

No.130

OCTOBER 2007

MODEL ENGINEERS' WORKSHOP

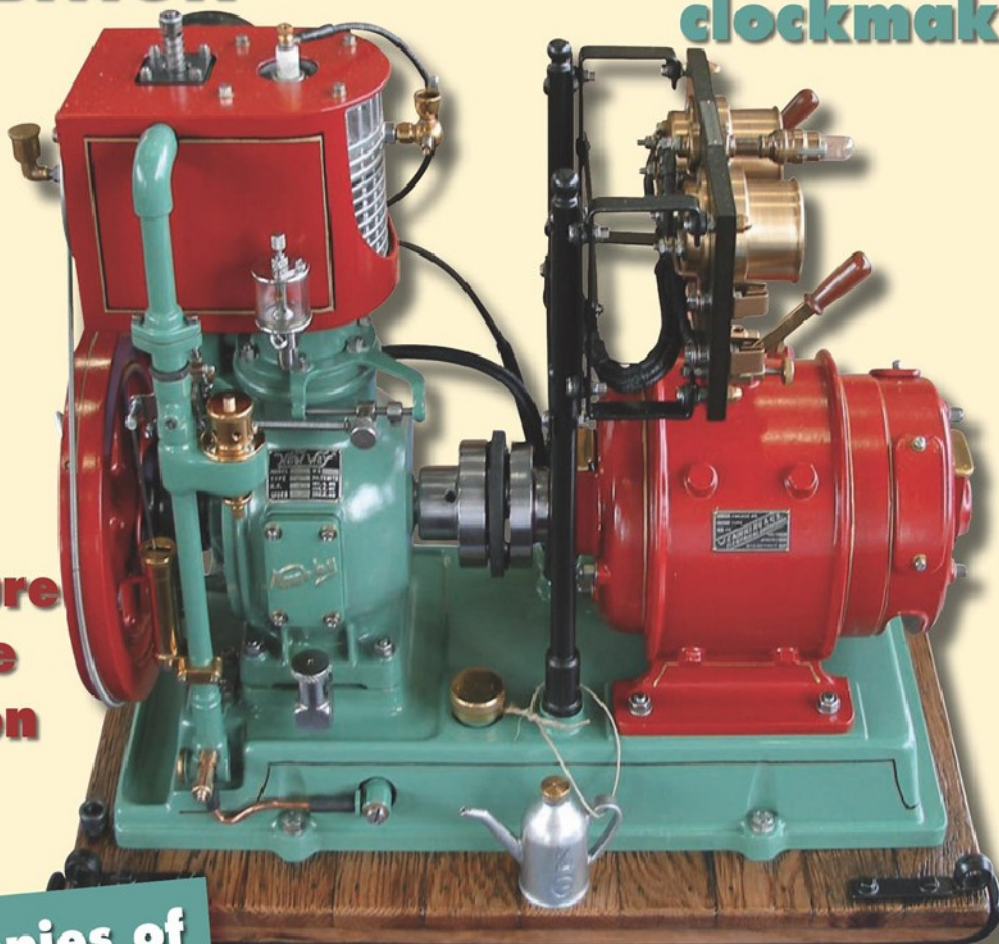
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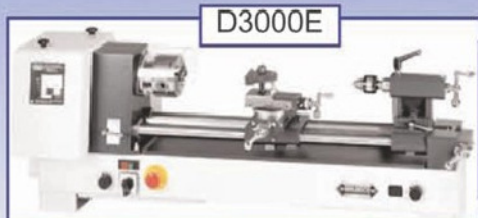
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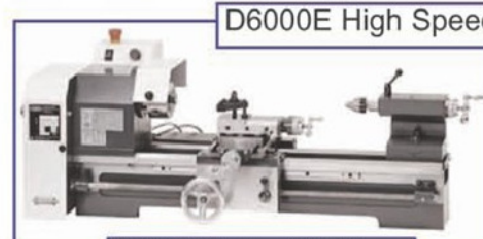
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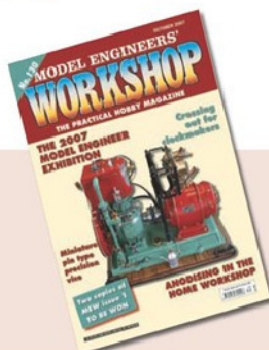
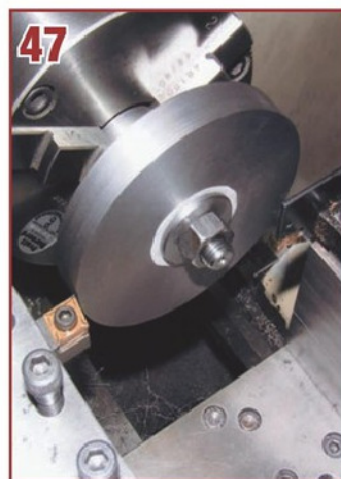
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On the Cover

This New-Way internal combustion engine with generator to approximately 1:10 scale was built by Johan Van Zanten from photographs of the prototype. No castings were used except for the flywheel. It was on display at the 2007 Model Engineer Exhibition.

See page 56 for our special subscription offer!

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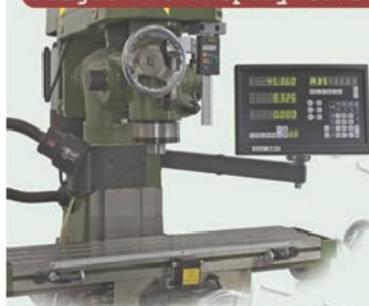
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Good Reading Useful Information

Myford



Myford Series 7 Manual • Bradley • £ 9.70

A welcome return of this book, which has been out of print for some time. The 'classic' book on the 'classic' model engineer's lathe - the '7' series from Myford, it covers the features of the various models, installation, and how to use the machine including, for example, milling, gear cutting, taper turning and repetition work, as well as everything to do with turning itself. Covers the ML7, ML7-R and Super 7 models. And, of course, a lot of the information here can be applied to any lathe. 232 pages, full of b&w photos, diagrams, formulae and charts. Paperback.



Tricks & Secrets of Old-Time Machinists • 1916 • £ 6.95

If you were on the shop floor of an engineers some ninety plus years ago, chances are your read AMERICAN MACHINIST MAGAZINE whenever you could get hold of a copy - it was THE magazine of choice. One of its most useful features were Hints and Tips provided by the readers, all experienced machinists, and this book is a selection of the bumper number that appeared in 1916 - around 150 of them, the vast majority illustrated. And they are GOOD! Don't let their age put you off as only a few are dated, most being as useful now as when they were written. Many of these articles deal with machines and parts larger than the norm for model engineers, but it is easier to scale down than scale up, and it is the underlying idea that counts. More useful ideas in one book than we have seen for years - and at a bargain price! 96 well illustrated pages. Paperback.



Gear Calculations Gear Cutting • 1921 • £ 6.95

This combines reprints of two International Correspondence Schools course books, the first (42 pages), and probably the more useful, describing the various types of gears, and how to calculate teeth, depths etc.; if not exhaustive, this is pretty comprehensive. The second book (48 pages) covers set-ups and methods of gear cutting - the methods are mainly commercial, but the set-ups have application in the model engineer's workshop. Good stuff. 47 illustrations, plus tables. Paperback.



How to Make Cutting-Shears for Sheet Metal • Hitchens • £ 6.95

In the Gingersy idiom, but with fewer words, this British book shows how to make a natty set of shears, largely from scrap material including, ideally, a truck leaf spring, for the blade. The tools you will need are an electric welder, a drilling machine and an angle grinder. A simple and useful project. 20 pages booklet, well illustrated with drawings and diagrams. Softcover.



Randolph's Shop • Bulgin • £30.45

This is a cracking good book, with great ideas and projects well explained, a lot of humour, and a lifetime's experience in engineering. Six of the fifteen chapters of this book are expanded versions of articles which appeared in *The Home Shop Machinist* or *Machinist's Workshop*, and cover such things as building a Variable Speed Vertical Bandsaw, Removing Broken Taps and Studs by Welding (this alone worth the cost of the book), Lifting Devices for the Small Shop, Repairing Worn or Damaged Shafts, Another Wife Pleaser(!) and Making Eggs. The author's experience is in small commercial workshops, and some of the projects are big - the bandsaw is floor-standing, but they can generally be scaled, and anyway there are so many useable hints, tips and suggestions here it hardly matters, plus you will chuckle much more reading this book than you will with any other engineering book we have come across; this is a pleasure just to read. 226 very well produced pages. Hardbound.



English and American Lathes • 1900 • Horner • £13.75

This was written, by a British author, at a time when American lathes were just beginning to be imported into the U.K., and was intended to provide an unbiased review of the different national practices. The text is excellent and there are 300 illustrations, the vast majority engravings, which really do show how English and American lathes differed. If you are interested in the development of lathes, this is a book you absolutely should have. 179 larger format paperback pages.

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Myford



MYFORD SERIES 7 MANUAL Ian Bradley

The latest re-issue of Ian Bradley's classic guide to using Myford's 7 series metalworking lathes in the home workshop. First published in 1973, the author subsequently revised the work to include the ML7, Super 7 and ML7-R lathes, so that the contents of the book are as valuable to readers who have the later types of lathe as well as those who possess the earlier machines. **£7.95 (D)**



REGULATOR CLOCK CONSTRUCTION

Peter Heimann

This book describes the construction of two different clock projects, an eight day regulator clock and a month going regulator clock, and features full working drawings supported by detailed photographs and line drawings. **£14.95 (F)**



MINIATURE INTERNAL COMBUSTION

ENGINES Malcolm Stride

This book sets out to show that any competent model engineer can make a working model petrol engine, and that there is nothing more difficult than would be encountered in the construction of an average steam engine. **£19.95 (F)**

WORKSHOP MATERIALS Alex Weiss

A guide to the many materials used by model engineers in their workshops, packed full of useful information providing the easy reference to finding the right material for a task or an item specified on a technical plan. **£6.95 (C)**

TOOL AND CUTTER SHARPENING Harold Hall

Sharpening workshop tools is probably the most diverse of all workshop activities and the one that is least understood by the majority of workshop owners. This book illustrates how most sharpening tasks can be carried out using an off hand grinder and a few simple made accessories, whilst doing this to a standard comparable to that achieved using much more sophisticated equipment. **£6.95 (C)**

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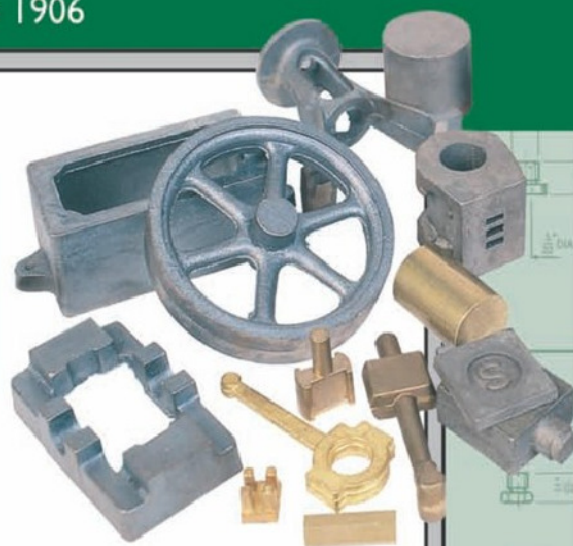


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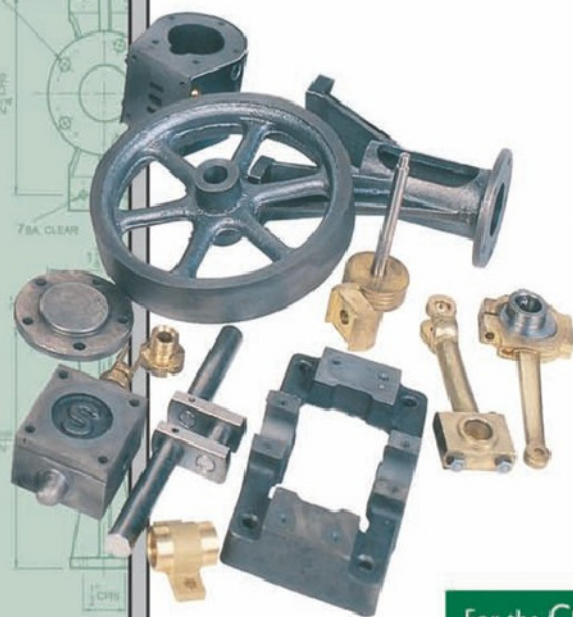
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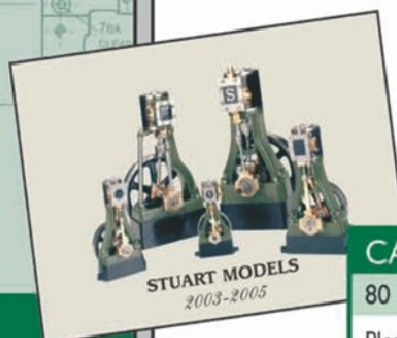
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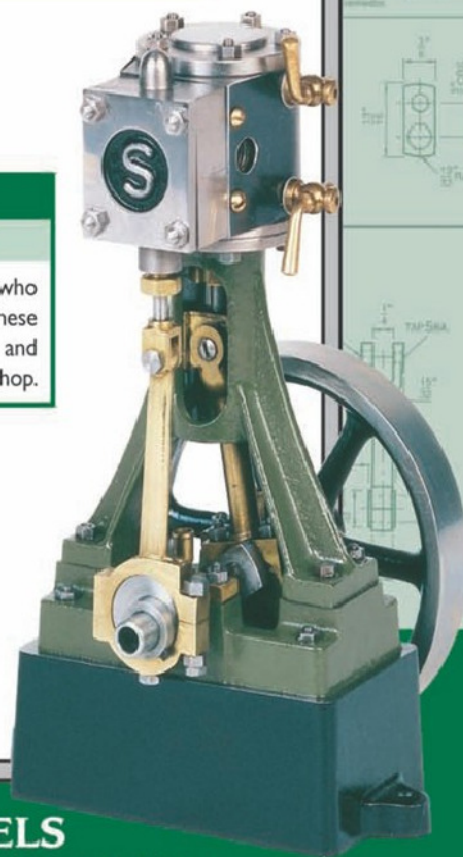
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David Clark

The Model Engineer Exhibition

It is Monday afternoon and I am recovering after four days at the Model Engineering Exhibition. They were four very enjoyable days and I met many contributors as well as readers. Feedback from readers is very important and everybody said how pleased they were with MEW. Comments received included several, "I am only a beginner and some articles aimed at us would be welcome". To rectify this, Dave Fenner is going to do some articles on using a mid range lathe from Arc Euro Trade. Similar machines are available from most of the main suppliers.

The variety of articles

Most readers I spoke to appeared to like the variety of articles included in MEW and a couple of people mentioned the possibility of doing a steam or internal combustion engine project. This is a bit outside our usual scope and is not really possible. However, there is nothing to stop me doing a series on machining different types of components and showing various types of machining and processes on different machines.

I have six issues under my belt now and the feedback has been very positive. I have some plans for future articles aimed at the beginner to intermediate model engineer as well as projects for the advanced reader. The controversy over health and safety has ended and we can, I hope, look forward to a bright and interesting Scribe A Line section. Workshop Practise books are still being given to the best letter and the best tip in every issue.

Harold Hall and new contributors

Harold has indicated that he might want to take things a bit easier in the future. I still have plenty of articles in hand from him and some more will still be forthcoming. This does mean that I would like a few more readers to write articles. We are not short of material but plenty of articles in hand are always welcome. We do pay quite well and anyone who would like some author's guidelines can email me at the editorial email or write to me at Berwick house. Address is on the contents page. Please mark your letter 'contributors notes'. There is no need to send a stamp due to the difficulty of overseas readers getting UK stamps.

ON THE EDITOR'S BENCH

Longevity

I had a quick chat with Ron Jarvis who is about 95 years young. He is very active for his age and spent many hours over the three days talking to visitors about his fine collection of models that were on display. I purchased a copy of Ron's book from the stand at the exhibition. It is very good and as soon as I find out where you can order a copy, I will put a full review in MEW.

Several other modellers I spoke to were getting on in years but all seemed very active.

I met Stan Bray, the original editor of **Model Engineers' Workshop** and again he appeared to be very active and in good health. I am just wondering if Model Engineering enhances life expectancy? Is it the physical effort expended or the fact that they are interested in something that prolongs life? I am inclined towards the latter, that having an ongoing interest after retirement keeps you going for much longer than the three score years and ten.

Size matters

I expect most readers know the size of the Stuart 10H or 10V steam engine, either having built one or seen one at an exhibition. I have been looking at casting sets in various catalogues and thinking, 'they are quite expensive'. Having looked at the stationary steam engines on display at exhibitions, I have realised that quite a lot of the castings build up into larger engines than you might think.

Some of Anthony Mount's engines are quite large models when built and are certainly value for money. In particular the bottle engine described recently in the model press was much more substantial than I had thought. Seeing it at the Model Engineer Exhibition made me realise that it was probably double the size I had visualised.

'Rachel', the wall mounted engine currently being described in Model Engineer by Stan Bray looks quite small in the photos but when you look at the drawings and see the dimensions of the main components, you begin to realise the finished size is quite substantial.

There are still quite a lot of engines that can be made on the smaller lathe but before buying, check that the castings will fit onto your lathe. The biggest component (diameter wise) is usually the flywheel. If you belong to a club, perhaps someone could machine this for you or they may even let you use their lathe under supervision.

2½in. Gauge

The 2½in. Gauge Association had a large stand with plenty of locomotives on display. The recent serialization of the new version of 'Ayesha' in **Model Engineer** has renewed interest in this gauge. I was

pleasantly surprised to see that narrow gauge locomotives are represented with castings available for the Groudle Glen locomotive 'Polar Bear', for 'Toby', a freelance narrow gauge locomotive and also for the big Leek and Manifold narrow gauge locomotive, E R Calthrop. If you are finding 5in. or 7¼in. gauge to heavy, perhaps a move to the smaller 2½in. gauge might be worth considering.

SMEE Model Engineer Training Courses

The Society Of Model And Experimental Engineers were present and asked me to let readers know about their Saturday training courses for model engineers.

The first course consists of three sessions, discusses the setting up of a workshop, what equipment is desirable and the basics of how to use machines and hand tools.

The second course, over six sessions, covers the construction of an oscillating steam engine and boiler based on Tubal Cain's "Polly" design. At each session you discuss parts, which delegates go home to make in their own workshops in time for the next session. You will need a small lathe, a drilling machine and possibly a small mill to participate in this course. I saw a display cabinet at the exhibition with several of these small steam engines in and they do look very nice when finished. You will also need a copy of Tubal Cain's book "Building Simple Steam Engines" This is available from www.myhobbystore.com

Lathe Tool Grinding

The third course covers the use of the off hand grinder to produce and maintain lathe tools. Unlike the other two, this course is for one day and includes practical sessions for all attendees. It is only open to Society members.

Full details are on the Society's website at www.sm-ee.co.uk or you can write to The Society Of Model And Experimental Engineers, Marshall House, 28 Wanless Road, London, SE24 0HW.

Dates for your Diary

The Midlands Model Engineering Exhibition.

Friday 12th – Tuesday 16th October at the Warwickshire Exhibition Centre, Fosse Way, Leamington Spa, Warwickshire. CV31 1XN. www.modelengineeringexhibition.co.uk

THE METALWORKERS WORKSHOP 4



1. The six most common file types. Left to right they are Hand, Half round, Flat, Three square, Round. A Square file is at the front.

Hand tools come in a very wide range of types, some are very common and used in other disciplines, DIY typically, and others more specialised and used predominantly in the metal working workshop. Some files for example, come in a wide variety of types and sizes and would need more space than can be justified in this series to cover the subject fully. Others are so common that I consider them well understood and do not intend to discuss them further, hammers, pliers, screwdrivers for example.

File types

The range of files needed in the home workshop depends of course on the tasks to be undertaken. Also, much that may have been done using them in the past is now done using milling machines, belt and disk sanders and the like. My advice therefore is to initially purchase a limited number and determine the ultimate requirement in the light of experience.

Their lengths are made in 2in. increments from 4in. to 14in., maybe even longer. I would though suggest two lengths to start with, 4in. and 8in., or 6in. and 10in. depending on the calibre of the work to be undertaken. Any longer than 10in. would I feel, have minimal use in the average set-up. There are many types but six are common, the Hand, Flat, Half Round, Round, Square and Three Square, photo 1.

Hand files have parallel sides but are

very slightly tapered on the thickness. They have one safe edge (uncut) allowing the file to be used into a corner without filing one of the surfaces. Flat files are similar but the width is tapered on about the end third and both edges have a cutting face.

Half round files have one flat face and one round face but no side faces as the flat face and the round face meet at the edge. The file is tapered both in width and thickness on about the end third.

The three remaining common files are Round, Square and Three Square (triangular). Apart from the files cross section, these all have a similar shape, that is, tapered towards the outer end.

With hand and flat files being similar there is no need to purchase both but I would recommend the hand file as this has a safe edge. On that basis, I consider that the hand file together with the other four types should make up the workshop's starter set.

Tooth sizes

Files come in three tooth sizes, Bastard (coarse), Second and Fine cut. Again I can only say choice will depend on your ultimate use. I would suggest that you work on the basis of either bastard or second for your longer files and second or fine for your shorter ones. I make this suggestion on the basis that the larger the file, the more likely that you will wish to use it aggressively.

Harold Hall discusses basic workshop hand tools.

In addition to the coarseness of the cut, there is one other aspect of the cut that does not always get a mention in suppliers' catalogues, that is single or double cut. With single cut the cutting edge is produced at an angle to the side of the file, but with double cut a second cutting edge is made this time at a similar angle but from the other edge, Sk1. This produces a diamond pattern and is by far the most common form of file. Perhaps this is why it does not get a mention, as it is predominantly the standard.

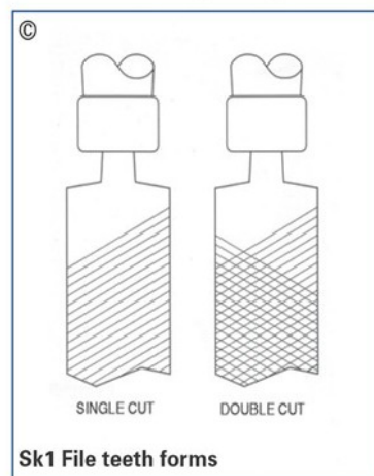
Needle files

The above is only a limited explanation of what is available with other lengths, shapes and finer and coarser cuts featuring. The fact that they do not appear in the majority of the catalogues is an indication of their limited use. There is one other common file type that I have not mentioned and that is the Needle file. These are very small files with their own built in handle and are made in a wide range of cross sections and in three cuts, known as 0, 2 and 4 as opposed to Fine, Second and Bastard. Photo 2 shows a range of these files. These would be a definite requirement if working in fine detail, typically modelling in the smallest scales, making small size clocks, etc.

Using a file correctly is most definitely a skill to be achieved and will only come with practice. However, I would suggest that you seek further reading on the process and types available. (Editor's note, see *Fitters Little Helpers* in MEW issue 129).

Scrapers

Scrapers are also used for removing metal from the surface of a workpiece, however, there the comparison ends as the file is intended to remove rather more than is the scraper. Scrapers are



Sk1 File teeth forms

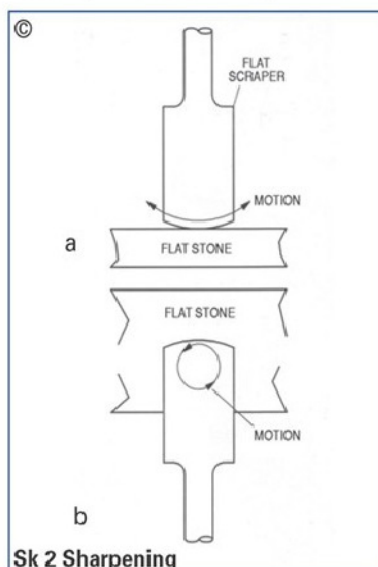


2. Needle files are essential for detailed intricate detailed work.

normally available in three forms, curved, flat and triangular, left to right, **photo 3**. Probably, the flat scraper is the most used apart from the triangular scraper used for deburring holes.

