

No.113

MARCH 2006

# MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

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tiny parts

**CNC**  
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on the X-3

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## On the Cover

*Removing the covers on this German tapping machine shows how a round belt is used to take the power around corners (and provide forward / reverse rotation). Philip Amos discusses various techniques on page 28.*

**See page 56 for our special subscription offer!**



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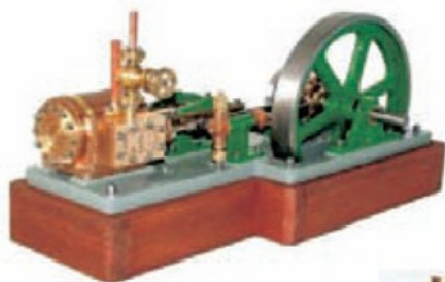




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- Vertical Travel 330mm
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- Drilling Capacity in steel 16mm
- Price £1489.00



## Milling Machine F1200E

- Long Travel 260mm
- Cross Travel 150mm
- Vertical Travel 280mm
- Motor 1.4kw
- Varispeed 180-3000rpm
- Drilling Capacity in steel 23mm
- Price £1757.00



## Milling Machine F1210E

- Long Travel 500mm
- Cross Travel 150mm
- Vertical Travel 280mm
- Motor 1.4kw
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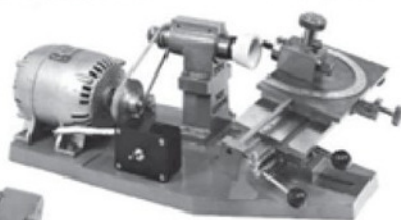
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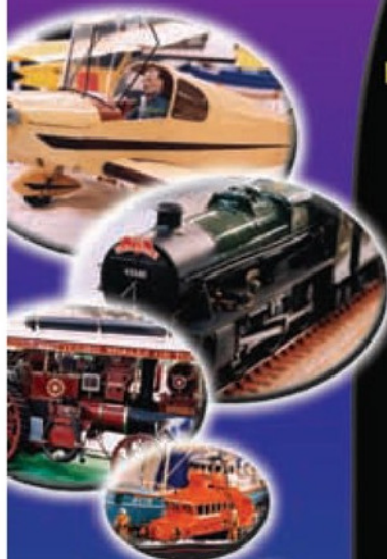
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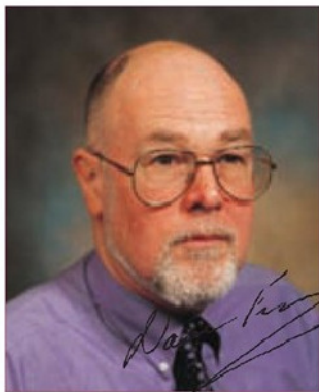
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# ON THE EDITOR'S BENCH

## Magazine ownership

Readers who stay abreast of city and financial matters will be aware that the former owners of this magazine, Highbury House Communications plc. are no more. In broad terms, they had overreached themselves on an acquisition spree about a couple of years ago and were then unable to service the level of debt, even after divesting several businesses. MEW along with senior sister "Model Engineer" and other hobby and gardening magazines, is now owned by Encanta Media Ltd. a new company set up to focus on this particular leisure area. Many readers may well have been unaware of the earlier difficulties and the change of ownership. This is a testament to the efforts of the team at Orpington who have ensured that almost all publications came out on time. For the future, we now benefit from having a small, tightly knit management group, which is focussed specifically on niche publications, and look forward first to a period of "bedding down", followed by logical and systematic development.

## In the Workshop

As I have observed on previous occasions, my workshop is a large cold draughty barn. During the height of winter, temperatures get pretty low, and in years gone by I did in fact fit thermostatically controlled heaters to a couple of the machine coolant tanks to allow production to continue. The "heaters" were simply 100 watt bulbs mounted in large tins, placed below the tanks. Of course this kept the "solly" above freezing and liquid, but did not raise the temperature of the machine body. On at least one occasion, switching on the coolant supply resulted in the rapid growth of a miniature white glacier all over the saddle and bed as the liquid froze on contact.

Moving towards spring, brings us cold nights but warmer days. The arrival of the warm air leads to instant condensation on cold metal surfaces. Even with a cover, at this time of year, I regularly find the Chipmaster coated with droplets of water, looking as though it had been liberally sprayed with a weedkiller gun. What I do not know, and here, readers may care to voice their own experiences, is to what extent, condensation is likely to cause problems amongst the electrics and electronics. I have not yet had a motor fail due to this cause, but it does present a nagging worry. The more obvious result of

condensation is the dreaded rust, and my pet prevention system employs two components. One is an occasional run around with a WD 40 spray gun, the second is to use an oily paintbrush for clearing swarf. The resulting oil film does help to keep the dreaded rust at bay.

## Unconventional tooling sources

Some months ago, a friend phoned to let me know that the local branch of Aldi was selling digital calipers at a knock down price, and if I wanted one, to be quick as he had seen one chap buying five. I visited the store and picked up a bargain. Since then I have made fairly regular checks for tooling bargains at both Aldi and Lidl. On the woodworking side, a small table saw appeared for under £30, a set of router bits for £6, then a set of hole saws for about £12. Now it has to be said that the saw table is a cheaply made folded and painted steel item and the two measurement rules are out of alignment by about 3mm, thus setting up needs a bit more care, until a more elaborate fence is constructed. Conversely it does have an induction rather than universal motor, which runs smoothly, relatively quietly, and has no brushes to wear out.

## Remap at Sandown

One of the exhibition stands up on the first floor, was that of Remap. For the benefit of newer readers who may not be familiar with the organisation, it is a charity whose aim is to provide technical equipment for disabled people, in particular where there is no available commercial solution. A number of aids were on display, including one for assisting with opening jars.

The Remap Year Book summarises around one hundred and sixty projects from around the country, selected from some three thousand five hundred cases annually, covering many of the twenty-three "Hamilton Index" categories. Looking back quickly through the 2005 Year Book, it is clear that solutions range from those involving complex electronics, to those which have required considerable thought to arrive at elegant simplicity. Two which embodied electronics, were the music triggering spoon, which encouraged an 18 month old infant to eat, and the large digital speedometer for a client who was unable to see clearly a normal analogue speedo at short range. Amongst the elegantly simple was the "U" shaped ignition key holder, which allowed the client to more easily rotate the key and start the car.

The growing popularity of powered wheelchairs, scooters and buggies has

generated a number of projects in this area. These have ranged from control alterations such as repositioning the joystick control, or converting from hand to foot control, to adding devices for "load" carrying. In this latter group are such items as a dog seat, for a dog unable or unwilling to run with its lead attached to the wheelchair. Other wheelchair/scooter attachments included a pannier basket and a trailer hitch for garden use.

Remap works collaboratively with three other charities.

**MERU** - is an engineering charity which designs and manufactures equipment for children with disabilities. It was founded by a Consultant Orthopaedic Surgeon and a Senior Lecturer in Engineering in 1973.

**Demand** - design and manufacture equipment for disabled people where no readily available solution exists, and offer an information service guiding clients to existing sources.

**BIME** - (The Bath Institute of Medical Engineering) is a non profit design and development organisation working on a range of projects aimed to benefit a number of people rather than to be one off solutions.

Remap is organised as a network of local panels of volunteers composed of technicians (engineers, DIYers, etc) and health professionals (occupational therapists, physiotherapists etc.) who work together to provide solutions to client problems. They are, as ever, keen to recruit more volunteers with a wide variety of skills for their worthy cause. If you are interested in devoting time to this most rewarding work the contacts are:

Remap - England  
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## Dates for Your Diary

**May 5th 6th 7th** National Model Engineering and Modelling Exhibition, Harrogate. Anyone wishing to exhibit at Harrogate should contact Lou Rex on 01977 661 998.

**August 18th, 19th, 20th**, Bristol Model Engineering Exhibition, Thornbury Leisure Centre.



# THE LATHE ONLY WORKSHOP © Cross Drilling Jig

1. The cross drilling jig



## Harold Hall constructs a useful Hemingway kit

that must make it amongst the best available.

The kit of parts, available from Hemingway kits (ref. 1), comprises very clear A3 drawings, all materials, hardware and a sheet giving brief instructions for manufacture. In the spirit of the "Lathe Only" series, I am proposing different methods for machining some of the parts. Even if you have a well-equipped workshop then this would still be a worthwhile project to undertake, especially in view of the ease of use of the finished article.

## Body (1)

This is the main item, which is made from an iron casting that machined well. The draw or taper, necessary when making castings, makes securely holding the part for machining a task that must be approached with care. The casting is largest at the base and tapers to a slightly smaller size at the top; the top and bottom surfaces being nominally parallel.

To securely hold the part in the four jaw for machining the top face first, place small pads of soft copper or aluminium a short way up the chuck's jaws, making sure that the casting is gripped over a wider area, not just the lower edge, see Sk. 1. However, before fitting into the chuck, using the coarse wheel of the off

do not make out to be an expert on cross drilling jigs but do know there have been many designs for carrying out what appears, though falsely, a

simple operation. Having made and used this item in this article, **Photo 1**, I can confirm that it performs the task with considerable ease and to a high standard



2. Machining the first face (top)



3. Having machined the four faces the casting can now be held with sufficient security to machine the ends.





**4. The Vee is machined using progressively smaller end mills, and doing this whilst on the top slide ensures that it is at centre height.**

hand grinder, make a substantial chamfer, say 2mm, around all edges. This prevents the lathe tool having to break through the outer faces that may have hard spots present, and is especially important if HSS tooling is being used.

Having machined the top, **Photo 2**, reverse and refit the casting with the now machined top held cleanly against the chuck's face and machine the base. We now have two parallel faces that will begin to make holding it in the chuck more secure. There is though a problem that can be overlooked. Turning the casting through 90 Degrees and holding it on the two machined faces one of the two remaining long faces will be against the chuck body. Having a taper as mentioned earlier and being much wider than the depth of the jaws, this can take over the positioning of the casting, see **Sk. 2**. Use a square, set against the chucks face, to check that this has not happened. Machine the third side and then similarly the fourth.

Now having four machined surfaces for the chuck to grip, the ends can be machined as in **Photo 3**. With the degree of uncertainty regarding the positioning of the part in the chuck so far it is unlikely all corners will be sufficiently close to 90 degrees; I hesitate to use the word, exactly. Therefore, skim over all six faces once more using the following sequence, do still use the copper pads under the jaws both to protect the machined faces and to increase the gripped area.

Set up the part in the chuck, again as in **photo 2** and give the top a finishing cut. This time rotate the casting by 90 degrees and again tighten chuck and give this second face a finishing cut. However, do not rely on the machined surfaces automatically positioning the casting, but check with a square that the face just machined is square to the chuck's face. Repeat the process for faces three and four after which check that the desired result has been achieved, that is, all four corners are 90 degrees. Now again set up the casting as in **photo 3** and skim the end. This time it will be necessary to check two adjacent faces against the chuck with a square. Repeat for the other end and you have the six faces finally machined. The overall dimensions are quite unimportant

so do not spend time attempting to arrive at a particular dimension. In any case the drawings themselves quote these dimensions as nominal.

Mark out the position for the jig fixing hole and centre punch. Set up casting, again as in **photo 2** and set the centre punch mark to run nominally true, checking it against the tailstock centre will suffice. This will though result in a very out of balance set up so now wind back the one jaw and insert a substantial block of steel to improve the situation, do ensure that the chuck is very firmly tightened again, we do not want this to fly out when the lathe is up to speed. It will in any case be necessary to run the lathe at a quite low speed as even a near perfect balance is unlikely to be achieved. Drill to suit the diameter of the tool post on the lathe on which it is to be used.

Mark out, drill and tap the three  $\frac{1}{4}$ in. BSF holes.

## The vee groove

The main method for using the device is for it to be mounted on the lathe's top slide with the drill in a drill chuck in the lathe's mandrel, more about that later.

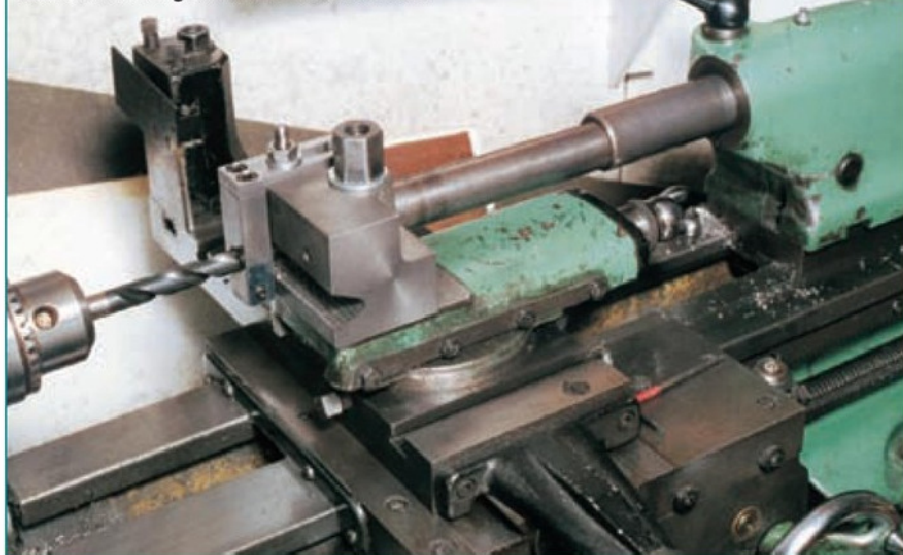


**5. A toolmakers vice mounting arrangement gives flexibility over the position of the vice. Very helpful on a small vertical slide.**

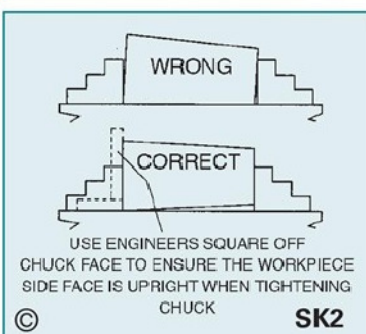
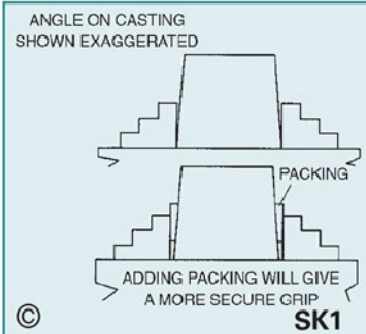
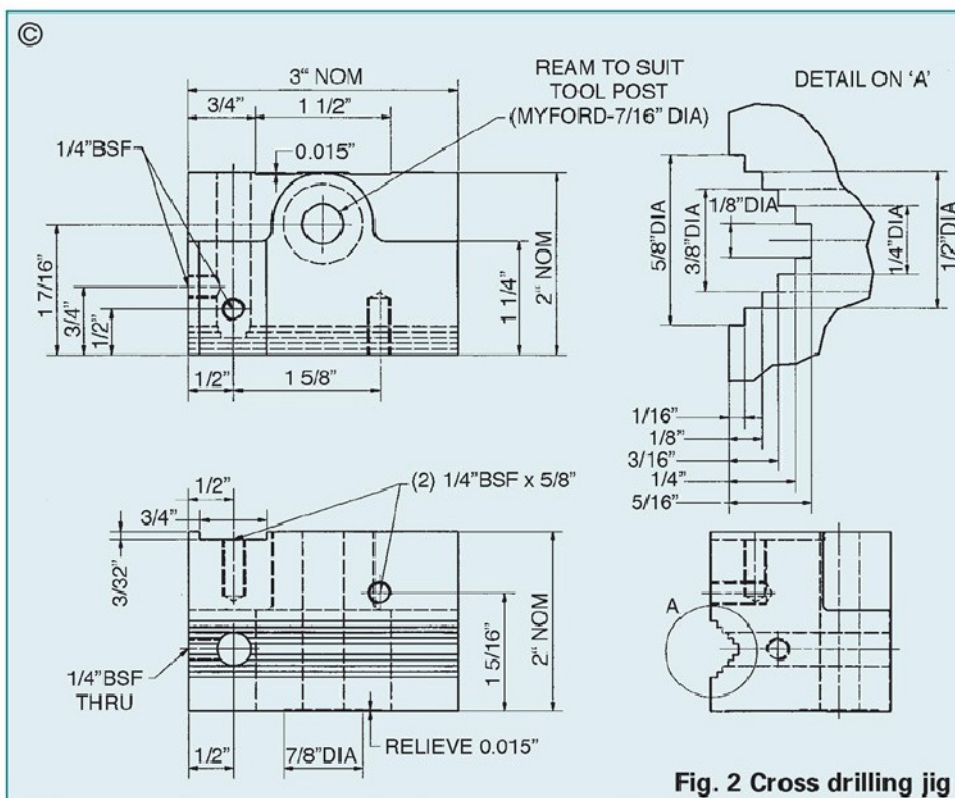
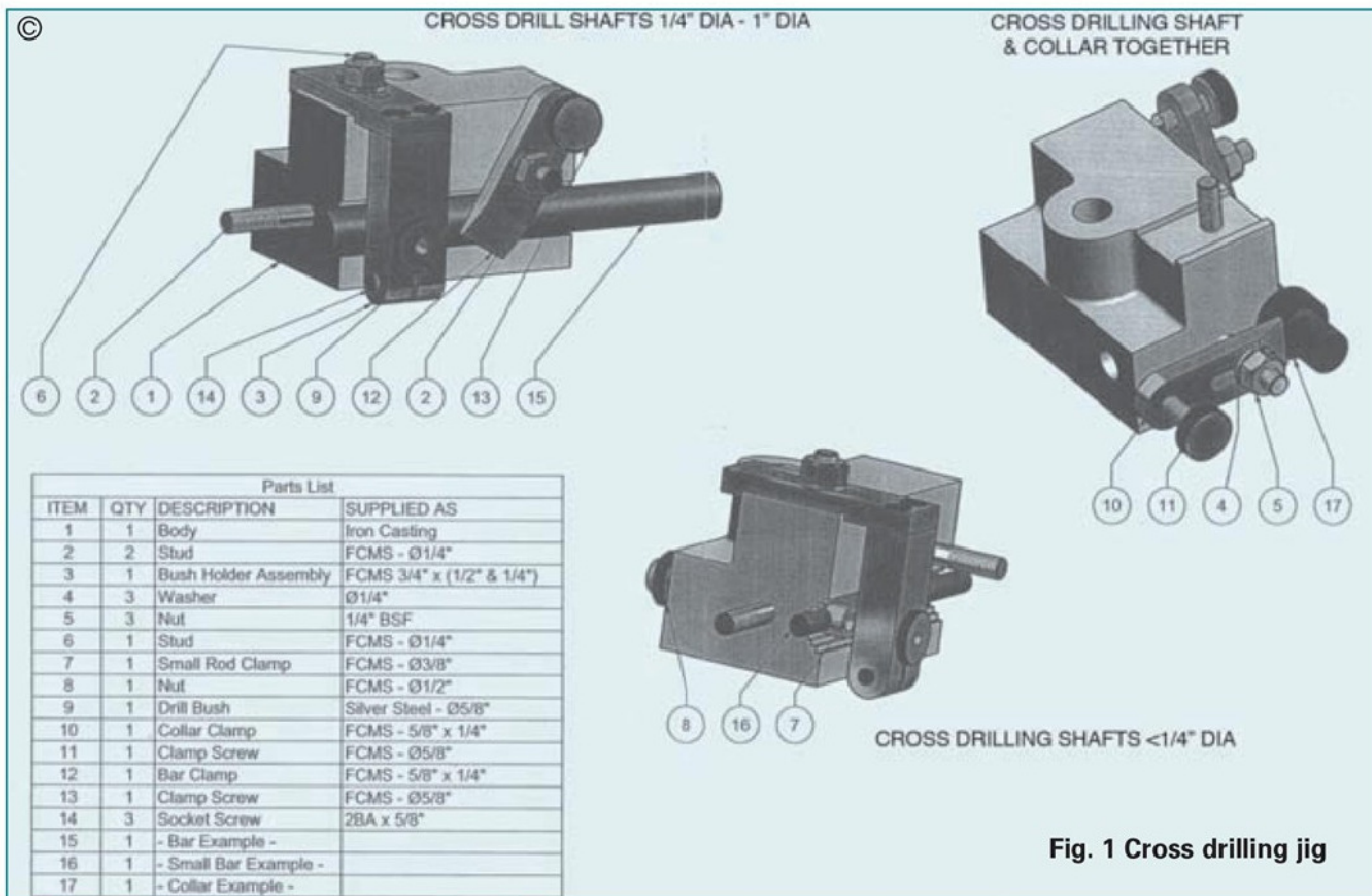


**6. Being able to rotate the vertical slide is a definite plus over using a conventional vertical milling machine.**

**7. Drilling the bush holder. Note that the tailstock is being used to feed the saddle.**







necessary when the finished item is put to use. If your lathe needs this extra reach but the top slide cannot be rotated a full 90 degrees all is not lost. All that is required is that the face

being machined is at right angles to the lathe's axis. This can still be achieved even if the top slide is set at 45 degrees. As a last resort, temporary spacers could be placed between the cross slide table and the leadscrew mounting bracket to increase the traverse. If using the method shown in the photograph the actual machining is carried out traversing the

Because of this it is essential that the vee is exactly at centre height. If a conventional vee was attempted this would be difficult to machine and even more difficult to ensure it was at the correct height. Making a stepped vee with progressively smaller end mills and whilst mounted on the lathe's top slide, results in the accuracy required and also being an easy process. If

like me you use metric end mills the increments will be in 2mm steps, 16, 14, 12, etc. and at 1 mm depth increments.

**Photo 4** shows that the top slide was rotated 90 degrees for this operation. The reason for this was that the traverse of the cross slide was just insufficient for the cutters to reach the right hand edge. As will be seen moving the top slide is not





**8. Boring the bush holder to size**

cross slide only, the top slide only lets the jig start that much further back.

The final task on the body at this stage is to produce the groove that positions the bush holder assembly, **Photo 5**. The set-up seen in the photograph uses a toolmaker's type vice though this is not essential. However, note how its mounting provides considerable freedom on its mounting position, very beneficial when working on the vertical slide.

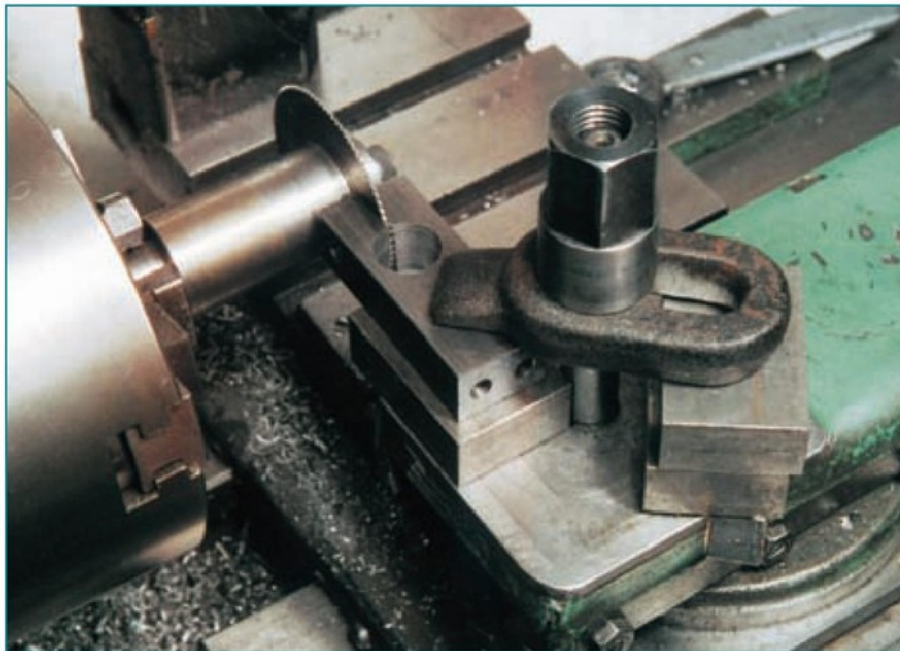
## Bush holder assembly (3), Bar clamp (12), Collar clamp (10)

These are made from rectangular stock and with the vertical slide and vice still set up from the previous operation. Skim the ends of these to the quoted dimensions. Grip the part in the vice just projecting from the ends of the jaws and machine by traversing the vertical slide.

Next, using a  $\frac{1}{8}$ in. slot drill make the two slots required. Finally with this set up, turn the vertical slide to 7 degrees and machine the taper on the two parts requiring this, **Photo 6**. The ability to swivel the vertical slide in the two planes is a definite bonus over the facilities available with a normal vertical mill, often worth making use of in the more fully equipped workshop.

Drilling and tapping the required holes is straight forward though in the case of the bush holder assembly it would be a good idea to drill tapping size holes first in the thinner part and use this to transfer the positions to the actual bush holder.

Mount the body with bush holder assembly onto the top slide and centre drill the bush holder followed by drilling and reaming  $\frac{1}{8}$ in. completely through holder and body. Finally, drill holder, **Photo 7** and ream  $\frac{1}{8}$ in. diameter. Note, the assembly is being fed by the tailstock and not the saddle mechanism, hence the bar between tailstock and the rear of the body. Also, you may be confused by the shape of the vee in this photograph. I actually made two jigs, one for another and one for myself, and on this one mistakenly stepped the end mills down by 2mm increments, hence the deeper vee. Actually, I realised my error after only two sizes of end mill but decided to continue



**9. Slitting the bush holder**

with the 2mm increments throughout the remaining end mill sizes.

If you do not have a  $\frac{1}{8}$ in. reamer you could set up the part on the faceplate and bore to size, **Photo 8**, use the tailstock with centre in the pre-drilled hole for positioning. The last task for these parts is to slit the bush holder as shown in **Photo 9**. This is an excellent example of a task more easily set up on the lathe even if a vertical milling machine is available.

## Miscellaneous turned parts

These are very simple and need little comment except for three points. The cross drilled hole in item 7 can be done using this jig after it has been completed. The drawings call for silver steel (mild steel supplied) to be used for the drill bushes

and eventually to be hardened, but unless you are to put the jig to considerable use normal mild steel should suffice. The drawing calls for three bushes to be made and you may be concerned if wishing to cross drill another size. In this case first drill with a smaller size then remove the bush and open up to the size required. **Photo 10** shows the complete kit of parts.

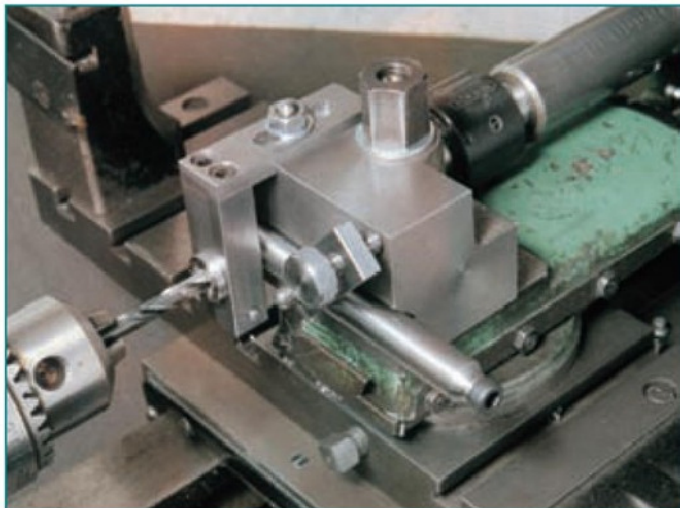
## In use

As already indicated the jig is primarily intended for use on the lathe's top slide but can equally well be used on the drilling machine as the rear face of the jig has been machined parallel to the front face. **Photo 11** shows a chuck key (for the project after next) being cross drilled for its Tommy bar. Again the saddle is being fed with the tailstock using a centre in the  $\frac{1}{8}$ in. through hole in the jig.

