor, or alternatively part of the control program in the drive electronics has a mathematical model to mimic the thermal properties of the connected motor to predict overheating and reduce the risk of thermal damage. Given the recent interest in the magazine in retro-fitting variable speed drives to older lathes, use the lathe's gearbox to keep the motor speed as close to normal as reasonable, particularly if long periods of operation at slow speeds are required.

Mr Ludwik Allerhand of London writes:

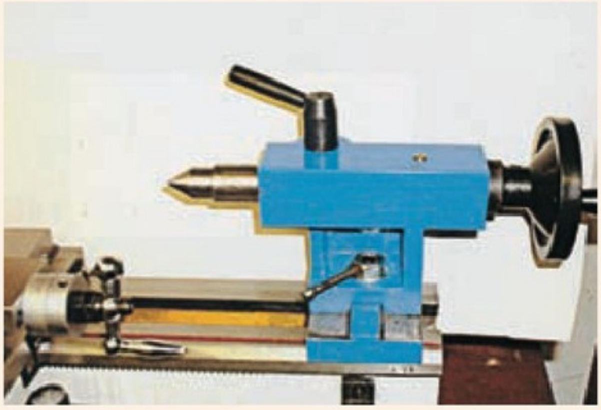
In the first chapter of his book "Workholding in the Lathe" Tubal Cain makes the point that a draw bar should always br used with any accessory, e.g. drill chuck, fitted into the lathe headstock taper. He goes on to say that the same principle applies also to the tailstock taper (but concedes that accessories can be fitted without drawbars because the taper socket is comparatively easy to replace).

My lathe is a Myford Super 7, the tailstock of which does not have a drawbar facility. I have had problems with the taper on my drill chuck turning in the tailstock barrel and scoring the internal taper. Although replacing the barrel is "comparatively easy" the cost of a new barrel is currently £63.29 (with VAT and carriage) and so I was wondering if there was a more economical remedy by adapting the tailstock to take a draw bar. Has any reader adapted the tailstock on a Myford Super 7 to fit a draw bar, and if so, how is it done? If it is impractical to make the adaptation, what can one do to remedy the problem of tapers turning in the barrel.

I might mention that I do not have an engineering background, I am a lawyer by profession and my hobby is metalworking.

Editorial comment: Morse tapers are designed to be "self holding" and in many circumstances such as morse taper drills are normally used without a draw bar. Where a draw bar does become necessary is when one is holding a milling cutter which gives rise to cyclic or vibrational loads, which in turn tend to loosen the taper. If a problem is occurring with tailstock drilling, then it suggests that the condition of one or other tapers is less than perfect. In the case of the Super 7 the advice would be to first inspect the male and female tapers, and their fit, perhaps using engineers blue. Any high spots on the arbor may be removed by lightly stoning, while the internal taper may be reworked by careful recutting with a number two Morse taper reamer. During a conversation with contributor Ray McMahon, he revealed that he keeps a No.

Edgar Powell of Tonypandy writes:



I wonder how many model makers who have a mini-lathe as described in the "Model Engineers' Workshop" Magazine for October 2003, get annoyed and frustrated when using the tailstock, having to move it backwards and forwards when in use, by unlocking it on to or off the lathe bed by means of the 10mm spanner provided?

I was one such person, and therefore I decided to alter the configuration of the clamping arrangement by simply placing a small lever in the clamping nut. This did not involve serious alteration, and entailed just a 15 minute job as described below. It made a world of difference, no spanner required, less frustration and time consuming, and more importantly far less chance of distorting the clamping plate under the tailstock through too much force and leverage from a spanner. Perhaps other model makers would like to follow my example.

The modification can be carried out using the existing domed nut or preferably a new nut (mine cost me just 30 pence from my local ironmongers shop). Either way, tighten the nut with the spanner, (locking the tailstock to the lathe bed), until one of the flats on the nut faces the apron and chuck, mark this flat with a line by means of a scriber or pencil. Now put a centre punch dimple in the centre of this flat, then using a tapping drill for a 2BA thread or metric equivalent, drill straight through into the thread of the nut. Carefully tap the appropriate thread of your choice. Myself, I obtained a two inch long 2BA Allen headed screw from my scrap box, domed the head for comfort in use then screwed a 2BA nut on to the thread. Now put the modified nut back on to the 10mm screw protruding in the tailstock, screw it down just finger tight for now. Screw in the 2BA screw, which has the locking nut fitted on it, until it bottoms on to the 10mm thread. Now unscrew it a fraction to allow free movement of the 10mm nut then lock the 2BA nut so that the little lever you have made is now secured into the 10mm nut. The tailstock is now ready for use. No more frustations of struggling to wangle the spanner to lock the tailstock or unlock it. Just push the little lever forward or back to move or lock the tailstock unit.