The most usual method of using a scraper is to highlight the raised portions of the workpiece and then to use the scraper to remove small amounts of metal at these points. To do this, an accurately flat (or mating curved) surface is needed to act as a comparison. This can either be a surface plate (see precision tools in the next issue), or a reasonable substitute such as a piece of plate glass.

The reference surface is very lightly smeared with engineers' blue on which the workpiece is then placed and then moved a little in a figure of eight motion. This process will leave small blue patches on the workpiece's high spots that are then removed using the scraper. With repeated attempts, the number and size of blue spots will increase until they are closely packed over the complete surface. Providing that there are no large areas



3. Curved, Flat and Triangular Hand Scrapers.

without a blue covering then the result should be adequate for most applications. If time is on your side you can always attempt to improve the cover.

Scraper applications

Typical applications for the scraping process are to produce a surface plate, or finalising the fit of machine slides and the like. In the later case the very shallow hollows that the process produces will provide pockets for retaining oil to lubricate the slide.

Large bronze or white metal bearings can also be scraped in a similar manner, matching the bearing to the spindle with which it is to be used. The flat surface would normally be scraped using the flat scraper and the bearing the half round version. Triangular scrapers could be used for scraping the narrow faces of the dovetails on a machine slide but are normally used for deburring holes.

Sharpening scrapers

The photograph, **photo 3** shows three commercially available scrapers though these can quite easily be made from old files that have passed their use by date. Do ensure that in grinding away teeth and creating the required shape that you have not overheated the file so as to lose the required hardness.

The end of the flat scraper must be kept totally sharp in view of the very small depth of metal to be removed. You will not be able to remove say 0.001 mm if the edge has a radius of 0.002 mm, it's physically impossible. The edge must therefore be near perfect!

Sharpening these is a job for the flat stone, however, it can be very lightly ground on the off hand grinder to re-establish the curved end. The end should then be polished on a fine flat stone as illustrated by **Sk. 2A**. Do this on a fairly hard stone, as the narrow end will tend to cut a groove in it. With the end polished, the sides should also be polished using a relatively fine stone, say 1000 grit minimum, **Sk. 2B**.



4. Ball ended wrenches with a homemade T wrench in the centre.

Spanners

In day-to-day terms, spanners have limited use in the average home workshop unless you are into restoration of vintage cars or do your own maintenance on the modern equivalent. I suspect that the latter is not to be recommended these days given the degree of complication under the bonnet. As an aside, what will the restorers of 50 years time do with all the electronics being used as spares are very unlikely to be available due to it not being practical to manufacture them in small quantities. Has any reader got any thoughts on the subject?

For the home workshop, do equip yourself with the very best spanners for those sizes that get very frequent use. These will be for such items as the clamping nuts used on the machine tables, the top of the milling machine draw bar and smaller sizes as used for clamps on the lathes faceplate. As an added facility in terms of safety, obtain ring spanners as well as open-ended ones.

Hexagon wrenches

If kept in good order, these have a lot going in their favour, as they are more secure but have the same benefits as a ring spanner. It will be tempting to purchase a set of the short length wrenches or even more likely, make do with those that seem to come with every conceivable item purchased. I now have well over 100 that have come via this route. Instead, purchase a set of long reach ball ended wrenches, **photos 4** and **5**. This will be money well spent



5. Ball ended hexagon wrenches are much easier to use than the more normal type.



6. Standard centre punch, left with spotting punch on the right.

as the long reach and in particular the ball end makes working on inaccessible cap head screws very much easier than with standard wrenches. For screws in inaccessible places, a short length taken from a standard wrench and driven into a length of bar will be well worth making, centre of **photo 4**.

Measuring and Marking out equipment

This is a vast subject and also an area for a much greater level of financial commitment where hand tools are concerned.

At the simpler end of this range, we have such items as rules, centre punches, scribers, etc. Very little comment is necessary regarding these as they are in the main very common place and without complication. For the rules I would suggest satin chrome, as these are so much easier to read. Also purchase a flexible 150mm rule and a rigid 300mm rule.

Two centre punches would also be worth having with one sharpened with a 90deg. point and the other 30deg. to 45deg. The sharper one will locate more easily in the scribed lines and can be used to produce, with a light tap from the hammer, a small indent in readiness to use the 90deg. point to produce the working indent. The sharper punches are often known as spotting or prick punches and can be ground from a standard centre punch. In addition to locating in the scribed lines more easily, the sharper angle makes for easier viewing of the point to be punched. This can be further enhanced by purchasing a special spotting punch that has a smaller diameter shank than normal as can be seen in **photo 6**.

Photo 7 shows three items that would have been very much used in past times, being an outside calliper (left) divider (centre) and inside calliper (right). Whether

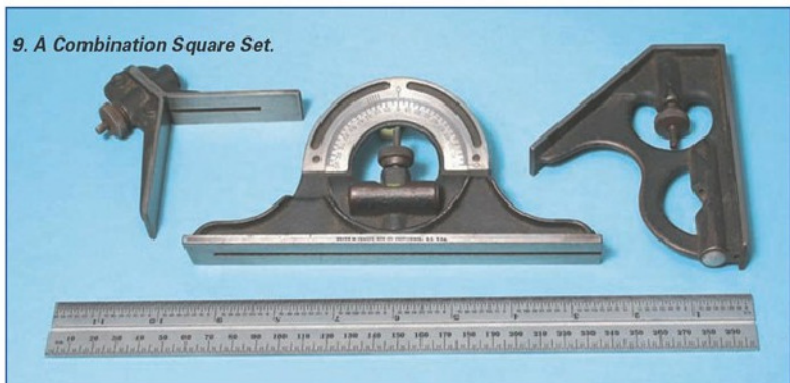
7. Left to right, outside calliper, divider, inside calliper. The divider is the only essential workshop item in most cases.



8. A Depth gauge/Protractor (front) and a Universal Bevel Protractor, (rear).



9. A Combination Square Set.



the callipers will find a use will depend on the sophistication of your other measuring equipment, micrometers, etc. but I suspect they will be rarely used. The divider is though, a tool worthy of any workshop being able to mark out circles and for stepping along lines and around circles in equal increments.

Measuring angles

Other than 90deg., working with angles is likely to be an infrequent requirement. It is though inevitable that at some time, some form of measuring or setting out of angles will be required. There is quite a range of equipment available for this ranging from a cost of a few pounds to a hundred



10. Marking out with a hand held square.



12. An alternative to using a hand held square for marking out.



11 The tools necessary for marking out. The broad felt tipped pen in the foreground is a modern alternative to using engineers blue.

pounds plus. In most cases, the need for accuracy will be quite low and the Depth gauge/Protractor, **photo 8** (front), will be more than adequate and may suit all your requirements. If there is a need for much greater accuracy then a Universal Bevel Protractor, **photo 8** (rear) will be necessary. Whilst the Depth gauge will work to say 0.5deg, the Universal Bevel protractor will work to 0.1deg., maybe better.

Between the two, in accuracy terms, there is the Combination Square Set, **photo 9**. The accuracy of this is comparable to the Depth gauge/Protractor but its more robust build makes it more suitable for many applications. Its extra facilities also make it a good proposition. These are, in addition to the protractor, a centre finding square (left) and a conventional square (right). The rule also doubles as a good quality 300 mm rule. Both the protractor and the square have a spirit level included and provided that you have set your machine tables level, can assist in setting components at an angle for machining. This will not be precise but will be adequate for many applications.

Combination Square sets are made in a wide quality range, from those made from die-castings, appropriate only for DIY use to high quality versions for use in an industrial tool room. Somewhere between the two will be those appropriate for use in the home workshop. My advice would be to purchase a mid quality combination set in preference to the other two items mentioned.

Another method of setting out angles is to use a sine bar and whilst capable of very accurately results the applications where it can easily be used are very limited. This device will be discussed in the next issue.

Getting back to setting and checking for an angle of 90deg. I would suggest two squares should be purchased, one small, say 50 mm, and a larger one of 150 mm blade length. The larger would often be too large for

intricate set ups and the smaller much too small for the majority of situations.

Marking out

The requirements for marking out a part for machining are numerous though three are I feel the most common. By far the most common being the marking out of hole positions for drilling. Marking out a part for sawing is also common. This may be just for cutting a length from a bar or shaping a component using a bandsaw or hand held jigsaw.

Another method that should be more common, but one I feel is not used as much as it should be is to mark out machining lines on a part before placing it on the machine table. This is much easier than attempting to measure the part in situ on the table during the machining process. In this case, access and the presence of pieces of swarf can make it difficult. A typical example for this approach is to mark out the ends and width of a closed end slot to be machined using a slot drill, a situation where high precision is rarely called for. Of course, in some cases precision will be called for and measuring the part whilst on the machine table will be the only option. Machining lines can still be made as an initial indication of the machine 'to' position.

Methods

Having decided that a part has to be marked out for later operations, there are two methods of doing this. The hand held approach will basically be using an engineer's square from one edge and measuring its required distance from another. With this done, a line is scribed, **photo 10** and if for drilling a hole, a second line will be necessary at 90deg. to the first.

Scribed lines can in some cases, depending on surface finish, lighting level, etc. be difficult to see. This can be overcome by covering the area to be marked out with a film of engineers

marking blue. A present day, and easier to use, alternative is to use a wide felt tipped marker. Any dark colour will do but stay with tradition and use blue. **Photo 11** shows this, together with the other tools required for marking out by this method.

An alternative to the square and rule method is to use the device shown in **photo 12**. This is very clearly marked in millimetres and can easily be set to better than a millimetre, certainly 0.5 mm. The wide locating and scribing faces and being easily set, make it very easy to use and it is adequate for a wide range of marking out requirements.

Where greater accuracy is required than is achievable with the above methods, using a surface plate together with various additional items becomes necessary. However, whilst very little more accurate than using the above methods, using a surface gauge, **photo 13**, will frequently be an easier option, sometimes where others are not possible. A surface gauge is therefore an essential item, that is unless a height gauge is to be purchased. This, together with surface plates, will be discussed in the next issue.

Hand Stamps

This is quite a different method of marking and with a different purpose. Whether they have a purpose in your workshop will, as with much else in this series, depend on the purpose the workshop is to be put. Even so, if only used to stamp an identification reference on the ends of material stock it would be worth acquiring a set.

They are commonly available in sizes from 1.5mm to 6mm but with smaller and larger sizes being available. Choose the size you purchase very carefully as in my experience, both with hand stamps and setting out type for printing one often finds the end result larger than one anticipates.

Hand stamping totally free hand is likely to produce a visually poor result, not in line and unevenly spaced. This may not be a problem say for a plant label for the garden but often it will not be acceptable. Because of this you will need to produce some simple device for guiding them. Another advantage of using guides is that it will be easy to return a punch to the same place should a deeper impression be considered preferable.

Precision tools will be the subjects in the next issue.



13. Using a surface plate and surface gauge for marking out. Where complex shapes are involved, this is the only practical method.

USING THE LATHE MOUNTED MILLING HEAD ①

Harold Hall uses the lathe mounted milling head

Background

Having completed the milling head, published in the last three issues, I decided I would like to put it to use and in so doing, provide some examples for publication of what can be achieved using it. However, as a departure from my more usual workshop projects, tooling that is, I decided a small stationary steam engine would be a good idea. For this I chose the horizontal mill engine, 'Tina', from GLR Ref. 1. Having decided on a "small" engine I was surprised just how big a project it was when the kit of parts was opened up and inspected. It certainly seemed good value for the money and realised that it would fully test the milling head I was about to use.

Readers will of course understand that an article fully detailing the engine's construction is not appropriate for this magazine, being more appropriate for the Model Engineer magazine. In any case, such an article regarding 'Tina' was published in that magazine commencing January 1996. I do though realise that these brief illustrations may prompt some readers to consider its construction and therefore some further information will not be out of place.

'Tina' The kit

The kit comes complete with all the required materials, castings, bar materials, hardware, etc. and an impressive range of drawings. As an indication of the physical size of the engine, seen in photo 1, the base is 315mm long by 120mm wide and the flywheel 155mm diameter.

There are 17 castings, the flywheel being cast iron and the base aluminium, the rest, gunmetal. As commented above, the drawings are impressive having obviously been redrawn since the time of the Model Engineer articles. They comprise 14 double sided A4 sheets of the assemblies and detail parts and are very clearly drawn. If like me, you are not very conversant with steam engines, you will have to study them in depth before starting work.

Also provided are 11 double sided A4 sheets of 3D images of the overall assembly. Many of the sub assemblies are shaded line drawings giving them an almost photograph appearance. Having been brought up on first and third angle projections I must confess to a reservation regarding 3D images. That having been said, if well done, as they are in this case,



The lathe mounted milling head used throughout this article.

they can certainly make understanding the assembly requirements very much quicker and easier than with a conventional assembly drawing. Some of the drawings are exploded so making it even easier to understand the assembly.

Value for money

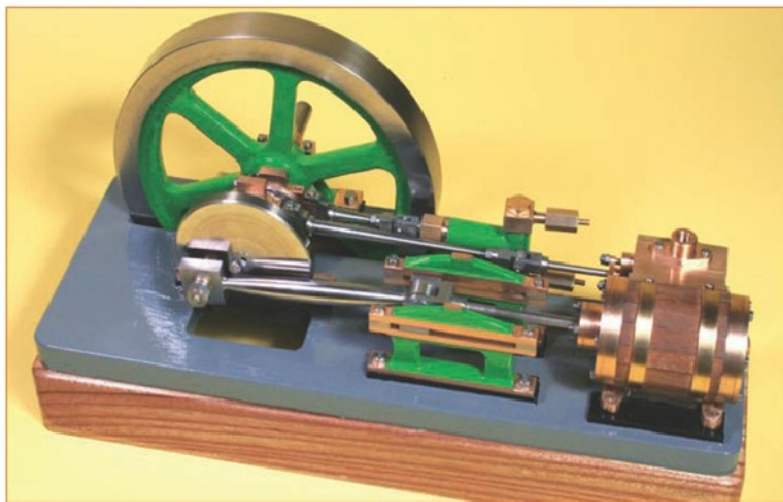
In all therefore, it is a very good kit of parts and at £163 (early 2007 price) a very good buy. The large flywheel does pass through an aperture in the base casting. This prevents the engine from standing firmly without a plinth being made. For a model, this will traditionally be of hardwood and if carpentry is not to your liking then GLR do provide one ready made.

As explained above, this article will not fully detail the construction of the engine but in keeping with the principle of making it using just a lathe with the milling head and a small drilling machine, I have not used any other machines in my workshop, even for tasks not illustrated.

The reader can therefore be confident that the engine is within the capability of a workshop comprising a lathe and a small drilling machine. The lathe will of course require either a milling head or a vertical slide, though the latter would only be acceptable if one of the larger ones and even then such items as the base will present additional problems. The flywheel being 150mm diameter will be a problem for those with one of the smaller size lathes. In this case, attempt to find a friendly model engineer (there are plenty of them) who will machine this for you. Failing that, perhaps GLR may have a facility for machining this part, it's worth asking.

Particularly the milling head

One final point then before I go into examples of some of the machining operations. My methods have been chosen with using the milling head



1. The finished horizontal mill engine, 'Tina'.

particularly in mind so as to display its capabilities. Even with a milling head being available, some parts could be candidates for machining by other means, whilst mounted on the faceplate or in the three or four-jaw chucks typically.

Do not assume my methods to be the best ones to adopt in all cases, though I have not included any that do not work well. To avoid the article being too one sided though, I will discuss a few turning and drilling operations where I feel they are of particular interest.

Jigs and fixtures

It is very tempting most of the time to attempt to produce a part using just the equipment presently available in the workshop. However, I am a firm believer that spending time making simple jigs and fixtures is frequently very worthwhile. In industry this will mostly be to improve productivity but in the home workshop it is more likely to be a case of improving the quality of the part being made, even avoiding the possibility of a scrapped component. Some of these I will detail as they occur throughout the article.

Even without these additions, there is very little reason why any task possible on a vertical milling machine cannot be carried out on the set up which is the subject of this article, only the size of the part being made and the accessories being used are important. I will therefore consider a few of the possibilities.

Rotary table

In most cases, a 100mm diameter rotary table should be quite at home on an average size lathe as can be seen from the following examples, though for readers with one of the smaller lathes, 75mm tables are also available. Such a table would be more than adequate for the parts seen being machined. (*Editors note, for any reader who is not conversant with using a rotary table, Harold has written an article to be published in MEW issue 133.*)

Photo 2 shows six holes on a PCD being marked out on the drilling jig, **Sk. 1** that will eventually be used to position the holes on the cylinder block and end covers. The set up uses the jig as **Sk. 2**, which is a multi purpose item. It can be seen that the locator has four diameters

that are used as follows. The smaller is a close fit in the rotary table bore ensuring it is accurately located. The other end has a centre drilled impression and is used together with the small centre, seen on the cross slide, placed in the drill chuck to accurately locate the rotary table centrally below the machine spindle. With the rotary table located in this way, the lathes cross slide can then be traversed to set the required PCD using the slide's micrometer dial.

Incidentally, if your rotary table has a Morse, or other, tapered bore, then an adapter as illustrated in the sketch should also be made.

Locating diameter

The 1.000in. diameter is used initially to locate the drilling jig when being marked out on the rotary table, as in the photograph, and eventually, when drilling the ends of the cylinder block as detailed later. It is also used as a gauge when boring the cylinder block when the slightly smaller diameter is used as an early warning that the bore is nearing size. The larger diameter is purely a clamping flange. The spacer ring in the sketch is used in some of the set ups, including that in **photo 2**.

As most of the items to be machined on the rotary table are small, holding them firmly on its centre can be a problem if approached conventionally, such as using an overhead clamp. Positioning them will be even more difficult. Because of this I developed the workpiece locating jig detailed in **Sk. 3**. The advantage of this arrangement is that it only requires a simple bush added for each different hole diameter in the items being located.

The jig locator is threaded to take the workpiece clamping screw and a number can be made to suit varying clamping screw sizes as the item being machined dictates, obviously the larger the screw the better. The smaller diameter of the jig locator (A) is a close fit in the rotary table's bore and the outer end, with a large drilled centre, is used for locating the rotary table in line with the machine spindle as detailed above. The larger diameter locates the upper plate (B) and must be a close fit in this. The two diameters and the centre drilled impression must be concentric.



2. Six holes on a PCD being positioned using a rotary table. The item being made is the drilling jig (Sk. 1)

Concentric bores

The two bores in the upper plate must be concentric otherwise the part needs no special attention. Do not think though that this clamps the jig locator to the table, it does not, and the large bore must therefore be deeper than the thickness of the flange. In use, the action of clamping the part being made will lift the jig locator to meet the bottom of the bore in the upper plate.

One diameter of the workpiece locator (C) must be a close fit in the upper plate whilst the other, which can be smaller or larger, a close fit in the item being made. This is the only item that needs producing for other workpiece diameters making it easy to adapt for various parts, concentricity again being vital. I have not given any dimensions, as these will need choosing to suit the rotary table being used. The parts that make up this jig are seen in **photo 3**. Note the notches in the jig locators and the pin in the upper plate that prevent the jig locator rotating.

The workpiece's that were made using the jig are seen in **photo 4**. This also shows the cylinder block drilling jig and upper plate, both of which used the rotary



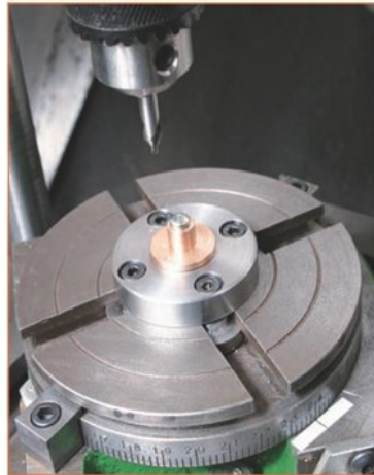
3. The parts that make up the workpiece locating jig, Sk. 3. A mirror has been included so as to see the bore and locking pin in the upper plate.



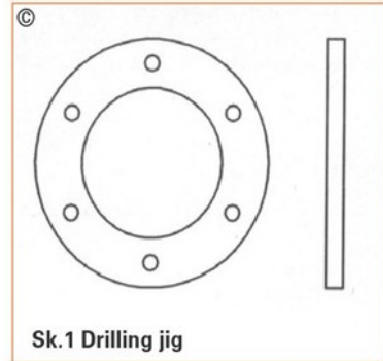
4. Items that were made using the rotary table.



5. Creating a radius on the end of a small link using the rotary table to establish the radius and the workpiece locating jig to position the part.



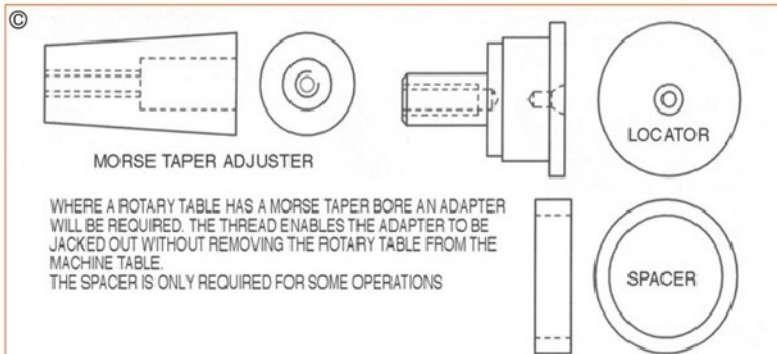
6. The task of placing holes on a PCD on a small component is made easy by this arrangement.



Sk.1 Drilling jig

radius through about 270deg. that was produced using the jig seen in **photo 7**.

Having made and used the jig, I have found that it works very well, and is well worth considering making, even for readers who use their rotary table on a milling machine. If using it as the photographs indicate and you only have one lathe, you will need to plan carefully as you will not want to remove the milling head just to make another workpiece locator.



Sk.2 Locator and accessories

table for marking out the positions of the holes on a PCD.

Machining a radius

Photo 5 shows the jig in use when adding a radius to the end of a small link with two already finished link ends seen on the rotary table. The washer seen under the component permits the workpiece to be fully machined to its lower edge without fouling the jig.

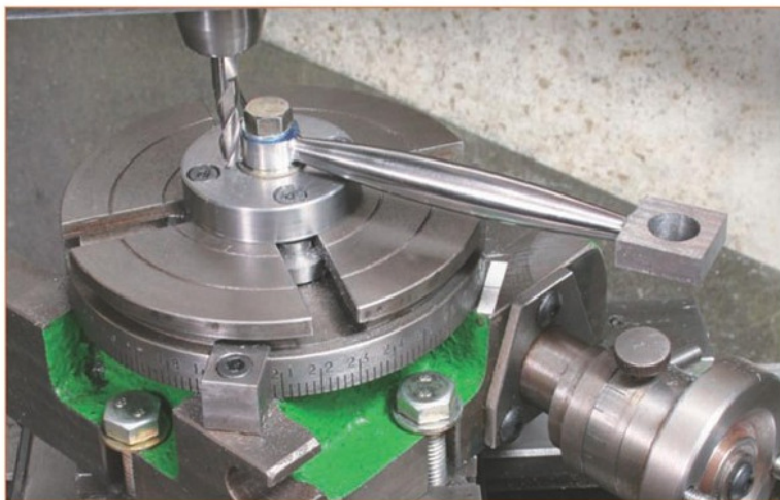
Placing holes on a PCD in small workpiece's is also a task where the jig is useful as seen in **photo 6**. You may have been surprised to see in **photo 4** that it was used for just two holes at 180deg. but this was much easier (and more accurate) than marking them out with a rule and scriber.