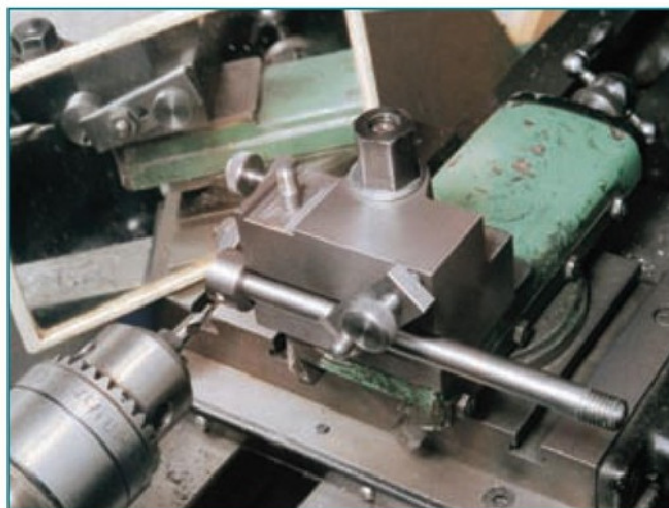


**10. The complete set of parts**





11. Using the jig to drill a chuck key for its Tommy bar



12. Drilling a collar. The mirror shows the hidden side.

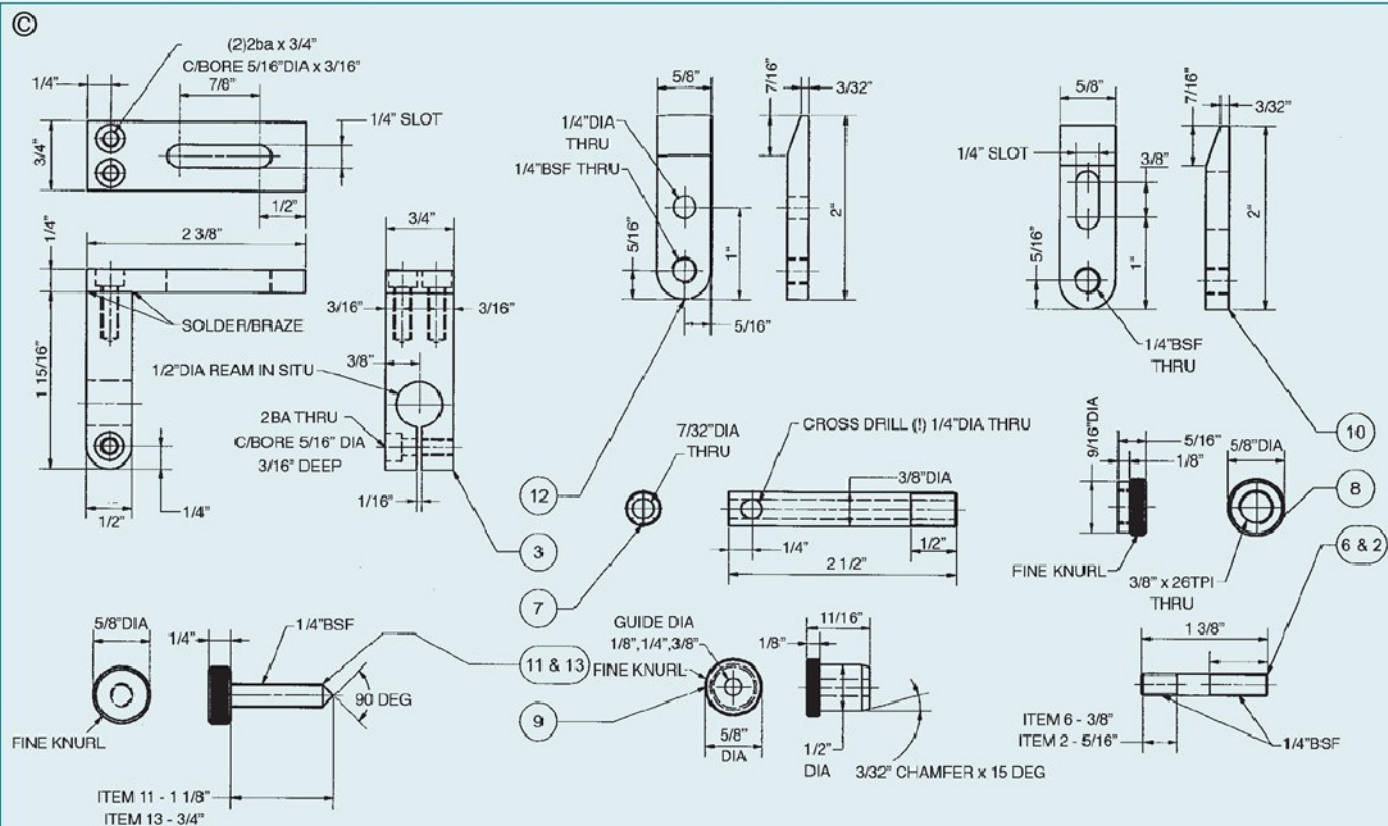


Fig. 3 Crossing drilling jig

Small diameters,  $\frac{1}{16}$  in. to  $\frac{1}{8}$  in., can be cross drilled using the small rod clamp to hold the bar in place. In this case the bush holder assembly is not used and the hole



13. Collars and similar can also be drilled at an angle.

is first positioned with a small centre drill.

Collars can also be cross drilled as shown in **Photo 12**, though this task can only be carried out with the jig mounted on the top slide. The collar can either be on a rod on which it is eventually to be assembled, or the rod can be there purely to assist with positioning the part whilst drilling. In this mode the drilling is not confined to drilling at 90 degrees to the workpiece. **Photo 13** shows a bush being drilled at an angle for a simple locking handle of the type that I often use as an alternative to the ball handles often suggested.

If using unhardened bushes they should be satisfactory of a few hundred holes at least. A wise precaution would though be to enter the drill into the bush before starting it to rotate. This will avoid any wander of

the front end of the drill attempting to bell mouth the bush as it enters.

If like me, you do not have any specific tooling for the task of cross drilling, then like me I am sure you will ask yourself, why did I not make one before?

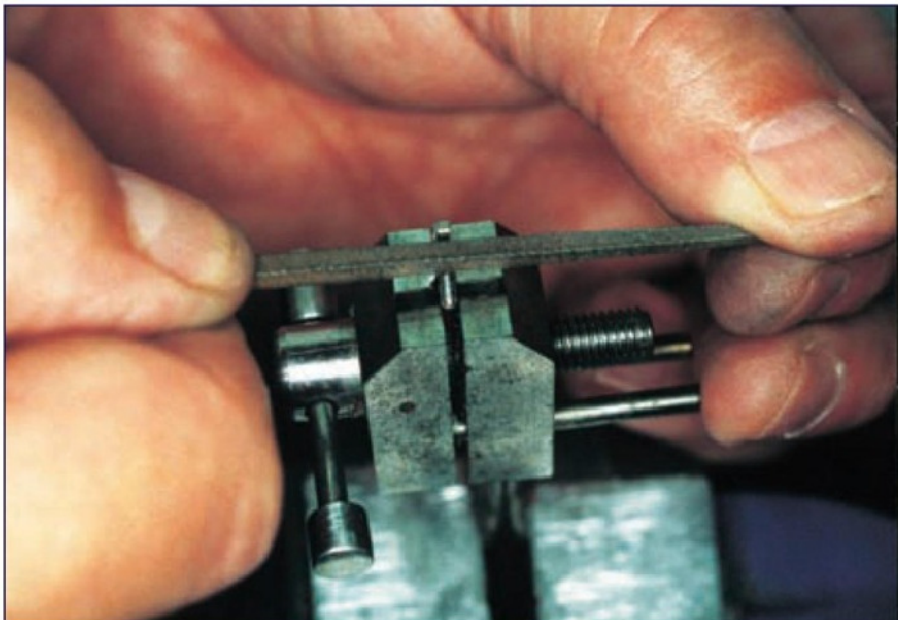


*In the next issue the subject is something much smaller, a matched pair of small vee blocks.*

## References

1 Hemingway Kits. 126 Dunval Road. Bridgenorth, Shropshire, WV16 4LZ. Tel/Fax 01746 767739. E-mail [info@hemingwaykits.com](mailto:info@hemingwaykits.com) Website [www.hemingwaykits.com](http://www.hemingwaykits.com) Kit HK1410 "Tidy" Cross Drilling Jig





1. Vice in use, gripping a small workpiece.

# MINI VICE

## Bob Loader describes a home made accessory for small scale workholding

I recently unearthed a mini vice which I made a long time ago for holding small and fragile parts. I needed it for working on several small components, for which my other two vices, one 3in. and one 2 $\frac{3}{4}$ in. would be too big.

On occasions, I have used a small parallel clamp to grip the work and held the clamp in the vice, but for what I wanted, it wouldn't have worked. The original mini vice had a complicated piece of ironmongery attached, which allegedly clamped it to a bench. It didn't, so I got rid of it and used it with a hexagonal post pressed into the back jaw, making the assembly shown in Fig.1. This allows six clamping positions and enough swivelling to cover most operations. I've dimensioned in metric units. The original was in imperial, but it translates very easily for those like me, of the dinosaur tradition. Only joking! I will work quite happily in either or a mixture of both. The construction is reasonably simple and the only part with any difficulty is the adjusting screw. Prospective builders who work from a mainly imperial scrap box, should have no difficulty in working to nearest standard size, and adjusting holes etc. to suit.

## Jaws

I haven't stated a material for these because I was lucky when I made them and could get any material within reason, so I used gauge plate and hardened and tempered them. They could be made from mild steel with separate jaws, or from mild steel case-hardened.

All these alternatives remind me of a whimsical senior draughtsman at a small company I once worked for. He put W H Y in the materials column of a drawing. When I asked what it meant, he said, 'what have you', meaning anything reasonable ~ silly me for asking! So use what material is to hand which is suitable.

The jaws are described in Fig.2 and can be machined or filed to the external dimensions, except for the 45 degree angles. They are then clamped together accurately and all the holes pilot drilled, except for the 2mm one. Use whichever drill size you'd normally use for a reaming size for the 3mm reamed holes (my views on reaming drill sizes seem to clash with most other peoples).

A hand reamer is the right one for the job and should be taken through till it pokes out about 2mm, then a 3mm dowel will be a sliding fit in the front jaw and stay put in the back one. If it needs a bit more reaming it can be done by hand. When both holes are dowelled it will locate the jaws for the rest of the drilling.

Drill through both jaws with a 5mm drill and open up the front one to 6mm, this will act as a guide for the tap to keep it

upright. Tap the M6 hole and open up the clearance one to 6.10mm.

The jaws can now be separated and the vee grooves put in. These are optional but will be very useful for holding round components. The 45 degree angles can also be filed or machined. The hole in the back jaw for the post can be drilled to suit whatever size the post will be, I'd suggest about 6mm.

The cross hole for the retaining pin, item 5, is not an easy one to position and needs careful marking out and accurate drilling. It helps to plug the 6.1mm hole with a snugly fitting piece of mild steel, then the drill won't try to wander. The plug can be left there for the reaming and tapped out when finished with. Like the 3mm reamed holes, the retaining pin needs to stay put, so the reamer should stick out about twice its diameter when the hole is finished. Start from that and adjust as needed. I haven't drawn the pin, which is a length of 2mm.dowel. If this is difficult to obtain, settle for  $\frac{1}{8}$ in., and adjust the sizes to suit.

## Adjusting screw

This, item 4 Fig. 3, will be straight forward but for the radius undercut. Made from stock 10mm mild steel, the turning, threading and undercutting should be done on the same setting with a tailstock centre support

As for the undercutting tool, if it is ground as a 2mm. wide parting tool, the radius can be formed by grinding a series of small flats down the front clearance face and stoning to the final shape. An alternative is to make it from silver steel, gauge plate or a piece of softened old file. The radius can be filed to shape and the finished tool hardened and tempered.

Whichever method is chosen, the tool will benefit from having the groove roughed out a bit first. A length of broken hacksaw blade held in a padsaw handle makes a good roughing tool. DO NOT attempt to use it without a handle and do not use too high a speed. The 1mm depth shown on the drawing can be cut a little deeper, up to one and a quarter mm. won't hurt and the same applies to the width, which will probably need some adjustment on assembly. It is no use trying to make every dimension exact, because they won't fit, so take the dimensions as nominal; common sense will tell when they need to be precise.

The plain portion of the screw diameter can be different from the 6.1mm. stated: if it is a good running fit and the pin retains the screw and lets it rotate, it isn't that critical. The cross hole in the head can be drilled in a crutch centre or a jig.

## Tommy bar

Item 8 Fig. 2, is a length of 3mm dia. mild steel cut to length and faced. The reason





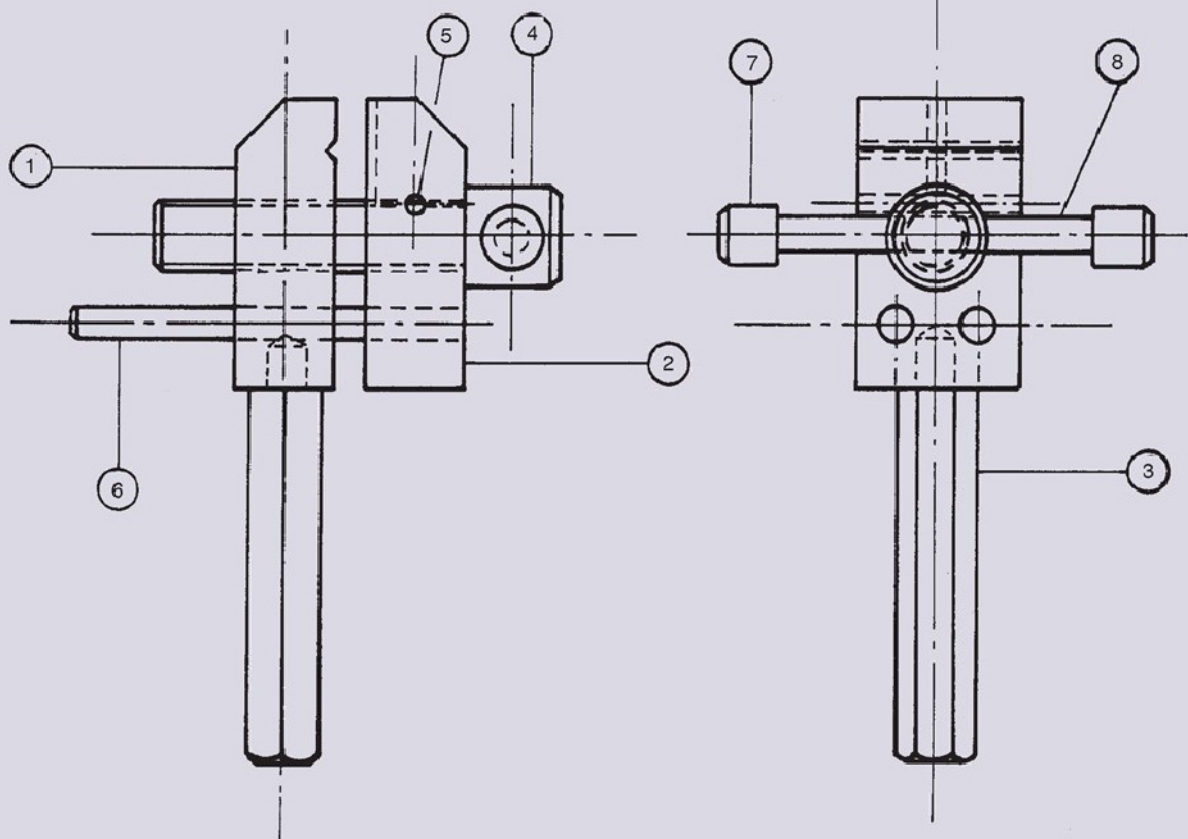


Fig. 1 Mini vice assembly

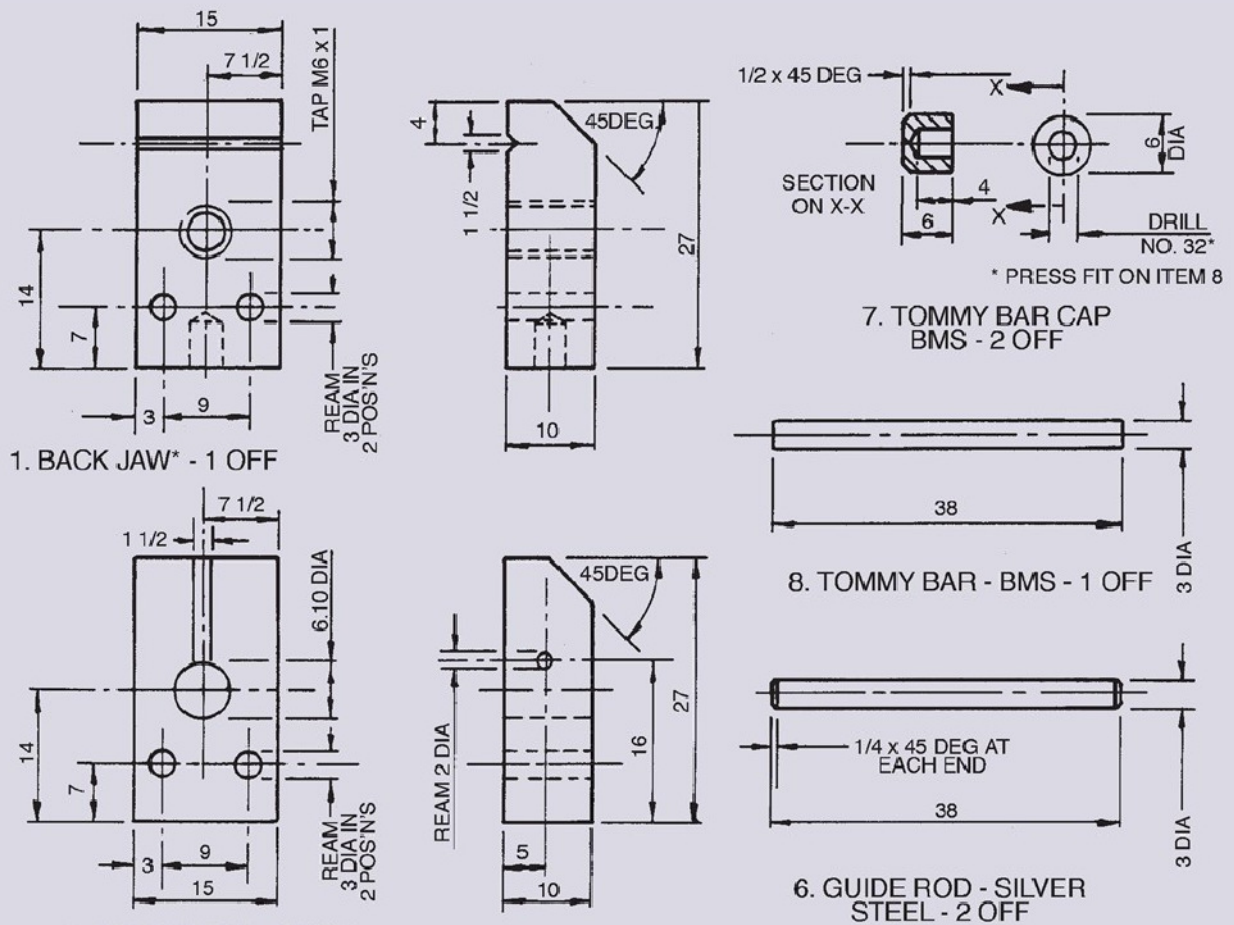


Fig. 2



why it is short is to reduce the clamping force. A longer one would encourage the user to get excited and small work could get damaged.

## Tommy bar caps

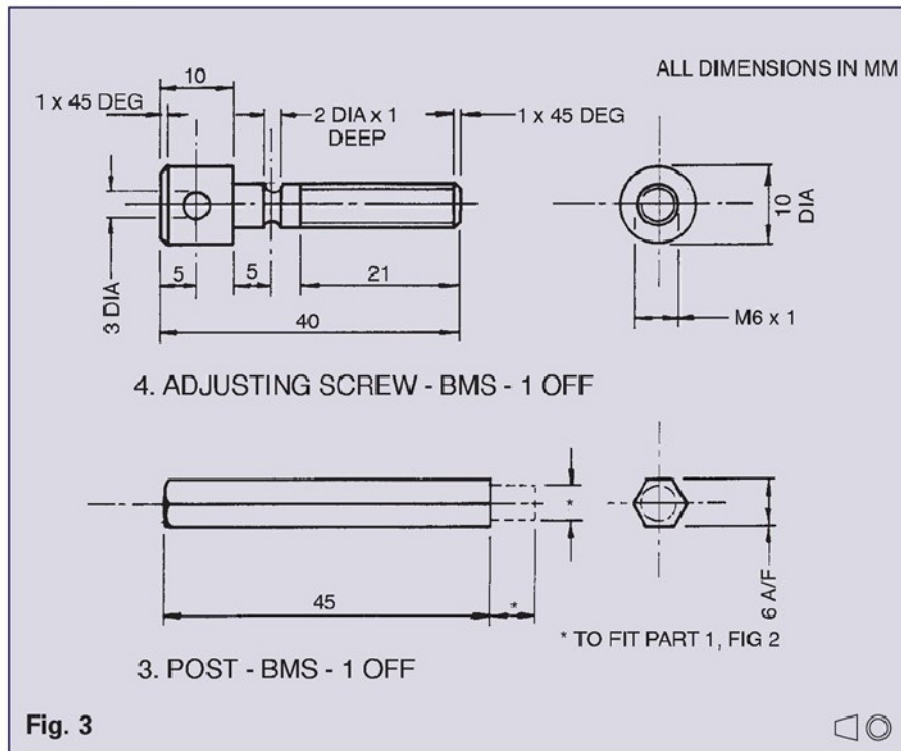
These two are pressed on to the tommy bar, the second one after it has been passed through the cross hole in the head of the screw. They have to stay there, so if a drill other than No. 32 makes a better fit, use it. It is a good idea to try out first with some scrap to get it right.

## Guide rods

The best material for these is silver steel and it is tough enough to need no hardening. If the reaming has been done correctly, they should press in till they come flush with the back face of the jaw. If by some mischance they don't, ream a little more. If the mischance is the other way and they are loose, lightly knurl the last 3mm. or so to raise the surface a little. This is the 'putting on tool' you may have heard about. It has got me out of trouble many times. If no knurling tool is available, try gently squashing the last 3mm. in a vice with roughly serrated jaws, or centre punching in several positions round the diameter. If none of these modifications appeal, rest a  $\frac{3}{16}$ in. steel ball on the rim of the hole and give it a clout. You might also consider using Loctite to retain the parts.

## Post

This is an example of W H Y on a drawing, because it doesn't matter what the



material is as long as it is long enough to hold comfortably in the vice and a press fit in the back jaw. I used a piece of hexagonal brass and would have preferred steel but there was none in the scrap box. The diameter and length of the spigot are a matter of choice, as long as the length is at least twice the diameter.

And that's it. **Photo 1** shows the vice

being used for finishing a small part and **photo 2** is the prototype of the adjusting screw. The final version is the same but has the plain portion fitting the front jaw.

It is a useful little vice and has been a boon when shaping small parts, which could get marked or squashed in bigger vices. It also beats fiddling about trying to position a small component in soft jaws.

# IN OUR NEXT ISSUE

## Coming up in Issue No. 114 will be



### Cylindrical Grinding Attachment

For use with a tool and cutter grinder, described by Shelley Curtis

### Nice Neat Control Panels

Les Riley gives tips for professional looking switchgear.



### Small Vee Block

Continuing the "Lathe Only Workshop" series, Harold Hall describes this useful item from Woking Precision.

### An Alternative Route to Milling Light Alloy

Arthur Davies achieved excellent results with unconventional equipment.



Issue on sale 13th April 2006

(Contents may be subject to change)



# LOUVRE TOOL



1. Rear view of louvres i.e. upper surface of workpiece.

## Background

A number of my projects have featured sheet metal casings, with a number of louvres (photo 1) to allow air movement. Our editor had noticed these and suggested that I write a short note on this item of tooling, namely the:- the louver cutting and pressing punch. The action is a combination of shearing and forming, between top and bottom tools, as illustrated in Fig 1. Hence a press is required capable of delivering a fair amount of force as well as accurately holding the tools in correct relative positions.

## Press requirements

My own press is a home made affair fabricated from mild steel and welded up. It uses a 2.5in. diameter double acting hydraulic cylinder which is pressure rated up to 3000 PSI. thus giving a maximum force of approximately 6.6 tons. This pressure rating is seldom used and about 1000 PSI is about the normal requirement, equating to a little over two tons. A rough idea of the arrangement of the press can

be gleaned from photo 2, which shows the tool set up in the press. I was lucky at the time of obtaining the cylinder as the company had cleaned out the stores and this was one part of the rubbish. At this time I also obtained a single phase hydraulic pump that had been out in the yard for some years but on inspection it was found to be in excellent order with the exception of the motor "Tails". So these I had replaced at a local rewind company. This pump had been out in the rain and

- for ventilation slots, by Peter Rawlinson

weather to my knowledge for some 5 - 6 years and it was surprising that the water level in the tank had not reached as high as the oil suction. All it needed was emptying, cleaning out, and refilling with hydraulic oil. I was then in business.

Originally this pump set was designed for use with prestressing equipment (In the concrete industry) and was capable of generating 10,000 PSI. As the cylinder has a considerably lower maximum working pressure rating, as noted above, this pump had to be fitted with a control valve and an appropriate pressure relief valve.

## Pressing jobs

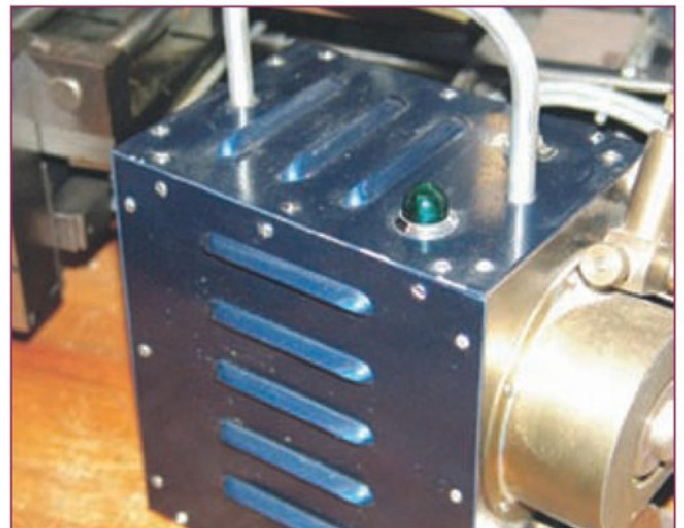
The hydraulic unit has been used many times for punching holes, and is also used for folding aluminium and steel etc. I have also made up a small guillotine (12in.) long. I cut my aluminium with a jig saw and trim it using the press. It has also been used for punching rubber blocks, making gaskets, and for my louver tool. I have also used it to form the two parts of a clock pendulum weight. (It takes much longer to make the tool than the parts.) Naturally it can be used for pushing bearings in or out, and has even been used for pressing grapes, which I used to grow for winemaking.

## Other forms of power

Modern sheet metal production would tend to make use of a CNC turret punch press for creating louvres. Repeated punch strokes using a short tool coupled with movement of the job allow a range of louver lengths to be formed from one piece of tooling. Moving back further in



2. Press set up with tooling.

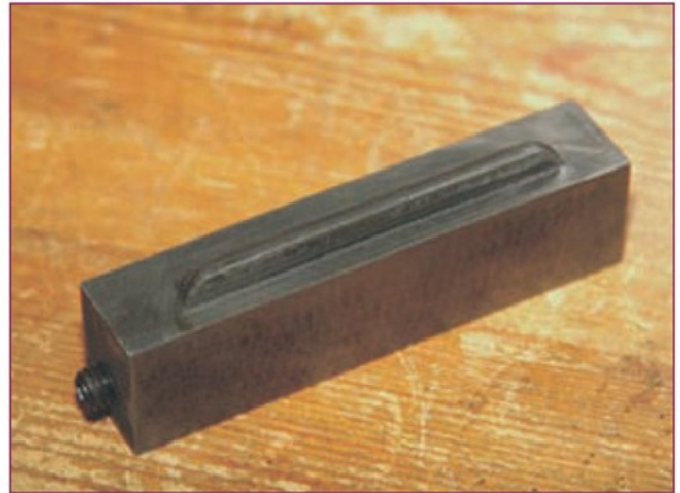


3. Ventilation louvres in blade grinder.





4. Form cutters for top tool (right) and bottom tool (left).



5. Underside of top tool.

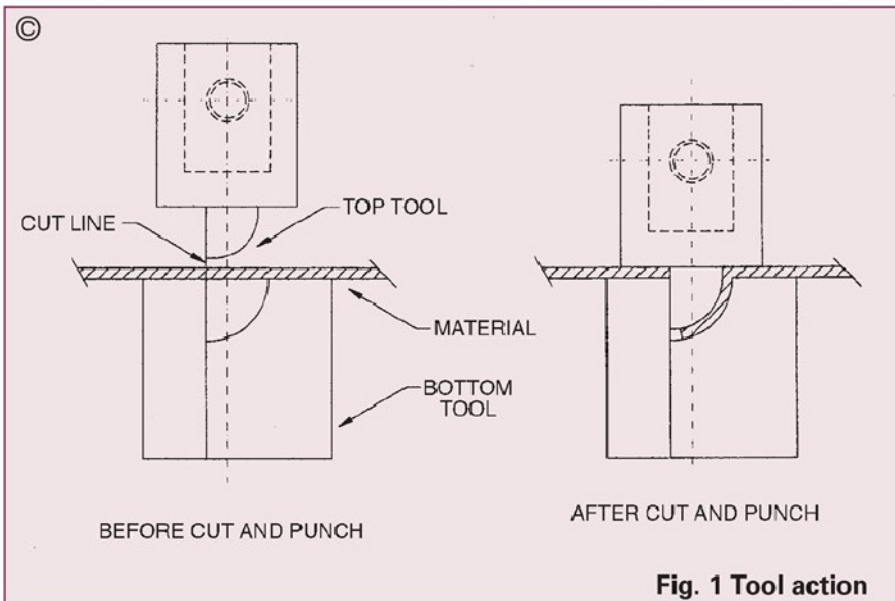


Fig. 1 Tool action

history, a single or multiple tool might be used in a power press or for light work, a fly press. Unfortunately when I last looked at these the prices of second hand units was, to say the least, exorbitant.

For the home built press, a standard car jack can be used, or even a vice (but watch the alignment) also check whether the car jack will work upside down, many will not.

## Alternative methods

Before making the louvre tool I made my ventilation "Holes" by cutting a large hole and covering on the inside with perforated zinc using "Plastic Padding" as the adhesive. This works perfectly well for airflow but is not a patch on the looks of the louvres.

I am also aware of, but have not tried, a method of creating louvres with a different tooling arrangement. This was referred to in the article on a visit to the workshop of Lee Dove (MEW Issue 82) and requires the cuts to be made first with a fine saw.

