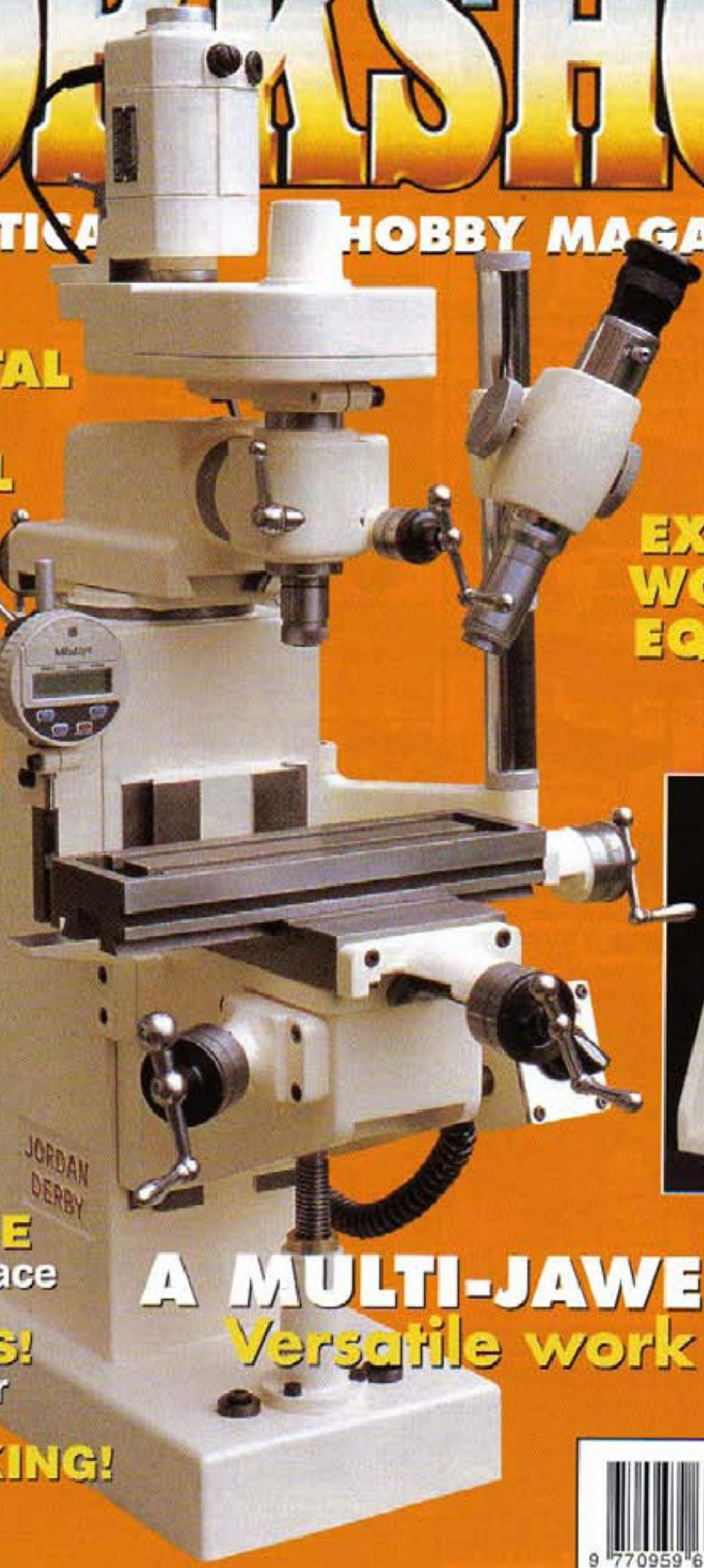
No.61

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE



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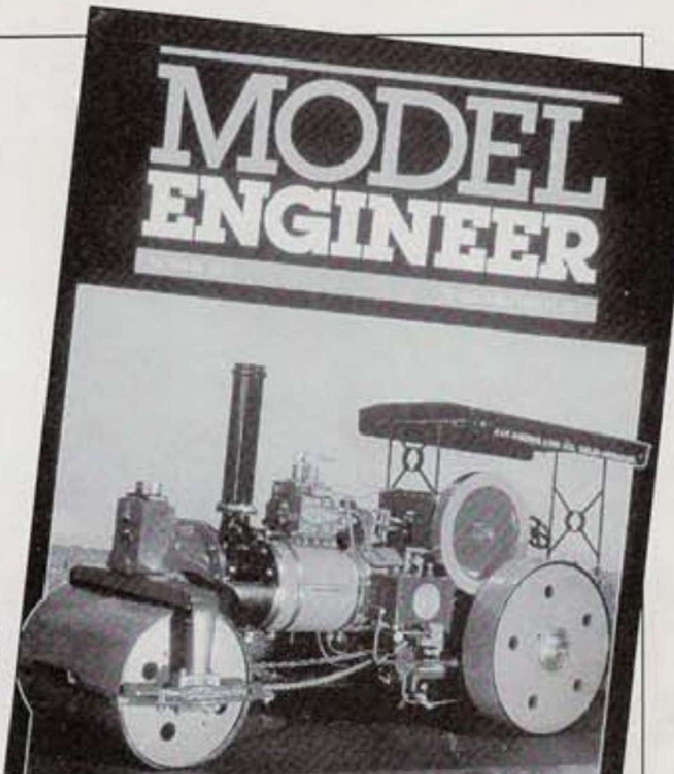

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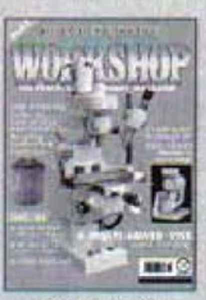

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On the cover

Barry Jordan's recent projects have been scale models of full size machine tools. Recently completed, this small vertical milling machine has been created to do a serious job of work - the manufacture of components for even smaller models. It will be on display at the International Model Show at Alexandra Palace in December

This photo shows that Barry has been producing small machine tools for quite a time now, this small lathe having been built some forty years ago!

ON THE EDITOR'S BENCH

With the model engineering exhibition 'season' fast approaching, I am pleased to have persuaded regular exhibitor Dr. Peter Clark to reveal some of his secrets on how to display items of tooling and workshop equipment to advantage. Peter's notes begin on Page 25 of this issue.

Details of a number of the major exhibitions to be held between now and May 2000 are now coming to hand, so I include some of them here so that readers wishing to attend or exhibit can take action in good time. There are usually discounts to be obtained on ticket prices by purchasing them in advance and it is often possible to take advantage of favourable travel rates by booking early.

Traditionally, the first major event of the series to take place is the Midlands Model Engineering Exhibition which is sponsored by our respected contemporary 'Engineering in Miniature'. It will again take place at the International Exhibition Centre, Donington Park near Derby, the dates this year being 16th to 21st October. Literature supplied by organisers, Meridienne Exhibitions indicates that the format will follow that established at the venue over recent years, with all the familiar features.

For those whose primary interest is boat modelling, Meridienne are also organising an International Model Boat Show, this time at the Warwickshire Exhibition Centre at their Fosse Way, Leamington Spa headquarters. This will take place on 12th - 14th November. Further details of both events can be obtained from the address given in their advert on Page 9.

Next in the chronological order comes our own International Model Show, which of course has its roots in the well known Model Engineer Exhibition, which will take place for the 69th time this year, once again as a 'show within a show'. As mentioned before, the exhibition will be returning to its former venue, Alexandra Palace in North London, and will take place between 5th and 12th December.

The Brighton Centre has made contact to let us know that, contrary to rumour, their annual Modelworld exhibition will take place next year, from February 18th to 20th. For further information, please contact Wendy Walton at the Brighton Centre on 01273 292646 or Derrick Rebbetts on 01444 235748.

At a slightly later time than usual, the National Model Engineering and Modelling Exhibition will be staged at the Great Yorkshire Showground, Harrogate, from 11th to 14th May 2000. With a promise of a doubling in size of the available accommodation, Exhibition Director Simon Boak and Exhibition Manager Lou Rex will have the opportunity to put on a most impressive event. I will publish more details when they come to hand.

In addition to the major events listed above, there will be many local club and society exhibitions which are well worth visiting. It is not M.E.W. policy to publish a running diary of such events, as this is well covered by my colleague Mike Chrisp in Model Engineer magazine, but if there is anything of particular note which comes to my attention, I will try to find space to mention it.

Returning to the International Model Show and Model Engineer Exhibition, I am told that entries have already been received in significant numbers, so I will bring news of them in the two issues of M.E.W which are due to be published between now and the opening date. I have again included a copy of the entry form and a list of the more engineering oriented classes, a full list being available from the Swanley office. If you do not wish to take a pair of scissors to your copy of M.E.W., then a photocopy of the entry form will be quite acceptable. I would ask that you make your intentions known, especially if you wish to make use of the collection service.

When attending events around the country, I try to gather readers' views on such matters as the IMS and have been intrigued by comments that the exhibition 'isn't what it used to be". This prompted me to look back to the first one which I attended, which took place at The New Horticultural Hall, Westminster in August 1951 (Festival of Britain year). The much heralded attraction was the Miniature Grand Prix track which brought, for the first time, multi car racing using a single guide rail for each vehicle. At an invitation race, celebrity 'drivers' included Reg Parnell, Stirling Moss and Bob Gerard, while the commentator was none other than Raymond Baxter! All the cars were commercially built and used a patented guidance system, the components for which could only be obtained from the patentee. In concept, if not in the level of technology, this was little different to the r/c car track we see today, so why should the latter be thought by some not to be within the scope?

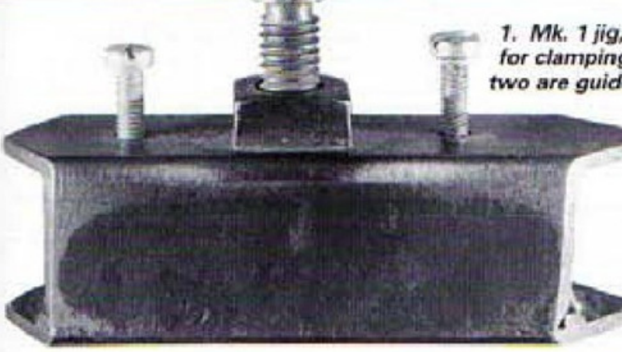
Ship models were present in impressive numbers, resulting in a daily paper reporting the event as the *Marine* Exhibition! As now, a large water tank had been installed for marine demonstrations, with control by radio and underwater sound. On the flying side, a jet-driven helicopter "took off, soared higher and higher and wrecked itself against one of the hanging lamps". A disappointed exhibitor was the owner of a 12ft 6in. long radio controlled airship, which was to have flown daily. Unfortunately the authorities decreed that the risk of fire in the event of a mishap was too great, so the demonstrations were called off. These days, Ron Moulton's lighter than air devices provide a popular spectacle.

The point I am trying to make is that the majority of the things we see these days were already included in the exhibitions of the 1950's. Even such things as military modelling diorama, plastic figures and robots were a part of those Wembley exhibitions of the 'seventies which many refer to as a 'classic' era of the M.E. Exhibition. Perhaps it was because these classes were displayed in separate rooms, some visitors considered them to be 'out of sight, out of mind'.

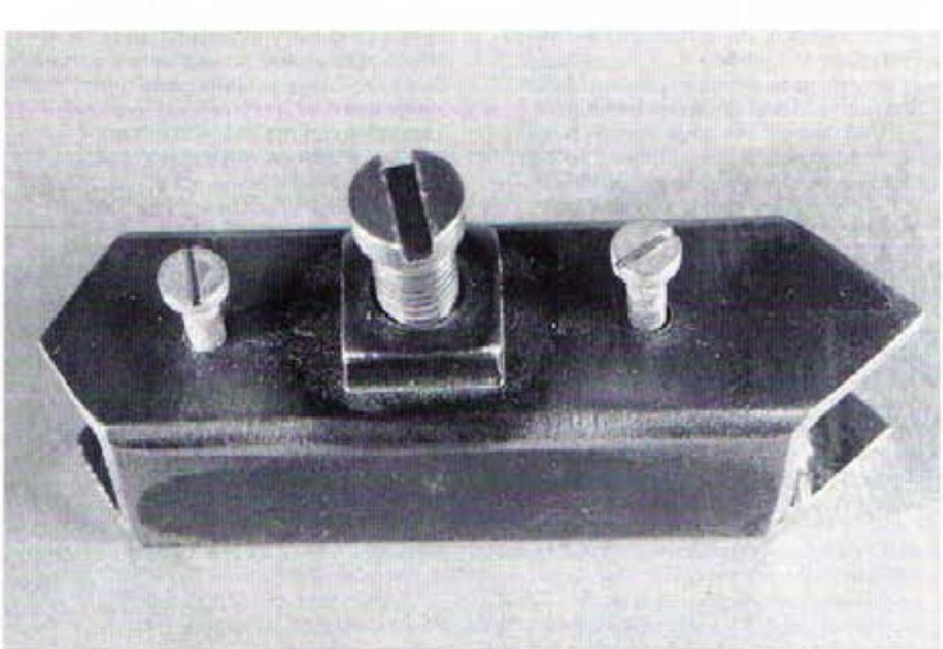
What I feel has happened is that the disciplines which some visitors consider not to be 'pure' model engineering have expanded greatly while the engineering side has suffered a modest decline. Certainly, much more money is being spent on these other aspects of the hobby. An entry level radio controlled helicopter can cost as much as a reasonably well equipped Taiwanese centre lathe or milling machine, and will not last nearly as long! What today's exhibitions do offer is a fascinating range of items of interest to anyone who is mechanically minded and willing to investigate things outside their usual subject. Interestingly, 'Smoke Rings' of the Model Engineer dated 18th October 1951, under the heading 'Tolerance' quotes the following item from the newsletter of a West Country Society ".....Our society tries to cater for a variety of interests from 'OO' railways to 5in. gauge live steam locos, from microscopes to traction engines. One cannot expect the 'OO' enthusiast to go into raptures over a Burrell scenic road loco, or the builder of a marine engine to enthuse over model architecture, but it is not difficult to appreciate the craftsmanship in any of these subjects. We should, therefore, be tolerant of the other fellow's efforts, even though we are not ourselves interested in his branch of the hobby. Personally, I admire the builder of any model, provided he puts his best efforts into the work and makes the best job he can of the model."

SIMPLIFIED DRILL GRINDING

Alan Bourne and Gordon Read decided to investigate drill sharpening from first principles. Their research gave them a new understanding of the requirements and led to the development of the simple jig which Alan describes here.



1. Mk. 1 jig, side view. The centre screw is for clamping the drill in position. The other two are guides for the clamp plate



2. Mk. 1 jig, top view

Sharpening drills tends to be a problem for some folk. Easy to see why. The surfaces of the 'business end', as bought, are parts of conical surfaces with axes offset from the axis of the drill. Not the easiest shape to reproduce, especially when both surfaces have to meet precisely on the axis of the drill. Some can grind them near-perfect by hand, but most cannot.

Over many years, various grinding jigs have been designed; some sold as commercial items and some published for making as 'one-offs'. Apart from the 4-facet method, all have attempted to reproduce the as-new shape of the drill end. This got us thinking; what are the real requirements for a drill to cut well and have a reasonable life before re-sharpening? Our investigation started from scratch; in other words, we 'drew a line' across everything we had heard and read to date.

Stage one was to dip a 3/8in. drill in layout blue, allow it to dry, and drill a hole in a bit of alloy held in the chuck; the drill being in the tailstock. Examination of the drill afterwards showed bright steel as a thin line across the chisel point and along the cutting edges of the facets. The 'reamering' spiral surfaces along the sides of the drill were also bright, naturally.

What did that tell us? It said that the only parts of the drill which touched the workpiece were those thin bright lines. Put another way, most of the drill facet surfaces never touched the workpiece. That being so, the exact shape of those non-touching surfaces was relatively unimportant. Lesson No. 1 to be applied!

Next came the question "How can we devise an easy way of grinding the 'bright bits' to be correct and at the same time have the rest of the facets not touching the workpiece, plus being strong enough to support the cutting edges?". The answer came with the realisation that very small drills are ground, as new, with those surfaces flat. In other words, single-facet grinding. That decided us; experiment was the obvious next step.

Another drill about 3/8in. diameter was ground with flat facets. The result looked a bit peculiar, as the line where the facets met the sides of the drill appeared a bit concave. Still, press on! The drill was tested as that first one, and it cut perfectly, except that the grinding was not as accurate as it should have been. One curl of swarf was thicker than the other. That was down to the fact that the grinding had been done freehand: even so, the difference was not large.

This was the decision point; make a jig which would do that sort of grind and which would be easy to make and use, plus have the ability to 'put the centre in the middle'. Out of the workshop and into the drawing office. Eventually, a design emerged and a Mark 1 version was made and tried.

The jig consists of two items; a holder for the drill and a strip fence on the tool rest of the grinder. **Photo. 1** shows the result; a square tubular holder for the drill, which has the end pointed at 118 deg. That angled end slides against the fence. The drill is clamped in the tubular holder with the chisel point at the correct angle, and the whole is drawn across the wheel to produce the flat facet. It worked fine, but had the snag that the screw clamping the drill prevented it from being turned over to do the second facet without shifting the drill. Still, it served its purpose in showing that the idea would produce the single-facet grind required.

The next stage was to develop this into a Mark 2 model to overcome that limitation. A recess method of clamping the drill was duly designed, the prototype made and found to work as required. It's now, as far as we are concerned, a standard workshop tool, used without a second thought.

Before we get into construction, a few words to the purists! The traditional drill-grinding methods and shapes work well and have done so for many years; we don't deny that. It may be that they have great advantages in production-line use as regards strength and so on. However, for

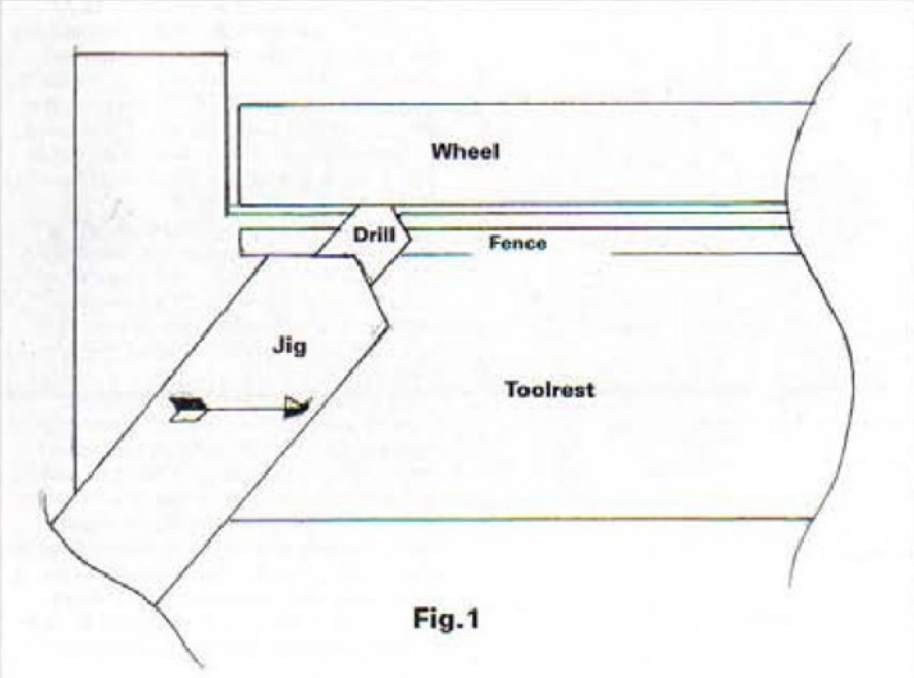


Fig.1

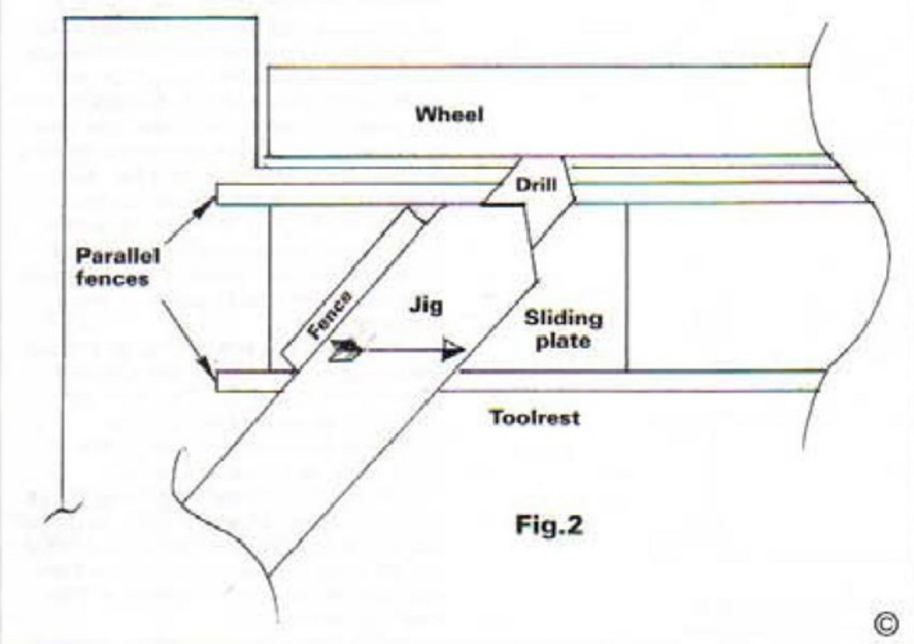


Fig.2

our sort of use, a single facet grind does just as well and is so much easier to produce. What we claim is that single facet sharpening is the easy way to keep drills cutting well in our sort of workshop and that we have proven it in practice. We don't doubt for a moment that someone somewhere will be able to demonstrate that our method has disadvantages in theory. In this context, we would recall a remark made by Laurence Pomeroy when he was a director of Vauxhall Motors before General Motors bought them. He said "If an improvement requires instruments to detect it, it's probably not worth having".

Construction

General

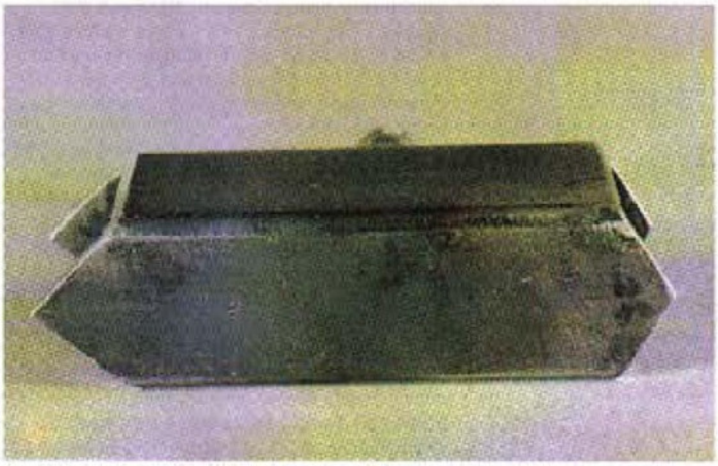
Most of the work is 'bench and hand tools' plus drilling. One bit of silver-soldering is called for: at a pinch, soft solder could be used. Material is all mild steel sheet, apart from a short length of $^3/_4$in. square mild steel tube, the sort of thing used for the legs of light tables and so on, so there may be a source of scrap which can provide it. If what you obtain isn't exactly $^3/_4$in., it doesn't matter much; slightly larger tube could be used with slight adjustments to the dimensions of other parts.

Two screw threads are used, 0BA and 6BA. US readers can substitute $^1/_4$ x 28 for 0BA and 4-48 for 6BA. Metric near-equivalents are M6 for 0BA and either M2.5 or M3 for 6BA.

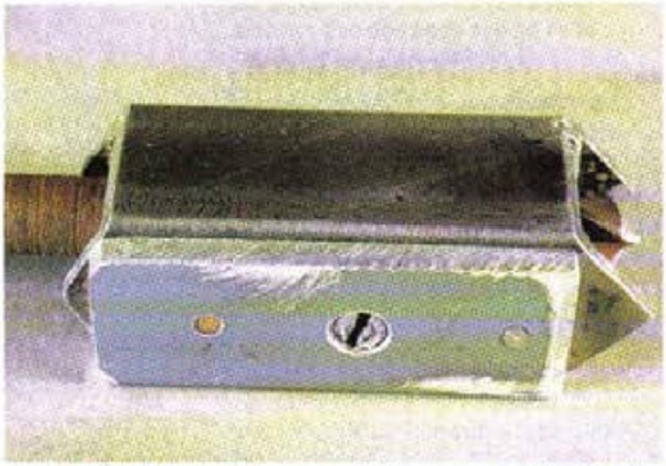
Detail

The drawings show all parts, itemised by numbers which will be used in this text as references. Start with Item 1, the jig body. Clean up a length of square mild steel tube, and mark it out for the holes and the pointed ends. One end is pointed at 118 deg. for standard drill-grinding, while the other is at 90 deg. to allow grinding a drill for use when countersinking.

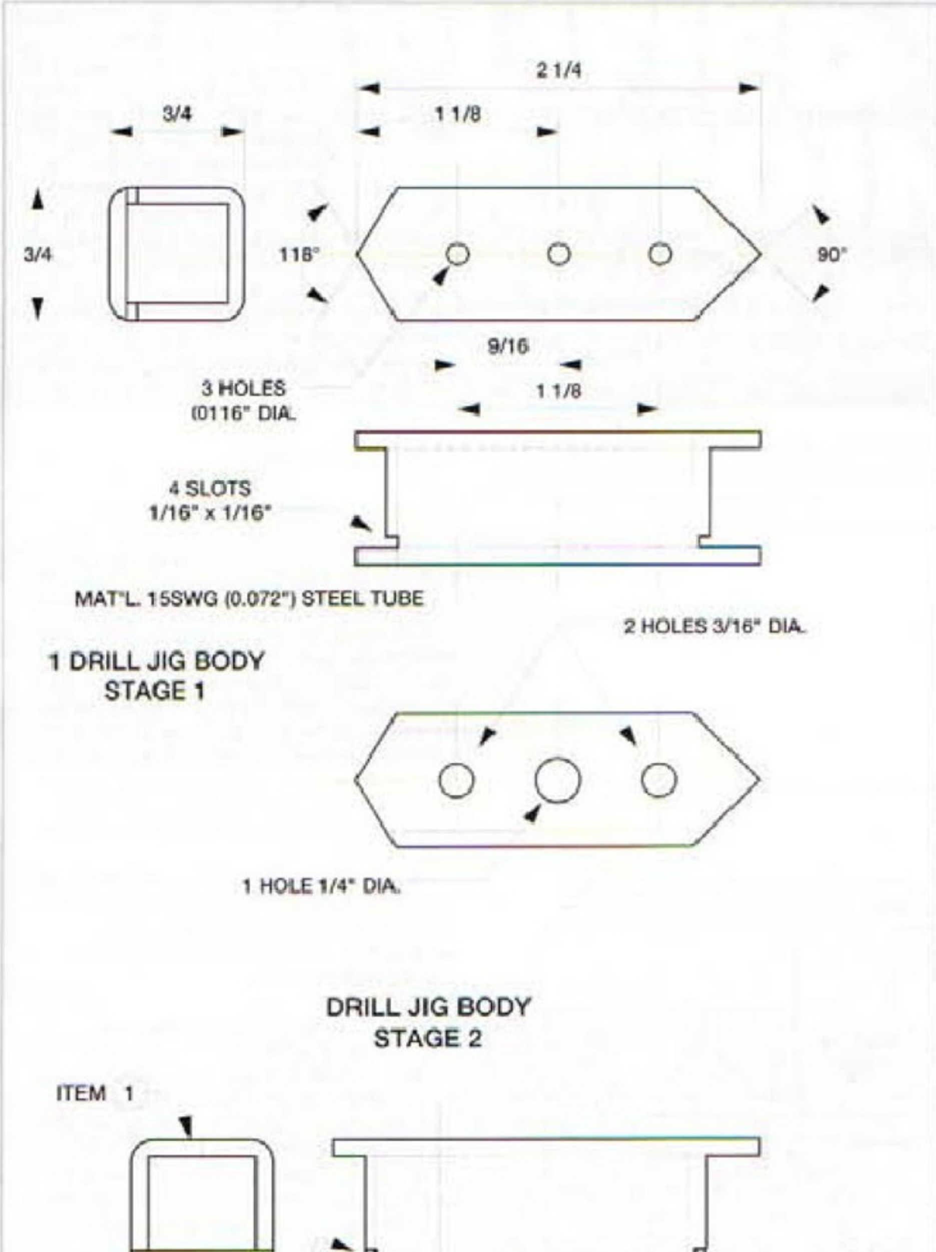
If hand tools are used, ensure that the ends are filed dead square to the axis of



3. Mk. 1 jig, underside. Note the different angles at the two ends, one for drills and the other for countersinks



4. Mk. 2 jig showing the recessed clamp screw and guide pins which allow the jig to be turned over. This removes the need to re-set the drill position in order to grind the second facet. The drill shown is a near-scrap one which was successfully resharpened



the tube, and with their 'points' dead central. Folk with milling machines will no doubt prefer to shape the ends on that machine. The 1/16in. slots are not critical in respect of cross-section. They are to take two bits of thin rod (thick wire?) soldered in place. Inch, or 25mm, nails are usually about 1/16in. diameter and provide the ideal material.

Having made the jig body, including drilling, cut the two lengths of 1/16in. wire and either silver-solder or soft-solder in place. Silver soldering is the preferred method, but soft solder will do the job if your facilities are really limited. You now have Item 2.

Items 3 and 4 come next, one from 1/16in. sheet and one from 1/8in. material. Item 4 has to be the same as the side of the jig body, so check your filing or milling against that. The three holes in each of the two items have to match up, so either make one and spot through to the other or drill the two together while stuck with something like cyanoacrylate adhesive. Come to that, the two items could be soft soldered together for drilling and then melted apart.

Fit Items 3 and 4 to the jig body with two 6BA countersunk screws. This is a permanent attachment, so Loctite 601 or similar can be used on the screw threads. Make sure all is pulled up tight, Item 3 being on the inside of the square tube and the screws inserted from inside the tube. Give the inside surface and screw heads a lick with a file to ensure all is flat, and remove excess screw lengths on the outside. Finally, tap the centre hole 0BA.

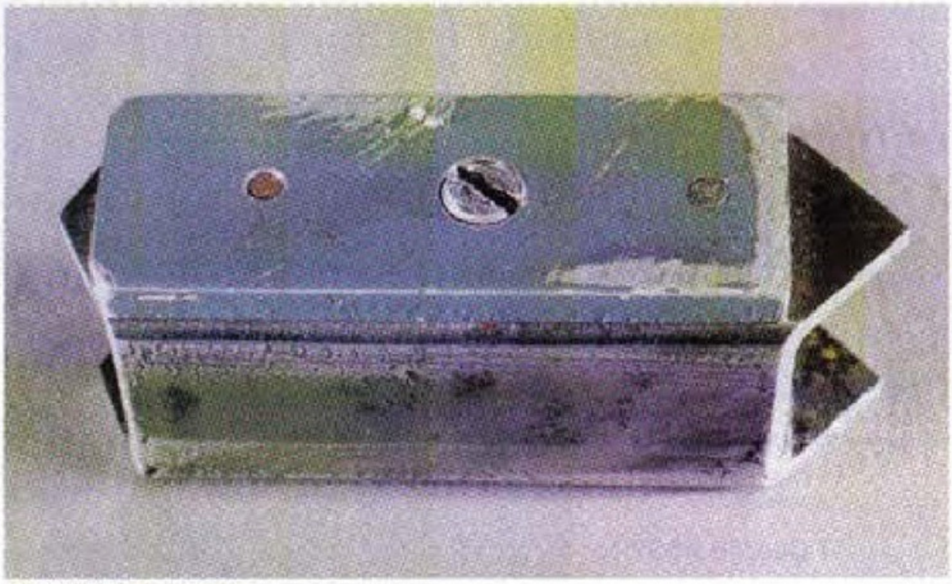
You now have the body of the thing complete, and can paint it if you so desire. Now for the various loose parts which complete the tool.

The jig clamps the drill to be ground between two steel rods and a clamp plate (Items 5 and 10). The rods are easy; just lengths of BMS of the appropriate diameters. If available in your stock, so much the better; otherwise it's a matter of turning those you don't have. Check lengths so that all are a nice fit between the two fences in the jig body; no accuracy needed here because all that really matters is that they are not too long.

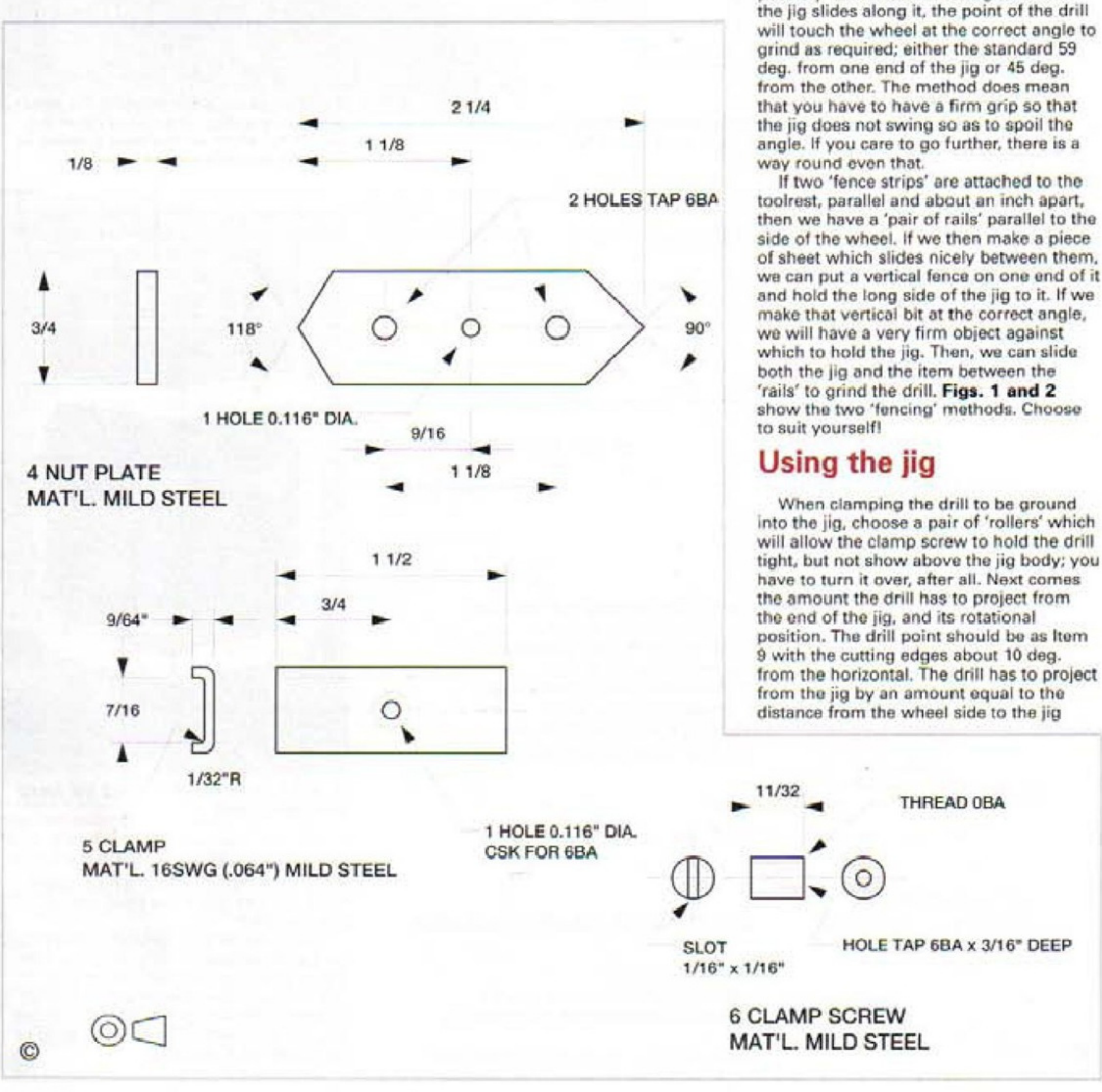
Item 5, the clamp, is a simple flanging job from 1/16in. BMS strip with a countersunk 6BA clearance hole in the middle. The flanges are vital to keep it stiff enough to do its job. This item has to be able to be forced against the drill by a screw thread, which is the purpose of the countersunk hole in it.

Items 6 and 7 come next. Item 6 is a threaded bush, 0BA outside and 6BA inside. It has a slot across one end, which can be made with two hacksaw blades in the saw frame at the same time. That slot is what engages with a screwdriver to clamp the drill to be ground. Here we have to do a crafty bit of assembly with Loctite, without sticking everything to Item 5.

The first task is to shorten a 6BA countersunk screw to 1/4in. long. Then make the double-threaded bush (Item 6). With that done, Item 6 has to be secured to Item 5 by the 6BA screw. The screw has to be fixed in Item 6, but the screw and Item 6 have to be able to turn in Item 5. In other words, the Loctite must not stick either the screw or Item 6 to Item 5!



5. Mk. 2 jig, top view



Assembly

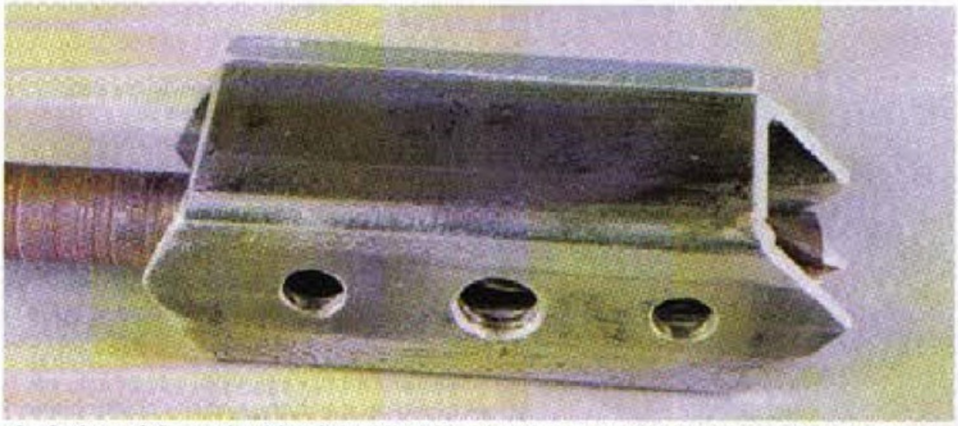
To assemble the jig ready for use, slide Item 7 inside the jig body so that the 0BA thread on Item 7 aligns with the threaded hole in Item 8. Using a screwdriver through the centre hole in the other side of the jig body, engaged in the slot of the countersunk 6BA screw head, screw the threaded bush (Item 6) into the jig body; i.e., into Item 4. This will secure the clamp assembly into the jig body. As an aside, it has been found in use that a thin piece of either leather or hard rubber can, with advantage, be glued on the surface of the clamp plate; it tends to give a stronger grip on the drill which is to be ground.

