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An introduction by acknowledged expert Ivan Law

IMPROVING A MINI LATHE

Alastair Sinclair offers expert advice and useful tune-ups

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25

Years Anniversary Special

Centre Punch

WELCOME

2015 marks the 25th anniversary of the original publication of Model engineers' workshop

Welcome to this celebratory special publication to celebrate 25 years of Model Engineers' Workshop!

The most engaging hobbies and pastimes are those that challenge both the hand and the brain; the most satisfying are those that leave you with something you can look at with pride and say 'I've made it'. Surely that means hobby engineering – I include everything from model engineering to vehicle restoration and all points between in that.

It's particularly rewarding to produce this special with the blessing of Stan Bray, the man who realised there was a gaping gap in the market for a publication on tools and techniques to complement our sister magazine, Model Engineer. Now in his nineties, Stan is hale and hearty and still a regular reader of MEW, though he admits that he does more woodwork than metalwork these days.

I have been an MEW reader for about fifteen years but, thanks to my Uncle, I have a nearly complete set of MEW magazines. In compiling this special I have had an incredible journey through the years going back

and forth through my collection. A fantastic resource of ideas and ingenuity has appeared in MEW since that our first issue in 1990. So how do I choose a representative selection with so much to choose from? For a start, in a special everything has to be self-contained, so these have to be relatively short, concise articles. I also wanted to reflect the great variety covered by MEW.

The optical centre punch, grinder rest, Lammas tool post, precision level, instrument vice, boring bar and tangential tool are all items that will be of real benefit in any workshop. Although rewarding items for anyone to build, with care they are all within the reach of the relative beginner in the hobby. The four jaw chuck and ball turning tools are more advanced projects that should inspire readers.

MEW often carries articles on 'machine modification' and to represent these I have chosen a classic on mini-lathes, which today are probably more numerous than any other machine in home workshop. Such features are obviously of interest to owners of these machines, but typically contain ideas with much wider application.

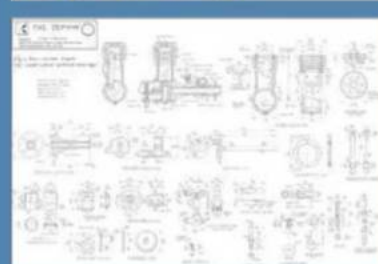
The other aspect of MEW is articles on techniques. The arc welding and hobbing features here reflect how these range from those aimed at the complete beginner to more advanced subjects. The four facet drill grinding article is a good example of one that combines theory with a practical accessory – one that could easily be used with the grinding rest.

As editor of Model Engineers' Workshop, I'm obviously keen to welcome you to the ranks of our subscribers. Personally, I still prefer paper subscriptions but an increasing number of readers have 'gone digital'. I should note that anyone taking out a digital subscription to the magazine gets online access to all twenty-five years of the magazine as well as download and keep copies of the subscription issues.

I hope you enjoy this journey through a quarter century of one of the most rewarding hobbies. ■

Editor
Model Engineers' Workshop

myhobbystore



92 THE MYHOBBYSTORE PLANS LIST

Inspired to make something, but looking for ideas? Browse through the suggestions in this list of useful plans.

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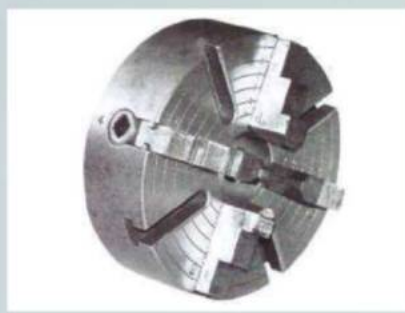
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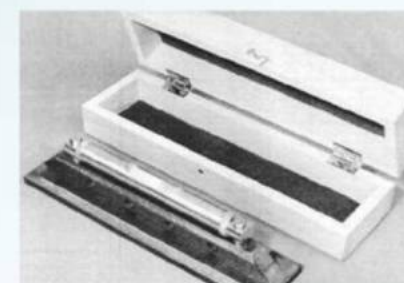
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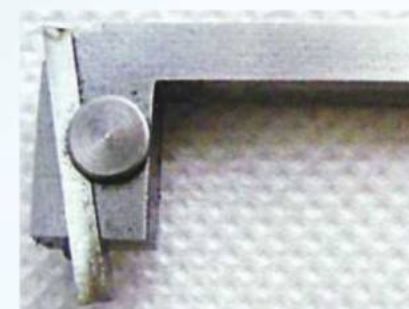
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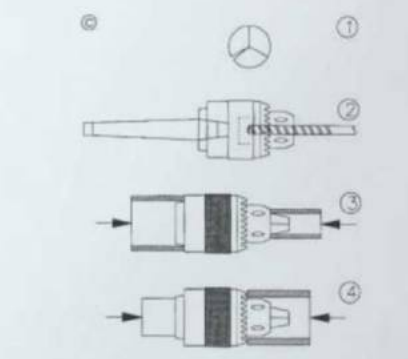
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Home Made Precision Optics

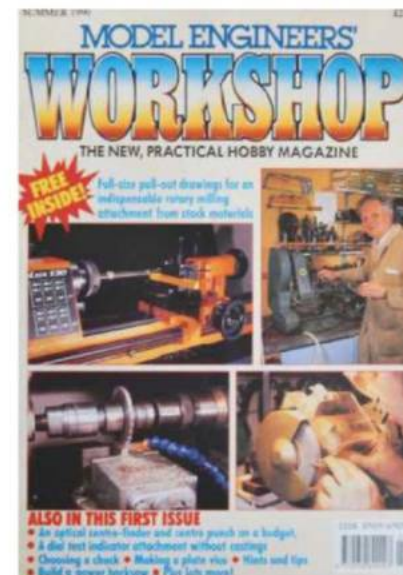
'Bluey' – Issue 1 Summer 1990



This article about a couple of handy optical aids appeared in the very first issue of Model Engineers' Workshop. Whilst they will be very useful if made to a reasonable standard of accuracy, the term 'precision' depends on your skill. The identity of the mysterious 'Bluey' was obscured in a mist of coolant, however, anyone familiar with his inimitable style will recognise that of founding Editor, Stan Bray!



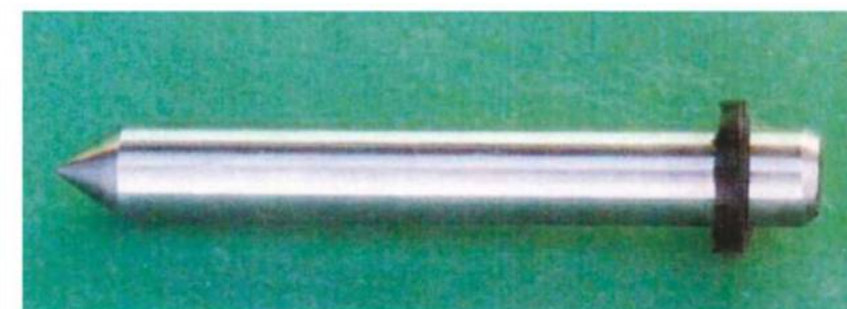
The completed optical centre-finder in the milling machine; in actual use it would be brought closer to the work than shown in order to line it up accurately.



The body of the optical centre punch; this one is from aluminium but almost any material will do.



The magnifying lens for the tool. Made from acrylic, it is a simple turning exercise; shank must be a good sliding fit in the body and the large diameter rounded at the end to provide magnification.



The centre punch. This, too, should be a sliding fit in the body; the 'O' ring at the top has no effect on the operation of the tool but makes it easier to handle.

When you are setting-up work or marking out, do you sometimes sigh 'oh for a pair of eyes'? In this ingenious feature 'Bluey' comes to the rescue with an easily made pair of aids for your workshop. You'll find this optical centre-punch and centre-finder indispensable and they'll cost a fraction of what you'd pay for commercial items.

Centre punching is a tricky business although in theory there is nothing to it! What should happen is that the centre punch should be used at the junction of two scribed lines and should be drawn along one until the intersection is felt and then at that point tapped with a hammer. I am sure most of us follow this excellent advice only to find that the punch has slipped out of position before being hit and we then have to start laying it an angle and trying to retrieve the position. (It is rather like sawing legs of a chair to make it shorter - we keep going a bit more and a bit more until the whole thing becomes quite a mess.) The

result is often an elongated punch mark more or less on the spot required but because of its shape, a drill, and particularly a small diameter one, is likely to wander some way from where we really want it to be.

The optical centre punch

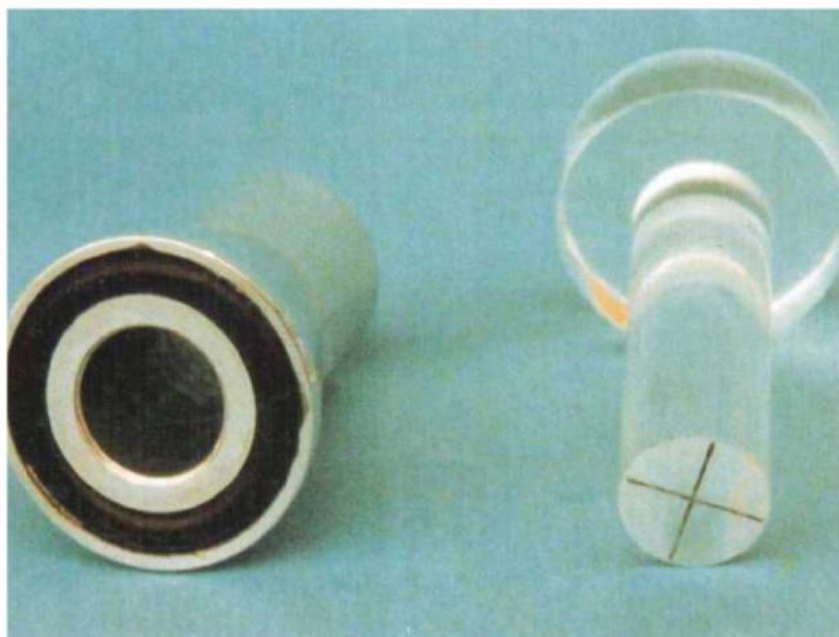
I had seen advertised an optical centre punch and at an exhibition actually saw one. I must say that I was quite impressed. However, buying things that can be made is not my way and so next day it was into the workshop and a start was made on scheming out an optical punch for myself. Although made from odds and ends which happened to be around my own workshop there is nothing required that is not very easily obtainable.

The actual punch is 3/8ths inch diameter and, whilst my own was already around in the workshop and was pressed into use, there is nothing difficult about making one from silver steel, hardening and tempering it to a

straw colour. The actual sizes shown suited me, but there is no need to comply with them if convenient materials are to hand. The point on the centre punch is shown as an included angle of sixty degrees, which is the angle I prefer. Technically speaking, the angle should really be ninety degrees to allow the drill to seat better in the punch mark, sixty degrees being normally used for initial marking-out and the mark then opened out with a punch at ninety degrees. However, all this is a matter for the individual.

The support body

The support body was machined from a piece of 1 inch diameter aluminium but could just as easily be mild steel or brass if these are more convenient. The central hole should be bored or reamed to a good fit as there must be no slop on the punch when it is inserted. A groove is machined in the end and this accepts an 'O' ring which stands just proud of the actual



The ends of the body and magnifier. The 'O' ring recessed in the body prevents accidental movement when adjustments are made. Black felt-tip pen ink wiped over the base of the magnifier picks out the cross-hairs.

body and so prevents the thing from sliding around whilst being lined up.

The insert

The original optical insert was made from Perspex and actually machined from a piece of sheet material, no other being available. Also, originally it was parallel; there was no magnification and not as much illumination as one might have wished for, so, whilst visiting the 1990 Model Engineer Exhibition, I purchased a piece of 20mm diameter acrylic rod from College Engineering Supplies. I then made a new insert with a domed top which gave more light at the base and also provided a degree of magnification. Acrylic is not quite so easy to machine as Perspex as there is a tendency for it to string. However, both are quite reasonable to work with.

Polishing

The insert must be highly polished and this was done with Solvol Autosol which can be obtained from most car accessory shops. It is rubbed on with a cotton cloth and then buffed hard to give a good finish. I should point out that it is essential that the original machining must also be to a fine finish to prevent excessive polishing being required. I also polished the support body by the same method. Very fine marks (cross hairs) must be made across the bottom of the insert and these line up at the place where the centre punch mark is to be made. These can be done in the lathe using a sharp pointed tool which is drawn across the face, the lathe then rotated through ninety degrees and the

operation repeated.

Of course, such an instrument relies on accuracy in the first place. There must be no slop on either the optical insert or the punch, as this would immediately lead to errors when in use. Care must therefore be taken to ensure that the point on the punch is made accurately. If the three-jaw chuck of the lathe is not one hundred percent accurate then set the punch up in the four-jaw chuck. Failing this, use a larger diameter piece of metal than required and turn the parallel shank and the point in one setting. Part off the excess larger diameter material and the punch must be right.

Similar precautions must be taken with the insert and, in particular, care must be taken to ensure that the tool used to scribe the cross hairs is absolutely on centre height.

The centre-finder

The centre punch proved a delight to use, making marking out both extremely quick and very accurate. Fired with enthusiasm, I looked at a very expensive piece of equipment in the form of an optical setting-up guide. We all know the problems; some form of pointer or a wiggler is put in the milling machine and brought to the work. Sometimes the setting can be done quite easily and no real concentrated visual observation is needed. On other occasions it is impossible to get the light exactly as required to see what one is up to, and if the light shines on the point of interest



The body with magnifier ready to be positioned over the work.

then it casts a shadow that makes it impossible to see exactly what is happening. Usually in these circumstances we resort to the use of a magnifying glass, which invariably is covered with dirt when needed, or hides itself away in a corner of the workshop (like on the marking-out bench) and cannot be found until other methods of setting up have been resorted to!

But an optical centre finder sounded quite formidable, and judging by the



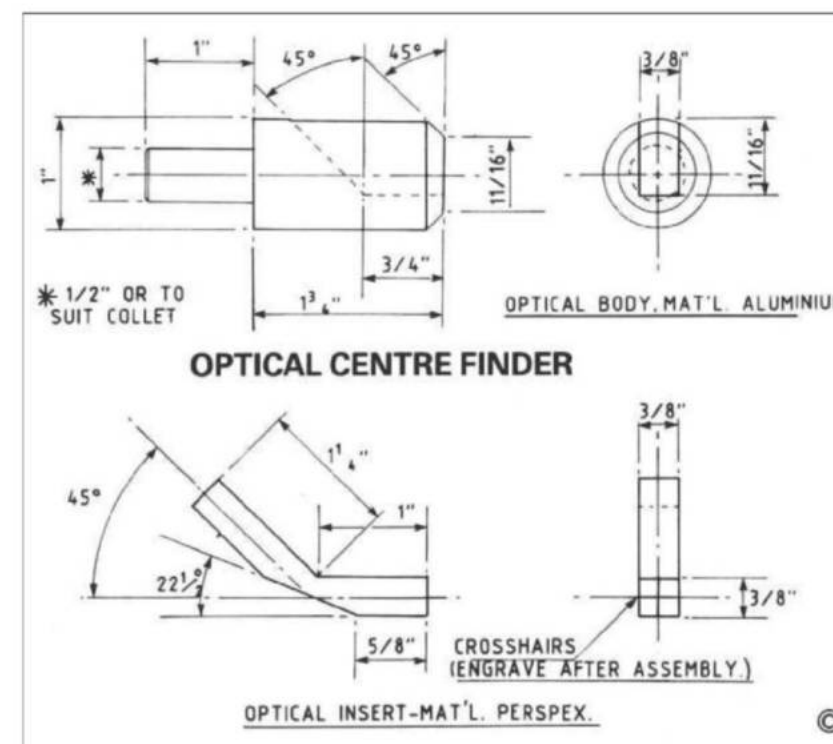
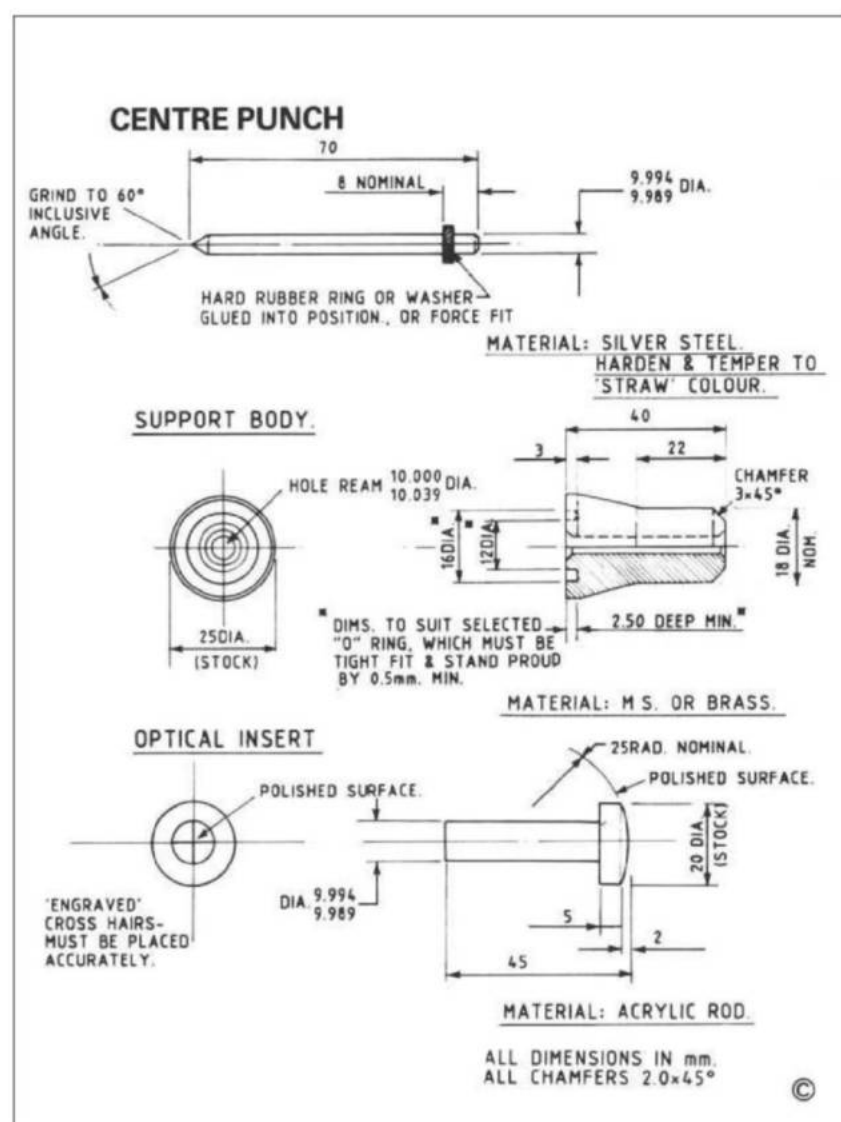
A good view showing the inked cross-hairs.

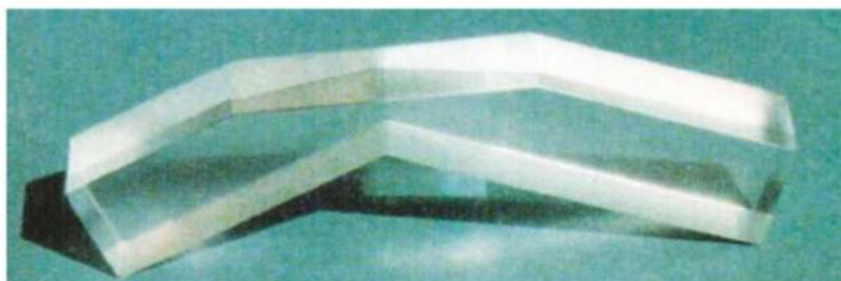


When the body is in the correct position the magnifier is removed and replaced by the centre punch.

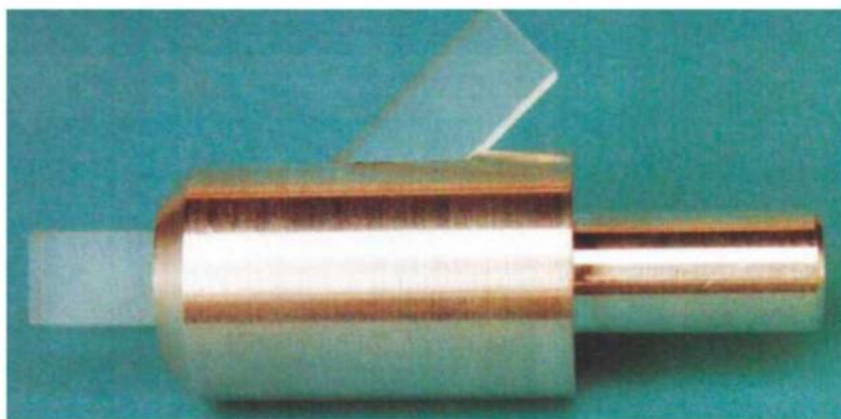
price they must be made of pure silver. So if I can make an optical centre punch, why not an optical centre finder? I picked up a piece of aluminium of what I thought would be a suitable diameter and started experimenting. Originally I made the optical insert from two pieces of Perspex which were to be joined. That caused problems as any adhesive would have upset the optics. I then hit on the idea of making it from a single piece of material.

The material I used was thicker than required and was very scratched and so I





The centre-finder lens. In the prototype, this was cut from a sheet of Perspex and polished. The angle enables the operator to look round the corner to the point of setting.



The assembled optical centre-finder; it is absolutely essential that the lens lines up centrally in the body if accuracy is not to be impaired.

had to machine all faces. This will not be necessary if the correct thickness of material is available. Perspex is not hard to come by in sheet form, a quick look in the Yellow Pages under plastics will, in most areas, reveal several suppliers and most of these keep boxes of odds and ends. The betting is that if you pay a visit to one then you will come home with bits of PTFE and all sorts of things.

My thicker diameter material was fly-cut with a very fine feed and this produced an almost polished finish all over, the only parts that really have to be polished up to a mirror finish are the two square ends and the twenty two and a half degrees chamfer. Again Solvol Autosol was used for the final polishing.

The body

The body was made, in my case, from 1 in. diameter aluminium, but brass or mild steel would do equally well. The bar was first machined as required in the lathe and then the slot was milled out with a 3/8 inch diameter cutter in two separate operations. The first operation was to machine a slot 11/16 inch deep and 3/4 inch long. The work was then carefully re-positioned in the vice and a second slot machined at an angle of forty five degrees so as to intersect the first slot at 3/4 inch from the end.

Assembly

The two components were assembled

ensuring that the protruding end was parallel to the body. To do this, temporarily fix it in place, stand the assembly vertically on a surface plate or, if you do not have a surface plate, on the drilling table or some similar object. Check right round the body to ensure that it is upright. When you are quite sure it is right, the assembly can be permanently secured with an epoxy adhesive ensuring that the adhesive does not touch the polished twenty two and a half degrees angled face. When the adhesive has thoroughly set, any excess can be scraped off.

The whole unit is now mounted in the lathe ensuring it is absolutely centralised, and the cross hairs engraved in the same manner as with the centre punch.

Using the centre finder

To use the centre finder, mount it in the spindle over the work. Adjust the table in either direction until the cross hairs are located exactly at the point required. Lock the table in position and raise the spindle to remove the centre finder which is replaced with the cutter. Do not, of course, alter the table position until cutting has started.

The tool proved remarkably easy to make and is one of the most useful little devices I have ever made. ☺



The body of the centre-finder showing how the slot has been milled out to accept the lens.



This frontal view of the body shows the two angles required accurately to position the lens. The angle value of the body itself is not critical, provided, of course, that it is matched precisely by that of the lens.

Events

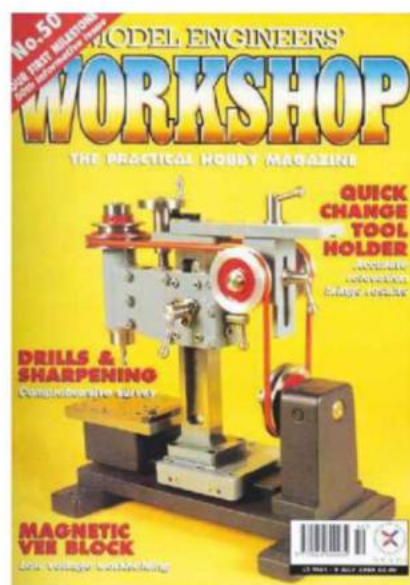
July 1 – Re-unification of East and West Germany
August 2 – Iraq invades Kuwait, triggering the Gulf War.

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Centres	Drill Chucks & Arbors	Lathe Chucks	Lathe Collet Chucks	Collets	
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Slitting Saws & Arbors	Measuring Tools	Glass Scales & Displays	Clamping Sets	Vee Blocks	Rotary Tables
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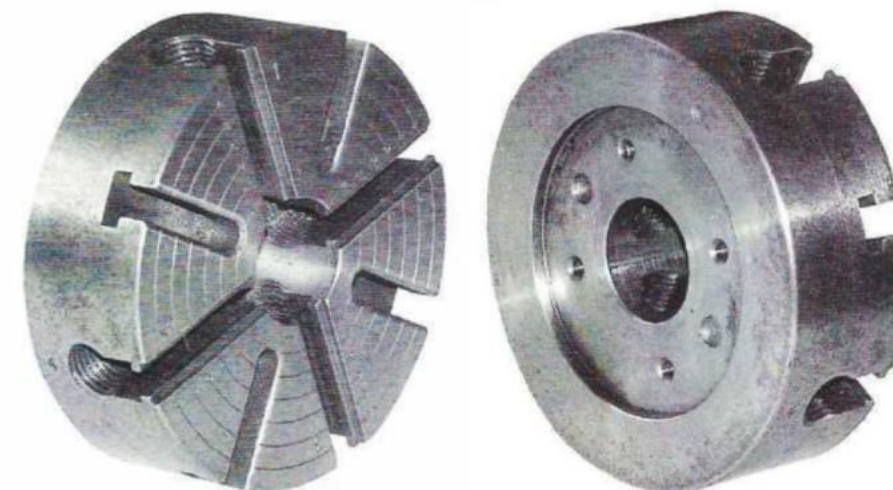
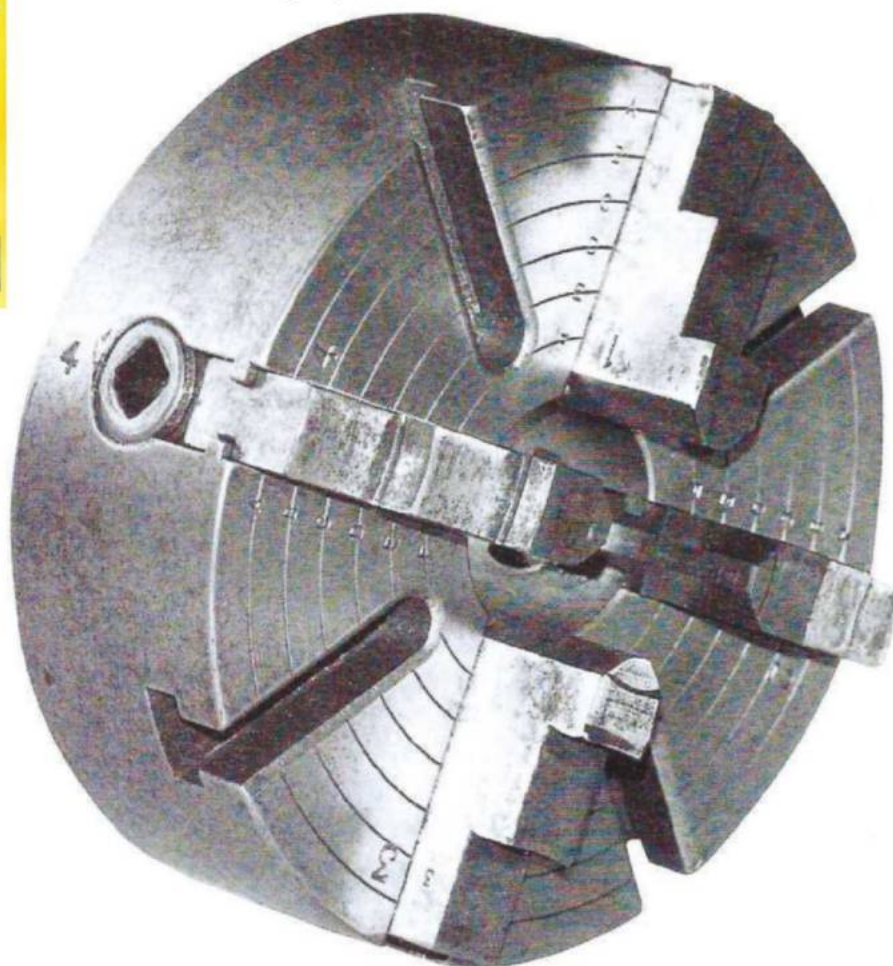
... and
Much
More

A Home Made Four-Jaw Chuck for the Lathe

Alan Jeeves – Issue 50 May/June 1998



Over the years Model Engineer's Workshop has featured many exceptionally ingenious and well-made pieces of tooling and workshop equipment. One excellent example is the four-jaw chuck by Alan Jeeves. Not only is it superbly executed, but the addition of t-slots and extended jaws gives it more flexibility than the standard item. Although this is quite a large chuck, the design could easily be reduced to, say, 100mm or 125mm diameter to suit slightly smaller lathes.



The chuck body, fully machined

The chuck body seen from behind showing backplate recess.

I don't really work that much with a 4-jaw chuck. Until this project was undertaken, the largest one I had owned for years was a 110mm diameter example, which came in useful for the odd square or rectangular piece requiring turning or boring in the lathe. Large and awkwardly shaped work could always be mounted on to a face plate, and such occasional jobs as model traction engine crankshafts or front axles could be dealt with between centres. This 110mm chuck was initially for use on a 3 1/2 inch lathe, but it can also be attached to the spindle nose of my larger 5 inch. lathe, upon which machine it looks completely lost.

I have often considered the possibility of obtaining a larger diameter 4-jaw chuck. I could see the advantage of mounting my 100mm 3-jaw chuck exactly true within a 4-jaw, for turning extremely accurate small work, but a new one would really be too expensive for the extent of use to which it would be put. The preferable option would be a second hand chuck, but such a chuck never seemed to turn up.

Some time ago, a fabricator friend

brought me a large piece of steel in connection with a job which he was doing at his work. This 200mm diameter x 65mm long blank was to be accurately bored and keywayed in my workshop, and was also to have a concave radius machined into the outside diameter, which was to be concentric with the bore. The aim was to make a female die for use on a hydraulic swaging machine. This powerful machine could already produce long straight lengths of half round hollow section and a second female die (or roller) would permit the section to be made into rings or segments of rings, there then being three forming rollers instead of the original two.

Time passed by, but the details of the die did not arrive, and eventually my fabricator friend left the company which, in turn, left me holding the 200mm x 65mm blank of steel. As he had no further use for the material himself and the swaging die project had been completely abandoned. I was allowed to keep the steel billet.

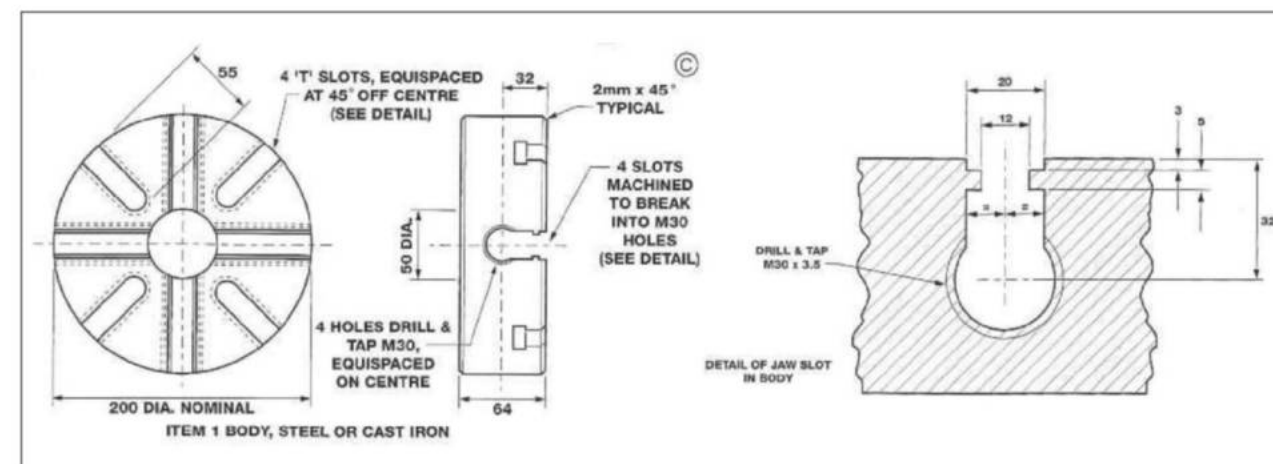
First thoughts

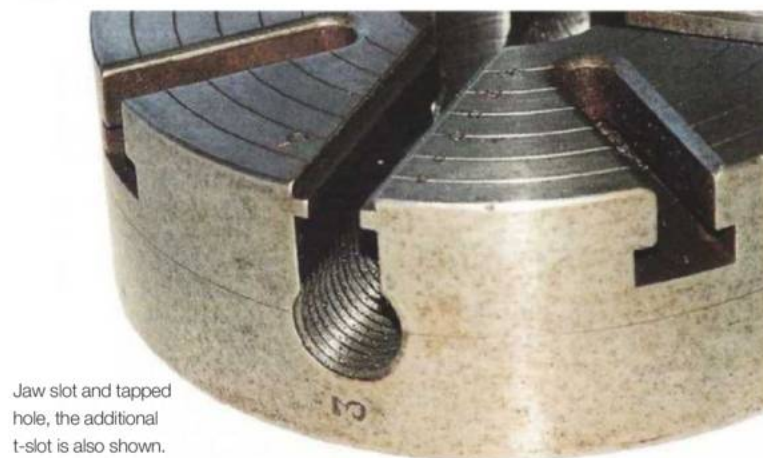
It was now becoming feasible for me to

consider manufacturing a 4-jaw chuck for myself, one which I could readily adapt to hold much larger work than the actual diameter of the new chuck body. As this was to be a turning/milling project both a lathe and a milling machine would be required, and after careful deliberation, I concluded that my mill/drill would be able to tackle the job. It would involve removing material to create the four slots in the body and making the jaws to fit. In addition, some large diameter hole drilling would be called for, and I consider that the mill/drill is just the machine for drilling large holes when required to do so in the home workshop.

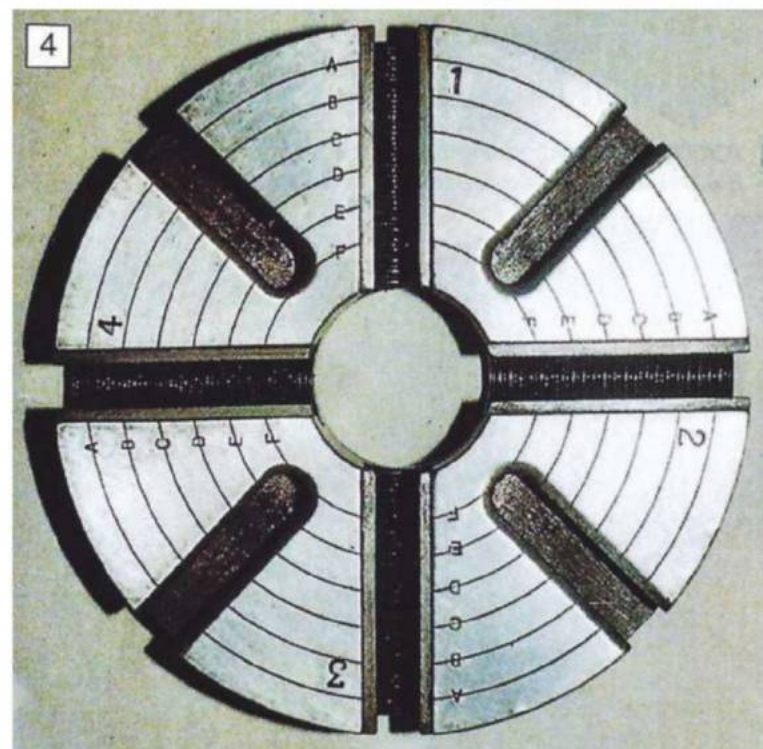
The design

I would make my new chuck as large as possible by barely cleaning up the (black) bar stock which was to form the body, resulting in a finished diameter of 198mm or so. One advantage of making the conventional pattern of 4-jaw chuck is that the jaws move independently of each other, thus eliminating the need for the spiral scroll which would be required for a self-centring chuck. This makes life

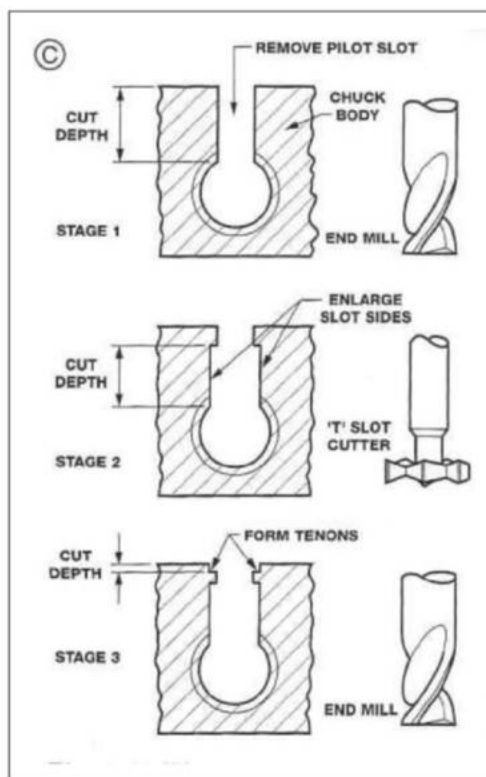




Jaw slot and tapped hole, the additional t-slot is also shown.



Chuck face showing radial setting rings.



a little easier.

On most larger sizes (over about 80mm) of 4-jaw chuck, the jaws are furnished with a half nut type of thread which engages with a captive screw, which thus provides the drive. This screw cannot move relative to the body, so as it is rotated by the chuck key, only the jaw is propelled inwards or outwards. However, on smaller chucks a different arrangement is usual. There are no threads cut into the jaw, but instead there is a fork which locates in a groove machined into the driving screw. Consequently, in order for the jaw to move, it is necessary for the screw to move with it. It is a simple idea, perhaps not quite as efficient as the captive screw principle, but it will never the less serve the amateur engineer well enough.

Turning the body

This very large piece of metal has to be machined to form the chuck body (figure 1), this being the main component. My 5 inch lathe is equipped with a screwed spindle nose which is threaded 1 inch diameter x 8 TPI (1 inch BSF). I had considered screwing the body directly with this nose thread, as is done on some chucks for popular lathes such as the Myford 7 Series. However, second thoughts turned me against this idea, for if, in the future, this lathe is replaced by another model, the spindle nose attachment thread may be different, making the chuck no longer usable. The backplate method of mounting was



Standard and extended jaws.



Jaw adjusting screw.



The fork on the jaw.



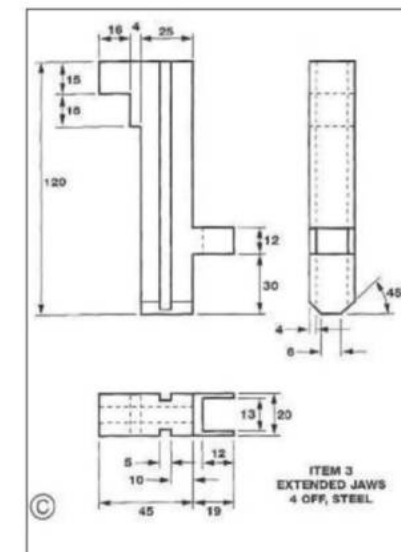
Adjusting screw fitted to jaw.

therefore the preferred method.

In order to get the job under way, the body material had to be 'chucked' in the lathe and, as I did not have a chuck which was large enough to get hold of the blank on the outside, the centre was marked accurately and a 30mm diameter hole drilled through it, using the mill/drill. This now allowed the component piece to be put up in the 3-jaw chuck, taking a bore grip. It was not the best of holds on such a large piece of material, so extreme care was taken whilst it was held in this way. Even so, one face could be machined true and a suitable recess provided for the backplate. A matching backplate already existed, as I have one or two spares put by for just such a situation, and the chuck body was made to be a good fit on one of them. The body was next removed from the lathe to have the backplate mounting screw holes drilled and tapped on the mill/drill.

When the backplate was actually screwed securely to the part machined body, the whole thing could be mounted directly on to the spindle nose of the lathe on which it was to be used and the remainder of the turning work carried out with this set-up. The outside diameter was cleaned up, removing the minimum amount of metal possible, and the opposite (front) surface faced true. The body was also finish bored to produce the required diameter of the centre hole.

At this stage, anyone making such a chuck may consider that it is worth putting a few light radial grooves into the front face, an enhancement which later assists greatly in the setting up of work, by allowing one to 'sight' the job true to one of these simple visual aids, leaving only a minimal amount of truing to do with the DTI. I machined in six circles at 10mm intervals and stamped them A to F (starting from the outside) as



an additional feature (see photo 4). A small chamfer was machined on to the outer corners and the front of the bore to complete the turning of the chuck body.

Heavy drilling & tapping

The four holes which had to be drilled and tapped to accommodate the jaw adjustment screws are quite large. I have used M30 for this thread, which meant drilling a tapping hole of 26.5 mm diameter. I chose M30 because I had a tap of that size to hand, although any similar thread such as 1 1/8 inch BSW would have done just as well. Whatever thread is chosen, it will be obvious that

one full turn of the chuck key will move the chuck jaw by a distance equal to that of the thread pitch. In my case, this is 3.5mm. Adjustment screws featuring 1 1/8 inch BSW thread (7 TPI) would move the jaw by 3.63mm per turn.

It is simple enough to mark out four equi-spaced holes on the outside diameter of the chuck body and to set it up on the mill/drill table, ready for drilling. In any event, these four holes do not need to be exactly equi-spaced. Half a millimetre either way will not matter a great deal. I found it to be a good idea, to tap the holes while the job was still in the milling machine, using a lathe centre to guide the tap, thus keeping the thread square with the hole.

When the holes had been tapped, a good sized chamfer had to be formed, in order to remove the first thread or so. This makes a nice smooth start to the threaded area, leaving no sharp edges which could cut the hand, should one get too close.

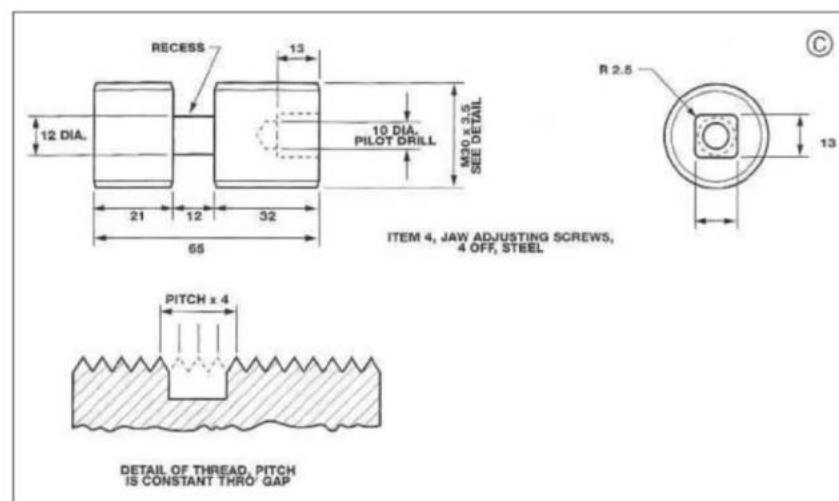
Milling the jaw slots

These jaw slots have to be machined from the front of the body and they do actually break into the tapped holes, interrupting the continuity of the thread spiral. They are not merely plain slots, but are provided with tenons which retain the jaws and effectively guide them in and out of the body.

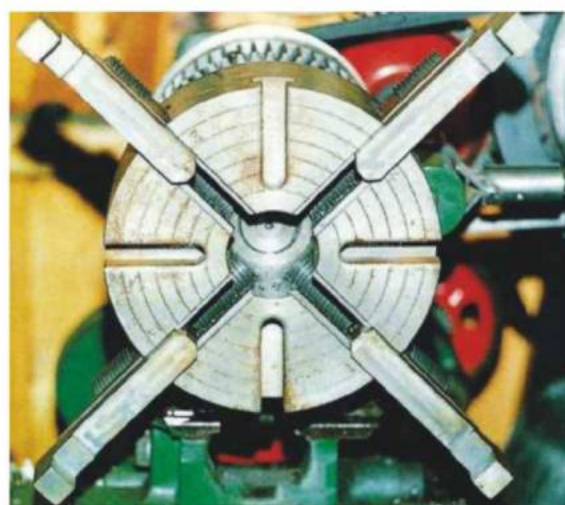
Each slot was cut in three separate stages (fig. 2). The first stage was to mill a pilot slot with an end mill of a diameter

equal to the distance between the tenons. The second stage was to remove the metal between the thread and the tenon using a t-slot cutter, and the third and final stage was to remove the metal between the chuck face and the tenon, again using an end mill. Great care must be taken to ensure that this jaw slot is exactly in the centre of the tapped hole for the adjusting screw. The chuck body was simply clamped flat to the table of the mill/drill and the work carried out by conventional vertical milling.

All the sharp edges must be removed after milling, an operation which completes the chuck body unless the slots are to be numbered. The advantage of numbering each jaw slot is that



Jaw and screw started in body.



Extended jaws fitted.



Double chucking (this should not be done with chucks that have hardened bodies, as they could slip free)

setting the work correctly is made so much easier if it is possible to identify an individual jaw. For example, if several pieces of the same size of square bar have to be set up in sequence, once the first has been set accurately, then the remainder should be able to be chucked by releasing and re-tightening two adjacent jaws only, the same two being used each time. This can save a considerable amount of time.

The standard jaws

The four jaws (fig. 3) were quite simply made from stock bright bar, and were a nice sliding fit in the previously machined slots. The tenons prevent the jaws from moving outwards from the body when they start to grip the work. On a factory made 4-jaw chuck, the jaws would be case hardened, but for amateur workshop use, they should give good service even if left soft. After all, soft jaws for the 3-jaw chuck are usually found to be very serviceable. The jaws are made in 'step' form and are reversible in their slots, thus enabling them to be used to take an outside grip.