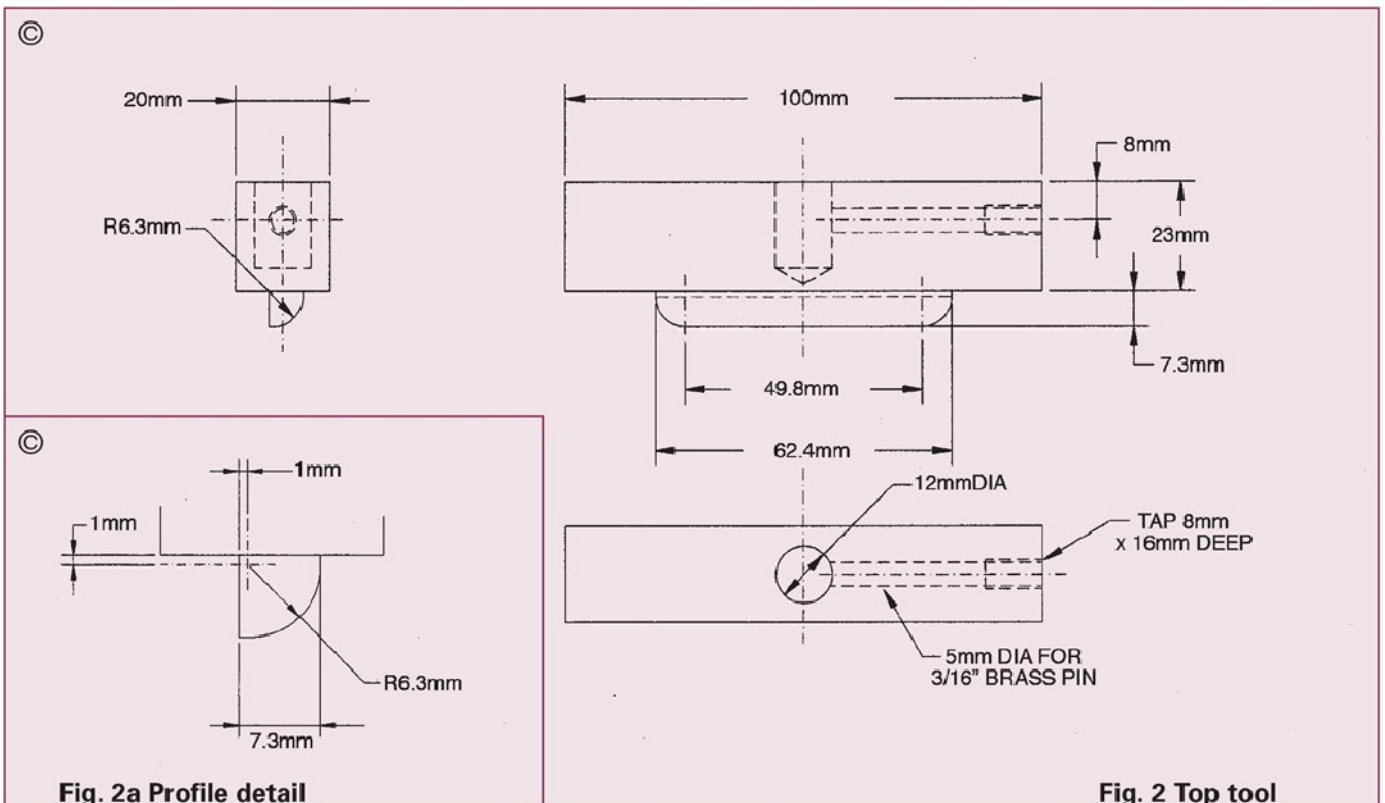
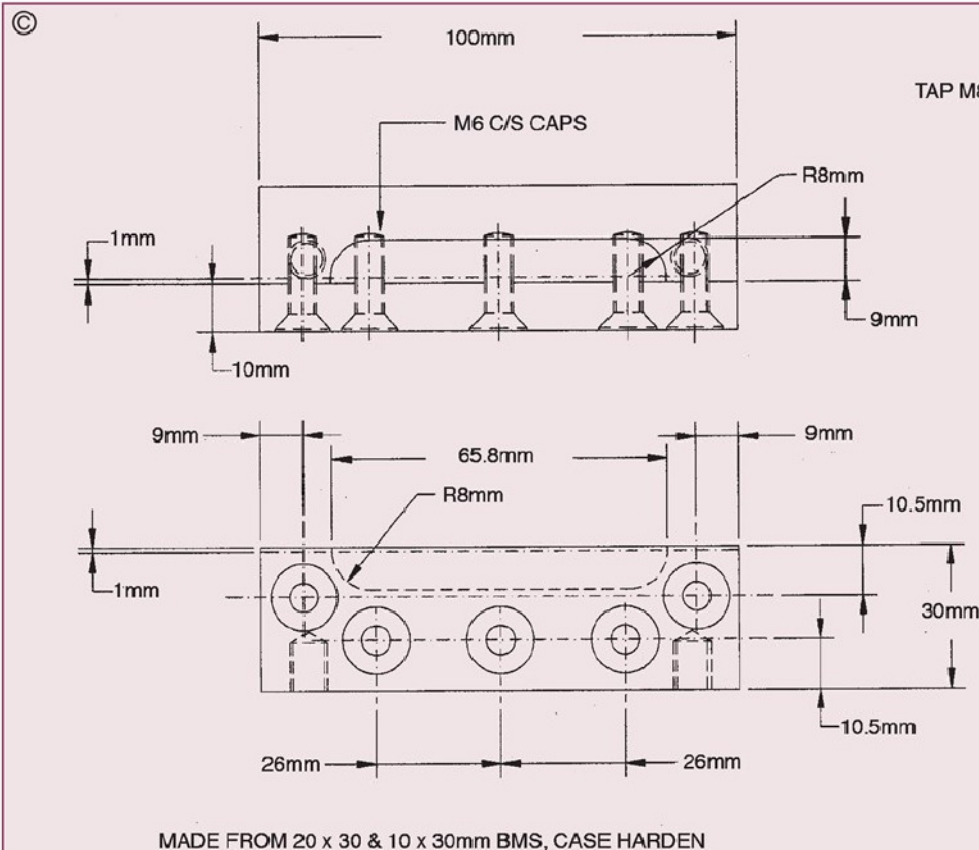


Fig. 2a Profile detail

Fig. 2 Top tool





**Fig. 3 Bottom tool**

top and bottom tools can be seen in **Photo 4**. This can be used to cut the radius along the length, and across the two ends. Each end must then be finished by hand to create the double curvature, unless you do a couple of set ups using a rotary table. A mounting hole is required in the top surface and the mandrel is held in position with a grub screw bearing on a brass pin. Make sure that the machining is symmetrical. The machined tool is shown in **Photo 5**.

### Bottom Tool - Fig 3

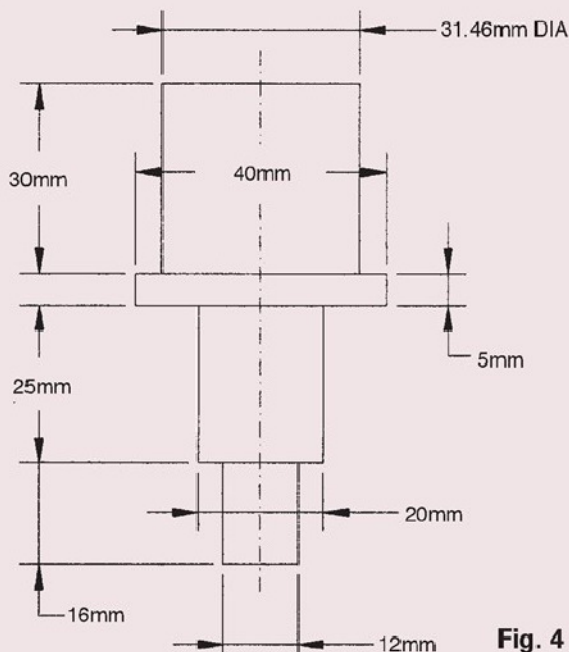
Due to the problem of machining the square corner, this part is made in two pieces which are then bolted together see **Photo 6**. The machining was carried out using a 16mm diameter ballnosed cutter, this then leaves a 1mm flat on the edges of the curve. The tool has a clearance of 0.1mm (4 thou.) over the 1.6mm material thickness. This part has two M8 tapped holes in the underside for the mounting and uses M8 countersunk cap screw to bolt the two parts together. Again make sure that the machining is symmetrical.

As can be seen from **Fig 1**, this arrangement of top and bottom tools, effectively traps the material (allowing just the clearance noted above) and forces it to conform to the tool curvature.

### Mandrel - Fig 4

The drawing and **photo 7** show the mandrel to fit my press. If you plan to use the tool with a fly press, then you will choose a mandrel diameter to suit. Many fly presses take one inch or one and a

© MATERIAL: BMS



**Fig. 4 Mandrel**

### Size

The same size louvres have been used on a number of tooling projects and they can be pressed in very easily. There is no need for a larger size as larger numbers of the louvres can be added as required. Projects on which I have used the tool have included band saw blade welder, blade grinder (**photo 3**), top slide power, spark eroder cabinet, and spark eroder head.

The size covered in this article is approximately 66mm overall length x 9mm wide and 9mm deep. The dimensions of the tooling have been

arranged to suit a maximum thickness of material of 1.6mm ( $\frac{1}{16}$ in.) and all my cases are made in aluminium of this gauge. (I have also tried it on MS of a thinner gauge with no ill effects.

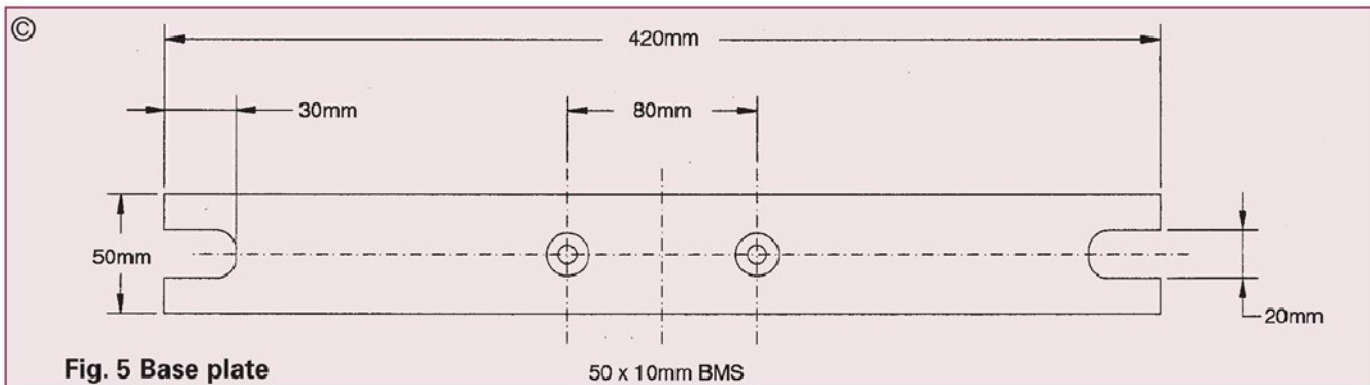
### Manufacture

#### Top Tool - Figs 2 and 2A

The top tool is made from one piece of mild steel 20 mm x 30 mm x100 mm long.

The only problem is the requirement for a  $\frac{1}{16}$ in. radius corner rounding cutter. The form cutters used for rounding both the





6. Upper surface of bottom tool.

quarter inch diameter. Similarly, alternative base plate arrangements may be needed.

## Base Plate – Fig 5

To suit my press, this a 420mm length of 50mm x 10mm BMS. Machining is a simple matter of drilling and countersinking for the two tool retaining screws, and then cutting the two slots at the ends. The end result is illustrated in photo 8 from which it may also be seen that I subsequently altered the holes to slots for holding other items.

## Hardening

The top and bottom tool parts will require to be case hardened to a good depth and should be quenched "end on" to minimise distortion. For gripping/manipulation when hot, the top can have a piece of screwed rod in the clamp hole and the bottom can have a strap fitted using an underside mounting hole. DO NOT drop these into the quench water at an angle. The Bottom



7. Top tool mounting mandrel.

tool should be hardened in two separate pieces as the expansion could break the clamp bolts. It can then be bolted together afterwards, and any slight distortion will be pulled out.

As an alternative, it would probably be quite satisfactory to make the Top and Bottom Tools from a material such as gauge plate. This would increase the cost of raw material, but could simplify the heat treatment.

## Mounting

The mounting of the tool is most important and there should be no rotary or sideways movement between the top and the bottom tools. The rod of any hydraulic cylinder can rotate as it extends or retracts if not restrained, and you will notice on



8. Base mounting plate.

mine (photos 2 and 9) the bar mounted on the rear of tool holder slides into a slot in the back of the pillar. This is a good sliding fit and stops the tool rotating. To mount mine, I clamp the top tool into position and carefully lower this into the bottom tool. I then push the two "flat" faces together, align the ends of both blocks and then clamp the base plate to the bed. (The slots at the end of the base plate are wider than the bolts, thus allowing a little positional adjustment before clamping down.) The eagle eyed will also note a packing piece to raise the bottom tool by about half an inch. This is unlikely to be needed, but should, in any case, be self explanatory.

## Use

Carefully check that the set-up is correct and the two vertical surfaces close tightly without fouling. These edges have to perform a shearing action as on a guillotine.

Always mark out your work carefully before punching your louvres. If you get the position wrong, they really do stand out like sore thumbs. Always use a light coating of oil on both top and bottom tools, as the sheet material does need to slide during the cutting/forming action. WD 40 is excellent.

I hope that this little tool is of interest and as usual, am happy to help if possible, but phone only please and I will not ring back for obvious reasons.

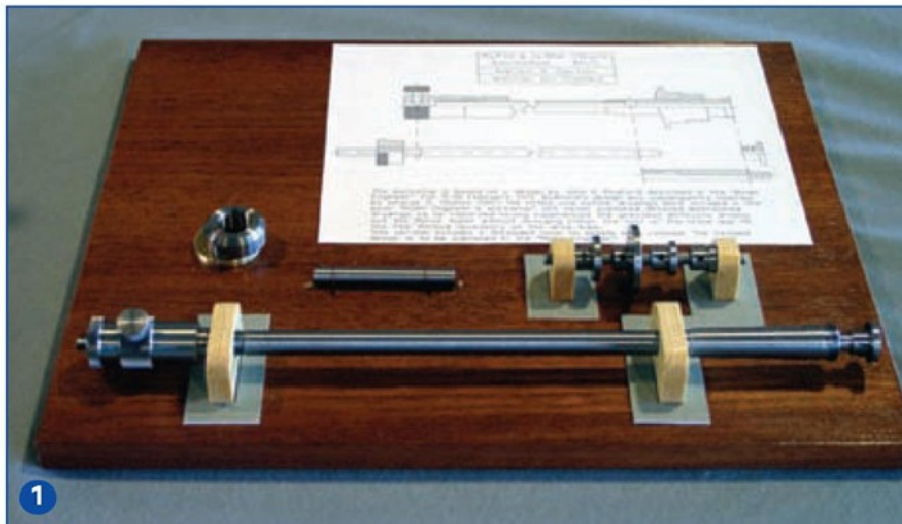
Peter Rawlinson, Charing, Kent  
01233 712158.



9. Face on view of set up, packing piece visible.



# 75TH MODEL ENGINE AT SANDO



## Workshop Equipment

### Competition Entries

Class A5 consisted of five entries and taking them in catalogue order, they were:-

#### A5/1 Myford Lathe Chuck Backstop by Adrian Garner

For those wishing further details on this, an article giving a full description has been submitted by Mr Garner to "Model Engineer" and will be published in Issue 4265. The device exhibited is based on that described by Mr J A Radford in ME (1971). One of the interesting features is the facility to retract the stop to allow the use of a boring bar. The design was subsequently modified by George Thomas, but still carried the potential for jamming the Morse taper component in the headstock leading to the possibility of headstock bearing damage on removal. Mr Garner has addressed this point by adding a threaded extraction feature. "A brass ring is slipped over the end of the Morse taper to protect the end of the Mandrel followed by a large nut. A small turn and the taper is released." The judges awarded a "Highly Commended"

#### A5/2 Lever Locking Top Slide by Alan Jackson

This was one of those exhibits that you really did have to study at length to fully appreciate the details of the design. Aside from the topslide assembly, a very neat

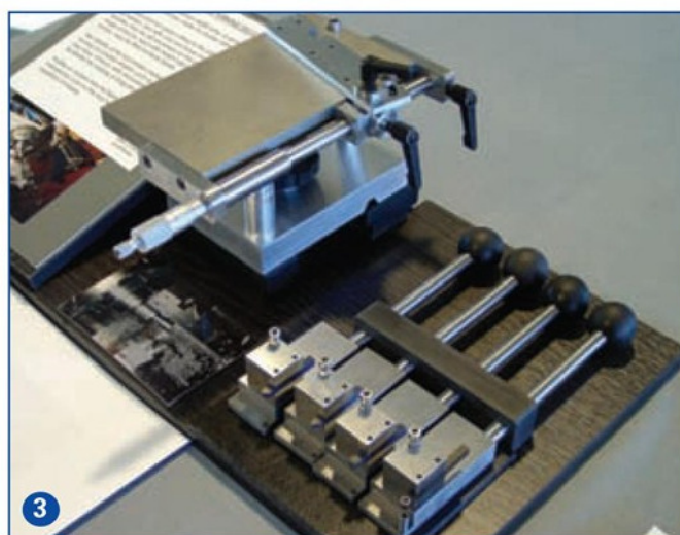
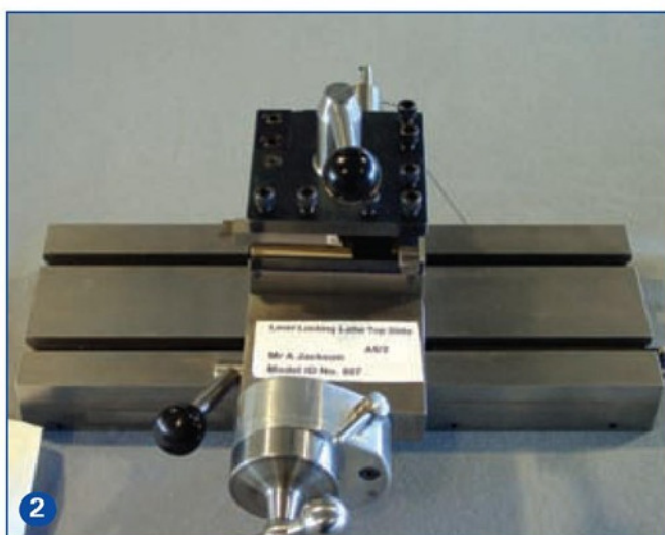
In spite of one or two mischievous rumours to the contrary, the Sandown Exhibition took place as scheduled, and was indeed yet another resounding success and a tribute to those involved in its organisation notably Colin, Tony, Terri and Jo.

Safely moving in and later out, such a large number of valuable exhibits is, in itself, no mean feat. Fortunately, the team of stewards, so ably lead by Norman Phelps have years of experience in this role. As recent correspondence in the SMEE Journal confirms, the criteria for judging exhibition models can be a contentious issue. The judges, and in particular chief judge Ivan Law must be thanked for devoting time (both at the show, and in prior research) and bringing to bear their considerable expertise. Behind the scenes, Gill Sheppard, Bill Burkinshaw, and John Cundell worked tirelessly, keeping the competition and loan paperwork on track.

The trend of recent years was unchanged in that once again a superb variety (both quality and quantity) of models and workshop equipment was on display, although naturally, from a personal perspective, I would have liked to have seen a greater number of workshop items. This probably has much to do with the present availability of affordable accessories (e.g. boring heads, rotary tables etc.) which, not many years ago, would have had to be home constructed either on grounds of cost or unavailability in home shop sizes.

Amongst the models, some notables which caught my eye included Cherry Hill's 1857 Blackburn Agricultural Engine - patent 414, awarded a Gold Medal and the Bradbury-Winter Challenge Cup, Bill Connor's Matchless Motor Cycle Engine, awarded a Gold Medal, and Graham Dean's Morgan "Super Sports" three wheeler 1934, awarded a Silver Medal.

1. Adrian Garner's Chuck backstop for Myford Lathe
2. The Lever Locking Topslide from Alan Jackson embodies a number of ingenious design features
3. Freehand and Profile Turning Device entered by Peter Clark





# ENGINEER EXHIBITION DOWN PARK

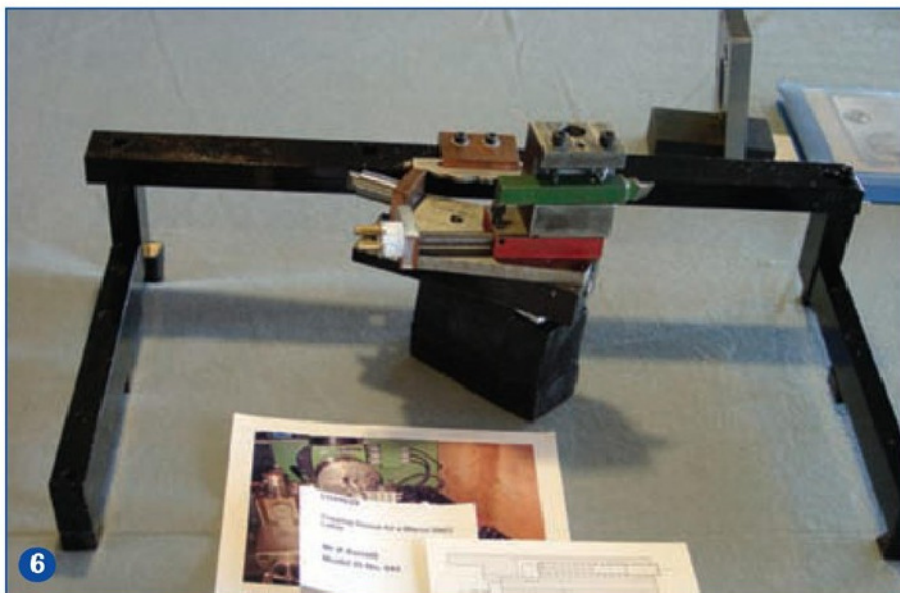
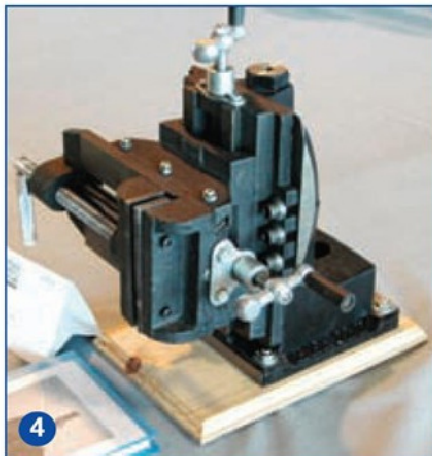
adjustable packing system allowed discrete steps in one plane, and finer adjustment by sliding up/down at right angles.

The top slide had originally been built for a Denham 4½in lathe, but following a change of machines had been modified to fit a Colchester Chipmaster. The Chipmaster crossslide had been altered by the addition of steel strips to form Tee slots running the full length of the slide, allowing the topslide assembly to be moved all the way from a typical front to typical rear toolpost position. The topslide included a rotational base and single lever lock arrangement which allowed it to be moved as noted above, rotated to a specific angle, then conveniently locked. A further refinement was the "Quick Retract" lever for either external or internal screwcutting. A neat tool height gauge was also included.

The judges awarded a Bronze Medal, and it is hoped that an article describing this Topslide will be featured in a future issue of MEW.

## **A5/3 Freehand and Profile Turning Device by Peter Clark**

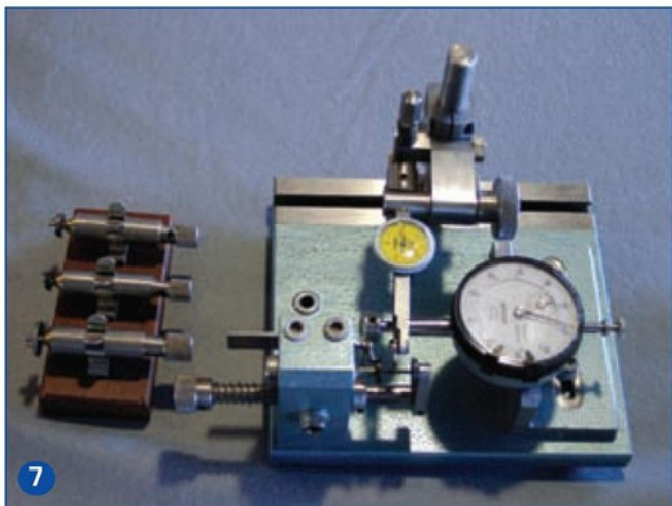
Freehand turning may be normally thought of as an activity associated with woodturning or small scale metalwork. Peter Clark's equipment takes matters up in size somewhat, being intended for use on a Harrison M300 lathe. The cast iron



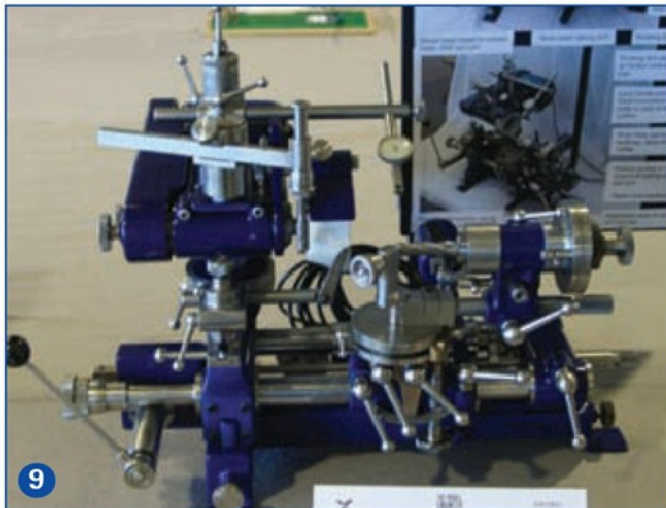
4. *Economic Vertical Slide produced by Nicholas Farr*
5. *Mr Farr also displayed this replacement Spindle Plate for a Hobbymat Lathe*
6. *Allan Barratt's Improved Copying Device for Warco 300/2*
7. *3mm Scale Wheel Checking Fixture, Geoff Helliwell*
8. *Ken Thornton's Chuck Jaw Machining Fixture*

top plate assembly is secured to the bed of the machine, and carries a fence, adjustable for angle, and by micrometer

for position. Profiles may be fixed via tapped holes in the fence for repeat turning of shapes.







The tool holders are equipped with ground cast iron base plates, tubular handles and large knobs. As the tool edge lies within the plan area of the base plate, a tendency to tip is avoided. This coupled with the long handle, and the ability to use two hands assures good stability, making the freehand turning of steel parts remarkably easy.

The judges awarded a Very highly Commended

#### A5/4 Economic Vertical Slide with Vice by N.W Farr

This was an entry which, in a way, had relevance to my comments above concerning the availability of imported accessories. A compound table with integral vice had been attached to substantial remachined castings, giving a

pretty robust vertical slide arrangement with two axis travel.

#### A5/5 Hobbymat Spindle Plate by N. W. Farr

Mr Farr had purchased a Hobbymat lathe with a broken Spindle Plate. The original plate had been a Bakelite or similar moulding, and he had effected a repair by means of a more durable metal replacement.

### Loan Exhibits

#### Copying Device for Warco 300/2 Lathe

This device, designed and constructed by Allan Barrett was shown last year and described in issue 107. It has been modified to improve performance. Details of the changes will be published in a future issue of MEW.

#### 3mm Society Model Railway Wheel Checking Fixture

Exhibited by Geoff Helliwell, the fixture embodied dial test indicators and standards, which could be used to check diameter, eccentricity and swash.

9. *Martin Gregory's Modified Quorn*
10. *Items of tooling devised by Brian Harding for producing his model cannon.*
11. *Small Dividing Head displayed on the Staines Society Stand*
12. *Clive Lawrence built this Dividing Head to a design by Harold Hall*
13. *A small spray gun made by Mike Dunning.*
14. *Mike Dunning also made this Collet Attachment for a Myford Lathe*







### Chuck jaw making fixture

Most of us tend to happily use the jaws supplied with chucks. Soft jaws are regularly used in industry as they can be machined to suit a specific diameter, and thus hold delicate work without damage. This set up was devised by Ken Thornton, and it is anticipated that an article on this will appear in MEW later this year.

### Modified Quorn Tool and Cutter Grinder

Martin Gregory showed his version of the Quorn and explanatory notes, which in

competition at the 73rd MEX was awarded a Silver Medal, and the Bowyer-Lowe Challenge Cup. Martin tells me he is now retired, and I hope to be able to twist his arm to write up the modifications he has introduced.

## Other Items of Interest

### Tooling for Cannon

Mr Brian Harding had entered his 12lb Cannon in class A2 and was awarded a Bronze medal. He also showed a number of items of tooling used in making the model; these included press tools, spherical turning tool, radius turning tool and drill jig.

## Club Stands

One or two home constructed dividing heads were in evidence, one by a Staines club member and another by Clive Lawrence, the latter made to a Harold Hall design published in MEW. The Ickenham society stand carried a most varied selection of tooling items. Mike Dunning had produced a small spray gun and also a collet attachment for a Myford lathe. Peter

Reynolds showed a set of rolls for corrugating boiler tubes. Interestingly, the accompanying text gave background information indicating that this development in the late 1800's allowed an increase in boiler pressure and significant reduction in specific fuel consumption. George Thomas has been a great influence on tooling for the home workshop, and it goes without saying that one expects to see something to one of his designs. Peter Pardington obliged with his version of the Tapping and Staking Machine. For steam enthusiasts, a 120degree crank setting fixture for a 5in. gauge Merchant Navy loco gave food for thought. Last but not least, and in this instance for use on a Boxford lathe, Vic Barton had produced a Mandrel Handle, probably still the most reliable way of cutting threads up to a shoulder.

15. Boiler Tube Corrugation Rolls from Peter Reynolds
16. Tapping and Staking Machine made by Peter Pardington
17. Crank Setting Fixture for 5in. gauge Merchant Navy
18. Vic Barton's Mandrel Handle





# GETTING POWER AROUND CORNERS 1



1. Steel wire rope over small pulleys.

## Background

Power transmission forms a significant part of mechanical engineering, so it is inevitable that facets of this activity will be encountered in the home workshop. These may relate to the restoration or repair of vehicles, domestic appliances or office machines, to lash-ups for experimental work, to understanding some functions of machine tools, or to making up ancillary equipment for machine tools.

## Introduction

This article relates to both design and bench activity, and contains only brief accounts of much of the material, but includes references where more complete information can be found. Over the years I have had to address a number of power transmission problems, and in digging out the information necessary for their solution have had to use manufacturer's catalogues, text books and other "how to" material. Hopefully what is recorded in this article will be helpful to others headed down the same track.

## Linear Transmission

### (i) Bell crank

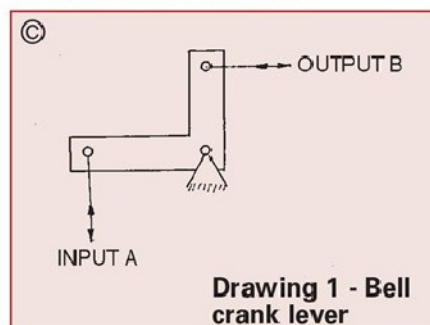
This comprises two lever arms fixed at

roughly right angles to one another, and pivoted where they meet as seen in **drawing 1**. It is used to change the direction of the input force 'A' from vertical to horizontal output force 'B', and can both push or pull, although typically with a limited angle of movement of say 60deg. Originally used in church towers for operation of the bells - hence the name.

### (ii) Ropes

#### (a) Cordage

These have been made from all kinds of materials since time immemorial. Over the last few hundred years the main materials used seem to have been sisal, hemp, manilla and cotton, and these tend to be still in use for large size ropes. Steel wire rope began to be used in the 19th century, and now it comes in a wide range of qualities and strandings. To an extent chain can be thought of as a form of rope with a different construction.