The final job is to fit a fence to the toolrest of your grinder. The idea is that the jig is slid against that fence, which is parallel to the side of the wheel. The basic fence is just that, a length of strip steel, possibly 1/8in. wide. If the angled end of the jig slides along it, the point of the drill will touch the wheel at the correct angle to grind as required; either the standard 59 deg. from one end of the jig or 45 deg. from the other. The method does mean that you have to have a firm grip so that the jig does not swing so as to spoil the angle. If you care to go further, there is a way round even that.

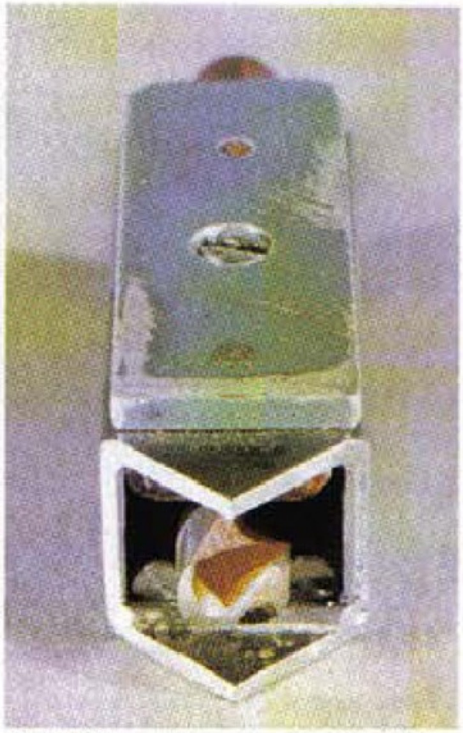
If two 'fence strips' are attached to the toolrest, parallel and about an inch apart, then we have a 'pair of rails' parallel to the side of the wheel. If we then make a piece of sheet which slides nicely between them, we can put a vertical fence on one end of it and hold the long side of the jig to it. If we make that vertical bit at the correct angle, we will have a very firm object against which to hold the jig. Then, we can slide both the jig and the item between the 'rails' to grind the drill. **Figs. 1 and 2** show the two 'fencing' methods. Choose to suit yourself!

Using the jig

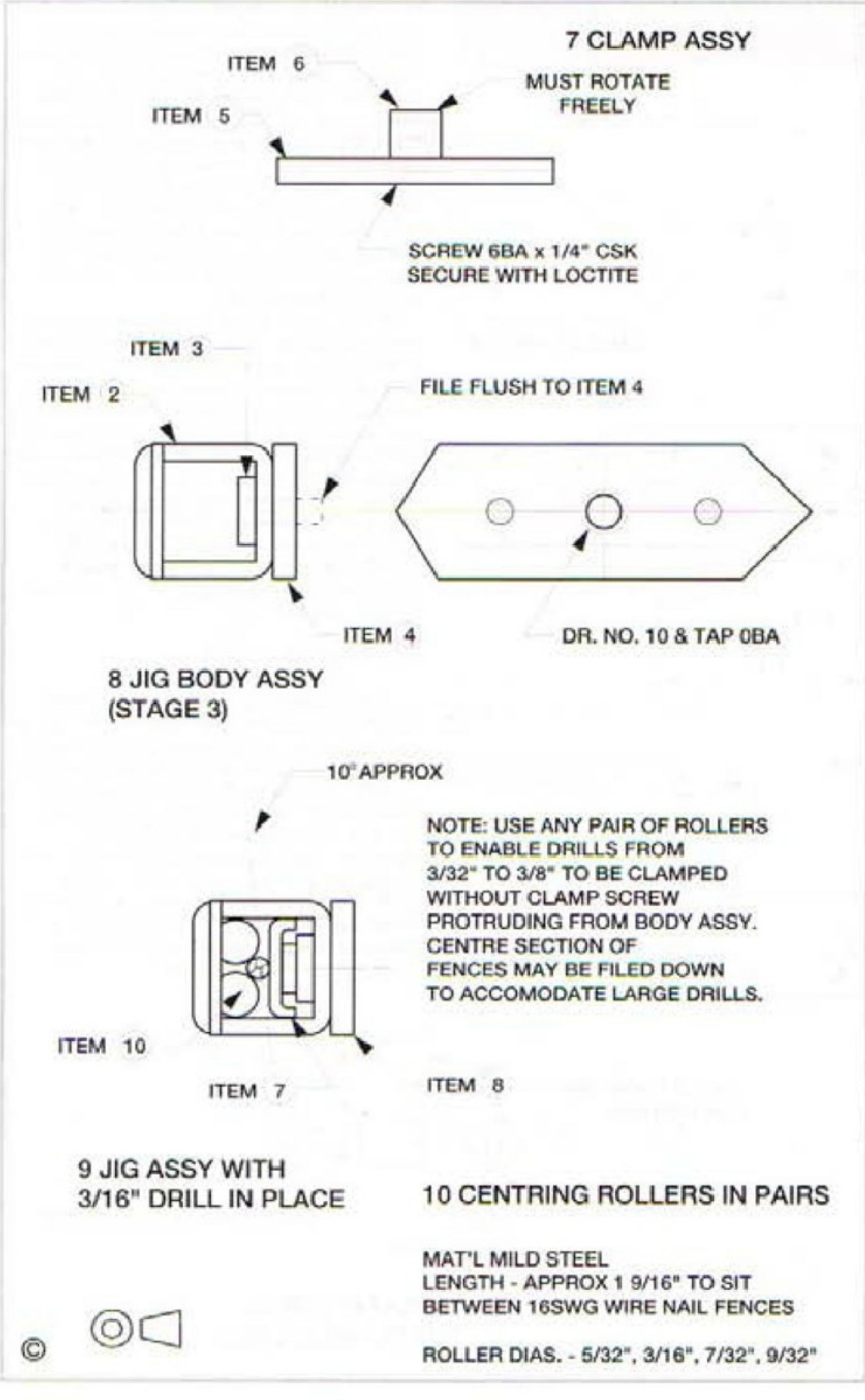
When clamping the drill to be ground into the jig, choose a pair of 'rollers' which will allow the clamp screw to hold the drill tight, but not show above the jig body; you have to turn it over, after all. Next comes the amount the drill has to project from the end of the jig, and its rotational position. The drill point should be as Item 9 with the cutting edges about 10 deg. from the horizontal. The drill has to project from the jig by an amount equal to the distance from the wheel side to the jig

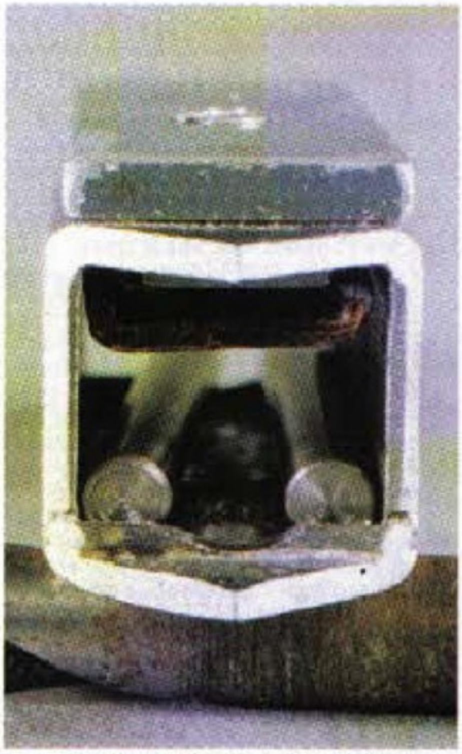


6. A view of the underside of the Mk. 2 jig, showing the three holes used for the initial assembly of the jig



7. Mk. 2 jig end view showing the drill in place for grinding. The end of the drill shows the effect of minimum grinding to produce the ability to cut metal





8. Mk. 2 jig end view showing the clamp plate and rollers

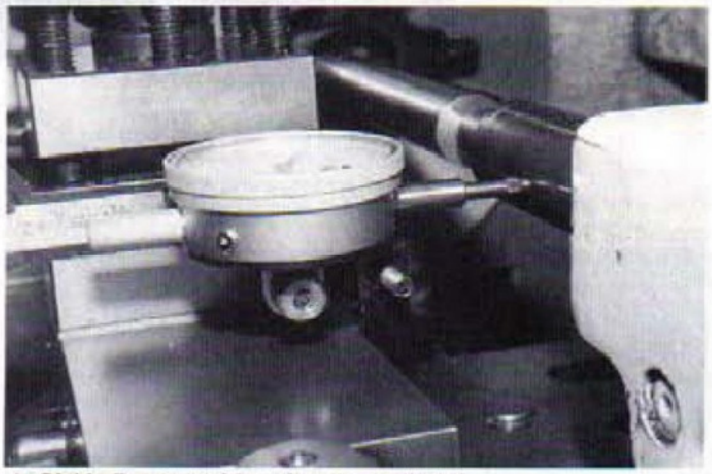
body plus about ten thou. or so for grinding. A fine grit wheel is best, unless the drill is one which has been abused beyond belief.

The jig can be used without a fence if you have a steady hand. If you do that, have the drill projecting about 1/16in. from the jig.

One final point; grinder sparks do a lot of harm to the lenses of spectacles, so use goggles over them. Come to that, goggles are a good idea anyhow.

TURNING PARALLEL

One of the most frequently encountered machining operations is the turning of a parallel cylindrical shape. Philip Amos gives some hints as to how this may be achieved with a greater degree of certainty



1. Dial indicator positioned against tailstock

The principal uses for a lathe are to turn cylindrical shapes, to face plane surfaces, and to cut threads. This article relates to the former activity; while it is sometimes desired to cut tapers on parts, more usually the intention is to cut parallel.

The capability of the operator to do this depends, among other things, on

(i) the accuracy of manufacture of the lathe
(ii) its installation
(iii) its adjustment
(iv) the technique used.

The home workshop practitioner can do little about item (i) which is determined for him when he purchases his machine. He must rely on the manufacturer's reputation, together with any quality inspection material provided, usually to Schlesinger standards - see Reference 1. My Taiwanese lathe came with such a report.

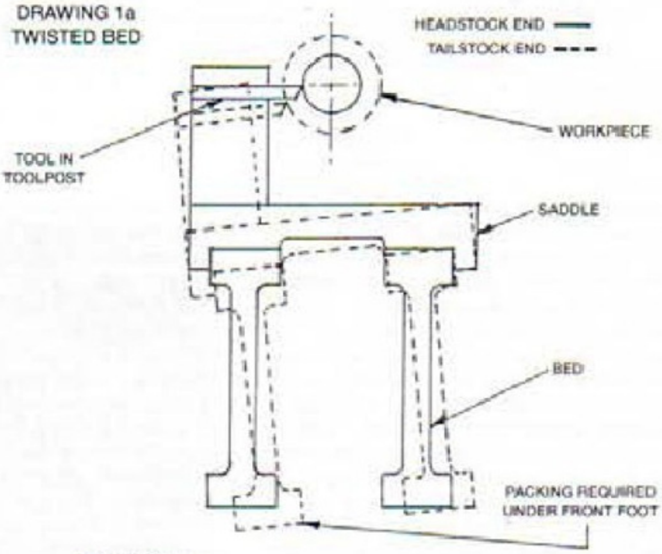
It is important, when installing a lathe, that it is level in both horizontal directions, and an engineer's precision level should be used to check this. If one has a lathe with inverted V ways, there is usually one flat way for the tailstock, so checking lengthwise is not a problem. Crosswise on such machine is difficult to do directly unless one assumes that the flat tops of the Vees are machined accurately to a common height. Indirectly, the level may be applied to the machined top surface of the cross-slide, which probably gives a fair result.

It is also important that the bed is not twisted when it is bolted down - **see Drawing 1a.** This can be checked by setting a cantilevered piece of (say) 1in. diameter steel bar (say) 6in. long in the self centring chuck and machining short lengths at both ends with the same cross-slide setting, as in **Drawing 1b**, then measuring their diameters. If the outboard end is larger, some packing is required under the front bed foot at the tailstock end; if smaller the packing is required under the rear foot (see Reference 2).

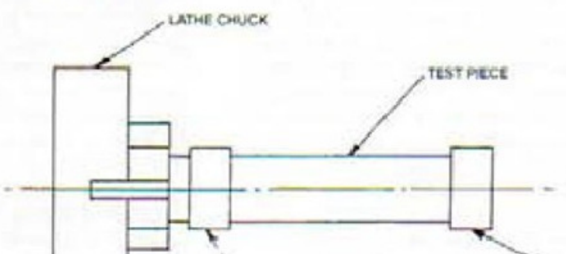
Normal workshop grade micrometers are calibrated to 0.01mm and settings can readily be estimated to about ⅓ of the gap between graduations - say 0.003mm (or just over 0.0001in.), so parallelism of a job can be assessed to quite fine limits, and with consistent readings using the ratchet knob. For this sort of accuracy, turning between centres is probably the only way to go.

A skim of the soft centre in the headstock

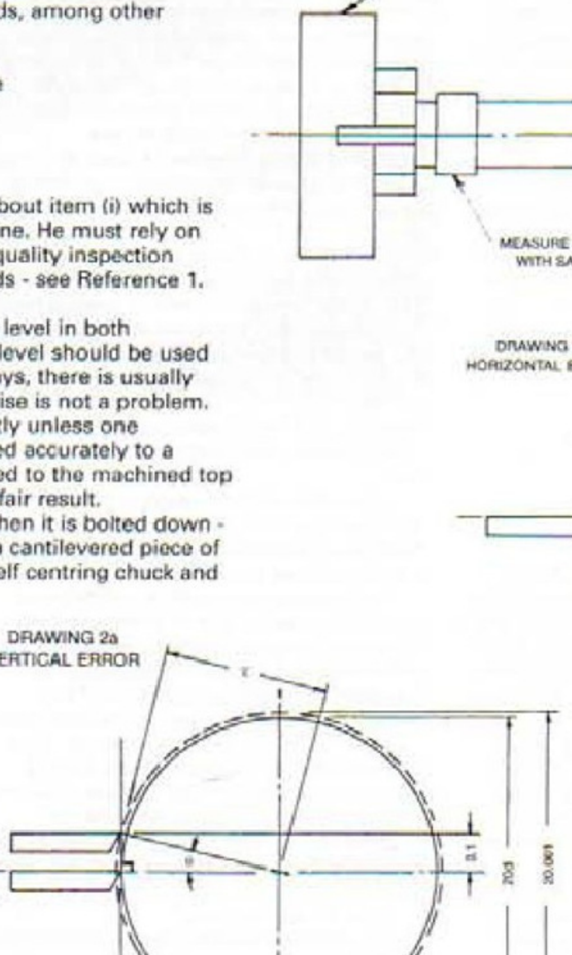
DRAWING 1a
TWISTED BED



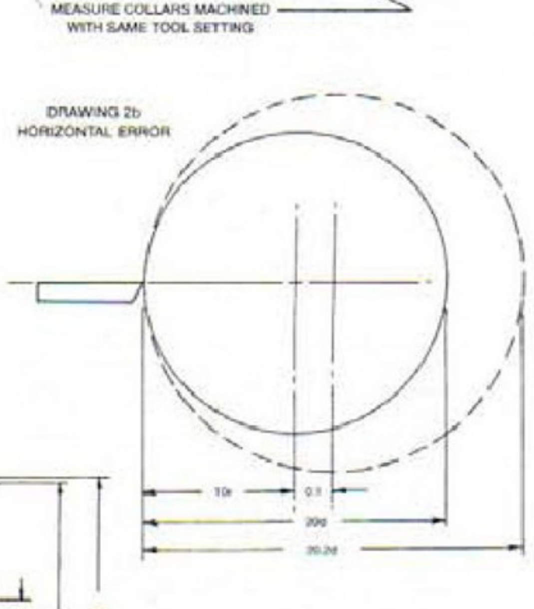
DRAWING 1b
CHECKING FOR TWIST

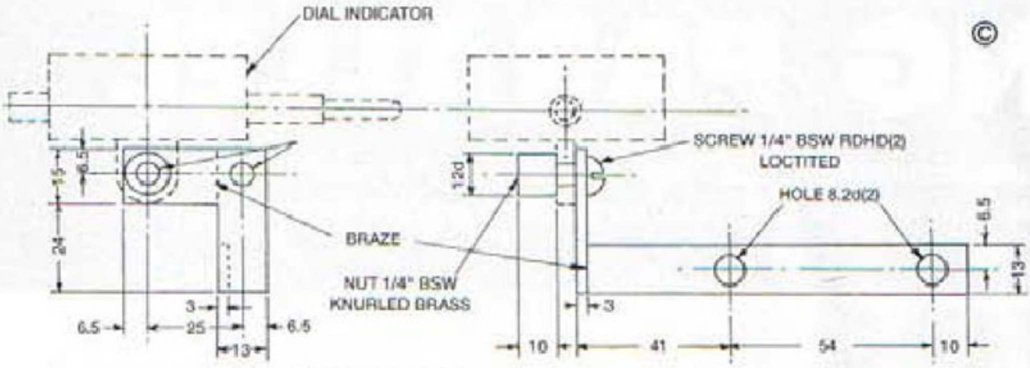


DRAWING 2a
VERTICAL ERROR

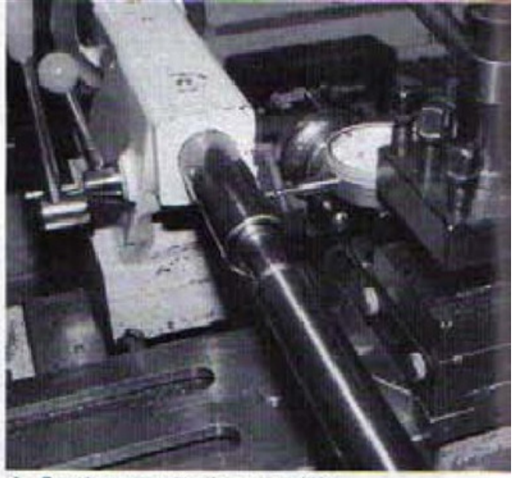


DRAWING 2b
HORIZONTAL ERROR





DRAWING 3
DIAL INDICATOR
MOUNTING BRACKET



2. Bracket mounted on topslide.

ensures that this is concentric with the lathe axis. Even if the spindle axis is at some slight angle to the bed ways, the effect of this error is minimal and probably undetectable in most cases.

If there is any doubt about the concentricity of centre holes drilled in each end of the workpiece, they can be skimmed with a small boring bar, but if Slocombe pattern centre drills are used for this task, this correction is rarely needed. However, the position of the tailstock centre is critical. The tailstock position and axis direction in the vertical plane are determined by the lathe manufacturer and are usually not a problem. Any error of the axis changes the height of the centre as the tailstock barrel is wound in and out. Any height error means that, as the tool point is traversed along the bed, it moves relatively up or down with respect to the centreline of the workpiece. However, this does not produce much error in parallelism of the job, but errors in the horizontal plane in the tailstock position or axis direction are serious.

Consider **Drawing 2a** showing the effect of error of the tailstock in the vertical plane. For a workpiece of (say) 20mm diameter, a height error of 0.1mm means that the tool point is moved to an angle θ from the workpiece centreline.

$\tan\theta = 0.1/10 = 0.01$

So θ = 34.5 minutes

$10/X = \cos\theta$

So $x = 10/\cos 34.5 = 10/0.99995 = 10.0005$

Thus the tool now cuts a diameter of 20.001mm instead of 20.0mm. However, in **Drawing 2b**, the effect of this error in the horizontal plane shows that the tool cuts a diameter of 20.2mm i.e. the same position error magnitude causes an effect 200 times more serious.

Most lathe tailstocks are arranged with two screws, front and rear, to allow the horizontal position of the tailstock to be moved relative to the lathe bed. On my lathe, these screws are 3/8in. UNF with 24 tpi, so that one full turn moves the tailstock 1.0583mm. Thus, for 0.01mm, the screw must be turned 3.4 deg. - very difficult to judge without some sort of measuring indicator.

I have three test bars, 200, 400 and 600 mm long, cylindrically ground on their own centres by a commercial toolroom, to be concentric and parallel. Checking with micrometer and dial indicator confirms that this is so to the limit that I can measure or detect.

With such a bar mounted between centres it is possible to adjust the tailstock so that the dial indicator shows no movement along the length of the bar as it is traversed by the saddle. If the workpiece is the same length as the test bar, then this setting usually gives a fairly good result in turning the work parallel. However, if the workpiece differs in length to any degree from that of the test bar, the result can be less satisfactory. In such a case, further adjustment of the tailstock horizontal position is required. If the headstock end of the workpiece is too large, the tailstock must be moved away from the operator; and conversely. I have found it convenient to make a simple mounting bracket for the dial indicator to readily attach it to (and remove it from) the topslide **(see Drawing 3 and Photos. 1 and 2)**. This bracket positions the indicator spindle at the centreline height of the tailstock spindle.

The bracket is made of 3mm steel, with three pieces being brazed together. Two 1/4in. BSW screws are held in tapped holes with Loctite 222. The bracket is secured to the far side of the topslide with two knurled-head brass M8 screws, into holes already there for another purpose. The indicator is held in either alternative position with a knurled brass 1/4in. BSW nut.

The actual configuration of each lathe and each dial indicator will determine how such an arrangement is to be achieved in each particular case.

The actual adjustment of the tailstock requires some finesse in technique. One screw is slackened, then the other tightened, and finally the first screw is retightened. It will be found that if the tailstock is firmly clamped to the bed, the movement of the screws is difficult - and can lead to bruising their noses. On the other hand if the tailstock is unclamped, the movement of the screws can rock the tailstock on its base slightly and give false readings. The procedure might therefore be

(i) note dial reading

(ii) unclamp tailstock carefully and note if reading changes

(iii) carefully moving clamping lever handle until it just (and only just) is clamping.

(iv) effect loosening and tightening of screws to arrive at required movement reading

(v) carefully apply full clamping force and note if reading changes.

This procedure seems to yield satisfactory results. It should be carried out before the final finishing cuts are made so that parallelism can be confirmed before heading for final diameter dimension.

Of course, the workpiece must be circular; unless one is starting from ground stock, a truing cut should be taken along the workpiece to ensure its roundness.

If the workpiece is slender, it will be necessary to use a travelling steady to ensure that the work does not end up barrel shaped i.e. bigger in the middle than at the ends. What is slender? It depends to some extent on the inherent stiffness of the material of the workpiece and its hardness/toughness in resisting the cutting tool. As a rule of thumb, if the workpiece ratio of length to diameter exceeds (say) 10:1 it may be considered slender.

Conventional cylindrical turning uses a right hand tool travelling from the tailstock end towards the headstock. So first machine about 15mm axially from the end of the workpiece. Then, as described in Issue 60, set the pads of the travelling steady on this machined portion, arranging that the cutting tool will be (say) 2 to 5mm ahead of the pads, which will therefore continue to engage the newly machined surface. The pads will of course need to be reset for each cut. The pads should be just in contact with the workpiece surface. The dial indicator set up as earlier described can show if the rear steady pad is too tight as it will move the work towards the operator. The adjustment of the top pad may require another positioning of the dial indicator; mostly however, adjustment of the pads can be effected satisfactorily by careful 'feel'. Experiment with the positioning of the rear pad using the dial indicator will help develop this 'feel' for future use on both rear and top pads.

Finally, don't forget to remove burrs at the ends of the parallel workpiece before measuring as these can easily give false micrometer readings.

References

1. Tubal Cain - ME Vol 177 No 4026 p396 et seq.

2. Bradley - Amateurs Workshop.

A TILTING TABLE

Bill Morris describes the construction of a substantial accessory for the milling machine

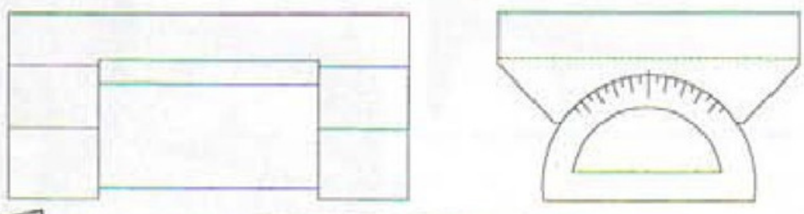
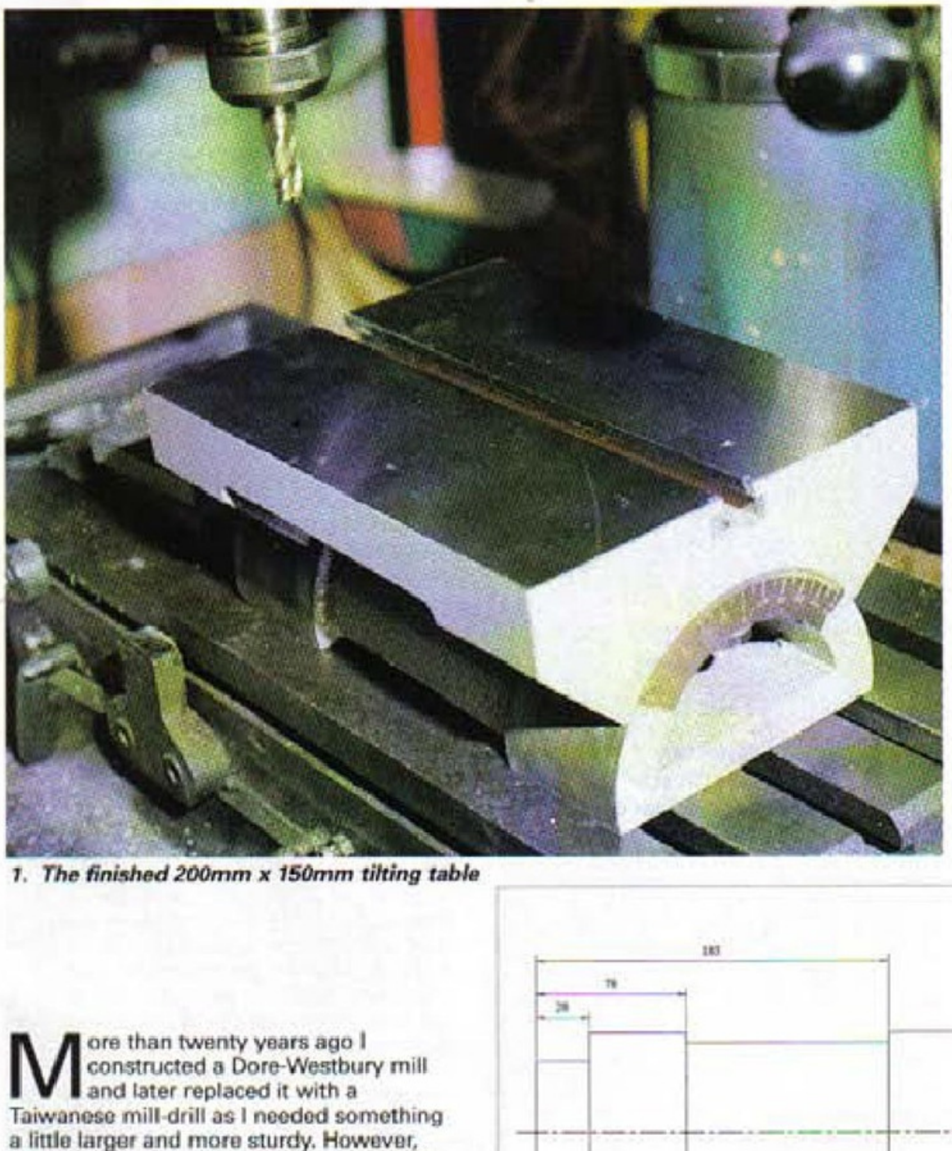


Figure 1. TILTING TABLE - General arrangement



1. The finished 200mm x 150mm tilting table

More than twenty years ago I constructed a Dore-Westbury mill and later replaced it with a Taiwanese mill-drill as I needed something a little larger and more sturdy. However, from time to time I have missed the ability to tilt the milling head. A few months ago at the Palmerston North Model Engineering Club's annual exhibition, I came across a tilting table that a fellow member had made from castings. I had recently been resorting to some precarious set-ups when machining my face geared indexing table, so that the tilting table was of interest to me. He introduced the maker of the patterns to me, Monty George from New Plymouth, and Monty was good enough to send me the patterns the very next week.

Patterns

The table **(Figure 1)** is of conventional design and requires only three simple patterns that can be made of traditional materials or, more easily and cheaply from medium density chipboard and plastic piping. It needs one core and this adds to the cost of making the casting, but the core could be omitted at the cost of some extra weight and significant complication in machining. I give details of the patterns, but as usual I do not expect the dimensions to be followed slavishly. No doubt suppliers such as College Engineering Supply and Reeves will be able to provide castings for those who do not wish to go the whole hog, although I believe that their stock items are somewhat smaller than the unit described here. However, if you have access to a friendly foundry that will do 'one offs', by making your own patterns you can get exactly the size and layout that you want.

Never having had to have cored castings made before, I mused for a while over the patterns **(Photo. 2 and Figures 2 a, b and c)** as it was not immediately obvious what the piece of plastic drainpipe was for. The table top was obvious, but a few words about the base for beginners like myself might be helpful. The base is essentially a hollow, semicircular tube and to get the hole down the middle, the molten iron is poured around a core. The cores at our local foundry are made by mixing a special material with the sand and blowing carbon dioxide through it to cause the grains to stick to each other. The result is of similar strength to a reasonably fresh ginger biscuit so is easy to handle and is porous to allow the escape of hot gases. So, the semicircular piece of drainpipe is used to make a semicircular core that occupies and is supported by the

Figure 2a.
PATTERN FOR BASE CASTING
Timber or medium density chipboard

2. Patterns and castings

3. Setting out centres on the base casting

4. Turning the base

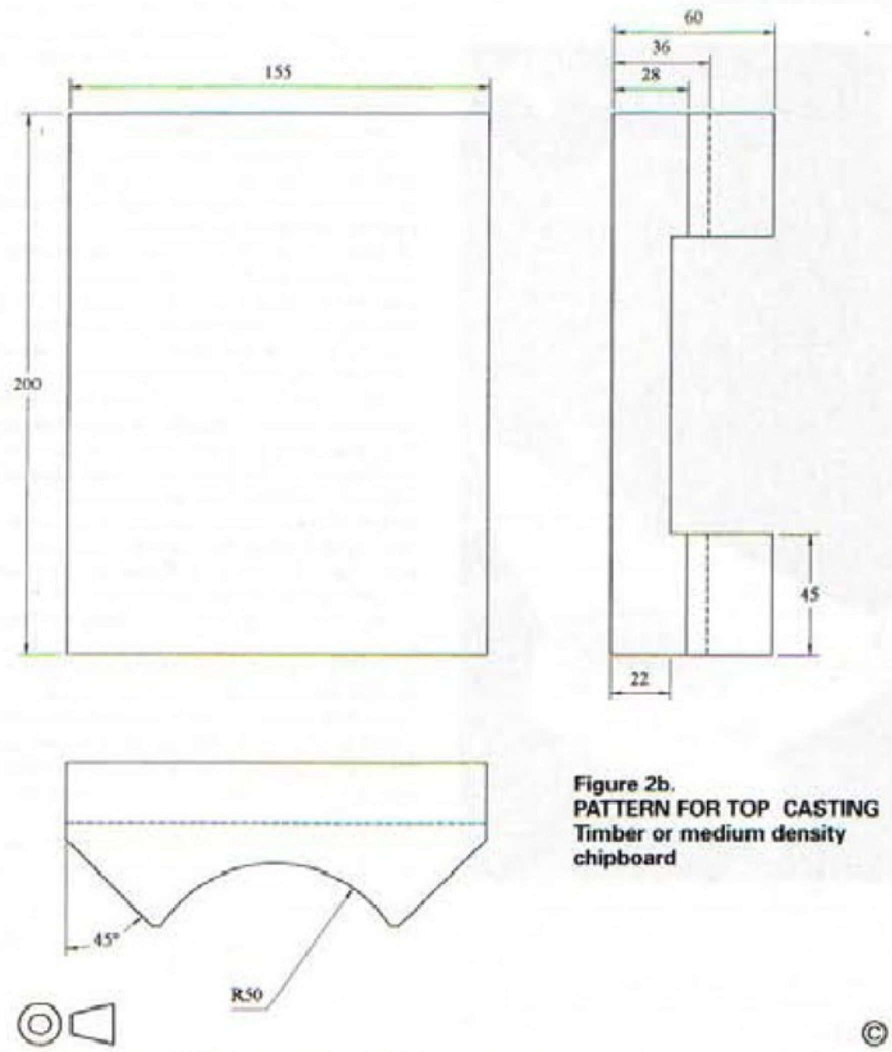


Figure 2b.
PATTERN FOR TOP CASTING
Timber or medium density chipboard

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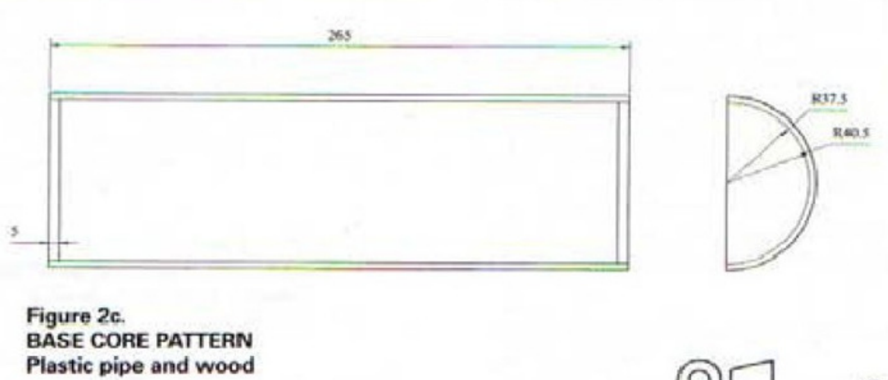


Figure 2c.
BASE CORE PATTERN
Plastic pipe and wood

©

depressions in the casting sand left by the 28mm long projections at each end of the base pattern. When the metal has cooled, the core is easily broken out, leaving the hole down the middle of the casting.

The staff at Milsom Foundry in Palmerston North were their usual friendly and efficient selves and I was able to collect the finished castings within a couple of days. There is, no doubt, more than one way and sequence to machine the castings and the professional with larger and heavier machines might well do things differently. The way I describe gives a finished article that is accurate and that works. I made a start with the base **(Figure 3)** while I worked out how I would manage to machine the table.

Turning the base

The base is a fairly hefty and irregular casting to turn in an amateur's lathe, but it is necessary to turn it between centres to ensure that both bearing areas are coaxial and that the ends are square to the axis. The flat bottom must also be parallel to the axis. Make a start by setting a pair of odd-leg callipers to the outside radius and locating a centre at each end as shown in **Photo. 3**. Drill a substantial centre hole at each end, in a drilling machine if there is room or otherwise by setting the casting in a four jaw chuck and doing it carefully in the lathe. With such a heavy, out-of-balance casting you will need to keep the speed down. When setting up between centres you will have to wire the casting to the driving pin to stop it clunking around and bending the driving pin due to the intermittent cut. Because the wire is in the way at the headstock end, this means that you have to take a facing, roughing and finishing cut at the tailstock end, noting the cross-slide index reading for the finishing cut, and then reverse the casting end for end and repeat the process in order to reduce both ends to the same diameter **(Photo. 4)**. Indexing for the protractor scale is best left until the flat under surface of the base has been produced, and this has to wait to a later stage. Put the base aside for a while and make a start on the top.

