

No. 137

APRIL 2008

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

Rebuilding the Myford Super 7 Lathe
PART ONE INSIDE

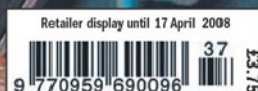
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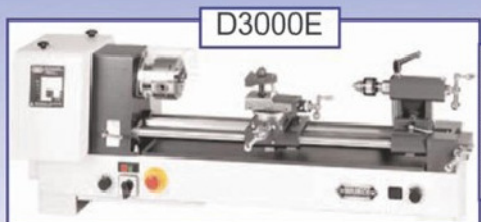
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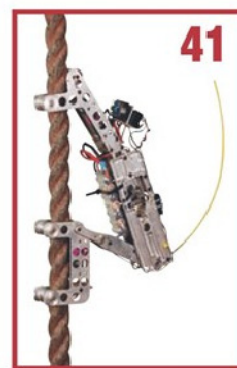
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On the Cover

A Myford Super Seven lathe bed
set up on a slideway grinder. See the
article starting on page 46.

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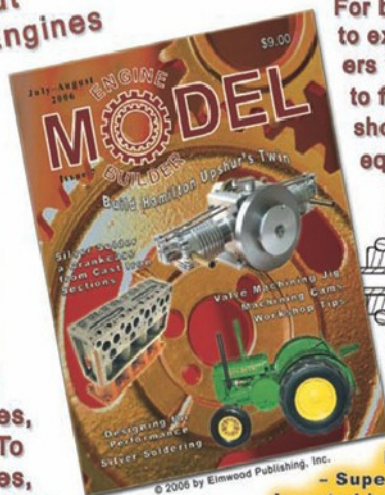
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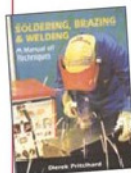
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Soldering, Brazing & Welding - a Manual of Techniques • Pritchard • £16.99

Very good book on all ways of joining bits of metal together. Covered are all ways of soldering and brazing, albeit slightly briefly and then, in much greater detail, Oxy-Acetylene, MMA, MIG and TIG welding. Most of the instructions refer to welding steel, but welding other materials and distortion control are covered in separate chapters, as is quality in welding. Recommended for those taking up welding, or as a reference book if you have some experience. 160 pages full of drawings, diagrams and photographs. Larger format paperback.

Farm and Workshop Welding • Pearce • £23.05

This really is exceptionally good although, as is implicit in its title, this book tends towards welding larger objects than the average model engineer will face. But the underlying principles are the same whatever the size of item and, as well as chapters on MMA welding, MIG/MAG welding, Gas Welding and Cutting, TIG Welding and Plasma Cutting, you get taught the special techniques for welding cast iron, pipe welding and hardfacing. Also covered are Soldering, Welding Plastics, Taps and dies, Drill sharpening and Basic Blacksmithing. The instruction is clear, and down to earth, and is greatly helped by numerous good illustrations, many in colour. 160 pages. Hardbound.

Artist Blacksmithing • App 154 mins • DVD • £29.99



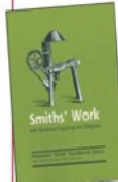
Really tremendous two disk set, in which Peter Parkinson lets you into the secrets of blacksmithing: apart from a useful general Introduction, he covers Tapering, Upsetting & Spreading, Hot Cutting, Punching, Twisting, Bending, Joining, Toolmaking and Finishing. The whole thing was shot to a very high 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 Artist Blacksmith Design and Techniques • Parkinson • £23.05



This really is a cracking good book! As its title implies this is about modern blacksmithing and making interesting shapes and designs, of which it shows plenty of examples. But it also has a heck of a lot more, on equipment, materials, safety and the various techniques required to produce all sorts of types of work. 160 pages crammed with colour photographs and B & W diagrams and drawings. Larger format hardback.

Smith's Work • 1899 • Hasluck • £ 8.05



Examples of Paul Hasluck's "Work" Handbook series pop up throughout our booklist. In many ways, most of the information in this book can be found in other books in this section, but what makes this different is, firstly, it is aimed at amateurs, so the explanations are perhaps that bit fuller and clearer as a result. Secondly, this book strays into the forging and making of cranks, which we cannot recall seeing elsewhere to any extent. So it is definitely worth adding to your blacksmithing library, even if you are not a Hasluck addict - many are! 160 pages. 211 illustrations. Paperback.

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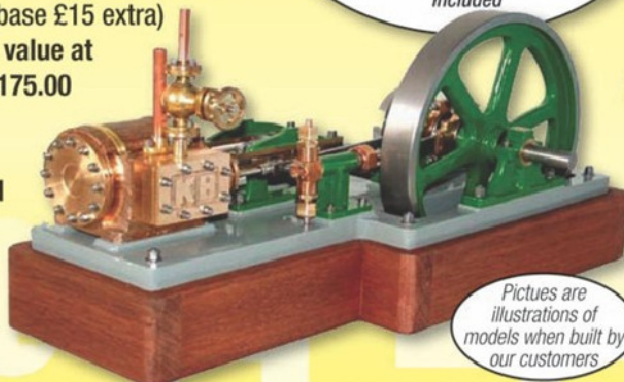
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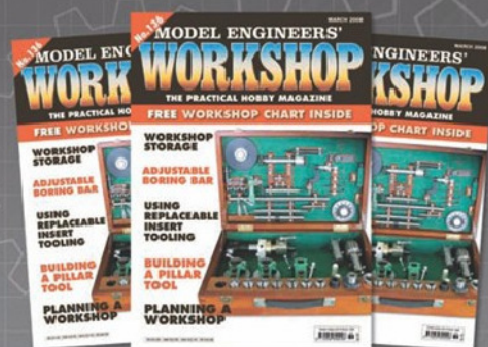
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David Clark

The editor's bench is usually the last bit of MEW that I write. This time though, I still have the readers' letters to edit afterwards. I have gone through quite a lot of readers' letters over the past 12 months but still have quite a few left to publish.

A few of these letters are perhaps now a bit out of date while others are more relevant to recent content. I would like to thank all of you who have written to me and do assure you that all letters are read even if I have not been able to publish them all. Please continue to write and if by letter, rather than email please put a phone number and best time to contact you so I can let you know it was received.

Sometimes I receive copyright material that I don't have permission to publish from the copyright holders. An example is the many people who contacted me with copies of the Clarkson Autolock handbook. I would like to thank you all who sent copies and letters about this handbook.

A younger reader

I have just received the following email from Anthony Parker in Essex

Hi mate

I would just like to say what a fantastic job you do with the mag. I have just started to buy it now I am moving more

ON THE EDITOR'S BENCH

into the custom engineering part of custom motorcycles and I am learning a lot through the mag. Could you please forward me the email address of Mick Morrill as I am pretty sure I know what his unidentified lathe is. Keep up the good work.

Thanks

Ant (aged 15)

I am always pleased when a younger person starts reading the magazine. I learnt a lot of my engineering skills through Model Engineer in the school library and it is nice to give something back. Rather than print Ant's letter in Scribe a Line, I have printed it here in the hope it will encourage some of our readers to help a younger relative or friend into a workshop. By the time this is published, Ant should have received several of the motorcycle and painting books reviewed recently as encouragement for the future. Keep in touch Ant, send us some pictures when the bike is finished for Scribe a Line.

In the Workshop

Dave Fenner always used to do a bit about what he was doing in the workshop. I would do the same but after two house moves the workshops are still not set up. I have just received a CNC mill which has to be removed from the crate and lifted on to the bench. It came in a wooden crate which is about 1 metre in height, width and depth. It is currently sat just inside the workshop door (still in the crate) and will probably remain there for a few days until I finish this issue.

I can then set it up and start on the new CNC series. This will be based on the MACH

3 package and the PC. There are other systems in use, especially in industry but as G code is the most common system in use in industry and is the main system used by hobbyists around the world that is the system I am going to use.

As the series is based on a CNC mill, I hope the readers who are not interested in CNC will pick up a few useful milling tips along the way. A typical item which will be relevant to the manual mill will be the use of an edge finder, the modern equivalent of a wobbler. Other examples are the ease of milling if you use two vices on the machine table rather than just one and how to mill a slot to the correct width. All will be revealed in the following months.

This series is intended to be a very comprehensive guide to CNC milling but I will try to limit it to 3 pages per issue so there is plenty of normal content for the majority of readers. As I have increased editorial by three pages from this issue, (see Free ads below) no one is being short changed. The first part will start with setting up the machine and the basic safety G codes to run the machine, how to set datum's, incremental and absolute programming and the use of the G0 and G1 moves. All being well, I intend to start the series in the next issue, May.

Free ads

I am not receiving many Free ads for publication so I have decided to publish this feature on an occasional basis, perhaps one month in 3 if sufficient ads are received. You don't have to destroy your copy of MEW; photocopies of the form are fine by me. This page added to the 2 pages taken from the advertising pages last month gives 3 extra editorial pages.

Dates for your diary

Please email david.clark@magicalia.com if you would like your event listed here. Please let me know at least 2 months in advance.

I will be at the Harrogate show on the Friday and Saturday. If you see me, please come over and say hello. I will have a name badge on.

The 16mm Association National Garden Railway Show will be at Stoneleigh Park Warwickshire near Birmingham on Saturday 29th March 2008. There will be lots of narrow gauge layouts on display, over 60 trade stands will be in attendance with over 2000 visitors expected to attend. Although organised by narrow gauge enthusiasts, it is worth a visit by O and 1 gauge modellers. In fact, anyone interested in railways or live steam will find plenty to interest them.

For the first time in many years, the association have permission (and insurance cover) to run meths fired locomotives. This will be confined to a 'vintage' layout but I am sure lots of Archangel and similar locomotive will be on display.

For those readers who are steam

enthusiasts, a visit may start an interest in 16mm scale, either on 32mm or 45mm track. The benefits of 16mm scale are that you can have a track round the garden at home, you can lift the locomotive easily without a crane and it does not take as much time or money to build as a 3 1/2in. or larger locomotive would.

Plenty of free parking is available on site. Refreshments will be available but I would advise sandwiches and a flask as the association has no control over catering prices. I went last year and the year before and thoroughly enjoyed myself. It is too far for me to go this year so I will have to content myself with starting to build a railway in my garden this year instead.

The Taunton Model Engineers Exhibition is on Sat. & Sun. April 5th - 6th

Harrogate National Model Engineering Exhibition - Fri 9th - Sun 11th May

The date of the **Guildford Model Engineering Society 2008 Model Steam Rally and Exhibition** has been changed to the 12th and 13th of July.

The 1st South West Model Engineering, Model Making and Hobbies Exhibition will be at the Royal Bath & West Showground, Shepton Mallet, Somerset 12th & 13th April 2008. 9.30am to 5.30pm

The Large Scale Model Rail Exhibition is on Saturday 12th and Sunday 13th April 2008 at the Warwickshire Exhibition Centre, Nr Leamington Spa on the Junction of the A425/B4455. For more details on entry to the show visit www.largescalemodelrail.co.uk or call 01926 614101. Opening Times are 10.00am - 5pm daily with last admission at 4pm.

Myford Ltd are holding their annual spring show on Thursday 17th April 2008 9am - 5pm, Friday 18th April 2008 9am - 5pm and Saturday 19th April 2008 9am - 4pm. Please see MEW issue 136 Trade Counter for more information.

Bristol Model Engineering and Hobbies Exhibition will be at the Thornbury Leisure Centre on the 15th 16th and 17th August.

THE METALWORKERS WORKSHOP 11

Harold Hall continues with the milling machine, part 2

In the last issue, the various types of milling machines were discussed together with details of the cutters that would be required. Now we deal with the very wide range of accessories available, some of which are essential whilst others will be purchased only if found to be required. Note that photo numbers follow on from those in the last issue.

The minor accessories

Essential requirements are the range of relatively simple items that are used to hold either the workpiece, or a device for holding the workpiece firmly onto the table. These will comprise Tee nuts, studs, washers, nuts, screws and clamps. The first option will be to purchase one of the clamping kits available, **photo 13**. Do though before purchasing one of these kits attempt to see what you are buying. In most cases, these are much too bulky for the work likely to be carried out. In the kit in the photo, which is the size intended for my medium size mill/drill, the stud size is M12, far too bulky for virtually all the work I carry out on it. However, this problem cannot be avoided by purchasing components individually as there is a standard thread size linked to the T slot size. My own preference therefore is to make clamping components myself, nuts and screws excluded of course, as this enables them to be tailored to their likely use. In this case, I use M8 predominantly with M10 being used for the occasional heavy duty application.

Purchasing the studs is worthwhile as these will be high tensile and have a short thread at one end to enter the T nut and a longer thread at the working end. Even here there is not a sufficient range of lengths and shortening longer

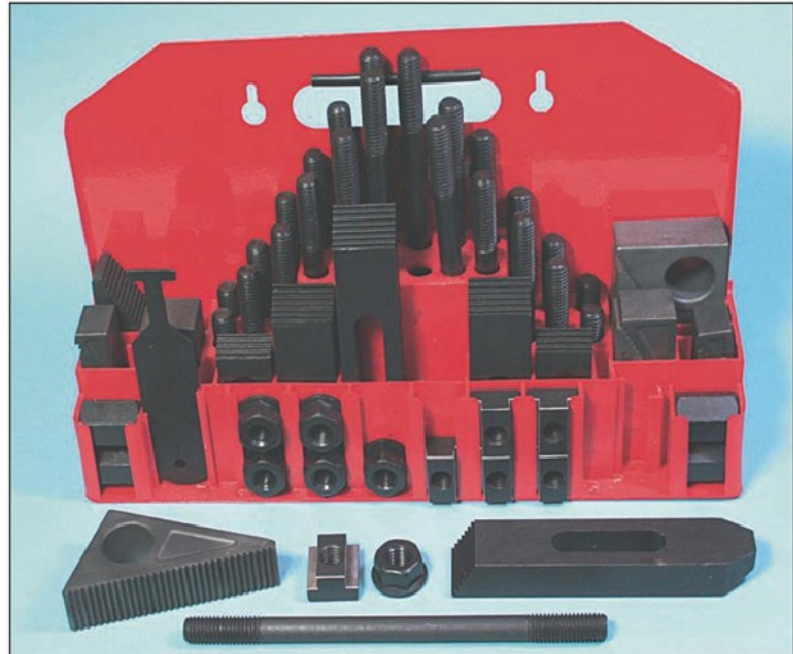


Photo 13 A standard clamping set.

ones for intermediate lengths will almost certainly be necessary.

Photo 14 shows a range of my shop made items and what better for a first project than making a collection of clamping gear. You will first have to make a couple of T nuts by hand (saw and file) and some simple clamp bars to get you started as invariably you will not get these with your new machine.

Adequately fixing a workpiece to the table is a varied task and a crucial one, as the part may move whilst being machined if this is not done. Unfortunately, due to the wide variety of shapes and sizes of items to be held, this

is a subject far too broad to be covered here in detail. Further reading on the subject should therefore be sought. The following are the major requirements.

1. Always use sufficient clamps, too many is far better than too few.
2. If unable to position as many clamps as would appear ideal, then additional clamps at table level that just restrain the edge of the component rather than clamp it should be considered.
3. If possible, the stud should be nearer the workpiece than the packing, maximising the clamping force as a result.
4. The packing should be a little higher than the component. My preference for this is to use a jacking screw as this gives precise control over the height, see **photo 15**.
5. When using screws to clamp a vice or other item, do ensure its length will not allow it to bottom in the T slot. If this happens, you may feel the vice is clamped when it is not, as a result the item being clamped may move when machining commences, with disastrous results.
6. When tightening a nut onto a slotted clamp, do use a substantial washer, 3mm thick minimum. Standard washers will certainly not do.

In addition to bar type clamps, there are others that may find a use, typically low profile clamps, **photo 16**. These types of clamps are particularly useful when the top surface is to be machined completely, as in the photo.



Photo 14 Shop made light duty clamping components will be preferable to the commercially available kits in most cases.

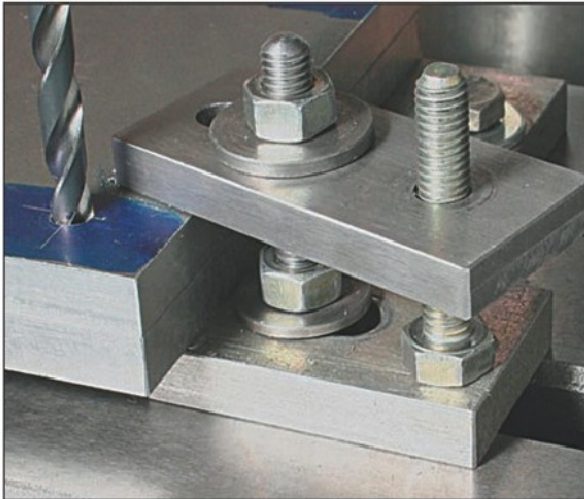


Photo 15 A jacking screw is an ideal alternative to fixed height packing as it permits the packing height to be precisely set.

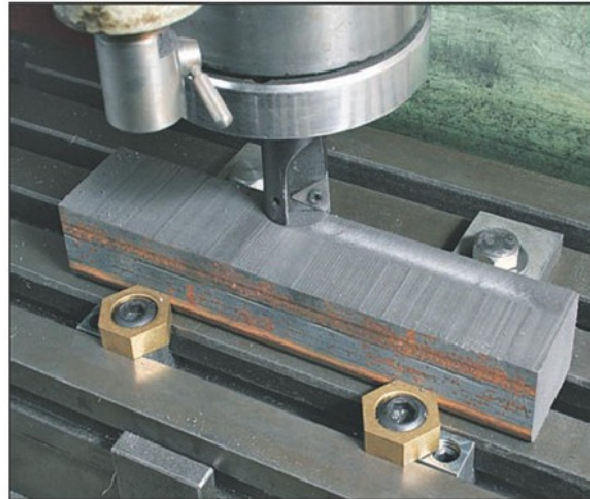


Photo 16 Low profile clamps can be very useful for some applications, typically where the top surface has to be machined fully as in the photograph.

The machine vice

The reader will no doubt be surprised when I say that in my estimation, the machine vice is far from essential for the vast majority of tasks undertaken on the milling machine. Its popularity is, I feel, due to its apparent ease of use, a situation that leads to its use when other methods would better meet the requirements. The first problem is to accurately position the vice on the table as few vices give any reference point other than the jaws themselves. This necessitates a dial test indicator being set up and the slide traversed to check that the jaws are at right angles to, and parallel with, the X and Y axis. My way out of this situation, where the vice construction permits, is to machine the front edge of the base precisely parallel to the jaws. With this done, all that is required is to use a square off the front edge of the table as shown by **photo 17**, this being sufficiently accurate for all but the most demanding situations.

Some vices have locating keys in the base that engage with the tee slots in the machine's table so as to position the vice. This would certainly make positioning the vice an easy and quick operation but I doubt if it will be sufficiently accurate enough for some applications. In this case, where precision is important, the keys would have to be removed.

Having got the vice in place, there is still frequently a problem to position the workpiece within the vice, a particular problem when identical parts are being made. In this case an angle plate fitted with a guide fence, or two, would be far superior.

Even though I make these reservations, I have to admit that I would not run my workshop without a vice for the milling machine and here there is a problem, what to choose? Its essential requirements are, compatibility in terms of size with the machine on which it is to be used, lack of jaw lift, accuracy and robustness, with priority in that order. However, choosing a vice for your milling machine may well be one of the most difficult choices you have to make in terms of equipping the workshop. The reason for this is that whilst there is a vast number to choose from there is in my estimation a gaping

hole in what is available to suit the average size mill/drill or smaller.

Jaw lift, if present, occurs when a component is held towards the top of the jaw as **Sk. 2** illustrates. In a good vice this is overcome largely by fitting a longer than normal moving jaw and by ensuring all the relevant parts are closely fitting. The length of the keep plate below the jaw is also important.

Accuracy is largely self explanatory but the major requirements are that the jaws must be at right angles to, and the face on which the jaw slides parallel with, the vice's base. This is because they are the two surfaces that will most often position the component for machining.

Robustness is a requirement that is more debatable as it will depend on what the workshop's intended purpose is. For example, if you are into model engineering in the smaller scales, the situation will be different to that if you are making say traction engines in the larger sizes.

Size may be the most difficult choice to make as in my estimation, most milling vice designs have developed from those used on horizontal milling machines. Here the load placed on them is far greater than that using a vertical mill. Also, as the majority of horizontal milling machines have been much bigger than the average mill/drill, most of the vices available are too big for most workshops. As an example, a vice having a jaw width of 100mm on a 200mm wide machine table may sound like a suitable combination

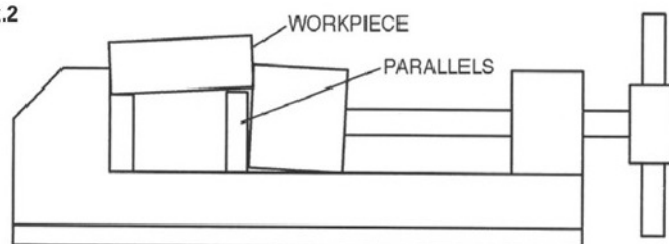
but, as **photo 18** shows, this is not so. In this case it also has a central fixing at either end but as the table has four tee slots, it has to be mounted either in front of, or behind the centre, the latter restricting the travel in the rear direction as the base fouls the machine's column.

In most cases regarding milling machine vices, 100mm wide is the smallest size available, though in a limited number of cases, 50mm and 75mm sizes are made. 50mm is far too small for most workshops but seeing how much the 100mm vice is physically too large, it is probable the 75mm vice will be also, to a lesser extent of course.

Even if you possess a large milling machine, also needing careful consideration are those with a swivelling and/or tilting mechanism. Unless you are likely to make considerable use of this feature, the problem of setting it for normal use outweighs its benefit. Being higher, they will also reduce the available space between the workpiece and the cutter. Admittedly, most enable the vice itself to be removed from the swivelling mechanisms, enabling it to be mounted directly onto the machine's table but even if that is done, that in **photo 18** is still too wide for the machine table.

DO NOT however, use an economy drilling vice unless like me you are prepared to do some work on it to make it suitable. **Photo 19** show two that I have modified by lightly skimming all the important surfaces to improve accuracy and to fit a longer jaw and or

Sk.2



RESULT OF JAW LIFT WHEN USING AN INADEQUATE VICE

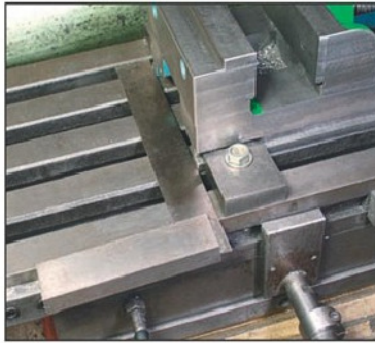


Photo 17 Providing the front edge of a machine vice is parallel to the vice's jaw, using a square off the table's edge to position it is an easy operation.

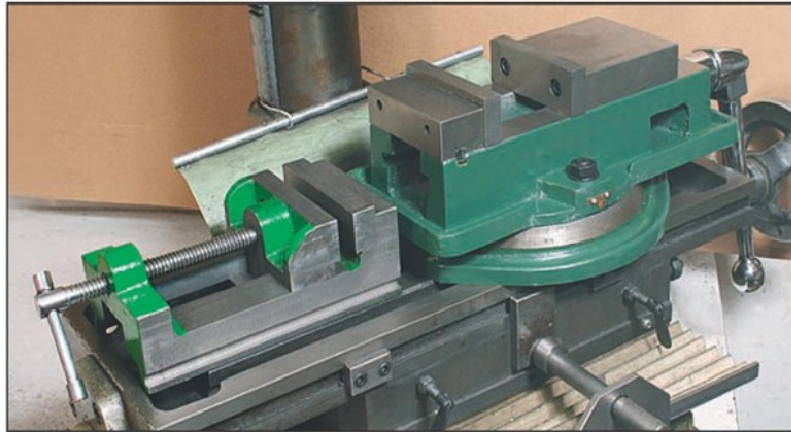


Photo 18 Choosing the correct size vice is essential. In this case the smaller vice actually has a slightly larger capacity, width and length.

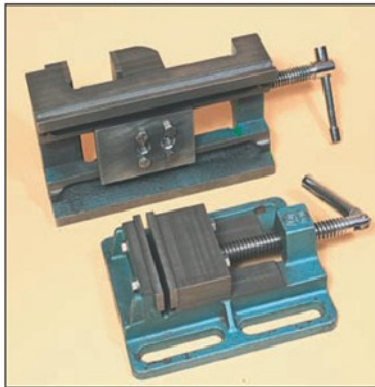


Photo 19 The smaller vice in photo 18 has been fitted with a longer keep plate to prevent jaw lift. The economy vice (front) has a longer jaw added for the same reason.

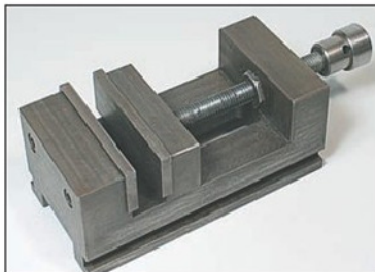


Photo 20 With most milling vices being too large for the average mill drill and smaller, a toolmakers vice can be a reasonable alternative.



Photo 21 Positioning a workpiece is often easier using an angle plate rather than a vice.

jaw keep plate. For medium duty applications, these are more than adequate. The larger of the two has been modified so that it has similar features to those of a toolmakers vice. This was also shown on the left of **photo 18** and actually has a slightly larger capacity, (both width and length), than the larger vice in the picture.

If you have a medium size mill/drill or smaller, the choice is not that easy. As I said above, there are a few generally as that in **photo 18** that have a jaw width of 75mm that may be worth considering. Some though can be very expensive. Failing that, my choice would be to purchase one of the larger toolmakers vices, **photo 20**. See also **photo 17** that shows how this type of vice is anchored to the machine table. If the anticipated milling work really does fall into the light category then there are a few better quality drilling vices that may fill the bill. Typically, the rear of **photo 7** in issue 135 on page 14. Even in this case, being simple to add, fitting a longer keep plate would be a good idea. For the best effect, the keep plate extension should be in front of the jaw.

Angle plates

These come in two types, with a fixed angle at 90Deg. and adjustable. The adjustable ones are rather special and most workshops will function adequately without one and are definitely an item only to be purchased when an obvious need for one becomes apparent.

Fixed 90Deg. angle plates are though

essential, even more so than a vice in my estimation, as they can satisfactorily hold anything that a vice can and often with advantages. The advantages are that it is easier to position the workpiece and doing it more accurately, a major benefit when making batches of components. **Photo 21** is a simple example where a fence is used to position the component at an angle and had an end stop also been fitted, it would enable repeat parts to be made to the same length. This would not be easy using a vice, even for a single workpiece.

Having decided that an angle plate should be obtained, there are a few choices that have to be considered. First, the angle plate can be a simple right angle or have webs between the two sides for added strength. In this case, I would recommend the angle plate without webs as these can sometimes be an inconvenience and the added rigidity is seldom of any benefit.

Angle plates are also sold without slots and may be useful where a complex workpiece demands fixings in places that the included slots do not provide. In this case, the angle plate can be drilled for fixings specifically for the job in hand and is especially suitable for making jigs for batch production, but for general purpose work, the slotted plate is to be preferred. However, **photo 22** shows the three options from which to choose. Size is another consideration and for the average mill/drill a main face size of around 150mm wide by 100mm high would be a good size to consider.



Photo 22 The three common forms of angle plate

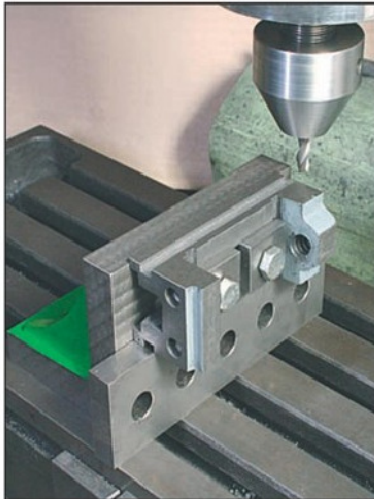


Photo 23 Parallels are an essential accessory for use on the milling machine, seen here being used to position a small vice for machining the fixing groove.

An advantage of the angle plate not yet mentioned is that if held in the bench vice with the working face horizontal, it will often be easier to position and fix the workpiece. The complete assembly can then be taken to the machine table for the required machining to be carried out.

Parallels

These are an essential requirement for the milling machine. They are used to pack up the workpiece, either in the vice where the height of the workpiece is less than the jaws, or against the angle plate as seen in **photo 23**. Less essential, but still useful, are the 1 2 3 blocks. **Photo 24** shows a typical example of their use. In this case, the base of a small machine vice is being machined to ensure it is parallel with the face on which the jaw will eventually slide.

V blocks

On the milling machine, these have limited use due to a number of reasons and in my workshop, due to me adopting a method that I consider far superior. However, if V blocks are available and being considered, the following must be taken note of. When milling is being carried out, security of the workpiece is vital and the clamps provided with the block will be inadequate for all

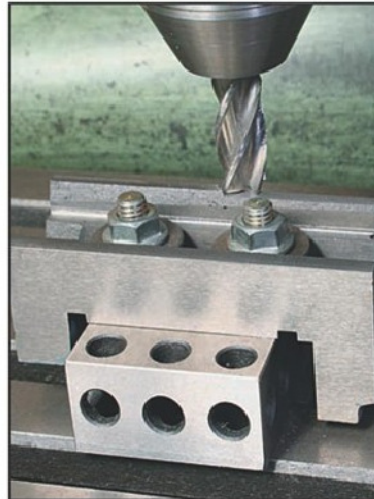


Photo 24 Using a 1 2 3 block to support the vice casting, also seen in **photo 23**.

but the lightest duties. Even if they are considered adequate for the task in hand the V block also needs securing to the table not leaving a lot of room for the V block's own clamps.

As an alternative to the blocks own clamps, those used generally on the milling machine can be employed for the task as shown in **photo 25** (right). Even so, this approach has a number of disadvantages, being:

1. The block is itself also loose until the workpiece is clamped and requires some means of positioning it to be provided. The photograph shows that locating plates have been clamped to the machine table for positioning the V block.
2. The system will not work with small diameters unless some packing is placed between the workpiece and the clamp.
3. The clamping force will be attempting to spread the block and it is known for blocks to split into two parts if the clamps are over tightened.

All is not lost though as the alternative method shown in **photo 25** (left) has many advantages.

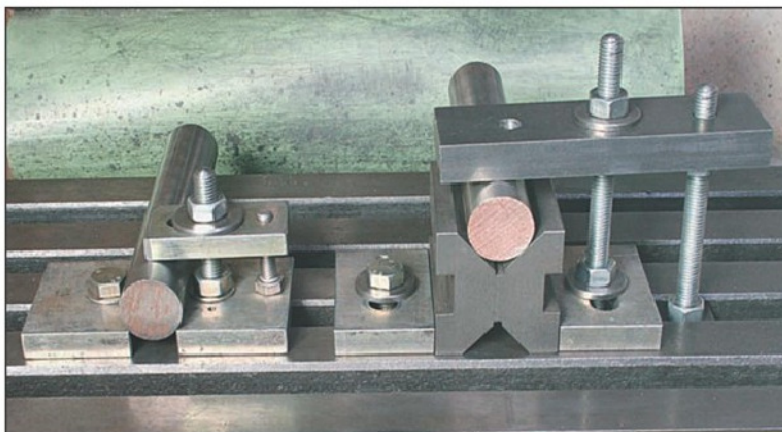


Photo 25 The method used on the left has many advantages over using a conventional V block, right.

- a. It will work with a very large range of diameters - say from 2mm and with an upper limit only dictated by the size of the machine.
- b. Set up is easy.
- c. It is very secure.
- d. Very long items can be supported with ease.
- e. No expensive items are required.

Fix the first plate on the machine table using a square off the front edge of the table to position it. Now, with a piece of material in width about $\frac{1}{2}$ the diameter of the workpiece to be supported, use this as a spacer to position the second plate for clamping to the machine table. Add the workpiece and clamp in place. For large diameters, thicker plates would be required and longer plates, maybe with two clamps, for longer workpieces.