The photographs may be of help in clarifying the arrangement, which I hope may be of help to others.

two MT reamer tucked away, and gives the tailstock a little gentle attention about every two years or so. In fact this reconditioning service is available from Myford as an alternative to replacement.

Mr Stephen Bates writes by email:

I've been reading MEW for a few months now and I fully enjoy reading them. I am new to engineering and I have only had my lathe six months. I thought I would write to you about a program for the Myford ML7 lathe change wheel gearing that would be of interest to your readers. The program allows you to find the right gearing for TPI TPM and threads per rev. The program allows you to use non standard gears also more then one gear of the same size. The user puts in data of the gears he has, so if he does not hold a particular gear, the program will work out the nearest setup for him. I have no connection to the author only a satisfied user. The program is free from: http://metal.duncanamps.com/software.php. also from my links page: http://homepage.ntlworld.com/stephen.bates590/lin.htm

Mr Leslie Austin writes by email:

A friend who subscribes regularly to your magazine lent me issue 96 with the suggestion I should read the item on Logan steadies, knowing that I have a 10in. Logan. Since I have a fixed steady, I shall not make one of those, but I will probably make the travelling steady.

What interested me also, however was your contributor's suggestion that manufacturer's parts would be unavailable. If he uses his computer to log onto the "loganactuator.com", or "lathe.com" website, he will quickly discover that most parts are still manufactured for Logan lathes, together with manuals and other stuff. Furthermore, Scott Logan, grandson of the originator of the lathe series, also hosts a group within the "Yahoo Groups", namely Yahoo groups lathe list. Here all topics relating to Logan lathes are discussed, which are most instructive.

I don't know how many Logan lathes there are in the U.K. (or even on the Isle of man like mine), but if any owners want to contact me by email, I will circulate to everyone; we may be able to help each other with spares, somebody may be "breaking" one, or whatever.

My own lathe is nearly 63 years old now, being one of the very early ones. I think it came over here on "lease lend", and maybe the others here did likewise. It is a model 200, screwcutting, powered cross slide, with change gears rather than a gearbox. Are all the others over here the same? If anybody wishes to contact me, email manxduke@manx.net.

I might add that my one Logan lathe shares space with three Ducati (Cagiva) motor cycles.

Mr John Coleman of Brighton writes:

I refer to issue 96, page 51 Jim Atkinson's letter about school teaching methods relating to the properties of a right angled triangle. His teacher was possibly better (or more imaginative) than mine. I was taught the following method and still use it today to remember how :-

SOH, CAH, TOA, leading to S = O/H, C = A/H, T = O/H, where S = sine, C = cosine, T = tangent, O = opposite, H = hypotenuse, and A = adjacent.

It may well be that "Percy" is a superior method to remember.

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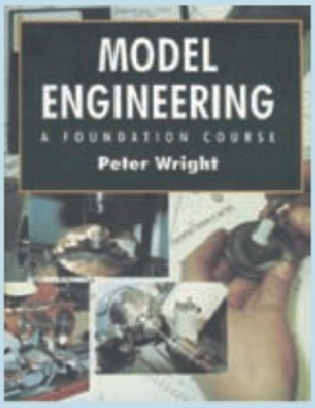

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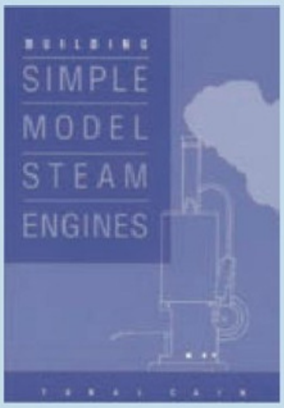

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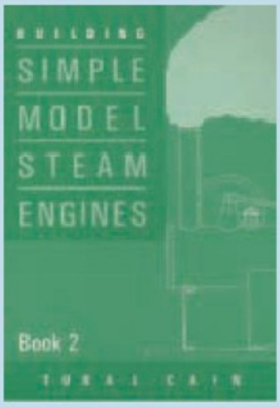

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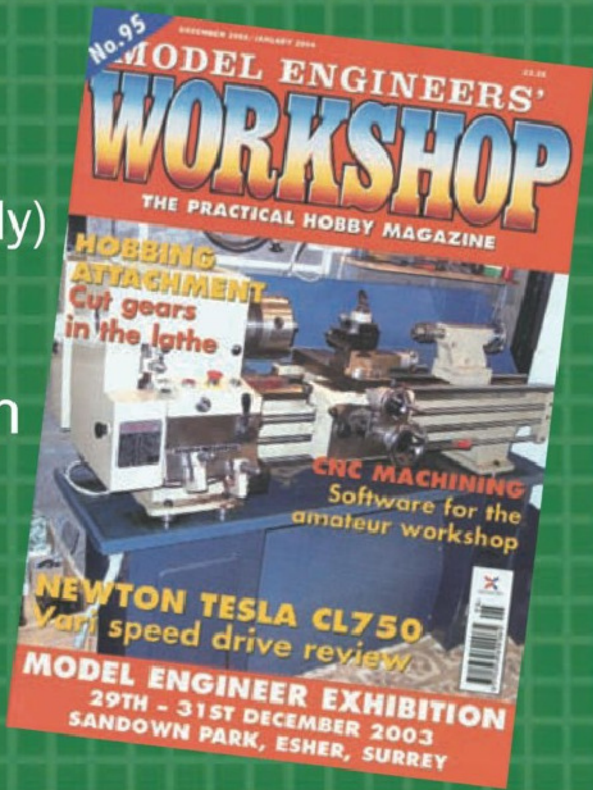