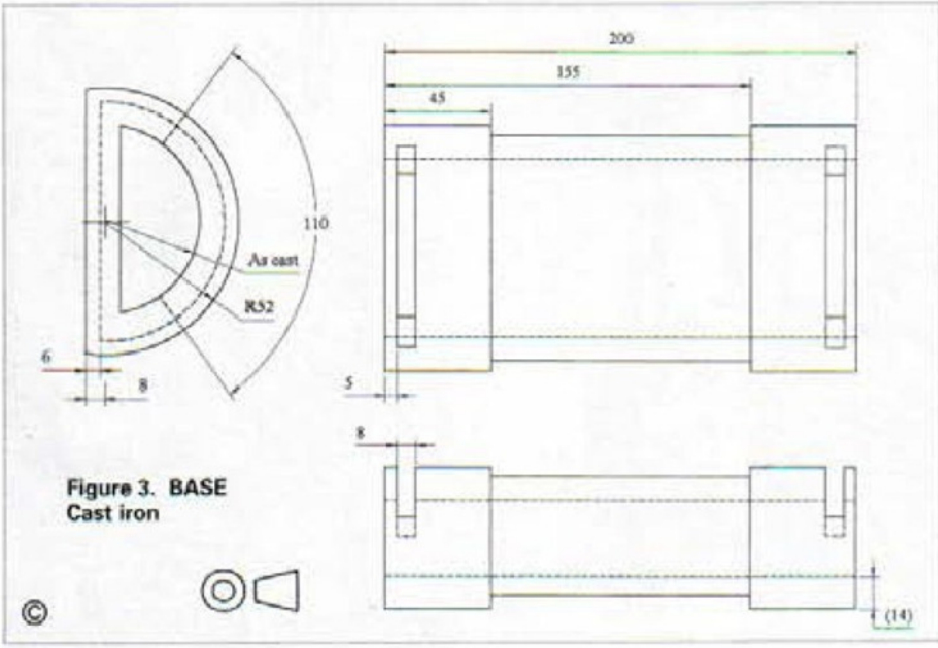
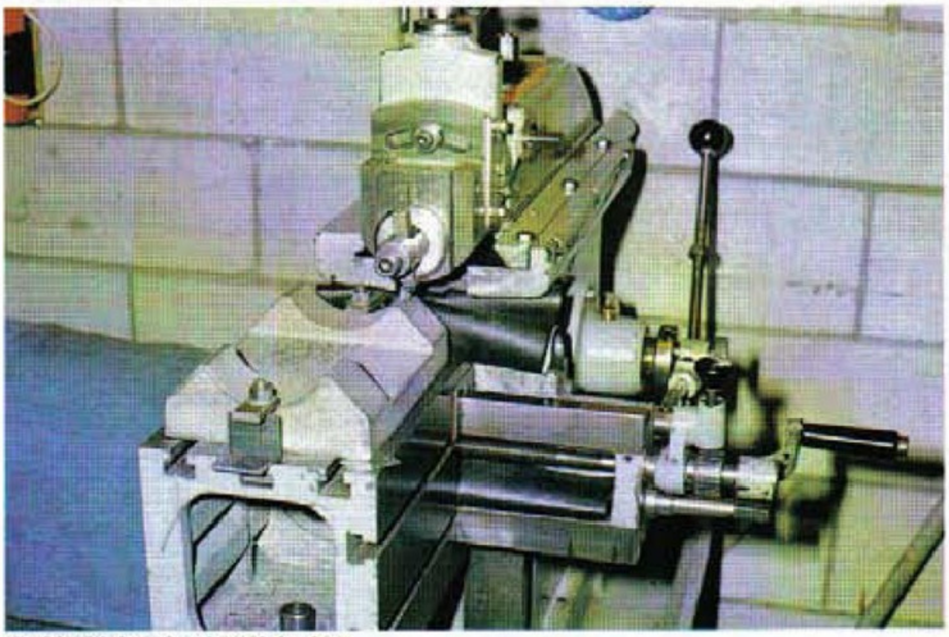


Figure 3. BASE
Cast iron

©



5. Machining the tips of the feet

6. Milling the holding-down recess

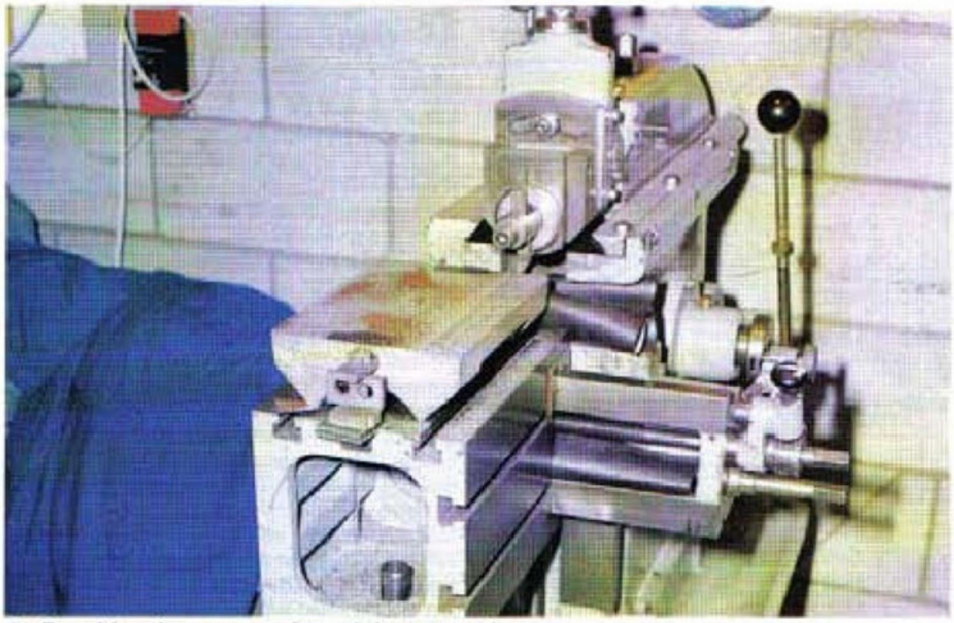
Machining the top

The first step is to file off any small projections from the table top with an old file and then to attach, it face downwards, to the table of a shaping or milling machine in such a way as to leave the tips of the feet unobstructed **(Photo. 5)**. Note from the photo the use of shim to stop it from rocking. Purists would also probably inset a sheet of paper to prevent marking of the machine table by the rough casting. A skim is then taken off the tips of the feet. This allows the table to be held down without rocking, so that a holding-down recess can be milled in each end with a tee-slot cutter, as shown in **Photo. 6**. This recess then allows the table to be held down, leaving an unobstructed top surface to be rough machined with shaper or milling machine, as shown in **Photo. 7**. While the feet and the top could be machined by holding the workpiece in a four jaw chuck, most amateurs would not own one large enough. It could also be held to a face plate by tapping holes and using studs.

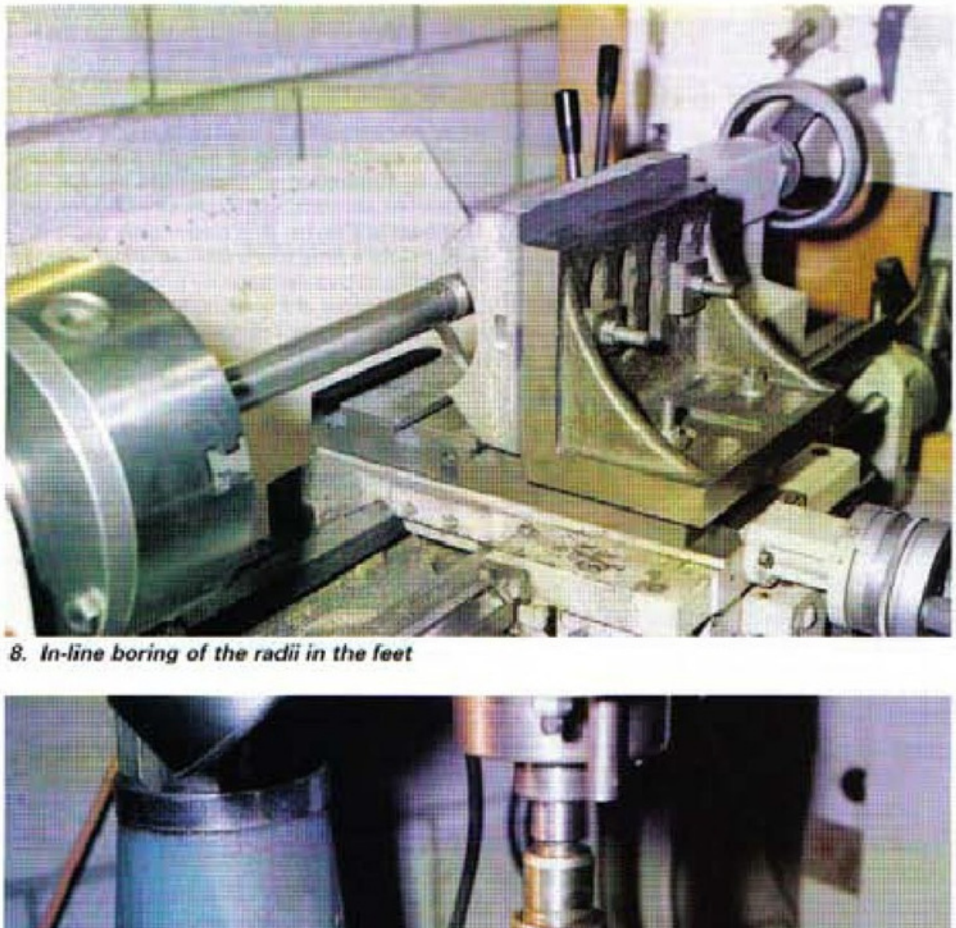
This is what I opted to do, in order to hold the part to machine the radii on the feet, siting the holes where they would eventually be replaced by a tee slot. For amateur in-line boring, the workpiece is usually attached to the boring table of the lathe and packed up to height. It should not be forgotten that an angle plate can be used to accommodate oversized pieces, as shown in **Photo. 8**. It also makes packing to height a little more flexible and increases rigidity, in this instance by ensuring that cutting forces are vertical. Note that the centre line of the table should be at the centre height of the lathe. The radii of the casting feet were deliberately made different to the radii of the base, so that one can be reduced to fit the other. In this case, the top has the smaller radii so that a good deep roughing cut can get under the skin of the casting, followed by one or more finishing cuts. The cutter is then set to project a nominal 52mm from the lathe centre-line for a final cut. The set-up of the boring bar and cutter with large overhang is relatively flexible, so speeds and feeds will need to be kept down to avoid chatter. It is worth noting that holding the bar rigidly in the chuck at one end and supporting it by a centre at the other gives much less tool deflection than supporting it between centres at each end.

Fitting base to top

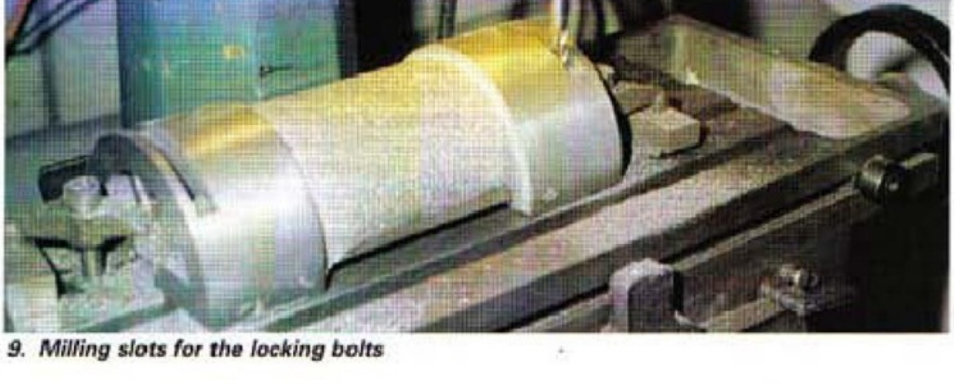
The base is then replaced between centres and its diameter reduced carefully until the feet of the top fit snugly. Use a little marking blue applied to the feet to get this just right or err on the side of leaving the diameter of the base slightly over size. The slots for the locking bolts are produced by end milling as shown in **Photo. 9** and finishing the ends of the slots by filing. If you had a tilting table, you could set up the base at 35 deg. to mill the ends of the slots! The next step is to marry the base to the top, scribe through the slots just produced and drill and tap two M8 or 5/16 BSW holes for locking bolts or studs. The two can then be bolted together and mounted, base up, on shaper or mill to produce a flat surface on the underside



7. Roughing the upper surface of the top casting



8. In-line boring of the radii in the feet



9. Milling slots for the locking bolts

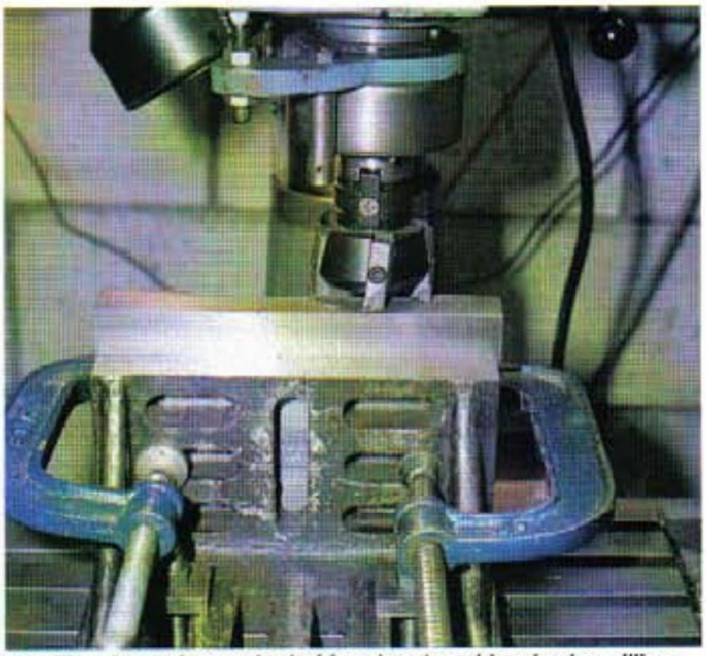
10. Cleaning up the undersurface of the base casting

of the base (**Photo. 10**). This sequence of machining ensures that the axis of the curved surfaces are parallel to the long axes of the flat surfaces in the vertical plane and that the latter are parallel to each other, at least, if your shaping or milling machine is in good order. It is convenient to have the long edges of the top parallel to the long axes in the horizontal plane. This is most easily done in the shaping machine by setting up the axis of the base parallel to the movement of the ram using a dial test indicator and feeding the tool slide down by hand, as in **Photo. 11**. The short edges can be done in a similar way, by setting a previously-machined long edge square to the ram movement. Alternatively, the top with attached base can be set up on the milling machine clamped to an angle plate with an edge of the base resting on a parallel, as in **Photo. 12**.

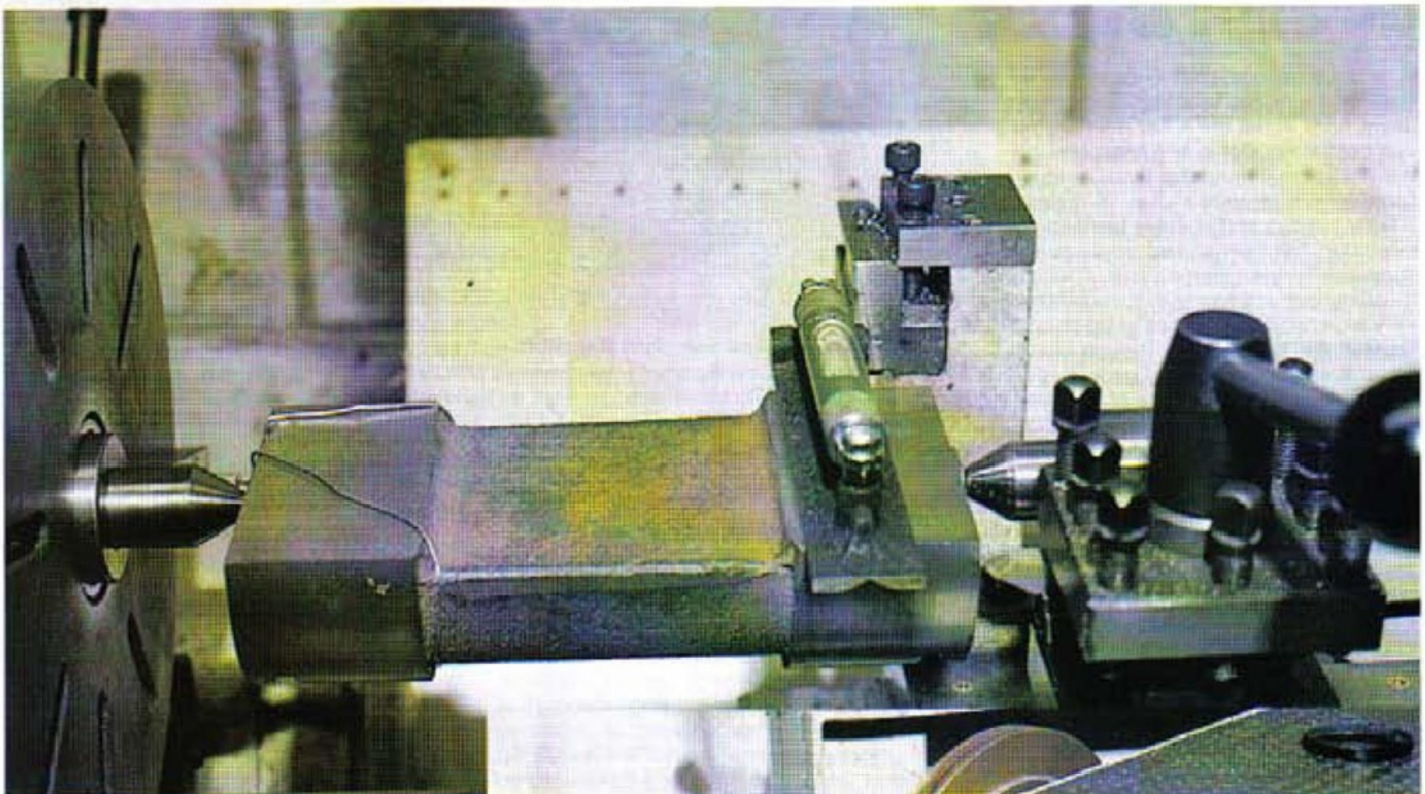
Graduating

To put the angular graduations on the base, set it up between centres again, set the underside horizontal with a level to establish where 90 deg. is (assuming that the movement of your cross-slide is horizontal or approximately so), wind on 45 deg. and, using a vee tool set exactly on centre height, begin to incise the graduations as in **Photo. 13**. Don't forget to wire the base securely to the driving pin to avoid backlash. I have a very large 360 tooth worm wheel that I use as the basis for a makeshift headstock dividing device (**Photo. 14**). If you use such a device, make sure you unplug the lathe or remove its fuse to avoid inadvertent switching on as worms don't like to be driven by their wheels! The graduations are only a guide to setting the angle of tilt and for anything other than rough work, the angle should be set with, in order of increasing precision, protractor, vernier protractor, clinometer or sine bar. The last operation on the base is to set it up in the

11. *Shaping the table edge*



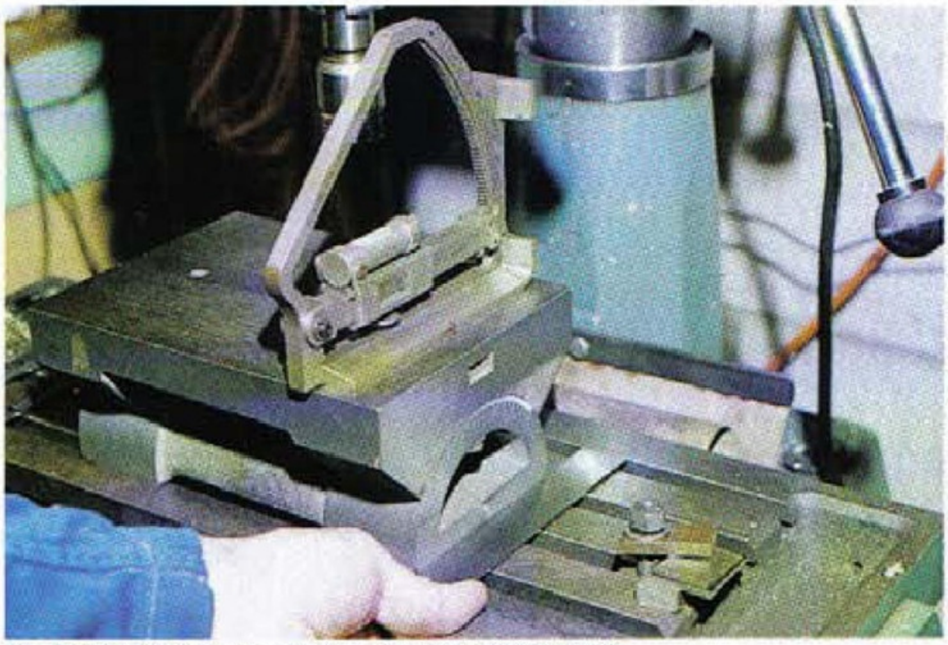
12. *The alternative method of forming the table edge by milling*



13. *Setting up for indexing*

four jaw chuck and carefully, because of the large overhang, face off the unmachined metal remaining around the centre holes. **Photo. 15** shows how, when this has been done, it is a simple matter to set the tilting table's long axis parallel with the machine table using a square off the front edge of the machine table and, if the latter has been set up level, a level or clinometer can be used to set the table top horizontal and thus parallel to its base. In this position, a fine chisel can be used to make an index mark on the table top or a little screw-on arrow made from sheet metal.

14. *Headstock indexing device*



15. Setting the axis of the table parallel to that of the mill

16. The danger moment for a tee slot cutter

17. Taking a finishing cut across the table top

Stressful tee slots

In the drawings, I have not shown any tee slots in the top or slots for holding down bolts in the base. For my purposes, one central tee slot is all I need, though there is room enough for three or four. Cutting tee slots with a shaping machine is a fairly tedious and at times terrifying operation, but uses cheap, single point cutters, whereas using a vertical milling machine is much easier, but the cutters are very expensive with prices of up to US$70 for slots for 10mm bolts. Though I have never broken one myself, I understand that one can make very little use of the remains. **Photo. 16** shows a tee slot cutter at its most vulnerable moment, as it is about to break out at the end of the slot. At this point, tighten up the table movement and slow down the feed to minimise the chance of fatal snatching. Tapping stud holes at spacings for whatever you are going to mount on the table is another option for the amateur, who is unlikely to have a wide variety of equipment.

My own preference is to hold the table down to the machine table with dogs and that way the clamping bolts and holding-down nuts do not get in each other's way so much. This is clearly seen in **Photo. 17** where a finishing cut is being taken with a broad faced tool with relatively coarse feed, prior to surface grinding the top and bottom and applying some paint to finish off. The end result is shown in **Photo. 1**.

QUICK TIPS

Clearing up liquid spillage

Oil lift granules similar to those used by garages are readily available under the name of pet litter. Many are Fullers earth, although a powdered wood compressed into pellets is also available.

H&MPE

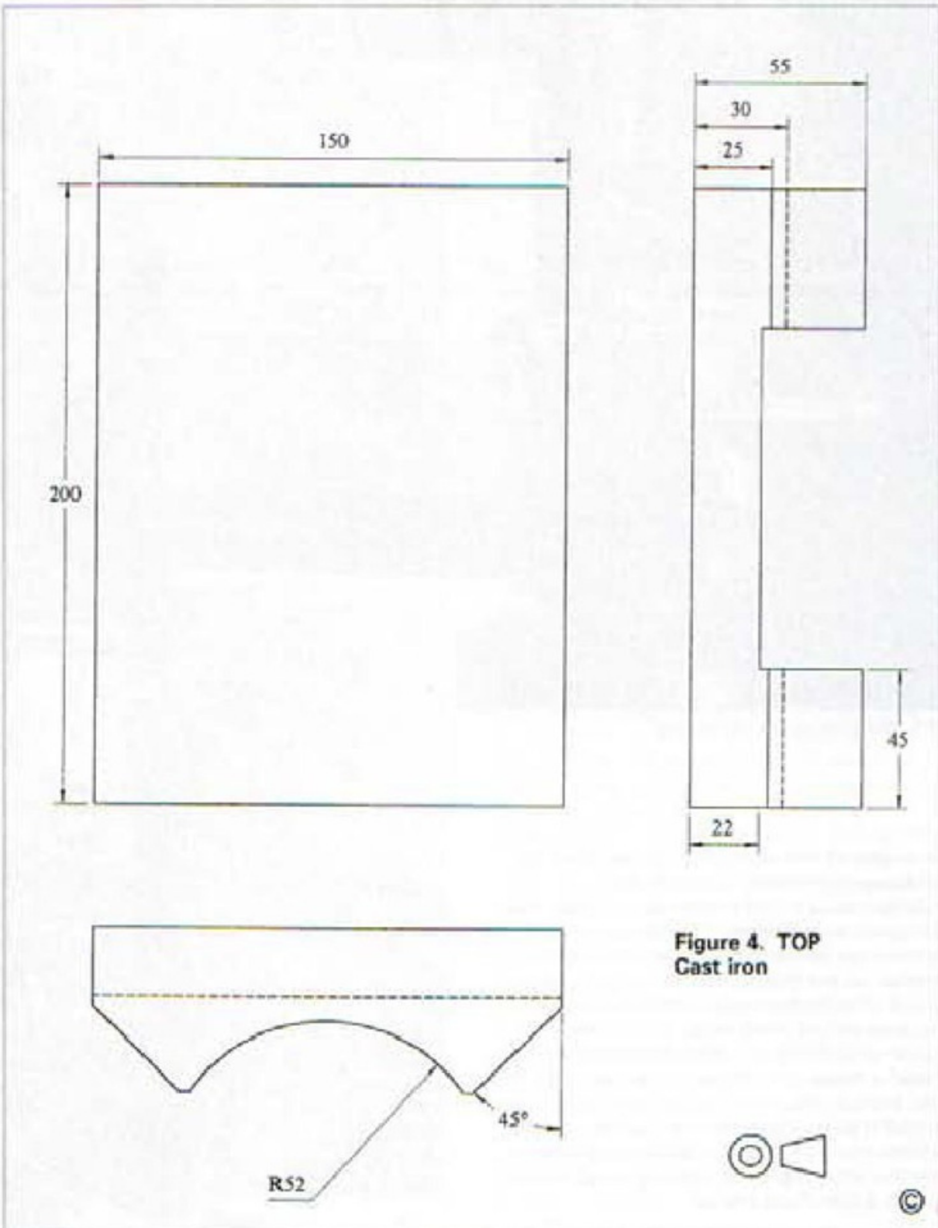
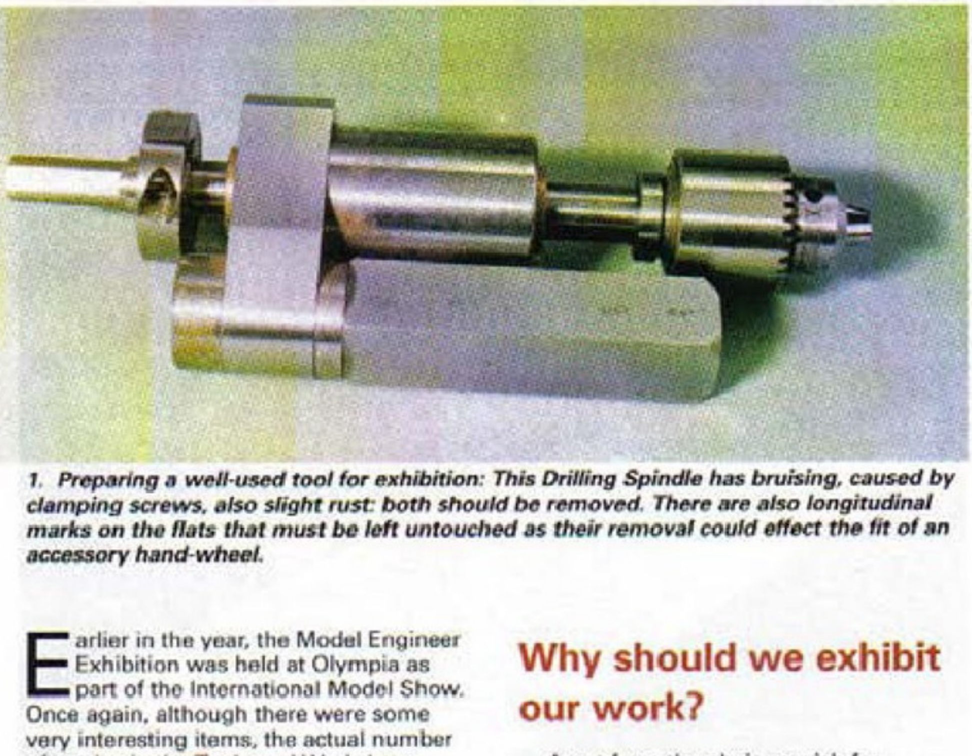


Figure 4. TOP
Cast iron

EXHIBITING WORKSHOP EQUIPMENT

With the 'exhibition season' fast approaching, seasoned campaigner Peter Clark gives some hints as to how workshop equipment may be best presented



1. Preparing a well-used tool for exhibition: This Drilling Spindle has bruising, caused by clamping screws, also slight rust: both should be removed. There are also longitudinal marks on the flats that must be left untouched as their removal could effect the fit of an accessory hand-wheel.

Earlier in the year, the Model Engineer Exhibition was held at Olympia as part of the International Model Show. Once again, although there were some very interesting items, the actual number of entries in the Tools and Workshop Equipment Class was disappointing. This seems to be a perennial problem and there is little doubt that many model engineers have a very real reluctance to expose workshop items to the public view. This is very unfortunate as there is a wealth of good ideas and well made tools about and there must be many people who, like myself, derive pleasure from making their own equipment.

Perhaps we should look at some of the reasons for this reticence. A potent factor is probably the fear that a piece of work is 'not up to standard'! This is inextricably linked with the myth of 'exhibition finish'.

There can be relatively few of us who have never made a piece of workshop equipment, either in its own right or as a way of facilitating other work.

Although some of these items may be quite conventional, perhaps using a published design or commercial castings, others have been made to deal with a particular problem and show some originality. These aspects may be linked when an existing design is modified or extended to make it more useful.

Why should we exhibit our work?

Apart from the obvious wish for competitive success, the reasons for exhibiting a piece of work are probably both highly complex and intensely personal. As one who starts many projects with great enthusiasm and has a much poorer record for completion, entry to an exhibition and the rapidly approaching submission day is a powerful incentive to get the job finished. Potential peer review can be a very real incentive to improve the quality of one's own work.

It is interesting to look at the type of entries that can be seen at the various exhibitions. There are often examples of commercially available designs that fulfil a very important role in encouraging their builders to start exhibiting their work. Although these must be judged on workmanship alone and therefore less likely to achieve the highest awards, one has only to look at the numbers of Quorn Grinders that still, quite rightly, gain such recognition.

Original variations and additions to existing designs always create a lot of interest and may well result in others deciding to use these ideas.

Lastly, there is the group comprising designs that are either largely or completely original. These may be sub-divided further:-

First are those that, while being original, are not particularly innovative . An example of this might be a small drilling machine of conventional design, without any unusual features. The second type would be characterised by completely original features, either in its purpose, design or construction.

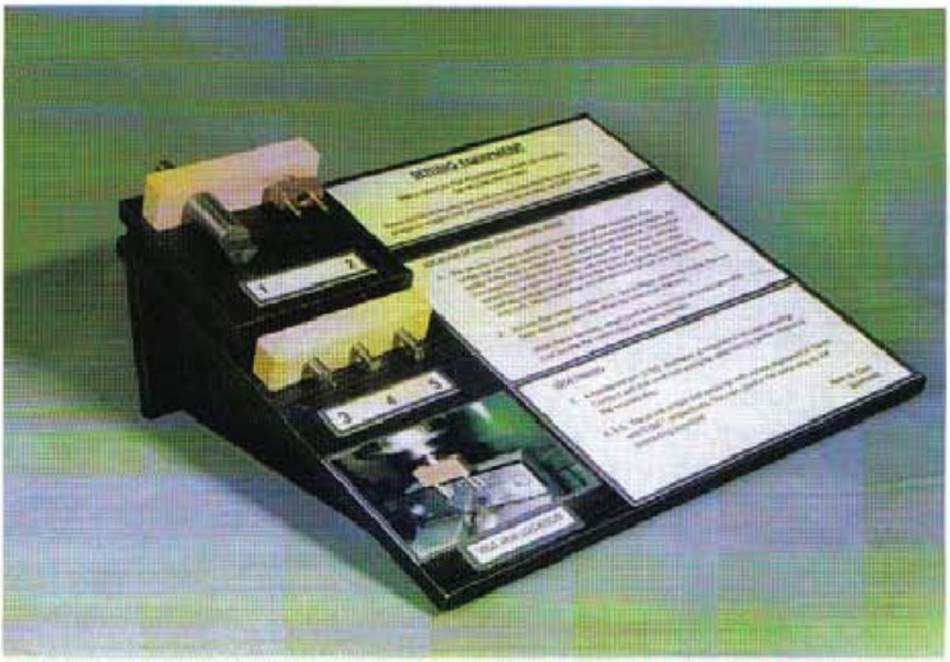
Finally, it is worthwhile mentioning that competitive success is not necessarily proportional to the quantity of swarf produced, nor to the time taken to do so. This is particularly true in the case of original items. Several of my own ideas, that were made in a day or two, have received awards at the Model Engineer Exhibition. One that has given me the greatest of pleasure was a group of five simple devices for setting work on milling machines, made in a only a few hours and given a Highly Commended. This gained from some of my friends, the highest accolade of "It's so obvious, why didn't I think of that?". However, the real pleasure was that several of them went off, determined to make their own versions.

Preparing the exhibit

There are many misconceptions about the way in which workshop equipment should be prepared for exhibition. Many of these centre around the idea that everything should have a brilliant polish. Polishing can be a double-edged weapon. It is almost a regular event to see an entry with a mirror-like finish to every conceivable part. All too often, this proves to be a distorting mirror, highlighting every surface blemish and flaw. More important, this polishing effort can easily overdone and the inherent accuracy of working components compromised. If we look at top quality commercial tools, we find that polishing is unusual and, if it exists at all, is limited to items such as hand wheels and knobs. Even these parts are nowadays often finished in satin chrome, rather than being highly polished.

My own philosophy is based on achieving an appropriate finish for a particular tool. This will obviously vary according to the nature of the item. Most of us will have access to well-finished commercial equipment that will provide a benchmark for our own work. It is worth while looking over your exhibit with a critical eye, or even better, having a friend do so, in order to pick up little faults like sharp or irregular edges, uneven chamfers and torn screw slots. Most of these points do not detract from the basic working function of a tool but provide a better image to both public and judges alike.

A common dilemma when preparing an entry is the correct approach to signs of previous use. My own preference would be to try to correct any actual damage such as chipped paint or burred edges but to leave untouched the signs of honest toil. An example of this is the drilling spindle illustrated here. **(Photo. 1)** Marks on the square shank from the toolpost clamping screws might be removed, as would be any slight rust. The end of the spindle has three flats to allow a positive drive with the



2. A simple 'lectern' style display board: Five individual pieces of setting equipment are mounted in blocks fitted to a sloping board for easy viewing. The descriptive notes are augmented with a photograph showing their use.

chuck of an electric drill. Although very difficult to show in a photograph, the longitudinal marks made by this chuck must be left, as they not only show an integral part of the function of the tool but, more important, their removal, although easy, would spoil the fit of the optional handwheel used for tapping.

Presenting our work

There are many reasons why a neat and clear presentation of the entry is much to be desired. The most obvious one is that the public (and perhaps, even the judges!) will more easily be able to grasp the features of the tool or machine.

It must be remembered that some of those seeing the work may not be familiar with every aspect of it. If, for example, the entry is a device for doing an unusual job or doing a common one in a new way, then it is essential to ensure that the salient points are made quite clear. In the past, my own entries tended to be accompanied by long and rather boring typescripts, detailing their construction and use. My excuse for this was long experience in writing scientific papers where every question must be answered before it is asked! More recently, it has been found much easier to use a photograph of the tool in use. A common question to be answered before it is asked is: "Yes, but does it work?". It is often useful, therefore, to show an example of actual work done with your entry.

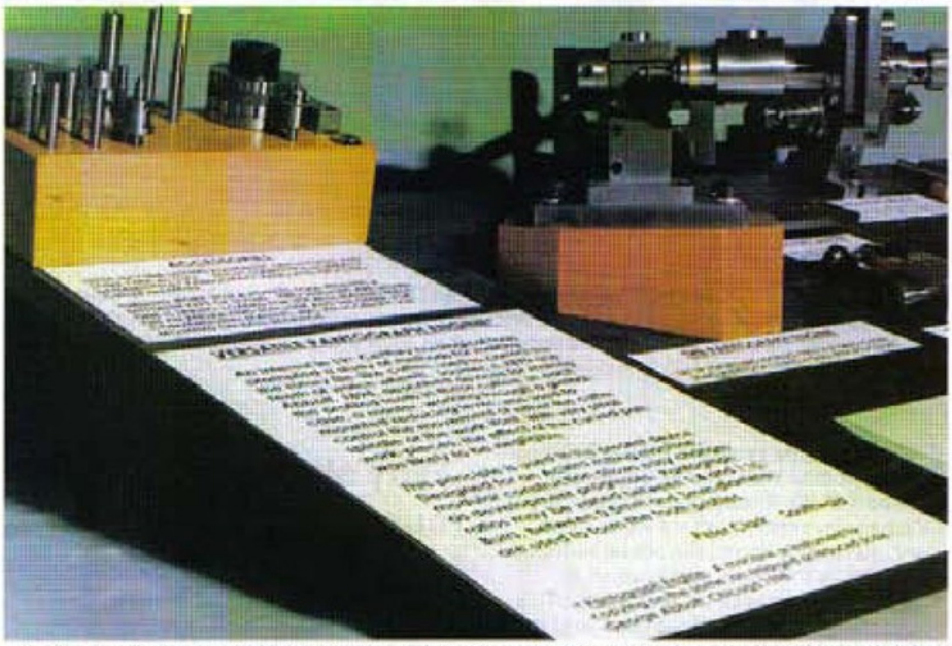
Now for the actual display. If your project is a simple one-piece item, whose function is well known, there may be no need for any other form of display. If, however, your entry has several parts or needs some form of explanatory material, then consider mounting everything on a board to make a self-contained display unit. Incidentally this will make you very popular with those long-suffering folk who actually set up the exhibits after we have put them on the reception table.

My earlier display boards were often made of birch-faced plywood that was not only expensive but also required quite a lot of finishing. The next choice was melamine-faced chipboard, initially white or magnolia colour. This was both cheap and easy to use but these light colours showed every mark and particularly, the dust that seems to be a feature of exhibition sites. Various wood effect boards were tried. It was soon found that a black finish showed steel components to their advantage, so 'black ash' effect boards have been used for several years.

Two types of boards with this finish can be found, one with a rather shiny finish and another with a duller finish, featuring a somewhat lighter 'grain' pattern that seems to be impressed into the board. An example of this latter type is Keyboard that is now used, whenever available, for my own work. The particular advantage of this material is that the pattern shows marks much less than shinier boards.

Having chosen the material, the design of the display must be considered. The prime requirement of any display is that the work must be easily seen by the public. Remember that many shows will have barriers in front of the exhibits, perhaps increasing the viewing distance by a couple of feet. A simple answer to this is to display the work on a sloping board that will make both it and any written description or photographs easy to see. It is axiomatic that any display board should be as simple as possible and a plain 'lectern' style board, sloping at about 1 in 4, may usually be comfortably studied when placed on a typical display table, perhaps 27in.-36in. high.

In its simplest form, the lectern style may consist of a suitable piece of melamine-faced chipboard, supported at each end by a wedge shaped piece of the same material, making a surface sloping towards the viewer.