The engine's connecting rod is an interesting part and will be discussed in more detail later. Even so, one end has a

Machine vices

There are numerous types of engineering vices that may be considered for use with the milling head, far too many to consider here. However, in my estimation, only a toolmaker's style vice anywhere meets the requirement for use on a small machine table, such as the lathe cross slide or a vertical slide. The reason for this is that the mounting method is far more adaptable than the fixed mounting points that most vices provide.

Photo 8 shows the mounting method clearly with the vice at right angles to the length of the cross slide table. From this it can be seen that the vice can be moved into any position whilst still leaving the fixings in the same place. In this photograph, one of the small castings is having its edges machined, taking a cut 0.050" wide by 0.2" deep using the side of the end mill, a cut that was well within the head's capability, machining gun metal in this case. Note also that it is being machined in the direction that the head is less rigid, more about that shortly. The upper surface had also been machined with the same set up.



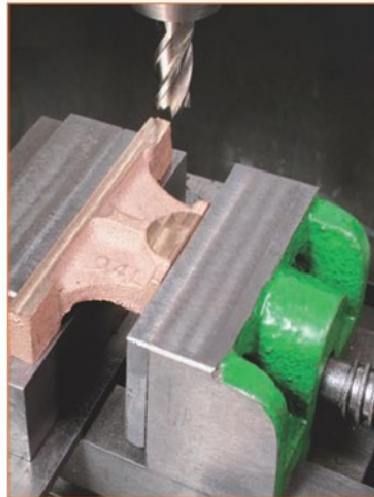
7. Making a radiused end to the connecting rod.



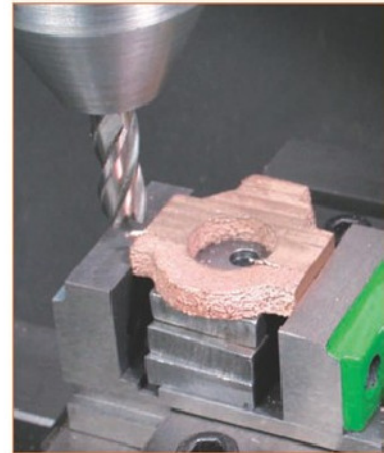
8. A toolmaker's style vice gives greater flexibility in positioning compared to vices with fixed clamping points.



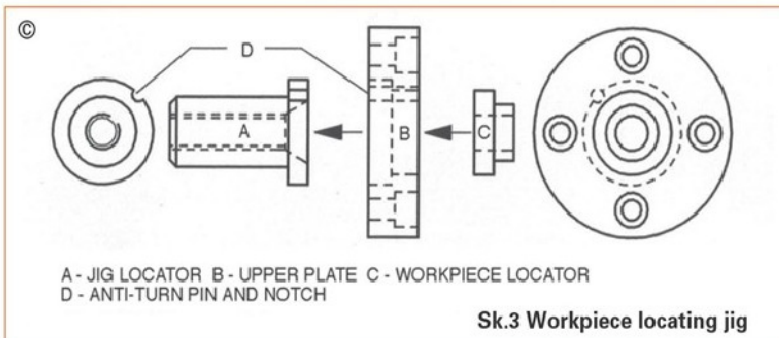
9. The vice mounted in line with the cross slide for machining the end of the connecting rod.



10. A main bearing having one of its sides machined.



11. Reducing the thickness of one of the eccentrics.



Machining the upper face however, highlighted a situation that I have previously overlooked to mention regarding the milling head. That is, the need for the spindle to be accurately perpendicular to the surface of the machine table. This I will discuss in detail later.

If you purchase a toolmaker's vice, it will not be supplied with the required table clamps so you will have to make these yourself. These are simple items but do ensure that you chose dimensions that will

enable the vice to be mounted both in line and at right angles to the cross slide without having to make a second set. Photo 9 shows the vice mounted in line with the cross slide. In this photo, the ends of the mild steel connecting rod are being reduced from $\frac{1}{2}$ in. to $\frac{1}{4}$ in. thick.

Capable of machining steel

The engine has a few steel parts that require milling and they proved the head's ability to cope with machining this material. As I explained at the end

of part three in the head's construction article, it is much more rigid when milling towards or away from the head using the saddle than across the head using the cross slide. I think most readers will understand the mechanics of why this is. For this operation I used a 10 mm cutter running at about 400 rpm and taking a cut of 0.060in. deep and 0.120in. wide with no noticeable stress when traversing the saddle. Incidentally, the saddle was fed under power at a rate of 0.002in. When machining gunmetal this was increased to 0.0029in. and I am sure these values could have been increased without any problem.

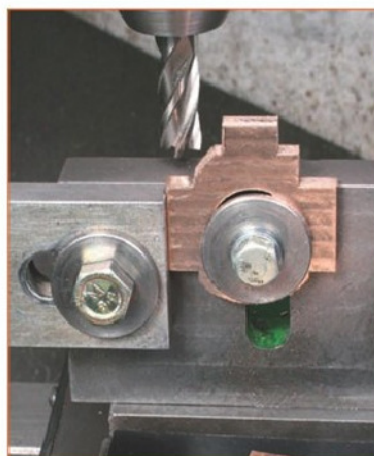
The limited throat depth in this direction may cause a problem in some cases, but using the cross slide for larger components would still be possible, it only being necessary to be a little more patient by taking lighter cuts.

Photo 10 shows one of the main bearings having its side machined and is another typical example of the machining tasks presented by this engine.

The vice in the above photographs is quite large and a smaller one may also be useful especially if fitted to another accessory, the rotary table for example. In this case, a smaller vice may be required, not only to fit the table but also the available headroom may not be sufficient to accept a larger vice. The thickness of the eccentric outer bearing is seen being



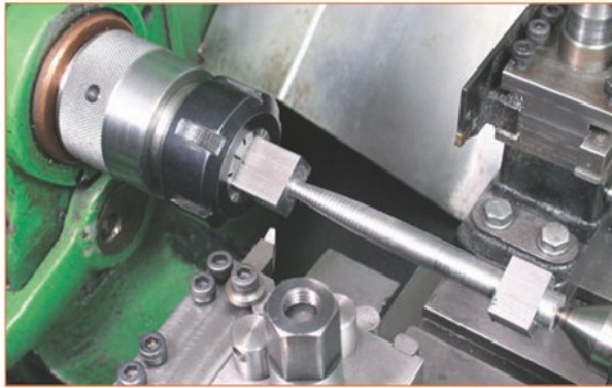
12. Machining the two sides of the eccentric outer bearing ensuring that they are parallel so that they can be held in the vice.



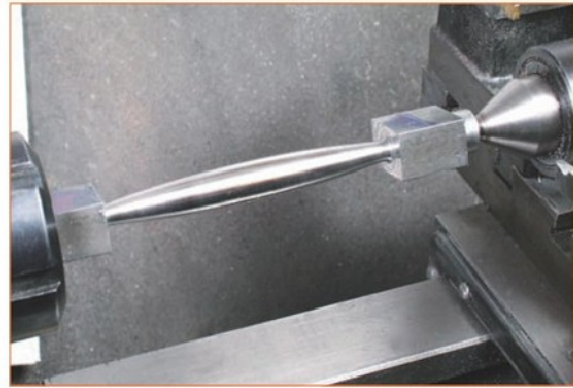
13. A fence has been set up exactly at right angles to the machine table for accurately locating the part for further machining.



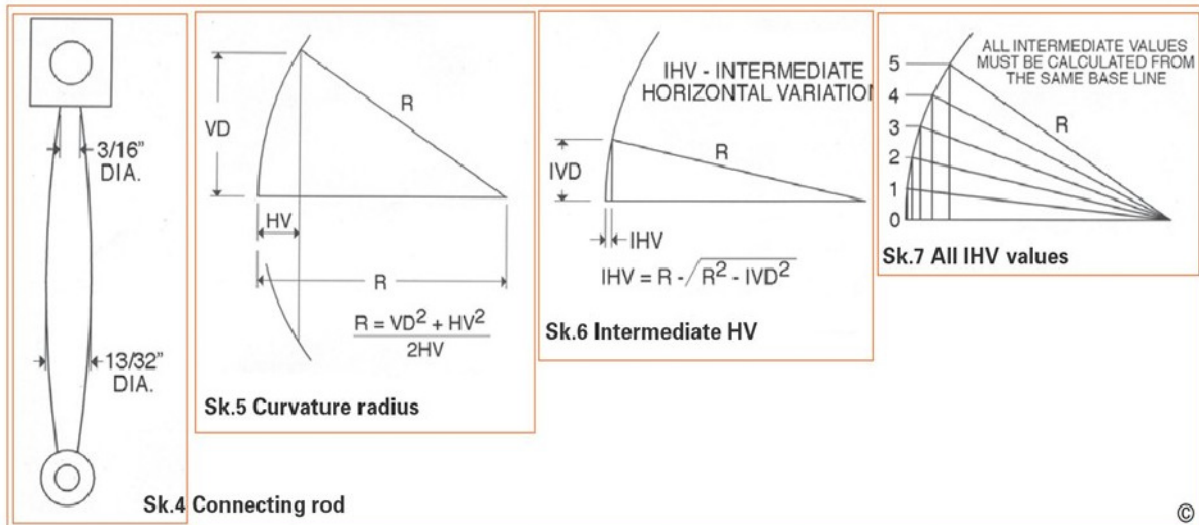
14. The slitting saw being used to split an eccentric.



15. Rough turning one end of the barrel shaped connecting rod.



16. The finish turned barrel shaped connecting rod.



machined to size in **photo 11** using a smaller vice.

An Angle Plate

It will frequently be found that an angle plate will have advantages over using a vice when positioning a part for machining. Typical examples of this can be seen in **photo's 12** and **13**. In the first photo, the edges of the part were machined parallel so that its thickness can be machined as was seen in **photo 11**. After machining the thickness, this part was machined, **photo 13** with a fence being fitted on the left to ensure the part was accurately located at right angles.

Slitting Saw

One simple device that will only find occasional use but be invaluable on such occasions is a slitting saw. In addition to the saw itself, an arbor will be required and in this situation one with a shank to be held in the milling chuck will be the best solution as in **photo 14**. When using a slitting saw, ensure that you do not run it at too high a speed as they have very little metal to absorb the heat developed and they easily over heat. This is particularly a problem with very thin saws.

Connecting Rod

Digressing from the milling for a while, I will go into my method of producing this item, illustrated in **Sk. 4**. It is an interesting item to make and is worth going into in detail even though there is only limited

milling required in its manufacture. It is made from $\frac{3}{4}$ in. x $\frac{1}{2}$ in. mild steel and is turned fully round over a length of $\frac{3}{4}$ in. However, this is not parallel but barrel shaped, being $\frac{3}{16}$ in. diameter at either end and $\frac{13}{32}$ in. diameter in the centre.

Not having made a part like this previously, I considered the different possibilities. The first idea that came to mind was to produce a template that could be used with a follower to control the cross slide as it was moved along the length of the rod. The cross slide lead screw would have to be disconnected for this to work. Another method that would require the leadscrew to be disconnected was to use a pivoted arm whose length was equal to the radius to be produced. As the radius worked out at about 12in. the rear fixed pivot would have to have a mounting well away from the bed of the lathe.

As both these methods would involve a lot of work making the required facilities, I decided that I would use a less engineered approach that had been going through my mind. This involved roughly turning it to shape and finishing with a file and emery paper.

Different methods

Two methods were considered, the simpler, to leave the centre portion parallel and turn a section tapered at both ends. I decided though to adopt a method that would more closely follow the curve required. This involved starting from the centre and traversing the saddle a set distance then reducing the diameter by

a calculated amount again traversing by the same distance before reducing the diameter yet again. The process would be repeated until the rod reached its smallest diameter when it would be turned end on end in the lathe and the process repeated to complete the barrel shape in rough form.

My first idea regarding this method was to use the four-jaw chuck with the outer end supported by the tailstock centre. Each end would have to be, say $\frac{1}{4}$ in. longer so that in the final machining the centre drilled impression would be removed. However, I was very concerned regarding the safety aspect of using a file to finish the barrel with a large four jaw chuck rotating at high speed very close by and would DEFINITELY NOT recommend this approach. Because of this I used the $\frac{1}{4}$ in. extension to turn a $\frac{3}{16}$ in. diameter spigot at each end. This could then be held in a collet chuck being a very much safer method. I did though remove the bulk of the metal, converting the rectangular shape into a circle, whilst holding one end in the four jaw and supporting the other with the tailstock centre, also at this stage producing the spigot at each end.

The step method

Photo 15 shows the first end having been machined and from this you should be able to see evidence of the tool being fed in at regular intervals along its length, also the spigot at the tailstock end. I did initially partially reduce the diameter in a few stages at the smaller end to avoid

too deep a cut being required to produce the final result. The overall system worked well as should be evident by the photograph of the finished barrel, photo 16. The finishing stage, filing and emery paper, took about 30 minutes but would have been substantially reduced if I had a much finer file. Taking out the filing marks took about 25 minutes, in all though it was an easy process.

Machining the barrel is only part of the task as calculating the changes in diameter along its length can be a lengthy task if done purely manually, even with a calculator of course. A programmable calculator will make the process much quicker.

Considering first the manual method, the first calculation is to determine the radius that produces the barrel form, Sk. 5 showing the basis of the calculation. In this R = the radius required with VD the distance between the smallest and largest diameters along the barrel and HV the difference between the smaller radius and larger radius.

VD stands for vertical distance and HV horizontal variation.

Using Pythagoras's theorem we get $R^2 = VD^2 + (R - HV)^2$

Requiring R this can be rearranged to give this value as indicated in the sketch.

Next stage is to calculate the tool infeed at each position, this shown for a single position in Sk. 6. Again we use Pythagoras's theorem, which gives

$$R^2 = IVD^2 + (R - IHV)^2$$

See the sketch to see how this can be rearranged to calculate the required value, IHV.

The calculation has to be carried out at each position that the infeed is changed and from the same baseline, see Sk. 7.

Initially, I chose to make the changes in diameter at $\frac{1}{16}$ in. increments, being one turn of my lathe's leadscrew. This resulted in quite large steps at the smaller end and I finally opted for $\frac{1}{32}$ in. increments, half a turn of the leadscrew, resulting in 26 increments. A benefit of this choice was that as precision was not required it was

unnecessary to read the micrometer dials, just observe the position of the handle on the hand wheel, typically up and down.

Avoiding manual calculations

Readers will no doubt be interested in my method for avoiding the lengthy process of manually calculating the twenty-six tool infeed values. Actually, purely out of interest, I tried two methods. First, using my CAD system, see Sk. 8, I drew actual size the distance between the two extremities X and Z and positioned point Y (B). Using these three points, I asked the system to draw a circle based on these (C) and from this called up the resulting radius. It was satisfying to find that even when calling up the value to 8 decimal places the result was identical to the calculated value.

I then drew a vertical line tangent to the peak of the curve, being the zero point for the tool in its starting position and drew horizontal lines at each of the 26 infeed positions, (D). These lines were then trimmed to the vertical straight and curved lines (E). With that done, I chose a typical position and requested the length of the line, manually calculating this value also. Again, I found both values identical even at eight decimal places. I have though exaggerated the curve and reduced the number of points on the sketch to make the drawing more easily readable.

Using a spreadsheet

My CAD system has a database facility but I have never found the need to conquer it and this was also not the time to attempt this. As a result I would have to select each line individually and write down the values as a list. Because of this, I resorted to my favourite method where repeated calculations have to be made, that is using a spreadsheet.

It would not be appropriate to discuss spreadsheets in detail in this article but if the reader would like some guidance on the subject then see my earlier article, Ref. 2. The major advantage of using a spreadsheet program over say a programmable calculator or a CAD program is the ability of obtaining a print out that can be used away from the computer, typically, in the workshop. Also, where only a limited number of values require inputting (HV, IVD and VD in this case) these can be changed and other sets of values obtained almost instantaneously.

I am including a copy of the infeed printout, table 1, that I used for producing the barrel shaped arm and from this it can be seen that the infeed progressively gets greater along the length of the arm, which is from two tenths of a thou to eight thou. Again when viewing this to eight decimal places, the results were identical to those using the CAD route. This was reassuring, as because no formula needed to be entered in the case of using the CAD program, it confirmed that the formula that I had been using both manually and in the spreadsheet was in fact correct. I often find this useful to confirm that a formula that I have developed is correct.

In the next issue I will return with examples of using the milling head, some quite complex.

Table 1

AMOUNT OF TOOL INFEEED TO CREATE THE REQUIRED CURVE

CURVE RADIUS SEE Sk. 5

VERTICAL DISTANCE	HORIZONTAL VARIATION	CURVE RADIUS
1.6250	0.1094	12.13

SADDLE FEED BETWEEN TOOL DEPTH CHANGES = 0.0625

TOOL INFEEED

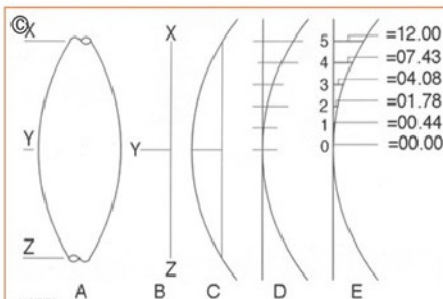
Position Number	Saddle Feed	Tool Infeed
0	0.0000	0.0000
1	0.0625	0.0002
2	0.1250	0.0006
3	0.1875	0.0014
4	0.2500	0.0026
5	0.3125	0.0040
6	0.3750	0.0058
7	0.4375	0.0079
8	0.5000	0.0103
9	0.5625	0.0131
10	0.6250	0.0161
11	0.6875	0.0195
12	0.7500	0.0232
13	0.8125	0.0273
14	0.8750	0.0316
15	0.9375	0.0363
16	1.0000	0.0413
17	1.0625	0.0466
18	1.1250	0.0523
19	1.1875	0.0583
20	1.2500	0.0646
21	1.3125	0.0712
22	1.3750	0.0782
23	1.4375	0.0855
24	1.5000	0.0931
25	1.5625	0.1011
26	1.6250	0.1094

Dimensions are in inches

References

1. GLR Distributors Unit No. 3
Gresley Close, Drayton Fields
Industrial Estate, Daventry,
Northants. NN11 8RZ tel. 01327
878988 fax. 01327 876396 E-mail
peteglr@btopenworld.com
www.modelmakingsupplies.co.uk

2. Holes on a PCD (The mathematical method), MEW Issue 100 page 18.



NOTES:
A. THE BARREL TO BE TURNED SHOWING THE MAX. & MIN. DIAMETERS
B. MAX. (Y) & MIN. (X & Z) DIAMETER POSITIONS MARKED
C. CIRCLE DRAWN BASED ON THE THREE POSITIONS (X, Y & Z)
D. THE FIVE TOOL INFEEED POSITIONS MARKED
E. LINES TRIMMED & THEIR LENGTHS (TOOL INFEEED) REQUESTED

FOR CLARITY OF THE EXAMPLE THE BARREL HAS A LARGE CURVATURE & LESS INFEEED POSITIONS THAN THE PART BEING DESCRIBED IN THE TEXT

Sk.8 Using CAD to determine tool infeed values

A MINIATURE PIN TYPE PRECISION VICE

Jim Whetren holds tight.

Background

To improve work holding on my milling machine, I have purchased a Soba precision vice from the Chronos catalogue. The vice is ground all over, allowing clamping on its sides or end. When the jaw is tightened, it is pulled forward and downward, reducing any tendency to lift, **photo 1**.

The catalogue also showed miniature versions of this type of vice and I thought such an item would be very useful. Using a piece of 1½in. x ½in. mild steel flat bar and a piece of ¾in. square bar, a base could be built up, and a piece of 1in. square bar would serve for the moving jaw. What follows is my attempt to make a 1½in. version of the vice with a 65mm capacity.

Photos 2 and 3 show the finished vice and **photo 4** shows the component parts. See also drawing GA Pin Type Precision Vice.

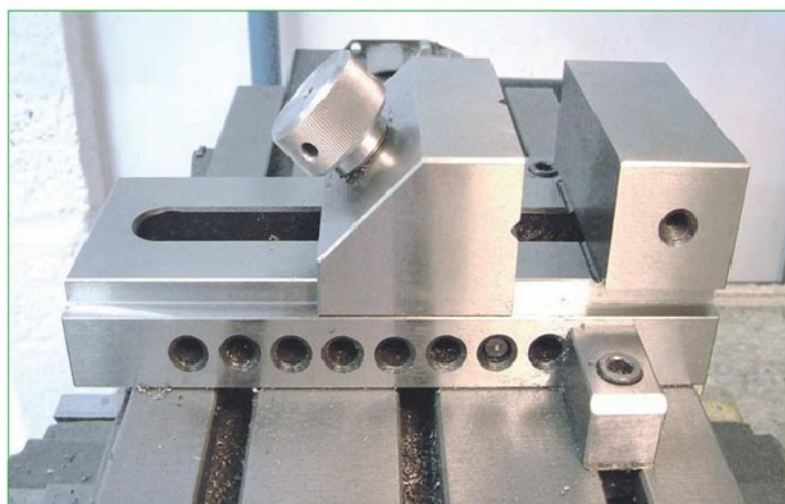
The body

Fig. 1

A piece of the flat bar was squared up on the ends to a length of 110mm and one side dressed with a file for the pin hole positions to be marked down the centre of this side. These holes were then carefully drilled through 5mm diameter and countersunk to a depth of 1mm on both sides, **photo 5**.

A centre line was marked on one of the wide faces and the centres of the ends of the slot marked and punched. Two 6mm diameter holes were drilled at these marks and the piece mounted in the milling vice on parallels to give a clear passage for cutting the slot.

With a 6mm slot drill mounted in the chuck, and the cutter aligned with the left hand hole, cutting commenced with 2mm down feeds, travelling left to right to the



1. The Soba vice in use.

stops for each cut until through at the bottom. The cutter was then replaced with a ¾in. (9.5mm) slot drill and the process repeated.

With the table locked, a 10mm end mill was slowly fed down to full depth and the table released to carefully traverse along the slot until it just made contact with the end where it was withdrawn and the table moved the last bit to contact the stop and locked. The cutter was again fed down to depth and the table released to take a final cut to the beginning. This yielded a straight slot with a good finish to the sides and ends, **photo 6**.

A countersink bit is fed down to a cut of 0.5mm and traversed to the end of the slot, providing a neat chamfer around the slot. This chamfering was repeated on the other side of the slot.

Clamp the base to the mill table, pushing against a snug fitting parallel in the rear T slot. Also use a piece of flat stock secured to the table at the front to keep it in place.

With a 10mm end mill, take the first pass along the front, 2mm deep with 3mm in-feed.

Add 0.5mm to both feeds and repeat. Measure the step to determine the exact amounts for the final pass. Reverse the piece and repeat this procedure for the other step.

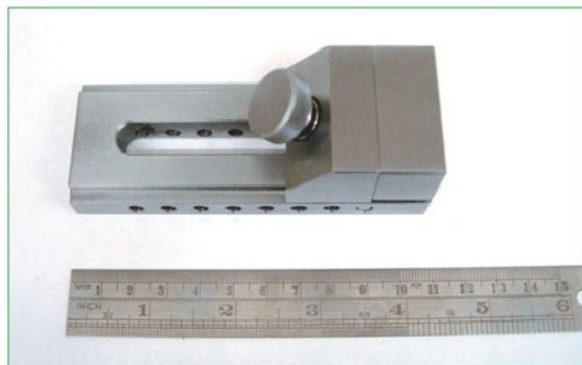
Making sure you are at the right end, mark and punch the positions of the holes for the fixed jaw securing screws and dowel pins. Drill the screw holes M5 tapping size and the pin holes 3mm, **photo 6**.

I also provided slots for clamping on the ends by plunging a 16mm x 4mm woodruff cutter 5.5mm deep on the centre line. You could also mill from the top to provide clamping clearance instead of using a woodruff cutter, **photo 7**.