Using a magnetic V block may be a possibility where the task is a very light one, but some means of accurately placing the block on the table will still be necessary, see **photo 26**. Note that even in this case, the magnetic grip cannot be relied upon completely and as the photograph shows, support plates have been added to the machine table. Also, an end stop in the form of an angle plate has been fitted to prevent the workpiece sliding along the V block. It is therefore a system that needs adopting with considerable thought and is a case of, if in doubt, don't! I have included these comments in the article not to say use the method, rather to say do not.

Positioning devices

Having accurately positioned the workpiece in relation to the machine's axis, X and Y, it is still often a requirement to position the cutter accurately relative to the workpiece, typically an edge. To do this there are a number of methods of achieving this, ranging from those costing virtually nothing to others needing to be purchased. Fortunately, even the most costly are not expensive.

Method one is to start the cutter and run it up to the side of the workpiece, listening for the sound of the cutter making contact with it, or to look for the first signs of the material being machined. In the latter case, covering it with marking blue will help. These methods have the disadvantage that the edge of the workpiece will be marked.



Photo 26 A magnetic V block should only be used for lightweight duties and then only when security of the workpiece and V block is certain. If in doubt, use another method.



Photo 27 The light in this edge finder lights when it contacts the item being located.



Photo 28 Two edge finders, illuminated and a Wiggler.

The traditional method of overcoming this was to moisten a piece of very thin paper and adhere this to the workpiece being tested. Then, when the cutter comes in contact with the paper it will drag it from the workpiece. This indicating that the cutter is at a distance from it nominally equal to the thickness of the paper. Another method, not defacing the workpiece, is to place a short piece of round material in the chuck and a feeler gauge between the rod and the workpiece and traverse the table until the feeler just becomes trapped. A more advanced version of this is one where the test piece, **photo 27**, has a light inside it that lights the moment it contacts the workpiece.

Knowing the diameter of the item being used to locate the edge, be it a cutter, rod or electrical tester, it will be a case of traverse the table by half its diameter and the machine spindle's axis will be above the edge being tested. It will then be a case of traversing the table further, as the dimensions of the workpiece require.

All the above have one disadvantage, that is, they cannot easily take account of the test items not running perfectly true. This will be particularly a problem if the test item is being held in a drill chuck, but even a more accurate collet chuck is likely to have some error, especially at a distance from the chuck itself.

A device that attempts to overcome this problem is an edge finder, often referred to as a Wiggler. This can be seen in **photo 28** (right) together with the electrical tester (left). The photo shows that there are a number of test pieces but all work in the same way. The holder, together with the chosen test piece are joined in a ball joint that allows the test piece to be set at an angle to the holder, as the photo shows. With the workpiece away from the edge finder and the machine running, the end of the test piece will rotate in a circle. If the workpiece is now moved up to the tester, gradually reducing the diameter of the circle, it will eventually get to a point where the end of the tester ceases to scribe a circle but just rotates on its own axis. With this situation, there is the advantage of the system, that is, no matter

how inaccurate the chuck holding the device is, the end of the tester will be exactly on the machine's spindle axis.

At this point, the spindle's axis is just half the diameter of the test piece away from the workpiece's edge. Unfortunately though, visually determining just when the tester ceases to scribe a circle is far from easy. However, this is not considered necessary as if the workpiece is traversed further the tester will be pushed off centre and will again attempt to scribe a circle but now part of the circle will be within the workpiece itself. This of course cannot be and the end of the tester will rapidly run to one side.

Just how much more accurate this is than the other methods, will I suppose, depend on the accuracy of the chucks holding the test pieces. For my part, I would suggest that allowing the cutter to just touch the workpiece, or to use the added paper, are more than adequate for the vast majority of applications.

Major accessories

There still remain a number of major accessories but definitely items not to be purchased until the workshop's activities show a need.

Dividing heads

The uses for dividing heads, **photo 29**, are many and varied and range from the simple to the very complex. At the simple end of the spectrum will be the need to machine a square for mounting an operating handle, **photo 30**. Beyond this there will be the need for many different gears, say when clock making.

For simple applications, and that includes the occasional gear, the shop made head, left of photo, will be more than adequate. Whilst the semi universal dividing head (right of photo) will provide many more divisions, only a universal head will fill in all the gaps up to 380 divisions, the latter being an unlikely requirement in most workshops.

5c fixtures

Photo 31 shows three accessories used for holding round workpiece's, all three of which use the 5c collet form as the means of holding the part. The device on the left is a simple dividing device, normally known as a spin index fixture. This can be set in one Deg. increments through a full 360Deg. but this one is particularly interesting as it is supplied with an adapter and closing ring, enabling it also to use the wide holding range of ER32 collets. The adapter is shown on the left with the closing ring centre left. An ER32 collet is included centre right with a 5c collet on the right.

Do not think that being able to be set in one degree increments, that it is a suitable alternative to a more expensive dividing head, it is not. For example, consider the need to cut a 50 tooth gear. This would require an angle of movement between teeth of 360/50 being 7.2Deg., obviously not possible.

The other two fixtures seen in the photo are simple devices for holding components using just 5c collets, and can be mounted either horizontally or vertically for machining, as the part requires. However, there is an interesting difference between the two that was briefly mentioned when collets were

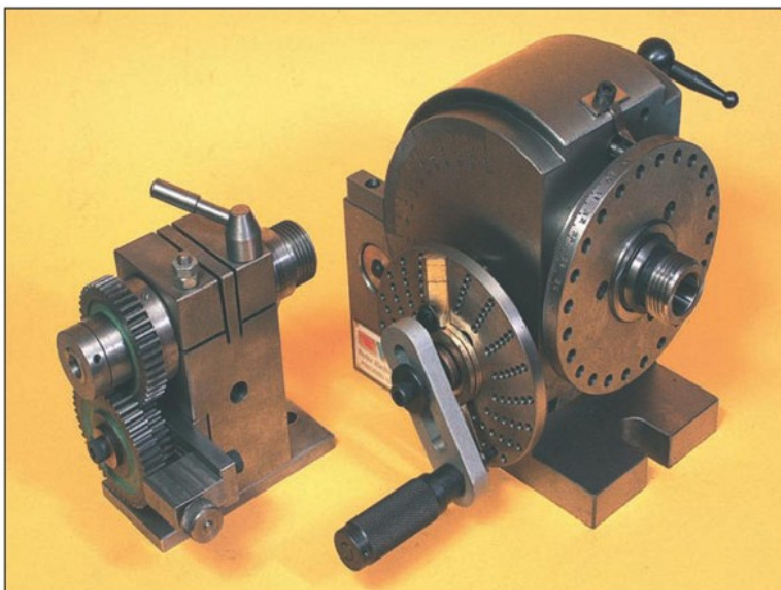


Photo 29 Shop made and commercial dividing heads

discussed earlier in the series. That in the centre has a closing ring to push the collet into its internal taper so as to close the collet and with this arrangement, the amount that the collet enters its internal taper will depend on the workpiece's diameter. Typically, with a smaller part, the collet will enter further.

From the photo, it can be seen that the fixture on the right does not include a closing ring. In this case, the collet is screwed into the base of the fixture using the collets threaded end (see the photo), and is closed by the internal taper moving forward. With this arrangement, the front of the collet will remain in the same position no matter what the diameter of the part being machined. This is very important where second operation work requires machining to be done accurately in relation to a flange on the workpiece that is located against the collet's front face.

Rotary tables

These, **photo 32**, are primarily intended for machining curved surfaces or slots, typically as seen in the changewheel quadrant, **photo 33**. However, commercially available rotary tables (left) can be supplied with added parts to make them suitable for dividing applications. The one on the right is a shop made table. Like the above major items, obtaining a rotary table should be left until there is an obvious need for one.

Taking a cut is easy

Having acquired the necessary accessories and being ready to start machining, the required knowledge is probably not what one will expect. In my estimation, apart from the sharpening of workshop tooling, the milling machine is more demanding in terms of decision making than any other machine, not due to the complexities of applying the cutter to the workpiece but in mounting the workpiece prior to a cut being taken. This is unlike the lathe where there are wider ranges of possible operations but all can be carried out with reference to the book, so to speak. Mounting components ready for machining will cover a wide range of situations, many of which are unique. Therefore, experience with a wide range of tasks, perhaps with some helpful reading, is essential to become at home with using the milling machine. Removing metal is relatively simple!



Photo 33 A rotary table is ideal for making the curved slot in this change wheel quadrant.

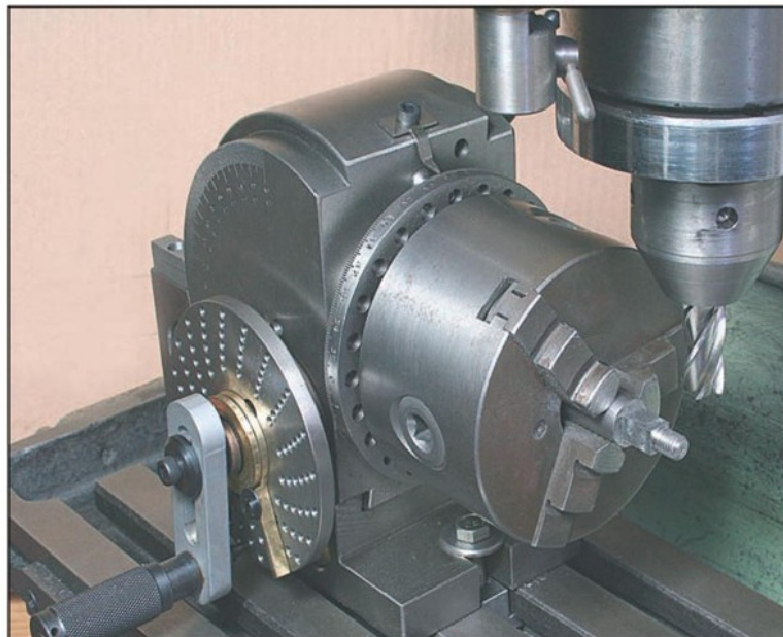


Photo 30 The commercial dividing head being used to machine a square for accepting a drive handle.



Photo 31 Three forms of 5C fixtures.

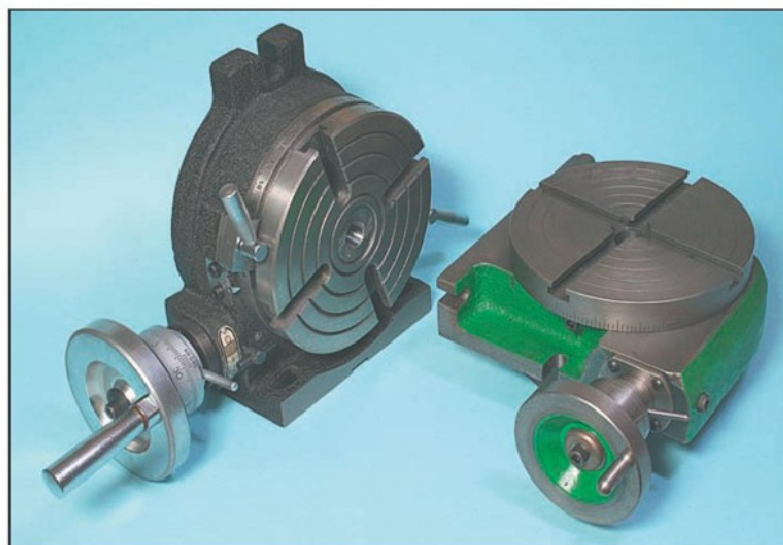


Photo 32 Commercial and shop made rotary tables.

The C3 Mini Lathe ⑤

The last article closed with the comment that added measures would be provided to enhance the rigidity for milling. Most turning involves continuous cutting and therefore a fairly consistent load on the tool. Thus under most circumstances, vibration due to the cutting action is not a major problem. Milling however is a rather different kettle of fish. A typical end mill with four edges, or slot drill with two, will take a corresponding number of bites during each revolution, and each bite will cause a sharp rise and fall in cutting load, which will tend to cause vibration. Changes to mitigate these effects are proposed in three areas: saddle clamps located at front left and rear right of the saddle, and clamp screws to lock or tighten the cross slide.

Saddle Clamps

Photo 1 shows the front clamp in place while **photo 2** shows the rear and the two cross slide screws. The clamp bodies are attached to the saddle, and are in contact with the upper surface of the bed. The clamping action is effected by simply pulling up a lower plate, which then bears on the underside of the bed and the body of the clamp. **Figs 1 and 2** show the component details. It may also be seen in **photo 1** that the two socket head grub screws used to blank the screw positions for the travelling steady have been substituted by a couple of slotted pan head screws. They don't look as neat but it's easier to remove swarf from slots.

Making the clamps is quite straightforward, but before getting started, measure the bed in two places as shown in **photos 3 & 4**. What is needed is the vertical thickness, front and back, as the clamps will be made to suit these sizes. It may be observed that the front shear needs to be measured close to the end of the bed, otherwise the rack prevents correct micrometer access. As it is possible that there may be some slight variation between machines, this is best

Dave Fenner makes a saddle clamp and parting off tool

checked on the individual lathe. The dimensions for other features are generally not critical and are given on the drawings. The thickness chosen was $\frac{3}{16}$ in. (9.5mm) and this proved quite adequate for clamping purposes. However, when checking later for clearance when used in conjunction with the travelling steady, it was found advantageous to place spacer washers between the front clamp and the saddle to create space for the clamping nut to turn. A similar result might also be achieved by using thicker material, say 12mm and drilling the 5mm and 3mm holes off centre.

How you go about making the clamps will depend on the equipment available to you. It is possible to produce them entirely with hand tools, a hacksaw, a file and a drill, but it may be quicker if you can access a small mill. I sawed off a couple of pieces of 9.5mm aluminium plate, squared them up in the mill (although this can be achieved by gripping edgewise in the four jaw chuck) and then sawed away the unwanted small rectangle from each, before trimming to size in the mill. The 5mm diameter hole is then drilled centrally on the thickness to leave a 0.5mm wall, and the 3mm dia. by 5mm deep hole to accommodate a silver steel anti-rotation pin.

It had been intended that two M4 Allen screws should retain each clamp, but after examining the features on the underside of the saddle casting, one only was used on the rear clamp. This has proved satisfactory, so it might be inferred that just one would also suffice at the front. In the case of the prototypes, the 4mm mounting holes were added, then the lower surface filed away at an angle as can be seen in **photo 5**. This would ensure that when tightened, the load would be applied as in **Fig 3**, with the clamp bar bearing correctly against the bed.

This latter component is simply a small piece of steel cut to the dimensions

indicated. Note that the prototype for the rear included provision for an adjustment screw, bearing on the clamp body. This proved not to be needed, and the drawings for both the front and rear reflect the arrangement used at the front. One hole is drilled and tapped M5, the other $\frac{1}{16}$ in. (clearance for 3mm)

A short length (say 12mm) of 3mm diameter silver steel is cut, deburred, and fitted to the clamp body with Loctite, the same adhesive being used to hold the clamp bar and M5 screwed rod. In both cases wipe away any excess adhesive, which might cause unintended lock up after uniting the two sub assemblies.

Positioning against the saddle

In each case the mounting hole(s) need to be accurately positioned on the casting. For the rear clamp, first remove the tailstock and move the saddle towards that end of the bed. Engage the half nuts to prevent it sliding towards the headstock. Now fit the rear clamp hard against the bed and the saddle and tighten in position, **photo 6**. I then used a cordless pistol drill and 4mm drill to spot through the mounting hole. The resulting "spots" can be seen in **photo 7**.

For the front, access is more restricted and so the pistol drill cannot be used. The easy answer is to make up a silver steel transfer punch. If you have a short length of 4mm diameter, then just grind a point on one end, heat to red hot and water quench. Otherwise use a piece of slightly larger diameter, and turn down a length of about 13mm to just pass through the 4mm hole, then complete as noted before, **photo 8**.

With the clamp locked in place on the bed and against the saddle, the punch can be inserted, **photo 9** and struck with a small hammer. Note that this time, the saddle is restrained by firm hand pressure, as transmitting the force of hammer blows to the half nuts would not be recommended.

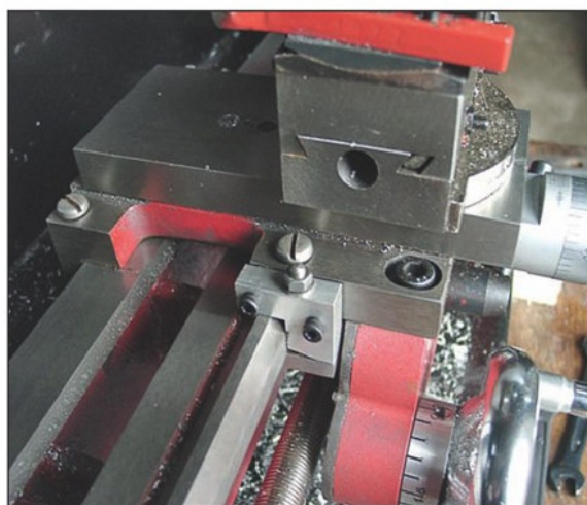


Photo 1 Front saddle clamp in place also showing alternative blanking screws.

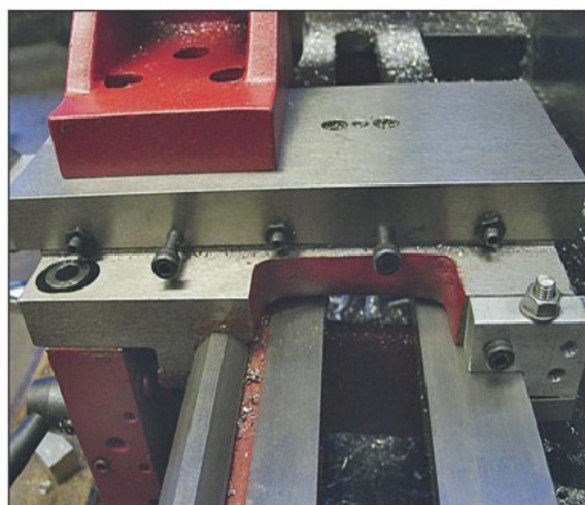


Photo 2 Rear saddle clamp and cross slide locking screws.



Photo 3 Measuring the front shear.

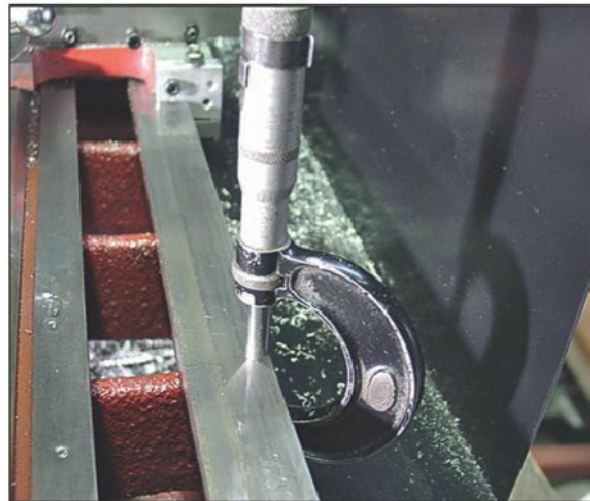


Photo 4 Measuring the rear shear.

After checking for satisfactory indentations, the saddle can then be removed from the lathe, and detached from the cross slide. The saddle casting may then be clamped to an angle plate and the marked positions drilled tapping size for M4. (The generally accepted tapping size is 3.3mm, however experience in production tapping indicated that tap life could be significantly extended by a small increase in tapping drill diameter. This is a practice I continue to adopt, so here I use a 3.5mm or No 29 drill.) The threads are then tapped.

At this stage, while the saddle is dismantled, you may choose to include the cross slide clamping screw modification described below.

As noted above, the front clamp is assembled being spaced away from the saddle by one M5 washer sandwiched on each mounting screw. This then allows the clamp to be left in situ at times when work on a slender component may require the travelling steady to be fitted.

Cross slide clamping screws

As supplied, the cross slide is fitted with a gib strip whose adjustment is effected by three screws and locknuts spaced at approximately 55mm apart. By adding

a couple of extra screws as seen earlier in **photo 2**, it is possible to temporarily and quickly tighten up the assembly in order to undertake milling work and then afterwards revert to normal.

The cross slide is removed as discussed previously, then the gib strip taken off. Now determine the height from the lower edge up to the centres of the adjustment screws. It is necessary to mark out and drill the two holes for the new screws at this height (approximately 3mm). Given access to a mill, this may be dealt with by setting up and adjusting the Y position so that a No. 30 drill fitted to the chuck will pass down through the existing holes without deflection, then moving the work along in X to pick up the new.

Without such luxury, the measurements (which can be made before dismantling) might be:

- Thickness of cross slide – approx 16mm.
- Drop from top surface to screw thread – approx 11mm.
- Diameter of screw – nominally 4mm from which the centreline is positioned some 13mm from the top surface or 3mm from the underside.

I chose to err a little on the plus side as regards the 3mm figure to be sure of



Photo 5 Component parts of the front clamp, note the lower surface filed away.

residual wall thickness, and moved the new screws up to about 3.5mm.

The screws are simply a couple of M4 x 20 socket head cap screws, whose ends are modified by filing or grinding on a cone angle, which will encourage line rather than point contact, when screwed in towards the gib strip.

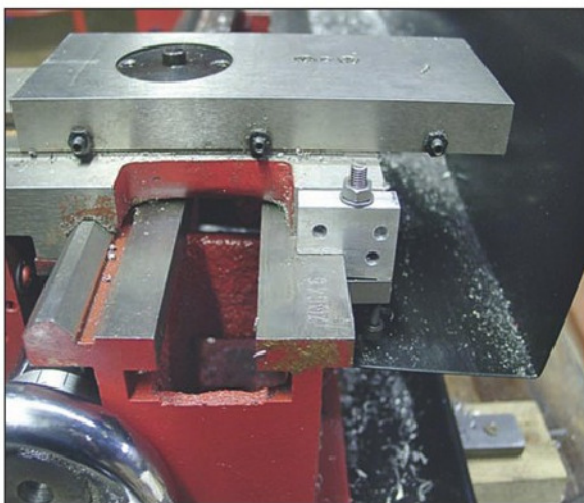


Photo 6 Rear clamp tightened in position, hard against bed and saddle. (Note only one bolt position is used).

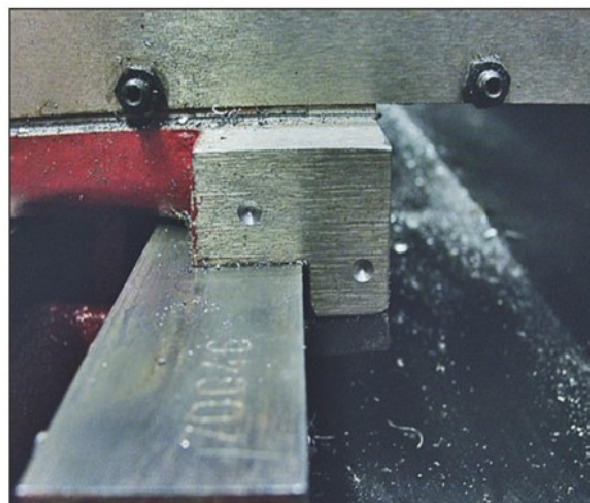


Photo 7 Centre marks after spotting through with a 4mm drill.



Fig.1

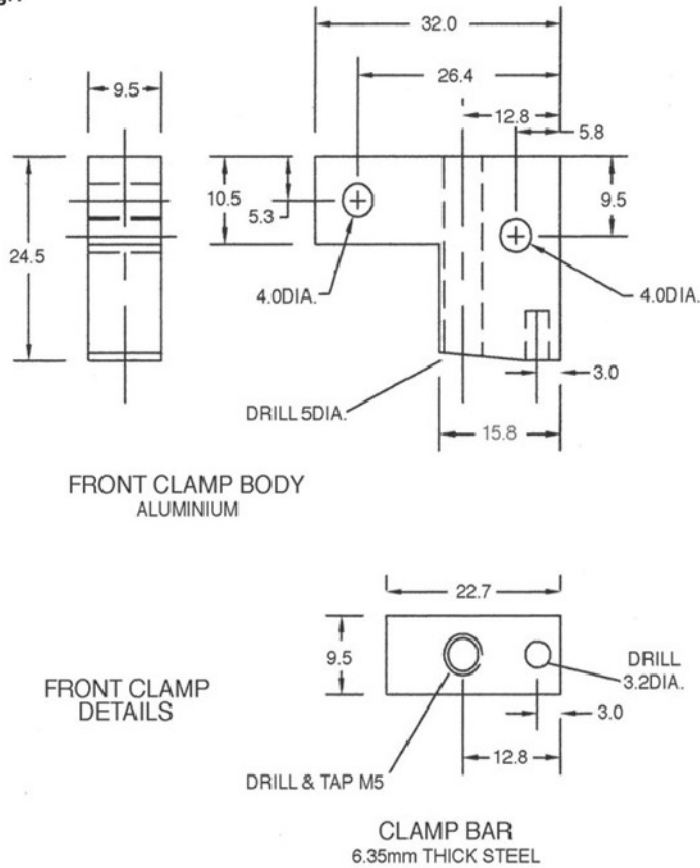


Photo 8 Transfer punch made from silver steel.

In Use

As a trial, I clamped a lump of aluminium in the vertical slide, and an 8mm end mill in the three jaw chuck. Note that holding the cutter in this way is not best practice. The collet chuck or a dedicated milling chuck would be preferable, but these may be items that many novices have not yet acquired. The saddle clamps were then tightened down, and modest pressure applied via the cross slide screws. (Just enough to give a tighter feel to the handle.) An initial cut of 0.5mm was followed by one of 1.0mm – the depth being controlled by the leadscrew handwheel. Both cuts were taken at a speed of some 900rpm and engaged the full width of the cutter. The resulting vibration was considered acceptable, although this was considered a severe test for such a small machine, particularly in view of the manufacturer's comment re turning "We recommend that for rough cutting, you do not exceed 0.010in. (0.25mm) as your depth of cut". The 8mm wide trial groove can be seen in photo 10 and this certainly suggests that much useful milling work will be possible probably using FC3 cutters running at similar or higher speeds.

Parting Off

In the last article, I commented on my preference for parting off by means of a rear mounted toolpost, and noted the difficulty that can arise due to deflection, when a front mounted part off tool is used in a lightweight machine. Briefly, a front mounted tool deflects downwards and into the work whereas one at the rear moves up and away. Thus deflection by the front tends to cause dig in whilst at the rear the effect is to reduce the depth of cut. A rear mounted toolpost would

Fig.2

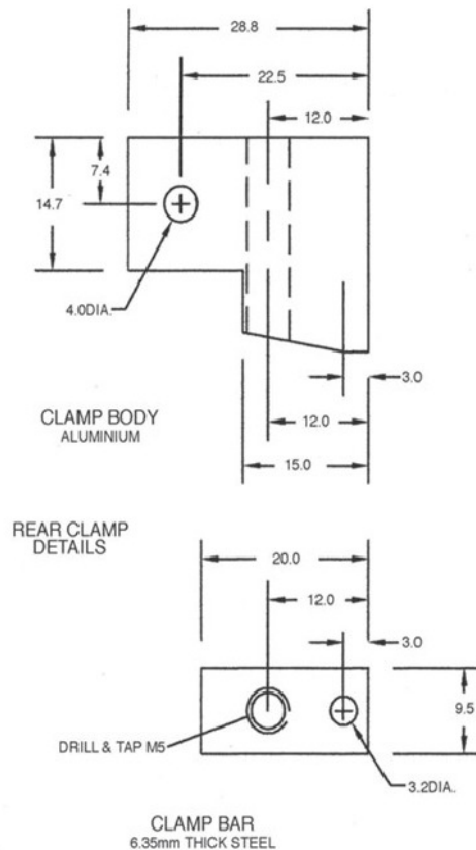
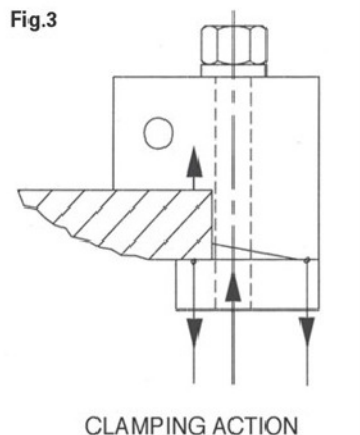


Fig.3



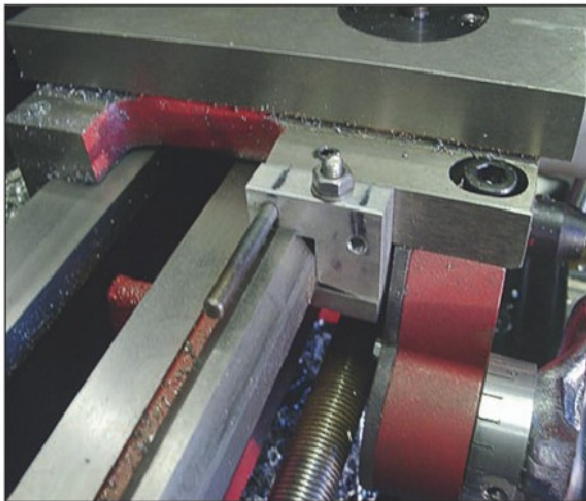


Photo 9 The front clamp locked in place showing transfer punch.

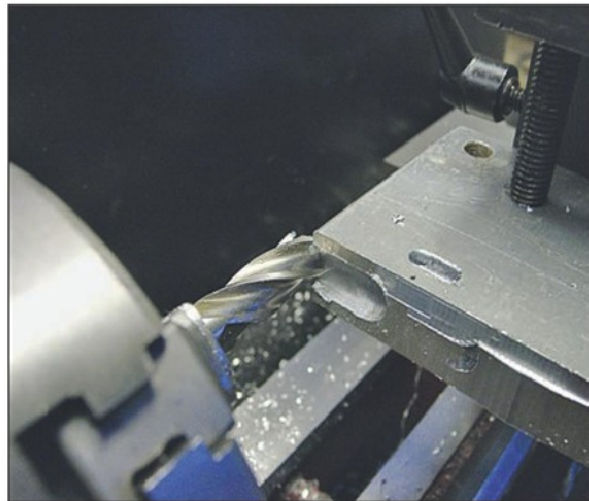


Photo 10 Successfully cutting a trial groove.

dictate a longer cross slide, and this will be looked at in the longer term. It may also be possible to incorporate modifications to increase the travel of the existing slide. This part of the article looks at an alternative design of part off tool, which involves no modification to the lathe.

Photo 11 shows three typical conventional parting off tools aimed at larger machines. Each takes a standard HSS blade. **Photo 12** illustrates a homemade tool employing the same principles. If mounted in a front position, then the comments above apply. **Photo 13** illustrates a tool made and kindly presented to me by Ivor Hill. Here, Ivor has designed the body so that any flexing will result in movement away from the job, and thus this type of tool can be used to good effect in a front post.

Two of the features of the C3 Mini-Lathe relevant to this topic, are a) the chuck is retained by three studs and nuts as opposed to a screw on fitting and b) the spindle control incorporates variable speed and forward/reverse facility. The combination of these features means that suitably tooled, you can actually undertake machining work with the lathe running backwards, and the chuck will not unscrew. Taking advantage of these attributes, we can consider a part off tool set up in the front position, but inverted, and thus arranged to cut in reverse.

Photos 14 & 15 show two views of the prototype tool described here, which uses a standard $\frac{1}{8}$ in. HSS blade, and which is designed to be made with minimal equipment.

Just three components need to be manufactured, as illustrated in **Figs 4a, 4b and 4c**. These can be produced either with just a drilling machine and hand tools, or using the C3 with the milling sub table described in the last article, to accurately position holes. The standard fasteners needed are two M4 x 20 plus one M5 x 20 socket head cap screws, two M4 x 10 socket head countersunk and one M5 nut and washer.

Before starting, purchase one or two 8mm part off blades such as those supplied by Arc, stock No. 060-320-00940 and measure them. (I have suggested more than one, as in the past I have found it useful to have one blade ground back to a specific width for cutting narrow grooves.)

Depending on the manufacturer, the thicknesses and angles may vary a little, but in general the form of the cross section will be as shown in **Fig 5** and the thickness at the wider edge will be around 1.5mm and about 1mm at the narrower.

Top Plate and Body

The top and bottom edges of the blade are angled at around 10 degrees, and on this basis, we may progress to make the top plate. A 63.5mm length of bright steel flat or gauge plate 15mm x 3mm is needed. I happened to have gauge plate available and this would give better wearing properties, particularly if hardened and tempered. It was placed in the vice, and one edge chamfered by filing at an angle to roughly match the blade. The chamfer was taken a little more than halfway across the 3mm thickness. Progress can be monitored by observing how far across the thickness the chamfer extends. Then mark out, drill and countersink the two 4mm diameter holes.