The drive from the adjusting screw is transmitted by a fork which is carefully

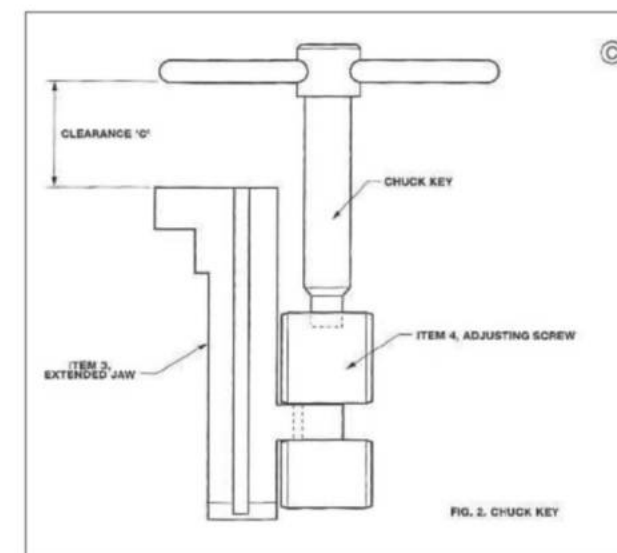
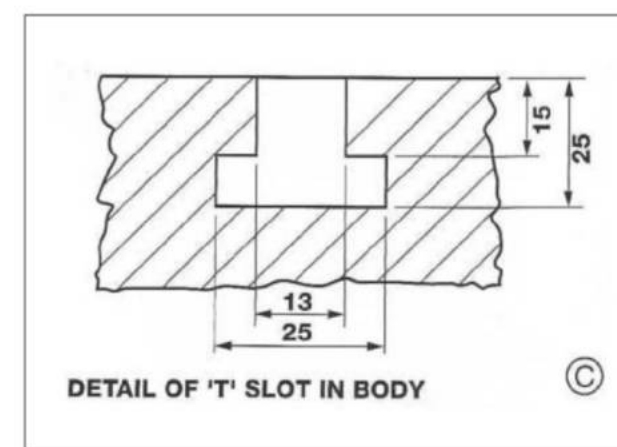


FIG. 2. CHUCK KEY



positioned on the back of the jaw in order to allow the jaw to be reversed. To achieve this, the adjusting screw must be completely removed from its tapped hole. Although all of the machining required to make the jaws is milling, when they are completed and can be set up in the chuck in the reversed position, they can be lightly skimmed with a boring tool to give a slightly radiused gripping area, which helps when taking an outside grip.

Extended Jaws

Extended jaws (fig. 4) may be made as required, these being able to hold a much larger workpiece than do the standard jaws. I made a set for my chuck, for the express purpose of swinging a 480mm diameter model traction engine hind wheel, in order to be able to bore the hub accurately. A 480mm wheel in a 200mm chuck! Again, these jaws are machined from stock bright bar, but cannot be reversed as can the standard jaws. They can, however, be radiused in the same way as were the shorter jaws.

Adjusting screws

Four jaw-adjusting screws (fig. 5) were

made from mild steel, screw cut on the lathe to fit the tapped holes in the chuck body. They should not be a slack fit, but on the other hand, they must not be too tight, otherwise the jaws will be difficult to adjust. Sensitivity will also be lost when truing work if the screws are not easy to turn. A groove machined into the screw, positioned asymmetrically along the length, accommodates the fork on the jaw, thus causing the jaw to move as the screw is turned.

The adjusting screw is turned in the conventional manner, by means of a square drive chuck key. The socket required to receive the square had to be cut by extending a pilot hole drilled into the head of the screw. This was done using an end mill of such a diameter which would create an acceptable radius in each of the four corners of the socket, the square end of the chuck key being radiused (by filing) to suit. Consideration should be given to the length of chuck key required if extended chuck jaws are to be used (fig. 6).

Using the chuck

When completed this chuck is used in



Typical use, a hub for a traction engine hind wheel (one jaw reversed). 380mm wheel being bored true. An extended jaw is visible between the two uppermost spokes.

the same way as is a conventional 4-jaw chuck, the only possible difference being the use of the extended jaws. They will be found to be very useful for jobs such as boring centre holes in large plates or flanges, especially so when the lathe is equipped with a gap in the bed, as is my machine.

It will be seen in the various illustrations of this chuck, that four additional slots have been machined into the front face of the body. These are t-slots which are compatible with the t-nuts supplied with my milling clamp set (fig 7). Their purpose is to provide additional means of securing large jobs should this become necessary. They also serve to lighten the chuck slightly. ■

Events

May 30 – a magnitude 6.6 earthquake in Afghanistan kills around 5,000 people.

June 30 – Argentina knock England out of the World Cup in a penalty shoot-out.

Marking the first 100 issues of MEW

Issue 100 August/September 2004



The Birth of Model Engineers Workshop

Stan Bray

My drift into model engineering with hindsight seems to have been inevitable. My father was a locomotive driver, although obviously he must have started, as did everyone, as a cleaner and fireman and followed what was in those days a very long and hard road to become a driver. Several uncles were railway employees, including one who was firing on the top link at Kings Cross. My first recollection of our own home was that of seeing the locomotives stabled at Hornsey in North London, parked at the bottom of the back garden and as Hornsey was where my father was stationed and the entrance was little more than a few yards from the house I was a frequent visitor. I knew a large number of the staff and was not only made welcome at the shed but had frequent footplate trips as well.

With the start of the war my school closed, most of the pupils being evacuated although some of the older ones joined the forces and so it was a case of finding work. It was made quite clear that the railway was not considered

In 2004, Model Engineers' Workshop celebrated its 100th issue with a special gold-inked cover. In a short section entitled 'Blast from the Past' then Editor David Fenner invited the previous incumbents to reflect on the magazines first fifteen years. Not only the first editor of MEW, but also the person who had the original concept for MEW, Stan Bray told the story of how the magazine came to be.

suitable. I obtained an engineering apprenticeship, at the princely sum of 14/- (70p) per week with an annual increment of 1/- (5p) per week for the next five years at which point my wages would go to £2-10s-0d (£2.50) per week and started to learn about milling machines, etc., although a considerable proportion of the time was spent on capstan lathes and power presses as the firm was engaged on war work and although I attended classes to study for City and Guilds, in the factory, production took preference over the learning process.

I later served in Palestine and on my return from there applied for my old job, the company being obliged by law to reinstate me even though work was limited and with the return of members of the forces they were over staffed. The result was a rather boring time on a spot welder doing production work, instead of the anticipated tool room appointment.

Finding this irksome I joined the Metropolitan Police Force and set myself up with a workshop, making 'O' gauge model locomotives and rolling stock. As the result of encouragement from a fellow officer I branched out to make machine tools and a wide range of models. I also for a period attended the local technical college to take further examinations.

The intention had been to possibly return to engineering at the end of my police service, but once again I found an industry not wanting staff, this time because it was beginning to contract and so for a period I taught metalwork and engineering practice at a secondary school. This led indirectly to an interest in writing and finally in turn led to employment on the editorial staff of the

company that was then publishing Model Engineer.

The Start of MEW

Working at the Model Engineer office involved a round trip of about a hundred and seventy miles a day and after a couple or so years I found this rather too much and it was agreed that I should finish full time employment but continue my association with the company in a variety of ways, including a regular column in the magazine and writing a number of magazines known as specials. These generally took the form of thicker than usual publications that were published at irregular intervals. There were a number of different ones but by far the most popular was one called World of Model Engineering that invariably sold out very rapidly, with a constant stream of requests for further issues. All this gave me considerable experience in model press publishing and it seemed obvious from feedback that there was a call for a magazine devoted entirely to workshop matters. The management had changed by that time and it was very difficult to persuade them that there was a call for such a publication; even after several meetings they were not entirely convinced but did agree to publish at three monthly intervals, with the proviso that if the publication did not sell a certain number of copies after two issues it would cease.

So work started on the first issue of MEW and the finished magazine was taken in for perusal by management who were not willing to publish it without first vetting the content. This led to quite an argument as there was no model making in it and they would not agree at first, that without models it would sell. Finally and

reluctantly they did agree to go ahead and I eagerly awaited the first copy. To my amazement although basically unaltered a number of photographs of models had been inserted.

This led to yet more words, but now I was on much stronger ground as not only had the magazine sold well, but also because of the demand, a reprint had become necessary, something never before heard of. Issue two did not contain unrelated pictures of models and again there was a reprint and so the magazine was launched.

Unfortunately for me it was a victim of its own success as some while afterwards the company decided it should be published bi-monthly instead of at three month intervals. At that stage little copy was coming in and most of the articles involved making things in my own workshop as well as photographing and drawing them and preparing the magazine for publishing. I was also involved in other publications and had contracted to write a couple of books, it was therefore obvious that I was not going to be able to do the lot and so rather reluctantly agreed to help the company find a new editor for MEW.

As luck would have it a number of articles had by then been received from Harold Hall and it was obvious from those, that he was the man for the job, if he would accept it. I contacted him and he agreed to take it on. This was ideal as Harold had far greater knowledge of modern methods than I have and as a result of his efforts the magazine went from strength to strength.

Well there ended my engagement with MEW except as an avid reader, and occasional contributor. I still like to consider it as my baby and have a certain amount of pride in having started it.

The Winds of Change Geoff Sheppard

My involvement with MEW started just a couple of weeks after I had taken early retirement from the aerospace industry, with an early-evening telephone call from someone whom I had met on a couple of occasions. It was explained that Harold Hall had decided to relinquish the editorial chair and that a 'mutual friend' had suggested that I may be available and interested in taking on the job, and would I like to be considered for the post? It didn't take me long to work out that the 'friend' was my old co-conspirator from the Primrose Valley model engineering holidays, Stan Bray.

I had been a regular subscriber to Model Engineer since having been introduced to the topic by an enthusiastic metalwork master at school, but was



Stan Bray, as pictured in the first issue of MEW.



Geoff Sheppard's regular photo used on Ed's Bench during his tenure.



Right: The late Geoff Sheppard.

aware that there were many owners of home workshops who were interested in other aspects of hobby engineering, the restoration of older vehicles being just one of them. Having purchased every issue of MEW, it seemed to be just the magazine for this wider audience and I had admired the work that Stan and Harold had put into launching and developing the new venture.

Having been involved in the model engineering scene since the late 1940s, I had contributed a few articles to M.E. over the years and had also written a short series for the short-lived Model Mechanics in the 1970s. I therefore knew a few of the then Argus team, and after taking advice from some of my old contacts, I decided to accept the offer when it came.

I was grateful for the support of Harold and his established contributors and also for that of Ted Jolliffe and Mike Chrisp of ME, and was soon able to get to grips with the job. One of my early objectives was to reach out to this wider audience and to attract contributions that would extend the scope of the magazine. Harold had put a lot of effort into trying to interest readers in new techniques, particularly in demonstrating how information technology could be adapted for our purposes. His evaluation of a number of CAD systems involved much work, but was not widely appreciated. Indeed, when I took over, I was informed by one reader that 'computers have no place in our workshop activities'. It was interesting that by the time I handed over to David Fenner, most of my correspondents were quoting an e-mail address on their letters.

Technology for the amateur

Not that many years ago, the machine tools and processes used in our home workshops were very similar, apart from

size, perhaps, to those used in industry. More recently, industrial developments have become less and less applicable to our operations and the gap has been widening rapidly. I tried to encourage those contributors who were prepared to experiment with newer techniques and it has been gratifying to see that some of these have become established. Most model engineering exhibitions now feature two or three trade stands that supply computer numerical control systems for the home workshop and they always seem to attract a great deal of interest.

One application which arose from discussions with one of our contributors has now been developed to the stage where it is selling in significant numbers to industry, so perhaps we have done a little to reverse the trend.

And the future?

It will be interesting to see the way in which the home workshop develops over the next few years. Items of tooling that were popular with the home constructor, perhaps because of lack of availability or the cost of the commercial item are now often readily available at a sensible price due to the efforts of our excellent and supportive trade suppliers. The emphasis has therefore changed. I am sure that the ingenuity of our readers will continue to provide us with some fascinating projects that will explore pastures new. 📧

Events

August 10 – A collection of unknown poetry by Philip Larkin is found at Hull University.

September 29 – First flight of SpaceShipOne.

Grinding Rest

Harold Hall – Issue 89 April 2003



Ask a group of Model Engineers' Workshop readers what they think are the best tool builds to appear in the magazine over the years, and you will get many different answers, but you can be sure that one particular article will be mentioned over and over again: Harold Hall's grinding rest.

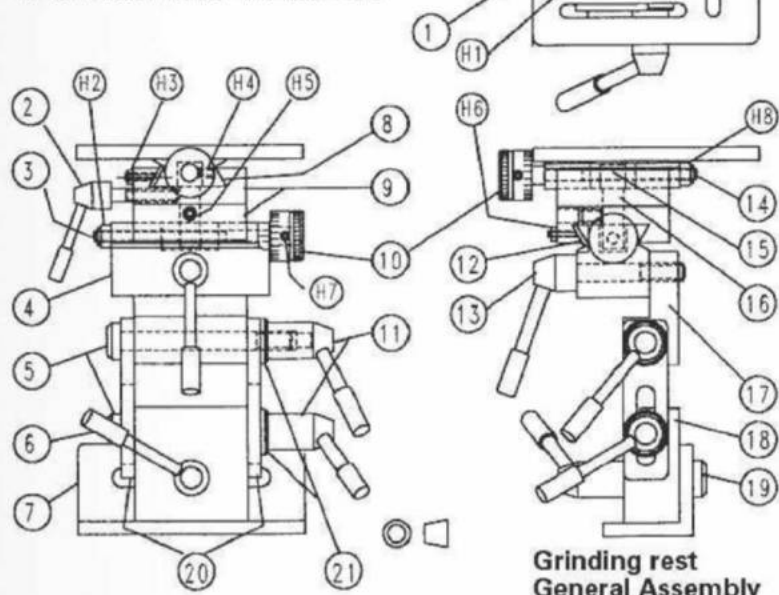
Of all items of machinery purchased for the workshop, the bench grinder almost certainly falls short in terms of precision requirements by more than any other. The rest supplied is always too small and frequently insufficiently robust, making it totally inadequate for serious use.

The significant feature of the rest, seen in **photo 1** and the **General Arrangement**, is that it gives fine

adjustment both to and from the front face and to and from the side face of the grinding wheel. This makes it possible to remove very small amounts whilst at the same time being able to grind close up to a point, such as an adjacent cutting edge, without any fear of damaging its edge. To make use of this feature the item being ground has to be held in an appropriate accessory rather than ground totally free hand.



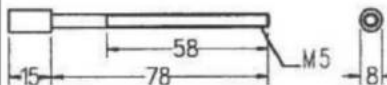
- H1 M4 X 14 SOCKET CSK SCREW 2 OFF
H2 M5 NYLOCK NUT, OR TWO LOCK NUTS
H3 M4 X 14 SOCKET GRUB SCREW AND NUT 3 OFF
H4 M4 X 6 SOCKET GRUB SCREW 1 OFF
H5 M5 X 8 SOCKET GRUB SCREW 1 OFF
H6 M4 X 14 SOCKET GRUB SCREW AND NUT 3 OFF
H7 M4 X 6 SOCKET GRUB SCREW 1 OFF
H8 M5 NYLOCK NUT, OR TWO LOCK NUTS



Grinding rest
General Assembly

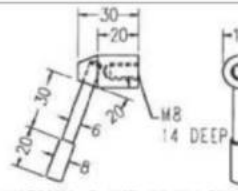


QUANTITY 1 OFF
2. Locking handle



MATERIAL 8mm DIAMETER
STEEL 230M07

QUANTITY 1 OFF
3 Lower lead screw

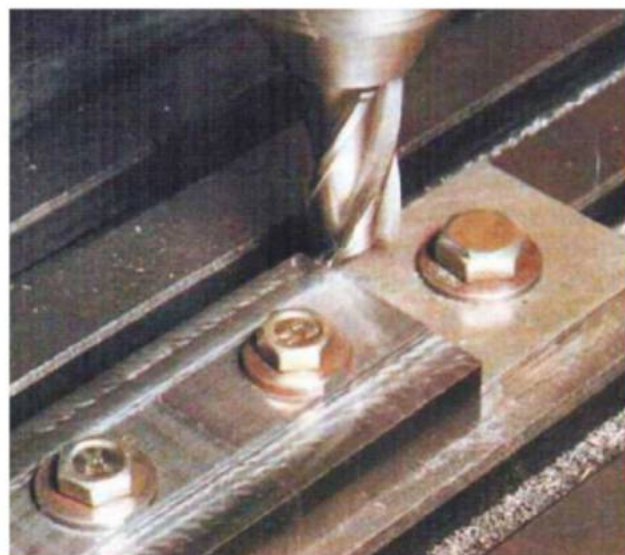


MATERIAL 8 AND 16mm DIAMETER
STEEL 230M07

6. & 11. Locking handle



Machining the ends of parts cut from 50mm square bar.



Machining the edges of the slide swivel pieces.

MANUFACTURE

The 50mm Square items

To economise on effort, first cut the material for parts 4, 8, 9, 17 and 18, machining the cut faces of these as in **photo 2**. However, machine one side only of item 9. Item 8 is made from 32mm square material to benefit from free cutting material, 230M07.

Slide Swivel Pieces (9)

Drill hole A and use this to mount both as in **photo 3**. Use an engineer's square to ensure they are accurately placed for a later operation. Machine both edges, 16mm thick and about 14mm wide. So as not to lose position, clamp to the machine table as in **photo 4** before removing the screws, also add end supports. Using a large slot drill, mill a

slot down the centre to a depth of 7.9mm. An end mill is also acceptable as the slot is open ended, for me though I prefer to use a slot drill. However, to widen an already made slot, I prefer to change to an end mill and widen to give the dimensions of 10mm and 26.5mm.

I am assuming that by now your confidence in using your milling machine is sufficient for you to justify the purchase of a dovetail cutter. If not, you will have to follow the method of angling the work and using a narrow end mill to cut them. Lower the dovetail cutter into the slot by about 4mm and start machining the dovetail, removing metal in stages until a flat of about 0.5mm remains along the top. Repeat this on the second side. Next lower the cutter and skim the base of the slot to establish the 8mm dimension. Using the same process as for the top half of the dovetail, machine the lower half until it



Preliminary work on the dovetails.



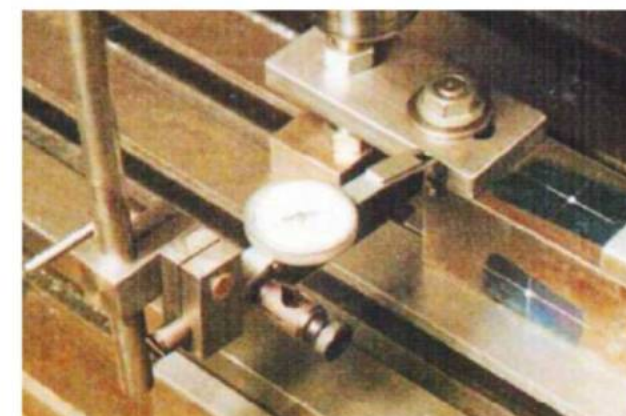
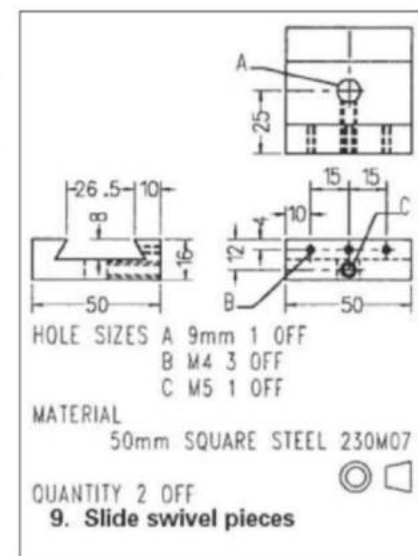
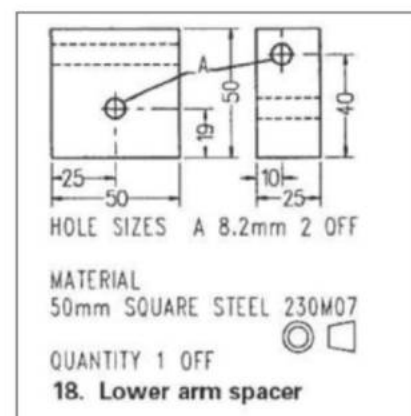
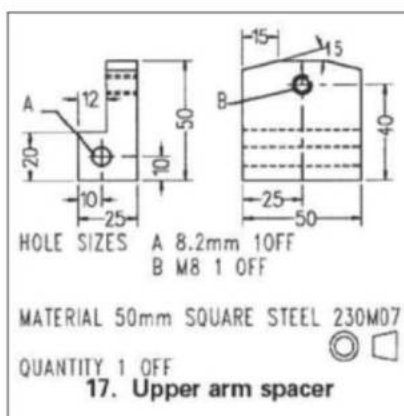
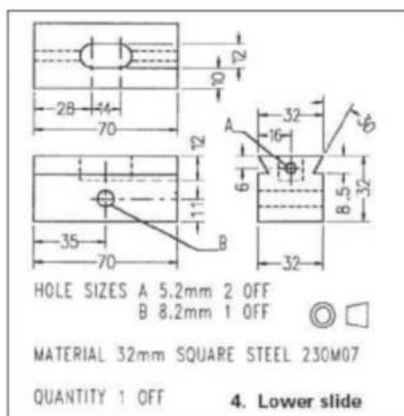
Finishing the dovetails in the slide swivel pieces.

becomes level with the half already produced. Norm moving the cross slide by only 0.1mm for each pass, continue until the flat is machined away. Leaving the cutter set at this height repeat the process on the first side, **photo 6**. Mark out and drill and tap the remaining holes. Lower Slide (4) Position the part on the table using a dial test indicator to ensure that it runs parallel with the

table traverse and securely clamp in place, **photo 5**. Do equip yourself with some form of mounting a dial test indicator such as seen in the photo as it is so much more convenient than mounting it in the drill or cutter chuck. Set the height of the dovetail cutter using a stack of distance pieces (ref. 1) 20 + 3 + 0.5 giving 23.5 as seen in **photo 7**. Produce the dovetail as in **photo 8**.

Ideally do this in two stages as was done for the slide swivel pieces using the distance pieces for the second stage, and not one stage as **photo 7** and B indicate.

Fit a 12mm slot drill and machine slot, **photo 9**, do not forget to set the table stops, when machining closed end slots. Having positioned one end, distance pieces to the value of 14mm will enable the other stop to be easily set. Mark out



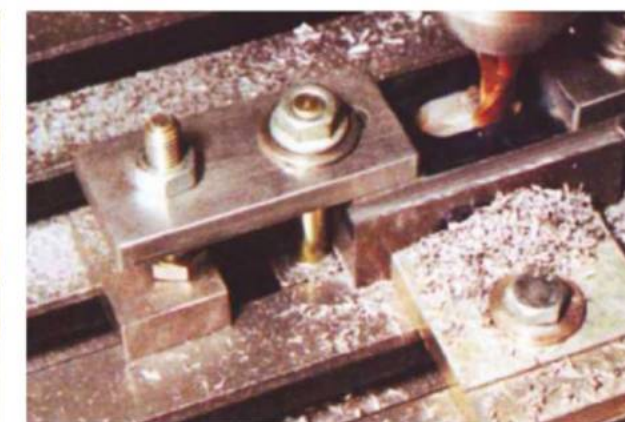
Positioning the lower slide prior to cutting the dovetails.



Setting the depth of dovetail using distance pieces.



Cutting the dovetails in the lower slide.



Cutting the slot in the lower slide.



Machining the lower arm spacer. With only one clamp being used the supports are essential for added security whilst machining.



Setting up a support for machining the side arms.

and drill holes A and B but making B tapping size for M5 at this stage.

Top Slide (8)

To reduce to 12mm thickness, after sawing to 12mm plus, clamp to the machine table with clamps on one side only and reduce half the width to 12mm. Before removing clamps fit further clamps on the already machined half and then remove first clamps. Reduce thickness of second side, without altering the cutter height between machining the two halves. The remaining operations on this part are now virtually as for the lower slide so repetitive detail will be omitted. The slot goes completely through the part so make sure you align the part with the T slot or use packing to raise it from the table. A little inattention here could result in a beautifully machined slot in your mill table. Again, hole A should initially be tapping size for M5.

Upper Arm Spacer (17)

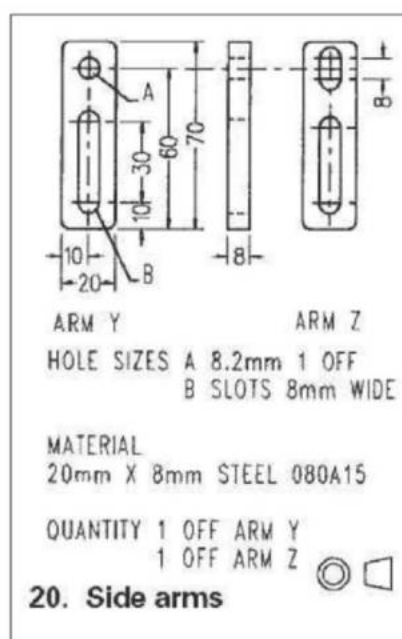
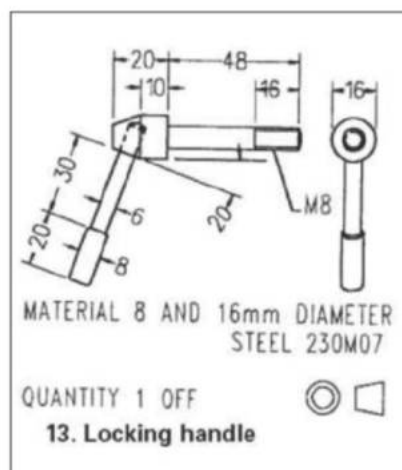
Set this up as shown in photo 10, only a single clamp has been used as there is insufficient space to take a second, the support pieces are therefore absolutely essential. Mill step as shown ensuring that you cut towards the support. Then mount onto an angle plate and machine the two angled faces. Mark out, drill and tap holes A and B.

Lower Arm Spacer (18)

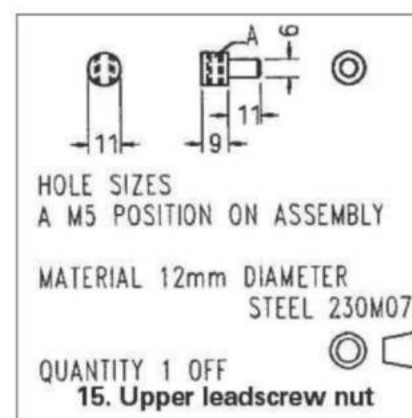
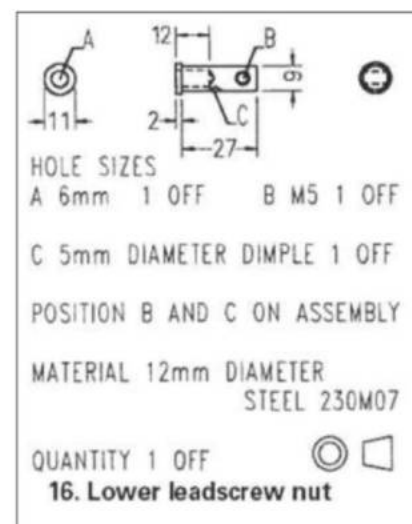
Mark out and drill holes.

Side Arms (20)

Position a clamp on the angle plate using an engineers' square as shown in photo 11 using this to support the arms whilst machining their ends. Remember to machine towards the support as shown in photo 12. However, the photographs show that I had second thoughts having moved the angle plate and the clamp is fitted higher. This does though remind me to comment that much mounting



Machining the ends of the side arms. Some second thoughts obviously resulted in the setup being changed between photos 11 and 12.



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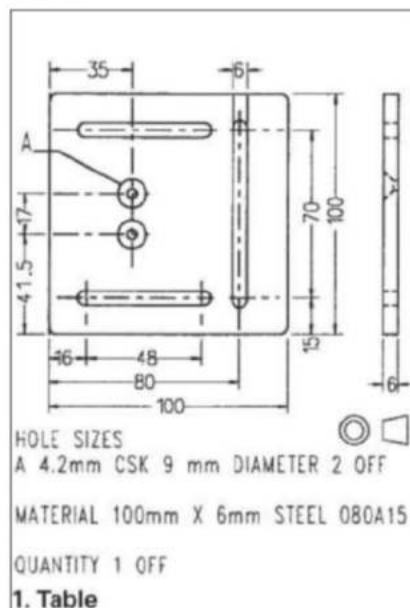
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work on the angle plate can be carried out remote from the machine. This can be on the surface plate, or even mounted in the bench vice with the working face horizontal, making positioning parts very much easier in many cases.

Table (1)

Cut a piece of 100 x 6mm, 100mm long plus an allowance for machining and place this on the machine table as shown in **photo 13**. Line up the edge to be machined with the gap of a T slot so that the cutter will not damage the table and machine the edge, **photo 14**. An improved finish can result if a light finishing cut, say 0.1mm, is taken where the traverse direction and cutter rotation are the same. This is a chance to try this out for yourself. Mark out, drill



Machining the table's edges.

and countersink the two holes and once more accurately position the part on the machine table. This time packed up to allow for milling the through slots, **photo 15**. Set the table traverse stops, and cross feed stops if your machine has them, (typically as seen at bottom of **photo 15**) enabling the slots to be cut without continual reference to the table traverse dials. At 6mm diameter you will need a speed on the high side, say 1000rpm plus.

Base Angle (7)

Photo 16 shows the set up for machining the slot.

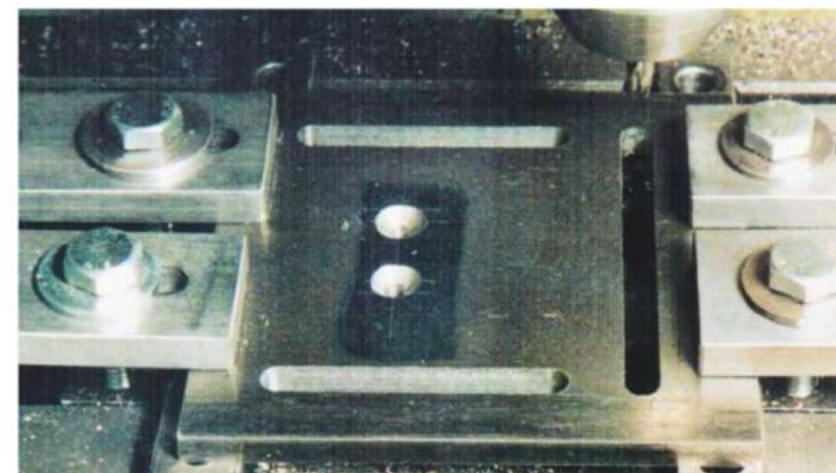
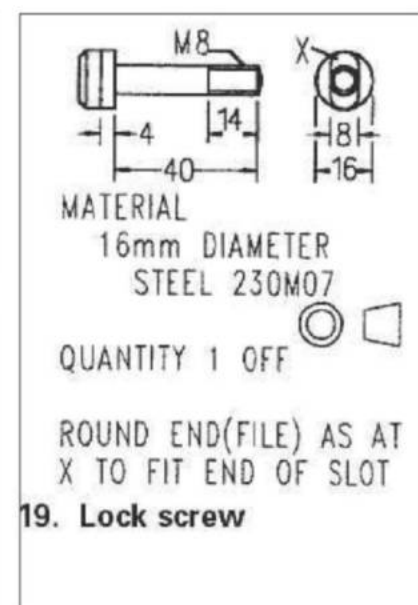
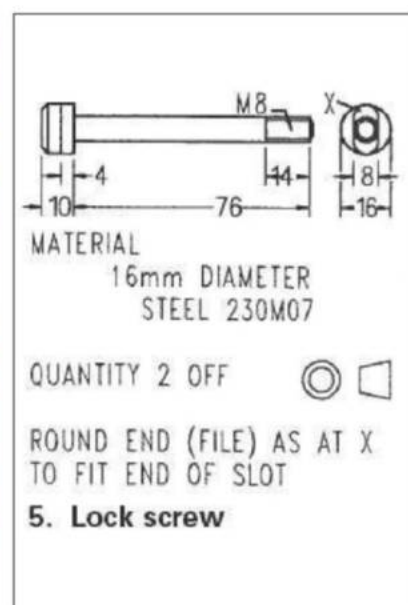
Lock Screws (5 and 19)

The turned parts are all quite simple and I do not intend therefore to go into the

lathe work involved in these. However the lock screws do have a little milling activity that could present a problem to the novice. The lesson to be learned is that what may be a problem when attempting to use the available methods for holding a part (angle plate, vice, etc.) can become a very straight forward operation if aided by a simple home-made fixture. Make the two items shown in Sk. 1 taking note that the hole must be central in item A, all other dimensions can suit available material and a length of tube will also be required. Set these up on the mill table and with a 4mm mini mill running at maximum speed mill the flat as shown in **photo 17**. Now turn over the lock screw with part A and relocate against the stop in part B making the operation of milling the second side, and



Positioning the table in preparation for machining its edges.



Milling the table slots.

the remaining two screws, a very simple operation.

Gib Strips (12)

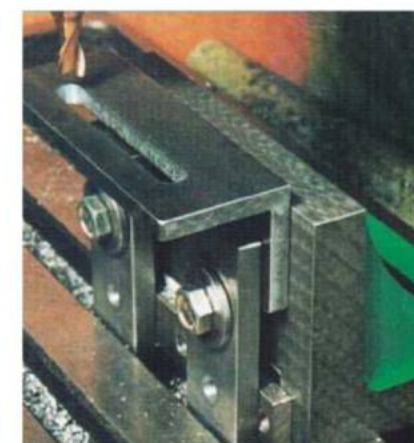
These may appear to present a problem if a tilting vice is not part of your kit, you have though already made the ideal fixture for holding these. Clamp one of the slide swivel pieces to the machine table and with a round rod and a piece of packing use this to hold the gib strips for machining, **photo 18**. Turn over, and machine the second side. What appeared a problem has turned out to be very simple.

Feed knob (10)

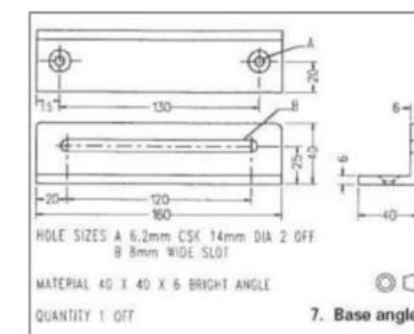
Calibrating the feed knob can done with a dividing head, or by indexing using a gear fitted at the back of the lathe spindle. After boring and making the knurl whilst mounted in the chuck, mount on a taper stub mandrel and turn

the portion to be calibrated. Do ensure that the knob is very firmly pushed onto the mandrel. Without removing from the chuck, transfer chuck, mandrel and knob to the dividing head and mount this on the lathe as shown in **photo 19**.

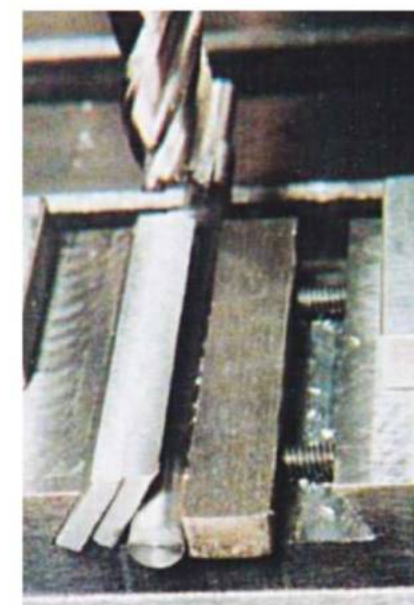
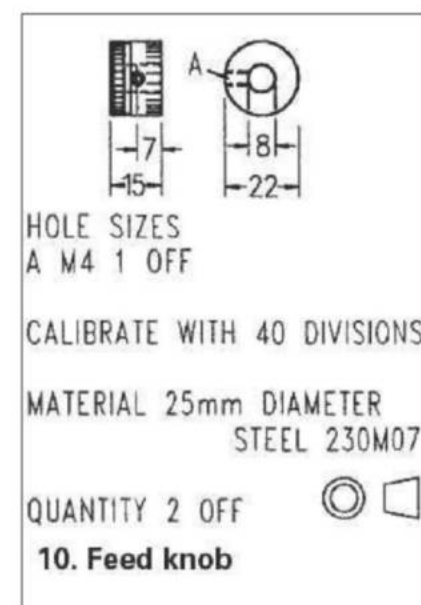
It is easy to fall into the trap of thinking that a pointed cutter should be used to make the lines on the dial. However, an error in concentricity will cause the line to change in width as the dial rotates. Make a cutter as Sk. 2, I would suggest a lip width of 0.2 to 0.3mm. Depending on the error in concentricity you may still need to make slight changes in the depth of cut as the dial rotates. I would suggest you find the mid-point of any error and set the depth of cut at this point to be 0.1mm. Make sure the tool is firmly clamped on the top slide and use its calibration to set the line lengths. With an M5 thread having a pitch of 0.8mm, 40 calibrations will give increments of 0.02mm.



Milling the slot in the base angle.



Set up for machining the lock screw using the parts illustrated in SK1.



Box 1: IMPORTANT SAFETY REQUIREMENTS

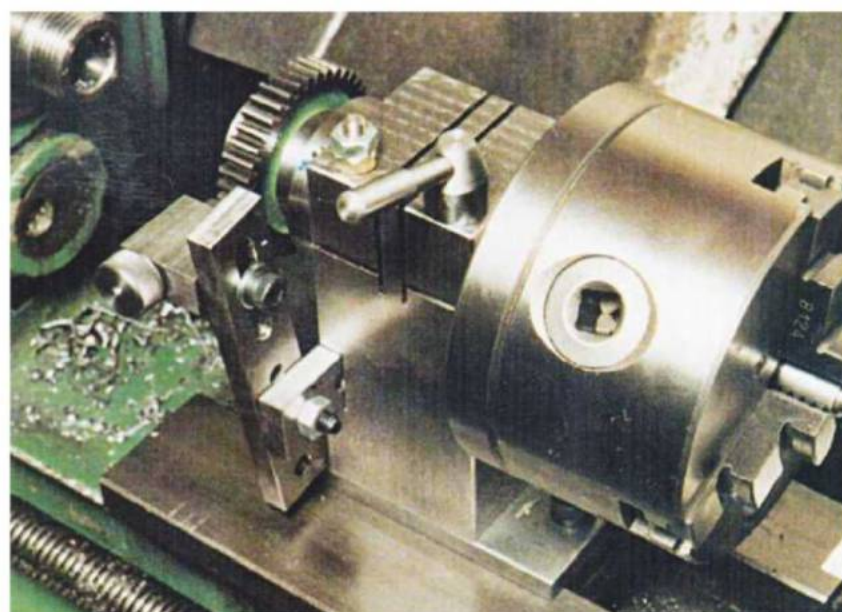
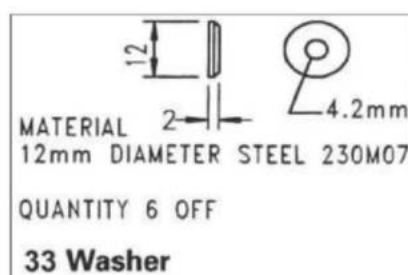
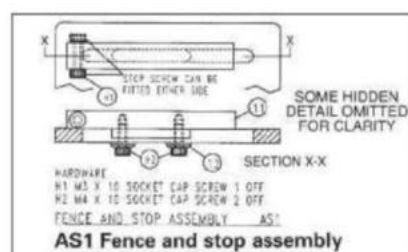
- Do wear safety glasses or a face mask, and ensure wheel guard is fitted.
- Due to the item being ground often being unsupported close to the wheel when using the accessories, only take very light Cuts. The depth of cut should be controlled by the fine feed and the fence rather than manually.
- Make multiple passes rather than try to remove a great depth at a single pass.
- Keep the overhang of the tool from the accessory holding it to a minimum.
- In view of the overhang do ensure the accessory is held firmly down on the rest's table.
- Keep the table and the sliding surfaces of the accessory as free of grinding dust as possible. This results in easier hand feeding and makes for safer working.
- The rest can be used as a conventional off hand grinding rest in which case ensure that the front edge of the table is no more than 1mm from the grinding wheel and the item being ground supported by the rest's table.
- When the grinder is running do not make adjustments to the rest, other than using the table's fine feeds.
- Make sure that all locking levers are firmly tightened before starting grinder.
- As the grinding rest is not directly mounted off the bench grinder it is essential that both are mounted on a very robust base. If this is not done the rest will be able to move relative to the off-hand grinder when in use. At best this may result in inaccurate results but much worse be the cause of a serious accident.

Assembly

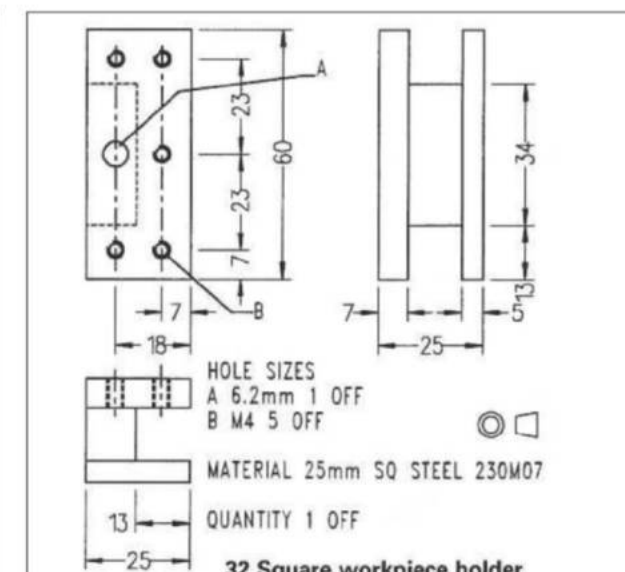
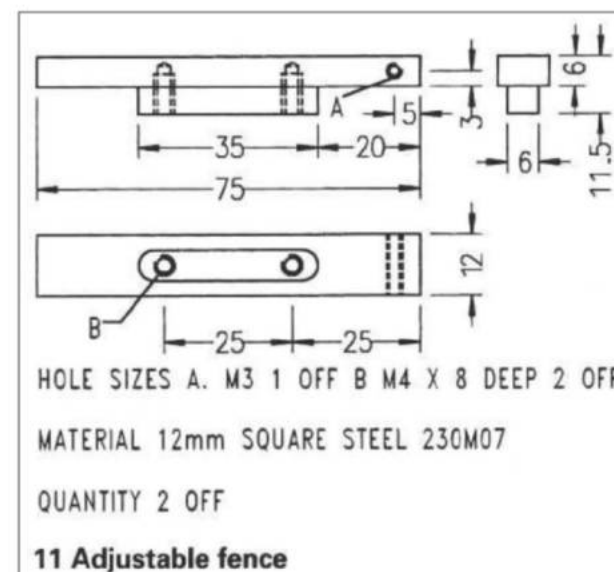
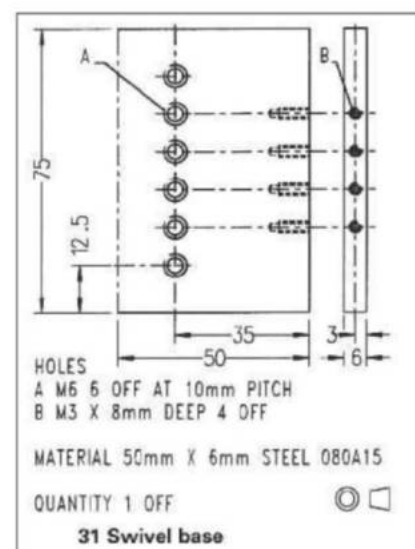
First, assemble both items 9 together with item 16 and fit and lightly tighten the screw H5. Take apart and drill dimple C in part 16 as indicated by the mark made by the screw. Reassemble with items 4, 8, 12, and 15 added making sure that screw H5 locates in the dimple and tighten gib strip screws so that the slides are firmly fixed. Drill through items 4 and 8 into the Leadscrew nuts, items 15 and 16, using an M5 tapping size drill. Open up holes in items 4 and 8 to 5.2mm diameter and tap the Leadscrew nuts M5 through the holes just drilled. This will ensure satisfactory alignment. Dismantle and drill the dimples in the gib strips as indicated by the screw marks. Assemble the parts involved in using the locking handles and mark the preferred position for their arms, remove, drill and fix the arms using two-part resin adhesive. You will see from the **photo 19** that I chose to fit the top locking handle 11 on the left rather than on the right as shown in the assembly drawing. This helps to make them both more accessible. Also, it is important to take note that items must return to the same position as variations in the position of their threads will cause handle arm positions to vary. I would suggest marking them with one, two or three, etc., centre punch marks in some obscure position, such as on the threaded ends of the lock screws. Assemble for the last time applying a little oil in appropriate positions and the rest is complete.

Grinding Rest Accessories

The full extent of the adjustable off hand grinding rest's capabilities will only be realised by the addition of various



Calibrating the feed knob using a dividing head described by the author in an earlier article



accessories. First however, please make sure you follow the very important safety considerations in Box 1.

THE ACCESSORIES

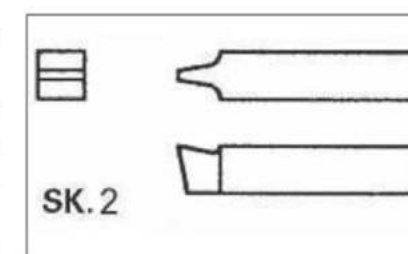
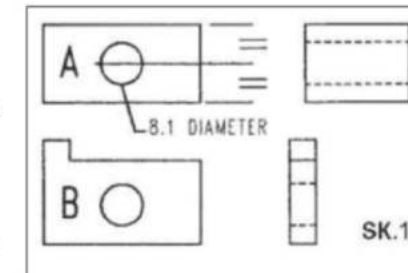
Fence & stop assembly (11)

This is an essential part of the system being used to accurately guide the part being ground, either across the face of the wheel or down its side. A stop screw can be fitted when required to ensure that the part being ground cannot pass beyond a certain point.

