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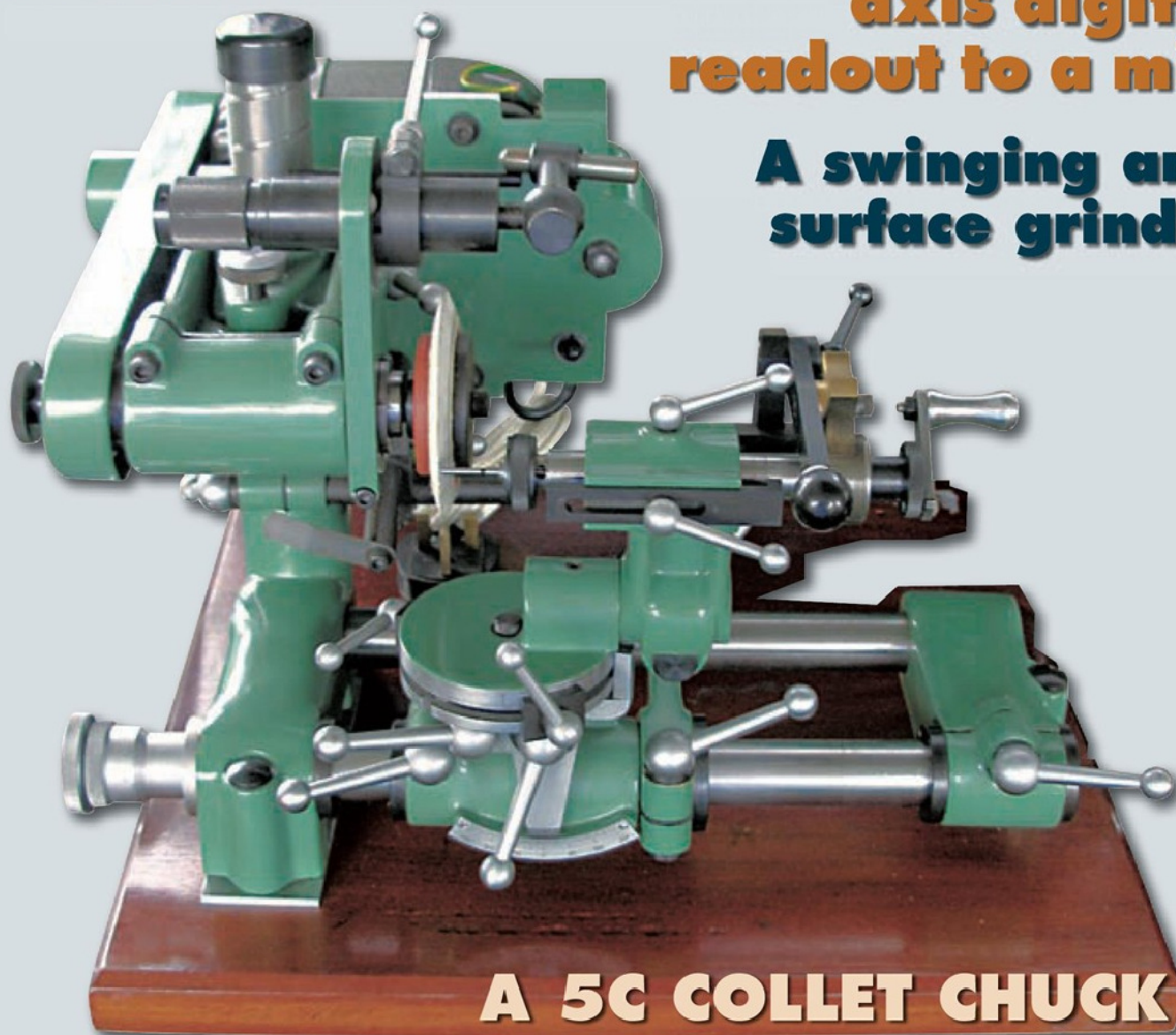
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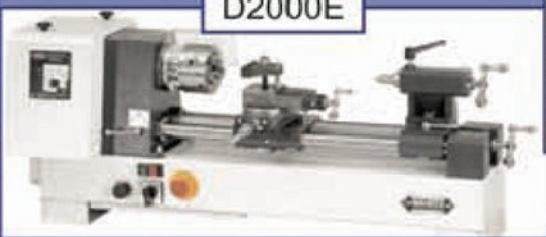


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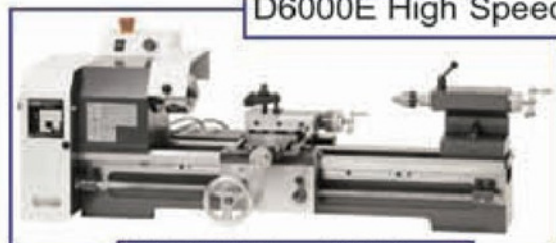
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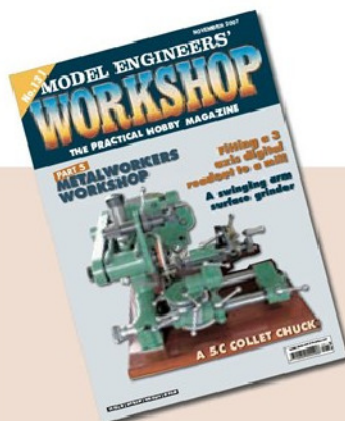
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On the Cover

This superb Quorn tool and cutter grinder was seen at the Ascot Model Engineering Exhibition. It was exhibited with a fitted case full of accessories.

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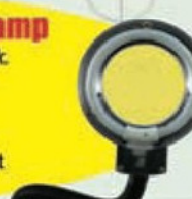
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MX95	SPARE EXT'D HOLDER BF	£ 29.00	£ 24.95

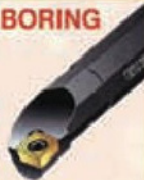
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XC36	10MM	£19.95	£16.00
XC37	12MM	£22.95	£19.00
XC38	16MM	£24.95	£21.00

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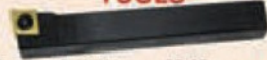
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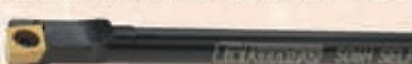
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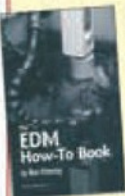
Digital Machinist • SAMPLE COPY • £ 6.35

Model engineering tends to be one of the last refuges of the old skills, but many model engineers are enthusiastically embracing the modern era in the form of CAD design, and CNC for machinery. It is the latter which is the main subject of this excellent quarterly magazine from the publishers of *The Home Shop Machinist* and *Machinist's Workshop*, sample copies of which are also available at £ 6.65 and £ 6.35 respectively.



Artist Blacksmithing • DVD • App 154 mins • £29.99

Really tremendous two disk set, in which Peter Parkinson lets you into the secrets of blacksmithing: after a useful general Introduction, he covers Tapering, Upsetting & Spreading, Hot Cutting, Punching, Twisting, Bending, Joining, Toolmaking and Finishing. Shot to a very high standard in Peter's workshop - and he is an excellent instructor. This really is very interesting - even my wife was fascinated by it. If you want to try your hand at blacksmithing of the artistic rather than the horseshoe variety, this is clearly very useful, but it is well worth considering if you are just intrigued by how a length of mild steel can be shaped using a fire and a hammer - plus a lot of skill.



The EDM How-To Book • Fleming • £ 13.95

The strength of this book lies in the care Ben Fleming takes explaining how to deal with the electronics and electrics, on the assumption that there are likely to be more engineers with minimal electronics experience, rather than the other way round, building this machine - which isn't to say that the mechanical bits aren't also top rate. EDMs are very useful machines, and not just for removing broken taps, and making one is an interesting process, which produces something you will end up wondering how you survived before you had it. This is an American book, so the voltages differ from most norms, but Ben assures us the adjustments for higher mains voltages are minor. 168 page paperback full of drawings, diagrams and photos.



Machine Shop Essentials - Questions and Answers • Marlow • £33.20

An exceptional recent book on the basics of engineering practice, covering hand tools, the lathe, the milling machine, and the vertical drill. The quality is evident the moment you open the book, there being vast numbers of drawings of set-ups, rather than photographs and, as the text is based on 'Questions and Answers', it is very much to the point; it is also strong where practices have changed, notably on fasteners. Whilst American, a whole host of manufacturers have been consulted in its preparation, including Colchester and Myford, and variations in practice between countries are covered. The spread of this book is well illustrated by the Chapters: Measurement Tools, Layout & Job Planning, Basic Hand Tools, Filing & Sawing, Grinding, Reaming, Broaching & Lapping, Drills & Drilling Operations, Threads & Threading, Turning Operations, Milling Operations, Fastening Methods, Machine Shop Steel Metallurgy, Safety & Good Shop Practices, Other Shop Know-how and Sharpening Steel Lathe Tools. This isn't cheap, but the quality of the information is priceless, especially if you have just shelled out large sums of money for machinery. For the newcomer to model engineering this book will be invaluable - even if you have been in the workshop man and boy you will find parts of it useful. Highly recommended - as if you couldn't guess that. 518 pages, 497 drawings, plus tables. Paperback.



How to Run Three Phase Motors on Single Phase Power • Lindsay • £ 4.00 Alternator Secrets • Lindsay • £ 4.00

Two useful little electrical booklets: the first shows how you can run three phase motors on single phase power by the capacitor, the autoformer or the dynamic converter methods. Also includes basic three phase and induction motor theory. Complete with drawings, diagrams and capacitor values. 18 pages. The second describes how the common car alternator can be modified very successfully to produce large amounts of power. This booklet is just 16 pages, but they are jammed full with modifications you can make, and what you can produce. Useful stuff! Both softcover.

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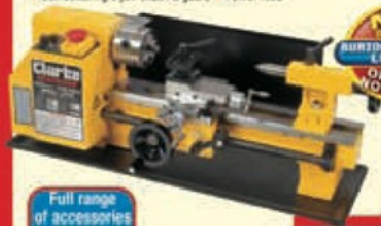
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7. BSW TAP SET (2 Taps each size) & BSW DIES: $\frac{1}{16}$ x $\frac{1}{8}$, $\frac{1}{8}$ x $\frac{1}{4}$, $\frac{1}{4}$ x $\frac{1}{2}$, $\frac{1}{2}$ x $\frac{1}{2}$			
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10. METRIC COARSE TAP SET (2 Taps each size) & METRIC DIE SET: 14, 16, 18, 20, 22, 24 mm			
11. UNF OR UNC TAP SET (2 Taps each size) & DIE SET: 0 to 12 UNF or 1-12 UNC			
12. UNF OR UNC TAP SET (2 Taps each size) & DIE SET: $\frac{1}{16}$ x $\frac{1}{8}$, $\frac{1}{8}$ x $\frac{1}{4}$, $\frac{1}{4}$ x $\frac{1}{2}$, $\frac{1}{2}$ x $\frac{1}{2}$			
13. UNF OR UNC TAP SET (2 Taps each size) & DIE SET: $\frac{1}{16}$ x $\frac{1}{8}$, $\frac{1}{8}$ x $\frac{1}{4}$, $\frac{1}{4}$ x 1"			
14. GAS (RSP) PIPE SET: $\frac{1}{16}$ x $\frac{1}{8}$, $\frac{1}{8}$ x $\frac{1}{4}$, $\frac{1}{4}$ x $\frac{1}{2}$ (2 Taps each size)			
15. METRIC FINE PITCH SETS (10 sizes from 3 - 12 mm) TAPS & DIES			
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18. SLOT DRILL SET (THREADED SHANK) $\frac{1}{16}$ x $\frac{1}{8}$, $\frac{1}{8}$ x $\frac{1}{4}$, $\frac{1}{4}$ x $\frac{1}{2}$, $\frac{1}{2}$ x $\frac{1}{2}$ or (mm) 3, 4, 5, 6, 7, 8, 10, 12 mm			
19. ENDMILL SET, $\frac{1}{16}$ x $\frac{1}{8}$, $\frac{1}{8}$ x 1" DIA. WITH $\frac{1}{8}$ THREADED SHANK TO FIT COLLET CHUCK			
20. COUNTERBORE SET (FOR SPOTFACING) $\frac{1}{16}$ x $\frac{1}{8}$, $\frac{1}{8}$ x $\frac{1}{4}$, $\frac{1}{4}$ x $\frac{1}{2}$ OR (mm) 3, 4, 5, 6, 8 mm			
21. REAMER SET (STRAIGHT SHANK) $\frac{1}{16}$ x $\frac{1}{8}$, $\frac{1}{8}$ x $\frac{1}{4}$, $\frac{1}{4}$ x $\frac{1}{2}$, $\frac{1}{2}$ x $\frac{1}{2}$ OR (mm) 2, 3, 4, 5, 6, 7, 8, 10, 12 mm			
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David Clark

On the move, new phone number

If all goes well, when you are reading this, I should be living in Scotland. The house I am buying is my most expensive Ebay purchase so far.

This is a major move of 725 miles with all the attendant problems of moving a workshop. An awful lot of items have had to be sold, taken to the dump or given away. I have however, promised to buy my wife some new bits and pieces. After all, it had to go so I could get the workshop onto the removal van. (Replacing furniture is cheaper than replacing machines.)

Seriously though, I have had to cut the workshop back drastically as it is just too expensive to transport it all. I have kept the Tom Senior mill, The Myford ML7 R and the power cutting off bandsaw. I am also taking two Axminster workbenches as recommended by Mike Houghton, which I only bought 6 weeks ago.

All the small tools and bits and pieces will be sorted and packed. Hopefully, I won't have to throw away too much.

I have purchased an engine hoist and obtained a pallet for the Tom Senior mill. We are going to load the mill on the furniture van, take it to the weighbridge and if the fully loaded van is within weight limit, the mill will go with the furniture. If the van is overweight, the mill will go to the furniture removal warehouse and they will send it up on a pallet in a week or two.

My new phone number is on the contents page and is believed correct at time of printing.

MEW availability

I get emails, customer services gets phone calls and emails, all about the availability of MEW (and sometimes, ME). MEW should be available at your local W.H. Smiths.

One of the problems is the inconsistency of the display. My local WHS, until recently has been very good, 25 copies on sale on an eye level shelf of which on average about 19 have sold before the new one replaced it. I went in to check issue 130 and found 129 was still on sale and had also been moved to a ground level shelf and placed at the back of the rack. Fair enough, this was on a Friday and it was not due out until the following Tuesday. Looking around at other magazines, I was surprised to see issue 130 on sale as well as issue 129 but it was in the woodworking

ON THE EDITOR'S BENCH

section. Dave Fenner had a similar problem in the Perth WHS. I counted them and found 26 copies, (I do my own limited market research).

I checked again on Tuesday (5 days later and found only one copy of no 130 had been sold. 129 had not sold any more copies. I would have expected 6 or 7 copies of no 130 to be sold by then. I spoke to the supervisor about the problem and he moved 130 to the correct place. I checked again the next day and three copies had sold overnight. It is still not easily seen as it is on a lower shelf and at the back, but at least it is back with Model Engineer and Engineering in Miniature (am I allowed to mention that) where it belongs, although all three are in the radio control section.

The other problem is that some WHS sell out quickly. I have been told Farnborough and also Nottingham sells out quickly. This should not happen, as they should receive sufficient stock. If there is a problem with availability at your local WHS please ask the manager and let me know as well. Smith's sales are supposed to be monitored to see which shops go out of stock. I don't know much about how this is done but I am going to check it out when I have settled after the move.

Newsagent orders

Sometimes, newsagents find that their order is not supplied. This is a difficult problem as there is a third party involved, the distributor. I had one of these problems checked out but resolution looks like being a long and difficult process. The long-term answer may be to subscribe or get your local WHS to keep you a copy. Whatever you decide, rest assured, the future of MEW is safe. It will be available for many years to come.

Overseas subscriptions

The USA and Canada subscription company is changing.

All subscribers through Wise Owl should

be contacted by letter. If you have had an unresolved issue with Wise Owl and have not received a letter please contact me and I will pass it on.

Sjef Pijls - calling all Dutch and Belgium readers

To start with, I would like to mention that I look forward to each issue of MEW. It contains always a right mix of machine specific projects, general projects and general technology and I always learn a lot from it.

A magazine like this would be impossible in the Dutch language, the number of readers would be just too small, but there is no requirement for this either because nearly everybody in the Dutch speaking countries has no problems with English.

The magazine has however another important function: it is a way of contact between model engineers among themselves and with their suppliers. Since I moved back to the Netherlands I continued with ordering my tooling and materials from the UK because I don't have the faintest idea where to get them in the Netherlands. With tooling this is no problem but raw stock tends to be quite heavy and the costs of transport become excessive compared to the price of the stock. I don't know other model engineers in the Netherlands so I can't ask them where they get their materials. Therefore, I would like to ask readers in the Netherlands and Belgium to send an e-mail to jmapijls@hotmail.com or phone me at 0223 721354. In that way I can create a list for the ones interested.

Sjef Pijls by email

Incorrect photo

Harold Hall has pointed out that the wrong photograph (photo 5) was printed in issue 128 page 14. The correct photo is printed here. I have cropped it down to aid clarity. The shelf supports form the end frame of the shed and run from floor to ceiling.



THE METALWORKERS WORKSHOP 5

Harold Hall discusses precision tooling

There are a very wide range of tools that fit into the classification of precision tooling, many being essential items. I have though also included others for academic interest only. Whilst these are not appropriate in the vast majority of workshops, I have included them as the newcomer may come across them and wonder if they should be acquired.

Micrometers

Outside micrometers come in a surprising range of types, but fortunately, almost all are very specialised and definitely outside the requirement of the home workshop. The basic outside diameter micrometer is though essential and the only decisions to be made relate to which units, range and quality.

Having already chosen your preferred units, metric or imperial, then this will determine the micrometer, or micrometers, to be obtained. Obviously starting at the smallest 0 - 25mm (or 0 - 1in.) it will be necessary to decide what larger sizes are also needed, if any. Whatever the workshop's purpose, I do believe that 25 - 50mm or the imperial equivalent should also be obtained, **photo 1**. At these sizes, do purchase the best possible as they will get a lot of use and will be used where accuracy is most vital.

If you anticipate working in both metric and imperial units on a frequent basis then you should purchase micrometers to suit both, certainly in the smaller sizes. Converting values in one unit so that they can be measured on tooling intended for the other should be limited to the very occasional requirement.

In addition to outside micrometers, there is a wide range of micrometers for other purposes. The two you are most likely to find a use for are for depth and inside measurements.

Depth micrometers can be had that just measure 0 - 25mm but most have interchangeable spindles so they can be



1. 0-25 and 25-50mm micrometer. Both are essential in most workshops.



2. 0-100mm depth micrometer having interchangeable spindles.

used over a wider range, typically 0 - 100mm, **photo 2**. The spindles are smaller than those on outside micrometers, in the order of 4mm diameter, enabling them to measure into narrow grooves. They can of course also measure steps, etc.

Micrometers for measuring internal dimensions, **photo 3**, will most likely be used to measure internal diameters but can also be used for widths of slots, etc. It will be obvious though, that the smallest cannot measure from zero up but has a range of 5 - 30mm. Larger sizes do though revert to the normal ranges, 25 - 50mm, etc.

Inside micrometers that go totally into the hole or slot are also available. These have interchangeable spindles, rather like depth micrometers, to extend their range with a very large span of sizes being



3. Inside micrometers are also very useful. These are 5-30mm and 25-50mm sizes.

available. At the lower end, a typical set would measure between 50mm and 200mm. I would not suggest that micrometers in this range are anywhere near essential, though those up to 50mm as shown in the photograph, will be found very useful, even more so than the depth micrometer.

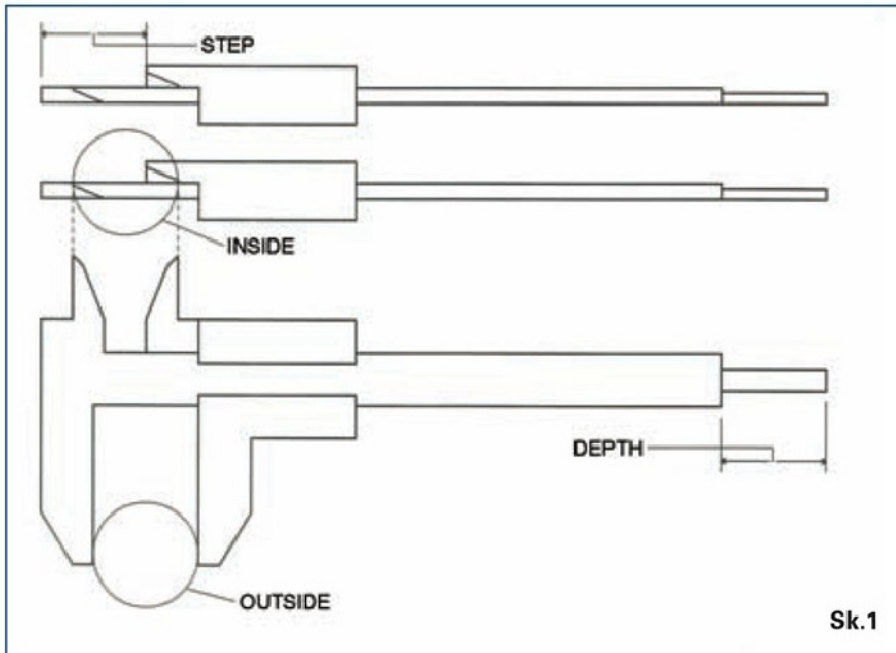
A rather specialised micrometer is the multi anvil unit seen in **photo 4**. Whilst this cannot in any way be considered essential, its various uses may swing the balance in its favour if finances can be stretched to include it. It can be fitted with a small diameter rod anvil, allowing it to be used typically to measure wall thickness of a tube. Similarly it can measure from the edge of a hole to the side of a component.

The rod anvil can be replaced with a thin flat anvil enabling it to measure from a thin groove. This is particularly useful as a normal outside micrometer is likely to start at around 10mm groove width. The rod anvil will be in the order of 3mm diameter whilst the flat anvil is about 1.6mm thick. With neither anvil fitted the micrometer can be used to measure steps, **photo 5**.

Other micrometers, of which there are very many, are too specialised to warrant inclusion. If though you wish to research



4. A multi anvil micrometer.



Sk.1

the subject, get an engineering tools catalogue from a stockist who supplies to industry. You will, I think, be amazed at the variety on offer.

Vernier callipers

These, **photo 6**, have been for many years the alternative to micrometers, in particular for larger dimensions. For smaller diameters, say up to 50mm they are no real alternative as they are not so easy to use, and results will therefore not be as certain. They do though have the major advantage of being able to read inside, depth and step dimensions in addition to outside diameters, **Sk. 1**. I would though recommend the reader to purchase the 0 - 150mm size to provide facilities for measuring larger dimensions. These are one item that are invariably calibrated in both metric and imperial



5. With the anvils removed the micrometer can be used for measuring steps.

units and are therefore a useful back up for the workshop that only occasionally moves from one unit system to the other.

For those who are not conversant with their method of measurement the following seeks to describe the principle, assisted by **Sk. 2**. The main scale is calibrated accurately along the full length of the calliper but the moving portion is engraved with a limited number of lines only, these being spaced at less than the divisions on the main scale as follows. For ease of describing the principle I will describe it in terms of whole millimetres though of course the vernier will be calibrated in much smaller increments.

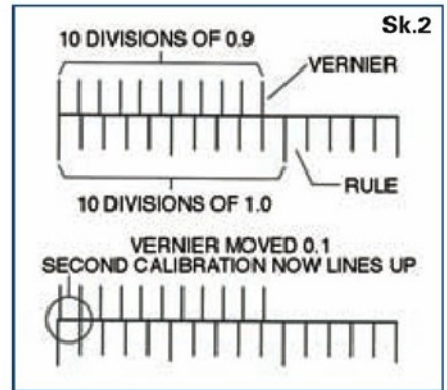
Assuming the main rule is calibrated in 1mm increments then the moving jaw would be calibrated in 0.9mm increments. Starting from zero, both zero lines would line up. However, the next calibration on the moving jaw would be just 0.1mm short of the next calibration on the main scale. To get the next two lines to line up, a jaw movement of only 0.1mm would be required. The jaw opening will therefore be 0.1mm. By this method, even though the rule is calibrated in 1mm divisions, measurements of 0.1mm can be achieved.

Height gauges

These, **photo 7**, also function using a vernier scale enabling then to be set in increments of 0.02mm (0.001in.) The most common height is 300mm though shorter ones are sometimes available. The shorter is likely to be adequate for most workshops and where this is not the case



6. For many years, the Vernier calliper has been the normal method for measuring larger dimensions, say 50mm plus, but has largely been replaced by its digital counterpart.



Sk.2

then the 300mm item should suit.

On some height gauges the main scale is adjustable, up and down, by a small amount so that all dimensions can be about some point other than the surface plate on which it stands. I do feel that this facility will be of little use in the average workshop so one without the adjustment will be more than adequate.

Dial type measuring instruments

These come in two types, Dial gauges and Dial test indicators, the latter often referred to as a DTI.

Dial gauges, **photo 8** left, have a plunger which when pressed causes the dial to rotate. Typically the range will be in the order of 12mm and the reading in increments of 0.01mm. However, dials with a greater range are available as are some with a smaller range and calibrated in much smaller increments, typically 0.001mm. The dial can be rotated enabling it to be zeroed at any convenient point.



7. A Height gauge is able to very accurately mark out and measure items on the surface plate.



8. Dial indicator (left) and a dial test indicator (right) plus mounting accessories



9. A DTI being used to ensure a component is running true in a four-jaw chuck.



10. A DTI can ensure a workpiece is parallel with the milling machine's table traverse.

However, as the pointer will rotate a number of times to cover the travel, a small secondary dial is provided to indicate the number of turns made. Unfortunately though, this cannot be zeroed. Mounting them is via the barrel through which the plunger works or using a lug on the rear.

Dial test indicators, **photo 8** right, work quite differently to dial gauges making the measurement using a pivoted arm, often referred to as the stylus. They also have a much smaller range and as a result their main purpose is as a comparator. In the workshop, the most likely usage is when setting a part to run true in the four jaw chuck, **photo 9** or to accurately position a vice or workpiece in line with the table's axis on the milling machine, **photo 10**.

Dial sizes are normally smaller with a dial of just 27mm diameter being common, larger dials are though available. As the indicator has a nominal range of just one revolution, a secondary dial to count turns is not required. Typically the dial will cover a range of 0.8mm with the dial calibrated 40-0-40 in 0.01mm increments. As with the dial gauge, the dial can be rotated so that it can be zeroed for easy reading. I stated above that they have a nominal range of one revolution but in practice there will be some overrun at each end, though it will normally be less than two turns.

The stylus has a friction mounting at its pivot that enables it to be rotated into the best position for the task in hand. This should be obvious by comparing **photos 9 and 10**. Also on some models, a small lever enables the direction of rotation of the stylus to be changed from clockwise to anticlockwise.

Whilst the longer measuring range of the dial gauge may be considered an advantage, the flexibility of the DTI enabling it to make tests in the most difficult locations makes it the number one choice. There will though be a few occasions where the greater range of the dial gauge will be beneficial. I would wait and see how the workshop's activities develop before purchasing one.

Either type of indicator will require a



12. These gauges are used in conjunction with a micrometer and or a calliper to measure internal dimensions. Those on the left up to 150mm and on the right 13mm.

range of accessories to enable them to be mounted for use, a subject that will be covered in more detail later in the series. **Photo 9** however, shows a typical set up.

Digital versions

Micrometers, verniers, height gauges and dial gauges are all now available in digital format. Whether you consider these worth purchasing will depend on your point of view. For me, the benefit of a digital micrometer is minimal, with the mechanical version being easy to read, but the situation with regard to a digital calliper is quite different. Vernier callipers are not that easy to read and the convenience of a digital readout is a definite plus. Therefore, despite disadvantages, reliability for example, I do feel that one is a must for most workshops.

With digital height gauges still being more expensive and having limited use, I recommend that if required you purchase a vernier type. Having made that point though, cost will no doubt continue to fall as it has done with the digital calliper.

Digital dial gauges are also now available and being digital do not have the problem of counting turns as the total reading is indicated at all times. I have also seen a digital DTI but with comparative tests being the normal use for this, the analogue meter wins hands down for me. Electronic devices will be covered in a little more detail in the next issue.



11. A set of imperial slip gauges.



13. A shop made precision level, often quoted as necessary for the initial setting up of a lathe. However, alternative and simpler methods are equally acceptable.

Slip gauges

These, in theory, can be very useful in the workshop to measure distances and to set up table stops and the like. Typically, if using a lathe to bore a hole to a depth of say 17.5mm deep then a pack of gauges to a size of 17.5 will enable the saddle stop to be easily set to this dimension. Whilst this is the case, they are made to a level of accuracy very much greater than the average home workshop requires, and obviously have a correspondingly high price. This of course prices them out for the vast majority of workshops. In another issue, on shop made items, I propose an alternative that I call Distance Gauges.

To complete the picture though, purely out of interest for the majority, slip gauges are made in sets of 87 metric blocks or 81 imperial blocks, **photo 11**. A metric set permits increments of 0.001mm and an imperial set increments of 0.0001in. In the metric set the smallest block is 1.001mm and the largest 100.000mm. However, some metric sets have an additional block of 1.0005mm enabling increments of 0.0005mm to be set up. Imperial sets start at 0.1001in. and go up to 4.0000in.

Smaller sets are available, 47 blocks metric and 41 blocks imperial. These still have the same range of blocks, maximum and minimum but less in between sizes. Even so, they can still achieve all the possible sizes within the range. They will though be limited if requiring setting up two or more stacks at the same time, either having the same or different dimensions.

Sine Bars

A sine bar's purpose is to accurately set up angles, but this is another item that is capable of greater precision than the average workshop demands. Even more important is that the angle is not presented in an easy to use method for most applications, this being best understood by looking at **Sk. 3**. Also, they will not function fully up to 90deg. They are not therefore an item that will find much use and I have included this detail for completeness, not to suggest that the reader should purchase one, rather the reverse.

Hole Gauges

Not strictly precision items in themselves, but devices very much involved in achieving a precise result are the hole gauges seen in **photo 12**. Above, internal micrometers were discussed and at the

smaller sizes, say up to 30mm, are a practical proposition. This is unlikely to be so for larger sizes due to limited use and at these sizes therefore, the telescopic gauges, (left of photo), are worth considering.

When using these, the two arms of the T, being sprung loaded, are pushed into the body and held in place using a locking mechanism. The gauge is then placed in the hole and the arms unlocked allowing them to spring to the hole's diameter and again locked. With this done, the gauge is removed and measured across the arm's ends using an outside micrometer or a vernier calliper. The set in the photograph covers the range 12.5mm to 150mm.