Work then moved to the body, cutting a rectangle of $\frac{1}{8}$ in. thick steel plate to 63.5mm x 35mm. You may then choose to clamp the top plate in position and spot through the two holes, or pitch them accurately on the machine. These are then tapped M4. The other two M4 holes may also be added.

Next a piece of ten thou (0.25mm) shim is cut 63.5mm long by 8mm wide. The top plate is then assembled to the body by two M4 countersunk Allen screws, trapping the shim as shown in **photo 16**.

The blade is then placed in position resting on the shim and against the top plate. The purpose of the shim is to tilt the blade slightly ensuring that clearance will exist on both sides when in use. (Some cheaper commercial tools are less than perfect in this respect.)

It is now possible to determine the position of the hole for the clamp bolt. This is done by spotting with a 6mm diameter drill just touching the edge of the blade. The hole is then drilled 5mm and counterbored using an 8mm drill to a depth of 5mm.

Clamp Bolt

This starts life as one of the M4 x 20 Allen screws, which then undergoes two modifications. First turn down the head



Photo 11 Three commercial part off tools, top $\frac{5}{8}$ - $\frac{1}{2}$ in. middle $\frac{1}{2}$ in. bottom $\frac{1}{4}$ in.

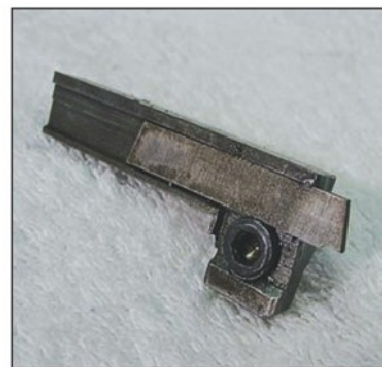


Photo 12 Home made tool to take $\frac{1}{8}$ in. blade.

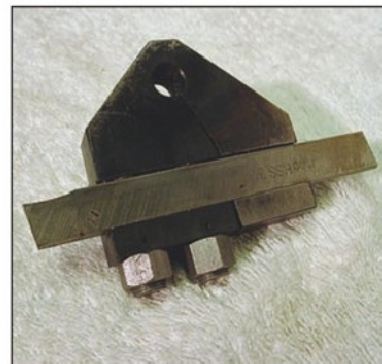


Photo 13 A chatter free tool from Ivor Hill.

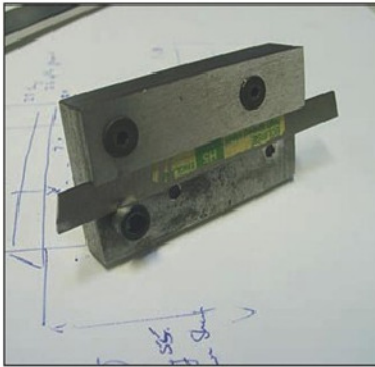


Photo 14 The reverse tool from the blade side.

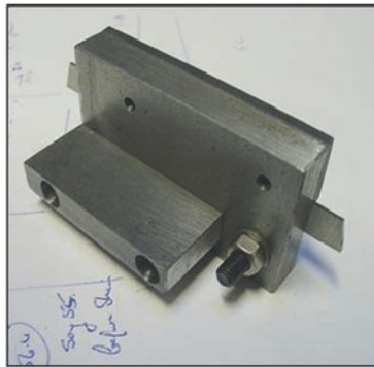


Photo 15 Reverse tool from the mounting side.



Photo 16 The top bar and body showing position of shim.

Fig.4a

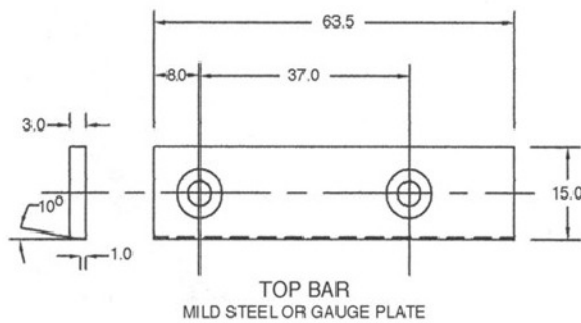


Fig.4b

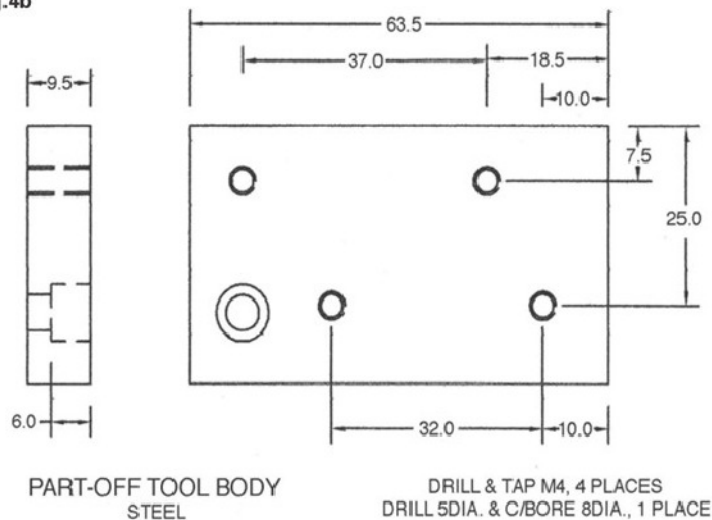
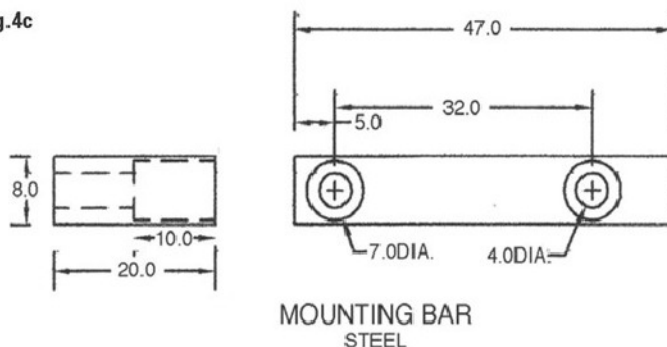


Fig.4c



diameter (Photo 17) to be a snug fit in the counterbore in the body (about 7.98mm if your 8mm drill cuts to size). Next file a flat on the head aiming to achieve an angle to match that on the blade, as shown in photo 18. Try the bolt for size. What is needed is for the head to enter the counterbore (but not bottom in it) before locking on the blade. This way, the clamping load is transferred directly across the head rather than by bending the threaded portion.

Support

This was produced from a 47mm length of 20mm x 8mm bright steel flat. Two holes are drilled through 4mm and counterbored 7mm x 10mm deep, photo 19. Careful positioning is needed here to ensure that the counterbores do not break out. Two alternatives may be considered. Countersunk screws may attach the support. In this case, the threads are tapped in the support, and holes drilled through the body then countersunk to ensure that the screw heads are under flush to clear the blade. Bar material such as 12mm square would be equally applicable, the component position being arranged by using the lower edge as a datum

Assembly and set up

With the top bar and shim in place, the support is bolted to the back face, and the blade then located using the clamp screw and nut. As we are working "back to front" it will probably be necessary to grind the end of the blade. My preference is to take off just sufficient material to give a flat "top" surface, then a 90degree (plan view) front.

(In production work, part off tools are often ground with an angled tip so that any pip is left mainly on the stock bar rather than the component just completed. However such geometry introduces side loads. These do not generally cause problems with heavy duty industrial tooling, but at the miniature level, can cause the tool to progress inwards at something other than 90degrees to the axis.)

It may be found easier to grind the blade in the holder, as this gives a bit more to hold on to, and the holder offers rectilinear reference surfaces.

The holder is then set up in the toolpost, shimming and adjusting to ensure that two criteria are met. The end of the blade should be at centre height and when in position, the blade should lie at 90degrees to the spindle axis viewed from above.

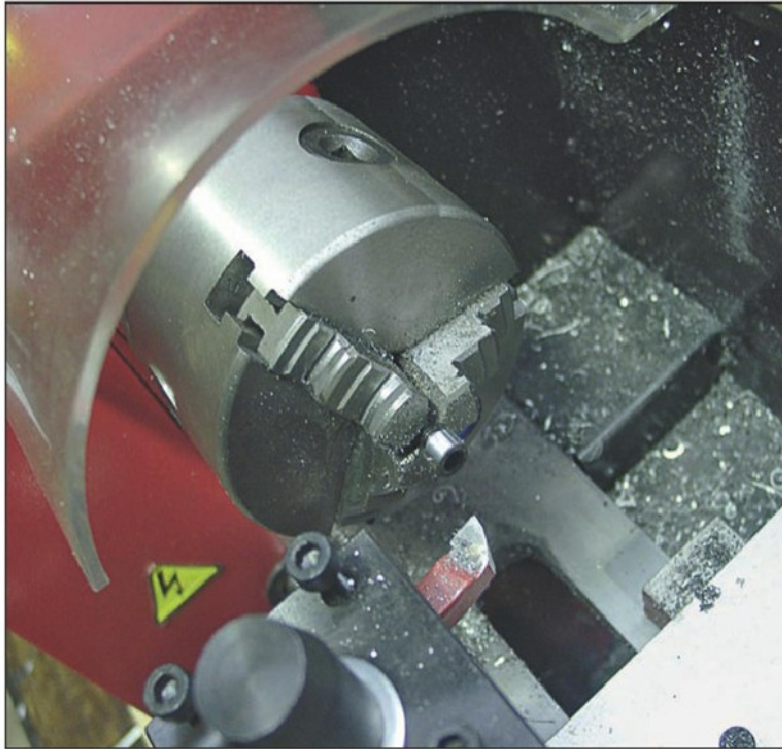


Photo 17 Reducing the head diameter.



Photo 18 Clamp bolt after modification.

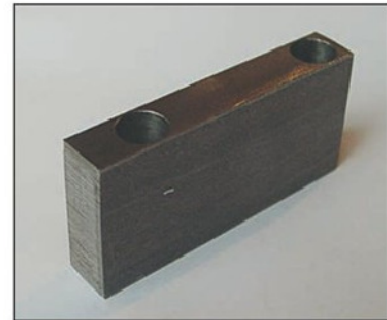


Photo 19 Mounting bar showing counterbores.

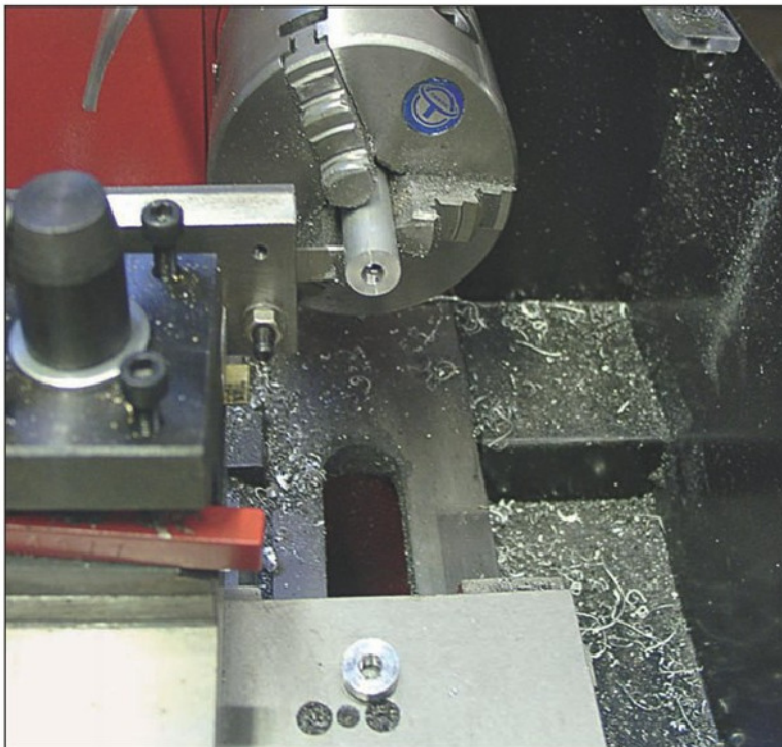


Photo 20 Detached slice can be seen on the cross slide.

In Use

As a quick trial, a redundant aluminium stand off was gripped in the three-jaw chuck. **Photo 20** shows the part off tool in place, also the short piece sliced away can be seen resting on the cross slide. This really was knife through butter stuff and a second trial employed a piece of 9.5mm diameter steel. This time there was a little audible vibration, but of course no tendency

to dig in and thin slices were taken off without any difficulty. The front/rear faces of two of these can be seen in **photo 21**.

It is quite possible that the tool's performance might be improved by careful attention to the "top" rake, where I have simply used zero degrees, also by using a mounting bar of more robust section such as 12mm square mentioned earlier.



Photo 21 The parted off components showing the pips.

Fig.5

CROSS SECTION OF
TYPICAL
PART-OFF BLADE

NOTE: SIDES MAY
BE FLAT OR
HOLLOW GROUND

REVISING WORKS STORAGE part ②

David Piddington finishes putting his workshop (and affairs) in order

When the computer arrived and remembering that there was no way my dear wife would allow this elsewhere in our home, the only space left was beneath the window bench. The computer and printer were put on a substantial shelf bracketed to the wall and the flatbed scanner was fitted into a slide-out drawer as in **photo 14**. Its outer end badly needed support and the crude "double-H" frame was devised but made quickly detachable with a pair of blue plastic knurl headed bolts.

Careful positioning of the milling machine's "Y" axis is vital to allow the lid to be raised. The computer's monitor was initially put underneath a corner cupboard but as this unit had been put in before other shelves had enclosed it, the only way to lift it was with a car scissor jack and substantial legs fitted at each side. Then a larger monitor arrived at "the right price" and the jack was used once more to lift the cupboard higher so that the monitor could stand on a hollow MDF plinth with a concealed space beneath for the keyboard when not in use. This can be seen in **photo 15**.

Beneath can be seen a series of narrow shelves where the original bar stock



Photo 14 Flatbed scanner in the working position. Note clearance for handles cut in 'H' frame.

stores were held and will be in future when a suitable method has been found. Square plastic gutter down pipes cut to suitable lengths, possibly in halves lengthwise, would seem the best option but are yet to be tried. Readers will

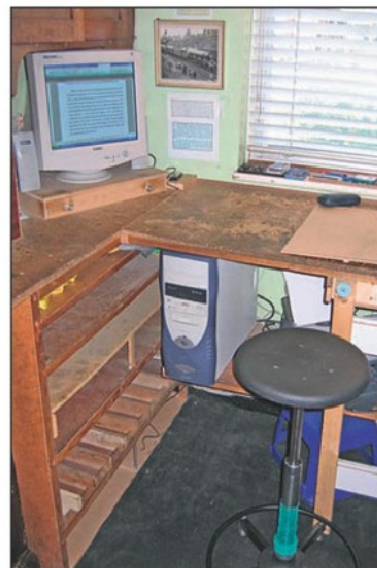


Photo 15 Computer corner showing original storage shelves.

probably have their own methods for this. **Photo 16** shows 'the computer corner' in use with the hinge mounted telephone ready for the next interruption.

In the earlier images of this series, downward views show an aged carpet. After a lot of thought, I took the plunge and bought a roll of 3mm grooved rubber matting from "Machine Mart". Now I shall never make a carpet-fitter but in the confines of my small shop it was cut and fitted (where it touches) and I am reasonably satisfied with the result. Even hexagon nuts as small as 12BA can be now found under close scrutiny when you will already be in the approved 'praying position' looking for that tiny component you have taken ages to make and dropped.

I find that the rubber will not lie exactly flat especially on the edges but some experiments with a shallow flanged bush, **photo 17** cured the major deficiencies. Thus the matting and flanged bush should have a combined thickness not greater than 5.5mm. However before you adopt this method of floor covering remember that the floor positioned slide-out drawers have to have their bottoms higher to clear these. I solved this by putting a layer of 6mm MDF under each drawer, though for economy a 2in. wide 'slide' at each side with perhaps one in the middle for a wide drawer should be satisfactory.

Using the premise that one can never have enough storage space, the previously empty space beneath 'computer corner' has been filled with four more drawers as

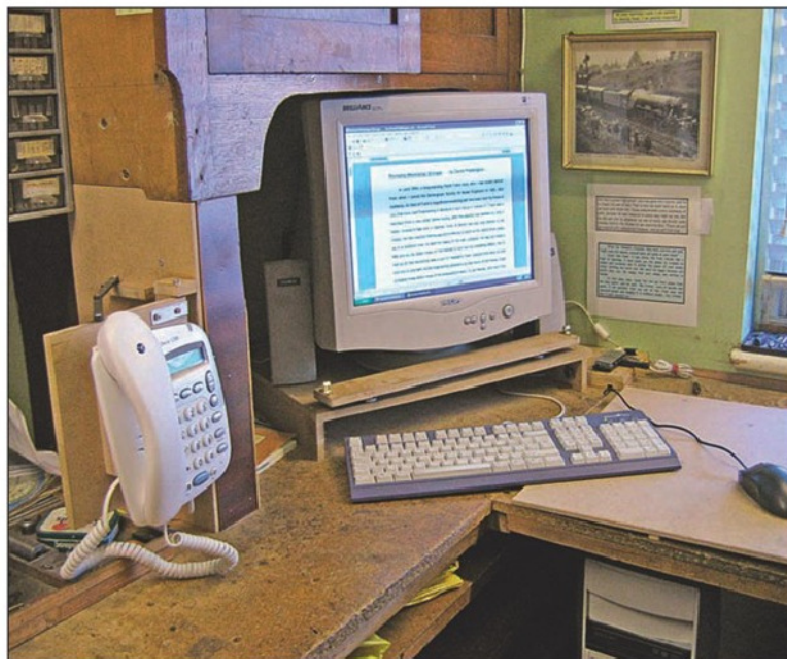


Photo 16 Computer corner with hinged telephone mount.

KSHOP

shown in **photo 18** but to give the maximum insert depth, the rear face was made from off cuts of aluminium sheet **photo 19** which were secured with epoxy resin glue and pins as before. The cut outs were to clear the rear cross-member of the bench structure. These drawers protruded from the bench front by 2in., and rather than have a secured top piece, detachable combined cover and depth stops with knurled headed dowels were used as in **photos 20 & 21**.

I had completed most of this work leaving the really difficult bit till last. How does one decide how to store that vast accumulation of small bits of steel and brass that are far too good to throw away and yet when one wants a small piece, the nearest you find is inevitably slightly too small on one or more dimensions? I realised that below the mill-drill bench there was room for a further selection of drawers, which could be utilised for this purpose. **Photo 22** shows one of these with an internal tray. The handle on the front was made from three pieces of 12mm MDF glued together with the inside pair cut away underneath to just wider than the width of my four fingers and deep enough to give a good grip. Once the glue had set, they were secured to the drawer fronts by screws from the inside. It will also be seen in this picture that the scanner's "H" frame right leg needed a clearance cut into it to pass over the handles which in turn had to be exactly in a horizontal line. In my area, local ethnic 'take-away' houses use plastic tubs measuring 6 1/2 in. x 3 3/4 in. and 2 1/4 in. or 1 3/4 in. deep for their products and I find these a suitable item for holding these offcuts of metal. If you do adopt these tubs, check the dimensions before making compartments within drawers for them to fit in.

The whole reorganising has taken more than two years and is still incomplete but I felt it was better to "get it right" once and for all. Part way through the basic work, or so I thought, I felt it was time to identify every compartment in some way and decided to letter the chests and boxes and number the drawers and shelves though whether this makes any real sense I will leave to your imagination. I decided to do my own thing and challenged myself to produce something suitable on the computer, having no stencils, no dry transfer lettering, nor even punches big enough.

I did have a packet of overhead projector film, which would do if only I could print the characters in reverse so that when applied to a drawer or box front, the ink would be inside and protected. Unfortunately, and as far as I am aware as a beginner to computing, "Word" typing cannot be 'flipped' to reverse it so I selected character numerals 1 upwards as required at 48 size font leaving a generous cutting allowance and printed these on white paper. Then I scanned the sheets and saved them as 'JPEG' images, which were then flipped, and printed the results



Photo 17 Flanged bush and countersunk screw used to secure matting.

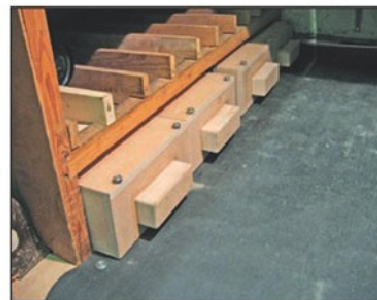


Photo 18 More storage drawers fitted under the computer corner.



Photo 19 Inner end of drawer shown in **photo 18**.

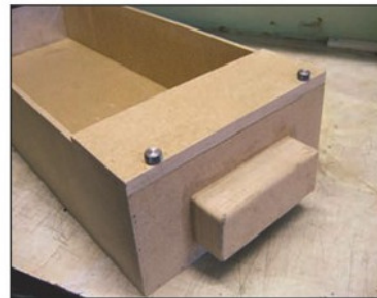


Photo 20 Outer end of the same drawer.

on to the film. It worked for me. I did try using a white colour background but on film this was 'wishy-washy' and unsuitable. Some of the older drawers were discoloured and heavily varnished so I marked these in advance and painted the square white by hand having marked the position around the edge of the drill jig described next.

As I had in advance decided that I would cut the characters out, centrally disposed, on a film size of 1 1/4 in. square, I had made a drilling jig with No. 54 holes in the corners and positioned this in turn with a dab of "white" on all the drawers and

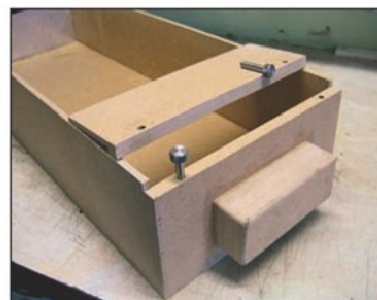


Photo 21 Outer end of the same drawer with top removed to show dowels.



Photo 22 Additional under-bench drawers with internal tray.



Photo 23 Cutting numbers from film using clamped jig.

boxes before drilling into, or through, the face as required. The MDF-lined steel tool chests were subsequently drilled through number 50 diameter and 10BA screws – round head look neater – long enough to pass through the MDF, with nuts to secure inside, were fitted.

On a spare piece of MDF towards its edge I repositioned the jig, drilled into it and scored heavily with a craft knife around the circumference. I could now position the film and its lettering centrally disposed over the square, put the jig back on top and with a small toolmakers clamp, hold all three parts together. I next drilled the film through and with the knife cut all the way around except where the clamp was positioned. **Photo 23** shows the procedure. The remaining pieces of film with their individual numbers were cut off with scissors and the holes enlarged to number 50 diameter. I used 10BA round head screws with a washer under each head to secure the film labels and I found then that MDF will also take a thread tapped dry into it, it is strong enough for this task. **Photo 24** shows the result; not a work of art I agree but as there's only two of us ever going to use the system, does it matter? I think not.



Photo 24 Finished numbers attached to storage drawers.

A short selection from the inventory pages

Drawer "2"

LOCATION

Dies $\frac{1}{16}$ " dia CSCT noted in black HSS in orange
4BA, 5BA, 6BA, 7BA, 9BA, 10BA, 12BA, 14BA, 16BA
2BA, 3BA, 4BA, 5BA, 6BA, 7BA, 8BA, 10BA, 12BA
 $\frac{1}{8}$ " x 40, $\frac{5}{32}$ " x 40, $\frac{5}{32}$ " x 40
 $\frac{7}{32}$ " x 40, $\frac{1}{4}$ " x 40, $\frac{5}{32}$ " x 32, $\frac{3}{16}$ " x 32, $\frac{1}{4}$ " x 32
 $\frac{1}{4}$ " x 26
 $\frac{1}{4}$ " BSF
 $\frac{3}{16}$ " BSW, $\frac{1}{4}$ " BSW
 $\frac{3}{16}$ " BSW LEFT HAND, $\frac{1}{4}$ " BSW LEFT HAND

Top Tray

Dies 1" dia CSCT noted in black HSS in orange
2BA LEFT HAND
 $\frac{3}{16}$ " x 40, $\frac{5}{16}$ " x 40, $\frac{3}{8}$ " x 40
 $\frac{7}{32}$ " x 32, $\frac{5}{16}$ " x 32, $\frac{3}{8}$ " x 32
 $\frac{5}{16}$ " x 26, $\frac{3}{8}$ " x 26

Top Tray

Table 1 A selection from the inventory pages.

Incidentally, the drawer knobs are the reverser handwheel castings from Westbury's Diagonal Paddle Engine; just the right size to promote the 'model engineer image' in my workshop, except that I should have bought a lot more while I could afford them. The wheel rims were cleaned up with files in the lathe, reversed in the chuck to drill and tap the stems and then they were bolted from inside the drawer.

A couple of weeks later I decided to number the individual drawers in my wooden tool chest, bought in 1959 towards the end of my apprenticeship when it was certain my future would be either on the fitting benches, or as came later, working as a fitter-machinist. A tool chest was an essential bit of kit in those days and this box went with me to several firms in the next six years.

I adopted a slightly different procedure in that I still used the flipped image numbers but used "Paint" on the computer to draw an outline box around each before printing in reverse on transparency film. Using 36-point font, the letters in their enclosing box were just $\frac{1}{16}$ in. high and so I placed a strip of 1in. wide double sided "Sellotape" across each of two rows of numbers 1 to

4, and 5 to 8. I then removed the backing strip and fixed the strips down on to white paper. A second strip of double sided "Sellotape" was then fixed on the back of the paper, the latter being sufficiently transparent to see the black characters through it, and the individual numbers were then cut out leaving about $\frac{1}{8}$ in. outside the border line. It was then a simple job to remove the second backing strip and stick each number on to the appropriate drawer front. **Photo 25** shows the result though the actual colour is not true white but "Sellotape" colour, which is very faint brownish-buff.

Photos 25 A, B, C and D respectively show close-up the final results of characters with different backgrounds. Type "A" was done with white paint on to the dark varnished original drawers; "B" was put on to some white faced hardboard I used for two swing doors to shelves just visible in **photo 9**, issue 136, page 27: "C" with a cut white paper backing. I found this to be a better alternative to the painted ones though they take longer to make and fit; and finally "D" are those on the tool chest described above.

The final process was to examine each container and enter on a separate file the



Photo 25 Numbers applied to tool chest.

full contents of each and from those create an updateable inventory. **Tables 1 & 2** show respectively a section from the tap and die drawer file pages and a section from the complete hard copy index. A lot of typing was involved, but I have already found the effort well worth doing. Locating a specific tool is now easy provided I can remember what I called it for indexing purposes.

More drawers were made to fit in the gap beneath the 'metals store'. I have already mentioned this but later, on the premise that 'excess space is better than not insufficient', I made four more drawers with internal trays. However I found that the bottom longitudinal strut had bent downwards, so using a piece of commercial threaded rod, two nuts and two washers, I devised a jacking bolt to lift it to a more-or-less horizontal position. Unfortunately this was not possible for the corresponding rear strut and further cut outs, mentioned previously, were required. **Photos 26 & 27** show one such finished drawer with longer and shorter trays and the bottom area used to contain off-cuts of metal in take-away plastic boxes. There is still work to do, but I feel I have 'broken the back' of the work now and earnestly hope that these notes will inspire many readers to set up an efficient and tidy workshop.

Before closing this narrative, I took opportunity to make a few special enclosures of which three are offered as my solution to particular problems and hopefully, to give readers the inspiration to solve their own difficulties of this nature. **Photo 28** is for my bending rolls, made not long after setting up my workshop. These, to Martin Evans' design have proved very useful over the years but



Photo 25A Container number on painted background.



Photo 25B Container number on white-board background.



Photo 25C Container number of cut white paper background.



Photo 25D Container number on sealed photo paper.



Photo 26 Storage drawer with internal trays and take-away tubs.



Photo 27 Storage drawer shown in photo 26, closed.

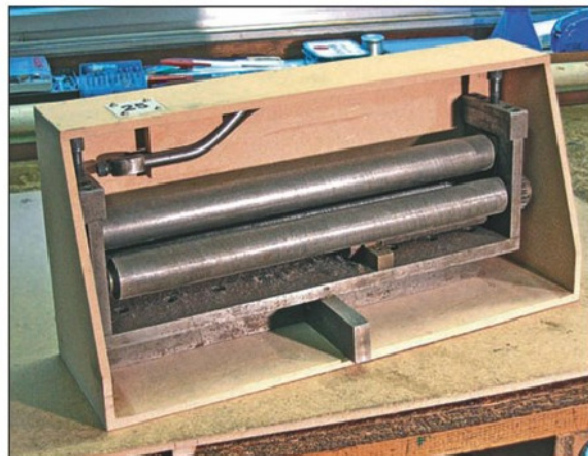


Photo 28 Dedicated storage for bending rolls.

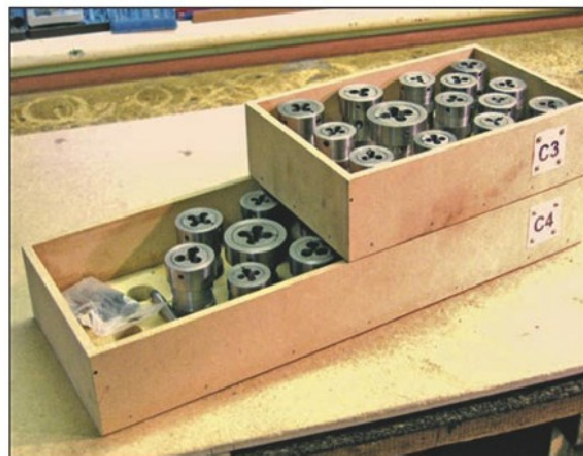


Photo 29 Dedicated storage for pre-set dieholders.

have always presented problems of storage. **Photo 29** is my method of keeping pre-set die holders secure in individual holes yet grouped together for easier accessibility. **Photo 30** is a box with a sliding lid housing my set of metric ER25 collets together with the backplate-mounted chuck. I produced a chart of comparable Imperial inch diameters and computer saved it as a JPEG image. This was then printed on to glossy photo paper and glued into a 0.010in. recess milled into the inside face of the lid thus protecting it from damage. **Photo 31** is a similar unit made many years ago, when I had completed George Thomas' small hand rotary table together with various attachments. Since this image was taken, I have fitted a Perspex hinged lid.

During the indexing process, I discovered some rather unusual items including a $\frac{3}{16}$ in. x 1MT shank reamer which, I assume tongue in cheek, is for making a hole truly round and parallel after it has been made oversize with a badly ground $\frac{1}{16}$ in. drill! Alternatively it could be used for reaming, almost but not quite, a 13.10mm hole! I also have a very old $\frac{3}{16}$ in. x 36tpi tap. I read through a copy of "Guide to World Screw Threads" dated 1993 and though I can find three sets of basic dimensions for this pitch, there seemed to be no specified use for it at the latter end of the 20th century. I shall keep mine just for its oddity sake. These are the sorts of tools bought at a club auction as part of a 'job lot'. Buyers beware or delight.



Photo 30 Dedicated storage for an ER25 Collet chuck and collets.



Photo 31 Dedicated storage for a small hand operated rotary table.