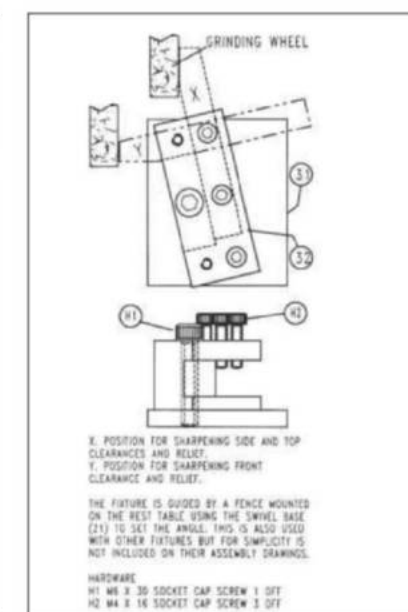
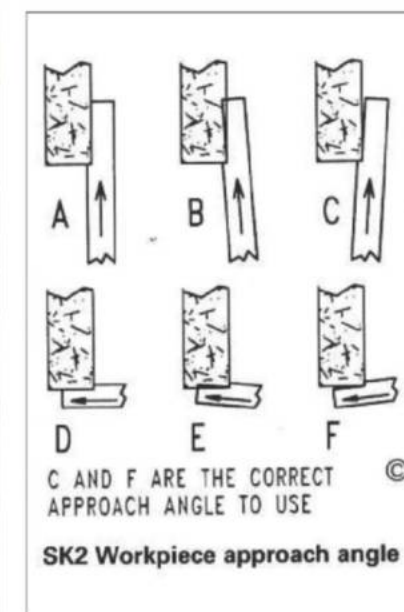
Much milling work can be carried out without using a vice as the work holding device. Where a vice does come into its own, is with the smaller items which are much more difficult to hold by other

means. The adjustable fence (11) is a typical instance. Machine lower web, **photo 20**. Turn over, hold on web just made, and machine top surface to reduce thickness to 6mm. Drill and tap holes. Radius web ends using a file. Note that the two M4 tapped holes are shown blind. If drilled through, then grinding dust will find its way very easily into the threads. The assembly also requires some turned washers (33). However, I will not comment on them in the text, as the drawings should give all the information required.

Photo 21 shows the fence fitted. It can of course be in any one of the three slots. The web which fits into the slot is shorter than the slot permitting coarse adjustment of the stop screw position. Final adjustment will be achieved using the fine feed facility



Milling the fence.



of the rest. You may find it easier to fit the fence to the table if you remove the table from the remainder of the rest.

Square workpiece holder and swivel base, AS3

The main purpose of the holder is to hold square section lathe tools but no doubt other uses will surface. The base (31) is used for setting the angle of the workpiece relative to the feed direction and is also used with many of the remaining accessories. For simplicity it is not shown on their drawings but can be seen in the photographs.

To machine the square workpiece holder (32) mount on an angle plate using a parallel to ensure the part is parallel to the machine table. Commence machining groove with an 8 or 10mm slot drill, working to the 5mm dimension. Open up to 13mm using an end mill. Drill and tap holes. Cut a length

of 50 x 6mm for the Swivel Base Machine (31) ends to 75mm, again using the angle plate for mounting. Drill and tap holes.

To sharpen a lathe tool, mount the holder on the swivel base at an angle to suit the tool's side relief and with the rest's table angled left to right to suit the tool's side clearance. **Photo 22** and **fig 34** show this operation.

If you have studied the grinding rest in detail you may consider that the angle set using the swivel base would actually be achieved using the rest's swivel facility. This is not so, its use, with a few exceptions, is purely to set the approach angle of the face being ground to the wheel.

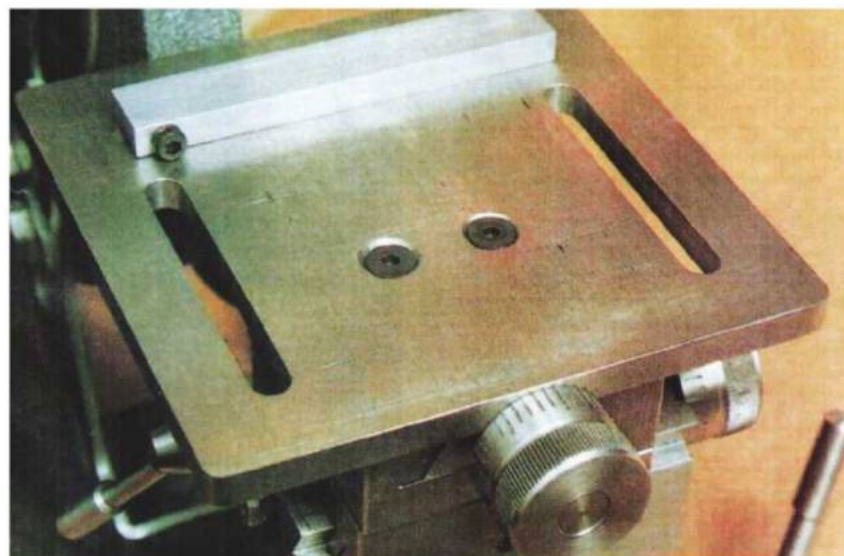
When grinding a portion from the side of a workpiece it would seem obvious that the feed direction should be parallel to the side of the wheel, see Sk4(A). However, any small error in the

approach angle could cause the part to be additionally ground on its side, as in Sk4(B). In view of this, feed direction is deliberately set to an angle to the side of the wheel to avoid this possibility. Sk4(C) shows this arrangement.

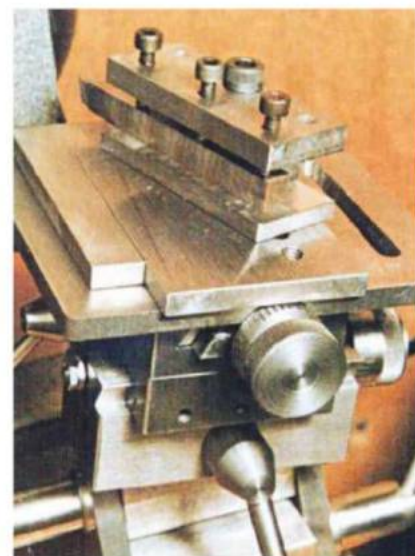
This may seem like a procedure to overcome the accuracy limitations of the home workshop, it is though frequently adopted practice in industry. Sk4(D,E and F) show the same situations relative to the front face of the wheel. This angle, set by the rest's swivelling facility, should only be a degree or two maximum.

Postscript

Harold Hall followed up with further articles on various accessories to simplify grinding all sorts of items from screwdrivers and scribes to lathe tools and milling cutters such as those in **photo 24**.



The finished fence in position.



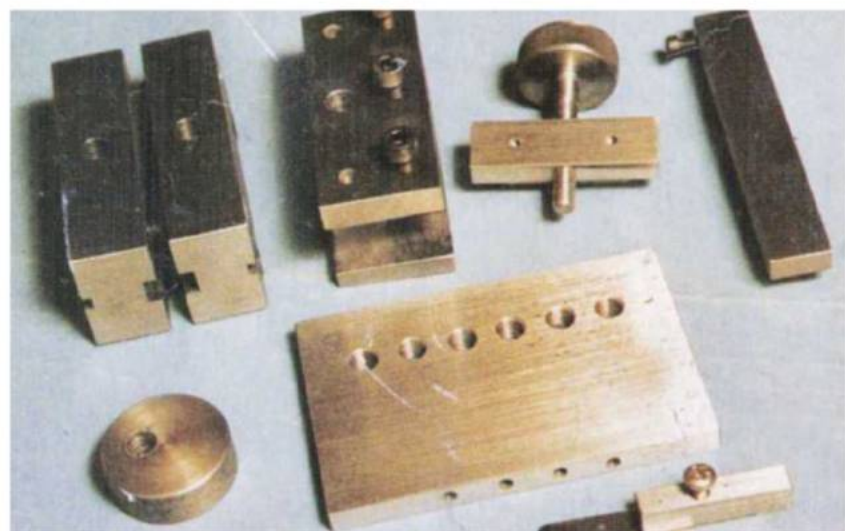
Using the square tool holder on the swivel base to sharpen a lathe tool.

Details of these various accessories were later published in his book *Tool and Cutter and Sharpening, Workshop Practice Series number 38*. Special Interest Model Books, available from www.myhobbystore.co.uk, search for 'wps 38'. Harold's website give details on using the rest at www.homews.co.uk/page224.html

References

April 9 – Baghdad falls to coalition forces in the Iraq War.

April 10 – British Airways turn down Richard Branson's offer to buy their Concorde for £1.



Some of the basic accessories for the grinding rest.

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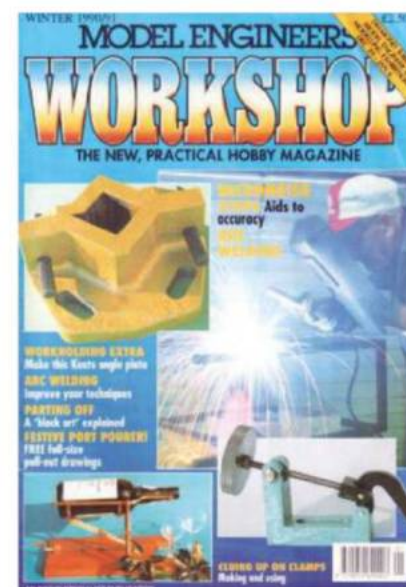
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Electric Arc Welding

Stan Bray – Issue 3 Winter 1990/91

Arc welding in progress, note the use of protective gear.



One of the features of early issues on Model Engineers' Workshop were short how-to articles that managed to give a good overview of tools or techniques unfamiliar to some readers. This short piece by Stan Bray on electric arc welding is an excellent example that should be just as useful to anyone starting out with a 'stick welder' today as it was twenty-five years ago.

Arc welding is something that needs a great deal of practice to become even moderately efficient in; such skill cannot be passed on merely by writing about it. The types of joint construction and details of equipment are another matter and perhaps some of these facts will be passed to readers through this article.

Welding is a process of joining metals by softening the edges and then fusing them together. Many years ago it was always a source of wonderment to watch the local blacksmith mending farming equipment by welding. There was none of the sophistication that we know today; both pieces were put in the furnace until they were almost white hot and then hammered together, sometimes with a form of lap joint. On other occasions the two pieces were simply hammered together. Of course, it took many beatings and required a great deal of skill, something that was rarely appreciated...

There are now many forms of welding used for different purposes, but it is proposed here to deal purely with electric arc welding. The reasons are simple. Firstly, a number of the projects in the magazine have called for welding. Whilst this does not necessarily mean arc welding, that certainly would be the quickest method. Then there is the fact that electric welders have, over the years, dropped in price to a level where a large number of home enthusiasts can now afford them. The third and most important reason is that a number of readers have written to say that they have bought small welding sets but cannot get the best from them.

It is not possible for a mere magazine (even though it is MEW!) to pass on

welding skills. A good welder earns a great deal of money because acquiring such skill is not easy and top people are not easy to find. We can offer some hints and tips on the best way to go about things but, when it comes down to it, the final result will only come with continual practice, and self-criticism.

The equipment

Whilst for industrial purposes there is a choice of many types of electric welder, for the average person in their home workshop the choice is narrowed to about three types – partly because a welder is needed that can be plugged directly into the normal thirteen amp socket. There are M.I.G. welders these days, very fine pieces of equipment, but comparatively expensive. These will do a very good job, and they actually weld the metal through a film of gas, a process which has many advantages. We will be dealing with their use in detail at a later stage. In this issue we are concerned with pure arc welding and so two choices of equipment are left. The oil-cooled set or the air-cooled set.

Oil cooled welders

The main advantage of an oil-cooled welder is that it can be used for continuous welding operations over a long period. The disadvantages are that they are the more expensive type, and they are invariably more bulky and much heavier. This is rather inconvenient unless the operator has a very large workshop where the equipment can have a corner allocated to it.

Air-cooled welders

For competitive price and for size of



A typical arc welding set, relatively cheap to buy they are the sort of equipment that will prove useful over a long period.



Face protection is essential.

equipment the air-cooled welding set will come into its own. Most have thermal cut-outs to prevent welding being carried on for too long a period and so ruining the transformer. As a rule, the time allocated before the set cuts-out is ample for home workshop usage. Prices obviously vary according to quality and often also govern the power available; it is as well to get a set with as much power as practical within the limits of one's pocket.

Electrodes

Arc welders work as a result of the heat created via an electric arc. To make this arc, an electrode – more commonly known as the welding rod – is used. This is a steel rod coated with a flux. As the arc is in progress, the rod melts away and so gets continually shorter. The question of the correct electrode or rod to use is not an easy one to answer. There are very many varieties, mainly designed for different purposes and so the manufacturer's instructions must be used as a guide as to whether or not that type of electrode is suitable for the job in hand. They also come in different sizes.

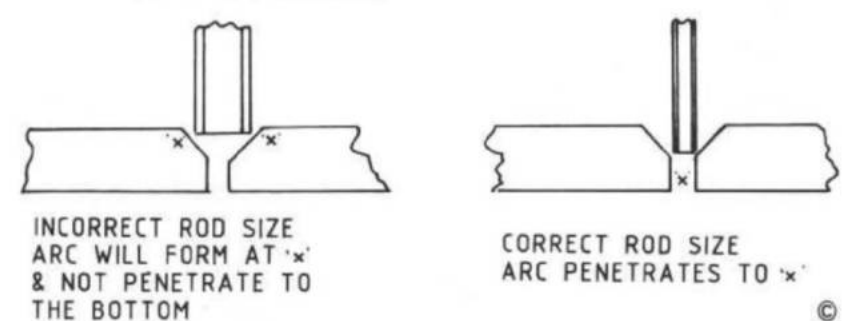
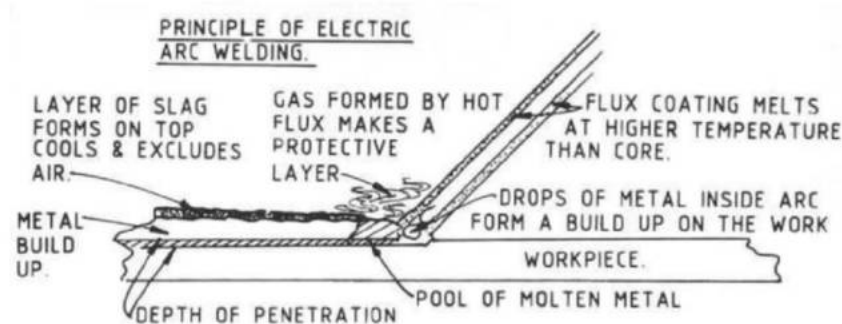
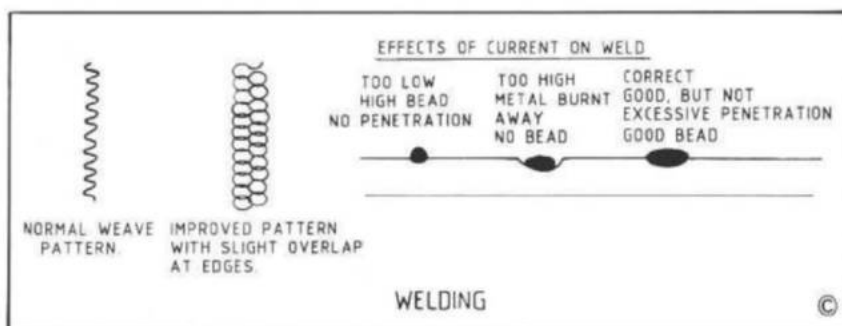
Most home welders will need one of the smaller diameter rods. Current rating of the transformer (all have a range of settings) will depend on the diameter of the rod used as well as the thickness of the metal to be worked on. Here again, practice is the important thing but a rough guide is to use one amp of current for every one thousandth of an inch thickness of welding rod.

Safety

Safety in welding is, like all other engineering practices, of the highest importance. There is a particular danger in this case from the arc itself. The eyes must be protected with a properly made piece of dark welding glass at all times. When the arc is in operation, both ultraviolet and infra-red rays are created and these can cause very nasty skin burns. In particular, they can affect the eyes, there being a particularly painful effect known as 'arc eyes'. Different grades of protective glass are designed for different current ranges in use and it is better to use a heavier one than necessary. The use of a lighter type than that recommended can result in permanent eye damage. If a welding set is purchased new then, as a rule, the manufacturer supplies a hood or shield with the correct glass already fitted. The glass can be either in a hood or a face shield. The hood is better, as it gives greater protection but some welders find they can use a shield better than the hood and prefer it that way. Never be



Good stout gloves should always be worn; if possible the gauntlet type such as these from Machine Mart.



tempted to use sun-glasses or even glasses designed for gas welding purposes for arc welding; the arc can cause permanent eye damage.

Other vulnerable parts of the body should also be protected; arms should be covered and necks also covered by a heavy overall or coat. Gloves should always be worn to protect the hands from burns. It hardly needs saying that slippers, sandals, etc., should not be worn. Remember that hot pieces of metal fly off the work when welding,

and you must be protected.

Welding sets should be switched off as soon as work is finished - you are dealing with heavy and dangerous electric currents, and whilst there is no danger under normal circumstances, it is silly to get careless.

The arc

The arc is created by striking the electrode on the work and quickly removing it to a suitable distance where the arcing effect will continue. This, for

A GAP OF ABOUT 1/16" SHOULD ALWAYS BE LEFT BETWEEN PLATES BEING WELDED ON MATERIAL THICKER THAN 3mm.



GRIND OR FILE A 'VEE' AS SHOWN.



THE SECOND RUN FILLS HALF TO TWO THIRDS OF THE VEE

THE FIRST RUN SHOULD FILL THE LOWER GAP & PENETRATE THE METAL



THE THIRD RUN CROWNS THE JOINT.

the beginner, is far from easy and the electrode will tend to stick. If this happens, the set must be switched off at once if a quick sideways jerk does not immediately free it. A cold electrode is always difficult to strike with, and a good tip is to clamp an additional plate of metal to the job. Make a couple of strikes on that to warm the electrode and then start on the actual work. The arc will be much easier to strike and maintain in position. Anyway, the practice strikes on the spare metal plate enable one to get the feel of things, and it is much better than trying to start straight away directly on the work.

Direction of weld

Always arrange the work so that it lies flat whilst being welded. Trying to work up and down is nearly impossible, and every effort should always be made to work on a horizontal plane. It is normal to weave from side to side when welding in order to get better coverage; this weaving effect must not be exaggerated and should only cover the equivalent of the rod diameter on each side of the straight seam being welded (total three times the rod diameter) If it is necessary to take a second run over the top, ensure that all deposited slag is first chipped away.

Coverage

All seam joints when possible, should be welded on both sides. Plates should never be butted directly up to each other but a small gap left to allow the pool of molten metal that is formed to run in and fill it. Any metal over 3mm thick should have a small vee along the seam to allow penetration of the welding material to take place.

In the case of angled joints, fillets should be built up along the edges of the metal. Again, a slight gap should be left between the metal to allow the weld to

flow into position. Seams should be made along both edges.

Where two different thickness metals are to be joined, it is an advantage to reduce the thicker one at the point of the weld to a thickness similar to the thinner material. If lap joints are made, then an undercut on one or both of the materials will allow better penetration.

Cast iron

Special electrodes are available for welding cast iron and these can be used for building up broken castings, etc. Care must be taken in the selection of electrodes as some leave a deposit that is difficult to machine. Almost inevitably, there will be some distortion when welding cast iron as there is with all welding operations.

Bronze welding

Bronze welding rods can be used for welding together dissimilar metals as well as bronze, etc. They are comparatively easy to use but might not be easily available. Stainless steel is difficult to weld without a M.I.G. welder but it may be possible to use a bronze rod on small stainless steel welds. ●



Above A typical example of a good quality weld where the electrode has made a single pass.



Above A typical weld with three passes of the electrode.

Conclusion

As stated at the beginning of this article, successful welding will depend almost entirely on practice.

Try as we may we cannot give any more than a brief account of the process in this short article. It is recommended that plenty of practice is done on scrap material before attempting the more important jobs. Under no circumstances should the unskilled welder try making boilers; this is a job for the expert. Only a qualified coded welder should be entrusted with such work and, in all probability, an insurance company would not accept a boiler for insurance purposes unless it had been made by such a person. This apart, small home welders can be very useful for the home workshop and enlarge the scope of workshop activities considerably.

Events

December 1 – British and French workers on the Channel Tunnel meet beneath the English Channel.

December 20 – The first ever web page is tested at CERN by Tim Berners-Lee.

Model Engineers' Workshop Today

Neil Wyatt – Issue 22 March/April 1994



I have been a subscriber to MEW for nearly fifteen years, and just over a year ago, it was my great privilege to have the opportunity to edit one of the UK's most respected hobby magazines.



I soon discovered that MEW is not just popular in the UK – I get almost as many contributions, letters and emails from fellow hobbyists around the world, especially the Commonwealth nations of New Zealand, Australia, South Africa and Canada, as well the USA, France and the Scandinavian countries, in particular. Perhaps the most exciting aspect of the magazine in 2015 is the way we can link up to our website www.model-engineer.co.uk. For example, we have been putting extra supporting information and related articles on the website to complement articles in the magazine, and you can always be sure that one or two articles in each issue will generate earnest discussion on the forum.

The forum on the website has members from all these countries and many more. It's remarkable to see ideas and information being shared and debated across the globe. Sometimes the forum has been a place to share tales of adversity – one reader had his entire workshop, with a lifetime's collection of equipment, swept away in coastal floods. At happier times there is awe at ordinary people's extraordinary achievements in their workshops, often pushing their tools and equipment to achieve tasks or results way beyond what their makers would have expected them to be capable of. The readership of MEW is more like a world-wide club of like-minded people, than a list of subscribers!

As editor I rapidly understood that I can't please all the people all the time, there will always be some 'Marmite' articles (Southern-Hemisphere readers should read 'Vegemite'), but it's my job to make sure that each issue of MEW has

something to offer every reader. That means aiming to cover a wide variety of topics – techniques, tools, materials and at levels from the absolute beginner to the experienced hand, I always try to make sure the content is readable and interesting, whatever level it is pitched at.

Unlike most magazines, Model Engineers Workshop isn't written for its readers, it's written *by* its readers. We have regular contributors, but a large proportion of each issue comes from the pen of completely new authors and all of our writers are people just like you. They all share a passion for the hobby that exercises both the hand and brain. But don't think this means lax standards, we pride ourselves on the quality of the writing in MEW, as underlined by the many excellent articles in this special.

In the early years of MEW, when the magazine was quarterly or bi-monthly, there wasn't much scope for long series, because of the gaps between issues. Once the magazine became more regular, it's now every four weeks, it became possible to cover many topics in much greater depth – technical articles and extended tool builds. Feedback from readers was that they wanted to see a more balanced approach, so now a typical issue balances some two or three part articles with plenty of complete single-part ones. Occasionally we run a longer series, for something like a complex tool build.

One thing I try to get in every issue is at least one complete construction article.

Hobby engineering tends to be something that needs a reasonable allowance of both time and money, although there are always ingenious folks who use a surplus of one to make up for a

shortage of the other! This does tend to mean that many MEW readers are 'empty nesters', however we are seeing model engineering and hobby engineering grow like never before.

First, it's never been a better time to set up a workshop, with competitively priced and increasingly good quality machinery available, much of it from the Far East. It's also a great time for buying classic machinery second hand, as an abundance of ways to sell and buy such equipment means it's far more likely to find a good home than end up on the scrap heap.

Secondly, the emergence of the 'maker movement' is introducing a younger generation to the possibilities of the hobby. Shared 'maker spaces' help get around the problems of space and cost in setting up a workshop. Increasing numbers of younger entrants to the hobby are looking to MEW as a great way to find out more about hands-on engineering. Perhaps the most exciting aspect of engineering as a hobby at the moment is the potential for bringing new technologies like 3D printing and embedded electronics together with traditional skills and techniques.

Like everything else in the world, Model Engineers' Workshop is having to adjust to the impact of the internet. This has seen the growing take up of digital subscriptions, yet despite the general trend away from print media, paper subscriptions are growing and the future looks bright for MEW.

So, if you enjoy the contents of this special and are hungry for more, why not take advantage of one of our special subscription offers and become a regular MEW reader? ☛



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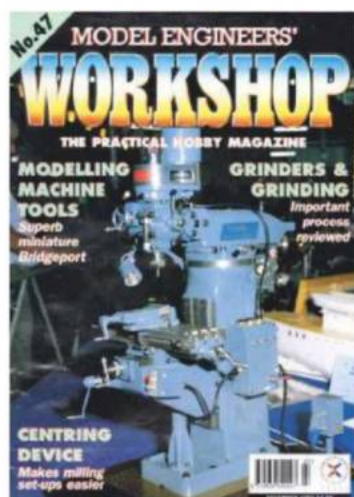
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A Small Instrument Vice

Len Walker – Issue 47 December 1997

This neat little vice was described as 'perhaps one of the simplest toolmaking exercises in the book, but a useful piece of equipment for all that' back in 1997. This delicate device designed to be held in a larger bench vice does require some care in its construction and so offers a good test of your skills.

This is a simple, easy to make version of the traditional instrument maker's vice. It is invaluable for securely holding small parts while carrying out accurate filing or similar operations. With the shank gripped (between soft jaws) in a bench vice, it brings small work up to a more convenient working height, with improved visibility. The shank can be quickly set at any angle, to suit the job in hand. A few construction notes may help.

Detail 1. The fixed jaw

Made from ½ inch square BMS, cut and filed to length. Mark off and mill or file the vee, which must be at 90 degrees to the sides. Drill and tap the ¼ inch BSF tapping hole, accurately square in both planes. This can be achieved if the work is clamped to the drilling machine table, then drilled and tapped at one setting, using a taper tap held in the drill chuck to ensure a true start. Aim for a good 'standard' thread – use a cap screw as a gauge. Chamfer both ends of the thread to ensure that there are no sharp edges left which, when case hardened, might damage detail 6, the clamping screw. File ¼ inch and 1/16 inch chamfers and set aside.

Detail 2. The moving jaw

This is also made from ½ inch square BMS. Leave over length (say 2 ¼ inch long) to make it easier to hold while drilling. Drill, then ream the 0.265 inch diameter hole. Drill at the ¼ inch diameter reamed hole position – but only 7/32 inch diameter. Also drill and tap the 6 BA hole, at the 0.250 inch dimension shown. Cut to final length and square up the ends. File the ¼ inch and 1/16 inch chamfers, and set this aside.

The finished vice. A plain jawed version with a file handle in place of the vice tail would please any fisherman who ties his own flies.



Detail 3. Locking screw

Make this from a 6 BA grub screw, the end 'pip' being polished.

Details 4 & 5. The handle

This can be made as an assembly, with one end solid and with the other as a loose cap, riveted on. Alternatively, the centre portion can be made from 1/32 inch diameter silver steel and fitted with a loose cap at each end (which, on reflection, is probably easier). Most important – remember to assemble the handle through detail 6 before riveting!

Detail 6. The clamping screw

Turn this from ½ inch diameter EN8 (for toughness). Chuck a 3 ¼ inch length, face the end and centre. Pull 2 ¼ inches out of the chuck and grip securely. With support from the tailstock centre, turn the 0.265 inch diameter to a running fit in the fixed jaw. Turn the retaining

groove as shown, then undercut and screwcut the ¼ inch BSF thread, a close fit in that in the fixed jaw.

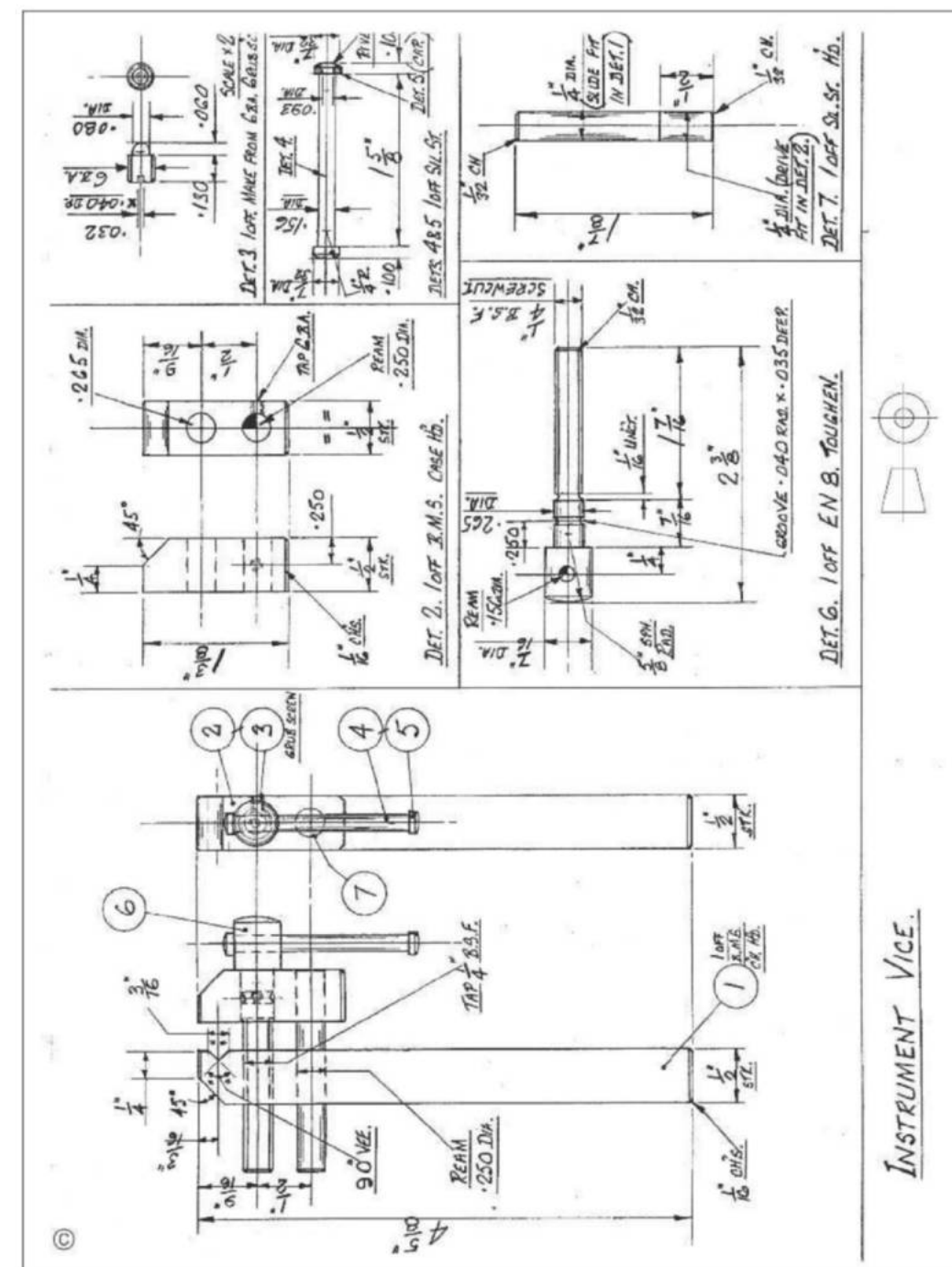
Turn the 7/16 inch diameter and part off. Reverse and holding on the 0.265 inch diameter, form the 5/8 in. spherical radius and polish. Mark off, then drill and ream the 0.156 inch diameter hole. Toughen, then polish the 0.265 inch diameter and the shoulder.

Reaming Details 1 and 2 together

Assemble the clamping screw through the moving jaw and screw into the fixed jaw. Line up both jaws and firmly grip together. With the assembly raised on a 1 inch parallel, the 7/32 inch diameter hole in moving jaw can be lined up, and the assembly securely clamped to the drilling machine table.

Now drill and ream 1/4 in. dia. through both jaws – this ensures a correct 'line up'. Lightly chamfer both holes.

Both jaws can now be casehardened, protecting the threads during this process. Clean out the threads and other holes, ensuring that the finished bores are smooth.



Detail 7 The guide pin

A part which can be made from silver steel, a drive fit in the moving jaw and a slide fit in the fixed jaw. Harden, temper and polish. Alternatively, it can be made from a ¼ inch diameter. x 2 inch long commercial dowel.

Any required adjustment of diameters can be made by using a medium oilstone (well oiled) while the dowel is rotating in the lathe. Polish finally using 600 grit wet or dry paper, with a few drops of light oil. To ensure the accuracy of line-up on assembly, the fixed jaw can be used as a guide for assembling the guide pin. Using the clamping screw to hold

the two jaws together, insert the pin through the hole in the fixed jaw to line up with the hole in the moving jaw and press it into the latter. This should ensure that the moving jaw and pin moves smoothly in and out when the clamping screw is turned. Ease slightly if required; smooth operation is essential.

Thoroughly clean everything, getting rid of any grit or swarf and assemble. A drop of Nutlok or similar will secure detail 3, the retaining screw. Lubricate with a light oil.

Finally, a passing thought from just pre-war toolmaking apprenticeship days. I remember one of the 'old boys',

every inch a master craftsman, saying to me "Lad, the only one you really hurt by doing bad work is yourself". Nearly sixty years on, I can't improve on his comment!

Go to it - work well, and work safely. ☘

Events

December 9 – the Toyota Prius, the first production hybrid vehicle, goes on sale in Japan.

December 19 – *Titanic*, the highest grossing movie at the time, is premiered.



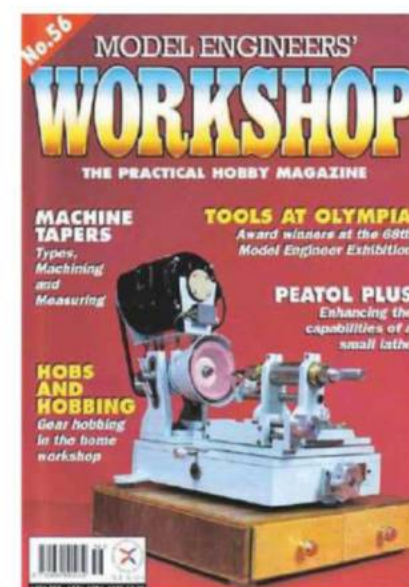
This hob is 26DP, but has the rather unusual pressure angle of 15 degrees, rather than the more usual 14.5 degrees.

Gear Hobbing in the Home Workshop

Ivan Law – Issue 56 February/March 1999



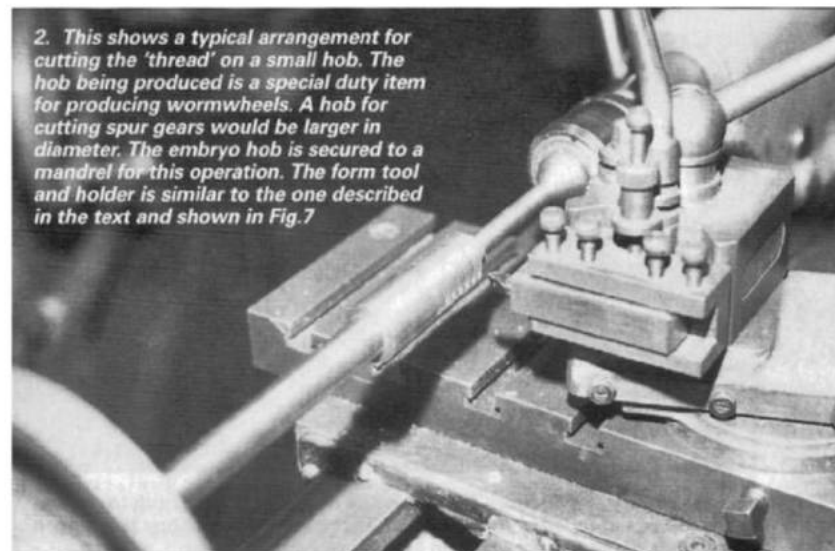
Many hobbyists are reluctant to take on making their own gears, by whatever method. Ivan Law is well known for taking on this huge and complex topic, and breaking it down into clear, understandable language that has helped many, many people to make accurate, efficient gears in their own workshops. On top of this, Ivan is a distinguished model engineer and has long served as the Society of Model and Experimental Engineer's Chief Judge at the Model Engineer Exhibition.



The hobbing process is one of the most accurate ways available in the production of involute gear teeth. Model engineers, in the main, do not consider the process suitable, or even applicable, to the home workshop believing that it is an industrial process and outside the scope of our – in comparison to industry – sparse and primitive workshops.

There are, I believe, a number of reasons for this attitude; one is the lack of understanding of the fundamental principle governing the functioning of both hobs and the hobbing process. Another is the high cost of suitable commercial hobs. It is true they are expensive, but surprisingly the cost of a hob for any given DP and pressure angle is usually less than a standard set of eight form cutters. A third reason is the belief that suitable hobs cannot be produced with the equipment we have at our disposal; and, finally, if we do have a suitable hob we do not have a machine on which it can be used.

I have 'volunteered' to introduce the subject by discussing in simple language what a hob is and how it functions.



2. This shows a typical arrangement for cutting the 'thread' on a small hob. The hob being produced is a special duty item for producing wormwheels. A hob for cutting spur gears would be larger in diameter. The embryo hob is secured to a mandrel for this operation. The form tool and holder is similar to the one described in the text and shown in Fig.7

Understanding the Requirement

I have said many times, in connection with a variety of subjects, but it is worth repeating because of its relevance, that when faced with a problem it is necessary to first of all understand what the problem is. Once that is fully understood then a great step forward has been made towards finding a solution. We will therefore begin by looking at the shape of a gear tooth and why that shape is needed.

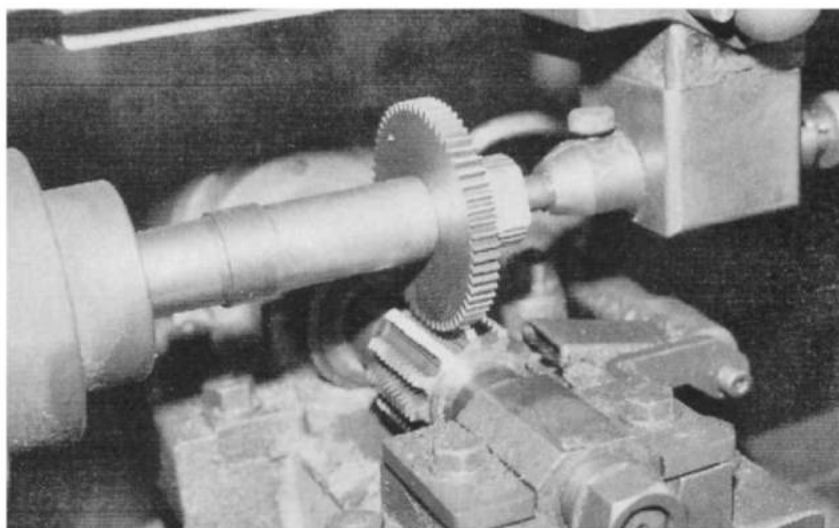
Gear Tooth Profile

A gear is far more than a disc with slots in its periphery. Gears with incorrectly formed teeth may, for a while, transmit motion and therefore power, but to keep on working effectively and efficiently the teeth must have a definite and specific profile. There are a number of profiles that can be used, however, these articles will only consider teeth based on the involute curve. The reason for this is that the majority of gears produced

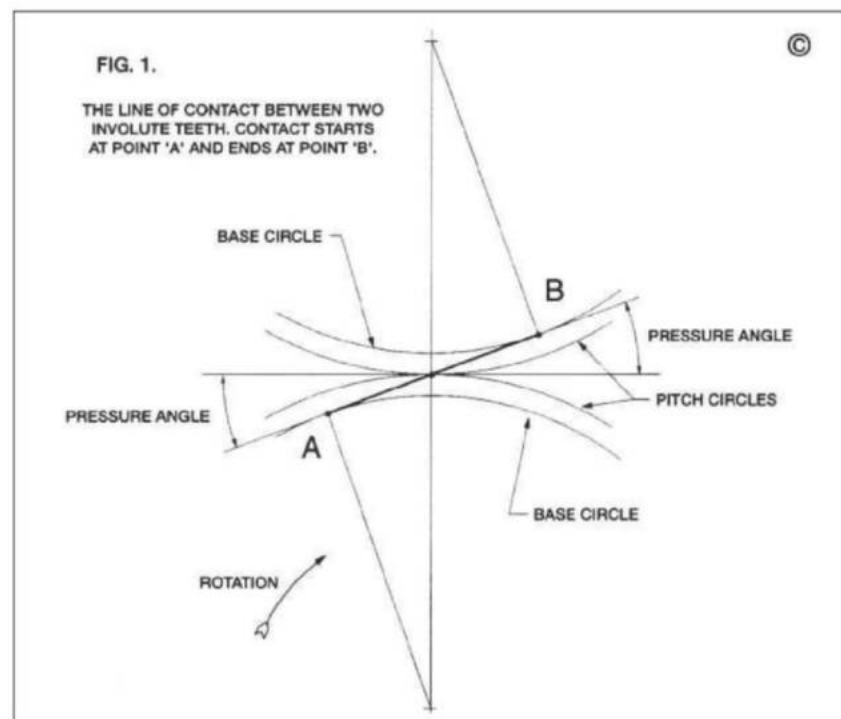
to-day are based on the involute curve, as this shape is ideally suited to the generating methods used in modern production engineering.

Although model engineers, in the main, cut their gears one tooth at a time using a suitable form cutter, as opposed to a generating process, the involute profile is almost always used.

Just what performance are we trying to obtain from a gear tooth? First of all, the gear teeth must not rub on each other, as this causes friction, heat and rapid wear. In order to reduce friction to a minimum, this phenomenon being the enemy of engineers, the gear teeth must push on each other but not slide. They should roll on each other along the line of contact until the point of disengagement is reached. As a matter of interest, the line of contact between two involute gears is a straight line along the pressure



This shows the cutting of a 60-tooth spur gear. The mandrels driving both the gear and the hob are connected together by a gear box. In this case the gear box is arranged to give 60 revolutions of the hob for one of the gear blank.



angle, as shown in figure 1. (Much more about this pressure angle later). Secondly, and often not realised, there must be constant relative velocity between two mating gears. If the drive shaft incorporating the driving gear moves at a constant velocity then it is important that the driven shaft also moves at a constant velocity – though not necessarily at the same velocity, and not in a series of jerks and hesitations. Gear teeth that are based on the involute curve meet the above conditions.

The involute curve

What is an involute curve? and how is it applied to a gear tooth profile? I will not

quote the technical definition of an involute curve as it may not help! From our point of view, think of a disc or drum with a string wrapped around it. Now, with the drum stationary, hold the end of the string and, keeping it tight, unwind it from the drum – the path followed by the end of the string will be an involute curve. The involute curve, in theory, goes on without end, but fortunately we are only interested in the small initial part of the curve, where the string leaves the drum. It can be seen from the above that the shape of the curve will vary with the size of the drum, a small diameter drum will produce an involute with a pronounced curve, a very large drum will

result in an involute with a shallow curve and if the drum is of infinite diameter then the 'curve' will be a straight line. In gear tooth nomenclature, the diameter of the drum is called the base circle and is an important element in gear tooth profiles.

When setting or laying out gears they are thought of as circles or discs and if the resultant gears are to run correctly, these circles, called the pitch circles, must touch each other. The actual tooth consists of two elements, the part above the pitch circle called the addendum and the part below the pitch circle referred to as the dedendum. The surface of the tooth above the pitch circle is called the face whilst the surface below the pitch circle is the flank. Since the involute curve is struck from the base circle then that is where the tooth profile begins, but as clearance in the bottom of the tooth is needed, the actual tooth profile continues for a short distance below the base circle.

Figure 2 illustrates a gear tooth and the relative elements so far discussed. It will be seen that about half of the tooth, the dedendum, is below the pitch circle and therefore the base circle must always be smaller in diameter than the pitch circle and also be concentric with it. Any pair of mating involute gears must have the same ratio between the radius of the base circle and the radius of the pitch circle. If this ratio alters then the diameter of the base circle for any given gear will alter and so will the resulting involute curve. It follows that, when considering gears, this ratio is an important element in determining the tooth profile – and so it is.

However, it is not expressed in the form of a ratio but as an angle, the pressure angle (figure 3). This pressure

angle determines the relative size of the base circle in relation to the pitch circle, a factor which is most important when designing and making hobs.

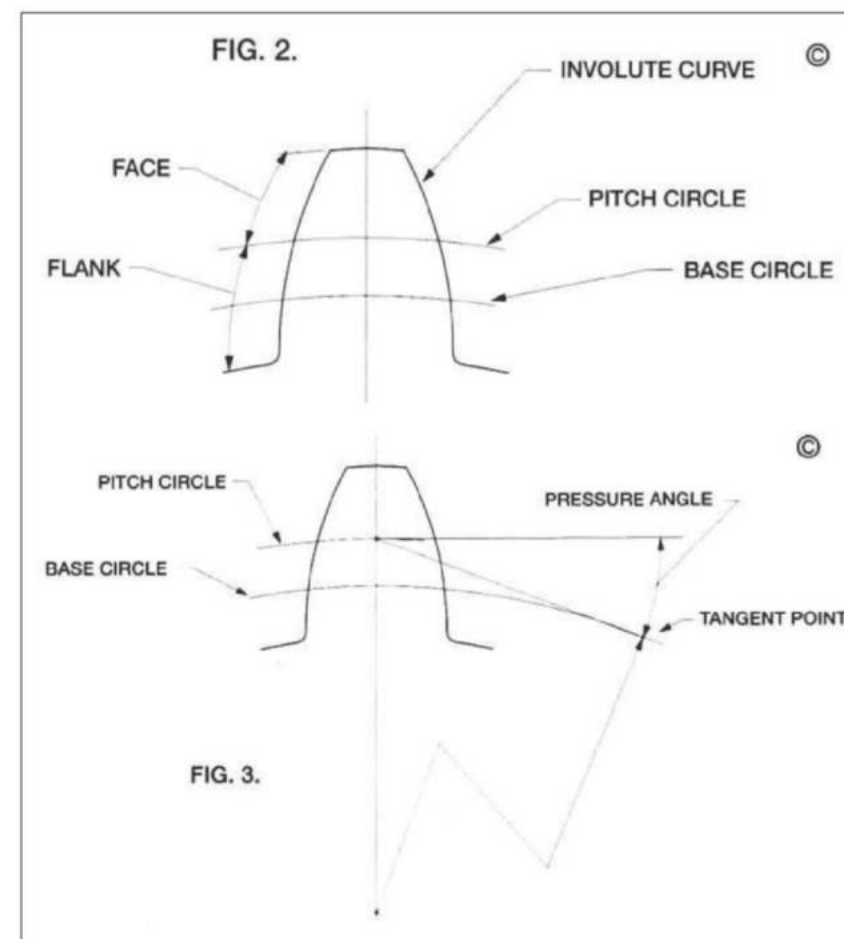
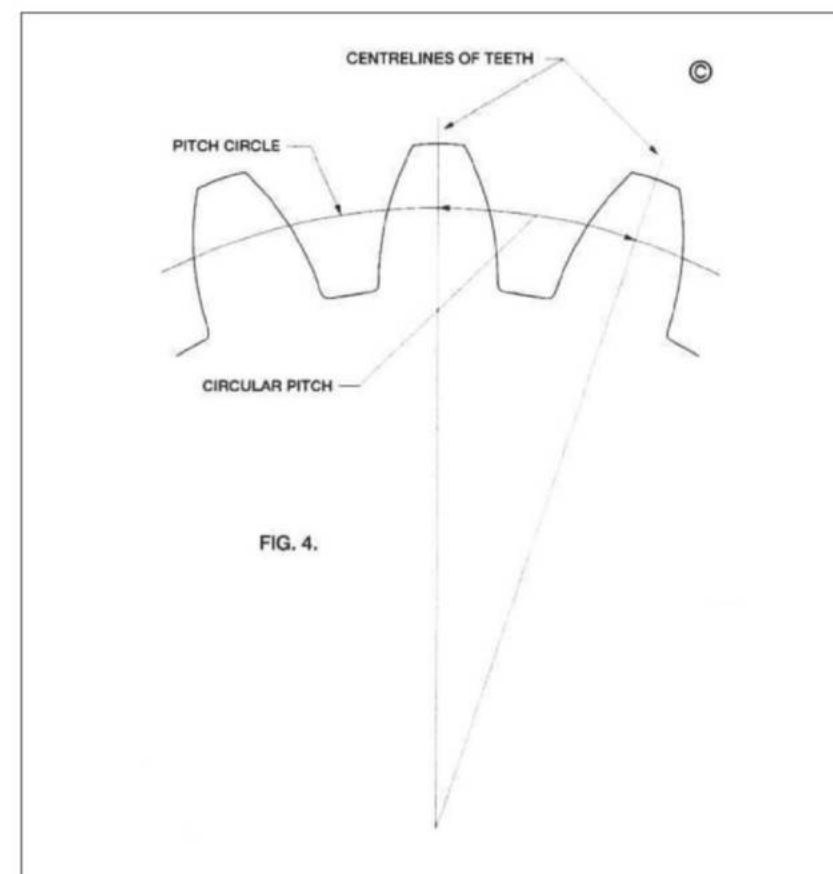
Gear tooth size

We have now established the shape of a gear tooth, but not its size. A gear of, say, 3 inch diameter could have 30 teeth cut on it – or even 100 teeth. Both sets of teeth could be of perfect involute form, but would not run together as their physical sizes would be considerably different. Some means or standard of determining tooth size is therefore necessary.