3. 'Lectern' style board with horizontal platform: In this case, the principal component, a pantograph milling device, is mounted on a wedge-shape block, allowing it to be displayed horizontally, while its accessories may be easily seen on the sloping board.

For strength, the ends should be fixed to the top using lengths of wood about 1¼in. square. These ends should be set in an inch or two from the edge of the top board to allow easy handling. Finish all the sawn edges with the appropriate iron-on edging and make sure that there are no rough points that might snag on any cloth covering the display table. This basic design can be used for all sorts of work. If your work is particularly heavy, add further supports underneath **(Photo. 2)**.

There will be some occasions when a sloping board may not be suitable for some part of the exhibit. An example might be a piece of equipment to be shown with a number of accessories. The shape of the main component might suggest that a level presentation would be preferable. In this case, a suitable horizontal platform could be added, leaving the rest of the components and any descriptive notes or photographs to be fixed on the sloping part of the board. A example of this is my 'pantograph engine', a device for milling profiled teeth in horological wheel cutters. The quite complex and heavy device was obliquely mounted on the horizontal surface of a wedge-shaped wooden block that allowed it to be easily viewed from adjacent sides. The considerable number of accessories, notes and photographs were put directly on the sloping surface of the board **(Photo. 3)**.

If the exhibit has a major component with vertical orientation, consider adding a backboard to the display. This may also be very useful in presenting notes and photographs.

Some machine accessories may be almost impossible to display by fixing to a board and recourse may be made to making a dummy fixture representing the machine to which they are to be fitted. For example these fixtures might mimic a lathe or milling machine headstock. They need not be very elaborate but should have the proportions of the actual machine. My own practice is to make them from wood that may be painted in some neutral colour to indicate that they are not part of the item being displayed. A typical example is a fixture to display a high-speed head for a Boxford G200 Tool and Cutter Grinder. Lest it be thought that this was a lot of unnecessary work, it may be mentioned that this fixture now provides a permanent home for the head when this is not in use **(Photo. 4)**.

Fixing the work to the display may call for some ingenuity. Many items can be easily screwed down through existing holes. If tapped holes are present, screwing from behind is very neat. It may even be justified to put in a couple of blind tapped holes into the back of a component, provided this does not interfere with its final use. Sometimes a simple wooden fixture may make the display of an awkward component relatively easy. A last resort may be to use foam-backed double-sided adhesive pads to secure really difficult parts. Do not use ordinary double-side adhesive tape, as this will not usually have enough power to hold anything but the lightest article. This problem should not exist with the foam-backed pads where the real difficulty can be persuading the adhesive to let go when the show is over!

Description and labelling

The proper description and labelling of the exhibit can be very important, particularly if the item or its construction is unusual in any way. As implied earlier it, the object should be to present the information in a form that is both easy to read and easy to understand.

Today, many of us will have access to some sort of word processor, something that makes a neat presentation much easier.

In choosing the style of your wording, remember that it will probably be two feet or more away from the viewer. For this reason, the ideal size of your lettering may be at least twice that of normal typescript. My own presentations usually use 20pt for most work and perhaps 26pt for titles. Bold type is desirable for all this work.

If you cannot get to a word processor and are compelled to use a typewriter or even hand-lettering, keep the potential viewer in mind and strive for clarity.

Any written description should be as short as possible and making your points clearly. Apart from the title, this description might include:- What it is, Why it was made, How it works and How it was done.

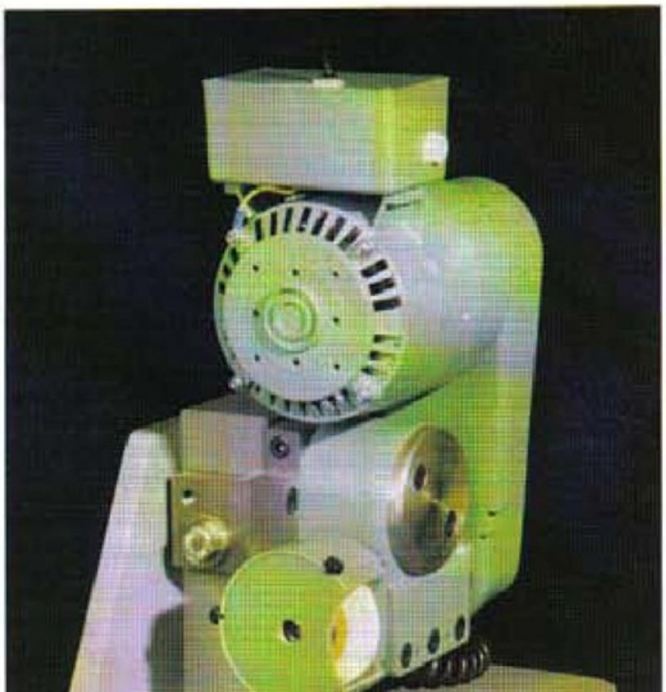
If you have modified or extended an existing design, it is vital that you clearly show why your idea is original, otherwise your own contribution could be missed by both the judges and the public at large.

It is all too easy to be verbose, so it is a good idea to set a maximum length for your description. Start with an A4 sheet and then see how much shorter you can make it. Keep editing until you have reached a happy medium where the important information is clearly given in a minimum of space. A well-composed photograph may often replace dozens of words and may provide the viewer with an easy understanding of the purpose of your work.

Labels for individual components of my own exhibits are usually done in 16pt bold type using upper case characters. Captions for photographs are done in a similar style, using lower case where appropriate.

If you can, print directly on thin card, otherwise use really good quality paper that is then attached to pieces of mounting board, using a suitable all-over adhesive. Photographs may be mounted in the same way.

The way your written items and photographs are attached to the display board can have quite critical importance. My own preference is the use of double-sided adhesive tape. This can be very neat and sometimes the printed items can be safely packed, brought to the exhibition separately and then put on at the last minute. There is a potential snag to most ways of mounting, insofar that changes of humidity can wreak havoc with paper-based items. In my own experience, a particularly vulnerable time is when exhibits are being brought in, prior to the opening of a show.. Even in winter, the heating in the hall may then often be minimal and the cold, damp atmosphere results in wrinkling of the larger pieces of paper or even card. There is no easy answer to this, except to try to fix your paper items down as firmly as possible.



4. Using a dummy headstock to display a large machine accessory: A high speed spindle for a grinding machine is mounted on a dummy version of the machine headstock. This is mounted on a base that also may be used to provide permanent storage for the spindle.

Let us all see your work!

The approach described is obviously very personal and there is no doubt that many people will have different views on some of the points raised. Nevertheless it is hoped that they will encourage many more of you to show us all, the tools and equipment that you have hidden under your bushels.

It is not always realised that the Model Engineer Exhibition and some other shows are not truly competitive. Although the special trophies are usually awarded to a 'best of class', the various medals and certificates are awarded on the basis of reaching a particular standard set by the judges. Thus a given grade of award may be given to more than one entry in a class, irrespective of the number of entries. In practical terms, this means that someone that has done a decent job, particularly if it shows originality, has a very real chance of going home with a pleasant memento.

Finally, in the words of the street evangelists, Come and Join Us!

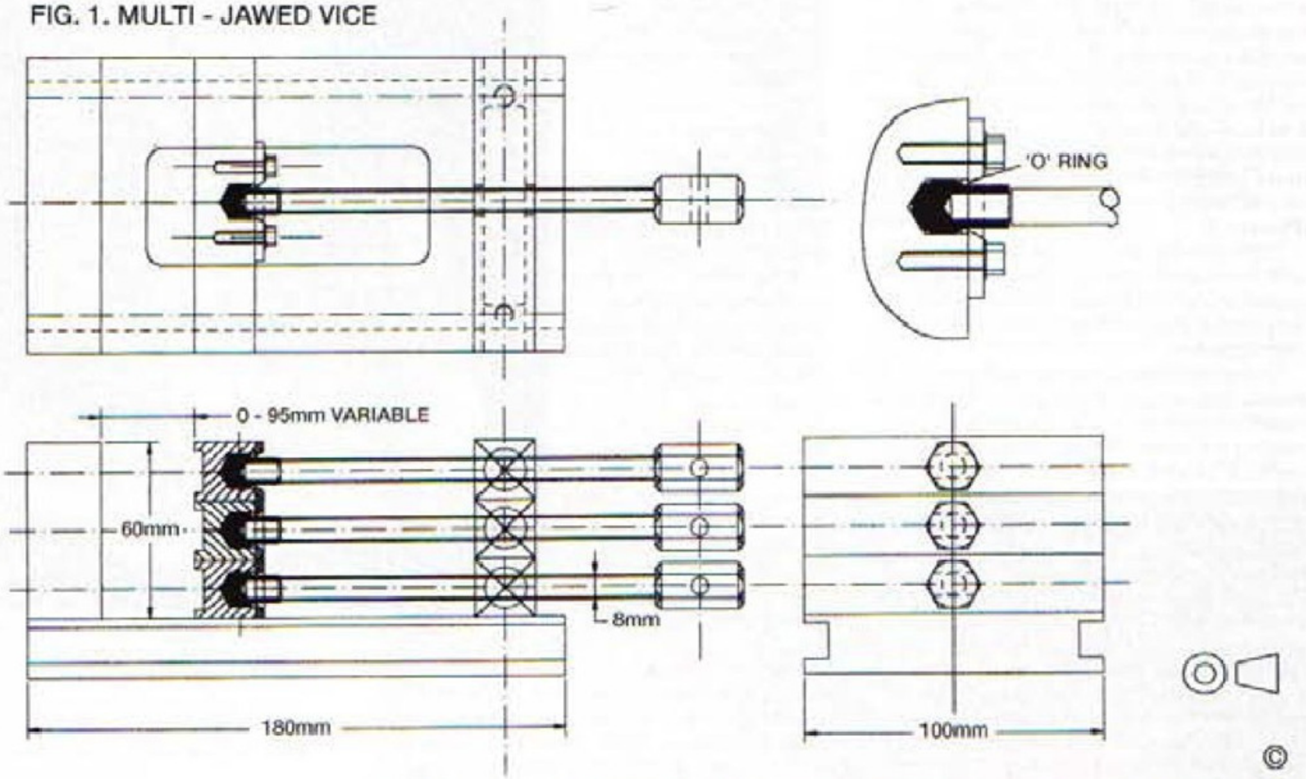
Acknowledgement:

I would like to thank Robert Shackle for all the photographs in this article.

A MULTI-JAWED VICE

Simple in concept but versatile in use, this drilling machine vice has helped Peter Rawlinson to overcome some tricky work holding problems

FIG. 1. MULTI - JAWED VICE

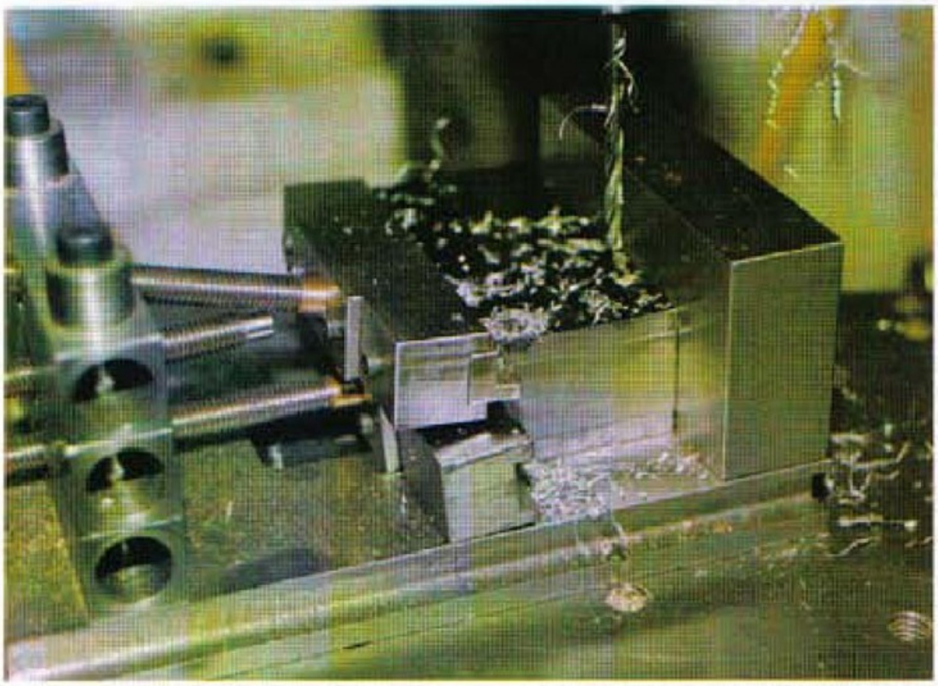


The 'Multi-Jawed Vice' came about because of difficulties experienced when attempting to hold pieces together in order to use the top piece as a jig when drilling. It is frequently not possible to hold the assembly so that edges are correctly located and the surfaces are clamped together while the lot is held securely. I wanted something that would carry out these apparently simple requirements, and so the 'Multi Vice' came into being. Now, I am not saying that it will solve all work holding problems, but it will contribute to helping on a number of jobs where multiple components need to be gripped.

Basic Design

My first thoughts were to make a vice with two adjustable jaws, but decided that for the small amount of extra work involved, the addition of a third jaw could be worthwhile. This has since proved to be the case, and although all three jaws are very seldom used together, the top two positions are used for different types of clamping.

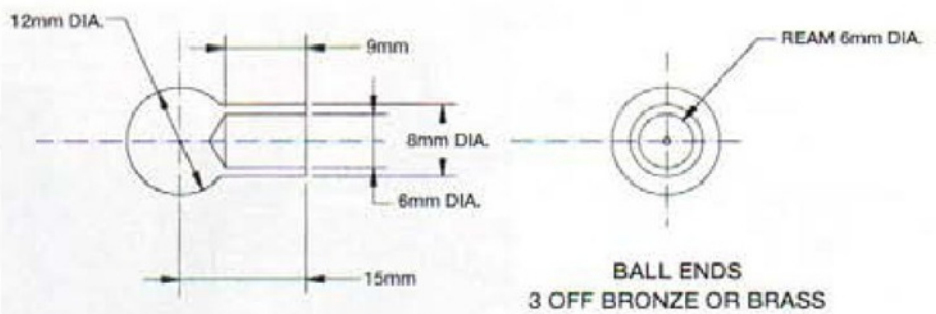
It was also decided to arrange things so that the clamping screws could swivel in a vertical plain, and that the moveable jaws should also be able to swivel, but in this instance, in all directions. It would then be possible to hold tapered components without needing to resort to the addition of extra parts (e. g. the Myford arrangement of using a loose jaw in the machine vice).



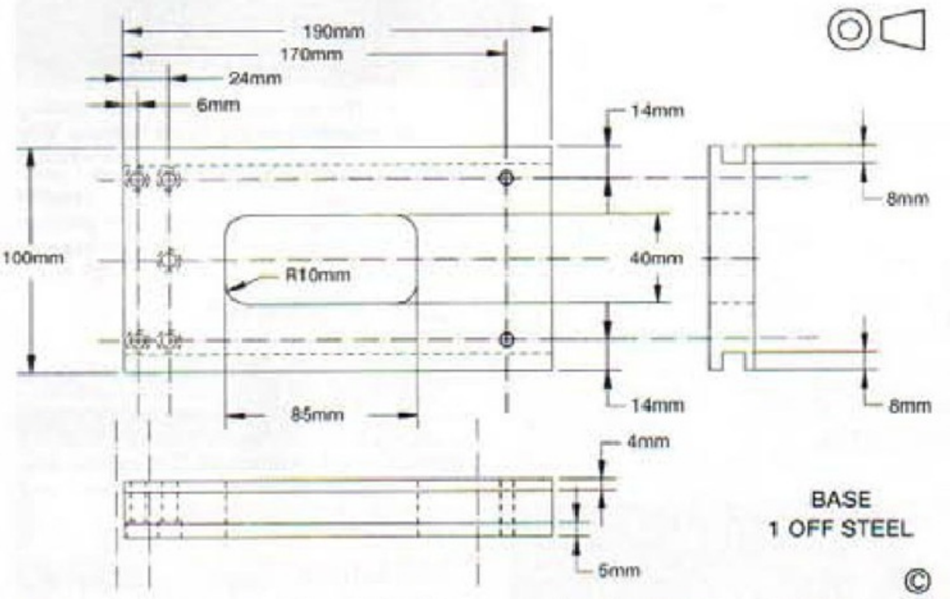
1. The multi-jawed vice in use, holding three components when drilling

Simple to use

Photo. 1 shows the finished tool being used to hold three pieces of material for drilling. The top and bottom pieces are 6mm thick, while the middle piece is 20mm thick. You will notice that only two of the three clamping screws are being used, and also that the lower one is used without its additional single jaw. In this manner the bottom moveable jaw will clamp the two lower pieces. Even if the parts are of different widths the lower jaw swivels to accommodate the variation. The top jaw is, in this



BALL ENDS
3 OFF BRONZE OR BRASS



BASE
1 OFF STEEL

photograph, using an additional 'single point jaw' which bolts into place when required. This then holds the top piece of material; in some cases a packer may be required between the top jaw and the lower jaw.

Photo. 2 shows the lower jaw only being used to hold a tapered component, namely a Morse taper drift, and you will note how the lower jaw is fitted with a single point jaw, and the jaw has swivelled in two directions to accommodate the angle of the taper. The vice has been made to deal with only relatively light work and if heavy work is contemplated, then a larger screw size should be incorporated, but for the home workshop the sizes on the drawing would seem to be adequate.

Photo. 3 again shows the two jaws clamping two separate pieces of differing widths and thicknesses. This system uses single jaws on both screws.

Photo. 4 shows a similar type of clamping system. Note the use of packers between the upper and lower jaws.

Manufacture

Figure 1 shows the General Arrangement of the vice, with each of the component parts being fully dimensioned on the individual drawings. All parts are fairly simple and were not difficult to make from stock materials. Castings could be used for some of the items if suitable patterns are available, or perhaps an existing casting modified. I used steel because I have a good stock and castings can be expensive.

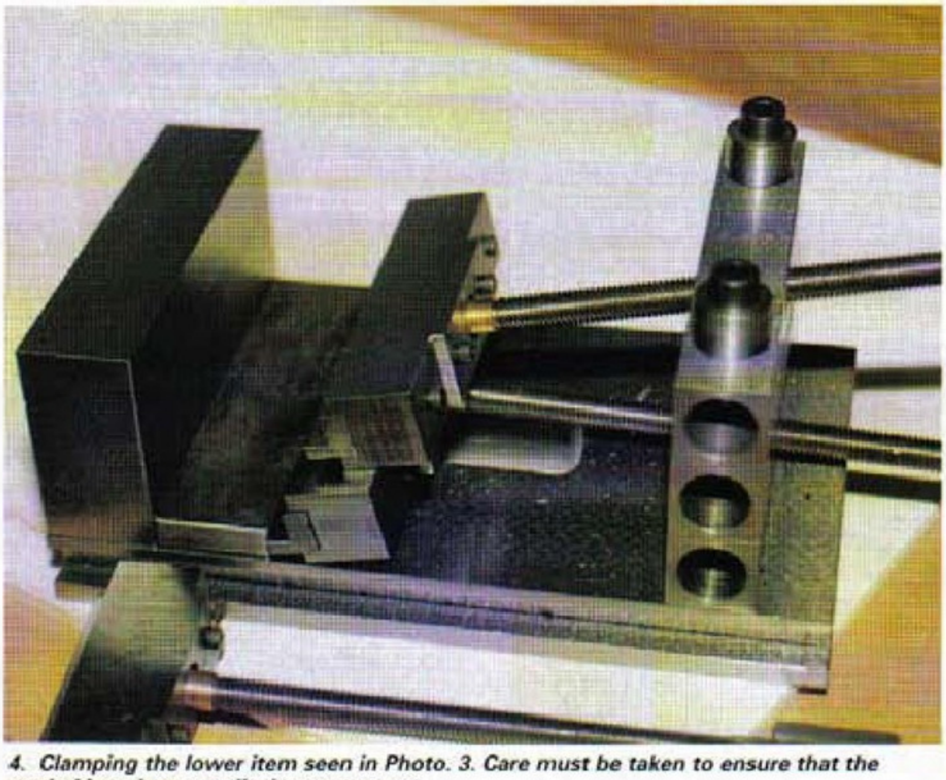
The base is a piece of 20mm steel plate, the slots along the edges being used for clamping down. The working capacity may be extended if required just by increasing the appropriate dimensions. The fixed jaw is also simple, but the lower face must be square to the working face.

Trunnions

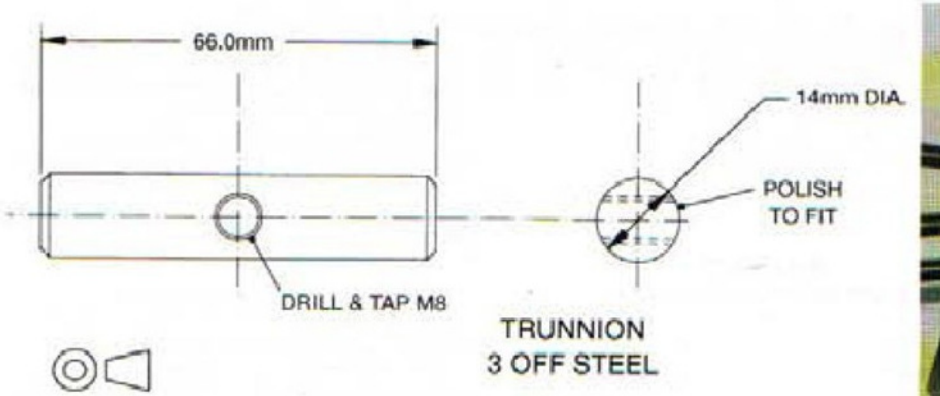
These are shown in **Photo. 5**, the housings being machined from 20mm square mild steel. They can be mounted in a 4 jaw chuck (self centring or independent), and can then be drilled and reamed to take the trunnion pins. The length of each pin is arranged to be such that the 6mm securing bolts hold it in position. If a clamp screw is removed, then the female thread in the pin will remain in line with the slot in the trunnion housing. The fit of the pin does not need to be too tight.

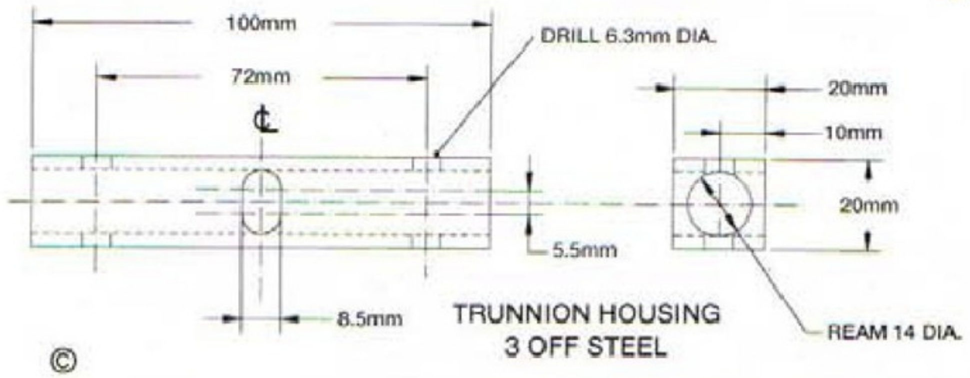
2. Accommodating a tapered component

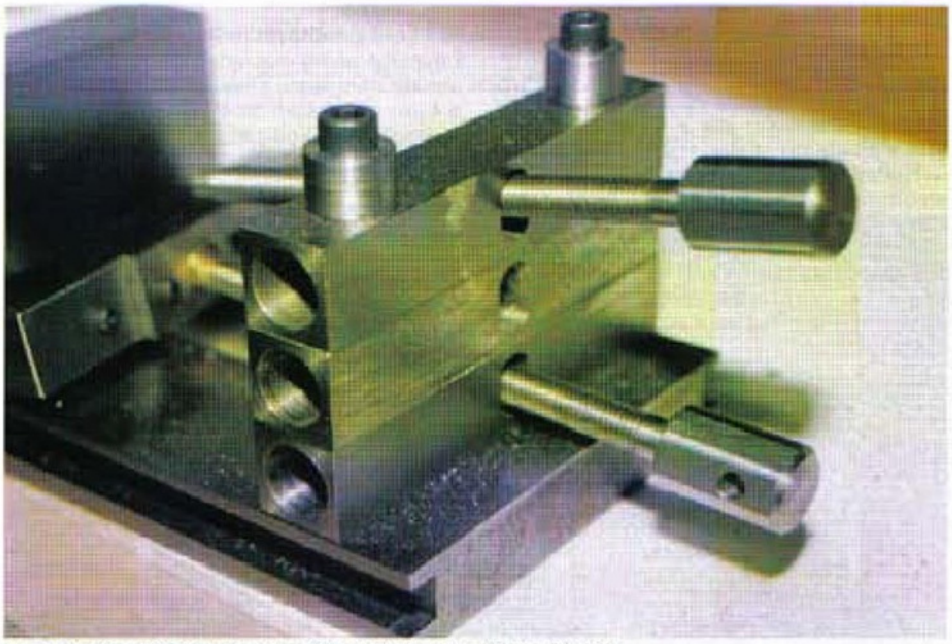
3. Clamping items of dissimilar widths



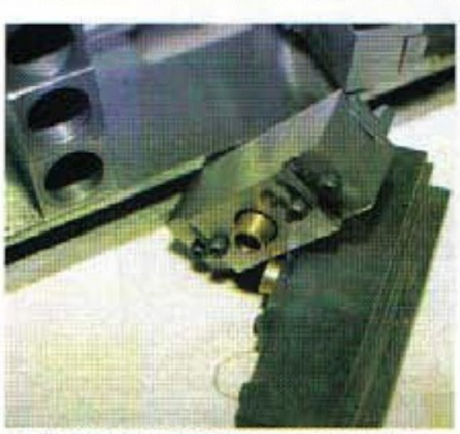
4. Clamping the lower item seen in Photo. 3. Care must be taken to ensure that the angled jaw does not tilt the component





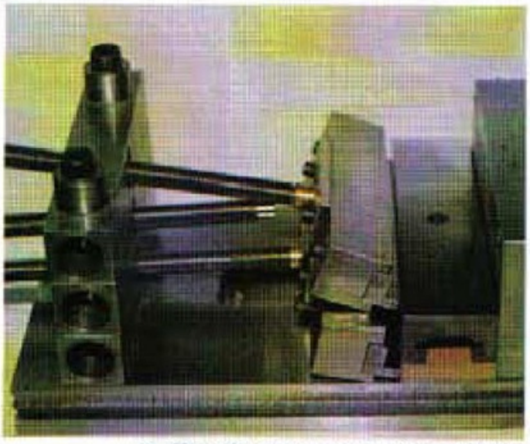


5. Trunnion blocks showing the slots for the clamp screws



6. Ball ends and their securing straps

7. Moveable jaw details, showing typical interchangeable secondary jaws



8. The vice being used when drilling components of the Quick Release Vice Jaw system

Clamp Screws

Machined from 16mm hex. mild steel and threaded M8 or similar, these could also be fabricated using commercial studding which is readily available from good tool or bolt stockists. The handle end may be machined from round material and knurled to give a good grip.

Ball Ends

Seen in **Photo. 6**, these were made from 1/2in. dia. brass, using a tool made many years ago from a design published in 'Model Engineer'. My procedure for the making of these ball units is as follows:-

1. Chuck a piece of 1/2in. brass

2. Face the end and centre drill

3. Drill and ream 6mm

4. Part off all to same length (within 10 thou.)

5. Loctite each in turn to a piece of 6mm silver steel

6. Hold in chuck or collet

7. Form ball and shaft

8. Finish with wet & dry and polish

9. Heat to break the Loctite joint and remove

Ball joint straps

These should be made before the main jaws, so that when machining the recesses for the swivelling balls, the ball, the 'O' ring and the strap can be offered up to obtain the correct fit.

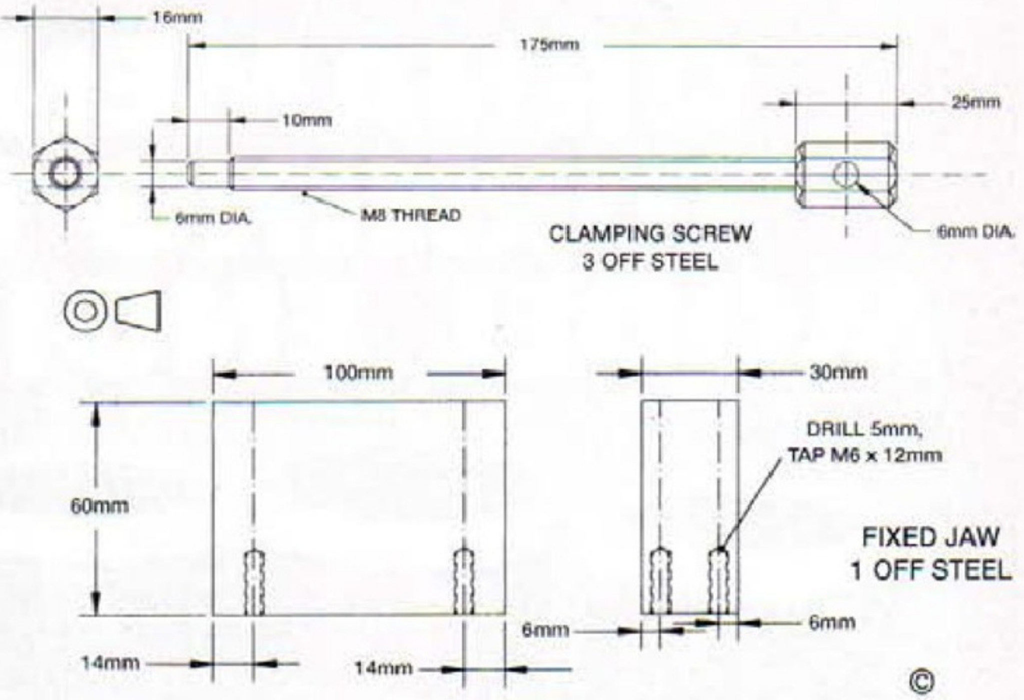
Moveable Jaws

Again machined from 20mm square mild steel, as shown on the drawing, careful control of the depth of the recess should be maintained, as mentioned above. Ideally the recess should be produced with a bull nosed end mill, but a well finished drilled hole would be acceptable, although it would result in only line contact of the ball. Typical jaw shapes are shown in **Photo. 7**, but a variety of shapes of jaw insert may be produced to suit the job in hand.

Assembly

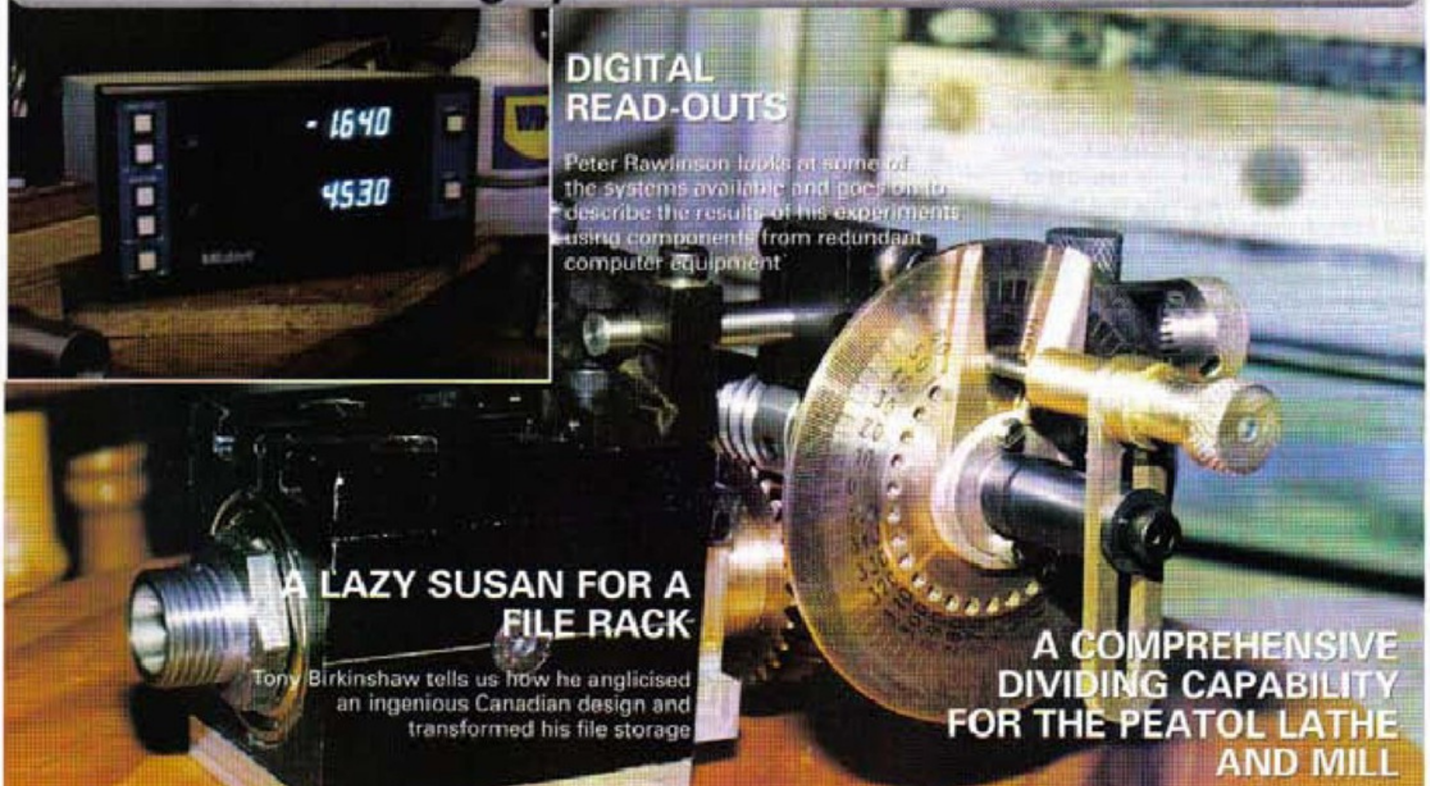
There is little that needs to be said about the assembly of the components, other than to emphasize that the fixed jaw and the trunnion housings should sit squarely on the base. Check that the slots in the trunnion housings allow the clamp screws to swivel to the degree required.

I hope that you find the vice as useful as I have. The final photograph **(Photo. 8)** shows it being used when drilling the soft jaws for my quick release vice system described in Issue 48.



IN OUR NEXT ISSUE

Coming up in Issue No. 62 will be



Issue on sale 29th October 1999

(Contents may be changed)

ORNAMENTAL TURNING FOR MODEL ENGINEERS

Visitors to recent Olympia exhibitions have admired the work of The Society of Ornamental Turners. Their Treasurer, John Edwards, shows that, with a few useful attachments, the equipment found in most home workshops can be adapted to make similar items

The traditional route to Ornamental Turning (OT) requires a fairly heavy investment in antique machinery, but a far less costly way is available to model engineers who are generally capable of adapting existing machinery and making new components. Most light engineering lathes are suitable for adaptation to OT and quite pleasing results may be obtained using relatively simple equipment.

Basic requirements are:-

- adjustable stops on the main leadscrew and both cross-slide screws
- an overhead drive
- a mill/drill spindle and cutters
- a quick-change indexing system

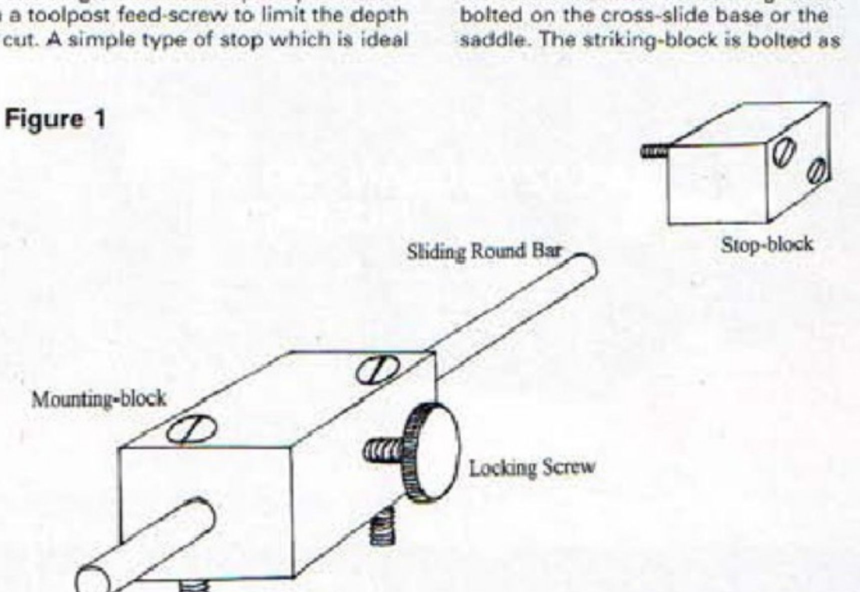
Several versions of similar equipment have been described quite fully in M.E.W. or Model Engineer and, for detailed methods of construction readers should refer to back issues. However, here are general details applicable specifically to OT:-

Adjustable Stops

There are numerous forms of stop mechanism. A simple single direction stop may be made from a stop-block and a mounting-block with a hole through it in which a round bar may slide or be locked in any position **(Figure 1)**. The stop and mounting blocks are bolted, one to a moving part of the lathe and the other to a fixed part so that the end of the bar will strike the stop, arresting the movement at the desired position. It is important to ensure there is some form of cut-out to the power feed to avoid damage to your lathe when the stop strikes. If there is no automatic cut-out you can easily fit a trip switch to cut off the electric current from the drive motor when the stop makes contact. Alternatively, if your drive belt is flat or round, you can slacken it so that it will drive the lathe for light cutting but will slip as soon as the stop strikes: but take care, do not try this with a V-belt as it could snatch and cause a serious accident.