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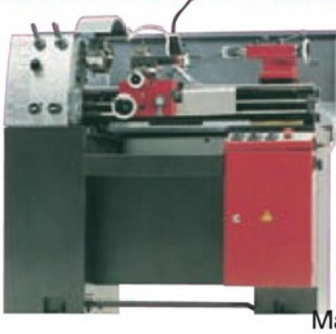

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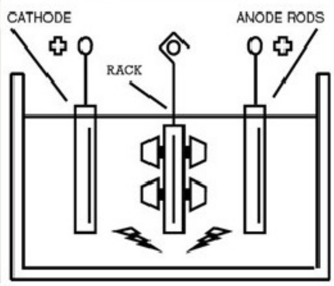

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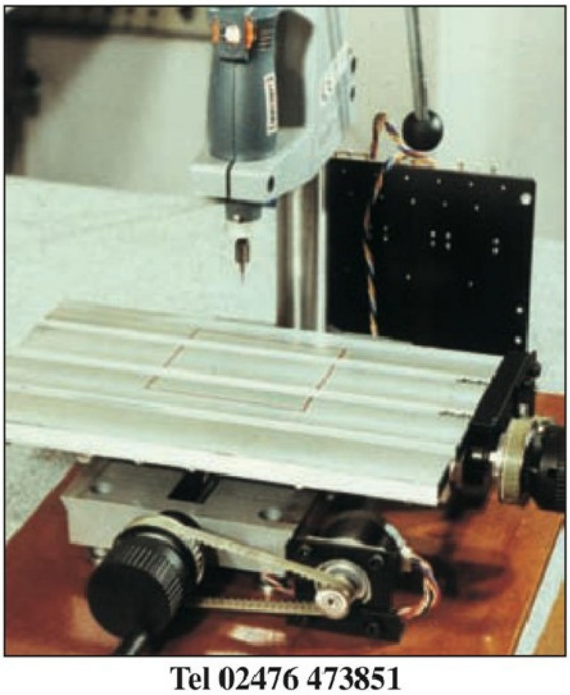

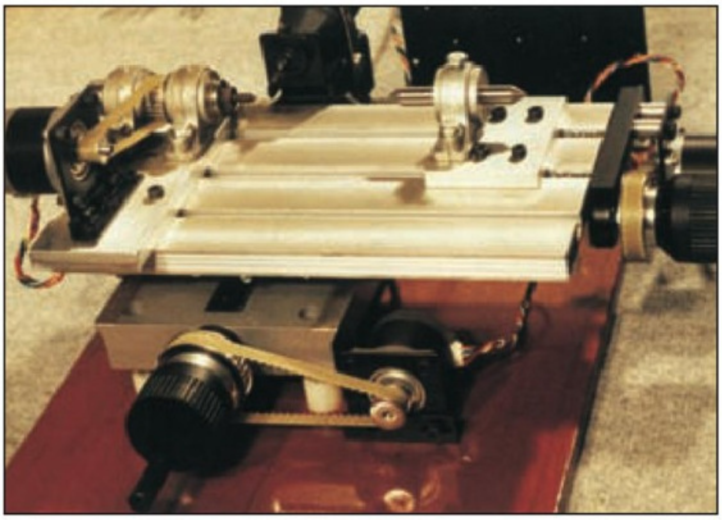

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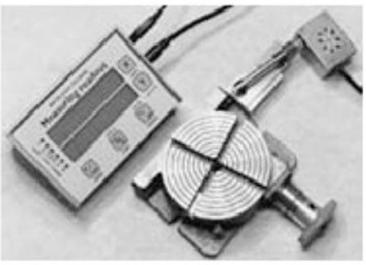