A short selection from the index pages

Collars	Shaft 1/4" bore x 3/4" OD x 3/8" thick with grub screw (x 3)	Drawer 5
Compound Table	Basic unit with index dials	Clarke chest "E"
Counterbores	(Industrial type) (Interchangeable bit - larger sizes)	Drawer 1 top tray Drawer 1 top tray
Countersinks	Various	Lathe shelf
Counters	Number (mileometer type (x 2)	Drawer 3
D-bits	(Model engineer type) (Industrial type - grooved top) (Taper reamers)	Drawer 1 top tray Drawer 1 top tray Drawer 1 top tray
Depth gauge	M&W 6"	Drawer 4 tray
Dial Test Indicator	Verdict, 0-15-0 thou reading with 1" dia dial Bracket for "Verdict" to Clarkson chuck Mitutoyo Dial Test Indicator 0.001" to 0.400" with extended 1/4" Ø clamp bar for above with locking nut	Drawer 8 Drawer (shelf) 23 Drawer 9
Dieholders	Single, with 5/8" bore, for 1.5/16" dies Double ended, with 5/8" bore, for 13/16" and 1" dies, with 2MT arbor Double ended, with 3/4" bore, for 1" and 1.5/16" dies, with 2MT arbor	Drawer (shelf) 24 Drawer (shelf) 24 Drawer (shelf) 24
Dividing Head	Myford, Main unit with steady bar and tailstock Rotation lever (separate storage point) Division plates 1 (on dividing head) Division plate 2 (separate compartment) Adapter block for horizontal mount on Myford S7 cross-slide Super 7 lathe, for headstock spindle "Thomas", for (see under "Rotary Table")	Clarke chest "A"
Dividers	M&W 6" Toolmakers M&W 5" Toolmakers (Brand new) M&W 4.3/4" Toolmakers (x 2) M&W 3" Toolmakers	Clarke chest "B"
		Drawer 4 tray Toolchest (2) Drawer 4 tray Drawer 4 tray

Table 2 A selection from the index pages.

THE PRACTICAL ENGINEER

Age 15 - get a job, any job. Also cutter and workpiece speeds

This series is intended to give the reader useful information gained from over 35 years experience in industry. It will cover various topics over the coming months and the occasional humorous moment and sometimes, what not to do. Please feel free to comment or complain through Scribe a Line. The first part of this article is more of an introduction to the workplace and the world of work from the viewpoint of a 15 year old. The second part gives some useful information on milling and turning speeds.

Out to work

I did not know what I wanted to do other than I had read Model Engineer and all the technical books in the school library. The metalwork teacher always had a Stuart engine on the go not that I knew what it was then. I also spent a great deal of time in the Science museum in London. It was only a tube train ride from my home in Wimbledon. Perhaps that is why I have spent most of my working life in engineering. The only bad part was I had to drag my younger sister around with me.

We always got return tickets and one particular day the ticket collector took the tickets and instead of clipping them, he threw them in a big sack with other tickets. When I complained, he looked but could not find them. He had to phone through to the departure station and tell them to let us through on the way back.

I remember queuing up at the science museum for a couple of hours to see a space capsule. I think it may have been one of the Gemini series and was on display for a short time only. The one thing I remember about it was how small it was. The astronaut must have sat perfectly still all the time he was in space. There was no room to move at all.

The first job

My first job age 15 was loading bars into automatic screw machines. As you can imagine, this was extremely boring. As part of the days duties, I had to take the previous days work out of the machine and take it to the oil separating shop so they could recover the oil (neat cutting oil

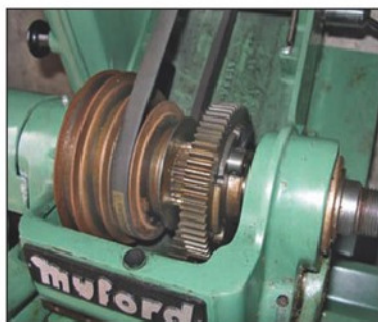


Photo 2 Back gears on the Myford lathe.



Photo 1 A Myford ML7R lathe speed chart.

in those days) and pass the work to the next department for deburring or drilling. Pity no one told me but it did give the charge hand an opportunity to shout at me. He liked shouting at people.

Another thing I had to do was grind a chamfer on the end of each bar before loading it into the autos. This was a little bit noisy if it was a round bar but very noisy if it was an extruded bar, a typical shape being half round. This caused the deburring shop charge hand to get annoyed as it upset his girls. He told me to get a cloth wiper and wrap it round the bar on the rest. This I did and it worked for a couple of bars and then the wiper got dragged into the grinding wheel guard.

Lesson 1

I turned the grinder off and went and told my charge hand what had happened. He was not very pleased but rather than shout at me, he went and shouted at the deburring shop charge hand. So lesson 1 is, don't put loose rag or clothing near moving machinery. This lesson will be reinforced in a later article.

I was asked to change the gears on one of the machines, which I did. I tightened them up as tight as I could. Unfortunately the nuts came loose and the gears came off, another chance to be shouted at.

Lesson 2

A couple of weeks after I had started work, the charge hand was not at work. It turned out he had put his hand into a machine and a drill had gone into the heel of his hand. So lesson 2 is, don't put your hand into moving machinery.

We used to get an hour for dinner break, which as it only took a few minutes to eat our sandwiches left us bored with nothing

to do. One old chap in the degreasing section used to lie down and have a sleep every day. One lunch time, we tied a rope to his Wellington boots and the other end of the rope to the double swing doors. A few minutes later, someone came through the doors and pulled both his boots off. Let's just say he was not very pleased and found somewhere else to sleep in the future.

Lesson 3

We had to find something else to relieve the boredom. There was a four wheel trolley in the degreasing section and the double doors lead onto a steep ramp. For something to do we took it in turns to ride down the slope on the trolley and this was successful for a few days. Then my turn, I rode down the slope but went a bit to one side. I hit a couple of trestles, which had a flywheel of about three feet in diameter resting on them. The trestles went flying and the flywheel fell about three feet to the floor. When the shop foreman found out, he was not very pleased and after six weeks, I was looking for another job. Lesson 3 is, if something can go wrong it is probably me that will do it.

Speeds

A basic knowledge of speeds and feeds is essential in any home (or professional) workshop. Speeds will be the same (ignoring rigidity for the moment) whether the material is moving (turning) or the cutter is turning (milling). For this article, we will concentrate on the home workshop. The industrial environment is totally different; there will be an adequate supply of coolant on the machines and ample horsepower to drive the cutter. Charts of feeds and speeds from the manufacturers will normally be available on request.

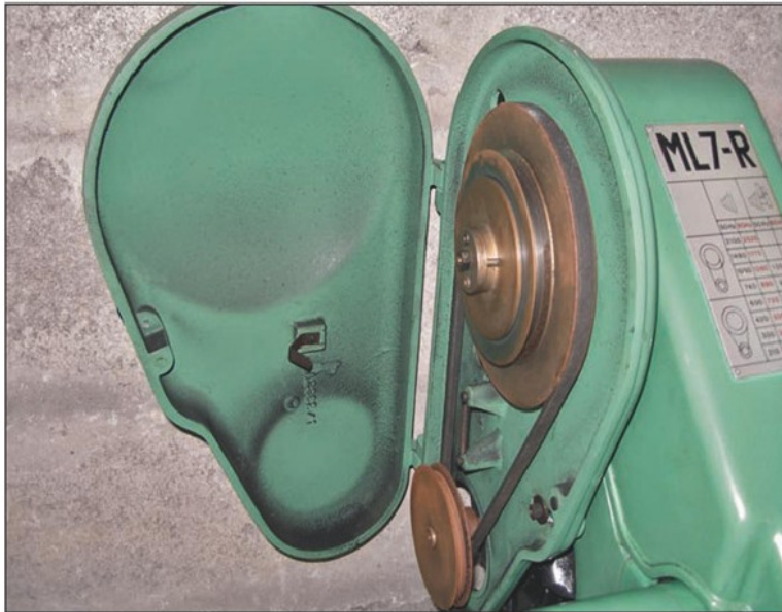


Photo 3 The two size pulleys driving the countershaft.

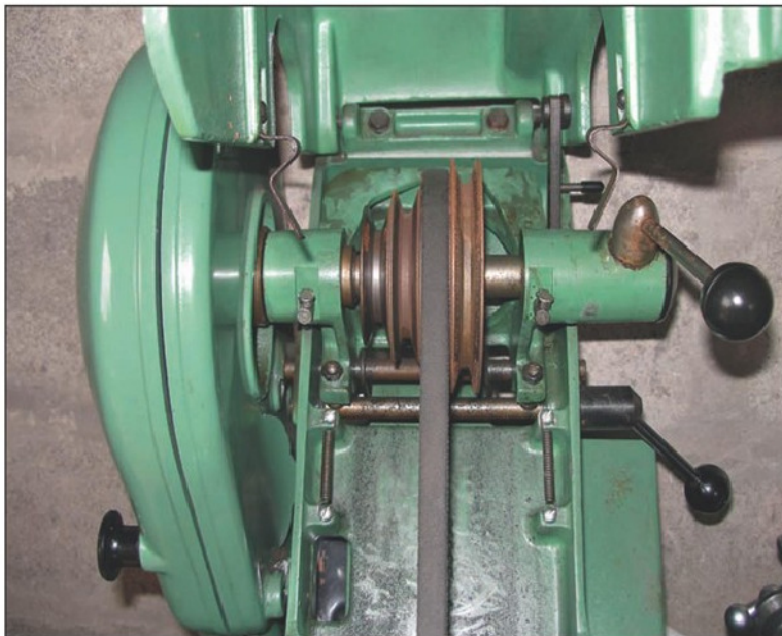


Photo 4 The four step pulley and clutch lever.

Speed is normally given in revs per minute (RPM). **Photo 1** shows the speed chart from a Myford ML7R lathe. The direct speeds go from 210 RPM up to 2105 RPM and the back gear (**photo 2**) speeds go from 27RPM to 135 RPM. **Photo 3** shows the two speed pulleys to the countershaft. **Photo 4** shows the 4 step pulley and the clutch lever on the Myford. The machine is not covered with rust, when I moved recently it was unexpectedly delayed for a few weeks and had not been protected. It was stored in the removal company's warehouse and some of the metalwork gained slight surface rust. The bed and other moving parts are fine.

Working it out

Referring to a chart of cutting speeds, a 1in. HSS cutter in mild steel requires a speed of 382 RPM. For practical purposes, this can be taken as 375 RPM. If you are

machining brass or aluminium, you can double the speed for the same size of cutter. This gives us 750 RPM for a 1in. cutter or we could use a 2in. cutter and leave the speed at 375 RPM.

For the harder steels, the stainless and silver steels or for more abrasive materials like cast iron, you can halve the speed so a 1in. cutter would then run at 187 RPM.

Carbide tipped tooling

So far, we have used a high speed steel cutter as an example. If we change to a 1in. diameter carbide tipped cutter, we can multiply the speed by at least 2 times. This means in theory we can cut mild steel with a 1in. diameter carbide cutter at 750 RPM. In practise, we are unlikely to be able to run a 1 in. Dia cutter at this speed because, a) they are too expensive, you probably won't have one, b) the machine probably



Photo 5 A digital readout on the C1 lathe.

won't hold a 1in. cutter, and c) even if it could, we probably could not supply enough coolant to cool the cutter down. Intermittent coolant will ruin carbide cutters.

So what is the use of working this speed out? Well, we are much more likely to be able to hold 1in. Dia. bar in the lathe and turn it at 750 RPM with no real problems. We could even turn it dry without any problems, don't forget the safety glasses and overalls though. Referring to the speed chart in **photo 1**, the nearest speed is 740 RPM and we would use that. Normally you would go to the nearest speed under the one calculated although in practice, slightly higher would be OK. Modern lathes, like the C1 for instance, have electronic variable speeds and you can just dial in the correct speed, **photo 5**.

So now you should be able to work out the speed for any HSS or carbide cutter for milling or the speed for turning bar stock using a bit of simple maths using 375RPM as a basis. Drills are the same, just calculate the speed as if it were a milling cutter or a piece of bar.

The following shows the method.

HSS cutting tools

- First, divide the cutter diameter in inches by 375 to get steel speed.
- Then if brass or aluminium multiply by 2.
- Or if harder steels and cast iron divide by 2.

Carbide cutters

For carbide cutters multiply the figures obtained above by 2.

(In an industrial environment this would be multiplied by four rather than two.)

Metric sizes

If you are working in metric, divide the cutter diameter by 25.4 before using the above calculations.

All speeds calculated as above are starting points. You may be able to higher them or may have to lower them depending on individual cases.

And finally

Please remember that all workpiece's and tools should be securely fixed before turning a machine on. Bar should be contained within the headstock and not allowed to protrude much. I once saw someone switch on a lathe with a piece of brass stuck out from the back of the headstock by about 2 feet. The lathe was running at 2000 RPM. The brass bar, which was about 3/4in. diameter, bent at right angles and made the heavy (1280KG) machine jump about. Luckily someone managed to switch the machine off before any major damage occurred. It was not the operator; he had run well away and was nowhere to be seen.



MAKING THE 'STENT' TOOL AND CUTTER GRINDER

Charles Woodward offers some advice and modifications

The milling machine

I have always worked in engineering and over the years had acquired various bits of used machinery and tools that I put to good use. My milling machine was a Taylor Hobson model K Mk 2 engraving machine with the cutting head clamped to the main column for stability. I had acquired a number of Clarkson disposable milling cutters of $\frac{1}{16}$ in. diameter that were used in the engraving head collet for all my milling. It was slow but I got there in the end.

An opportunity arose to buy a damaged Deckel boring head with a broken spindle. Although the spindle was damaged beyond repair, I thought it should be possible to make a new one. This I did with a No 2 Morse taper to suit the Autolock chuck I had just acquired. I mounted a 1HP motor on top of the head and fitted suitable drive pulleys and an extension shaft to the original drive. After removing the pantograph arm and all the other bits of engraving equipment, the whole assembly was grafted onto the top of the engraving machine column. This is my milling machine; there have been few modifications since. The assembly works surprisingly well, the boring head gives me automatic traverses at all head angles from +90Deg. to -90Deg., however, the

Background

About 15 years ago it occurred to me that I should have some form of cutter grinder. Back then, my only grinding equipment was a standard bench grinder. I had a look at what was available and initially the 'Quorn' appealed to me so I bought the book and inquired about the cost of the castings. Cash was short at the time so I did a lash up with my bench grinder, replacing one of the wheels with a cup wheel and making a carriage for holding lathe tools using parts from a setting fixture I had acquired some years earlier. This consisted of a pair of bars held parallel in a couple of blocks and a further block running along the bars on antifriction bearings.

To complete the setup, a fixture was mounted onto the sliding block to hold the lathe tools. After adding covers to the slides, I arranged the whole assembly to tilt to obtain clearance angles. The bench grinder was mounted on a steel disc, which could rotate and the whole assembly was clamped on a further slotted steel plate. The bench grinder could be slid back and forth towards the tool holder. The contraption certainly would not win any prizes but it worked and I used it for a number of years.

table traverse handles are graduated in 0.002in. increments and the vertical traverse on the table in .001in. increments. It has a few other similar oddities.

The 'Quorn' or the 'Stent'?

I had been collecting used end mills and slot drills for some time from various sources (some were only slightly used). After I had modified my milling machine to use cutters up to 16mm diameter it became urgent that I should have some means of regrounding them.

My existing arrangement could have been modified to take milling cutters, but I wasn't really happy with the arrangement for grinding lathe tools and couldn't see myself

spending yet more time improving a dodgy arrangement to make it even dodgier, so it had to be a new (to me) tool and cutter grinder. I considered buying a second hand commercial machine, but didn't really have the space (or the money), so it would have to be a bench mounted machine. I also wanted a machine with adjustable grinding wheel height. The only machines on the market that appeared to suit my purposes were the 'Quorn' and the 'Stent'. Both machines would be capable of grinding all my lathe tools and milling cutters, but the 'Stent' lacked the accessories of the 'Quorn'. I already had the 'Quorn' book and there are loads of articles on the Quorn, so why not the Quorn?

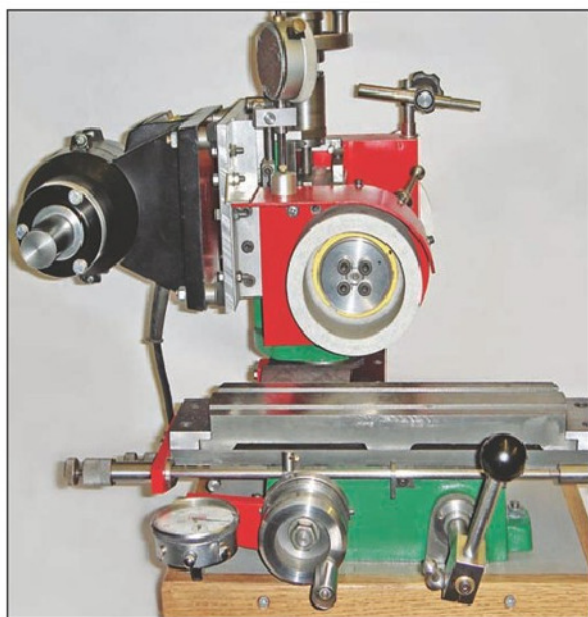


Photo 1 Stent with cup wheel to the front. Note overhang of drive motor.

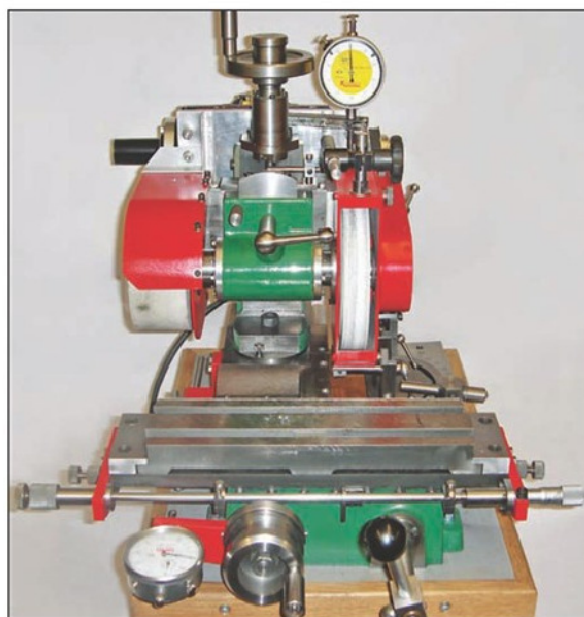


Photo 2 Stent with plain wheel to the front.

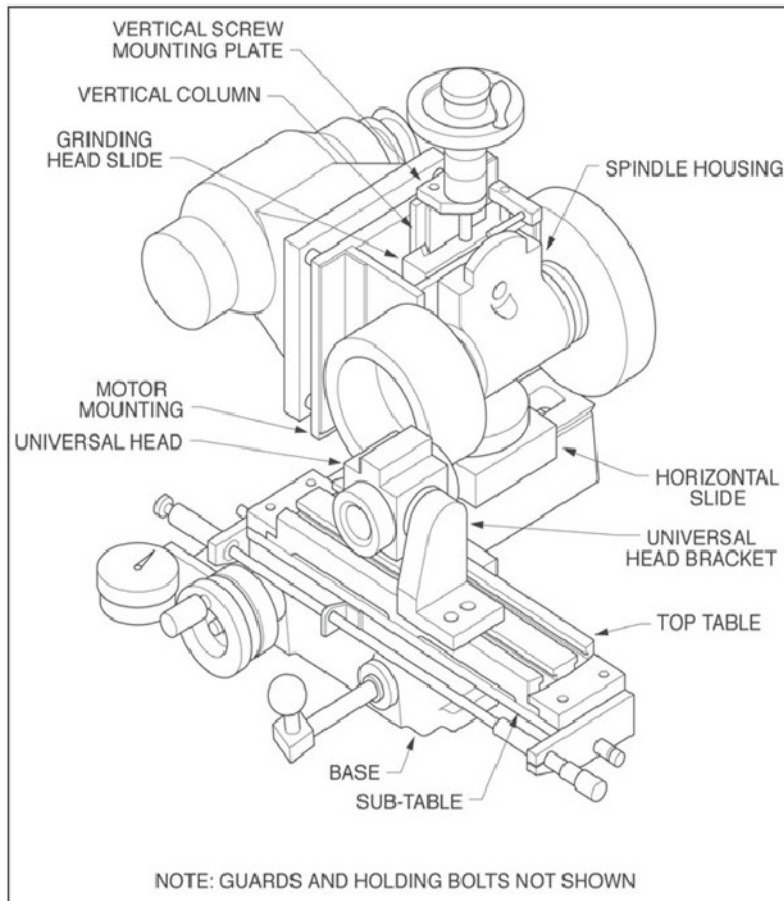


Fig. 1 Isometric view of Stent tool and cutter grinder.

I considered the following:-

There was no similar handbook on the 'Stent'. Lots of builders had made a 'Quorn' judging by the number seen at various exhibitions. Far fewer 'Stent's were to be found. Both casting sets cost about the same, approx £200 in September 2005.

There are 86 references to the 'Quorn' in the ME index and only 16 for the 'Stent'. I read as many as possible including correspondence in the letters column of

the ME, where a reader was casting doubts on the 'Quorn's' capabilities and I also read Prof Chaddock's replies.

The correspondence made me pause for thought. I could though see the reader's point of view in some respects. If I was going to spend time making a grinding machine, I did not want to make a machine I would be unhappy with. After reading an article By Giles Parkes in MEW 108, I spent part of my time at the next

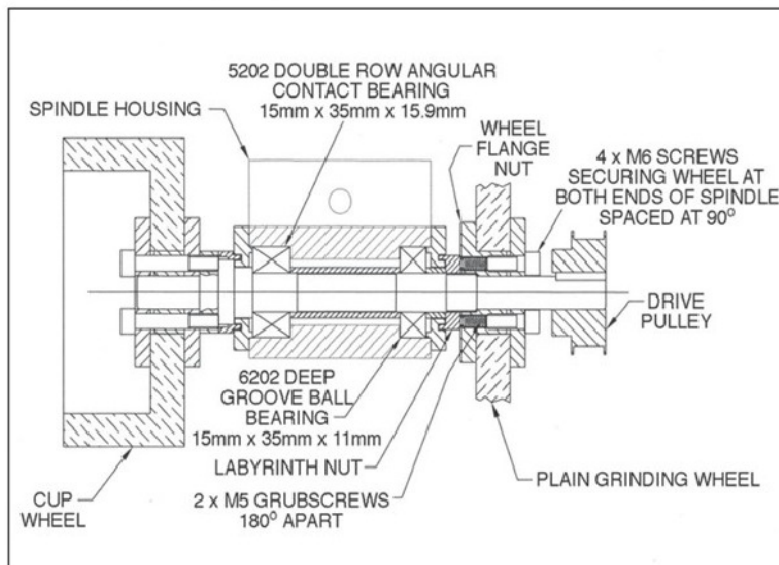


Fig. 2 Section through spindle.

TEE exhibition (2005) asking various exhibitors of the 'Quorn' their opinion of the machine. I also asked the advice of Giles Parkes who had built both machines. I wasn't particularly happy with some aspects of the 'Stent's' design, particularly the motor mounting, the hand wheel for the vertical slide and the way the table could be traversed to expose the slideways to grinding grit.

Looking at the 'Quorn' and 'Stent' side by side, I could see why most builders chose to make the Quorn. With its profusion of ball handles and nicely thought out work head, it looks the more sophisticated of the two. It has also had loads of publicity. By comparison, the 'Stent' looks more "rough and ready". However, I thought it should be possible to improve upon the 'Stent' and couldn't see why it shouldn't be capable of doing everything the 'Quorn' could do and possibly more. The 'Stent' design, incorporating a Tee slotted table provides a good basis for a tool grinding machine and it is easy to mount any number of fixtures for grinding lathe tools, milling cutters, drills etc. This arrangement is adopted in most of the commercial tool and cutter grinders with which I am familiar, such as machines made by Clarkson and Cincinnati. At this time, I did not appreciate that the 'Stent' was a copy of the 'Clarkson' tool and cutter grinder. I could see possibilities for developing the 'Stent' and so ordered the castings in November 2005 from Blackgates Engineering (no connection) and started work as soon as I received them.

Modifications

After my previous conversations and researches, I had decided the grinding wheel position would be changed by turning the vertical column through 180Deg. and I would mount the grinding wheel at the opposite end of the spindle. This arrangement would bring the wheel closer to the centre of the table.

I would change the motor mounting; the arrangement as drawn appeared to be unnecessarily extended and this would tend to over balance the machine once the vertical column and spindle assembly had been turned through 180Deg. I also wanted the grinding head to tilt ± 10 Deg. The 'Stent' drawings indicate it should be possible to tilt the head, but I had no idea by how much and there was no angle indicator built into the machine.

The position of the handle for raising the grinding head would need to be changed to bring it to the centre of the vertical slide. The existing position of the screw and nut at the side of the slide and the large motor overhang would cause it to stick due to the slide being approximately square. It's never a good idea to have a screw that actuates a slide at the side. It will cause the slide to tilt towards the screw and stick. Lathes and other machinery combat this tendency by having long sliding surfaces in relation to their width in the direction of the screw actuation.

There were no arrangements for guarding the machine against grinding dust so this would have to be remedied.

Double ended

It seemed like a good idea to put a grinding wheel at both ends of the spindle. This would make the machine more versatile and it would also be possible to



Photo 3 Square tool grinding fixture.



Photo 4 Table scale.



Photo 5 Removable table adjuster and micro setting for table stops.

experiment with plain grinding, once a way of driving the component between centres had been devised.

The table stops as drawn seemed cumbersome. Setting the stops required unbolting each stop from the table, moving them to a new position, then setting the adjustment screw on each. I wanted a simpler arrangement, preferably with some sort of fine adjustment.

Spanners would be used as little as possible, handles being fitted wherever practicable.

I would fit ball or roller thrust washers to the feed screws for both slides. This would give a smooth and easy movement particularly on the vertical slide, which supports the weight of the motor and grinding head.

Any other modifications would wait until (or if) inspiration struck.

A general guide

I don't intend to write a blow-by-blow account of the way I made the 'Stent', but rather give the reader an idea of what I did, the design changes made and the reason for making them. I possessed, a 4in. cup grinding wheel and a 5.25in. dia wheel both of 1.25in. bore. The 'Stent' was redesigned around these two wheels.

On receiving the drawings from Blackgates, my first priority was to redraw the machine in 3D CAD, Fig. 1. This may seem strange as I had just paid for the Stent drawings, but it allowed me to examine the capacity of the machine with all my major modifications before I started cutting metal. It is cheaper and far less frustrating to find out your scheme won't work at the drawing stage than after hours have been spent cutting metal.

I first made detailed drawings of each component, then brought the individual components together on one drawing sheet to obtain an assembly drawing. The individual detailed drawings are preserved on separate worksheets and from these drawings are generated the sectional

drawings and the manufacturing drawings with the associated dimensioning and orthogonal views. This system makes it possible to make changes to any detail drawing and the assembly drawing changes automatically without being redrawn. However, it is easy to skip a few stages and get component drawings with the bare minimum of dimensions and views. These frequently changed as manufacture proceeded, but I did not always revise the drawings.

When all the major parts had been drawn, I was able to view the capacity of the machine with the new grinding wheel position turned through 180Deg., with the second wheel fitted.

The basics of the reconfigured machine seemed satisfactory and so it was time to go into the workshop to start cutting metal. There must be other builders like me who are inspired by looking at lumps of metal when thinking about design problems? Looking through the scrap box to find a bit of discarded piece of machinery or material "that will just do the job" solves a lot of problems, after appropriate modification of course.

Consequently the crucial basic components got drawn in CAD. Fig. 1 got revised as I went along, and is still being revised as I write this article. A lot of smaller parts and modifications were done on various bits of paper that sometimes made it to full drawings and sometimes did not. Very little additional material was purchased apart from the castings. The dial indicators were obtained as scrap and repaired, the micrometer head was from a precision lathe stop, the wires used for the table traverse were bought as spare brake cables for my pushbike.

I used a wooden board for some time as the motor mounting board, but decided shrinkage etc would play havoc with the belt tension and was forced to buy a piece of Aluminium to replace it.

The base casting

The first component to be machined was the 'Stent' base. The casting was marked out to give the best advantage and machined to the Blackgates drawing. All the castings were good dimensionally and I had no problem machining any of them, no hard spots or blowholes were found. All the other castings were machined generally as the Blackgates drawings. Making a note of which were the sliding faces and clearance faces on the dovetail slides, I machined the base and slides omitting details not required such as the slot in the grinding head slide for the raising nut.

I spent some time dismantling and reassembling the machine in order to make various modifications. It is impossible to foresee the result of all the modifications and besides, I would think of a good idea and would have to try it out.

The grinding wheel spindle incorporates a double row angular contact bearing at the cup wheel end that is clamped in the spindle housing by the end cap and a deep groove ball bearing which is free to "float" sideways is fitted at the pulley end, Fig. 2. I machined the spindle housing to suit the new bearings and incorporated simple labyrinth seals in the end covers. The grinding wheels at both ends are both secured with 4 off M6 socket head Allen screws in place of the single nut normally used. This obviates the need for cutting a LH thread to hold the cup wheel and has the advantage of making it possible to grind on both sides of the wheel.

The right hand wheel is mounted on the wheel flange nut, which in turn is accurately located on the grinding wheel spindle by a reamed hole and screwed on to the spindle. The labyrinth nut on the LH side of the spindle tightens the whole assembly and the wheel flange nut is tightened against this. Two M5 grub screws provide additional clamping for the wheel flange nut. The drive pulley is keyed



Photo 6 Engraving the table scale.



Photo 7 Scale for the tilting grinding head.

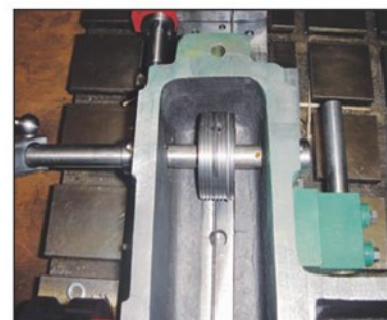


Photo 8 Tensioned wire on grooved pulley for table traverse arrangement.

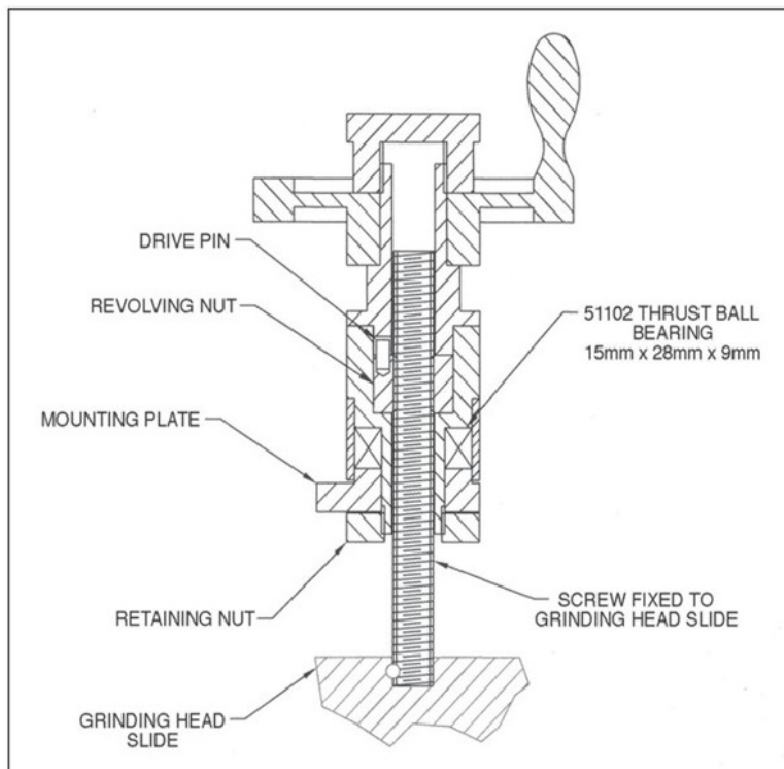


Fig. 3 Section through vertical screw assembly.

on to the grinding spindle.

Having constructed the grinding head and slides, lots of scraping followed. I am no expert but perseverance paid off because I eventually achieved a sliding fit I was happy with.

The motor mounting

I started thinking about the motor mounting. I drew up a couple of different schemes and played around with wooden mock-ups before I was happy with the arrangement. I was aiming to get the motor as close as possible to the rear of the vertical column. This would reduce any tendency for the machine to overbalance when using the cup wheel and at the same time it would reduce the side loading on the horizontal slide. **Photo 1** shows the 'Stent' with the cup wheel facing the table, **photo 2** with the column turned through 90Deg.

Examining the drawings of the Stent, it is apparent that there is no equipment included for grinding lathe tools. Anyone who has built the 'Stent' in the past will probably have made their own arrangements for grinding square tools, possibly by making a square adaptor for the universal head.

I think it is essential that a grinding machine for the model engineer should have this facility and incorporated a graduated tilting head into the machine, which enables anyone, as a minimum setup, to simply hold a lathe tool in a small vice and use the tilting head to grind the clearance angles.