The single direction stop may be used on a toolpost feed-screw to limit the depth of cut. A simple type of stop which is ideal for limiting the movements of the saddle and the cross-slide in either direction **(Figure 2)** comprises a bar on which two sliding stops may be clamped at any position along its length. The bar is held at both ends by mounting-blocks bolted usually to the longer of the fixed or moving parts. The striking-block is usually bolted to the shorter part. The bar to limit travel of the saddle is bolted to the bed casting or frame with the striking-block bolted to the saddle. The bar to limit the cross-slide is bolted on the moving part of the cross-slide with the striking-block bolted on the cross-slide base or the saddle. The striking-block is bolted as

Figure 1



close as possible to the middle of the range of travel and the mounting-blocks are set as far apart as possible to avoid restricting the range of movement unduly. Alternative types of dual-direction stop may be made from a piece of rectangular steel bar with a T-slot milled along it **(Figure 3)** or, if you lack the facility to cut a T-slot, a series of holes drilled and tapped at regular intervals along it. With the latter type, adjustable stop screws can then be located on the bar to either side of the striking-block **(Figure 4)**.

Dual direction stops are used in OT when taking a series of cuts to equal depth, for stopping at the ends of fluting cuts (slots) or, when cutting to a predetermined shoulder. They are equally useful in non-OT operations, especially to preserve settings in repetition work.

The Overhead Drive

The most popular type of overhead drive used on traditional OT lathes is a Double Standard Overhead **(Figure 5)**. This comprises two standards, usually made from cast iron, mounted on the frame at each end of the lathe; with a bracing bar across the top upon which are two sliding-blocks that can be arrested at any point along the length of the bar. Each sliding-block supports a crane with a weight at the rear and a pair of loose jockey pulleys at the front. The crane bar slides through the block and is clamped in position when the jockey pulleys are directly above the pulley of the driven mill/drill spindle. The weight slides along the crane bar and is clamped at a point where it will provide sufficient but not excessive tension to the driving band.

About 5in. below the bracing bar a spindle is mounted between centres, and on the spindle are two sliding stepped pulleys (and sometimes a drum) which can be clamped in any position on the spindle. One of these pulleys is driven by an electric motor (or, by a foot-wheel for those who enjoy the exercise) and the other drives the mill/drill spindle by a belt running over the jockey pulleys on the crane above.

The second crane is used when an additional drive is needed; for example, when a miniature mill/drill head, driven by one band, is mounted on a special OT accessory (e.g. an Epicycloidal Cutting Frame) which is driven by another. This usually necessitates a variation in the speed of the two drives so a second (variable or slow speed) motor is often employed.

A simpler and earlier form of overhead is the Single Standard type. As there are few applications where two cranes are needed, a modern variant of this type is suitable for basic OT and is simpler to make. It is sometimes designed to use the electric motor as a counterbalance weight **(Figure 6)**. The standard is bolted firmly to the lathe frame, usually at the headstock end or, if convenient, it may be better fixed to the ceiling or the wall of the workshop, thus avoiding undue vibration to the lathe.

A single crane is mounted on a double (horizontal and vertical) swivel on top of the standard so that it may be swung into any position over the bed. On the back of the crane is mounted a small electric motor which is usually sufficiently heavy to balance the crane but extra weights maybe added to provide the correct tension. On the front arm of the crane are two sliding-blocks each holding a pair of pulleys on swivels so they may swing from side to side, with the intention of preventing the drive belt from jumping off when the mill/drill spindle is traversed across or along the lathe bed. The sliding-block nearest the standard is positioned in line with the pulley on the electric motor and the second sliding-block is positioned above the pulley of the mill/drill spindle.

Figure 2

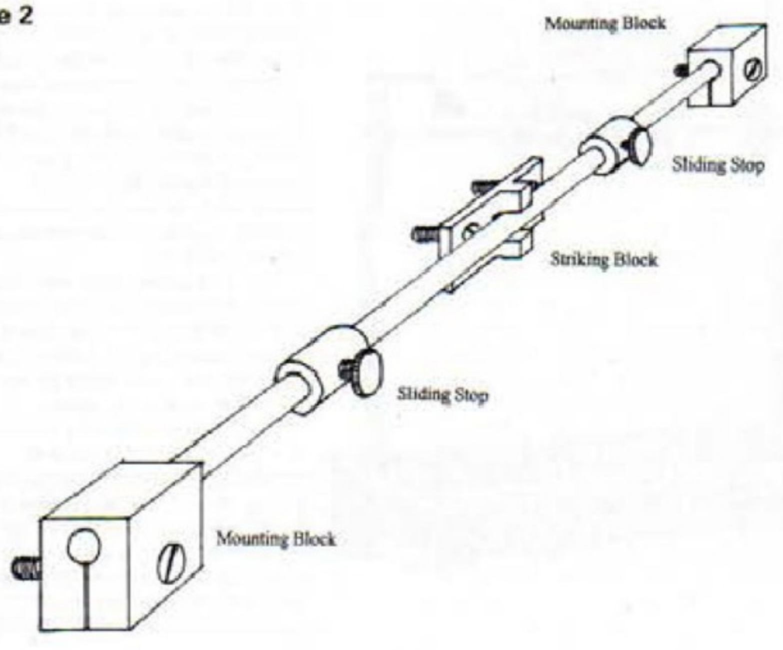


Figure 3

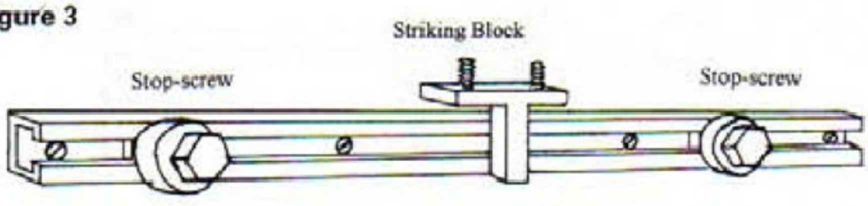
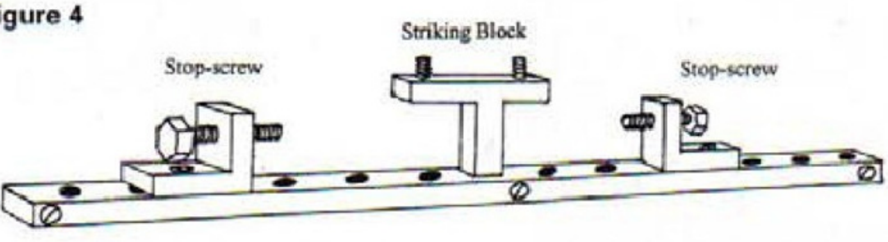


Figure 4



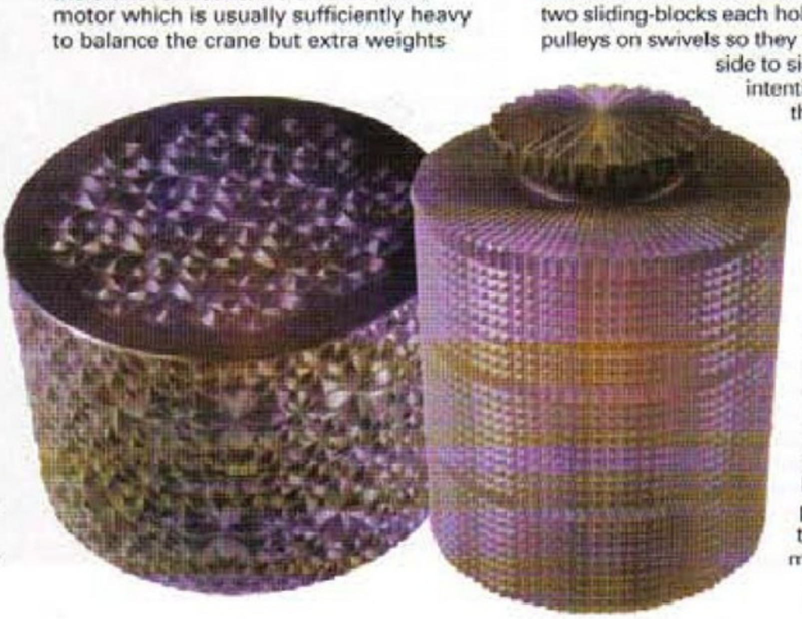


Figure 5

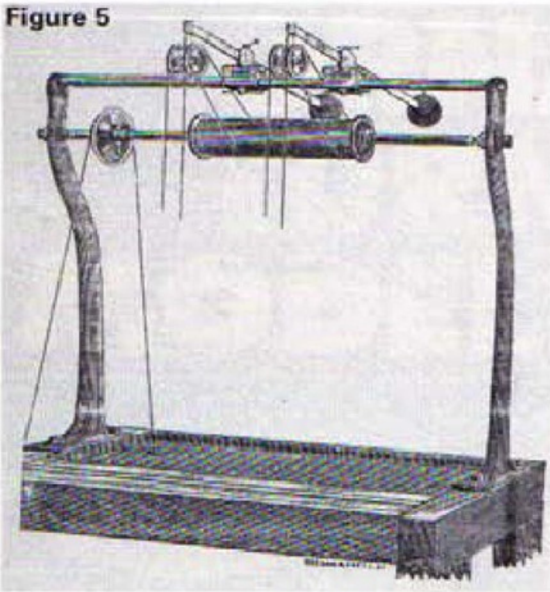
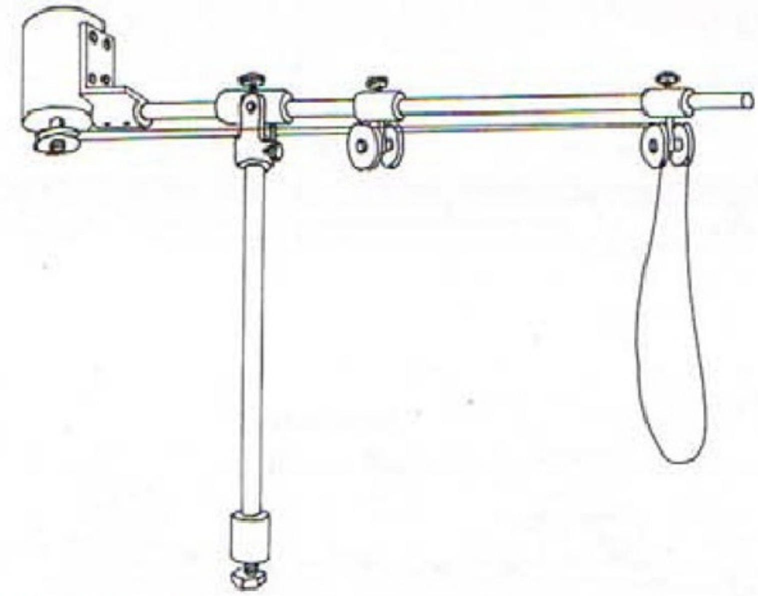


Figure 6



©

The Mill/Drill Spindle

The milling spindles described in previous issues have been generally of a heavier type than those traditionally associated with OT, although most could be adapted in some way to that use. For ornamental milling and drilling, the main requirement is for a spindle that can be mounted on the toolpost horizontally and in line with the direction of travel of the tool-slide (compound slide) and adjusted to cut at centre height. In a true ornamental slide-rest the tool-slide has its own cutting-depth stop and is capable of traversing across the work at any angle in the horizontal plane, but it is not worth the trouble of making an OT slide-rest unless you are certain you want to pursue this hobby seriously.

The chuck may be of the small Jacobs type but a collet chuck may be more suitable for holding cutters and cutting heads. Collets should be made to fit standard sizes of tool steel and small end-mills or slot-mills in a range of diameters, say, from about 1/8in. or 3mm to 1/4in. or 6mm **(Figure 7)**.

Various cutting heads may be made to fit in the chuck; one to hold a slitting-saw or small horizontal mill and others to hold single-tooth cutters made from round, square and rectangular section tool steel. Another useful addition is a fly-cutting head for planing and circular cutting **(Figure 8)**. (The OT equivalent, known as an Eccentric Cutting Frame, will be the subject of a future article.)

Ball or needle-roller bearings are best if the spindle is to be run at high speed, but the traditional hardened and lapped steel taper bearings are quite suitable for light cutting at moderate speed.

The drive pulley may be at either front or rear but, for ease of removing the driving band, the pulley should not be enclosed. If there is any possibility that you may become deeply involved in OT you would be well advised to make this item with a standard shank of 9/16in. square steel bar of 5in. length, so that it will fit the tool-slide of an OT slide rest should you ever acquire or make one. It is a simple matter to make an adapter to mount the mill/drill to your lathe toolpost **(Figure 9)**. However, if you already have a small vertical slide (the Myford type would be ideal) you can, with a little more effort, make a universal adapter which will turn your mill/drill into a Universal Cutter **(Figure 10)**.

The universal adapter allows the mill/drill spindle to be adjusted to any angle in the vertical plane and the vertical slide allows the point of the cutter to be fixed at centre height in any orientation. When designing your adapter, bear in mind that, when the spindle is vertical (with the cutter downwards), the vertical slide must be capable of raising the cutter point to centre height: conversely, when the spindle is horizontal, the vertical slide must be capable of lowering the cutter point to centre height. Also, if the spindle is to be set more than a few degrees above or below the horizontal position, a pair of jockey pulleys will be needed to prevent the driving band from jumping off **(Figure 11)**.

When set in the horizontal position the mill/drill spindle may be used for drilling, slotting (fluting) and routing, using a twist, flat, or ornamentally profiled drill, a slot-mill or an end-mill. When set in the vertical position or at any angle in the vertical plane, it may be used to cut grooves at any angle or slots (flutes) at any width between the width of the cutter to its maximum cutting radius, using a single tooth cutter, face-mill or slitting saw.

Indexing the Chuck

Many OT patterns are formed by a series of cuts made at regular intervals around the work, the intervals being determined by a quick-change indexing system. Traditional OT lathes have a Division Plate on the headstock pulley with a spring index (or detent). This generally has six circles of division holes; 360, 192, 144, 120, 112 & 96. The most useful ones are 96 & 120.

The engineer's indexing head is really too slow for use in OT but, if you have one, it will simplify the task of making a Division Plate. On a light engineering lathe such a plate may be conveniently attached to the chuck backplate. The plate can be a disc of brass or steel, something about 3/16in. (5mm) thick will do, and, ideally 7in. (180mm) or more in diameter, but it cannot be greater than the swing of your lathe. The larger the diameter you make the plate, the wider-spaced will be the division holes, making them easier to see and to count. If readily available, a disc of brass looks more attractive than steel and the division holes will be more visible.

Some engineering lathes have a positive spindle lock; if yours does not, it probably has a gearbox or gear train which can prevent movement of the spindle when the power is off. Any backlash in the gearing can be taken up by winding a cord around the chuck and suspending a weight on it so the backlash is taken up. If your lathe has no means of locking the spindle, you may devise a spindle clamp which can be made from scrap materials **(Figure 12)**.

To make a Division Plate cut a disc on the bandsaw if you have one

Figure 7

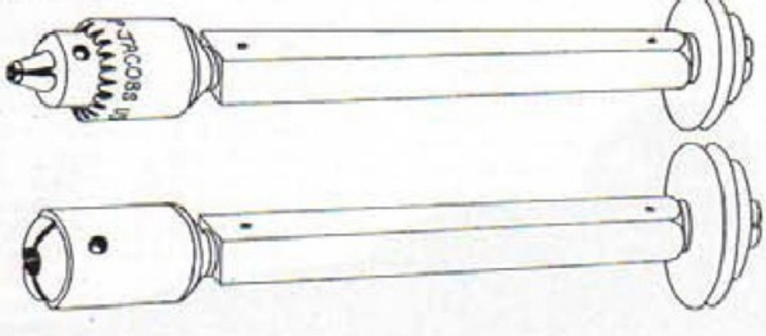
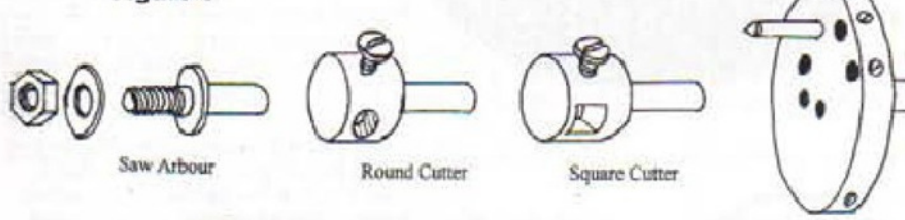


Figure 8



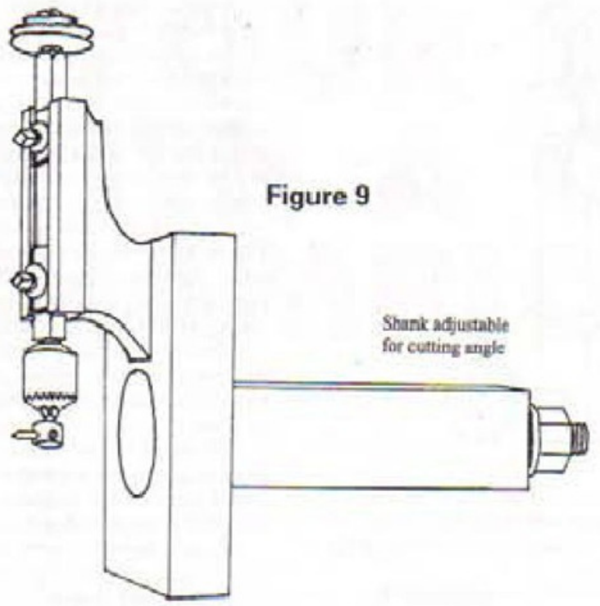


Figure 9

or, by chain-drilling and filing if you haven't. Cut a hole in the centre to fit over the boss of the chuck backplate. Drill fixing holes (usually three) to correspond with the bolt holes in the backplate and fix the disc, backplate and chuck together. You will probably need to replace the original fixing bolts with longer ones. Fix the disc to the chuck, mount it on the lathe and turn the edge of the disc true.

Using your engineer's indexing head, if you have one, and your new Mill/Drill Spindle in the toolpost, with a centre drill fitted for accuracy, drill your circles of holes at convenient radii around the disc; largest numbers outer-most. If you do not have an indexing head the task will be more laborious so I suggest you start with just two circles of divisions, 120 & 96, perhaps leaving space to add the other circles at a later date. If you have a set of gear wheels with your lathe you can use these to locate the divisions. For example, for the 120 circle put an 80 tooth gear on the Headstock Spindle, mesh it with a 40 tooth coupled with a 60 tooth (or any combination to give the same result). Make a detent to stop the train at any position on the 60 tooth gear, wind a cord around the headstock pulley and attach a weight to the free end so that the backlash in the train is always taken up. Each time the detent is moved by one tooth on the 60 gear the headstock will turn $^1/_{120}$th of the circle enabling you to drill a hole at each of 120 equal division points. With your new Mill/Drill Spindle in the toolpost and the Headstock Spindle locked, drill a hole at the radius on the disc which you have chosen for the 120 hole circle. Unlock the lathe spindle, move the detent by one tooth on the 60 wheel, re-lock the spindle and drill the next hole, repeating the operation until all 120 holes have been drilled. The holes may be between 0.040in. and 0.080in. (1 - 2mm) in diameter: the size becomes critical only when the numbers are high; e.g. a circle of 360 holes on a 7in. diameter will require the holes to be not more than, say, 0.030in. if the space between holes is to be not less than their diameter. On an OT lathe the holes are

Figure 10

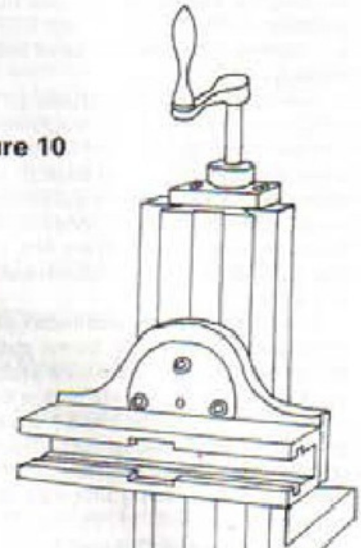
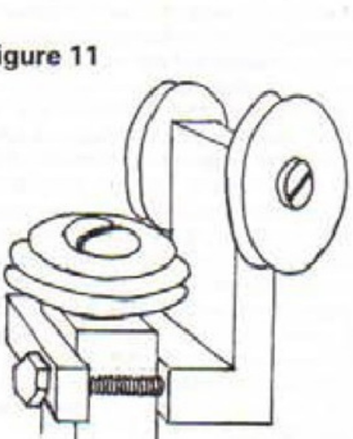


Figure 11



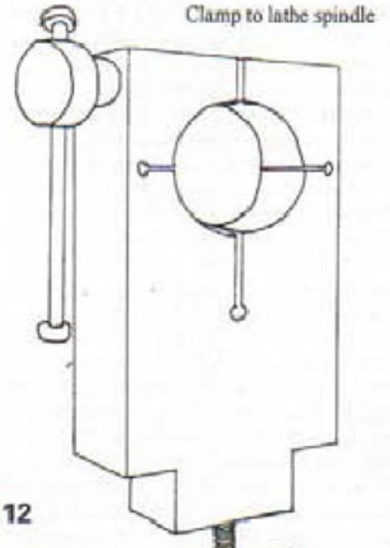


Figure 12

Figure 13

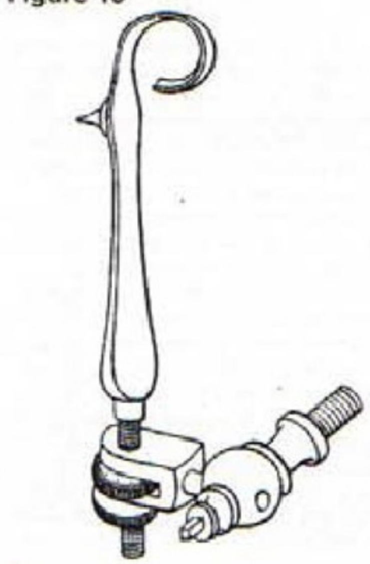
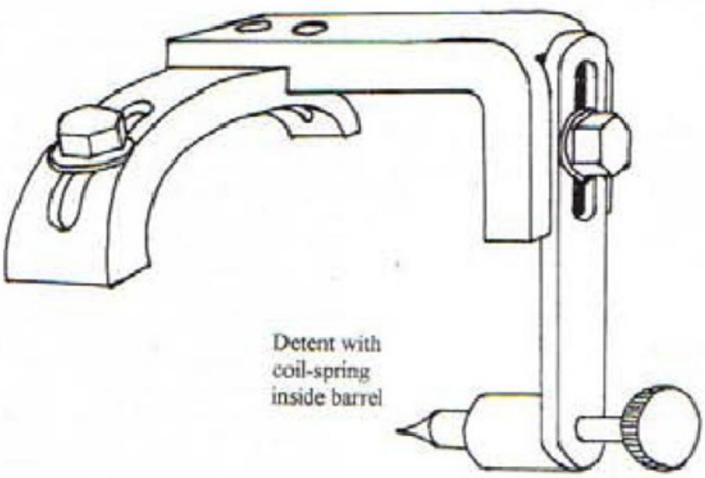


Figure 14



©

$^{3}/_{16}$in. or less deep and do not pass completely through the plate. However, they will be easier to keep clean if you drill them straight through.

For the 96 circle move the Mill/Drill to a smaller radius on the plate; e.g. if the 120 circle is at 3 $^{1}/_{2}$in. radius, the 96 circle could be at something around 3 $^{1}/_{4}$in. radius. Put an 80 tooth gear on the headstock spindle, mesh to a 50 tooth coupled with a 60 tooth gear (or other combination to give the same result), adjust the detent to the 60 tooth gear and proceed as before. In the absence of either a Dividing Head or a set of gears, a third way of making a Division Plate is to take a large sheet of paper (about size A2) slightly longer than the circumference of the disc and cut two narrow strips from one long edge, wrap these in turn around the edge of the disc and cut each one to the exact length of the circumference. On both long edges of the remainder of the sheet mark off 120 equal spaces (intervals of 0.2in. or 2mm would be suitable); then draw parallel lines to join the marks, giving 120 equidistant parallel lines. Place one of the circumference strips diagonally across the lined page so that one end of the strip is aligned exactly with the left edge of the lined paper and the other end is aligned exactly with the 120th. line. Now, mark the strip accurately at each point where it crosses a line until the strip is divided into 120 equal parts. Next, place the second strip diagonally across the lined page as before, but this time align the right-hand end with the 96th. line; mark off the 96 divisions and put the strip aside for later use.

Glue the 120 division strip carefully around the circumference of the disc so that the ends butt together. Lock the lathe spindle. Mount a scribing gauge on the lathe in such a position that the scribing point may be placed accurately alongside one of the division marks on the edge of the disc: a magnetic base may be used to mount the scribing gauge.

With your new Mill/Drill Spindle in the toolpost, drill a hole at the radius on the disc which you have chosen for the circle of 120 holes. Unlock the lathe spindle, rotate it to the next division mark, re-lock the spindle, re-check that the scribing point is exactly in line with the mark and drill the next hole, repeating the operation until all 120 holes have been drilled. Remove the paper strip, clean the glue off the edge of the disc and glue on the 96 division strip. Adjust the cross-slide to the radius chosen for the 96 circle of holes and repeat the drilling operation.

The traditional type of Index **(Figure 13)** is a long arm made from spring steel about 8in. (200mm) or more long, mounted in the plane of the chuck backplate such that the index point will be at or above centre height for good visibility and quick access.

For this type, the bracket is usually fixed to the headstock casting, the lathe bed or the lathe bench in such position that it will not foul the leadscrew or any other apparatus. You could use an old spring steel rule for a prototype and you might like to make an improved version later. Another method which may be more suited to modern lathes is a plunger-type detent with a coil spring **(Figure 14)**. This may be mounted on a bracket fixed at any convenient position on the headstock casting. Sometimes a pattern will require indexed intervals starting at a specific point on the workpiece so the detent will need to be adjustable to span two or more holes in each circle whilst the spindle is locked. This facility can be provided by some means of adjusting the length of the detent arm and/or, by slots to allow re-positioning of the bracket.

The point of the index arm/detent should be tapered so it will fit snugly in any division hole without sticking; the traditional type has a curved taper.

Adjust the index arm/detent so that it may be placed into any hole in the range you select and you are ready to do indexed milling. The 96 circle will give divisions of 2, 3, 4, 6, 8, 12, 16, 24, 32, 36 and 48; the 120 circle will give in addition 5, 10, 15, 20, 30, 40, 60. These are sufficient for the needs of most OT patterns.

For ease of use, the circles on the division plate should be engraved with numbers and guidelines: for the 120 circle I recommend numbers to indicate every 10th. division and guidelines at each intermediate 5th. division; for the 96 circle, numbers at every 6th. division and guidelines at each intermediate 3rd. division.

The Division Plate and Index are used in several ways for OT. Some patterns are formed from simple cuts around the work at regular intervals (e.g. a cut at every 6th. division on the 96 circle will give 16 equally spaced cuts). Some complex patterns are made with cuts at increasing/decreasing intervals (e.g. cutting at 1, 2, 4, 7, 11, 16, 20, 23, 25, 26, etc.). Stepped and brickwork or basketwork patterns are made by progressive or alternating series of cuts (e.g. cutting at 1, 3, 5, 7, 9, etc., then turning the leadscrew a pre-determined distance and cutting at 2, 4, 6, 8, 10, etc.).

A few words about leadscrews

All the leadscrews and guide screws on traditional OT lathes are of 10 threads per inch, with micrometer dials marked in 20ths, so cuts may readily be placed at intervals measured in multiples of 0.005in. For quickness and simplicity most OT patterns are calculated in 10ths of an inch and regulated by full turns of the leadscrew. Many OT cutters are 0.100in. wide or multiples thereof. If your lathe leadscrew and cross-slide screw are of any other thread pitch you will need either, to calculate and regulate your patterns on a different basis or, calculate the leadscrew movements necessary to advance in 10ths of an inch.

The next moves

These items will increase the versatility of your lathe in several ways so, if you should find that OT is not for you after all, you will not have entirely wasted your effort in making them. If, however you become fascinated by this hobby, you may wish to take it further and make some of the following:-

special cutting frames
ornamental cutters
special chucks
special slide-rests
synchronised drives
shaping mechanisms

and that should be enough for one lifetime!

The shapes and patterns that can be made by ornamental turning are many and various. The photographs show a few examples of the author's work.

FOUR YEARS WITH A CHESTER CHAMPION MILL

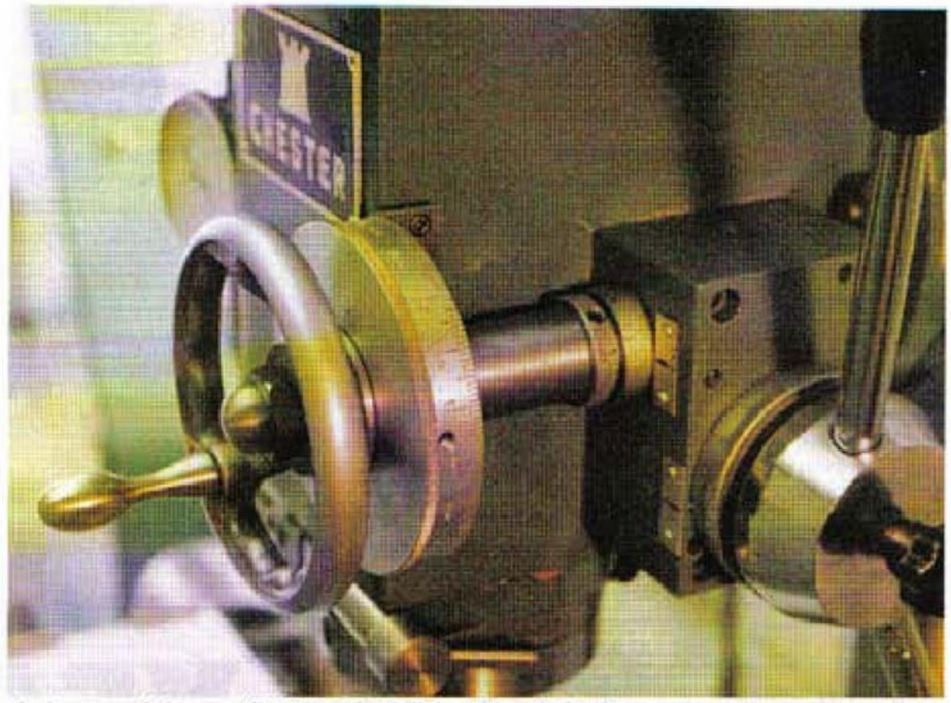
We are often asked our opinion of a particular machine tool, but find it difficult to help because, to make a fair assessment, information must be gained over time and a range of tasks. It is therefore helpful when readers offer to tell us of their experiences. Here, John Crammond of Ulverstone, Cumbria gives us his impressions of a popular small milling machine

Thirty years ago. when I was starting to assemble my workshop, milling machines were thin on the ground, especially small vertical types. Far Eastern products had not yet appeared and choice was very limited. Having had my share of heart stopping moments through milling in the lathe, I reached the conclusion that a small mill was becoming essential, and after careful deliberation I constructed a Dore Westbury, which served me wonderfully for 25 years. Constant use over this period of time inevitably causes wear, despite the most careful maintenance, and the day arrived when I decided that a new machine would be nice. Nowadays, we are faced with a bewildering choice, each offering its own special attractions, so I decided to make a list of the points that were important to me. These were:-

1. Front to back depth to be as short as possible
2. Good head and table rigidity
3. No. 3 Morse taper
4. Long table and quill travel
5. Adequate speed range
6. Ability to take a ½in. dia. draw bar.

It goes without saying that, in addition to the above list, the machine should have an accurate spindle, properly supported, and so I spent the next few weeks pouring over adverts and specifications, comparing one machine with another until I decided that, with one or two reservations, the Chester Champion fitted the bill best. With the motor mounted on top rather than behind it was shallower than

A general view of the head



A close-up of the modified downfeed dial and handwheel

most other mills. A heavy machine has a better chance of being rigid than a light one, providing the weight is in the right place of course, and at 300lb for a small machine, I was hopeful that rigidity would be good. As all other requirements bar No 6 were satisfied from specifications provided by Chesters, a visit to the Company to inspect the machine was planned. This involved a round trip of over 200 miles from my home in the Lake District, but Chesters were easy to find - though they have since re-located. I was expected, having phoned earlier, and I was greeted by Chris who took me to the showroom where I was left on my own to examine and try the machine.

My reservations

The cosmetic appearance of the Champion was better than I had hoped, and the controls of the machine on show all operated smoothly; dovetail surfaces were all hand scraped and I had a good feeling that the machine would suit me nicely. I raised the reservations I had with Chris, these being:-

1. Was the slim 2 3/4in. column strong enough?

2. Could the head be lowered closer than 3in. from the table?

3. Could the hollow spindle take a 1/2in. draw bar?

I was reassured firstly that the column was a substantial casting with very thick sections, and not thin tubing. Secondly by removing a large spring from a housing on top of the column, the head could be lowered to within 1in. of the table. Though supplied with a 12mm draw bar as standard, there was ample room to fit a half inch one, so as there were no further obstacles in my way, I placed an order for one with variable speed. I collected it three days later, having taken the opportunity to have a short holiday in Snowdonia, an area I had frequented often in my youth, but had not visited for many years.

Installation

Back at home the machine was installed, the remaining protective grease removed and the electrics connected up. The variable speed model differs in that it uses a 3 phase motor powered by an inverter, which amongst other things provides motor braking, reversal of direction of rotation and, of course, variable speed. I screwed both the inverter and the mains control box high on a wall out of danger, but still within easy reach. I subsequently found it necessary to fit a filter into the line, to eliminate radio interference. Chesters supplied and advised me on this important item which enabled me to continue to enjoy a musical accompaniment while working as the mood takes me.

I had to remember that inverters do not like frequent mains disconnection, and it is good practice to leave them on standby, using the switch on the inverter to stop and start the motor.

The Champion is traditional in construction, differing only from most other mill drills in that the motor is mounted on top and that the head will rotate under control of a worm and wheel, giving an angular milling facility. The table is superbly ground, obviously the product of modern computer controlled machinery, and the matt finished lockable dials are crystal clear to read and a pleasure to use. Table travel is approx. 17in. x 6in., quite remarkable for a small machine, although to achieve this the table is withdrawn 2in. or so past the left hand side of the saddle. The width of the saddle is so great however that 9in. of table still remain in contact, and as the longitudinal feed screw is supported in bearings at both ends, there is no danger of winding it out of its

The dial indicator mounting

bronze nut. Both X and Y feed screws and nuts are hidden from view, but have lubrication points to ensure long life, as do their support brackets, which contain plain bearings and thrust races to control end float.

Additional spring loaded oiling points are provided for all dovetail ways and the bottom quill bearing. Bed wipers on both sides of the saddle work effectively, and the machine is very easy to keep clean. Regardless of how hard or long I work my machine, the motor never gets hotter than luke warm and is almost silent in use.

Quill travel is around 3 1/2in. and the fit of the quill in the head casting is excellent. I must admit that I was worried about this as no adjustment is provided, the usual clamping arrangement being replaced by a

The spindle flange for mounting a boring head, the register having been machined in situ

separate split ring bolted to the bottom of the head casting where the quill emerges.

Normal belt changes are easy, with the motor body revolving eccentrically in a casting on top of the head, and even without variable speed, a useful range of 400 - 1600 rpm is on hand. The variable speed option however gives an infinite adjustment between 50 and 1800 rpm, with plenty of torque throughout the range. I cannot emphasise how good this option is as it makes belt changing a rare occurrence.

Testing

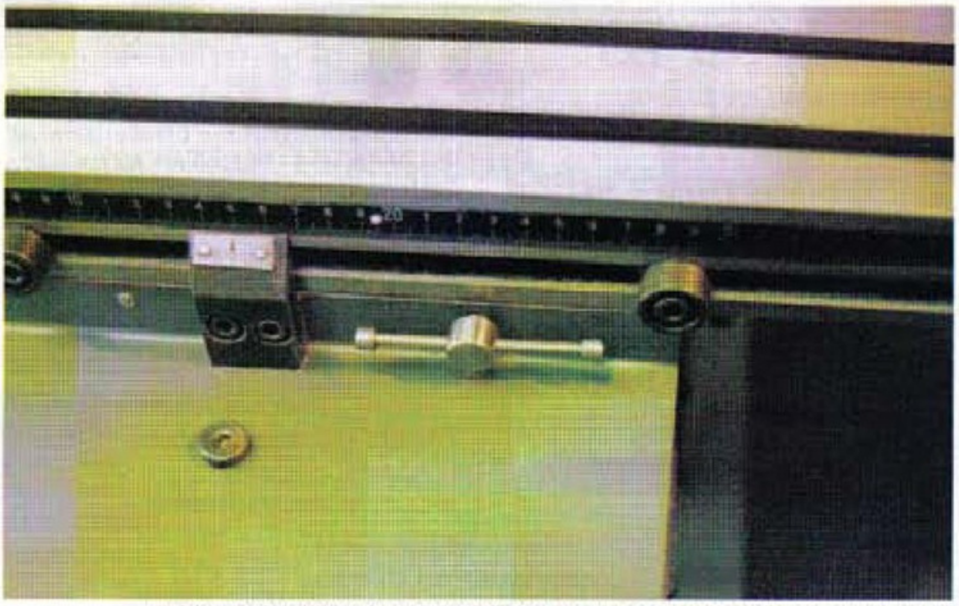
My first job was to verify the results of the individual Test and Accuracy report issued with every machine, and I was pleased to note that whereas none of my findings were worse than those shown on the certificate, some were better. For instance, Morse taper run out was listed as 0.012mm whereas my dial test indicator failed to detect any movement at all. My table was flat within half a thou, in any 10in. length, and from end to end there was no more than one thousandth of an inch total deviation from zero. Feed screws showed only tiny errors over distances of 3in. and I would not expect cumulative errors over their whole lengths to exceed more than a very few thou. I never rely on feed screws completely anyway, and prefer to cut a little short, measure and add further travel as necessary.

Having satisfied myself that the machine was accurate in theory, it was time to try it out, and the smile was soon wiped from my face with the first cuts which were very poor. An examination of the surfaces and my experience with the Dore Westbury left me in no doubt that the spindle bearings were slack. After proper adjustment, the transformation was magic and I got the surface finishes I had hoped for.