Those on the right operate quite differently. These have a ball end that is split enabling it to expand to the size of the hole being measured as a tapered inner is pulled into it. Turning the end of the handle does this. The width across the ball is then measured. This set covers the range 3 to 13mm. Both types are of course equally at home for imperial sizes, also width of slots as well as holes.

Precision Spirit Level

A precision spirit level is often quoted as necessary for the accurate installation of

a centre lathe and whilst helpful it is far from essential. This will be explained later in the series. Such a level is not therefore a required item but again I include this data for completeness.

Photo 13 shows a shop made version, which is typical of those available ready made. It is fitted with the most accurate vial available from the supplier and is easily able to detect an error of 0.1mm over a length of 1000mm. To put this into perspective, for my builders level, one millimetre in 1000mm results in a hardly perceptible deflection of the bubble. Also, the level in my engineer's combination set is no better.

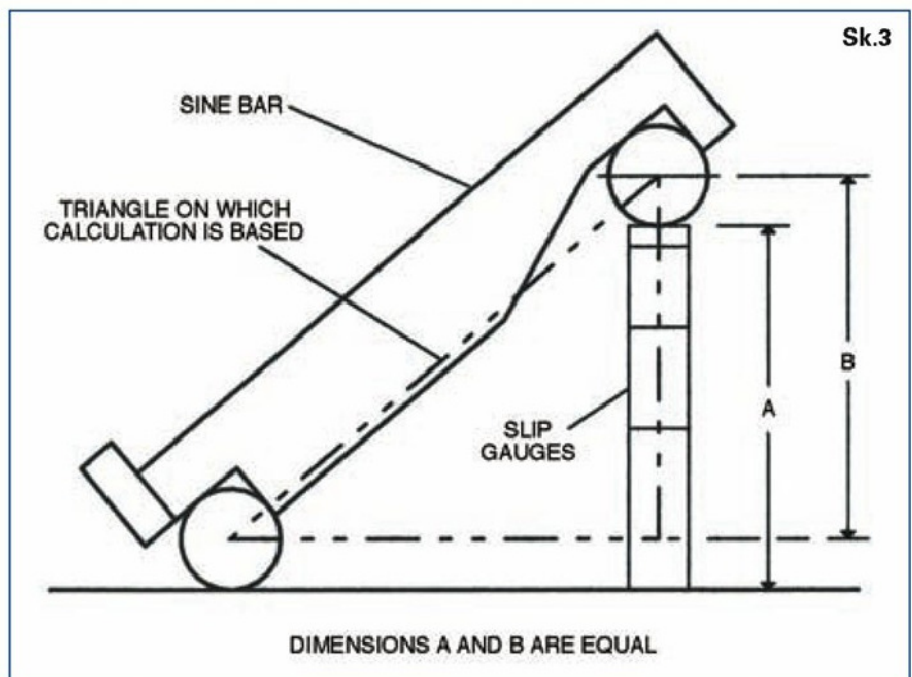
Parallels

These are items of tooling that will find a use in many applications, typically, marking out on the surface plate and positioning workpiece's on the milling and drilling machines. However, they are mostly made to an accuracy that puts them into the realm of a precision item even though in many applications this level of accuracy is not fully required.

Whilst there are some specials, the most common are the fixed width parallels, **photo 14**, with those on the left the ones that can be truly called precision. In this set, there are just four sizes, 1in. to 1 3/4in. in 1/4in. increments. The two large sizes being 1 1/2in. and the smaller sizes 3/4in. thick are thick enough to stand firmly on their edges but the range of widths is rather limited.

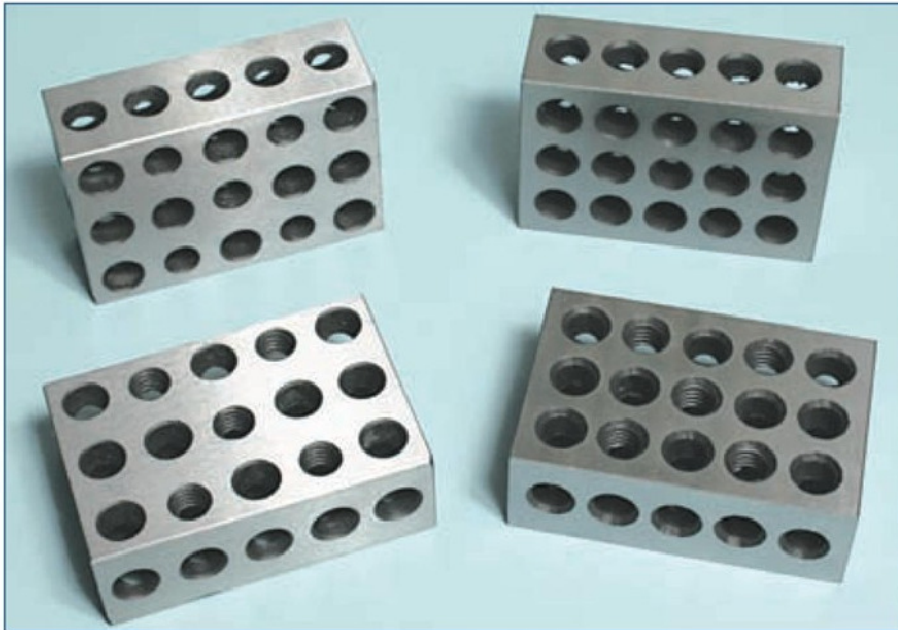
A common requirement for parallels is to pack up a workpiece within a vice so that machining can be carried out above its jaws. As workpiece thicknesses will vary, a range of parallel heights will be required and, if you work with more than one vice having different jaw heights the need will be even greater.

The parallels, right of photo, are a readily available budget set having 10 pairs of parallels from 1/2in. to 1 3/4in. The 1/2in. increment means that they will meet the requirement of different workpiece's and jaw heights. On the down side though, they are only 1/8in. thick and as a result will not stand reliably on their own. This





14. Parallels, precision, shop made and economy, left to right.



15. Parallels of a different kind, these are 123 blocks. So called because they are 1in. x 2in. x 3in. overall.

problem can be overcome when used between the vice jaws by placing a largish diameter compression spring between them though I cannot suggest that this is a convenient approach. Another minor disadvantage is that they are 6in. long, rather on the long side for most home workshop activity.

As an alternative, you may like to make some yourself, centre of picture. In this case you can tailor them to your own requirement and the process is not at all difficult. Hardly any, if any, of the requirements for parallels will benefit from the accuracy of the purchased sets and something a little less precise will be more than adequate.

The essential requirements of a pair of parallels are invariably not their actual width but that they are parallel and both the same height. This can easily be achieved as follows. Mount two round pillars on an angle plate, say at 75mm centres, and at nominally the same height. Using an end mill, very lightly machine their top at one pass to produce two narrow flats. These flats will then be parallel to the table traverse. Clamp two pieces of mild steel strip onto the faceplate ensuring they are in contact with the posts and lightly machine along the top edge. Turn over and repeat the process and you will have two lengths of steel, accurately parallel, and both the same width. Repeat

the process with other widths of material to produce the number you require. Their actual widths are not important providing the intervals between them are sufficiently small, say about 4mm maximum.

A quite different form of solid parallels are 1 2 3 blocks, so called because they are 1in. x 2in. x 3in. in size, **photo 15**. They

have 15 holes in the main face, five in the side and 3 in the end with some being clearance and others threaded. I find these extremely useful and like other parallels they are sold in matched pairs. Larger 2 4 6 blocks are also available as are 25 50 75 metric blocks, the latter though not that easy to find.

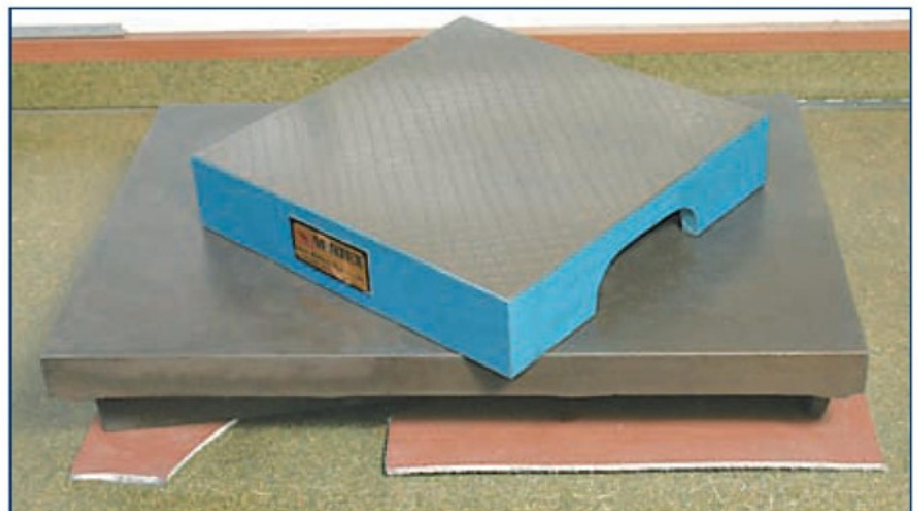
Another type of parallel are those known as wavy. These are made of spring steel and in pairs with a corrugated form that enables them to stand even though they are made from relatively thin steel. I have no first hand experience of these and wonder if the corrugations of a single parallel could be compressed between a vice's jaws enabling it to grip thinner workpiece's, could anyone confirm this. These are less accurate than other types and I doubt their benefit to the average workshop.

Finally, there are the adjustable parallels. These are made from two tapered halves that when slid, one on the other, the distance between the parallel sides can be made to increase or decrease. This enables the width to be precisely set to the dimension required where it can be locked. They are supplied singularly so if a need for a pair were required two would have to be purchased. The amount of adjustment is quite small and so 6 are required to cover the range of 10mm to 55mm.

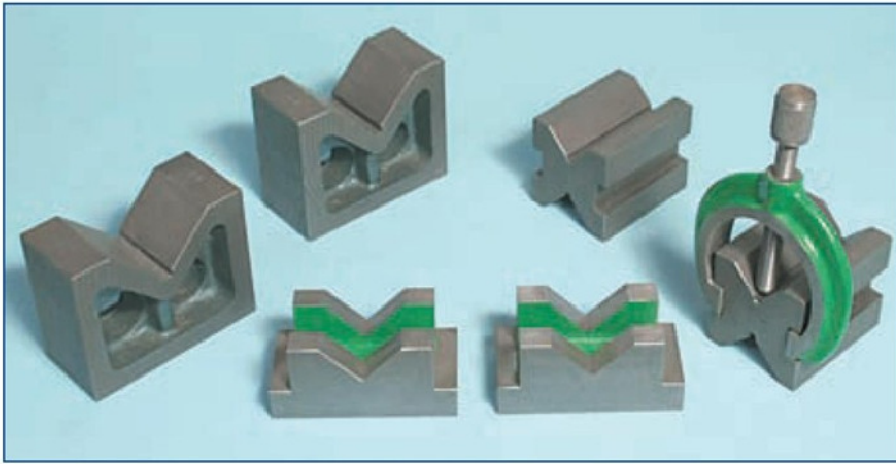
In terms of what the workshop should be equipped with, I consider the solid parallels with a small size increment, purchased or shop made, to be essential. A pair of 1 2 3 blocks would also be very useful. Others I would suggest should be left until a definite need surfaces.

Surface plate

Surface plates come in two types and a wide range of sizes, **photo 16**. There is also a third and economic alternative. Commercially available plates will be either cast iron or granite with granite having some distinct advantages. It is harder wearing and more stable with both time and temperature. Neither will it suffer from rust. Even so, cast iron plates have been used for many years and are perfectly adequate. Independent of size, prices seem to vary quite widely with granite plates normally being the more



16. Two surface plates, the larger having been rescued from an industrial workshop. It looks like it was used sometimes as an anvil I think, but it is still adequate for home workshop use.



17. Three forms of V block. Those on the left are made in large sizes but are less accurate than the precision ones shown on the right. In the front are two shop made blocks.

expensive, though not always.

It is therefore a good idea to check prices but this must of course be done with quality in mind. In this respect, workshop grade plates will be more than adequate, inspection grades being quite unnecessary.

Sizes start at about 250mm x 300mm, a size that will be adequate for the majority of workshops. Some will though have a need for a larger plate and 300mm x 300mm and 300mm x 450mm are also common.

If you do not feel you have the need for such an expensive item, or perhaps room to store one, as the larger sizes are heavy, then there is an alternative. A piece of plate glass, say 10mm thick being much thinner and lighter, will be easier to store away. The cost will also be less. On the down side it will scratch easily, though this is unlikely to be anything other than a visual problem.

Having obtained your surface plate, there are commonly two items of equipment used for marking out. The Surface gauge, discussed in the last issue, and the height gauge mentioned earlier in this issue. The surface gauge is not a precision item but the height gauge, mentioned above, is capable of marking out (and measuring) to within 0.02mm (0.001in.) Whilst this level of accuracy is not often required, it is much better than can be achieved with the Surface gauge and is much easier to use. This makes it a very worthwhile item for use in most workshops.

Equipped with a surface plate and a height gauge (or a surface gauge) there will still be other items needed so as to make best use of the set up. Whilst some workpiece's, typically those with a large footprint, will stand on the surface plate adequately on their own, others will need supporting. This does not as such create extra expense, as they are all items that are essential for use elsewhere and are an angle plate, V blocks and parallels.

The angle plate will be used to support thin items that would not stand on their own and will often be when a plate has to be marked out, typically for drilling a number of holes, (photo 7 showed an example). Angle plates will be discussed in detail in the section on milling.

V Blocks

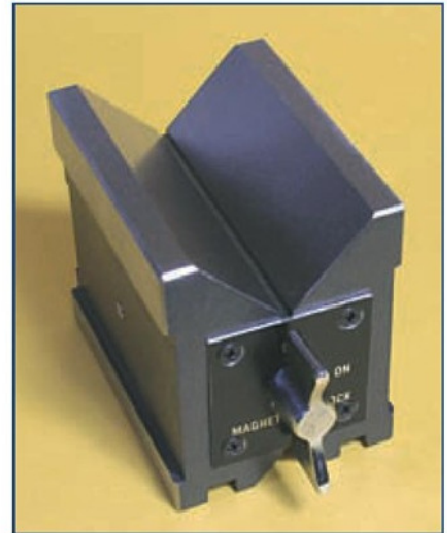
These are sold in matched pairs and are available in a large number of forms, sizes

and levels of precision, as seen in photo 17. Those shown on the left are the most basic but are made in by far the widest range of sizes, with footprints up to 8in. x 4 1/2in., maybe even larger. Blocks as per those on the right are made in a smaller range of sizes but have the advantage of including a workpiece clamp. They are also invariably made to a higher precision level.

It will of course depend on the workshop's purpose what V blocks will be required. However, for the majority of workshops a pair of those shown on the right would be adequate. If larger blocks were also considered a requirement, then a pair of those shown on the left with a footprint of about 4in. x 2in. would be useful. Incidentally, two useful shop made blocks are shown in the foreground.

Magnetic V blocks, photo 18 are also made that hold firm both the workpiece to the V block, and the block to the surface on which it is being used. Their main purpose is for inspection and marking out but they can be used for very light machining operations providing great care is taken. They have a means of turning on and off the magnetic force and are almost always sold as individual blocks. I have though seen a matched pair being advertised by one supplier.

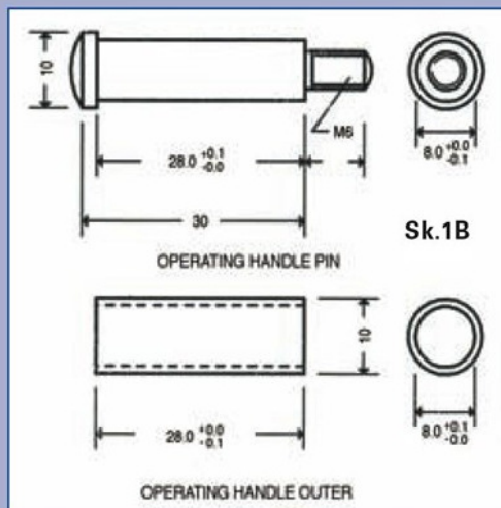
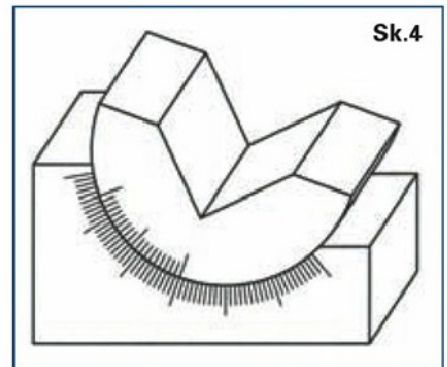
Sk 4 shows another form of V block, one where the angle of the V can be varied and to better than 10 minutes (1/6th. of one



18. A large magnetic V block. These are likely to have limited use in the home workshop.

degree). As with the magnetic V block, I have included this for completeness not expecting either to find a place in the average home workshop.

Most workshops will at some time find it beneficial to make some item of workshop equipment, most likely because an item is not available commercially. A few such items will be given an airing in the next issue. Also in the next issue, will be some discussion on the remaining general items such as, drive systems, electronics, machine installation, etc. before we begin to look at individual machine types one at a time.



Correction

SK.1B in issue 129 had the dimensional tolerances changed at the illustration stage.

Harold Hall's original drawing was correct. The corrected drawing is reprinted here.

USING THE LATHE MOUNTED MILLING HEAD ②

Harold Hall uses the lathe mounted milling head

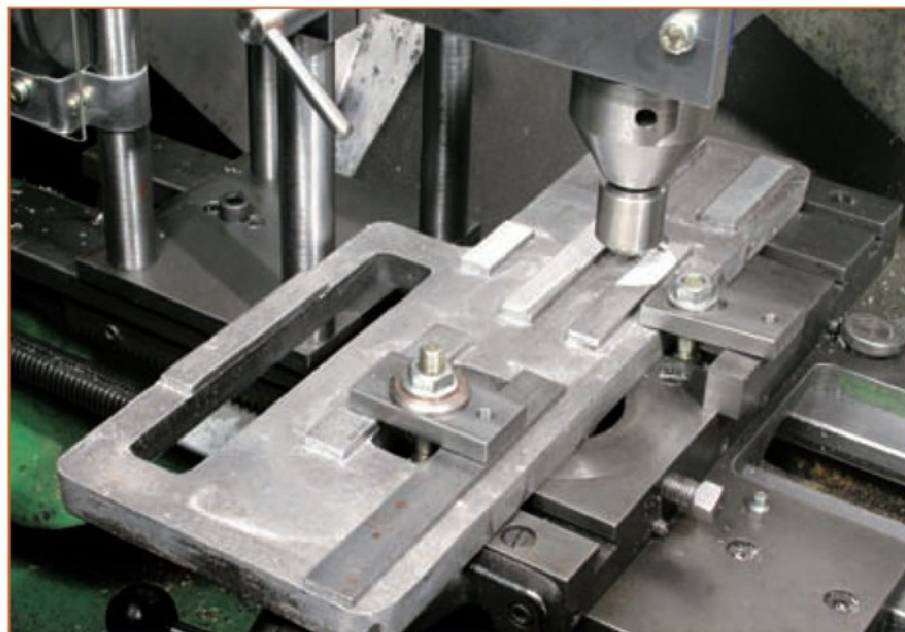
Having concluded the last part of this article with the mathematics of machining a barrel shaped connecting rod I am now returning to examples of using the milling head and as will be seen some of these regarding the cylinder block are quite complex.

Using the cross slide table

Having deviated into a largely turning operation I will now return to milling and illustrate some items being machined purely mounted on the lathe's table.

The greatest limitation of milling in the lathe is the size of parts that can be accommodated and the engine's base at 315mm long is quite a large item. However, this is made of aluminium and it was relatively easy to get the underneath sufficiently flat using a file and checking it against a surface plate. A high degree of accuracy is not required but sufficient to enable it to be clamped to the lathe's cross slide without it being distorted. With that done, I considered it possible to move the base on the cross slide so that the upper surfaces, seven in all, can be machined in stages.

Ideally, the four lands that support the cylinder assembly should be machined at one setting to ensure that these sit accurately at the same level. With a traverse requirement of about 150 mm



17 Machining five of the lands on the base.

and this being within the travel of my cross slide I considered that there would be no problem. However, I had overlooked the effect of the large overhang of the casting at the rear and found that this would contact the workshop wall before the full area was machined.

Turning the casting end on end, with the overhang at the front, looked a possibility but whilst the length could now be accommodated, the end mill could not quite reach the extreme width. This was due to the milling head's throat not being sufficient and the lands being further from the left hand edge than the right hand. Whilst I had reservations regarding using a flycutter with the head, due to the head's relative light weight construction, I decided to give it a try as the increased diameter would comfortably give the added reach required.

Being aluminium, I felt that I was in with a chance, and found this to be so as it coped easily, **photo 17**. This would be the same if requiring to machine gunmetal but I still have reservations regarding its use on steel. Of course, the diameter of the fly cutter and the depth of cut would be a factor. The photograph does show clearly that with the left hand edge being close to one of the head's columns that an end mill would not be able to reach the right hand side of the land being machined.

Having completed the first five lands the base was repositioned so that the remaining two could be machined similarly.

As all the remaining parts are small, the

size of table and the available travel ceased to be a problem, the two parts shown in **photo 18** being typical. These need to be the same height and to a given dimension. The setup made this easy to achieve with their height being measured using a depth micrometer between the two.

With the height having been machined, it was necessary to machine the sides to achieve the required width and centrally above the base (previously machined, see **photo 8**, last issue). The base being $\frac{3}{16}$ in. and the top $\frac{1}{4}$ in. To achieve this, a fence to position the part was set on the cross slide precisely parallel to the cross slide travel, being checked as shown in **photo 19**. With that done, the cutter could be set $\frac{5}{16}$ in. from the fence and each edge finished as shown in **photo 20**.

Flywheel

Departing again from milling, I will briefly comment on machining the flywheel. With care, even the base could be finished totally manually but unfortunately, as already mentioned, the flywheel is the one part that may make it impossible to produce the engine on one of the smaller lathes. This is a pity and it is certainly worth trying to find alternative means of machining it. The casting includes an extended boss, about $\frac{3}{16}$ in. diameter by $\frac{3}{4}$ in. long, obviously intended for holding the wheel in the three or four jaw chuck. However, being a rough casting and including a taper, it needed some



18 Two parts being machined at the same setting to ensure that they are exactly the same height.



19 Setting a fence parallel to the cross slide traverse for machining the sides of the part as seen in photo 20.

work doing on it to make this possible. I considered filing three or four flats onto it but ultimately chose to mount it onto the faceplate as seen in **photo 21**. The screws that clamp the wheel to the faceplate also pass through the packing pieces that can be seen. I chose to do it this way, as should the clamp become loose, the packing piece will still be captive.

In addition to the central boss, I also machined the outer diameter and the wheel's face on one side but still left a little for final finishing. I then reversed the wheel on the faceplate, fixing it using the same method, and machined the other side, concentricity not being vital at this stage.

Next, I mounted the wheel in the three-jaw chuck, holding it on the central boss now turned, and centre drilled the end. Whilst the wheel now only needed lightly machining on its outer diameter and sides I took the precaution of supporting it with the tailstock centre whilst these were machined, **photo 22**. With the tailstock centre removed, I then drilled and bored the through hole in the central boss. This sequence ensured that the bore and outer diameter were concentric but being a large casting it is not necessarily balanced. If the engine were to be run under steam then it would no doubt be worth attempting to improve the balance. Finally, I mounted the wheel on a taper stub mandrel and carefully machined away the temporary boss.

Drilling

I mentioned early in the article that I considered that the lathe with milling head should be augmented by the addition of a small drilling machine rather than attempting to do the drilling on the lathe also. In keeping with the spirit of the article, I have myself also done all the drilling work on the small drilling machine seen in **photo 23**. This is a five-speed machine with speeds from 500 to 2900rpm and coped with all but one of the tasks required of it, including the need for a $\frac{7}{16}$ in. diameter hole in the mild steel connecting rod and initially through $\frac{1}{2}$ in. thick material prior to it being reduced in thickness. The hole was drilled initially $\frac{1}{4}$ in. followed by $\frac{3}{8}$ in. and finally $\frac{7}{16}$ in. and

was of course firmly clamped in place for this process. The 500rpm minimum speed was rather fast for this but the machine coped reasonably well.

Photo 24 shows a typical task for the machine in which the bearing cap is being used to position the holes in the lower portion of the main bearings. This was followed by drilling the hole (prior to reaming) for the flywheel spindle, **photo 25**, and was the task where the problem surfaced. When using a standard drill there is a tendency for this is to be drawn in to the gunmetal casting. Because of this, the chuck was pulled from the taper on the machine spindle. Fortunately, I had, as one should for a task such as this, clamped the vice to the machine table as can be seen in the photograph.

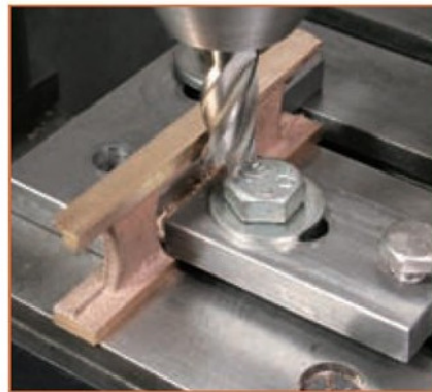
I should have removed the helix from the drill's cutting edge as is the norm for drilling brass and similar materials but as I normally work with mild steel, I was reluctant to modify my drill as I would then have to remove a fair amount of the drill to get back to a cutting edge suitable for my normal uses. With a lot of care and quite a few failures, I eventually managed to complete the two holes. One should really use the appropriate drill but even so, I had no problem drilling the large number of smaller holes in this material using standard drills.

Cylinder assembly

Finally in terms of machining activity I will comment on the cylinder assembly showing a few operations involved with this including two that show that the milling head set-up is more than a match for even quite complex tasks.

Whilst the cylinder block is quite large and certainly the most complex item that the engine requires, most of the activity is of a simple nature. As a result, they are tasks that I will not expand on.

Having accurately bored the cylinder block to the required diameter using the 1in. diameter of the locator jig to act as a gauge, the jig was again used to position the drilling jig for drilling the six holes on a PCD as seen in **photo 26**. Using the tapped hole on the rear end of the jig, a bar was clamped onto the other side of the cylinder that was then held in a vice as the



20 With the part located against the fence in photo 19, one of the top edges is machined parallel to the base.

photograph shows. The process was repeated for drilling the holes on the second end

As the cylinder end flanges have a 1in. spigot for locating them onto the end of the cylinder, this could also be located in the drilling jig allowing the jig again to be used for placing the holes on a PCD, **photo 27**. The four sets of six holes were therefore made with ease, but far more important, with a degree of precision that would not be possible by any other method

Photo 28 shows the partially finished cylinder block and end flanges and from this it can be seen that it is not possible to fully machine the outer diameter of the end flanges due to the positioning of its fixing feet. The design of the engine also



21 Carrying out the initial machining of the flywheel's outer diameter and the central boss.



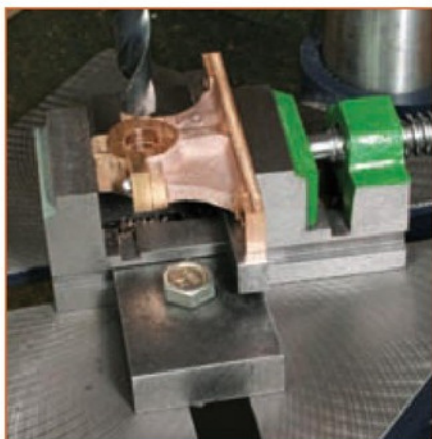
22 With the flywheel now held in the three-jaw chuck, the outer diameter and sides were finished to size.



23 A typical drilling machine to complement your lathe with milling head set up.



24 Drilling the bearing caps on the small drilling machine. Note that the vice should be clamped down.



25 Pilot drilling for the crankshaft on the small drilling machine.

calls for hardwood strips to be placed between the end flanges as insulation. However, as this is a rough casting, the inner faces are not that precise and making a tidy job of fitting the strips would be difficult and as the flange does not provide a complete circle, machining them on the lathe is not possible. Careful filling would improve the situation but as I am attempting to stretch the machinery to its limit I have used the rotary table to overcome both of these situations.

Photo 29 shows the inner surfaces being machined and **photo 30** the outer diameter. Whilst the workpiece locating jig (**Sk. 3**, last issue) was developed with small components in mind, a 1in. workpiece locator was made for this and used to position and hold the cylinder for both these tasks showing that it capable of dealing with quite large workpiece's.

One point worth noting regarding using a rotary table in the position shown in **photo 29** is that it is easy to fall into the trap of thinking that the end mill should sit on the crest of the curve being machined. This is not so as this would call for the cutter to cut on its end cutting edges, as the workpiece rises towards it, rather than predominantly on its side as is normal. The cutter must therefore be positioned with its leading edge on, or just, behind the crest.

High Speed

As the task undertaken in **photo 30** was using a 3mm diameter end mill, a higher speed than for other tasks undertaken was preferable. Whilst I had no doubts regarding running the actual spindle at high speed, I was a little concerned regarding the drive mechanisms. The belt I was using was not as flexible as I would have liked and as the idler pulleys were less than half the size of the pulley on the machine spindle they would run probably 2½ times as fast.

Despite these reservations, I set the lathe such that the milling spindle would run at about 1500 rpm and found that it coped well. As a result, for a subsequent task, I set the speed at 2100 rpm, again without any undue sign of stress. Only the idler pulleys becoming rather hot were not what I would have liked. It had though, been running for most of 30 minutes at 2100 rpm, probably an idler speed of around 5000 rpm. However, if a user were thinking of running the head at high speed and for long periods, then using ball bearings in place of the plain bearings would be worth considering.

The Plinth

Readers may be interested in my method of making the plinth that avoids the need to make a cut out to take the flywheel, though this was not the reason for my adopting the approach. The plinth needs to be at least 35mm thick and whilst I had two planks that were thick enough these were earmarked for the legs of a dining table. In any case they were sawn and would need thicknessing to check their grain patterns before I could decide if I could use a short length.

Readers who do some cabinet making from time to time may be aware of the advice to "keep your timber as long as you can for as long as you can", in other words, use your short lengths before cutting short pieces from longer planks.



26 Using the drilling jig (Sk.1, last issue) with a location bung to drill the cylinder block ends.

I had just one short piece available but this was only 25mm thick. By cutting strips 38mm wide and using these on edge the thickness required could be achieved. With the strips available the plinth was fabricated as **photo 31** shows and a use for another small off-cut had been found.