The fixture for grinding lathe tools can be seen in **photo 3**. The base plate is graduated ± 90 Deg. Clearance angles for grooving and parting tools can be set on the table which gives an additional 10Deg. in addition to the settings on the fixture.

I wanted the table to index accurately

and engraved half degree divisions on the right hand table clamp. The clamp is accurately located using a couple of dowels fitted into the sub table, **photo 4**. Fine angular adjustment for the table is achieved by a couple of separate brackets, which are bolted to either end of the table as and when required, **photo 5**. The lines were cut using a Graduating Tool from Hemingway, which I bought as a kit and with a few modifications, used it on my milling machine to engrave the table clamp and other indicator lines, **photo 6**. I made a couple of modifications to the graduating tool. As designed, the tool uses a dowel for locating the ram, running in a slot in the square body. I fitted two dowels through the ram very close together to act more like a key in the location slot, using grub screws in the ram to secure the dowels;

the grub screws are reached via a drilled hole in the body. I also stamped the turret L, M, S, (large, medium, and small, and not the railway Co!)

After making the machine, I discovered from Blackgates that the design of the 'Stent' is based on the 'Clarkson' tool and cutter grinder. Anyone familiar with Clarkson's will know they made milling cutters such as end mills and slot drills. Clarkson's designed the tool and cutter grinder for use in their own works, so they had no reason to incorporate facilities for grinding lathe tools. They did not manufacture drills, but offered a drill grinding attachment as an extra. In the Model Engineer, No 4310, there is a very good description of the Clarkson machine written by Tony Griffiths.

A novel motor

Needing a motor to drive the 'Stent' I was contemplating paying about £100 for the recommended motor when an idea occurred. Why not use a cheap grinding machine as sold at my local DIY store to power the 'Stent'? The grinder cost less than £15 and what had I got to lose? If it didn't work, I would buy the recommended motor. A flat platform was part of the motor mounting design so it shouldn't be difficult to fit any small foot mounted motor (or cheap grinder).

After buying the grinding machine, I stripped off all the guards and other bits I didn't need, fixed it to the motor platform and after fitting a suitable belt and pulleys to give me 3000 RPM at the grinding wheel spindle, gave it a run. I wondered if it would burn out quickly, but it hasn't so far. The longest time I have run it continuously has been for about ½ hour. The drive pulley is fixed to the motor (grinder) shaft by the original nut, which came with the machine. No drive key has been used, and no slippage has been experienced. I used a timing belt to drive the machine as it bends much more easily over small pulleys compared to a vee belt and will not slip unlike a round belt. Also tension is not as critical, thus reduced the load on the grinding spindle and motor assembly.

The motor/grinding spindle assembly is provided with a dowel pin to locate the zero position and the setting scale is shown in **photo 7**. I have also used dowel pins in the vertical column base to give the

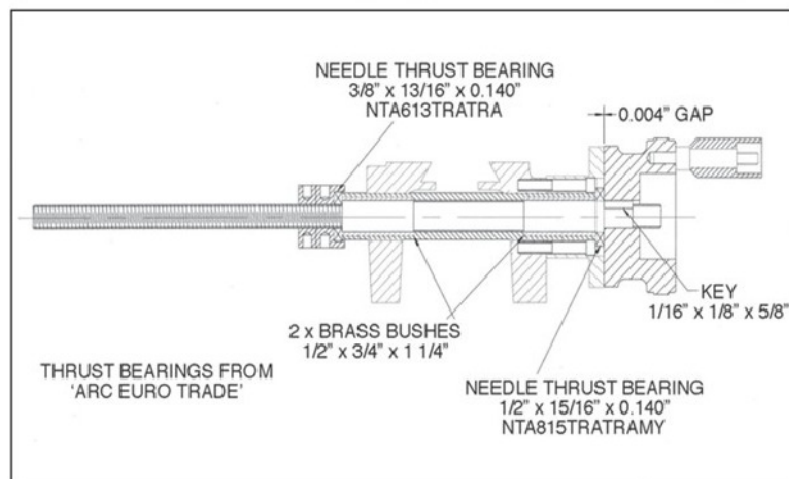


Fig. 4 Section through base and horizontal slide feed screw.



Photo 9 Cutter guide finger.

two positions for the grinding wheels and in the milling cutter grinding fixture.

An alternative

The table traverse mechanism is by wire tensioned at both ends of the table. I used this in preference to a rack and pinion partially due to cost. Although the cost of the rack and pinion as supplied by Blackgates is not high, I just had to try a tensioned wire once I had thought of it and with a tensioned wire, I would get a table traverse system with no backlash. I pulled the wire out of the internal pulley once by over tightening the tension nuts at the ends of the table. Fitting two additional screws to clamp the wire into a grooved pulley that is attached to the table traverse handle solved this, **photo 8**.

I used a dial indicator to show the position of the horizontal slide rather than a scale engraved on to the hand wheel. This offers several advantages. The dial indicator can easily be changed to suit the preferred units (imperial or metric), it is easy to zero the readings, there is a direct indication of the position of the table if the grinding wheel has to be retracted for any reason and it gives an indication of possible table movement during grinding. For the same reason I fitted a dial indicator to show the vertical distance of the plain grinding wheel above the centre line of the cutter. This distance gives the clearance angle when grinding the outside diameter (the cutting edge) of milling cutters using the plain wheel, see **chart 1**. The position of this indicator has been moved between **photo 1** and **photo 2**. I was getting too much vibration on the indicator in its original position when I ran the machine.

In the 'Stent', the hand wheel for the vertical slide has been located at the side of the slide probably because the clamp bolt for the grinding head assembly is in the centre of the slide and the spindle housing. Without redesigning the clamp bolt and making the grinding head slide casting thicker, the only way I could think of to put the handwheel at the centre of the slide was to rigidly fix the screw into the slide casting and rotate the nut within the hand wheel assembly, **Fig. 3**. It is fitted with a ball thrust bearing to ensure smooth and light movement when raising or lowering the grinding head and motor. With this arrangement, the screw goes up into the hand wheel assembly; this is made deep enough to accommodate the screw. Thrust bearings were also fitted to the horizontal slide feed screw. **Fig. 4** shows a section through the screw assembly.

The idea for the degree indicator scale



Photo 10 Drive unit on RH tailstock.

on the tilting work head came from a colleague, Jan Huning, who had built a 'Stent' some years ago together with a very nice drill grinding attachment that I hope to build one day. Originally I had a much cruder arrangement.

Cutter guide

Some difficulty was encountered with designing the cutter guide finger, which is fixed to the rear of the table and in front of the grinding wheel. The purpose of the finger is to guide the cutter when grinding the cutting edges of an end mill or slot drill by locating into the spiral flutes of the cutter and following the spiral as the table is traversed. The space between the table and the grinding head is somewhat restricted with the guarding fitted to the table. Also the simple guide finger drawn for the Stent would have been used originally by the skilled grinders on a Clarkson machine who had trained in its correct use. I felt a more user friendly arrangement was called for on a machine that would be used occasionally by amateurs, so I redesigned it and incorporated a screw height adjustment. I used the original mounting block secured to the bed of the machine, merely rotating it through 90Deg. to move the guide finger fixing away from the table and around the table guard, **photo 9**.

The stops

There are two table stops clamped to a spring loaded bar at the front of the table. The bar is sprung against a 0.5in. travel micrometer head at the RH side of the machine, **photo 5** which provides fine adjustment. A similar bracket at the other end of the table holds the spring housing. The tension screws for the table traverse wires are attached to these brackets and limit the table travel to 5.25in.

There are various other changes and modifications to the machine. I have fixed the table traverse handle at 30Deg. and fitted a handle to the handwheel for the horizontal slide. A plunger fitted to the top of the head indexes the universal head rather than a blade locating in the cutter flutes. Experienced grinders may say this is incorrect, but I am not sure there is any difference and it seems easier to set the cutting edge horizontal once and rely on indexing to a drilled collar than fiddling about with a spring location in the flutes. I stand to be corrected and have yet to try the alternative.

The 'Stent' is mounted on a wooden base made from an old school desktop, which is fitted on the top of a unit with two drawers. The drawers contain most of the equipment required when operating the machine.

The equipment comprises of:-

A set of ER20 collets from 2mm to 13mm.
The universal head and bracket and the following adaptors:-
A Collet holder, a No 2 Morse taper adaptor, a Parallel holder for grinding the ends of slot drills etc plus adaptors.
A Collet holder for Crawford collets from 3/16in. to 3/4in. (using collets from my lathe).
An M10 spanner, a 5/16 Whit spanner and an ER collet spanner.
Two centre holders (tailstocks).
Test bar.
Holder for grinding plane irons and wood chisels.
Table setting brackets.
Three Allen keys, a pin spanner for removing the vertical hand wheel and two tommy bars.
Misc tee nuts and screws.

The machine and baseboard lift off the drawer unit for easy transportation. I have not needed to secure it to the drawer unit. The 'Stent' took me about 12 months to redraw and build, I got the castings in December 2005 and started using the machine in January 2007. I spent a further 7 months making the drawers and base unit, remaking bits which didn't work, making guards and the lathe tool grinding fixture, painting it, and generally smartening it up. I have no idea how many hours it took, as I don't have the self-discipline to note down the hours every time I go into the workshop.

I thoroughly enjoyed making the 'Stent'. I like to use my own ideas on the equipment and clocks I make and workshop equipment gives you the freedom to try them out and make them work, or not, as the case may be. One idea I have been playing with is using the machine for plain grinding by fitting a small motor and work driver disc to the RH tailstock casting. I have got it to work to some extent, **photo 10**. The problems are - heat, parallelism and finish. But all is not lost, if I can't get it to work on the 'Stent', I will fit the drive unit onto the tailstock of my Myford as a counter rotating drilling unit for drilling small holes straight. The ball handles were made by the method I described in MEW No 111, page 46.

Wheel Dia	5.250 inch	
	133.35 m/m	
Cutting Angle (deg)	h (inch)	h (mm)
3	0.1374	3.49
4	0.1831	4.65
5	0.2288	5.81
6	0.2744	6.97
7	0.3199	8.13
8	0.3653	9.28
9	0.4106	10.43
10	0.4558	11.58
11	0.5009	12.72
12	0.5458	13.86
13	0.5905	15.00
14	0.6350	16.13
15	0.6794	17.26
16	0.7235	18.38
17	0.7675	19.49
18	0.8112	20.60
19	0.8546	21.71
20	0.8978	22.80

Chart 1 Clearance angle when grinding the outside diameter (the cutting edge) of milling cutters using the plain wheel.

INSERT TOOLS

part 2

In the first part of this series, I looked at cutting tool materials. In the second part, I will concentrate mostly on cemented carbide tool inserts and describe the ISO standards system.

So many choices, which way to turn?

Whilst I was preparing background material to write this article, the large number of insert manufacturers or importers that supply into the UK market constantly surprised me. I was already aware of Sandvik, Seco, Widia, Mitsubishi, Kennametal and Iscar but a quick search of the Internet by Googling carbide inserts and searching Ebay UK showed over 20 manufacturers, a market ripe for consolidation? Yes, probably and some consolidation has already taken place, but the old names tend to remain, often under new ownership.

Most of the major manufacturers maintain good or excellent websites and many offer free download(s) of technical data about their products. I found that there is actually too much data available and it all gets pretty confusing, especially if one is only interested in a small range of applications pertinent to a Home Workshop and relatively small machines with limited power or tool tip speed.

I found that some of the downloaded documents were massive and it was difficult to find my way around on the screen. Most downloads were .pdf documents and you will need a broadband connection to promptly complete some of these downloads.

I acknowledge a lot of help from Sandvik UK, ref. 1 who supplied a number of weighty manuals by post after I had asked for technical help, photo 1. The main Sandvik catalogue alone is over 900 pages.

Once you start to read these tomes and reflect on all the possible variables for an inserted tool system it soon becomes obvious why standardisation of nomenclature became necessary. The numbers of variables are enormous. E.g., the carbide grade, the insert shape and size, its coating(s), the tool holder and last but by no means least, the metal or plastic being worked. In the descriptions that follow I will describe parts of the ISO system. (International Standards Organisation ISO 1832-1991). Similar National systems exist, most notably ANSI in the US and most good suppliers can supply against either ISO and ANSI and can provide cross referencing. So let's take a look at the ISO system.

Workpiece materials

You won't complete more than a few projects in your home workshop before you realise that our commonly encountered workpiece materials, iron castings, aluminium alloy castings, low carbon steels, tool steels, stainless steels,

Mike Haughton looks at the ISO system

copper bearing alloys and aluminium alloys all require different methods of working. We expect one tool to cut everything and are often disappointed by the performance, even though we soon learn to adjust the tool shape, feed rates and depth of cut on a trial and error basis.

The same situation exists with inserted carbide tooling; a truly universal carbide grade and tool shape really doesn't exist and we shouldn't expect anything different in our workshops. The various carbide manufacturers have spent a lot of development time optimising the carbide grades for specific workpiece materials. The ISO system categorises work materials into colour coded groups and many (most) insert manufacturers carry this colour coding system onto the labelling of their insert boxes. Photo 2 shows a couple of insert boxes from Seco (Secolor™) and Sandvik (Corokey™). If you Google both of these names you will find comprehensive descriptions of how these classifications work.



Photo 1 Tons of Literature

ISO Designation	Description of Workpiece material
P	Steels, low alloy
M	Stainless Steels
K	Cast Irons
N	Aluminium Alloys
S	Heat Resistant Super Alloys, Nickel based alloys
H	Hardened Steels

In Table 1 above I have attempted to reproduce the ISO colour scheme for each work piece classification. Sorry if you have colour vision problems. Most brasses and bronzes probably fit in ISO category N. The Sandvik Coromant box indicates that the inserts are intended for low alloy steel, ISO grade P, blue. The Seco box also indicates their insert is suitable for medium machining of stainless, yellow and low alloy steels, blue. Seco use 3 vertical columns on their labels to indicate, from the left, finishing, medium and roughing. Please note these boxes are not exactly current and the style may have changed a little.

Most manufacturers maintain extensive lists of workpiece materials, usually by

national specification, against the insert ISO designations and their own grade codes. You can easily download these lists from the manufacturers' websites.

ISO CARBIDE GRADES

Under the ISO system, the P, M and K grades are each sub-divided into compositions containing different amounts of Tungsten, Titanium, Tantalum and Cobalt carbides and nitrides. In the P series P01 to P50 there are 6 sub species each optimised to provide a range of hardness to toughness properties for the cutting of low alloy steels. There are 4 M series M10 to M40 (stainless steels) and 4 K series, K10 to K40 (cast irons).

When these compositions were formalised, coated grades were only in their early development stage and were not covered.

Manufacturers of inserts will assign ISO identification numbers to their products based on what they believe is their best



Photo 2 Typical Inserts boxes with data.



Photo 3 Sandvik grade equivalence.

performance range. So a P30 grade from different manufacturers will not necessarily have the same carbide composition. As an example, **photo 3** shows an insert box from Sandvik with two of the inserts placed on the label. You will see that the Sandvik carbide grade is 4025 and they have translated this into the ISO grades P25 and K20. This is the rear of the Sandvik box shown in **photo 2**.

Most manufacturers produce charts of where they place their grades against the ISO "standards", e.g., **ref. 2**. One manufacturer's grade will often be shown spanning several ISO grades.

As far as I know, there are also 5 ISO sub grades for N, 4 for S and 4 for H workpiece materials, but not all manufacturers seem to quote them.

Insert grade comparisons

Obviously manufacturers don't want you to switch to equivalent grades from another manufacturer. However, a number of sources do give comparison tables of manufacturers grades. Look in *The Black Book*, See **ref. 3**, which I find to be an extremely useful pocket book of engineering data. It is published in Australia, but available in the UK from J&L Industrial, **ref. 4**.

Newcomer, now owned by Ceratizit, has a useful grade comparison chart available on the web, **ref. 5**.

These read-across grade tables can only ever be approximate but might be useful in identifying markings on inserts or their boxes.

Insert grade marking

If you are lucky enough to get a full box of, usually 10, inserts the box labels should give sufficient information to allow you to identify the ISO properties of the inserts. Inserts not in a box, a likely scenario for us as we may only acquire small numbers of inserts, are often a problem, as manufacturers are pretty variable in their insert marking policies. Some mark the grade with a laser, some print the grade, some mould coded marks in the top face of chip breaker inserts and some don't seem to mark at all.

Generally the more sophisticated the application and the higher cost of the insert, the better chance you have of having some marking. E.g., most screw cutting inserts are marked with the pitch and thread form. For examples see **photo 4**. These marks are not very easy to photograph but they illustrate some of the different styles. Sadly, many inserts are unmarked and there seems to be a tendency in the UK to supply unmarked inserts to Home Workshop users. Many of our suppliers don't give the full ISO description of their inserts either, which is not at all helpful to the average user and leads to a reputation for a patchy performance in the home workshop.

Type of work

Most manufacturers designate their inserts as finishing, medium or roughing for both milling and turning operations. Remember the following descriptions are for industrial operations, not necessarily in a home workshop. They will often add the code F, M or R somewhere in their own insert descriptions. The ISO insert codes may also indicate the intended application, see later.



Photo 4 Insert marking styles.

This is what a manufacturer says about F, M and R grade descriptions.

Finishing (F)	Light depths of cut at low feed rates for operations requiring low cutting forces.
Medium (M)	Wide range of feed rate and depth of cut.
Roughing (R)	Maximum stock removal for high depth of cut and feed rate combinations.

In my opinion, most home workshop machining operations fall into the Finishing class because of the machine's lack of rigidity and our desire for an excellent surface finish.

Machining conditions are usually classified as good, average or difficult.

Good	Continuous cuts, high speeds, pre-machined work piece. Excellent component clamping.
Average	Profiling cuts. Moderate speeds. Forged or cast workpiece. Good component clamping.
Difficult	Interrupted cuts, low speeds. Heavy cast or forged skin on workpiece. Poor component clamping.
Again these are industrial operations.	

Kennametal, **ref. 5** seems to add a Fine Finishing (FF) classification to the 4 described above.

Cutting Data

If you look at the Sandvik box in **photo 2**. This is a lathe insert and gives the following starting point for the user.

Depth of cut $a_p = 3\text{mm}$ (range 0.05 – 5.0mm)
 Feed $f_n = 0.30\text{mm}$ (range 0.015-0.50mm)
 Cutting speed $v_c = 255\text{m/m}$ (range 315-205m/m)

If this had been a milling insert f_n , the feed per tooth, and v_c the cutting speed would have been quoted.

Just to be clear, v_c , the cutting speed is the speed of the tool tip passing over the workpiece surface.

These v_c numbers are easily passed over, but a cutting speed of 255m/m on a 25.4 mm dia workpiece is equivalent to a rotational speed of about 3200rpm. That's more than twice the maximum speed of my lathe! Oh Dear!

Manufacturers cutting speed (surface speed) is often optimised for a 15 minute tip life! Fortunately, cutting the surface speed gives a big bonus in terms of a longer tool life. Rule of thumb: Halve the tip speed to see a 10x increase in tool life.

Remember that even 'carbide' inserts have to be run at lower cutting speeds as the workpiece material becomes harder or tougher. This will be reflected in the manufacturer's data for the insert. E.g., a

finishing insert might be assigned the following optimum surface cutting speeds in metres per second.

Work Piece	Cutting Speed
P	95-125
M	95-115
N	95-200
S	10-15

The insert cutting performance

Diagram 1 shows the best cutting performance zones for ISO P materials within the blue tiles for 4 inserts described as suitable for FF- fine finishing, F-finishing, M- medium machining and R- roughing. The chart shows depth of cut against feed rate. The 4 inserts in my drawing have geometries optimised for each application and are made from the same carbide grade. The red construction lines show how the correct insert geometry is selected for a 1mm depth of cut and a 0.4mm/rev feed rate. The manufacturer defines this cut as Medium, but I would describe it as roughing or even unattainable!

Please notice that the axes in this drawing are not linear. Manufacturers vary in this point, so be careful.

I guess that most of us seldom work out our feed rates, especially on a mill, and we often adjust the depth of cut on the lathe or mill to get the best results. Notice that for these inserts, even the FF insert

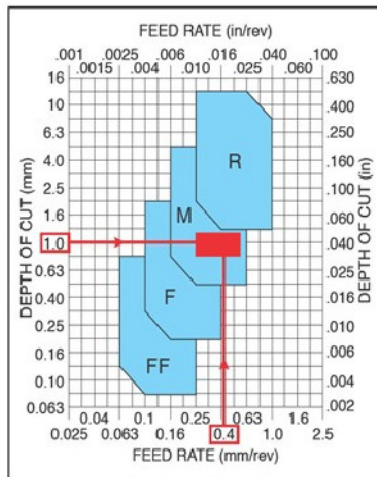


Diagram 1 Cutting performance zones, P materials

geometry is out of its comfort zone at depths of cut below 0.003in. (0.08mm), which sort of confirms what most of us have discovered when we try to take light finishing cuts, even with a new carbide insert. Equally, cutting the feed rate below 0.0025in./rev is not a good idea.

Caution please, **Diagram 1** is just an illustration. Get manufacturers data on any inserts that you hope to purchase as some may well be optimised for lower feed rates, smaller depths of cut and lower surface speeds. Remember, industry generally wants high productivity inserts (high rotational speed, high feed rates and large depths of cut) so that industrial insert gift horse may give a really disappointing performance on home machinery. I've been there!

Tool tip speed

In my Sandvik example, above, the 250m/min tip speed is fairly typical of a Cermet or coated Cermet working low carbon steel, ISO P grade material. Since my lathe just won't go that fast, I am left to search for inserts that will allow me to finish turn at lower tip speeds, say below 80m/min.

I find Mitsubishi Carbide quite useful in this respect, **ref. 2**, because they produce charts of cutting speed against feed (mm/rev) for their different insert types for each of the ISO material groups. In most P, M and K work materials, Mitsubishi Carbide's charts indicate that cemented carbide with no coating(s) gives the best low speed cutting speed performance, i.e., compared to PVD coated carbide, CVP coated carbide and Cermet and coated Cermet.

Insert edge geometry

The cutting edge of our insert is a complex 3-D shape. We need to work out what types of insert will give finishing cuts at modest feed rates, depths of cut and tip speeds in the materials of interest to us. If you take the ISO code description DNMG 11 04 08-PM given on the insert box, **photo 3** this requires some interpretation for you to get all the information it contains. Although the following looks complex the same approach is used for other insert types, threading, grooving and parting off, internal turning, milling, etc, and it's worth making the effort to learn some of the ISO naming logic and to realise its shortcomings.

The ISO code for this turning insert consists of up to 12 symbols. Symbols 8 and 9 are used only when required. In addition the manufacturer may add a further 2 symbols.

It pays to separate out the ISO code into fields as follows:-

Code D	N	M	G	11	04	08					PM
Field 1	2	3	4	5	6	7	8*	9#	10	11	12

* - many manufacturers omit this cutting edge symbol

- many manufacturers omit this feed direction symbol if the insert can cut left and right.

Field 1 is the insert shape. D = diamond, 55° nose angle.

Field 2 is the relief angle. N = 0 degrees.

Field 3 is the insert size tolerance. M = +0.13-0.13mm on thickness.

Field 4 is the insert type. G = can be used on both sides, i.e. turned over.

Field 5 is the cutting edge length. 11mm

Field 6 is the insert thickness. 04 = 4.76mm from the insert base to the cutting tip.

This is less than the thickness of the insert in this case as it's double sided.

Field 7 is the nose radius. 08 = radius of 0.8mm

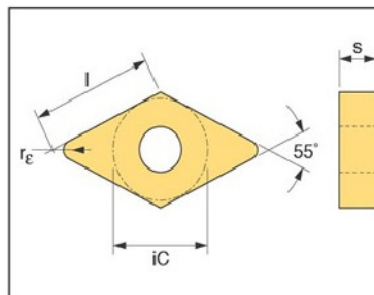
Field 8 is the cutting edge condition. Optional, nothing shown in this case.

Field 9 is the hand of the tool. Nothing shown, this is a neutral insert, it can cut left or right.

Field 10 is the insert chamfer width in mm. Nothing shown. See later.

Field 11 is the insert chamfer angle. Nothing shown. See later.

Field 12 is an optional manufacturer's code. In this case, Sandvik, PM = ISO P – Medium machining. Unfortunately there seems to be no uniformity amongst manufacturers in these optional codes.



The drawing supplied by Sandvik for this insert is shown here. S is the insert thickness, iC is the inscribed diameter of the insert, rε is the tip radius and L is the length of the cutting edge.

Taking each of the ISO fields in turn, from the left and listing all the field symbols.

The most robust inserts have large nose angles, like the trigon and square. They are preferred for roughing operations in industry. Inserts for fine finishing tend to have lower nose angles like the 35, 50 and 55° diamonds and these make good tools for profiling smaller components. They can often cut right and left. The 55° diamond shapes can also be used to roughly cut BSW and BSF threads. You can then finish off with a die or chaser to get a good thread profile and accurate pitch.

The Relief Angle or Insert Clearance Angle is the angle of the front face to the vertical. An insert with a 0° Relief angle, ISO symbol N, is often described as a negative insert and has the strongest (most robust) cutting tip. Industrial inserts for steels are often negative for strength.

Inserts with a relief angle greater than 0° are described as positive inserts. The bigger the positive angle, the sharper the insert and the more suitable for light finish cutting. Very positive inserts are preferred for ISO N materials, aluminium alloys and some brasses.

Field 1 INSERT SHAPE

ISO Symbol	Shape	Nose Angle
A	Parallelogram	85°
B	Parallelogram	82°
C	Diamond	80°
D	Diamond	55°
E	Diamond	75°
F	Diamond	50°
H	Hexagon	120°
K	Parallelogram	55°
L	Rectangle	90°
M	Parallelogram	86°
O	Octagon	135°
P	Pentagon	108°
R	Round	
S	Square	90°
T	Triangle	60°
V	Diamond	35°
W	Trigon	80°

Field 2

ISO Symbol	Relief Angle
A	3°
B	5°
C	7°
D	15°
E	20°

Relief Angle

ISO Symbol	Relief Angle
F	25°
G	30°
N	0°
P	11° or 10°



Field 3

Dimensional Tolerance

Dimensional Tolerance These are the dimensional manufacturing tolerances for the insert thickness, inscribed circle and insert width. Grade M is common, occasionally G,U or E. See manufactures literature, not critical for Home Workshop machinery use, in my opinion.

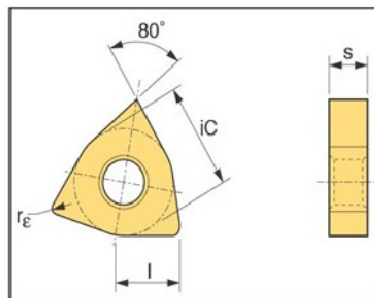
Field 4

Fixing / Chip Breaker

ISO Code	Fixing hole	Chip Breaker Style
A	Hole, no countersink	No Chip breaker
G	Hole, no counter sink	Chip breaker on both sides
M	Hole, no counter sink	Chip breaker one side
N	None	No chip breaker
P	Hole, no counter sink	Chip breaker one side or both sides
Q	Hole, counter sunk both sides. Double sided insert.	No Chip breaker
R	None	Chip breaker one side
T	Hole, counter sunk one side	Chip breaker one side
W	Hole, counter sunk one side	No Chip breaker
X	Special	Special

For long chipping materials like low carbon steels, a chip breaker helps prevent continuous steel strips being formed that can wrap themselves around the tool and tool holder. This can be dangerous to you, the operator, the workpiece and the insert. Chips evacuating the cutting zone can cause rapid wear of the tool insert and damage the work surface. Chips are an important way of removing the frictional heat generated by cutting. Chips are often seen to be blue/ black when cold, due to heat build up. Industrially, red hot chips are often seen. Many chip breaker styles are pressed into the insert before sintering. See **photo 4**, the insert marked with the grade K40. This drawing is of a trigon insert with a hole fixing and is countersunk on both sides so it can be turned over to give 6 cutting edges.

For light finishing, we are only likely to use the tip of the tool to cut the workpiece. Industrially this isn't the case and wide ribbons of chips are not uncommon especially in roughing and 'bar peeling' operations. All of the generic tool shapes shown here are available in a range of sizes and thicknesses and it's important to match the insert shape and size to its holder. See Part 3 in the series.

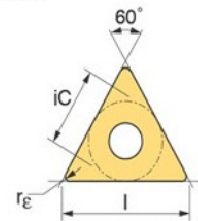


Field 6 Insert Thickness, mm

ISO Symbol	s
01	1.59
T1	1.98
02	2.38
03	3.18
T3	3.97
04	4.76
05	5.56
06	6.35
07	7.94
09	9.52
10	10.00
12	12.00

Please note that for double sided inserts, the insert thickness s is not the thickness of the insert at its thickest point. It's the tip of the tool to the base it's sitting on.

Field 7 Nose Radius, r_E , mm ISO Symbol, metric*



M0, 02	0.2
04	0.4
08	0.8
12	1.2
16	1.6
24	2.4

* You may come across imperial inserts. These are marked differently. Please check with the manufacturers data.

The nose radius is shown for a standard corner radius. Many manufacturers offer so called "Wiper" nose inserts where the nose shape is modified to be a shape that promotes a better (2x) surface finish at the same feed rate or the same surface finish at 2x the feed rate. The presence of a wiper nose format will normally be indicated with a W or WF in the ISO manufacturer's optional fields, **Field 12**.

In my example on page 38, the DNMG insert has a 0.8mm nose. In my opinion this is too large for finishing on a light machine and a better starting point would be a 0.2 or 0.4mm radius. Large tool nose radii and long cutting edges promote juddering on light machines. Avoid by changing the machining conditions.

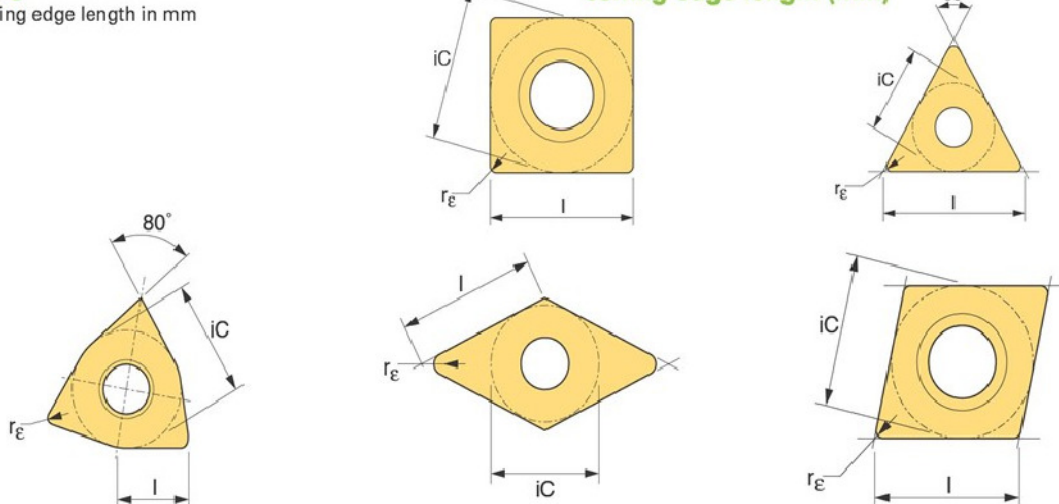
If you look at the Greenwood Tools website, **ref. 6** you will find that they specialise in inserts for Home Workshop machines. Greenwood offer useful advice on insert selection and use conditions for these smaller diameter nose inserts for home workshop use.

In my opinion, wiper style insert noses offer no advantage on light machines. Tell me if you find differently.

Field 5

l = cutting edge length in mm

Cutting edge length (mm)





Field 8	Cutting Edge Condition	
ISO Symbol		
F		Sharp cutting edge
E		External radius treated cutting edge.
T		Negative Land
K		Double negative lands
S		Negative land and external radius treated cutting edge.

Edge styles E, T, K and S are intended for negative and positive geometry inserts and the external radius style is probably the most common. Positive inserts with a sharp cutting edge, F, may be further modified by the manufacturer by adding a negative top surface to the tool to improve finish turning. These modifications don't appear to be within the ISO code. The Manufacturer has the option to add his own code letters in Field 12 to indicate special features. Many inserts do not have an entry for Field 8 in their ISO code.