## A review of power transmission methods from the late Philip Amos

Since World War II a number of plastic materials have come into prominence for rope manufacture - particularly nylon and polyester. While nylon finds service for rough usage (e.g. anchor lines) such rope is abrasive and for lines which must be handled polyester is much more comfortable on the hands, so is recommended for home workshop use.

The traditional ropes were measured by circumference, but modern practice for small sizes seems to be to use metric diameter and sizes 6, 8, 10 and 12 mm seem most useful for the home workshop. Their breaking strengths are usually stated at the point of sale.

Sashcord is a cotton rope about 10 mm diameter used originally to support the balance weights for vertical lift window sashes and has been in use for centuries. It forms a most useful general purpose rope for home workshop purposes. An advantage of ropes made from synthetics is that they are rot proof whereas the traditional materials will deteriorate in time. For procurement, ship's chandlers provide a good source.



2. Three to one block and tackle.



Cordage around a pulley provides direction change for angles up to about 180deg. and as much movement as there is available cord. However cordage can only pull and not push. The groove in the pulley is usually semicircular so as to provide least possible restraint on the passage of the cord - see **drawing 2**.

### (b) Wire rope

In order that wire rope can be extremely flexible while also maintaining its strength it is subdivided into many strands. In the sizes of interest in the home workshop, (say a typical galvanised steel wire rope of 3.5 mm diameter which has a stated breaking strength of 570 kg) it will have a construction of 6 lots of 19 strands arranged around a nylon core. Most wire ropes find application in cranes, elevators and mine haulage.

The minimum pulley bending diameter 'D' recommended in reference 2 for 6 x 19 rope is 45 d which for 3.5 mm diameter amounts to 157.5 mm. Now this probably envisages maximum rope life, and very continuous usage. But in yachting service, such wire rope will normally be used with pulleys more like 50 mm in diameter, and it seems to be quite satisfactory in hundreds of thousands of installations worldwide. It would therefore seem that a figure of 12 to 15 might be more appropriate in the home workshop - see **photo 1**.

End connections for small wire ropes are properly made by passing the rope around a thimble and swaging a specially shaped copper (or other malleable metal) ferrule over the wire as shown in **drawing 3**. This requires a special tool - the friendly ship's chandler will probably do it for you if need be. Otherwise one is reduced to using knots - bowline, fisherman's bend or round turn with two half hitches. When tightened, the ends of strands will still stick out and penetrate fingers, so it is helpful to shroud the end of the wires with plastic insulating tape. Joining the end loops of the wire rope to other components is best done with D shackles, which are inexpensive.

### (c) Chain

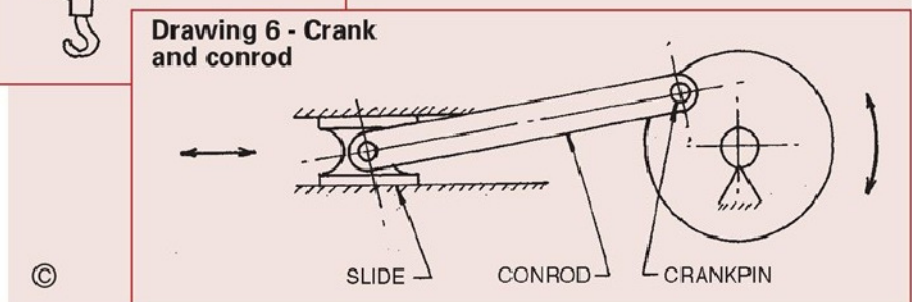
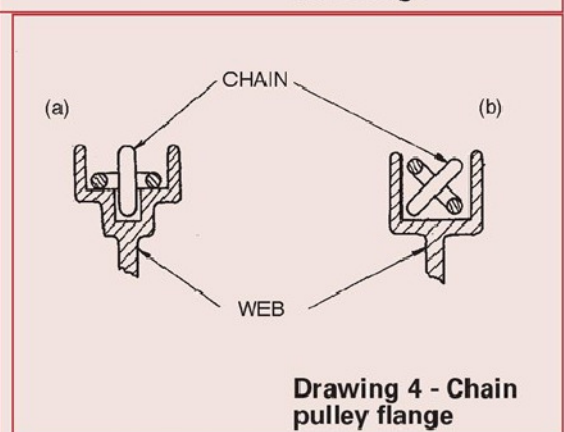
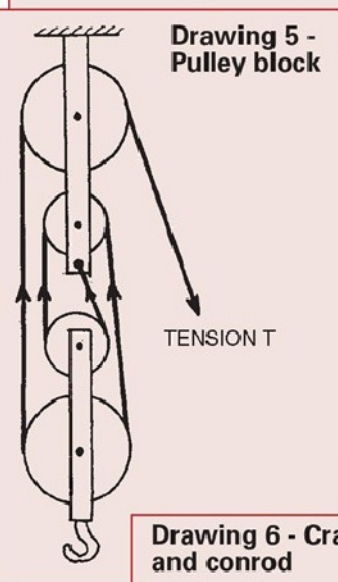
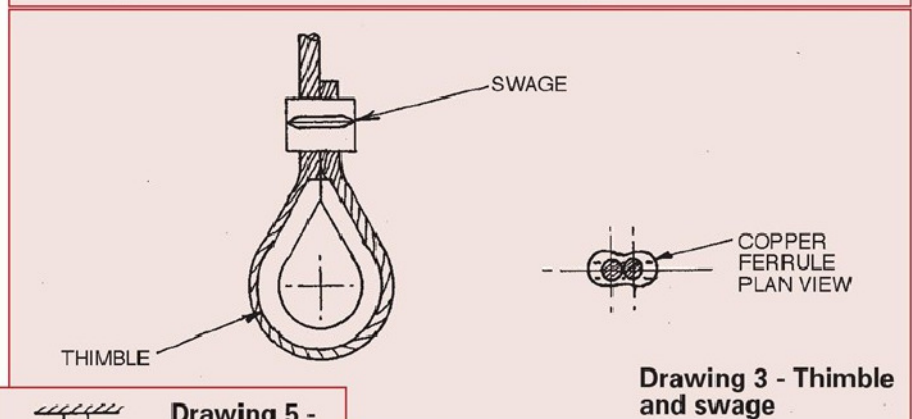
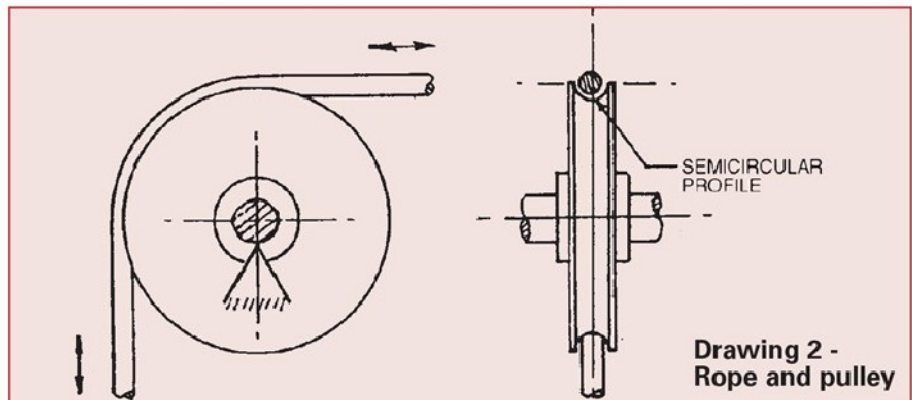
Some pulleys intended for use with chain (e.g. on boat anchor winches) have a slot at the bottom of the pulley groove to accommodate each second chain link in a "vertical" disposition, while its neighbouring links lie flat in a "horizontal" disposition against the floor of the groove - see **drawing 4(a)**. Much the same result comes from a square pulley groove as in **drawing 4(b)**.

### (d) Block & tackle

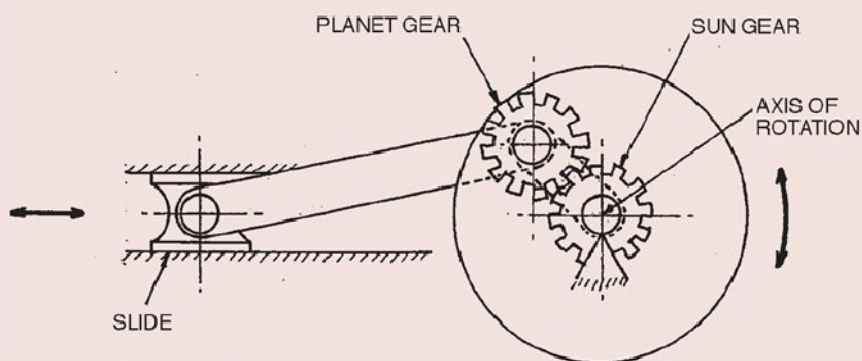
By the use of several pulleys at the point of support, and at the point of loading a number of parallel "strings" is obtained. The tension in the cord is continuous throughout its length i.e. in each of the "strings", so the load is supported by all the "strings", and the load can therefore equal their sum. Thus the block and tackle achieves a load multiplier effect - see **drawing 5** and **photo 2**.

### (e) Bowden cable

This concept comprises an outer (frequently flexible) tube, in which can slide axially a stranded metal wire. As the

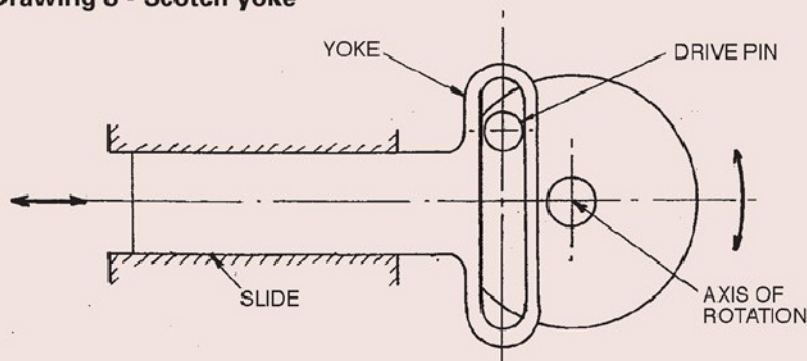




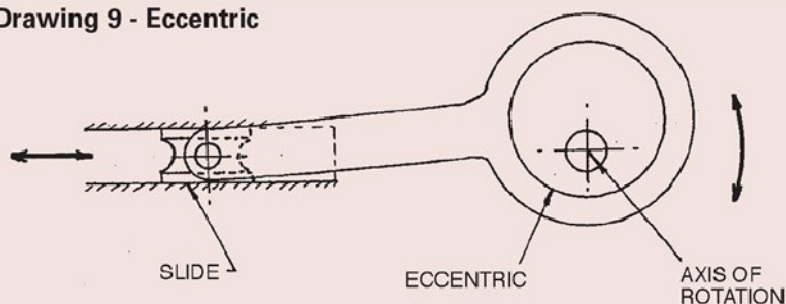


**Drawing 7 - Sun and planet**

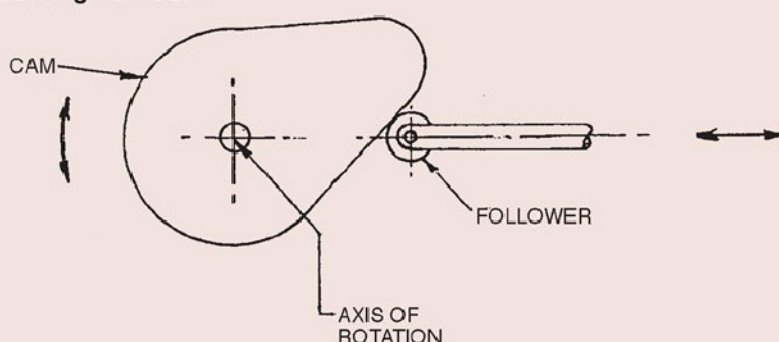
**Drawing 8 - Scotch yoke**



**Drawing 9 - Eccentric**

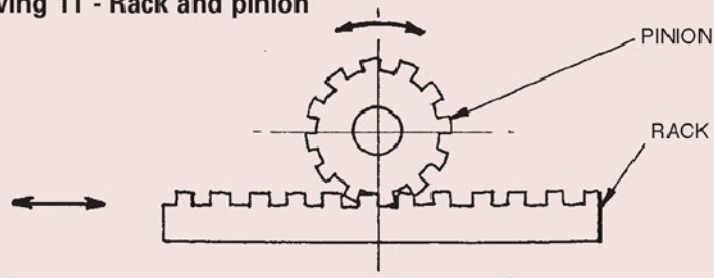


**Drawing 10 - Cam**



©

**Drawing 11 - Rack and pinion**



tube can be bent around obstructions to a limited degree, there is available a convenient means to use the central wire to effect tension action at a distance. It is much used on the brakes and gears of bicycles, but also finds service in motor vehicles to operate brakes and clutches. A variation employing a single (less flexible wire) is often used for car heater systems where the lower flexibility allows pushing as well as pulling.

## Linear to Rotary Transmission

### (a) Crank and Conrod

The most common way to convert linear to rotary power transmission (and vice versa) is by use of a rotary crank, with a connecting rod to some form of slide as shown in **drawing 6**. The classical example is the steam engine, but it also finds wide use in internal combustion engines and positive displacement pumps.

In **drawing 7** is shown the Sun & Planet gearing adopted by James Watt to circumvent the patent on the crank and conrod granted to James Pickard in 1780.

### (b) Scotch yoke

In this arrangement the crank operates in a slot at right angles to the slide as shown in **drawing 8**. This concept has been used over many years, but has not been too popular. One application which led to considerable volume was in Westinghouse compressors for domestic refrigerators for almost half a century.

### (c) Eccentrics and cams

Motion similar to that of crank and conrod is imparted by an eccentric as shown in **drawing 9**. The classic use is for steam engine valve movements. However a cam and follower arrangement allows much greater flexibility in the acceleration and velocity characteristics of linear motion produced from constant rotary motion - see **drawing 10**. Their greatest use is probably for the operation of the valves of internal combustion engines

### (d) Rack and pinion

Another simple conversion means is the rack and pinion as depicted in **drawing 11**. This provides constant torque in contrast to the crank and conrod where the torque varies with the angular position. However the rack and pinion has limited traverse whereas the crank and conrod can operate continuously in either direction.

### (e) Screw and nut

Screws for fastening usually have triangular thread forms, but for power transmission more often are square or trapezoidal (Acme) in section see **drawing 12(a)**. Such are found in lathe lead screws and in cross slide, top slide, and tail stock drives. Ballscrews are a refinement to reduce friction and eliminate backlash in the movement - see **drawing 12(b)**.

Screw power transmission drives are usually driven by relative rotation between the screw and nut, but if the thread pitch is



lengthened sufficiently, it is possible to drive the arrangement by holding the nut to prevent rotation then moving the nut axially causing rotation of the screw; the thread then may be thought to resemble a helical spline.

An example is the Bendix automobile electric starter design, where such a thread throws the starter pinion axially (due to its inertia) along its shaft to engage the engine gear there to provide the cranking effort. When the engine fires its speed exceeds that of the starter motor, and the starter pinion is thrown out of engagement back to its original position (again due to its inertia).

## Misalignment

Two shafts in machinery are rarely exactly aligned. When it is necessary to achieve this condition, as for example when joining a steam turbine to its generator in a power station, extreme measures of measurement and adjustment are required using optical and laser technology, and requiring the expenditure of much time and patience. For most mechanical engineering power transmission such expense is not warranted and therefore provision must be made to acknowledge inaccuracy and take appropriate action to accommodate it.

The shafts' axes may be displaced relative to one another, or may be at a small angle to one another, or both. Merely joining them together with some sort of fixed coupling necessarily must distort them, and may lead to failure by fatigue stressing, excess friction resisting turning or increased wear.

Over the years a number of means of dealing with these problems have evolved some of which are set out below:

### (i) Double slider or Oldham coupling

As depicted in **drawing 13** this has a floating intermediate plate having two projecting keys at right angles to each other on opposite sides. These keys engage with slots in the half couplings attached to the two shafts. The floating plate compensates for the misalignment by a sliding movement. Such couplings may be used in situations where the shafts are parallel but the axes slightly offset; e.g. for the direct coupling of motors to leadscrews.

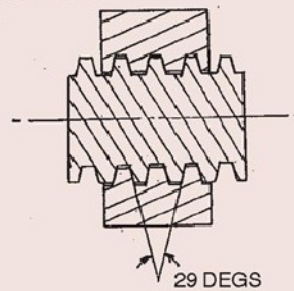
### (ii) Rubber block coupling

The two half couplings each have 3 projecting lugs between which are located six elastomer (synthetic rubber) blocks. This is a low cost, nil maintenance solution to the problem and is widely used - see **photo 3** and **drawing 14**. The arrangement may also be designed for four blocks instead of six.

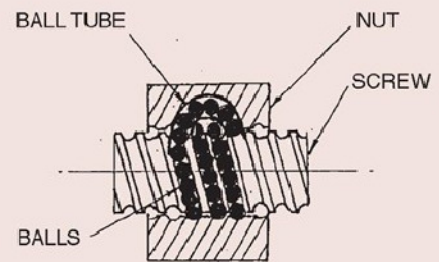
### (iii) Disc coupling

For this arrangement each half coupling is attached by bolts to an intermediate flexible disc, which transmits the power. This disc can be made of leather, rubber fabric or (rarely) steel laminations. **Photo 4** shows a miniature version for a model boat, while **photo 5** illustrates a coupling for automotive steering.

(a) ACME

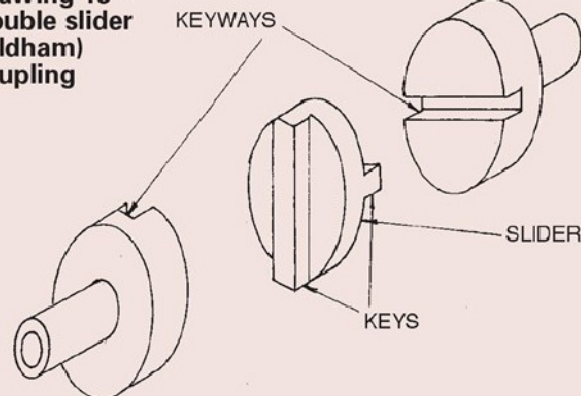


(b) RECIRCULATING BALL

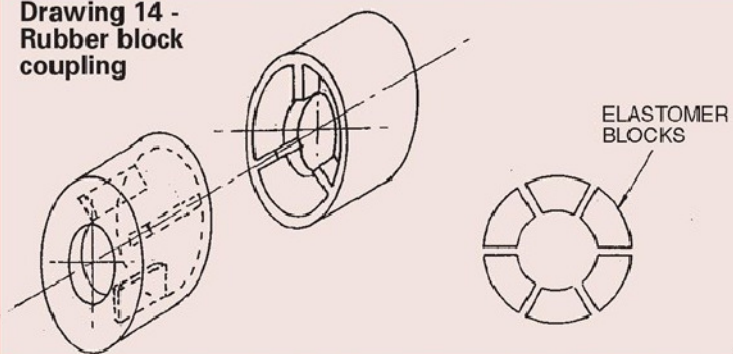


**Drawing 12 - Screw**

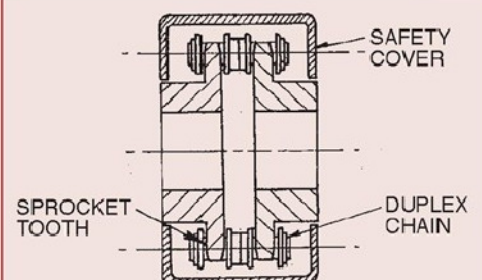
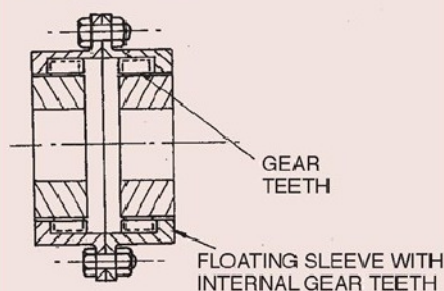
**Drawing 13 - Double slider (Oldham) coupling**



**Drawing 14 - Rubber block coupling**

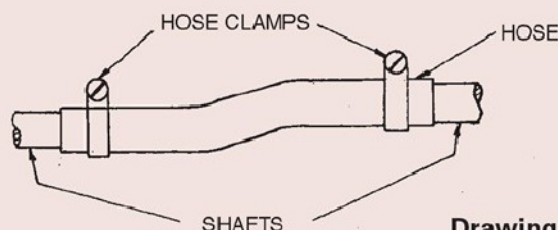


**Drawing 15 - gear coupling**



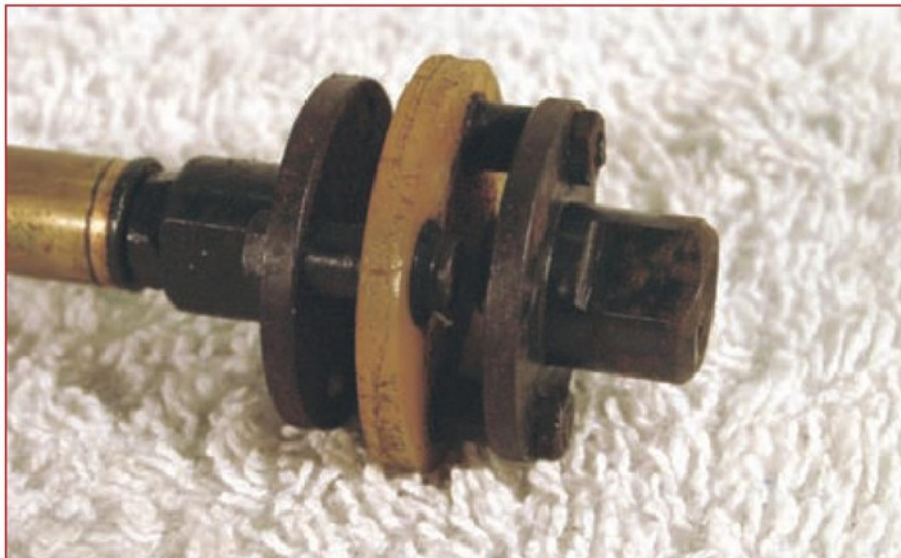
**Drawing 16 - Chain coupling**

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**Drawing 17 - Hose coupling**

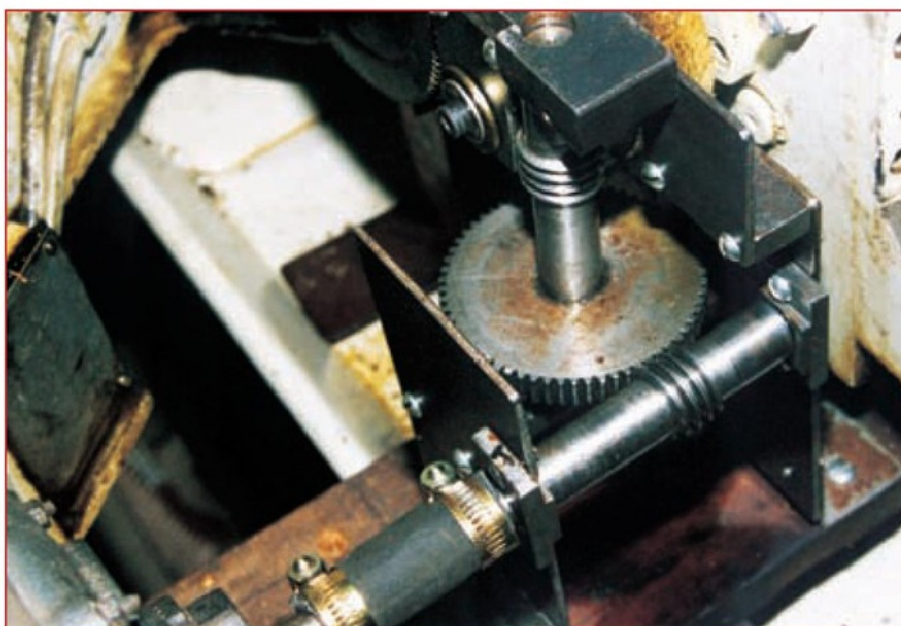




4. Miniature disc coupling for model boat use (approx 1hp & 11000 rpm).



5. Disc type coupling for automotive steering.



6. Double reduction worm and wheel (spur gear) with hose coupling.

#### (iv) Gear coupling

Each shaft has a spur gear mounted on its end and both are embraced and continually in mesh with the corresponding teeth of an internal gear formed as a floating sleeve - see **drawing 15**. Clearance in the gear teeth allows for slight linear and angular misalignment. This is probably the most costly but also the most effective coupling for high speeds and high torques.

#### (iv) Chain coupling

This comprises two chain sprockets attached to the shafts. After alignment a duplex roller chain is wrapped around and joined to transmit the torque - see **drawing 16**. A cover can be fitted to exclude dirt, retain lubricant and enhance safety. Probably second in effectiveness to (iv) above and less costly.

#### (vi) Flexible tube coupling

All the above (and many others) find use in the commercial industrial world, but in the home workshop are usually too large, too expensive and unnecessary. A much more simple approach is to use a piece of garden hose slid on to the two shafts and held in place with worm drive hose clamps - see **drawing 17** and **photos 4-6**. At a smaller scale, small bore tubing such as for model aircraft fuel lines may be used.



*The second section of this article will appear in the next issue and will consider larger and deliberate misalignments, also various transmission methods, including gear types, and non mechanical means.*

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# BROADBAND INTERNET ACCESS

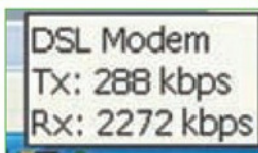
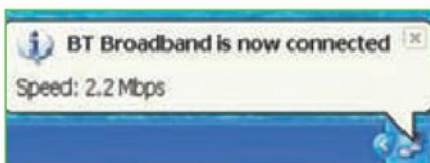
## Mike Houghton gets up to speed

I use the Internet a lot in connection with my workshop, employment and business interests. I have previously covered a lot of the basics of Internet searching in two earlier articles in MEW issues 88 and 98, so if you need some background before reading this, please go to these issues first. When I wrote these earlier articles I was connecting to the Internet via a dial-up modem and paid for the minutes on-line via the phone bill. This is a peculiarly UK situation as local calls are not free. To keep the phone bill under control I only connected at low call rate times. (Evenings and weekends) The maximum connection speed was 56,000bits per second (56Kb/s), which became the standard dial up modem rate around 1998. 56Kb/s is the maximum amount of information that can be crammed into the 3,000 hertz bandwidth on a normal voice grade copper phone line.

## A fall off in performance

What I have observed over the past two and a half years has been a gradual decrease in my connection speeds. 56Kb/s became 42Kb/s then 33.6Kb/s then 28.8Kb/s etc. These high speed modems employ gradual degradation, meaning that they test the phone connection and fall back to lower speeds if needed. Worse still, my ISP (Internet Service Provider) started cutting my connection after about 1MB of data had been downloaded. If I dialled again I got an even slower connection to the ISP. I suspect this was a sort of load shedding, too many customers connected and too little investment in equipment to handle the load. Complaints to the ISP didn't work, so I voted with my feet and chose a new ISP who offered a "Broadband" connection.

## Asymmetric DSL



A Digital Subscriber Line (DSL) is simply a very high speed connection that uses the same copper wires as a regular telephone. The DSL modem was supplied by the ISP. You install it yourself and the telephone company makes changes at the local telephone exchange to activate the new broadband service. As you can see from the two screen shots I now connect at 2.2Mb/s downloading data and 288Kb/s uploading data. (Hence the description "Asymmetric".) Boy what a difference in performance and its available 24/7! I would never voluntarily go back to the old dial up system. My new broadband connection is actually proving to be cheaper to use and it's faster and always available.

The DSL modem works by splitting the frequency spectrum above the audible range into 249 bandwidth slices of 4,000Hz and attaches a virtual modem to each slice. Hence the household can use the phone normally whilst I concurrently explore the Internet. Brilliant! A small filter protects the phone from the higher frequencies on the line.

Unfortunately, ISPs in the UK have been in the habit of offering speeds of 512Kb/s and even 256Kb/s and calling them "Broadband", then charging extra for higher connection speeds. The speeds given in the screen shots are for a basic domestic service not an upgraded or business one. The ADSL bandwidth limit over copper lines is said to be around 8Mb/s for customers "close" to an exchange, but I have read that this limit could well be pushed close to 24Mb/s soon and then 50Mb/s. (ADSL2+ technology).

The driver for all this speed increase is the potential delivery of compressed "live" TV and video (films) via the Internet. Another welcome change, in the UK, is charging for data volume rather than speed of download.

## Contention ratio

A domestic customer unknowingly shares his broadband ADSL connection with up to 50 others. Hence, this is a 50:1 contention ratio. Provided all 50 don't all decide to download at the same instant you get the agreed download rate for your service, otherwise the equipment in the exchange will share out the bandwidth available and downloads will slow at peak times. Many ISPs will not disclose their contention ratios!

## Internet speed freak

OK, so what use have I put my new Broadband connection to? What can I do now that was impossible or impractical over my old a dial-up connection? Obviously this is a personal selection, but

I'm sure you will find some useful home workshop references. Just "Google" the names I refer to and follow the links. I have no connection with any of the organisations mentioned below.

## Large on-line catalogues

I found that many of the MEW tool and machine advertisers websites operated tolerably well over a dial up modem. E.g. Arc Euro Trade, Chester UK, Warco and Chronos.



Chester UK, for example, gets around some of the speed problems by providing parts of its small tools catalogue as downloadable .pdf files. You then read these .pdf's off-line.

As soon as I attempted to search a live on-line catalogue with a lot (thousands) of products everything fell apart and the response was so slow, almost unworkable. My prime example here is the J&L Industrial (UK) website which I find really needs a broadband connection to make it fly.

I was given a printed flyer from J&L over a year ago by a friend and was impressed with the quality of information on industrial specification tools and machines. I rang the company and received two 600plus page catalogues the next day! The latest version is one catalogue of 1000+ pages. Broadband has given me the chance of buying discounted and clearance items from the J&L catalogue and the sale flyers. I often find cheap imported tooling has a short life or poor performance and the sizes you need for a job often aren't there. If you have to machine tough materials, like some stainless steels, getting the correct grade of cutters, that have been properly shaped, makes all the difference. Discounted



tooling from a reputable source can often be a better bet in the long run.

Other examples of massive UK on-line catalogues are Farnell, Rapid Electronics, CPC, Radio Spares, Electrovalue, Maplin and Ebuyer. Unsurprisingly, nearly all these are electronics or computer related. In many cases semiconductor specifications sheets can be downloaded as .pdf files from some of these sites. This can be very useful.