Setting the spindle perpendicular

This crucial requirement was briefly mentioned earlier but unfortunately was overlooked in the article regarding the milling head's construction. If the spindle is not perpendicular then one edge of the cutter will be lower than its opposite edge.

If the direction of the traverse is such that the lower side is either leading or lagging then the result will be to produce a concave surface. However, this, if slight, will be of no importance, unless you are using a very large diameter fly cutter. If the lower edge is to the side of the cutter then the result will be a surface with a saw tooth form. As it will be necessary at some time to make cuts left to right and back to front, if the spindle is not perpendicular then the saw tooth surface is bound to occur. How can this be avoided with the milling head being used here?

There are two potential errors and of course a combination of the two. First, the bottom of the spindle can be out of position left to right as viewed from the front. In this case, as the spindle is held via the four holes C in the spindle mount (**C18**) the clearance between the holes and the fixing screws will allow some measure of adjustment. If this proves insufficient, then some, or all four, of the holes could be enlarged to increase the adjustment possible.

An error, back to front, is at first sight more difficult to deal with. However, the method of checking for errors should be with a dial indicator being swung on an arm mounted from the spindle and onto the machine's table. From this, using the error found, it will be easy to calculate



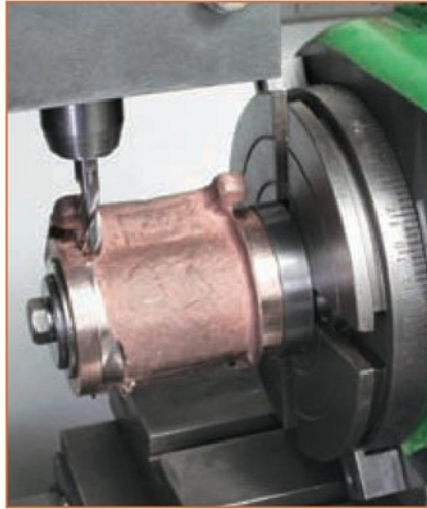
27 Using the drilling jig (Sk.1, last issue) to drill the cylinder end covers.

the amount of packing required between one of the spindle mounting brackets (C4) and the spindle mount (C18) to minimise the error.

It must of course be realised that perfection is unlikely to be achieved and some error will have to be accepted. The aim is to reduce the error to a point that the effects are hardly discernible. Even commercial machines have a permitted error in this respect, albeit very small.

Some final thoughts

Having completed the milling head and written the three part constructional article it was almost a year before I found it possible to start work on the steam engine "Tina". During this time I began to have doubts as to whether the milling head would be worthwhile proposition and had I wasted time and money on making it and writing the article. However, having started the engine's construction, I soon began to realise that my fears had been quite unnecessary. Of course, I had to accept that it could not perform in terms of size of workpiece's possible and rate of metal removal as my much larger mill/drill, but I soon found that the satisfaction of using it was the equal if not an improvement to using my milling machine, especially as



29 Two complex milling operations on the cylinder block using a rotary table that clearly shows the extent of tasks that can be carried out using the milling head.

the parts being machined were so small. It is far superior to using a vertical slide. Setting up for machining a component is so much easier on a horizontal table. The larger table and greater traverse also makes it easier as well as permitting larger components to be worked on.

A major plus was that I had power feed to both the saddle and the cross slide, my mill/drill being manual in both axis. This enabled me to make progress on other simple tasks, if only putting a few tools away that were not being used, whilst the milling head was completing a single pass. I would though add that I consider it essential that power feed of the saddle is always away from the head as the much greater traverse available makes a disaster much less likely should one become distracted for a short while. If you were still unhappy with the idea then some simple form of warning device would be easy to set up.

For readers who are unfamiliar with power feeding the cross slide, this has an auto stop when feeding the slide in and if



30 Two complex milling operations on the cylinder block using a rotary table that clearly shows the extent of tasks that can be carried out using the milling head.

left when feeding it out the leadscrew eventually disengages itself from its nut. The potential for a disaster is therefore all but eliminated. That is of course assuming that the workpiece, or the item it is mounted on, does not prevent the traverse from passing the workpiece completely.

What then are the negative aspects of using the head and its design? Well almost none if that does not sound too smug. Avoiding adding and removing the head too much throughout a project does make the work being undertaken rather one track for a while. Because of this, I would have liked to be able to do some turning for a change, that having been said, adding or removing the head is only a matter of five minutes work.

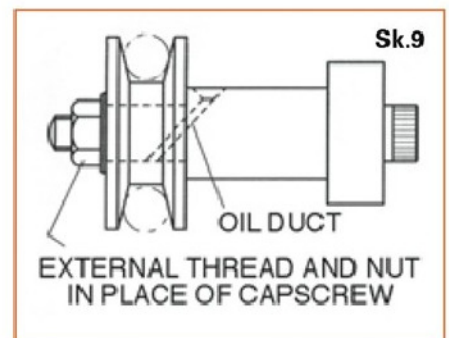
Minor change

A very minor change that I made during its use was to fit wing rather than hexagon nuts for fixing the shrouds. The reason for this was that I needed to have access to the draw bar quite frequently and I also found that the idler pulleys need lubrication from time to time. The latter I feel warrants a design change to add a lubricating duct to each idler assembly. Sk. 9 shows my proposals for this.

My only major dislike of the system really is nothing to do with head's design but with a feature of my Myford Series Seven. This uses the leadscrew to power the cross slide power feed and because of this the half nut has to be opened to avoid the saddle also traversing. As a result, the



28 The cylinder block drilled and tapped for the end covers.



readings on the leadscrew hand wheel cease to have any relevance to the machining taking place. Having completed a pass it then becomes a little difficult to add on a further cut with any degree of certainty. Some lathes do have I think a separate shaft for this purpose and if so the problem would not surface.

Fitting a digital readout would overcome the problem but I did not wish to break away from the job in hand to fit such a device so had to accept the situation as it was. I have though some ideas that I think would make the fitting easy using a standard 150mm calliper and will make the required parts to prove the set-up. If this works, I will produce a short article for the editor to use.

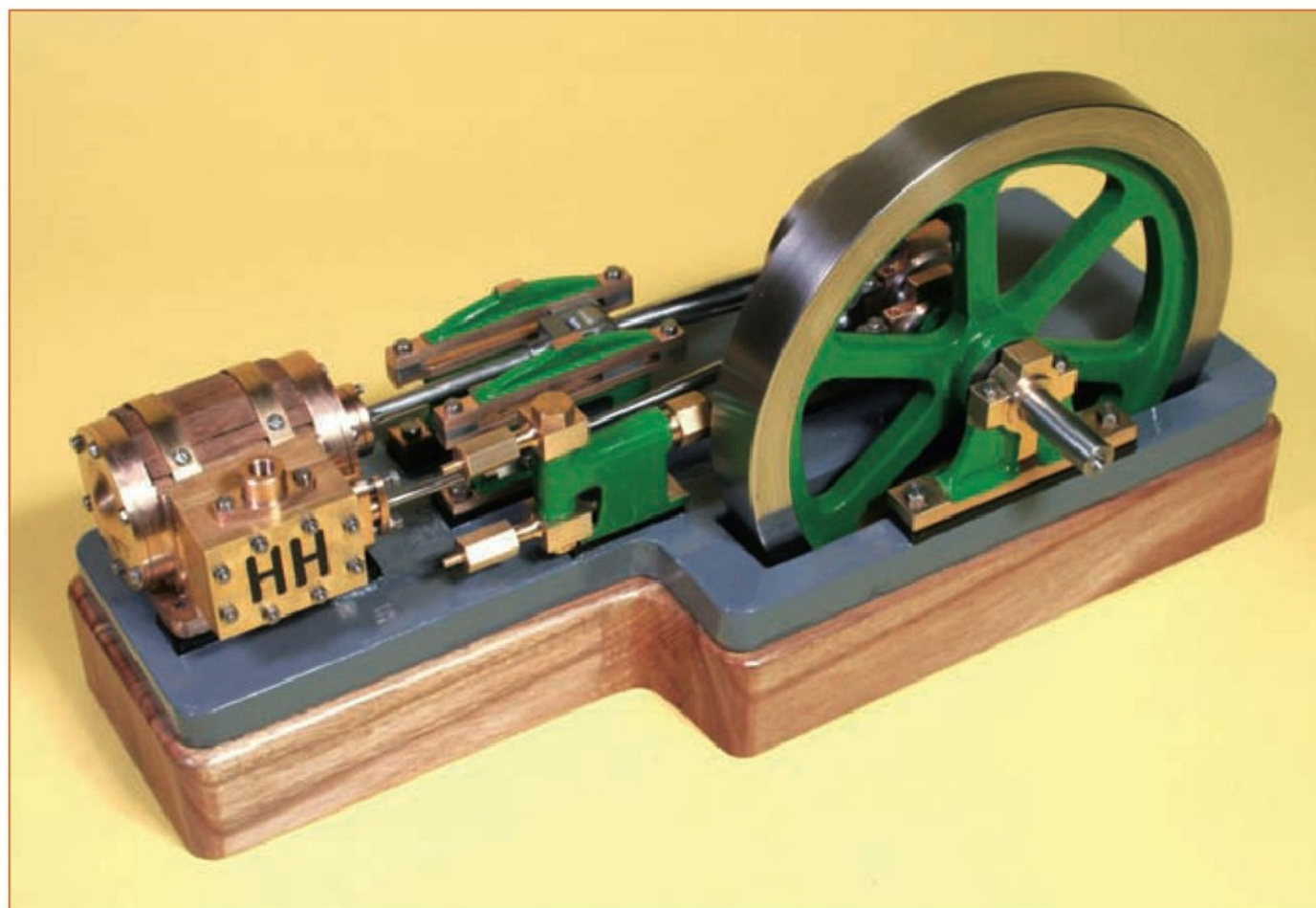
Minor modification

I also have a simple modification in mind that will increase the throat depth by around 25 mm and the cutter to table headroom by 15 mm without sacrificing rigidity. Should this prove satisfactory, I will include it with my brief article on adding a digital readout?

In a nutshell then, I consider the head worked like a charm, far exceeding my expectations and consider that this is illustrated by the numerous examples that I have published. If you only have a lathe then the head is relatively easy to construct, especially as it does not require a milling machine for this, and its possession will add a new perspective to what you can achieve in your workshop as is seen by the completed steam engine "Tina"  photo 31.



31 The plinth was fabricated from a small off-cut of American Red Elm.



32 The completed engine, 'Tina'. A satisfying project for any workshop owner to have completed, but even more so on the set up used in this article.

A USELESS GIFT PUT TO USE

I have a friend who visits various engineering firms as a consultant. Typical of industry, when something becomes redundant it is thrown in the scrap bin. He rescued a set of collets in a wooden rack and gave them to me. They were probably not all of the same set as the logo and size stampings were of various styles.

There were 16 collets ranging from $\frac{1}{16}$ in. to $\frac{7}{16}$ in. with $\frac{3}{16}$ in. & $1\frac{3}{16}$ in. duplicated. They were $3\frac{3}{16}$ in. long with a body diameter of $\frac{1}{4}$ in. The drawbar thread was $1\frac{1}{4}$ in. x 12 TPI left-hand Whitworth. This was all very nice, but with the mandrel bore of my lathe measuring only 20mm, I could not see how the collets would be of any use to me.

After some thought, I decided that if a body was made to accept the collets, with a threaded ring used to draw the collet into the body and close it, this could be fitted to the lathe. The face of the collet would only protrude 20mm further than the tips of the jaws of the 4in. three-jaw chuck normally used.

I was fortunate to have some pieces of large diameter FCMS, also ex scrap bin,



Jim Whetren makes use of redundant collets

which would make up the chuck components. The body was from a 40mm length of 100mm dia. And the nose was from a 70mm length of 70mm dia. Incidentally, were the materials to be purchased, current price lists show a 2in. length of 4in. dia. is £6.50 and a 3in. length of 70mm dia. is £4.62, which is £11.12 plus postage of £5.95. Less than £20.00, which is not a lot when a commercial chuck with a set of collets ranging from 1/16in. to 1in. would probably run to hundreds of pounds. The other small parts were already to hand.

I will describe my chuck purely out of interest, and to illustrate the point that if given something which at face value seems to be of no possible use, give it some thought and you may be able to use it after all, and gain a very useful piece of equipment.

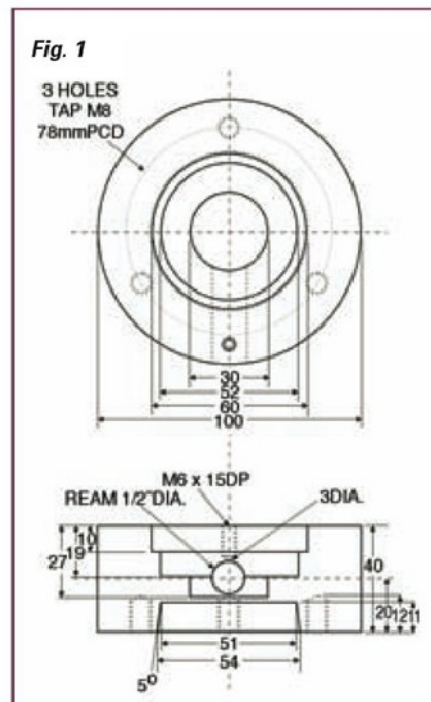
The body Fig. 1, photo 1

The 100mm lump was held in the outside jaws of the three jaw chuck with the OD as square as possible to the chuck face and light facing cuts were taken to remove all the sawing marks. The piece was reversed and pushed hard back into the jaws and the other end faced to length. This face was centred and drilled out to 1/2in., then bored to 25mm dia. turning a small chamfer on the outer edge.

As the mandrel of my lathe has a short taper to locate chucks, the next job was to taper bore the body blank to be a good fit on this taper. The finished bore size is 54mm OD and 51mm ID for a length of 11mm. This is achieved with the top-slide swung round to 5 degrees, having confirmed the setting by traversing the nose taper on the mandrel with a dti set on centre height. Three M8 tapped holes are required in this face on a 78mm pcd to



Photo 1



accommodate the bayonet ring studs. This diameter was carefully marked on the piece and with headstock dividing, the three hole positions were lightly centre punched before removing from the chuck and drilling and tapping the holes M8 for a depth of 12mm. The studs were removed from another chuck and temporarily screwed into these holes to enable the embryo body to be secured to the lathe mandrel to carry out the machining on the other side and thus ensuring concentricity.

Before remounting the piece, it was a good time to drill and ream the $\frac{1}{2}$ in. dia. hole in the side for the pinion. An interrupted boring cut is more desirable than drilling the hole with half the diameter in the inner portion of the material missing.

First, the body was bored 59mm for a depth of 10mm for the 60mm x 1mm thread to locate the Nose. A 1mm deep undercut was made at the bottom about 2mm wide to allow the screwcutting tool to run out. Then it was bored 52mm dia for a depth of 9mm for the screw ring and finally bored to 32mm dia for a depth of 8mm to form the seat for the screw ring and to clear the collet thread. It was then set up and screwcut 60 mm x 1 mm and this outer edge was chamfered. With these short threads the mandrel handle comes into its own.

The M6 threaded hole was marked out for the dog ended grubscrew used to secure the pinion on the centre line of the 1/2in. hole drilled earlier, at 7.5mm from the

outside diameter. This hole was initially drilled 3mm dia. right through then opened up to 5mm for a depth of 15mm and to 6mm dia. for a depth of 2mm then the M6 thread was tapped. A short portion of the 3mm hole is left at the bottom to locate the dog of the grubscrew.

The nose Fig. 2, photo 2

Remount the three-jaw chuck with the outside jaws fitted. The facing and initial boring operations were as with the previous piece, only this time bored to 30mm dia. and a small 30deg. chamfer formed on the outer edge of the bore. With a pipe centre, or failing this, an adaptor to fit the running centre, the end was supported and turned down to 60mm dia for a length of 9mm and an undercut 1mm deep and 2mm wide cut for runout and to ensure the piece seats squarely on the body. The 1mm pitch thread was screwcut, using the body to gauge progress and final fit. Then a light skim was taken from the shoulder to ensure it is square to the thread, chamfering lightly.



Photo 2

Fig. 2

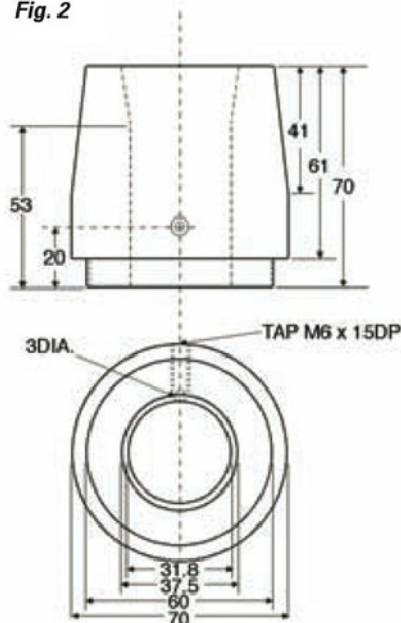


Photo 3

The chuck was then removed.

Remounting the body and screwing the nose into the body tightly, check that the unit runs truly in the bore. The bore in the nosepiece was then opened up to the final diameter of 31.8mm, using a collet as a gauge. With the topslide set over to 10deg., the taper bore for the collet closure was turned 17mm deep, finishing the outer edge at 37.5mm dia. to bring a fitted collet flush with the end of the nose. With the same taper setting, the nose was tapered, finishing at a length of 41mm. This was for appearance and to lighten the bulk. A large radius was formed on the end to match the face of the collets.

The nose was removed, marked out and drilled for the M6 thread for the key at 20mm from the threaded end. Again starting with a 3mm drill right through, opening out to 5mm for a depth of 12mm and 6mm to a depth of 2mm, finally tapping M6.

The geared nut Fig. 3, photo 3

As the nut had to be screwed onto the collet from outside the chuck, the only means I could think of was a form of bevel gear arrangement. I do not have the tools, knowledge or mathematical ability to produce a set of bevel gears. All I knew was that a form of right-angle drive was required for the Nut. Having examined the various drill chucks that I have, the teeth on the ring and key were of quite a basic profile, and given the easy fit of the key spigot in the hole in the body and the loose meshing of the gears, the turning action was quite smooth, so this is what I did.

A 12mm length was cut from a piece of 52mm bar and one end faced in the outside jaws, the piece reversed and the other end faced to clean up. With a pointed tool, a shallow mark was made



Photo 4

around the piece 2mm from the face. The topside was then swivelled round to be at 26 degrees to the face (a scale reading of 64deg.) and a bevel turned until the mark was reached. The piece was reversed in the chuck and with the bevelled end pushed against the jaws, the chuck was tightened and further facing cuts taken to bring the piece to length at 9mm.

The piece was centred and drilled through 1/2in. dia. and bored out to 29.6mm for the thread to be screwcut left-handed. A collet was used as a thread gauge for a good fit.

The Cowells lathe was setup with the indexing head on the vertical slide at 26deg. to the mandrel and with a 34 tooth wheel fitted, the teeth were cut with a 3mm endmill to a depth of 2mm. When this was finished there were a lot of square ended tapering teeth with square parallel gaps. I then ran a countersink along the gaps to remove the corners of adjacent teeth.

The pinion Fig. 4, photo 4

A piece of 1/2in. dia. bar was chucked and the end faced. With the topslide set this time at 26deg. to the side of the bar, a bevel was turned to leave 7mm dia. at the centre. The bar was parted off at a length of 24mm. This was now reversed in the chuck and centred and drilled 7.9mm to a depth of 12mm. The head of an M8 Allen bolt was sawn off with 14mm of plain shank, the end squared off and well chamfered before pressing it in to the pinion piece. The head was given a skim to bring it to the same diameter as the pinion and a 3mm undercut made behind the head to a depth of 2mm. The parts were later cross-pinned for security. The same procedure as before was followed to cut the 6 slots in the pinion face.

The keys Figs. 5 & 6, photo 5

These require no comment. They are M6 socket grub screws 18mm and 14mm long with a 3mm dia. dog on the ends as per the drawing.

The stud & nut Figs. 7 & 8, photo 6

Again no comment as it was straightforward turning, threading and milling as per the drawings.



Photo 5



Photo 6



Photo 8



Photo 9

The Moment of Truth - the assembly, photo 7

The pinion was fitted into the body, well oiled and secured with its key screw. The nut was dropped into the body with some valve grinding paste smeared around the teeth. The back of the nut was oiled and the nosepiece screwed on to locate it. With the body gripped in the vice, there followed some vigorous Allen key twiddling in both directions to bed the parts in. When the movement felt satisfactory, all was dismantled and the parts thoroughly washed in paraffin. The chuck was reassembled with grease on all moving parts and a collet fitted, **photo 8**. Although there is serious winding to fit or remove the collet, only a quarter of a turn or so is required to grip or release a work-piece.

The two spare collets were fitted with small strips of $\frac{1}{16}$ in. material in the slots to stop them closing and fitted into the chuck where the $\frac{3}{8}$ in. one was opened out to $\frac{3}{4}$ in. and the $1\frac{3}{16}$ in. one opened out to 1in. This now gives a full set covering $\frac{1}{16}$ in. to 1in. by $\frac{1}{16}$ in. and has turned out to be quite a useful addition to the workshop after all!

I know the bevel cutting is laughable but hey, it works so who cares?

Photo 9 shows the collet set stored in a finger-jointed hardwood box. Another useless gift, a portable fingerprinting kit?



Photo 7

Fig. 3

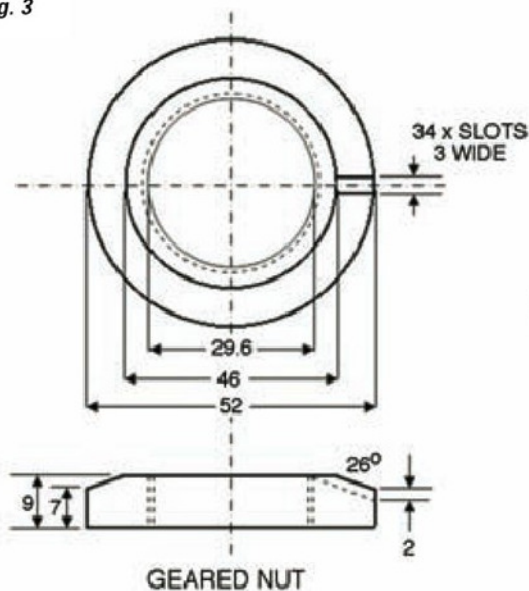


Fig. 4

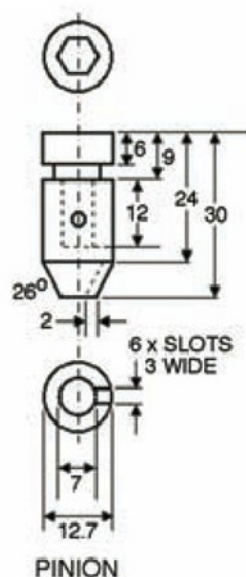


Fig. 5

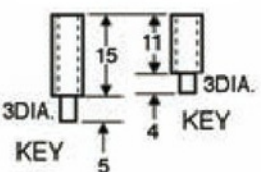


Fig. 6

Fig. 7

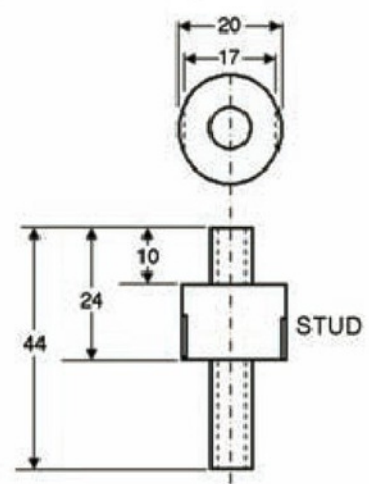
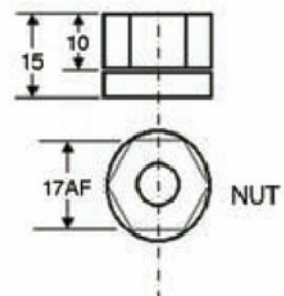


Fig. 8



GEAR CUTTING WITH FORM MULTITOOTH

Background

A friend presented me with what, if I had been a professional clock repairer, would probably have been a simple problem to solve. His long-case clock had a broken tooth in an idler wheel between the winding arbor of the clock and the barrel arbor. This wheel was about 16mm diameter, with 20 teeth, pressed onto a 13mm long 4mm diameter shaft. The clock itself is more of sentimental value than monetary value, as it is a fairly modern piece. Even so, I was reluctant to take the obvious route of cutting out a section of the wheel, grafting in a new piece of brass, and cutting to shape. That is definitely a one-way trip, as once you have fouled up the original part, there's no way back without making a completely new part. So it seemed to me that the best approach was to make a new wheel and shaft and to leave the broken part alone in case my efforts proved to be futile and he ended up having to find a more competent repairer.

Tony Jeffree makes a simple gear-cutting form tool

0.7 module cutter

On close inspection, the tooth form of the damaged wheel and its two neighbours from the adjacent shafts looked to me like Involute rather than the Cycloidal form traditionally used in antique clocks. A quick search through the pages of a gear catalogue showed that the outside diameter of a 20T, 20deg. pressure angle, 0.7 module gear was a close match. So, the obvious but expensive solution would have been to buy a conventional No.6, 0.7 module, multi-tooth gear cutter and whiz off a 20T gear. However, the fact that I didn't particularly want/need a No.6, 0.7 module gear cutter for any other purpose made me look for other solutions.

I have had many conversations with John Stevenson over the years on a wide range of engineering topics, and I recalled one such conversation on the subject of gear cutting using CNC, where John was describing the old Sunderland gear cutting machines that use a "planning" technique with a rack form cutter, and suggested that this technique might lend itself to adaptation for CNC. After a cutting stroke,

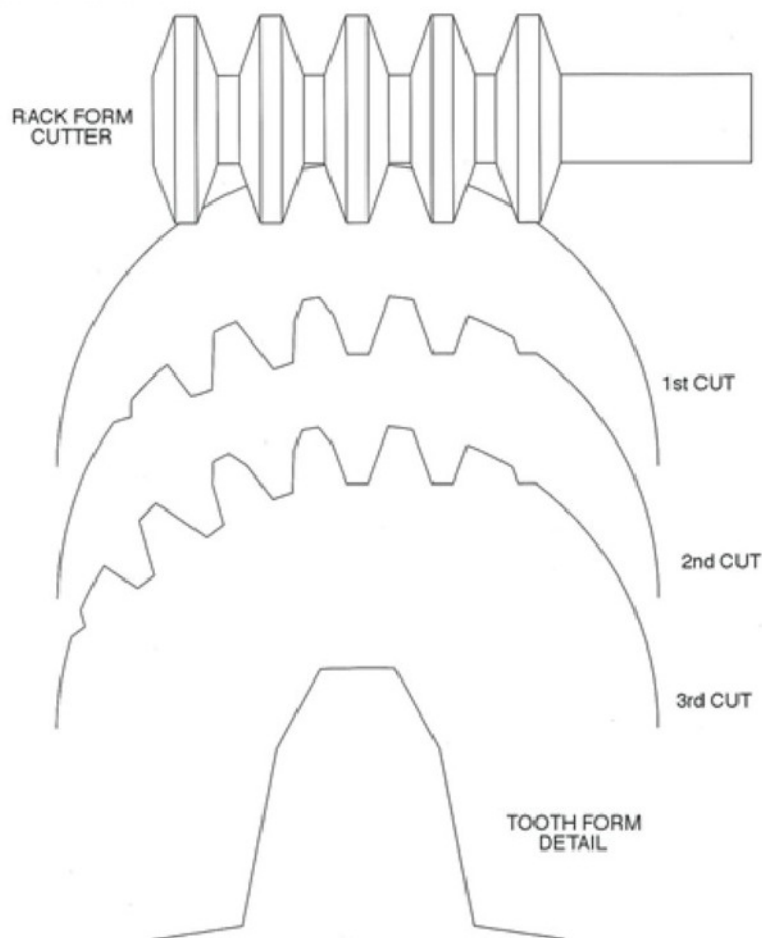
the gear blank is rotated a small amount, and the cutter is advanced in the same direction, along a tangent to the circumference of the blank, by a corresponding small amount. This process is repeated until the blank has rotated by a full tooth, at which point the rack is moved back by a tooth position and the process starts again. This results in a near-perfect generated Involute gear form – because the cutting involves discrete steps, the surface of each tooth will actually be a number of facets; however, make the number of cuts per tooth large enough and this isn't an issue.

Single point cutter

The CNC connection here was that it would be straightforward to make up a single point fly cutter with the right rack tooth form, and the coordinated movements would be easy to achieve using CNC. Hence, for the investment of the time needed to grind up a single point cutter with the right dimensions for a given module size, you could readily cut gears with any number of teeth from not very many right through to rack.

Talking the problem through with John, he suggested an alternative method that would lend itself to more conventional gear cutting approaches. Instead of a single point fly cutter, it wouldn't be hard to make a cylindrical cutter with a rack tooth form – this would at first sight look rather like a hob but instead of generating the teeth by screwcutting at the correct pitch for the rack, you take a series of plunge cuts with a rack-form lathe tool, the cuts spaced apart by the module size of the desired rack. In other words, the basic cutter looks like a rack that has been wrapped around a cylinder. Cutting teeth can then be formed by gashing, hardening, and finally honing of the cutting edge. And yes, if you want to go the whole hog and form-relieve the cutting teeth, you could do that too, although for my purposes, cutting a gear in brass, it seemed likely that I could get away

Fig 1: One cut per tooth, 20 teeth



1 The crude boring bar holder and home made collet used to hold the HSS blank.

A RACK CUTTER

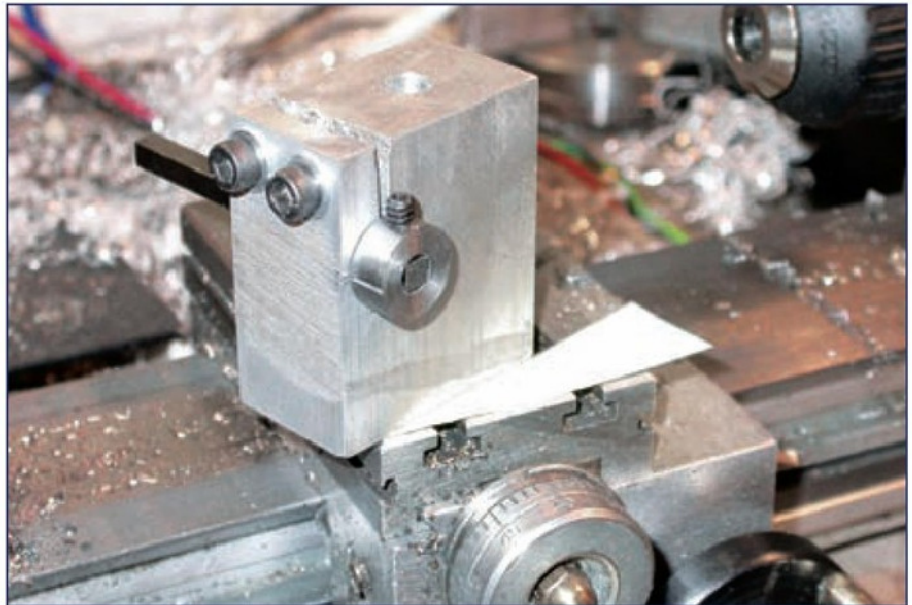
without bothering with that refinement.