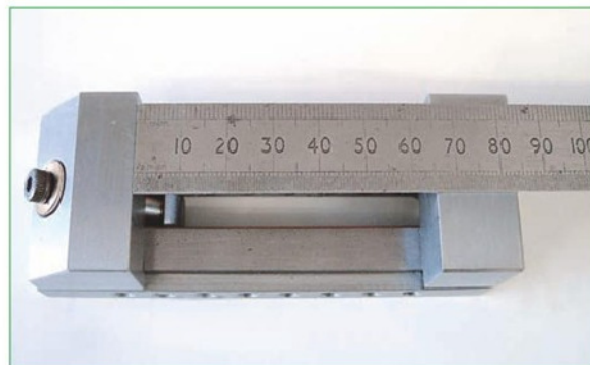
Fixed jaw

Fig. 2

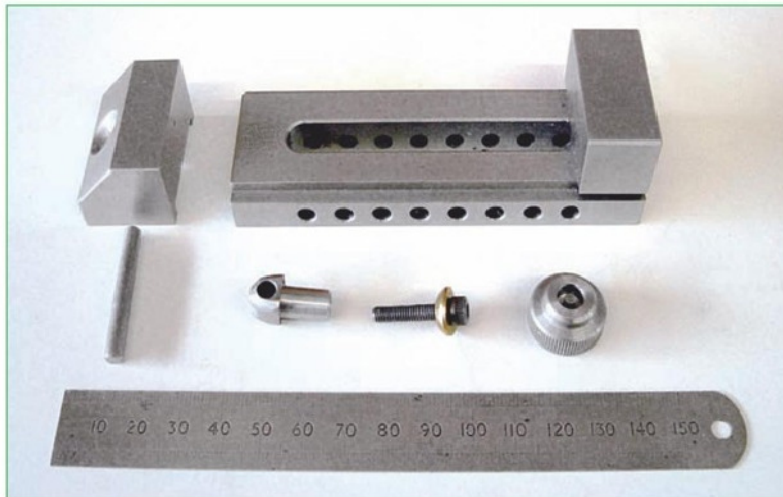
Cut a piece of ¾in. square bar 40mm long



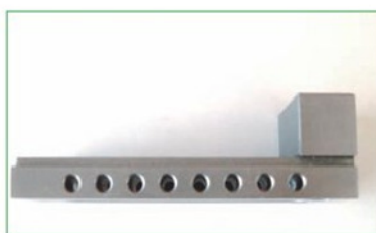
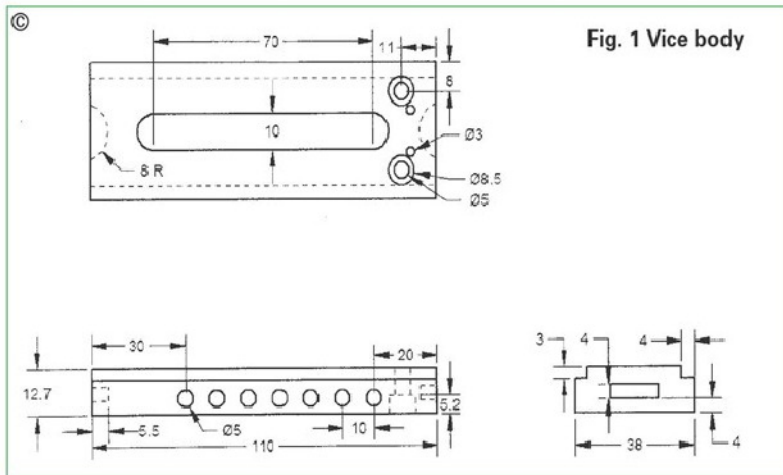
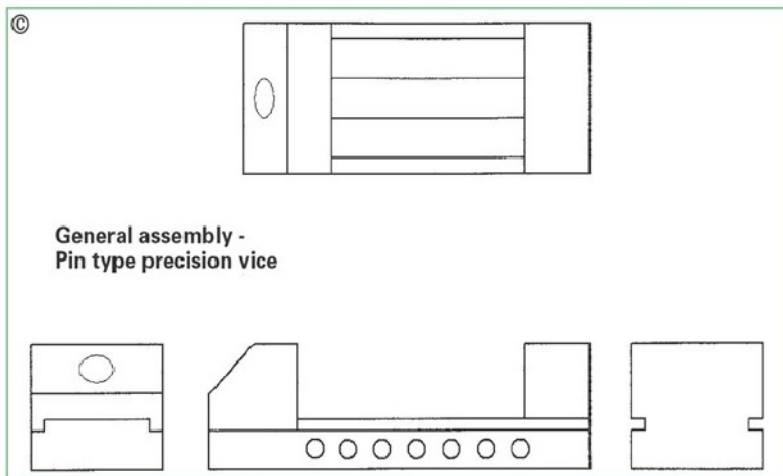
2. The finished miniature vice.



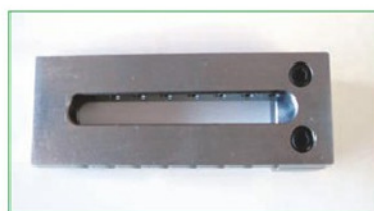
3. The vice showing capacity.



4. The component parts.



5. The base and fixed jaw.



6. The base showing central slot and fixed jaw holes.

and draw file all sides to a good finish, ensuring all faces are square to each other. Either face or mill the ends to clean up and bring the piece to length.

Use a square to align the jaw piece flush with the end of the base and clamp it in place to leave the screw pilot holes clear, again check with a square after tightening the clamp. Drill through the first hole to a depth of 14mm, checking nothing has moved before drilling the second hole. Remove the clamp and tap the holes in the jaw.

Open up the holes in the base to 5mm and counterbore 8.5mm, flat bottoming the holes to a depth of 5.2mm, or whatever is needed to bring the heads of the screws just below the surface.

Assemble the pieces using the square to keep the ends flush and when all is well, firmly tighten the screws. Drill the dowel holes to depth in the jaw and press in the dowel pins. Draw-file the bottom to remove any burrs from the counterbores and to bring the dowels flush.

Moving jaw

Fig. 3 and photo 8

Cut off a piece of 1in. square bar 40mm long and clean up the sides and face or mill the ends to length. Although one side is over width, leave it for now as a backup for cutting the slot at the bottom. Scribe a centre line for the slot and mount the piece by its ends in the milling vice.

Set the line central and lock the Y feed, zeroing the dial after taking up any backlash. With a 10mm end mill, take a 2mm deep pass down the centreline, followed by a 1mm pass. Check that the slot is actually 10mm wide and in the direction you took up the backlash. Put on a feed of 9.5mm and relock the Y feed. The feed needs to be into the cut, so move the table to the appropriate end and again take cuts of 2mm followed by 1mm depth. Measure one of the steps in the base and compare this with the remaining land on the jaw. Apply the required Y feed and take another pass.

Take up backlash in the opposite direction and zero the dial on the Y feed. Move the feed 19.5mm in this direction and take the two passes. This time, measure between the steps in the base and compare with the width of the slot. Apply this amount of Y feed, minus 0.1mm and take a cut in the appropriate direction of about 10mm and try the base, which needs to be a firm sliding fit. Take further light cuts until this is achieved, then complete the final pass. Clean up all edges and try the fit on the base. If still on the tight side, rub each side of the jaw slot along a fine flat file with a safe edge to get a smooth sliding action.

Mark out the amount to be removed from the top to bring it level with the fixed jaw and remove the excess material. Mark the lines at 9mm and 13mm as Fig. 3 for the edges of the bevel and carry these



7. The woodruff slots in the end.



8. The moving jaw.



9. The toggle pocket.



10. The toggle.

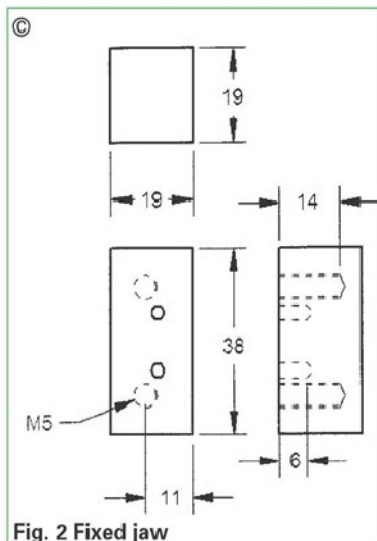


Fig. 2 Fixed jaw

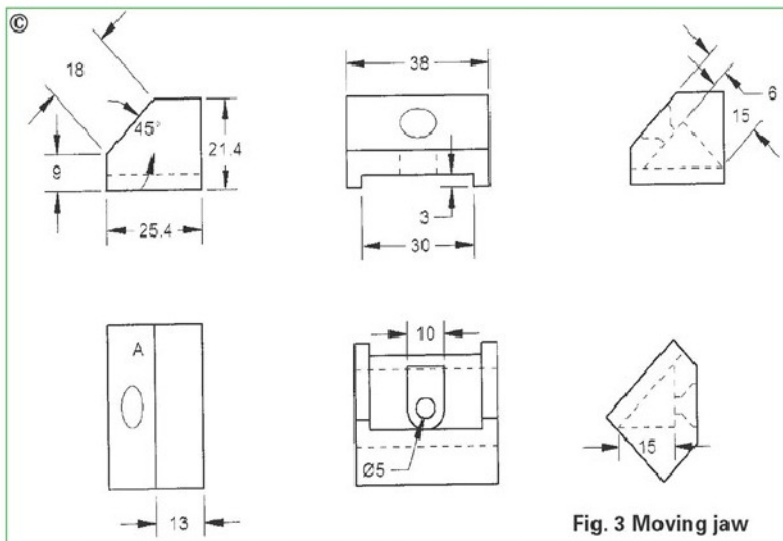


Fig. 3 Moving jaw

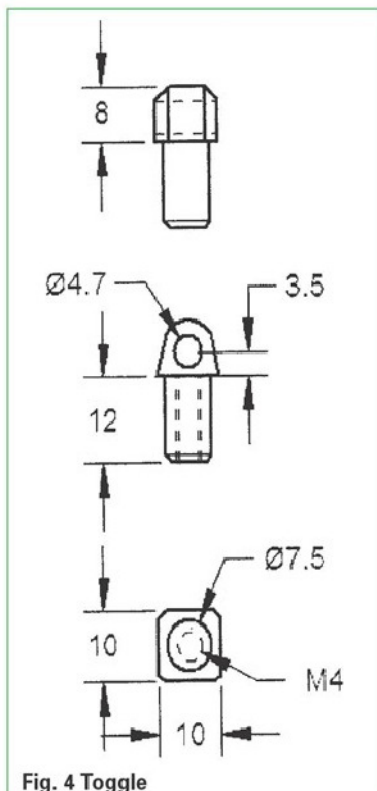


Fig. 4 Toggle

marks around the ends. Saw off the excess just clear of the lines. Holding by its ends, set the jaw in the mill vice on a small vee block to finish the bevel with a fly-cutter.

Mark the position of the 5mm diameter hole and drill this just short of breaking through. With a 1/2in. countersink bit,

countersink to the full width of the cutter. If a ball ended cutter is available of this size, a better job can be made by feeding this down 6mm. Remove the V block and use the 5mm drill to align the piece in the vice again to finish the hole.

Set the jaw in the vice resting on the bevel (A) and use the drill to align the 5mm hole centrally. Open the hole in stages to 10mm x 15mm deep at the full diameter. Replace the drill with a 10mm end mill and take 2mm cuts until the toggle pocket is 15mm deep, photo 9.

Toggle

Fig. 4 and photo 10

Set a piece of 10mm square bar in the 4 jaw chuck with about 20mm protruding and face the end. Drill and tap M4 to a depth of 12mm and deeply countersink. Turn down to 7.5mm Dia for a length of 12mm, and then part off leaving a 8mm length of square material. Drill the 4.7mm (3/16in.) cross-hole as per Fig. 4 and leave for now.

Washer

Fig. 5 and photo 11

Holding a piece of 1/2in. diameter material in the three-jaw chuck, turn down a 4mm length to 11.5mm diameter if using the countersunk hole, then form a 7mm radius on the end. Drill 4mm diameter x 5mm deep. Polish the radiused end and part off to leave 0.5mm of parallel material after the radius as per the sketch.

Pin

Fig. 6 and photo 12

This is just a 37mm length of 1/2in. diameter rod chamfered on both ends.

On both of these vices, I found that turning the respective jaw tightening Allen

screws with the fingers to initially set the jaws was unsatisfactory, as was using an Allen key.

My answer was to make a knurled knob bored to a close fit on the screw head, with a piece of hexagon key pressed into the bottom of the hole to fully engage in the socket with the knob fully covering the head. In fact the larger knob has three radial holes to accept a tightening pin for the final tightening of the vice and this is used exclusively.

Knob

Fig. 7 and photo 13

Knurl 12mm on the end of a piece of 19mm diameter bar and reduce 4mm long to 13mm diameter. With a 90deg. V tool, chamfer the end and the edge of the knurling on both sides. Traverse the tool to the left of the knurling by the width of the parting blade to give it a good start.

Drill the end 6.7mm diameter to a depth to fully engage the head of the screw, and drill into the bottom of this hole 3.5mm for 2mm and at 3mm for a further 4mm deep. Use a 5mm drill to provide a small lead in chamfer.

Cut 7mm off the leg of a good quality

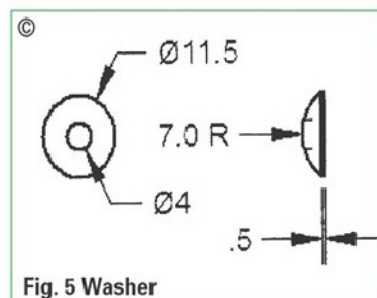


Fig. 5 Washer



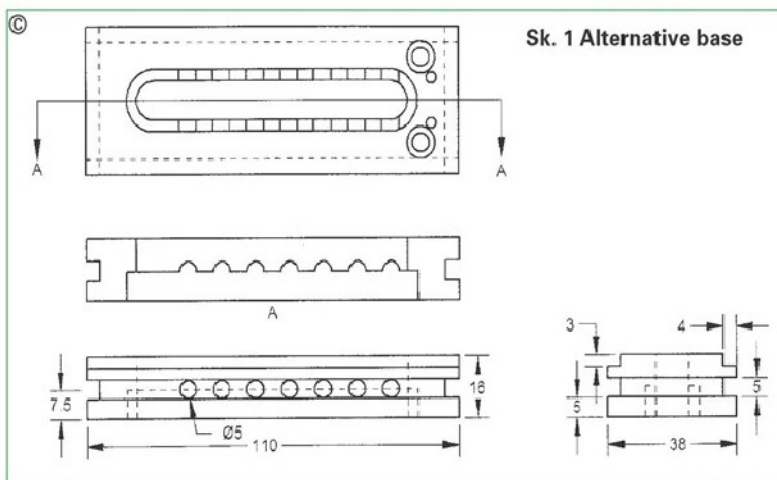
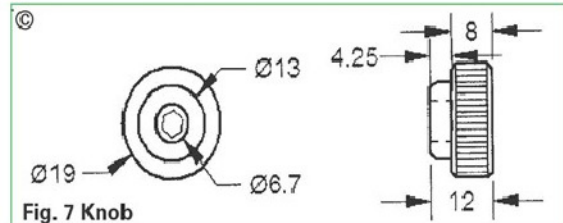
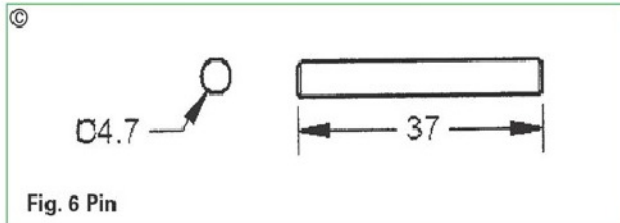
11. The spherical washer.



12. The clamping pin.



13. The tightening knob.



Allen key by scoring all round and snapping it off. By far the best way to score the key and also HSS tool bits is to use a cut off disc in a mini drill, thereby preserving the pristine corner of your bench grinder's wheel.

Form small chamfers on one end of the piece of hexagon key and grind the other end square, leaving sharp corners.

Grip the chamfered end in the jaw tips of the tailstock chuck and bring it up to the knob. Use the tailstock feed to start the key

into the hole, making sure it is in quite tight then release the tailstock and move it out of the way for parting off the knob.

Press the key in flush using the bench vice and insert the shortest M4 Allen screw you can find, using this as the means to complete the pressing so there is full engagement with the key when the head is fully covered.

Assemble the screw, washer and toggle to the moving jaw and bring the jaws together. Insert the pin in the first hole and check that the jaw will tighten fully. Slacken the jaw and check that it will open at least 12mm. Some final tweaking of the screw seat and hole may be required. With the jaw fully forward and back, observe underneath to see what has to be removed from the toggle to keep it below the base of the vice. The final shape is as Fig. 4.

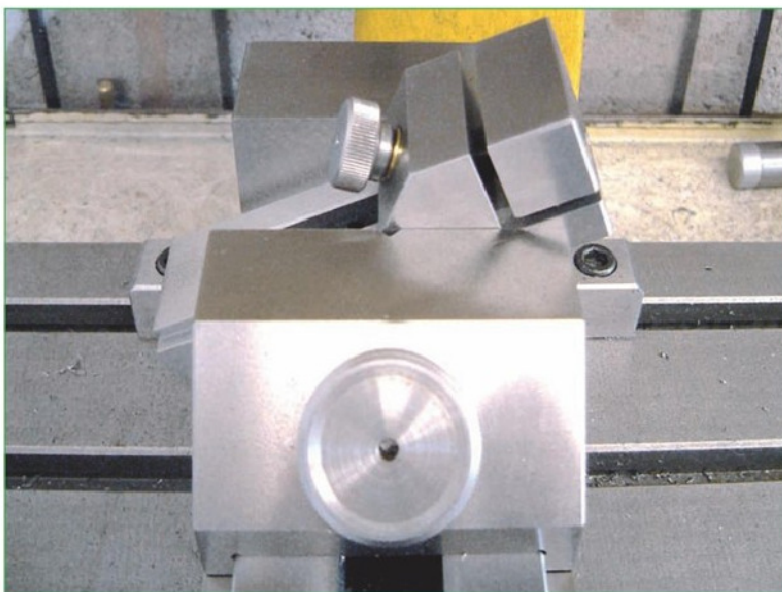
Finishing off

Assemble the vice and lock the jaws tightly, use a fly-cutter able to sweep the full width of the jaws to bring the tops level. Draw file all surfaces to a smooth finish and take a little extra material off the sides of the moving jaw. This allows the jaw to be released whilst still gripped in a larger vice, if it is to be used in this way. Chamfer all exposed edges and the vice is ready to go, photo 14.

Further thoughts

An alternative method of engaging the toggle is to fix a short pin to locate in 'half holes' in the base, which would need to be at least 16mm thick. After the 10mm slot is milled in the base, a further cut is taken at the bottom with a 16mm end mill to just break the centres of the pinholes. With a suitable length of pin fixed into the toggle, it only needs slackening to slide the jaw to a new position and re-engage the pin in another curved slot. Sk. 1 shows the idea for the more adventurous with a better stock of materials than I have.

Another advantage of this method is that it allows a 5mm slot to be milled down the sides along the line of the holes to provide for clamping down. As it is, I only had material this size so if clamping is required, it only needs to have a couple of clamps made with 5mm pins in the ends. This is the method used on my mill.



14. The finished vice in use.

A MOTORCYCLE LIFTING BENCH



1. The completed framework for the bench.

Background

Some time ago, whilst still occupying the **MEW** editorial chair, I mentioned that with the continually advancing years and attendant reduction in physical agility, a lifting bench would be an ideal accessory for work on motorbikes, certainly one which would cut down on backache. In the best traditions of the magazine, several readers offered comment. One sang the praises of a commercial item, another, Mr Robert MacKay had built an excellent unit from scratch, and Mr R. Tree sent details of a simpler version designed by Brian Pollitt, and publicised within the BSA owners club. As I had earlier been presented with the (working) remains of a two tonne trolley jack, and since this design used one of these, work progressed using this as a basis. More recently, other readers have been in touch with editor David Clark requesting more information, hence this article, which it must be emphasised has been compiled some time after construction. Thus almost all of the photos have been taken after the event.

Safety

When a picture of the frame, **photo 1** was published in issue 117, several readers

leapt aboard the safety bandwagon to point out that, at that stage, no mechanical provision had been made to guard against

Dave Fenner cuts down on backache with a motorcycle lifting bench.

hydraulic failure. Within the descriptive notes compiled by Brian Pollitt, the closing statement reads, "The final part you should add is a bar across from the rear lever arm to the base, which can be locked in position and is strong enough to support the total weight including motorcycle, in case the jack's hydraulic seals fail". This would suggest a fixed length bar to hold at a specific height. To add this safety feature and maintain full convenience, the prop bar really needs to be lockable at a range of height settings. Some solutions to this requirement embody a form of saw tooth ratchet arrangement.

My own solution to this has been not to add the extra component, but to operate with a car type axle stand located between base and table. This is shown in **photo 2** and allows locking at height increments of about two inches. At the time, I looked at some of the commercial products and it appeared that not all included the mechanical safety lock, so presumably there are varying schools of thought on this particular safety point.

General notes and modifications

It may be noted that when a bike is on the bench, the centre of gravity will be not far away from the upper pivots of the rear lever arm. This is therefore the arm doing the lion's share of the lifting work. The front arms function mainly to keep things steady and level. One aspect, which did concern me, was that when folded down, the front arms would be close to horizontal, and hence there might be some



2. Axle stand put in position for safety.



3. Height stops for the front arms.



4. Attachment angle for access ramp – also shows the ramp detached.



5. Tread plate stops centre stand digging into wood.

reluctance to pull up cleanly. I therefore chose to limit the downward movement of the front arms by adding a pair of stop plates. These are cut from 110 x 50 x 6mm plate and welded in place as shown in **photo 3** and keep the front arms a few degrees above horizontal.

The original Brian Pollitt design called for 35mm square steel tubing. This was a not a regular size available from my local stockholder, so the section was upped to 40 x 40mm (3mm wall thickness). As this would contribute a substantial increase in flexural stiffness, I felt justified in eliminating the doubler longitudinal base tubes, also the numerous triangular and trapezoidal gussets featured in the original. 12mm pivot bolts were originally

specified, however I have used M8, which should be amply strong, but will probably wear faster.

As regards the 2 metres by 70cm plywood top, 18mm thick was originally suggested, however as I had some spare 22mm this was put to good use. To allow the bike to be easily rolled on to the bench, a detachable ramp was added, again from 22mm ply, and locating on a length of steel angle shown in **photo 4**

A sheet of aluminium tread plate, **photo 5** was considered a worthwhile embellishment. This is attached to the ply top by screws and is positioned to take the inevitable abrasion from the centre stand. In some of the photos, two sets of wheels may be seen. The small steel wheels were

added to allow the bench to be moved within the workshop. The larger rubber tyred pair, **photo 6** are mounted on a detachable axle pushed through the end tube, and allow the assembly to be easily "wheel barrowed" around over rougher terrain.