## Emails, screen dumps and digital photography

This is where Broadband really comes into its own! Emails download in a flash and I no longer have to consider attaching large photographic files to emails to share with fellow workshop and ME nuts. It's great to be able to share project ideas, progress and problems, especially as distance is suddenly not a barrier. E.g. a photographic comparison of Club loco track layouts often throws up useful ideas. Why do so few clubs include these in their websites?

Receiving message 3 of 35 (21.1 KB of 400 KB)

The images in this article were produced by doing a "print screen" and pasting the resulting image into Paint. Selected areas of the Paint screen can be cut out and saved as files, which can be attached to E-mails.

I have recently "retired" a very good, and quite recent, Nikon 35mmSLR film camera in favour of a digital camera, simply because I can get photographs for publication so much faster. With digital there are no processing delays or costs. The digital image quality is so good and I can quickly go back to the workshop and repeat a shot if it doesn't come out just the way I wanted it. Once the images have been downloaded to the PC, I can use the PC software (Adobe Photoshop Elements) to crop the image, manipulate the exposure, correct the colour balance etc. Once everything is as I want it, I can send a quite high resolution 1Mb jpeg file by email as an attachment, and it's gone in seconds.

Most digital cameras can also record short video clips, seconds to perhaps a few minutes long, and these can also be attached to Emails or loaded to websites. These videos don't have the same resolution as a still photo.

If you are into creating a close to scale model and plan a visit to inspect the original, a digital camera is a "must have" to record all those details that you couldn't possibly remember when you get back home. I find myself carrying a digital camera around ME Exhibitions for similar reasons. Similarly, I find when recording the disassembly of a machine a digital camera pays big dividends when you finally get around to final assembly again. Helps with those senior moments!

Assuming that a fairly high resolution image of 4Mega Pixels will become a 1Mb jpeg file in the camera's memory stick, one can easily take over 100 images on a 128Mb camera memory card. A couple of memory cards will hold the details of quite a large project and don't cost much more than the equivalent number of 35mm

films, probably a lot less if you count the cost of film processing. Of course memory cards can be erased and used again once they have had their images downloaded to a PC. Once you have converted to a digital camera, a fairly large hard disk and software to organise all your files soon becomes essential. Adobe PSE will "date stamp" all your images and make them much easier to locate again. Most digital cameras also have a macro facility that allows close up photography without supplementary lenses.

## "Videos" and Software Downloads

Very good short videos illustrating engineering practice, or training videos, are starting to appear on some enthusiast's websites. Although strictly not a Video, Art Fenarty of CNC software fame, has started making "video" training files available of Mach3 (CAM) set up and use. Have a look at <http://www.machsupport.com/>. At 20Mb each, these downloads would be impossible without a broadband connection.

Similarly, Dolphin, the Scottish based CAD / CAM software producer has recently started doing something similar to assist users of their products. <http://www.dolphin.gb.com>. Dolphin also provides their software as a free download for evaluation / non commercial use.

Desk CNC can also be downloaded for evaluation purposes from [www.imsrv.com](http://www.imsrv.com). If you visit the Scan2Cad website, [www.softcover.com](http://www.softcover.com) you can download Video tutorials and trial versions of their software that converts scanned documents to CAD drawings. Clearly download to try or to train is becoming a big growth area that would not be viable without Broadband.

There are many, many producers of CAD/CAM software out there and the majority now offer some sort of trial download. Personally, I have found that there is a pretty steep learning curve with all these products. Once you have made the effort and mastered one, there is a fair chance you won't want to do it all over again and move to another!

## Yahoo Interest Groups



I offer no apology for mentioning Yahoo Groups again. MSN, and probably other ISP's also offer competing Interest Group systems, but I have so far found the Yahoo variety superior. But it's certainly not perfect. Groups can put you in touch with like-minded individuals all around the world. I will be very surprised if you don't get new ideas for projects, hints and tips, interesting websites and photographs (occasionally videos) of member's workshops and models. Interest-Group Membership is free and you only have to supply minimal information about yourself to register. Choose a user name and e-mail



address that conceals your identity if you are concerned about security.

If you go to <http://groups.yahoo.com/> and sign on as a new user you will be assigned a Yahoo Mail account. E-Mail messages are the way Group members communicate. Once you have signed up you can change your preferred E-Mail address from Yahoo if you wish. A major problem is finding Yahoo Groups with interests similar to you. Although Yahoo categorises its Groups, the system doesn't work well for our, very specialised, interests and a lot depends on the person who formed the Group in the first place, writing a good profile. There are already a very large number of groups simply because anybody can sign up and form their own Group.

Another search approach is to use the Find a Group Search box, but the results can be less than precise. E.g. Entering Steam in the Search box produced 950 groups and a summary list on the screen. Look for the ones with the highest membership; say over 500 members, they are likely to be well organised and informative. You might want to avoid some of the stuff that the search finds! That's the price you have to pay, apparently. Finding useful Yahoo Groups can be very frustrating and personal recommendation or sheer good luck plays a big part.

Once you have located a useful looking group, join it to read current discussions and have access to the other members, files, archives and photographs. You can always quit the Group if you have made a mistake. I guarantee that you won't find many useful Groups using the above search box, but you may well find a lot of undesirable ones. Yahoo doesn't seem to care! Don't be put off; there is a lot of useful stuff here.

I am currently building a Quorn Tool and Cutter grinder and soon stumbled across the 1000 membership Quorn-Owners groups. (Search for Quorn). There is also a more general T&C Grinding Group, search for Tool Grinding. To get you started, here is a selection that I currently find useful:-

**VMC type milling machine imports:** search for 6x26millingmachines and milling machines.

**If you are into the Seig type smaller mills,** search for mini\_cnc\_mill.

**For other small machine tools,** try miniature\_machine\_tools.

**For Rong Fu round column mill-drills and clones,** search for mill\_drill.

**For imported 12in. swing lathes,** search for 12X.

**A very active group** is the CAD\_CAM\_EDM\_DRO group with over 8000 members.

Once you have joined a Group look at the photo and files sections. Whatever the current discussion threads are, will be delivered to you by E-mail. Remember that many of these groups have up to 5 years past discussions on file that you can search.

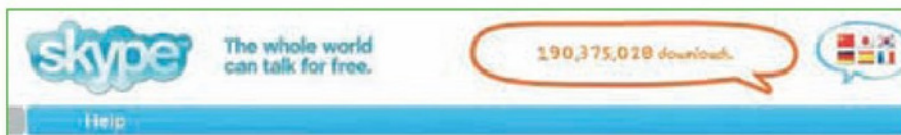


## Golden oldies

There are a number of Yahoo groups that exist to share articles printed in ME magazines from the 50's and 60's. I'm uncertain of the legality of scanning old copies of ME magazines and making the scans available to all; but since the authors are mostly no longer around and no payment changes hands it may be OK. If you are fortunate to have a collection of ME's from this era you will know that the articles by Duplex, Ned, Geometer et al are an invaluable resource for the beginner and expert on techniques, design, workshop hints and tips etc.

Finding, (and storing) these back issues can be a problem, even in the UK. Imagine you live in Tasmania. I looked at the costs of sending some copies of magazines out there from the UK, it was horrendous. If you are interested search Yahoo Groups for mwsmltools; mwhints; mwmills; mlprojects; mlhorology; mlathemods; hintstips; Geometer and beginnersworkshop. In each group look at the files section.

A well known resource for indexes to UK ME magazines can be found at [http://www.groundlevel.demon.co.uk/me\\_index.html](http://www.groundlevel.demon.co.uk/me_index.html) but there is also a Yahoo Group meindex that covers similar ground but includes North American publications, including Home Shop Machinist, Projects in Metal/Machinists Workshop and Modeltec.



## Skype

If you have Broadband it is possible to download, for free, the Skype voice over Internet protocol (VOIP) software to allow you to phone any PC that is connected to the Internet with a broadband connection. The phone call is free; all you need is a headset with a microphone built in! To phone a conventional land line phone results in a very small charge. To phone a mobile costs a lot, don't do it. Skype is a Swedish Company that has just been snapped up by EBay.

My experience of "Skyping" is that the voice quality is better than a conventional phone line, despite the amount of digital processing that has gone on to get the analogue voice signal to digital, transmit it and reassemble the message back to analogue at the other end.

## Broadband safety

If I get a broadband connection aren't I just opening my PC to Internet attack, viruses, spy ware, Trojan horses etc? If you have ever suffered from an attack from a computer virus or malicious hacker you will know that these can vary from just plain annoying to extremely frustrating

and expensive to sort out. Your ISP should supply some free software to help avoid some of these threats, but you need to take steps yourself. Install a firewall and activate it. The one supplied as part of Windows XP would be a good start. Get an antivirus software package installed and keep it up to date. Many of the commercial antivirus packages are expensive and annual updates are a recurring cost. Here I can recommend a free download of AVG Free from Grisoft. Go to [www.free.grisoft.com](http://www.free.grisoft.com) Interestingly Microsoft has just recently bought a large stake in the Czech company Grisoft. Don't let a PC, which is controlling a machine, anywhere near the internet!

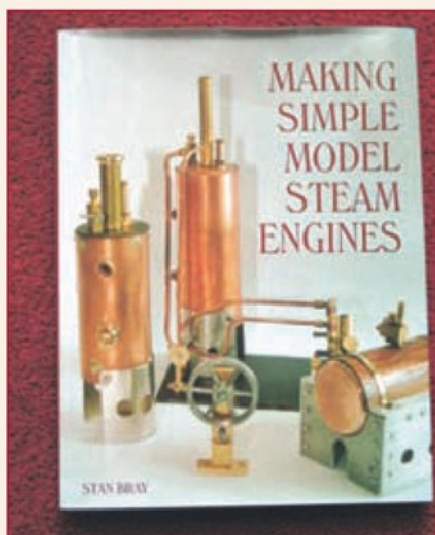
## In conclusion

Give Broadband a try. You won't look back. If you don't have access to a PC remember that there are now loads of Colleges, Schools, Public Libraries and High Street Internet Café's where you can pay a small fee to search the web at Broadband speeds. Usually help will be at hand.

If you have any questions, comments or recommendations for good ME websites or Groups write to MEW or e-mail me at [mikehaughton@btinternet.com](mailto:mikehaughton@btinternet.com)



# FIRESIDE READING



**A**t the recent Sandown Exhibition, I met up with an old student pal from the sixties. During the tour of the exhibits, he (being an engineer and someone who has owned a workshop) expressed informed admiration for the builders of the many major projects, but then added that he just would not have the patience. It prompted me to think further about the spectrum of amateur and model engineering enthusiasts. Like my pal, I take my hat off to those who can single mindedly pursue

## Making Simple Model Steam Models – Stan Bray

a complex project over several years, however, I tend to lack the staying power for long term projects. For example, the Stuart Triple lay abandoned for some twenty-five years before a rush of enthusiasm prompted a drive to completion. Many parts for the Bentley engine are now made, but currently the attention is directed elsewhere. I suspect that many others "suffer" from a similar mindset, and hence in part, the appeal of this latest book from Stan Bray, who will be known to long term readers as the founding father of Model Engineers' Workshop.

In summary, following a brief introduction in Part One, Stan gives plans and constructional notes for a series of steam engines and boilers, culminating with a De Winton style locomotive for gauge 0 or gauge 1. Part Two – "The Engines" begins with two versions of "Hero's" engine, which can probably be made using just hand tools, then progresses through several single cylinder oscillating engines, single and double acting, to various twin cylinder arrangements, leading finally to a "Clapper" engine in which an inlet valve is opened by piston contact.

Part Three - "Boilers" looks first at basic boiler construction and fittings, before moving on to describe a series of

five boilers of generally increasing complexity, starting with a simple pot boiler, then vertical and horizontal types with flues and tubes, then a double barrelled boiler. The section concludes with a chapter on supports and burners.

Part Four – "Finale" describes a small vertical boilered, spirit fired locomotive, again driven by a twin cylinder oscillating engine.

This is a book which I can see having an appeal to several types of reader. For many experienced metalworkers and modelmakers, it offers a compendium of less demanding projects many of which could put together in a weekend. The finished result might then be either polished for the mantelpiece or used to keep the grandchildren mesmerised. For newcomers to the hobby, looking for a project to cut their teeth on, the book has excellent drawings and photographs giving clear details of each of the several engines, boilers, and associated fittings, presented in an easy to follow manner. Moving down the age range, this may be just the thing to wean some of the "Playstation" generation off their electronic gizmos and into a hobby that will inculcate a range of practical skills.

"*Making Simple Model Steam Engines*" published by Crowood Press, is available from good booksellers (ISBN 1 86126 773 8) and costs £19.95.



# X3 - CNC FURTHER OPTIONS



1. One half of the Oldham coupling has been threaded to allow endfloat adjustment.

**D**ick Stephen has written extensively in this magazine of his experiences with CNC conversions, and most recently on converting an X3 mill to CNC. Dick kept me updated with his progress as he performed his conversion, knowing that I planned to do a similar conversion in due course, so I not only had the benefit of seeing his articles before attempting my own conversion, but also the benefit of having talked through some of the techniques with him at various times.

The overall approach I took was broadly the same as Dick has described – replacing the leadscrews on all axes with 2mm pitch THK ballscrews, using size 23 stepper motors, and so on; however, my

conversion differs in a number of details from Dick's. As some of these detailed differences may be of interest to other would-be CNC-ers, I decided to put together a small article to describe them.

## Leadscrew mods

The installation of the leadscrews in the X and Y axes proceeded pretty much as Dick described in his articles (*MEW* December 2004/January 2005). However, I used a couple of short cuts:

1. Dick modified the existing bronze Acme feed nut for the Y axis to act as a mount for the ballnut, but replaced the X axis feednut with a new, slightly larger piece of bronze machined to fit in its place. I decided that

**Tony Jeffree suggests alternative mechanical and electrical details, then makes surprising measurements.**

the X axis nut was just big enough to be machined out to hold a ballnut, which saved a little time and effort.

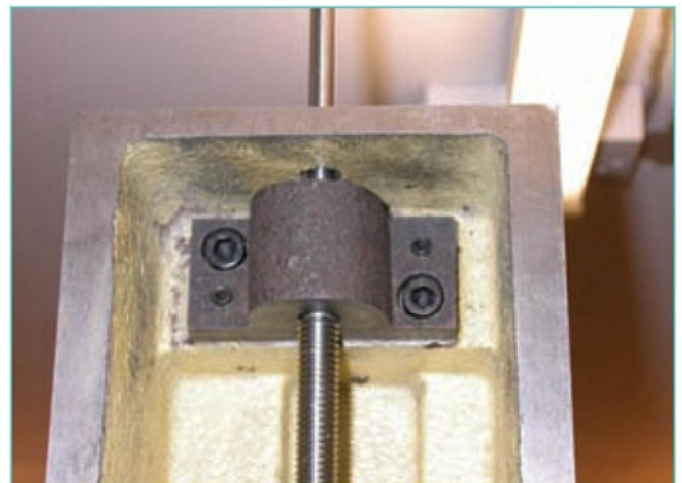
2. It is necessary to provide end float adjustment for the thrust bearings on these axes. I realised that by threading the leadscrew half of the Oldham coupling M12 it could perform two jobs – adjusting the end float and coupling to the motor. This has the advantage of keeping the leadscrew extension as short as possible, so the motors stick out a little less. **Photo 1** shows one of the threaded coupling halves in place on the X axis. I used the clamp type Oldham couplings, and used a little Loctite threadlocker on the threads before adjusting them to their final position.

With the Z axis, I also adopted a slightly different approach to Dick's; he used a 2:1 toothed belt/pulley reduction drive, mounting the motor at the bottom of the leadscrew. A significant part of his decision was to make sure that the Z axis motor wasn't underpowered for the job; the 2:1 reduction drive meant that there would be plenty of torque available for this job, which has to contend with the mass of the head and the frictional resistance imposed by the gas strut that is fitted as a counterbalance for the head. I decided that there should be ample torque and mechanical advantage around to dispense with the reduction drive, and opted for direct drive to the leadscrew as with the X and Y axes.

The logical conclusion of this decision was to place the motor on top of the Z axis casting rather than at the bottom of the

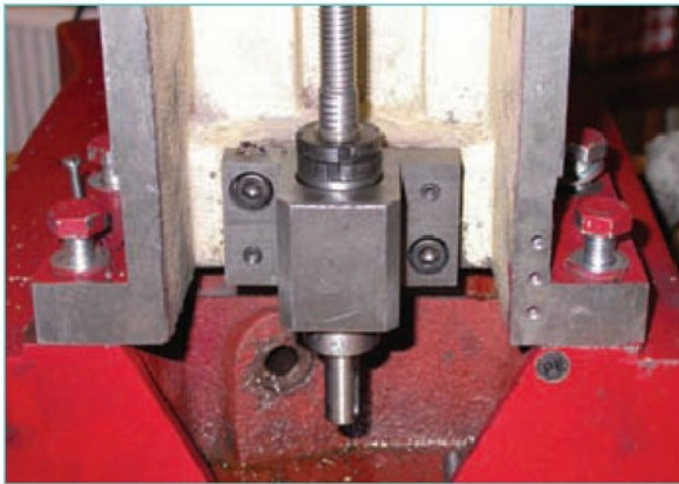


2. Stepper motor mount, as used for rotary tables etc.

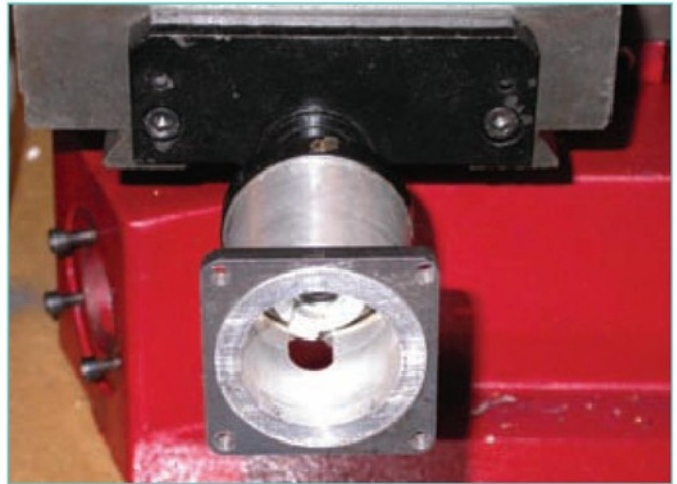


3. Top of Z axis leadscrew showing extension.





4. Bottom of Z axis screw uses part of original screw.



5. X axis motor mount fitted.

column. So, as shown in **Photo 2**, it was a simple job to fit one of the motor mounts that DivisionMaster Ltd (ref.1) sell for converting rotary tables for CNC use to the top of the column, and drill a hole through the top of the casting to allow the leadscrew to be extended up into the mount. **Photo 3** shows the top of the leadscrew in place; I simply extended the ballscrew by drilling and reaming the end 8mm diameter to a depth of 40mm and supergluing a length of 8mm silver steel into the orifice. Of course, concentricity is

the name of the game here, so careful machining and setup for the gluing operation are important, but it is perfectly achievable with care.

Having decided to go this route, and not needing to modify the bottom end of the leadscrew to take a pulley, I decided that the easiest approach was to re-use the bottom end of the Acme leadscrew and thereby remove the need to machine a completely new extension piece to add to the bottom end of the ballscrew. **Photo 4** shows the result; the bottom end of the

leadscrew was again drilled/reamed 8mm to 40mm depth, and the bottom end of the Acme leadscrew was chopped off, allowing enough length so that I could machine down the Acme thread to give an 8mm diameter spigot that could be Superglued into the ballscrew, again with care taken to ensure concentricity.

## Motor mounts

I have already mentioned the Z axis mount; this is essentially an aluminium tube with a flange at one end that a square motor mounting plate locates and locks against, and a circular plate inserted into the other end (see **Photo 2** and **Fig 1**). The circular plate has a central hole for the leadscrew shaft, and three mounting holes for M5 screws. Normally, this mount is used by DivisionMaster to convert Vertex and similar rotary tables to CNC; the mounting holes are the same size/spacing as appear on the division plates for these tables.

The same motor mounts were modified to use on the X and Y axes, essentially by shortening them and reducing the internal diameter at the open end and fitting a pair of setscrews to clamp them in place. The dimensions of the modified mounts can be seen in **Fig. 2**. They are designed to fit in place of the chromed ring that is pressed over the thrust bearing housings on the X and Y axes – this ring can be seen in **Photo 1** and can readily be removed by inserting a thin piece of metal behind it with the help of a hammer (a light tap on the back edge of a Stanley knife blade worked for me!) to get it started before resorting to more robust levers. The boss underneath is 40mm in diameter. The mounts are held in place with a couple of setscrews 90 degrees apart. **Photo 5** shows the X axis mount in place, and **Photos 6, 7, and 8** show motors in place on the Y, X and Z axis mounts respectively. Note that the Y axis motor shown is smaller than the other two – this will be explained in the next section.

## Choice of motor and drivers

The motors Dick used were approximately 1.63 Nm holding torque, NEMA 23 size motors. As he indicated in his article, he could have used smaller motors than these, but chose a greater margin of safety by using larger ones.

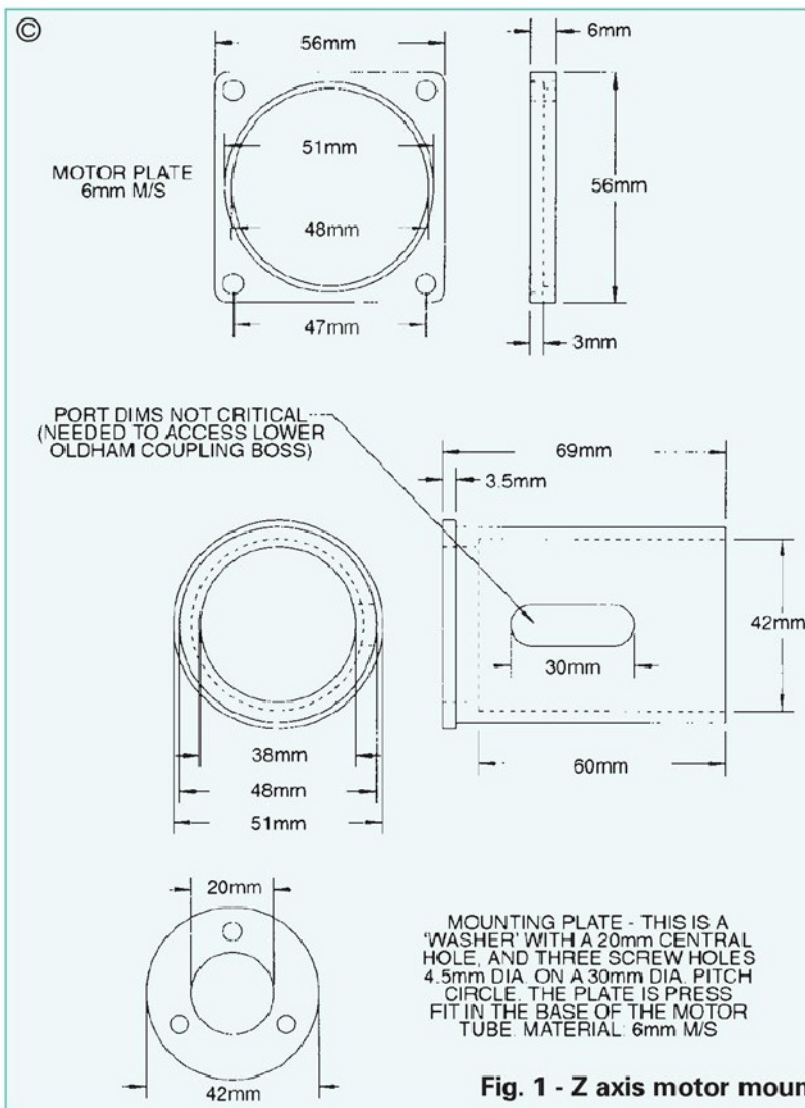
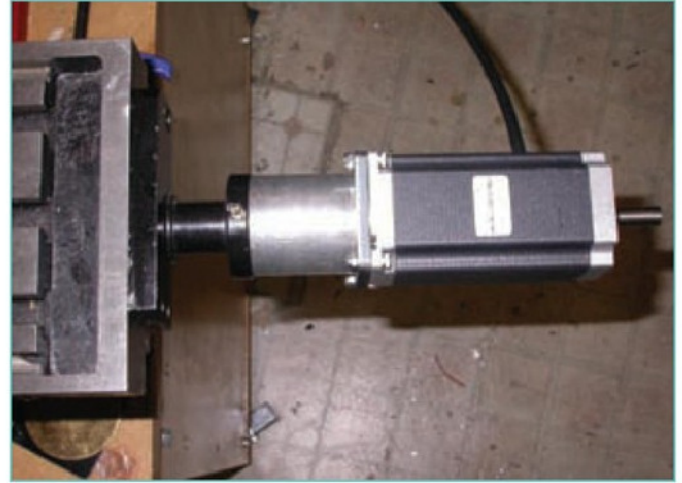


Fig. 1 - Z axis motor mount





6. Y axis motor in place.



7. X axis motor fitted.

Arc Eurotrade (Ref.2) has recently been selling two sizes of NEMA 23 stepper motor of Chinese origin; one that is very similar in size and performance to the ones Dick used, and another that is capable of generating about 50% more torque. I wanted to try these out, partly out of interest to see what kind of quality they were, and partly because they are relatively very cheap compared with other sources of stepper motors. Because I was not using the 2:1 reduction drive, and because these motors were an unknown quantity, I decided to use the larger ones, but as I already had one of the smaller ones, it would be possible to do some comparison tests later on.

Similarly, Arc have been selling two sizes of stepper drive, one rated at 3A and 40V; the other at 7.8A and 80V. I had used the larger drives already as an auxiliary driver for a rotary axis, so decided to use these for the X3 drive system. I had the makings of a 74V, 6A power supply to hand, which seemed about right to drive the system. This proved to be considerable overkill, both in terms of motor size and driver size, but more of that later.

## Installing the power supply

The power supply is a very simple linear power supply, similar to Dick's design, but delivering a somewhat higher voltage. The toroidal transformer I used has two secondary coils rated at 25V AC, 6A (i.e., a 300 VA rated transformer); by connecting these in series, it delivers 50V AC at 6A. When rectified using a bridge rectifier and smoothed with a 10,000 microfarad capacitor, this gives a no-load supply voltage of a shade under 74V, and its current rating will be correspondingly lower.

At first sight, this sounds like a rather lightweight supply, as the motors are rated at 2.5A/phase; 3 motors, 2 phases each, 2.5A/phase, sounds more like a requirement for 15A. However, a number of factors come into play here:

In a modern microstepping "chopper" drive, such as the ones I planned to use, the full current is never applied to both phases at the same time. What the drive does is to adjust the current in each phase

to generate the "microstep" positions; when stepped continuously, the current in each phase reasonably accurately follows a pair of sine waves 90 degrees out of phase with each other. So when one coil is at its max current, the other is not, and vice versa; it turns out that the absolute maximum total current drawn by a single motor is 1.414 times its rated phase current in a microstepping drive.

Chopper drives are in effect switch-mode power supplies; they take a high supply voltage, much higher than the motor nominally needs to drive the rated current through its windings, and by sensing the current in the motor windings, they switch off the supply when the rated current is reached, switching it back on when the motor current decays again below the rated level. In the setup I am using, the 74V supply is 10 times as much as is needed to drive the rated current through the motor windings; hence, the average current drawn from the supply will be very much less than the motor spec would lead you to believe. I tested this out using a 25 volt bench supply that had a current meter fitted, using one of my



8. Z axis motor, located at top of head.



9. Showing mains rocker switch, fuseholder and IEC socket fitted to housing.



10. Interior of housing awaits transformer.



DivisionMaster controllers to drive one of the motors; even under significant load, I could not persuade the drive to draw more than 1.5A.

Stepper current increases with the mechanical load that the motor experiences; however, in a practical CNC system, there are rarely more than two (the X and Y axis) motors that are heavily loaded at the same time, and often, when doing straight line moves, it is only one motor that takes the strain. So again, the average current drain that the supply will have to source is less than you would expect from the motor specs.

The whole of the power supply fits neatly inside the cavity at the base of the X3's rear housing; the top half of this housing contains the electronics for the spindle motor speed control. **Photo 9** shows the mains on/off rocker switch, fuse holder, and IEC socket fitted into the bottom of this sheet steel housing; **Photo 10** shows the inside view with a pair of wires and connectors hanging down ready to connect mains to the transformer, mounted on the case back plate (**Photo 11**) along with the rectifier and capacitor. The smoothed DC is fed through the back plate into the controller mounting box, which is "piggy backed" onto the case back plate, as shown in **Photo 12**.

As can be seen, I have only built a 3 axis drive system; as I have a variety of fourth axis devices, all of which can be driven by my DivisionMaster controllers; thus a built in fourth axis drive was somewhat unnecessary for me.

## Installing the motor drivers

One potential disadvantage with the larger drivers sourced from Arc is that if you decide to mount them flat on their backs, they are quite large. It wasn't till somewhat later that I realised that they could also be mounted vertically; however, by that time I had already decided on a mounting solution based on a long metal case, part number 215-5310 sourced from RS components (Ref.3) (Radiospares as was). This case is slightly smaller than the large back plate of the mill, and when attached to the backplate, (**Photo 12**) there is room to access the six screws that hold the backplate in position.

The case is slightly shallower than it needs to be to allow space for the wiring into the two connectors on each stepper driver, so I turned this into a virtue by fitting 8mm deep stand-offs so the lid, when fitted, leaves an 8mm gap at the top and the bottom, allowing free flow of air



**11. Transformer and associated components fitted to backplate.**

through the case. In use, with a setting of 2.5A on the drivers, they do get warm (but not hot) using this arrangement, despite their ample heatsinks; if you were to use higher current ratings than this I would advise fitting a fan to force cool the drivers.

**Photo 12** shows the drivers mounted in place with the 74V supply connections wired up. Note that I have "star wired" these from the smoothing capacitor of the power supply - it is not a good idea to "daisy-chain" the supply wiring from one drive to the next, as current drawn by a drive that is nearer to the power supply can effectively "starve" drives of current lower down the chain. In fact, if the wiring from the power supply to the drive is likely to exceed about a foot (300mm), it is advisable to fit local reservoir capacitors of 470 microfarads across the supply terminals of each drive -these must have a voltage rating at least 25% higher than the supply voltage.