The appeal to me of this approach was that I wouldn't even have to think about the CNC programming needed to do the "proper" job (although in reality, this should be fairly simple) – instead, I could press my "CNC gear cutting engine" into service (described in MEW issue 96), which makes use of a stepper-motor driven dividing head, and still get the desired result. For practical purposes, the technique would be the same as using a conventional multi-tooth gear cutter; you take a cut, advance the blank 1 tooth, take a cut...etc., with the difference that the cutter would cut (parts of) more than one tooth at the same time. How many teeth the cutter will span depends on the tooth count of the gear being cut – the more teeth, hopefully the more accurate the final tooth form would be, as the cutting action would more closely emulate the action of the "shaping" approach. Attempting this with a 20 tooth gear seemed a bit of a stretch, but I thought it was interesting enough as an idea to give it a try, and in the particular application to hand, accuracy of tooth form wasn't a big consideration as long as the final gear would mesh well enough with the existing gears.

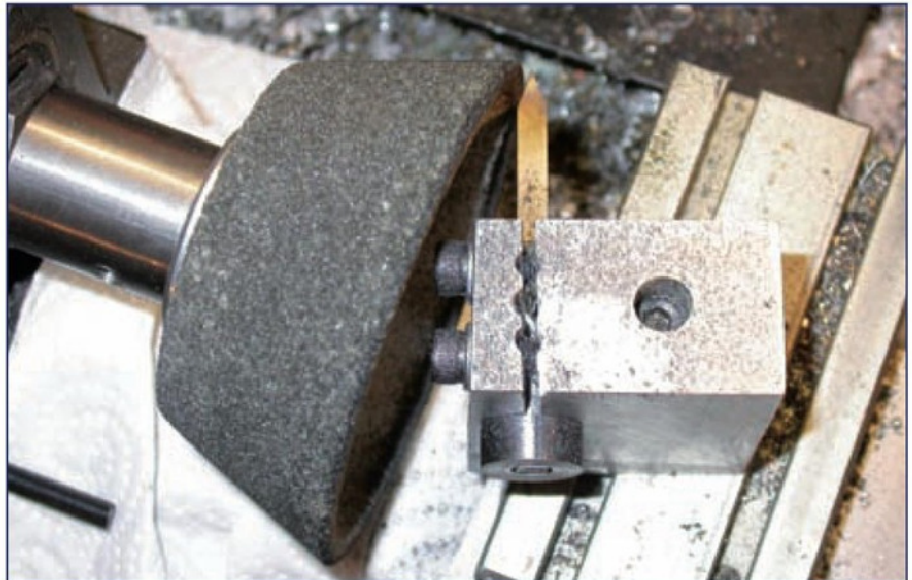
Tooth form

Fig. 1 shows diagrammatically the progress of cutting when using a cutter of the form described, taking cuts to full depth, and rotating the blank a full tooth per cut, and also shows the resultant tooth form. One of the things that surprised me (maybe it shouldn't have if I had thought about it more) is that only the central cutting tooth and the adjacent flanks of its two neighbours do any real work when cutting a low-count wheel – the final tooth form is basically formed by just two facets on each of the flanks of the teeth. The root of the tooth is the basic rack form, but the tip of the tooth is a little narrower. If you increase the tooth count to 40 teeth, **Fig. 2** you start to detect a bit of undercutting at the base of the teeth, and this will increase, as the tooth count gets larger.

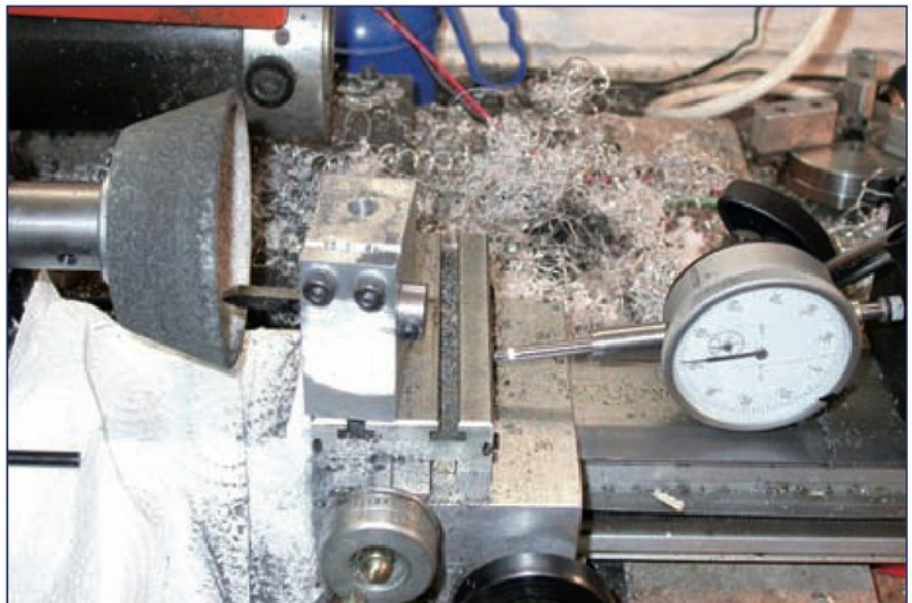
Fig. 3 shows what happens if you take two cuts per tooth-space on a 20 tooth blank – the first cut with the cutter at the central starting position, as in **Fig. 1**, and the second after rotating the blank by $\frac{1}{2}$ a tooth position and advancing the cutter in the same direction, along a tangent to the circumference of the blank, by $\frac{1}{2}$ the linear pitch of the rack (the linear pitch being equal to pi times the module size in mm). The detail of the tooth form shows that this produces a much closer approximation to the correct Involute form, and again, shows the beginnings of some undercutting at the base of the tooth. **Fig. 4** shows the results of doing 4 cuts per tooth, and clearly demonstrates what one would expect, that the more cuts you take per tooth the nearer the tooth form will get to the correct



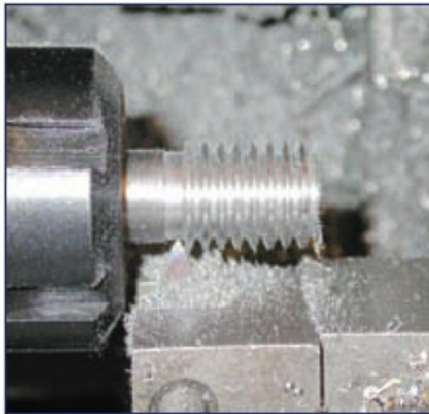
2 The holder in position, with a paper 20deg. "protractor."



3 The flanks of the cutter being ground, using a cup wheel mounted on the Taig spindle.



4 A dial gauge touching on the saddle allows the infeed to be measured accurately.



5 The next stage is to cut the grooves in the rotary cutter, using the lathe tool.



6 The cutter after "gashing" with eight longitudinal cuts.



7 The cutter and the wheel blank set up in the wheel-cutting engine.

Fig 3: Two cuts per tooth, 20 teeth

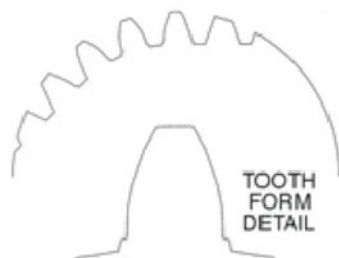
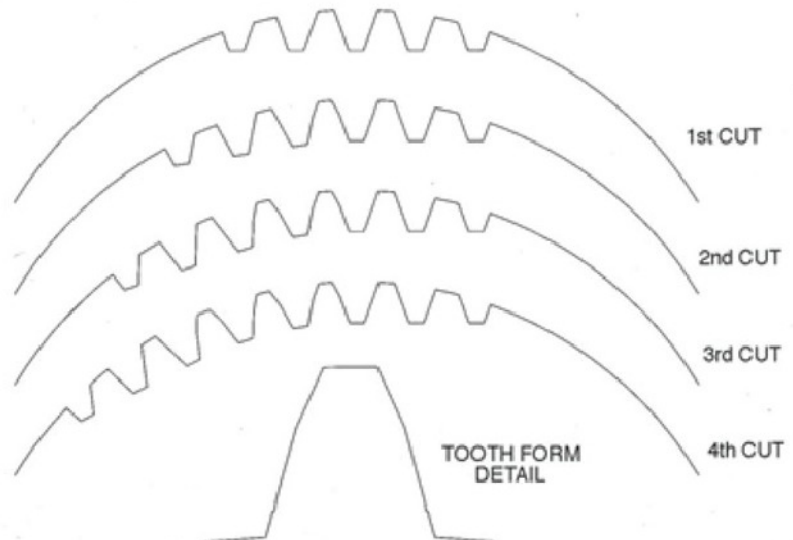


Fig 2: One cut per tooth, 40 teeth



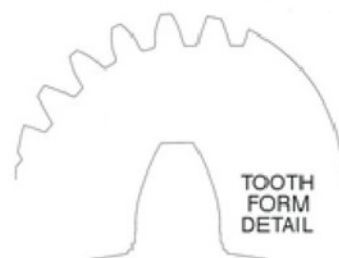
generated form.

What these diagrams illustrate is that this is a gear cutting technique that can potentially be adjusted to suit the application and the time available. In some cases, a single cut per tooth will be "good enough" (as was the case in my application – the wheel that I cut using this method is now installed in the clock's winding train and works just fine). In others, increasing the number of cuts per tooth will give a more accurate, and appropriate, result. In practice, to do N cuts per tooth, you would probably start by cutting all of the teeth at an initial setting, using the "one cut per tooth" approach, keeping the cutter position constant and advancing the blank one tooth per cut. You would then advance the dividing head by $1/N$ th of a tooth, and the cutter by $1/N$ th of the linear pitch, and then go round the wheel again, repeating the process for N cuts per tooth in total. This is potentially fairly tedious if N is large and you are using a manual dividing head, but on the other hand, making the cutters is easy to do and most importantly, cheap.

Theoretical cutter dimensions

The technique described here uses a single-point form tool to cut the grooves in a cylindrical cutter, and in turn, the cylindrical cutter is used, in place of a conventional multi-tooth gear cutter, to cut the final gear teeth. It follows that the single-point form tool should be an accurate replica of one tooth of a rack made to the appropriate module size (a rack being just a gear with an infinite number of teeth).

Fig 4: Four cuts per tooth, 20 teeth



Chapter 7 of Ivan Law's excellent book "Gears and Gear Cutting", number 17 in the Workshop Practice series, describes the formulae necessary to calculate the tooth proportions and depth of cut, and these can be used to work out the proportions of the corresponding form tool. In my first "stab" at this, I cheated and used the table at the bottom of page 88 of the book, which is strictly speaking intended as a table of dimensions for a single point cutter to cut a worm to mesh with an Involute spur gear. In practice, this proved to be close enough, although probably not entirely correct for what I was doing. When interpreting that particular table, please note that the table's headings got messed up in the typesetting so careful reading is required!

Using the discussion in Chapter 3 and the formulae in Chapter 7, one reaches the following conclusions:

D (the depth of an Involute gear tooth) is exactly twice the module size.

However, the teeth are cut slightly deeper than this to allow an additional clearance, f , at the base of the tooth; Ivan's book gives f as $1/20$ th of the circular pitch. As the circular pitch (or in the case of a rack, linear pitch) of a module gear is π times the module size: $D+f$ is 2.157 x (module size).

$D+f$ is the total length of the tooth, and is therefore also the total depth of the tooth space (measured from the OD of the gear), so this is also the depth of cut necessary when cutting the grooves in the cylindrical cutter, and the depth of cut necessary when using the final cutter to cut a gear. So, in my case, cutting a 0.7 module gear, $D+f$ should be 1.51mm. This is the same as the figure quoted in the table at the bottom of page 88.

The width of the tooth at the pitch circle diameter should be equal to $\pi/2$ x (module size). Therefore, the width of the tip of the rack tooth (and therefore the tip width of the form tool) should be:

$((\pi/2)-0.739)$ x (module size) for a 20deg. pressure angle, or

$((\pi/2)-0.517)$ x (module size) for a 14.5deg. pressure angle.

For my 0.7 module, 20deg. pressure angle gear, this gives a tip width of 0.58mm, which is rather wider than the

0.51mm quoted in the table. I believe the difference here is simply a reflection of the fact that the table is intended for a different purpose – cutting a worm, rather than cutting a groove in a gear cutter.

Making the cutter

The first step is to make the single point lathe tool with the appropriate tip shape to cut a rack of the right module size. I used a length of 1/8in. diameter HSS to make my lathe tool, and temporarily converted my Taig lathe to a cutter grinder for the purpose. I already had a rather crude boring bar holder that I was able to press into service to hold the HSS blank, as can be seen in **photo 1**. I made up a collet to hold the HSS blank that allowed me to rotate the blank either side of horizontal to get the necessary relief on the cutting edges of the tool.

Photo 2 shows the holder in position, with a paper 20deg. "protractor" to set the angle of cut. **Photo 3** shows the flanks of the cutter being ground, using a cup wheel mounted on the Taig spindle. The blank was ground to a sharp point, and then the tip accurately ground off to give the right tip width – a bit of elementary Trig gives the amount of infeed necessary to grind off the point and give the right tip width:

Infeed = (tip width) x 1.374 (for a 20 degree pressure angle), or

Infeed = (tip width) x 1.933 (for a 14.5 degree pressure angle)

A dial gauge touching on the saddle allows the infeed to be measured accurately **photo 4**. Adjust the setup so that the sharp tip of the cutter is just touching the grinding wheel, zero the dial gauge, and feed the cutter into the wheel by the required amount.

The next stage is to cut the grooves in the rotary cutter, using this lathe tool.

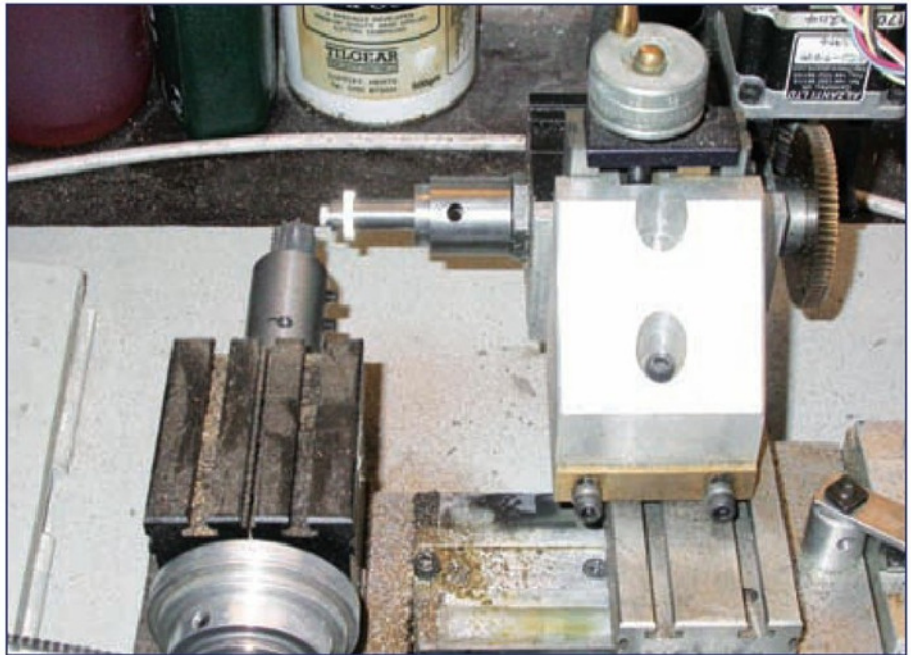
Photo 5 shows this in progress; I ended up making a 7-tooth "rack", overkill given the conclusions I reached later when drawing up the diagrams (see "tooth form" above). In practice, there is little point in making the "rack" longer than 3 teeth. The lathe tool proved to work very well, giving clean chatter-free cuts in the silver steel bar I used for the cutter. The spacing of the cuts is exactly the circular pitch in mm corresponding to the module size of the cutter, 2.2mm in the case of my 0.7 module cutter.

Photo 6 shows the cutter after "gashing" with eight longitudinal cuts to below the bottom of the "rack" grooves – this was done by hand using a Dremel fitted with an abrasive disk, and is rather crude, but it did the job all the same. After hardening the cutter in the usual manner, a final lick with the Dremel gave very serviceable cutting edges on the teeth. I didn't bother to temper the tool at all, on the basis that the heat generated by the final honing of the cutting edges and taking the first cut would do this for me, and in any case, cutting leaded brass with this kind of tool would be unlikely to damage a "glass-hard" cutter.

Cutting the wheel

Photo 7 shows the cutter and the wheel blank set up in my wheel-cutting engine. I positioned the blank so that its axis of rotation lined up with the central tooth of the cutter, as can be seen in the photo.

Photo 8 shows the overall arrangement of the wheel cutting engine – this is based



on Peatol/Taig lathe components (see **MEW** issue 96), with the cross slide giving movement to align the blank and cutter, the vertical slide to control cut depth, and the saddle traverse allowing the blank to be passed across the top of the cutter. The dividing head is stepper-motor driven, controlled by one of my Divisionmaster controllers, and steps on automatically when the saddle is moved to the right against a limit switch. However, there's no reason why a similar approach shouldn't be taken using conventional manual dividing techniques.

Photo 9 shows the resultant 20-tooth gear (right) and the original broken gear (left). The photo shows clearly the fact that each tooth is basically 5-sided (two facets on each flank and a square top); however, in practice it meshed very well with the original gears on either side, which was the important point. **Photo 10** shows the new gear with its shaft in place in its plate, meshing with one of its neighbours.

Conclusions

This approach has the benefit of allowing a gear cutter for the desired module size to be made very simply, using materials to hand in the workshop. While the cutter as described may not prove to be entirely satisfactory for cutting harder materials, due to the lack of "form relief" on the cutting edges, the cutter works very well in softer materials such as brass and aluminium.

The "one cut per tooth" technique, while not generating the ideal Involute tooth form, produces a tooth form that can actually work where the application doesn't require critical accuracy. However, by increasing the number of cuts per tooth, as described, it is possible to approach more and more closely to the ideal Involute tooth form, so the degree of accuracy of the final tooth form can be adjusted if necessary to suit a more critical application. For those with access to a CNC mill, it would be a simple matter to generate the necessary "G" code that would allow this kind of cutter to be used to generate Involute gears of any tooth count, and with a highly accurate tooth form.



8 The blank positioned so that its axis of rotation lines up with the central tooth of the cutter.



9 The new 20-tooth gear (right) and the original broken gear (left).



10 The new gear with its shaft in place in its plate.

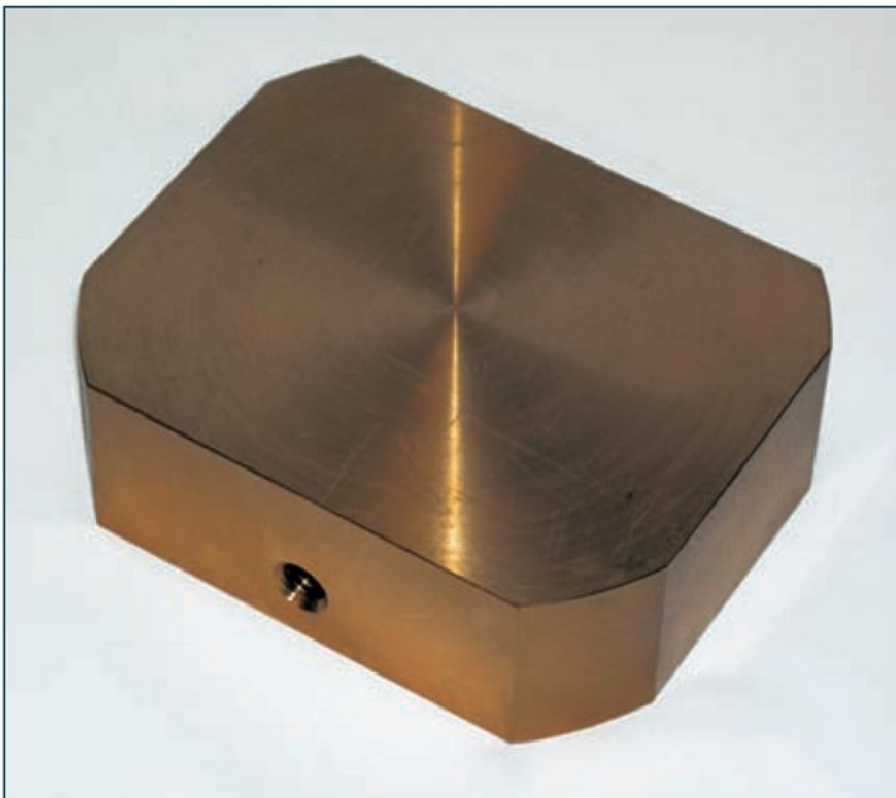
References

"Gears and Gear Cutting" by Ivan Law, Workshop Practice Series No. 17, ISBN 0-85242-911-8. available from www.myhobbystore.com or customer services at Magicalia.

The Divisionmaster automatic indexer is obtainable from L.S. Caine Electronic Services, 25 Smallbrook Road, Broadway, Worcs, WR12 7EP. Tel: 01386-852122.



1 The original cracked casting.



2 The material as a basic square block.

Peter Worden refurbishes an old bandsaw

Introduction

I was recently given a Whitehead vertical band saw from someone who was moving house but couldn't take it with him. It was kept for many years in an unheated and uninsulated garage. Consequently it developed a severe case of the matt brown finish.

As the machine had to be dismantled to get it home in the back of my car, I decided to clean it up and maybe modify it, if necessary, before reassembly. On inspection it was found that the trunnion, if that is what it's called, the quarter round bearing between the frame and the table that it rotates on to enable angled cuts to be made, had been over tightened at some time and being a casting it had cracked as can be seen in **photo 1**.

As it was also bent out of shape, it was possible that this would cause the table to be out of square so it was decided to make a new one, the dimensions of which are shown in **Fig. 1**.

This is not so much an exercise on how to make a part for a Whitehead band saw, as I don't suppose there are too many readers needing to make such a specific item, but more a project on one way to go about making an awkward shaped component.

There are other ways to make this item, either from a casting or from large diameter tubing. A one off casting would probably be a bit costly and there is the problem of holding the part to machine it.

The tubing route would be easier to machine but sourcing a piece of tubing 5in. diameter with a 1/2in. wall thickness might prove to be a problem and after machining, the tube would have to be cut into four pieces along its axis. If only one item is required, then the other three would be destined for the scrap box unless quantity production is the aim.

The method chosen here is to machine it from a solid block, mainly because being a recently retired self-employed engineer, I had a piece of 5in. diameter brass left over from a job, which was wide enough and I had the tools and machinery to make it.

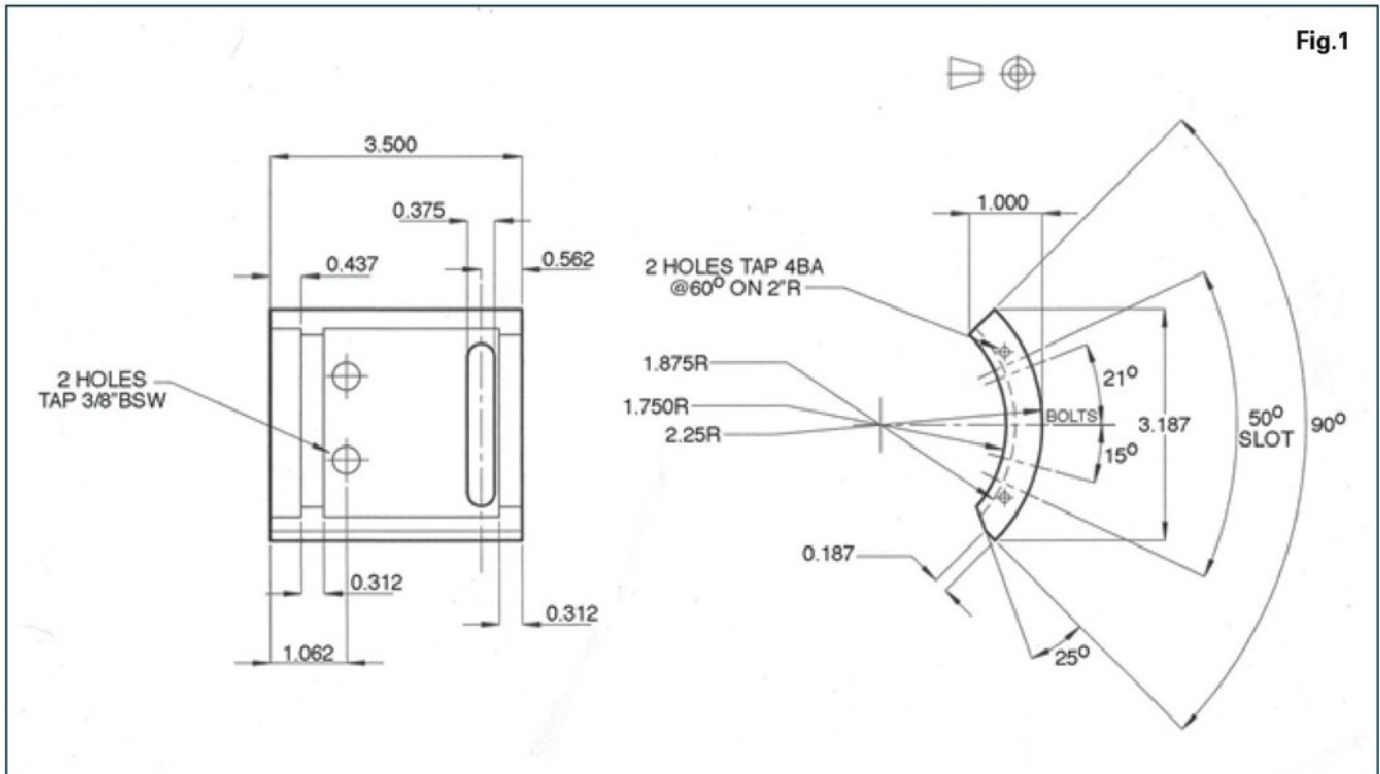
Preparation

The first operation was to face both sides in the lathe then transfer to the milling machine to produce the oblong-ish block as in **photo 2**.

The idea was to hold the block in the lathe off-centre and turn the external and internal radii. But to mount the block as it



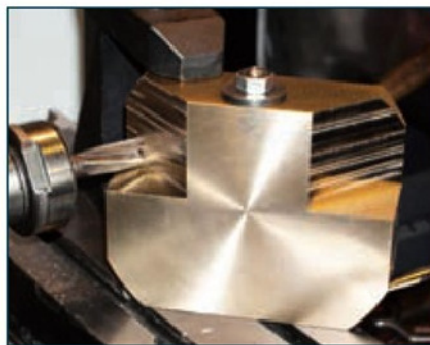
3 The fixture mounted on the rotary table.



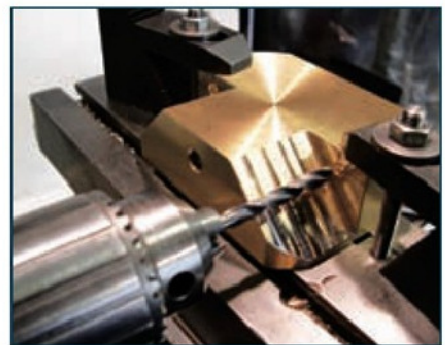
ONE WAY TO MAKE AN AWKWARD SHAPED OBJECT



4 The fixture transferred to the lathe.



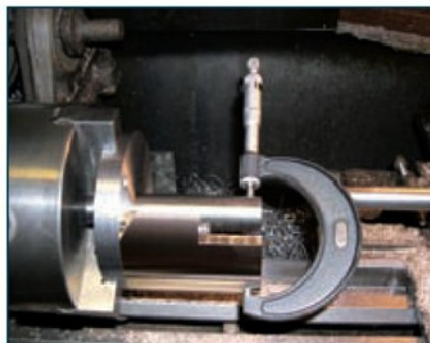
5 The waste metal was removed at 45deg.



6 Drilling the fixture mounting holes.



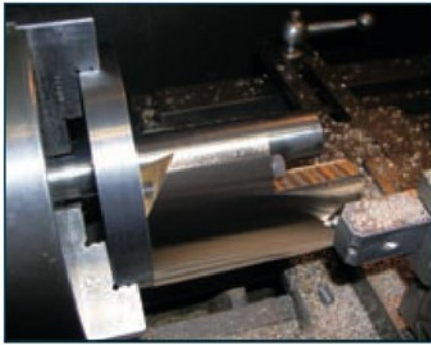
7 Rough milling the outside diameter.



8 Measuring the outside diameter.



9 Rough milling the inside radius



10 Finish turning the outside.



11 Measuring the inside diameter.



12 The inside shape after relieving the centre.



13 Drilling the holes.



14 Milling the slots.

is, it would be a bit out of balance and would probably cause the machine to take a walk around the workshop. So some material had to be removed to make it lighter. This was best done in the milling machine.

As the part has to be roughed on the mill, turned in the lathe and then the holes and slot machined back on the mill, it was decided to make a fixture that could be transferred from one machine to the other with the component bolted to it, as shown in **photos 3 and 4**. The fixture consists of a disc located centrally and clamped on the rotary table on the mill for roughing and then held in outside jaws in the lathe to do the finish turning.

The two bolts holding the part to the fixture need to be in line with and between the outside radius and the largest inside radius so that the bolts won't be machined away when turning in the lathe. So as to use shorter and more rigid bolts, two steps were milled at 45deg. as in **photo 5**.

Rough milling the outside radius

The two bolt holes were drilled, **photo 6**, and the part was bolted to the fixture,

see **photo 3**. The rotary table axis was set at 90deg. to the axis of the milling machine and then the outside radius was rough milled by rotating the rotary table, **photo 7**. The 1in. dia spigot through the fixture was used to measure the radius as in **photo 8**. This was achieved by adding the radius of the spigot and the roughing radius of the component.