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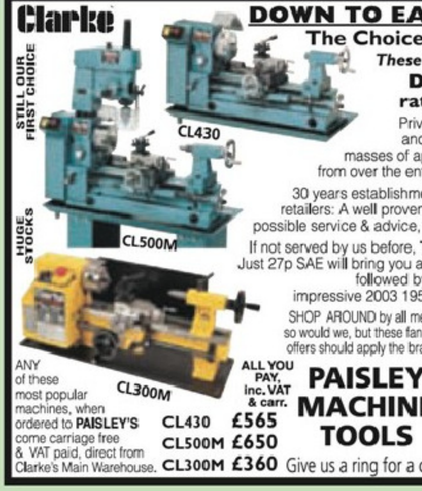

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HARRISON M300 6" x 24" precision lathe, geared head, gearbox, power feeds, 3 jaw & 4 jaw chucks..**Choice** £3250
HARRISON M300 6" x 24" precision lathe, geared head, gearbox, power feeds, 3 jaw chuck, Dickson toolpost ...**This machine is 240 volts as new and in very good all round condition** £3550
HARRISON M300 6" x 40", geared head, gearbox, power feeds, gap bed, 3 jaw & 4 jaw chucks, fixed steady ....**in very nice condition** £3750
HOBBYMAT MD65 2½" x 12" screwcutting lathe with changewheels and some tooling **as new** £395
MYFORD SUPER 7 3½" x 19" changewheels, 3 jaw chuck and tooling ....**Choice** £950 - £1150
MYFORD SUPER 7, 3½" x 19" 3 jaw chuck, power cross-feed ....**Late model Choice**
MYFORD SUPER 7 3½" x 31" changewheels, 3 jaw chuck and tooling ....**Choice** £1400
MYFORD SUPER 7B 3½" x 19" gearbox, 3 jaw chuck and tooling..£1650
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MYFORD SUPER 7B 3½" x 19" gearbox, power cross feed, 3 jaw chuck and tooling on stand excellent condition from new and **NOT** re-conditioned £3550
MYFORD C7 CAPSTAN LATHE £1200
SMART AND BROWN collet lathe complete with cross / top slides and collets £345
VICEROY TDS 1 GBL 5" x 24", gearbox, power slides, 3MT tailstock complete with fixed steady..£1250

TOO MANY LATHES TO LIST!!

MILLING MACHINES (V – VERTICAL, H – HORIZONTAL)
ACIERA F3 Universal milling machine complete with collets 1/16" – 5/8" & 2MM – 20MM, suds and light in all round good condition..£3250
BOXFORD VM30 vertical variable speed / 30 INT head, table 21½" x 6" + Abwood vice and chuck... ....£1500
BRIDGEPORT vertical belt head 2 speed (short motor) head, R8 powered head, gearbox table, 42" x 9" table..**needing work hence** £750
CENTEC 2A Vertical/Horizontal, swivel 2MT head, 16" x 4½" table, pedestal model........................£950
CENTEC 2B Horizontal, 1" arbor, table powered, 3 ph motor, single phase main motor...............£725
CENTEC 2B Vertical/Horizontal, quill 2MT head, 25" x 5' table, pedestal model £1400
ELLIOT MINIBORER (Jig borer) collet fixture head with good selection of collets, ...£1200
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HARRISON Horizontal, 31" x 8" powered table ....**still good value** £625
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MYFORD VME turret type milling machine in nice condition complete with R8 collet chuck.......£2400
SIP RF30, vertical milling/drilling machine complete with accessories...........**Still only and New** £799
TOM SENIOR M1 horizontal, 25" x 6" powered table, 1" arbor..£575
TOM SENIOR M1 V/H, 25" x 6", 2 MT, 1" arbor. ....**Selection** £1200 - £1950
TOM SENIOR ELT MAJOR, 2 MT quill feed head, powered 37" x 8½" table in £2,750
VICEROY AEW vertical mill, 30 INT swivel head, powered table 34"x 8", ...**choice** £1250 - £1625

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ASQUITH 14-54 001 Mk2 (5mt) radial drill £3950
BOXFORD 2MT pedestal drill..£295
BOXFORD 2MT pedestal drill..**very late machine** £425
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FOBCO ½" pedestal drill tilting table £345
MEDDINGS ½" pedestal drill £245
MEDDINGS 2MT pedestal drills £275
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SIP HDP 600B ⅝"/2MT bench drill, table operated by rack, speeds; (16) 162-3000 rpm .....**New** £175
STARTRITE Mercury ½" 4 speed bench drill £225


Asquith 5MT radial drill £3950


Raskin 14 Ton power press £345


View of our vast stores


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RJH 4" horizontal finisher complete with built in extractor £625


Emco Compact 5 lathe complete with new chuck £400


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Harrison L5, L5A, 140 vertical slide £375


Raglan / Littlejohn fixed steady £85


Harrison M300 40" lathe complete with gap, chucks and travelling steady £3750


Myford Super 7 lathe in very nice condition £1700


Myford Super 7B power cross feed lathe new never used POA


Aciera F3 universal milling machine complete with collets £3250


Boxford 1130 lathe £2450


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