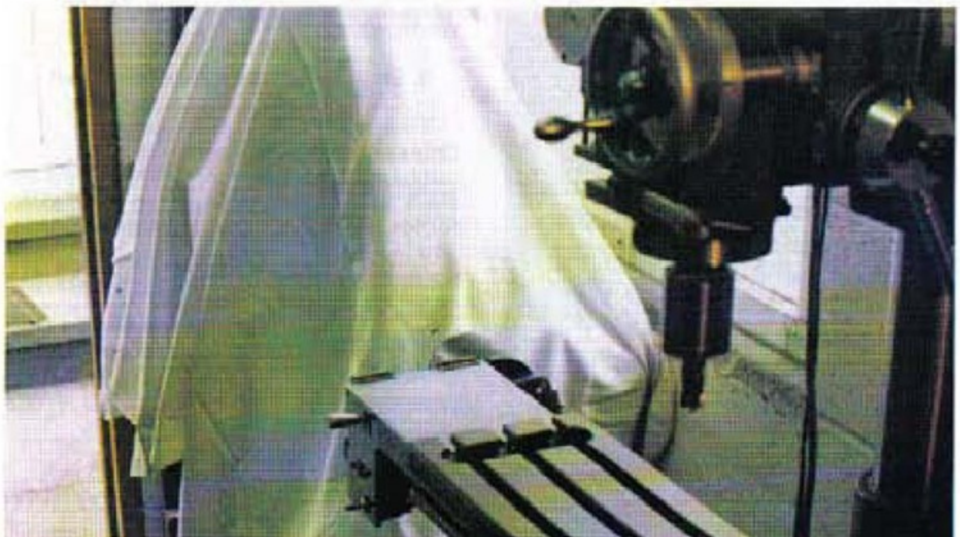
Endmills up to ¾in. work very well, and heavy cuts can be taken if necessary. I personally prefer to take one or two moderate cuts rather than one deep one as it is kinder on the cutter, has less chance of causing cutter deflection and usually produces a better finish. Where wide surfacing cuts are needed, good results are obtained by the usual overlapping procedure, but I frequently use shell endmills up to 2in. dia. to equally good effect. Spindle speeds do of course need to be considerably reduced with this size of cutter, and common sense used with depths of cut, but providing the tool is sharp, surface finish remains good.

I was never able to produce a perfect right angle when changing from X to Y axis on my Dore Westbury, but I was delighted to find that this little machine produced a true 90 deg., perhaps not true to the second, but good enough to show no light under the blade of a square.

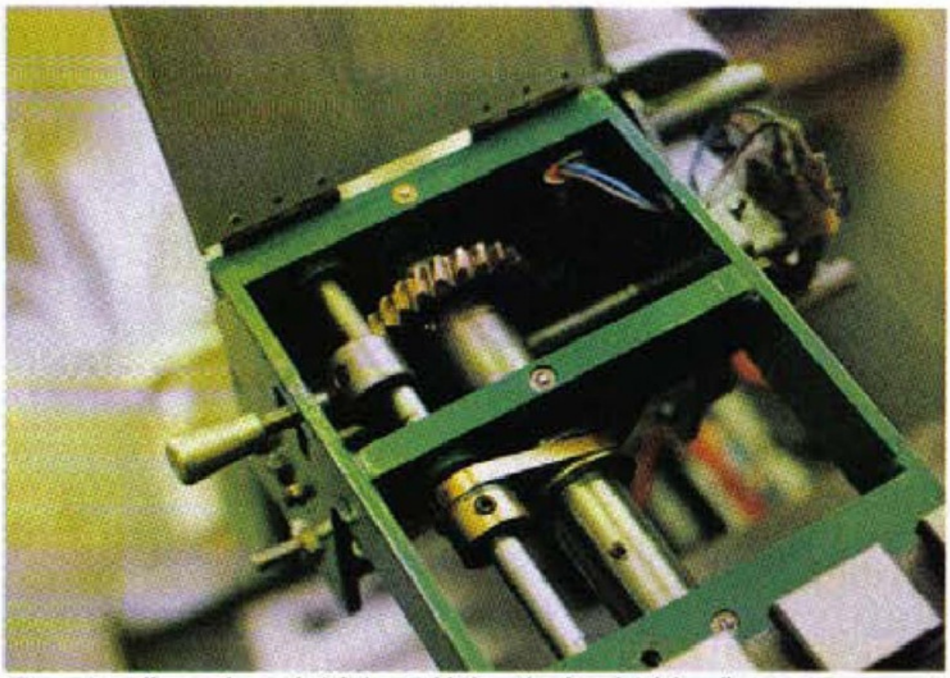
It quickly became obvious that there was some misalignment of the feed screws, for when the handwheels were screwed close to their nuts, additional turning pressure was required. the



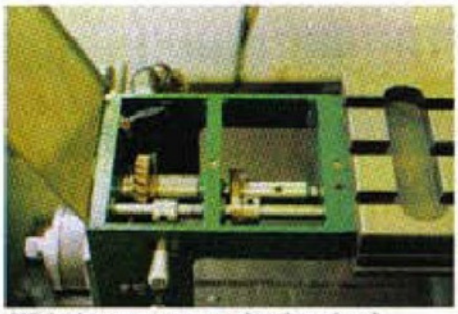
A table lock with spring loaded 'T' handle. This can be slid from side to side, allowing 360 deg. rotation. A similar lock is fitted to the cross-slide



The left hand end of the table, showing the location of the self-act feed mechanism



The centre-off reversing switch is located below the dog clutch handle



With the cover open, the dog clutch mechanism is easily accessible. To the left is the housing for the wire wound variable resistor which provides control of the feed rate

The centre wall forms a bearing support for the gear shaft. Note the three spring loaded oiling points which facilitate spindle lubrication

tapered gib strips were not to blame and slackening off the bracket screws did not relieve the problem as the brackets were additionally dowelled. Removal of the dowels however allowed the brackets to be moved slightly, effecting a cure, and as there were more than enough screws to ensure nothing would be likely to creep in the future, no attempt was made to refit the dowels

Criticism is often levelled by owners of mill drills at the amount of backlash on the downfeed handwheel. Sometimes this is evident from new and sometimes it develops over a period of time. It can usually be traced to one of the following, or a combination of them:-

1. Poor meshing between the rack cut into the quill and its pinion

2. Poor meshing between the worm fitted to the handwheel shaft and its worm wheel

3. Endfloat on the handwheel shaft

Thankfully for us, those clever Chinese folk had the sense to fit a removable housing for the worm and its shaft, enabling us to take it to the bench for inspection. Here you will find that you can machine new eccentric bearings for both ends of the worm shaft, enabling it to be placed deeper into mesh with its wheel if necessary. End float can be adjusted to near zero with shims and the results of one's labour should be a big improvement.

Improvements as a result of experience

In four years of regular use, the only failures I have had have been stripped threads on the 'T' bolts that permit the head to swivel and similar stripping of the two bolts that lock the motor following belt adjustment. I replaced these with studs and nuts and have had no problems since.

Over the years, I have made a number of what I consider to be improvements, some of which are the following:-

1. Original handwheels replaced with 6in. ones. These give more control, and with increased leverage are easier to turn.

2. Original socket headed table locking screws replaced with sliding 'T' handled types.

3. A large 3in. dia. calibrated downfeed dial fitted.

4. A 1in. travel dial indicator permanently fitted to the downfeed arrangements to ensure that any backlash in the system is seen and any creep quickly corrected.

5. A large diameter register clamped to the bottom of the spindle for the attachment of a boring head. I like this method of fitting and like to think, rightly or wrongly, that it is more rigid than Morse taper systems.

6. A self-act table feed was designed, specifically not to reduce table travel or interfere with access to 'T' slots. This runs off a 12v windscreen wiper motor and a second worm and wheel, and with speed adjustment provided by a wire wound variable resistor gives a maximum of just over an inch of travel per minute. It has a dog clutch for instant disconnection, and direction of travel is reversible.

I have auto table travel on my larger universal miller and the difference between auto and hand feed is like chalk and cheese. Cutters stay sharp longer and it is possible to get on with other work during those long cuts, with complete safety if a cut-off mechanism is fitted.

Conclusions

I cannot say with honesty that this machine is perfect. It has bitten me on several occasions, likes to produce those needle sharp slivers that find their way under one's skin, and prefers to make a mess on my floor rather than on its own table. In truth I should add that it has not made any mistakes that have not been my fault and, so far, it has not had the bad manners to break a cutter.

I have no connection with Chesters at all, but liked their friendliness and enthusiasm. It would be wrong of me to infer that the Champion will do all things for all men, It clearly won't. What it has done for me is to confirm my belief every time I use it that, for me, it was a very good buy.

I hope the foregoing will be of use, but not influence prospective purchasers for, at the end of the day, you need to try these machines yourself before arriving at any decision. I hope also that those others who, like me, simply enjoy machinery will have read with interest my experiences over a number of years with this little machine.

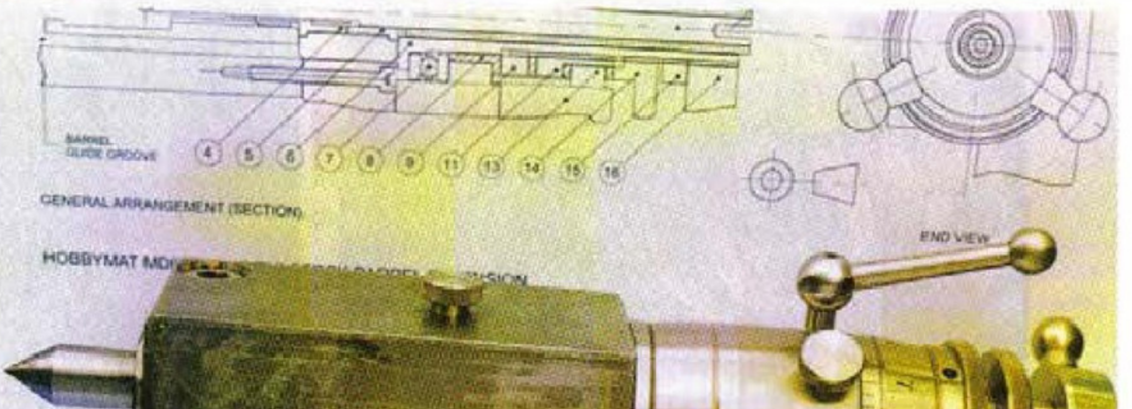
MODIFICATIONS TO THE HOBBYMAT MD65 TAILSTOCK

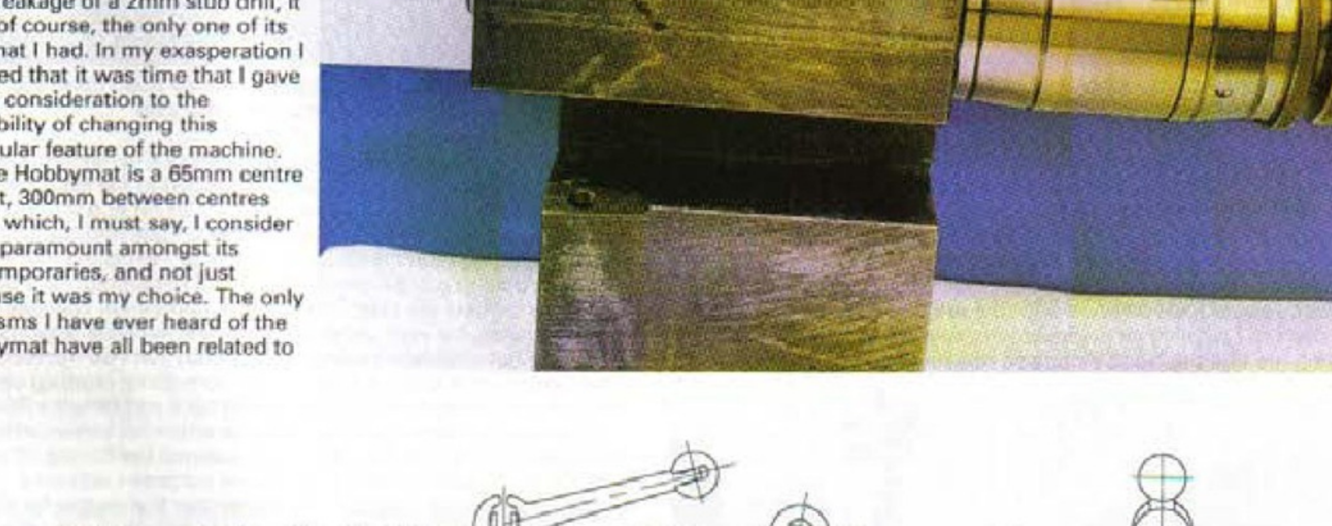
E. J. (Mac) Mackenzie relates how he set about specifying and designing improvements to his example of this popular machine and provides drawings and some constructional hints for those who may wish to follow his example

Introduction

Whenever I return to the Hobbymat after a lengthy spell on the Myford, I invariably try to advance the tailstock barrel by the normal method of clockwise rotation of the feedwheel. As Hobbymat users will be well aware, this results in the retraction of the barrel, and any tooling installed therein might well be ejected, with the possibility of some damage. After a recent occurrence of this, when I suffered the breakage of a 2mm stub drill, it was, of course, the only one of its size that I had. In my exasperation I decided that it was time that I gave some consideration to the possibility of changing this particular feature of the machine.

The Hobbymat is a 65mm centre height, 300mm between centres lathe, which, I must say, I consider to be paramount amongst its contemporaries, and not just because it was my choice. The only criticisms I have ever heard of the Hobbymat have all been related to





HOBBYMAT MD65 LATHE TAILSTOCK BARREL EXTENSION

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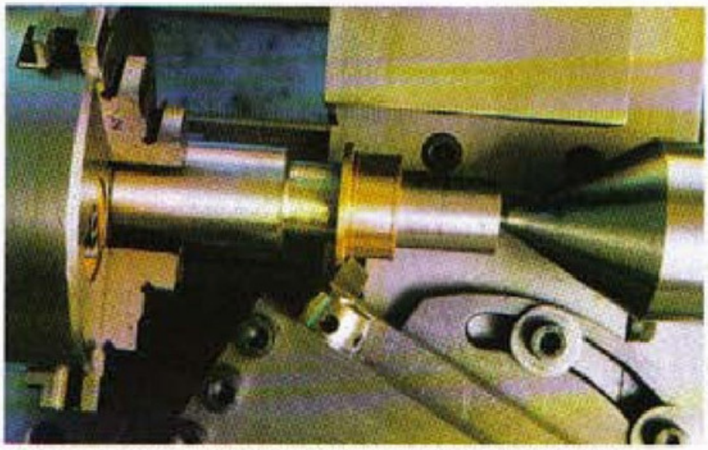
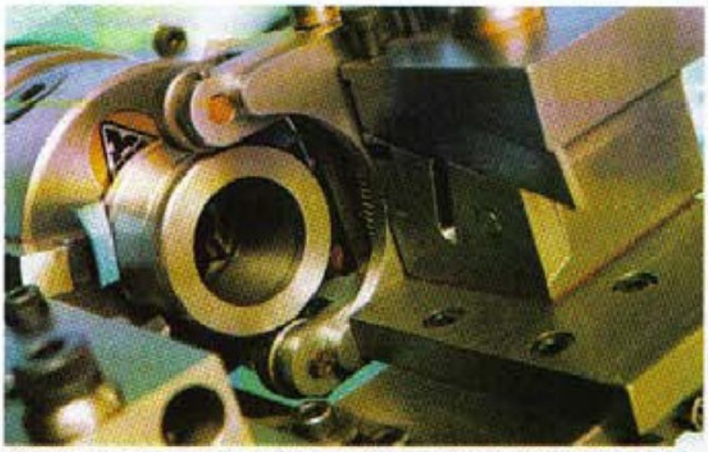
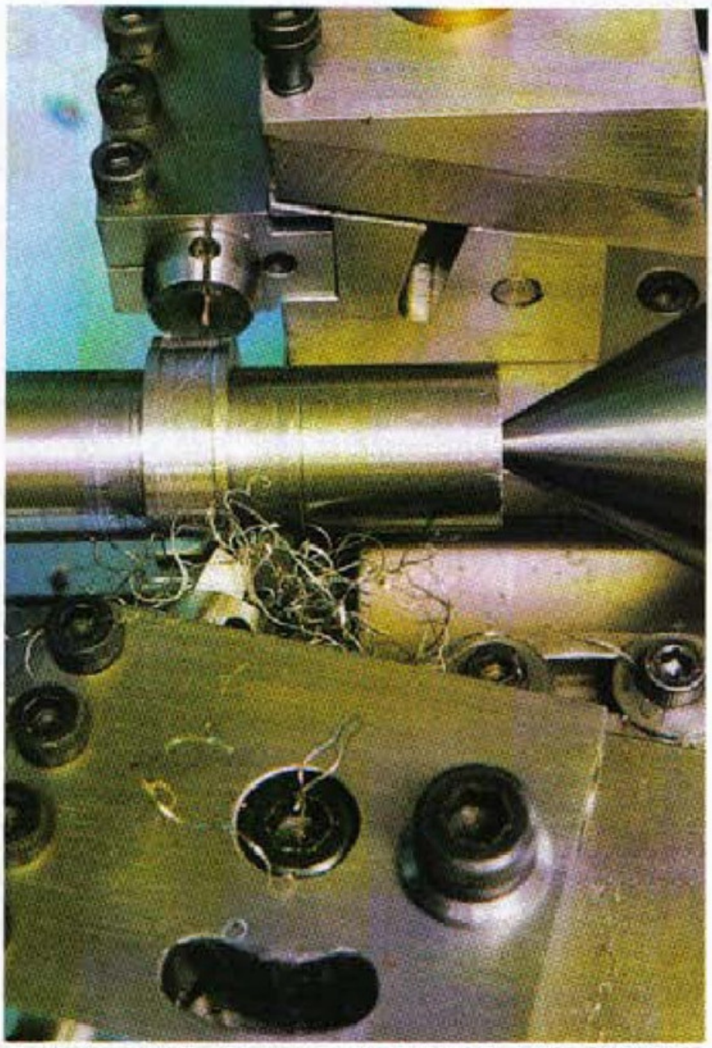


Turning the Spindle Bush Liner (Item 8) to produce the gap required to obtain a satisfactory adhesive bond. Note the lands which maintain concentricity of location



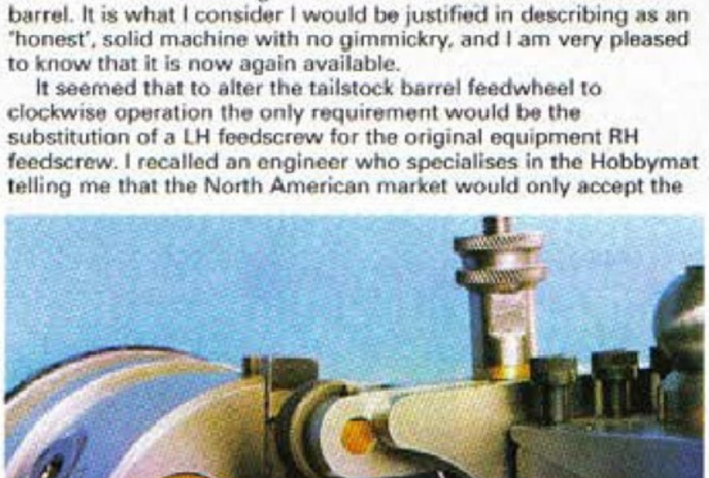
Knurling the finger grip of the Micrometer Index Collar (Item 13C). The work is held in the chuck, gripping the diameter which will carry the graduations after final skimming to size



Producing a similar clearance on the Spindle Bush (Item 3B). This component is also mounted on a taper mandrel

the anticlockwise feeding features of the leadscrew and tailstock barrel. It is what I consider I would be justified in describing as an 'honest', solid machine with no gimmickry, and I am very pleased to know that it is now again available.

It seemed that to alter the tailstock barrel feedwheel to clockwise operation the only requirement would be the substitution of a LH feedscrew for the original equipment RH feedscrew. I recalled an engineer who specialises in the Hobbymat telling me that the North American market would only accept the



The Micrometer Index Collar Clamp Nut (Item 14) is seen here mounted on a stub mandrel which has a matching M16 x 1.0mm thread

machine with clockwise feeding of the tailstock barrel, though he didn't say whether that condition also applied to the leadscrew.

The tailstock barrel feedscrew is M8 x 1.25 RH and my first impulse was to dash off and order a M10 LH tap, and die, in case my screwcutting didn't measure up. M10, as I expected that I would be drilling out the barrel thread and re-tapping. I am aware that many owners are loath to make any permanent changes to their machines, for very understandable and sensible reasons. Since I do not envisage trading-in my Hobbymat I do not feel. any constraints in this respect. Fortunately, something cropped up to delay this move and I had time to stand back and reflect a little.

I then remembered that in a previous article on screwcutting on the Hobbymat (M.E.W. No. 40.), I had outlined the cutting of a M10 x 1.0 LH tap, intended for the very same purpose I was now considering, though I cannot now remember the reason for the long shanks at each end. The same article describes a modification to allow cutting of LH threads on the machine. It just goes to show how one can be side-tracked from one project, which then gets put on hold and often forgotten, by other, suddenly more pressing projects. I currently have two prototypes and redesigns awaiting my attention.

It became obvious that the best way to proceed was only after fully considering what I wished to achieve. It always is, but I usually expand and enlarge upon my first brainwave, only to realise, after considerable expenditure of design and make time, that the design currently being worked on would benefit very much from some further thought, and that it was once again "back to the drawing board" time. The Editor can confirm this , because I (probably unwisely) posted him - I'm not into e-mail - a copy of my first, very flawed design. I don't really mind this because unlike, it would seem, most of our hobby's enthusiasts, I get my greatest satisfaction from the design stage, rather than the 'make' activities. I consequently tend to stretch this part of the project, though usually, I claim, with considerable benefit, until my procrastination and self indulgence prick my conscience and I have to start cutting metal. Even then, plenty of excuses seem to

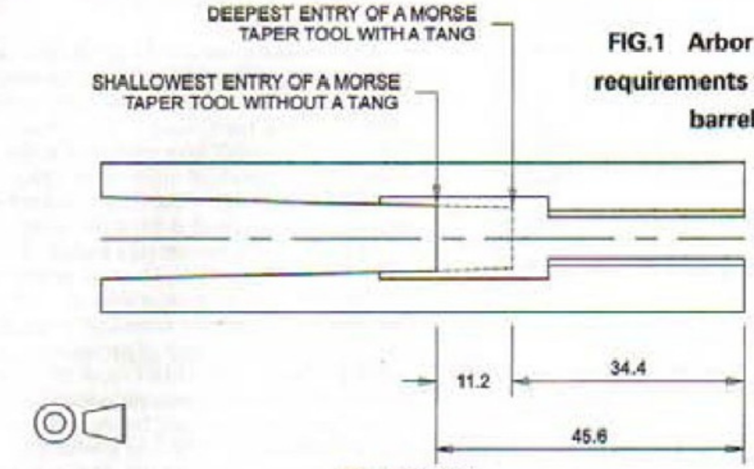


FIG.1 Arbor ejector requirements tailstock barrel

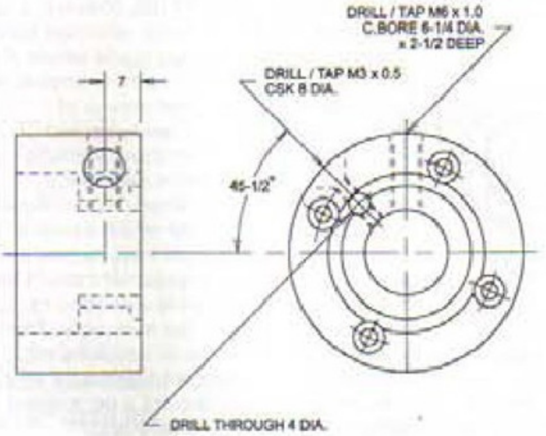
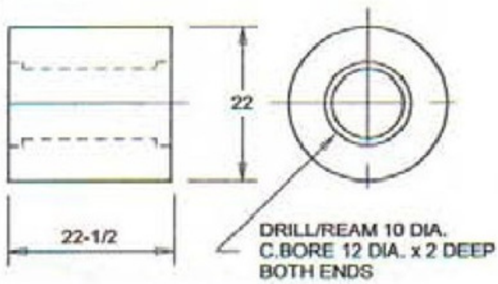
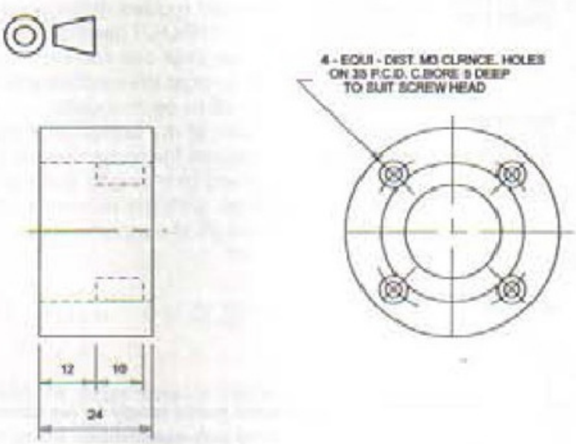


FIG. 2 Lubricating bearing housing and spindle bush

crop up for minor re-designs, dragging out the pleasure a bit further. I will qualify this by saying that this time, part way through the design stage, I was looking forward to getting into the workshop (shed) and making something. Nevertheless, regardless of my continuing search for improvements in the design, I fully concur with the famous saying of Sir. Robert Watson Watt ('The Father of Radar') - "Give them the third best to go on with; the second best comes too late, the best never comes", from his "Cult of the Imperfect". But don't forget, we're supposed to enjoy our leisure activities, not make a cross out of them. Any road up, I started to cast about for ideas.

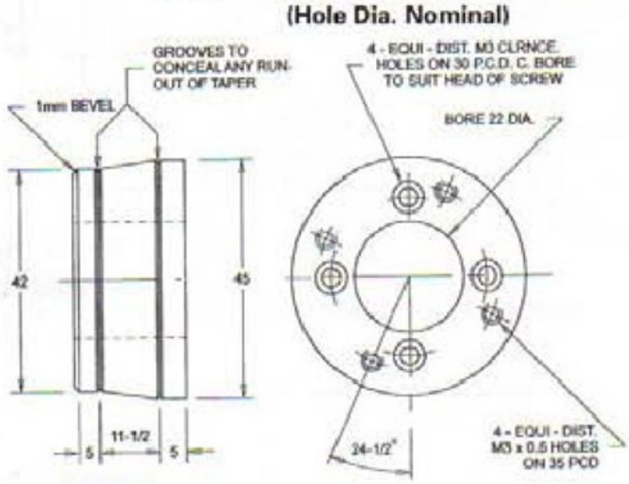
ITEM 1 Barrel extension
3/4" BMS RD.

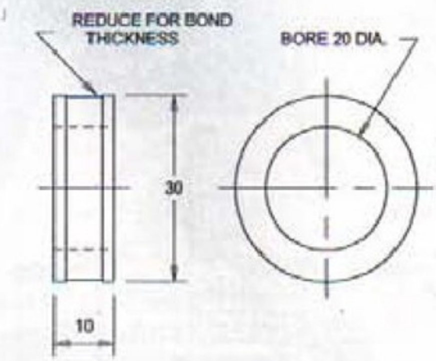




ITEM 3 Bearing housing and spindle bush assembly items 3A and 3B (Secure with adhesive)

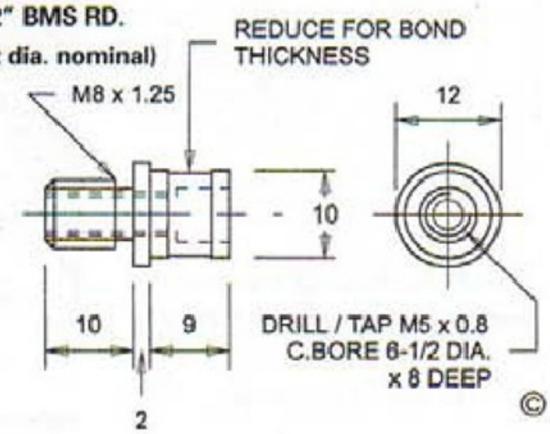
ITEM 2 Tailstock extension 2" BMS RD. (Hole Dia. Nominal)





ITEM 3B Spindle bush
1-1/4" BMS SD.
(Shaft and hole dia.S nominal)

ITEM 4 Barrel adaptor
1/2" BMS RD.
(Shaft dia. nominal)



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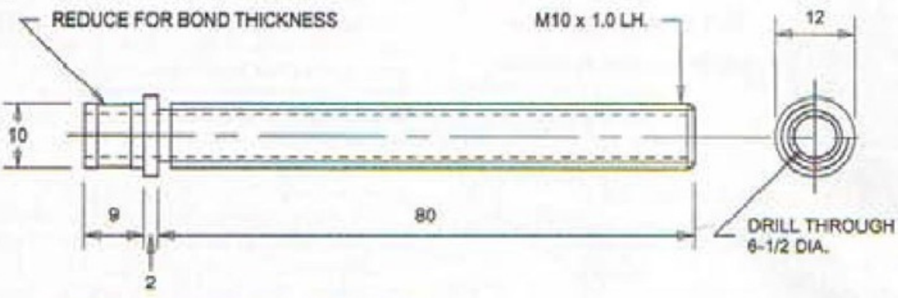
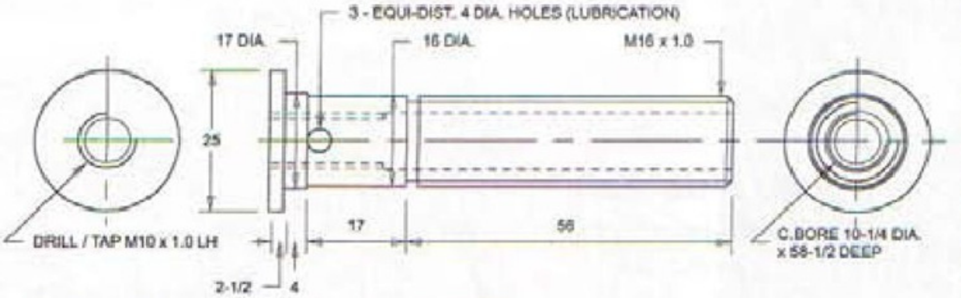
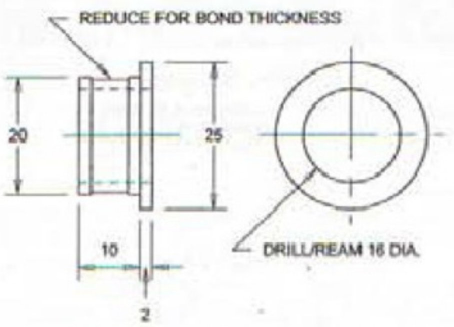


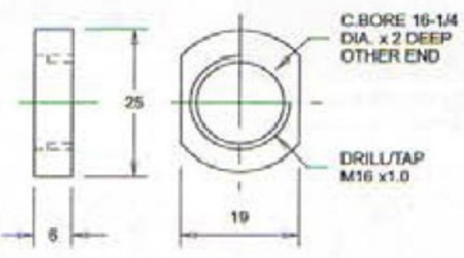
ITEM 5 Feed screw 1/2" BMS RD.
(Shaft dia. nominal)



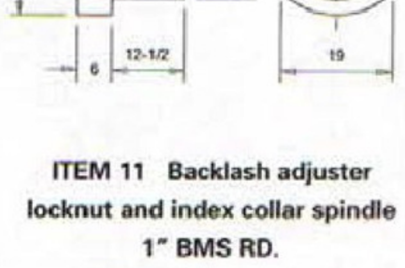
ITEM 6 Feed nut and spindle 1" BMS RD.
(Shaft dia.s nominal)



ITEM 8 Spindle bush liner
1" Phosphor bronze rd.
(Hole dia. nominal)



ITEM 9 Backlash adjuster
1" BMS RD.



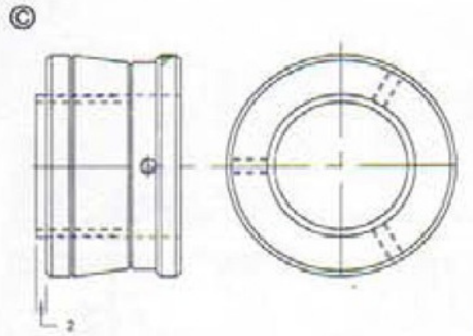
ITEM 11 Backlash adjuster
locknut and index collar spindle
1" BMS RD.
(19 Shaft dia. nominal)

Design Objectives

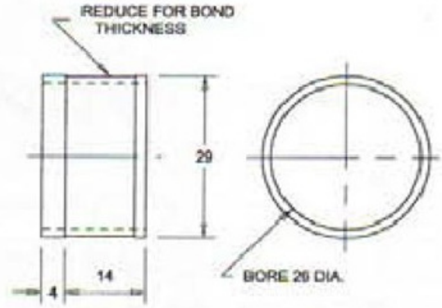
A statement in an article by 'Duplex' in a much earlier 'Model Engineer', relating to the fitting of a thrust ball bearing in the tailstock barrel feed, reads - "whereas, before, the tailstock was unable to exert a measured pressure of more than 20lb., after the conversion 40lb. could be applied without difficulty, and drilling became more normal and reasonably sensitive". Also, the late George H. Thomas refers to the Myford tailstock's capability of "exerting considerable pressure", due, in part, to the employment of thrust ball bearings. How could I not follow the lead of two such eminent practitioners? So, a thrust ball bearing would be incorporated in the modification. The one eventually selected is a standard 51103, 30mm dia. x 9mm thick and 17mm bore, obtained from a bearing stockist. To give credit where it is due, I have found that a bearing stockist is the quickest and cheapest means of supply, besides being a ready source of useful advice and information. If you're really fortunate you might even get a bearing catalogue, extremely useful if you have any project in mind which needs a bearing. A bearing would require means of lubrication, and this requirement could be incorporated and possibly extended to other moving parts in the assembly. The exception would be the tailstock barrel, lubrication for which could be easily arranged but would require a permanent alteration (a hole in the tailstock).

As the existing M8 x 1.25 RH thread in the barrel obviously could not be replaced by a LH thread of the same size, it initially seemed that it would require drilling out and re-tapping to M10 LH. I hesitated for a long time, for more than one reason, about taking this almost irreversible step. I am not at all averse to permanently altering any feature of my lathe, but if this modification stuttered for some reason, I did not look forward to trying to make a replacement barrel, with the necessity of cutting an internal Morse taper and the

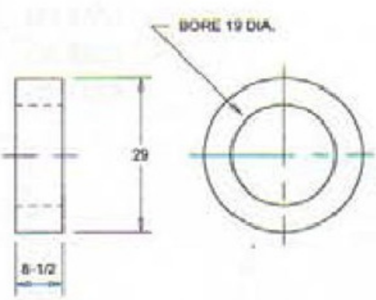
Component parts ready to be formed into sub-assemblies using the adhesives illustrated



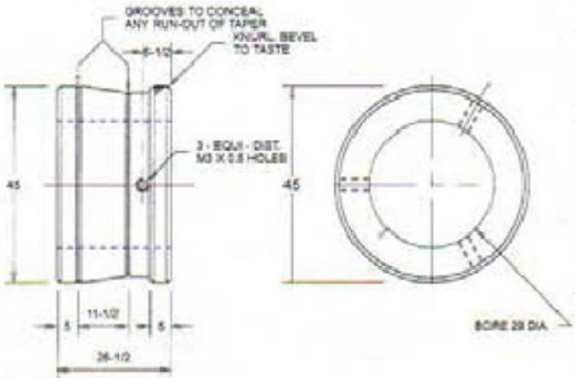
ITEM 13 Micrometer index collar assembly items 13A and 13C (Secure with suitable adhesive)



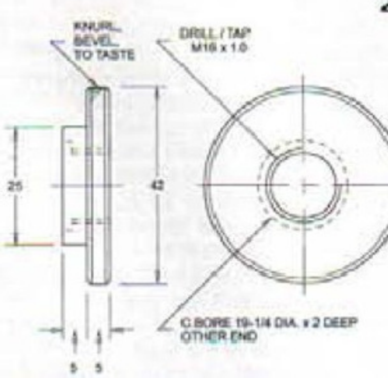
ITEM 13A Index collar inner sleve 1-1/4" BMS RD. (Shaft dia. nominal)



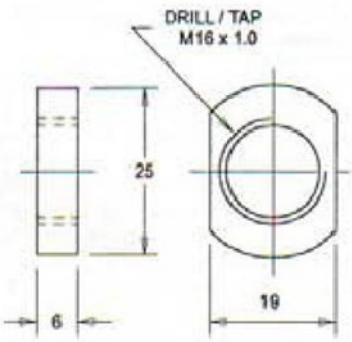
ITEM 13B Index collar bush 1-1/4" BMS RD. (Shaft and hole dia.s nominal)



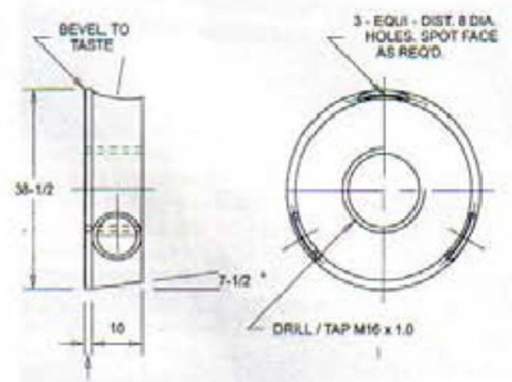
ITEM 13C Micrometer index collar 2" BMS RD.



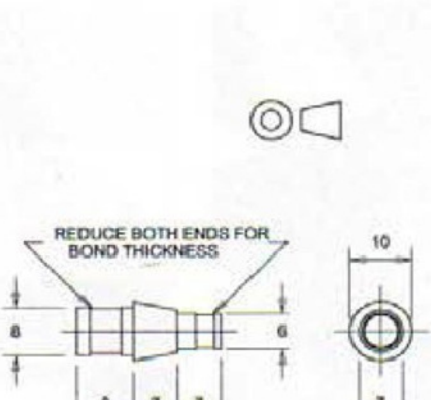
ITEM 14 Micrometer index collar clamp nut 1-3/4" BMS RD.