Rough milling the inside Radius

The rotary table was reset so that its axis was parallel with the milling machine axis and the inside radius was rough milled, **photo 9**.

Once enough material had been removed to make it light enough to swing without too much vibration it could then be transferred to the lathe.

Turning the outside radius

In the lathe the outside radius was turned first, measuring as before, **photo 10**. On my lathe the spindle takes 5C collets so the 1in. dia spigot could be held in a collet through the fixture, and the fixture held in the chuck. My lathe, incidentally, is an American Hardinge which can still out perform most modern machines, especially the Chinese imports, even though it is 90 years old this year.

Turning the inside radius

Then with a boring tool the smallest inside radius was turned measuring the thickness as in **photo 11**, using a 1/4in. dia ball attachment on the anvil of the micrometer.

The attachment in question is basically a tube 1/16in. larger in diameter than the anvil of the micrometer. One end is bored to a snug fit on the anvil; the other end is bored to accept the ball, preferably 1/4in. diameter, using an angled boring tool, deep enough to allow the ball to enter the first bore and make contact with the anvil.



15 The finished component.

Overall length of the attachment should be made to allow a quarter of the diameter of the ball to protrude, and then crimp the end to trap the ball, see **Fig. 2**. When using this attachment don't forget to subtract the diameter of the ball to obtain the correct measurement of course.

The smallest radius of the component is the actual bearing surface. The clearance radius, in between the bearing surfaces, was turned with a radiused boring tool to achieve the result shown in **photo 12**.

The threaded holes and the slot

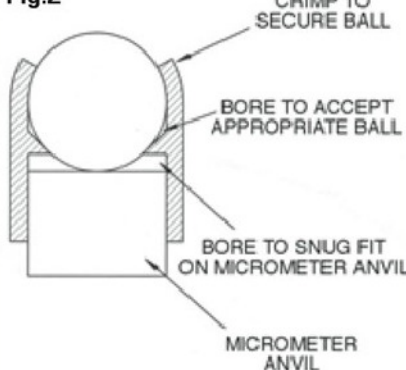
When the turning was finished the fixture was transferred, with component attached, back to the rotary table on the milling machine and its axis was set at 90deg. to the machine axis. The screw holes were drilled and tapped, **photo 13**. Then the slot was milled, **photo 14**.

The component was then removed from the fixture and the mounting-hole pads were milled off and we ended up with something like that in **photo 15**.

There you have it, one way to make an awkward shaped object.



Fig.2



FITTING A 3-AXIS DRO TO A TOM SENIOR VS MAJOR MILL

**Brian Corfield improves
George H. Thomas's original
Tom Senior mill**

Background

This article is based on my experience of fitting a 'Sino' SDS2-3MS (3-axis) DRO to George H. Thomas's original Tom Senior VS Major mill, **photo 1**. It is important to ensure that the locations of the scales are free from interference and can operate freely throughout the anticipated travels of the knee, saddle and table. In particular, the telescopic table drive spindle may interfere with the rear edge of the Y-axis scale cover when the table is positioned at the outermost extension and highest practical machining height. Similarly, the X-axis scale is vulnerable to being squashed against the column and it is recommended that saddle stops are put in place. I considered fitting the X-axis to the front of the table but I am loath to remove the table travel dogs and table power feed knock-off lever. The use of a right-angled drilling attachment is necessary to fit the X-axis reading head if the table and saddle are left in place. Otherwise the fitting process is reasonably straightforward.

Tools Required

I used the following tools:
Electric variable-speed drill
Right-angled drilling attachment (for drilling rear of saddle)
3, 4 and 5mm taper and second taps
Small T handle tap wrench
DTI
Metre rule
Adjustable Square
Scriber
Thin permanent marker (remove with T-Cut after fitting components)
Centre-punch

Other bits used (not supplied)

20 off, sticky backed cable tie pads
1 off, 80mm length of 19mm x 40mm

square section tube to secure Z-axis reading head bracket to saddle
1 metre of single strand plastic covered wire to fit between the DRO unit PE terminal and an earth on the machine
4 off, 3mm x 25mm countersunk screws to fit aluminium brackets to Z-axis backing plate
1 off, 70mm of 50mm x 50mm x 6mm aluminium angle

The DRO Package

The kit (as delivered from Allendale Electronics) contains all the necessary fittings, fasteners and comprehensive (English) installation instructions, except for the 'other bits' mentioned above. An additional X-axis installation guide is

available on the www.machine-dro.co.uk web site and should be read first. Note the method of finding the centre of the table travel, as this is important. The same method is used to find the centre of the Y-axis travel. The Z-axis is set up slightly differently as machine geometry and practicalities dictate its position.

Fittings for the Tom Senior VS Major Mk I

I used the following DRO and scales to fit my Mark I machine – it has the motor mounted on top of the column. If your machine is different, you will need to find the maximum travel on each axis and select a scale reading length that is at least, and preferably longer, than the maximum travel. If not, the excess travel will need to be limited by some form of mechanical stop.

The scales come in standard and 'slim' sizes. I chose the slim GS500 series for the X-axis to minimise loss of Y-axis travel towards the column and the standard GS300 series for the Y and Z-axes. B and D type scale covers with scale mounting plates are essential.

My chosen kit comprised:

SDS2-MS3 3-axis DRO with support arm, bracket and notes table
X-axis scale – GS500 520 with D type cover with scale mounting plate
Y-axis scale – GS300 170 with B type cover with scale mounting plate
Z-axis scale – GS300 470 with B type cover with scale mounting plate

Fitting the DRO Support Bracket

I fitted the support bracket to the right hand side of the column just below the top left hand corner, **photo 2**. On the VS Major there is a pad screw, which holds the horizontal overhead milling support arm in place. The bracket was placed below this

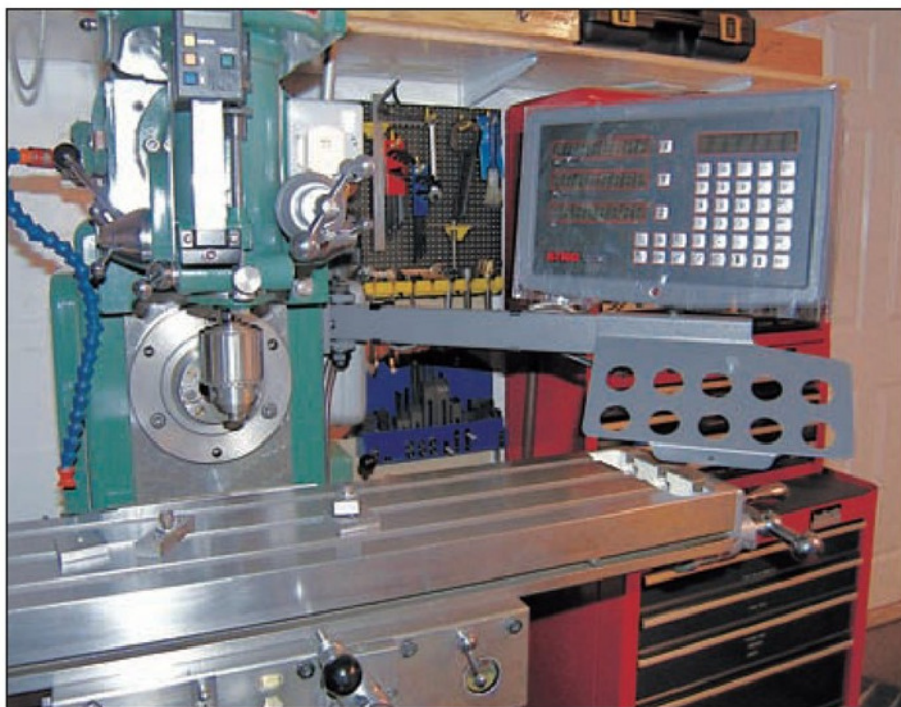


Photo 1



Photo 2



Photo 3

with sufficient room to get a spanner on the bolt head of the bracket to tighten the support arm so it does not swing around. I used the left hand edge of the machined face of the support column to align the bracket. This gave me adequate clearance and room to get at the 'on/off' switches on that side. I found too, that this put the DRO at about the right operating height for me. Drilling and tapping the 5mm holes was relatively straightforward if a little time consuming. The cast iron tends to form a fine powder and this creates a lot of friction when trying to turn the tap. Do not attempt to over-strain the tap and break it, but be patient and withdraw and clean it every couple of turns or so.

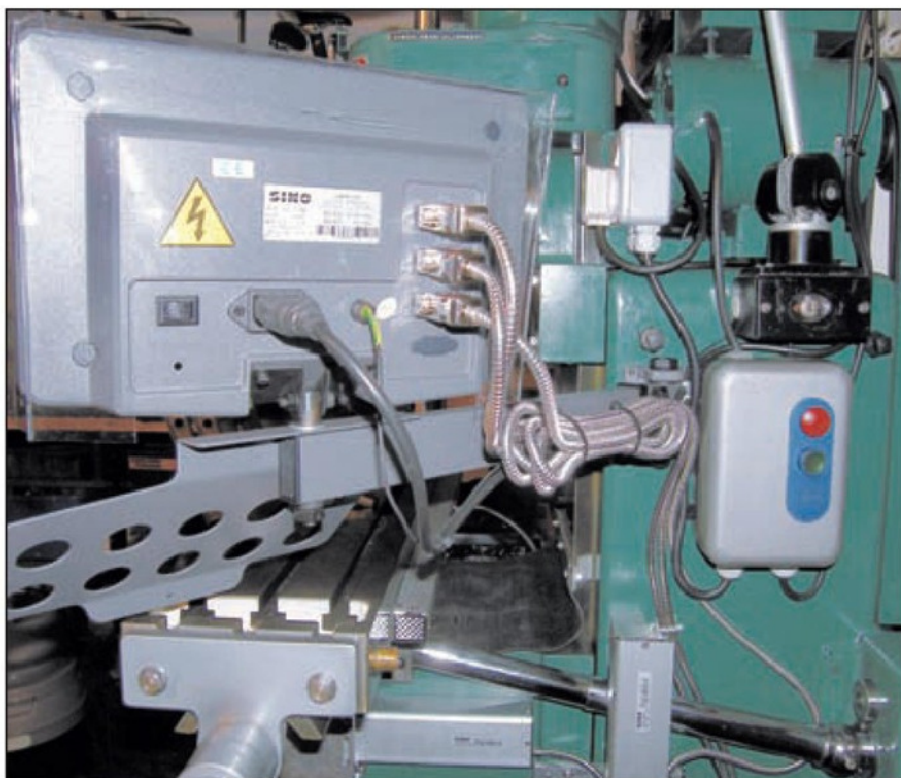


Photo 4

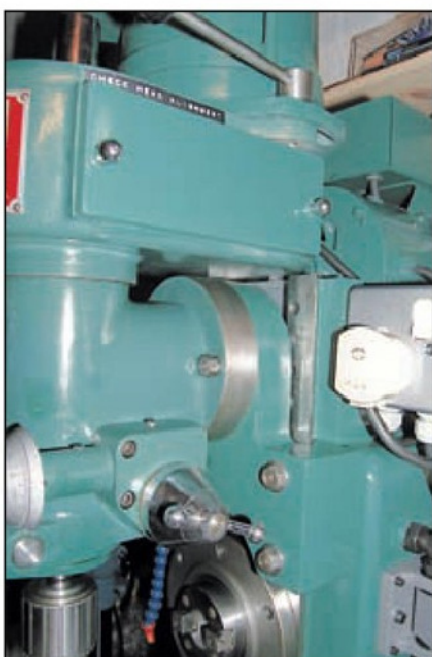


Photo 5



Photo 6

Fitting the cables

I routed the X and Y-axis armoured signal cables around the column of the machine below the door and lip of the cover for the suds pump, **photo 3**. I used sticky backed cable tie pads. The Z-axis does not lend itself so readily to this treatment and I simply coiled the cable at the rear of the DRO, **photo 4**. I clipped the DRO mains supply cable to the mill supply cable and to the same double socket on the wall behind.

The grey, switched mains socket, **photo 5** that can be seen above the support bracket powers the S-type vertical head when in use. Power is taken from the NVR main motor switchgear on the column so that in the event of a power failure, the motor will not switch on again when the power is restored. My vertical head is supported on an extension to the column slide so I don't have to lift the unit on and off – I use an engine pulley hoist to slide the unit up and down. The lower edge of the vertical head support bracket obscures part of the socket when in the raised position. I don't find this a problem as I have another socket around the other side, **photo 6**! I digress....

CAUTION!

Remember to fit the separate earth cable to the connector on the rear of the DRO marked PE and thence to an earth point on the mill. This is to maintain equal polarity



Photo 7



Photo 9



Photo 9

and avoid signal interference. Feed the wire in through the central hole in the terminal and then out through the small hole at the rear of this one and tighten down the plastic nut.

Fitting the scales

The scale reading heads are supplied fitted with small plastic clips to prevent unnecessary movement and damage during transport. These can be left in situ until fitting is completed. They do not need to be re-attached if the scale is subsequently removed for cleaning or re-positioning. It is also possible to re-position the signal cable by removing the four small screws in the corners of the reading head, prising off the cover, it is 'siliconed' in and removing the blanking plate and 'end-for-ending' the cable. Refit the blanking plate and cover with some new silicone sealant. I did not find this modification necessary.

Several machined cast aluminium plates are supplied with each scale to enable the reading head to be held rigidly to the machine and detect the slightest movement. Finding the simplest combination of angle plates, long and short plates that would fit the machine and reading head took some time to sort out. The final set up I used enables fine adjustments to be made and once tightened up is very rigid.

X-axis scale, photo 7

The first thing to do is to find the centre of the table travel. It is not at the geometric centre of the table and is, in fact, offset to the left. Mark the centre (permanent marker) and, using a square, scribe a light vertical line down the back of the table. Mark off too, the centre of the saddle. This is the position for the reading head. Mark lightly the centre of the scale backing plate and offer this up with the lower edge just clear of the top edge of the saddle. I found this provided just enough 'ground' on the saddle to fit the reading head. It is possible to drill the rear of the table by moving the table from side to side. Fit the scale and check that it is horizontal using a DTI. With the reading head at its centre of travel, mark through the two holes of the reading

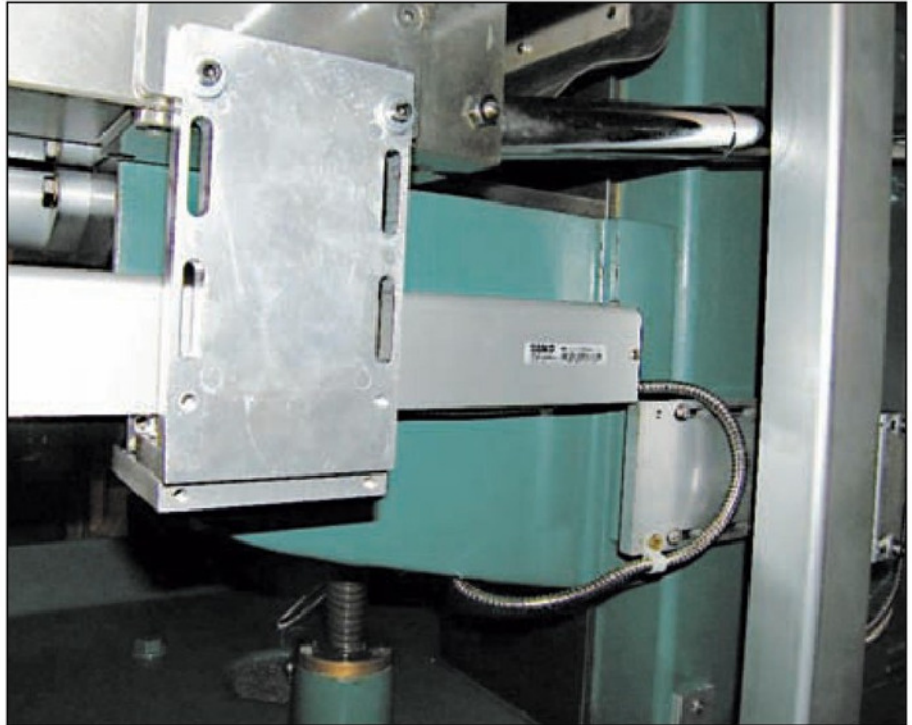


Photo 10

head onto the rear of the saddle and centre-pop these holes accurately. At this point, either remove the table and saddle (a lot of effort!), or obtain the use of a right-angle drilling attachment. Following my usual policy of 'judicious laziness', I chose the latter method.

Taking care and double-checking the alignment of the drill, drill a 2.5mm hole using a sharp drill. Tap the hole, remembering to withdraw and clean the tap frequently. Then fit to the reading head, in each corner, the four small slotted grub screws. These butt against the saddle to firmly locate the reading head when the securing screws are pulled up tight. Refit the scale, ensure that it is horizontal and on the same axis as the table, use the shims provided to make any adjustments. Then secure the scale in position, adjust the grub screws and tighten the fixing screws. Finally, remove the plastic clips by removing the small crosshead screws. Check that the table traverses its full travel and the reading head does not hit the end of the scale. When satisfied, fit the scale cover and route the cable as suggested above. I put a couple of 2in. bump stops in place on the knee so that the cover did not get crushed against the face of the column.

Y-axis scale

Photos 8, 9, 10, 11 and 12

This where the fun starts. I moved the knee up and down its full range of travel and the saddle in and out at each position to see if there was an optimum position where the scale cover would just clear the table power feed spindle cover. The problem area was at the highest position of the knee and the most outward position of the table and saddle. I marked a limit of clearance position for the scale cover on the right hand side face of the knee. This affected both the lateral and vertical position of the scale and consequently the selection and fitting of the brackets to the reading head. There is relatively

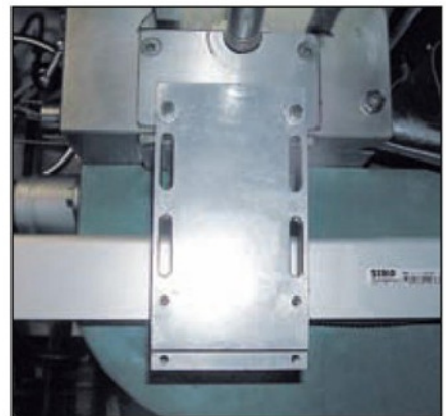


Photo 11



Photo 12

little scope for error here and I offer some suggested dimensions viz. the outer end of the scale backing plate is 35mm from the vertical edge of the front of the saddle and the top edge of the plate is 55mm below the top edge of the saddle.

Once the position was established, fitting was straightforward, but beware the face of the casting is not necessarily flat and do check to make sure that when the scale backplate is fitted, it is not bent into a curve! Use shims to take up any irregularity. I used an engineer's square to obtain the horizontal position and a DTI with a magnetic foot to check for axial alignment.

I drilled two 4mm holes in the square plate on the side of the saddle covering the table power feed gear pinion to hold

the reading head bracket to the saddle. I then loosely assembled the bracket I had designed to the reading head and when satisfied that everything was aligned, tightened the screws, removed the plastic clips and checked for any interference of the reading head at each end of the saddle traverse and at the topmost position of the knee travel.

At this point I wired up the DRO to see if what I had done so far worked. It did and I felt justified in proceeding with the Z-axis installation.

Z-axis scale, photos 13, 14, 15, 16, 17 and 18

The Z-axis solution was constrained by the design of the machine. It cannot be fitted, or so I think, to the left hand side of

the column because of the column access door. On the right hand side there is the table power feed spindle, which moves up and down and also changes in angle slightly with saddle traverse. The only solution I could think of was to position the scale vertically just outside the table power feed spindle and held to the column by brackets made from some 50mm aluminium angle I just happened to have.

A trial assembly was attempted and appeared to work without interfering with anything else. I made two brackets and fixed each to the very end of the scale backplate using 3mm countersunk screws and again, fastened the brackets in line with the left hand vertical edge of the column. I machined a horizontal and vertical slot in the brackets to facilitate any adjustment and secured them with 5mm pan-head socket screws. Again I had to solve a three dimensional puzzle making the reading head bracket but I was getting quite creative by this time and had no difficulty in sorting out a solution. I discovered that the small, vertical aluminium plate to which the reading head is screwed, required a 5 x 12mm section to be machined off so that the cover, when fitted, would not interfere with free movement of the reading head bracket. I used a piece of 19 x 40mm rectangular tube to pack out the reading head bracket from the side of the knee to which it is screwed. I fitted the scale and checked it for alignment, fitted the reading head and its bracket, removed the plastic fittings and finally shortened the scale cover so that it would fit neatly on the swarf tray. I could not route the signal cable quite so neatly and simply coiled up the excess and clipped it to the rear of the DRO support arm. On switching on the DRO again, I found that I now had readings on all three axes - fantastic!

Validation

Allendale Electronics supply a rewritten version of the user instructions and, having seen the original, Chinese English version, I think that this is a good idea. I understand that Allendale are working on an updated version. I found the photocopied instructions just a little difficult to read and in some places the instructions contained minor errors that had me puzzled for a little while. I found using the 'Enter' button and/or vertical arrows when entering data was a little confusing at first. The real teaser was when I was checking out the PCD calculations - for drilling 12 holes as it happened - and found that the DRO would show an 'OVER' (sic) error after hole number 6. Try as I might, I could not overcome the problem. After a bit of head scratching and tightening up the DRO mounting bracket, I found at last that I could enter a calculation for 12 holes on a 2.125in. PCD. I need this to repair my Quorn index ring!

I think that the problem was that I was not pressing the buttons hard enough and perhaps there was an internal error, which cleared itself after switching off the DRO and leaving it for a bit. I find that this is sometimes a cure for a persistent error on a PC when I am doing a lot of software re-installation. I also discovered that the unit would only accept metric dimensions when doing a PCD calculation. I am told that this is a known software bug and can



Photo 13

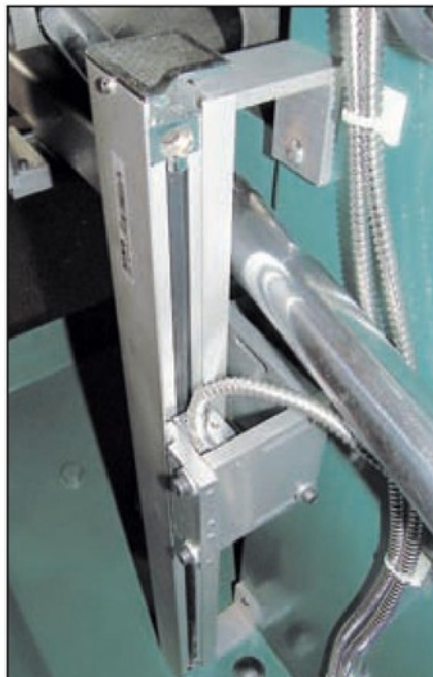


Photo 14

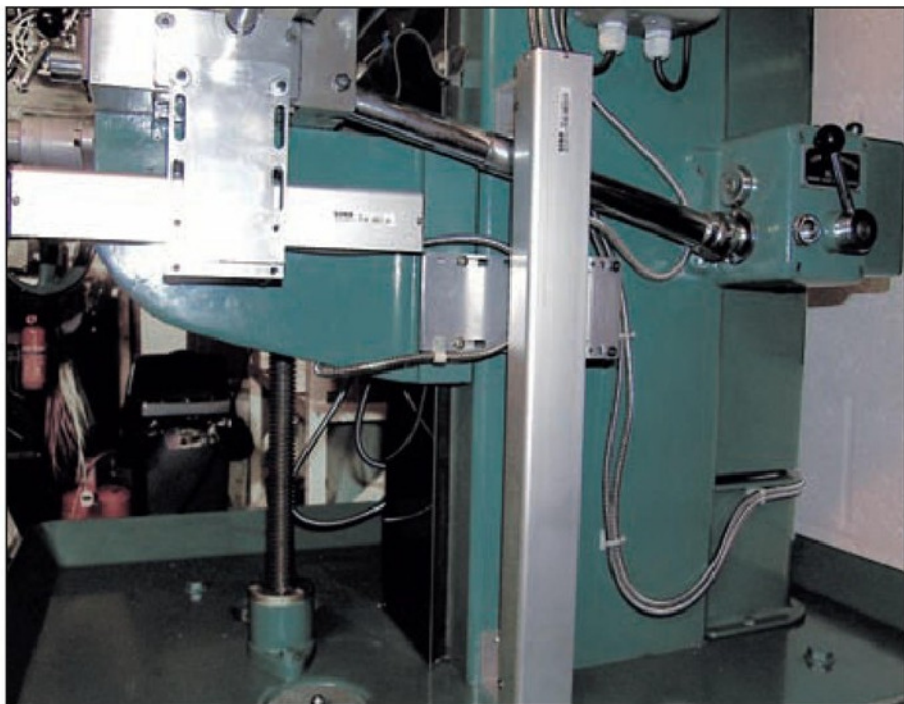


Photo 15



Photo 16



Photo 17

be fixed with the installation of a new chip. At the time of writing this article, I am awaiting delivery of said chip. Nevertheless, the DRO is still entirely usable and I did manage to drill the Quorn index ring PCD accurately. The moral of the story is always to check the functionality, as software is still notoriously 'buggy'.

Functionality

The DRO enables one to move to a level of positional accuracy not normally available by 'winding' the handles and accounting for backlash. The sensitivity of the scales is more than adequate for model engineers.

The use of absolute and incremental measurement enables an origin to be set and holes to be spotted and drilled merely knowing the X and Y coordinates. Similarly, if working with three dimensions, the Z-axis can be zeroed to an origin. The centre position of a work piece can be found by measuring the length

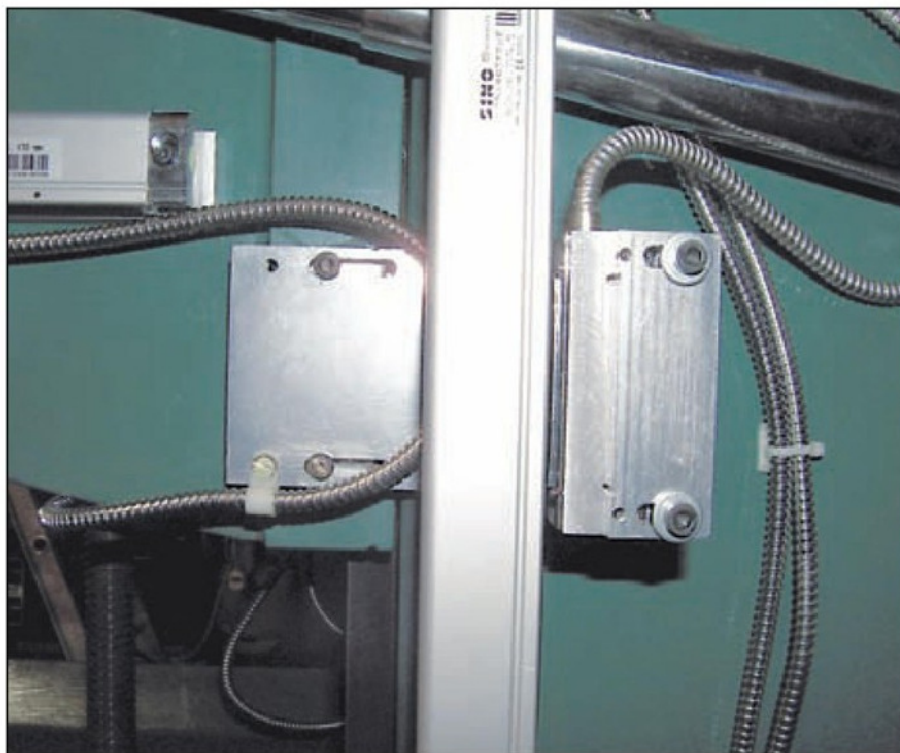


Photo 18

and/or width and using the $\frac{1}{2}$ function key. (I really like this aspect as I find setting up using a 'wobbler' and loupe really awkward and keep banging my head on the machine!) The table is then positioned so that the X and Y readings are zero. It is always possible to return to this position.

Other functions include inter alia, a metric/imperial conversion key, arc calculator, PCD calculator, oblique line of holes, sine, cosine and tangent processing keys, and a standard calculator. The read out figures are large and bright and appear to be quite stable with the machine running. I suspect that a little instability might be present if taking a heavy cut and there is more vibration than usual.

Conclusions

The project took me several days to complete. As mentioned in the text, figuring out the geometry of the reading head brackets and fitting the Y-axis scale were the most difficult parts of the job. The brackets, as fitted, look so obvious, but at the beginning I found that there were several combinations of the bracket components that would work and it was a case of choosing the least complex.

I have always thought that the Tom Senior mills are good examples of elegant functional design. The curves of the castings and the frosting on the column are nice touches. I did wonder if installing the DRO would detract from the visual elegance and I have to say that it does, but when I consider the benefits of fitting a 3-axis DRO and the ease and accuracy with which I can now proceed, I have to say that looks aren't everything! At some point I shall need to replace the saddle lead screw feed nut as the backlash is getting a little excessive, but I don't really need to worry too much now – except to take out play before I start any milling. I have also fitted a readout scale to the quill, **photo 19**.

I wonder what George H. Thomas would

have done had DROs been available to amateurs in his time, since the machine I now own was originally his. I like to think he would have taken advantage of the additional versatility that a DRO provides and would approve of what I have done. Finally my thanks go to Allendale Electronics for their help and advice.

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Photo 19

Linton Wedlock describes a method of grinding large flat surfaces with a standard bench grinder

The accessory described in this article, when used in conjunction with an ordinary bench grinder can produce flat surfaces up to at least 260mm x185 mm. No major alterations were made to the grinder, so it can still be used for all normal grinding operations.

The swing arm was built using relatively simple equipment. The machine tools used were a 75mm lathe, a small pillar drill, an arc welder and an angle grinder (the latter is not essential). It must be admitted that improvisation with materials to hand, rather than planning, had a big influence in the arm's construction and the design could be improved both aesthetically and structurally. It is unlikely that anyone else would build another device of this type in exactly the same way, so this description is presented in the form of an idea for further adaptation, rather than a full construction article with engineering drawings.

For the same reason, a large amount of constructional and operational detail has been omitted and only a few dimensions are given where they may be useful as a guide to anyone wishing to build something similar. Some further details however, may be seen in the photographs and diagrams. Little background information on grinding is included, as this can be found elsewhere (for example, the swing arm was built with the aid of material found in the references).