**Photo 13** shows the remainder of the wiring "harness" fitted into the lid. I use 4-pin XLR plugs and sockets for the motor connections; these are robust and have a locking mechanism that prevents accidental removal, and their pins are rated for 15A each, so they are perfect for this job. Most importantly, the solder "buckets" on the pins are big enough to easily take heavy gauge cable.

There are three sockets fitted to the case. The first is a female D25 socket that carries the step and direction signals for



**12. Controller mounting box fitted with three stepper drives.**

the drives, and which can also carry limit switch signals if need be (a later project here!). I have used a fairly conventional connection plan for this socket, as follows:

| Pin | Signal           |
|-----|------------------|
| 2   | X axis Step      |
| 3   | X axis Direction |
| 4   | Y axis Step      |
| 5   | Y axis Direction |
| 6   | Z axis Step      |
| 7   | Z axis Direction |
| 8   | A axis Step      |
| 9   | A axis Direction |

The A axis signals are wired directly into pins 4 (Step) and 9 (Direction) of a D9 female connector; this is to allow me to connect a DivisionMaster controller into the system to use as the fourth axis drive.

This arrangement allows me to drive the mill directly from a PC parallel port, using (for example) Mach 2/Mach 3 (Ref. 4) or Turbo CNC (Ref.5) software, which are popular and inexpensive "control" software packages. However, as the Arc drives are opto-isolated, a "common" 5-volt signal is needed, which must originate from the computer that generates the step and direction signals. This is provided for via a small 2.1mm power supply socket that can be seen between the XLR and D-



**13. Showing wires and connectors fitted to lid.**



**14. Modified USB cable provides 5V supply.**





15. Motor connectors etc. now fitted.

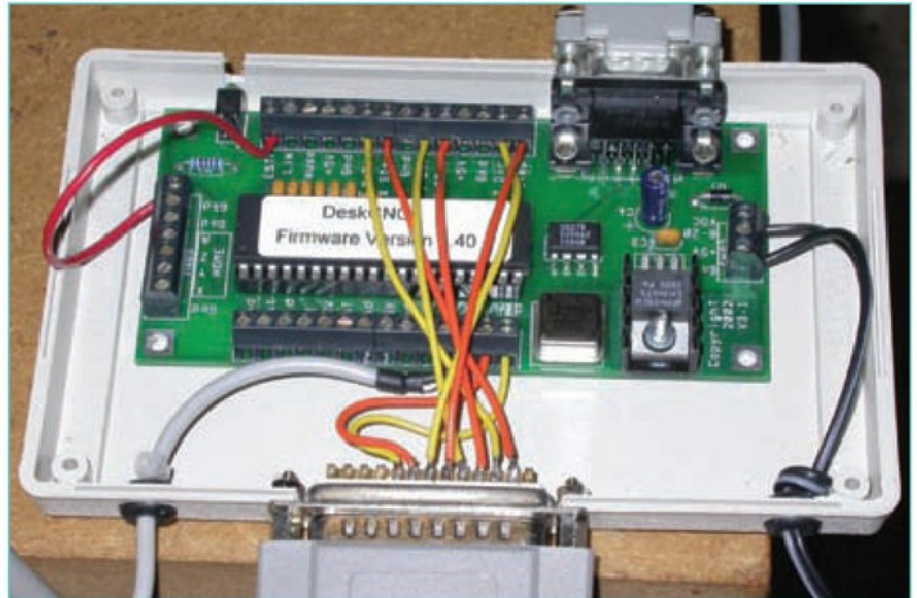
type sockets in the photo. From this socket, the 5V is taken individually to each drive and connected to the "+" signal connections for step and direction, the D-type pins (2 through 7) are connected to the "-" signal connections.

Deriving the 5V from the PC is straightforward if the PC has USB sockets – Photo 14 shows a USB cable that I have modified for this purpose. I simply chopped off the device end of the cable and wired the +5V wire (conveniently, this is the red one) into the centre pin of a 2.1mm power plug to match the socket in the driver case.

Photo 15 shows the case cover fitted, with the motors plugged in. This photo shows the one "deliberate error" that I managed to make during the conversion – if I had mounted the drivers the other way up (connectors on the left), and shifted them to the right hand side of the driver box, the motor sockets would have ended up on the left (looking at the back of the machine), which would have been right for the X axis motor. This way, I ended up with the X motor cable a little on the short side, so a spot of rewiring is needed to make this work properly.

## Driving the mill

The D25 connector arrangement means that I can easily swap between software that can drive the mill directly from the parallel port (Mach 2, Mach 3, Turbo CNC, etc.) and other packages, such as DeskCNC (Ref.6), that use some form of external processor to generate the step pulses. I already had a DeskCNC controller board and software license, so my initial experiments were with this. I mounted the DeskCNC controller board in a simple plastic box, with its D9 serial port connector and power LED poking out one side, and a D25 female connector, power supply in cable, and 5V reference out cable poking out of the other side, as seen in Photo 16. The wiring from the DeskCNC

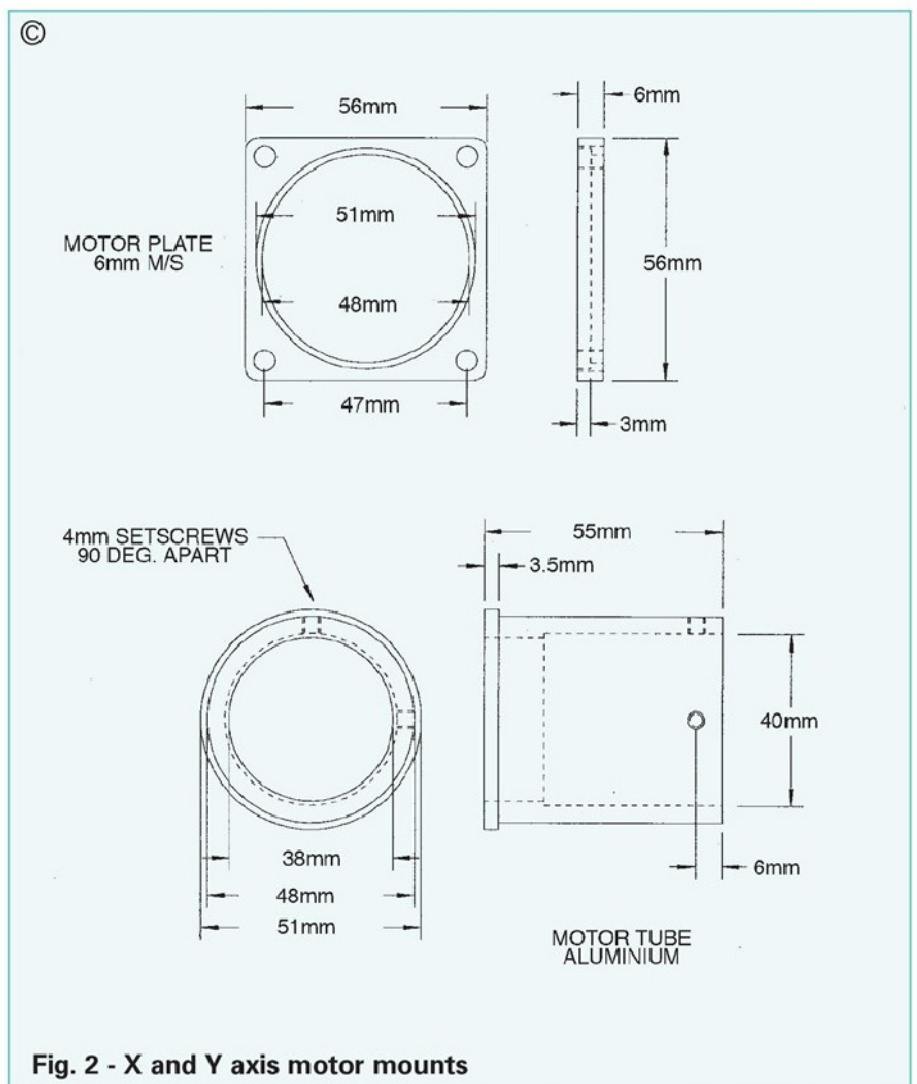


16. DeskCNC controller board fitted to plastic box.

controller to the D25 is as described above – X Step to Pin 2, etc. The power supply for the controller was derived from a spare "wall-wart" power supply. The only other wiring for the DeskCNC controller is to ground the "Emergency Stop" (EStop) line; eventually I will make proper use of the Estop and the limit switch connections available on the board in order to produce

a more complete and safer conversion, but in order to get up and running this is all that is needed.

Some of the more modern PCs use parallel ports that are not capable of generating the full 5V signals needed to drive the stepper drives' opto isolators; if this is the case, and you plan to use software that uses the parallel port, then







17. Testing with 30 Kg scales.

there are a number of "breakout boards" available that will buffer the PC's output signals and generate proper 5V signals as outputs. At some point, I plan to try using Mach 3 to drive this mill, in which case I will probably make up a similar box with a breakout board in place of the deskCNC controller, using one of the boards available from CNC4PC (Ref. 7).

Setting up DeskCNC is pretty straightforward, as described in Dick's article. The main difference is that I am using 8 microsteps per step; the Arc drivers can be set for a variety of different microstep settings, from half-stepping through to 256 microsteps per step. In reality, there is absolutely no point in using more than 8 microsteps per step with these drivers (the Geckos that Dick used are 10 microsteps); a larger number of microsteps simply means that the PC or external driver card just has to work harder to get the same motor speeds, and the improvement in smoothness of drive is marginal beyond this level.

## Performance

The version of the DeskCNC controller that I have (the Mk.1 version) can generate a pulse train up to about 45,000 steps per second. With my setup, which needs 800 step pulses to move 1mm (8 microsteps per step, 200 steps per rev of the motor, so 1600 microsteps per rev, with a 2mm screw pitch), this would equate to a table movement of 3,375 mm/minute, which is shifting pretty fast. My starting point for initial tests was to set up the DeskCNC software for a maximum speed of 40,000 steps/sec (3,000 mm/min); I found that the larger motors were being over-driven at this step rate and were missing steps, whereas the smaller motor (fitted to the Y axis, which actually has a harder job to do than the X, as it carries the weight of both axes) was perfectly happy running at these speeds. This is not unexpected; as both motors have the same current rating, the

larger motor is a higher voltage device, which means that it will lose torque at lower step rates than the smaller motor, although at low step rates, it will generate more torque. So, having reduced the step rate to 30,000 steps/sec, which still generates a very respectable 2250 mm/min max speed, all motors seem to operate well within their capability.

These results very much bear out the comments on motor sizing in Dick's article; if I was repeating this exercise, I would probably go with Arc's smaller NEMA 23 sized motors, if for no other reason than that they are physically shorter than the others and therefore stick out less.

In my very initial tests on the machine, before completing the drive circuitry, I used one of my DivisionMaster controllers, which has a 24V supply and a max current rating of 2A/phase, to drive one of the axes, just to see whether all was working OK. Even with this lightweight drive system, which was down-rating the available motor torque to 80% of the motor's capability because of the lower phase current, I was able to achieve table movements of around a metre a minute. Consequently, if it is desirable to do a "budget" CNC conversion on one of these mills, the smaller (40V, 3A/phase) drivers and the smaller motors would still deliver a respectable performance.

## Heavy tests!

At one point, I was driving the Z axis up and down, and leant on the top of the head to see just what kind of force the drive system was generating. Admittedly, it was difficult to put much weight on the head due to its height and the need to hold the jog button down at the same time; however, the fact that the motor showed no signs of stress led me to do some more definitive tests.

I have a small spring balance, calibrated to 30 Kilos, to hand, so I attached this between the head and the table, as shown in **Photo 17**. The motor happily drove the Z axis up to beyond the end of the 30 Kilo scale, without breaking a sweat. Encouraged by this result, I looked around for a tougher test. **Photo 18** shows the result – a set of bathroom scales resting on the bed, with the head bearing down on them via a piece of timber and an old cable reel, inserted as a spacer. I chickened out when the indicated weight on the scales reached 130 Kilos; not because I was concerned for the mill, but because I didn't want to have to replace a crushed set of scales!

So, the conclusion from this is that the setup described is capable not only of generating rapid movements at respectable speeds, but also capable of generating forces in excess of 130 kilos at the tool tip. I strongly suspect that this is more than sufficient for most requirements on a mill this size, and perfectly capable of ruining the larger sizes of cutter that might be used if driven too hard for the spindle speeds and materials in use.

## Final comments

The performance observed with this conversion has convinced me of one thing – many people approaching CNC conversions go way overboard when it



18. In excess of 130Kg of down force was available

comes to choosing the stepper motors that they will use. I am (or should I say, was) probably just as guilty of that as anyone else – I have to admit that at one point I was seriously considering using NEMA 34 motors rated at about twice to three times the torque of these NEMA 23 motors. Clearly, if my setup is capable of generating the kinds of forces that I have measured, extra torque is not a requirement; the other side effect of using NEMA 34 motors would have been a reduction in the top speed obtainable. Hence, using the bigger motors would have been a waste of time and money.

Certainly one of the reasons that this setup is relatively easy to drive, and hence, can use smaller motors, is the decision to use ballscrews, which give an efficiency advantage of 2-3 times over using ACME screws; however, I suspect that even if I had decided to drive the original ACME screws, the motors I used would have given an acceptable result. Now it is probably time to stop fiddling with the conversion and start making some chips fly; however, as mentioned above, my eventual plan is to see how Mach 3 compares as a control system for the mill. Expect a further article when I have had time to try it out!

## References

1. **DivisionMaster Ltd**, 11a Poplar Grove, Sale, Cheshire, M33 3AX, Tel 0161 973 4278, [www.divisionmaster.com](http://www.divisionmaster.com)
2. **Arc Euro Trade**, 10 Archdale St, Leicester, LE7 1NA, Tel 0116 269 5693, [www.arceurotrade.co.uk](http://www.arceurotrade.co.uk)
3. **RS Components Ltd**, Birchington Road, Corby, Northants, NN17 9RS, UK, Tel 08457 201201, [www.rswww.com](http://www.rswww.com)
4. **Mach 2** and **Mach 3** can be downloaded from <http://www.artofcnc.ca/>
5. **Turbo CNC** can be downloaded from <http://www.dakeng.com/turbo.htm>
6. **DeskCNC** products can be obtained from <http://www.deskcnc.com>
7. **CNC4PC's** website is <http://www.cnc4pc.com/>



# MUSING ABOUT ... a problem to die for!



**1.** One way to protect taps and dies that are in fairly frequent use is to submerge them in oil. For that purpose, one of these workshop storage "tubs" will hold all your small metric items, another will hold all your Whitworth ... and so on. The downsides are that the oil makes it a teensy bit messy when you need to locate a particular item, and having a number of taps stored together raises the possibility of cutting edges contacting each other reducing sharpness. A big, big upside is that the thread identities remain etched on the shanks or flats as clearly as the day they were made. With those identities being easily readable through the thin film of oil, you do not need to borrow Granny's glasses to do the sorting.

(Note: Do not seek to economise by using old engine oil. It can contain lots of water and combustion acids, and will NOT protect your surfaces.)

**A**fter any painful experience, particularly one where the pain might have been avoided, we may make the resolution that we will "learn the hard way". If asked to provide an example of learning the hard way, my own contribution might be to recount the number of times that I have been reduced to tears by someone else's taps and dies!

When yet another of these events is about to happen, there are clear warning signs. The feature common to such events is that, on first becoming involved with a job, I find that parts of that job have been done already. Typically, some holes will have been drilled and tapped, or some bars will have been threaded. Such earlier work would, you might think, save me any amount of effort. All that should be necessary is to make such further threads as are needed.

## A sense of foreboding ...

If the task in hand is destined to become one of the problem situations, the first inkling that things are not right will usually happen when everything is being

put together, when the male and the female threads are presented one to the other. Then, the engagement of the threads might start OK, but the torque then necessary to cause further engagement increases so rapidly that you soon have to call a halt, long before full engagement. Either you are blinded

**2.** When we need to protect big boxed sets of taps and dies, our old friend Waxoyl takes some beating. Do however use a de-wetting fluid (such as our old friend WD40) before applying the Waxoyl, otherwise you can still suffer patches of light rusting. Finally, when putting the boxes into storage, try to identify a location that is dry and does not follow atmospheric temperature changes. (The reason to avoid those temperature changes is that, when a warm spell follows a cold spell, there will be condensation onto cold metal surfaces from the relatively warm and relatively humid air that has brought the higher temperatures).

## Trevor Marlow considers care of taps and dies

by sweat, or you fear that you are going to break something, be it spanner or wrist.

When presented with these symptoms, it is natural at first to suspect the possibility that you have encountered galling, such as can happen most familiarly with the austenitic stainless steels. Galling, when it happens, is indeed a mind-numbing problem. However, the cause of the problems that concern us here is quite different, often occurring in forging materials such as free-cutting or silver steels. The cause of these latter problems can usually (but not always, see later) be traced back to the conditions in which the earlier worker has stored his taps and dies!

## Cause and consequence ...

The reason why neglect can cause these problems may be visualised by thinking through what happens to a die left on the bench in a damp workshop. That neglect presents the near-inevitability of light to moderate rusting of all surfaces, including those that do the cutting. The rusting on the cutting surfaces of the die might in the first instance cause a trivial tendency to cut threads that are too small. With more rusting however there is, because of spalling of the oxide, a significant loss of material from all surfaces on the die. Thereafter the die will tend to cut threads that are significantly larger (on the various diameters) than the nominal value, while remaining accurate in pitch.







**3. A convenient way to apply the Waxoyl to small components like taps and dies is via a small (about one inch) paintbrush. To have that charged brush always ready to hand, a good strategy is to drill a hole in the top of an old coffee jar, put the brush handle through that hole, and use masking tape to fix the brush handle to the jar lid while retaining some freedom of movement between the handle and the lid. (That freedom of movement allows you to stir up clumps of Waxoyl that otherwise tend to gather around the sides of the jar.). Another strategy is to dip each component into warm (and hence very fluid) Waxoyl, but the low viscosity then leads to a much thinner coating on the treated article.**

As can then be imagined, we might in direct consequence of that rusted die seek to engage an oversize male thread with a correctly sized female thread. Such an interference fit might in the smaller thread sizes just seem to be on the tight side, but in the larger thread sizes the torque requirement will defeat those blacksmith arms you have spent so much effort in developing.

## Even worse ...

There are several variants of the problem. In the example described above, we have a rusted die and a non-rusted tap. If both die and tap are rusted, we might then make both an oversize male and an undersize female (on diameters, not pitch, remember) which in combination makes the interference problem far worse.

(Note, in passing, the range of different possibilities if the earlier operative has used a rusted split die, as opposed to the one-off possibility if he has used a rusted die nut.)

The ways to remedy these problems are pretty obvious; you simply re-dress the threads using good quality taps and dies that are in first class condition. In the workshop, that is no problem, but in the way of this worst of all worlds, you are often destined to discover the deficiencies of the threads only when you are underneath a large agricultural vehicle, you do not have any taps or dies with you, it is more than a mile to the nearest road, you have diesel dripping on your spectacles, the midges have come out, and farm dogs have just marked you out as part of their territory.

The ways to prevent your own taps and

dies ever causing such problems are pretty straightforward. On that topic, be warned that it is not a good idea to leave taps, dies or other precious surfaces in contact with the soluble oil coolant that must often collect in your lathe tray. After a moderate period of inhibition, all such protection is lost and corrosion will then proceed at a rapid rate. As with all corrosion, once it has occurred, it is very difficult to reverse the process!

## Just sometimes ...

As promised earlier, a quick word of explanation as to why corrosion is occasionally not the cause of these problems. While a well-made tap or die can be a thing of beauty and a joy forever, some of the cheaper taps and dies can be wildly inaccurate in pitch and in diameter and in thread form. These deficiencies become painfully obvious if items from a newly purchased tap and die set are used to make nominally matching female and male threads. It can happen that you then discover that those threads will not engage properly, if at all. (Occasionally you will find that some of the "cheapo" tap and die sets seem only to be sufficient for making a rough thread that will serve for some trivial domestic or automotive purpose. To have better quality and reliability, you may need to pay considerably more!)

## Caring for what you've got ...

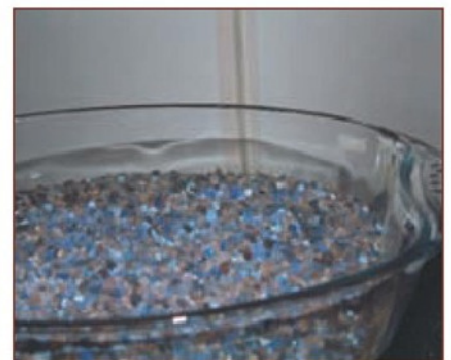
It must be nice to possess a full set of first class taps and dies, but Mr Average can usually only justify the purchase of a few of the preferred and well-used sizes. So, if we are talking about something that we can hardly afford, what better reason can there be to protect the pristine newness of those items?

(Note: The methods suggested in the Photos to prevent corrosion of taps and dies are not a complete listing. Most methods can be applied with great benefit to many other precious surfaces in your workshop and home. For example, one of the spray bottles as found in every kitchen is great for dispensing a 50:50 mixture of engine oil and paraffin, which initially allows easy cleaning of dusty and waxy surfaces, followed by reasonable protection of those surfaces after the paraffin has evaporated. Some methods have a very special value, such as the Vapour Phase Inhibitor powders to protect the wire in your MIG welder)

## It's Widget time ...

Finally on the topic of making accurate threadforms, it is entertaining to use the sheer excellence of first class taps and dies to make yourself an unusual widget, an item that will cause amazement and fascination whenever you choose to introduce it into the conversation. To make the first part of the widget, you start off by making a male thread on a piece of free cutting brass. You then carefully finish that thread with the best quality die nut you can lay your hands on. To make the second part of the widget, you then rummage through your off-cuts box and find another (more

chunky, but compact) piece of free cutting brass, which for your first trial need only be a piece of bar of much larger diameter than that from which you made the male. Through this stubby bit of brass you drill the correct size of tapping hole for making an equivalent female thread. You then carefully use the correct sequence of taps to make that equivalent female thread. You then introduce the male thread into the female thread, and finish the construction of the widget by any finishing or grinding operation that you choose, provided that the final operations level or merge one of the junctions of the two items. (In the simplest case, you might for instance saw off the excess male thread and then finish the ends of the surfaces to mutual flatness.) What then happens is that, because of the excellent matching of the two threadforms, and the fact that any gaps fill with finely powdered brass, the junction of the two items becomes nearly invisible. In that situation, the provision of any simple method to rotate the male within the female thread (even an action as simple as rotating the other end of the male thread with your fingers) will then cause the spooky effect of an unsuspected male thread suddenly appearing from (or disappearing into!) an apparently continuous surface. To an observer it then seems likely that, to make such spooky behaviour possible, both threadforms must have been made to unprecedented accuracy by someone with Master-Craftsman skills. You, knowing that the truth is actually far more mundane can then in all honesty reply, "It was nothing ... absolutely nothing ...really!"



**4. When surfaces are so valuable that they must be given the most rigorous protection, they need to be free of salty fingerprints, dry, lightly oiled, and stored in a benign atmosphere. Here, a large heat resistant (Pyrex type) dish full of silica gel is about to be re-energised simply by popping it into a fan oven for an hour or so. Such a quantity of gel will render the atmosphere benign even in a large cupboard provided that the cupboard is airtight. It is easy to make three sides of the cupboard door airtight; the tricky bit is the hinged edge. Here, in the background, the (fully) hinged edge of a welded steel cupboard has been provided with a long lasting, flexible and airtight seal using the 50 mm wide version of adhesive insulating tape. The flexibility of the tape allows repeated opening of the door without needing to remake the seal.**



# LATHE SUDS DISPENSER BASE



1. Original base with "Lockline" spout.

One of my acquisitions whilst building up my home workshop was an independent coolant system for my second (or third or...) hand Myford 7. The system came complete with magnetic base, spout and pipe. I found the spout difficult to position and it did not stay put, so I replaced it with "Lockline" and ended up with the system in **photo 1**. All was still not well as the magnetic base tended to pivot under the influence of the hose as the saddle moved. This often caused the suds to fly as they sprayed onto the chuck and operation of the control tap was far from positive as the base moved. Also, the magnetic base attracted swarf, which always seemed to end up underneath making it swivel even more, **photo 2**, and it was difficult to remove. I tried the "Time Team" system of

wrapping the base in polythene to assist the removal, **photo 3**, and although this assisted in the removal of the swarf it did not cure the original problems. A new base was required.

## Design of the new base

The new base design had to accommodate the shortcomings discussed above. Thus it had to:-

- stay put when placed on the saddle but be easy to remove;
- not swivel as the saddle moved;
- be relatively immune from swarf;
- be stable when operating the flow adjustment cock.



2. Swarf attracted to the original magnetic base.



3. Use of polythene to assist in the removal of the swarf.

**Laurie Leonard regains control of the coolant with a neat "slip on" accessory**

It also had to be cheap to make and thus utilise existing components from the original dispenser. Taking the above criteria into account and the contents of the scrap box, a design evolved as shown in **drawing 1**. The dimensions shown relate to a Myford 7, parts cannibalised from the original dispenser and the contents of the scrap box.

## Machining

The main body was centered in the four-jaw chuck and faced. The body was then reversed and the other end faced. The position of the flow control cock was then marked and the body remounted centred on this mark. It was then drilled and tapped with a thread to suit the cock.

The positions of the spout connection and the holding down plunger were then marked and the work remounted in the four-jaw chuck centred on the spout connection. This was then drilled and tapped to suit the spout.

The work was then remounted centered on the plunger hole. This was drilled though at 0.25in. dia. and then drilled 12.5mm for the plunger knob. The bottom was then bored square to give a landing for the holding down spring. Finally, the land to engage in the "T" slot was machined on the milling machine.

Machining the remaining parts is straightforward lathe work.

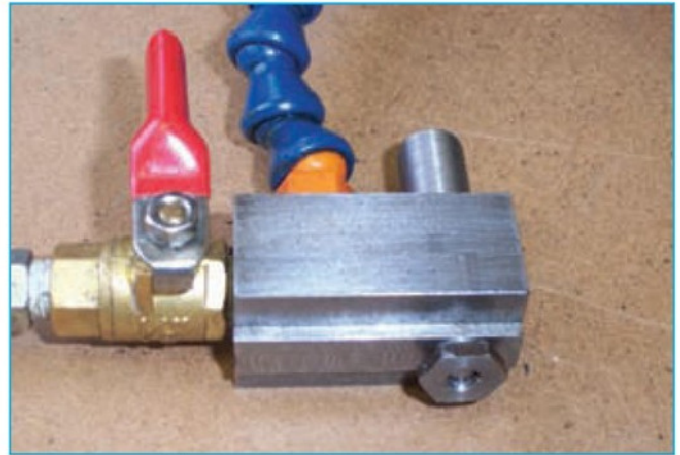
## Assembly

The parts, shown in **photo 4**, are simply assembled as shown in **photo 5**. The spring came from the "spring" box and

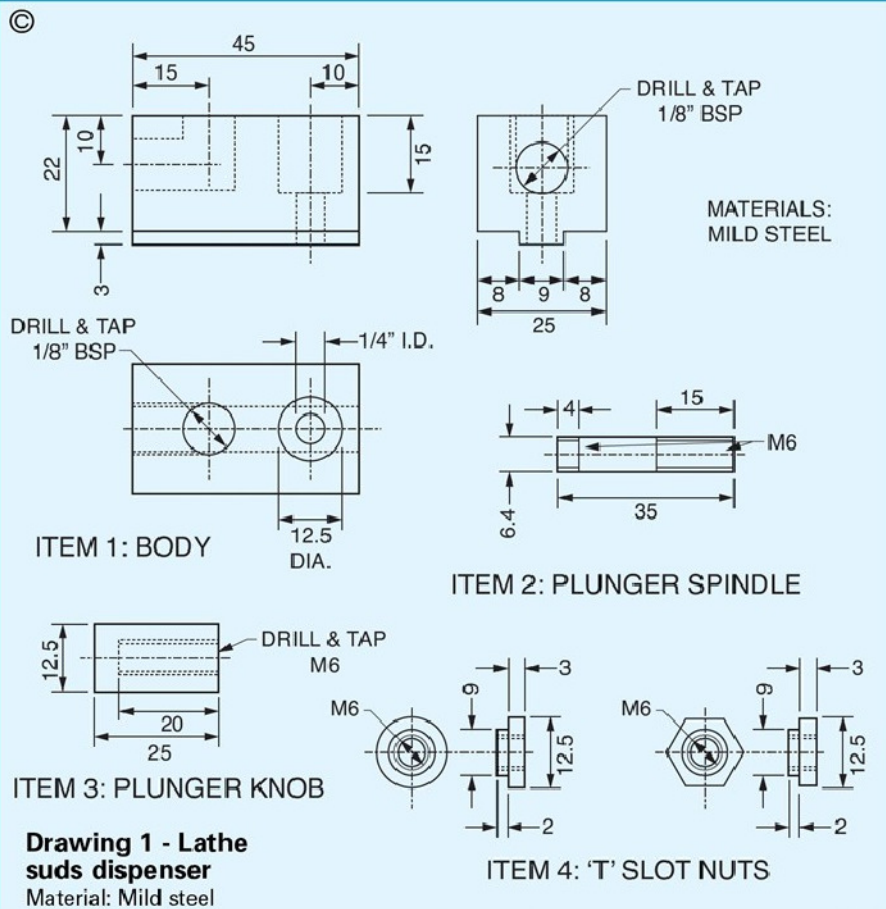




4. The component parts of the new base.



5. New base with parts assembled.



was chosen to give a reasonable tension, which is adjustable by varying the engagement of the plunger knob on the plunger spindle. It was also chosen to have a diameter quite a bit larger than the plunger spindle so that it would be clear of it and not cause jamming.

The hex. section of the nut that engages in the "T" slot was chosen so that the plunger knob could be tightened hard down to rigidly secure the dispenser. It was intended to knurl the knob to assist this and to secure the hex. nut to the plunger spindle with adhesive. In practice the spring tension has been found adequate and the hex. nut could be replaced with a round section shown as an alternative in item 4, **drawing 1**. This would facilitate engagement with the "T" slot when replacing the dispenser on the saddle.