ITEM 15 Feed wheel locknut 1" BMS RD.



ITEM 16 Feed wheel hub 1-3/4" BMS RD.



ITEM 17 Feed wheel spoke 1/2" BMS RD.

inevitable accompanying cost and time involved (not to mention the skills which might be required - all part of the learning process?).

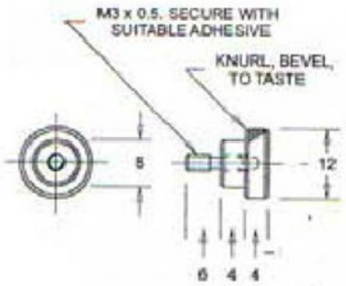
The solution should have been obvious, considering other potential features of the modification which were hovering about waiting to be considered. I have frequently been frustrated by the tailstock creating an obstruction when trying to carry out some operations between centres. The barrel nearly always seemed just that fraction (decimal?) too short. It looked as though I would have to make a replacement barrel after all, but one with a modest increase in reach.

Now, define a modest increase in reach! I remember having drummed into me many years ago that whenever making a choice or decision I should have a logical reason for my selection, very wise advice, particularly in the design procedure. In trying to apply this principle to increased reach I was forced to acknowledge that I could not justify any one selection rather than another, and therefore opted to increase the 95½mm barrel length to 118mm, quite arbitrary, but a selection which would provide 60mm of feed, a nice round number and the same dimension as the top and cross slide widths, and 57¼mm engagement of barrel and tailstock with the barrel fully-advanced, some 5mm greater than the original equipment design.

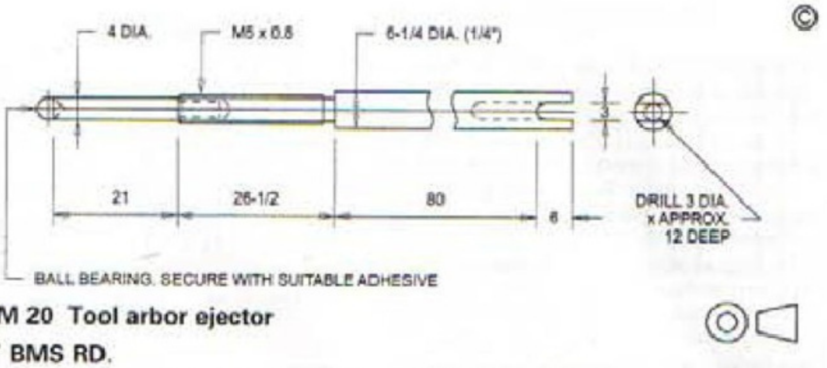
Since a replacement barrel was now envisaged, why not make it with a No. 2MT? This would enhance the range of tooling which could be employed and reduce the number held, as they would be common to both the Hobbymat and the Myford. However, a No. 2MT would be bulkier than a No. 1MT, I already had a considerable range of No. 1MT bits and pieces, a No. 2MT reamer was bound to be more expensive than a No. 1MT one and as the barrel is only 22mm in diameter some weakening and loss of rigidity would probably result. I decided to stick with No. 1MT.

Using CAD

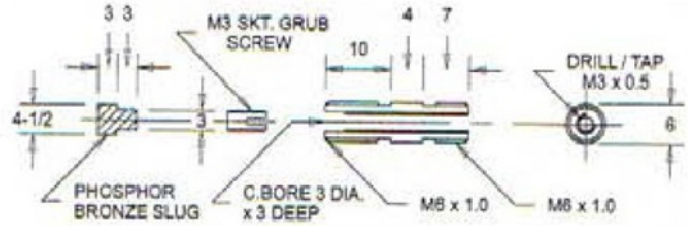
Design and drawing continued, now with the assistance of a modestly priced but extremely versatile CAD computer programme, AutoSketch 6. I don't know how I ever managed without it: looking at my previous attempts at draughtsmanship I obviously didn't. It has the advantages over a drawing board that a word processor has over pen and ink, and probably more. To be able to change any dimension or feature of a drawing at will, without being obliged to rub-out or completely redraw is extremely useful and satisfying, and may well prevent the burning of a lot of midnight oil. It is also conducive to good design, as it eases the changing of those features which would benefit but to which a blind eye might be turned, because of the time and trouble involved in amending them. The symbol libraries are not those I would choose, the smaller fasteners that we use are not present. I am told that other symbol libraries can be imported but I have been unable to find out from where, and I do not have access to the WWW.



ITEM 18 Lubrication hole plug
1/2" BMS RD.
M3 Studding or similar

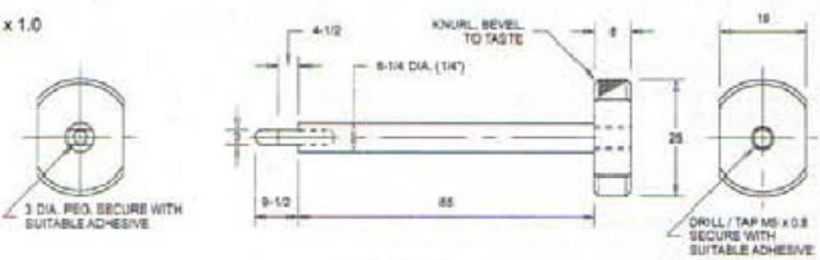


ITEM 20 Tool arbor ejector
1/4" BMS RD.
Ball bearing to suit, or hardened silver steel, shaped to taste



ITEM 19 Spindle clamp construction (Section)
Screwed component
1/4" BMS RD.

ITEM 21 Arbor ejector extension key
1/8" BMS RD.
1/4" BMS RD.
1" BMS RD.



The breakthrough

As I firmed up the above mentioned features and others in the still tentative design, the 'blindingly obvious' presented itself. Why not simply add an extension to the rear of the original barrel? As is so often the case, my thought processes had been blinkered on a railtrack, the usual 'first brainwave' syndrome. This suddenly-conceived approach had several advantages:

(i) the barrel would require no modification, so, in the event of a stutter, the original state still obtained

(ii) a Morse taper need not be cut

(iii) an expensive reamer need not be purchased

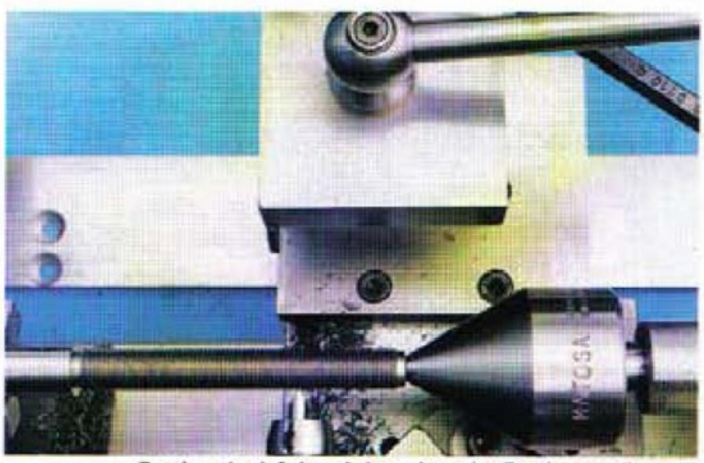
(iv) the existing accuracy of fit of barrel and tailstock would be retained

(v) similar accuracy of fit of the extension, whilst desirable, would not be essential, and

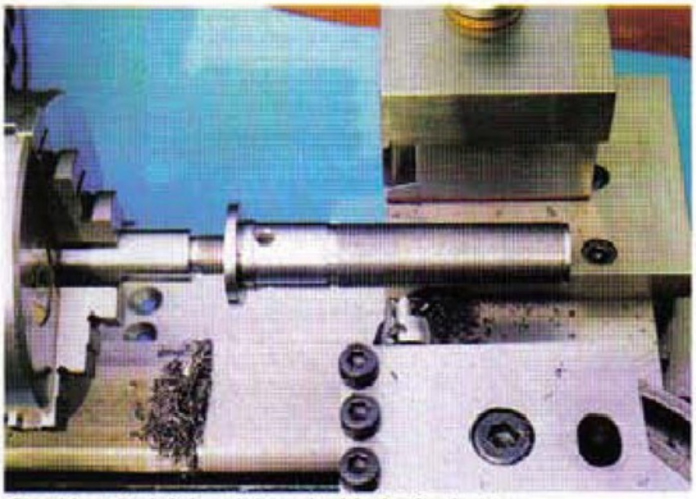
(vi) the original graduations on the tailstock barrel would still be relevant and could be extended, if so desired.

Another article in 'Model Engineer' by 'Duplex' on tailstock barrel graduation contained the following statement - "It has been suggested that, as in a micrometer, the feedwheel should be graduated to enable measurements of a thousandth of an inch to be made, but it is not readily apparent when and how such fine readings could be utilised". I well remember mentioning this point of view to 'Good old Ray' when discussing this very facility on the 'Harrison' lathes in the night school workshop. He instantly related several situations where it could be usefully employed, one of which was drilling to depth in identical components. George H. Thomas describes in his wonderful book how he carried out this modification to his Myford lathe, indicating the above mentioned repetitive operation as one of the reasons for so doing. With George H. Thomas and 'Good old Ray' pointing the way my choice was obvious. A M10 x 1.0 LH thread would be employed for the feedscrew and nut, thereby providing one millimetre of measurement for one revolution of the feedwheel. This could be further refined to more useful increments of one fiftieth of a millimetre. I expected that reducing the feedscrew pitch from 1.25mm to 1.0mm would reduce

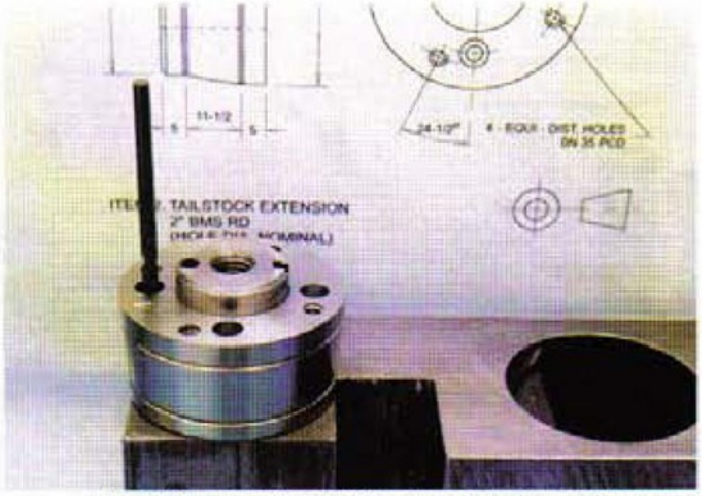
Graduating the Micrometer Index collar while mounted on a tapered mandrel



Cutting the left hand thread on the Feedscrew (Item 5)



Checking the left hand thread with the feed nut



Jig drilling the tailstock using the extension and the barrel

sensitivity when drilling, an expectation that I have not been able to determine because I haven't taken the time to compare the different set-ups.

In order to select and readily control such measurements, a micrometer index collar would need to be incorporated, one which could be easily set and positively clamped at any chosen setting. In an earlier project employing micrometer index collars, I had found it necessary to sacrifice the facility of collar location adjustment along the longitudinal axis of the spindle (to vary the gap between the collar and the bearing housing to the preference of the user). This had been forced upon me by the need to keep the overall length of the assembly to a minimum. I now saw a way round this. The locating of three M3 socket grub screws in the outer collar, corresponding with three longitudinal keyway-type grooves in the inner bush would provide a satisfactory degree of adjustment. Rather basic and not pretty in isolation, but it would be mostly hidden and it would function.

Clamping of the tailstock barrel in the original set-up is achieved by the conventional method, albeit in the rather basic form of a loose 6mm hexagon key. A more elegant solution would provide a few hours of pleasure at some future date. I considered that a spindle clamp would be of assistance when setting the micrometer index collar. The clamp handle need not be adjustable for its radial location when clamped, but if there was a preference for a particular location, that feature could be included. Nor need it be of the ball handle type, but since I could readily produce that type, it would be my selection, using the design, proportions and methods described by George H. Thomas.

In the original Hobbymat design, spindle backlash/end play of the tailstock barrel is taken up by adjustment between the spindle bush and the feedwheel, with a locknut, on a M8 x 1.25 thread. I thought I would replace this with something a little more sensitive and positive and opted for a 1mm pitch thread backlash adjuster and locknut. At the same time, I decided to use phosphor bronze washers between steel clamping or locking parts which might require adjustment.

Adhesives

Another feature of the design would be the use of suitable adhesives, with the objective of simplifying some machining operations, particularly those involving boring. The adhesives selected are 'Araldite Professional Pack' two part epoxy resin, 'Loctite High Strength Retainer 638', 'Loctite Bearing Fit 641' and subsequently 'Loctite Nutlock 242e'. Previous experience with these in similar applications, following the manufacturers' recommendations had demonstrated their reliability, and meant that no experimentation or choice was necessary, and I already had them. There are of course many other products of a like nature and equally suitable, so use your own favourites. In the earlier applications I had made simple jigs, as suggested by product advice, to achieve accurate location of the parts being joined. Once again, it should have been very obvious to me then that the parts themselves, being cylindrical in shape, with an appropriate portion machined to provide a suitable gap for the bond thickness required, would be self-locating. For both 'Araldite' and 'Loctite' products, optimum bond strength is obtained when the bond thickness lies between 0.05mm and 0.15mm. The application of even a small increase above room temperature increases the bond strength of epoxy resin adhesives. They also benefit from abrading or chemical etching of the relevant surfaces.

Removing tools

As design progressed, I suddenly realised that I had lost the tool-ejecting action of the original tailstock feedscrew. I knew that this would inevitably lead to the need for some deep drilling, as access to the rear of any installed tooling would be essential in order to be able to eject it. Once I had resigned myself to this, I decided that I could not face the prospect of clouting a bar through a hollow tailstock barrel feedscrew every time I needed to remove a tool. An ejector with a screw action would fit the bill, a complication but easily adopted and more acceptable than a 'knocking-out' bar. I now confess that this idea was an over-elaboration, due to my attempting to take advantage of the force capable of being exerted by a screw thread. Any road up, in practice I've taken out the screwed ejector and use a 'knocking-out' bar, it's so much quicker, and if you want one I'm sure you can design one to your own specification.

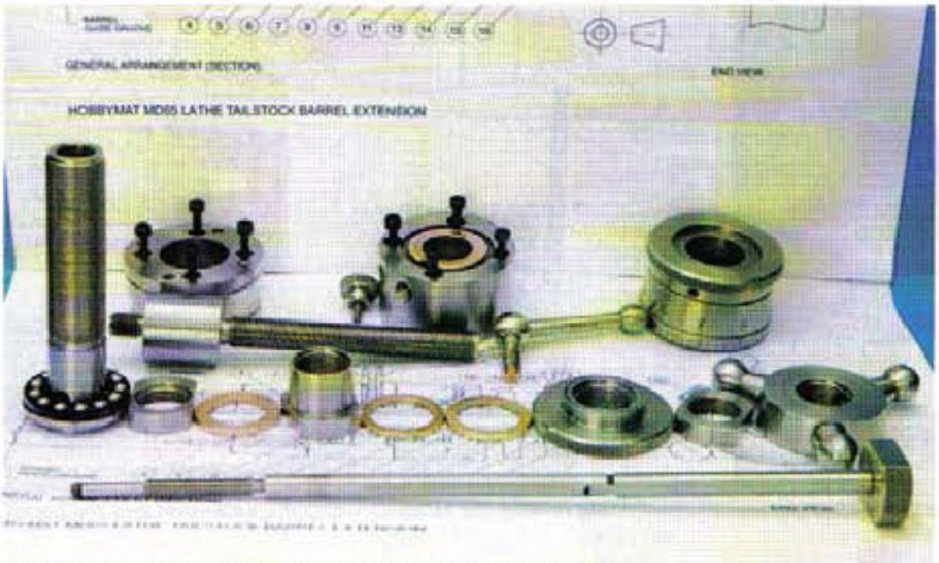
The objectives summarised

I had now assembled eleven design objectives:-

(i) a thrust ball bearing would be incorporated
(ii) there would be provision for all desirable lubrication except for the tailstock barrel
(iii) the barrel would be increased in length by a $22^1/_2$mm extension located at the rear
(iv) the feedscrew would have a LH thread
(v) the thread would be of 1.0mm pitch, permitting a one millimetre advance of the barrel per feedwheel revolution
(vi) a micrometer index collar would be included to facilitate the control of measurements and would be refined to one fiftieth of a millimetre increments
(vii) a positive clamp would be provided for the index collar
(viii) a spindle clamp would be installed to assist setting of the index collar
(ix) tool ejection force would be applied by a screw thread and ejection would be possible at any stage of advancement of the tailstock barrel
(see the above comment on the practice actually adopted by the author)
(x) suitable adhesives would be used in construction where appropriate
(xi) a three spoke capstan type feedwheel was the preference of the author, selected because of its ease of use and incidentally keeping the overall length of the modification to a minimum, obviously not mandatory

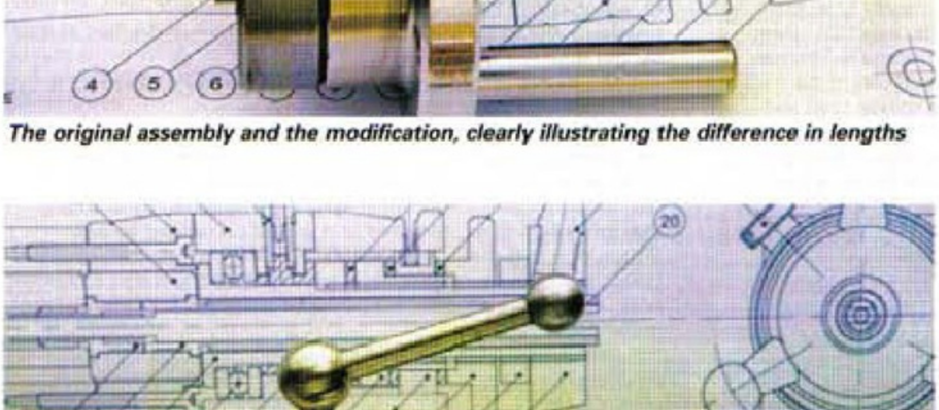
Design Considerations

I must point out to anyone considering adoption of any part or parts of the modification(s) described here, that all the dimensions and conditions relate to my Hobbymat MD65 lathe, purchased some five or six years ago. Reliable sources informed me about three or four years ago that some components and dimensions had changed, and now that the machine is being produced by a different manufacturer there might well be more differences. I



Another view of the component parts and sub-assemblies

The original assembly and the modification, clearly illustrating the difference in lengths



With the Feed Wheel and Index Collar assemblies removed, it can be seen how provision is made for backlash/bearing adjustment

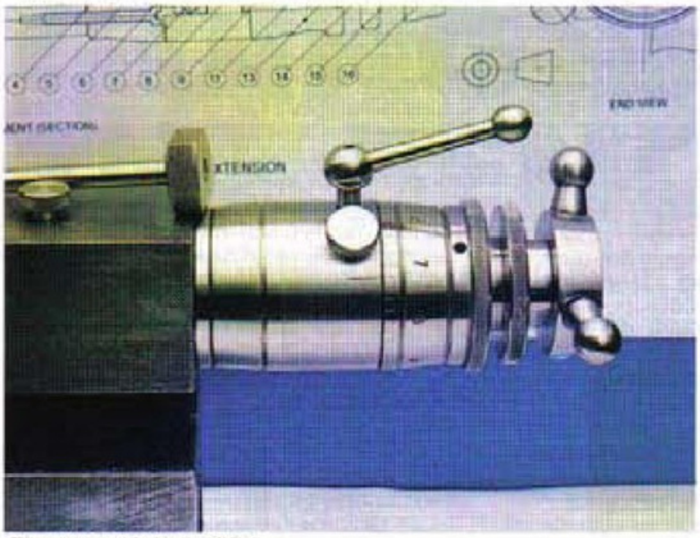
therefore think that you would be well advised to not accept my stated dimensions but rather to establish those for YOUR lathe. For new owners, it will add to your knowledge of your machine, and increase your confidence in any decision making regarding considered or proposed alterations/modifications. I went all the way and made fully-dimensioned drawings of everything. A general arrangement drawing with dimensions has proved to be of particular use. I would suggest that you do the same, you won't regret it.

1. As supplied, the length of the Hobbymat tailstock is $95\frac{3}{4}$mm and that of the barrel $95\frac{1}{2}$mm. When fully retracted, the front of the barrel protrudes from the front face of the tailstock by approximately $3\frac{1}{4}$mm. This is because the $3\frac{1}{2}$mm thick flange of the feedscrew is sandwiched between the rear face of the barrel and the front face of the spindle bush, which itself is flush with the rear face of the tailstock.

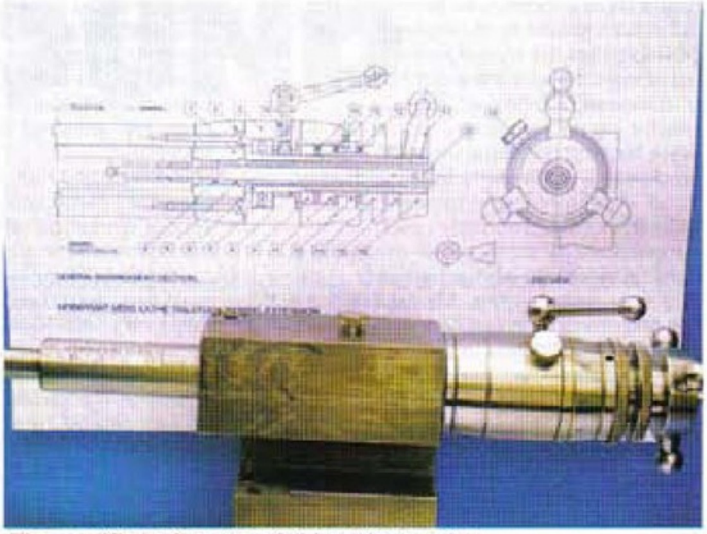
2. The feedscrew, which also doubles as the tool-arbor ejector, is 46mm long. When a Morse taper tool WITHOUT a tang is installed, such as the hard centre supplied with the lathe, the front end of the barrel needs to protrude approximately $5\frac{3}{4}$mm from the front face of the tailstock, in order to prevent ejection of the tool by the feedscrew. If it can be accepted that there should be a minimum thread engagement of the barrel and feedscrew of eight threads (10mm), the feed capability of the barrel becomes $33\frac{1}{2}$mm.

3. When a Morse taper tool WITH a tang is installed, the protrusion of the barrel from the front face of the tailstock is increased by the length of the tang, which might vary slightly from tool to tool, to approximately 13mm, and the feed capability, more important for, say, a drill chuck than a centre, is reduced to $26\frac{1}{4}$mm. In this situation, the 40mm of graduation on the barrel might seem to be of limited value.

4. The modification described here allows a useful barrel feed of 60mm, without the need to relocate the tailstock, beginning with the 'Zero' of the barrel graduation in line with the front face of the tailstock, with the tailstock paint removed; it had become so damaged as to be an eyesore and I felt obliged to remove it, the same as I had already done with the saddle. At any extension of the tailstock barrel up to 60mm there is a feedscrew and feednut engagement of twenty threads (20mm). At the full 60mm extension there is a barrel (including the extension piece) and tailstock engagement of $52\frac{1}{2}$mm. It might be considered that the twenty thread engagement is greater than necessary. There is room for it in the design and it is the length of internal thread selected for the feednut (Item 6), arbitrarily I agree, but I don't know the formula(e) for determining the correct thread length for any given set of conditions, or what factors and calculations are components, though I dare say likely ones are maximum load and the form and shear strength of the thread employed. As the 1.0mm pitch selected here might be regarded as fine, I have consciously opted for caution. The



The new unit in position



The modified tailstock at full barrel extension

M6 x 1.0 screw thread is used in the original Hobbymat design for the cross and top slide feedscrews.

5. The longitudinal dimension (thickness) of the spindle bush is determined by the requirement for an adequate bearing length/surface of the spindle and bush, and provision of sufficient material to permit the installation of a spindle clamp. The original equipment spindle bush is 12mm thick. In the modification, I have reduced this dimension to 10mm, justifying this step by the 233% (or thereabouts) increase in bearing surface resulting from the increase in spindle diameter to 16mm from 8mm, and the inclusion of a thrust ball bearing (Item 7), located immediately in front of and in contact with the spindle bush and affording accurate axial support for the spindle.

6. The longitudinal dimension of the bearing and spindle bush housing (Item 3) is determined by:-

(i) the selected clearance between the rear face of the tailstock extension and the front face of the feednut/spindle flange (Item 6.) - ½mm

(ii) the thickness of the flange of the feednut/spindle (Item 6.) - 2 ½mm,

(iii) the thickness of the thrust ball bearing (Item 7) - 9mm

(iv) the thickness of the spindle bush (Item 3B) - 10mm, and

(v) the thickness of the flange of the phosphor bronze spindle bush liner (Item 8) - 2mm

Total - 24mm

7. The longitudinal dimension of the tailstock extension (Item 2) is the same as the length of the tailstock barrel extension (Item 1) which protrudes from the rear face of the tailstock when the barrel is in the fully retracted position 21½mm. The 1mm of the barrel extension which is located in the rear of the tailstock serves to locate the 'Zero' graduation on the barrel level with the (paint-stripped) front face of the tailstock. It also functions as a lead and assists in maintaining the alignment of the original barrel and its extension.

8. For aesthetic reasons, I wanted the dimensions and shape/taper of the micrometer index collar (Item 13) to mirror those of the tailstock extension (Item 2). By fortunate coincidence, this nicely matched other features of the design and provided a useful dimension of 8½mm for the index collar bush (Item 13C):-

(i) there are three phosphor bronze washers, one Item 10. and two Items 12, each 2mm thick, the same as the flange of the spindle bush liner, - 6mm

(ii) the backlash adjuster, (Item 9) and the relevant part of the adjuster locknut (Item 11) are each 6mm thick - 12mm

Total - 18mm

This, deducted from the above mentioned 21½mm longitudinal dimension of the tailstock extension (Item 2), leaves 3½mm, which when added to the thickness of the knurled grip of the index collar (Item 13), 5mm, gives an available thickness of 8½mm for the index collar bush (Item 13B). This nicely suits the inclusion of the keyway-type grooves for the collar-adjusting facility, and can also accommodate a small amount of variation in length if required.

9. The thickness of the micrometer index collar clamp (Item 14) - 10mm, discounting the 2mm counterbore, gives eight thread engagement, more than adequate for finger tightness, and its diameter, when viewed in relation to the index collar knurled grip, is selected to display the same tapered appearance as the index collar, itself a mirror of the tailstock extension (Item 2)

10. The feedwheel locknut (Item 15) has a six thread engagement and 19mm AF spanner flats, a preferred size and the same as the spanner flats on the backlash adjuster (Item 9) and backlash adjuster locknut (Item 11).

11. The diameter and taper of the feedwheel hub are intended to provide a continuation of the visual line of taper provided by the micrometer index collar and its clamp. It's about 7 deg. 26 min., but 7½ deg. will do!

12. The backward rake of the feedwheel spokes (Items 17) is perpendicular to the taper of the hub and the preceding tapers, a cosmetic feature, once again, for aesthetic reasons only, and not mandatory. If selected, 7½ degrees.

13. The design of the arbor ejector (Item 20) requires that it be capable of properly functioning with Morse taper tooling with or without tangs. **Fig. 1** indicates the range of variation of dimensions, and the selected dimension of 13½mm plus a small safety margin in case an exceptionally short Morse taper crops up has been adopted. The overall length of the arbor ejector is such that it is totally enclosed in the modification when the barrel is fully retracted, in case it might make contact with the hand(s) when the feedwheel is in use. Yes, that black sphere which you might spot in one of the photographs is a 4mm dia. ball bearing. It was pickled in old battery fluid for about six hours in order to remove the highly polished finish and accommodate the bonding of the adhesive.

14. The diameter of the knurled grip on the arbor ejector extension key (Item 21), has been selected to provide sufficient finger tightening force to effect tool ejection and provide 19mm AF spanner flats in the event of a stubborn taper. It has been my experience that it is not likely to lie permanently in position. Its length is such that it can be conveniently used when the tailstock barrel is fully advanced.

15. The location of the screws (I selected M3 x 0.5 socket cap screws) securing the spindle bush and bearing housing (Item 3) to the tailstock extension (Item 2) is partly to keep the diameter of the modification to a minimum but primarily to support the adhesive-secured spindle bush (Item 3B) against the thrust of the barrel when it is under a substantial load, such as when drilling at near the machine's capacity. A belt and braces approach maybe, and only adopted out of respect to those of us who, in earlier days, might have experienced failures of the adhesives available to engineers. It is possible that the manufacturers' recommendations were not fully understood or followed, or required machining and assembly tolerances which were beyond the capabilities of many workshops, particularly those with very 'tired' equipment, as engineering adhesives were definitely used successfully by many of the medium to light (aircraft and instrument etc.) engineering industries. My experience with the adhesives selected here has given me complete confidence in them, provided the manufacturers' recommendations are followed.

16. The lubrication screw hole is located at the longitudinal centre of the spindle bush so that lubricant will reach the spindle, to either side of the spindle bush via. the horizontal through hole, and therefore other relevant moving parts, with the exception of the tailstock barrel, which would require its own dedicated application. The screw hole is at an angle of 45½ deg. to the horizontal which allows it to avoid an adjacent socket cap screw and still accept lubricant without dribbling (in theory anyway, by half a degree). Lubrication of the feedscrew is via. three 4mm dia. holes around the spindle at a non-bearing surface location.

17. Parts not drawn:-

Item 7. Thrust ball bearing 51103
Item 10. Phosphor bronze washer 25 dia. x 2mm thick, 16mm bore
Item 12. Phosphor bronze washer 25 dia. x 2mm thick, 19mm bore

Notes

As I am definitely not a skilled workshop technician I am not going to try and offer blow by blow instructions on how to go about making this project. My intention is to describe as well as I am able and as well as I remember (I should have taken notes like all the pundits tell us we should) a few methods which enabled me to achieve the desired results and make a few comments which might be worthy of consideration by anyone contemplating this modification.

The diameter of the modification outlined above is 45mm. This could be reduced to 42 - 43mm, as part way through my deliberations I substituted M3 for M4 fasteners to secure the spindle bush to the tailstock extension. Two immediate advantages that would accrue are that no taper turning or run-out concealment grooves would be required and the dreaded number stamping would not need to be carried out on a sloping and cylindrical surface. This would be of particular benefit, I would think, to those who have constructed a jig or device for the numbering of micrometer index collars and the like. Expanding a little on the numbering on the dial, I needed to make a choice here. I prefer an index collar dial which others would say is numbered the wrong way round. I find it easier to set the reading to the total (half diameter) amount of metal I wish to remove then apply successive cuts until the dial reads zero. However, for the sake of the article photographs, I numbered in the conventional way. Now if I had adopted a parallel 42 - 43 diameter I could have made two interchangeable indexed rings and satisfied both schools of thought.

I mentioned half diameter above because I came across a lathe in the night school workshop which made me begin to doubt my arithmetic. I would measure, put on the necessary reading, cut until the dial read near zero then re-measure, only to find that I was nowhere near the required dimension. I eventually realised that the feedscrew/index collar relationship was such that if a 20mm diameter needed to be reduced by 1mm, that was the setting for the dial, not ½mm. An arrangement which was beyond my experience even though it may be considered logical.

Some care is needed when counter boring the M3 screw head holes in the bearing and spindle bush housing (Item 3). I used a 6mm end mill, with everything locked up tight, and managed to keep them concentric with the screw holes.

You might observe from the photographs that I make frequent use of taper stub mandrels for turning operations subsequent to boring and turning to length. This is usually to prevent spoiling of a surface with the grip of the chuck jaws. I have found the use of taper stub mandrels, whilst extremely convenient, does require great care in ensuring true running. I mark all my mandrels so that they are located in the same position in the chuck each time they are used, also assisting alignment with a tailstock centre. Even then I frequently need to give the mandrel a slight skim, at the taper angle I employ, to true it up. The use of a D.T.I. should then enable you to get the item running acceptably true, but it is essential that the mandrel is securely aligned between the chuck and tailstock centre. I cannot honestly say that I have yet succeeded in obtaining a 'running perfectly true' condition, probably because the tapers I adopt are too coarse. An alternative is to use the 4 -jaw chuck- if you have one. Of course, if a heavy load is involved, such as in knurling, the use of the chuck is usually necessary, an example being the micrometer index collar. Spoiling the surface was not a primary problem here as the subsequent operation of graduating, which could be carried out on a taper stub mandrel, required that material should be left on the relevant diameter to permit one or more light cuts to bring it true and to size while on the chucked mandrel.

An exception to the necessary use of the chuck when knurling can be demonstrated with Item 14, the micrometer index collar clamp nut. A stub mandrel with a M16 x 1.0 thread in advance of the chuck-gripped portion was employed.

When drilling and tapping the tailstock to accept the tailstock extension (Item 2), I found it convenient to use the tailstock extension and the barrel as a jig set-up. I stamped a mark at the top hole location on the tailstock extension (it may be spotted as an inverted 'V'), so as to enable correct relocation when necessary. I also adopted the same 'V' device to indicate the correct relationship between the bearing housing and the tailstock extension.

I found it necessary to employ an adhesive, nothing too permanent. I used 'Loctite Nutlock 242e, in the screwed joint between the tailstock barrel and the barrel adapter (Item 4) as I experienced the occasional situation when the feedscrew was retracted and the barrel stayed behind. You live and you learn. A permanent fix could be easily arranged, but it would involve some change to an original component which in this design it is mandatory to avoid.

I marked the location of one of the keyway type grooves on the micrometer index collar bush (Item 13B) by spotting it with a 2.5mm drill through one of the M3 x 0.5 holes around the index collar (Item 13C). At the same time I marked the bush and the front face of the collar so they could be correctly aligned whenever necessary, as in using the above mentioned inverted 'V' for the tailstock extension. I then cut a shallow 3mm wide groove, re-assembled the bush and collar and secured them with a socket grub screw through the selected hole before repeating the procedure for the other two holes.

Conclusions

I think I can say that the final result satisfies the stated original requirements. I cannot say whether drilling sensitivity has improved or deteriorated but it certainly requires less effort. I think this is mainly due to the thrust ball bearing, but possibly also to the larger diameter of the feedscrew. Hole depth can be as accurate as I choose to make it and a vernier calliper has proved the accuracy of the index collar in setting it. If I have a regret it is that I allowed the aesthetic appeal of the taper to outweigh the simplicity of the smaller parallel design. The rake of the feedwheel spokes could then have been varied to taste though I don't think the 'feel' of the feedwheel could be improved beyond that which currently makes it a pleasure to use. The above might be a reflection of the post war ('39-'45, remember that was my era) conflict between 'function' and 'appearance' design interests. It still goes on, performance/function versus appearance.

All in all I'll be satisfied with what I've got: a barrel feed of 60mm without any tailstock adjustment, a thrust ball bearing with lubrication, a micrometer index collar with a positive clamping arrangement and a feedwheel which 'handles' like a dream. Not bad for an increase in overall length of only 25mm.

References:

"In The Workshop" Vols. II and III by "Duplex". Articles previously published in 'Model Engineer'.

"The Model Engineer's Workshop Manual" by George H. Thomas.

"Good old Ray", my friend and mentor at the night school workshop.

M16 x 1.0 tap and die, M10 x 1.0 LH tap and die, Tracy Tools Ltd. of Dartmouth. (Usual disclaimer).

GOING ROUND THE BEND

Stan Bray has a reputation for devising simple but effective items of tooling. Here he describes a few gadgets which, with the aid of a bench vice, may be used for forming metal

Our trusty old bench vice stands placidly in its place, waiting to be used or perhaps mis-used and, when the time comes, it often does little more than grip a bit of metal to be filed or sawn. Sometimes we might need to bend something and the usual procedure, unless a proper bending device is available, is to stand the material in the vice and hit it with a hammer. More years ago than I care to remember, as an apprentice, I will never forget the look of horror that would come over the face of the foreman when he saw such treatment being handed out. The words that accompanied the look I most certainly do not wish to remember anyway. He was right of course. Such treatment does not benefit the vice in any way at all, and if the hammer blows are too heavy there is a danger of destroying it. This increases if the hitting is carried towards the moving jaw, and many a good vice has been broken in this manner.

Mind you, we used to quite enjoy seeing those expressions of horror, and it was not beyond one or two of the lads to deliberately start the treatment when it was known that he was walking down the shop in our direction. When I acquired my own workshop it became a different kettle of fish. I actually bought the vice, even if it was war surplus and I remembered those words of wisdom that were included amongst the expletives. The answer to using the vice for bending is to make simple press tools and to squeeze the work rather than use personal brute force. All sorts of shapes can be devised and there is the advantage that if a number of items to the same pattern are wanted, they can easily be reproduced.