Field 9	Hand of Tool	
ISO Symbol		
R		
L		
N		

Field 10	Chamfer width, mm	
ISO Symbol	mm	
010	0.10	
025	0.25	
070	0.70	
150	1.50	
200	2.00	

Field 11	Chamfer angle	
ISO Symbol	Angle, degrees	
15	15	
20	20	

The presence of cutting edge chamfers, their width and angle are not always visible in some inserts. **Photo 5** shows a close up of a Mitsubishi Carbide insert, part of a batch of positive inserts being used by a local engineering company for finish turning ISO P steels on non CNC machines. You can clearly see that the cutting nose of the insert is not round, it's not a Wiper shape either, and that a tiny chamfer has been ground (honed) on all edges of the top surface.

Should you come across inserts made of HSS, Ceramic, Cermet, PCBN (polycrystalline Boron Nitride) or PCD (polycrystalline diamond) they will generally conform to the ISO codes described here. Since many of these materials are extremely hard, see part 1, but also extremely brittle, the inserts may well have the active cutting material just on the tip of the insert, the rest of the insert being support material.

Conclusions

You should now have sufficient information to determine the meaning of various ISO codes on a box of inserts and be able to take a stab at working out a code for an unmarked or partially marked insert.

In my opinion, for the type of work materials we are likely to attempt to machine, the actual insert grade material is probably less critical than the insert

Field 12

The ISO code consists of 9 symbols including 8 and 9 which are only used when required. In addition the manufacturer may add 2 further symbols e.g.

Manufacturer's Option

WF	Wiper-finishing
PF	ISO P-finishing
PR	ISO P-roughing



Photo 5 Positive finishing insert

geometry and the holder it is mounted in.

If you have unmarked inserts and a suitable insert holder it's fairly simple to determine the best operating conditions on your machine and work piece by carrying out a set of turning or milling test runs noting (calculating) the tip speed,

metres/second, depth of cut in mm and feed in mm per rev. Remember to set the tip at the exact centre height and keep examples of the turnings produced by each set of conditions and observe the surface finish. You will be surprised how much the machining conditions affect the results. Unfortunately you will need a lathe or mill with power feeds to do this, so dust off those change wheels, use the gear box or table feed.

In the next part I will deal with ISO INSERT tool holders for the lathe and describe some insert/ tool holder solutions that have worked for me.

References

- Ref 1: <http://www.coromant.sandvik.com/uk>
- Ref 2: <http://www.mitsubishicarbide.com/EU/Vest/index.htm>
- Ref 3: <http://www.engineersblackbook.com/>
- Ref 4: <http://www.jlindustrial.co.uk>
- Ref 5: <http://www.newcomerproducts.com/>
- Ref 6: <http://www.greenwood-tools.co.uk>
- Ref 7: <http://www.secotools.com>

DIARY OF A CNC CONVERT

Dave Senior takes the plunge

Slow progress

Progress was slow until Dick Stephen wrote his series of articles in MEW issues 102, 103, and 104 and I got closer still when Peter Edwards described his conversion in issues 118, 119, and 125 as his machine was very similar to mine. The final trigger came when I discovered that the Hethel Engineering Centre, **ref. 1** – a high-tech training facility close to where I live in Norfolk – was running CNC Mill 'Taster' Days. I booked myself on one of these, where I had a very pleasant day being given a basic grounding in the use and capabilities of CNC milling machines. That was enough to realise that I had dithered for long enough – I had to get on with the conversion! Incidentally I would recommend those 'Taster' days for anyone with an interest in modern machinery – I think they do them for the CNC lathe as well as the mill, and they also have rapid-prototyping machines, which are just amazing. My day cost just £50 + VAT with lunch included.

One of the problems facing the beginner like me is not knowing how you are going to use the system – will it do everything under computer control that you could do before the conversion, or do you need to be able to use it manually? If you convert the machine and then struggle to cope with the programming, are you going to be unable to make anything?

Not being confident enough to answer these questions, I decided I had to retain the option of manual control. At its most basic, that means being able to fit handles to the outer ends of the stepper motor shafts – i.e. picking motors with through shafts – and having some means of measuring where you are. The minimum would probably be to fit collars to the handles graduated to suit the pitch of the leadscrews, but I chose to fit a digital readout, which in hindsight was probably unnecessary but has been very useful in troubleshooting.

I also decided that I wouldn't modify any of the standard components in such a way that would stop me changing everything back to original if the whole process was a disaster.

Mechanical Conversion.

For the mechanical conversion, I chose basically to follow Peter Edwards' work, as his machine is the same size as mine. One key difference was that I decided to try and power the knee for the Z-axis travel, instead of the quill. This would give me the advantage of leaving the quill free for manual drilling if required, but would require a more powerful motor and may have issues with surface finish on the components if the gib strip

Background

I have owned a Myford VMF milling machine for over 18 years, but whilst it was a useful machine for all those odd jobs that crop up, it didn't get a huge amount of use until 2002 when I took on the challenge of building RC1, a rope climbing robot, **photo 1** and entered the BBC's TechnoGames competition. In the early '80s I had worked on F1 racing cars, where we designed bulkheads that were machined out of solid aluminium plate to leave just a thin skin with stiffening ribs. I used the same techniques for the main components of the robot, but found it frustrating that, due to the limitations of my manufacturing skills, I had to restrict myself to designing in straight, orthogonal lines. I also found that turning the handwheels whilst counting in 4's (4mm pitch leadscrews) gave plenty of scope for mistakes!

Whilst a digital readout would have cured the counting issue, a conversion to CNC seemed to answer all the problems, so I resolved to investigate further. I confess I have a general interest in automation and ideally would like to design components and have them miraculously appear as finished items – I have never been a great fan of handle turning!

adjustment was less than perfect. I also decided to try and use a ball screw on the Y-axis that had bearing support at the outer end only, to avoid having to construct a bearing mounting on the unmachined inner surface of the knee casting.

I don't propose to go into much detail of the modifications. Mechanically, the Z-axis conversion was straightforward. I replaced the acme leadscrew with a 25mm diameter, 5mm pitch ball screw, with the nut fitted with a flange and bolted in place of the standard version, **photo 2**. The bearing arrangement in the knee casting had an additional ball thrust race added, **photo 3** and a toothed belt pulley was fitted on top. The belt led out through the side hole (where the knee operating handle had fitted) to the stepper motor mounted on a (temporary) bracket bolted to existing holes, **photo 4**. I opted to use the same size stepper motor for the Z axis as I was using for the X & Y axes, but arranged for a 2.5:1 reduction in the belt drive in the hope that there would be enough power to cope with the considerable weight of the knee and table assembly, (there wasn't, but more of that later).

For the X & Y axes, I made new bearing housings for the 20mm diameter, 5mm pitch ball screws, incorporating features for mounting the stepper motors, the Y-axis is shown in **photo 5**. How I wished for a CNC machine to make them! I chose not to try and modify the existing housings so that I could retain manual use for as long as possible. As the Y-axis ball nut was rather longer than the acme version being removed, I lengthened the slot in the knee casting to ensure that I did not lose any Y travel, **photo 6**. The adaptor blocks which fitted between the motors and the

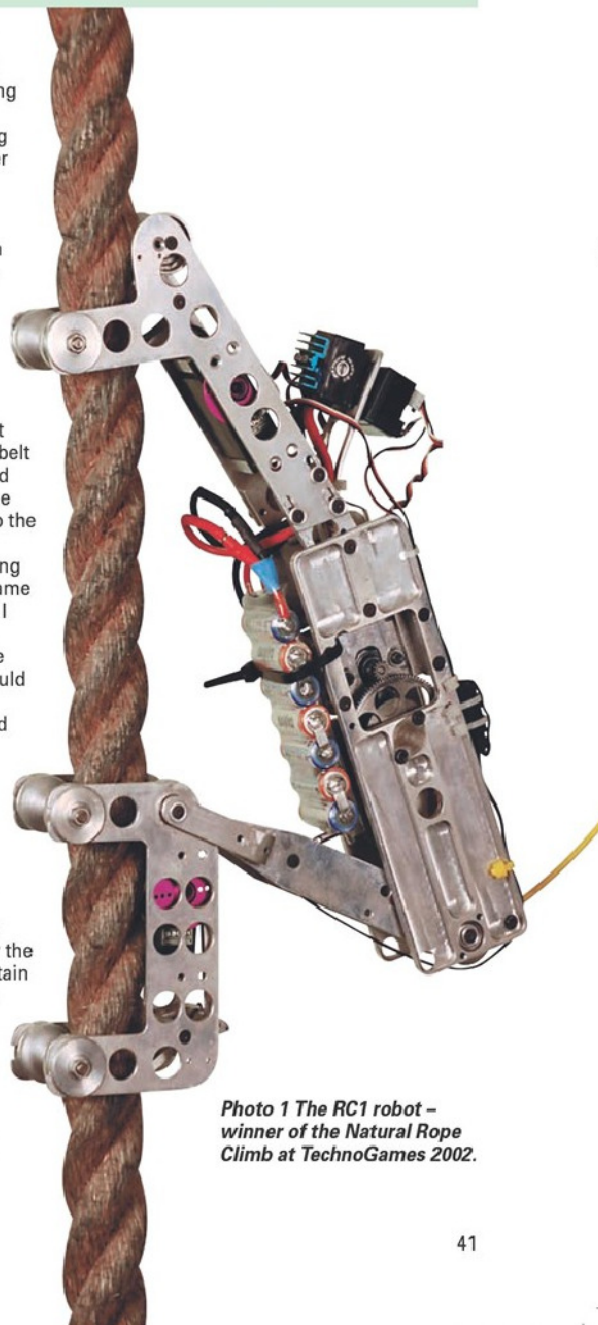


Photo 1 The RC1 robot – winner of the Natural Rope Climb at TechnoGames 2002.



Photo 2 The Z-axis ballscrew. 2 Morris Minor rack gaiters await clipping into place.

bearing housings were part-finished only at this stage – the machining of the outer shape was left until the conversion was working.

I used Marchant-Dice, **ref. 2** for the ball screws and nuts and also used their machining services for the end features. Toothed belts and pulleys are Reduced Backlash 5mm pitch from HPC, **ref. 3** and the stepper motors are AC571157525M from Arc Euro Trade, **ref. 4**.

Electrical Conversion.

Generally speaking, if something is available ready-made at sensible money, I am unlikely to want to make it myself. That, coupled with the fact that I am not keen on specifying electrical components, meant that I wanted to try and find a ready-made controller if possible. It was clear from Dick Stephen's articles that a rotary knob for manual control of the axes was very desirable (and the HAAS machine that I had used at the Hethel Engineering Centre had one), so that was going to be a key part of the specification. After searching on the Internet, I came across a product called the CNC2X control box, **photo 7** from Conqueror Design & Engineering Ltd, **ref. 5**. This included the stepper motor drivers, the CNC controller card, the power supply, front mounted 'jog' buttons and the all-important handwheel, all built into a case with the relevant connectors on the back. I was able to download the manual and a trial version of the controller software (EaziCNC) from their website, to try and evaluate the product. It is always difficult to make an assessment of something when you don't really know what you need, but this seemed to satisfy all my requirements, so I ordered one.

That just left the software for producing the g-code files of my designs. I have been using TurboCad for some years now, so didn't really need a CAD program, just something that could take my CAD file and convert it to g-codes.

The obvious choice would have been the



Photo 3 The top of the Z-axis ball screw awaiting pulley.

matching product from CD&E Ltd, EaziCAM. This happily accepted .dxf files from TurboCad, but I wasn't convinced about the program itself. Another that I considered was Dolphin PartMaster Level 2, **ref. 6**. Their website has some excellent 'how to' videos which demonstrated all the features that I felt I would be using. All these programs use a post-processor to output code tailored to the chosen machine controller. If your machine controller isn't listed then you need to be confident that you can use the output for another controller or modify an existing post-processor to suit. Dolphin didn't list the EaziCNC as a controller in their post-processor list, so I laboriously tried a sample file through all the controllers in the list and found a handful that appeared to work. I confess that I didn't understand their methods for modifying the post-processors so I wasn't sure whether I would be able to fine tune it if necessary. However, before I could resolve that, I went to a show where a CAD/CAM program called OneCNCXR2 Mill Express, **ref. 7** was being demonstrated. Like Dolphin, this program appeared to have all the features that I wanted, but their post-processor has a very simple configuration system that appeared to be ideally suited. The only stumbling block was the price - £1295 + VAT for the basic 2-1/2D version! Fortunately for me, the sales director decided the price could bend, so with a very substantial discount, I bought it. As you can imagine, it is a very professional piece of software that has performed faultlessly.

Wiring up

Wiring and configuring the system was straightforward. The stepper motors were connected temporarily using plastic terminal blocks and insulation tape – proper boxes were on the job list for when the machine was working. I was using a laptop computer to connect to the CNC2X control box. The box needed a serial port to plug into, but the laptop only had USB ports, so I bought a serial-to-usb converter cable, which appeared to work. Entering the configuration data was easy – information like stepper motor steps per mm of table travel – everything was explained in the manual. The motor direction was corrected as necessary by swapping the wires at the motor. Incidentally, the strategy I am using has the position of the table determined by the number of steps of the stepper motors, meaning that if a motor stalls (and hence 'loses' steps) then the table will not be in the position that the controller believes it is. The CNC2X box is able to deal with encoders for positional feedback if required, potentially giving greater accuracy (something for the future maybe?)

So, that completed the system – the question is - would it work? I started with a simple pocket in the top of a block of aluminium – drawn in TurboCad, imported as a .dxf into OneCNCXR2 where it was converted into g-codes for use in EaziCNC, which then controlled the mill. It worked! Heartened by that, I quickly drew a shape with curved sides (the whole reason for the conversion). That worked as well so I was happy, **photo 8**.

Problem solving.

I appreciated that I had taken some shortcuts during the build, which I would have to re-address once everything was working, so I recognised that it would be some time before I could say the conversion was finished. Even so, there were lots of unexpected issues that needed resolving. The first of these was the need to stop the coolant spraying everywhere, especially with the computer alongside. It was apparent that some

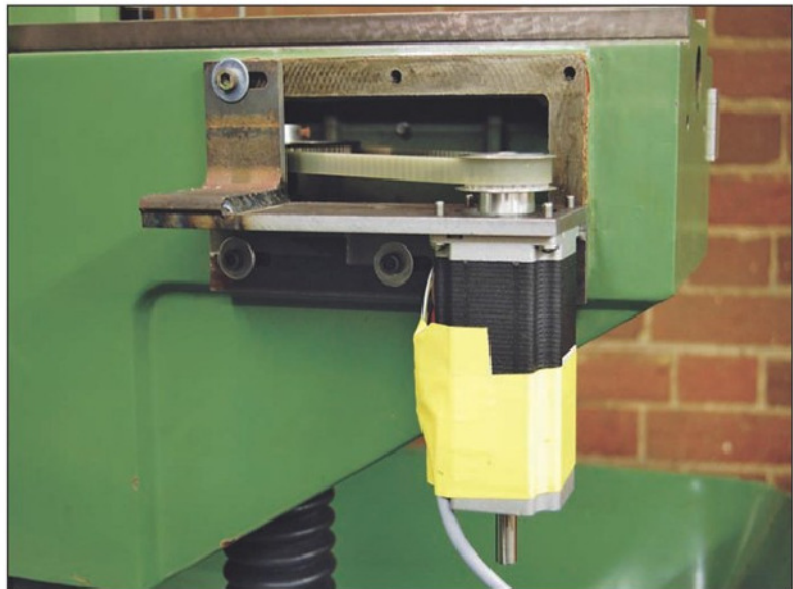


Photo 4 The Z-axis motor, the belt drive and the temporary mounting bracket.



Photo 5 The Y-axis motor mounting.

form of screening was required. I decided to build a complete enclosure around the machine. A few hours work with 25mm square tubing, sheet steel, a welder and some pop-rivets produced a freestanding 'funnel', which drained into the existing drip tray, **photo 9**. Rubber sheeting formed a curtain to seal around the back of the table. The door is a bit crude – just a steel sheet that hooks over the top of the frame that needs lifting off to gain access to the workpiece or tooling. Hopefully I will replace it at a later date with something that hinges or slides to make it more usable.

That successfully contained the swarf and coolant, but it was becoming clear that the whole coolant system was now rather overloaded. I guess that when using it manually, I was in the habit of clearing the swarf from the table regularly, but now the machine was capable of generating lots of swarf with no human intervention and the drains were getting clogged. The table had only one drain, so I drilled two more and fitted little spouts made from domestic copper water fittings. That sorted that bit, but the main machine drain (back to the coolant tank) is now rather inadequate, so I will need to deal with that sometime.

The next problem to arise was rather more serious. The OneCNCXR2 software has a neat little utility for engraving from a .jpg file. This seemed like fun, so I had a go at engraving my company logo onto a piece of aluminium. Halfway through, I realised that the cutter was no longer

milling the aluminium, but was cutting fresh air above the workpiece. It transpired that my Z-axis motor was not quite up to the job, and I was losing a small amount on every Z movement. As this engraving had a lot of Z movements and the original depth of cut was probably only 0.5mm, the table had effectively ratcheted itself down until there was no cutting taking place. The diagnosis of this was one of the times when the digital readout proved invaluable.

I considered three solutions:

- Counterbalancing the weight of the table with cables, pulleys, and a large weight hanging behind the machine.
- Fitting a larger motor.
- Changing the pulley ratio.

The simplest and quickest option was to fit a larger motor, so an order went in to Arc Euro Trade, an adaptor plate was designed and made (so easy with CNC!) and the drive pulley was bored out to 14mm to suit the new motor. The immediate problem went away, though not necessarily in a very elegant way. Despite the motor being rather more powerful, I find I can't run it any faster than the previous one. I suspect that this is because of the reasons explained in Tony Jeffree's article in issue 121. Peter Edwards suggested that I use gas springs to counterbalance the table weight, so I have bought some and am currently working on an installation that hopefully will allow me to refit the original smaller motor and change the pulley ratio to 1:1.



Photo 6 The chain drilling in the knee casting to provide clearance for the Y-axis ball nut.

Protected power

Another issue was also becoming a serious nuisance. I was running the machine when a friend was also in my workshop using an electric welder. I suddenly realised that the machine had stopped cutting. It appeared that communication between the laptop and the control box had been lost. The mill had finished the last instruction it had been given, and was patiently waiting for more. I put this problem down to a voltage issue when the welder was working, exacerbated by the fact that my laptop had no battery. I considered it unlikely that the welder would be used normally whilst I was milling, so was not unduly concerned, but I added a computer protected power supply to the laptop and control box to prevent any recurrence. I could now switch off the mains to those items and everything would carry on as normal.

However, I still found I was losing that connection intermittently, usually when I switched on the coolant pump. It got to the stage where I hardly dared switch anything on whilst a program was running, as it was such a nuisance to lose everything mid-way through a complicated machining operation. This was another area where the digital readout was a lifesaver. As that still maintained the position, I could usually re-enter those figures into the controller software after it had been restarted. It appears that the problem was probably related to the serial-to-usb converter cable – there had been some suggestions on the EaziCNC forum that an opto-isolated version was required. Rather than tracking down the necessary cable, I solved the problem by using an old desktop computer in the workshop instead of the laptop. This had a traditional serial port and the problem has never recurred.

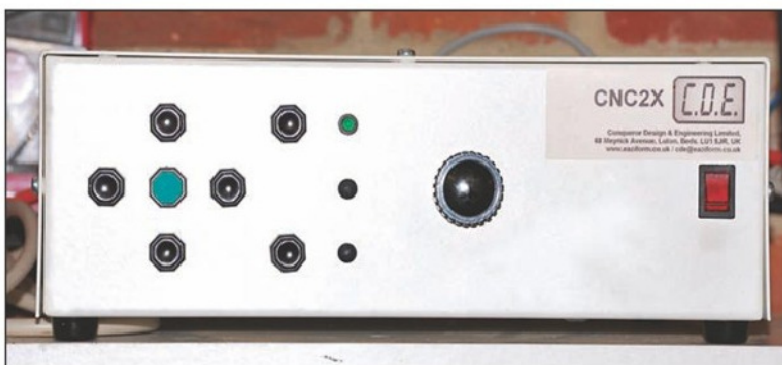


Photo 7 The CNC2X controller box.



Photo 8 First cuts – simple pocket and curved profile – both in 2 1/2in. square blocks.



Photo 9 The freestanding enclosure to contain flying swarf and coolant.

Using the machine.

Having got the basics working, it was now time to start using the machine to make some bits! First on the list was an emergency stop system. The controller has provision for an emergency switch, but without one fitted, the way to stop the machine was to press and hold the 'escape' key on the computer – not the easiest of things to do in a hurry. I decided that a button fixed to the machine and another on a flying lead would be the best arrangement for me, **photo 10**. If these were wired in series, then pressing either one would break the circuit and halt the table movement. Note – I do not use the CNC2X box to control the spindle motor, so stopping the cutter would have to be done by the normal machine on/off switch. I bought switches (part no 4774890) and cable glands (part no 4442616 and 4442694) from RS Components, ref. 8 and metal boxes (part no N88BQ) from Maplin, ref. 9. The switches needed mounting in a hole with a notch in the side to stop the switch rotating, **photo 11**. That would be easy enough to achieve with a drill and file, but easier still with a small (2.5mm) slot drill under CNC control just cutting inside the perimeter. Incidentally, this is one of the areas that the CNC excels – cutting large holes in relatively thin material. There is no longer a requirement for big drills or hole saws – just trepan them out with a smaller slot drill.

The mounting for the fixed switch also demonstrated how a simplistic assumption can give problems – I was using a pair of existing holes (formerly used to hold the belt access door hinge) to bolt the block to the head of the machine. When I bolted it on, it sloped downwards at a rather drunken angle. I had assumed that the pair of holes would be vertical – wrong! I had to slot one of my mounting holes to get the block square.

The next job was to finish off the stepper motor mounting spacers. I had made a spare, but left them all unfinished on the outside, as I wanted them to be neatly radiused and that seemed like a perfect task for the CNC mill.

One of the challenges is always going to be deciding how to mount the workpiece to allow access to all the surfaces requiring machining. In this case I decided to make a simple jig from 3in. x 1/2in. aluminium bar. By holding this in the machine vice, I could drill four holes to be tapped M5, mill out three holes clearance for M12 fixings and remove 3mm from all of the top surfaces apart from a 38mm diameter section at the centre, which would form a locating diameter for the blocks. Then the jig was bolted directly on the mill table with a long stud through the centre and two shorter bolts at the ends. The part-finished adaptor block fitted onto the central location boss and was held down by the central M12 stud (with a special washer) and 4 x M5 cap heads, **photo 12**.

A 20mm diameter long series end mill made short work of profiling around the shape in 5mm deep steps, leaving a finishing allowance to be cleared in one pass at full depth. I did get quite a lot of chatter on the finishing cut, but it was 43mm deep and the end mill was past its best, so it was probably to be expected. The surface finish was quite pleasing, even if not as intended.

Tool holding

One thing that was becoming apparent was the requirement for several chucks. Once a part has been programmed, all the cutters for that component need to be set up in the mill to have their length offsets established. Normally the procedure is to fix the workpiece first, then locate the zero datum.

I usually set the left hand end as X=0, the face nearest to the operator as Y=0, and the top surface as Z=0, using an electronic touch point sensor. Then the datum tool is removed and replaced by each cutter in turn, setting the length in the controller for each one by touching it down onto the workpiece top surface. If you are replacing the cutter in the chuck each time, it needs to be at a repeatable length – usually only possible if the cutter can be pushed fully home. The alternative (and easier) approach is to have each cutter for the job in its own chuck. A natural extension of this is to have the most commonly used cutters assigned permanently to their own chucks,

therefore removing the need to set the lengths after the first use. The downside is the need for rather a lot of chucks!

The next phase.

I now have a CNC mill that works. There are still improvements to be made, but I can make bits. The engineering manager at the Hethel Engineering Centre produced for me a g-code file of a 3D sculpted shape so that I could see whether the machine could cope with that, my version of OneCNCXR2 will only deal with 2-1/2D. **Photo 13** shows the result. The rather coarse finish is a function of the large step size for the cutter passes to keep the file size down. Sometime in the future, I would like to upgrade to a full 3D version of the software, but I am still somewhat stretched learning the 2-1/2D at the moment. I have recently started doing my designs using the CAD in OneCNCXR2 and whilst it has a somewhat different approach to that used by TurboCad, it works perfectly well and obviously it makes sense to use it in the circumstances.

Am I happy with my conversion? Yes. Would I do it differently if I had to do it again? Only by missing out the mistakes and getting to the final result directly. Would I recommend others to convert their milling machine to CNC? Yes, but only if they wanted CNC. If you are happy with what you can produce by turning the handles, then stick with it. I think most people would have no problem with the mechanical conversion, fitting ball screws and bolting on the stepper motors, it just needs a little planning to make sure that everything is made before the machine gets immobilised.

Picking the stepper motors is a different issue, it would be wonderful if someone could compile a list of what motor/driver/leadscrew pitch/gearing combination was suitable for all common machines. The bit that worried me was picking the controller/software combination. All I can say is that my choice of OneCNCXR2 CAD/CAM and CD&E Ltd CNC2X controller box works.

I can't justify saying the combination is the best available because I have never tried anything else, but it certainly has capabilities far beyond mine at the

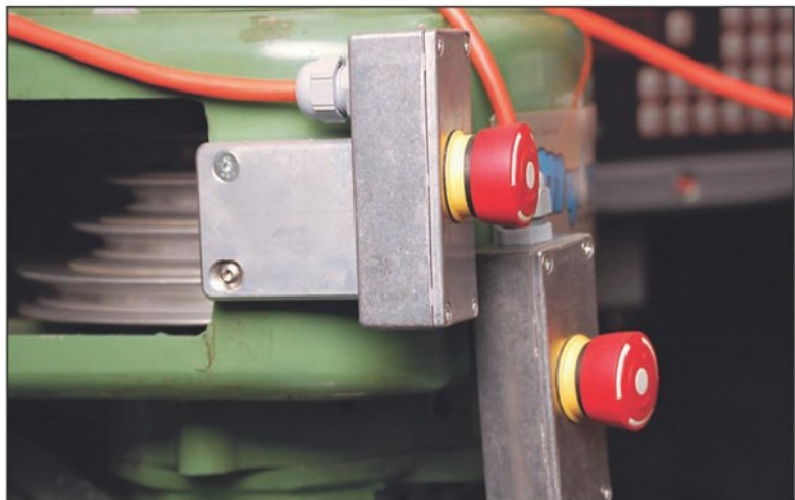


Photo 10 Emergency stop switches – one fixed to the head of machine, the other hand-held.

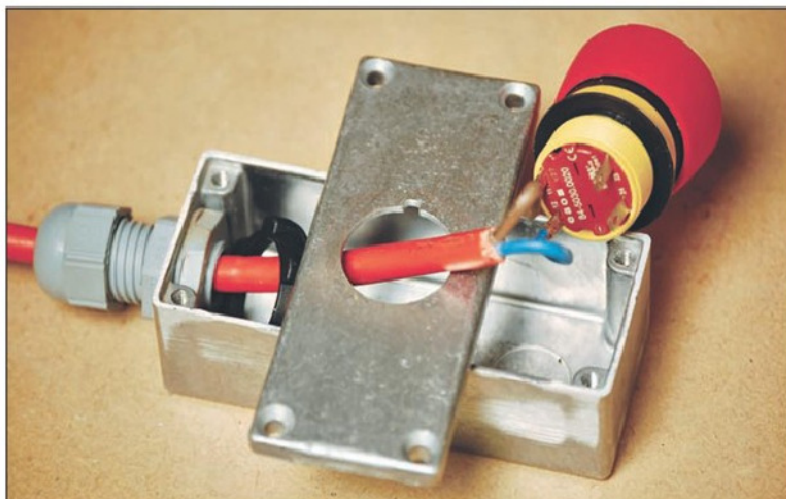


Photo 11 Hole in box lid for switch – easy with CNC.

moment. And I haven't had to fit handles to the stepper motors – manual control from the CNC2X box is easy, either by pressing and holding the 'jog' buttons, or by typing where you want the cutter to move using the keyboard. Similarly, changing the feed rate for manual operation is simply a matter of typing in the figure you want. (Incidentally, the CNC2X controller has a neat feature – you can use the control knob to vary the feed rate whilst a program is executing – useful if you are worried that it's all going too fast, or if you are getting bored and want to speed it up a bit!

For me the key issue is that my design process has been liberated. Inevitably I was designing components with the restriction of knowing that I had to be able to make them. Whilst that is still true, my manufacturing capabilities are now so much more extensive than before. I have yet to get back to designing parts for robots, but I can indulge myself with rather excessive 'machined out of solid components' like the connection boxes for the stepper motors, **photos 14 & 15** and the bracket for the lower Z-axis limit switch, **photos 16 & 17**. Above all, I am enjoying it.

I hope to have the opportunity to follow up this article with another, demonstrating my experiences with the machine as I get more used to it and specifically with details of using the software from design to finished article. In the meantime, I am more than happy to answer questions via email to dave@theseniorfamily.co.uk

Suppliers and other contact details:

- Ref. 1 Hethel Engineering Centre, www.hethelcentre.com 01953 859100
- Ref. 2 Marchant Dice Ltd, www.marchantdice.com 01363 83918
- Ref. 3 HPC Gears Ltd, www.hpcgears.com 01246 268080
- Ref. 4 Arc Euro Trade Ltd, www.arceurotrade.co.uk 0116 269 5693
- Ref. 5 Conqueror Design & Engineering Ltd, www.eaziform.co.uk
- Ref. 6 Dolphin CAD/CAM Ltd, www.dolphin.zenwebhosting.com 01563 543989
- Ref. 7 OneCNC UK, www.onecnc.co.uk 01384 294800
- Ref. 8 RS Components Ltd, www.rswwww.com 08457 201201
- Ref. 9 Maplin Electronics Ltd, www.maplin.co.uk 0870 4296000

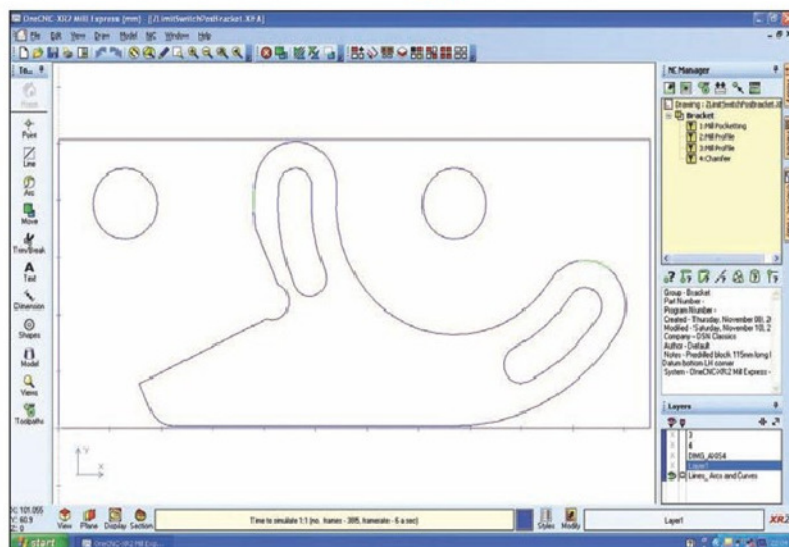


Photo 16 Screenshot of Z-axis limit switch bracket at the design stage.

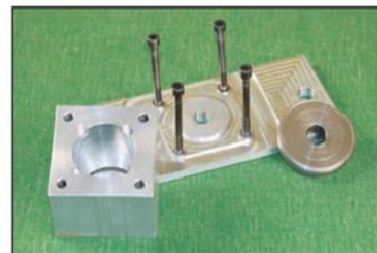


Photo 12 A jig for holding a motor adaptor block, with part-finished block.



Photo 13 A 3D test block.



Photo 14 The stepper motor connection box and lid.

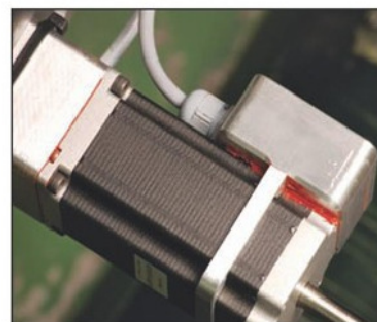


Photo 15 Stepper motor connection box installed with fixing strap (and plenty of instant gasket to seal out the coolant).



Photo 17 The finished bracket installed on the Z-axis ball nut flange.