My bench was built for personal occasional use. Anyone planning heavy usage should consider welding in tubes through the arm pivots, and also moving to heavier gauge pivot plates with original spec. 12mm pivot bolts

Construction

Construction is really very straightforward and does not call for great precision. The operations are essentially sawing, drilling

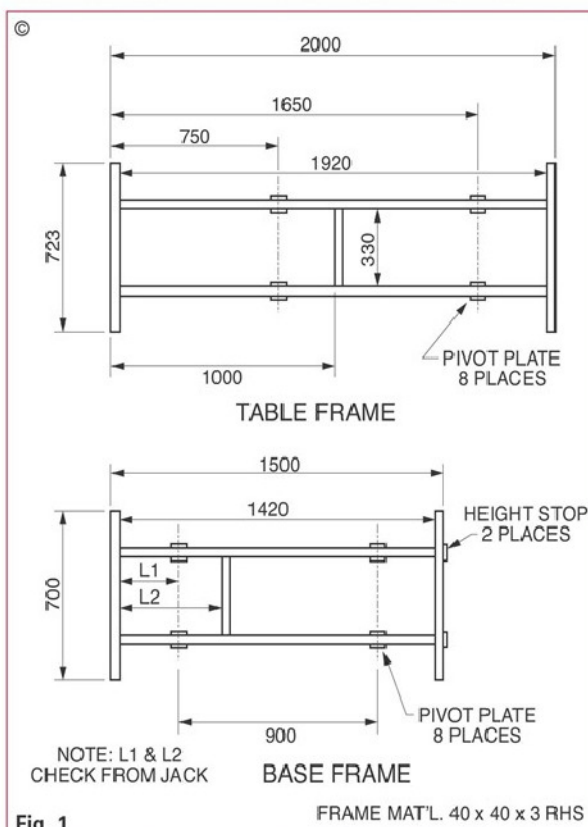


Fig. 1

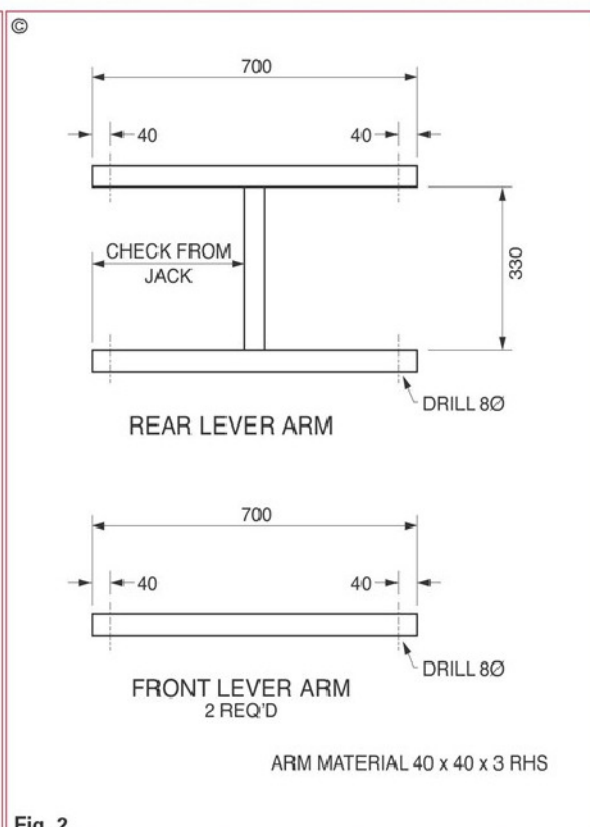


Fig. 2



6. Large detachable wheels make for easy moving.

and welding. It is however worth spending a little time to get the position of the jack optimised so before fabricating the base, start with the trolley jack, and remove its wheels. Mine came in near ready condition having been previously cannibalised for an abandoned school project.

You can also dispense with the parallel linkage and load cup. **Photos 7 and 8** show the stripped down jack in position. Because of the "work" already undertaken on the jack, I chose to locate its forward end by welding to a length of 40 x 40 x 5 steel angle, which is in turn bolted to the base frame cross member. For this reason, it is worth sorting out the attachment details before welding in the crossmember. As an alternative approach, it should also be possible to simply remove the wheels and axle, and bolt in, using a long M16 bolt or threaded rod.

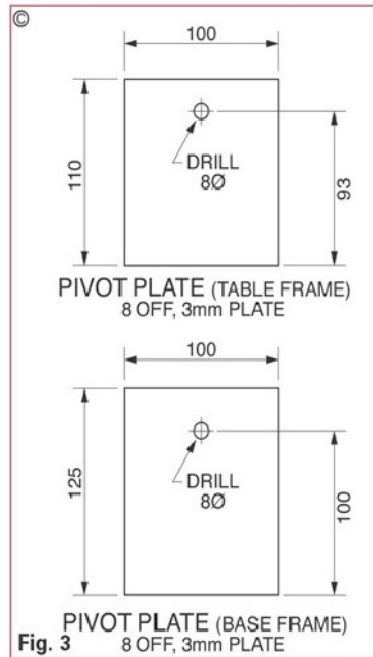
The base perimeter should be built up, then the jack located and the base crossmember attached. Now that the jack location has been established, it is possible to fix the position of the rear arm pivots. The aim here is to arrange the pivot bolts and the jack main pivot to be in line. This alignment is depicted in **photo 9**. If you do not get these dead in line, it is not the end of the world, but there will be some sliding movement, and hence abrasive wear, where the jack arm contacts the rear arm (**photo 10**). My procedure was to delay fitting the forward pivot plates until final fitting up with the table frame.



7. The jack front fixing point.



8. The jack rear fixing.



To make life a bit easier at the fabrication stage, I set the pieces up on a matched pair of joiners trestles, using a number of G clamps and metal flat bars to hold things in place while tacking up.

The components for the rear lever arm can now be tried in place, positioning the crossmember to contact the pad on the jack arm. Tack weld then remove, check for squareness and fully weld. It may be worth clamping the arms to minimise weld distortion. If the two side members

of the lever arm are not perfectly parallel, then it may be necessary to compensate with a slight adjustment to the table frame width.

The table frame was then built up and welded per the sketch. Here I had looked at the pivot plate sizes given for the 35mm tube and casually added 5mm height. This of course failed to take account of the bit of extra radius needed to clear the lever arms, so a small amount of corner rounding with an angle grinder was needed to save the day. The amended dimensions given now have added clearance.

The final part of the fabrication exercise is to assemble the base with jack, rear lever arm and table frame. The front arms are then bolted to the table, and their lower pivot plates added. With the table resting in its lowest position, jack fully retracted, front height stop plates in contact, the locations for these pivot plates can be determined and they may be G clamped then tack welded in place, prior to welding round.

Using the lift

For much general work, the bench functions perfectly as it is. However, there are occasions when an accessory such as front wheel clamp would be a useful addition. Mr Robert Mackay, of whom I made mention earlier, also sent me details of the one he had designed and built, but so far I have not progressed with this. Whilst rebuilding the Bonneville wheels, it did prove necessary to pull down the front end of the machine. This was done simply by using couple of lightweight ratchet straps, passed around and under the tabletop.



9. Alignment of lower pivots with jack arm pivot.



10. Contact between jack arm and rear lever arm.



1. Scribing from the centre.



2. Pricking for the divider point.

AN INTRODUCTION TO CROSSING OUT

Bill Morris puts his spoke in

The title of this article has nothing to do with correcting schoolwork but refers to the production of spokes on clock wheels. I can think of several reasons why clock wheels should have spokes and appearance is the least of them, as the wheels of most clocks remain hidden from view.

Tradition probably played some part in the early days of clocks, as wheels on vehicles had spokes, so why not wheels on clocks but until quite recently, the iron and brass, from which clock wheels were made, was very expensive and hard to manufacture so there was probably a cost incentive to keep the quantity of material to the minimum.

It is clear that by the end of the eighteenth century, some other reasons for keeping weight down had been appreciated, as evidenced by the delicate appearance of the wheels in regulator clocks by "greats" such as Benjamin Vulliamy.

The driving force

A heavy wheel will load its bearings more than a light wheel and will lead to more rapid wear, but more importantly, a clock's wheels and pinions do not revolve smoothly. Rather, they rotate in a series of jerks as the controlling mechanism of the escapement releases the power of the driving force at intervals that are hopefully even and regular.

With each beat, the inertia of the wheel train has to be overcome and since this is proportional to both the mass and the square of the velocity, the problem gets worse as the escapement is approached and the wheels revolve faster. The escape wheel itself interacts with the pendulum

and the lighter that wheel can be the better as it will then interfere less with the time keeping properties of the pendulum. So, there is much more to be said about spokes than meets the eye.

Craft skills preserved

Nowadays it seems, some clockmakers simply draw a wheel on their computer CAD program and feed it to their computer-controlled milling machine, which then chews out the metal between the spokes with a small milling cutter while they do something else. For many of us however, part of the pleasure of making a clock comes from using craft skills that have remained the same for at least a couple of centuries. This article aims to pass on some tips to beginning clock makers and perhaps there will be something for experienced amateurs working in other fields too.

Marking out

Crossing out begins once the teeth of the wheel have been cut, but it is helpful to mark out the spokes or "crossings" while there is still a centre punch mark at the centre of the wheel, unless of course you cannot rely on being able to drill a hole

that remains centred on the punch mark. This is sometimes the case when drilling through thin sheet brass and my own practice is to drill and ream the hole and mount the blank on an arbor, using the hole as the location for centring the teeth. How then do I mark out from a centre that is no longer there? I keep a little collection of discs bearing a fine centre mark for a compass point, made by a sharp tailstock centre before parting off the disc. In **photo 1**, you can see a disc occupying the 4 mm hole in a wheel, providing a centre for a pair of spring-bow dividers to mark out three circles. One for the hub, one for the inside of the wheel periphery and a third one that lies very close to the roots of the teeth. This last one is used only for marking out the spokes. Scribe lightly, for the deeper you scribe, the more work you will have to do when you come to finish and polish the faces of the wheels.

The number of crossings

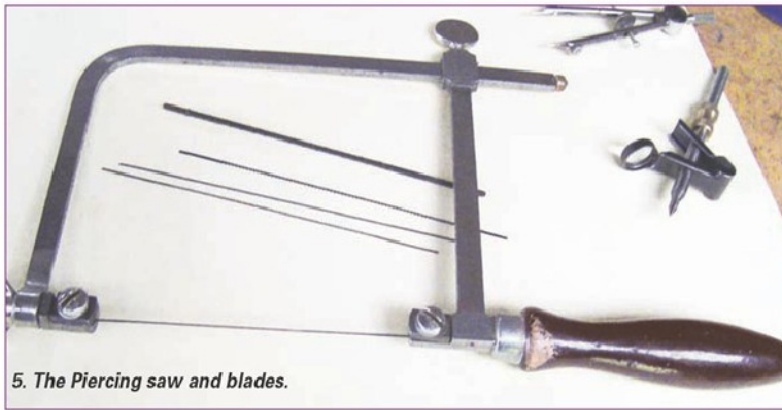
At this point you have to decide on how many crossings there are to be and this of course depends on a compromise between strength and lightness. Perhaps there were originally four crossings, but in older clocks that I have examined, five seems to



3. Marking the first side of the spoke.



4. Marking the second side of the spoke.



5. The Piercing saw and blades.

be the commonest number, six are slightly easier to set out and I make a habit of using only three in my escape wheels.

If you decide on six or three, the next step is very easy. Keeping the dividers set at the diameter of the largest circle, you step around that circle and if you do so accurately, you should end up back where you started after six steps. Make short scribe marks across the circle as you go and be very careful that the other point of the dividers doesn't slip as you do so.

Dividing into five is slightly more difficult and I recommend that you make a very fine mark with a sharp pointed punch to start with, as shown in **photo 2**, just deep enough to be able to feel the point of the dividers slip into it. You then step around the outer circle, adjusting the dividers until you arrive back at the starting mark having divided the circle into five steps. This is

after all, why they are called "dividers". This needs care and a light touch as, on the one hand, you don't want to make marks that the divider points will find in error and on the other hand, you don't want the points to skid off the metal. Once you have got the dividers set right, mark off little arcs on the outer circle. These will be used after the next step.

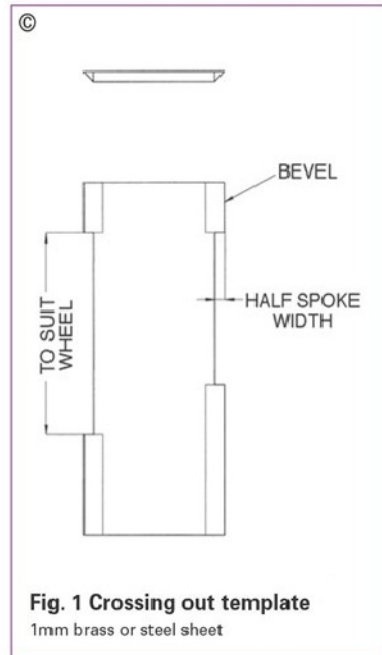
Templates

Now you will be well advised to make a template so that all your spokes are the same thickness. Uneven spokes look amateurish. A template can be made from a small piece of scrap brass or steel sheet about a millimetre thick. Simply file one edge straight and smooth, bevel it and then file a notch in it half as deep as your projected crossings are to be wide and slightly longer than the space between the hub circle and the circle that marks the inside of the wheel periphery. **Fig. 1** shows a two-sided template and it can be seen in use in **photo 3**.

The edge of the template is lined up with the centre and with a scribe mark on the outer circle and the edge of the spoke marked out from the notch. I am right handed so I do all the left hand edges first, with the template up (shown shaded green in **Fig. 2**) and then do the opposite edges with the template down as in **photo 4** (shown shaded blue in **Fig. 2**).

Cutting out

All that remains is to remove the metal between the marked out spokes. Some people like to make punch marks along



lines so that when the marks are halved they know when the line, possibly no longer visible, has been reached. I like to do so too, at each end of the lines only, in case for some reason I later lose the line. However, I make only the very lightest of marks, using a very fine prick punch provided with a magnifying glass to aid location, and pressing down quite lightly using hand pressure only. Remember that any deep scribe or punch mark will have to be removed later at the cost of much elbow grease.

The best tool for cutting out is a proper piercing saw, **photo 5** but I made do for years with a cut-down fret saw, trimming a bit off the piercing saw blades to make them fit. Piercing saw blades are very narrow and have very fine teeth with no set and are sold in bundles of a dozen, varying from 0.5 mm thick and tooth pitch of 11 per cm to 0.18 mm thick and pitch of 32 teeth per cm. The finer ones are quite fragile and you should not be too upset if you break them quite frequently, as they are reasonably cheap. Buy Swiss ones if you can.

The general rule that at least two teeth should be in contact with the work can



6. Cutting straight.



7. A third hand.



8. Turning a corner.



9. Nearly home.



11. Barrette files.



10. A collection of cheaters.

serve as a guide to the maximum tooth pitch to use. Using a finer pitch than this makes it easier to keep to the line. Some people advocate lubricating the blade with candle wax. My own experience is that the wax strips off the blade quickly and obscures the line while being more difficult to blow away than dry brass filings.

The piercing saw is used while sitting down with the work held horizontal on a board and cutting on the down stroke. It helps to have extra illumination and some magnification, so that you can see the lines clearly, as shown in photo 6. Those with strong fingers who have had a lot of practice often hold and manoeuvre the work-piece by hand. I almost invariably clamp the work to the board so that I can use two hands to guide the saw.

To keep my head behind the saw, where I can see the line and the blade, I shuffle round on my seat. It is the work of a moment to loosen a clamp to change the orientation when I run out of seat. Whether you clamp the work to the edge of the board or over a vee notch cut in its front is largely

a matter of preference. I tend to start by clamping at the edge and, as the wheel gets more fragile, move to a vee-notch, where it can be supported each side of the cut if necessary. Forcing the blade through the work makes it harder to keep to line and results in broken blades. It should not be necessary if the teeth are sharp and well formed, as Swiss blades invariably are.

Before you can start to cut out, you will need to drill some holes inside the corners made by the spokes with the periphery, to allow the blade to pass through. Except in very large wheels, only one per segment is needed. **Photo 7** shows how to thread the blade and attach it to the saw frame without needing more than two hands, one of which wields the screwdriver. You can then clamp it as shown in **photos 6** or **8** and start to cut.

As in any sawing activity, the closer you get to the line, the less finishing you have to do. When you get to a corner, you have to keep the saw going up and down without advancing it, while you turn the saw around the corner, photo 8. The narrower the blade, the easier this is, but it is one of the times when blades get broken, so use short fast strokes as you turn the saw frame (or the work piece if you don't use clamps). Another time when blades frequently break is when changing the workpiece orientation before re-clamping. Letting the end part of the blade that has no teeth enter the cut until the frame rests on the workpiece seems to reduce this risk somewhat.

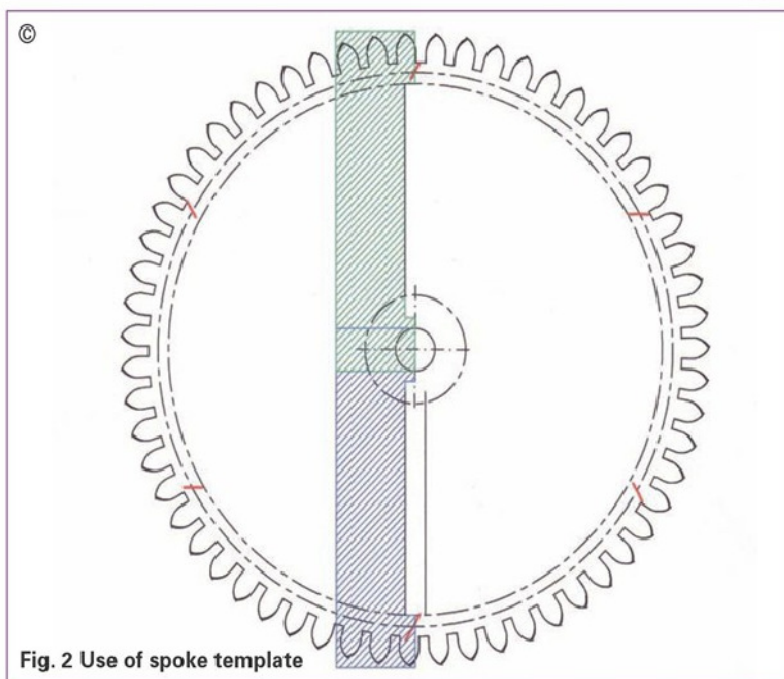


Fig. 2 Use of spoke template



12. Filing the crossing.



13. Filing the periphery from left to right.



14 Filing the periphery from right to left.



15. Filing the hub.



16. Draw filing with a barrette file.

Filing jigs

Once you have made the final saw cut, **photo 9** you can think about getting out your files and finishing off to the marked out lines. No doubt this could be done entirely by eye by those who did nothing else for their livings, but it does help to use what are picturesquely known as "cheaters" when forming the hubs. A cheater is two short hardened steel cylinders with the same diameters as the hub. They are mounted on a close fitting threaded mandrel of the same diameter as the hole in the wheel, one on each side of the wheel. A selection is shown in **photo 10**. I don't know whether the other filing jig in the photograph is also called a cheater, but it is extremely useful when it comes to doing the periphery of the crossings out.

For making just a few wheels of a particular size, it can be made of a close-grained hardwood, though I have found that 6mm Paxoline, donated by a friendly electrician, wears better. It is scarcely worth the trouble of making one out of hardened steel. Mild steel wears very well but at the cost of possibly blunting the files. It does not seem to be generally known that files do not cut well on brass after being used on a harder material. I keep a set of files that I use only on brass and identify them by painting a yellow band on them at the handle ends, visible in several of the photos.

The jigs are simple to make by mounting a square of material in a 4 jaw chuck and boring a hole right through at the diameter of the periphery of the crossing out followed by a recess into which the whole wheel will fit snugly, slightly shallower

than the wheel is thick. This is an occasion where a sharp corner is needed or, better still, a tiny undercut.

Choice of files

Depending on the size of the wheel, most of the filing can be done with half-round files with the edges lightly stoned off. You don't want the edge to cut in to something you've already finish filed, but on other hand, you want to be able to form corners using the round and flat bits. To get into the corners to make them sharp, use a barrette needle file, **photo 11**. Its name comes possibly because of its resemblance to a cardinal's biretta hat, barrette in French. It has teeth only on the flat side and two uncut planes that intersect at an obtuse angle form the back. The cheaters used with the jig make filing and holding the wheel much easier.

Photo 12 shows a crossing being filed with a half round file. To form the concave surface at the periphery, again use a half round file. File from the left hand corner to the centre and stopping short of the opposite corner, **photo 13** and then work from the opposite corner, **photo 14** to avoid marking the crossing. For the convex hub surfaces, I find a small square file with the teeth stoned off two opposite surfaces easy

to use and you should not hesitate to modify files to do the job, **photo 15**.

Finishing off

This is done by draw filing, either with barrettes or half round files of progressively finer cut, **photo 16** followed by wrapping emery paper around the files to polish the surfaces. **Photo 17** shows a 96-tooth wheel in the cheater used to file it, all ready to be polished on the face. The faces of the wheel can be polished by rubbing face down on progressively finer grade wet and dry emery paper lying on a flat surface and immersed in water to which a drop or two of washing up liquid has been added.



17. The finished wheel ready to polish.

INDEX FOR ISSUES 117 TO 128 OF MEW

The information contained in this index supplements that published in issue 118 and brings the information up to issue 128. A computer based index is also available for those with suitable equipment to run the software.

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2	Autumn	1990	31	Sept/Oct	1995	64	February	2000	97	April	2004
3	Winter	1990/91	32	Nov/Dec	1995	65	April	2000	98	May/June	2004
4	April/May	1991	33	Jan/Feb	1996	66	June	2000	99	July	2004
5	June/July	1991	34	March/April	1996	67	August	2000	100	Aug/September	2004
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7	Oct/Nov	1991	36	July/August	1996	69	November	2000	102	November	2004
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9	February/March	1992	38	November	1996	71	Jan/Feb	2001	104	Feb/March	2005
10	April/May	1992	39	December	1996	72	March/April	2001	105	April	2005
11	June/July	1992	40	Jan/Feb	1997	73	May	2001	106	May/June	2005
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17	June/July	1993	46	November	1997	79	January	2002	112	February	2006
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Model Engineers Workshop Computerised Index

The computer index is available from CAHW. It is supplied in DOS format on two floppy disks with a full manual. Facilities are included to VIEW, SEARCH, SORT, EDIT, UPDATE and PRINT. Cost is £10 for full version and £6 for update; non-UK orders should add £2 carriage. CAHW are at 43 Waller Drive, Banbury, Oxon. OX16 9NS

TAILSTOCK DRILLING DEPTH MEASUREMENT

Dave Fenner adds demountable accuracy to the Super 7 tailstock

Back in 1979, when my first lathe, a Myford ML7 gave way to a Colchester Bantam, one of the advantages that rapidly became apparent was the indexable micrometer ring graduated in thous on the tailstock hand wheel. This is a feature usually found on quality toolroom lathes and meant that at least in theory, holes could be drilled to a depth of that accuracy.

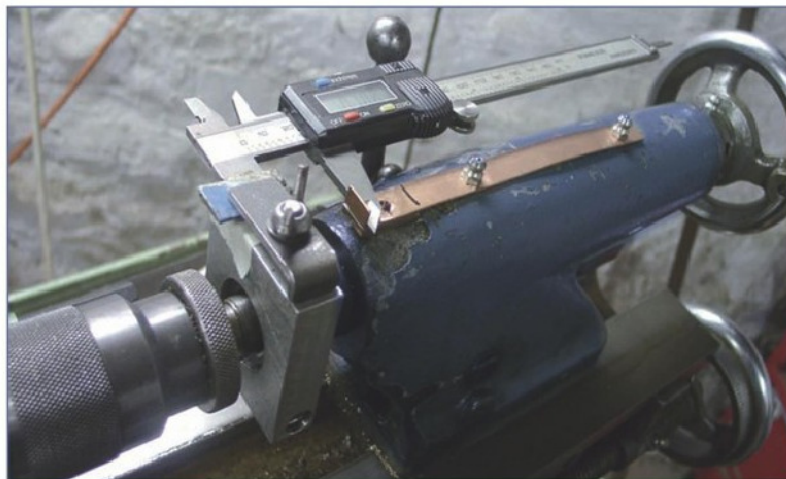
When, in the mid 90's, the Chipmaster replaced the Bantam, the same facility was again present, **photo 2**. More recently again, a Myford Super Seven was added to the plant list, and here, as with the ML7 the tailstock does not have a graduated dial. Here one must either rely on the barrel markings, **photo 3** or add a hollow stop to the drill itself. The S7 advances the tailstock barrel some 0.3 in. per revolution of the hand wheel and so a micrometer ring would have rather fine divisions.