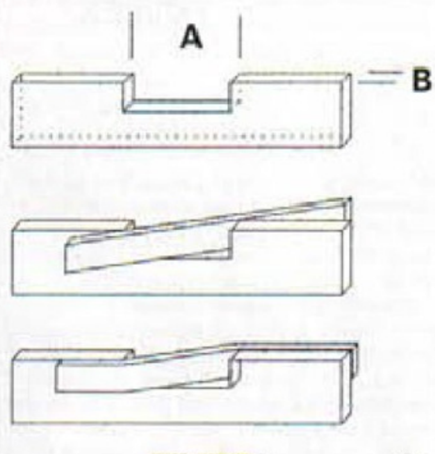


FIGURE 1. ©

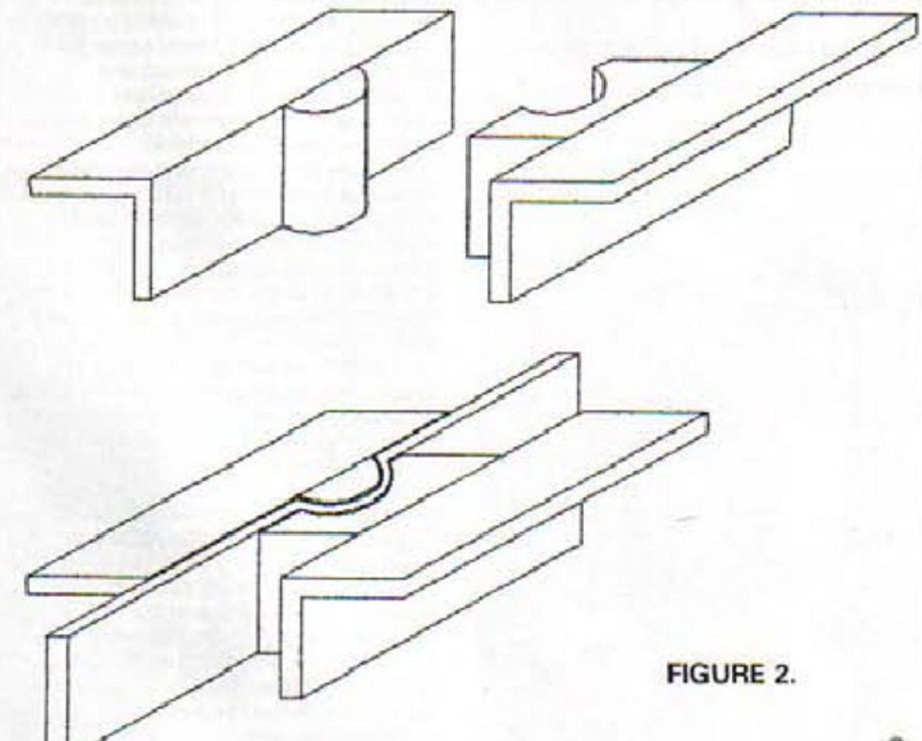


FIGURE 2. ©

Off-setting

Figure 1 shows a simple arrangement for producing off-sets such as those required when making valve gear. It consists of a single block of metal, the thickness of which is the same as the off-set required (B). A slot is milled in it and this is to the length that is suitable for the work (A). It may also be desirable for the depth to be correct for the metal in use, but this is not essential as, if it is made deeper, packing can always be used and the tool may well be used for several different jobs. The metal to be bent is simply laid across the gap as shown and the vice tightened on it. It is a good idea to use two pieces of angle iron unless smooth jaws are available; don't try it with soft jaws or they will be completely ruined. There are two things to watch for, the first being that some mild steel and indeed some hard brass will not bend, but will snap. In the case of brass, it can be softened by heating to a dullish red colour and quenching in water. With steel, the metal should be taken to the colour of a boiled carrot and allowed to cool as slowly as possible. Even so, some steels will not bend to a sharp angle without snapping, so if possible, get a free machining steel in the first place as generally these will bend. Frequently there is no need for such a sharp off-set and the opposite angles of the slot (those which the metal will rest against) can be filed to an angle and, if possible, rounded off as well. It will of course all depend on the job in hand. Even if the bend is to be square, the edges of the cut-out should be slightly rounded so that there is less tendency to shear the metal. An allowance must be made for each bend and as a rough guide, this should be half the thickness of the metal. This figure is not technically correct, but is easy to work to, and for most purposes is good enough. It is advisable to mark off and drill any holes that are required after bending, as this is far from being an exact science unless quite sophisticated equipment is used.

Pipe clamps and straps

Figure 2 shows an idea for making half round bends such as might be required for a pipe clamp. In Figures 2 to 4 it will be seen that angle iron is used to support the tools, which are made of mild steel. This allows them to be easily located while at the same time being easy to make. Angle iron is cheap to buy and easy to obtain, but has one major fault - it is very rarely square and so it will be necessary to cut the lengths required and then using one side of the angle as a datum, machine the other square. This can be done in a milling machine but a personal preference is use the four jaw chuck in the lathe. Of course, the inside angles also need to be square to provide an accurate location on the top of the vice jaw.

The male part of the press tool is a piece of bar of a suitable radius which is machined along its length to produce a half round section and is then screwed to one piece of angle. The other part is a piece of rectangular section bar which is bored in the four jaw chuck, machined across to leave a half round recess and bolted to the other piece of angle. Two things to look for; firstly that the pieces are mounted square, secondly that an allowance is made for the metal to be bent. Which part this allowance is made on will depend on what the work is needed for. If the outside radius is the one being aimed at, the reduction is made on the male section; if the accuracy is required on the inner side of the component, obviously the other section is bored over-size. Don't make an absolute spot-on allowance as doing so can result in real problems when it comes to unwinding the vice. Allow at least ten thou. over size. It is also a good idea to coat the tool with grease prior to use as this helps to release the work.

If care is taken with the hole spacings, it should be possible to make a number of interchangeable tools by just bolting different pieces to the angle as required. This makes storage easier, rather than having a number of complete tools knocking about. In fact, the next tool, shown in **Figure 3** could also be bolted to the same angle.

It is really only a variation on the previous device. For round read square and you have it. Square or rectangular bar on one side and a square or rectangular piece to match machined from the other and the tool is made. Once again, don't forget the allowance for the material. The edges of both parts should be just radiussed off a little to prevent a cutting action, but that is the only thing to worry about.

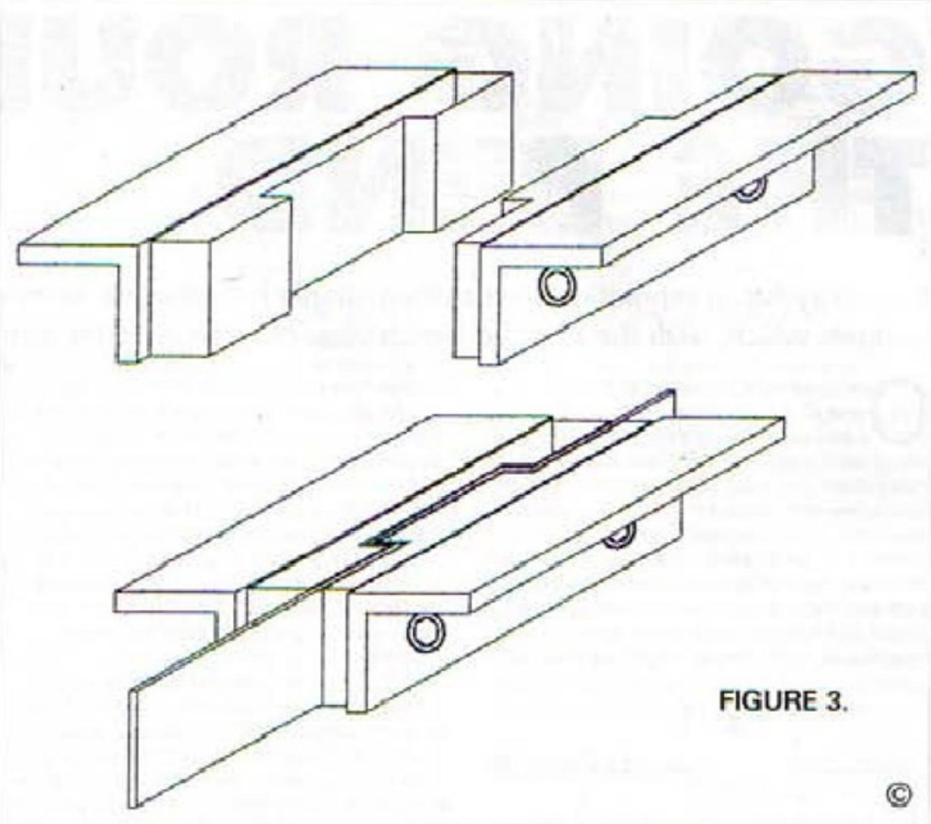


FIGURE 3.

©

A hole punch

The tool shown in Figure 4 provides a means of punching holes and, while not ideal, it is effective. Really speaking, to punch holes the work needs a good sharp bang and, in fact, only a punch is needed as the work can be laid on a piece of lead and the punch will drive through. It is a bit hit and miss though, as the punch has a habit of moving slightly out of place just as the hammer arrives. At best it means an out of position hole. At worst, a bruised hand. Using the vice prevents this, or should do unless you catch your fingers in it!

Punches can be round, square or any other desired shape. They should be made of silver steel, hardened and tempered to a dark straw colour. The punching end will benefit from an angle of about one degree or so and the edges need to be nice and square.

The other side of the tool is drilled to accept the punch and slotted to accept the work so that the punch is supported immediately above the work, making it rigid enough for the vice to squeeze it through. This section should, if possible be made of Ground Flat Stock, sometimes called Gauge Plate, hardened and tempered to a light straw colour, although if only one or two holes are being made, mild steel would do the trick.

It will be seen that the device shown in the drawing has two bits sticking out; one is the punch, the other a spring loaded locator which allows holes to be punched at even spacing along a length of work, a combination of the distance between the holes and the depth of the slot ensuring absolute accuracy. Incidentally, there is no need to mill the slot as two pieces of gauge plate can be assembled with a strip of mild steel in between and the assembly screwed together. This will do as well, if not better, than a milled slot.

It is all simple enough but, in the long run, a great deal of time and accuracy can be gained by making these simple fixtures. The bending tools will work with mild steel up to about $^3/_{32}$in. thick, depending on the tightness of the bends and the size of the vice. The hole punch should not be used with metal of a greater thickness than $^1/_{32}$in. The possibilities with simple tools like this are endless and worth experimenting with.

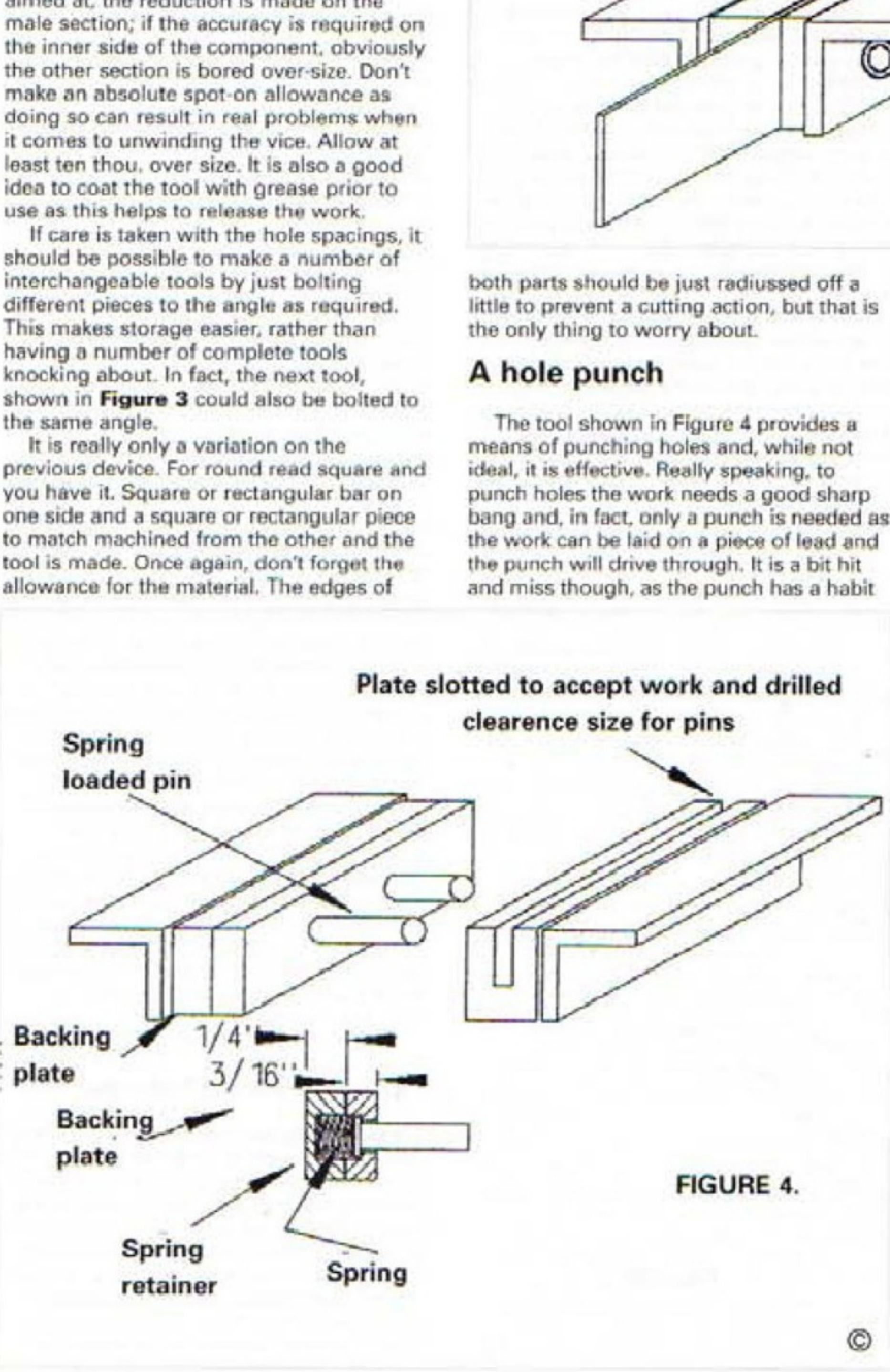


FIGURE 4.

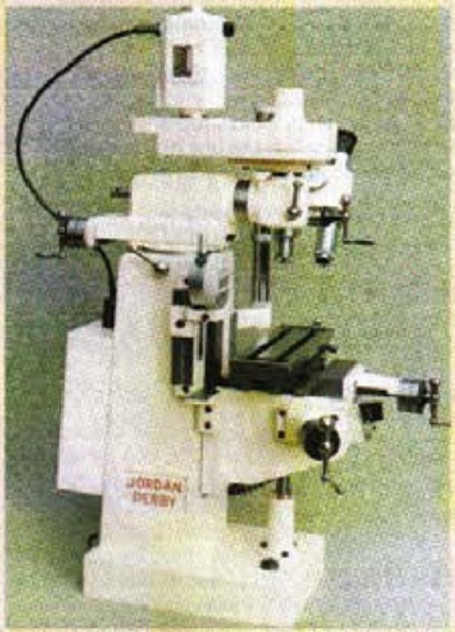
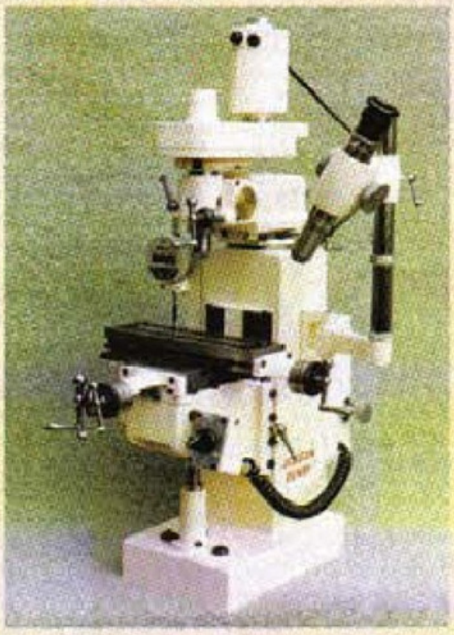
©

BARRY JORDAN'S LATEST CREATION

Best known for his working models of well-known machine tools, Barry Jordan decided it was time to go for something bigger, so he has designed and built this small but practical vertical milling machine. Its purpose? To help in the building of even smaller models, the next example of which is not too far away. We have been promised more details, but for now, here are a few photos of the machine, which may be seen, together with all Barry's other masterpieces at the forthcoming International Model Show.

A few statistics

Overall height	28in.
Base size	6½in. x 10in.
Table size	8½in. x 2½in.
Table to column	3in.
Table travel	5in.
Vertical movement of knee	3in.
Ram movement	2½in.
Quill movement	0.5in.
Spindle capacity	0.25in.
Head tilt	60 deg. either side of vertical
Spindle speeds	180 to 3000 rpm (Electronic variable speed control)
Electrics	250V AC
Building time	15 weeks (28.4.99 to 12 8.99)



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

Tungsten Carbide and Diamond gritted products from Eternal Tools

Based in Pershore, Worcestershire, Eternal Tools offer a range of gritted needle files and rod saws, either as singles or packs. The tungsten carbide files and rod saws are mild steel blanks with tungsten carbide grit brazed onto them, allowing them to cut most materials including metals, wood, plastics glass fibre, stone and foams. The diamond files are steel blanks with diamond grit electroplated onto them, suitable for dealing with the more difficult materials such as tungsten carbide cutting tools, engineering ceramics, marble, glass and carbon fibre.

The 160mm tungsten carbide needle files are available with fine or medium grit in a variety of shapes and come with comfortable wooden mushroom handles. They are offered either in a boxed set of six or as singles at £5 each or as a wooden boxed set at £29.95.

The diamond gritted files are available in two lengths, either 180mm or 140mm, again with handles and in a total of ten blade shapes. The longer variety cost £7.50 each as singles or £35 for a pack of five, while the shorter ones are available at £5 singly and £45 for a pack of 10.

The tungsten carbide gritted rod saws fit conventional coping saw and hacksaw frames in lengths of 12in., 10in. and 6in. at £5, £4.50 and £3.50 respectively.

Postage and packing costs are additional in all cases.

Eternal Tools, 159 High Street, Pershore, Worcs. WR10 1EQ Tel./Fax 01386 555909

Additional 'Worden' kit from Hemingway

The Worden Tool and Cutter Grinder is an interesting machine constructed largely from sheet metal components produced by CNC punching techniques, a process which allows the major items to be produced at a most economical cost. These components and the remaining raw materials and items such as the motor and grinding wheel are supplied as three kits, making it possible to complete the machine using a $3\frac{1}{2}$in. lathe and a drilling machine. The Worden will grind lathe tools up to a maximum of $\frac{1}{2}$in. square to pre-set angles and will sharpen the ends of slot drills and end mills up to $\frac{5}{8}$in. diameter.

A new kit has been added to the range, comprising all the punched, folded and welded components which, together with the drawings and instructions, allows the builder to use his own stock materials for the machined parts and to source his own electrical components.

The new kit is priced at £71.00 including VAT. P&P (UK only) is £8.75. The drawings and instructions are available at £12.21 post free.

The full kit for the machine costs £316.61 including VAT, P&P £10.00.

A range of accessories can be added to the Worden, including attachments for sharpening slitting saws, woodworking chisels and plane blades, a 6in. dia. sanding disc and a 4 facet twist drill grinding jig.

Details of all these, together with information on castings and materials for the full Hemingway range can be obtained by sending four First Class stamps for the latest price list.

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

Garryson Minidiscs

In a recent article, our contributor Peter Clark was extolling the virtues of Garryflex rubberised abrasive blocks for obtaining a good finish on steel components. The manufacturers of these useful items, Garryson Limited now inform us that they have introduced a new range of 'minidiscs' - small diameter abrasive flap discs - which are ideal for working on intricate workpieces, small surface areas and in locations with difficult access such as deep narrow channels.

Available in a range of four grits (040, 060, 080 and 120) and diameters of 50mm, 65mm and 75mm, the discs can be fitted to screwed nose spindles or quick change holders, both of which come with 6mm shanks.

Garryson products are available from good tool suppliers, but in case of difficulty, contact them for the location of your nearest distributor.

Garryson Limited, Spring Road, Ibstock, Leicestershire LE67 6LR Tel. 01530 261145 Fax 01530 262801 email: garryson@compuserve.com

SCRIBE A LINE

Peter Rawlinson's Spark Eroder

From Allan Gill, Wokingham, Berks

I am very interested in constructing the spark eroder as described in Issue 57. In the introductory article, under 'Future Projects' in Issue 52, mention was made of the use of paraffin as the dielectric and the lack of success in using water. Where from the water? Natural water, such as tap water can contain many dissolved chemicals and as such becomes, not the required dielectric with a very low conductivity, more like an electrolyte. An electrolyte is a material in which the component parts split into positive and negative ions causing the conductivity, in this case of the water, to increase dramatically. The consequence of this is to prevent the build up of the intense electric field across the electrode gap necessary to produce the arc discharge (spark). Pure distilled water, having no dissolved salts to ionise (often referred to as de-ionised water) will, hopefully, solve the problem and let the local fire-chiefs sleep in peace.

From Spehro Pefhany, Mississauga, Ontario, Canada

Thank you for another interesting issue of M.E. Workshop. It reaches Canada with some delay and I have been preoccupied with other matters, so it was only this evening that I went through the article by Mr. Peter Rawlinson (Issue 57) on the spark erosion machine (EDM).

I would like to warn your readers to modify the 'Precautions' that Peter gives on page 54 for safety's sake. One should NEVER deliberately ground oneself, particularly at the wrist, since that completes half of a potentially fatal circuit through the heart .All that is then required is to touch a source of voltage with respect to ground (such as an appliance or tool with a frayed cord) with the other hand and the circuit is completed. Fibrillation or cardiac arrest can result if the current is high enough.

Professional wrist grounding straps always use a resistor (or two in series for better reliability) of approximately 1 MOhm (1,000,000 Ohms). This conducts sufficiently to prevent build-up of static electricity, but not enough to allow an electrical shock to occur, even at full mains voltage.

In practice, a wooden bench top will conduct well enough to prevent static damage in most cases, provided you touch the bench with some part of your body before handling the chips

I look forward both to future articles and to building Mr. Rawlinson's project in some form in the months to come.

Soldering aluminium

From Colin Usher, Warrington Cheshire

In reply to the letter from Ted Wale, Nova Scotia (MEW 15th April 1999) on the subject of aluminium soldering, there is no obvious reason why the so called 'Lead-Free' solders will solder aluminium when the traditional tin lead alloy does not.

The plumbing industry, in response to Health & Safety concerns regarding lead in domestic water supplies switched to a lead-free solder some time ago.

Most solders are produced with the electronics industry as the major user, particularly the cored wire and solder cream. The flux used in electronics normally conforms to an accepted standard of activity (the ability to remove soils and oxides without compromising long term reliability both mechanical electrical) known as RMA (Rosin Mildly Activated). There are also R, RA & RHA grades. It is almost certain that a model engineer will (perhaps unknowingly) be using an RMA type flux. This has a fairly low level of oxide removing power as it is designed to solder copper printed circuit boards (usually pre-tinned or with some other solderable coating, tin, gold, silver etc.). It is safe to leave on the assembly and can he painted over if required.

The lead-free solder picked up at B&Q is designed to solder (relatively) massive copper & brass water fittings, where any internal flux residue is soon washed away into the heating system or into the tap water. This flux is known as Water Soluble (rosin based flux is not water soluble). Water Soluble fluxes usually have a very high level of activity and thus are more able to remove the very hard oxide layer on aluminium. When using these, care should be taken to remove ALL traces of flux by copious washing in hot water & soap, with a cold water rinse. Aluminium soldered joints do eventually fail due to an electrolytic action between the solder and the aluminium, but this can take years.

Flux also performs the secondary function of preventing the re-formation of oxides as soldering proceeds. Oxides form faster at high temperatures and all metals form an oxide layer, even silver and gold. This layer may be very thin and hard or it may be thick and soft (iron). The porosity of the oxide layer on steel allows moisture to pass through the oxide film down to base metal and the oxidation (rusting) is more or less a continuous process. When non-porous oxides form, they protect the surface and prevent further corrosion. Oxides may form very slowly (gold) or very fast. (aluminium). Aluminium does in fact corrode (oxidise) very fast, but the thin hard oxide film forms virtually instantaneously, preventing further corrosion. This is what makes aluminium so difficult to solder; as soon as you remove the oxide film it re-forms. Very hard metals are also difficult to solder, but for other reasons.

The new 'Lead-Free' solders are based mostly on tin with additions of copper and silver, although many suppliers are working on new alloys for the EU draft proposals, See below.

There is an EU proposal to convert all electronic manufacturing to lead-free by 2004, so it is almost certain that the conventional tin / lead solder alloys will disappear and will not be available for model use either. Solder manufacture is a complex process and traditional solder will not be produced in the small volumes for model makers. Lead-free solder also requires an increase in temperature of approx. 40 deg. C. The joint is however stronger but slightly duller and the solder does not 'wet' as fast.

Differential for a 'trike'

From Geoffrey Walsh, Edinburgh

A friend of mine, well over 80, thinks he should get a trike for his pleasure and to keep fit. His legs and arms are quite strong, but he has a bad back.

He has tried a standard model but found the steering very heavy. This, I think, is because on the models available in the UK, only one of the two rear wheels is driven. Thus the machine is constantly getting an unbalance force. Models are available with a single rear wheel which is driven, the two front wheels being steered. In these, I take it for stability, the rider is reclined. These are probably much easier to steer, but the disadvantages are that:-

1. The person will have a much poorer view than if he was upright

2. The vehicle will not be seen so readily by other traffic

3. An old gentleman with a bad back may find the posture awkward

4. They cost much more.

It seems that the problem could be largely overcome by driving both rear wheels of a traditional tricycle using a differential back axle. Such a thing could be made in a small workshop, but I would like to know of a firm that could supply a suitable differential gear ready-made - or of other solutions that may be suggested.

I have been told that tricycles of the type I am suggesting are available in continental Europe, but so far have not been able to obtain any details.

Isolating an 'artificial' 3-phase supply

From Alan Tudor, Allestree, Derby

I have a workshop detached from the house and electrical power is supplied by a household type twin and earth mains cable (2.5mm) which runs underground encased in thick walled alkathene water pipe and protected by a 20-amp trip in the house consumer unit. In the garage, the supply line is terminated at a distribution block with two fuses, one for lights, the other for sockets.

I am in the process of moving some of the equipment around in the workshop and at the same time wanting to improve the safety aspects if possible. I would like to incorporate an earth leakage trip near the door, firstly to give me a means of isolating all the machines as I leave but secondly to give me greater protection from electrical fault.

In particular, I have an old milling machine which has been doing good work, but has a 3-phase motor. This cannot be replaced or rewired for single phase because the speed range is obtained by switching field coils in and out, and I'm told it's just too complicated. It has been running for years now with artificial 3-phase provided by a 240/440 volt transformer and a bank of capacitors. Under the circumstances, therefore, I am concerned whether I would get protection from a normal upstream 240 volt earth leakage device in the event of an electrical fault in the 440 volt system. Although all metal surfaces are bonded to a common earth, it seems to me that the 440 volt side is isolated from the earth leakage device by the transformer. Can anyone offer advice?

Making small power transformers

From A N Claridge CEng., MIEE, MINucE, Mickleover, Derby

I feel that I must comment on both the article on transformer construction by Philip Amos (Issue 57) and the letter from Mr Colin Long (Issue 58).

Having spent several years designing transformers for a living, as well as supervising their manufacture, I would suggest that Mr. Long is somewhat misguided in his remarks.

Firstly, the kind of transformer described in Mr. Amos' article is by no means obsolete. It occurs to me from the reference to experience on electronic products that Mr Long is more familiar with toroidal transformers, which have some advantages in electronic systems, but are rarely used in other applications.

His view that the demands of transformer construction are beyond the reach of amateurs is nonsense. The chance of mishap, given either some degree of understanding or the ability to follow a constructional description is probably less than the risk involved in constructing a steam boiler for a scale loco. Only recently a mechanical engineer friend of mine has made a completely sound spot welding transformer working from my design guidance.

The article by Philip Amos does, however contain a number of errors, some of which are of great importance. Mr. Amos is handicapped by his choice of reference books which are both very out of date in some cases, and in the case of the J & P book deal with large power transformers. References 2, 3, and 4 are clearly aimed at non-specialists.

Among the errors is the fact that, except for multiphase transformers, core type construction is never used. Even with these, both primary and secondary windings are on the same limb. The most serious is to claim that the power rating is determined by the cross-sectional area of the central limb. In fact, the power rating is decided by the iron cross-section, the winding window area, the magnetic flux density and the current density. The latter is fixed by considerations of temperature rise due to resistance heating and/or to the 'regulation', which is the fall in output voltage with rising output current. The type of load, particularly if it includes rectifier circuits, makes a difference to the regulation. To quote continuous current rating as an absolute figure, and to a resolution of 1mA is absurd. The relationship of effective cooling surface area to watts generated is the most critical factor in deciding current density from thermal considerations. If any reader feels in need of guidance over the manufacture of a specific transformer, then I may be able to provide help via the editor.

The later part of Mr Long's letter contains a germ of truth in saying that an earth strap should be taken to a true earth, which may not be a water pipe. However his reference to a high value resistance in the strap reveals that he does not understand its purpose. Inserting a resistor has nothing to do with discharging a static charge; its purpose is to protect the wearer of the earthing wrist strap from the risk of electrocution should he accidentally come into contact with the mains supply. It is almost always the case that an electric shock which does not entail a current in excess of 35mA is not fatal. It is on this basis that the residual current protection device which is now standard in most installations is set to trip the supply if a leakage current of 35mA or more is detected. The resistor which is often added to the strap's wiring is there to limit any current to less than this safe level.

Drills and tapers

From Derek Cooke, Katoomba, New South Wales

Philip Amos' contributions are interesting, instructive, and useful, and I wonder if I might be allowed to add a belated twopennorth?

With reference to the drill article, I would like to give a boost to those drills with a pilot point. They are 'perfect' for drilling sheet metal, and they make useful counterbores for Allen Head screws. They seem to make a less accurate hole than jobbers' drills, but if you are about to convert a solid bar into a hollow one, they make as good a starter as any, particularly as they require a lot less 'shove' than the jobbers' drills. The bottom of the counterbore is not dead flat, but I have a theory that this gives a better grip to the Allen head. When the hole has to be precisely placed, pilot drill with a drill the same size as the pilot on the 'patent' drill (or a shade smaller) then counterbore, following up with the clearance drill.

I enclose a photostat of the Reliance Drill Grinding jig, which has been a great support for nigh on 50 years. My first machine tool was a Wolf 'Cub' pistol drill with a stand and other bits and bobs, and I found I was blunting twist drills at a fast rate, and being slow at hand grinding them, I jumped in when I saw the jig in Mr Swindell's shop window, near where Percy Street joins the Haymarket in Newcastle-upon-Tyne. I have only seen one other since, in a second-hand tool-shop up near the Moonee Ponds (a place made famous by an Australian comedian). It was rather pricey at 26/5d (£1.32), which would be about £30 in today's pennies. It has only one draw-back: turning the drill through a precise 180 deg. After I had spent some time mulling over this problem, I got so good at doing it that I bothered no more. It makes points that look just like those on a brand new Dormer drill. If anyone would like further information, I will park the details with the Editor. (How did I remember the price? I didn't. It is printed on the instruction leaflet, the front of which provided the picture. The No. 3 model for drills up to 2in. was over £6.00).

On the subject of taper turning using the topslide, I use the following method. Chuck a scrap of steel and centre drill for the point of a 2 MT, and support its tail with a centre in the tailstock. In the case of a taper to fit in the mandrel, which like Philip's is 4½ MT, a larger piece of steel is required in the chuck, and its shoulder turned to an included angle of 60 deg. to fit in the big end of the 4½-2 MT adapter, and a 2 MT centre fits the little end. (For years I thought that 4½ MT was a Taiwanese leg-pull, until one day looking up a taper in the 24th Edition of Machinery's Handbook, I found it there). The DTI is next fixed in its tool-holder mounting, and brought to centre height and horizontal using a gauge at the stylus end, and a bullseye spirit level resting on the glass. The cross-slide is now locked, and an attempt made to rotate the topslide with the DTI stylus in contact with the centre. The gib is tightened to the minimum which allows no rotation.. This performance is repeated with the cross-slide. The topslide is now made to run parallel with the test taper. It now only needs a tool to be fixed to centre height, and after all that trouble, one runs off at least half a dozen (of the 2 MTs anyway). Being of a pessimistic nature, I test the first one off the rank by dropping it into a suitable socket from a couple of centimetres height. If I need a drift to get it out, I assume it's OK to go ahead. Should this ever fail to happen, I would go back to square one. With the 4½-2 MT adapter, I found, shock, horror, that while the two tapers were concentric at one end, they were about 0.01 min. out at the other, so I rotated the adapter so that the half-way mark between min and max. was presented to the DTI stylus. Being over 60 years away from the days when I could solve problems in solid geometry with

some degree of nonchalance, I haven't tried to work out the error of having the tool a bit on the low side, but would hazard a guess that if the tool were say 0.1mm low, the consequent waisting of a 2 MT would be of the order of a micron.

To match a pair of tapers 'perfectly', the following is a sovereign remedy. Rough out the male taper first if there is much material to remove, and then use the topslide to bore the female taper. Run the spindle in reverse, and use the boring tool behind the male taper to finish it. There is of course no need to check on slide 'wiggle' in this case, as it cancels out. And you can use the SC chuck, and you have the female taper on hand to check on depth of engagement.

Machining hobs

From Peter J. King, Christchurch, New Zealand

I have read with interest the excellent articles on the subject of Hobs and Hobbing in editions 56 & 57 of ME Workshop. Of possible interest for this series of articles is a personal 'hobbyhorse' of mine: that is using some of the possibilities of a built-in screw-cutting gearbox, viz.:-

The basic requirement for cutting Imperial DP worms and also hobs is a lathe with a 4, 6, or 8 tpi leadscrew, a screwcutting gearbox with a reasonable selection of normal pitches and a set of four gears that initially you will probably have to buy. These are 20t, 50t, 51 t, 77t (77/50 x 51/20). These gears will replace the usual fixed 1 : 1 ratio between the mandrel and the gearbox.

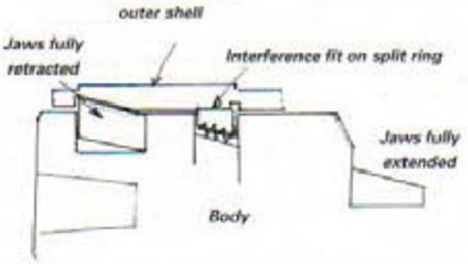
The method is to use a mindset that recognizes the gearbox/leadscrew combination for what it in effect is - a variable pitch leadscrew. If this is then combined with a gear drive from the mandrel to the gearbox that provides a ratio of 1 : 3.1416 (and in most cases power input is made to the leadscrew not the mandrel) then what we have achieved is that any pitch of 'threads per inch' set on the gearbox is spread out to become a 'DP' pitch on the work.

So if we take for example: set 16 threads per inch on the gearbox and multiply the input drive by 3.1416. We have moved the cutter by 16 tpi x 3.1416, which is the same pitch as '16 per inch of diameter'; the thread (or rack) form cut will be 16 DP. 16 tpi = 0.0625in. pitch, multiplied by 3.1416 = 0.19635in. - right on to 5 decimal places! BUT DO NOT DISENGAGE THE LEADSCREW HALF NUTS DURING THE OPERATION!

Some of the larger (and more expensive) Chinese and Taiwanese lathes sold here in New Zealand have this pi-factor for cutting DP worms built in as basic by means of a differential mechanism, which is what gave me the idea in the first place. I have saved others doing the weeks of conjugate fractions with 'Brocot's' tables to get those four gears! Six gears will give you an accurate 'pi' to about 12 places, but you can work it out.

I started on the above because my lathe did not have the standard set of gears, but like many modern lathes has instead a semi-fixed ratio between mandrel and gearbox, making the tables of gears for cutting DP worms useless, as I did not have the gears.

All the above should be 'one arm behind the back' stuff to real model engineers - even the very model of a 'Model' engineer may be tempted. I do not know if any of the above will work on metric gears as I have not given it any thought. Perhaps one of the 'ancient wise ones' of the hobby would care to comment.



Jacobs chucks - a warning

From Philip Bellamy, Brütten, Switzerland

In M.E.W. for July & August (No.59), there was an article by Bill Morris on dismantling and cleaning Jacobs chucks. While in principle there was nothing wrong in his description, there are two points that were left out, which are very important if no damage is to be done to the internal chuck threads.

If the jaws are fully retracted, then the lip at the rear of the internal taper bore at the rear of the outer shell will foul the rear teeth of the jaws and these teeth might get broken. Equally, if the jaws are fully extended, then the internal split threaded ring will be forced against the rear of the groove. When the outer shell is being forced off this split threaded ring, it will mean that excessive pressure will be applied to the teeth of the ring and jaws.

To overcome the above two possible problems, it is best to count the number of turns that the outer shell revolves to fully move the jaws between the two extremes. Halve the number of turns and set the outer shell at this position. It will probably be necessary to make a further ring for the front of the chuck to protect the jaws.

The photographs in the original article clearly show the internal taper and the rear lip in the outer shell, however I have made a sketch to make this more clear.

Model engineers 'on air'

From Pete Neave (G4DAN), Manningtree, Essex

I have been 'volunteered' to write you as one of a small group of three Radio Amateurs who are also actively into model engineering.

We have a weekly informal chat or 'Net' as it is known in Amateur Radio jargon: every Thursday starting at approximately 09.30hrs Clock time.

There is an interchange of ideas and a wide variety of engineering topics are discussed at length. This usually lasts about an hour or thereabouts and has now been operating for over two years.

We are aware that there are other model engineers who are also Radio Amateurs, but may not know of our weekly Net. They would be very welcome to participate in the discussions.

The Net is on the 80 Metre Band on a frequency around 3.660 Khz SSB Mode.

Clock-wheel engine

From George Swallow, Dorking, Surrey

Referring to the design published in Issue 60. I would be pleased to deal with any queries via e-mail on swallow@beechcottage98.freeserve.co.uk

LINK UP

FOR SALE

- Myford lever operated collet chuck. £50
  Tel. John on 0151 521 1346 (Liverpool)
- M.E.W. back numbers 3, 7, 8 9 and 10 in good condition.
  Please call Gordon Cave, Tel. 01628 631873 (Maidenhead) any time.
- Heavy gauge stainless steel drip tray, 4ft x 2ft. Suit Myford, Boxford or similar. £50 o.n.o.
  Tel. 01625 576709

WANTED

- Compound table base for the Hobbymat BFE 65 vertical mill. Would consider suitable alternative to adapt.
  Peter White, 92 Hoe Lane, Abridge, Essex RM4 1AU Tel. 01992 812216
- Good readable copy of CENTEC 2B milling machine handbook. £20 paid.
  Tony Crosse, Beech House, Bank, Lyndhust, Hants. SO43 7FD Tel. 01703 282672

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