REBUILDING THE SUPER SEVEN LATHE

'Richmond' gives new life to a 50 year old lathe

An original Super 7

It is the original style Super 7 with the oil drip feed integrated into the headstock casting, **photo 2** and the old style countershaft clutch, **photo 3** as manufactured between 1956 and 1959. The gearbox is of the newer type which is still in production today with all the gearing internally mounted. The power cross feed is an aftermarket type which was fitted at a later date.

The lathe is mounted on homemade raising blocks on a Myford stand. It is complete with a 3 jaw-chuck, driving plate, centres, travelling steady, and a Dixon toolpost, and is powered by a single phase Brook Crompton ¾HP motor with Dewhurst reversing switch.

As for condition, well, the stand had been modified to incorporate a drawer, **photo 4** where the normal Myford name plate sat in the top centre of the stand and numerous holes had been drilled

Background

Like most people, never having had the money to afford a new or refurbished Myford Super 7, I resorted to buying second hand and refurbishing myself where possible. Further, having had it suggested to me that I "needed" a 'Super 7', or similar lathe, to enable me to write articles that people with more modest workshops could relate to, I decided to "put my money where my mouth is", so this is the story of my rebuild, warts and all.

During one of those evening chats I have with Harry, and after exclaiming that "I would love a 'Super 7', if only I could afford one!", I was duly informed that a friend in the club was selling one. The name and phone number were looked up, further calls were made, and a visit to see the said 'Super 7' was arranged. After visiting, and twiddling the dials, a price was agreed which was comparable to an Ebay price given the age, condition and accessories with the lathe.

On Thursday 13th December 2007 at 7.30pm, Malcolm duly arrived with the lathe and an extra pair of hands to offload it, and an hour later it was assembled in the workshop. I was now the proud owner of a Super 7, **photo 1**.

over the years to accommodate differing fixings. The cross and top slides were a little rusty, **photo 5** and both showed signs of abuse over the years where they looked to have hit the chuck. However, the screws showed little or no backlash. The headstock, countershaft clutch, gearbox, and main bearings all appeared in good condition, and none of the gears

were worn or had damaged teeth, **photo 6**. The bull wheel and back gear assemblies were also in excellent condition. The bed appeared to be in good condition apart from the odd mark. However, the saddle did go "tight" when approaching the tailstock. Originally, I thought this could be adjusted out with shims, but more of that later.



Photo 1 The Super Seven as purchased from Malcolm.

THE MYFORD LATHE

Model Engineering use

The lathe and stand were covered in aluminium and brass shards, and I had been informed that the lathe has been used for model engineering for some considerable time. Subsequent investigations have shown that the lathe was shipped by Myford to G. Lodge & Sons, a local (Hull) machine tool dealer, on 21st February 1957. Unfortunately, Lodge's records don't go back that far, and they are unable to tell me who originally bought the lathe from them. However, the model engineer who last used the lathe, Ron, is thankfully still with us, and remembers buying the lathe in the late 1970's or early 1980's from a local engineering company in a closing down sale. He used it to make a gauge 1 loco, a Minnie Traction Engine and a clock amongst other things. This fits with the brass and aluminium found on the lathe, and that the saddle / bed wear were in the first third of the bed.

Originally 3 phase

The lathe was originally a 3 phase machine and was converted to single phase by Ron when he first acquired the machine, as was the drawer modification to the stand. The aftermarket power cross feed and raisings blocks were also added by Ron in approximately 1987 when he finally retired. He sold the lathe to Malcolm about 2 years ago and it has lain idle whilst the pressure of family and business commitments has kept Malcolm busy.

Given that the mechanical condition of the lathe seemed good, my original intention was to strip the lathe down, fill the chipped areas and repaint. However, once I started attempting to adjust the saddle to compensate for the wear, it became apparent that this was likely to be a much larger project than I first thought. Eventually, I removed the top and cross slides to enable me to remove the saddle, and only then did I see the extent of the wear under the cross slide on the top of the saddle, **photo 7**. Constant use had eroded a strip approx 5 thou deep on the left side, and about 2 thou on the right. In hindsight I should have checked this more thoroughly prior to purchase.

Once I removed the saddle and apron, I was able to test the bed and saddle. The bed itself appeared to be parallel and flat along its length, and no discernable wear had occurred along the shears. The saddle was a different matter all together. Wear had occurred all along the front and rear edges of the underside, approx 3 thou at one end, and 2 thou at the other. Hence, when adjusting for no play at the headstock end the saddle went tight when moved towards the tailstock.

A complete restoration

The prospect of a regrind loomed. This, coupled with the condition of the cross and top slides, and the paintwork forced me into thinking about a complete restoration project. The main issue being how much would a regrind cost? Given that Christmas was fast approaching and SWMBO needed lots of presents to enable her to forgive my constant lack of attention, money was likely to be tight.

So, working on the premise that things are always cheaper in the north, I started trawling for prices for a regrind. I should say that I did originally look up the price of a Myford regrind, as well as survey the various specialist interest ME newsgroups on the web. The "online" consensus appeared to be

that Myford were expensive, and that there were alternatives. These ranged from the DIY variety through to "My mate got his done at work".

After consulting some local model engineers as well as engineering contacts in the area it seems that there is no machine regrind specialist locally. Phoning around the specialist engineers, I was quoted anywhere from £600 to £800 plus VAT, and a lead-time anywhere from 2 to 8 weeks. The prices seemed high to me, and this I was told, was because the machines had to be jigged specifically for the lathe, which is a fair comment.

Guarantees of accuracy

Further, I asked what tolerances would be used, and what guarantees of accuracy would I be given? Usually, the phone went silent for a moment, and then a response similar to "We will take off just enough to make it square and parallel". My confidence went west, also dented somewhat by the admission by several specialists that they had not reground



Photo 2 The headstock before refurbishing.

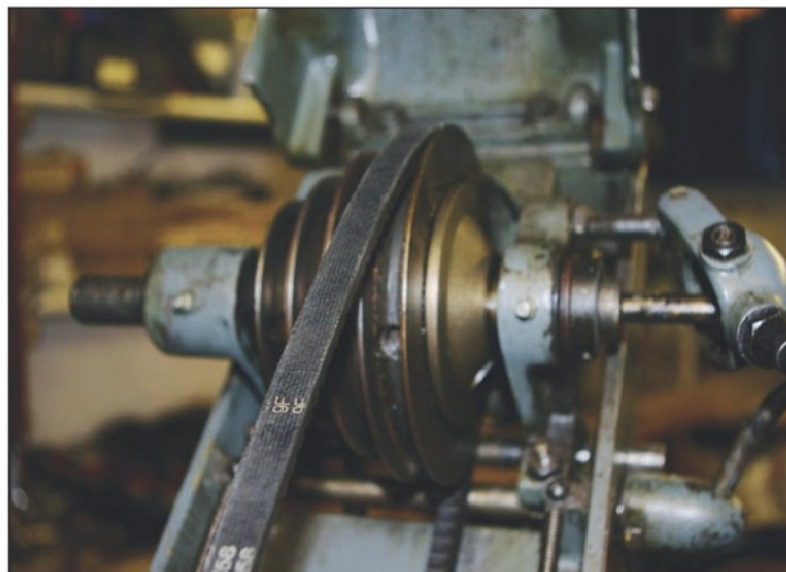


Photo 3 The old style countershaft clutch.



Photo 4 The drawer was not original.

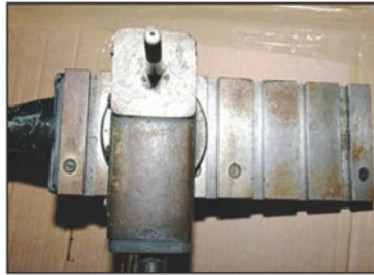


Photo 5 The cross and top slides were in a sorry state.

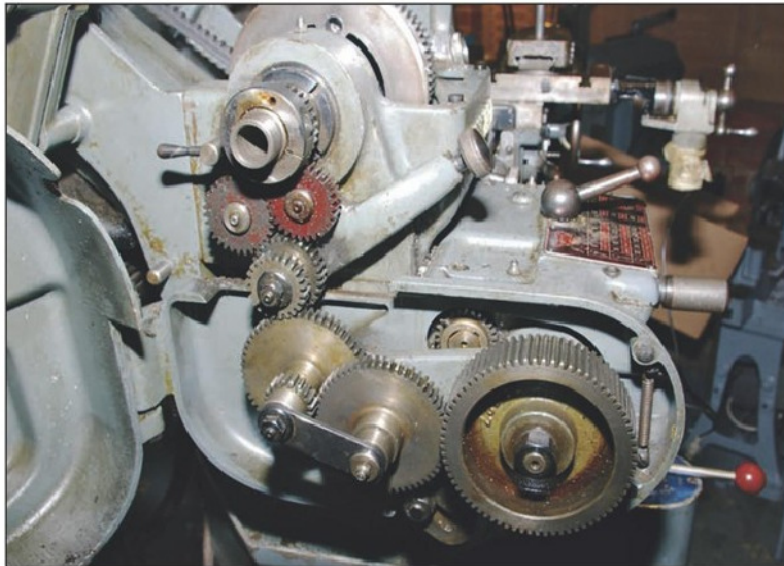


Photo 6 The change gears appeared to be in good condition.

a Myford before, and them being more used to "professional" as opposed to "hobby" lathes. Perhaps, unfairly, I took this to mean they would not treat the lathe with the same level of respect. However, in the end I decided to call Myford themselves. They appeared to be the cheapest, they certainly knew the lathe, the tolerances, and, perhaps I could actually see what the process was!

Myford to the rescue

I phoned Myford and spoke to Malcolm Townsend. Explaining my tale of woe, and that I was writing this article, we discussed whether I could bring the lathe and watch the whole process from start to finish, taking photo's and asking the pertinent questions along the way. After some consultation with Myford's MD, Chris Moore, kind permission was given, and a

date in late January was set. Regrinds are normally done in batches for economic reasons, approximately every other month, and that coupled with the fact that the factory workshops are normally out of bounds to visitors, meant a great opportunity to see what goes on.

In the meantime, lots of work needed to be done.

- The lathe needed to be stripped back to a bare bed, with the saddle and apron removed and cleaned. Myford ask all customers to present the components in a clean condition ready to go onto their machines.
- The stand needed to be stripped, the holes welded up, filled, primed, and painted.
- Missing accessories needed to be purchased.
- The damage to the cross and top slides needed to be assessed, and repaired.



Photo 7 There was a lot of wear on top of the saddle.



Photo 8 The stand has been refurbished completely.

e) A coolant /suds system needed to be fashioned.

f) A decision regarding a single phase motor or a 3 phase motor and inverter had to be made.

g) A power Supply for the power cross feed needed to be designed and built.

Three weeks of illness over Christmas and well into the New Year forced my hand with lots of the above work having to be put on hold. Whilst laid up in bed, I contented myself with the decision making, and playing on my laptop. Being a big fan of inverters and the flexibility they offer – most of my workshop equipment is 3 phase run from a single 3 hp inverter, using "flying" 3 phase power leads and remotes for each machine – I decided that the Super 7 would be converted to 3 phase and have a dedicated inverter. Ebay has provided a brand new ABB ¾ hp motor, and a compact Allen Bradley Inverter. Further items such as a faceplate, driving dogs, and spare Dixon toolpost holders also came from Ebay. Just a 4 jaw chuck, machine lamp, and fixed steady remain on the "to buy" list.

A new Hemingway kit

I had made the commitment to visit the London Model Engineering Exhibition and write the review article and this also took up 4 days on an already stretched, yet self imposed deadline. Further, I was well overdue on the building and review of the Hemingway Westbury Dividing Head kit for MEW. This particular conundrum has been resolved with the agreement of Hemingway and the Editor that I will make the Westbury kit on this Super 7 once the rebuild is complete and it will be published hopefully in an upcoming issue. At the show I managed to pick up a College Engineering Fixed Steady Casting Kit for the Myford, as well as yet more toolpost holders – I never can resist a bargain.

Refurbishing the stand

Anyway, back to the job at hand. Harry, being his usual helpful self, and being an ex shipyard welder with the appropriate skills and tools, offered to help with the refurbishment of the stand and the topline, as well as imparting some of his 45 years of experience to me, the novice welder. He duly came round, and about 8 hours later we had a stand devoid of surplus holes, cleaned and ready for primer. We also had a nice stainless steel coolant tank fabricated, which fits in the bottom right hand side of the stand, out of the way, in a place where you don't want to put tools that are heavy or awkward to pick up. All I needed now was a pump! The next day I set forth with the spray gun,



Photo 9 The new coolant tank fits nicely into the stand.



Photo 10 Setting the bed true on the horizontal mill.

and now the stand and coolant tank look good as new, **photos 8 & 9**.

Several months ago the pump on my Smart & Brown failed and I needed to get something sorted, and quick. It was that time of the month, after the bills had been paid, but still with 29 days to go till payday. So, with £20 in my wallet I set myself a task – build a coolant system for £20! With a submersible pond pump from a DIY store, 2m of ½in. pipe, a waste bin and lid, a rice strainer to catch stray swarf on the return to the reservoir, and some bin liners, I set to, and an hour later it was working. By the way, the bin liners, 6 in all, are placed in the bin inside each other, and then the inner one is filled with coolant. I hate the sludge that builds up, so when I detect some, in my experience every 6 months or so, the plan is to make some small holes in the inner liner and allow the coolant to drain through, but keeping the sludge inside. The inner liner is then disposed of safely, and one has fresh, sludge free coolant for 2 or 3 years! Unfortunately, I went 1p over budget.

With the Super 7, I decided that something more permanent and professional was needed, so some 10mm copper piping and fittings have been purchased, and luckily Harry's scrap box has provided an impellor which matches nicely with a ½hp sealed motor I have tucked away under the bench. The plan is that all the wiring for the coolant system, inverter, and power cross feed will be mounted in the stand to the left and right of the drawer unit, complete with the inverter itself and the power supply and controller for the power feed. It will also house a small fan to draw cool air through as a precaution to overheating. The various switches will be in a custom, panel mounted box, just to the left of the drawer in a convenient position, with everything being at hand.

Stripping down

The date at Myford was fast approaching, and I had previously lifted the lathe from the stand using the engine hoist, so I stripped down the rest of the lathe, removing the motor, headstock, and gearbox, cleaning the bed and saddle ready for the trip. Surprisingly, this only



Photo 11 One of the ceramic tips used to mill hardened beds.



Photo 12 Milling the front shears.



Photo 13 The first pass left some marks in the bed.



Photo 14 The second pass cleaned the bed up completely.



Photo 15 Setting up the bed to surface grind the top faces.

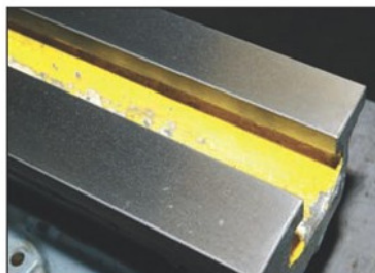


Photo 16 The ground bed, a few small marks are still left.



Photo 17 Testing the bed after grinding.



Photo 18 Grinding the underside of the shears.

took an hour or so, but during this time I managed to damage the large countershaft pulley. Whilst using the pulley extractor I put too much pressure on it and a large lump detached itself in two pieces from the casting. More repair work!

The evening before the trip to Myford, I put everything into the boot of the car. I did not fancy lifting the bed early in the morning prior to a two hour journey to Beeston, Nottingham. However, the weight of the bed casting was just about manageable for the 10 yard trip from the garage to the boot of the car. The saddle, apron, and rack followed in a box.

The following morning, after a bacon butty and tea courtesy of the local cafe, Harry and I were on the road. The trip was uneventful, except for the rush hour traffic on the A52 into Nottingham. The directions I had copied from the Myford website were faultless.

A day at Myford

Arriving shortly after 9am, we were greeted by Malcolm Townsend, the Sales Manager. The introductions having been made, and with the itinerary set, we looked around the sales room at the new and second user machines, all in immaculate condition, whilst Malcolm went to find Chris Musson. The showroom is a testament to the longevity of Myford with lathes from the 1940's on show, as well as examples from the current range.

The plan was for Chris to complete the regrounding of the lathe bed and saddle, and then, time permitting that day, for us to move into the care of Darren Boden for the refitting and setting up part of the exercise. The condition of the bed and saddle would dictate the amount of time needed, so, if we ran out of time we would return the following day to complete things. As things turned out we managed

to complete everything in one day due completely to the efforts of Chris and Darren, and we left shortly after 5.30pm.

The workshops

After being introduced to Chris, we unloaded the various parts onto a trolley and made our way into the main workshops. Myford manufacture a range of cylindrical and surface grinders, as well as the lathes we know and love. Part machined and bare castings from lathes were in evidence, as well as the other machines, all neatly stored in trolleys ready to move to the next process in line.

The first job was to visually inspect the parts for damage or for any excessive wear, which would prevent the regrind from taking place. Firstly, the saddle was checked to ensure that enough of the oilway on the underside is present so that after grinding, the oilway is still able to carry oil. I was nervous about this part knowing that the saddle appeared to have borne the brunt of the wear in my lathe. Had there not been enough depth, this would have been a "show stopper", and a new saddle would have been required. Luckily, it passed this test. However, with the saddle having excessive wear on the cross slide bearing surface, Chris decided to send it to another machinist for the top to be relief milled. This was done in parallel with the bed regrind to save time.

Milling the bed

Measurements were taken on the bed to ensure that the shears met the minimum size requirements - some lathes have been reground more than once, and given the age of my lathe (over 50 years old) it was worth checking. A further visual inspection took place to assess the condition of the bed to see if there were nicks and warps that need to be removed. The feet were

then emery papered to ensure that any loose grit and dirt was removed, and the bed was then placed in the jig on the large horizontal Archdale mill, **photo 10** to enable the sides of the shears to be milled. If you carefully look at the picture, you can see the marks on the side of the mill bed that show the approximate position for the jig clamps for the differing types of machine and bed lengths. The bed was then "clocked" into position, checked, and the clamps locked. Something that I missed, which Harry pointed out to me later on was that Chris cleaned the magnetic base of the DTI with fine emery paper prior to use to ensure a clean and even surface prior to use. Note to self: Do this in my workshop at home, and pay attention during demonstrations!

Ceramic indexable tips are used, **photo 11** when milling hardened beds, and carbide tips for standard beds. The milling takes place in 2 phases. First the front faces of both shears are milled, **photo 12** and once clean, the tips are moved to the alternative positions on the cutting head, and then the rear faces are completed. The mill runs at 326 rpm, with a feed rate of 4.85in. per minute.

On my bed, the first pass removed 2.5 thou, and some marks were still visible on the side of the front shear, **photo 13** so a further 2.5 thou pass was made to remove them, **photo 14**. Each pass took approximately 7 minutes. In total, this part of the process took about 45 minutes.

Surface grinding

After a welcome cup of tea, we moved over to the grinding and fitting shop for the tops of the shears to be ground on the huge Snow surface grinder. This machine has a capacity of 31 ft by 13in. in a single pass. It certainly seemed overkill for this small lathe but ensured rigidity in the grinding



Photo 19 The saddle is set up in a special jig for grinding true.



Photo 20 Grinding the underside of the saddle.



Photo 21 Testing the saddle with marking blue.

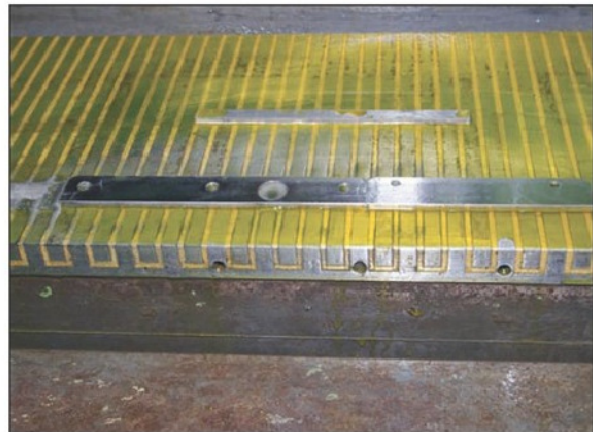


Photo 22 Grinding the saddle strips.



Photo 23 The strips with the steps ground in.



Photo 24 The "fast" edge on the saddle after scraping.

process! As is usual in industry, the first job of the day was to dress the grinding wheel. The machine had been running for a while to enable it to come up to operating temperature, something I always forget when using my own surface grinder, but then I am not working to the same accuracy. The bed was then placed on the grinder and set square to a known reference, in this case the magnetic chuck edges, **photo 15** and the magnets were engaged.

Grinding took place in 3 passes, two of 2 thou each and a finishing pass of 0.5 thou. Rather than attempting to remove all the bed blemishes, the aim is to provide a clean and flat surface along the length of

the bed. Some persistent blemishes were still in evidence near the tailstock end of the bed, **photo 16** but would have required a lot more to be taken off to remove them. To be honest they do not affect performance, they add a small amount of character, and they will be hidden most of the time under the tailstock! Chris did mention that because the bed I have is an early version it has no cast holes to allow swarf through to the drip tray. More modern beds have this feature cast in, and Myford use an additional clamp in the centre of the bed when these are being reground. The centre clamp provides additional pressure to provide a 0.5 thou

"dip" in the bed, and is measured as per **photo 17**. Once grinding has been completed, the clamps are released and the bed springs back to its normal position, which is very slightly convex. This helps to maintain the lathe accuracy when using these more modern beds.

The slideway grinder

The last port of call for the morning was the Churchill slideway grinder, **photo 18**. This machine was used to grind the lower surface of the shears to enable an even bearing surface on the saddle strips. Luckily, the shears on my lathe had a starting thickness in excess of the



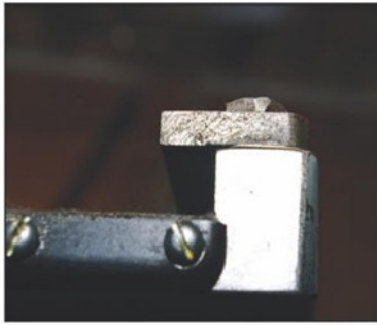


Photo 25 A saddle strip clamped to the saddle with the shim in place.

nominal 0.500in. so after being surface ground on the top, and relieved on the bottom by the Churchill, they finished up at 0.495in. for the front, and 0.494in. for the rear, leaving plenty of scope for another regrind long after I have passed away! The one thou difference in thickness is not crucial because the saddle is independently shimmed front and back to provide clearance.

The saddle

For lunch, we departed to the local hostelry. We did invite Chris, but he had other commitments. So, after an extended wait for our food in the friendly, but empty, pub we made our way back the 50 yards to the factory. Chris was setting up the saddle on the jig ready for the bottom surface and inner sides to be ground, **photo 19**. The inner side surfaces or "fast" edges are the ones that meet with the rear part of the shears on the bed. For a non power cross feed machine the "fast" edge is on the rear of the front shear, and for a power cross feed machine, it is the rear edge of the rear shear.

The jig ensures that once ground, the saddle sits squarely and flat to the ground bed, with an even grind over the oil ways. Further, it ensures the cross slide ways are perpendicular to the bed. Given that this saddle had some considerable wear, the first task was to flatten the bottom surface to see how much of the oil ways would be left. After taking off 7 thou, an even and flat surface was obtained. A skim along the front edge follows to clean up the surface.

The rocking motion evident in a worn saddle is usually because the "fast" edge is worn. This was certainly the case in my lathe, with 7 thou needing to be removed to obtain a flat surface. As you will remember, this is the edge on the rear of the front shear for a non power cross feed machine. Had it needed substantially more removing, the surfaces on the bed and saddle would not have met. All would not have been lost though. The rear edge is also ground, in my case 3 thou was removed, **photo 20** and this would have become the "fast" edge. This is only possible with non power cross feed machines though.

Fitting the saddle

After grinding, the saddle is cleaned and dried, blued up, and laid carefully on the freshly ground bed. It is then moved along the bed, and then carefully removed. Any tightness of movement along the bed is removed by scraping during the fitting stage. **Photo 21** shows

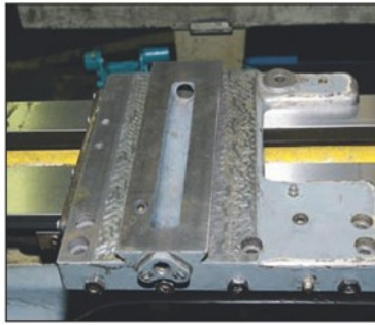


Photo 26 The saddle scraped for reassembly. Note the relief at the front.

the results, with an even removal of blue on the saddle. The oil ways can clearly be seen, much to my relief!

On to the last grinding process – the saddle strips. These are required to be flat, and need careful handling because of the thin section. Chris spent several minutes carefully tapping them whilst they were laid on a flat surface, cajoling them to bend flat. The principle is much like a tuning fork. When the strip is not totally flat a ringing can be heard when tapping, and when flat, it is like a dull thud. This process prevents them from having an unevenly ground surface, and from "springing" when the magnetic chuck clamp is removed. They are set up on the grinder, **photo 22** parallel to a known surface (the magnetic chuck edge), and have a cleaning skim along the top surface. A 10 thou step is then ground in them to enable shimming of the saddle. **Photo 23** shows the freshly ground strips with the steps in place.

After another welcome break for tea, we were introduced to Darren Boden, one of the fitters. Darren was to take us through the process of remounting and aligning the saddle including the all important shimming.

The lathe bed is firstly mounted on a known flat surface, and visually checked. Grinding and milling can raise small edges on the bevelled area around the

top of the bed. These are carefully flattened with a file, and the even bevel restored. Next, the "fast" edge on the saddle is scraped, **photo 24** to provide a bearing surface, and help retain oil during movement. The bed is oiled, and the saddle trial fitted and slid along the full length of the bed to test for tight spots. None were found, so far so good!

After fitting new gib strip adjusting screws (mine were worn), the gib strip is fitted to the front of the saddle, and adjusted with the saddle at the "gap" end of the bed. This consists of tightening the screw evenly until they are just nipped, then backing off approx 1/4th of a turn, and locking the nut. The saddle is then slid along the bed to check for tight spots across the width of the bed, and once again was a perfect fit.

Shimming the saddle

Now on to the "fun" part. The grinding of the underside of the shears should provide a thickness which is accurate to 0.5 thou over the length of the bed. With the saddle strips and shims fitted to the saddle, the aim is to produce a sliding motion with no tight spots or play. The 10 thou rebate on the saddle strip allows for a shim, the thickness of which can be approximated by adding the amount ground from the saddle (7 thou), and the difference between the nominal shear thickness (0.500in.) and the actual thickness (0.494in.) which is 6 thou. So, a total of 13 thou of shim is required. Myford use laminated shims, which can be peeled to the required thickness. Our shims were peeled to 14 thou – it is easier to peel more off rather than stick it back on!

Photo 25 shows a saddle strip clamped to the saddle, with one of the shims in place. The shadow of the edge of the 10 thou step is just to the left of the vertical face on the saddle. It can be seen that the thickness of the shim raises the bearing surface of the strip and allows adjustment. The strips are mounted, and the clearance tested with a feeler gauge, before attempting to

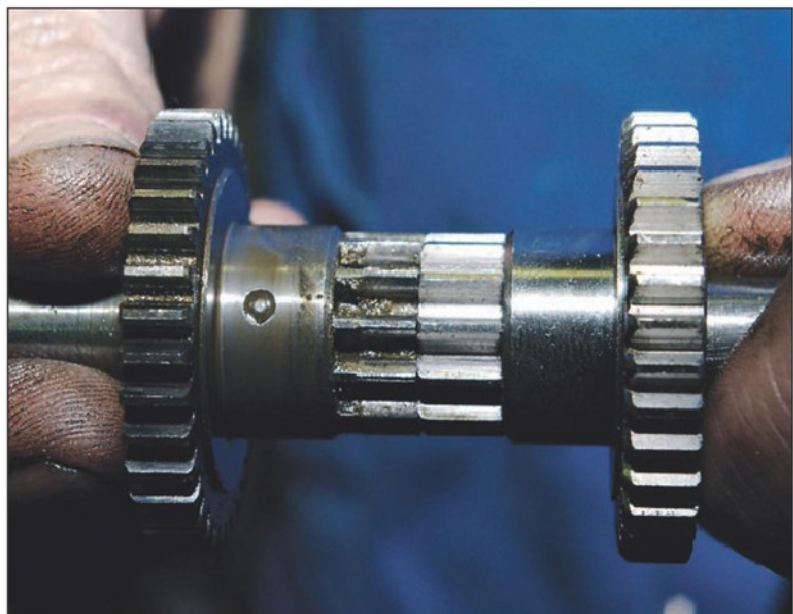


Photo 27 The old handwheel pinion has a lot of wear.

move the saddle. This prevents scraping of the surface if the shims were too small. The saddle was then moved along the bed where a tight spot was found near the tailstock. This was removed by wrapping a file in emery paper, and carefully rubbing the underside of the bed shear, cleaning, and then retesting. The saddle then moved like silk with no trace of play!

The felt wipers were adjusted and clamped in place, and the saddle moved along the bed to check for even oil distribution. Earlier in this article, I mentioned that the saddle was relief milled on the top surface to remove a step worn over the years by the cross slide, this can be seen in **photo 26**. Darren then demonstrated the art of scraping to provide a clean oil bearing surface for the cross slide, and the trademark Myford pattern can also be clearly seen. The carbide tipped scrapers in use are very expensive, but having seen the art demonstrated I now want to have a go myself.

Rack and pinion

We were on the home straight now, with only the apron and rack needing to be fitted and adjusted. The rack was cleaned and fitted, and the bolts lightly nipped in place. The apron was then checked. I had some concerns over wear in the hand wheel pinion as in comparison to a new pinion, the wear is substantial as you can see in **photo 27**. This was replaced, and the apron fitted in place. Meshing between the pinion and rack was adjusted until the play was minimised, and then the bolts on the rack were finally tightened.

Headstock and tailstock alignment

The painting of the inside of the shears in Myford yellow was the only job remaining. Whilst this was being done, I asked Darren about the alignment of the headstock and tailstock. He took the time to demonstrate this to us, and in essence it is quite simple if you have a 6 or 8in. test bar with a 2 Morse taper end to fit in either the headstock or the tailstock. With the bed mounted on a flat surface and free of tension (unclamped from raising blocks or stand etc.), the test bar is mounted in the headstock mandrel. A DTI is used to check that the end of the test bar does not point down towards the bed, but in fact is parallel to it, or, points slightly upwards by a maximum of 2 thou over 12in. or pro rata for the length of test bar in use. Further, the test bar should not point towards the back of the bed, but be parallel to the centre of the mandrel, or point towards the front of the lathe by a maximum of 2 thou over 12in. This test can also be applied to the tailstock, where it should, at worst, point upwards and towards the front of the lathe again by 2 thou over 12in., but ideally it should be parallel in both axes.

Myford records

The final part of the day was spent looking at the Myford log books in the old foreman's office above the workshop, confirming the information regarding the original manufacturing date and customer information. Myford have records of all lathes manufactured, and this confirmed that this lathe was shipped as a 3 phase lathe, on the stand, with 3 & 4 jaw chucks and the gearbox it currently

has, so all the original parts except the 4 jaw-chuck and 3 phase motor were in my possession. I know who has the motor (Ron), and I might well collect that for posterity, even though I won't use it with my inverter drive.

After collecting some Vactra No 2 oil for the headstock and some Myford paint to enable me to re-spray the lathe once I got it home, we loaded the lathe back into the car sometime after 5.25 pm.

Thanks to the dedication of Darren who stayed after 5, the normal finishing time at Myford, to complete the project, it saved us another trip the following day. I am thankful to Myford and the staff for all their efforts in enabling a two day job to be turned around in one day. Chris and Darren, you are stars!

In hindsight, it was the right decision to go to Myford, and no, they weren't too expensive, in fact they were the cheapest, by a long way! They have the right tools, certainly the right people - Malcolm, Chris and Darren are "man and boy" employees, all having served apprenticeships there. They also have the commitment to service, and they stand by their products.

Next time, I will cover the re-painting and rebuilding of the lathe and setting up the headstock and tailstock, the saga of the countershaft pulley, the top slide regrinding, and hopefully I will end up with a working Super 7 with power cross feed, coolant system, and light.