As was mentioned earlier, gears in the design stage are considered as rotating pitch circles and this pitch circle forms the basis when determining gear tooth size. There are three methods in use which the model engineer may encounter and the first is circular pitch.

Circular pitch

The circular pitch of a gear is the distance from a point on one tooth to the corresponding point of the next tooth, measured around the pitch circle (figure 4). This circular pitch is usually quoted as some friendly figure such as 0.100 or 1/16 or 1/8. In order to obtain the gear's basic datum, i.e. the diameter of the pitch circle, it is necessary first of all to



multiply the circular pitch by the number of teeth in the gear. This must be a whole number and it will give us the circumference of the pitch circle. We then have to divide this number by pi to find the pitch circle diameter. As pi is rather an unfortunate number, it follows that the diameter of the pitch circle will be 'awkward' and therefore the centre distance between two mating gears will not be a round figure, but one quoted to at least three decimal places. It can be argued that this matters little as in the workshop an 'awkward' size is just as easy to obtain as a standard one. This may be so, but the problem is largely academic because unless the gear is going to be used in conjunction with a rack to measure linear displacement, such as down-feeds on milling machines, gears encountered by the model engineer will not be based on the circle pitch notation, but on a more popular method known as diametral pitch.

Diametral pitch

This method, usually referred to as the DP, is the most common of gear size notations, particularly when considering the size of gears likely to be encountered by model engineers. The diametral pitch is simply the number of teeth per inch of

pitch circle diameter. For example, if a gear has a pitch circle diameter of 1 inch and has 20 teeth, then that gear is referred to as 20DP. If, on the other hand it has 40 teeth, then the size is quoted as 40DP. A 40 tooth gear of 20DP would have a pitch circle diameter of 2in. and so on. DPs are usually whole numbers and also even numbers, at least in the sizes that model engineers will encounter. The DP notation simplifies setting out a train of gears. For example, should it be desired to produce a pair of gears to give a speed reduction 3:1 and 20DP was chosen for the gears, then two gears, one with 20 teeth and one with 60 teeth would give us the required ratio. The pitch circle diameter of the 20 tooth gear would be 20/20 or 1 inch whilst the PCD of the other gear would be 60/20 or 3 inches. This would result in gear centres of 2 inches – this being half of the sum of the two PCDs.

Module

Nowadays, as far as we are concerned, we can regard the module as a 'metric' way of noting gear sizes. The module is the pitch circle diameter in millimetres divided by the number of teeth, or to put it the other way round, the PCD in millimetres is obtained by multiplying the module number by the number of teeth required. There are 25.4 millimetres to one inch so a number 1 module is the same as 25.4DP. A number 2 module would be 50.8DP whilst a 0.5 module would be 12.7DP. I believe that most of the machinery imported from the Continent has gears based on the module system.

It was stated earlier that part of the tooth was above the pitch circle and part below. Before we can determine the specific shape of any teeth, we must look at the proportions of the various elements that combine to give the complete tooth profile. These proportions are shown in figure 5. The sizes quoted may be termed 'theoretically' correct and if followed exactly would not allow for clearance between the mating teeth. We know from general practice that size and size do not fit, and some small clearance must be provided. Precision gear manufacturers usually decrease the tooth thickness to about 0.48 of the circular pitch, thus making the tooth space 0.52 of the circular pitch. In practice, by our methods of production, I have found this complication to gear cutter calculation can be ignored! I usually cut my gears to the theoretical proportions shown and they usually assemble without difficulty. Maybe I inadvertently cut the teeth just fractionally deeper than theory suggests!

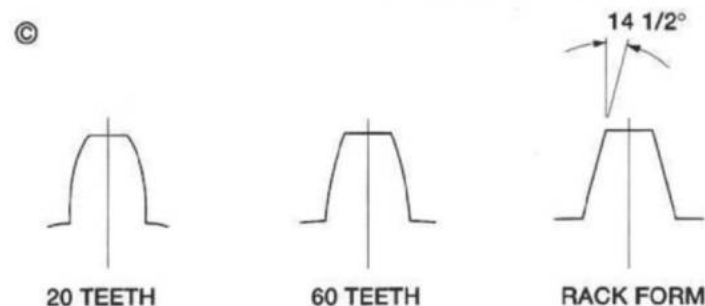
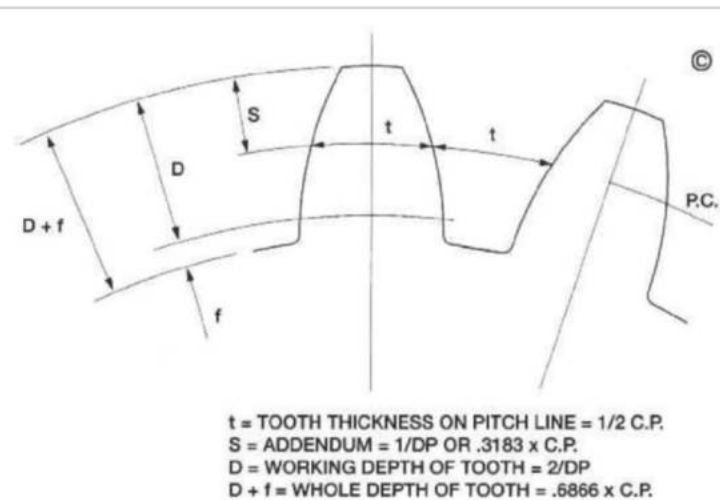


FIG. 6a. 14 1/2° PRESSURE ANGLE

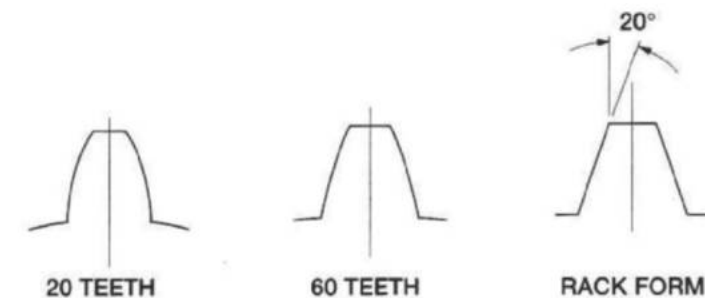


FIG. 6b. 20° PRESSURE ANGLE

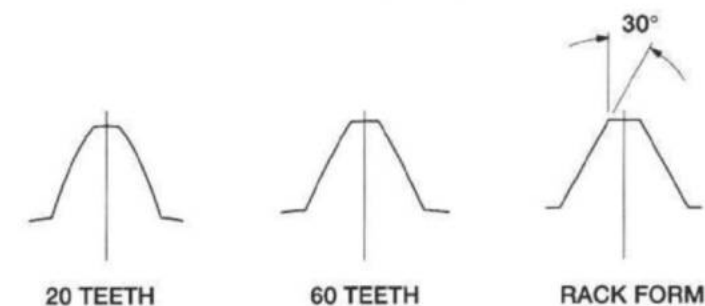


FIG. 6c. 30° PRESSURE ANGLE

SHOWING HOW THE SHAPE OF GEAR TEETH VARY WITH THE NUMBER OF TEETH ON THE GEAR AND ALSO THE EFFECT OF PRESSURE ANGLE.

FIG. 6.

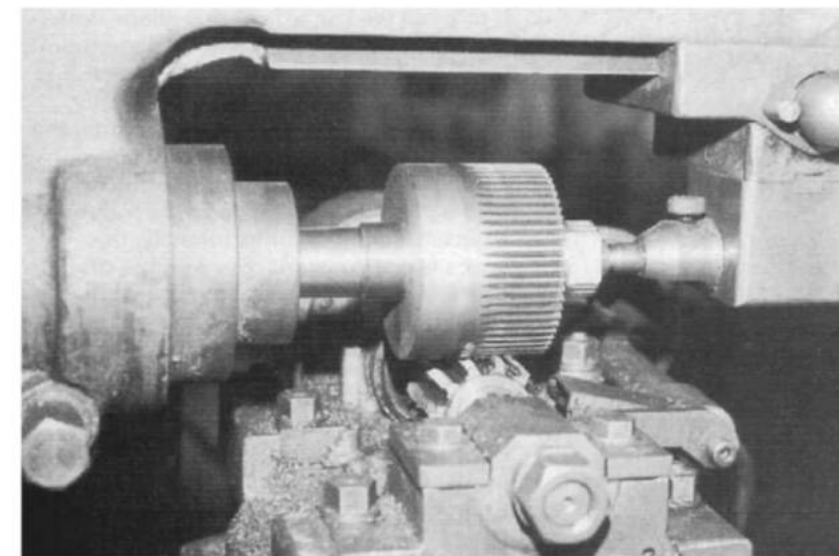
Some considerable time has now been spent and the word 'hob', the subject of the article, not even mentioned – but it is necessary to understand just what we are trying to achieve. You do not obtain a good tooth profile by chance! If all the above ramblings have been understood, then the rest becomes very easy.

We now know the shape of a gear tooth, but we cannot cut this shape, only the space between the teeth. All cutting tools produce the same thing – swarf! It is the bit that is left behind that we really want. If we cut the teeth one at a time, the usual method employed by model engineers, then we require a form cutter that is the shape of the space between two adjacent teeth but, unfortunately, this space is not constant

be tolerated, and so one cutter may be used for a range of tooth numbers, provided they are of the same pressure angle. In fact, a series of eight cutters covers the entire range from a small pinion to a rack, but – to be pedantic – each cutter can only cut one tooth number to the correct theoretical shape.

Enter the hob

This is where the hobbing process enters the story. By this means, no matter what number of teeth are required on a gear, the correct involute form for that number will be automatically produced. It may be 20 teeth or 21 teeth or even 87 teeth, it matters not. The teeth will always be the correct shape as the appropriate involute curve is generated



In this case six 60-tooth gear blanks are sandwiched together so that all six gears are produced at one pass. A typical time for this pass is about 15 minutes. The number of teeth produced is 60x6 or 360; this is equal to 2 1/2 seconds per tooth.

over a range of gears, even though they may be of the same DP and pressure angle. It follows from what has been said so far that the diameters of both PCD and the base circle from which the involute is generated will alter with the number of teeth on the gear. Figure 6A shows this change in shape although the same DP has been used for each profile and the same pressure angle, viz. 14 1/2 degrees. The next two drawings figs. 6B & 6C show the difference in shape when the pressure angle is increased to the popular 20 degrees and finally to 30 degrees. It is now apparent that cutting gears one tooth at a time by form cutters can only give theoretically correct teeth if a form cutter of the correct pressure angle and specific tooth number is used. This would need a very large number of cutters and would make the process impractical. Fortunately, a small deviation from the theoretical form can

be tolerated, and so one cutter may be used for a range of tooth numbers, provided they are of the same pressure angle, and all the teeth are produced with just one pass of the hob, thus making the cutting of gears much quicker and simpler, as no mis-count of the dividing head can arise because a dividing head is not needed.

The hob is a cutting tool in the form of a thread or single start worm. The shape of the 'thread' is the rack shape of tooth profile that the hob will eventually produce (figs. 6A/B/C). It should now be apparent why I have kept emphasising the importance of the pressure angle as this is the angle that determines the 'thread' form of the hob.

The hob is provided with a series of gashes or flutes that form the cutting edges of the hob where they meet the thread. In order for it to cut effectively, the teeth should be 'backed-off'. This process is outside the scope of this article

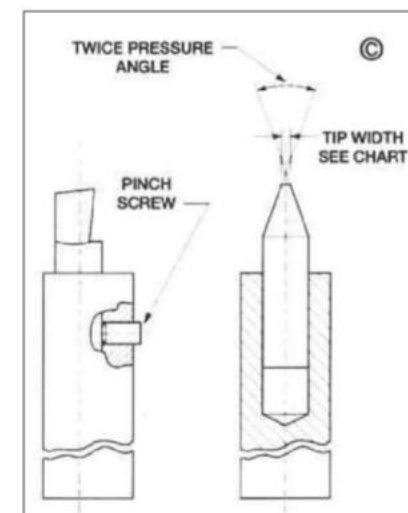


FIG. 7. SUGGESTED TOOL AND HOLDER FOR PRODUCING THE HOB HELIX

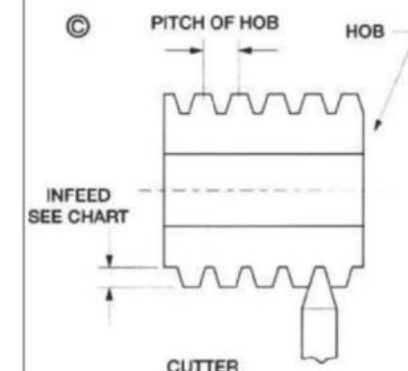


FIG. 8. VIEW OF HOB SHOWING CUTTER, PITCH AND INFEED

but has been dealt with elsewhere. Unlike general milling cutters, a hob can only be sharpened on its front or radial face, otherwise the tooth profile would be lost and the hob become useless.

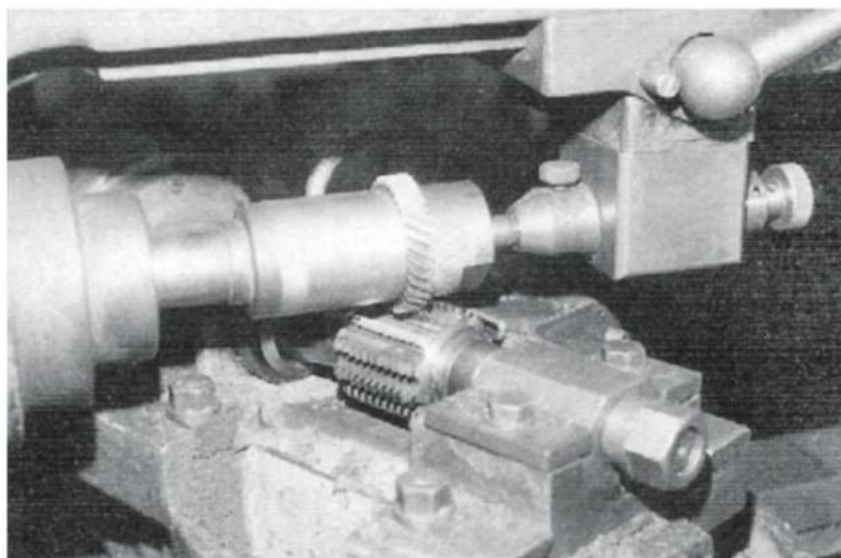
How does it cut a gear? If the hob is secured to a rotating spindle and a workpiece is slowly brought into contact with it, the hob would (neglecting the helix angle) produce slots in the workpiece similar in shape to the teeth on the hob. Now, if that workpiece is replaced by a circular disc, viz. the gear blank, and that blank rotated, then a series of slots or teeth would be produced on the blank. The number of teeth produced on the blank would depend on the speed ratio between the hob and the blank. If the hob were to make 20 revolutions to one revolution of the blank, then 20 teeth would be formed on the blank. In other words, the number of teeth required on the gear is the same as the speed ratio

between blank and hob. Now, and this is the most important function of hobbing, as the blank is rotating, the shape of the teeth produced is not the same as the straight-sided shape of the teeth on the hob. The teeth of the gear being cut gradually come into contact and out of contact with the hob teeth; in other words the gear teeth roll past and through the teeth of the hob and it is this rolling action that produces the correct involute curve that we desire.

As stated at the beginning of this article, commercial hobs are expensive, but making things is what model engineers like to do, so why not make your own hobs? It is, after all, only a screw-cutting exercise. The hobbing process has one great advantage - it is 'self-correcting'. If the angle of the tooth profile on the hob is not correct to drawing, or if the pitch is not quite what

Producing hobs in the lathe

As referred to earlier, making a hob or at least the threaded part is only like producing a single start worm or a coarse thread. A screw-cutting tool will be needed and this can be similar to a normal screw-cutting tool except that the shape must be similar to the gap between two adjacent teeth of the rack profile. The shape of the tool will, of course, be dependent on the DP and pressure angle required. The tools may be produced by skilful off-hand grinding but it is recommended that a tool and cutter grinder, such as a Quorn, Kennet, Stent or similar machine should be used. This special form tool is the start of the whole hobbing process and so it pays to produce it as accurately as possible. As shown in figure 7, the cutting flanks of the tool are ground at the required pressure angle, thus the included angle



The same hob as shown in the previous photograph is being used to cut a helical gear. Setting up a hobbing machine to cut helical gears is much more complicated than setting for spur gears. The speed ratio between the hob and gear blank is not only determined by the number of teeth required but also the helix angle of the gear and the rate of feed. The rate of feed in relation to the hob and blank speeds determines the helix angles of the gear produced.

was intended, it does not matter, as all gears, regardless of the number of teeth on them, will mesh and run together perfectly satisfactorily, providing they are produced with the same hob. Another advantage is that we can, if we wish, produce our own standard. We need not keep to standard DPs or pressure angles. This could certainly be useful for anyone having trouble with high speed gear reduction boxes for use with steam or gas turbines. Increasing the pressure angle to about 30 deg. or so will result in a gear more suited to these arduous conditions and so prolong the life of the gears considerably.

of the tool is twice the pressure angle. If a cutter grinder is being used, then this angle can be obtained simply by using the protractor scales on the machine. It should also be possible to form the clearance angle at the same setting. The pitch of the hob (the distance from one tooth to a similar position on the next tooth - figure 8) is usually very much coarser than that encountered in normal screw-cutting and this affects the side clearance. In order to cut cleanly and without rubbing, the leading cutting face of the tool must have the normal clearance angle of about 4 or 5 degrees plus the helix angle of the 'thread'. The trailing cutting edge will be angled at the

normal clearance minus the helix angle. This latter will result in what, with normal turning tools, would be called negative clearances. It is therefore necessary to determine the helix angle of the 'thread' before the form tool can be made, that is if the form tool is being produced from the normal rectangular high speed tool blanks. I find it easier to produce tools of this type from round material - in fact this provides a use for broken centre drills! Form tools for DPs as large as No. 10 can be made from ¼ inch diameter material.

It is necessary to have some form of holder when grinding small round tools. In the present case a piece of ½ inch square mild steel about 2 inch long is ideal. Drill a ¼ inch diameter hole in one end for the tool and secure it by means of a pinch screw. The helix angle of the hob can then be ignored and the tool ground, applying normal clearance and rake angles. The same holder can then be used for mounting the tool in the lathe tool-post for the screwing operation. As the tool is round, the helix angle can be obtained by rotating the tool in its holder.

Using this method there is no need to worry about the true value of the helix angle; set the angle by approximation and start cutting. If the angle is incorrect you will soon find out as the cutter will start to rub on one side. Simply slacken the pinch screw, rotate the tool in the desired direction and try again. This round tool method allows the same cutter to be used for different helix angles, situations which would occur should hobs of the same pitch but different diameters be required.

When hobbing gears the only control we have in determining the tooth profile is the depth of cut, the hobbing process and the hob do the rest. It follows that, when cutting the hob, the only control we have on the hob tooth profile is the depth of cut applied to the form tool. From this we can see that the width of the tip on the cutting tool is important. The table (figure 9) gives the tip width for a number of DP and pressure angles.

Obtaining this tip width is not easy. There is nothing tangible to get the micrometer on to. If you have access to the equipment of a metrology department then go ahead and use it. I have not, and I am sure almost all my readers will not have either, so we have to do our best with what is available (isn't this the story of model engineering?) The method I use, and one that has proved satisfactory, is to set the micrometer a 'thou' or so greater than the required tip width and then, using a magnifying glass with a large magnification, grind the

tool until it just enters the micrometer anvils - a slight resistance can also be felt to any movement of the cutter through the anvils. The method may not be scientific but it gives results perfectly satisfactory for our needs.

The next problem is to determine the pitch of the 'thread' and then the change wheels needed to produce that pitch. Should the hob be for gears based on the circular pitch notation, then there is no problem. The circular pitch of the gear may be regarded as being similar to the pitch required on the hob. This is not strictly correct as the true theoretical pitch of the hob should be the circular pitch of the gear divided by the cosine of the helix angle of the hob. In practice this makes little, if any, measurable effect and can be safely ignored. So, for example, if the CP is 0.100 then set the lathe to cut a pitch of 0.100 or 10 tpi. However, most gears that we encounter will be DP based and so we will have to convert DP to CP in order to obtain the pitch of the hob. It has been pointed out the advantages of the DP system compared with the CP for general gear calculation but there is a snag. To convert diametral pitch to circular pitch, we simply divide the DP into the function pi. Unfortunately pi is not what could be termed a friendly number and so any whole number divided into pi will result in an equally unfortunate number for the pitch of the hob. For example, to convert 20DP into CP divide pi by 20, which gives 0.1571 for the pitch and this, in terms of threads per inch, is 6.366. It is pointless looking at the lathe change wheel chart for 6.366, it won't be there. We have, therefore, to work out the change wheels ourselves in order to cut this strange pitch. There is a basic method of doing this termed continuous fractions. I am not going into this somewhat complicated process here, but if any reader wishes to pursue this line, then the method is described at length in 'Gears and Gear Cutting' which is No. 17 in the Workshop Practice series.

A very close approximation of pi is 22/7 and we can use this to simplify our change wheels calculation. Paradoxically, using this approximation for pi can be used to advantage. It makes it possible to produce a hob that will cut a gear with a theoretically perfect pitch. If the number 35.2560329 is divided by the DP required and the hob then made with a pitch circle diameter to the number obtained, the gears produced with that hob will have a CP correct to within nine places of decimals; this, however, is of academic interest only. If we multiply both top and bottom of the fraction 22/7 by 5 we get 110/35. A 110-tooth wheel is

D.P.	DEPTH OF CUT	WIDTH OF TOOL TIP			D.P.	GEAR TRAIN	D.P.	GEAR TRAIN
		14/12° P.A.	20° P.A.	30° P.A.				
16	.135	.061	.045	.015	16	55 x 35 IDLER	30	55 x 40 35 x 75
18	.120	.054	.040	.013	18	55 x 40 35 x 45	32	55 x 30 35 x 60
20	.108	.049	.037	.012	20	55 x 40 35 x 50	36	55 x 20 35 x 45
24	.090	0.41	.030	.010	24	55 x 40 35 x 60	40	55 x 20 35 x 50
30	.072	.033	.025	.009				
32	.067	.030	.023	.008				
36	.060	.027	.021	.007				
40	.054	.025	.019	.006				

FIG. 9. CHART SHOWING DEPTH OF CUT AND TIP WIDTH

FIG. 10. CHANGEWHEEL CHART
UPPER WHEELS DRIVERS
LOWER WHEELS DRIVEN

not part of a standard set of change wheels but a 55-tooth wheel is, so the pi factor in our change wheel calculation can be 55/35 - multiplied by 2.

The chart (figure 10) quotes the change wheels required for most of the standard DPs. These gear trains are based on a leadscrew of 8 tpi, such as the Myford 7 range. In each case the top numbers are the driving wheels whilst the bottom numbers are the driven wheels. I consider the quick-change gearbox fitted to the Super 7 series of lathes to be a tremendous time-saver as a large range of standard threads and self-act feeds are available at the flick of a lever. Unfortunately, it is of little help when cutting DP pitches. A quick-change box does not preclude the use of a normal gear quadrant or banjo. These are available from Myford and can be fitted in a few minutes and so can suitable change wheels. It may be an added expense but it does increase the versatility of the lathe. When using any of the gear trains shown in the chart, set the gearbox to cut 8 tpi. When cutting non-standard pitches, it is not possible to disengage the feed screw half nuts at the end of each cut because it would be extremely difficult to pick up the pitch correctly for subsequent passes of the tool. The tool will have to be withdrawn at the end of each pass and the lathe reversed to the starting point before the next cut can be applied.

It is not advisable to use power when cutting pitches or threads greater than that of the lathe's feedscrew, otherwise the stress in the gear train becomes excessive. The 'power' can be easily supplied by fixing a handle on the end of the lathe mandrel and turning the lathe by hand; it will only require a few turns to cover the length of a hob blank. The handle can be made quite quickly from a few pieces of bar material, alternatively

Myford supply such a handle and it can be fixed to the mandrel in a few seconds - an accessory well worth having. It gives ideal control over the cutting process and is a great asset in general screwcutting, particularly when screwing up to a shoulder. For very coarse pitches, where the leadscrew may make several revolutions for each turn of the lathe mandrel, it is advisable to fix a handle on the end of the leadscrew. This will considerably reduce the stress in, not only the gear train, but also the elbow! The depth of cut required for a variety of pitches is shown in the table (figure 9). This depth can be obtained by direct reference to the cross-slide micrometer dial.

The diameter of a hob (other than special hobs such as those used for cutting worm wheels) is in no way related to the diameter of the gear it can produce. For model engineers, the diameter may well be governed by the size of the material available for its manufacture.

When the threading is completed, the hob is ready for the next stage, gashing to form the teeth and for form-relieving to provide the clearance needed to obtain a satisfactory cutting action. ■

Ivan Law's book *Gears and Gear Cutting* is available from www.myhobbystore.co.uk just enter 'wps 17' in the search box.

Events

February 11 - Pluto crosses the orbit of Neptune and will remain further from the sun until 2231.

March 21 - Brian Jones and Bertrand Picard successfully complete the first circumnavigation of the globe in a hot air balloon.

Improving a Mini Lathe



Alastair Sinclair – Issue 91 July 2002

Alastair Sinclair's Update
I can't believe that I wrote this little piece as long ago as 2003. That feeling may be due to the seeming accelerated speed of my own ageing making it now seem like yesterday. Looking at the article today in the light of more recent experience, and in the knowledge that the popularity of the little mini lathes has soared beyond all expectations, it is interesting that they can clearly be seen to have met a real need within the hobby which continues to this day. After the publication of the article I was completely taken aback by the amount of correspondence I received from all over the world offering observations and asking for further information. Looking at what I said at the time in the piece, I today feel no need to alter any of the statements, suggestions or recommendations that were made. I still use this lathe today and continue to add additional features which improve its scope and versatility.

My first lathe purchased in 1986 was a Hobbymat MD65, then a relatively recent offering in the small machine tool market. This suited my requirements at the time since the available workshop space solely comprised of a bedroom cupboard into which a bench was squeezed supporting the said lathe and a ½ inch drilling machine. I also subsequently added a milling attachment to the lathe and this set up served me quite well for a number of years. The MD65 was a well-made and sturdy machine and was capable of producing good quality work. However it was quite noisy and its 65 mm centre height I found rather limiting at times. A replacement was therefore sought which offered a greater capacity along with more conventional design which could fit the available space and be somewhat quieter in use within a domestic environment. The eventual answer to this was the Conquest mini lathe as popularly marketed by Chester UK.

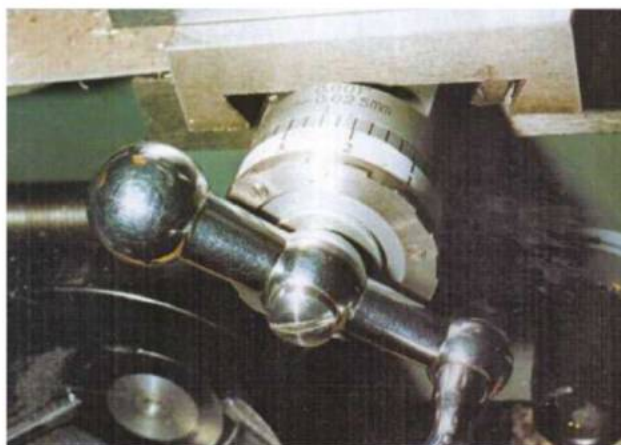
What's in a name?

Chester's Conquest lathe is of far Eastern manufacture and it or very similar models are marketed in many countries under various names. It is a 90 mm centre height machine with fully variable speed range from 100 to 2900 rpm via the combination of electronic control of the motor and a two speed gearbox. The bed is a raised single vee design giving 300 mm between centres and the mandrel is of generous proportions with a 20 mm diameter bore machined for 3 MT tooling. There is a conventionally arranged gear train with the usual adjustable banjo and gear set for fine feed or screwcutting via the leadscrew and the split nut at the saddle apron. Motor reverse is available electronically and there is also a tumbler reverse provided for controlling the direction of rotation of the leadscrew. The tailstock barrel is machined for 2MT tooling and is graduated along one side, while the casting has the facility for set-over to enable long tapers to be machined.

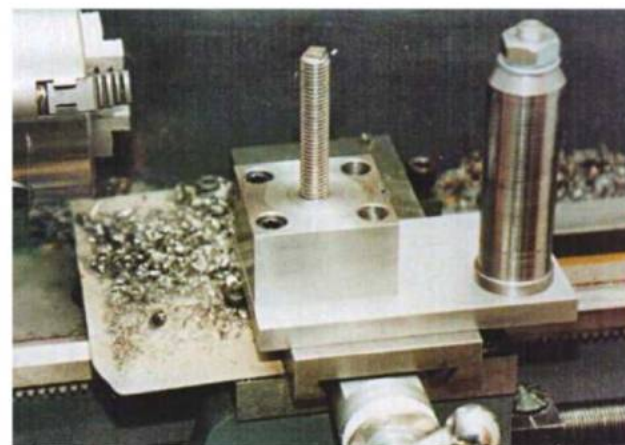
The cross slide and top slide are entirely conventional in design, with fully graduated dials supporting an indexable four way tool post. Overall weight is approximately 40 kg.

Irrespective of the name on the side of the machine, the above specifications appear to be the same in its various guises, the only difference being the





Improved graduations and grip-ring for the cross-slide dial.



The alternative toolpost fixture.

colour and the changes necessary between metric and imperial versions. This principally applies to the leadscrew, the number and size of associated change gears supplied and the thread dial indicator. Oddly the cross slide and top slide feed screws seem to be the same for both versions although I am prepared to be corrected on that.

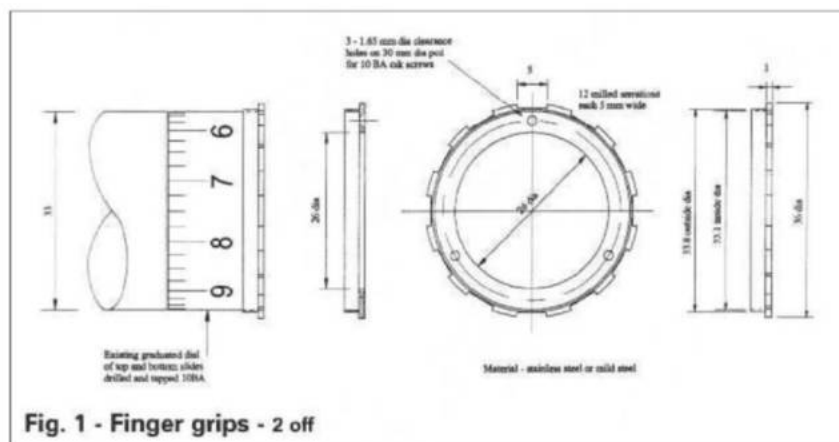
So what needs improving?

Originally offered at over £800 when first introduced, this is a well specified machine for the current (back in 2002) sub-£400 asking price and you may well wonder what needs to be improved. Well of course no machine is perfect and you might reasonably expect such a budget priced lathe to be lacking in finish, accuracy etc. Indeed there is some truth in this as my lathe as delivered exhibited a substantial lack of squareness between the cross slide and the between-centre axis which, after eventually convincing Chester UK that this was genuine and not operator error, was quite promptly corrected by them using their in-house machining facilities. I understand that this problem was confined to that particular batch of machines and that these were therefore all corrected in a similar manner. Other clear signs of manufacture to a price were noted but by and large these were generally cosmetic in nature, and do not seem to affect the operational accuracy of the lathe which is, in all normal respects, quite satisfactory.

All of the initial small improvements which I am sure most owners carry out were undertaken shortly after delivery and included the making of flush head screws for the cross and top slide handles, a saddle chip tray, a saddle lock and a tailstock clamp lever. Less commonly carried out I'm sure but very necessary in my opinion is the lowering of the four way toolpost to allow this to



Four-way toolpost and boring bar holder fitted to fixture.



use normal sized tools of 10 mm to 12 mm square. While the turret is designed to accept these sizes of tool, it is in my opinion set too high relative to the centre line of the mandrel to properly use these and requires about 2.5 mm of material to be milled off the top surface of the top slide. This is most easily accomplished using a fly cutter but a decent sized end mill will be equally suitable in achieving this end.

One unaccountable feature of the

metric version of this lathe is the number of graduations on the feed dials of the cross slide and top slide. There are 40 small graduations of which every 10th is enlarged and numbered, no doubt intended to suit the imperial version where every division is equal to 0.001". This is not at all appropriate for the metric version and I have therefore retained but re-numbered these graduations using a computer printed plastic film over a white taped background for ease of reading. The

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A selection of boring bars and the high-speed drilling spindle.

40 graduations are split into ten groups of four and numbered 0 to 0.9, each large division being 0.1 mm and each small division 0.025 mm. This arrangement is shown in **photo 1** along with new 'grip-rings' for the dials which make these much easier to adjust and use. The advantage of using a computer printed film is that this can be made to a precise length to suit the diameter of the dial using a CAD program. A detail of the grip-rings is given in figure 1 made in stainless steel although there is no reason why they cannot be made of mild steel if so desired.

Top slide - who needs it?

While the Conquest performs satisfactorily as supplied, it has to be borne in mind that it is a very light lathe and is consequently not capable of really deep roughing cuts or heavy handed parting-off operations. Tooling has to be kept very sharp in order to get the best out of the machine, and providing this is done, perfectly satisfactory work can be carried out with good finish and accuracy. As a matter of good practice all slide gib adjustments should be kept fairly tight in order to avoid undue flexing of the tool and the resulting chatter which can spoil the finish of the work. In all amateur size lathes the top slide particularly is guilty of a certain degree of flexibility which affects the rigidity of the tool tip and this of course is all the more serious in any lightly constructed lathe such as the Conquest. So who needs the top slide then? Well I do actually but not all the time and if given a little thought it is quite clear that this is really only required occasionally for machining short tapers or setting over the single point tool during screwcutting. True, it is often also used for parallel turning short lengths or applying facing cuts, but in all honesty, the majority of the time, it is doing very little other than that of a tool holder on top of the cross slide.

I am by no means the first to consider

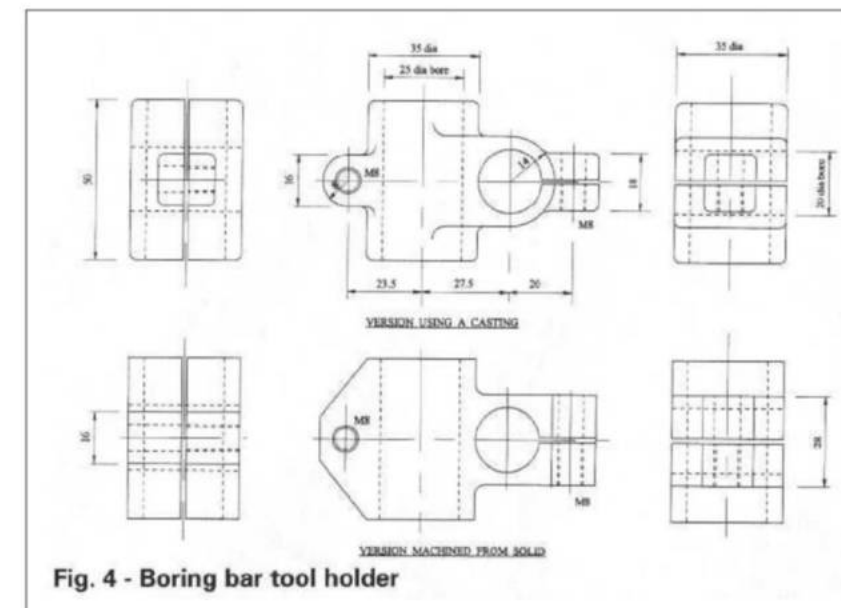


Fig. 4 - Boring bar tool holder

this matter as an article in a recent (ref. 1) MEW pointed out. This reports that Tubal Cain designed a toolpost which for the reasons discussed was mounted directly off the top of the cross slide. The same article describes a similar toolpost for the Myford which reportedly has 'made an enormous difference to both the lathe's cutting capability and to its accuracy'. As a result of these thoughts, I set out to design a more rigid tool post fixture to entirely replace the top slide and obtain by this means greater stiffness which would allow deeper roughing cuts to be taken and improve general finish. It also seemed possible at the same time to improve the versatility of such an arrangement by incorporating a permanently fitted additional tool holder for boring tools which could if necessary also accept a light drilling spindle or grinding head. As yet a further bonus, a directly mounted tool post could, it was clear, obtain the same effect and advantage as a rear toolpost using parting tools mounted upside down while the mandrel runs in reverse. This is possible

with the Conquest since the chuck is bolted directly to the mounting flange on the mandrel and cannot therefore come adrift during reverse running.

The versatile tool post

The design of the basic tool post fixture is really very simple with a base plate holed to match the fixing screws for the top slide and a square block of steel the same size as the four way tool post, fitted together such that the turret is in the same relative position to the cross slide as it is when fitted on the top slide. The main features of this are shown in **photo 2** and figure 2. It is of course essential that the height of the substitute fitting is precisely the same as that of the top slide assembly in order that the turret is interchangeable between each of these without having to adjust the packing height of the tool bits. On mine that is 38 mm but remember that I have reduced the tool height by 2.5 mm and this has therefore to be measured in each individual case to maintain the essential interchangeability necessary. The same

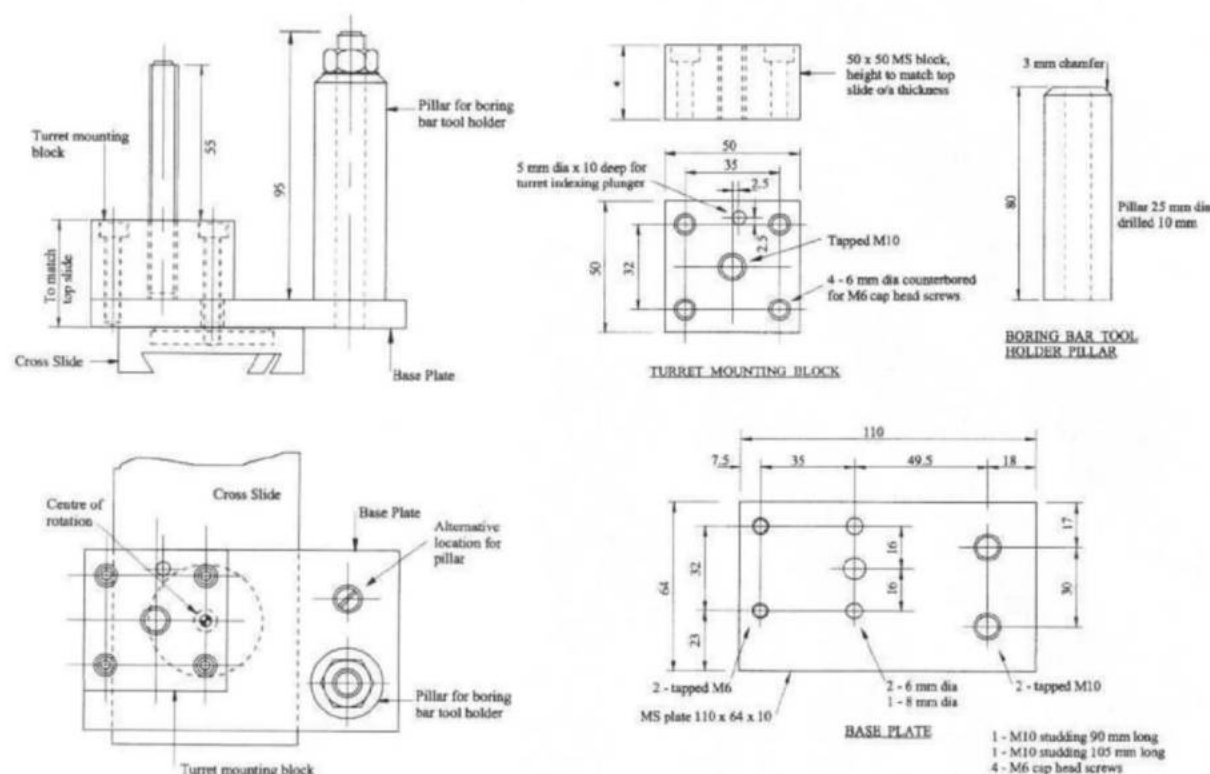
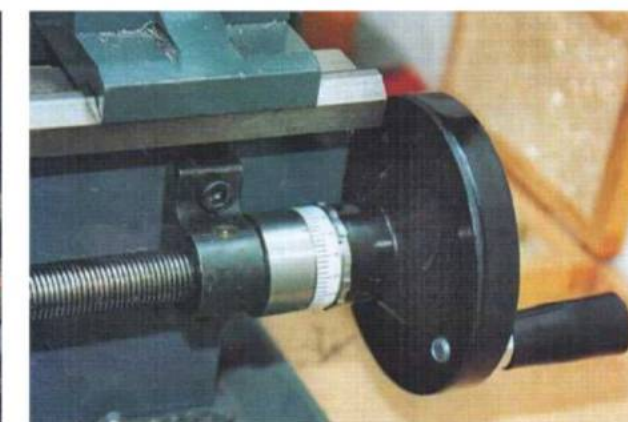


Fig. 2 - Assembled toolpost

Fig. 3 - Parts of toolpost



Showing the fixture rotated 180 degrees to present the boring bar.



The matching handwheel might be mistaken for original equipment.

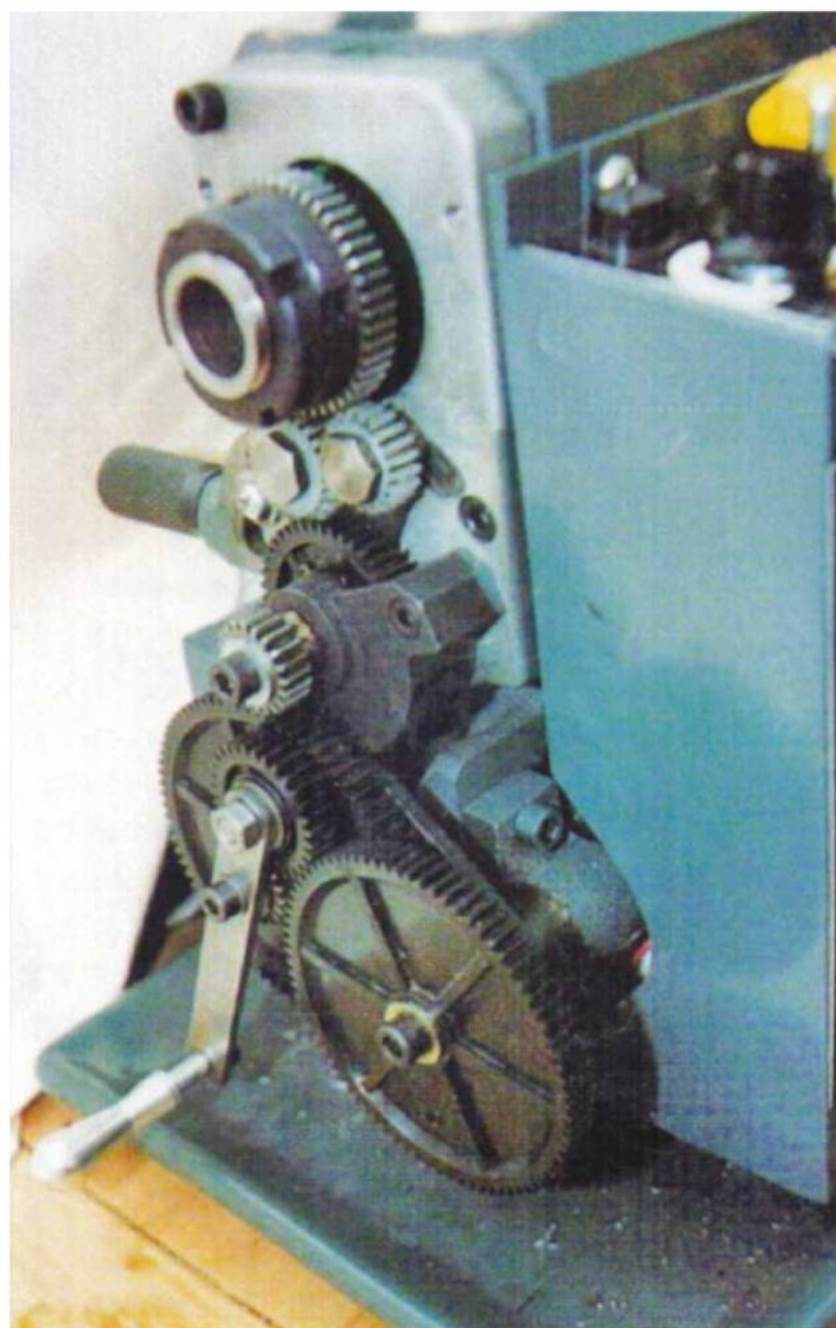
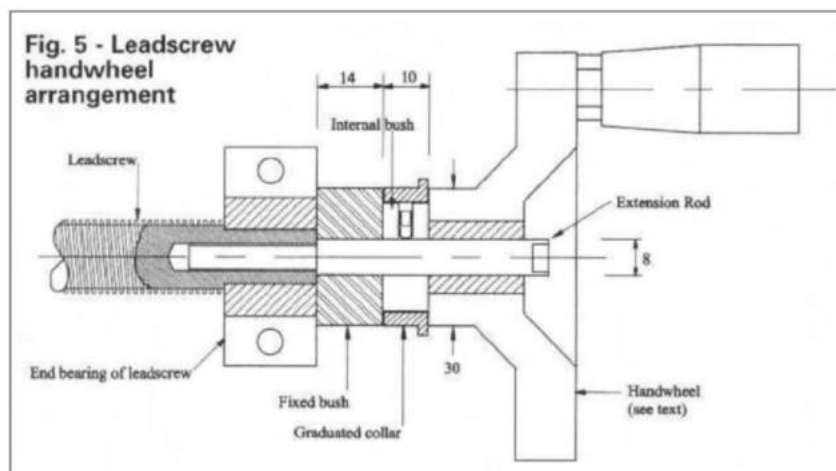
indexing plunger is used on the replacement so that the turret can index round as normal.