## Conclusion

The base has worked well in service, **photos 6 and 7**, and has satisfied the design requirements. The dispenser is easily moved/removed on/from the saddle by depressing the knob. The modification suggested above to replace the hex nut overcomes the slight problem experienced with quick installation but some may think that the ability to firmly secure the dispenser with ease is worth the short time it takes to align the hex. nut.

The size of the body is "over engineered" but that is what comes of raiding the scrap box! Must get round to blacking it.



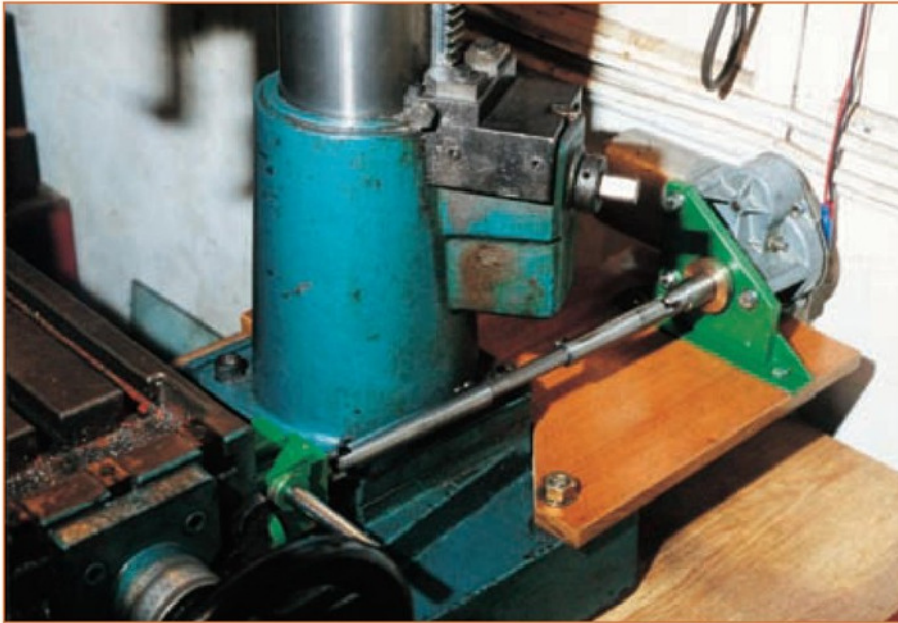
6. New base in use.



7. Close up showing new base mounted on the cross slide.



# POWER FEED FOR MILL-



1. Motor and telescopic drive-tube mounted on machine

Having successfully completed the Power Cross-feed for Small Lathes by David Machin in the Model Engineer dated 17-23 June 1994, I turned my attention to his earlier article for a power-feed for his Dore-Westbury, which appeared in MEW Issues No 14 and 15 which included a suggestion for fitting one to a typical Asian produced mill-drill.

On measuring my Naerok I found that there was insufficient depth of metal in the table to allow for machining the necessary clearance for the wormwheel. I wrote to Mr. Machin pointing this out and he very generously responded with a freehand sketch of an alternative design that eliminated this requirement, retaining part

of the general drive layout, but introducing a telescopic shaft along the rear of the table. From this it was a fairly simple matter to develop a set of working drawings to suit my machine. This design should be readily adaptable for most of the similar machines on the market. The attachment has worked flawlessly for quite a number of years and was produced at a fraction of the cost of a commercial product.

The design results in a slight reduction of the table movements. The backplate - item 1 - which carries the gears on the left hand end of the table abuts against the cross-slide causing a reduction in movement in the left to right direction, and the feed-shaft - item 16 - touches the column base a few millimetres before the

Mr R A Raffan describes an attachment which offers improved finish and adds convenience.

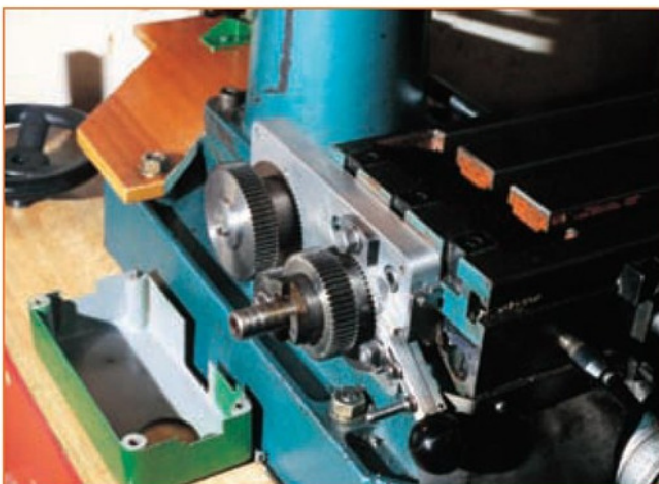
'normal' stop is reached on the cross slide. In practice this has not caused a problem in operating the mill. Photos 1 and 2 show the arrangement.

## Modifications to the machine

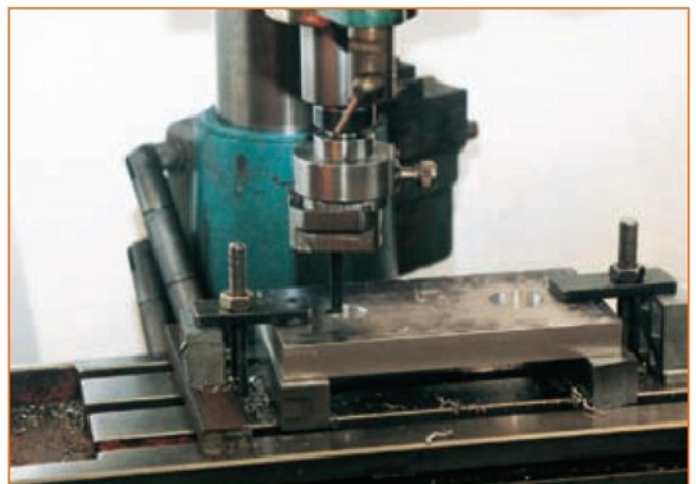
A plus point is that the design calls for little modification to the machine. Only two  $\frac{1}{16}$ in. BSF tapped holes are required. (Metric aficionados might prefer M8.) These are in the cross-slide body to carry the feed-shaft gearbox - DRG.5. A keyway is required in the re-used driving collar - item 11 - to pick up the drive from the 55T pinion. The lead-screw is unaltered and the left-hand handle goes back in place; DRG.3 shows the before and after assembly. The left-hand index has however to be forfeited; fortunately there is one on the other end, but with only one, accounting for backlash is a little more difficult.

## Drive motor

I had intended looking for a car radiator cooling motor as used by David Machin but browsing in my local model engineering shop a motor with integral gearbox caught my attention. This had originally been used on one side of a wheelchair. I understood it to be 12v but there was no plate on it to confirm this. Later, a club member informed me that the chairs to which these motors were fitted carried two 12volt batteries to enable



2. Gear train with cover removed.



3. Boring Gear-train backplate for bearings using boring head.



# DR NAEROK 350 DRILL 1



**4. Checking alignment of bearing bracket fastenings for transfer to gear-train backplate.**

switching to 24 volts when extra power was required. This knowledge enabled me to purchase a transformer for the control with two 12v 50va secondary windings and a double pole switch to put between the transformer output and the rectifier to allow for either 12v or 24v operation. Thus, two speeds are available, but in practice the low speed is never used, the thyristor control giving ample variation in feed rate.

On dismantling the motor the commutator was found to be in very bad condition and one of the brushes was worn down to the embedded copper tail. The commutator was machined and a pair of Kenwood food mixer brushes needed only a few strokes on a smooth file to make them fit. The motor should be good for many years of use in its new duty.

## Gear ratios

A feed rate of 1.5ins. per min. was chosen as the figure to determine the gear ratios and not having all the tooling to produce gears I selected suitable items from the catalogue of HPC Ltd of Chesterfield. These were from their 24DP range.

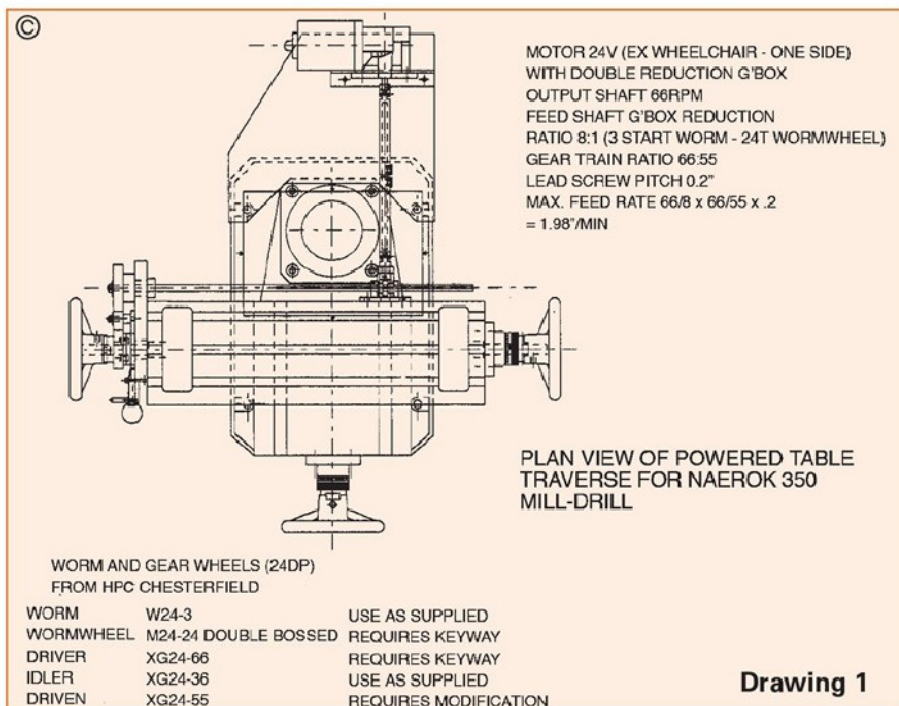
|         |                              |
|---------|------------------------------|
| W24-3   | 3 start worm                 |
| M24-24  | 24t worm wheel double bossed |
| XG24-66 | 66t spur gear (driver)       |
| XG24-55 | 55t spur gear (driven)       |
| XG24-36 | 36t spur gear (idler)        |

On 24v full power, the output shaft of the motor gearbox runs at approximately 66rpm and with the lead-screw pitch of 0.2in. the rate of table travel is: -

$$66 \times \frac{3}{24} \times \frac{66}{55} \times 0.2 = 1.98 \text{ ins/min}$$

## Materials

The materials used were whatever was to hand, provided they were suitable and these are specified on the drawings. Alternative materials could have been used for a number of the parts.

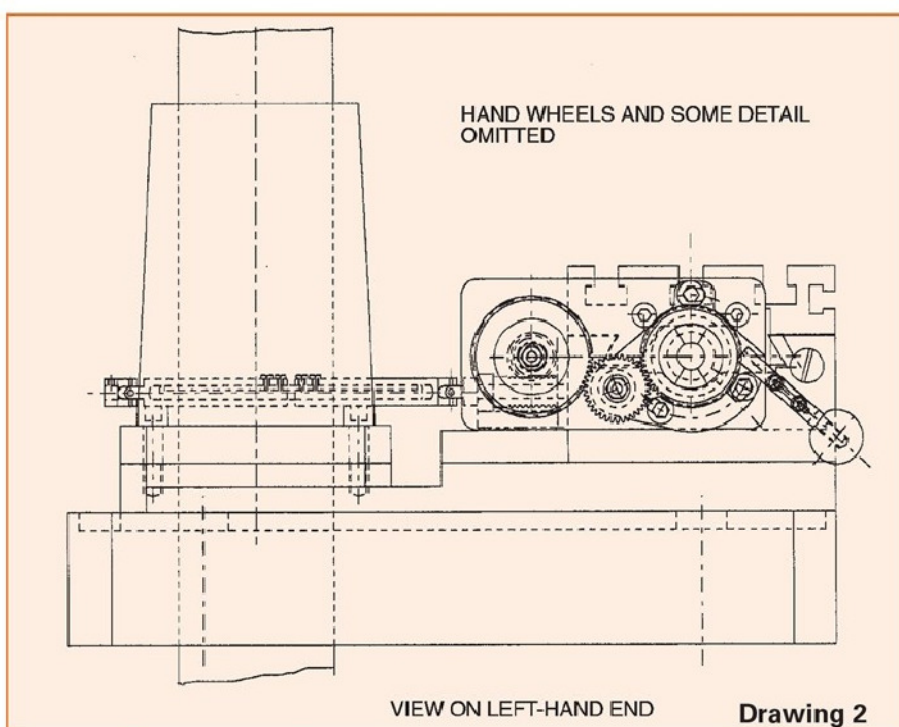


**Drawing 1**

## Item 1 Backplate

This was made from a scrap piece of alloy plate  $\frac{3}{16}$ in. thick. After machining to 7.125in. x 3.5in. the holes that carry the bearings were located on the mill by indexing, the final diameters being obtained with a boring head as shown in photo 3.

The backplate replaces the existing bearing bracket so it was important to get the two holes for the 8mm socket head fasteners in the correct position in order that the lead screw returned to its original alignment. It could be seen by eye that the centre line through the tapped holes in the end of the table for the fasteners was not at



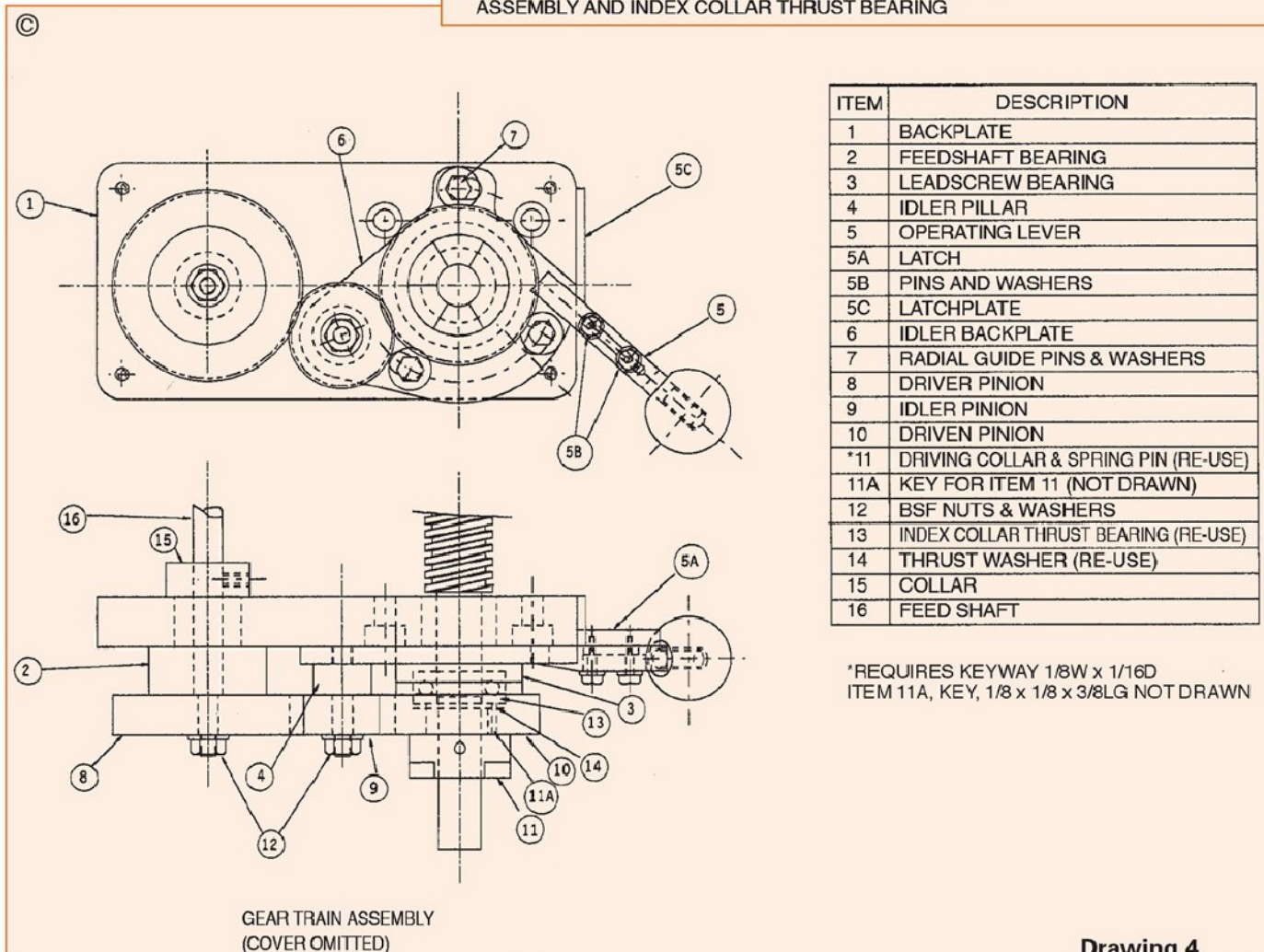
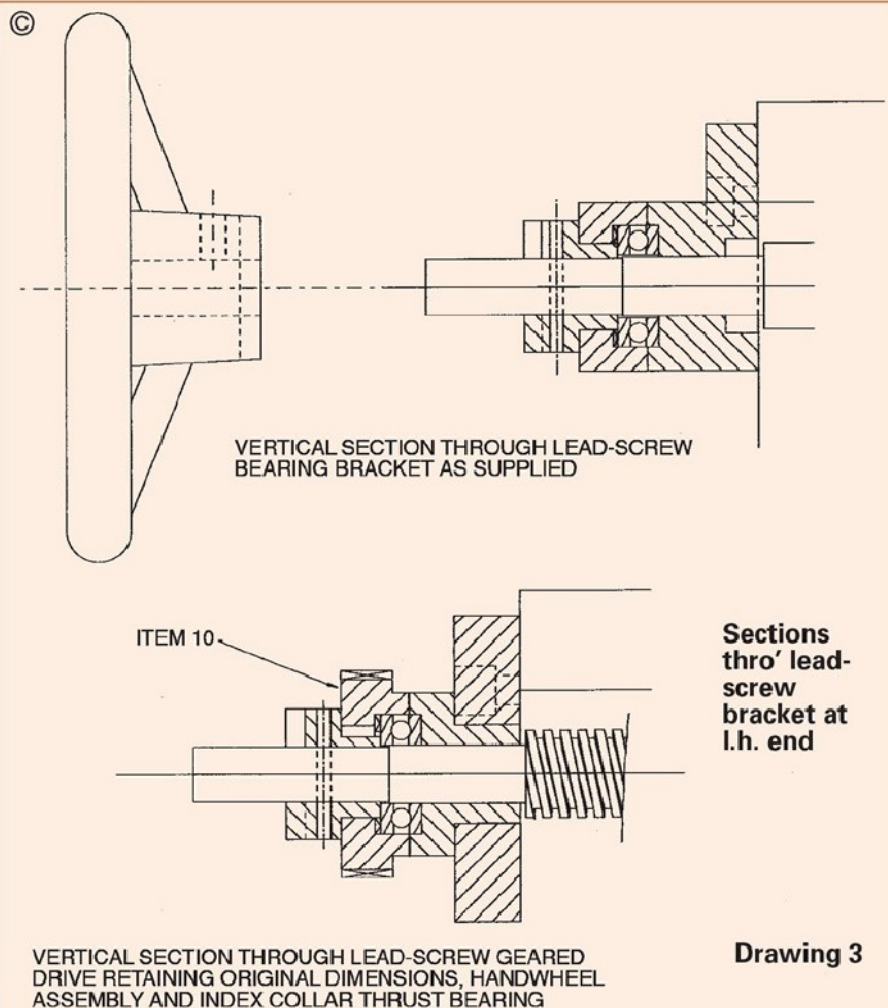
**Drawing 2**



right angles to the front face of the table i.e. the measurement from the centre of each hole to the top surface of the table differed. To do this two  $\frac{3}{16}$ in. dia. collars were turned up to be a close fit on the 8mm fasteners and secured in position. A combination square stock was set against the front edge of the table and the blade set to align on the two collars – **photo 4**. A stub mandrel was turned with two diameters; one to locate in the 1.125in. hole in the backplate and the other in the existing lead-screw bracket. With the blade of the combination square at the required angle and sandwiched between the two parts located with the mandrel, the top of the holes in the bracket were lined up by eye with the top edge of the blade. The bracket was removed and the required angle scribed on the face of the backplate. The parts were then clamped together in correct alignment and held in register by the mandrel and drilled as shown in **photo 5**.

## Bearings Items 2&3

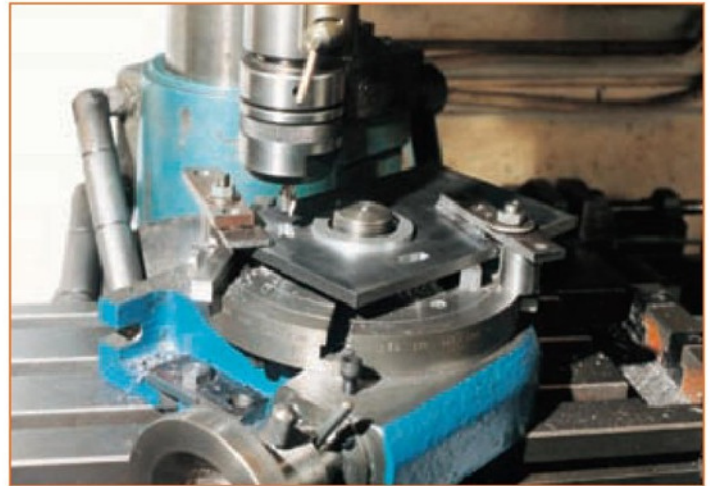
These were turned from cast iron and secured with Loctite 601. When the Loctite had cured the backplate was tried in place on the lead-screw and secured with the original socket head fasteners. The lead-screw rotated without any binding and the backplate top was parallel with the tabletop.







5. Drilling holes in gear-train backplate using lead-screw bracket as template which has been located with a mandrel axially and set radially to the angle of the holes as measured on the table end.



6. Milling radial slots in idler back-plate.

## Idler Backplate Item 6

A piece of  $\frac{1}{2}$ in. M.S. plate was cut to 4.125in. x 3.5in. and clamped to the mill table on a couple of parallel spacers. The pre-marked centre for the 1.875in. dia. bore was picked up using a wobbler and drilled in stages up to the largest drill in my collection and then finishing to size with a boring head.

To machine the slotted holes a centre was turned with two diameters to suit my rotary table and the 1.875in. dia bore. With

the plate clamped to the rotary table and the quill centred, the 1.437in. radius was set using the lead-screw index. It was now a simple matter to rotate the table by the correct number of degrees and drill a  $\frac{1}{8}$ in. dia hole at each end of each slot, following up with an end mill to complete the slot - photo 6. The tapped hole for the idler pillar - item 4 - was also located using the appropriate scales. It was essential to get this right to ensure correct meshing of the gears.

The plate was then sawn and filed to profile.

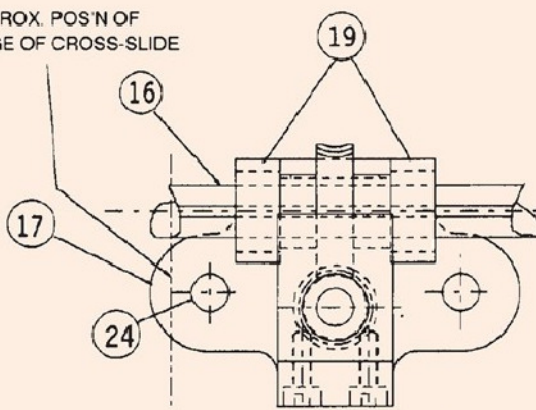
## Guide Pins Item 7

The three guide pins were turned from hex. bar and need no comment here except to say that their tapped holes in item 1 were not located until correct meshing of the driver/idler pinions was established.

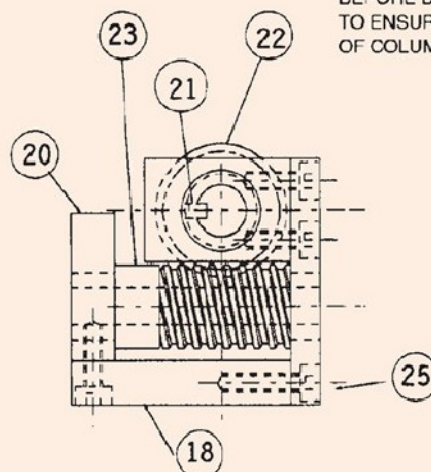
*The second section of this article, to appear in MEW Issue 114, will contain the remaining drawings and give details of the other components.*

©

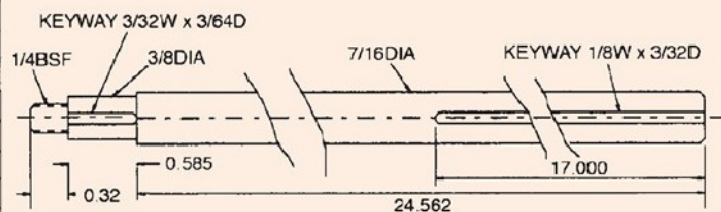
APPROX. POS'N OF  
EDGE OF CROSS-SLIDE



CHECK POSITIONS OF  
GEARBOX ON CROSS-SLIDE  
BEFORE DRILLING FIXING HOLES  
TO ENSURE IT CLEARS HEAD  
OF COLUMN BASE H/D BOLT



| ITEM | DESCRIPTION                  |
|------|------------------------------|
| 16   | FEED SHAFT                   |
| 17   | BACKPLATE                    |
| 18   | BASE                         |
| 19   | FEED SHAFT BEARINGS          |
| 20   | WORM SHAFT BEARINGS          |
| 21   | KEY                          |
| 22   | WORM WHEEL                   |
| 23   | WORM                         |
| 24   | FOR 5/16BSF SOCKET HEAD SETS |
| 25   | SOCKET HEAD SETS 8 OFF 2BA   |

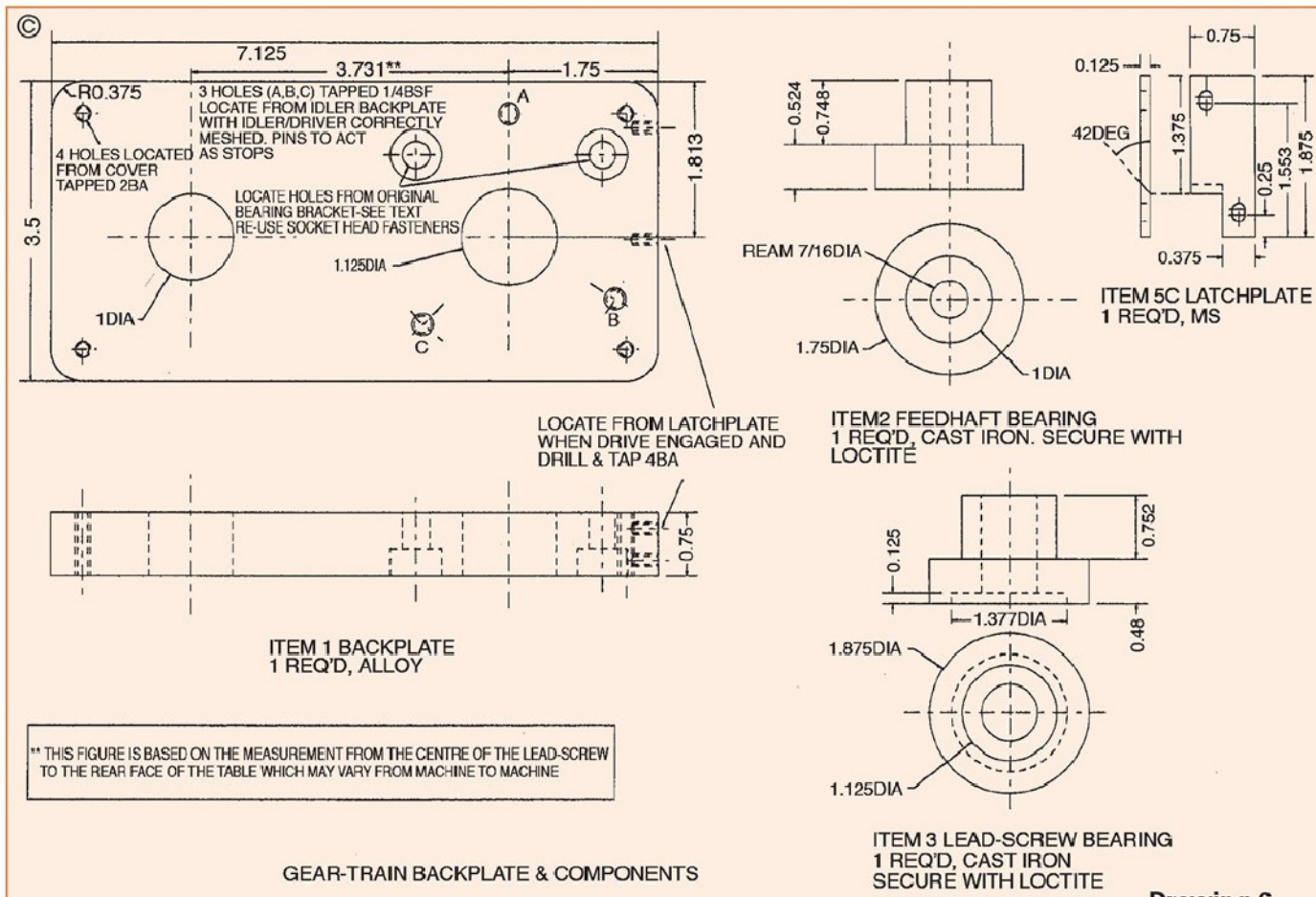


ITEM 16, FEED SHAFT  
FIT 1/4BSF NUT & 1/16THK WASHER  
1 REQ'D, MILD STEEL

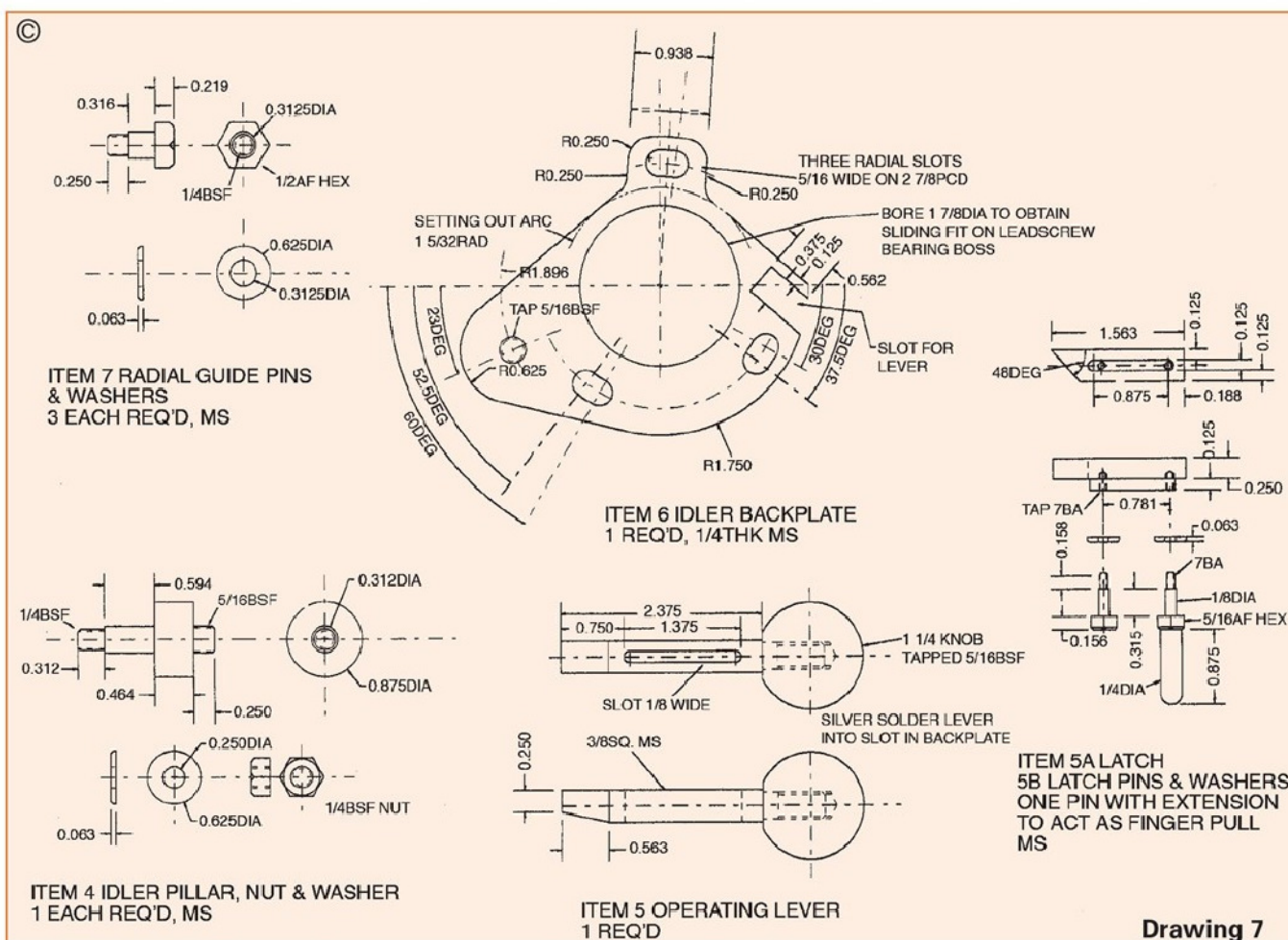
DRIVE SHAFT GEARBOX ASSEMBLY  
ENCLOSURES OMITTED

Drawing 5





**Drawing 6**



**Drawing 7**



# 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.

## Miniature Live Centre

Steve Clarke (of Clarke Engineering), mentioned previously for the parting system and cobalt cutters, has come up with one of those "why didn't I think of that" new products, a miniature live centre. The prototype provided the solution to a long small diameter job to be done on a Myford and has proved popular with members of his model engineering club. The centre has a  $\frac{1}{16}$ in. dia, hardened nose, and the body can be held in a  $\frac{1}{8}$ in. capacity drill chuck. The geometry will allow access to small parts which conventional live centres will not let you reach. The centre contains two sealed ball races, and is priced at just £19.95 including VAT and UK postage. After trying out the device, it also occurred to me that as the body is not hardened, it would be a simple matter to drill a centre in the arbor end, then mount in reversed sense putting the male centre in the tailstock chuck to give a dual purpose female live centre support. **Clarke Engineering can be contacted at 307 Wroxham road, Norwich, NR7 8RN or telephone 01603 301 738.**