I believe that others have added digital scales to their tailstocks, but decided that as I already had a couple of six inch digital callipers, it might be worth investigating the possibility of using one of these in a manner that would not call for irreversible modification of the tool so that it could be taken off to be used for normal measuring.

The development process

All that we really need is some form of bracket to support the calliper and give it something to measure against. A clamp was concocted which locks on to the tailstock barrel then holds the calliper in place. It was originally hoped that the adjacent oil nipple could be used to locate the other jaw, but this meant that the depth rod protruded to the right hand side, **photo 4** and obstructed access to the hand wheel.

As I try to avoid drilling holes in machines, I added a "jaw stop" made from a length of 12mm x 1mm copper. $\frac{3}{16}$ diameter holes were punched to allow this to be held in place by the two oil nipples, although short 2 BA screws might also be used. I used copper for convenience, but brass or steel would be suitable alternatives. One end was bent up at



1. The brackets fitted and the calliper clamped in place.

90deg. ensuring that the inside of the bend really was sharp, as any radius would encourage variable readings.

A quick trial at this stage looked encouraging but it was found that with relatively little force, the calliper could rotate on the clamp, losing its datum. The immediate solution pursued was to add a clamp for the second jaw on the copper jaw stop. This was done by soldering a piece of 12mm x 3mm at the end, on the underside, filed to meet the contour of the tailstock casting. It was then drilled and tapped M5. The second clamp proved to be a blind alley. This was because my lathe has significant wear in the barrel key, which then allows the barrel to rotate a visible amount. This slight relative rotation between the two clamps meant that they were fighting each other, upsetting the positioning of the calliper.

The solution was to keep the 3mm reinforcement, as this firmly fixed the copper bracket height, and then to improve the clamping at the aluminium bracket. This was done by laying a strip of masking tape on the aluminium, and placing a piece of card between the steel clamp and the calliper jaw. As the right hand calliper jaw is not now fixed to the tail stock casting, it is necessary to move it by hand to contact the stop. Care here should also be exercised when peck drilling.

Construction

Fig 1 shows the basic layout of the aluminium clamp, **photo 5**. My procedure was first to saw roughly to size then deal with most of the milling operations. The opportunity was taken here to try out an industrial "roughing cutter". These are characterised by what looks like a screw thread running up the body of the cutter. For industrial applications they give high rates of stock removal. However the downside is that the surface finish has a series of fine grooves and it was therefore decided to take a finishing cut with a conventional end mill. The two positions for the M6 stud and the cap screw were drilled and tapped, and that for the cap screw counterbored. It is worth checking the depth of hole for the stud carefully as if this is taken too deep then it breaks into the bore causing interrupted cutting as the final diameter is approached when boring.

As you are aiming for a close fit over the barrel, it is worth measuring the diameter carefully, mine came in at 1.115in., and turning up a gauge piece, which can then be used to test the bore diameter as it approaches finished size. The work was then marked out and centre punched for the location bore, before being gripped in the four-jaw chuck for centring up, **photo 6**. It was then bored to fit the barrel after



2. Indexing ring fitted to Chipmaster tailstock.



3. Barrel graduations on the Super seven.



4. The depth rod interferes with the hand wheel.

which it was then back to the mill to cut the slot with a slitting saw.

The steel clamp bar, **Fig 2** was cut over length from 3mm plate, then folded, **photo 7**. Adding length gave a bit more to get hold of when folding. It was then cut back to size and filed to remove burrs. A 6.3mm clearance hole was then drilled for the location stud.

For the jaw stop, **Fig 3** the copper strip was simply cut and folded, then the two holes punched $\frac{3}{16}$ in. diameter using a Roper-Witney hand punch. The positions of these were determined by measurement of the positions of the oil nipples. As mentioned, a piece of 3mm copper was added on by soft soldering, **photo 8**. The original intention was to form a second clamp, but with the underside filed away a little to bring the brackets to a common level, this proved useful in adding to rigidity.

In use

Unlike the ML7, the Super 7 has a self-ejecting tailstock so that as the barrel is wound back close to its limit, the Morse taper is released. Most of my MT2 accessories have the usual tang, and these are ejected about $\frac{3}{4}$ in. before the limit. Thus for most of the time, the aluminium bracket may be left in place. Some centres have no tang, and to release these, the clamp has to come off as the barrel needs to be wound right back.

In any case, from a standing start, it should take only a minute or so to assemble the bracket plus jaw stop and then locate the calliper. It is quite an easy matter to align the bar of the calliper with the edge of the lathe bed by eye. The moving jaw is then pushed against the stop. It is then a newfound luxury to be able to move the drill to touch, press zero, and then drill accurately to the required depth without guesstimating from the barrel markings. The heading photo shows the brackets in place and the calliper clamped in position.



5. Card packing protects the aluminium in the chuck.



6. The steel clamp after folding

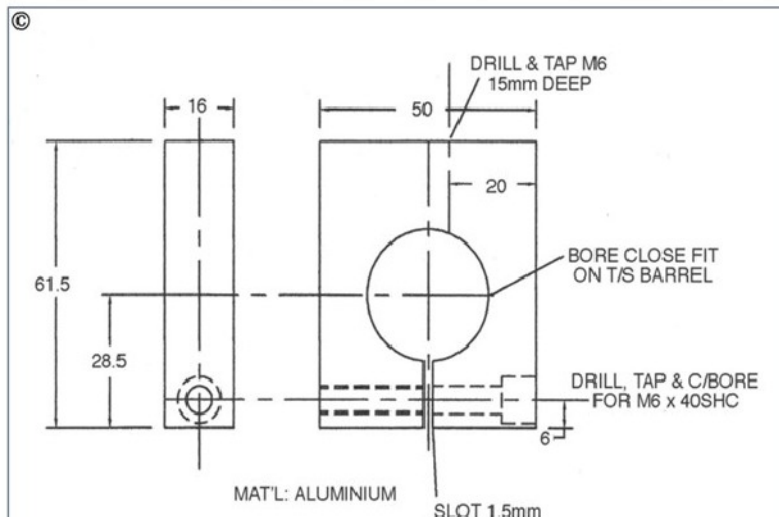


Fig 1. Clamp body (aluminium)

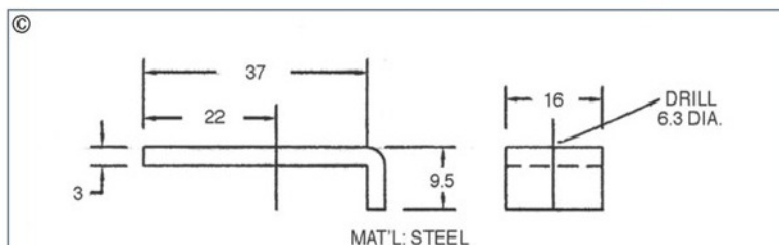


Fig 2. Clamp bar (steel)

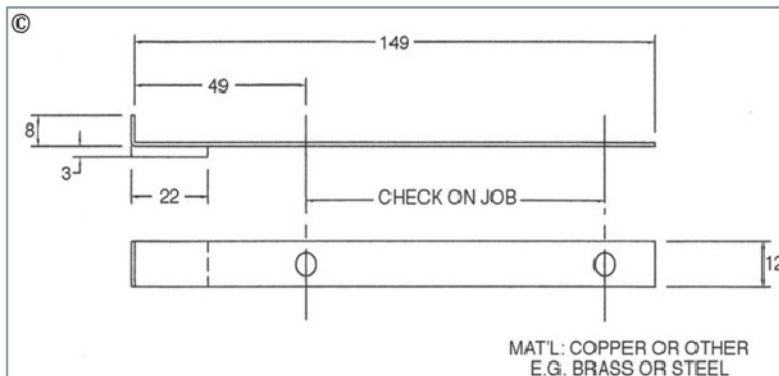


Fig 3. Jaw stop (copper or other e.g. brass/steel)



7. Aluminium bracket with steel clamp.



8. Copper strip folded with added 3mm part.

ANODISING IN THE HOME WORKSHOP

Michel Christiaens protects and dyes his parts.

Anodising aluminium? Isn't that difficult and expensive? No! On the contrary: it's very simple and it can be done in every home workshop without much expense, with results that look in every aspect "professional".

Before we begin

Though the chemicals used in the process are quite common and easy to come by, they are nevertheless dangerous and/or poisonous. So please, please, take the security warnings issued in this article very seriously.

All of the following explanation is aimed at a small-scale setup. If you need it bigger, it is wise to consult the specialised literature on how anodising is done in industry. There are some important differences, both in the materials and the processes used.

What is anodising?

Anodising is covering aluminium in a layer of oxide by an electrolytic process. This is done in two stages. First a porous layer of oxide is grown partly out of the surface, partly inside the base material. Second, the pores are sealed and the outside of the aluminium gets its very hard cover. When the anodised part is submerged in a bath of suitable dye before the sealing is done, the colour particles of the dye migrate into the pores and after sealing the colour is part of the material itself. So, unlike painting, the colour cannot peel off, get scratched or be the victim of many other menaces and it looks pretty and it lasts forever!

The principle

Bare aluminium exposed to the oxygen in the atmospheric air, gets oxidised



1. The part on the left is sanded, the one on the right buffed.

immediately. That oxide is impermeable to air and invisible. So why should we go through all the trouble to cover the aluminium in an oxide layer when it happens all by itself? Well, for one, this naturally formed oxide layer is very thin, some 0.5 to 1 micron (0.00002 to 0.00004 inch) and quite soft.

A much thicker and harder layer can be realised by submerging the part in a solution of sulphuric acid and water. A DC current is then applied to a cathode (minus pole) made of lead or aluminium and the part we want to anodise is the anode (plus pole), and that is why the process is called 'anodising' Fig. 1A and B.

When a voltage is applied, several events happen. First a current flows through the bath and on one electrode (the anode) oxygen is formed. On the other side (the

cathode) hydrogen bubbles up and slowly the oxide layer builds up on the surface of the anode (our work piece). It's as simple as that!

At first, a closed layer of aluminium oxide is formed but, as the layer gets thicker, small pores make their appearance on the outside, Fig. 2A. In these pores, the colour particles of the dye can find a place, Fig. 2B. and finally, the oxide is sealed, Fig. 2C.

What we have to do

Treating the surface of the parts.

The surface must be clean and well prepared to achieve to the result we have in mind. There are several ways to get to our goal but usually it involves:

Sanding: This gives a uniform, coarse surface.

Brushing: the marks get oriented in one particular direction.

Polishing: buffing so the surface is mirror-like. Photo 1 shows the difference between a merely sanded and a buffed part.

Cleaning: A very important condition to arrive at a perfectly anodised part is that it should be absolutely free of all dirt, dust and grease, including fingerprints.

Rinsing: Gets rid of all residues of the cleaning agent.

Anodising:

Rinsing again: Gets rid of all residues of the acid so the following baths are not contaminated.

Dyeing: With the colour of your choice.

Sealing: With boiling water to seal the surface to a hard, almost indestructible layer.

Anodising in practice

The preparation

Everything starts with the preparation of the surfaces we want to anodise. One



2. A buffing motor is not necessary but it can make life easier.



3. Some of the compounds used in buffing. From coarse (1) to fine (3).

general rule, what you see when the part is not yet anodised is what you will get after the anodising! The layer the part will be covered in is so thin that all blemishes will show very well after the anodising.

More still, it seems all imperfections stick out more clearly on an anodised surface. So, in order to get to a perfect result, it is necessary to carefully prepare the parts to be anodised.

First you have to decide what aspect the finished part should have. If it should be matt, sand it carefully until all scratches and other blemishes are gone. This can be done with gradually finer grades of sanding paper or with steel wool. Even if the anodised part prepared in this way has its own charm, the colour of the finished part looks at its best when the part is carefully polished. To achieve a mirror-like lustre, for us amateurs, usually there is just one way open to us, buffing by hand.

All you need is a buffing wheel on its axle and some compound. A flannel or cotton wheel driven by a hand drill, the lathe (cover those ways!), a bench grinder or a dedicated buffing motor is what we need, **photos 2 and 3**. Most likely you already have the equipment at hand. Just one observation about hand buffing, sharp corners can easily get rounded over so you have to decide if that is tolerable or not. When not, all that can be done is slowly and painstakingly polish the part by hand. With a little practice however, buffing can lead very fast to stunning mirror-like results without affecting the



6. The "chemicals" you will need.



4. The part in the back is not cleaned well enough. The water stays on it in beads.

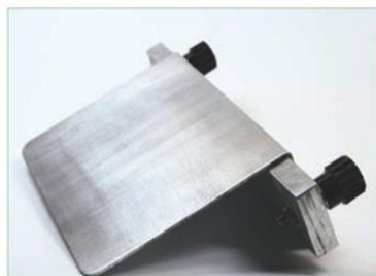
shape of the parts too much.

The chemistry of anodising

From now on we enter the field of chemistry. This begins by cleaning the part. I cannot stress it enough but cleaning is very, very important. It helps to first dip the parts in a solvent to get rid of eventual residues of cutting oil and buffing compound. Whatever solvent you use, it will almost always be very flammable and it produces harmful vapours so take care not to make any open fire, flame or spark nearby when using it. Use it in a well ventilated area and wear gloves to avoid contact with the bare skin and remember, do not touch the parts with bare hands anymore!

There are cleaning baths readily available in specialised shops but we can manage with simpler means. Start with a good household detergent, hot water and use a toothbrush to get into the corners, grooves and holes. After a good scrubbing, submerge the part in a solution of washing soda in water. The concentration is not at all critical. After a little time you will notice little bubbles coming from the aluminium. In fact some material is now eaten away but if the stay in the soda solution is not too long, it will not affect the part in a noticeable way.

Rinse the part in running water. There is a simple and very effective way to check if it is cleaned thoroughly enough, if the water covers the WHOLE surface with an even layer the work has been done well. If the water forms beads and pearls on the surface you have to go back to the previous stages of cleaning and start all over. The "water test" is shown in **photo 4**. On the well cleaned part the water film is hardly visible because it is thin and even. If you are not critical enough, you will end with a part that is not completely anodised and that will not take the dye in certain spots. Fingerprints are greasy and, unless you want to see a clear image of your fingerprint on the finished part, you should avoid touching the cleaned part.



7. A cathode and bus bar made of aluminium.



5. Etching in lye takes away the shine but cleans the part very well.

If it proves difficult to clean the part as well as it should be, it is possible to 'etch' it in lye. The necessary sodium hydroxide to make this caustic solution, the concentration is of little importance, is readily available at very moderate cost as drain cleaner. Dipping the part in lye is the way to go if you want it to look less lustrous when finished. Be very careful with lye!

Safety first

Usually most of us are aware of the dangers and the disastrous workings of (concentrated) acids but we tend to underestimate how dangerous a base (like sodium hydroxide, caustic soda) can be. I can assure you it is at least as dangerous and hazardous as an acid so be very careful using it. Never, ever touch the crystals or the solution with bare hands. If splashes get on your skin, rinse in plenty of running water. Avoid at all cost getting it in your eyes. If this should happen, again rinse with clear water and see a doctor immediately. If you wear contact lenses the danger is even bigger because the dangerous fluid gets trapped behind the lens.

Wear safe (closed) safety glasses or even a visor and use undamaged rubber or vinyl gloves. The same goes for handling acid, by the way. This said, when the aluminium is submerged in the lye, a violent reaction will take place, the aluminium starts sizzling and bubbling and material is eaten away fast so take care not to let it remain in the solution for too long or your beautiful piece of work will be ruined.

Anyway, the part will be thoroughly clean after this treatment but the shiny surface will be affected as can be seen in **photo 5**. It's up to you to decide if you can live with that. Do not forget to rinse the

What we need for the anodising process

- A container in an electrically non-conductive material.
- One or two cathodes in either lead or aluminium.
- Wires to connect the part to the plus pole.
- Flexible wires to connect the anode and the cathode to the power supply.
- Sulphuric acid in a concentration of 15 to 20%.
- A DC power supply of sufficient capacity and voltage.



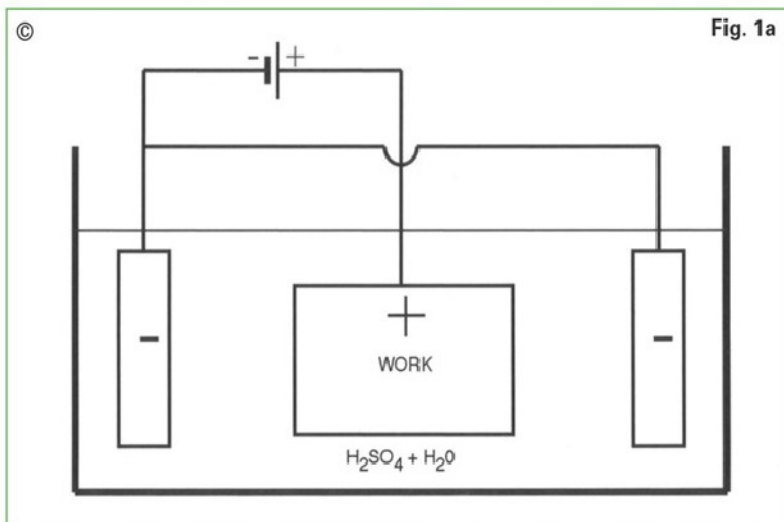
8. Some of the connecting wires.



9. A suggestion of how a current control with light bulbs can be made



10. ... and that's the way it looks like on the inside.



part carefully in running water once again, to avoid lye getting into the acid bath.

Photo 6 shows the products involved in the cleaning and the process itself. From left to right, sodium bicarbonate (baking soda), household detergent, battery acid, de-ionised water, sodium hydroxide (drain cleaner, caustic soda), solvent (here acetone), dye (dissolved in water)

The container can be whatever you have handy provided it is large enough to hold both the cathodes and your part(s) without any danger that the electrodes should touch each other during the process. It is imperative the material is resistant to the acid, of sufficient mechanical strength and electrically non-conductive. It is possible to use plastic buckets, for instance, but in my experience they are less practical because of their form. It's an advantage if

the container can be closed with a lid so the acid can remain in the container with little risk of spillage and contamination. Nevertheless, handle a container with acid very carefully.

The cathodes can be lead or aluminium, **photo 7**. These days it seems lead is a little harder to get hold of than it used to be. An advantage of leaden cathodes is that they can remain submerged in the acid forever whereas aluminium gets dissolved slowly. On the other hand aluminium off-cuts are easily found (everyone has some, no doubt) and cut to the shape and measurements you need. As a matter of fact, I never leave the cathodes in the acid for a prolonged period. The cathodes should 'surround' the part as good as possible or there is a risk some areas of the parts being anodised are in a

"shadow" where the anodising is not so good.

Anyway, no material other than lead, aluminium or titanium should come into direct contact with the acid. Stainless steel cannot be used here because it gets attacked immediately and it will contaminate the bath making both the bath and the hardware useless.

Of course the question arises as to how large (or small) the cathodes should be. Sometimes a cathode to part ratio of 3 to 1 is suggested. No doubt this ratio is important for larger (industrial) set-ups, but in my experience for small scale work it is not at all critical. The main reason for suggesting this ratio is in the possibility to obtain the necessary current density at the applied voltage within the capacity of the power supply. If the parts are small this is rarely a problem, provided there is enough scope for regulating the parameters involved. More about that later on.

Electrical contact

Because anodising is an electro-chemical process, the parts to anodise must make a good, reliable and lasting electrical contact with the plus pole of the power supply. This is easier said than done. First the wires used should be aluminium or titanium. All other materials are out of the question because they get useless in a short time and they ruin the process.

Aluminium wire of sufficient cross section is easy to come by but it gets anodised as well in the process. Anodised aluminium is electrically non-conductive so you can use them only once unless you put them in a lye bath and let it eat away the anodised layer.

Titanium wire is expensive and not readily available but it can be used over and over again. The acid does not affect



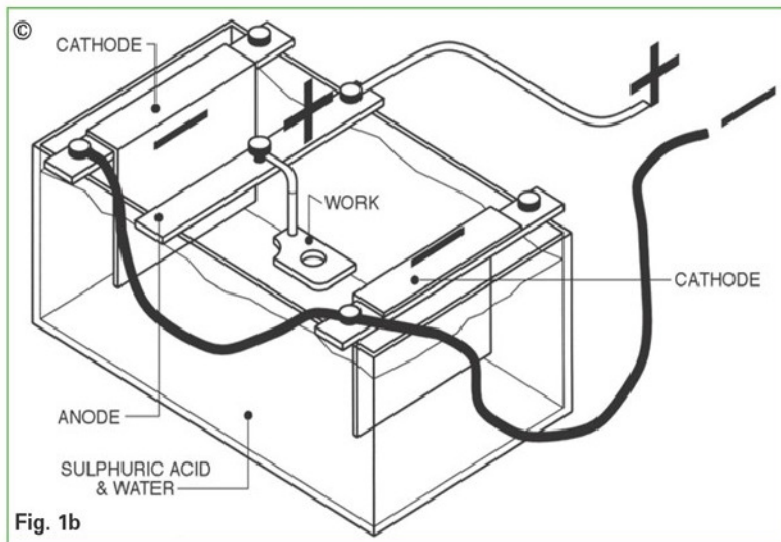
11. Setup with current control and analogue ammeter.



12. Setup with a laboratory power supply with controlled voltage and current.



13. At work for the next hour.



this material except it just gets discoloured. Whatever material you use for connecting wires, it is sometimes not



14. The difference in aspect between an anodised and sealed part and one that's just "bare".

easy to assure a reliable and lasting contact, moreover the contact area where the connecting wire touches the part is not anodised, so you have to look for a spot which will be less visible on the finished part. If the part has a tapped hole, this usually makes a good contact point. The connecting wire can be forced into the screw thread if the aluminium wire is soft enough. The inner thread very rarely shows on the finished part so it usually can stay not anodised.

Sufficient cross section

In other cases some improvisation may be necessary and the solution is entirely dependent on the case at hand. It is difficult to make hard suggestions. From now on, however, the connecting wires should manipulate the parts. The wires connecting the anodising setup and the power supply should be of sufficient cross section to carry the current involved.

Their isolation should be good enough to avoid short circuits to spare the power supply and because sparks and the gasses emanating from the electrodes can make a dangerous combination, as we will see later in more detail. In **photo 8** you can see

some of the wires I used in different anodising runs. The thick-ones are made of titanium offcuts and purpose made for special, small parts.

Now for the sulphuric acid, first and foremost be very careful with this stuff! Take the precautions seriously and don't improvise. Sulphuric acid is readily available in small quantities as so called 'battery acid'. We need a concentration of 15 to 20% and off the shelf the battery acid has a concentration of 35%. Arriving at the correct density, however, is simple enough, mix equal quantities of battery acid and water and you're done! **Always add the acid to the water, see below.** The water should be distilled or de-ionised. The resulting concentration is a little less than 20% and so almost precisely what we want. As a matter of fact the concentration is not at all critical. The lower the concentration, the slower the process evolves and the smaller the pores in the oxide layer will be.

Sulphuric acid is a very dangerous substance. When handling it, cover your work table in plastic, wear safety glasses, preferably closed-ones (your reading glasses will not do!) and, if possible, a visor. Wear old clothes and undamaged vinyl or rubber gloves. Keep a box of baking soda at hand.

In case of spillage of the acid, throw some baking soda on it to neutralise the acid. When it stops sizzling, it's neutralised. If you get acid on your skin, use the baking soda and wash with much water. Handling the parts by the connecting wires prevents you have to come in direct contact with the liquid.

The AAA rule

Now for something very important concerning the handling of the acid, we have to dilute the battery acid and there is only one way to do it safely. Obey the AAA-rule: Always Add Acid. Never, never the other way round. When mixing sulphuric acid and water a tremendous amount of heat is generated. If you should add water to the acid, the first drops of water entering the acid evaporate immediately and explode throwing acid all around! Really, this is not an exaggeration. Slowly add the acid to the water, stirring constantly. If you take a little care, you will not have to do this mixing often anyway, because the bath lasts a long time.