For other owners of the Conquest who wish to make a similar fixture, Figure 3 gives the necessary details and it will be clear that many of the dimensions can be varied to suit materials at hand. The thickness of the base plate at 10 mm can, for example, be increased if desired, the only consequence of which is a corresponding reduction in the height of the attached square block for mounting the turret. The overall size of the plate can also be varied but that shown is the minimum required to comfortably allow both the four way toolpost and the boring bar toolpost to operate independently without undue interference between them. Each of these main components requires to be machined on all faces to ensure that mating surfaces are square and flat. The clamping screws through the assembly to connect this to the cross slide require to be spaced 32 mm apart to suit that of the circular plug in the slide thereby allowing the full 360° rotation of the fixture in the same way as the top slide that it replaces. The 25 mm dia. pillar for the boring bar tool holder is a straight turning job with a central 10 mm dia. hole, and needs no special comment regarding its manufacture.

The four way tool turret supplied with the machine is quite satisfactory with regard to its design and for me, the question of quick change tooling is solved by having three of these each with a range of tool bits permanently fitted. The cost of each turret is only £7 or so (2002 price) from Machine Mart and there is therefore hardly any need to consider going to the trouble of making them. The boring bar tool holder has been made using a casting but a similar holder can easily be fashioned from a suitable block of mild steel. **Photograph 3** shows this and the four way turret mounted on the tool post fixture while Figure 4 provides a detail of the boring bar tool holder both as a casting and as the alternative machined from solid version. The 20 mm diameter horizontal hole through this is the tool mounting point and allows all diameters of round boring bars up to that maximum size to be used, the smaller sizes being fitted using a 20 mm diameter collar with a central hole of the appropriate size and the necessary socket grub screws. A selection of such tooling is shown in **photo 4** with boring bar sizes between 8 mm and 20 mm diameter.

No free lunch

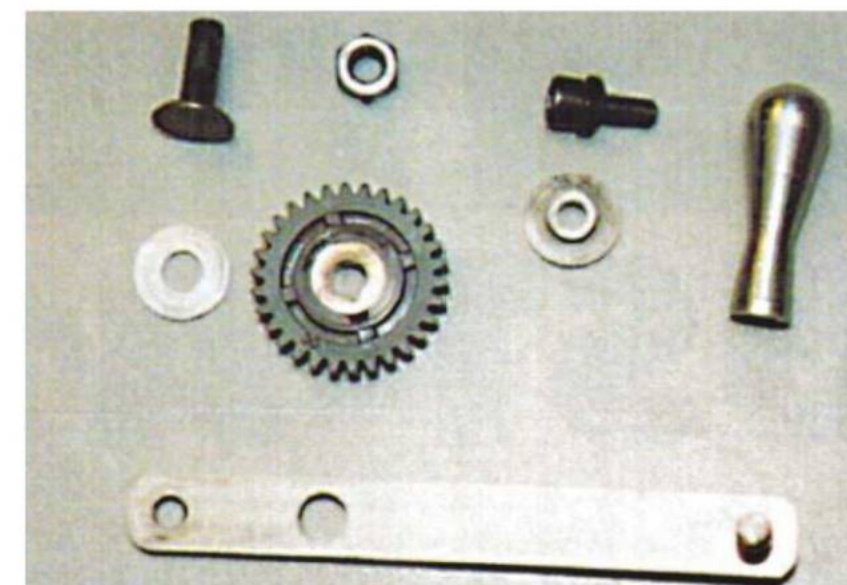
There is tremendous advantage in a tool post fixture of this design which imparts substantially greater stiffness and rigidity



The swing arm arrangement to disengage the leadscrew.

to the cutting edge of turret mounted tools rotated through 180° to present the fitted boring bar to the workpiece. This is shown in **photo 5**. Returning to normal turning work is simply the reverse of this and takes no more than twenty seconds or so to carry out each time. An engineers square can be used to set the fixture at right angles to the cross slide but this is not at all critical.

So far, so good. It is at this point I should however repeat the old adage that there is no such thing as a free lunch and many readers who have followed my simple logic to this point will be keen to point out that removal of the top slide also means that the important matter of the taking of fine facing cuts to a precise depth becomes no longer possible. Quite true and with this problem comes the obvious solution which, you have probably also anticipated, is the need for



Components of the swing arm assembly.

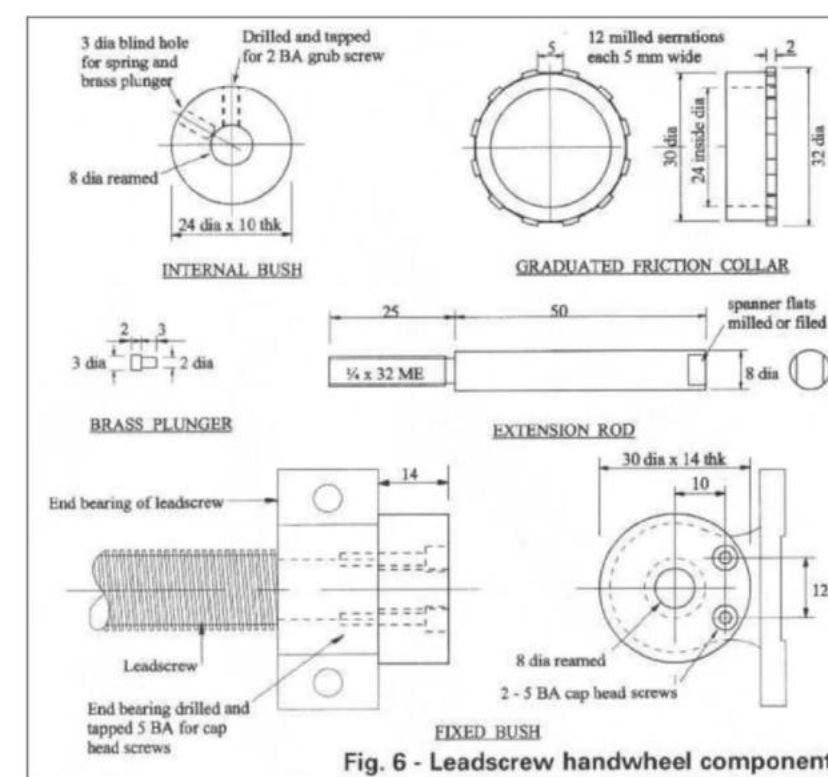


Fig. 6 - Leadscrew handwheel components

a leadscrew handwheel with graduated dial. Right. This is a simple solution to the problem which is also quite desirable in other ways (of which more later) that allows accurate advancing of the facing tool along the lathe axis. In this case, the leadscrew is 1.5 mm pitch and one complete turn of the handwheel will therefore advance the tool by this amount. However, things are never quite as easy as they seem at first sight as anyone will find out if after placing the tumbler reverse into neutral they grasp the wheel also providing the convenience of a permanently fitted boring bar tool

holder. This allows boring operations to be quickly set up while avoiding removal and later resetting of the normal turning tools in the turret. Indeed, mounting boring tools in a turret is generally more awkward, usually disturbs and requires the removal of at least two of the turning tools and less easily permits length adjustment to minimise overhang of the tool tip. For boring operations therefore, this design is a worthwhile improvement both in greater stiffness at the tool point and in general ease of adjustment and use. To quickly change from the normal turning set up to that for boring, it only

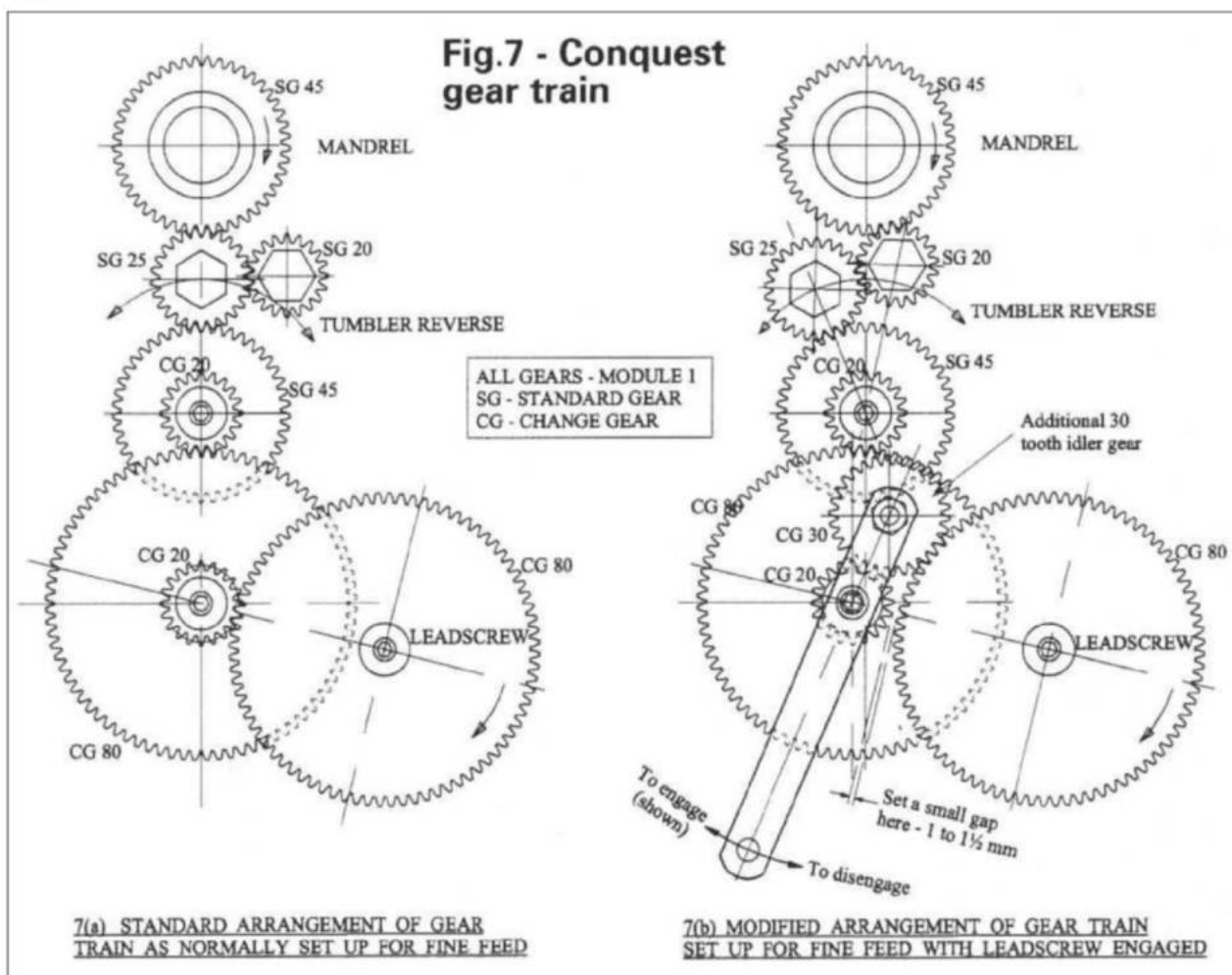
requires the two clamping screws beneath the turret to be slackened and the entire tool post fixture leadscrew and attempt to turn this. Although the mandrel is not then in gear the reverse velocity ratio of the gear train which is set up usually for fine feed, is such as to create considerable resistance to rotation of the leadscrew and effectively make this too stiff and laborious to conveniently use. What clearly is also needed therefore is a clutch of some kind which effectively disengages the leadscrew from the rest of the gear train when the handwheel is in use.

So, as is often the way, one thing leads to another. The removal of the top slide which will allow the fitting of a superior tool post fixture is not by itself a solution and requires in addition the installation of a leadscrew handwheel and the design and fitting of a suitable leadscrew 'clutch'. I have to admit that as the germ of the idea for the new tool post arrangement had initially formed in my mind, the need for the handwheel had been easily anticipated but that for disengagement of the leadscrew had unfortunately not, until much later in the process.

A leadscrew handwheel

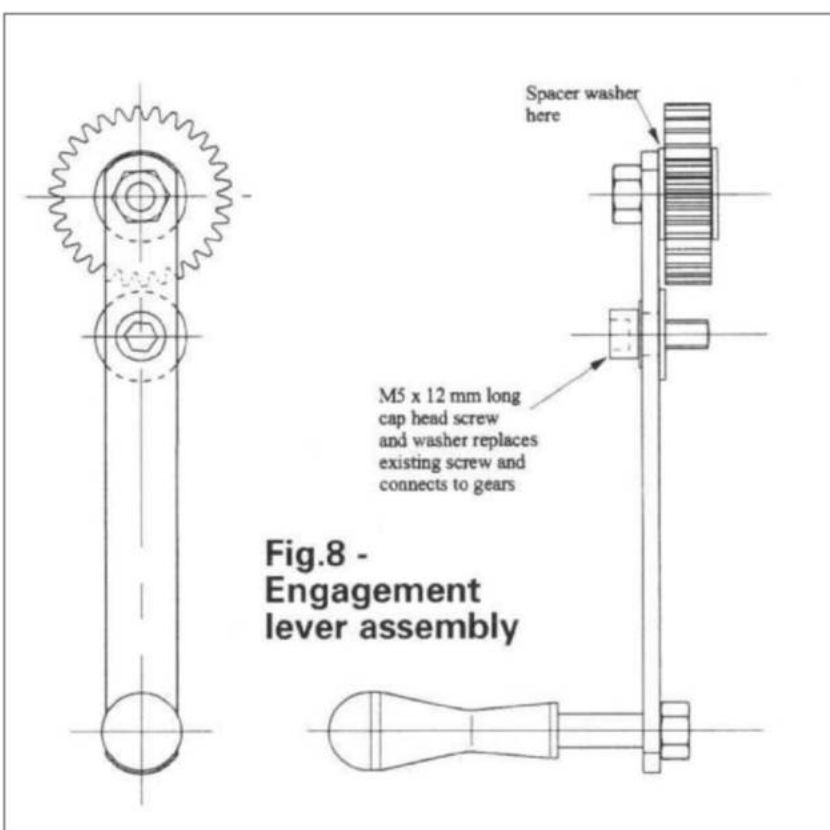
Just about any suitable handwheel fabrication or proprietary casting could be used for this but it is in my view better to use the same style of wheel as that used for the saddle rack handwheel and tailstock. This gives the appearance of it being part of the original lathe design (see **photo 6**) and is in any case easily obtainable from one of the suppliers. I can't remember how much this cost but it is usually worth checking the price of any such spares with all of the suppliers, as this in my experience

Fig.7 - Conquest gear train



seems to vary quite substantially. It is the one normally provided for the saddle rack that is required which has an 8mm dia. bore and a fitted grub screw. The assembled arrangement is detailed in Figure 5 and it should be noted that it firstly involves the removal of the leadscrew to enable a drilled and tapped hole to be made in the end of this. No difficulty should be experienced with this removal if the gear cluster and banjo is first taken away at the headstock end followed by disconnection of the bearing at the remote end then unscrewing the cap screws from the headstock end bearing. Withdrawal of the entire leadscrew may then be toward either end of the lathe depending on the extent of clearance available.

The leadscrew is 16mm dia. and will therefore easily pass through the hollow mandrel allowing the end that is to be drilled to be gripped in the chuck leaving the remainder to project at the rear. It is important to use a piece of aluminium sheet or tinplate around the end of the leadscrew to prevent the chuck jaws from damaging the square thread. Centre and drill a tapping size hole for $\frac{1}{4} \times 32$ ME thread as shown and cut this using a

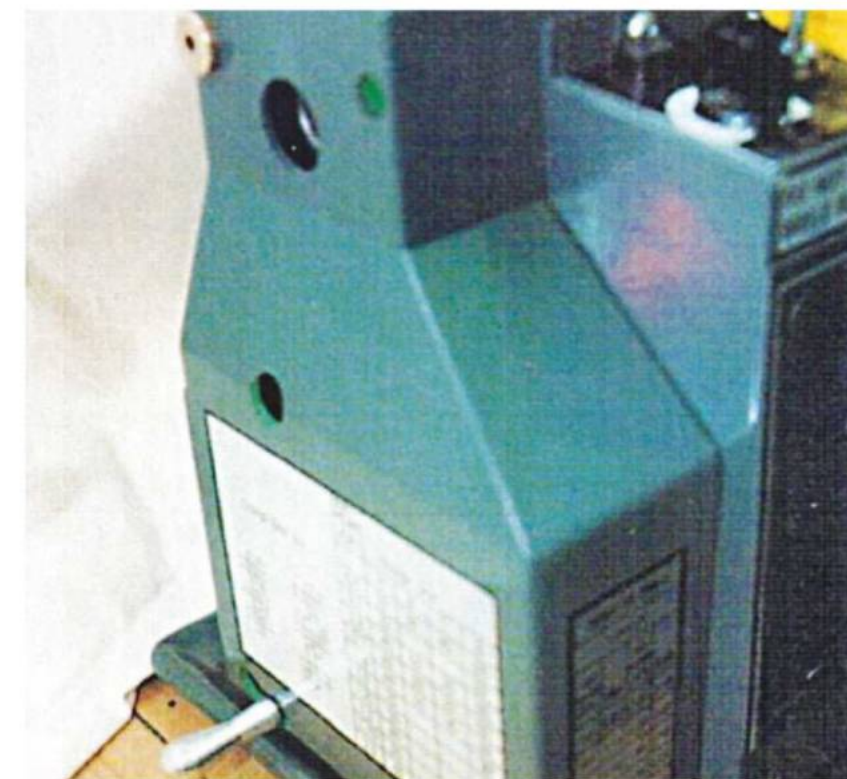


tailstock mounted tap. Simply gripping the tap in the tailstock chuck is unlikely to be satisfactory as the turning force required will easily overcome the gripping power of this. A better strategy is to use a hand tap wrench keeping the centred end of the tap firmly lodged in the fixed centre of the tailstock. The 8 mm diameter extension rod to the leadscrew which screws into this is a straight turning job with a die cut $\frac{1}{4} \times 32$ thread one end and milled spanner flats at the other. This has to be quite fully tightened into the end of the leadscrew applying Loctite to the thread to ensure its security during use of the handwheel. Note that the greatest turning force on the handwheel is when advancing the tool towards the headstock which needs a counter-clockwise direction of rotation. It would no doubt have been better therefore to have used a left hand thread and dispensed with the use of Loctite. I did not however possess the necessary left hand threading tap and die and I have to say that the method of attachment described has proved in use to be very secure.

The other three main parts of the handwheel assembly are the fixed bush, the graduated dial and the handwheel itself. These parts are shown fully detailed and dimensioned in Figure 6. The fixed bush is a plain 30 mm diameter turned disc with a central drilled and reamed hole 8 mm diameter to give a good fit on the extension rod. This is connected to the end bearing casting using two recessed 5 BA cap head screws. The reference graduation mark is on the periphery of this, cut with a fine blade saw. The graduated collar is 3mm thick and 10 mm wide with a 1mm high serrated finger grip. The serrations are made by using a simple dividing fixture and milling 12 gaps through it with a 5 mm end mill. The collar requires to be a good running fit over the internal bush which is locked to the extension rod with a 2 BA socket grub screw. The bush is drilled for a spring and brass friction plunger 3 mm dia. as shown in Figure 5. No alteration to the handwheel is necessary as already mentioned since this is supplied with an 8 mm bore and a socket grub screw already fitted. The graduations on the collar are for reasons of clarity again produced using computer printed plastic film over a white background tape. Fifteen main divisions this time of 0.1 mm each with four small divisions of 0.025 mm.

Declutching the leadscrew

As earlier discussed, the use of the handwheel to advance the saddle along the bed requires that the leadscrew be



The small slot in the end casing and the swing arm operating lever.

disengaged from the gear train. Ideally this should be in the form of a straightforward dog clutch which enables the leadscrew to be isolated from the gear train no matter whether this is set up for fine feed or screwcutting. However, the only suitable position for this kind of clutch mechanism is directly in front of the headstock where, in the case of the Conquest, all of the electronic speed control circuitry is located. This is enclosed in a box completely covering the front face of the headstock entirely surrounding the leadscrew. Inspection internally showed all of this space to be fully utilised leaving no room whatsoever for a clutch. So this was not the answer I was looking for and some other approach was needed which would produce the same affect. A search of various texts and ME articles was undertaken to see if anyone else had done anything similar. I have always been a great believer in trying to avoid reinventing the wheel if I can possibly help it). Surprise, surprise... an early article in an old ME (ref. 2) describes a means of disengagement of a Myford leadscrew using an idler gear on a swing arm interposed between the leadscrew gear and the one immediately preceding it in the train. This is an elegantly simple solution and easy to introduce but while such an idler gear has no effect on the final gear ratio, it has the obvious effect of reversing the direction of rotation of

the leadscrew. Fortunately this is not really a problem with the Conquest as the tumbler reverse can be used to correct the rotational direction and it is then only a matter of getting used in future to using the tumbler reverse the opposite way round from normal. The arrangement of this is illustrated in Figure 7 where the standard setup for fine feed (a) is shown alongside the modified set-up (b) incorporating the swing arm and the additional 30 tooth idler gear. For this to work it is obviously necessary that a small gap is created between the final 20 tooth gear and the 80 tooth leadscrew gear. This gap is not critical but I suggest that 1 to 1.5 mm is about right. The arrangement described is illustrated in photo 7.

So there you have it. Not a clutch at all but a disengagement gear which in practice works extremely well and is particularly easy to make and install. Its one disadvantage over the clutch is that it will only properly work with one arrangement of gears, that for normal fine feed. This however is not really a disadvantage at all since there is no need in screwcutting to use the handwheel and it is in any event rarely desirable to disengage the gears and risk the loss of the pickup of the thread being cut. Its primary purpose, which is to allow disengagement of the fine feed gear train and enable longitudinal control of the saddle using the handwheel, is achieved simply by moving the lever towards the

front. This will be clear from examination of figure 7(b); moving the lever forward disengages the 30 tooth idler from the 80 tooth leadscrew gear thereby freeing the leadscrew for handwheel control. The assembled lever and gear arrangement is shown in figure 8.

Disengagement Gear

The bits and pieces required for this could not be simpler and these are detailed in figure 9 and shown in **photo 8**. The control lever is merely a 12 to 12.5 mm wide flat 3mm thick cut to length and drilled 7.5 mm diameter at the pivot point with two M6 tapped holes either end. A turned mild steel collar to fit the 7.5 mm diameter hole is 16 mm overall diameter with the part which fits the hole being a little more in length than the thickness of the control lever; 2.1 mm is about right. This, together with a M5 x 12 cap head screw and washer enables the lever to be fitted to the gear train as shown in Figure 7(D) and freely pivot at this point. The 30 tooth gear is of course one of the change gears supplied and this requires to be push fitted with a bronze bush 12 mm diameter having a drilled and reamed 6 mm diameter hole through the centre. The bearing pin for this is turned from 16 mm diameter steel bar to 6mm diameter over most of its length leaving a 1 mm thick head at the full diameter. An M6 thread is cut at the

end of this and the gear mounted at the end of lever introducing another washer and adjusting the bearing pin to allow free rotation without any binding. To maintain this the locknut is then tightened.

The control knob fitted to the end of the lever is turned from aluminium to the sizes shown or as desired from personal preference. This can equally be a black plastic knob of one kind or another but should not be unduly large or heavy. The reason for this is that in operation the idler gear remains in engagement with the leadscrew gear by virtue of the turning and tooth meshing forces which tend to impart a clockwise moment to the lever assembly. This has the considerable advantage that no locking mechanism is required to hold the lever in the engaged position during use of the fine feed and requires only a light touch to then disengage. Use of a heavy knob would reduce the turning moment effect and taken to extremes could risk unintentional disengagement.

When there is no engagement of the leadscrew the lever simply hangs freely on its pivot point. A slot therefore has to be cut in the rear cover to allow the engagement knob to project through and this can be cut to suit the swing movement of the lever using a fretsaw. **Photograph 9** shows the result which I think is neat and looks the part. The

really nice thing about the disengagement arrangement described is that it does not require any modification to the existing gear train to install and can be taken off very easily when a screwcutting set of gears is required. An existing change gear is used in this design and therefore does not require to be purchased specially, although one can easily be obtained from one of the suppliers if so desired.

In use

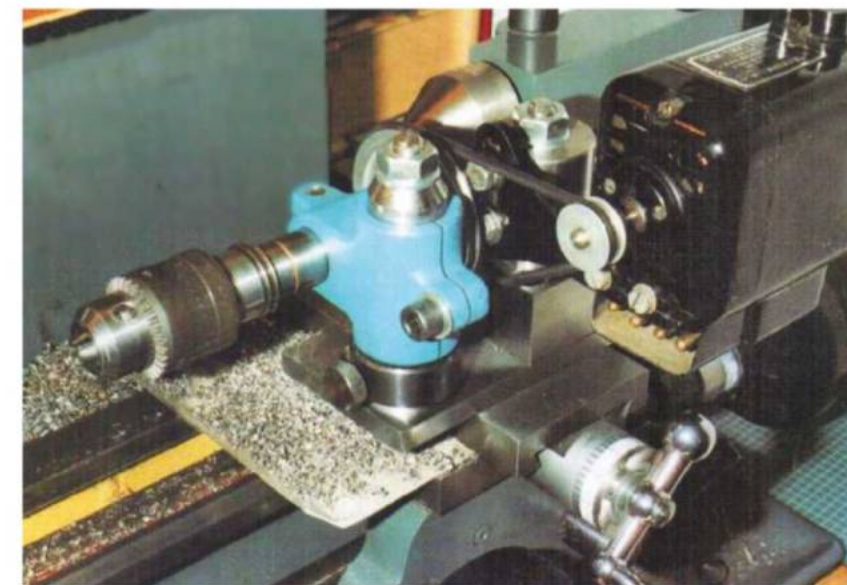
I have got quite used to the new toolpost arrangement with associated leadscrew control and gear train disengagement. I have to say that I could not now do without it. The resulting ease with which the turning and boring tools are presented to the workpiece and the convenience of the leadscrew handwheel for both parallel turning, facing and boring cannot in my view be bettered in a small lathe like the Conquest. The relatively short length of the machine means that the use of the handwheel is not at all awkward and while the direction of rotation of this for advance of the tool along the bed is opposite to the natural direction, one soon gets used to it. The selection of tool bits instantly available from three turrets is certainly enough for all my usual needs although I generally leave one space clear for a special tool to be fitted when

required for a one-off situation. The design of the boring tool holder which allows quick and accurate tool height adjustment and/or overhang adjustment is a pleasure to use. The deployment of a boring tool is as previously pointed out so rapid given that it can be ready for use immediately upon rotation of the tool post fixture through 180°. Combined turning, facing and boring operations are therefore easily undertaken and the flow of one operation to the next is particularly smooth and natural. There are consequently no annoying and time wasting delays in setting-up tooling during the progress of producing a workpiece which involves multiple and diverse machine operations. No loss of function has been created either and the original top slide can still be easily installed in place of the new arrangement whenever a taper is required or a screw thread needs to be cut.

Unexpected bonus

The original aim of the top slide replacement was as previously noted primarily to improve tool point rigidity and allow deeper roughing cuts to be taken and improve general finish. The former aim has been quite clearly achieved as has the lathe but the additional control available for achieving a better finish straight from the tool was an unexpected bonus. Previously, using a carbide tipped or HSS tool with fine feed engaged resulted in an extremely fine 'screw thread' type of finish unless the tool was made to effectively cut and rub the surface at the same time. Use of a round nose finishing tool sometimes helped but not always and the achievement of the desirable standard of finish became at times a little unpredictable. The increased rigidity of the tool using the new fixture of course has improved the finish but final cuts using fine feed still exhibit the 'screw thread' type of finish, albeit to a better standard. However by taking a final cut of say 0.05mm at about twice the normal turning speed and using the leadscrew handwheel to advance the tool along the work does obtain a good standard of finish even using a HSS knife tool. It of course requires the handwheel to be manually turned quite slowly for the final pass but this is no serious problem and any unevenness of handwheel rotation is not noticeable on the finished surface due to the high mandrel speed.

While on this subject it is perhaps worth mentioning that another way of improving surface finish is to turn the leadscrew and hence advance the tool under independent power. This need not be elaborate and indeed use can be made



A high-speed drilling spindle mounted in the boring bar holder.

of the humble electric screwdriver hand held with a socket bit applied to the retaining screw of one gear within the gear train. Which gear to apply this to depends on the speed of the particular screwdriver used but in my case, a Black & Decker screwdriver works well on the 20 tooth gear immediately below the tumbler reverse. Obviously the tumbler reverse itself requires to be in neutral and the leadscrew engaged for this to work. The hole required for this through the end casing can be seen in photo 9. If a separate permanently fixed small electric motor is used this can be located behind the headstock with a round belt drive to a pulley on an extension projecting through the end case from the gear in question. In that arrangement, the belt would only be quickly fitted immediately prior to taking the finishing cut and removed again afterwards.

Parting thoughts

With its somewhat generously proportioned mandrel, parting-off problems are not overly serious on the Conquest. Using a sharp tool, I found parting off mild steel and even stainless steel all from the normal top slide position to be reasonably free of trauma. There were occasional dig-ins however and when this happened it often ruined the work piece completely. With the new toolpost fixture came the promise of obtaining completely trouble free parting-off not only because of the more rigid mounting of the tool, but by reverse running of the mandrel while using the parting tool upside down. This obtains all the advantages that are credited to a rear toolpost which are both geometric and mechanical. Tests of this approach have indeed proved the

case and I now have a parting tool mounted upside down in one of the turrets giving excellent cut-off even if handled quite roughly. The one small difficulty is in getting the tool tip to centre height in the standard turret and I now have a 50 mm square plate 3 mm thick which is interposed between the underside of the turret and the tool post block to raise the tool to the correct height. It is of course important to remember to put this in before attempting to part off. Only lathes like the Conquest where the chuck is directly bolted to the mandrel can use this approach as otherwise the chuck could unscrew with disastrous results.

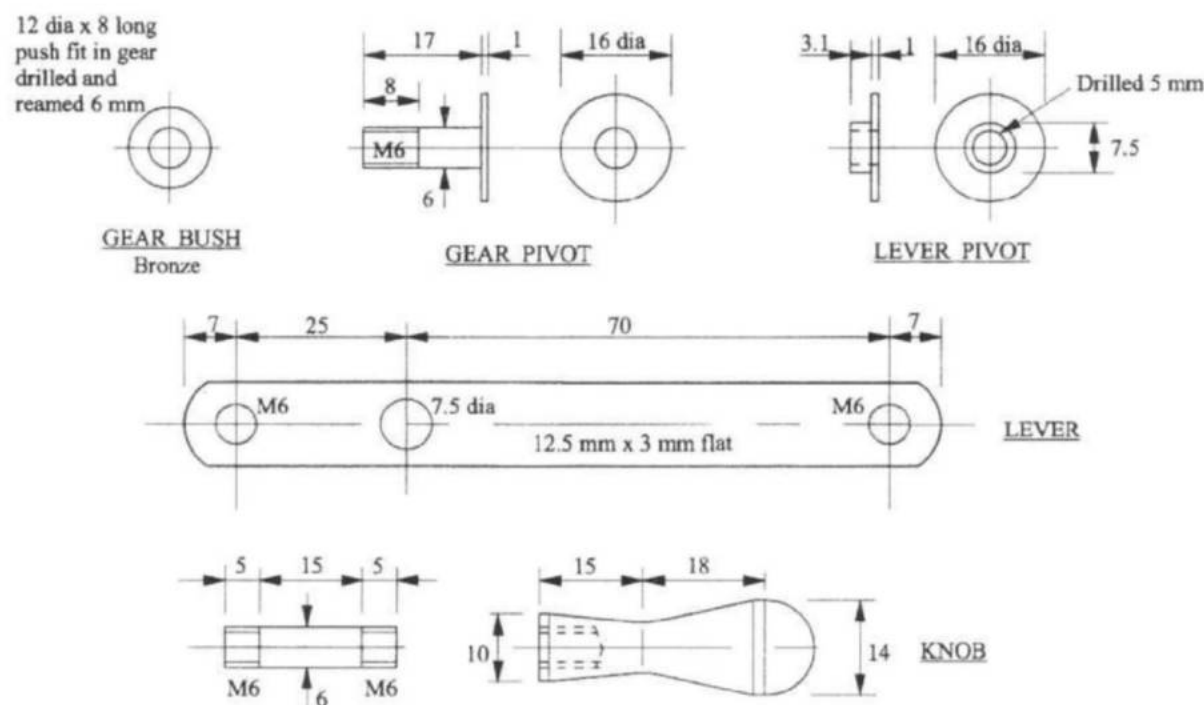
Future development

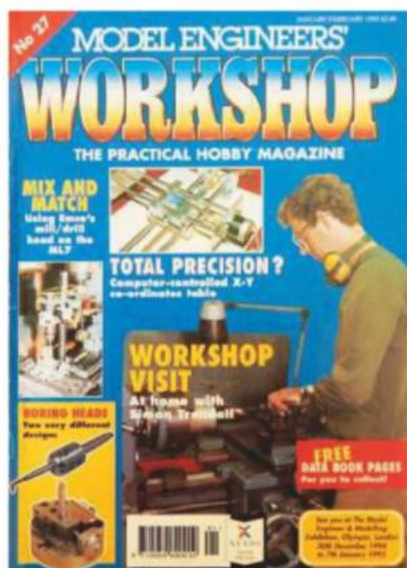
The boring tool holder would appear to be ideal for mounting a high speed drilling spindle or grinding head. In either case a small electric motor would require to be fitted to the square block which nominally supports the turret with a round belt drive to the spindle. An experimental set-up for this is currently being developed to initially determine if this is worth having and, in the case of the grinding head, to see if the lathe and mounting is rigid enough to achieve a good enough quality of finish (**photo 10**). ■

References

1. A Tale of Two Read-Outs, Barry Harrison, Model Engineers Workshop No. 86, November 2002.
2. Two Accessories for the ML7 by L Taylor, Model Engineer Volume 143, Number 3556, March 1977.

Fig.9 - Engagement lever parts





Three-Way Toolpost

Dave Lammas – Issue 27 Janary/February 1995

The three-way toolpost originally appeared in ME in 1985, and the design was so effective it became really popular and universally known as the 'Lammas Toolpost', and can be made in a size to suit any lathe. In 1995 a posthumous article in MEW introduced the idea to MEW readers. It's possible to carve one out of a solid block of steel or cast iron, but three sizes of casting are available from Blackgates Engineering that make machining a relatively straightforward exercise.

Before you start to say 'Oh no not another gimmicky toolpost' let me state that this design has now been in use by me for a long time and by friends or other model engineers in this country and abroad for almost ten years. I have yet to hear of anyone who has tried the system wanting to go back to the awkward old fashioned 4 way toolpost with all its drawbacks. In fact one user in Australia was kind enough to write in Model Engineer magazine that the designer of the 3-way toolpost should have been awarded a knighthood for the

Look at almost any modern hobby lathe, and you will see that it is fitted with a square block toolpost, capable of holding four tools. In practice, you can usually tell anyone who has tried to run their lathe with four tools fitted by the plasters on their hands! Dave Lammas came up with a simple and elegant solution – the three way toolpost, a design that doesn't leave you with a tool pointing straight out at the lathe operator. Dave Lammas was a prolific writer in Model Engineer and Model Engineers' Workshop, covering subjects ranging from quirky models to an advanced hardness tester.

greatest advance in lathe design for many years. Perhaps he should have written to some other department because I never did get that knighthood. At a display a few years ago the toolposts were shown together with a notice saying 'Better than a 4-way, quicker than a quick change'. Perhaps at this stage the advantages should be briefly explained. It is well known that the biggest defect of the 4-way is the fact that the following tool fouls the work under certain conditions of use. This means in effect that separate shaped tools must be

used for each type of operation, for example a tool used for plain turning cannot normally also be used for facing cuts, if the toolpost is rotated slightly to bring the turning tool into position for facing the following tool immediately fouls the turned portion, with the 3-way toolpost there is ample clearance even when it is rotated through quite a large angle.

It will therefore be appreciated that although holding one less tool it can perform more operations, in addition anyone who has caught their hand on a



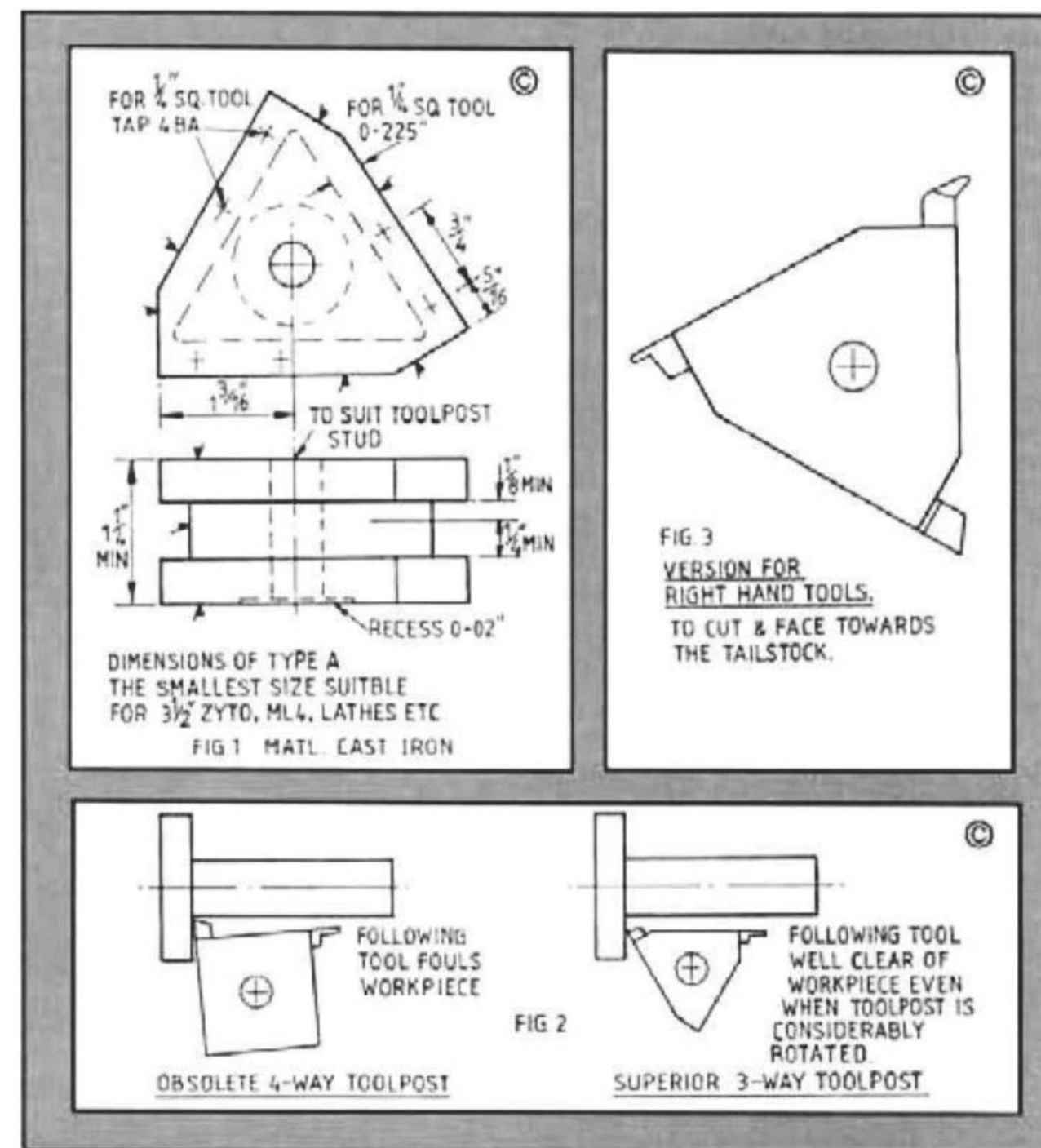
The Lammas Three Way toolpost loaded with raked tools for cutting steel and aluminium.



Another similar toolpost loaded with zero-rake tools for cast iron and brass.



This version is loaded with a set of tools for right hand cutting.



sharp cutting edge with the 4-way type will be pleased to know that with the new system there are only two cutting edges to watch out for instead of three. Taking the other point regarding speed of use; it is readily seen that a toolpost holding 3 tools can be changed over more quickly than the complete removal and replacement of the single quick change type. There is another important aspect to consider here as well, how many individual quick-change holders do you need to buy to get best use from the System? They are not cheap.

Summarising the advantages of my method we can say:

- 1) Less danger of accidental injury.
- 2) Fewer shapes of tool do more work.
- 3) Fouling of workpiece does not occur.
- 4) Fast interchange of tools.
- 5) Cheap to use because the simple casting can be machined entirely on the lathe with which it will be used.
- 6) Because it is cheap we can afford more than one toolpost. Thus the first is loaded with raked tools for cutting steel or aluminium, the second is loaded with zero-rake tools for brass or cast iron.

7) By the same token, one toolpost can be machined 'upside down', meaning that it will then hold tools for cutting towards the tailstock.

8) Need another for tipped tools? No problem, just order another casting.

By now I reckon even the most sceptical reader should be admitting there may be something to it after all. If still doubtful just ask someone who has used it for in while, it is a fairly safe that they wouldn't go back to the bad old ways.

In the first place the idea was developed for my own use but after it had

been seen by fellow model engineers requests to 'make me one' came thick and fast. Mine was designed for an ancient 3 1/2 inch Winfield lathe which is of similar size to the Myford ML4 and the Zyto. Soon I had to design a larger version to fit the Myford ML7 and similar lathes. The casting supplier now stocks three sizes A, B and C. A is the original. B fits ML7 and C is the largest for the Boxford lathe or similar machines.

Construction

The casting as received is fully shaped but needs machining on all surfaces as indicated on the GA. drawing. The overall size is not critical, just taking of sufficient to clean up is usually enough.

Facing

Grip the casting firmly in the 4-jaw chuck, top outwards with the base resting against the face of the chuck. Take a roughing cut to remove the skin from the cast iron then take at least one more cut of around ten thou (0.010 inch) to achieve a good finish.

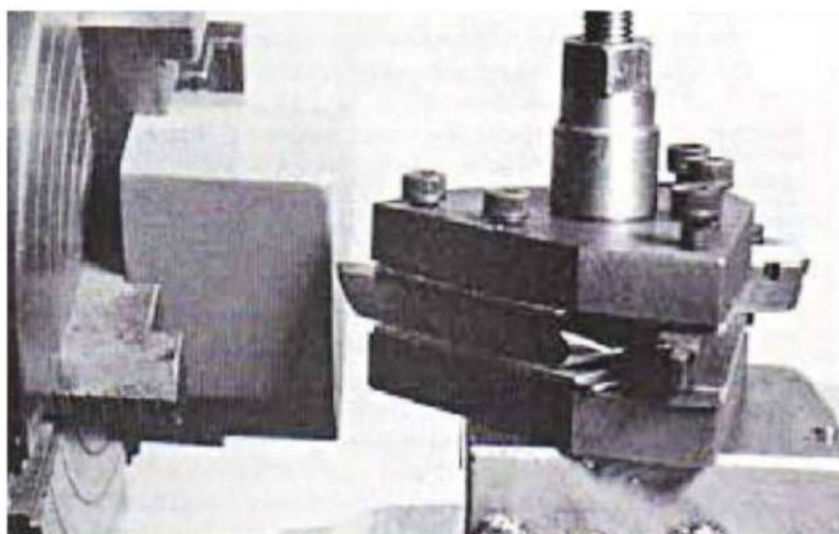
Reverse in the chuck pressing the newly machined face hard against the chuck body and repeat the treatment, this leaves top and base flat as well as parallel to each other.

Marking out the central hole

The diagram for this operation shows where to scribe the lines with respect to the finished dimensions of the toolholder. All drawings refer to type A toolholder only, as detailed drawings are supplied with the castings. When scribing the three lines allow for the fact that at least 1/8 inch will have to be added to the 1 3/16 inch dimension.

In any case it is quite easy to see if the lines cross at the centre of the casting. Don't just rely on two line crossing or errors can easily arise, just like navigating a boat in choppy waters when compass bearings apt to be slightly out.

Having found the centre, 'pop' it with the centre punch then drill it through to suit the toolpost stud of your lathe, making it a close though free fit. The recess round the hole at the base is to ensure that swarf does not get trapped close to the stud. The recess does not have to be accurately concentric with the hole so just set it up in the chuck 'near enough', remove about 20 thou



Facing the casting in the chuck, using a HSS tool set in a previously made three way toolpost

(0.002 inch) or so to a diameter of roughly 1 inch.