A question, which may be asked of such a lightly built piece of equipment is, 'does it work?' Well, the results can be read at the end of the text but it would be safe to

A SWING ARM WORK HOLDER FOR SURFACE GRINDING

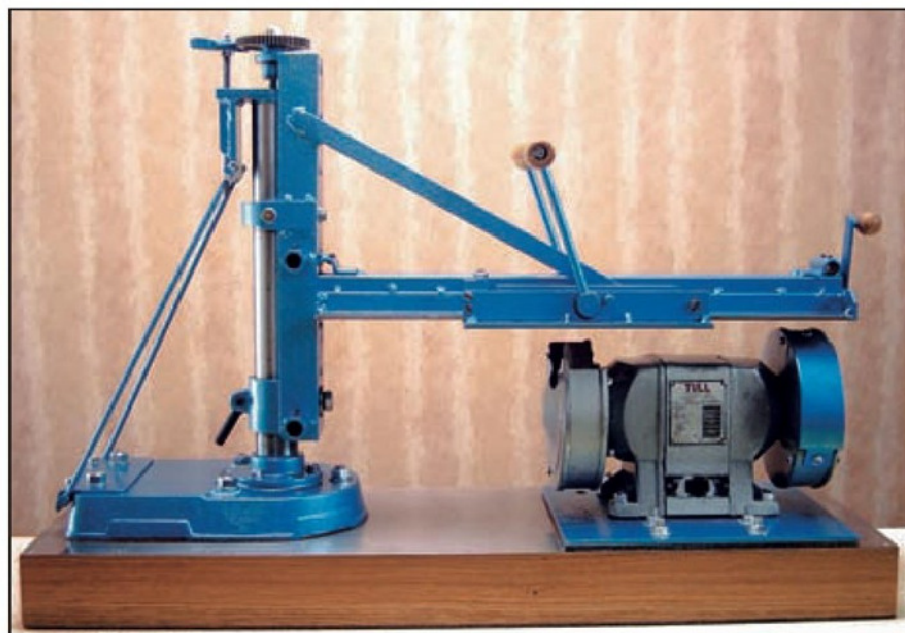


Photo 1. The main components.



Photo 2. Another view of the main components.

assume that this article would not have been written if the finished device had not been at least moderately successful!

When carrying out any metal grinding operation, eye protection and a dust mask should be worn and, unless the grinding time is very short, hearing protection should also be used.

Construction

Photos 1, 2 and 3 show the three major components, a grinder and a swing arm work holder, which are both mounted on a base. The swing arm has four subcomponents. These are a support stand, the swing arm itself, a workpiece holding plate and a height adjusting mechanism. The arm has two collars that fit around the support stand's column and that allows it to swing in an arc around the column's axis. The work holding plate is in the form of a carriage that can move horizontally along the swing arm, radially from the supporting column's axis. By means of these two movements, a workpiece can be positioned anywhere in a flat horizontal plane above the bench grinder. The grinding depth can be adjusted by moving the arm up or down the column.

The general procedure for grinding a surface is to clamp a piece of work on the carriage plate, and then alter the height of

the swing arm to give the required depth of cut. The carriage plate is then moved stepwise along the length of the arm and at each step, the arm is swung back and forth one or more times, passing the workpiece over the rotating grinding wheel. This procedure is then repeated, each time lowering the swing arm by a small increment, until the desired workpiece dimensions and surface finish have been reached. In this way, a flat surface consisting of a series of arced grinding patterns traversing across the workpiece is produced.

The base

An exploded view of the base (880 mm x 280 mm x 70 mm) can be seen in **Fig. 1**. The structural parts are a welded steel frame, cast in a solid concrete base (not shown in the diagram). Together these provide a heavy, stable and inexpensive foundation on which to mount the grinder and the swing arm. The concrete is covered with a stainless steel sheet and is inside a hardwood frame. These are used only for aesthetic reasons and could be omitted but in that case a separate concrete mould would have to be made.

The steel frame has nine short lengths of threaded rod that protrude up through the top of the concrete. These are used to bolt down the swing arm stand and the

grinder. In addition to firmly anchoring the lengths of studding, the steel frame has a second function of stiffening the concrete base. A 4 mm thick piece of polypropylene felt carpet is glued to the underside of the concrete to take-up any irregularities on its surface, and to help reduce vibration.

The base is made by making a simple oak frame and then screwing the stainless steel sheet, with holes for the lengths of studding, onto the top of the frame. The gap between the sheet and the frame was sealed with cyanoacrylate (CA) glue to prevent water leaking during the concrete casting process. Incidentally, all wood used in this project was finished using CA glue as a quick drying varnish, (beware of the fumes), followed by rubbing a candle over the wood surface and melting it with a heat gun until no more wax is absorbed into the wood. Although unsuitable for good quality woodwork, this finish is very good at keeping wood clean and in good condition in a metal workshop environment.

After constructing the steel frame, it was placed in the upside-down wooden frame with the lengths of studding protruding through the holes in the stainless steel sheet. Nuts on the studding, either side of the sheet, held the frame in position during the concreting process. CA glue applied to the nuts was again used to seal any gaps. A slightly wet concrete mix was poured into the frame, and the whole thing vibrated to remove as much air from the concrete as possible. After levelling the concrete flush with the top of the (upside-down) frame, it was left several days to harden. Finally the carpet was glued on the underside of the base.

It was originally intended that the base should be bolted down to a bench, so the inner steel frame had six M12 nuts welded to it and spaces were left in the concrete for bolts. However, the whole unit (total weight 77 Kg) seems to be heavy and stable enough and so far has not been bolted down.

The grinder

An ordinary grinder was adapted for this project. It should be noted however, that this has a power rating of 375 watts and that a lower powered model may not be so effective in this application. The particular grinder used also had the merit of having easily detachable wheel guards, they are just held in place by four bolts. This feature is desirable because firstly, the right-hand wheel and its guard, which are not used with the swing arm, may occasionally have to be removed from the grinder to enable large or awkwardly shaped workpiece's to be ground. Secondly, the left-hand guard is modified so that it can quickly be rotated between the normal grinding positions at the wheel front, to the swing arm grinding position at the highest part of the wheel. **Photo 4** shows the guard in these two positions and **Fig. 2** is an exploded view of the modified part. The inner face of the guard had its centre removed, and three circular slots were cut in it. A new plate was made which is to be bolted to the grinder housing, and the modified guard was attached to this with three bolts through the circular slots. Nylon washers, spring washers and Nyloc nuts were put on the bolts and tightened so that the guard could be

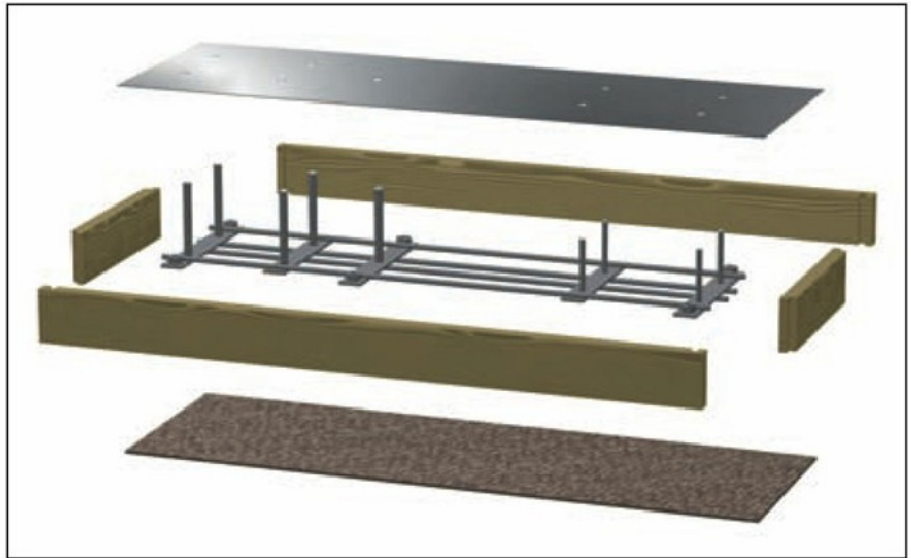


Figure 1. Exploded view of the base components

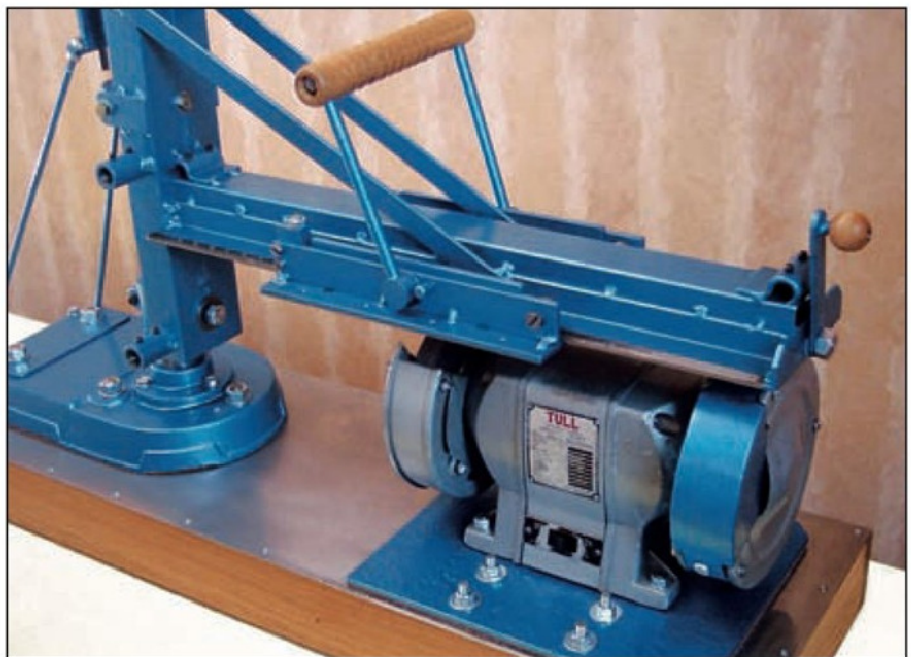


Photo 3. A third view of the swing arm workholder.

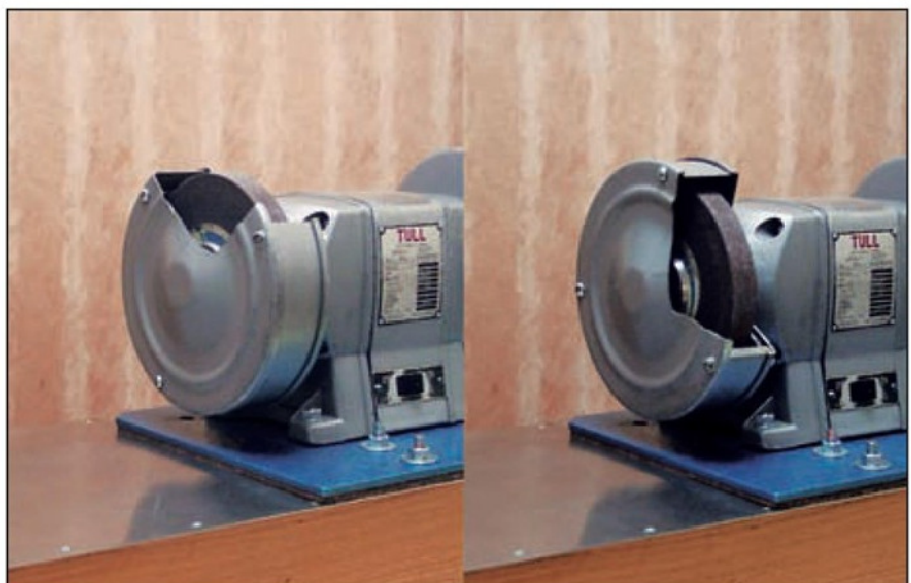


Photo 4. The two positions of the grinder left-hand wheel guard.

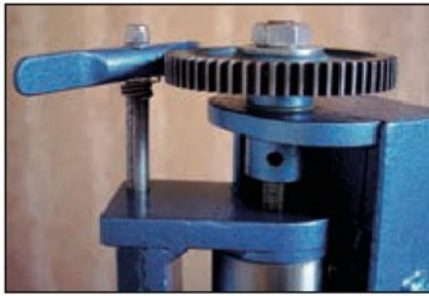


Photo 5. The height adjusting mechanism.

rotated by hand but would not move by vibration from the working grinder.

The thin tool supports of both guards were cut off. New supports of various types will be made as the need arises and these can be mounted on a new 4 mm steel plate, which goes under the grinder. Four short upright lengths of studding have been welded to the plate for this purpose. The grinder and the plate fit over the four right-hand lengths of studding protruding from the concrete base and are firmly tightened down. As the top of the concrete was unlikely to be flat, a piece of 4 mm polypropylene felt carpet was cut and placed between the plate and base. This should also help to reduce vibration a little.

The swing arm stand

This construction project would probably not have been started were it not for the fact that an unused base and column, from a small pillar drill were available to make a stand for the swing arm. A little work on this ready-made component and the making of a few extra parts to go with it, were all that were necessary to complete the stand, **Fig. 3**.

An essential requirement of the stand is that it should be as rigid as possible during the grinding process. In this respect the pillar drill base and column were not ideal because they were both made of quite thin, lightweight castings. To overcome this deficiency, two solutions were adopted. Firstly, both base and column were filled with concrete to increase their mass and stiffness. Secondly, two supporting rods were added between the base and the top of the column.

Before putting concrete in the base, a hole was drilled in the casting to provide an extra clamping point near the base of the column. The first step in the concreting process was to block all gaps in the base casting using pieces of plastic sheet held in place by adhesive tape. Holes in the concrete had to be left to accommodate five lengths of studding and the three column fixing bolts. This was done with short lengths of rubber tube, held in position with nuts and studding (coated with petroleum jelly). The metal casting was filled with a slightly wet concrete mix, vibrated to remove air, and levelled flat with the top of the (upside-down) rim. The concreting of the column was done in a similar way except that a 15 mm diameter axial hole was left in its whole length to accommodate the height adjusting mechanism. Again, rubber tube and a long length of studding were used, as this is easy to remove from concrete once it has set.

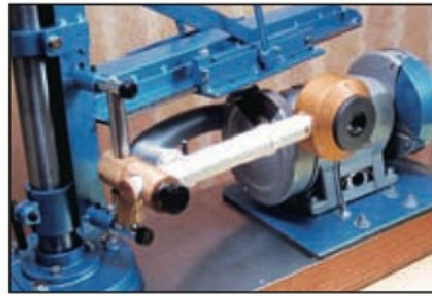


Photo 6. The dust and metal particle collector.

The two stay rods are threaded at their top ends. Their bottom ends were put through holes in a short horizontal bar and welded. The bar is in turn held in position on the base with a flat plate and two self-tapping screws. The upper ends of the stay rods are attached to the top of the column by means of a bracket. This bracket has a slightly complex shape because, in addition to holding the stay rods, it has the height adjustment components mounted on it and it also has to allow the swing arm to move right to the top of the column.

The bracket was fabricated by welding together a turned plug, with three pieces of steel and a short length of bar. The latter has two holes for the stay rods. The turned plug was made to be a tight fit in the top of the column and also, two self-tapping screws were used to prevent it rotating.

The rather clumsy way in which the stay rods are attached to the column could probably be improved. This method was chosen because the line of action of the stay rods passes through the top centre of the column. It would have been better structurally to attach the rods directly to the column top, but this would have reduced the height by which the swing arm could be raised, and with it the maximum workpiece size, by about 50 mm.

The stand, like the grinder, is firmly clamped in position by means of five pieces of studding protruding from the concrete base and it also has a piece of polypropylene felt carpet underneath it. To give a guide to the size of the stand, the dimensions for the base are 305 mm x 190 mm x 42 mm and the column is 400 mm high with a diameter of 46 mm.



Photo 7. The safety guard.

Height adjustment

Photo 5 shows a close up of the height adjusting mechanism. A threaded hole in the bracket (described previously) holds a leadscrew, which has a fixed collar and nylon washer towards its upper end. A hole, in a plate at the top of the swing arm, allows the plate to pass down the leadscrew and rest on the collar. Rotation of the leadscrew will therefore raise or lower the arm. For simplicity, a length of M10 studding was used for the leadscrew. To give a guide to the amount of vertical movement of the arm, a 60 tooth lathe changewheel was fixed to the top of the leadscrew with another threaded collar, washer and nut. This gear is used as a hand wheel and a one-tooth rotation of it gives a nominal 0.025 mm vertical movement to the swing arm (with the 1.5 mm pitch of the M10 studding).

The changewheel and leadscrew are prevented from rotating by a spring-loaded lever, the end of which has a point that engages between the gear's teeth. This lever is situated at the top of a rod, which can be adjusted in height and locked in position on the bracket with a setscrew. This mechanism does not have to be very substantial because it only has to overcome the low frictional coupling force between the swing arm and the leadscrew collar.

The Swing Arm

Various assorted pieces of steel that were to hand were welded together to make the arm, **Fig. 4**. As it is unlikely that any other arm would be built with exactly the same materials, only a brief description of it is given.

The upright part of the arm (400 mm high) is made of two pieces of angle iron



Figure 2. Exploded view of the modified left-hand wheel guard

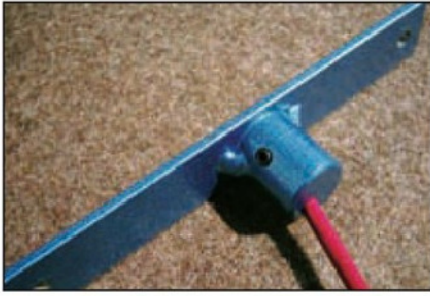


Photo 8. The grinding wheel diamond dresser holder.

welded together. At the top of this is a small 8 mm thick plate with a hole in it. This fits over the leadscrew as previously mentioned. This upright section has two collars that fit around the vertical column and allow the arm to swing in an arc around the column's axis (by about 135deg.). The top collar was turned on a lathe and made to be a close sliding fit on the column. This collar is joined to the upright section with three bolts, one to the upright itself and two to short welded brackets. The outside diameter of the collar is a few millimetres smaller than the space it fits so that the arm may be adjusted slightly in the two axes that are perpendicular to the column's axis.

By selecting the thickness of the fixing bolts' washers, small inaccuracies in the arm can be compensated for. The lower collar already existed; it was the collar of the pillar drill stand that had already been used and which clamped the worktable to the column. At first it was thought that the clamp on this collar would be quite a useful feature but it has actually been found to be an almost essential component of the swing arm. It is used, for example, when moving the whole unit around and also during grinding wheel dressing. The lower collar is attached to the upright section with its original bolt, which allows a slight rotational adjustment to be made to the arm. A small piece of shim was needed with this bolt to prevent the arm movement from stiffening when the bolts of both collars were tightened.

The horizontal part of the arm was made from two lengths of 5mm thick angle iron attached to the sides of a thin walled rectangular tube section (all 560 mm long). The precision of the whole arm depends a lot on the two pieces of angle iron and so they were chosen for their straightness and the lack of twisting along their length. The three pieces of steel were welded together leaving a 20 mm deep channel between them. Small tack welds were made along the length to minimise distortion. At the far end of the horizontal section, a short strip of steel, with a hole (for a leadscrew, to be described in the next section), was fixed. The near end was attached to the vertical part of the arm and two steel bracing strips were welded diagonally between the two sections. An angle grinder, files and a scraper were then used to get the underside of the horizontal section as flat and as straight as possible. Twisting along the length was checked by placing two steel rules, a distance apart, on the surface and looking for any angular deviation between them (proper straight edges would have been better). Once this had been done, the upper horizontal surfaces at the edges of



Photo 9. The dresser in position over the grinding wheel.

the angle iron were made parallel to their undersides to ensure the smooth running of the work holding plate. The sides of the arm were also made square and parallel to each other.

The work holding carriage

The construction of the carriage can be seen in Fig. 5. Basically it is just a plate (chosen for flatness) that slides along the underside of the swing arm. Two steel strips are welded to the plate, and these slide along the sides of the arm. Another two strips are used to make a clamp. Pushing the wooden handled lever to the left performs the clamping action. The lever rotates two round eccentric cams, each located in a hole in each clamping bar and this moves the bars and the plate closer together, pulling the work holding plate tightly against the underside of the arm.

This mechanism was designed so that a 60deg. rotation of the cam lever produces a 0.5 mm closing action. Each cam (shown enlarged at A in Fig. 5) was made by turning a short length of bar to fit a hole in each carriage side strip. A little packing was then put under one jaw of the three-jaw chuck and the bar checked for squareness and for the required eccentricity with a dial gauge. The end was then turned to fit a hole in the clamping bar. A hole was then drilled and tapped in the end of the bar for a bolt that holds the clamping strip in position. Finally, the cam was parted off and a hole drilled in its side to accommodate the end of the lever bar (the position of this hole made each cam a mirror image of the other).

On the underside of both ends of both clamping bars is a piece of shim, held in place by a self-tapping screw. The shim thickness determines how far the lever has to move to fully lock the work holding plate. In use, the clamping mechanism has proved to be quite efficient; only one hand is required to move the carriage along the swing arm and lock it in position.

On the work holder's edge strips are three ball races, which allow the carriage to slide freely along the arm when it is unclamped. A guide to the movement along the arm was provided by a spring-loaded ball bearing, inside a small block. This forms a detent mechanism, which engages with a series of holes, which were drilled along the length of the arm at 18mm intervals (2 mm less than the width of the grinding wheel).

For finishing grinding and for wheel dressing, a second way of controlling the movement of the carriage was provided by means of a leadscrew. This was simply a length of M12 studding, which was held



Photo 10. The swing arm holder in use.

in place at the end of the swing arm by a collar. A small arm was made to rotate the leadscrew. As the leadscrew is infrequently engaged and disengaged, it is coupled to the carriage by a small threaded block (fixed by two bolts), rather than by a split nut mechanism.

The work holding plate is 185mm x 254 mm x 6mm thick with eight tapped holes for the attachment of various clamps.

Other components

In addition to the major components described so far, two further parts were made for safety reasons. The first of these is a guard, photo 7 that prevents a workpiece from being flung outwards should it be accidentally separated from the work holding plate during grinding. A wooden handle can be seen at the right-hand end of the guard. This allows the operator to swing the arm back and forth while standing at the side of the device. The user is therefore not in direct line with the grinding wheel or workpiece. The guard fits in two brackets, which have been welded to the swing arm and its position can be adjusted to accommodate different sized workpiece's. The second safety component is a cover for the opening at the right-hand grinding wheel. This ensures that there is no possibility of a distracted user



Figure 3. The main parts of the stand

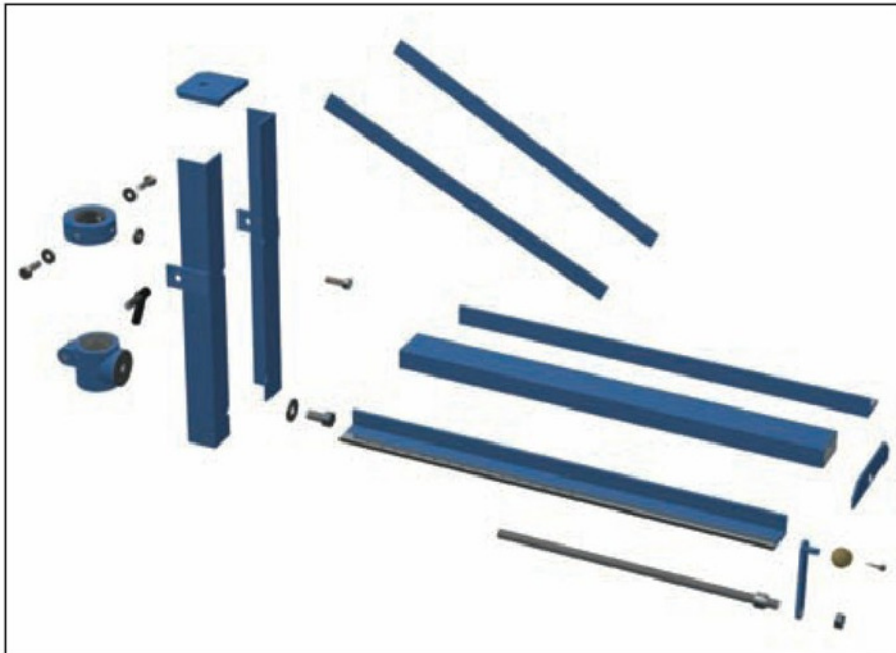


Figure 4. The swing arm construction

accidentally touching this wheel.

It was felt that some attempt should be made to collect as much as possible of the dust and metal particles that are created during grinding. The resulting collector is shown in **photo 6**. It was made from various miscellaneous materials that were to hand so no description of it is given except to say that it is entirely non-magnetic. This is so that when a magnet on its back is unclipped, the metal particles remain loose within the collector, and are ready for easy disposal.

The non-magnetic dust is drawn through a tube to a vacuum cleaner. The vacuum however has turned out to be too noisy and powerful for continuous use and so is now only used during grinding wheel dressing (a simple low-powered air pump may be added in the future). The collector is pivoted so that it stays close to the grinding wheel as the arm moves backwards and forwards. It is kept in place by another two magnets, (one either side of the guard's mesh), which repel the magnet at the back on the collector. Incidentally, the repulsion between these magnets helps to give a smooth action to the swinging movement by pushing the arm forward at the end of its back swing. The pivoted collector fits in two tubes on the swing arm (originally intended for an operating handle that was found to be redundant).



Photo 11. Back view of the grinder in operation.

Setting-up

When all the subcomponents had been made and the stand and grinder bolted to the base, the setting-up of the swing arm was started. Three adjustments are needed and these are done simultaneously by using different washers or shim pieces with the bolts that fix the two collars to the swing arm upright section. The first adjustment is to make sure that the movement of the carriage along the arm is at right angles to the column axis. Secondly, the underside of the work holding plate should be parallel to the two axes which are perpendicular to the column axis. Finally, the two collars must not stiffen up on the column when the bolts are tightened. This trial-and-error process is done as well as can be measured but further refinement is carried out after grinding some test pieces.

Before grinding, the wheel has to be dressed so that its line of contact with the work is parallel to the underside of the swing arm. A bracket, **photo 8** was made to hold a diamond dresser at the correct



Photo 12. Test 1.

angle with respect to the grinding wheel, **photo 9** and this is attached to the work holding plate by two bolts.

Wheel dressing is done by lowering the arm to the correct height and then fixing its position with the collar clamp. The carriage clamp is then tightened slightly and the carriage, with the attached diamond dresser, is moved horizontally by means of the leadscrew, to dress the surface of the rotating grinding wheel.

Considering the methods, materials and equipment used in the construction of the swing arm work holder, it was at this stage probably lacking in precision. However, some of the inaccuracies could be automatically corrected by grinding the underside of the work holding plate and this was done until the surface was flat and uniformly ground.

In use

So far, the only the only method used to clamp work to the carriage has been to use powerful magnets. These do not have the same convenience as a magnetic chuck, but they are still very effective. A steel bar is fixed to the front of the work holding plate, to prevent the work from sliding horizontally, due to the (quite low) grinding force. As the operator is in direct contact with the swing arm, this horizontal force can easily be felt.

When using this accessory, the usual approach taken has been first, to grind the workpiece by moving the carriage along the arm in a series of steps determined by the ball bearing detent mechanism. The final surfacing is done by connecting the carriage leadscrew and moving the work by a distance given by one turn of the leadscrew handle (1.75 mm for the M12 studding used). Every time the carriage is moved, it is unclamped by the lever and then reclamped before swinging the work back and forth over the grinding wheel.

This process may appear rather complicated, but in practise it is quite easy and an automatic rhythm soon develops. To reduce wear, all moving parts are oiled regularly during use. **Photo 10** shows the swing arm accessory in use and **photo 11** is a back close-up view that shows a workpiece, a holding magnet and bar and the metal particle collector.

The arm height adjusting mechanism seems to work well. Perhaps the height moving increment of 0.025 mm is slightly too coarse, but this can easily be compensated for. The lack of perfect rigidity in the arm is here an advantage, because if the grinding depth is too great, the arm will be forced upwards slightly, automatically reducing the depth. With deeper cuts, it has been found better to swing the work over the grinding wheel



Photo 13. Test 2.



Figure 5. The work holding carriage components

at a fast rate, or alternatively a slight upward force can be applied by hand to the end of the swing arm. With light finishing grinding, a slow feed rate seems better and of course, no vertical force must be given to the arm. The finished surface of the work can be improved a little by doing further grinding passes at the same height setting.

Vibration has not been found to be a problem. It is true that the arm is not entirely free from this factor and that slight ridges caused by vibration can just be seen in the ground surface, particularly at fast feed rates, but it is certainly within acceptable limits.

Heating during the grinding process can be a problem, but only with small workpiece's and coarse cutting depths. Large pieces of work get only slightly warm with light finishing cuts. If the work does get hot, it has been found helpful to press a moist cloth against the work between each pass over the grinding wheel. Editors note – keep the cloth well away from the grinding wheel.

When this device was first used, the surface produced was found to have a series of regularly spaced ridges on it. They were not very deep, but were very noticeable visually. The source of this problem was caused during wheel dressing. The diamond dresser moved up

and down slightly as the leadscrew was rotated, producing ridges on the wheel, at the same pitch as the leadscrew. Applying a small flat diamond coated plate to the wheel to remove the ridges solved the problem. The diamond plate is also used regularly during grinding to remove glazing from the grinding wheel surface.

So far, the largest piece of work (not including the carriage plate) that has been ground is 200mm x 120mm. It should be possible to produce work as large as the plate (260mm x 185mm) and it is possible to grind much larger workpiece's, but the size limit, at which a satisfactory finish is still produced, is unknown (probably when vibration becomes a dominant factor).

Photo 16 shows an example of the surface finish produced with the swing arm holder (this piece of steel was originally heavily corroded, and the remains of the deepest rust pitting is still visible).

Testing

The swing arm is not absolutely rigid and knowing the amount of flexing of the separate components will show its limitations and the best places to make improvements. Some simple tests were done to find how much bending occurs at different places, by putting a 5 kg weight at the end of the arm and measuring any movements with a dial gauge. The process of finding some of these measurements, which in some cases required a little improvisation, can be seen in **photos 12 to 15**. The following measurements are the most significant results and are within $\pm 0.002\text{mm}$. The 5 kg weight caused the underside of the carriage (in mid position) to be deflected by 0.065mm at

the grinding point, **photo 12**. 0.024mm of this movement was due to the bending between the horizontal and upright sections of the arm, **photo 13** and the rest was due mostly to movement of the column. The top of the column, relative to the base, moved by 0.044mm , **photo 14**. The maximum displacement of any part of the stand's base, **photo 15** relative to the grinder position, was 0.003mm . This latter value is not very accurate, because it is quite difficult to measure, but it shows that the bending in the concrete base and the stand's base is negligible. In summary, these values show that the arm is suitable for grinding lightweight or moderately heavy workpiece's, but further stiffening (possibly temporary) would be required for heavy work, particularly to the column.