The power source can be anything you have, provided it can deliver the necessary direct current at a tension of at least 12 to 14 Volts. It should be DC so the power source will have distinct + and - poles. It is unimportant if the voltage and/or the current are stabilised or filtered completely or not. An AC "ripple" is quite tolerable. A simple battery charger could be used but the "automatic" kind is of no use here. Even a well charged car battery of sufficient capacity is useful.

A regulated power supply

Because we must be able to control the current density through the bath, it is very convenient if you can use a regulated power supply with variable output. Once the necessary current is calculated, the power supply can be set so the current will always be kept at the intended value. But even with an unregulated supply there are quite simple means to get at the current we



Fig. 2a

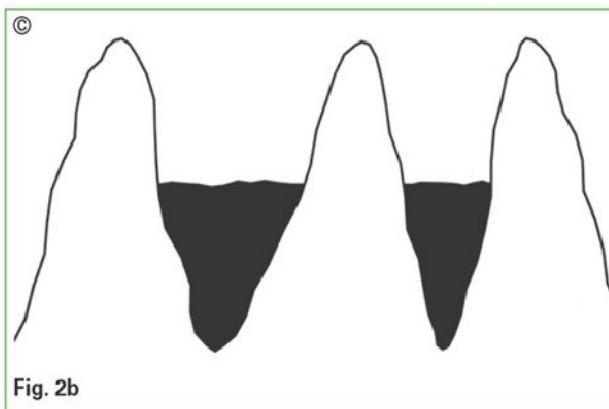


Fig. 2b

must have. In **Fig 3** a possible system to arrive at that goal is shown. By switching in or out some of the light bulbs, the current through the entire circuit can be controlled. A practical solution to have all the elements readily at hand is shown in **photo 9**.

The inside of that box can be seen in **photo 10**. The enclosure unveils here its true nature, it's a cigar box! The light bulbs are the kind that is used for car tail lights. They have two filaments, one for a 5-Watt light source and one for a 20-Watt. By switching one or more lamp filaments in or out the circuit, the current can be controlled. Anyway, no matter what system you use, it is quite necessary to have a means of measuring the actual current. Some variable power supplies have volt and ammeters and these should be sensitive enough to indicate the current and voltage with some precision.

When using the system with the variable resistance (the light bulbs) an external ammeter is mandatory. I prefer to use an analogue instrument in this case because I managed to blow the expensive fuse in my digital meter on a couple of occasions. Analogue instruments are a little harder to read but are, on the other hand, usually more forgiving to abuse (if not too harsh) **photo 11**. Of course, using a laboratory power supply is more convenient. Voltage and/or current can be preset to intended values and they stay there for as long as the process goes on, **photo 12**.

Current density

When you surf the Internet for information on how high the current for anodising should be, you are in for a jaw-dropping experience. The currents you will find there are so unthinkably high you should need a power plant of your own to anodise anything but the most modest of parts. What almost never is mentioned is the time during which this current should be applied. In fact it's not so much the current itself we are interested in as the current density and the time it should be used. The current density is the current divided by the area measure hence some amperes per square centimetre (or square foot) over an hour's time. That taken into account, the data you find then are far more realistic. Nevertheless the data still differs considerably for different sources. Grossly put, you will find figures between 0.0085 A/cm^2 (8.0 A/ft^2) and 0.015 A/cm^2 (14.0 A/ft^2). So let's say 0.012 A/cm^2 (11 A/ft^2) will be about right.

As an example, assume you have a part with a total area of 50 cm^2 .

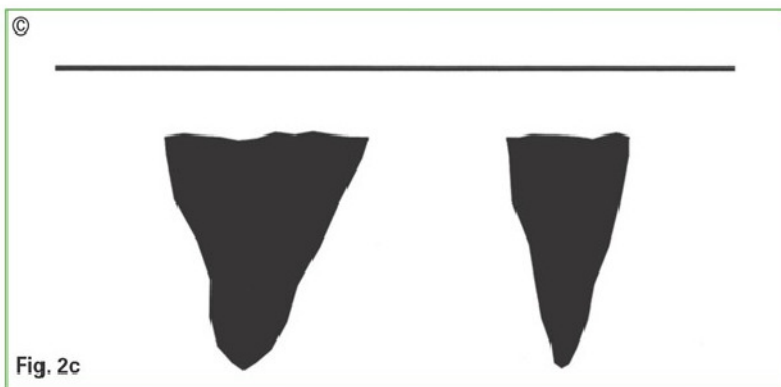


Fig. 2c

The necessary current to anodise the part in 1 hour calculates then to: $50 \text{ cm}^2 \times 0.012 \text{ A/cm}^2 = 0.6 \text{ A}$.

Should the calculated current exceed the capacity of your power supply, you can, to a certain extent, make the process time longer. You cannot stretch that infinitely because the longer the time at a lower current density, the finer the pores become. In the end they may be so small the colour particles of the dye cannot get in there anymore! Nevertheless it usually is better to take the time a little longer than it is to take it too short.

You have to bear in mind that the values mentioned are only approximate. There are many more parameters involved. For instance, the temperature of the bath is usually held at 20 degrees centigrade (68 degrees Fahrenheit), and the concentration of dissolved aluminium in the acid. It complicates matters still more that the electrical resistance of the anodised layer raises as it grows, so the current will sink (given a constant voltage). But you can rest assured that all in all, it is not critical. Just remember to calculate ALL of the area of the part, including the inside of holes, the sides of the part and so on.

When the anodising is taking place, small gas bubbles will rise from the cathodes and the part itself. Partly this is oxygen and partly hydrogen, as mentioned before. When these two gasses react with each other a very innocent product is generated, water though the reaction itself is far from harmless! The two gasses form a highly explosive mixture and even a little spark or nearby fire can get it started so do the anodising in the open air or at least in a well ventilated place and keep fire and sparks far away from your setup! **Photo 13** shows the setup using an anode bus bar, which

makes it easy to ensure a good contact with the wires connecting the parts.

Rinsing

When the anodising is done, the part has to be rinsed once again in running water. If the form of the part is complicated (with many confined places) the sulphuric acid should be neutralised in a mixture of water and sodium carbonate (baking soda) or sodium hydro carbonate (washing soda).

Applying dye

You can either dye the anodised parts or not. If you want to keep the natural colour of the aluminium (well, almost) you can now proceed to the sealing. In **photo 14**, the uppermost part is anodised and sealed. The lower part is just buffed. As you can see, the mirror like shine is lost in the anodising. If you want to apply dye, you can choose from a virtually infinite range of colours. A couple of the references found at the end of this article will unfold more than a rainbow for you on their web sites.

The dye consists of special colour pigments suspended in water. Results are best and most consistent when a specialised product is used though there have been reports of the use of food dyes and textile dyes with good results. I have not experimented with these because the dyes I have kept on working and working. Apart from that for example, textile dyes cost almost as much as the 'real' product, so why bother?

The rinsed part is submerged in the dye at a temperature of approximately 50 degrees centigrade (120 degrees Fahrenheit) and under movement left in the bath for a time between 2 minutes and 20 minutes depending on the

intensity of the colour you wish. It's clear that, the longer the part stays in the dye, the deeper the colour will be. Take care not to let the dye bath get too hot or the pores can get sealed and the layer does not take dye anymore. **Photo 15** shows a couple of anodised, dyed black parts. Of course you have been wondering what those strangely shaped things might be. Here you can see it, the finger pieces of a telegraphic key (a 'paddle') that I make.

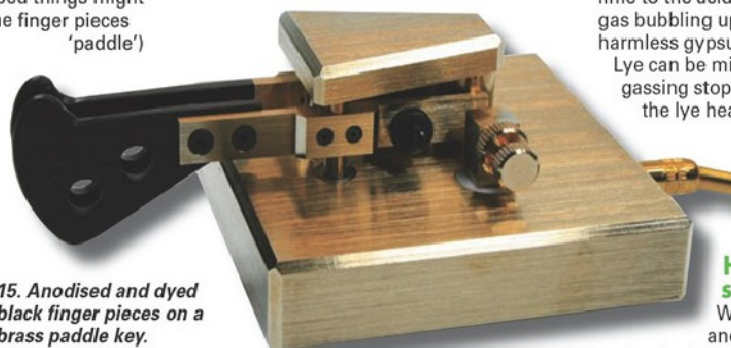
If something has gone wrong in the previous process and the aluminium does not take the dye evenly, it is possible at this stage to start all over again with very little hassle. So, back to cleaning, etching and anodising. If you want to start over after the part has been sealed you have to get rid of the anodised layer first. This can be done with mechanical means (sanding through the glass hard layer) or chemically by submersing the part in concentrated lye until the layer is gone completely.

Sealing

This is absolutely necessary to obtain the hardness of the final layer and to assure the colour pigments are captured within the pores and stay there. Sealing could not be easier, just boil the parts in water for about 60 minutes. Yes, you read it correctly, boil it! Doing that the pores close and the oxide reacts with the water to form the extremely hard layer. As an example, the substance your part is now covered in is the same material as the one used to make certain grinding stones! It's best to use distilled or de-ionised water to do the sealing. Normal tap water contains salts and other matter that can leave a veil on the surface. Sometimes it is advised to use a nickel acetate sealer, which has distinct advantages. It prevents the dye from "bleeding" during sealing and the sealing temperature can be lower. In my opinion, however, it is only of interest if you have larger anodising runs.

What can be anodised?

Well, aluminium, obviously. But there is aluminium and aluminium. Not all what we see as aluminium is created equal. The material best suited for anodising is pure aluminium. As a general rule we can put that the purer the aluminium is, the easier it is to



15. Anodised and dyed black finger pieces on a brass paddle key.

anodise. But rarely can pure aluminium be found.

Usually it is some alloy with several components. Cast aluminium is almost impossible to anodise because of the presence of too much silicon. Sometimes copper is part of the alloy and you have to get rid of, at least, a thin layer of that material on the outside of the part before anodising is possible.

Of course we often use raw material coming from an unknown origin and you cannot see if there is copper present in the material or not but if the part turns black when submersed in lye it is quite sure to contain copper. You can etch a layer away in specialised de-smut and de-ox solutions but I manage using the etching fluid for etching printed circuit boards, ferric chloride. You know, the unsavoury looking brown soup. Parts submersed therein for not more than a minute or two get covered in a layer of something. Again: this ferric chloride is an aggressive, dangerous substance and it stains your clothes and your work environment forever. Take good care of the usual safety precautions. When the crust on the part is brushed away and the parts cleaned in the usual manner, anodising is possible even if the result is not always predictable.

Disposal of the used chemicals

Obviously you cannot simply pour the used chemicals in the drain. Because of their nature and their impact on the environment this would be, at the least, irresponsible. It is, however, possible to neutralise them. Sulphuric acid can be neutralised by adding prudently slaked lime to the acid until there is no more gas bubbling up. The result is water and harmless gypsum.

Lye can be mixed with acetic acid until gassing stops. Another way is to dilute the lye heavily with water. This fluid can then be poured in the drain. After all, sodium hydroxide is used as drain cleaner or de-stopper!

Hard versus not so hard

When reading about anodising, you will no doubt, bump into the term 'hard anodising'. On several occasions, I have mentioned the very hard layer we can achieve with anodising. So is it possible to get an even harder layer then? Well, as a matter of fact, hard anodising is used to indicate an industrial process where the electrolyte is cooled down even to the freezing point of water and the current density used is very much higher than what we use. The result is a thicker oxide layer in so much even that small blemishes are masked or covered. Dying this kind of anodising is very difficult though. Cooling the electrolyte in our small scale setup is almost never necessary. It becomes a problem if many parts must be anodised at the same time in one bath (or one very big part) due to rising temperature generated by the higher currents that are needed then.

References

A-1 Eloxieren von Aluminium V1.1.3 (in German) March 2005. Electronic Thingsks www.electronics-thingsks.de where you can find different products as well.

A Practical Guide to Anodizing Aluminium at Home. Ron Newman. May 2005. www.focuser.com/anodize.html Anodising kits, products and power supplies.

Yahoo users group on anodising. Mostly aimed at larger scale setups. groups.yahoo.com/group/anodizing101

Electroplating J. A. Poyner. 2005. Special Interest Model Books. Caswell Europe www.caswelleurope.co.uk/ Products and kits. "Teck-Nick" Nickel Plating Operating Instructions.

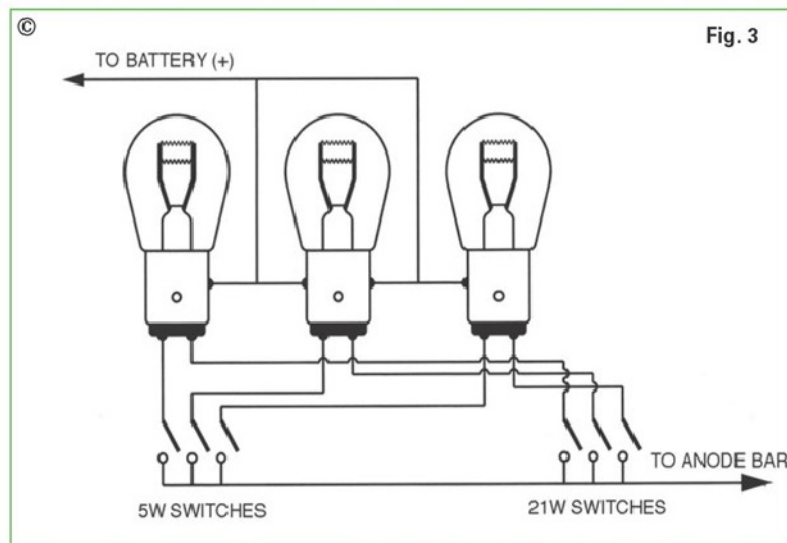


Fig. 3

THE CENTENARY MODEL ENGINEER EXHIBITION

"A display of models offering quantity and quality of a level never seen before and unlikely to be equalled in the future".



1. Praise be – the lock pickers.

After a number of successful years at Sandown Park, this years centenary Model Engineer Exhibition moved to a new date and a new venue. The pavilion at Ascot racecourse provided a "right royal" setting offering superbly appointed and spacious areas with a pleasant airy ambience. This being the centenary show, David Carpenter (editor of *Model Engineer*) and Lou Rex (exhibition organiser) had put in a great deal of effort to ensure that this would indeed be one to remember. The extent of their success may be judged from the comment from Mike Crisp (former, now retired, editor of the same magazine) that the number and quality of items on display far exceeded anything seen previously, and was unlikely to be equalled in the future. This was due to the numerous "Collections" which had been brought to the show in addition to the normal competition and loan entries, and a high level of club support.

In addition to the many exhibits, for those wishing to learn more about specific topics,

a series of lectures had been organised under the auspices of SMEE. Subject matter included "Why not build an internal combustion engine" by Malcolm Stride, "Direct and analytical methods of setting tool grinders" by Prof. Joerg Hugel, and "Choosing and using CNC machines in the home workshop" by John Stevenson.

The "Collections" covered a wide range and included models from such revered creators as Cherry Hill, Anthony Mount, Arthur Bodily, Ron Jarvis, and Bill Connor, and on the tooling side, equipment from George H Thomas, Len Mason, Tom Walshaw, and our own former editor, Harold Hall. Only when you see the full range of items produced by Harold, do you come to appreciate just how much he has contributed to **MEW** over the years. It is hoped to present a flavour of some of these in a future issue.

Outside the main hall, a ground level live steam track was in operation, and periodic demonstrations of one of his gas turbine engines were given by James V G Hill of the Gas Turbine Builders Association. One

interesting approach to gas turbine construction had been followed by Mr L Nutbrown, who has used a complete automotive turbocharger as his basis. (Health and safety considerations apparently did not permit a demo of this unit, although it had been operated at the recent Bristol show.) Another interesting item featured on the GTBA stand was a locomotive under construction, - not so much the model as the construction method for the bogie frames. Sheet steel parts had been laser cut and joined rather like the old fashioned tinplate toys by passing tags through slots, then twisting to lock. Having performed this initial assembly work, the job was then sent for vacuum brazing, after which the protruding tags were ground off leaving a superb job, which would be exorbitantly expensive to try to cast even if technically feasible. This technique may offer fresh routes forward for innovative modelmakers.

Day three offered some amusement around the trophy cabinet. As the appointed hour for prize giving became imminent, it transpired that the lock had jammed, giving rise to the scene shown in **Photo 1**. Two captions sprang to mind "How many muddle engineers does it take to pick a lock" and "Oh Lord please answer my prayers for a trophy." Undoubtedly readers will have their own ideas. See the end of this article for details of a caption competition!

Competition Entries

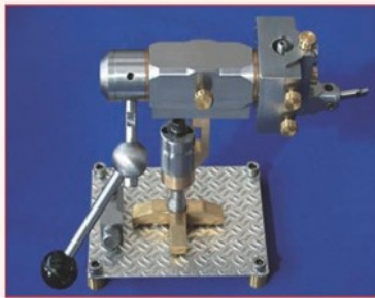
Class A5 originally consisted of nine entries, however one competitor was unable to attend and therefore A5-3 and A5-4 do not appear in the results.

A5 - 1 Spherical turning tool - A Ramsay

As can be seen from **Photo 2**, this was a well finished accessory operating around a horizontal axis. The adjusting screws and knobs are all from brass, turned and milled, and these with the steel ball feature convey an element of quality. The judges awarded a Highly Commended

A5 - 2 Bench Mountable Drilling Station - N. Farr

This machine is shown in **Photo 3** and constitutes a lightweight and fairly sensitive drilling machine mounted to a common base with its motor for convenient bench location. This was one of two entries from Mr Farr, and secured a Commended.



2. Spherical Turning Tool – A Ramsay.

A5 – 5 Pattern for a Cast Belt Guard – D Lampard

When we are shown wooden patterns, they are normally painted, and sufficiently smooth to avoid pulling away moulding sand. In this case, the pattern itself was indeed a work of art. In the model boat circles, I have heard it said that if a modeller chooses to finish not in paint (which would hide the wood) but in vanish then the standard of workmanship must be good. That is exactly what we have in this instance. Photo 4 gives a flavour of the finish, but close inspection of the fit of the various elements was really needed to fully appreciate the attention to detail. Mr Lampard received a Highly Commended for his work.

A5 – 6 Air Powered Draw Bar – K Willson

It is always an inconvenience to have to first find the spanner and then reach up to slacken or tighten the draw bar on a vertical mill or mill/drill. It becomes even more of an inconvenience if the machine is large e.g. a Bridgeport, or the operator is vertically challenged. In this case, the entrant was not short in stature, but his machine was a Bridgeport, and it had been mounted on anti vibration feet, making it just a little taller. He is also considering a raising ring. This draw bar offered an ideal improvement in convenience. The primary



7. P Clark's Sensitive Drilling Attachment.



3. Bench Mountable Drilling Station – N Farr.

components – air motor and cylinder are commercial items, however the air control has been divorced from the air wrench assembly, using homemade fittings. An air pressure of some 60 psi is sufficient and "just a touch" is needed. Photo 5 shows the device, and the concept could well be used on other machines. The judges' verdict was a Highly Commended.

A5 – 7 The Fonly Watchmakers Lathe – P Clark

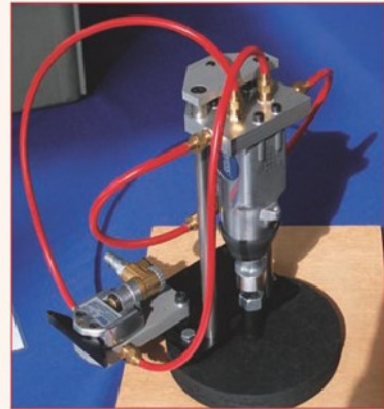
If you care to survey the entries to this class over the years, you will undoubtedly find that Dr. Clark's name appears regularly and is always associated with high quality workmanship. This year he has moved down the size spectrum (his previous tooling entry being associated with a Harrison M300) and has produced a very capable watchmaking lathe with sensitive drilling attachment. The name derives from "If only I had a watchmakers lathe". Its construction employs ground flat stock for the bed, and a spindle running in preloaded bearings and configured to accept 6mm Lorch collets. As exhibited, photos 6 and 7 it was fitted with a Jacot drum for pivot polishing, and shown with the drilling attachment and hand guided tool holders. The result of the judges' deliberations was a well deserved bronze medal.



8. Lathe Topslide with Integrated Electronics – K Willson.



4. Pattern for a Cast Belt Guard – D Lampard.



5. Air Powered Draw Bar – K Willson.



6. The Fonly Watchmakers Lathe – P Clark.

A5 – 8 Lathe Topslide with Integrated Electronics – K Willson

One of the difficulties that arise when fitting a DRO is that first the scale takes up space and then the guard takes even more. This device endeavours to mitigate the effects for a topslide, by incorporating the DRO slide within the slide. Photo 8 illustrates the neat result for which the judges awarded a Highly Commended.

Caption competition

I have 2 unused copies of *Model Engineers' Workshop* for summer 1990. This is the original no 1 issue.

To win one of these highly collectible magazines, send a caption for the photo of the three people trying to break into the trophy cabinet. One copy will go to a UK reader and the second copy will go to an overseas reader. Closing date for UK entries is 7th November and closing date for overseas entries is 7th April 2008. Please mark emails and letters 'MEW caption competition'.



ER25 COLLET CHUCK for a Camlock D1-3 Mount

Shelley Curtis improves his lathe.

One of the endearing features of our magazine is that it provides a forum for the exchange of ideas and a platform for the launch of a myriad of designs for workshop tooling and "gadgets". This has been of inestimable value to me. As a newcomer to the hobby in 1990, I spent the first two to three years making workshop items and tooling - "learning the trade", as it were - before moving on to making "things that go round". And, of course, one never finishes learning.

For a while, I have felt that a collet chuck for my Harrison M250 would be a useful adjunct but - of several choices - which one? As I already have ER25 collets for use in the collet chuck for the Myford, this would be the logical route. A semi-finished Camlock D1-3 backplate would be required and this was purchased from Rotagrip Ltd (usual disclaimer). An intermediate plate would be needed on which to mount the collet chuck. My first thought was to make this with a Myford nose and use the existing chuck. On further consideration, I decided to use the flange mount version, as this would reduce the overhang of the completed assembly by some 30mm. However, an intermediate plate would still be needed, as the clearance hole in the D1-3 backplate is 50mm diameter, likewise the PCD of the holes in the adaptor flange. That settled - let play commence!

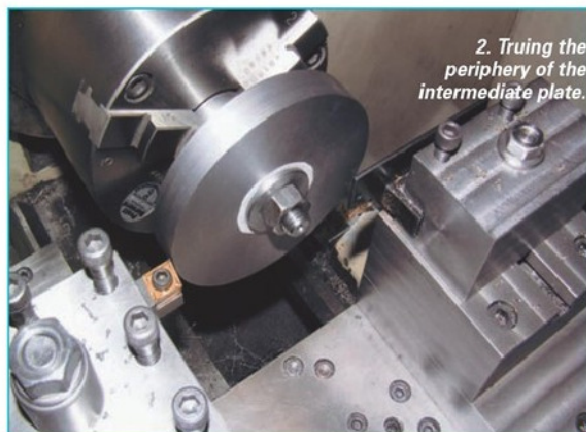
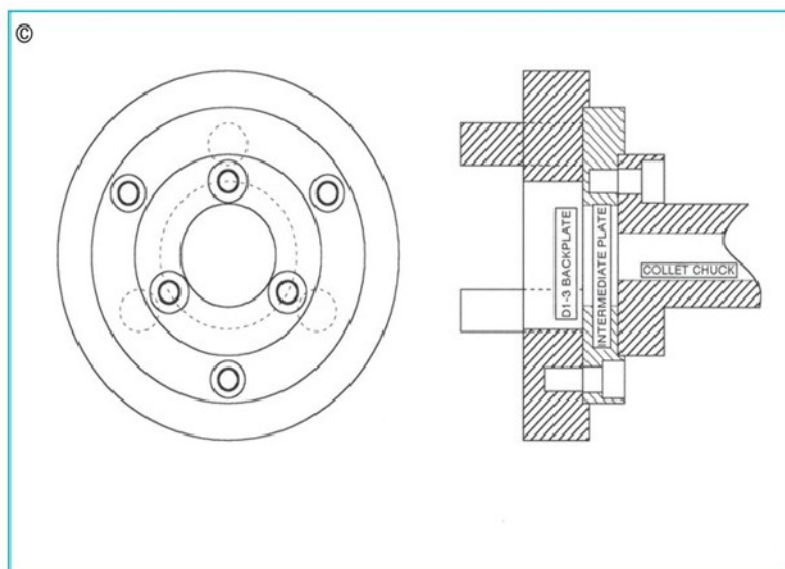
The intermediate plate

Prepare M8 cap screws by reducing the head diameter to 11.00mm.