Machining the sides flat

This can be done, either by flycutting or end milling. Place the casting on the topslide using the toolpost stud to clamp it down. It is a good idea to first of all turn and bore the special clamping collar, (Spacer, fig. 5) to be used with the toolpost. Like recessing the base its shape makes certain that a firm grip over a good area can be guaranteed, you do not want the toolpost shifting during machining any more than when it is in use for its legitimate purpose.

The endmill or flycutter can be held in the lathe chuck. If it only cuts over a smallish diameter, say 1/2 inch, it will be necessary to take several cuts with different sizes of packing.

Turn upside down to complete the coverage. A larger diameter flycutter can do the job in one pass. The various sides of the casting are readily aligned parallel to the face of the chuck by placing a rule across the jaws then moving the saddle until one face of the casting traps the rule.

Milling the tool slots

When all the sides are machined flat bring one side up against the tailstock centre to scribe a short line along it indicating lathe centre height. Now decide what size of lathe tool you intend using. Years ago I bought 1/2 inch square tools which were reasonably cheap at the time, but as prices increased I changed over to 3/4 inch square tools, which are perfectly adequate for model engineering purposes. There is four times as much steel in a 1/2 inch tool as in a 3/4 inch one and the only advantage with the larger one is that it conducts heat away from the cutting edge more

quickly. This might be a factor to consider in industrial work aiming for maximum rates of metal removal but is irrelevant for most of our jobs. So far as rigidity is concerned 3/4 inch size has always proved to be satisfactory.

Whether deciding on 1/4, 3/16 or 3/8 inch square the rule is that the top of the tool should be at centre height. As the cutting edge is ground lower in successive re-sharpenings the tool is raised a corresponding amount by thin packing strips below it. At least 1/8 inch should be allowed above centre height to accommodate this movement.

Therefore another line must be scribed on the side of the toolpost blank 1/8 inch or so above the line already made, then a third line is scribed below centre height equal to the thickness of the tool. It is only necessary to do this on one side since all three slots will be milled one after the other at the same setting.

If a slot drill or end mill the same size as the slot is available just place packing beneath the toolpost sufficient to raise it so that the end mill coincides with the slot position. Set the casting parallel to the face of the chuck and tighten down firmly. Since large forces are generated when milling do not attempt to cut the slot in one pass but take a series of shallow cuts around 40 thou (0.040 inch) at a time, this will minimise the risk of movement by the toolpost. The total depth of cut should be about 25 thou (0.025 inch) less than the width of the lathe tools to be used. It is a mistake to have the slots too wide.

Where an endmill smaller than the slot is being used it will be necessary to pack the toolpost up in stages. Take the metal out with a series of cuts as described above, then place more

packing below and take a second series of cuts. Retain the packing pieces so that the other slots can be dealt with in the same manner.

Completion of a set of toolposts intended for turning steel, brass etc. as well as one for right hand cutting, is facilitated if they are all dealt with as a batch. For instance, face the top and bottom of all the castings before proceeding to flycut the sides. Flycut them all before milling the slots. Do not forget to turn the 'right hand' one upside-down before marking out and milling the slots.

Tool Clamping Screws

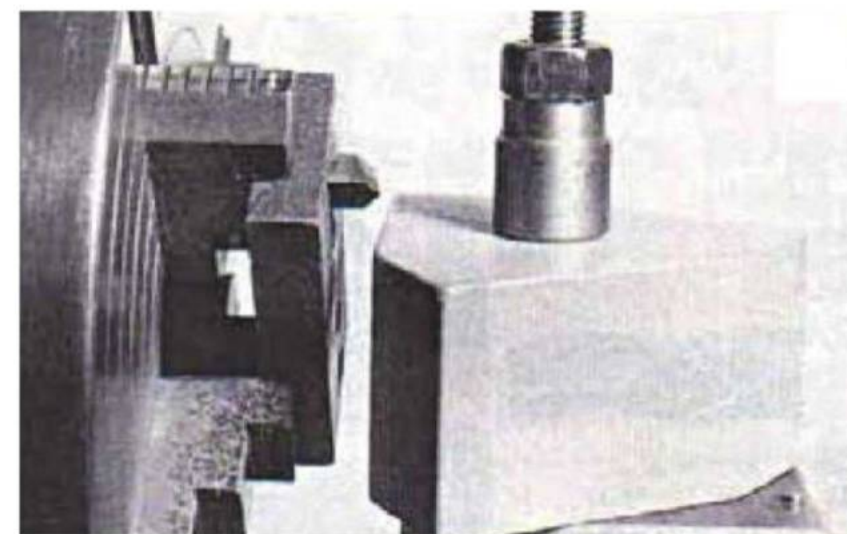
The old 4-way toolpost was often fitted with square-headed screws which are rather clumsy looking, some modern toolposts are fitted with socket grub-screws thought by some to look quite neat as they sit flush with the top of the toolpost. Think again about these because they invariably fill up with fine swarf that is not easy to remove, their designer should have foreseen that fault. The best method is to use socket cap-screws which being clear of the surface are far less likely to accumulate swarf. Get some that are not too long though. If using 1/4 inch square tools in slots milled for that size only it will be best to employ 4BA cap screws. If 2BA were used the holes would be too close to the edge. 2BA is the ideal size for larger slots.

Only two screws per slot are drawn, which is only enough for new or only slightly worn tools. If you want to use short ends of HSS another hole must be drilled and tapped between the existing ones.

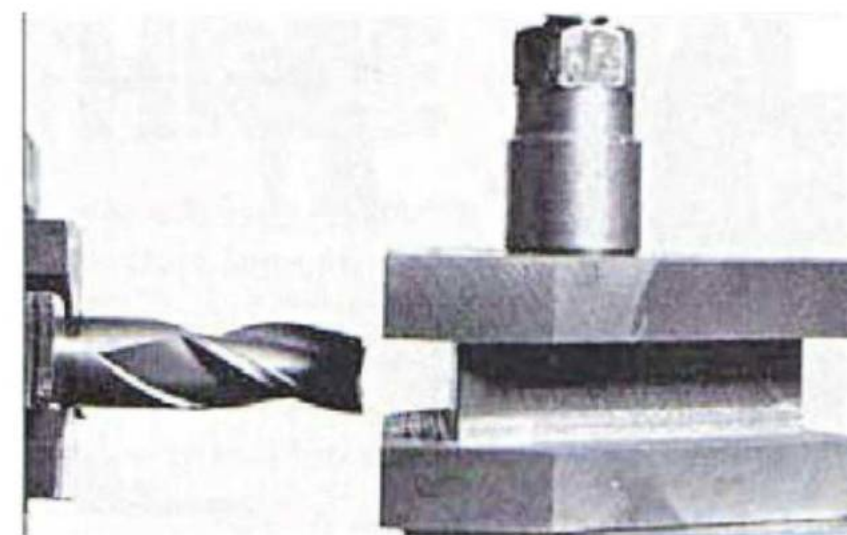
Indexing stop

I have not drawn this item partly because I do not use one but also because readers wishing to replace their old 4-way toolpost will already have part of the mechanism attached to the topslide. It might then be possible to adapt this to the new 3-way posts or at least to make similar new parts that will fit in.

As mentioned earlier one of the big advantages of the 3-way system is that the toolpost can be used at various angles to the topslide giving greatly improved versatility. It does not always have to be at right angles to the slide. The conventional indexing stop



Flycutting the faces of the casting, which is mounted on the topslide



Cutting the tool slots. This is carried out using an end mill in the chuck. The casting is raised on suitable packing.

mechanism would probably interfere with this feature. An adjustable stop designed to catch one corner of the toolpost can be fitted to the top of the topslide if ability to return to a pre-set position is deemed essential for certain operations, such as making a large number of small screws for instance.

The tools

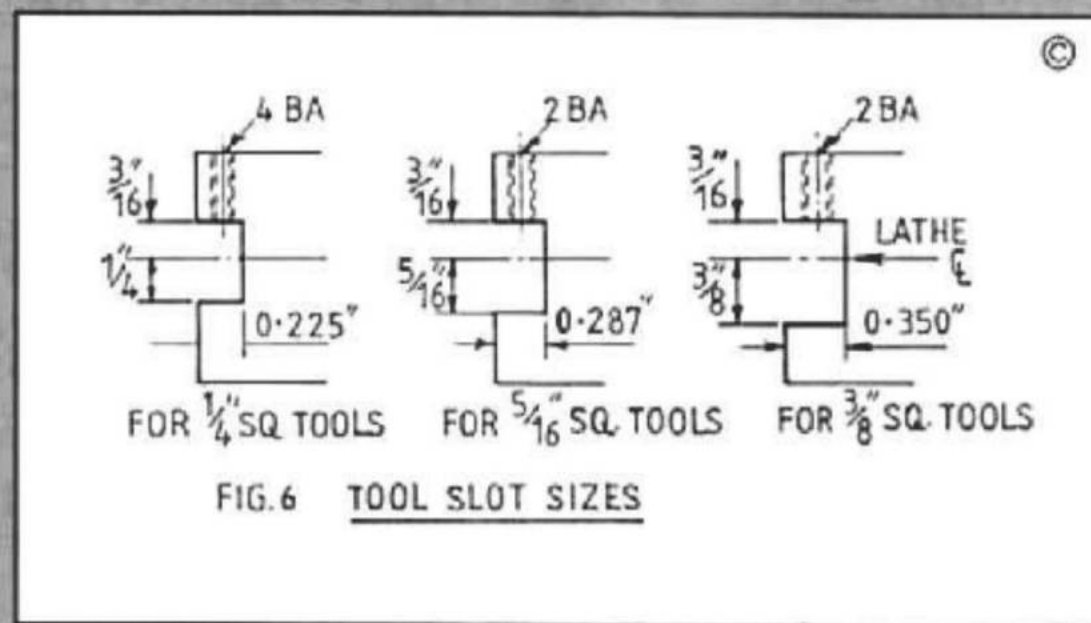
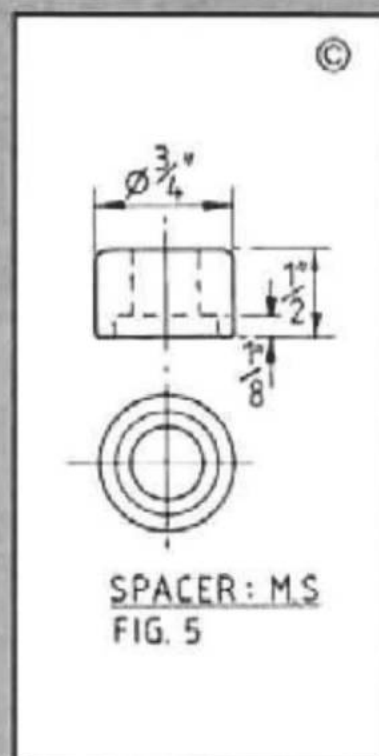
Careful selection of a few basic tool shapes will enable one to perform the majority of turning operations without too many tool changes.

A knife tool, round nosed tool and recessing or small parting off tool will handle most jobs. I like to use a more substantial parting tool in a rear toolpost in any case, so perhaps the small one could be replaced by a roughing tool. Loading the steel, brass and right-hand toolposts with a similar selection will go a long way towards

speeding up one's lathe work, leaving more time to concentrate on the interesting parts of the task instead of constantly hunting for odd tools of assorted rake angles then wasting time setting them up.

There is no reason why another toolpost could not be kept loaded with boring tools or maybe a boring tool, an internal recessing tool and an internal screwcutting tool. Likewise an external vee screwcutting tool, a square thread tool and a chamfering tool already to hand would be very useful there is plenty of scope in this system.

Storage of toolposts on a rack consisting of short lengths of 3/8 inch diameter steel set in a wooden block adjacent to the lathe also helps to speed things up, the tool for the job can be selected without having to think about it and changed instantly. How often have you attempted to do a job with the



wrong shaped tool just because it happened to be fitted to be fitted in the 4-way turret and it seemed too much trouble to change it?

When you manage to get away with bodging things in this manner it may seem alright. When the job goes wrong and you have to start again from scratch with the other tool, you begin to wish things were better organised. I believe

my toolposts will meet this requirement in an entirely satisfactory manner.

Castings supplier

Castings for the A, B and C toolposts are still available from Blackgates Engineering, Unit 1, Victory Court, Flagship Square, Shaw Cross Business Park, Dewsbury, WF12 7TH. T. 01924 466000. www.blackgates.co.uk

Events

January 17 – the Great Hanshin Earthquake devastates Kobe, in Japan.

February 9 – Michael Foale becomes the first Briton to walk in space.

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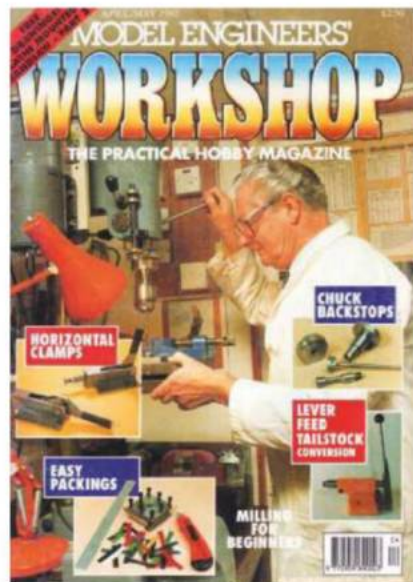
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Adventure

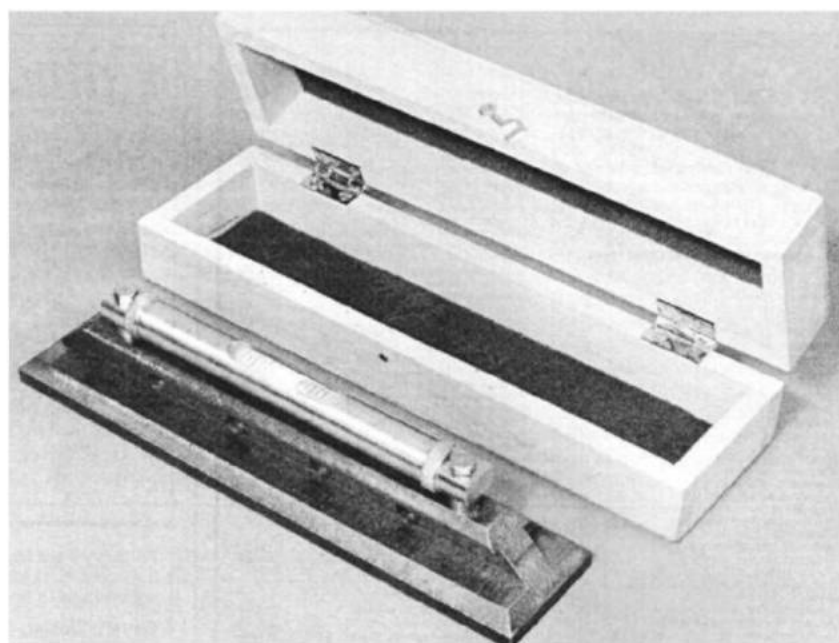
An Engineer's Level



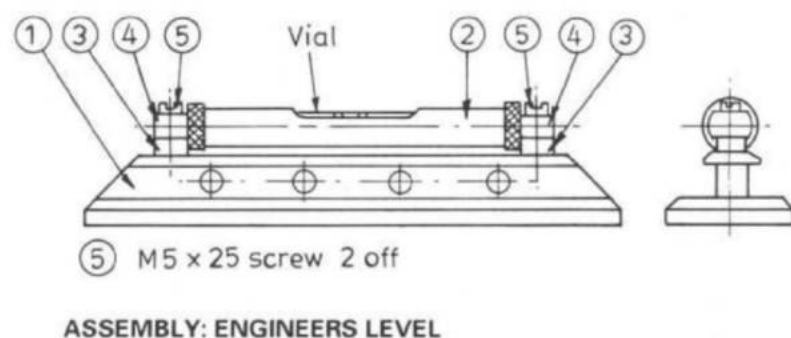
Anon – Issue 10 May 1992



Anonymous, but probably from the prolific pen of Harold Hall this article covers the making of a precision level using a kit supplied by College Engineering Supplies. Today, the use of such levels is regularly debated on the Model Engineer forums at www.model-engineer.co.uk, and the excellent kit is still available from CES.



Finished level complete with storage case



In issue 9 of MEW, Bill Morris referred to a requirement for a precision level when levelling a lathe, stating that one with a calibration of 60 seconds per division was barely adequate.

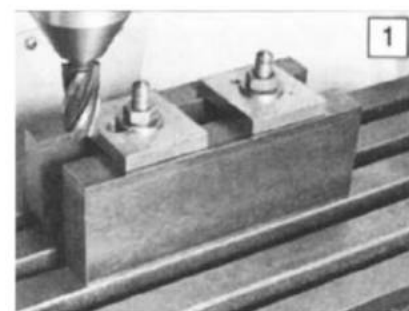
Bill went on to explain that the need to detect errors of 10 seconds was about 0.04mm error in 1 metre.

As purchasing a level would be costly, those sold by College Engineering as a casting and vial were considered. Their catalogue shows a base available in either aluminium or cast iron, the standard vial supplied has a sensitivity of 0.41 degrees (7mm per metre).

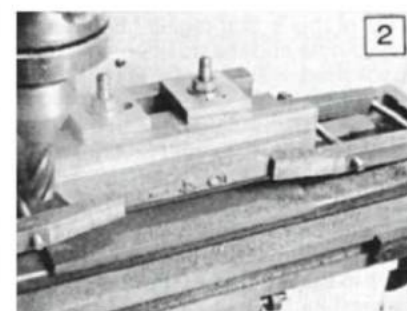
An alternative vial is available having sensitivity of 60 seconds per division (or 0.005 inch per 12 inches, 0.03mm per metre), suitable for accurate engineer's use.

Most people will only be familiar with the common builder's level with the vial in the form of a bent tube, and will be surprised to find that the tube is straight. In precision vials the curve is produced on the inside only.

The precision vials are larger in diameter than the standard vial, this being the reason the tube is not supplied. Therefore the assembly requires slight modifications from that shown on the



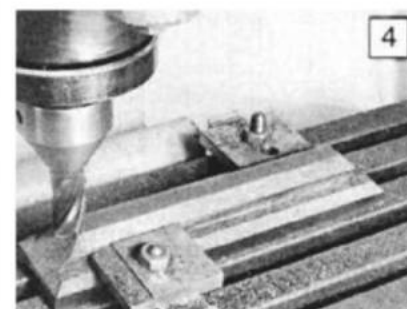
An alternative arrangement for an angle plate.



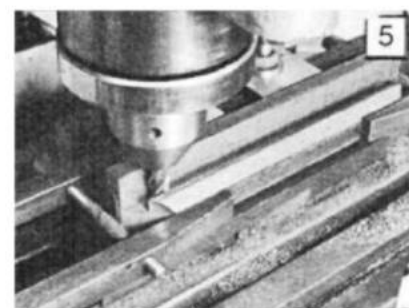
First machining operation, cutting the central web for gripping with toolmaker's clamp as shown in photo 3.



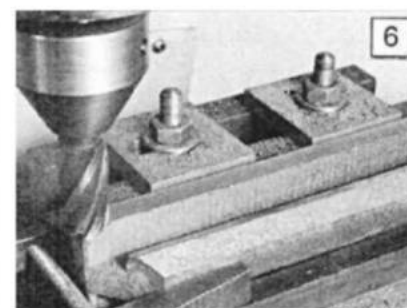
The setup for machining the base; note how clamps grip central web and are then clamped to the machine table.



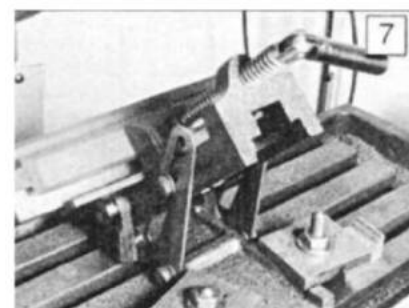
Finishing the top.



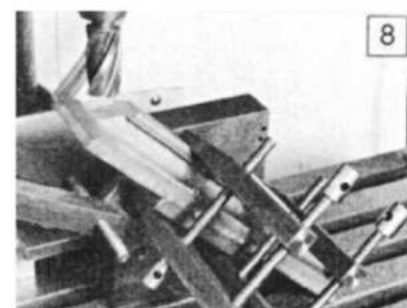
Making the groove in the central web.



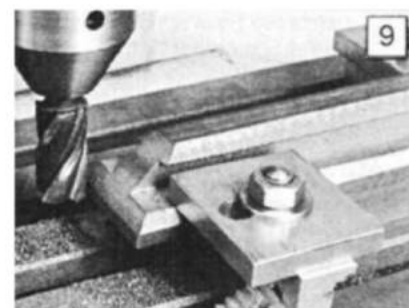
Machining the base to final width.



Making the chamfers.



Finishing the angle on the end.



Machining the end of the base.



Machining width of top to final dimensions.

College Engineering drawings, and can either be made from larger diameter, or thinner walled tube. The same outside diameter but with a thinner wall was the approach chosen.

Whilst drawings are supplied, the drawings reflect the changes necessary for the precision vial.

The base

Other than the size and shape of the casting, which may present some problems with holding the part, machining the casting should be quite simple. The sequence suggested here, should be found suitable for those with limited work holding facilities.

Clamp two pieces of rectangular steel to the machine table to form an angle plate. This arrangement is shown in **photograph 1**; set the front one of the two pieces parallel to the movement of the slide.

Clean up the casting with a file removing any projections that may prevent it sitting firmly when clamped in position. Clamp the bottom of the level to the steel pieces as shown in **photograph 2**, and machine faces A and B (indicated in **sketch 1**).

Turn over casting and with face B firmly against the milling machine table, or suitable packing piece, machine face C. This will ensure faces A and C are parallel along their length.

The casting can now be lightly gripped on faces A and B with two substantial toolmaker's clamps, and the arrangement now clamped to the machine table, as shown in **photograph 3**. Note the packing pieces below the clamps that make sure the clamps, and not the casting, are clamped to the table.

Care must be taken in this operation not to distort the casting, for if the toolmaker's clamps are tightened firmly before clamping to the table, twisting of the casting may occur. To avoid this, progressively tighten all four clamps in turn.

The base of the casting can now be machined; take care to set the cutter for the first cut, below the harder outer skin. The base as cast will not be flat, and what starts as an adequate cut may eventually be too shallow as it passes across the surface. Watch out for a shiny surface to indicate that the cut requires to be set deeper.

Remove the casting and clamps from the table, and return the casting to the table, base down as is shown in **photograph 4**. Machine the top face, only just sufficient to clean the surface, as this will be finished at a later stage.

Recreate the makeshift angle plate as was used for the original machining, and ▶



Drilling holes in central web after first positioning them with a centre drill.



The finished base, note all the edges have been given a 1/32 inch chamfer with a fine file.

Photo 12. The finished base; note the all edges have been given a 1/32" chamfer with a fine file.



Slotting the vial tube.

clamp the casting on to this as in **photograph 5**. Make sure the surface B is fully in contact with the table or packing piece.

Now start to machine the slot along the side. Make the depth such that approximately equal amounts will be required to be taken from either side. The width of this slot is not critical, and if a 12mm end mill is not available but a 1/2 inch end mill is, use this.

This is better than using a smaller end mill and creating the slot in two passes. With the base still in position, machine also the edge of the base as in **photograph 6** to give the 18mm dimension.

Turn the casting over and produce the second slot, such that the thickness of the central web is 12mm. Follow this by machining the second edge, again to achieve the 18mm dimension. If a long adjustable angle plate is available, machining the chamfers should present no problem. If not then the arrangement shown in **photograph 7** should suffice, providing only light cuts are taken.

Start by taking only a light cut; check

to determine if an equal cut is being taken along the length, this to ensure an equal chamfer results. If not, adjust to achieve this.

To machine the angle on the end, fix a small angle plate at 45 degrees onto a larger angle plate. Clamp the base onto the small angle, and machine the angle as shown in **photograph 8**.

Clamp the base onto the machine table making sure the base is parallel with table travel, and machine the ends as shown in **photograph 9**. Do pack up the base from the machine table to avoid the cutter fouling the table. Follow this by machining the top surface to the 28mm dimension.

With the base still mounted in the same manner, machine both sides of the top part of the central web, as in **photograph 10**. Take a light cut only to start with, check if the resulting flat will be equal along its length, and if not adjust to suit.

Now again recreate the angle plate as in **photograph 1**. Clamp on base and, using a centre drill, mark off the 4 x



The vial tube mounted on a tapered stub mandrel.

10mm holes, positioning these using the machine dials. It is here that one of the weaknesses of the usual mill/drill may become apparent.

Line up the drill with the first centre mark and zero dials; drill first hole. Now drill remaining holes, again using the machine dials to position the base correctly; this is seen in **photograph 11**. All that remains is to drill and tap the M5 holes in the top and to make an appropriate 1mm chamfer on all edges (**photograph 12**).

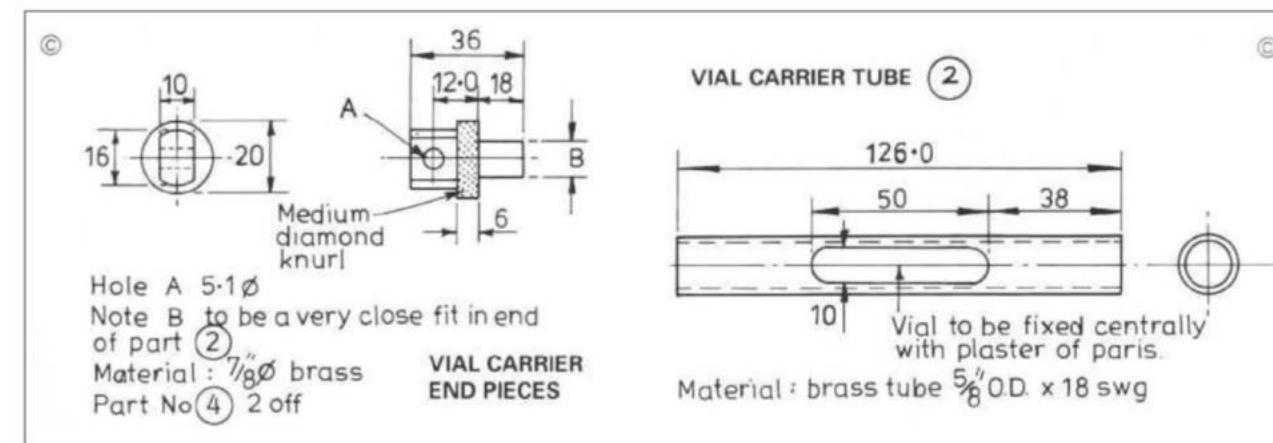
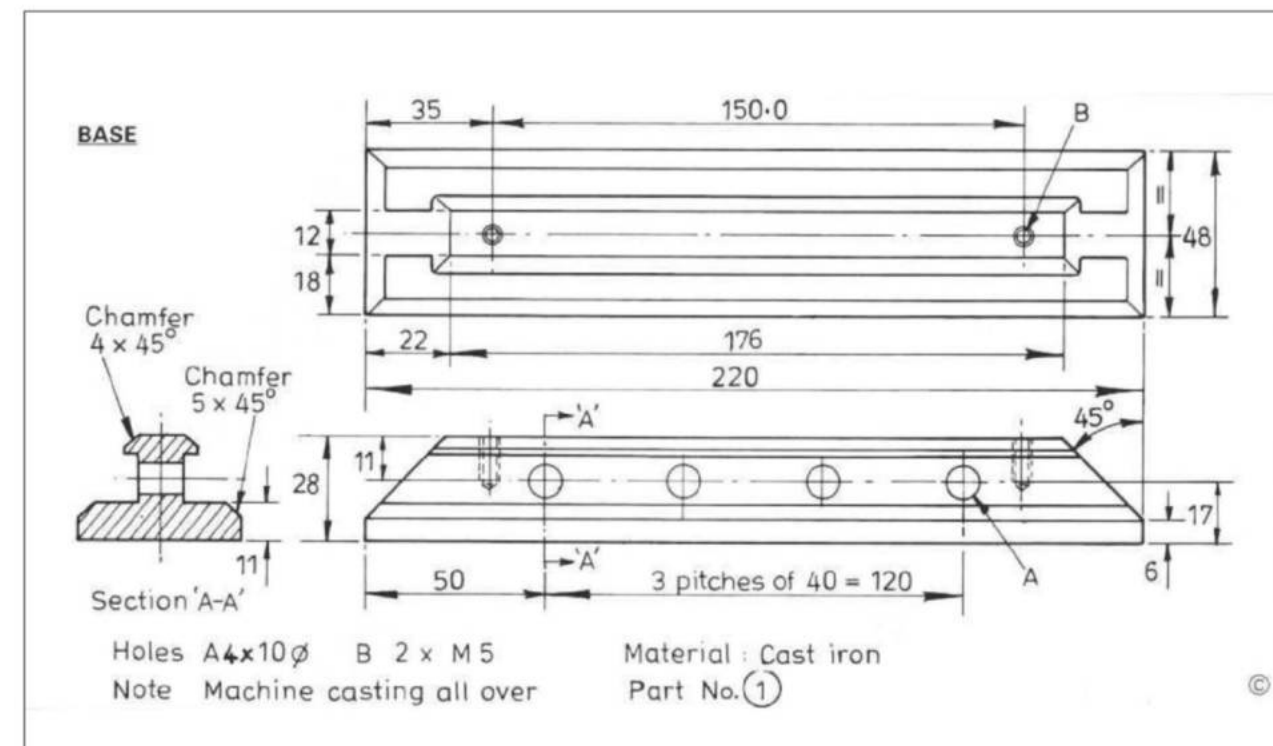
As this removes so much metal from all faces of the casting, it is possible that internal stresses may cause the casting to change. This may result in the base, being one of the first surfaces to be machined, becoming distorted.

Before proceeding check the base on a flat surface, any very minor errors could be removed by scraping. More severe errors would require both the bottom and top faces to be remachined, removing only a few thou. This test would best be carried out a few days after completing machining.

The vial carrier

The precision vial supplied measures about 13mm diameter and is larger than the standard vial for which the College Engineering drawings are prepared.

Brass tube 5/8 inch diameter with an 18swg wall thickness will enable the design to be followed closely, other than for the diameter of the thread (please note, the currently supplied vial



may need another size of tube).

Having limited time available it was decided not to use a thread for securing the end pieces, but to rely on a parallel portion being a very close fit in the end of the tube. To give this method more chance of working satisfactorily, the depth of this insert was increased from 12mm to 18mm for the plain end.

This proved very satisfactory and the drawings published with this article indicate this method. Drawings showing threaded ends will be provided with the base and can be worked to if preferred. The thread will though have to be a larger diameter.

Saw off a length of brass tube and carefully face both ends to the required length. Remove any burrs from inside the bore as these may cause confusion when turning the ends to a close fit.

Place vice on milling machine table

and ensure it is positioned accurately - that is at right angles to length of table. Make slot as seen in **photograph 13**.

The outside of the tube may be left as supplied, or alternatively can be turned to give it a machined surface. To do this, place a short length of 5/8 inch dia. steel in the three jaw chuck. Turn a tapered stub mandrel to support one end of the tube (**photograph 14**) whilst the other end is supported by the tailstock centre (**photograph 15**).

Two points require to be taken note of to avoid the possibility of failure. First, the end supported by the centre will have a sharp edge that will quickly wear. This will result in the part becoming loose when machining commences, and a poor finish resulting. To avoid this run the lathe for a short while without taking a cut, but progressively advancing the tailstock barrel by a very little. Do

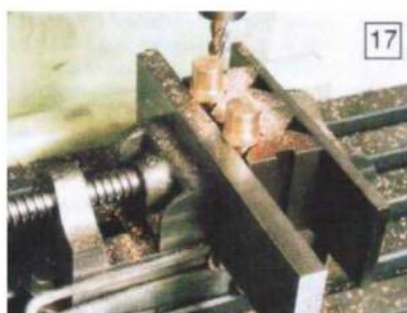
this until the edge has become slightly worn; use oil during this operation.

The second possible cause of a problem will be if the part is forced further onto the stub mandrel during machining, resulting in the part becoming loose at the tailstock end. To overcome this possibility, turn the mandrel with a greater internal angle than would normally be used. Setting the top slide to an angle of 2 to 3 degrees, rather than the normal 1 to 2 degrees, should prove satisfactory providing the part is pressed well home before machining.

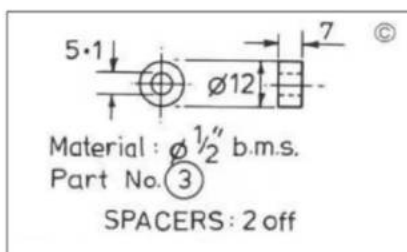
Having made these preparations, machining the outside of the tube should present no problems. Follow this by making the two end pieces. **Photograph 16** shows this being done using a fixed, and machining the part on the end. This is by no means essential, but it will avoid



Machining the vial tube; note how this is supported between stub mandrel and tailstock centre.



Making the ears on the vial tube ends.



ending with small pieces. Using this method is always a worthwhile consideration, particularly for the more expensive materials.

First machine the end that goes into the tube. This requires to be a very firm push fit by hand. To achieve this, the diameter will be required to be finished to a very precise size; a 0.005mm difference will result in it either being too tight to insert or, on the other hand, too loose. Because of this, very precise control of the diameter will be necessary. The best method for arriving at this precise control of diameter is to set the top slide to an angle of about 1/2 degree. Then winding the slide back will result in a depth of cut of 0.001mm for a 0.1mm movement. Use the saddle to turn the part parallel.

It is possible that the inside diameter of the tube may vary slightly from one end to the other; scribe a line inside the tube and always test using this end. When a satisfactory fit is arrived at, scribe a line on the turned portion only.

Now produce the knurling and part off first part to length. Follow this by producing the second end piece, making sure it is made to fit the other end of the



Making the vial tube ends; the fixed steady is being used to minimise scrap.



The complete set of parts.

tube. Do not mark this end to ensure that the end pieces will always be fitted to their end of the tube.

The parts can now be held in the three jaw chuck on the parallel portion just turned, and the outer diameter created.

Accuracy

It is at this point that it is worth considering the differing demands for accuracy which the different vial sensitivities require. If the base was machined in the manner described above on a reasonably accurate machine, then the lower and upper faces should be parallel to a very close tolerance. As a result, only the vial mounting arrangements require considering.

Three items will affect the accuracy of the final assembly. These are the mounting of the vial in the tube, any differences between the two end pieces and, similarly, any difference between the two spacers.

The two sensitivities amount to errors of 1.4mm and 0.1mm over 200mm, this relating to the bubble moving one

calibration mark, about 2mm. It is obvious from this that quite large manufacturing errors could be inherent in the least sensitive, and for these not to be apparent in the vial reading.

For the most sensitive vial, the situation is quite different. Here it is unlikely that the unit will work satisfactorily, no matter how much care is devoted to manufacturing the parts. This will result in the requirement for some adjustment to be made on final assembly.

Returning now to the two end pieces on which the flats require to be made. The method of doing this is shown in photograph 17; do attempt to get the tabs that result, central, by machining the equal amounts from both sides. In any case it is worth marking two sides machined at the same pass, and then ensuring they are used the same way up when fitted.

Spacers

These present more of a problem than is apparent at first consideration. This is

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particularly so for the most precise assembly. Make two spacers both the same length. To do this, machine a short length of 1/2 inch diameter to the required size, and drill through sufficient to make two spacers.

Now set the rear parting off tool at a position to make a spacer a few thou longer than required. Do not move the saddle but bring into position a facing tool on the top slide, face off a few thou using only the top and cross slides, and then part off.

For the second spacer, do not move the top slide but bring the facing tool into position using the saddle and face off a few thou to clean up this surface. Again, part off using the cross slide only, both spacers should be the same length and have parallel faces.

The full set of parts is now complete and these can be seen in photograph 18.

Assembly

The first stage of the assembly procedure will be to paint the rear of the vial with white paint, and allow it to dry. With this done, fix the vial in position using plaster of Paris or similar. Position such that any excess clearance is below the vial, so that it is positioned close against the opening in the top of the tube.

When set, the final assembly can take place. If the fit between tube and ends has been made quite tight, cooling the ends in the freezer will help to ease the assembly. The finished level is seen in photograph 19.

Calibration

Calibrating the finished unit will depend on which level of accuracy has been made. The lower level should present no real problem, though much of what is said will be appropriate to both. Photograph 20 shows the calibrating marks on the vial.

The first problem will be the absence of a sufficiently accurate level surface on which the tests can take place. Because of this it will be necessary to establish the level surface using the level already made, but itself not accurate at this stage.

A surface plate will be a good item on which to carry out the tests; this can be packed up at the corners until level.

Alternatively, a piece of steel, say 1 1/2 inch square and 10 inches long, can be mounted in the vice; this can then be adjusted until a satisfactory level surface is achieved.

First get the surface as level as possible using the most accurate level available. Now place the precision level on the surface and note the reading; turn the level though 180 degrees and again take note of the reading.



The finished level.



The vial calibration; each line is about 2mm apart.

Almost certainly errors will be present in both the surface and the level itself which will make analysing the readings difficult. First let us consider the unlikely event of the surface already being perfectly level. In this case, if the bubble reads to the left in the first position, it will read the same amount to the right when reversed. If the reverse were the case, that is the level being correct, then if the bubble first reads to the left it will still read to the left by the same amount when moved through 180 degrees.

Almost certainly an error will exist in both cases. Adjust the surface on which the test is being carried out until the error indicated is equal in both directions. At this point the surface can be considered level. When subsequently the level itself is adjusted to be nearer correct, return to the test surface to make further minute adjustments.

With the surface now reasonably accurate, it is time to adjust the spirit level. To do this place the level on the test surface and, using feeler gauges under the base at one end, determine how much it has to be raised to make it read level.

To correct for the error remove the spacer from the other end and reduce the thickness of this to suit. This will be about 1/2 of the error measured over the total length.

The method of doing this is to turn a stub mandrel to be very close fit in the hole, with the spacer placed on this the length can be reduced to suit. This is more difficult than may be anticipated

as, when the level approaches its required calibration, corrections of only a 0.002mm will be required.

In setting up the prototype it was sometimes found that, when returning the spacer after machining, the opposite effect to that anticipated resulted. This situation was difficult to understand but was eventually put down to the fact that the two sides of the spacer sometimes were not parallel by up to 0.005mm.

When finally adjusted, place on the surface and pack one end just sufficient to move the bubble one division; this should be around 0.1mm. This will serve as an indication to you how accurate the level is, also that you have been supplied with the correct vial, as there is no way of knowing by just looking at it before assembly.

This method of adjusting the level was more difficult than anticipated. An alternative would be to use a spacer at one end, but in the other, screw a stud firmly into the tapped hole. If nuts are now used on either side of the ear on the vial tube end piece, adjustment will be much easier, though the result will look a little untidy.

Castings and vials are still available from the College Engineering Supply 0845 166 2184 www.collegeengineering.co.uk

Events

April 6 - Microsoft releases Windows 3.1.
May 7 - Space Shuttle Endeavour makes its maiden voyage.



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Right 1. ER20 spring collets, normally used in the Morse taper chuck (right) can be fitted to the square holder (left) and used to hold a wide range of drill diameters.



Twist Drill Sharpening by the Four Facet Method

Giles Parkes – Issue 64 February/March 2000

One thing that many people find a challenge is accurately resharpening twist drills. In 2000 Giles Parkes rose to the challenge of making a quick to use but accurate jig using the 'four facet geometry'.

I am an old newcomer to engineering workshop practice and I don't suppose I shall live long enough to learn to sharpen twist drills properly freehand. I have made many attempts and I sometimes succeed in getting a drill which cuts true and to size, but what I want is consistency. Many devices have been studied and tried for grinding the clearance correctly, but I can't make most of them produce an accurate drill repeatedly.

As all proper engineers know, the first essential is to have two cutting edges of equal length and at the same angle to the axis of the drill. The second is to have the clearance equal on each side and the third is to be able to change angles and clearances for different materials. Provided that the drill can be offered to the grindstone at a predetermined angle, it should not be difficult to obtain a consistently good drill. I therefore turned my thoughts to a jig to make this possible, and at the same time I chanced upon articles by D. A. G. Brown on four facet drill sharpening (Model Engineer Vol. 172 Nos. 3690 and 3692). His jig makes it almost impossible not to grind a

drill properly, but it is confined to small drills up to about 3mm. I wanted to sharpen larger drills to the same high standard, and ER20 spring collets provided the next answer when I was told that they will hold a drill accurately by the lands. They have the advantage that each collet has a holding range of 1mm, so all drills from 3mm to 13mm, metric or Imperial can be held in relatively few of them.

My Jig

A piece of 1 inch square mild steel, 125mm long is drilled 14mm longitudinally through its centre, has a 16 degree included angle recessed taper in one end, turned accurately to fit the collets, and a 25mm diameter 1.5 pitch metric thread cut over the taper for the collet nut (Fig. 1). ER collets and collet nuts are readily available from the usual hobby suppliers. I also find it convenient to stamp a number on all sides of the square holder, in order to identify which facet is being ground. The components are shown in photo 1. The flexible collet then holds the drill, with cutting edges more or less parallel with two of the

vertical sides of the 1 inch square, and the drill tip is applied, in my case, to the face of the grinding wheel on a Worden grinder. The table is set down to 121 deg. to the face of the wheel to provide the 118 degree tip angle (photo 2) and the feed slide is set over to give the 25 degree secondary clearance (photo 3). The table, complete with jig and drill is then passed across the face of the wheel, with the tip of the drill just touching the wheel (photo 4). After turning the jig over, through 180 degrees, the other side of the drill is ground at the same setting. Feed is then applied via the feed screw and further passes are made, turning the jig over after each pass until the facet just reaches the cutting edge of the drill. The slide is then set over to give the 10 degree cutting facet and a very careful lick taken off each lip until all four facets meet at a point in the centre of the drill (photo 5). If, on inspection, they are seen not to do so it is simplicity itself to take a further lick off whichever facet is wrong, though if the set-up is accurate there should be no wrong facet!

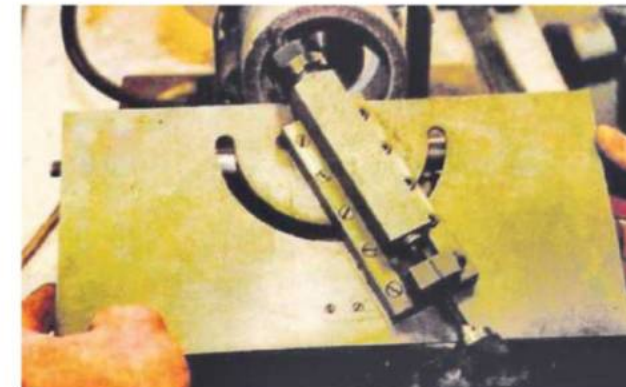
Any grinding rest on which angles can be accurately set and a fine feed



2. Setting the tip angle by tilting the table.



3. The angle of the slide creates the clearance.



4. Traversing the table to sharpen the drill.



5. A sharpened drill in the ER20 spring collet.

incorporated should enable drills to be ground by this method, on any grindstone.

Any square holder which will accurately hold a drill centrally could be used instead of the spring collet holder, but all metric sizes from, say, 3 to 13mm would require 100 different holders!

The maximum length of drill that can be ground with this jig on the Worden is about 7in., but this can be increased by using a longer feed slide. I lengthened my Worden feed slide by 1 inch, and this enabled me to sharpen an 8 inch long 1/2 inch drill with a No. 1 Morse taper shank.

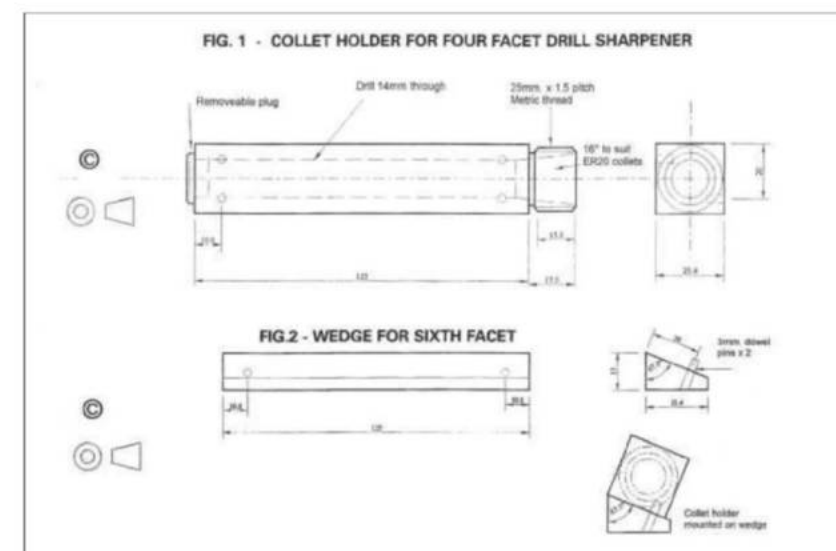
Six Facets

Derek Brown's further articles on the subject (M.E. Vol. 177 Nos. 4023 and 4025) progress to six facet drills. These present no problem with this jig, but you will need an addition to cope with the sixth facet, i.e. a wedge of 22 1/2 degrees, the same length and width as the collet holder (Fig. 2). It is equipped with two dowel pins which locate in two holes in the holder and it fits in the slide, thus rotating the holder 22 1/2 degrees. The feed slide is set over to 35 degrees and the sixth facet ground, turning the

holder over on the wedge after each pass, until all six facets are seen to meet at the point on the tip of the drill. Derek Brown's article gives the back-off angle for the sixth facet as 45 deg. but as I am not an engineer, I think that 35 deg. looks better and, as it is only clearance, enough is as good as a feast.

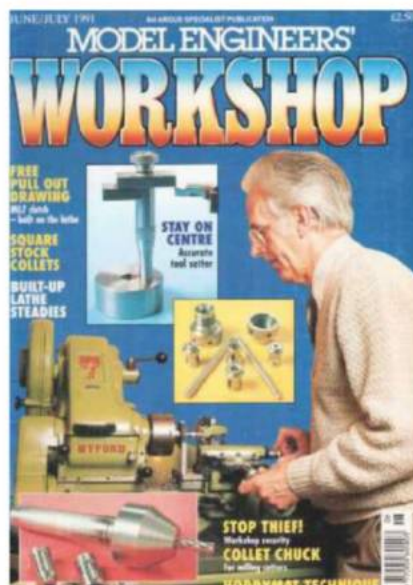
Since the wedge raises the holder in relation to the feed screw, you may need to insert a small block between feed screw and holder to achieve proper feed. If you prefer, all these facets can be ground with the drill lips in the horizontal instead of the vertical plane. In that case, use the slide to set the drill tip angle and the table adjustment for the facets. Your preference will depend on whether the feed slide or the table adjustment is easiest to set.