The first work done with this accessory was to grind some steel plates to make them flat and to improve their surface finish. The dimensional precision needed in these plates was not critical and so they also usefully served as test pieces for the swing arm grinder. The resulting surfaces certainly had a satisfactory finish. There was a slight noticeable pattern at the same pitch as the carriage leadscrew, but overall the surface was better than expected. The finish was compared with a set of surface roughness comparison standards and was found to have an average roughness height of less than 1.6 microns. It is expected that, with experience of grinding and wheel dressing, the average roughness height could be reduced to 0.8 microns.

The dimensional precision of the test pieces was found to be tolerable for a first attempt. They were placed on a surface plate and any gaps measured with feeler gauges. The plates' thickness was also measured with a micrometer. The maximum error in a 185mm long by 7 mm thick plate was 0.08mm . The nature of the errors suggests that there is still a little twisting along the length of the arm. With further correcting of the arm, and the gaining of more operating experience, it is expected that work could be produced with a dimensional precision of at least $\pm 0.05\text{mm}$. With better design and construction, it is believed that a swing arm of this type could produce work to within $\pm 0.025\text{mm}$ or better.

During the first use of the grinder, it was found that one factor had not been allowed for. This was the vertical movement of the grinder spindle, as the grinder's housing heated up and expanded. The maximum size of this movement was measured with a dial gauge, and found to be 0.06mm . It is not too difficult to overcome this problem however, because the swing arm can be



Photo 14. Test 3.



Photo 15. Test 4.



Photo 16. A surface finish example.

raised or lowered to compensate. An alternative arrangement would be to mount the bench grinder with its base fixed to a vertical backplate, which is in turn fixed to the concrete base (most of the movement would then be horizontal). However, this would have complicated the project and it is likely that vibration would become more of a problem if this form of mounting were not very substantial.

With hindsight

Some aspects of the construction of this accessory could have been done better and these are mentioned here as they may save other builders some time and trouble. The biggest mistake was to fail to notice that a twist had developed in the horizontal section of the arm when it was welded. More work was therefore necessary to make the underside flat. It would have been better to take the section apart and reweld it. Another mistake was to forget that the arm had to be capable of being lowered sufficiently to grind off the underside of the carriage plate. The grinder had therefore to be raised up temporarily on packing strips a couple of millimetres in order to carry out this task. A more thorough checking of the work holding plate should have been done because, although the face next to the arm was flat to within acceptable limits, there was quite a large variation in its thickness. This meant that up to 0.4mm of material had to be removed from the lower face, a large amount, particularly on such a big area. The plate was about 6.5mm thick initially, but a greater thickness, perhaps 8mm, would probably have been better.

The swing arm has been found to work

well, but two main elements could be improved. First, the pitch of the vertical adjustment leadscrew could be reduced, from 1.5mm (of the M10 studding) to say 0.9mm (giving a vertical increment of 0.015mm with a 60 tooth gear). The second improvement would be to increase the stiffening of both the swing arm and the stand's column. Another small improvement would be to reduce the step size of the carriage movement detent mechanism to 10mm (half the grinding wheel thickness). Moving the swing arm up and down by large amounts is perhaps a little tedious. A simple solution to this may be to make an adaptor that can be held in a portable electric drill, which can be used to rotate the vertical leadscrew. At present, the dust collector moves across the front of the grinding wheel a little more than is desirable, and so a minor correction would be to put the collector's pivot point at a slightly better location.

One improvement that has just been started when this article was completed is to add a small fan to pull filtered air through the grinder housing. This should help to keep the motor cooler, and also reduce the expansion of the housing and with it the vertical movement of the grinding wheel spindle.

The best improvement that could be made, if suitable facilities, skills and materials are available, would be to make the swing arm with a greater degree of precision. The carriage clamping mechanism would then be unnecessary, which in turn would make the grinding operation slightly easier and quicker. The carriage could then be moved entirely by the (probably coarser pitched) horizontal

leadscrew, eliminating the need for the ball bearing detent mechanism. For convenience, a leadscrew split nut arrangement could also be added.

Conclusion

Because the swing arm has a relatively lightweight construction, it is best regarded as a guiding tool for producing flat surfaces. It has been found to be easy to operate and with careful use, produces work with an acceptable surface finish and moderate dimensional precision. With a little more work on the arm and more operating experience, these factors can only be improved. Of course, it cannot compare with a heavily built commercial machine, but considering it only required the concrete, materials, paint and a diamond dresser to be bought to make it, it has turned out to be a worthwhile project and a useful accessory. 

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1. Bruce Black, Workshop Processes, Practices and Materials, Edward Arnold (Publishers), ISBN 0-7131-3409-7, pages 169-181.
2. Alan Jeeves, A 'Swing' surface Grinder (2), MEW issue 46, pages 20-30.
3. Alan Jeeves, Grinders and Grinding, MEW issue 47, pages 23-34.
4. Alan Jeeves, Understanding Grinding Wheels (2), MEW issue 49, pages 20-27.

IN OUR NEXT ISSUE

Coming up in Issue 132 will be



An alternative work holder for the 'Worden'

A swing clear toolholder



Making a cutter grinder

ISSUE ON SALE 16 NOVEMBER 2007

(Contents may be subject to change)

A SHED TOO FAR

Purchasing a new workshop

As readers will be aware if they have read Editor's Bench, I am moving to Scotland. One of the problems faced was moving my workshop at the same time as the house but there was no outbuilding to store the tools and machinery in. So, a major priority was to get a suitable size shed erected as a workshop prior to moving so storage was immediately available.

I had looked at my local garden centres first but although the manufacturers covered most of the country, the KW postcode was absent from their delivery area. Then I looked on Ebay. Great, there were several shed manufacturers who made high quality sheds at reasonable prices. Two days, lots of phone calls and emails later one of the Ebay sellers said they would deliver to Scotland. They gave me a quote and I was pleased that they did not charge me for the first 200 miles, which was free.

I asked what the width of the door was and then checked this against my Tom Senior mill and found there was plenty of clearance so the extra expense of double doors was not necessary.

Placing the order

I placed the order, paid a 25% deposit and waited for confirmation of the delivery date, which they agreed to do over a weekend. I don't think that they normally deliver on a weekend but as it was so far, the boss said he would bring it up himself at a weekend if I could help him erect it. You could always ask if you need it done at a weekend. They may be happy to do this. Delivery was quoted at 4 weeks maximum but they said they would try and do it within 3 weeks, which they did.

The Sunday of delivery arrived. We had driven up to Scotland overnight and waited for the shed to turn up. It arrived at



Photo 1 The completed shed minus any windows.

about 10.45 and the boss had bought someone to help him put it up as they had erected another shed in Cumbria the previous day. The shed was erected and within an hour, they were gone.

The ground where the shed was to go was covered in gravel and this was not quite level, but the shed was erected anyway. I will have to level the shed when we finally move in. This will be fairly easy as we are taking another smaller shed with the furniture van and after we have settled in, we can erect the other shed, transfer most of the tools and stuff to into it, which will leave the large shed empty.

I would have levelled the ground in advance but did not have time, as we had not yet moved in, (also living 725 miles away did not help matters). Make sure your ground is level before the shed people arrive. They will not want to hang around. They will want to erect and be on their way.

Tanalised bearers

I purchased 9 off 3in. x 3in. tanalised bearers to go under the shed. This I feel, is better than putting the shed directly onto the ground. On my previous shed I have used wooden fence posts to do the same job, but because we did not have time to buy any, I bought from the building manufacturer and they delivered them with the shed.

Access to the garden is essential, as they will not lift the shed over fences or walls. If they cannot get access to the shed area, they will leave the shed as close to it as they can for you to erect. Erecting a shed yourself is not a major problem if you have someone to help you. It may be a bit heavy in the larger sizes. The worse bit is lifting on the roof, as the roofing felt is very heavy.

The roof came ready felted except for the join at the top. This was fitted after the roof was put on. The roof must be pretty strong as the erector walked all over the top while he was tacking the felt down. It did bend a bit but there were no ominous cracks. This was an apex roof but if you order a pent shed, I would expect the felt to be fitted all over prior to lifting the roof on.

The shed appeared to be substantially made and should last longer than I will. Because I am putting a heavy mill in, I will put MDF on the floor. I have not decided to just put it under the mill or cover the whole floor to spread the load. In my previous shed, I covered the whole floor. This one though, would be a lot more expensive, being twice the size of the previous shed. I expect I will cover it all as I need to reassemble the mill with an engine hoist and the load on the wheels would probable send it through the floor.

The door fittings

The door is mounted on three substantial hinges and there is a strong bolt fitted that doubles as a padlock holder. There are also two toggle latches fitted. From a security point of view, at least some of the



Photo 2 The shed partly erected.

holes in the bolt and the hinges should be replaced with 6mm coach bolts so that they can't be unscrewed and access gained. I can't remember if I specified which side the door was to open but it opens the right way on my shed. It would be safest to specify which way it opens if you have a preference.

The windows

There aren't any! When the shed arrived and they started erection, I saw there were no windows. I mentioned this and was told that I had not ordered windows. There was no way of checking this, as I had no Internet connection or computer available. I knew I had not ordered windows but had thought they were included. I could not risk them taking the shed away so I just let them get on with erecting.

When I got home, the next day, I checked the Ebay auction to see why I had not ordered windows. The Ebay auction said the 12 x 8 shed had 3 windows as standard. Mystery solved, I had not ordered the windows, as they should have been included.

The problem is, I placed the order direct, not through Ebay, as the size I wanted was not listed. At the time of writing, I am waiting for this to be resolved. It is not the end of the world though. I can cut holes and fit some windows if necessary. At least if you are buying a shed, you now know to make sure windows are included.

Despite the problem with the windows, I still consider the shed to be good value for money and would not hesitate to order from them again.

The shed was supplied by Himley's Garden Buildings

Himley's craftsmen produced highest quality garden sheds, summerhouses, playhouses, work buildings and home offices.

Himley buildings are manufactured using highest quality kiln dried 25 x 125mm Tanalised Log Lap Cladding on 50 x 50mm planed framing and are also available clad with 12mm Shiplap T&G cladding.

The tanalised log lap is available in either tanalised green or brown treatment and is guaranteed for 15 years.

The brown colour is sprayed over the



Photo 3 The inside of the shed.

green tanalised timber.

The 12mm Shiplap T&G cladding has a 5 year guarantee against rot. The 12mm shiplap is only available with a golden brown treatment.

The floors are tongue & groove with framing spaced every foot (300mm) and the tongued and grooved roof is finished with 40kg green mineral felt.

Himley's also offer a custom build service.

Himley's offer free delivery and erection on all direct orders within 200 miles of Stourbridge in the West Midlands. They will also deliver and erect anywhere in England, Scotland and Wales. Please ring for a quote.

To order direct or for all enquiries please contact Himley's on 0800 9961888 Mon-Fri 8-5, Sat 8-1 or on 07835011439. Please mention Model Engineers' Workshop



Photo 4 The door showing the substantial fittings.

Himley are also one of only a few timber-building companies throughout Europe who are credited with F.S.C. certification. Basically, this means the forest products they produce come from a responsibly managed forest.

Himley Garden Buildings
HGB House
Maypole Hill
Halesowen
West Midlands. B63 2NZ.
Telephone: 0800 996 1888

Email: enquiries@himleygardenbuildings.co.uk
www.himleygardenbuildings.co.uk/



A DETENT FOR A VERTEX BSO

Maurice Turnbull makes indexing easier

Along with many other model engineers, I possess one of the popular Vertex BSO dividing heads. Although very useful it does have a fault, which can cause problems when multiple turns of the indexing handle are required. (This also showed up when I was experimenting with "Paper Plates", but that is another story.)

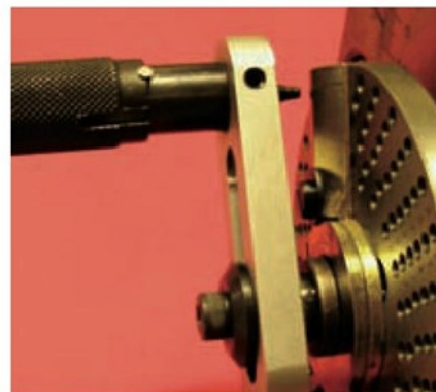
When it is pulled out of the index holes for turning, the detent cannot be latched and the spring, which is quite strong, tends to make it creep back in until it catches the indexing fingers, moving them from the correct position and so spoiling the count. Disaster! To correct this manufacturers oversight by fitting a latch takes only a few minutes.

Disconnect the arm from the machine. After marking the position of the end of the plunger in the outer sleeve, knock out the roll pin with a punch. Dismantle the outer sleeve, spring and plunger, but there is no need to remove the inner sleeve from the arm.

Decide on a piece of rod for the peg, mine was an oddment of .110in. dia., about 2.8mm dia. Drill a suitable hole through the inner sleeve at 11/16in. (17.5mm) from the face of the slotted arm. It can be a forced fit for the peg or fixed with adhesive, but it should not protrude on the inside where the spring slides. Cut off about 3/32in. (2.4mm) high.

In the outer sleeve, mill a slot in the open end 9/16in. (15mm) long, and of a width to easily slide over the peg. Turn the sleeve about one eighth of a turn and make another shorter slot, the length equal to about half the diameter of the peg.

Reassemble the components with the roll pin and the job is done. The photo shows the detent in the latched position, well clear of the indexing fingers.



LOW TEMPERATURE REPAIRS TO LIGHT ALLOY COMPONENTS

Occasionally, in my search for bargains at model flyers bring and buy meetings, I find, usually in someone's junk box, a model engine with a broken crankcase. Usually the engine has a mounting lug missing or the carburettor has been knocked off. In these cases, I am able to make a repair using a low temperature welding process called 'Techno Weld'.

Where normal welding requires a lot of heat, this will distort lightweight castings as used in model aircraft engines. I have found that the Techno Weld process, using only the heat from a normal DIY blowlamp causes little or no distortion and so I have been able to put back in use, engines that would otherwise have ended their lives in the scrap bin.

To demonstrate this process, I borrowed a damaged crankcase from my pal Laurie Brock. The engine is an Oliver Tiger 2.5cc diesel made in the 1950s and quite collectable as well as being as powerful as many modern engines, and therefore quite useable.

The Tiger had lost part of its mounting lug forward of its right hand front bolt hole and I felt there was too little surface area to effect a really strong repair so I filed more of the lug away making a flat area to work with.

From reading Tiger engine tests in old model magazines, I know the crankcase is cast in L.A.C. 113B aluminium alloy, therefore I did not want to use any of the really soft aluminium I had in my scrap box to replace the missing metal. I managed to locate some aircraft quality duralumin however, and felt this would fit the bill.

A piece of duralumin was cut oversize to make it easier to hold and one side filed to correspond with the flat on the crank case. To prevent any oil baking on during the heating, I washed the crankcase in paraffin and wiped the surfaces with kitchen towels dampened with cellulose thinners.

What it's all about.

At this point I will explain briefly what the Techno Weld system is and how it is used.

Specifically designed for amateur metalworking, the system is easy to use and even model engineers with no welding or brazing experience will have complete success, PROVIDING THEY READ AND FOLLOW THE INSTRUCTIONS!

The starter kit contains the following:-

A stainless steel brush

A stainless steel abrading rod

Welding rods

The all important instruction sheet.

Unlike any other welding or brazing process, the metal to be joined is heated

Alan Johnson repairs a model aeroplane crankcase



Photo 1 The patient, an Oliver Tiger crankcase with a damaged mounting lug.



Photo 2 The mounting lug filed flat and a duralumin replacement prepared.



Photo 3 The mating surfaces are cleaned using the stainless steel brush provided in the kit.

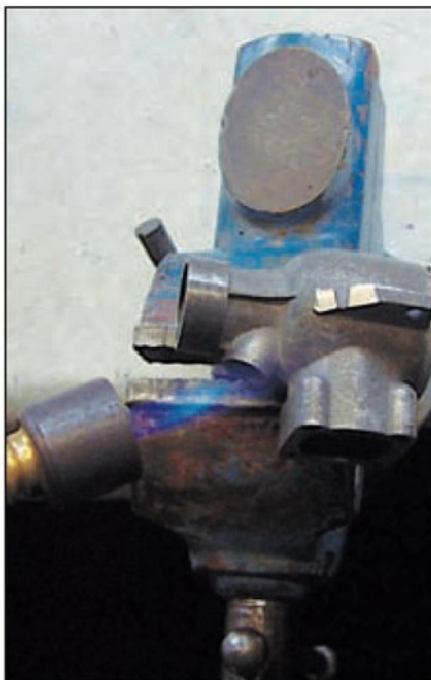


Photo 4 The crankcase is brought up to welding temperature.



Photo 5 The mating surface "tinned".



Photo 6 The surface is abraded through the molten weld using the stainless rod.



Photo 7 Likewise the replacement is "tinned". Note the plywood pads to insulate the work from the vice jaws, now somewhat charred.

and not the welding rod. First the surfaces to be joined are prepared and finally cleaned by brushing with the stainless steel brush.

Using an ordinary DIY butane blowlamp, the base metal is heated until a welding rod held against it begins to melt. Now the heat can be reduced, as it is only required to maintain the working temperature. Raising the temperature even more is unnecessary and may cause distortion. The surfaces can now be "tinned" by drawing the rod across.

At this stage, there will be a layer of

oxide under the weld and this must be removed before an efficient join can be made. This is done by reaching through the molten weld and scraping the surface of the base metal with the stainless steel rod. It appears that the oxide layer has only to be punctured to ensure a good bond between base metal and weld.

Now the pieces can be joined, reheat the larger piece until the weld is liquid and play the flame over the smaller piece and with both welds liquid bring the pieces together. Remember the weld stays liquid until the temperature of the pieces has



Photo 8 Both parts are brought up to temperature, and then held together while the temperature is allowed to drop.



Photo 9 A solid bond has been produced. The replacement part is oversized to make handling easier.



Photo 10 With the repair blended in, the bolt hole is drilled using a simple drilling jig.



Photo 11 Sawn, filed to shape, and drilled, the repair is a success.



Photo 12 To match the repair with the crank case shot blast finish, I used sand paper tapped rough side down on the shiny surfaces.

fallen below the weld melting temperature and the pieces must be supported until the weld hardens.

Get to work

I held the crankcase in my smallest bench vice supported between two small pieces of plywood to stop the heat migrating to the vice and with the area to be tinned as horizontal as possible to stop the liquid weld running off. Following the process above, I 'tinned' the area and turned my attention to the small piece; this was also held between plywood pieces and I similarly 'tinned' the surface to be joined.

With the two parts brought up to weld melting temperature, I assembled them and after checking they were in the right place removed the heat, taking care to hold them until the temperature had fallen enough to solidify the weld.

When the crankcase had cooled enough to handle, I gripped the smaller piece with pliers and tried to wrench it off. It remained firmly attached. The weld was good and solid.

Finishing and Fettleing.

The next task was to saw and file the new metal to blend in with the rest of the bearer lug and drill the hole for the mounting bolt. To make sure the bolthole was drilled in the right place, I made a simple drilling jig from steel plate with its centres spotted from another engine of the same make and size.



Photo 14 The basic requirements for weld-aluminium at low temperatures.



Photo 13 Disguised, the finished repair almost disappears.

I thought I had finished but the repair did not blend in as I had hoped it would. The Tigers crankcase was originally shot blasted and the new shiny part looked wrong. I have no shot blasting facilities so I had to improvise (cheat). I held a small piece of sand paper rough side down and with the lug supported and using a short piece of beech wood and small hammer I tapped the sand paper against the shiny surfaces to imitate the shot blasting.

The repair has returned the Tiger to a useable condition, certainly an expert would spot the repair but the object of the exercise was to prevent the engine being relegated to the "to be broken up for spares" box.

Clearly the Techno weld system will have many uses in the modeller's workshop. I certainly wish I had discovered it many years ago. I have no connection with the Techno Weld Company other than as a satisfied customer. Be sure to ask about their excellent how to do it DVD. for £5 with free post and packing.

A visit to their site at www.techno-weld.co.uk is very worthwhile.

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www.techno-weld.co.uk



Photo 15 The Techno Weld kit contents: stainless steel brush, abrading rod, welding rods, and the most important instructions, study carefully.

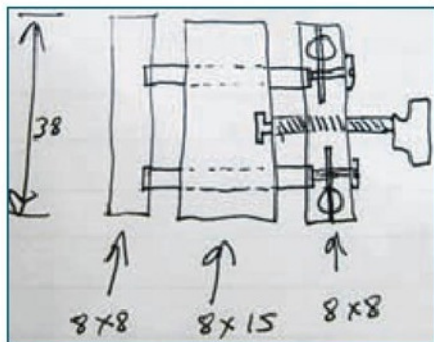


Photo 1 The sketch used to produce the polisher.

Steve Jackman polishes his head

There are certain times in the summer when you don't want to be shut in the workshop. The garden calls and you slowly get further behind with the 'to do' list in the workshop and the waiting clocks. This year, however, I think there has barely been a day that I have wanted to be outside, this week particularly, with non-stop rain hitting the windows above my bench. This is a good thing for the 'to do' list, as jobs that have been put off are now getting done, which brings me onto the next project' A screw head polisher.

The one I have been using came, a few years ago, from a retired clockmaker and has certainly seen better days. I have been meaning to make a new one for a long time and now the time was right. I had thought (over the years in the planning stage) of all sorts of ways of improving the design but why? It works brilliantly, so I decided to copy it exactly (without the wear and sloppiness) and stick to the tried and trusted.

The first thing was to find a suitable piece of brass big enough for all three parts to be cut out together. The brass I chose is probably CZ120 but I can't be sure, as it was one of those bits that you buy thinking it will come in handy one day!

I measured the old polisher and cut the brass to size, allowing a bit for cleaning up. The finished size of the two end pieces are 8mm x 8mm x 38mm long with the middle section being 8mm x 15mm x 38mm long, **photo 1**. Then I milled all the sides and ends to square the three pieces to size.

Whilst using the mill, I machined out the small opening where the screw comes through and the steel insert is placed, **photo 2**. This does not go right through and 5 or 6mm deep is sufficient. This is, I think, pretty self-explanatory from the picture. The size of the steel insert and the groove for the screw is definitely not important and you could make this to suit yourself. The steel is only a bearing surface for the screw to tighten up against. This was where the improvements were conceived, by having a spigot on the end of the screw so the sliding block would be screwed in both directions and not just one way as my old one does. However, as I said earlier, mine works so why alter it!

The next step was to mark out and drill the two holes for the slide bars. Now you could do this before cutting the bar into three but I decided to do it the hard way



Photo 2 The slot for the steel insert being milled.



Photo 3 The three main components of the polisher.

and clamp the three bits back together and then drill the holes. Don't drill the holes right through as you want to stop about 4mm from the end. This end is then drilled for the two metal threads or screws as us "clockies" call them. I drilled the

holes at 4.1mm dia for a snug fit and the screw holes at 2.3mm dia to give clearance for 8BA screws. Again the bar size is not that important and I also changed it from the original. For this one I chose 4mm dia. This was purely to use a

THE CLOCKM WORKSHOP





Photo 4 The screw adjuster end.

piece of steel from the drawer rather than buying it. The 8BA is not critical and you could easily have used 3mm if that is more convenient, **photo 3**.

You have to remember that this project has been on the 'to do' list for a very long



Photo 5 Cutting the clamp slots.



Photo 6 The polisher with the bars fitted.

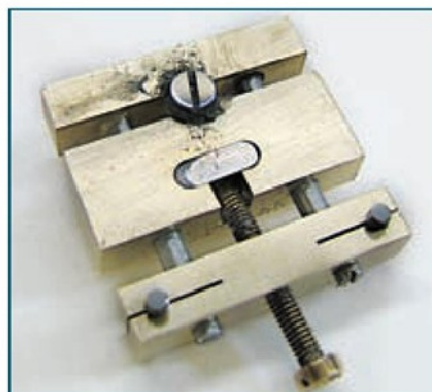


Photo 7 The finished polisher.

picture you place the screw-head to be polished in the opening and tighten in place. Then adjust the two adjustable screws to stick out the same amount. You should now have all three protrusions the same length. This is obvious when you use it, because if it's not right as only half the screw-head will be polished, **photo 7**.

You can again use this on a flat piece of wood with wet and dry, or I use a piece of thick glass. The advantage of glass is being able to do the work with wet and dry or micron paper whilst under a running tap. This gives a far superior finish.

If needed, you can use it with diamantine powder and finally a polishing compound to give you a mirror finish.

I first used a gadget like this to polish my deadbeat escapement pallets for my BHI final exam. So if you can cramp the item to be polished or flattened in the jaw opening you get a flat surface just where you need it.

Happy polishing.



time and I felt the distraction of going to the tool shop for a three inch piece of steel might be a bad move! The other thing to remember is that clockmakers only stick to critical measurements and modules etc. when cutting wheels and pinions. Normally things have to be made to fit and not made to an engineers' drawing. I digress again.

Next I drilled two holes on the screw end (as seen in the photo) 2.3mm dia and tapped these with a 6BA thread. The centre hole was then marked and drilled 3.1mm and then tapped 4BA, **photo 4**. Then it was back to the milling machine to cut two 0.5mm slots with a slitting saw, 11mm into the ends, **photo 5**. This cuts through the 6BA threaded holes and just past the 8BA clearance holes. These two slots do the job of allowing you to tighten the end screws that in turn clamp the polishing tip screws tighter so as to stop them moving when in use.

Next, you should fix in place the slide bars. Before you do this you need to put each piece into the lathe and drill and tap one end of each 8BA ready for your screws. I have always found drilling with a centre drill first, no matter how small, is a very good idea. Even if you barely mark the steel, it will give the twist drill a place to aim.

You are then ready to fix the two steel slide bars in place by means of silver solder. To do this, I cut the steel to 32mm in length and cleaned up the ends with a file. Then I assembled the three parts of brass onto the slide bars, having first fluxed the ends of the bars. This is then carefully set up on some soldering blocks and heated up with solder being introduced from the far end and hoping not to get too much to clean up afterwards.

You can then remove the screw end block, **photo 6**. This should allow the centre block to slide off the bars. This works very well and all I have to do is run a cutting broach in the two slide bar holes until the centre section slides up and down satisfactory.

Making the screws is straightforward with only the tightening centre screw coming out of stock. This is brass with the other four being made of steel.

After this, comes the task of cleaning up the whole job, which I do on a block of wood with sheets of wet and dry in different grades placed on top. Then rub the brass backwards and forwards on the sheets. Don't worry if you round the corners slightly as you will need to take off the sharp edges anyway.

Once cleaned and reassembled it's time to give it a try. As you can see in the

Scribe a Line

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Know that spanner and making radius turning tools

I've just read your June addition of MEW, we're a bit behind in the colonies! Congratulations on the changes I see creeping in, especially the hints section. I am what is referred to, as an Inventor, although I prefer the term Product Development Engineer. Most of the prototypes I make are trying to prove a concept and my time is spent about 70% designing and 30% in the workshop, this is the part I enjoy most.

We are about to launch a product called Strength Soles <http://www.backassist.com.au/>, which fit into the shoe. They fool the brain into thinking the body is on uneven ground and switch on the supporting muscles for the spine, thus helping to prevent injury from

Star Letter

Home workshop condensation

I read with interest Harold Hall's article on setting up a home workshop and in particular the problem of condensation and consequent rusting that can occur in garden shed and garage workshops. I wonder if I might offer some comments on the subject. For forty years I was lucky enough to have a warm and dry indoor workshop. However, 8 years ago, because of a house move, I was obliged to become a shed dweller. I must admit I was not prepared for the extent to which condensation would occur and came close to giving in and taking up knitting! It is not too much of an exaggeration to say that in winter, my machines are often awash with water and I am therefore well aware how much of a problem it can be.

Rusting, like other forms of corrosion, can be random in nature and it is not always possible to predict what will rust and to what extent. For example I have a Myford Speed Ten lathe and a Korean drilling machine neither of which have received any special rust treatment yet have remained rust free despite frequent exposure to condensation. On the other hand, the worktable of my mill/drill and an HV6 rotary table, which I think are of Chinese or Taiwanese origin will rust very quickly if left without treatment. I have read that the Chinese do not weather their castings so perhaps that might have something to do with it. The unpredictable nature of corrosion also means that what will act as a cure in one circumstance will not always work in another and therefore

each of us has to some extent to find our own salvation.

Harold Hall gives a good account of why condensation occurs and goes on to suggest that condensation can be avoided by temperature control of the workshop environment. This is true but I wonder if it is a practical, and perhaps more importantly, a cost effective solution for the small shed workshop. A balance has to be struck between the amount of insulation that can be accommodated in such a building and the size of the heating bills. As the late L.B.S.C. would have said "alright for those brethren who drive around in Rolls Royce's and build 5" gauge locomotives!" If you are going to keep costs to a reasonable level, it will take quite a thickness of insulation to be an effective barrier.

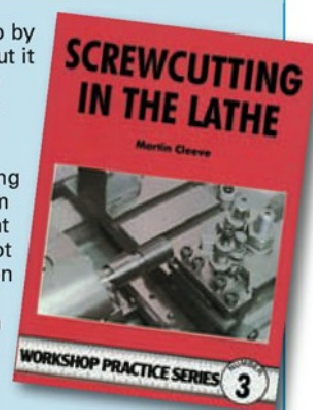
If you are going to approach the modern standards expected in house insulation, then there is not going to be much room left in an 8x6 garden shed for machines and machinist. There is also another aspect to this and that is the dynamics of the process. It would seem to make sense to turn down or off the heating when there is a low probability of condensation occurring. However, because of the large heat capacity of even modest sized machinery and the relatively low rate of heat transfer which will pertain, it is quite likely when the system goes back into top gear that the air will heat up faster than the machines and down will come the rain.

It seems to me that in winter, you could only ensure no condensation if you heat 24/7. Incidentally, Harold Hall was right to say that moisture in the fabric of building

will be taken up by the air inside but it is also the case that every time you open and close the door, moist air is being pumped in from outside and that if the door is not a good seal then moisture will diffuse through gaps if the moisture content is higher outside than in.

I spent a lot of time with playing about with heaters without curing the problem and decided to give up the unequal struggle and live with condensation. The rusting process is quite complex and, so I have read, electrochemical in nature. Further it requires not only the presence of water but also carbon dioxide and oxygen. All three of these substances are present in air so to deal with the rust problem, you have the option of excluding air or disrupting the chemistry and for pessimists to do both.