## New mill from Warco



This latest mill from Warco designated the WM14 sets a new trend for added inclusive features. Not only does it sport a variable speed 500watt motor giving spindle speeds from 50 to 2500 rpm but also features a built in digital tachometer and digital readout on the quill, allowing precise measurement of the downfeed. The basic statistics are, table 400mm x 120mm, X travel 220mm, Y travel 160mm, spindle to table height 285mm. The head tilts and carries a 2MT spindle with 50mm quill travel. Existing owners of current generation Warco variable speed lathes will be interested to note that the head and column assembly of the WM14 is available as a unit for attachment to a lathe thus creating an extremely versatile package. **For further details, contact Warco at Warco House, Fisher lane, Chiddingfold, Surrey GU8 4TD. Telephone 01428 682 929. Customers in the north of England may prefer to contact the northern showroom operated in conjunction with Newton Tesla at Unit G14 Warrington Business Park, Long Lane, Warrington WA2 8TX. Telephone 01925 444 773.**



## Machine DRO

On display at Sandown were a number of lines from Machine DRO. The equipment they offer tends towards the professional quality digital readout in that it uses glass scales (standard and slim) rather than the cheaper "Chinese units" which have gained great popularity in the hobby market. Similarly, their readout head is a pretty robust piece of kit. **For full details of specifications and prices for the range contact them via their website [www.machine-dro.co.uk](http://www.machine-dro.co.uk) or by telephoning 01992 450780 or email to: [Sales@machine-dro.co.uk](mailto:Sales@machine-dro.co.uk)**



## DivisionMaster company/product changes

DivisionMaster Ltd. has ceased trading as from the end of January 2006. The remaining stock of DivisionMaster automatic indexing controllers and motors will be sold by Tony Jeffree over the next few weeks. In the long term, the controller will continue to be available in kit form, marketed by Lester Caine Electronic Services. Tony will continue to sell his book "The Taig Lathe" that was hitherto marketed through the DivisionMaster company.

Tony commented: "These changes will allow me to concentrate on writing and practical projects, some of which may spin off further kits and books in the future."

**Tony Jeffree can be contacted on 0161 973 4278 or [tony@jeffree.co.uk](mailto:tony@jeffree.co.uk)**

**Lester Caine Electronic Services can be contacted on 01386 852122 or [lester@lscs.co.uk](mailto:lester@lscs.co.uk)**



# TAPER SETTING TOOL

Dave Fenner offers a simple gadget for accurately and repeatably setting topslide tapers.



1. Device off machine from above.



2. Device inverted, showing stop pins.

## Background

In building the Bentley BR2, one comes upon components like the crankshaft, and maneton shaft which feature mating tapers. In the more general workshop context, these are frequently useful for applications such as tool location, also for taps for coolant or gas. Often in the past, various esteemed authors have recommended that for such workpieces, the topslide should be set, and both the internal and external taper features machined without disturbing the setting. This is of course an ideal approach, which will ensure that the mating parts do indeed fit. I felt that as one of the lesser mortals, it was highly likely that my job planning would be imperfect, and that Murphy would intervene (and he did), forcing the topslide to be reset for another job between making the mating components. The question then became one of how to set over the topslide to a specific or at least accurately repeatable angle.

I recalled reading two letters to Scribe a Line, dealing with the subject of quickly setting a milling vice square to the table. One came from Mr John Wilson (issue 93) the other, I have not been able to identify. In each case, the vice, gripping a bar or setting tool, was moved until contact was made with stops which ensured correct positioning. I also considered the approach advocated by Will Bells (issue 106 page 12) which employed a DTI check at spaced marks on the topslide, but on balance felt that the time spent in making the gadget given here would probably be repaid in speedier setting.

Given that most machine shop devices had been pretty well thought out by about by the year 1900, it is unlikely that something similar has not been concocted before, its just that I haven't seen it.

## Concept

The Colchester Chipmaster features machined surfaces at the front of the saddle and at the sides of the topslide. The former are assumed to be accurately in line with the bed, while the latter are assumed to be parallel to the topslide movement; thus both are used in this context as reference surfaces. Colchester Bantams and Students are similarly constructed, and thus it is believed that the concept can be read across to these and probably a number of other machines with similar features.

The device is in essence, nothing more than a glorified bracket, which includes two stop pins and a surface, which is positioned parallel to the lathe axis. It is placed on the saddle and held firmly in place. A sine bar and packing is then interposed between this and the topslide.

If the topslide is slackened, then, when the cross slide is wound gently back, the topslide is brought into contact with the sine bar, and rotates to the appropriate angle. Keeping everything in place with one hand, the topslide is nipped up with the other, prior to clamping firmly.

## Accuracy

The ideal packing for use with the sine bar is of course a set of slip gauges. Home workshop packing might take the form of a machined spacer, a pack of shims, or the shank of a drill. We can assume that a machined spacer will be accurate to a thou, and a rough and ready domestic shim pack might use aluminium (0.003in. thick) from Coke cans as a minimum increment. With a five inch sine bar, 0.003in equates to an angular increment of a little more than three hundredths of a

degree, probably good enough for most amateur applications.

## Repeatability

In terms of making part A fit perfectly with the taper of part B repeatability is a more important consideration than setting to a specific angle, unless matching to a commercial part of specified geometry. Once clamped up, the accuracy of the setting can be checked with a one and a half thou feeler gauge, and the setting process repeated if necessary

## Construction

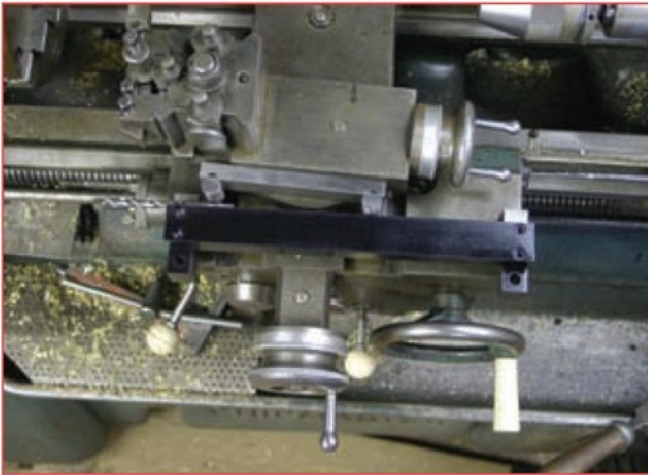
Mine has been built using 30mm x 20mm mild steel flat bar (because there was sufficient in the scrap box). Three pieces were cut, two at 65mm long for the side bars and one at 290mm long for the main bar. The VMC milling machine vice was then set up with the rear jaw 10mm back from the spindle centre. My preferred quick cheat for this was to load a short piece of 19mm bar in a collet, lower between the vice jaws and then move the table to just nip a twenty thou feeler gauge between the bar and the fixed jaw. This ensured that the 20mm thick material for the two side bars would be on centreline within a thou or so.

It was then a case of drilling the three positions, each time starting with a centre drill. The first is a location for the stop pin and while the position (on what will be the underside) is important, the diameter is not critical. I drilled through the first position 9.5mm and followed up with 10mm. At this sort of size and depth, drill wander was unlikely to be a major problem. The second and third positions were centre drilled then counterbored 8mm diameter by 5mm deep, then drilled down 5mm as tapping size for M6.

Again, I cheat on the initial stage of tapping. To ensure that the tap starts on line, having positioned the work in the mill, I put the tap in the drill chuck, run up



# OL FOR CHIPMASTER



3. In use with sine bar employing a drill shank as packing thickness.

the spindle at a medium speed, then hit the stop button, allow the spindle to slow down a little and lower the tap into the work. The residual inertia will continue to drive it in for two or three turns, enough to give an accurate start. Slacken the chuck, remove the work, leaving the tap in place, transfer to the bench and complete the thread by hand.

The reason for the counterbores is to accommodate hollow dowels. It will be appreciated that if the assembly is simply bolted together, the clearance around the Allen screws will permit an unacceptable

tolerance in dimension between the stop pin and the datum face. Close fitting dowels are a well known technique to reduce this source of potential inaccuracy.

The cross bar simply requires two holes to be drilled and counterbored 8mm dia. at each end, the hole positions being determined from one datum edge. The part is then inverted, and counterbored 10mm dia. to house the heads of the M6 socket head cap screws.

The stop pins were turned from a convenient piece of free cutting bright mild steel, and sized to give a light press fit in

the cross bar. The hollow dowels were again from free cutting material.

## Inspection

Before committing to use, the accuracy of the assembly can be checked by locating the reference surface across the corner of a surface plate or on a parallel or pair of identical packs of slips. The height of the two stop pins is then compared with a DTI. If a significant error is detected, this can be overcome by turning down one pin to arrive at equal readings.

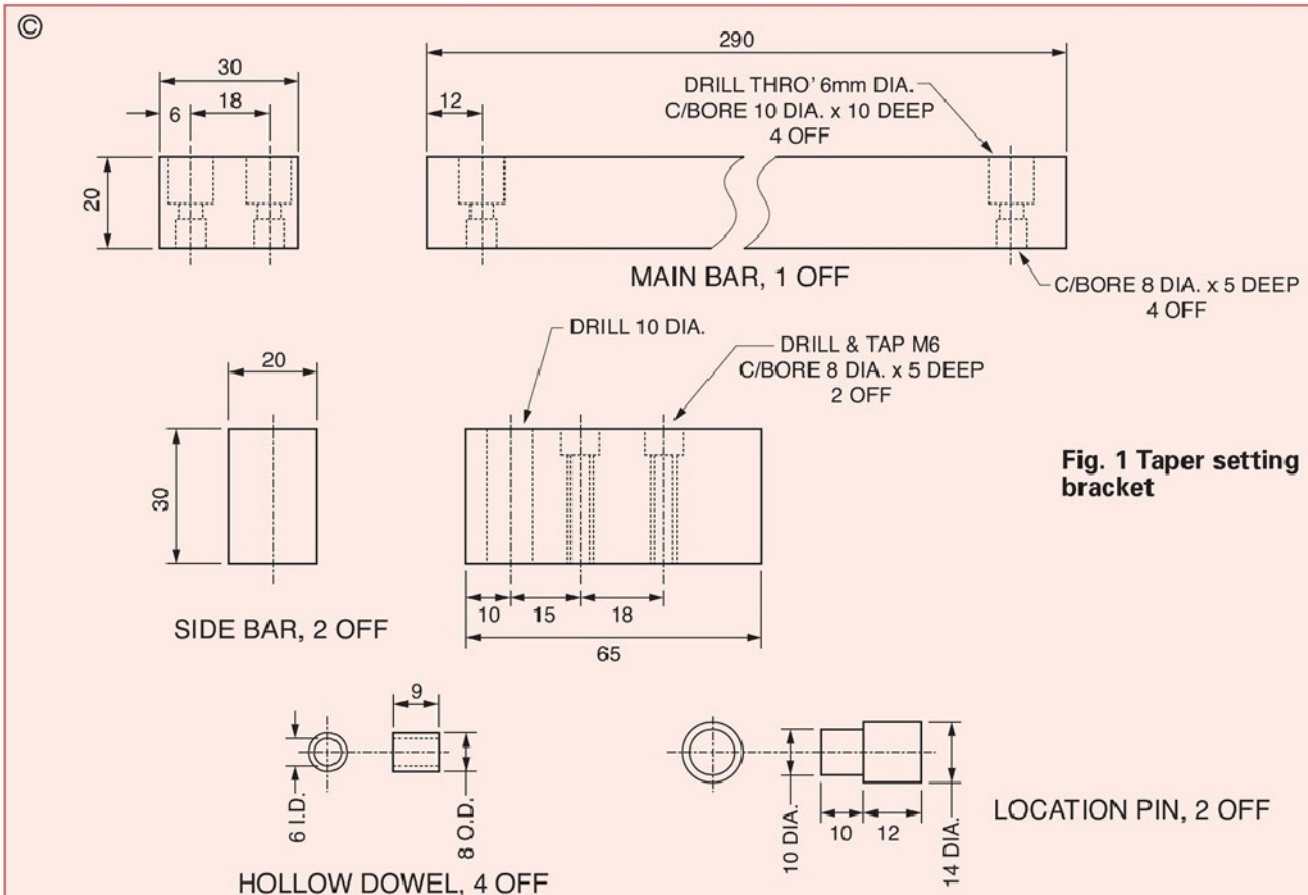


Fig. 1 Taper setting bracket



# Scribe a Line

## Fred Taylor of Auckland, New Zealand writes:

I have a 95 year old friend who I consider to be a "Master Machinist" - he commenced his apprenticeship in the late 1920's, I started mine in 1935, so you can see we have both been around for some time. The friend after retiring, set up a home workshop based on an old lathe he picked up. Made his own shaper and drilling machines, all high quality gear. For some reason he set and produced a number of shot guns, all complete with the traditional fancy work around the breech area and stock.

Now comes the point of this letter. He, my friend, bored his own barrels, 36inches long (maybe one should now say 914.4mm on his lathe working from 1.25 AF hexagon bar. I never had the privilege of seeing the boring being done, we were living in different cities at that time. I have seen him a number of times over recent years and in answer to my question "How

did you bore the barrels, he always gives the same answer - "I used a D drill" - he made up the equipment in his own shop.

Other people have commented that these guns had perfect bores, dead straight, complete with chokes, and honed to a perfect finish. As far as I am aware I have never seen or handled a D drill. My engineering friend has tried to explain but won't attempt a sketch so I'm still in the dark. I need help! Where can I obtain details, sketches etc. of D drills, - one never knows, I may need a "long" hole sometime in the future. Even so, with the details, I'd make one or two and have some fun drilling a long hole. You may agree, when the hair is white and you're fully outfitted with mechanical joints and hi-tech gear, spectacles, hearing aids etc. one is entitled to have a "play".

I have a pretty old Myford ML7 that is due for some more T.L.C. purchased about three years back. My background may be of interest - an apprenticeship on steam locomotives, nearly eight years on aero engines, (servicing, overhauls, flying WW2) seven years on heavy engineering plant, and then thirty years in a

manufacturing operation leading to retirement.

## John McIntosh writes:

Peter Shepherd might find the following data useful for his compensated pendulum. This has been extracted from the Design Data Book of a large engineering company, and applies in the range 70 to 100 degrees Fahrenheit. The units are inch/inch/degree Fahrenheit and should be divided by one million. Low Carbon Steel Mild Steel)

6.2

Medium & High Carbon Steels (.3% C & upward)

6.2

Carbon-Moly, Carbon-Mang, Cr-Moly, Steels through 3% Chrome

6.2

Intermediate Cr-Moly Steels, 5%-9% Chrome

5.9

Stainless Steel 12%-27% Chrome

5.4

Austenitic Stainless Steel

9.2

*Dave Fenner adds:*

*On this topic, thanks are also due to various other readers, notably Michael Green, John McCrone, Mr R H H James, Jim Wilks and to Roger Trewinnard who had come upon information gleaned from an up to date copy of Machinery's Handbook. This gives a great deal of information concerning the expansion coefficients of expansion for many materials. It is clear that nowadays, the range of stainless specifications is very extensive, and the coefficients vary widely. This underlines the need to know exactly what material you are working with when expansion is a critical issue.*

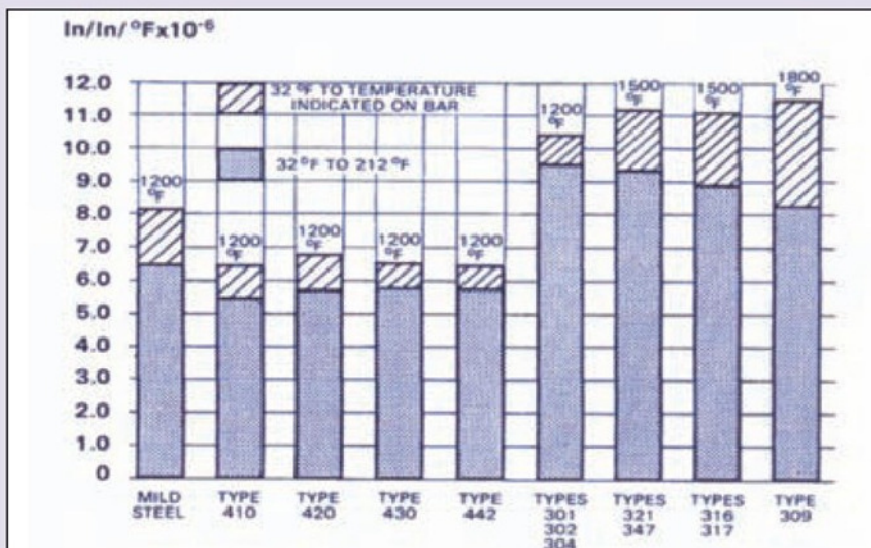
## Grant Notley writes:

In a recent edition of MEW, the question was raised regarding more detailed info on the expansion coefficient for stainless steels. The accompanying table is taken from an old but detailed descriptive catalogue put out by a Canadian based stainless steel company, probably in the mid seventies. Note that the coefficient itself changes with the temperature being considered.

For those who wish to look at this aspect in more detail, a good reference is the ANSI/ASME Piping Codes B31.1 and B31.3. These give the expansion coefficients for ferrous and non-ferrous metals from near absolute zero to a couple of thousand degrees, at reasonably close intervals. For those with a knowledge of spreadsheets, it is then quite easy, albeit somewhat laborious, to input the data, graph it and then fit an expression to the graph so constructed.

By averaging the expansion coefficient over the temperature range in question, this allows a more precise calculation of the expansion of any length of the particular metal.

I hope this is of some interest. If needed, I can be contacted by email to grant.notley@xtra.co.nz



## Amhlaoibh Hennessy of Dublin writes:

I note Mr. R.G. Munden's letter in Issue No. 108 of MEW, seeking information on the construction of Northumbrian pipes. The following may be of help.

**The Irish Bagpipes, Their Construction and Maintenance.** By Wilbert Garvin. 1978. Published by: Blackstaff Press, 255A Upper Newtownards Road, Belfast BT4 3JF.

This gives full details for the construction of a set of Irish pipes, commonly called Uilleann Pipes. These are more complicated than the Northumbrian pipe, as a full set has no less than eight pipes, each with its own reed, but the techniques of construction would be



similar, and I am sure that if Mr. Munden had access to a set of Northumbrian pipes he could work out a design with the help of this book. This book gives a reference to another, which sounds as if it would be helpful:

**The Northumberland Bagpipes**, Cocks, W.A. and Bryan, J.F., The Northumbrian Piper's Society, Newcastle Upon Tyne, 2d Edition, 1975

I wish Mr. Munden success in his project.

## Chris Fouweather writes:

Readers may recall that some time ago I gave details of the paper used in the toner transfer method, in connection with image transfer and etching. The company involved have sold it all around the world and contacted me to say that the product spec. had changed. They very kindly sent me a sample of the new product, which is as good as the previous one. The packaging has changed in that it now comes in packs of 500 sheets but they did indicate a willingness to split packs. This is service on a different scale to many companies. I have indicated below the ordering arrangements:

### Supplier:

CTS Direct, 102 Lowfield St. Dartford, Kent  
Tel 0870 442 2496  
sales@ctsdirect.co.uk

Product: 4CCA4120GL Gloss Laser 120g  
A4 paper  
Price: £13.49 + vat a pack of 500 - however they will split packs- no surcharge.

Delivery free on orders over £35.00+  
VAT within UK mainland - any goods.

Worldwide despatch no problem -  
quote given on receipt of client's address

## Albert Oldham of Manchester writes:

I was interested in the letter from Mr. Bert Coyle of Australia concerning the articles on building a screwcutting gearbox for the ML7 that appeared in M.E. during 1990/1991 by Alan Buttolph. The design of the above was based on L.H. Sparey's 1950 design, which appeared in the Model Mechanic magazine, it was an excellent design but suffered problems with casting supplies and didn't take off.

I purchased a full set of castings, gears and drawings from Garners of Barnsley in 1951- I still have them and must get round to making it some day! Though having a Super 7 with gearbox puts this job on the back burner, as our American cousins would say. The 1990 gearbox was marketed by the original Hemingway of Rochdale, he also supplied castings and drawings: The new Hemingway of Shropshire who advertises in our magazines may do so but I have not yet seen it mentioned.

So for Mr. Coyle the information is in those 1990 ME articles for the modified Sparey design. I doubt if it would be suitable for a 6.5in. lathe but you never

know with model engineers, do you!

*Editorial comment: Hemingway can still supply a casting for this gearbox, contact Kirk Burwell at Hemingway on 01746 767 739 for more details.*

## Michael Gilligan writes:

Frank Campbell (Scribe a Line - MEW No. 110) is looking for low cost shaft encoders. May I suggest that he investigates the internals of the older-style computer mouse. There are numerous web sites offering advice, a few of which are listed below:

<http://www.luberth.com/plotter/pmdro.html>  
<http://www.seattlerobotics.org/encoder/200311/johnson/Mousebot.html>  
<http://www.amsky.com/atm/accessories/mouse/mouse.html>  
<http://www.labyrinth.net.au/~steve/opto/>  
[http://www.ultrasmart.org/CTLplus3\\_mLogicEncMseSer.html](http://www.ultrasmart.org/CTLplus3_mLogicEncMseSer.html)  
<http://www.doug-smith.net/kf6dx7.pdf>

So far as I am aware, the cheapest commercial encoders are from:  
<http://www.usdigital.com/>  
Hope this helps

## Ted Wale writes:

I have often idly wondered how a Slocombe drill works. In North America it is called a center drill. (That's right, they can't spell "centre" either). As we all know an ordinary twist drill, if offered to a flat piece of metal, hunts around to get purchase as the chisel point tries to make a starting mark and it then drills a hole anywhere within the flexing circle of the drill and/or its mount.

I decided finally yesterday to ask "Why". If I place a Slocombe drill in the tailstock of my lathe (or in my vertical drilling machine) and offer it up to a workpiece it does the opposite. It may move in a little circle at the start if there is play in the tailstock as there often is without the tailstock lock being applied. However very rapidly it hunts to the true

centre and the wobble is removed.

Examination of the tip with it's very different flutes shows that it is clearly not the same as a twist drill but it doesn't explain (to me at least) how these flutes cause it to hunt to the true centre before it has done more than scratch the workpiece; I expect that it is the same effect that causes it to adhere to even the lightest centre pop.

Could some knowledgeable reader, or perhaps a member of our helpful drill suppliers, give us a clear explanation of this clever device?

## Mr P M Antrobus writes:

With reference to Peter Rawlinson's Article on resistance soldering.

Micro-Mark, a well known supplier of tools and equipment for model makers in the United States have two resistance soldering tools in their catalogue. Being purpose designed for the job, these tools appear to be better suited to much soldering small photo-etched parts than the various expedients described in the above article.

Micro-Mark list a number of small tools that do not appear to be available in this country and I have found them most useful.

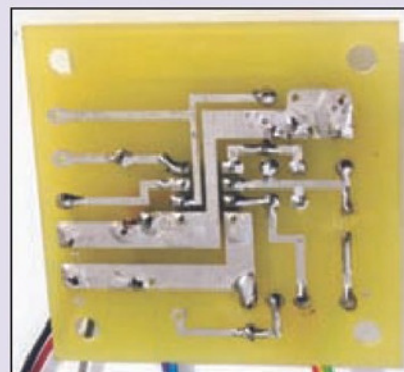
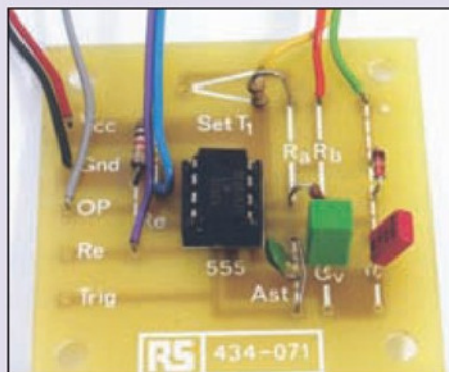
Micro-Mark's address is:- 340 Snyder Avenue, Berkeley Heights, NJ 07922-1595, United States

## Peter Rawlinson writes:-

Since writing up my experiments on resistance soldering, other readers have been in touch to let me know of commercial products, which are available. Micro-Mark in the US have equipment ranging in price up to about \$450 -00, while in this country the "Graskop" device seems to have been a well kept secret amongst model rail enthusiasts. It costs about £95.00 and is available from: **Dick and Simon Ganderton**, Graskop, Dewlands Road, Verwood, Dorset, BH31 6PN

## Ted Fletcher writes:

Readers may be interested in a further use for the RS board for use with the 555 chip, mentioned in an earlier letter. The accompanying photos show it together with two resistors, two capacitors and a piezo sound transducer. Powered by a PP9 battery, this makes a useful home/workshop continuity tester all for about a pound.





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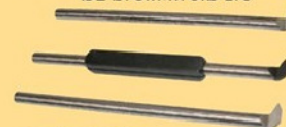


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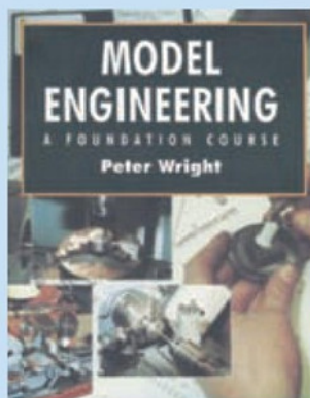
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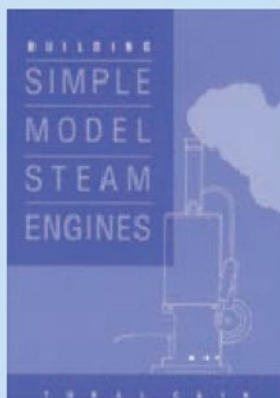
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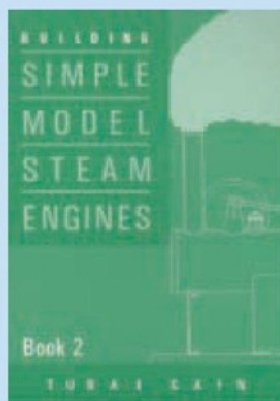
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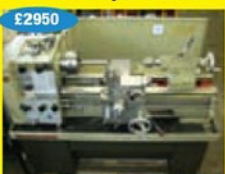


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