The greatest benefit of this device, apart from producing sharp drills, is that the operation can be inspected as it progresses. The whole jig can be lifted away from the grinding wheel and the tip of the drill examined before replacing the jig to grind further, as required, from exactly the previous position. ☛



Events

February 13 – The final Peanuts comic strip is published
March 30 – Americas Cup won by Team New Zealand



Issue 5, Harold's first appearance on the cover of MEW



Issue 7, the first issue edited by Harold Hall.

25 Years of Model Engineers' Workshop

Harold Hall was one of the earliest contributors to Model Engineer's Workshop, and the second editor. Over the years his tool designs, always functional and clean in appearance and effective in use, have proven enduringly popular. Here he looks back over the magazine's first quarter-century and observes that the big changes haven't just been in our workshops.

When Neil, the current editor of Model Engineers' Workshop, suggested to me that I write an article describing the development of the magazine over the 25 years of its existence, he made no comment as to what he was looking for, obviously leaving it to me to come up with something interesting. As I see it, the changes that have been made, and there are many, divide into two categories, those initiated internally by the publishers, editors and the readers, and those in the wider world which encroach on the magazine's content, 3D printing for example.

It was the publishers, encouraged by Stan Bray whose brain child it was, who chose to publish it as a special four times a year. It was so popular that the print run was increased for the second edition and then again for the third. With it being the intention that the magazine would be published four times a year, the first three copies were dated as Summer, Autumn and Winter copies. However, as the demand was well

beyond expectations it was decided to publish six issues a year with the fourth copy then dated as April/May 1991. During this time I was totally unaware of its existence as I did not take the Model Engineer Magazine, where no doubt it was being advertised.

This was all to change when, due to a car accident (not my fault!) and being off work for seven months, I chose to write an article on a milling cutter chuck I had made a year or so earlier, and send it for consideration to the Model Engineer. The reply came back that they would send it to the editor of MEW, this being a new magazine and in need of articles.

Stan liked the article and asked if there could be more. Still being off work I was able to provide five for issue five and two for issue six, all being for items I had made, or processes I had used, quite recently. These being my only workshop activity of any significance since making a drilling machine in my teens.

By this time Stan had decided that six issues a year was too much for him and

he asked if I would like to take on the task, to which I agreed. This was despite me feeling that it was a big gamble on both mine and the publisher's part, as I was an electrical control systems engineer and the items that had appeared in those two early copies were the only things, apart from the drilling machine, that I had made. So by issue seven I found myself as editor. I provided nine of the articles in that issue due to the very limited pool of authors in those early days.

The Editors

As indicated above, as well as coming up with the idea for MEW, Stan Bray was editor for the first six issues. Whilst the magazine was reasonably well thought of during my time as editor I did not take to the task as, being a poor reader, I found editing articles from others quite demanding and decided to call it a day, with issue 28 being my last.

I was followed by Geoff Sheppard who had been involved with model engineering for many years and had a

large involvement with the Bristol Society of Model and Experimental Engineers and also with their annual Model Engineering Exhibition as many will remember. He then eventually passed the task onto David Fenner at issue 79. David had also been involved in home workshop activities but this had been at a local level with the local model engineering society, and he was also very active in restoring classic cars. He continued in the position eventually handing over to another David, David Clark at issue 124.

David Clark's background was in production engineering, and his main interest was in 16mm model railways for which he was editor of their magazine. David eventually passing over the task of editor to our present editor Neil Wyatt, an occasional contributor to both ME and MEW, at issue 215.

Geoff and the two David's, in addition to their interest in the home workshop, were very much into engineering at an advanced level in their day to day occupations, unlike Stan, Neil and myself who came from non-mechanical engineering backgrounds.

The publishing process

This, I feel, is where the major changes in the magazine have taken place and mostly without the readers knowledge.

When I took on the task of editor I was fortunate to live just a few miles from the offices where the process of publishing the magazine took place. I had to choose the articles for an issue from the available (very shallow) pool and prepare them for the publishers to convert into a magazine. This included checking the text, ensuring the photos were of adequate quality and having the drawings redrawn for publication.

Text frequently came hand written but typed on mechanical typewriters was preferred, ideally double spaced so as to provide room for making hand written changes to the text, both by myself and the in-house sub editor. Drawings similarly came in various guises from free hand sketches to reasonable quality pencil drawings. Just one, Bob Loader, produced pen on film drawings which were almost always used as supplied. For all of the others I had a local draughtsman who would prepare them for publication ensuring that they all were done to a consistent professional standard. CAD was

nowhere to be seen.

The authors text went to the offices (with my mark ups) for the sub editor to give them a once over and then retyped, with the modifications, by the office secretary. She used the publisher's one concession to computers having a word processor.

From here the page layouts were produced using cut and paste, yes I do mean cut and paste, with the individual pieces being placed on a thin cardboard backing sheet. From this point they went away to be finally processed for printing.

The next move towards modern methods, after the word processor, was to obtain an OCR (Optical Character Recognition) system, it was very expensive I remember. As most articles came typewritten they could be scanned so that the typist did not have to fully type it out. However, it was not perfect, not even as good as the free programs which can now be obtained. A typical error was replacing the letter B with 8, or visa-versa. The result of this was that the errors often did not get spotted and appeared in the magazine, much to the irritation of certain elements of the readership.

Another problem in those early issues,

very popular feature in the magazine and I was allowed the use of the in-house photographer to come with me to take the photographs I felt may be useful. However, this needed me to visit the workshop twice, once to see if it was suitable and then with the photographer to take the photographs. Wishing to save the time and expense of two visits I purchased a second SLR film camera so that I could take the pictures (slides and prints) myself, having seen how the professional went about it.

If you were to look at the front covers for the magazines whilst I was editor you would find they always included a picture of the owner in his workshop requiring me to make a visit for each one. As a result, workshop visits were confined to the south east corner of the UK!

By the time I vacated the editor's chair computerised production of the page layouts had just started and PCs had started to make an appearance in the home, but not widely. This would have helped Geoff who took over from me as, unlike me, he lived a considerable distance from the office, though I do remember that he travelled to the office quite often so working entirely from

As I see it, the changes that have been made, and there are many, divide into two categories, those initiated internally by the publishers, editors and the readers, and those in the wider world which encroach on the magazine's content, 3D printing for example.

compared to today's facilities, was that communication was limited to old fashioned mail and the telephone, this slowed things up considerably even with authors living in the UK. With articles coming from other countries, typically New Zealand, the delay would be weeks rather than days.

Yet another problem was that the publisher would only accept colour slides for the front cover, something not available from the authors of the day, myself included. However, they were a little more willing to accept prints for the small inset pictures but I also produced slides for many of them.

At the time, workshop visits were a

home was still not fully up to speed.

Email was still in its very early days but communicating using email would have been very beneficial for Geoff being so far from the office. But for the authors it would still be largely a case of surface mail. Of course that changed over a period of time, but even today there are a few people who do not use computers, so perhaps even now surface mail is necessary for conveying articles. Digital cameras were still a long way off so prints had to go back and forth.

By the time David (who lived a considerable distance from the office) took over, use of the internet was a must, with full page proofs being sent

Where does this leave us then? Well, in my opinion, a much more secure hobby than there was at the start of the magazine, with the number of workshop owners having grown significantly over the 25 years.

back and forth. I expect broadband had arrived by then enabling them to be downloaded reasonably quickly.

Magazine appearance and content

Outwardly, the magazine has changed little with only subtle changes. One early one which I pressured them to do, was including the issue number in the triangle at the top left hand corner to make for easier filing. Also, somewhere along the line, the paper quality for the front cover changed making them more slippery which some did not like. Much more recently there were some changes to the contents page.

Internally, the only major change was the increase in the colour pages. In the very early issue only about 25% of pages included colour content but by issue 76 we had a full colour magazine. Of course there will always be mono pages such as when a page is fully text, or only has drawings, but even these would be printed on a colour printing unit enabling colour to be placed anywhere. This was very unlike the early issues, where only specific pages would be available for colour content due to the relation of the colour and mono print units within the machine. The result was that it was quite tricky choosing where the articles selected for colour went.

One subtle change has been the move from hand drawn drawings to CAD. I had, as a result of taking on the task of editor, obtained a computer for text and equipped it with a CAD program. With this I did the drawings for my own articles and redrew a few of the simpler ones provided by the authors, at the same time often changing the dimensions from imperial to metric. Doing this was a means of encouraging others to take up the metric system, something I was very keen about. I did not just convert the dimension but changed the sizes of the parts so

dimensions were nice round numbers.

To encourage the use of CAD I produced an article on using it, for which I was told in no uncertain terms by a number of readers that those wanting this information should go purchase a computer magazine. Being new to computing I had been purchasing magazines on the subject for a couple of years and the only two articles on CAD would have been totally inadequate for the home workshop owner as they did not say how to use it, being more a review of the available functions and how easy they were to use.

As for the articles which appear in the magazine then if one made a list of subjects included in the first three issues then you could say nothing's changed. Looking deeper, one would see that the subjects are now covered in greater detail and to a much greater degree of complexity. Typical of the range were making workshop equipment and a review of a commercial wood working lathe, followed in the next issue by a design for making one. Soon electronics got a look in with the circuits for a motor speed control. Not many issues later computer programming appeared.

Out in the Workshop

What was happening then in the home workshops during this period? Considering the span of workshop activities one could again say not very much. At one end of the spectrum there are those that are using modern methods, CNC typically, and at the other, still those turning out fantastic results using just a lathe, much as there would have been in the early issues and for many years prior to that.

In my opinion though, gained from threads in the numerous forums I visit, and correspondence to me as a result of my website, is that both ends have expanded. There is obviously a greater interest in the use of CNC with many

more workshop owners equipping their workshop with the facility. However, whilst this expansion has occurred the increase in numbers with limited workshop facilities, say only a mini lathe and milling machine, has grown by a very much larger proportion. This almost certainly due to the economics of setting up such a workshop making the hobby viable for the first time for many. Of course, for just a few it would have been because they had no room to install anything larger.

Where does this leave us then? Well, in my opinion, a much more secure hobby than there was at the start of the magazine, with the number of workshop owners having grown significantly over the 25 years. In terms of numbers I am including those who are not readers of MEW.

What then of the future?

Well, if I may take this article beyond the boundaries of that was asked for by our editor, what will the workshop of future be like?

There are a few who comment on the forums that CNC will be at the centre of future workshops, on one occasion this was backed up by it being said that future young workshop owners would leave school computer literate. This I do not see, yes, they know how to cut and paste, save and copy files, etc. but this does not make them able to carry out computer programming. From time to time, I had university graduates come and work in my department but they were not able to apply logic to a control system. Where does this leave CNC users then? Well I consider that they will become a much larger proportion of the overall workshop owners, but with the purely manual workshops still being in the majority and by a quite large amount. Unfortunately, being 81, I am unlikely to be around to see if I am correct with this prediction.

Other modern devices making an appearance are the 3D printers. These are very intriguing devices, perhaps their uses are limited so I feel will only appeal to a few, but I would love to have one to play with. Typical uses would be for buildings and the like for small scale (HO, OO, etc.) model railways. Also, making patterns for metal castings, providing that is that the user knows how to design them. ☺

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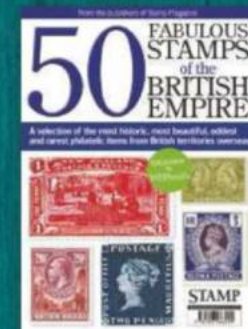
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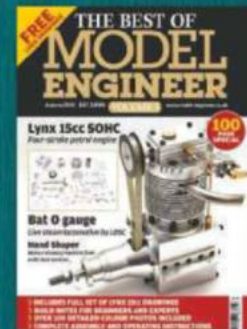
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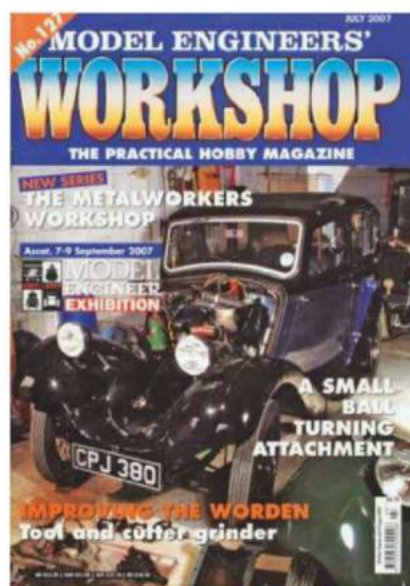
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A Ball Turning Attachment for the Smaller Sizes



David Fenner – Issue 127 July 2007

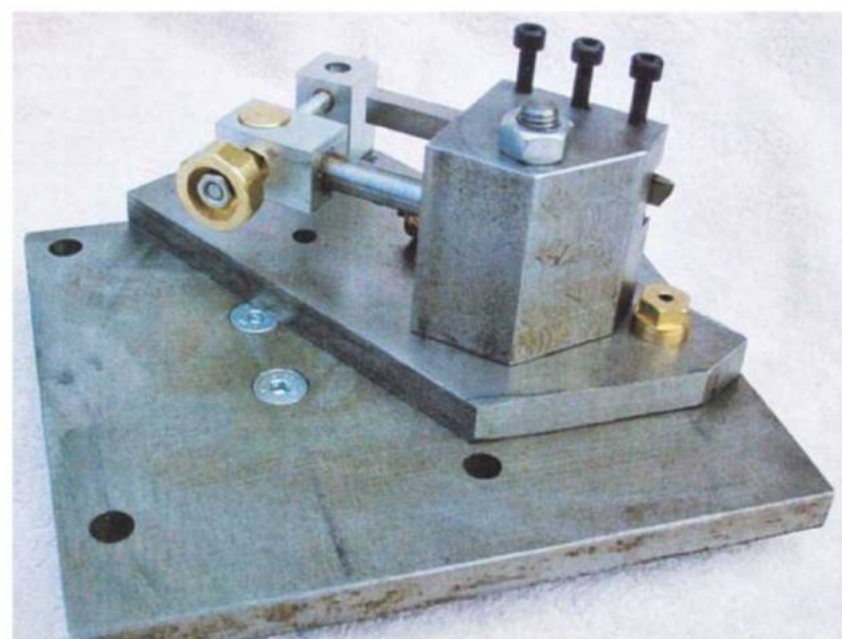
Former MEW Editor Dave Fenner ran a jobbing machine shop for many years, and as a result is happy to make jigs, fixtures and tools to get a job done with more regard to function than fine finish. Though he has described himself as a 'blacksmith', this very practical and well-proportioned ball turning attachment for smaller balls shows that he's hiding his light under a bushel.



Many overhead valve engines have some form of spherical location for the cam follower - pushrod - rocker connection. In the case of the model Bentley BR2 engine, the pushrods incorporate adjusters with spherical ends, the ball diameter being 1/8 of an inch, and the adjuster thread 6BA. Having nine cylinders, the engine

would therefore require 18 pushrods, and 36 adjusters. Consequently, I felt that the subject deserved a little fiddling around or should we call it research, before diving in and creating swarf.

In general, one may separate ball-turning methods into four main categories. The first and probably most popular relies on sweeping a cutting tool



Finished level complete with storage case. The completed accessory.



A ball turning tool based on that marketed by Hemingway kits.



A form tool made from gauge plate.



A sharpened tool from silver steel.

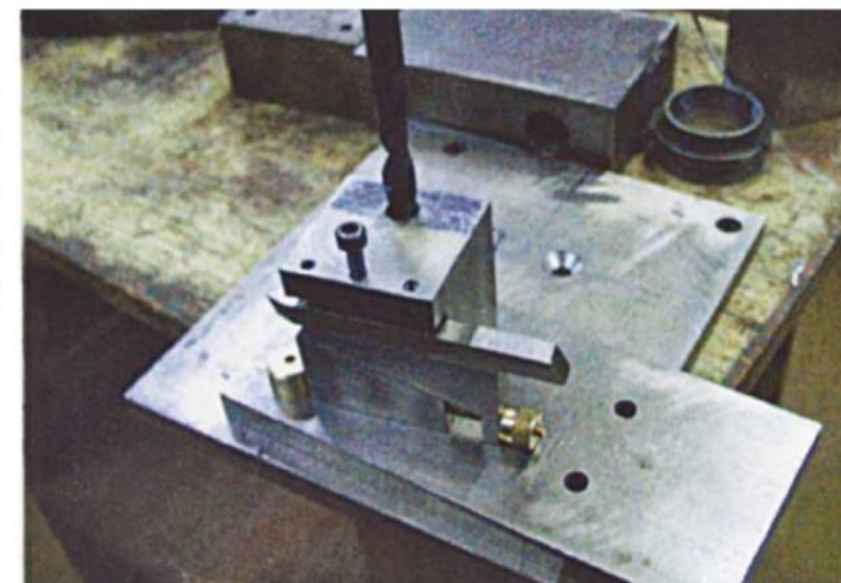
around an arc whose centre coincides with the work centre to generate the sphere. Within this category, some versions employ a sweeping action in which the turning tool moves around a horizontal axis, while others use a vertical pivot as in photo 1.

A second method is to use a form tool. Here the length of cutting edge actually in contact with the work becomes relatively large, with consequent high forces on the tool and the work. With careful set up, it would probably be possible to use two form tools, say one for the front and one for the rear, thus reducing the cutting forces to more manageable levels.

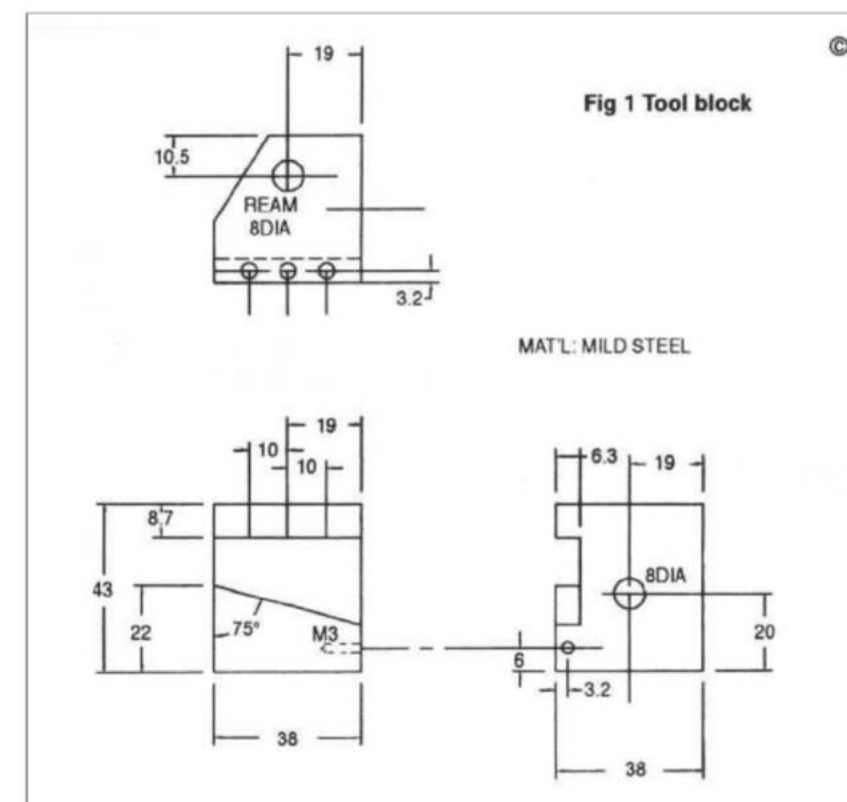
The third method uses a tubular tool with a sharpened edge, however this is likely to be of more use for finishing rather than roughing. Descriptions of these techniques will be found in several of the well-known books, Refs 1, 2 and 3.

The fourth method is more appropriate to the milling machine, and was described by Charles Woodward in Ref 4. Here the cutting tool is mounted, typically in a boring head so that its cutting radius may be varied. The work is set at a suitable angle to the cutter, and then rotated slowly in the dividing head or rotary table to generate the spherical shape.

Over the years, other authors have presented suggested designs for ball turning tools, most working with a vertical axis. Some have controlled the cutting radius by sliding the tool bit, either within or together with its holder,



'Scientifically' determining the pivot position (by eye) and marking with a drill.

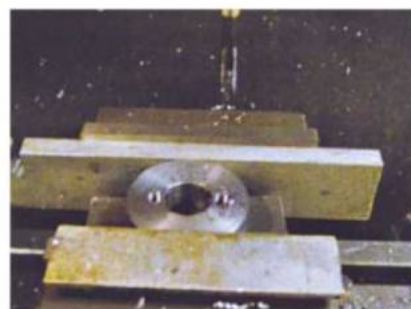




Initial marking out by felt tip pen although the c/s hole spacing was accurately controlled.



The easy way to scribe the centre height.



Drilling and tapping the boltholes. Note the aluminium packing to avoid marking work.



The spigot located on an expanding mandrel.

while others have designed the tool holder to rotate on its base and thus vary the radius cut. Refs 5 to 10 list a number of articles on this topic, which have appeared in earlier issues of MEW.

Some time ago, I did construct a ball turning tool after seeing one built by a friend from the excellent Hemingway kit. The intended duty at the time was to turn aluminium automotive gear lever knobs at about 1.5 to 2 inches in diameter on the Colchester Chipmaster or Herbert 2D. This design operates by rotating the cutting tool about a horizontal axis. An adjustment screw operating via a dovetail slide provides for varying the cutting radius, and there is a convenient advantage in that the device may be moved to cut on the work axis by means of the cross slide.

For turning small parts though, I felt that this device, illustrated in photo 2, was somewhat on the large side, and that its general geometry meant that cutting would have to take place some distance from the chuck.

Initial trials

Before spending time and effort constructing a new tool I first tried two of the methods that required rather less in tool making effort, namely the form tool and the sharpened tube. To create the first, the recommended procedure is to produce a tapered hole, by drilling and reaming, to give clearance below the cutting edge. As I did not have a taper reamer to give the necessary 1/8 inch diameter, I resorted to drilling a hole of that size, through a piece of gauge plate, at a slight angle, probably about 5deg. The plate was then cut and filed as shown in photo 3, leaving the required form. It was then hardened by heating red-hot and quenching in water. Tempering was omitted. On an initial trial, this tool worked well, but when work on a real component was attempted, the forces caused fracture at the screw thread.

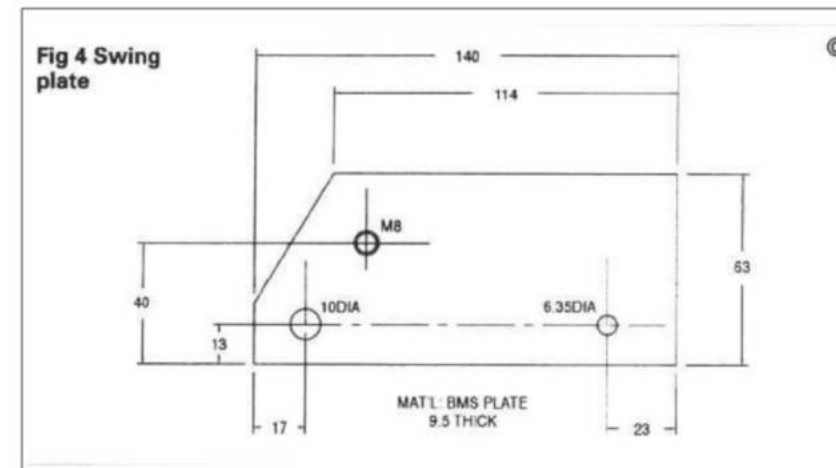
The sharp tube tool was made by drilling through a short length of 1/4 inch diameter silver steel, which was then hardened as above. It was then located



The finished spigot showing the relieved inner area of the abutment face.



The vice has been set over at 15 degrees to cut the lower section of the slot.



Tapping using a pump centre for alignment.

on a holder for easy freehand grinding as shown in photo 4. While this could not be used for working from scratch, it could be used quite effectively to tidy up a rough shaped part machined with a form tool.

After the breakage noted earlier, I decided to bite the bullet and build a new ball turning device, with these small size components in mind.

Design

As with almost all of my projects, the process starts with a trawl around the scrap box cum material store. One likely looking candidate emerged as a strong possibility for a base plate, which did in fact have a slightly related history. And here I digress! Some years ago a customer, for whom I produced small stainless parts at about a pound or so a piece, sent me in error, an order intended for another supplier, for half a dozen Perspex concave lenses, priced at some five hundred pounds each - three thousand pounds for six bits of plastic! These would be destined for a submersible camera system. The concave form was spherical and about three-inch radius. After forwarding the order to its intended recipient, I first wondered if I was in the wrong job, then experimented to see if these lenses would be hard to make, in the process,

concocting a concave spherical turning device. The upshot was that cutting the form was not difficult, however achieving the required degree of polish whilst still retaining the accuracy was entirely another matter. I eventually admitted defeat and stayed with the stainless parts. Now some fifteen years later the experimental gadget has been dismantled and partly recycled.

The general thinking follows established practice in locating the cutting tool in a block, which can be rotated to vary the spherical diameter. An adjusting screw controls the size variation. For added convenience, having worked for some years with quick-change tool posts, which dispense with the need for shim packing for height adjustment, I felt that this was a feature worth incorporating. I cannot claim any originality for the method chosen, having seen something similar on a large industrial tool post some years ago. However, I have not seen the principle adapted to a ball turning application, though no doubt, someone will prove me wrong. The photos show a 1/4 inch square high-speed steel cutting tool supported on a sliding tapered block. The position of the block, on a fifteen-degree ramp, is controlled by an adjusting screw, which allows accurate setting of tool height.

Whereas the original gadget had been set up on the Chipmaster, (legacy mounting holes are visible), it was intended that the new device should be fitted to the Myford Super 7. While it could have been attached by say, four bolts, I figured that if the existing Myford topslide hold down system could be used then this would add flexibility in positioning. Note that for the ML7, a conventional bolting arrangement would be needed, probably using countersunk screws.

The choice of most of the components was influenced (even dictated) by what was found lying in the scrap box, notably the M3 and M5 screwed rod and the 1.5in. square bar used for the tool block. Although much of the material was to imperial standards, the drawings have been presented in generally metric form.

As may be deduced from careful examination of photos 5 and 6, which show evidence of a black felt tipped pen, some parts of the marking out procedure were not accomplished with great accuracy. As the parts started to come together, they were placed in what looked like suitable locations, and the positions marked. This is also true of the Heath Robinson method, photo 7, used to establish the required tool centre height by scribing from a centre drill in the tailstock. While the drawings reflect

Fig 5 Base spigot

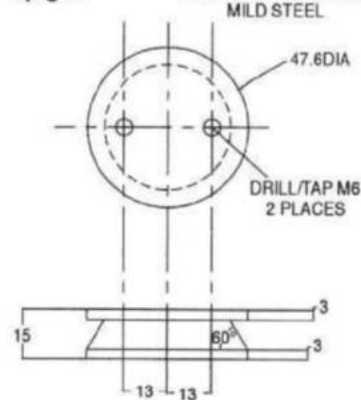
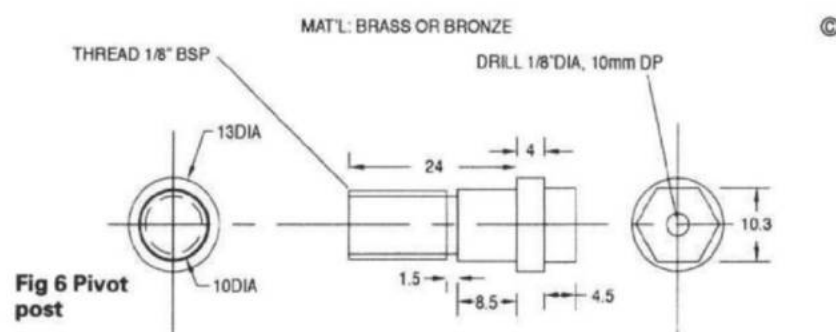


Fig 6 Pivot post



accurate measurement of what was eventually made it will be obvious that a fair amount of latitude may be taken on many parts.

Construction

The conical Spigot

Measuring up the Myford Super 7 topslide gave a spigot diameter a thou or two shy of 1.875in. So a piece of two-inch diameter bar was faced on one side then bored to closely fit a convenient expanding mandrel. This was then mounted in the collet chuck and the work clamped in place with the unfaced end outermost. It was then turned to diameter, faced to thickness and the conical profile cut, **photo 8**. The abutment face was part relieved a few thou to assure stable contact over the outer ring. This was then transferred to the mill to drill and tap the positions for the M6 screws, (**Photo 9**). The finished item is shown in **photo 10**.

The base Plate

As noted above, this was a conveniently sized piece of 3/8 inch thick bright mild steel plate. The work on it requires no special mention, except to ensure that the depth of countersinking is sufficient to take the screw heads below flush. If they are proud, then expect interference with the swing plate. Also ensure that the pivot thread is accurately vertical.

Swing Plate

Again a convenient length of 3/8 inch thick bright mild steel plate, this time left over from the set up for reboring motorcycle barrels (with thanks to Alex Fairbairn). The work is all pretty straightforward, but it is worth making sure that the thread for the block pivot rod is truly vertical. Here I did all the drilling and started the tapping in the mill. If your mill does not have a suitable

low tapping speed then several choices are available. You can fit the tap to the chuck, lower the quill and rotate by hand, or run the machine, hit stop, then lower the quill and let the residual inertia tap the first few threads. Alternatively, use a tap wrench and a spring-pump centre.

Tool Block

A length of 1.5 inch square BMS bar was first cut a shade over length, then faced in the four jaw. The slot for the tool bit and taper slide was cut in two stages. During stage one with the vice set in line with the table, the upper edge of the slot was formed down to a depth of a quarter of an inch. The vice was then set over 15 degrees to cut the lower section, as in **photo 11**. Further work included drilling and tapping the three M4 holes for tool clamping, and the M3 hole for the height adjuster rod. **Photo 12** shows a pump centre in use to ensure vertical tapping. The 8mm dia. hole for the block pivot was drilled and reamed to ensure a neat



Cutting the slot in the adjuster slide with a slitting saw.



Knurling the adjuster knob.

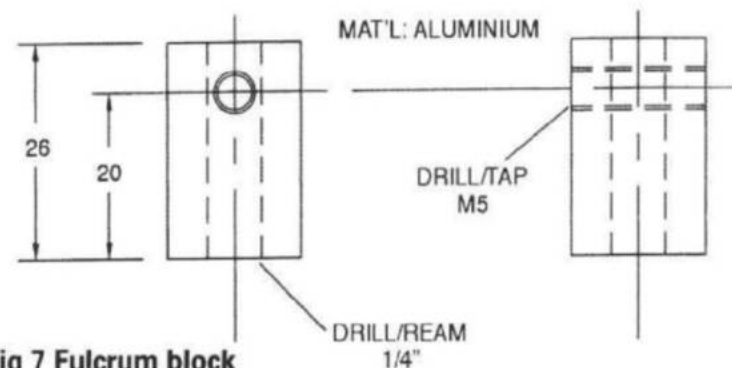


Fig 7 Fulcrum block

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The kit comprises the following: Cast iron flywheel (152mm dia.) Grey iron cylinder halves (H.P.22mm L.P.32mm x 32mm stroke). Engine base, Engine bed, Crank bracket casting Precision cast crank halves, slide bar brackets and bell crank. Stainless steel H.P. & L.P. cylinder end cap blanks. Steel governor balls, Stainless steel pump balls, Steel drive band, Copper tube, Machined hard wood base and comprehensive drawing pack, which suggests other materials and fixing that will be required.

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fit. Slicing off one corner (viewed in plan) was a modification in the light of experience, to give better access close to the chuck.

Adjuster Slide

No great difficulties here, just a piece of quarter thick BMS, cut-milled to shape, having a 15 degree angle to match the block. **Photograph 13** shows the screw slot being cut by slitting saw, the work being clamped to a suitable chunk of steel held in the vice. This is probably one of those situations where it might have been preferable to leave the work attached to the main bar for easier clamping.

Fulcrum Block and Pivot Rod End

These need no special comment, and may well be made from alternative materials. It was convenient to use these pieces of aluminium, as they came from the scrap box, ready cut to size, being left over from a batch of earth blocks made many years ago.

Knobs

Turned parts are needed for the tool adjuster knob, the radius knob, and its associated stop. I chose to knurl the outside diameter of the small knob **photo 14**, but made the larger knob from hexagon material, merely turning off the corners. Here the 12.5mm diameter recess is to accommodate an M5 locknut, the diameter quoted being sufficient to clear a socket spanner.

Pivot post

This carries out several functions, the main being to provide the pivotal location for the swing plate. Using the Math. BSP thread and a locknut allows fairly fine adjustment of the vertical clearance. Make sure that the 10mm diameter is a close fit in the swing plate. The post is also drilled to take a centring pin. Here I did not drill through, and with the benefit of hindsight, this will be a sensible mod, to avoid a build-up of swarf in the blind hole. If necessary, the same hole might be used to accept a height gauge for off-machine tool setting. As may be seen in **photo 15**, I chose to mill a hex on the post for easy adjustment with the locknut. Others might prefer a couple of cross drillings for a tommy bar.

Other parts

No drawings have been given for the block pivot, 8mm bar 60mm long, threaded M8 both ends or the two lengths of screwed rod, one M5 - 80mm, the other M3 - 30mm.



Set up using rotary table to mill hex on pivot post.

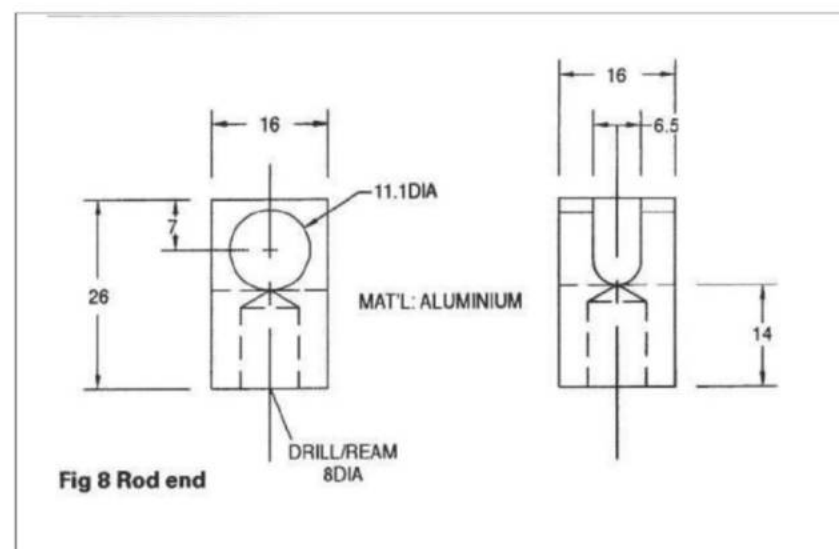


Fig 8 Rod end

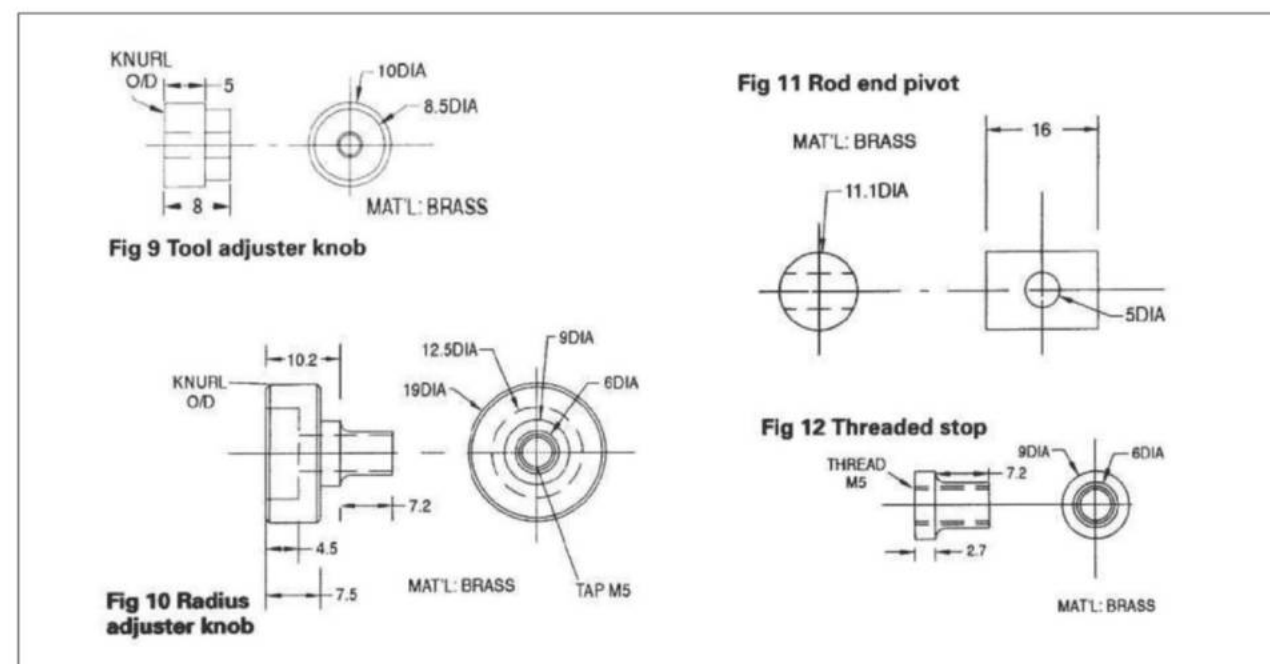


Fig 9 Tool adjuster knob

Fig 10 Radius adjuster knob

Fig 11 Rod end pivot

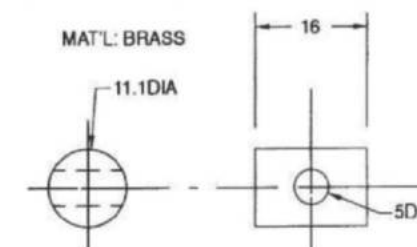
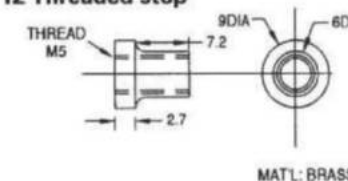


Fig 12 Threaded stop



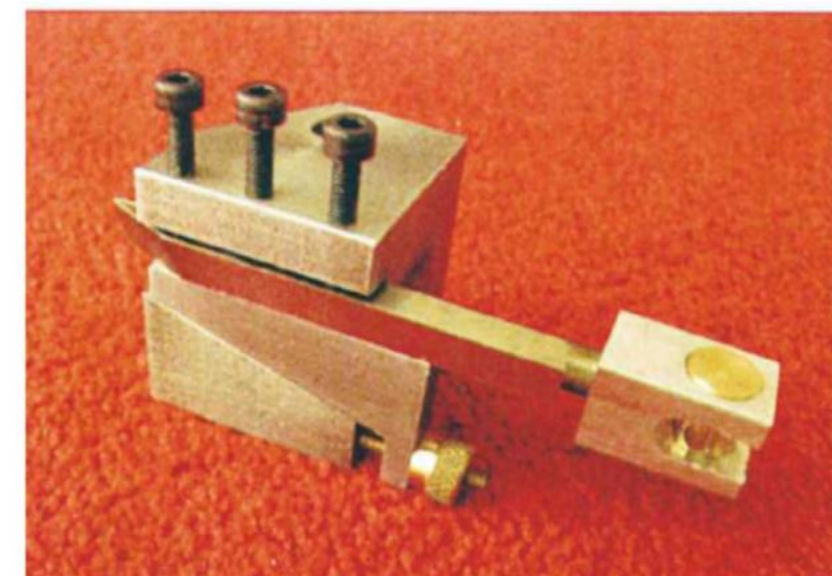
Assembly

I chose to Loctite in the threaded block pivot bar, noting that if the bar protrudes on the underside of the swing plate then this must be filed off to give a flush surface. In a similar manner the connection of 8mm rod and aluminium rod end to the tool block was also a Loctite job. For reference, after assembly, as in **photo 16** the distance between rod end and tool block was measured as 32mm.

Operation

Prior to use, it may be useful to examine the position of the tool tip with reference to the size of sphere to be produced. As the size goes down, it becomes more necessary to establish that the tool overhang and the lateral position of the point will be satisfactory. For cutting the small 0.125 inch balls, I found it useful to be able to cut on two edges of the tool, on both the clockwise and anticlockwise swing. Adjustment of the tool height is clearly straightforward.

The assembly is then positioned on the lathe in such a way that an eighth inch dia. setting pin fitted to the pivot post lies on the machine axis and at the required spherical centre. This would typically then involve a saddle stop for longitudinal position and a noted dial reading for cross slide travel, so that clearance may be obtained for placing/removing work in or from the chuck. The tool is wound out on the radius adjuster, to just clear the work, then progressive cuts are taken, incrementing the adjuster knob at each cut. ■



Tool block assembly.

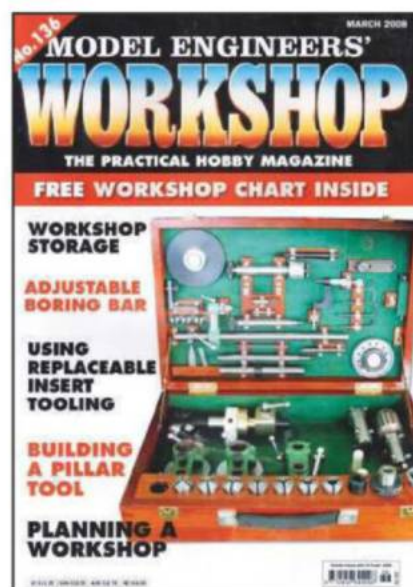
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- Ref 4 MEW Issue 111p 48 Machining Ball Handles by Generating on the Mill - Charles Woodward
- Ref 5 MEW Issue 6 p 44 A Ball turning Tool
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- Ref 7 MEW Issue 26 p 52 A Ball Turning Tool - Phil Thomas
- Ref 8 MEW Issue 28 p 68 Machining Spherical Surfaces - David Turner
- Ref 9 MEW Issue 80 p 55 Basic Tools for Radius Turning - J. Lait
- Ref 10 MEW Issue 99 p 18 A Quicker Approach to Ball Handle Turning - Ray Newton

Events

- July 13 - The world's third largest optical telescope, the Gran Telescopio Canarias starts observations.
- July 21 - RAF helicopter crews rescue hundreds from flooding across the UK.



A Between Centres Boring Bar with Fine Adjustment

Paul Murton – Issue 136 March 2008



The completed Boring Bar

Many different designs for between centres boring bars have been published over the years, with various arrangements for adjusting the diameter of the cut. Paul Murton's example is meant for boring larger holes, of 40mm and up, and has the benefit of one of the neatest adjustment systems. With care it should be possible to make a 2/3 sized version using 1/8 inch square HSS toolbits and proportionately smaller threads.

This project came about from a need to line bore some bearing housings for an alternative energy project I am planning using the stepper motor from a New Zealand designed Fisher & Paykel smart drive washing machine. New Zealand fully metricated in the 1960's so all the dimensions are in mm except where related to the 1/4 inch high speed steel tool bit used. The boring bar is designed to bore holes from about 40mm up to 80mm diameter, photo 1. For smaller holes the dimensions can be scaled down and a smaller tool bit used. You can make the bar any length to suit your particular purposes. I made mine 400mm long with the position of the cutter off centre about 50mm towards the tailstock end. The basic design of the adjusting mechanism can also be used for a collet mounted boring head for the mill.



Boring the hole for the tool holder.



Drilling and tapping the offset hole.

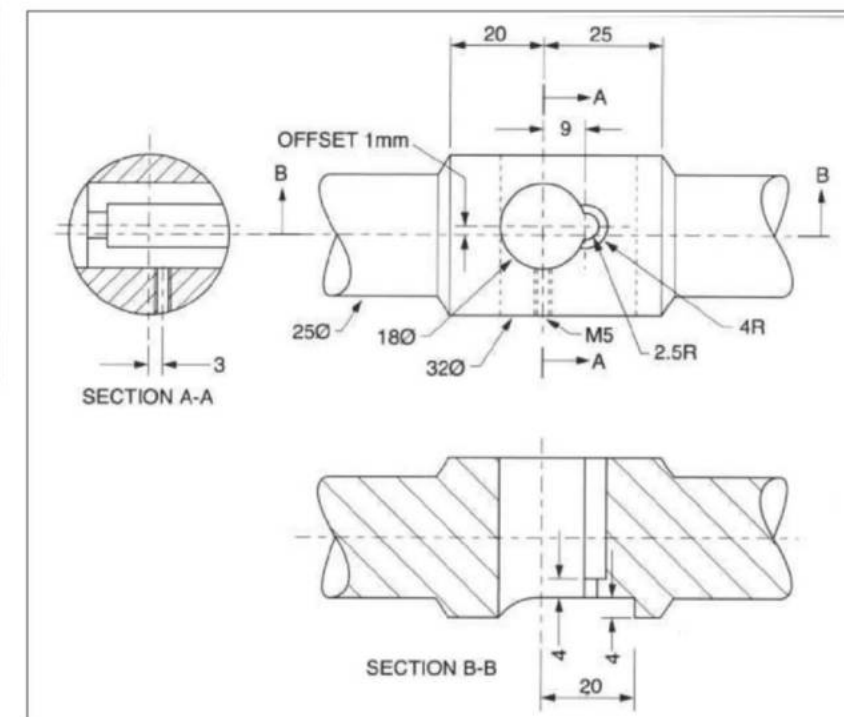


Milling the slot in the tool holder.

The bar

A 400mm long piece of 32mm dia. mild steel bar was faced and centre drilled on both ends. The bar was placed in the milling vice as shown with the area to be drilled for the cutter overhanging the vice by about 30mm. Centre the length of steel in the vice then offset the table 1mm away from you, see fig. 1.

Firstly mill a flat on the bar at the adjusting screw location to start the centre drill then drill 5mm right through the bar. Open this out with a 7.8mm drill to a depth of about 22mm then finish with an 8mm end mill to a depth of 24mm. Without removing the bar from the vice, traverse the table along 9mm to the tool holder location. Drill a 12mm hole then bore it out to 18mm. The two holes will overlap so a 12mm drill is about as big as you can go without the drill running off too much, photo 2.