Comments and criticisms are welcome

I can be contacted at richmond@richmondrd.karoo.co.uk



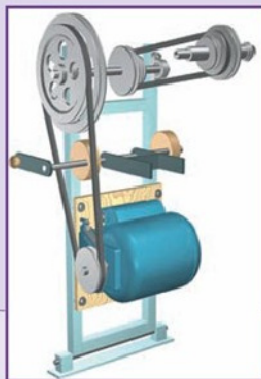
IN OUR NEXT ISSUE

Coming up in Issue 138 will be



A spin on collets
Jim Whetren modifies a spin indexer

Adding a drive to the older lathe
Linton Wedlock shows us how



New CNC milling series
No previous knowledge required

ISSUE ON SALE 18 APRIL 2008

(Contents may be subject to change)

Scribe a Line

Please send your letters to Scribe A Line (or Readers' Tips), The Editor Model Engineers' Workshop, Magicalia Publishing Ltd., Berwick House, 8-10 Knoll Rise, Orpington, Kent, BR6 0EL or e-mail to david.clark@magicalia.com and you will have the chance to win a book. Please remember to include your name and address with the letter and also in the email. I normally answer letters where necessary but a lot just get put in a letter tray (after reading them) ready to insert in Scribe A Line so please be patient. Emails are normally answered very quickly although please allow at least 12 hours for reply. I have a copy of a book from the Workshop Practice range to give to the writer of the best letter (the editors decision is final) and also another book for the best readers' tip in each issue. If you would like to purchase a copy of any book in the Workshop Practice series, please e-mail customer.services@magicalia.com for prices or visit www.myhobbystore.com to order online. Anthony Parker receives some motorbike books for his 'helpful' email (see Ed's Bench) and Steve Foster receives one for his excellent tip on cutter storage.

Unidentified lathe 1

It looks like I get to return the favour. A couple of years ago I emailed MEW asking about my lathe which had been homebuilt by someone else (it turned out to be a JJ Neave design) and now I can say with some confidence that Mick Morrith's lathe as pictured is a Sphere.

My Father has one that is identical in colouring and construction. They were made under licence during and after WW11 and are copies of the American Atlas Lathe (possibly 6"). www.lathes.co.uk have got some information on the Atlas, Sphere and Halifax although the pictures of the sphere were my dad's which we emailed Tony Griffiths, the sites owner.

The drive gears for the leadscrew are diecast as are the cross feed (which are bevel) and are prone to breaking teeth if pushed too hard. The Headstock has Timken taper head bearings which work well and although the pulleys are bakelite, they transmit the 1/2HP from the motor to the headstock without any problems or failures (so far).

Its good to have something from MEW each month now, long gaps were a bit frustrating.

Keith Quiney by email

Unidentified lathe 2

In response to Mick Morrith's letter in this month's MEW, his lathe looks very like a fairly late Atlas or one of the clones such as Sphere or Halifax and Acorn tools.

If it is an Atlas or a clone, there are manuals and parts lists available from Tony Griffiths whose web site www.lathes.co.uk/ is a mine of information about these and many other machine tools.

Spares are still manufactured and can be obtained from M J Kurn of 16 Mansfield Place, Ascot, SL5 8ND, who used to be involved with Acorn tools. Another place to obtain parts is www.latheparts.co.uk/ that makes a range of parts such as T-slotted cross slides for the Atlas as well as for other makes such as South Bend and Raglan.

There is a very active Atlas lathe group at http://groups.yahoo.com/group/atlas_craftsman/ which as the machine is American tends to be USA biased. There are lots of ideas on

maintaining and improving these lathes. Atlas bits and lathes do turn up on eBay from time to time.

John Harris by email

The Editor replies:

Several letters have included Mr Kurns details but I have also been told that having just retired, he is currently on a world tour.

Unidentified lathe 3 and editorial errors

David, Excellent work with MEW, please keep up articles about anything technical, it is always amazing how odd subjects can be applied to different fields, particularly for readers, (since No1), like me who don't do much modelling but do rebuild/restore vintage and veteran vehicles, and who are not professional mechanical engineers.

To get to the main point of this e-mail, please tell Mick Morrith that his lathe is a Halifax, a British clone of the US Atlas 10 inch, 5inch to us. Superb details can be found by referring to Tony Griffith's web site Lathes.co.uk. The manufacturers, Acorn Tools, were once situated in Edgware, but I last heard they had moved to outside London supplying Atlas spares still. I think the reference to them was in Model Engineer, so someone may know if they still exist.

I look forward to the next issue, now only a month away. Oh, and page 57 of the March issue seems to have a couple of disjointed Editor's comments, isn't it always the same, there is always something you miss even after reading everything umpteen times!

Keith Patchett, Editor,
Jowett Jupiter Owner's Club Magazine.

The editor replies:

There was a last minute change to Scribe a Line in issue 36 due to a photo being missed while the page was laid out. The easy way out was to remove the letter with the photo and substitute another. Unfortunately an irrelevant sentence was left in. I do read the magazine umpteen (at least 5) times but still miss the odd mistake. I usually spot one or two little errors when I read the finished magazine.

Unidentified lathe 4

The lathe bears a close resemblance to my Atlas, a WWII lend lease machine from Atlas Press Co Kalamazoo Michigan. It was copied in the UK as Acorn, Sphere, Halifax and also Craftsman.

I have some info sheets and would be happy to exchange emails with Mick if he wants help but also Google Acorn lathe Also Google Atlas lathe but that gets mainly US sites but more hits.

Keep up the good work

Bob Dodds by email

Unidentified lathe 5

The lathe shown in the photographs from Mick Morrith appears to be an English market version of the "Atlas" lathe built by the Atlas Press Company in Kalamazoo, USA. There were three English versions, namely "Halifax", "Acorn tools" and "Sphere". From the documentation that I have, I suspect it is a "Sphere", though this should be established before ordering spare parts. Some spare parts are still available from a company in the USA www.clausing-industrial.com. Parts are also available on Ebay, although to date I've not had cause to use either service.

Kevin Wiggett by email

Unidentified lathe 6

I just received my March copy of MEW, issue 136. It's an excellent publication, which I enjoy very much; and have taken since issue # 2.

I was at the Ascot show to meet Ivan Law, as I am making a copy of his differential dividing head, and he had mentioned to me that the original would be there and this gave me a chance to see it up close. (It was almost finished except for painting and change gears.) I was racking my brain to remember if I met you there. Ivan introduced me to so many people.

I'm sending this missive to help Mick Morrith identify his mystery lathe which is some sort of derivative of an American Atlas. Thousands were exported to the UK during the last war under the Acorn name. I have seen spares advertised in Model Engineer, but as I do not take this publication I cannot vouch if they still appear.

Also spares are available from Clausing in Goshen Indiana USA. I am

willing to assist Mick if he has any questions. I'm familiar with the variant as I have one myself as a second lathe modified for automatic thread pickup like Martin Cleeve's Myford.

John Whalley by email

Unidentified lathe 7

The lathe Mick has is a copy of an American ATLAS 10f which was shipped over during the war as lease/lend. I also have a lathe the same as Mick's which I know as a Halifax because I saw it an advert in a 1950's Model Engineer. I also have an ATLAS 10f and the only difference I can see between the two apart from the Bakelite covering on the Halifax is that you can't put any bigger than a 6in. face plate on the Halifax as any bigger will foul the back gear lever.

John Smith - Erith Kent by email

Unidentified lathe 8

Re the unknown lathe on page 55 of MEW no.136. It is an "ACORN". Most of the parts on the one I had were of Mazak. The bed was of good quality cast iron and although it was fairly lightly constructed it served me quite well for a few years. I was able to get a hand book for it from the manufacturers but that was about 30 years ago. When I got an old Colchester Master I swapped the Acorn for a little milling machine.

Jeff Tanner by email

Old machinery

The Scribe a Line letter from Alan Marshall reflects my thoughts about your magazine contents. Several articles over the past few issues have contained some very excellent articles on machine tool practice and such subjects as the Outrunner electric motors. I have had a mechanical workshop most of my life and have collected and disposed of many machine tools. My first lathe was an early Myford ML4 and I have now expanded to a Raglan.

The many years of experience has shown that many of these machine tools, often dating from pre-war, (1939) have such a quality of robustness that makes them a wise investment even today. A dirty Raglan or similar appears on Ebay or the local scrap market for a few hundred pounds. Once brought back to life, as your adverts show, they fetch over a thousand pounds and will appreciate more over time.

A sturdy 5 inch lathe is a joy to use and not unduly large, they can tackle bigger jobs with ease. With sleeves in the headstock, 3MT, I drill holes at 1inch diameter with ease. However, I write to invite you and others to include articles on the older British made tools to stimulate an interest before all are melted down for scrap.

One has to beware of some faults which time has revealed over the years, in particular the variable speed drives of the Raglan type, but whilst many scrap or other merchants will write the machines off for scrap, the machines generally are repairable, at the same time such broken machines can be bought for very little. The Raglan has replaceable slides which can be removed and reground. These and other details would provide a wealth of articles from your readers in particular

how to go about repairing or replacing the variable drive on my machine.

Don Jones - Aberdovey

The Editor replies:

I have an article on rebuilding old machines to publish shortly and more articles on the way. See also the Myford rebuild in this issue and part two in the next issue.

Backwoods Three Phase MEW No. 135 February 2008

Hector Vos (Pretoria SA) is worried about using capacitors to simulate three phase. Why? After all, that is exactly what a static converter is.

The patterning he gets could well be from the vibration of the single phase motor. Most people seem to believe that a single phase induction motor is smooth, but it is far from smooth. For smoothness you need at least a three phase motor. However, running it from a static converter will not necessarily give you perfect smoothness, as achieving a perfectly balanced three phase supply this way is well nigh impossible.

If his lathe is not fitted with a clutch then he would be well advised to steer clear of a static converter - or capacitors - unless he fits a large pilot motor to continuously generate the third phase. That will increase the cost.

Inverters have lots of advantages, not just speed control, as you get a balanced three phase supply - and they are not necessarily expensive, either. Have a look on eBay. Pre-owned ones can be picked up for not a lot of money. In terms of costs the latest 240V single phase in, 415V 3-phase out, inverters compare favourably with new static converters and cost a lot less than rotary converters. Also you can use the inverter's speed control to shift the spindle speed slightly to overcome chatter - a very useful feature.

The patterning could also be due to

problems with the gears and/or the spindle bearings, but recent experience with replacing a static converter with an inverter on an 'eastern origin' lathe would indicate that it's motor vibration that causes the problem.

Dick Ganderton by email

Velcro

I have a 300mm disc sander which I use as a finisher. The abrasives have to be stuck on with contact adhesive, and I would like to change to Velcro backed discs. I can obtain the Velcro backed abrasives, but so far I have been unable to obtain the hook side of the Velcro, preferably with self adhesive backing, that I can stick on to my disc. Does anyone know where I can obtain such material?

I am about to have cast a set of aluminium castings for the Atkinson Differential Engine as described in Vincent Gingery's book. There are a total of 9 castings including the flywheel. Would anybody else like a set at £95 plus p & p? Note, this is not a commercial venture, just a way for me to keep the price down.

Some while ago I read an article on using a computer to display the readout from digital scales. Can anyone let me know the month and year? I have looked through my back issues, but I can't find it. Lastly, I believe there was a computer list of back articles. Can you advise if this is still available, and if it is, could it be mentioned in future issues? I like the changes you have made to MEW. Keep up the good work.

Richard Masters by email

The Editor replies:

You can find an index for MEW at www.colinusher.info

CNC milling

First, thanks for a great magazine; it's always fun to get a new issue in the mailbox. I am looking forward to this

Single cut files

In issue 131, Shelly Curtis asks about a source for single cut files. I can't help there, but while trying to find a better way to file brass, I did discover something that may be of interest.

Nicholson make a file called a 'Magicut'. As can be seen from the picture attached it is nearly a single cut file, but has some strange notches in it. I've used mine on brass and plastic and while it removes material at a bastard file rate, the finish is similar to what I can get from a smooth file. I can only guess that the notches act as some form of chip breaker, while the lack of second cutting stops pins forming.

At the moment there are only two sizes (10" and 12" if I remember rightly) available and only in the flat form, but I think that most ME's will find one of these useful regardless. According to the packet the file seems to be suitable to use on most materials. All I can suggest is buy and try.

Michael Green - Adelaide, South Australia by email

The Editor replies:

A quick internet search revealed the 'Magicut' is readily available. I also spotted an 8in. version.



springs CNC articles!

You wanted ideas for CNC articles as well. The thing I have most problems with after almost a year in this side of the hobby is the machining strategy. I can draw parts easily in cad but then figuring out how to machine them is the really hard part. Since most readers probably have simple 3 axis machines, maybe an article or several on how to machine some example parts would be nice. Questions like: How do I 'best' machine this part? After changing the part around, how do I find zero again? What does 'this' (CNC-lingo) word mean? Etc. Probably just a CNC for dummies.

Björn Wallentinus - Stockholm, by email

CNC milling 2

I have just read Editors Bench MEW 134 (we are a month slow here in Canada) and was as pleased as punch to hear about your upcoming series of articles on CNC milling and MACH3. I am mainly interested in CNC machining (I have a mill, a lathe and a router) and this great news might just be enough incentive to subscribe as I currently just buy every issue at the newsagent. However, sometimes the agents seem to miss the odd issue here and there. (Why does that happen David?)

CNC is of such interest to me that I did 150hrs of formal training at a local trade's school in night classes as well as another 50 hours in AUTOCAD which I sometimes use for draughting up simple parts. CNC is becoming so affordable and the software so powerful that it surely is to become a much larger part of home workshops on many levels. To this end MEW is taking an important step forward and potentially opening up a whole new category of readers especially among the younger end of this market as they are often lured in a hobby by nifty gee whiz technology!

Keep up the great work David, MEW looks great and while always a great read, will be so much more with a new focus on CNC technology. A regular column would surely be appreciated. Who knows maybe even I will put pen to paper and try my hand at being the author of an article in this arena!

Gerald Hynes - Winnipeg Canada by email

The Editor replies:

Mew availability - When I used to try to buy some of the US magazines in a Borders bookshop, I had the same problem. I asked the staff about availability and they said that they only got what was leftover from the US sales. Perhaps a similar thing is happening in the states and Canada. The best way to ensure a copy is to subscribe.

Dormer Drill Grinder model 108, Scribe a Line MEW issue No 134

The gauge required is simply 1/4 scale i.e. a 1in. drill requires 1/4in. projections + the amount to be ground off the drill. Also, spares for these grinders i.e. chuck jaws, grinding wheels & most other bits are available from MICRON SERVICES LTD

- Tel no: 01327 704921 to contact CLIFF HUGHES (a most helpful gentleman).
John Griffiths - North Yorks by email

Unimat toothed drive

The following is in response to the comment in Issue 136 Scribe a Line. Michael Gilligan's comment and source of information for a more efficient tooth profile, was most welcome and his theory is probably more correct than my own. However the intention of the article was to provide an alternative simply constructed reliable drive, using a more robust belt. Whether there is a slight rise in noise level is difficult to decide and was mentioned only as a possibility. Lacking the set-up of the two drive systems, the comparison of noise levels is difficult to decide, but would suspect that if there is a difference, then this would be slightly greater using the toothed components.

Simplified rather than over-simplified, tooth profile is the term that I would use and as mentioned in the article, were based on the teeth of professionally manufactured wheels and have been found to be quite adequate for the purpose. Also, these results were found before the days of the availability of the internet source of such information.

My own Unimat has been using this system for many years now with no breakage and very little wear to its teeth. I have never had the opinion that a more elaborate tooth form would be of any further advantage.

Having reproduced the components, for the purpose of the article, they have now replaced those of the original.

Star Letter

Cutter storage

I have been trying to tidy my workshop up recently & decided to put into practice an idea I had a while back, but never acted on. I haven't seen anyone else doing this and have often wondered why they don't.

I'm always trying to find better ways to store my milling cutters that will protect them from being knocked around & possibly damaged; also a way to stop them collecting dust which always seems to promote rusting.

As a PC user, I often have empty CD-R & DVD-R canisters. Each of these canisters also contains a plastic separator disk in the bottom. The canisters & especially the separator disks often get used in my workshop - as storage containers or to make plastic washers from.

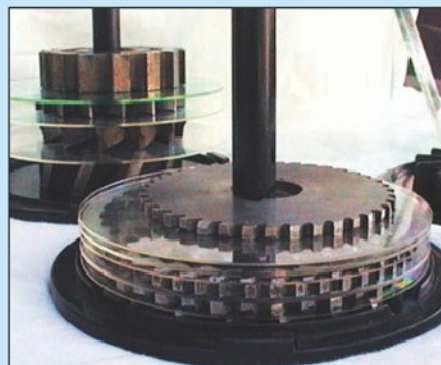
I recently implemented an idea to use the canisters & disks to store slotting saws & cutters. I just stack the thinner cutters, each one separated from the next by one of the plastic disks, on the central spindle that originally held the disks. For larger cutters, I just place them, on their own, in a smaller capacity canister. Now my cutters stay safe & protected - in containers with lids.

By putting a disk of thick timber, MDF or similar in the bottom of a canister, then drilling holes (of appropriate sizes) in it, they could also be used as a stand for end mills or slot drills - the cutters standing upright - the lid acting as a cover when not being used. A small screw or two could be inserted through the base of the canister to stop the piece of timber moving. Perhaps as an alternative, the piece of timber/MDF could be simply glued into place with a good builder's glue or silicone. It would end up looking like a round drill stand, but with a lid.

Steve Foster (an avid antipodean's MEW reader)

Editors comment:

You could always use old CD's between cutters if you run out of the plastic disks.



There is also further information on making wheels in a fairly recent article by Dick Stephen, (Issue 110 of MEW).

Maurice Rhodes by email

Floating reamers

I have been reading the article in issue No. 136 about an adjustable boring bar and by some weird train of thought, I was reminded that I have in my possession seven, micrometer-adjustment, floating reamers and I wondered if you had come across such in your time in engineering.

These floating reamers were my late father's, purchased some time before 1952, and were made by Offen & Co. Ltd of South Nutfield, Surrey. Each reamer has two cutting jaws which are driven apart by a hardened steel cone of included angle 43.5 degrees, forming the end of a rod which is threaded at 40t.p.i. The other end is terminated by a graduated thimble with 100 divisions, so that one division corresponds to each cutting jaw moving out by a thou. (0.001in.). The jaws are retained by an anvil which can be tightened remotely by means of a small tommy-bar inserted into holes provided in a knurled locking ring. Without such tightening the jaws can fall out! They do not retract automatically. Each reamer is adjustable over a span of about 0.1in. The reamer body fits into a holder with a M2 taper and cut away to permit adjustment without removal from the tailstock. I find it hard to believe that the level of adjustment available could really have been necessary. Incidentally, I think they retailed at around £9 each.



I have no idea why these reamers were purchased, i.e., what job they were intended for, since my father at that time earned his living, with a partner, in the production of engineering prototypes. Strangely, this reamer assembly would have been used on a Myford lathe built in June 1943 (one of a batch of 500), which I still have it in my possession and which I still use from time to time. It predates the ML7! I would be most interested in your comments, and particularly intrigued to know if there is a modern equivalent.

Trevor Delchar by email

Wavy parallels and floating reamers

A couple of issues back, Harold Hall asked if anyone had experience of wavy parallels. I have a set which I use regularly, particularly on the milling machine. Not being a trained engineer, I have no experience of the solid variety, but economy dictated the purchase of the wavy type. I find they work very well and have the obvious advantage that they can support quite thin material - down to approximately 1/4 inch.

It is also possible to use a pair in different ways. They can be overlapped to give long narrow support, or they can be used back to back to give support to thicker sections. Of course they can be used in a more conventional way, further apart. Being of spring steel they can be squashed up a little in the vice, which can be useful. The only disadvantage I can see, although not a major one, is when tapping an item down onto the parallels, being springy they tend to twist around. In my ignorance, I am quite satisfied with them.

As far as items I would like to see covered in MEW, the following would be useful, an article on the best way to set adjustable reamers. I have a set, but I never seem to be able to get them really accurate. This may fit with the recent request from someone else for an article about reamers. The other article would be one on the best way to set up a new chuck and backplate, where it is necessary to provide a separate backplate from a casting. I am thinking of getting a four jaw self-centring chuck, but cannot get a ready made back plate to fit my lathe.

Ian Varty by email

The Editor replies:

I am not familiar with this particular make of reamer although 'Offen' rings a bell. I have used adjustable reamers with varying degrees of success but overall found them a poor substitute for a fixed diameter reamer. Perhaps readers could help with more information and methods of use.

If any one would like to write an article on adjustable reamers, how to set them and get the best from them, I would be willing to publish it. I intend to cover fitting a backplate in the 'Practical Engineer' series.

Steam engine on the cover

I cannot see anything wrong with a picture of any piece of machinery on

the cover of MEW; and if it is being driven or held by an attractive young blonde so much the better!

Comparing the covers of 134 and 135, I would imagine that casual readers are far more likely to go for the locomotive than the jig borer - even if they knew what the latter was - but do you really have enough casual readers to make the issue important. I buy every issue of the magazine and will continue to do so regardless of the picture on the cover and I think virtually all of your readers will do the same. Anyway, you have now intrigued me as I have no idea what a Darjeeling Himalaya is so I am quite looking forward to seeing it on the cover.

As to the contents of the magazine: yes, by all means have the occasional article on building something, be it a steam locomotive, a stationary engine or a clock, after all even the most ardent tool maker must produce something from the workshop from time to time, although I must admit that mine seems to be limited to household repairs and maintenance at present. I would, however, ask that if you do introduce constructional articles please limit them to two or three issues.

I also buy EIM and although I enjoy reading most of the articles, some of them can take an entire issue to describe how to position the rivets on the boiler backhead which is of little interest unless one is building the locomotive. Personally, I think that the present mix of articles is good, with very few that I do not read, and you also seem to have a good selection of competent authors - although I do wonder how Harold Hall ever has time to make anything - he must spend most of his life writing.

Please could I pass on two, slight, criticisms of the pictures? The articles would be much easier to read if the drawings particularly, and also the photographs were on the same page as the text referring to them instead of up to several pages away; in fact in the article about the Myford lathe being reconditioned in South Africa some were even in an earlier issue.

I feel that sometimes the photographs are too heavily clipped. For example that in issue 134, page 25 top right would be more meaningful if we could see the cross slide and bar, even at the cost of missing out Dave's hand. Surely the photo could simply be printed at a smaller scale; after all we don't need to read the gauge.

Overall I think you produce an excellent magazine and look forward to every issue. Any plans for making it fortnightly?

Paul Hogarth by email

The Editor replies:

I don't think MEW will ever be fortnightly. It makes sense to change to 13 issues a year to fit into the schedule between fortnightly Model Engineer issues. The Darjeeling Himalaya is a railway in India. I will probably put a photo of this loco on the cover of issue 138. I think any piece of interesting machinery is a good cover subject. The cover is very important and is the only part of the magazine that has to have

management approval. I don't know how many casual readers MEW has but the intention is to make as many people as possible, regular readers. Subscriptions and newsagent sales both at home and abroad are steadily rising; issue 135 broke all records having better sales than issue 133, the Christmas edition. David Piddington picked up the last copy on the shelf of MEW 136 in his local Smiths to read his article and it had only been on sale for about 5 days. Don't delay, subscribe today. You don't want to miss any issues in the future, do you?

Sand casting

I have been a regular reader of Model Engineers Workshop for some time and I must say that it is very informative and lots of useful information is readily gleaned from the many and varied articles.

Upon reading edition 135, the article by Dyson Watkins has caught my attention. Firstly I must make it quite clear that I am not a skilled foundry man, however in my school days I did a little aluminium casting and in the following years did a few simple alloy "blocks" in order to obtain a piece of metal large enough for the project in hand.

In the article Mr Watkins says that he used WATER to moisten the sand to the correct consistency to hold together, indeed he mentions the risk of explosion

May I question the safety implications of using water to hold the sand as I was taught that water and molten metal must not be brought together and I am lead to believe that commercial foundries use an oil as a binding agent, so surely the addition of a little extra oil would be a safer option?

Indeed when I was doing my very basic castings, I used oven dried silver sand bound with engine oil, which produced large volumes of smoke and left a very hard bunt surface inside the remnants of the mould but no explosion and some successful "lumps" were produced.

Please note that I am not trying to "have a go" for the sake of it but I do feel that there are serious safety implications and perhaps an article or short series explaining the do's and don'ts of basic foundry work would be a worthwhile topic. Hopefully other readers/contributors could supply any correct information.

Mr Raithby by email

Reply to comments on casting aluminium

An explanation of the 'greensand' moulding process was given in the article, and the information provided was correct, ref. the paragraph 'The moulding set up', page 34 issue 135. I decided to use this method for the purpose of the article, because if I had referred to the method of using 'Petrobond' or any other brand of oil tempered sand (which would be safer from the point of view of freedom from explosion due to the use of water), and then someone decided to try out builders sand mixed with water in an uncontrolled manner, e.g. as in making

a sand castle, there could be a problem.

Most school workshops, the ones where I used to teach included, used Petrobond, which although much more expensive, was safer. There was always the risk of a pupil doing something wrong, for whatever reason, and it was better to remove the hazard at the start from any practical session, although pupils were made aware of the inherent dangers of the process.

Petrobond is sometimes used where improved detail is required, but due to its expense, it is then surrounded by greensand. The greensand can be re-used time and again, but Petrobond does burn into a hardened mass which is mainly waste. The article was intended as a means of making a lathe steady, not as a complete description of the methods of making castings of which there are many more. The important thing to remember is that greensand moulding has been used since the Iron Age, long before oil was discovered. I hope this will remove any doubts.

Dyson Watkins by email

Soft centre replacement

I was just re-reading my issue of MEW no134, The Metal Workers Workshop 8, about live and dead centres. Generally I am too lazy to remove the chuck and fit the live centre to the spindle, I just take a piece of scrap round bar about 10mm dia, put it in the 3 jaw-chuck and turn a 60Deg. point on it. The tail of the driving dog engages with one of the chuck jaws, quick and easy and the centre runs dead true, this is also a good substitute for a soft live centre if one is not available!

Frank Hasieber by email

A taper turning trick

If you want to turn a taper between centres, you must adjust and readjust the tailstock. If you have a boring head, put it into the headstock and turn a centre for it. With the head in the tailstock, it's easy to adjust the centre with the help of the heads micrometer dial.

E. Normark Sorensen by email

Weight of round bar

I found on the internet, on the site of a firm selling steel reinforcing rods, a useful formula for calculating weight of

round steel bar per metre. It might be of use to other readers. I want to make some counterweights to run up and down a bar and need some method of calculating a 10kg weight.

The formula is $d^2 / 162$

I have some 110mm diameter steel bar available. I need to bore it out to 24 mm for sliding clearance. Ignoring 2 small sections of slightly larger bore to seat nylon bushing into (the job is not super critical regards weight) the calculation is simple (all figures rounded up).

$110 \times 110 / 162 = 74.7$ kg per metre
 $24 \times 24 / 162 = 3.6$ kg per metre

Bored bar = 71.1 kg per metre ($74.7 - 3.6$)
 $1000\text{mm} / 71.1 \text{ kg} = 14.1 \text{ mm / kg}$
 $10\text{kg} = 141\text{mm}$

If you have a small lathe, not capable of machining the required size in one go, if the job allows, simply make it in sections which total the required length and therefore the weight.

Mick Grant by email

Headstock cover modification – safety improvement

I refer to the letter from Mr Peter Titterton published in the March 2008 edition of MEW where he makes a very valid observation concerning my modification to my lathe headstock cover published in the January 2008 edition. My initial reaction was 'Oh here we go; nanny state raises it head yet again'. I have used many ideas from other enthusiasts published in MEW but have modified and adjusted those ideas to suit my own particular requirements and satisfaction and in doing so I have taken my own view as to the level of safety practices I carry out in my own workshop for my exclusive use.

If on the other hand, my workshop were for use by others as well, then as I would presumably be the 'legally responsible person', I would need to comply with adequate/improved safety requirements, risk assessment etc. I think the lesson learnt from Mr Titterton's observation is that, when as an enthusiast offering to share an idea through the model engineer media, it's important to take safety considerations a step further than one would usually in ones' own workshop, perhaps considering your idea as one that would be applied to a workshop in the public domain.

Such feedback as Mr Titterton provided is a great motivator and not to lose face, I decided to offer a solution. A lever inside the headstock operates a micro switch located inside the guard covering the screw cutting/feed gear train. This lever can easily be re-positioned and extended as shown in **photo 1**. This however reverses the operation of the lever, the spring action holding the lever down rather than up. The spring could be moved to lift the lever, though if the micro switch were to be left in its original position, it would need to be changed from a NO to a NC connection.



Photo 2



Photo 1

I decided to move the micro switch into a new position to retain the NO connection. **Photo 2** shows the micro switch and its small operating lever on the gear train side after modification with the micro switch cover removed for photo clarity only. (Sorry, my photo before modification came out unacceptably blurred).

One of the original micro switch fixing screw holes was used while the other had to be drilled and tapped M4. A new location for the spring holding screw was also drilled and tapped. The red shoe on the short lever was removed and fitted on the other side. Some slight modification to the gear train guard was made to prevent fouling the small lever.

The underside of the head stock cover is recessed. This recess needs to be filled in the location where the extended lever makes contact. This I did by fixing in place, with two M4 screws, a piece of aluminium 20 mm wide by 75 mm long. Gaps were filled with epoxy filler.

I hope this resolves any safety concerns regarding my headstock cover modification. Once I had decided on the course of action the additional work took about half an hour.

Of course while carrying out this modification it's important to isolate the machine from the electricity supply and refit all guards before reconnecting. While drilling for new screw positions protect the headstock gears from the ingress of swarf.

I do think that Model Engineering Press is a wonderful media for enthusiasts sharing ideas, this is the true spirit of the magazine and we owe gratitude to those who take the trouble to offer their experiences, expertise and ideas. This media only exists because of the continuing support from contributors, which is why I decided to make my humble small offering. I hope others are also encouraged to make offerings. Thinking beyond your own workshop environment will enhance your contribution to the magazine and hopefully improve safety of others.

Nigel Walton by email

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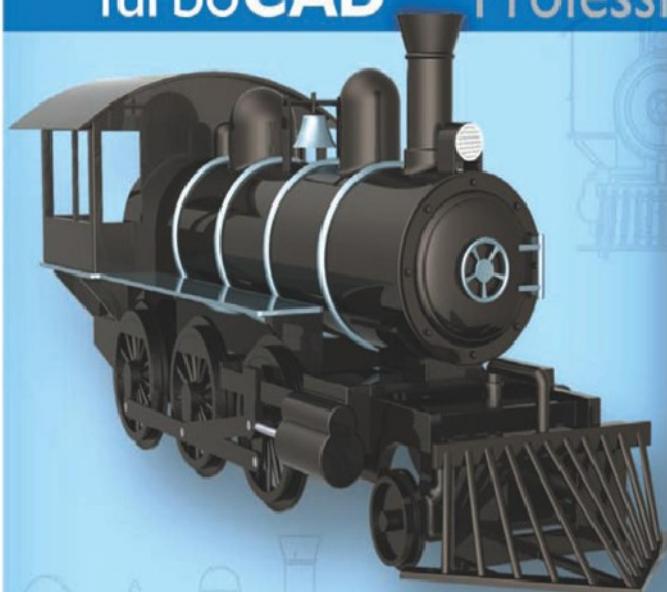
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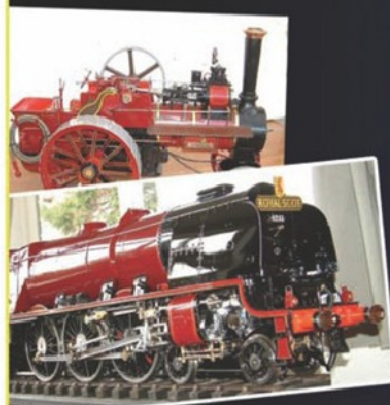
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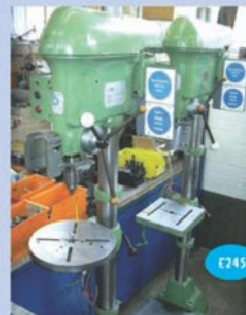
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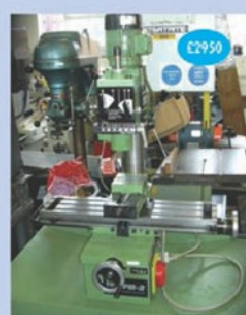
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