Coatings of some sort are a common way of excluding air. Lubricating oil is often advocated as a coating but in my experience, where there is serious condensation on surfaces prone to rust, oil is about as much use as the proverbial chocolate teapot. The reason for this is that oil being lighter than water, it will be displaced by water. There is also a further problem and that is we do not know what



lifting and the terrible backache you get from spending a day on the lathe, which maybe of interest to your readers. We have several more products under development.

Along the theme of hints, I always write on my machines, the sizes of spanners, Allen keys etc. required. This saves several trips to the tool board. I'm sorry about the dust but this is a working workshop.

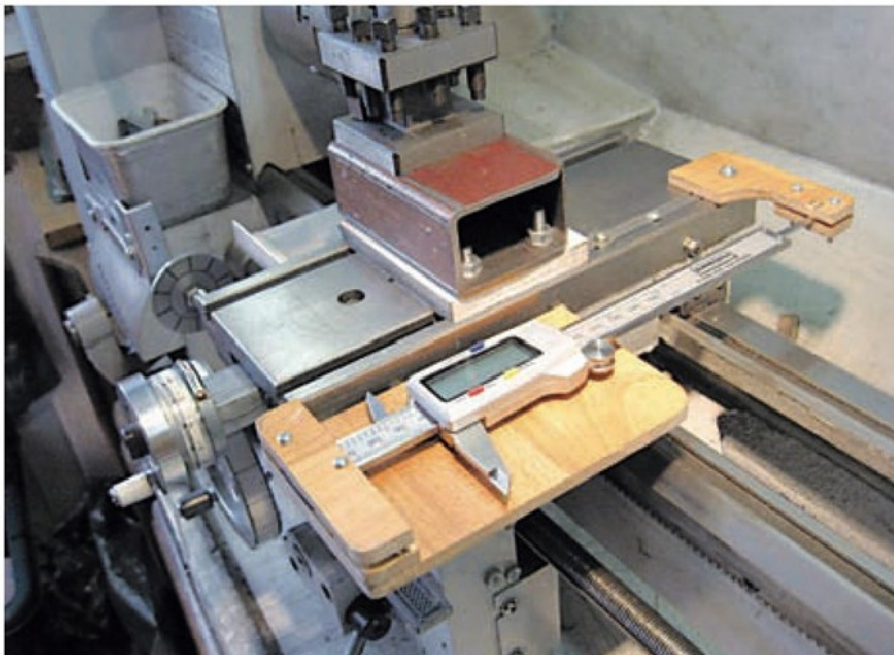
I served my apprenticeship with Hawker Siddeley Aviation at Ham in Surrey, UK in the early 60's and spent a few years on a lathe. This was the time the P1127 Vertical Takeoff and Landing plane was being developed, later to become the Harrier. I would see men in white coats and clipboards attending huge computers, which probably had less ability than my ancient mobile phone, fussing around the prototypes, unaware that I was seeing history in the making. I was more worried about meeting girls.

We often had to make internal and external radius tools. The tools for machining an external radius were ground as close as possible using a piece of Duralumin turned as a gauge and finally finished by resting the tool on the Duralumin, spinning in the lathe or drill with Carborundum paste which impregnated the Duralumin and quickly and accurately finished the radius.

Tony Rossiter by email from Australia

Time for praise

I would like to make comment about the high standard of articles written by Richard Stephens. It was a pioneering article by



Richard, in ME quite a few years ago that got me into CNC. I soon started to suffer the problems associated with early machines and software and Richard came to the rescue with the next CNC article, addressing these problems and his modifications produced a very usable machine.

My hobby is clock making and the clock that I'm finishing has an escapement with tungsten carbide nibs, another DS article.

He introduced me into the world of machining carbide with diamond tooling, a fascinating subject that is still in its infancy in model engineering.

My clock needed a dial and low and behold an article appeared in MEW a few months back. I carefully followed his instruction, wishing to learn a new approach and method. His design of cutter worked effortlessly. The simple dividing arrangement took minutes to make and showed Richards's years of experience in matters CNC and clock making. The uncluttered tool path area and fault free method of indexing, his tips on fonts, contouring and pocketing have been a real gem. Well done Richard, well done MEW.

Keith Dickinson by email from Kent

Single cut files

In Bob Loaders article 'Fitters Little Helpers' in MEW no 129, he mentioned single cut files. I have one single cut file, which I protect like gold dust. It is very useful when you want to file a smooth surface such as a chamfer on a bit of metal. Do any readers know where I can obtain single cut files? I would love to add a couple more to my workshop but they don't appear to be available.

Shelly Curtis by email

Cheap readouts, live chucks and rev counters

Thank you for using the contents of my email to you. Here is another contribution.

Last time I mentioned cheap Digital Callipers as machine DRO's, and the use of laminated flooring.

I enclose a digital photo of a calliper mounted on the cross-slide of my BL920 Lathe, using the flooring as brackets. Also in the photo can be seen the raising block (replacing the topslide) made from the previously mentioned rectangular thick walled steel tubing

There has been occasional correspondence about obtaining live Jacobs type chucks for use in the tailstock.

Well, I have successfully married a chuck to a commercial live centre by extracting the centre from the 2MT body

is in the oil. The oil companies go to a lot of trouble to develop sophisticated additive packages to improve lubricating oil performance for specific purposes. If oil is used for some other purpose than it was intended, then it might not perform so well. For example, I keep the column of my mill/drill well oiled to ensure smooth up and down movement of the head. It would appear that the engine oil I use for this purpose contains some surface active material because in conditions when condensation is present, the column looks as if it has been painted with Brylcreem, i.e. the oil and water have formed an emulsion.

Some years ago, one of your readers suggested using a Vaseline/petrol mixture as a coating. Vaseline belongs to a class of materials known as petrolatum, which is a by-product of lubricating oil manufacture. Although Vaseline looks like grease, it is actually a mixture of microcrystalline wax and oil. These waxes are widely used as protectives and I am sure the suggested mixture works well. However, maybe in my old age the nanny state is getting to me but I would be wary of using petrol in a confined space. The fire risk is obvious but also inhaling petrol vapour is not exactly healthy so I would be inclined to use an alternative dispersant such as turpentine. For those not keen on bucket chemistry and would prefer a commercial product, a material called Tec-Seal was recommended to me by GLR. I have found this to be a very effective coating material, not cheap but it seems to go a long way. Admittedly this type of product is a bit on the messy side and leaves a thick waxy coating. This

needs to be scraped off (an old credit card makes a good scraper) any sliding surfaces before use and from worktables to ensure the work is in intimate contact with the worktable. I know all this is a bit of a bind but worth it if expensive equipment is to be kept rust free.

I have also found that resealable plastic bags are useful for relatively small items. The air can be largely expelled from the bag before it is sealed. If I know I will have to leave unfinished jobs on the milling table, I try to position the work as near one end of the table as possible. I can then slip a large plastic bag over the end of the table and seal the mouth of the bag to the table with a rubber band. For how long this will keep work rust free I don't know, but it seems to work for a few days at least.

As for chemical inhibitors, I have to admit that I have no experience of using liquid phase inhibitors but of course, they are used industrially. In the past, I have used vapour phase inhibitors to good effect but they can only be used in a closed container. They could probably be used to advantage with items kept in plastic bags.

And what of the machinist? I must admit I am a bit surprised when I read that some of you chap are reluctant to get out to shed or garage in winter. Long standing members of the bus-pass club who remember life before central heating don long johns, two sweaters and a cloth cap and brave the elements. Freezing cold machine handles can be a bit painful to the touch but they say one has to suffer a bit for one's art.

Chris Haupt by email.

which contains the ball bearings, then making a short mandrel, one end of which copies the extracted centre and the other end is tapered to suit the chuck.

Currently, Kellogg's are offering a free (with tokens) Cyclometer. I have taken advantage of their offer to make a rev. counter. A small magnet attached to the cycle wheel activates it. Therefore if a small magnet is mounted in a disc (floor laminate again!), this can be suitably attached to a machine spindle. Set the cyclometer to read km/h, and set the wheel circumference to 170cm. The speed indication, multiplied by ten, gives the machine R.P.M.

Allan Tudor by email from Solihull

Gunmetal grey paint

I noticed in your latest editorial in MEW 129 that you mention Hammerite Smooth Gunmetal grey for painting machines. This sounded like a great option but I could find no mention of 'gunmetal' in this range of paints, and none of my local stockists have it, Halford's have a pale grey. I had a message from ICI paints following my enquiry, and they stopped the colour about a year ago. Perhaps a campaign to get it restored? Mind you, as I did find it still listed on an American website, someone still has stocks, at least in the USA, not that it is much use to me there given the prohibitive shipping costs!

I would love to paint all my machines and equipment with such a colour, as they would look great coordinated. I hope that an appeal to your readership might suggest a suitable alternative?

Terry Dixon by email

Enjoyable articles

I enjoyed the article about reboring the model aircraft engines. I do this as part of my semi-retired business so could relate to much of what Alan Johnson wrote.

I have similar techniques except that I do not use wet and dry paper to size the contra piston as I find even when backed with ground flat tool steel there is sufficient compliance in the grit coated paper to cause rounding of the edges. Broad diamond files and translucent Arkansas stones yield a better result. There are some reasonable demands of the fit of this part as it must be free enough to move both hot and cold but if too free a fit, will cause the compression screw to unscrew whilst running which is of course 100% unsatisfactory.

I make all new pistons and contra pistons in close grained cast iron for my rebore and have evolved certain techniques that yield perfectly round parts and under test, completed engines hold their compression even when hot, yet are free enough to turn over slowly and rap the back of the finger with the prop. going over TDC.

I also enjoyed the notes on Ebay and concur with your findings. It is nothing to be quoted locally \$10 AUD for say, a replacement #58 drill and yet I can buy 10 for almost the same sum in HSS, made in Germany and delivered in the post.

Making small parts for model aero engines and clockwork timing mechanisms as I do, obtaining the great variety of raw material continues to prove

challenging, especially spring steel and phosphor bronze/beryllium copper in 0.010 to 0.020in. thickness.

Jon Fletcher by email from Australia

Small stationary engines

You mentioned in the July issue about the possibility of publishing details of small stationary engines etc. Although I realise the main purpose of the magazine is to provide articles relating to the actual workshop itself, I nevertheless feel that many of us who lead busy lives and don't have time for the major projects such as locomotives, traction engines and the like, would very much welcome some relatively simple designs which can be made in just a few hours and which don't often appear in model magazines.

I know there are quite a lot of books on such subjects: "Building simple model steam engines" by Tubal Cain or "Making simple model steam engines" by Stan Bray, to name just a couple on that subject but I haven't really come across anything simple at all in the internal combustion field. Quite often the designs in many books are decades old and some of the materials and techniques used are much more difficult, if not impossible, to come across these days so some more up-to-date stuff would be welcomed. Please don't flood the magazine. Just the odd short article would be appreciated.

This does tie in nicely with the start of your excellent new series "The Metalworkers' Workshop" by Harold Hall, which has recognised the very fact that a large number of us just don't have the time, or often the expertise, for the complicated stuff. Incidentally, the series looks so good that I have taken out a subscription to make sure I don't miss any. Many thanks for a super magazine.

John Wood by email from Hereford

Types of article

I have just received Copy128. I have to say that I think you and your editorial team are doing an excellent job and have made many beneficial changes. The magazine is produced to a high standard with plenty of interest for all tastes. Even if one is not making a particular project, there is much, which can be learnt from the set-ups and techniques, described.

I also liked the articles on lapping bores for model aircraft engines, and the article on wheel building. Please continue with this style of article. I find it much more interesting to read about lapping as applied to a particular item rather than only describing the basic techniques. Similarly, the planned article about CNC milling Minnie spokes is exactly on target. However, please do not stray into ME territory with any complete constructional articles - (I may have misunderstood one of your editorial comments).

You have heard all this before and I am not telling you anything new, but in summary, an excellent magazine that is receiving a strong editorial hand for the better.

John Reid by email

The HSE and the home workshop.

It was with dismay that I opened the new issue of Model Engineers Workshop today and flicked straight to the Scribe A Line pages, my usual first-glance section.

I am faced with not one but 5 separate letters on the subject of safety in the home workshop. I have been reading model engineer publications for over 30 years and am now getting to the point of not wanting to bother any more due to the over zealous publication of these articles. I can't see that home workshops have changed much over the last 30 or more years so why is everyone desperately trying to involve the HSE in home practice. As the name suggests, the Health And Safety Executive (HSE) deals with the Health and Safety At Work Act. They will never get involved in hobby shop practices. We are all responsible for our own destiny, not the government.

If you are clever enough to purchase, install, setup and use lathes, milling machines, drills etc then you certainly must be smart enough to know that long hair is dangerous, loose clothing is dangerous and sticking your fingers into exposed gears will hurt severely! We don't need overzealous jobsworth's writing up just because a magazine publishes a picture of a lathe with a pretty young woman standing next to it. She was NOT operating it, it was NOT running, and quite possibly was not even connected at the time. The magazine did NOT even state that she was just about to start work, it was just a posed, well executed picture of a lathe and its proud owner.

I deal with the health and safety of a large printing shop using machines from 1 to 60 years old and 15 employees. We have regular inspections from our risk assessors and they are very pleased with the measures taken. I don't feel that they would be quite so happy with most home shops though. Most are overcrowded, underlit and generally not nice places to spend a day in.

Mr G. Laycock (scribe a line, August) had it right in his reply when he said "Stop sounding like you are a bunch of moaning old twits", I couldn't have put it better myself Geoffrey! Health and safety in the home workshop is entirely up to the individual. If I feel like working in sandals, wearing a tie, running a lathe with a loose chuck and dodgy wiring, then that is up to me. I don't need someone telling me it "could" be dangerous. BEST PRACTICE is the golden rule, do the best you can to ensure safety. If you have doubts then ask someone. Imagine what would happen if the HSE did get involved in home shop safety! I would put a bet on that nearly ALL-home workshops would get an instant prohibition notice and be faced with spending thousands of pounds to bring it up to code.

Personally, I feel that this subject is threatening to frighten off many needed newcomers to our hobby, and make existing home engineers look like petty jobsworth's. You should continue to publish wiring diagrams and such like. All a magazine needs is a small disclaimer somewhere that states that the use of the enclosed information is at the users own risk and no liability is accepted. Please get back to proper engineering articles and letters. I for one don't want my magazine to read like a directive from the government. I also feel that terms such as "Health And

Safety Police" are childish and pointless. It is a known fact that by proper "Risk Assessment", even some unguarded machinery can be used in a factory. Best practice and common sense along with training is enough to satisfy the regulations in most cases. Keep up the work on a great magazine.

Dave Kearley by email

The Editor replies

Dave's daughter is hopefully making a welcome return to the front cover of our Christmas Edition on 7th December, subject to management approval. Order your subscription now so you don't miss this collector's edition which is sure to sell out fast.

Mike Hurley's best tip

Hydrochloric acid (HCL) is easily obtained at your local ironmongers under the name of AMO KLEEN spirits of salts the strength of which is 32 per cent and sells for around £3 for 500mls. Further info is available from the makers on 01923-233977. I have it from a reliable source that if you use HCL as a flux, you can solder die cast zinc but watch out for fumes. Also, when using any acid, always add acid to water never water to acid as it can explode.

David Sterling by email

Clarkson Autolock holders

Having recently obtained a Clarkson Autolock holder without instructions, there appears to be lots of different methods for tightening the cutters. Would it be possible to have the correct way explained on the MEW editors bench page.

Mr Burdon from Sheffield

The Editor replies,

The method I use is the following. Put the cutter into the collet, assemble the collet and end cap to the holder tightening the end cap hand tight. Screw the cutter into the holder until it stops on the centre. Undo cap 1/8 of a turn, screw cutter up to centre again and tighten end cap with the spanner.

This gives a good fit and if the cutter tightens up more, it automatically tightens the collet on the cutter, hence the name Autolock. I don't usually use 1/4in. or 6mm shank cutters in an Autolock. If the centre is not in good condition, the cutter shank around the centre can break causing the cutter to run out.

Does any reader have the official method of tightening an Autolock chuck? If they do, I can print it here.

Ian Garner, Star letter MEW issue 129

Ian Garner's letter makes some very valid points. Some letters offer useful criticism but others are unnecessarily harsh in tone and content. We are here to help each other, not hinder. As Editor, you would be within your rights to tone them down or at least, file the burrs off.

I found the articles on files and also soldering interesting and well written and if I may, would like to add a couple of tips of my own. Firstly, I recently had to repair a belt buckle made of die cast zinc and was able to solder a piece of brass to it using hydrochloric acid as a flux. My other tips are about files. I have not tried these myself and would welcome comments

from anyone who has. Firstly, if you want to bend a file, you should do so when it is cherry red when seen in the dark and secondly, files can be resharpened by standing them in strong sulphuric acid after giving them a good clean.

David Sterling from Essex

The Editor replies

I have on occasion needed to bend files to do an awkward job. A typical example is bending the last 1/2in. of a round needle file to a curve. I heated the end of the file to a bright red and then bent the file carefully by putting the end in a small hole in a block of metal and bending it down. I then hardened the file by heating to red again and quenching in cold water. I did not bother to temper the file.

Safety and other rantings.

I was saddened to read the last batch of letters to the editor, particularly the critical one regarding Ted Fletcher's electrical mods. I was always taught that it's fine to be critical as long as you make some positive contribution to the argument.

Marcus Middlehurst knows enough about electrics to see the flaws in Ted's suggestions. How much more beneficial it would be to offer his improved version rather than calling for a proofreader, who, in technical journals, would often only filter out spelling and grammar mistakes. With this in mind, I would point any interested readers to RS Components who have a No-volt relay assembly with an already fitted 13A plug and socket waiting to fit onto any sort of dangerous gear that shouldn't accidentally re-start. One version even has extra contacts for remote (knee or foot pedal etc.) stopping. RS part no 398-5279 is the push button version, costing just over £10, but there are lots of other options, rocker switch, moisture sealed and so on.

I recently bought an Aldi router table to mount my old plunge router onto and that came with a similar switch on it, again ready fitted with 13A plug and socket for easy assembly. Works a treat! Draper's band saw has a similar system but without the 13A socket.

Then there is the case of the downloadable programs to do dividing calculations for which we are very grateful and can be fun to learn to use, but it is still very satisfying to be able to work these calculations from first principles because every so often the look up table doesn't have your particular case in it. And then what do you do? I still keep my seven figure "trig tables" with all the triangle solutions in the back for just such a day.

With the demise of so many of the corporate engineering companies, I sometimes think that the one remaining pool of practical knowledge of Mechanical Engineering is soon to be confined to the sheds and garages of "Model Engineers" around the world. It would be a great pity if each one operated in isolation without the benefit of MEW to share the little snippets of information.

The interests and disciplines of us all are so varied that it is impossible to satisfy everyone's needs in detail so we must learn to use and adapt as befits our particular area of ignorance.

Before writing this note I re-read Stan Bray's welcoming editorial from Issue No1 in 1990 and his aim for the magazine then

was to be for "all those who are interested in using model engineering machinery at home to make models, tools and a host of other items, with the accent very firmly on making things rather than merely reading about them." It is still true today, so keep them coming.

Bob Dodds by email

Ted Wale's letter about removing broken taps, sheared bolts etc.

Being a goldsmith I've had many occasions to remove broken drill point from jewellery I'm making and screws from watchcases and bracelets. Hopefully here are some answers and tips for you:

A. Make the alum solution fairly strong and heat it. Heating will increase the reaction and speed up the time taken.

B. Alum will work on any steel bit broken in any non-ferrous metal. (Gold, brass, coppers). Depending on the type of steel, some are eaten away quicker than others. It may be possible to just fill a hole in steel with alum solution so that it only affects that area enough to loosen the broken tap/drill without too much damage to the thread.

C. I'm not 100% certain it works on stainless steel, but if it does, be prepared for a long wait. Brass screws can be eaten out with nitric acid. Add a few drops at a time until the acid goes blue/green and stops fizzing. Rinse and repeat as necessary. ***Keep your nose away from the fumes.***

D. The larger the size, the longer it takes to break down. However, you only need to do enough to eat away sufficient thread to loosen the broken item.

E. Taps can be removed by inserting a tool with short prongs into the flutes of the broken tap and carefully applying pressure. Luckily I've not had to do this yet. I have successfully removed broken screws (of less than 1mm diameter) by carefully drilling enough of a pilot hole into the body of the screw and forcing in a sharp bladed watchmakers screwdriver. Unless the thread is seriously bunged up, you should get enough purchase to remove the screw.

No matter which method you try, screaming ranting and raving does not work, (but you might feel better afterwards).

Mark Rose. By email

Anodising in the home workshop

I read with interest Michel Christiaens article on anodising in the October MEW.

It largely mirrors my own armature attempts at the process but not having access to the genuine dyes, I had some problems achieving the required colour intensity. However, I discovered that the inks sold for the refilling of inkjet printer cartridges give very satisfactory results. Being available in yellow, cyan and magenta as well as black you can produce any colour or shade you wish. They are of course, water soluble and available in bulk from computer consumables suppliers.

A true black seems to be the most difficult to achieve. If the oxide layer isn't thick enough you get Gold through to dark brown depending on the thickness. Quite attractive but not if it's black you are after!

I hope this tip may be of use to others.

Martin Kaye by email

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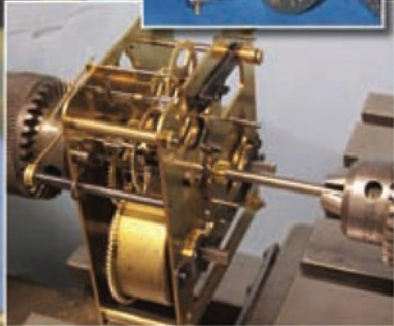
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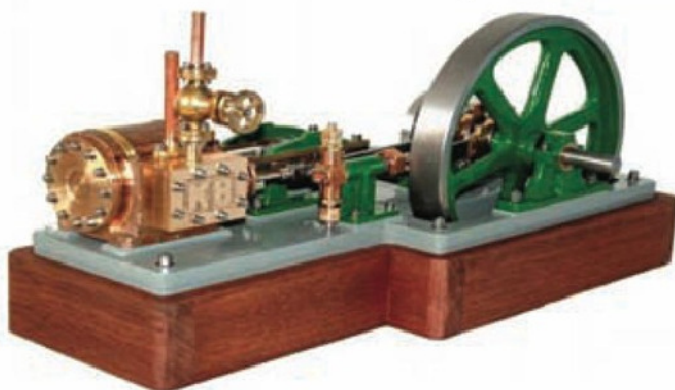


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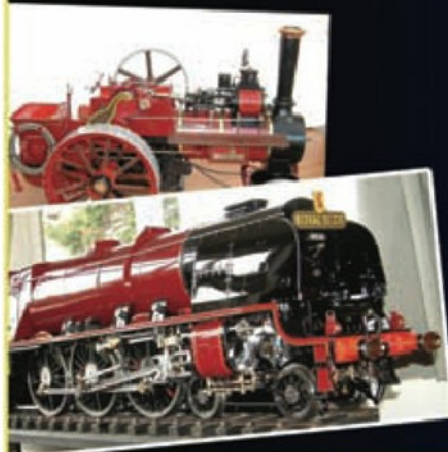
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Opening Times: Monday-Friday 9am-5.30pm - Saturday Morning 9am-1pm
10 minutes from M25 - Junction 3 and South Circular - A205



Denford Viceroy buffer

£245



From £80 each

Selection of NEW 240 volt motors



Set of 5" rolling mills



Denbigh No.6 flypress + stand

£575



Flamefast DS 230 ceramic chip forge

£275



Startrite 18-S-5 bandsaw, 18" throat / 5 speed / non ferrous

£950



Crompton Parkinson Motors NEW 3/4HP ideal for Myford & Boxfords etc.

£150 each



Selection of drilling machines

FROM £90



Boxford CUD 5" centre height precision lathe

£1250



Hayes Diemaster milling machine - sure quality!!

£1425



RJH 6" linisher built on it's own extractor with 2HP motor

£675



Milling/Drilling ground X-Y table

NEW £125



Clarke 917 vacuum machine

£345



Gabro 2ft box and pan folder

£425

COMING IN WE HAVE;

Jones and Shipman broaching presses,
Hulton Universal press,
Harrison M250 lathe,
gear cutters, broaches,
material etc.
New CMZ 40" rolls,
New Leyton 50" rolls,
Blacksmith tooling from £10,
Micrometers boxed from £10,
Rapidor hacksaw £145,
Clarkson radius attachment £425
Denford Micromill and
Starturn lathe £849 each.



Flamefast ceramic chip forge/240 volts

£345



Qualters and Smith 6" hacksaw

£345



CMZ 40" rolls (brand new)

£875 Each



Edwards 50" (1.5M) x 16g box and pan folder

£1425



Raglan 5" lathe + gearbox and variable speed

£1250



Boxford 1130 5 1/2" x 30" + stand

ONLY £2450



Carbolite electric muffle furnace 6" x 5" x 10" inside measurements

£345



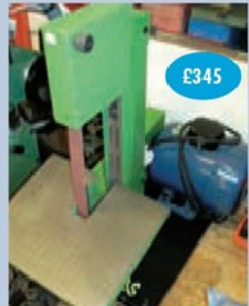
Eagle Model 3 + magnetic chuck

£845



Tom Senior Major horizontal / vertical milling machine

£2450



Vanco Flexiband 1" linisher, 240 volts

£345



Myford milling head for Myford series Lathes

£1425



Travin TP2 plastic injection machine / 21 gram

£425



Harrison Graduate wood lathe

£950



Boxford MKIII AUD 5"x22" lathe in fine shape

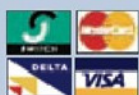
£1595



Myford Super 7B powercross feed, gearbox and stand

£725

£3450



PLEASE PHONE 0208 300 9070 TO CHECK AVAILABILITY OR TO OBTAIN OUR LIST

DISTANCE NO PROBLEM!

DEFINITELY WORTH A VISIT

ALL PRICES EXCLUSIVE OF VAT

OPEN DAY'S + DISCOUNTS 28th & 29th December 2007

We also have a massive range of small tooling for too much to list!



£1625

Wadkin BAO/S 12" planer thicknesser

OPEN

DAYS

+ 10%

OFF

28 & 29

DECEMBER

2007



£849

Denford Starturn lathe



£12 each

Gear involute cutters 'More just in'



from £25

More broaches metric and imperial



£175

Myford accessories by the shelf full !!



£175

Tyme fine dust extractor (three speed) 240 volts



£425

Fobco pedestal drilling machine (excellent)



£575

Denbigh No.6 flypress



£475

Multico M3 morticer



£3250

Tom Senior 'E' Type milling machine (excellent)



£145

Kasenit crucible furnace (natural gas)



Just in £345

Q and S 6" power hacksaw + coolant



Selection of small rotary tables, cubes



£2250

Tom senior Major horizontal / vertical milling machine, powered table



£545

Startrite Bandit (240 volt)



£345

Wellsaw 4" hacksaw

OPEN

DAYS

+ 10%

OFF

28 & 29

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2007



£849

Denford Micromill like new



£145-£175

Denford Viceroy 16" Sharpedge grinder



From £145

Selection of Myford and Boxford vertical slides



Just in £1450

Colchester Student 6" x 24" geared head, gap bed lathe



£1950

Tom Senior Major / horizontal + powered swivel table to cut bevel gears



£825

Boxford dividing head complete

OPEN

DAYS

+ 10%

OFF

28 & 29

DECEMBER

2007



£7 each

Selection of tongs



£350

Tom Senior slotting head



From £40

Colchester / Harrison / Boxford and Myford steadies



From £50

Various arc welders



£345

Rishton 6" bench grinder (quality English model)



Just in £2950

Harrison M250 20" lathe + taper turning and dual dials



£345

Meddings 1/2" bench drill

Chester UK Ltd

www.chesteruk.net

Secure
Online
Shopping



MICRO MILL

£109.00



DRILLING CAPACITY 6MM
TABLE SIZE 275x165MM
SPINDLE TAPER B10/JT1
RANGE OF SPEEDS 0-5000RPM
MOTOR 150W
WEIGHT 14KGS

COBRA MILL

£275.00



FACE MILLING CAPACITY 20MM
TABLE SIZE 145x240MM
SPINDLE TAPER MT2
RANGE OF SPEEDS 100-2000RPM
MOTOR 150W
DIMENSIONS (LxWxH) 480x380x680MM

CONQUEST MILL

£450.00



FACE MILLING CAPACITY 16MM
TABLE SIZE 90x404MM
SPINDLE TAPER MT3
RANGE OF SPEEDS 0-2500RPM
MOTOR 350W
DIMENSIONS (LxWxH) 490x445x860MM

CHAMPION 20V MILL

£775.00



FACE MILLING CAPACITY 63MM
TABLE SIZE 145x240MM
SPINDLE TAPER MT2
RANGE OF SPEEDS 50-2200RPM
MOTOR 1HP
DIMENSIONS (LxWxH) 670x550x860MM

EAGLE 25 MILL/DRILL

£675.00



FACE MILLING CAPACITY 65MM
TABLE SIZE 190x585MM
SPINDLE TAPER MT3 or R8
RANGE OF SPEEDS 100-2150RPM
MOTOR 1HP
DIMENSIONS (LxWxH) 900x940x1040MM

LUX MILL

£1195.00



FACE MILLING CAPACITY 75MM
TABLE SIZE 240x820MM
SPINDLE TAPER MT3 or R8
RANGE OF SPEEDS 95-1600RPM
MOTOR 1HP
DIMENSIONS (LxWxH) 880x780x1150MM

SUPER LUX MILL

£1545.00



Complete with stand
FACE MILLING CAPACITY 80MM
TABLE SIZE 240x820MM
SPINDLE TAPER MT4
RANGE OF SPEEDS 95-1600RPM
MOTOR 1.5HP
DIMENSIONS (LxWxH) 1120x1040x2100MM

626 TURRET MILL

£1395.00



Complete with stand
shown with optional powerfeed
FACE MILLING CAPACITY 75MM
TABLE SIZE 156x745MM
SPINDLE TAPER MT3 or R8
RANGE OF SPEEDS 190-2100RPM
MOTOR 1.5HP
DIMENSIONS (LxWxH) 1085x990x1710MM

836 TURRET MILL

£3871.63 (delivery by quotation)



DIAMETER OF QUILL 80MM
TABLE SIZE 200x660MM
SPINDLE TAPER R8
RANGE OF SPEEDS 100-1300RPM
MOTOR 1.5HP
DIMENSIONS (LxWxH) 1400x1300x1955MM

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All Prices Include Vat & Delivery*

*UK Mainland only

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