Slacken the vice and rotate the bar through 180 degrees. Move the table 2mm towards you to allow for the offset. Place a piece of 5mm silver steel or equivalent in the milling chuck and centre the 5mm diameter hole in the bar with it. Tighten the vice and the bar should be accurately located under the centre of the arbor. Mill a flat on the bar as shown in the drawing. Transfer the bar to the lathe and reduce the ends to 25mm diameter.

The tool holder

There is some accurate machining required here so take care. To make the threaded half-hole, I used a piece of 32mm diameter x 100mm long piece of tool steel. Grip this work piece in the three-jaw chuck and skim the surface to true it up. Transfer the chuck to the rotary table on the mill and centre it under the arbor. Offset it by 9mm then drill and tap the 8mm x 1mm pitch thread to a depth of about 30mm, fig. 2.



Engraving the divisions on the dial.



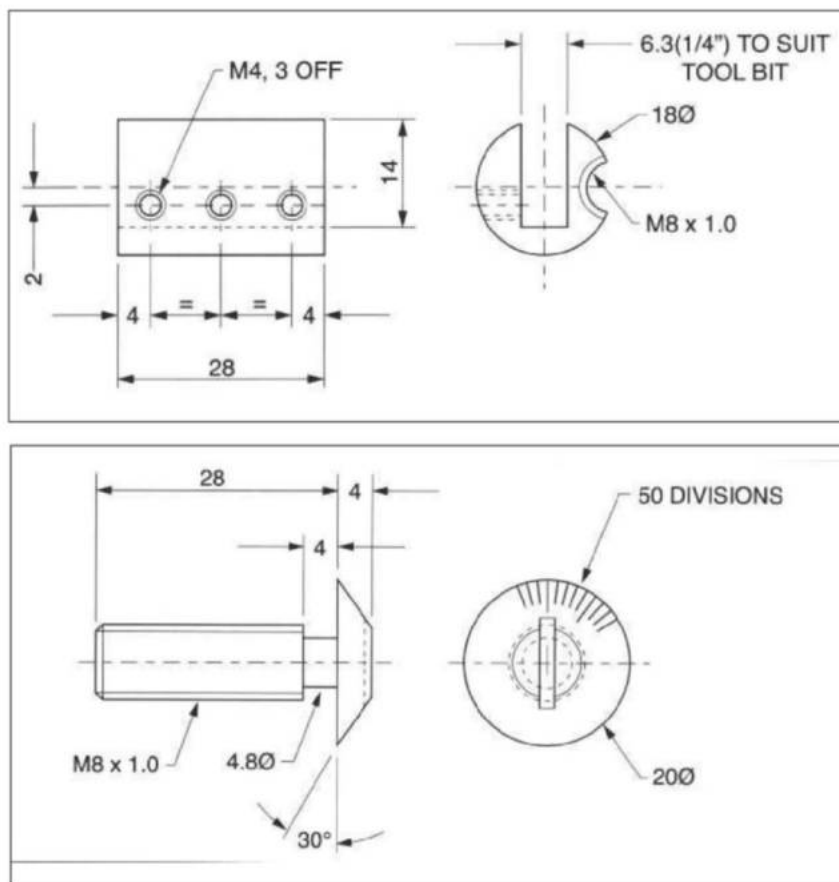
The three parts of the boring bar.

Ideally a left hand threaded tap should be used here so that you turn the dial clockwise to advance the cutter, photo 3. If you don't have a rotary table you could use a vee block in the vice on the mill. Transfer the work back to the lathe and turn the diameter down to 18mm to be a sliding fit in the boring bar. This will expose the half thread. Because the finished holder is difficult to hold in a vice without crushing, it is necessary to machine the slot for the tool bit while it is still attached to its parent bar. Make sure that the slot is at right angles to the threaded half-hole, photo 4. Transfer the job back to the lathe and part it off. Drill and tap the three 4mm holes for holding the tool bit. Harden and temper the holder if tool steel has been used.

The dial

This is a straightforward turning job. Clamp a piece of 20mm mild steel bar in the three jaw chuck and machine the threaded end to the dimensions shown. Part off and reverse the job in the chuck using sheet copper to protect the thread. A collet chuck would be ideal here.

Face off and shape the 30 degree angle of the dial. I indexed and inscribed the dial while it was still set up using the rotary table locked into the headstock spindle, photo 5. Divide into 50 divisions making every fifth division 4mm long with the in between ones 2mm. This makes each small division amount to a movement of the tool bit of 0.02mm and every large division 0.1mm. The screw-driver slot was cut using a small slitting saw and the cut was made more towards one side to provide a zero reference point, fig. 3. Photograph 6 shows the three parts that make up the boring bar.



Using the boring bar

Set the tool bit into the holder so that it protrudes the minimum amount you are required to start the hole size you are boring.

Assemble the holder into the bar and set it back as far as possible. This leaves about 12mm of adjustment available. When making fine adjustments, take up the backlash before undoing the locking-screw and moving the cutter.

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March 27 - the oldest known voice recording, made by Édouard-Léon Scott de Martinville in 1860, is replayed.

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Clarke BOLTLESS QUICK ASSEMBLY STEEL SHELVING

- Simple fast assembly in minutes using only a hammer

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Clarke METAL LATHE

- 300mm between centres • LH/RH thread screw cutting • Electronic variable speed • Gear change set • Self centering 3 jaw chuck & guard • Power feed

£449.00 FROM ONLY
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Clarke COMPACT PRECISION LATHE CL250M

- Variable speed • 250mm between centres • Power feed, optional screw cutting

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Clarke MIG WELDERS

- Quality machines from Britain's leading supplier
- All models featured are turbo fan cooled (except PRO90) • See online for included accessories

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Clarke ARC/TIG INVERTERS

- Used for ARC & TIG welding, utilising the latest technology
- Low amp operation - ideal for auto bodywork & mild / stainless steel

£155.00 FROM ONLY
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Clarke 9 DRAWER WOODEN TOOL CHEST

- Felt-lined drawers
- LxWxH 610 x 280 x 440mm
- Keep precision tools safe and tidy

£109.00 FROM ONLY
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Clarke MILLING DRILLING MACHINE - CMD300

- Bench mountable, tilts 45° left & right from vertical
- Table travel 100x235mm
- Table Effective Size LxW: 92 x 400mm

£479.00 FROM ONLY
£574.00 EX. VAT

Clarke MICRO MILLING & DRILLING MACHINE

- Bench mountable
- MT2 Spindle Taper
- Face mill capacity 20mm, end mill 10mm • Table cross travel 90mm, longitudinal travel 180mm

£329.00 FROM ONLY
£394.00 EX. VAT

Clarke ANTI FATIGUE FOAM FLOORING

- 6 interlocking foam tiles protect flooring & provide comfort when standing or kneeling
- Ideal for use in garages, workshops etc. • Each tile is 610 x 610mm & includes detachable, yellow borders

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Clarke DRILL PRESSES

- Tables tilt 0-45° left & right
- Depth gauge
- Chuck guards
- B=Bench mounted F=Floor standing

£59.99 FROM ONLY
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Clarke BENCH GRINDERS & FLOOR STANDS

- Stands come complete with bolt mountings and feet anchor holes

£41.99 FROM ONLY
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Clarke ENGINE CRANES

- Fully tested to proof load

£144.99 FROM ONLY
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Clarke POLISHING KITS

- Kit Inc: Tapered spindle, Coloured mop for initial cleaning, pure cotton mop for high polish finish & polishing compound

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Clarke AIR TOOLS

- HUGE CHOICE IN-STORE/ONLINE

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- Bend, Roll & Shear metal up to 1mm thick • Min. Rolling Diameter 38mm • Bending angle 0-90°

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Clarke MEASURING EQUIPMENT

- High quality tungsten steel
- Supplied in metal storage case, except 16pc

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- High quality tungsten steel
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- Variable output power to match HP of motor to be run

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Clarke 6 SPEED METAL LATHE WITH 12 SPEED MILL DRILL - CL500M

- 430mm between centres
- Compound slide with 4 way tool post
- Power fed screw cutting facility
- Forward/reverse lathe operation
- Clutch for independent mill/drill operation

ALSO AVAILABLE: CL430 - As above but without the Mill/Drill head

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- Sturdy lower shelf
- Durable powder coated finish

Shown fitted with optional 3 drawer unit ONLY

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Clarke POLISHING KITS

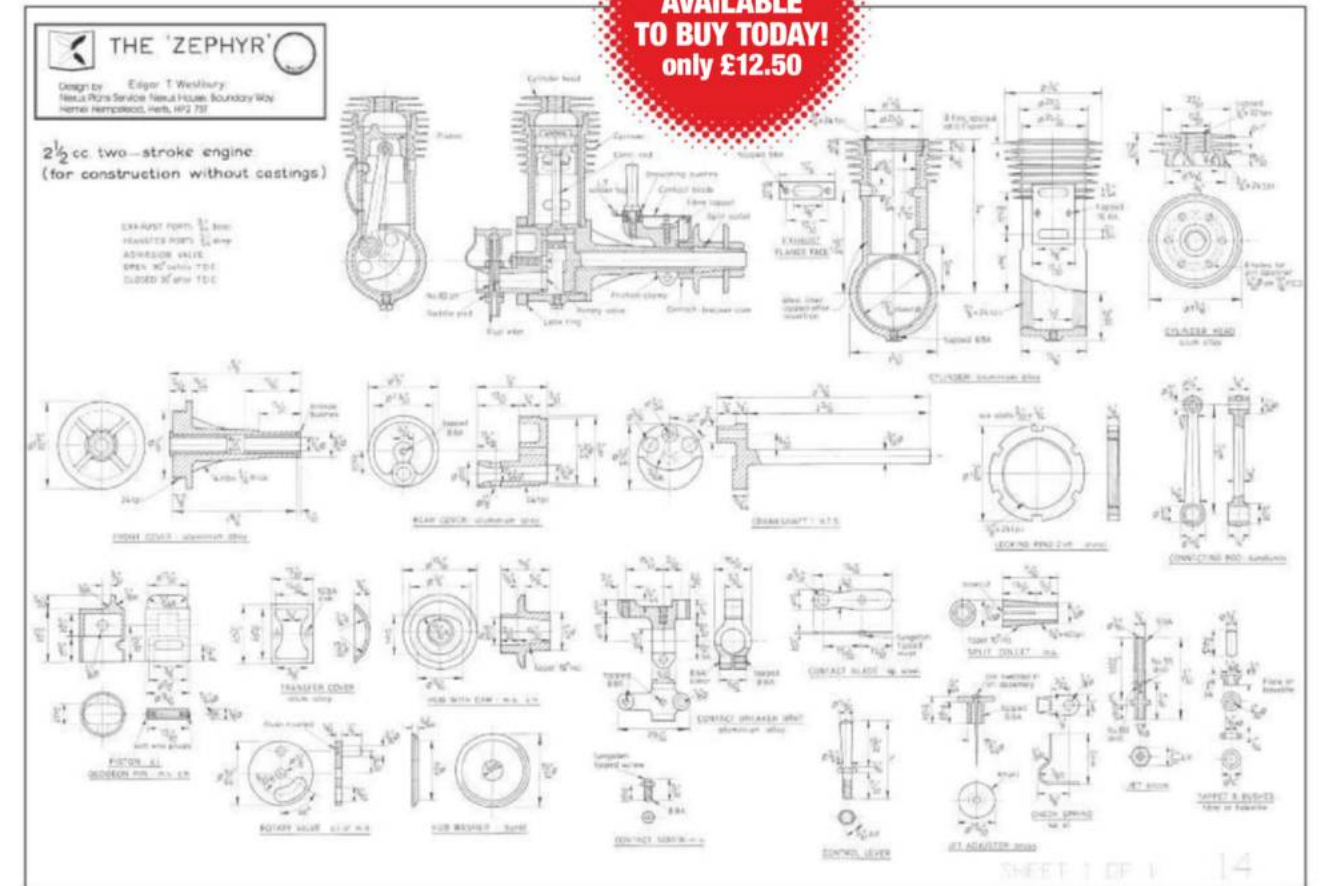
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Designed by: Edgar T. Westbury

A 2.5cc air-cooled, two-stroke engine. (Vols.94 - 95.) 9/16 in bore x 7/16 in stroke suitable for model aircraft, this highly successful engine is intended to be made by machining the parts from solid, without the use of castings.

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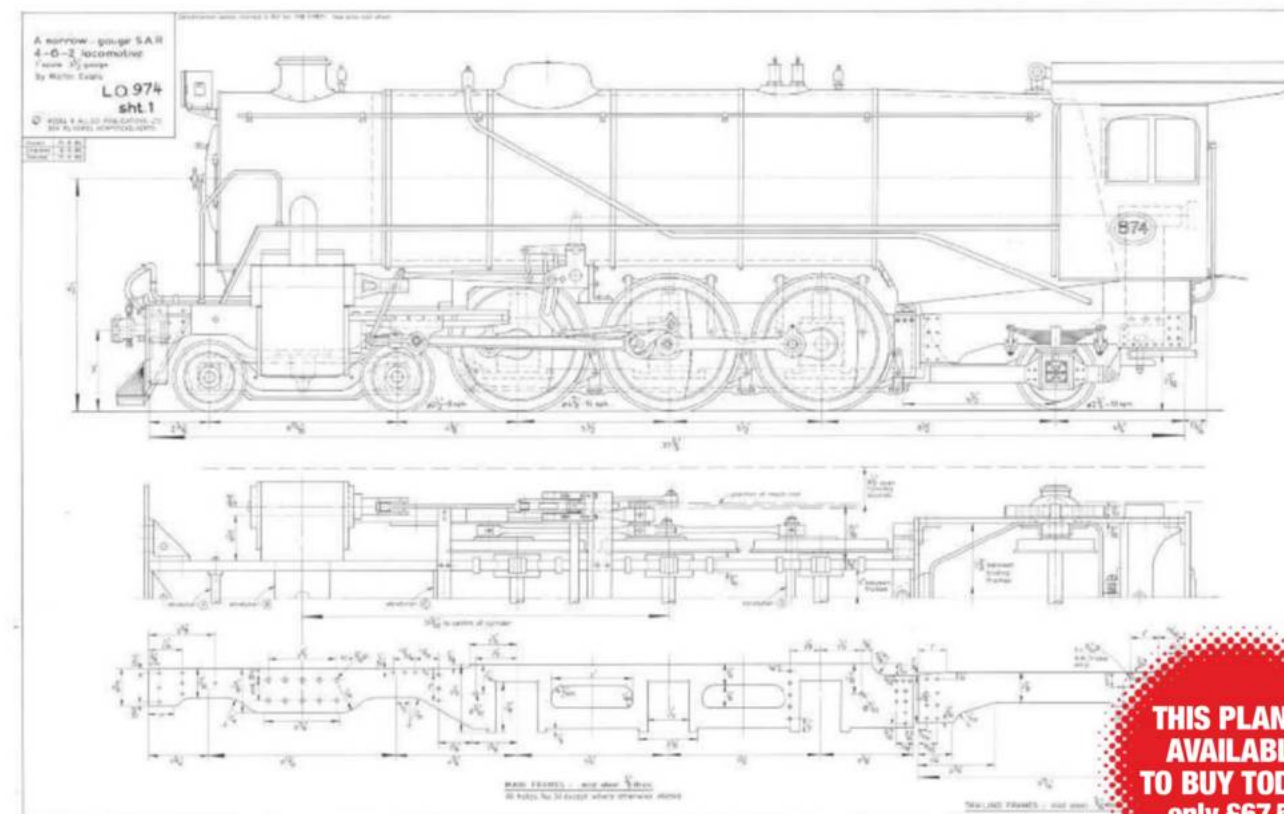
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Seal PE20	PE20	12.50
Cadet PE21	PE21	12.50
Ladybird PE22	PE22	12.50
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Carburettor PE26	PE26	12.50
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Sealion PE29	PE29	12.50
Kestrel PE3	PE3	12.50
Atomag Minor Mk Ix PE30	PE30	12.50
Jones Glow Plug PE31 Plan	PE31	12.50
Bentley Rotary PE33	PE33	37.50
Starling PE34	PE34	12.50
Miniature Magnetos PE38	PE38	12.50
V8 Engine PE39	PE39	17.50
Kinglet PE4	PE4	12.50
Kittiwake PE5	PE5	12.50
Atom V PE7	PE7	12.50

Atomag Minor PE9	PE9	12.50
Lynx NE15S Drawings	NE15s	49.00
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Betty MM923	MM923	32.50
Mollyette LO51	LO51	17.50
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Juliet LO53	LO53	12.50
Chingford Express LO54	LO54	12.50
Dot LO55	LO55	17.50
Juliet LO62	LO62	32.50
Juliet No 2 LO64	LO64	27.50
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Maisie LO70	LO70	37.50
Doris LO72	LO72	57.50
Tich LO75 Plan	LO75	67.50
Tich Passenger Car LO76	LO76	12.50
Canterbury Lamb LO77	LO77	47.50
Maid Of Kent LO80	LO80	92.50
Britannia LO81	LO81	72.50
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Titfield Thunderbolt LO89A 5 in	LO89A	62.50
Netta LO90	LO90	57.50
Virginia LO95	LO95	37.50
Mabel 3.5 In LO97	LO97	37.50
Titfield Thunderbolt LO89 3 1/2 in Plan LO89	LO89	47.50

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Twin Sisters LO18	LO18	189.95
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Alternative Valve Gear Lo28 For Lo26	LO28	12.50
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Firefly 5In LO32	LO32	67.50
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Hand Pumps LO36	LO36	12.50

Injectors LO37	LO37	12.50
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Designed by: Martin Evans
3 1/2in gauge S. African Railways Classic 16 DA locomotive. 12 sheets

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LO 29 Steam Brake	LO29	22.50

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Timber Framed	BC2	12.50
Builders Merchants	BC3	12.50
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Windmill - Open Trestle Post Mill Plan	MM206	12.50
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Smock Mill	MM211	12.50

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Triple Expansion Engine M1	TEE M1	27.50
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Theseus M19	M19	12.50
Heinrici Hot Air Engine M2	M2	12.50
Perseus M20	M20	27.50
Centaur M21	M21	17.50
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Beam Engine Plan M23	M23	22.50
Centre Flue Boiler M24	M24	12.50
Cygnat Royal M25	M25	12.50
Grasshopper Beam Engine M26 Plan	M26	22.50
Corsair M27	M27	12.50
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Product Name	Plan Code	£'s
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Vertical Multi Tube Boiler M31	M31	12.50
Gemini M32	M32	27.50
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Piston Drop Valve Mill Engine M34	M34	47.50
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Test Boiler 5 Inch M36	M36	12.50
Trailer For Clayton Wagon M37	M37	12.50
Georgina M38	M38	12.50
Warrior Mk II M39	M39	37.50
Steam Generator M4	SG M4	12.50
Ergo II M40	M40	12.50
Stirling Hot Air Engine M43	M43	12.50
Princess Royal & Goliath M44	M44	12.50
Test Boiler 3In	M46	12.50
Atmos Vapourising Burner M5	M5	12.50
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Polly M54	M54	12.50
Nodding Donkey M56	M56	12.50
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Clayton Wagon Brake Gear M61	M61	12.50
Comet M62	M62	17.50
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Borderer M65	M65	12.50
Warrior M7	M7	22.50
Pisces II M72	M72	12.50
Wenceslas M74	M74	12.50
Marcher M75	M75	22.50
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Clayton Engine M79	M79	12.50
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Vee Steam Pump M84	M84	12.50
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Diagonal Paddle Engine M9	M9	12.50
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Working Beam Engine	MM416	12.50
Marine Steam Plant MM546	MM546	12.50
Marine Steam Engine MM749	MM749	12.50
Centre Flue Boiler MM750	MM750	12.50
Scott Boiler	MM788	12.50

LO974 Natal	LO 974 Natal	67.50
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LO974 Natal Plan - Individual Sheets	LO974/3	12.50
LO974 Natal Plan - Individual Sheets	LO974/4	12.50
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LO974 Natal Plan - Individual Sheets	LO974/8	12.50
LO974 Natal Plan - Individual Sheets	LO974/9	12.50
LO974 Natal Plan - Individual Sheets	LO974/10	12.50
LO974 Natal Plan - Individual Sheets	LO974/11	12.50
LO974 Natal Plan - Individual Sheets	LO974/12	12.50
M58 Trevithick Steam Dredger Engine Plan	M58	21.50

Product Name	Plan Code	£'s
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Aveling And Porter Road Roller TE14	TE14	57.50
Traction Engine Accessories TE15	TE15	12.50
Ransomes, Sims & Jefferies TE16	TE16	52.50
Agricultural Traction Engine TE17	TE17	52.50
Suffolk Dredging Tractor TE18	TE18	47.50
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Fowler Water Cart TE26	TE26	22.50
Ruston & Procter 3 Ton Tractor TE27	TE27	57.50
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Wards Wagon Plan MA113	MA113	12.50



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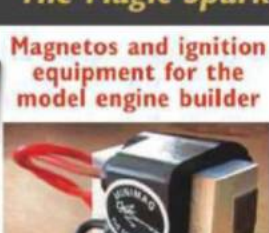
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NEW Compact, low power Ignition System for moderate speed engines

- Connections by colour-coded screw terminals
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Kit includes everything you need:

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- 3 x 2 neodymium magnet.
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I made this tangential toolholder back in early 2011. Since then it has been the tool I use for 95% of my lathe work. The only times I use other toolholders are:

- When making heavy intermittent cuts, because the tool tends to get hammered down in the holder.
- When it is physically impossible to access the surface to be machined with the tangential toolholder.
- When carrying out special operations such as parting, chamfering and knurling.
- When making left handed cuts. I still have not made a left handed version.
- In use the toolholder has performed well and no modifications have been made.



A Quick and Easy Tangential Tool

Michael Cox – Issue 179 February 2011

There is much interest in tangential tool holders not only on the Model Engineer website but on many others. The big advantage of tangential tooling is that tool grinding is very quick and easy since only one face needs to be ground. I find that using a tangential tool holder, I can make deeper cuts than with conventional tooling and others have reported the same.

Commercial tool holders are available but are costly. There have been a number of designs published in the past that can be home-made. All the previous designs that I have seen require complex angles to be set up for milling the slot for the tool. The design presented here avoids setting up complex angles so making the tool holder easily and quickly made.

The tool holder was made for my Asian mini-lathe and uses a 1/8 inch

square HSS tool. It could easily be scaled up to accept larger tools for use on larger lathes. **Photograph 1** shows the finished tool holder. It can be seen that the tool is clamped in a slot using an M4 screw and that the tool is angled at 12 degrees to the front of the tool holder. In order to obtain the 12 degree tilt of the tool in the other direction the shank of the tool holder is parallelogram shaped as shown in **photo 2**. In the photo, the tool holder is shown upside down lying on the top edge of the shank in order to show the inclination of the tool.

Construction

The tool holder was made from a piece of 6 x 25mm mild steel bar 65mm long (**fig 1**). This was clamped in a milling vice set at an angle of 12 degrees to the X or Y axis and the slot was milled with a 3mm

milling cutter to a depth of 3mm. The slot was enlarged laterally until a 1/8 inch square piece of HSS was a snug fit. The tool must protrude slightly above the surface of the tool holder so that it can be held by the clamp screw. The hole was also drilled for the clamp screw.

The excess material (approximately 52 x 17mm) was then removed with a hacksaw and all the edges cleaned up with a file. The front corner was also sawn off at about 50 degrees to the front of the tool holder and then filed smooth.

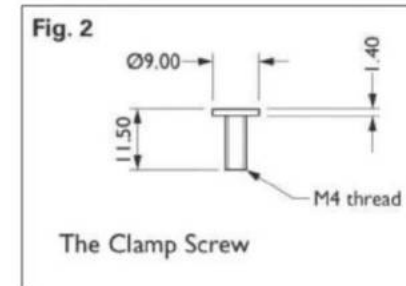
The parallelogram shaped shank was then made. This can be done by mounting the tool holder in a tilting vice at 12 degrees from the horizontal and then milling away the excess material on both sides of the shank. This was the method I used. However there is relatively little material to remove and it



Note the parallelogram shaped shank



Looking at the tool from the end



could be done by hand filing. The 12 degree angle is not critical and as long as it is about right (+/- 2 degrees) the tool holder will work.

The clamp screw was made from an M4 screw with a large head. The head was turned down to the dimensions shown in **fig 2** and the screw was then cut to length.

Tool grinding jig

The tip of the tool is ground at an angle of 30 degrees. To facilitate this grinding operation a simple jig was made (**photo 3**). This has a Vee groove angled at 30 degrees. The bar at the back is used to guide the jig against the edge of the grinding rest. The dimensions of my jig are given in **fig 3** although these may need to be changed to suit other grinding rests. In use the tool is lightly clamped in the vee groove with a finger and the bar is held against the edge of the grinding rest. The tool is advanced by finger pressure onto the grinding wheel to form the 30 degree tip.



The tool grinding jig



The tool holder mounted on the lathe

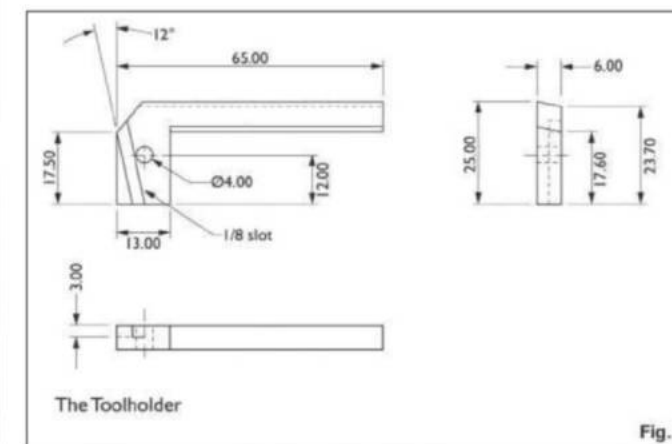
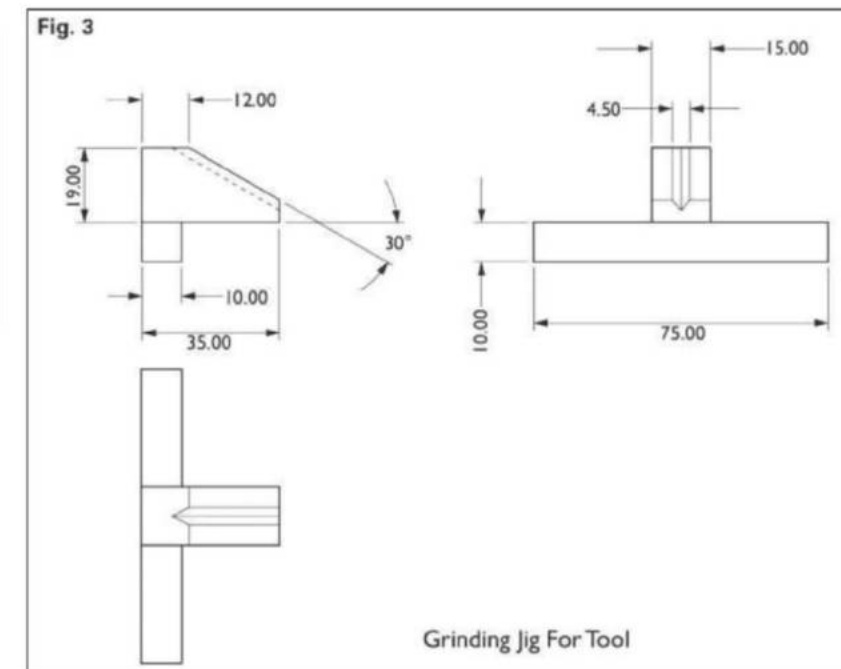


Fig. 1



Grinding Jig For Tool

Use

The tangential tool holder is shown mounted on my tool post in **photo 4**. **Photo 5** is another view of the mounted tool holder. The forward inclination given to the tool by the parallelogram shaped shank is clearly visible.

The tangential tool is a universal tool that can be used for turning or facing a workpiece without adjusting the angle of the tool in the tool post. I routinely take 1mm cuts with it whereas with conventional tooling my lathe struggles

with more than 0.5mm cuts. The best surface finish is obtained by very lightly stoning the tip of the tool to a small radius after grinding. 🛠️

Events

August 5 – The Mars Reconnaissance Orbiter captures photographic evidence of liquid water on Mars.

August 28 – Libyan rebels overthrow the government of Colonel Gaddafi

Ten Ways Your Workshop Will Change By 2040



Model Engineers' workshop has always looked to the future, in issue 1 there was an article on Engineering of the Future. In 1990 a 486 PC with floppy disc and a whole megabyte of RAM would have cost you around £1,000, and computers at home were still a specialist interest. That said some home computers, like the BBC Micro, had basic CAD capabilities, but it was no surprise that issue 1 of Model Engineers' workshop dismissed the idea of CNC in the home workshop. It did, however, concede that 'digital readouts on machines could be useful at home'.

The typical hobby engineer in 1990 would probably have grown up with a suspicion of anything 'plasticky'. Many quality items, such as cameras, would usually still be made largely of metal. Even so, the use of plastics for durable, quality items was rapidly becoming the norm. In 2015, plastic are still scarce in our workshops, aside from handles and storage boxes. Perhaps it's still a bit soon to anticipate the plastic lathe, but what changes can we expect over the next 25 years?

1 3D Printing

A recent survey on the www.model-engineer.co.uk website showed that 15% of respondents already had a 3D printer and the majority were considering getting one. With phenomenal improvements in quality and reliability being seen over the last ten years, matched only by decreasing prices, it seems inevitable that a 3D printer will be as commonplace in the workshops of the future as milling machines are now.

But what will we be using them for? Already hobbyists are making replacement and custom changewheels, printing patterns for castings and creating stylish casings and housings for their projects. Recent developments with home printers include the new ability to print in nylon - a stronger 'engineering plastic' that opens up the possibility of printing much heavier duty parts than are possible using PLA or ABS, the two common plastics.

In the future expect to see designs for new tools and equipment that include 3D printed parts - imagine how much easier it might be to make a geared mechanism when you can print a set of

gears and a housing for them, just machining the shafts and linkages? Who will be the first person to submit such a project for MEW?

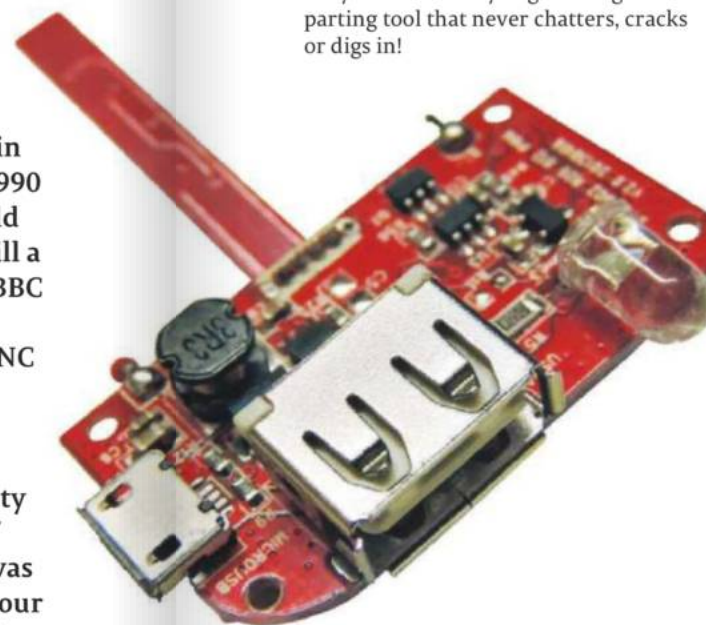
2 New Cutting Tools

It's a fact, but despite the appeal of indexable-tip carbide cutting tools, sometimes you just can't beat high-speed-steel for finish, and it's more forgiving for the beginner and easier to sharpen. If you want to make form tools or 'special' cutters then we still turn to high-carbon steels that are easily hardened and tempered in the workshop.



The Wimberley Toolholder, combining HSS and an innovative holder.

But what of the future? New steels are unlikely perhaps, but the possibilities for new formula inserts, particularly advanced ceramics are unlimited. Not just new materials, but also new tool shapes - will we see inserts that can shave off a 'tenth of a thou' like a specially honed HSS tool? Or even the Holy Grail of hobby engineering - a parting tool that never chatters, cracks or digs in!



Chips with everything.

3 Embedded Electronics

There's no doubt that electronics goes hand in hand with metalworking as part of many people's workshop activity. In the early days of Model Engineer there were articles on making your own transformers and motors, charging batteries and even making your own x-ray tube! Over the last 25 years there has been a big change in hobby electronics as microcontrollers, best described as 'computers on a chip' have become more and more accessible to ordinary hobbyists. Today, with the advent of prefabricated boards such as the well-known Arduino and Raspberry Pi, it's possible for anyone to make use of incredible amounts of computing power.

So where will this take the hobby in the future? We will surely see more and more 'smart' projects with embedded electronics, already the SMEE are experimenting with the Piccolo, a tiny CNC bot based around an Arduino board, and some lathe owners have replaced change wheel gearboxes with stepper motors synchronised to the lathe spindle. In the future expect to see machine tools and devices that think for themselves, are controlled from smartphones or even over the internet.

4 Advanced Adhesives

We've all done it, taken off a little bit too much metal and resorted to using a retainer, or even superglue, where we had planned to have a force fit. But when are we going to stop treating the use of modern adhesives as a 'cheat'? Two part epoxies date back before the Second World War, and Loctite dates back to 1953. Even superglue is over fifty years old. Engineering grade adhesives are used to hold fighter jets and passenger planes together, yet it is still unusual for Model Engineers' Workshop to feature a project which uses these tried and tested ways of joining materials.

Perhaps it is time for us all to trust these marvellous adhesives and start to learn more about how to design in their use for effective and reliable joints, rather than seeing them as a stop-gap.



Industrial adhesives offer us new ways of making secure assemblies.

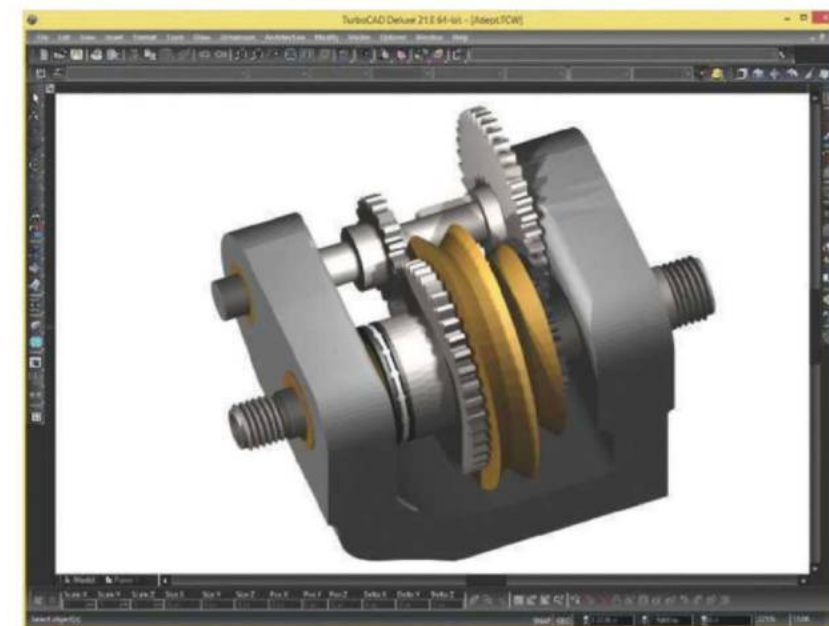
5 Integrated Software

One of the biggest barriers to the hobby use of CNC is the lack of simple, joined up software. Whilst many are comfortable using computer-aided drafting (CAD) to produce our plans and drawings, why is it such a complex journey from completed drawing to finished part?

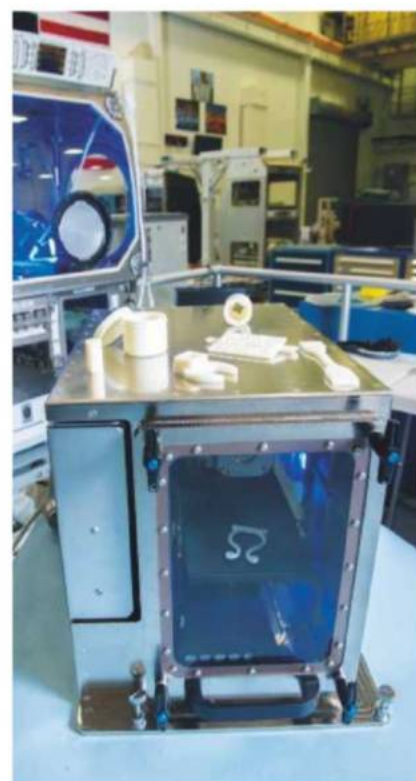
If you have ever looked at a page of G-code and tried to visualise what on earth it is supposed to do, or have managed to navigate the steps from a drawing to a 3D print or CAD machined part, you could be forgiven for believing that some software is there to hinder not help.

Now that 3D printers are becoming consumer items there is suddenly the demand for easier to use, integrated software. The average user wants to create an object on screen and then press a button and have it printed out. They don't want to battle with translation software or spend more time setting things up than designing their masterpiece.

Once these things are cracked for consumer products, they will soon spill over to all types of computer controlled workshop equipment. Imagine if changing your design was no more than pushing it into shape on a touch screen? Or if changing a tool was no more complex than doing so on a manual machine, with the size, shape and position of the tool all automatically detected?



3D design is now commonplace - what comes next?



The space shuttle's 3D printer. Photo credit MSFC/Emmett Given



Precision grinding - under-represented in our workshops.

6 Grinding & Sharpening

One of the biggest challenges in every workshop is caring for the condition of cutting tools, whatever materials they are made from. Whilst grinding basic angles on simple lathe tools can be addressed by relatively straightforward accessories, like that designed by Harold Hall, the complexity of 'universal grinders' still puts off many potential constructors and users.

How might this challenge be addressed in the future? Better grinding wheels such as those coated in cubic boron nitride are becoming available to hobbyists, combined with CNC control the sharpening of the most specialists cutters may come within easy reach.

7 Composite Materials

There's nothing particularly new about composite materials. Paxolin and plywood have been around since before any of us started in the hobby, and there is a huge range of far more advanced composites out there. Plastics reinforced with glass-fibre, carbon-fibre and Kevlar, for example, have wide applications in industry. In the seventies they were used to make many parts of the space shuttle including the pressure vessels and wing leading edges and in 2010 NASA said they needed to keep up with a paradigm shift from metals to composites occurring in aerospace, automotive, marine, and pipeline applications. But how often do you find them in the home engineering?



The Space Shuttle contains many composite materials. Photo Credit: NASA/Bill Ingalls

workshop? This is strange, as other hobbyists, notably aeromodellers and ship modellers and even people who make their own fishing rods or bows are happy to use advanced composites.

Surely the future we will catch up with industry and start taking advantage of the combinations of lightness, flexibility and strength that composites offer.



The gateway to your future projects?

8 Collaboration

One of the things that new technology has brought are vastly more opportunities for the sharing of ideas and information. The incredible benefits of having a wealth of people's experience 'on tap' is proven time and again on our web forum, but it's now possible for hobbyists who live miles apart, or even in different parts of the globe, to work together on their projects and ideas. With the ability to share designs and experiences truly collaborative projects are possible with the kind of close working formerly limited to teams sharing the same workshop. It's even possible to join on-line meetings and conferences over video links, demonstrating techniques or explaining problems in real time.

This way of working together has long been common for software projects and has been firmly embraced by the 'maker movement'. Already more 'traditional' hobby engineers are starting to collaborate on line, how soon before this becomes commonplace?



Five-axis machine tool.

9 Multi-axis CNC

Take a look in any modern CNC equipped factory and the machines you see won't bear a strong resemblance to either a mill or a lathe. Multi-axis CNC machines allow both work and tools to be rotated and moved in many ways, allowing the machining of extraordinarily complex shapes – such as cylinder heads for high-performance IC engines.

No doubt the most advanced machines will remain in the hands of specialist engineering companies, but the step to combining both turning and milling capacity in a single CNC machine is an obvious opportunity at the top end of the hobby market. As for homebrew solutions, Alan Jackson's award winning Stepperhead machining centre was a 'step' in this direction – what's next?

10 Going Retro

If all of this talk of new technologies is getting you down, don't despair. Let's face it, one of the real pleasures in the workshop is operating a manual machine tool and the satisfaction of working to close tolerances and getting fine finishes just using our hands and eyes (and brain!)

There is one enthusiast in Canada who runs a 1940s workshop, and he strictly avoids any tools or materials that were not available back then. You don't have to go that far, but there will always be a significant percentage of hobbyists who eschew any form of computer control, or at the very least keep a manual machine in their workshops. Even for the neo-luddites the computer age has brought one big positive – old machines can now find new owners much more easily. Second hand machines of any vintage, from Victorian treadle lathes to

early CNC, like the Denford ORAC, are much less likely to end up on the scrapheap when they can be auctioned off on line with little fuss.

Auctions always mean the chance of a bargain, and as many have found 'rescuing' a basket-case of an old machine tool and restoring it to a useful piece of workshop equipment can be incredibly rewarding.

The Bottom Line

So there you are, that's our glimpse into the future and – like all attempts at futurology in 2040 it will probably raise a few smiles, if nothing else. Almost certainly there's at least one big change we have completely missed. What will it be – robots in the workshop? More women taking up the hobby? Perhaps it will be going back to the roots of hobby engineering, now well over a century ago, embracing all new engineering technologies and techniques rather than the stricter focus on metalworking we have today.

At the end of the day, what you do in your workshop is up to you. Hopefully this journey through the past of Model Engineers' Workshop has given you some new ideas and inspired you to try something different or more challenging. With thirteen issues a year, MEW is a great source of more ideas and, together with our online forum at www.model-engineer.co.uk, offers a great way to stay in touch with the vast and exciting world of home-shop engineering.

Whatever you decide is the future of YOUR workshop, enjoy it and work safely. Now, why not share your achievements and experiences by submitting an article to MEW or joining in on the forum?

I look forward to the next 25 years of MEW and finding out what you make of them!

Editor, Model Engineers' Workshop

Events

April 1 2040 – First inhabitants of the MarsBiosphere project arrive on the red planet.

June 14 2040 – Wales beat China 4-2 to win the World Cup for the second time.



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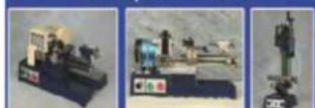
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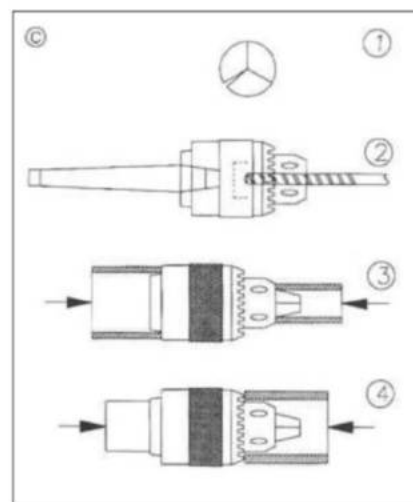
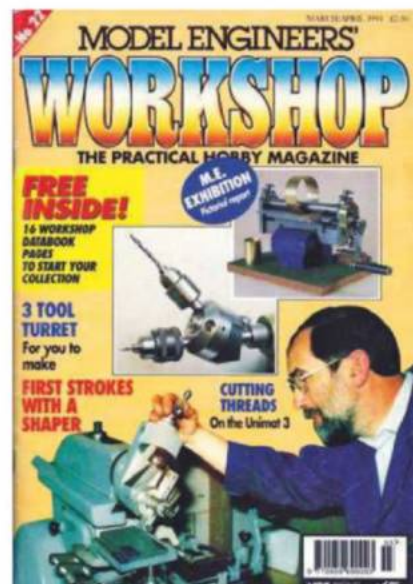
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Dismantling a Jacobs Type Chuck

Doug Cooper – Issue 22 March/April 1994



Many inexpensive modern chucks have pressed steel bodies and dismantling them means having to make a new body, but did you know that many older Jacobs-type chucks can be taken apart? The method of assembly is far from obvious making a full strip down for cleaning and maintenance a non-starter. In 1994 Doug Cooper let MEW readers into this little secret, which may help you to breathe new life into some old, but good quality, chucks.

To remove the taper arbor from the chuck body, rotate the open chuck in the lathe and drill through the rear of the body, say 0.25 inch. Pass a punch through the hole, to the head of the arbor and drive it out. New arbors can be obtained from the usual tool merchants, but take the body, chuck tapers do vary in size.

To disassemble the chuck for cleaning, make up a short tube to clear the rear of the chuck body and a similar one just large enough to clear the jaws. With the jaws nearly closed apply opposite pressure to the two tubes. This will force the gear ring off the body. (Some makes of chuck may come apart in the opposite direction.) It may take quite a hefty pressure to shift it! When the gear ring parts company with the body you will find a split ring inside - yes, it is made that way! Remove the split ring and the three jaws can be slid out. Either clean them individually or mark them so that they go back in the same position. Some are numbered but others may not be, so take care.

Clean and check the jaws for burrs on the gripping surfaces - these can be carefully stoned off. Check also for burrs on the nose of the chuck, where it may have contacted the work at some time.

To reassemble, lightly oil and slide the jaws into the body. Replace the split ring, with the jaws in the near closed position, and push the gear ring onto the body. Using the larger tube, press the gear ring back onto the chuck body. Make sure this goes fully home or the key will not fit the gear ring.

Sometimes for light milling opera-

tions, it is necessary to retain a Morse taper arbor in the machine mandrel with a drawbolt. Although Jacobs chuck arbors look rather hard they can be drilled and tapped for a drawbolt. First cut off the tang, a 'blue blade' will do this easily and set the arbor up in the lathe to run truly. On my Myford I push the 'chuck' end of the arbor into the Myford mandrel and grip the middle of the arbor in the three jaw; not ideal, but it seems to hold it well enough to drill the tapping hole: 3/8 inch BSW was used for No.2 Morse tapers, but this may have changed since metrication. If being used for milling the chuck must be made captive to the arbor. Perhaps using a screw into the arbor through the hole in chuck as made in 2 above.



Events

March 14 - First Macintosh Power PC launched

April 8 - Kurt Cobain, lead singer of Nirvana, found dead

April 27 - South Africa holds first multi-racial elections marking the end of Apartheid

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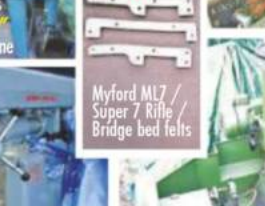
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