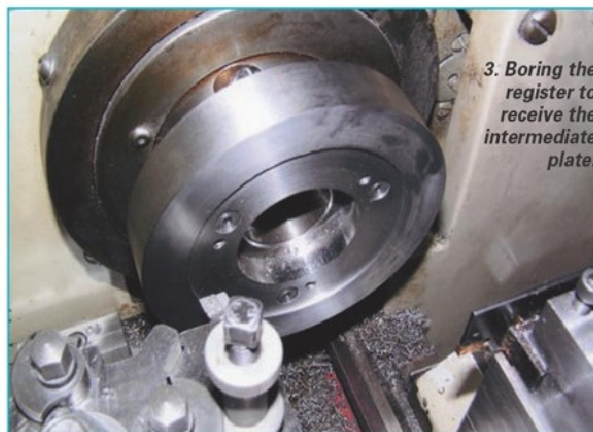
Using outside jaws, chuck a billet of BMS 100mm dia. x 17mm thick. Face off, reverse in the chuck and face off to 15mm thickness, **photo 1**. Drill, bore and ream a 1/2in. diameter hole. (Or any size - but preferably not smaller - to suit available reamers). Place on an arbor and careful machine the periphery until running true **photo 2**. Next drill and counterbore the three holes on a PCD of 84mm using a



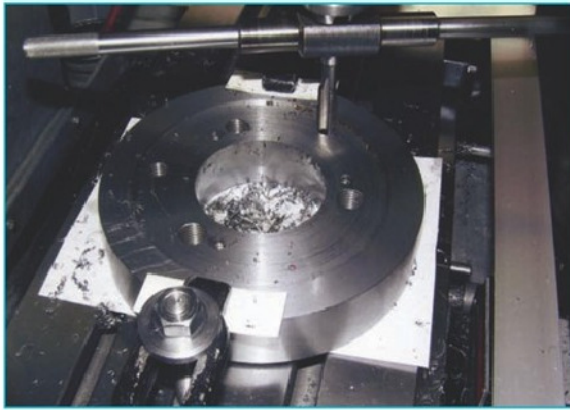
1. Facing the sides of the 100mm diameter billet.



2. Truing the periphery of the intermediate plate.



3. Boring the register to receive the intermediate plate.



4. Tapping the 8mm holes in the Camlock backplate.

8.7mm drill and a 1/8in. slot drill. Use a rotary table or drill them by coordinates on the milling machine.

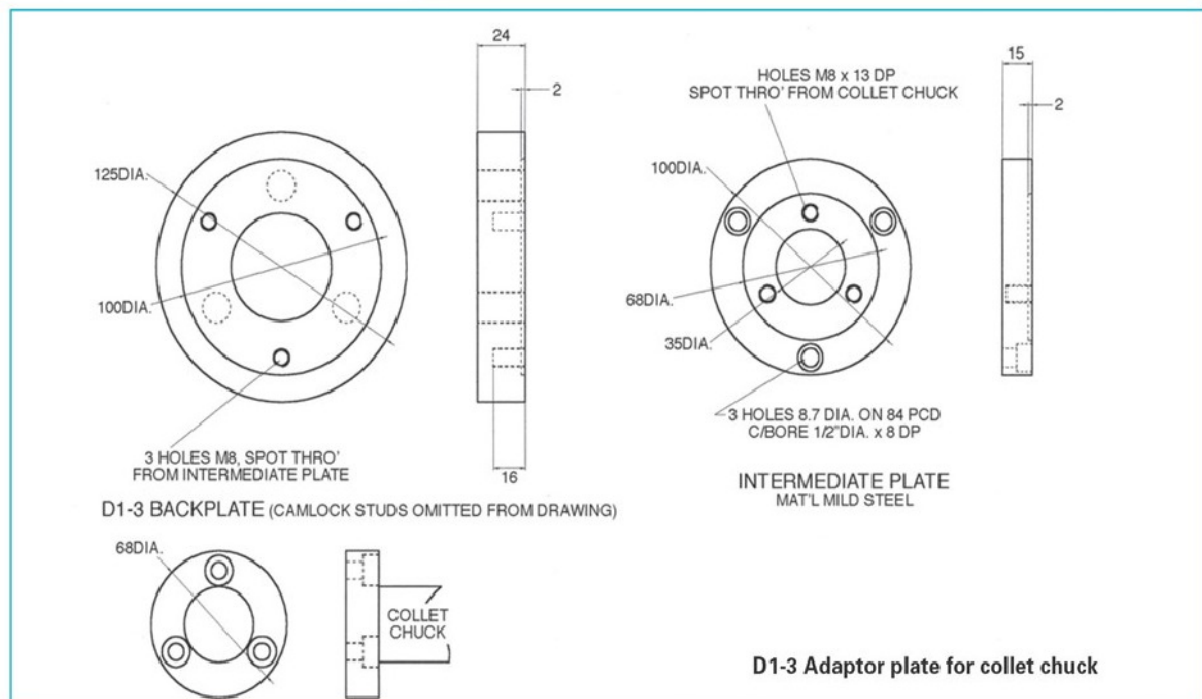
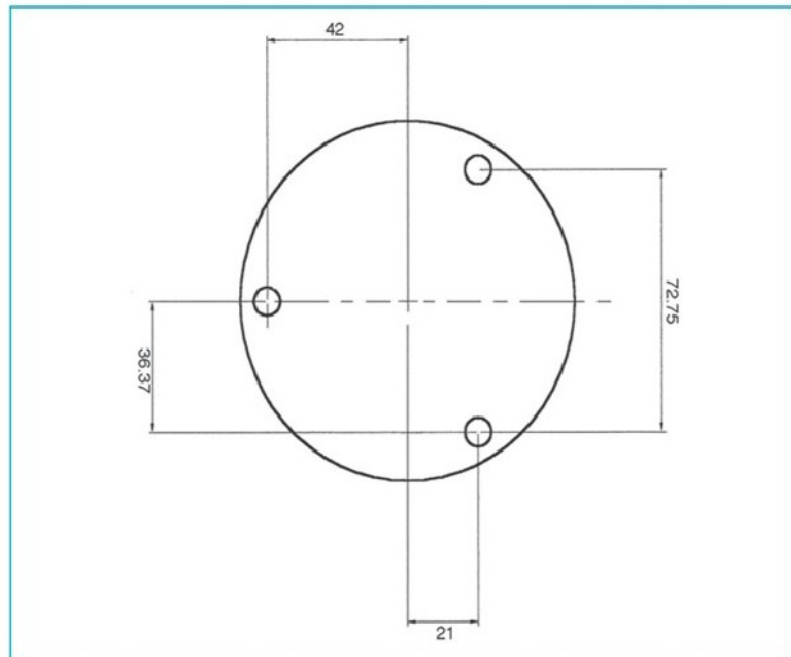
Camlock Backplate - Czech made - TOS

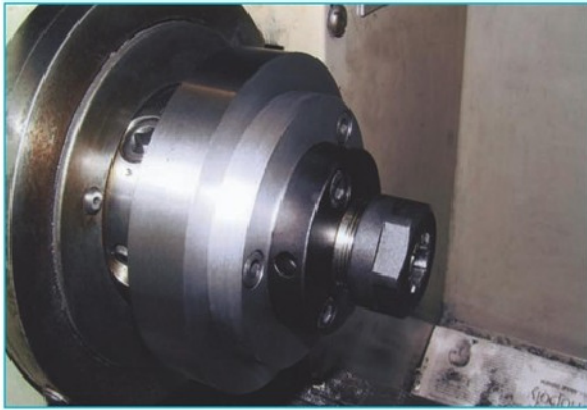
What bliss - something not from the Far East! As a 2mm deep register is required for the intermediate plate it is necessary to reduce the threaded length of the Camlock studs by 2mm. They are not hardened and can be faced off on the lathe. Fit the studs to the backplate and mount on the lathe spindle. Adjust the studs as necessary to ensure that when each cam is tightened, its index line lies between the two vee marks on the spindle nose. Scribe a line on the periphery of the backplate to coincide with the reference line on the spindle nose as an aid to subsequent re-mounting.

Using the finished Intermediate plate as a gauge, bore out the register 2mm deep, **photo 3**. Take a final cleaning cut across to ensure flatness. Remove the studs and clamp to the milling table. Place the Intermediate plate in the register and position it so that the three holes lie midway between the stud holes. Using a



5. The register machined ready to take the chuck adaptor.





6. The assembled unit.

8.7mm diameter probe centre the spindle over one of the holes and lock the table and cross slide. Drill and tap M8, **photo 4**. Replace the Intermediate plate and insert a 8mm cap screw visually checking that is concentric with the hole in the plate. Tighten it, re-position the spindle and drill and tap the next hole. Repeat the procedure for the final hole. Disassemble and thoroughly clean the components. Re-fit the Camlock studs, fit the intermediate plate and tighten the cap screws. Mount the assembly on the spindle and apply final torque to the cap screws.

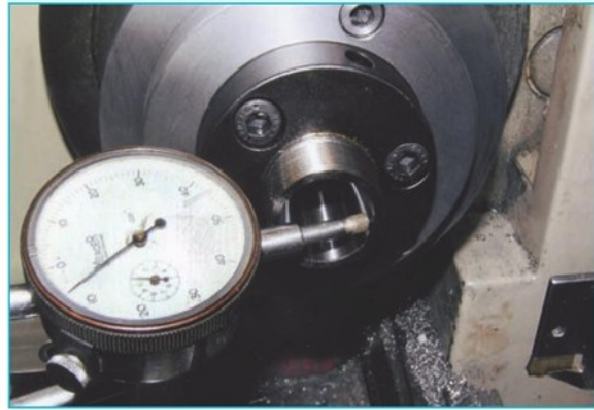
Bore out the centre hole to 35.00mm diameter and bore the register for the collet chuck flange - 68.00mm x 2.50mm

deep - using it for the final sizing, **photo 5**. Take a cleaning cut across the register to ensure flatness. Again de-mount, remove the Camlock studs and clamp the assembly to the mill table. Adopting the same procedure as before, drill and tap 3 x M8 holes in the intermediate plate. Fit the collet chuck, after ensuring that it and the register are absolutely clean. Re-assemble the Camlock studs and re-mount the whole assembly, **photo 6**.

And now folks - the moment of truth! Check for concentricity with a DTI probe on the chuck's internal taper, **photo 7**. If the TIR is less than 0.0004in. (Rotagrip's figure) you're on a winner!



7. Checking for TIR.



The Camlock backplate is available from

Rotagrip
16-20 Lodge Road
Hockley
Birmingham
B18 5PN

The collet adaptor plate is available from several suppliers.

Arrand engineering, Chronos and J&L Industrial all sell them.

IN OUR NEXT ISSUE

Coming up in Issue 131 will be



Making an awkward shaped component
How to machine a difficult item

A big collet attachment
A useless gift put to use



Fitting digital readouts to a Tom Senior Mill
Improve your accuracy

ISSUE ON SALE 26 OCTOBER 2007

(Contents may be subject to change)

TRADE COUNTER

Please note that, unless otherwise stated, Trade Counter items have not necessarily been tested. We give news of products and services which have been brought to our attention and we consider may be of interest to our readers.

ALLENDALE ELECTRONICS



Allendale Electronics is pleased to announce the addition of three new display consoles to our range of Glass Scale DRO systems. The new AE-10 Series consoles have been launched to form a new budget range, aimed as a cost-

effective entry-level console for the home workshop user. The new systems are compatible with our existing three ranges of SINO glass scales, the GS300



(Standard series), GS500 (Slim Line Series) and GS600 (Long Series). Our GS Series scales provide the model engineer with the reliability and precision that SINO has earned over the last 3 years at Allendale.

Their three ranges of glass linear scales give Allendale the flexibility to offer full glass scale systems to the more compact machine, by using the GS500 slim series. The slim design and reading lengths from 70mm up to 570mm make the GS500 ideal for limited or confined mounting areas. Next in the glass scale range is the GS300 standard series of scales that are available from 170mm up to 970mm in travel. These are made from larger aluminium housings to give the required rigidity for up to one metre reading length. The GS600 scales complete the scale range with reading lengths from 1 metre to 3 metres. We stock different types of Protective covers made from aluminium extrusion, which provides an extra level of protection against knocks, coolant and swarf.

The new AE-10 Consoles are available in a 2 or 3 Axis system for Mill's and a 2 Axis Lathe Version. Both are supplied with mounting arms, plastic protective cover, Mains Lead and English user manual. The units offer more than just a positioning readout as they also have functions such as Metric/Imperial, PCD, line of holes and arc contouring, 99 Zero Memory position, and the Lathe version provides radius or diameter display and centre find functions. The new additions to Allendale reduce the cost of a glass scale DRO system, whilst giving the accuracy and reliability where it counts with the SINO glass linear scales.

For more information please contact us or visit our website.

Allendale Electronics Ltd, 43 Hoddesdon Industrial Centre, Pindar Road, Hoddesdon, Hertfordshire, EN11 0FF
T: 01992 450780 F: 01992 450781
www.machine-dro.co.uk
E: Sales@machine-dro.co.uk

MYFORD LTD

Myford Ltd are having an open house on
Thursday 25th October 2007 9am - 5pm
Friday 26th October 2007 9am - 5pm
Saturday 27th October 2007 9am - 4pm

Come and meet:

Ivan Law - With an industrial background working for Rolls Royce on design and the experience of running the partnership 'Model Engineering Services' for a good number of years, it is not surprising that Ivan represents the Society of Model and Experimental Engineers as Head Judge at The Model Engineer Exhibition, and brings to our Open House a wealth of knowledge accumulated over 70 years while enjoying his hobby.

Harry Paviour - Like so many Model Engineers, Harry started his Model Engineering in a small way. As he progressed into the hobby he purchased an ML10 lathe, which was subsequently replaced by an ML7, and more recently the new Myford Super 7B Connoisseur lathe, which is complemented by a VM-B Mill. Over the years, Harry has built a number of award winning models and is the Chief Judge at The National Model Engineering and Modelling Exhibition held at Harrogate.

Demonstrations - Meet Terry, Darren and Brian in our Fitting Area. Terry and Darren will have a number of Series 7 Lathes in various stages of being rebuilt. Brian will be demonstrating the much-feared task of changing the headstock belt on the Super 7 Lathes, and the all-important adjustment of the headstock spindle bearings.

Gary and Dill will be running Milling and Turning demonstrations throughout the day, and will be pleased to

discuss your machining problems and projects.

Part Exchange - Myford are always willing to consider and quote against taking your existing Myford Lathe in part exchange against a New Model. Why not bring along photographs of your existing machine, and talk to Malcolm or Chris about a part exchange.

Buying New - Talk to Malcolm and Chris during the Open House. As per usual, there will be some excellent offers on new lathes, which will include some high value accessories. Used Lathes and Milling Machines - A large selection of reconditioned machines all rebuilt to a very high specification, covered by one year's warranty, will be on display.

Pre Owned Equipment - 24 x 6ft tables full of used equipment from taps, dies, milling cutters to gearboxes, swivelling slides, dividing attachments and much more (too much to list!).

No VAT to pay - A full range of new spares and accessories to complement your Myford Equipment will also be available at reduced prices to save you the VAT.

FREE PARKING, FREE TEA, COFFEE AND BISCUITS
FREE ENTRY INTO A £500 PRIZE DRAW FOR ALL ATTENDING.

Come and have a great day out and meet the Myford team. Have a good chat, treat yourself to an accessory, buy yourself that long awaited lathe, or simply come along and enjoy yourself.

Myford Ltd, Wilmot Lane, Chilwell Road, Beeston, Nottingham, NG9 1ER. Tel: 0115 9254222 email: sales@myford.com
www.myford.com

Fireside Reading

Gears And Gear Cutting

by Ivan Law

One of the books which never came my way to review during my time as editor, is Number 17 in the Workshop Practice Series, namely Gears and Gear Cutting by Ivan Law.

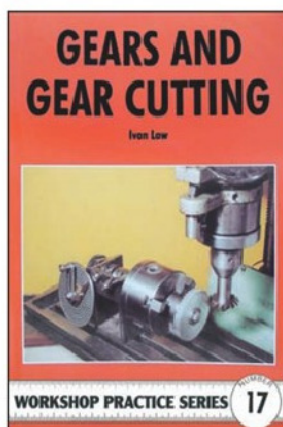
Nowadays Ivan is probably best known as the chief judge at the Model Engineer Exhibition. When one thinks about it, the reason it never came in for review was that the general theory and practice of gear cutting has not changed over the years, and Ivan got it right first time so there has never been a need for a revised edition. The popularity, however may be judged by the frequency of reprints: 1990, 93, 95, 97, 99, 2002, 03, 05, and 06. As I have been playing with one or two projects involving gears and in particular bevel gears, I decided to buy the one remaining copy on the Magalia stand at MEX, really to confirm that I fully understand the description given in Machinery's Handbook and elsewhere.

What a pleasant surprise. This little book presents more information, more concisely and more understandably than many others with many more pages and far higher price tags. For the benefit of those who may not have looked at the book, the twelve chapters are entitled: Basics; Tooth form; Gear tooth sizes; Rack and pinion gears; Bevel wheels; Worm gears; Definitions and formulae; Dividing heads; Cutting spur gears; Cutting worms and wormwheels; Cutting bevel gears; Making gear cutters.

The first two chapters guide the reader through the concept of ratio and then the manner by which the cycloidal and involute forms are derived, then progressing to chapter three which covers gear tooth sizes, (definitions and formulae are covered in detail in chapter seven) while the special cases of rack & pinion, bevels and worms are discussed in chapters four, five and six. Having explained the theory, chapters eight onwards deal in detail with the nitty gritty of actually cutting gears on typical home workshop equipment, with clear instruction on the use of such items as dividing heads, and on what I was after on bevels. The book concludes with a chapter on making gear cutters. In addition to useful detail on cutter shape, drawings are given for the Eureka relieving accessory.

All in all, a book to be recommended – published by Special Interest Model Books (ISBN 0-85242-911-8) and available from Magalia Publishing and www.myhobbystore.com at £6.95 + postage.

Reviewed by Dave Fenner



The Amateur's Workshop

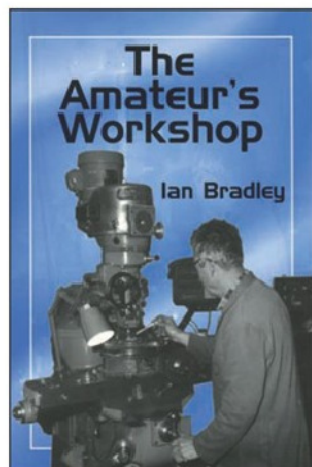
by Ian Bradley

Several times at the Model Engineer Exhibition, I was asked for articles aimed at the workshop enthusiast who had limited knowledge, not quite a

beginner but still lacking in confidence. This will be addressed in future issues but in the meantime, I can recommend the book 'The Amateur's Workshop' by Ian Bradley. This book takes you right through from the basics of setting up a workshop, then shows how to select machine tools and then how to use them. It covers lathes, mills and drilling machines and there is a very useful section on the shaping machine. Tool sharpening is covered in detail as are basic turning operations including taper turning and boring. Dividing is covered in detail and there are drawings for a headstock mounted dividing attachment.

Cutting threads is covered in detail and marking out and measuring equipment coverage is also very comprehensive. There is also a lot of information on special purpose tools as well. This is a very good book for the beginner to intermediate model engineer and is thoroughly recommended.

Again published by Special Interest Model Books (ISBN 1-85486-130-1) and available from Magalia Publishing and www.myhobbystore.com at £8.95 + postage.



Model Engineers' Workshop Projects

by Harold Hall

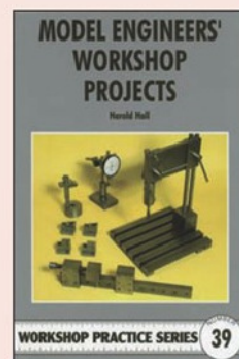
Harold's books sold very well at the Model Engineer Exhibition. Workshop Projects and Tool And Cutter Grinding both sold about 12 copies in the first day and a half before they sold out. I could have sold a lot more.

Model Engineers' Workshop Projects contains many useful tips as well as drawings and photographs of many useful workshop accessories. Chapter 1 covers a simple auxiliary workbench which doubles as a drawing board, a method of supporting files inside a cupboard door and chuck boards to make carrying and fitting lathe chucks easier. Chapter 2 covers simple tapping guides, chapter 3 describes a guided die holder and chapter 4 shows a large tap wrench.

Chapter 5 describes a set of simple distance gauges for length measurement and setting machine stops. Next is a lathe tool setting height gauge followed by a useful lathe backstop. A useful set of tailstock die holders are described together with photographs of the simple machining operations to make them.

Clamps suitable for angle plates and lathe faceplates are followed by a collet holder and a set of collets. Stepped collets are next. These are suitable for holding thin workpiece's, which can be difficult to hold using other methods. There is a comprehensive section on dial indicator mounts and a very useful faceplate balancing fixture.

Low profile machine clamps are described in detail with many drawings and instructions are given for making a useful pair of sash cramps. The book concludes with a very useful tapping stand to ensure the tap is at right angles to the work. This is an excellent little book and should be on every Model Engineers bookshelf. It is published by Special Interest Model Books (ISBN 978 185486 248 8) and is available from Magalia Publishing and www.myhobbystore.com at £6.95 + postage.



How (not) to paint a locomotive



and line it out
and build a spray booth
and apply transfers
and more.....

Christopher Vine

How (not) to paint a locomotive

Christopher Vine's LNER Locomotive 'Bongo' is an absolute delight to look at. It has an absolutely superb paint job and is finished to the highest standards. It certainly deserves the Gold Medal it received at the 2004 Model Engineer Exhibition and it also won the Charles Kennion Memorial Trophy for the best finished model in the show.

The book has 168 pages, 130 colour photographs and 30 diagrams. It takes the reader through all the stages and processes in painting a model engineering subject. It is not just about painting a loco, it is relevant to almost any model that needs painting to an exhibition standard, indeed if you are intending to exhibit any model in an exhibition I would suggest you read this book first.

Chapter 1, the introduction covers the reasons for writing the book, a few notes on health and safety, general ideas, preparation, practice, test pieces and record keeping. Chris suggests you keep a record of every thing you do. Paint requirements are touched on and there is a chart of characteristics required from the paint and a section on gloss versus dull.

Making for ease of painting is discussed as is colour scheme, number of coats and thickness of paint, multiple layers of different paints and whether to use brush, spray can or spray gun.

Chapter 2 discusses the equipment needed. Spray guns are dealt with in great detail, as are pressure regulators, compressors, a simple homemade spray booth, (a cheap plastic greenhouse), respirators and abrasive blasting.

Chapter 3 covers

paint. Types of paint, one pack and two pack, primer and etch primer, spray filler primer, synthetic coach enamel, car paints and acrylic paints are all covered as are many more types of paint. This chapter also covers metal blacking and all the miscellaneous materials required such as thinners, paint stripper, cleaners, tack rags and cotton buds.

Chapter 4 is all about preparation. In fact, it starts with planning the painting sequence. Next comes work holding, a turnover stand and a bit about jigs and fixtures.

Surface preparation is next together with rubbing down for the next coat, masking and a few warnings about what to avoid.

Chapter 5 is all about spray painting. It is very comprehensive and covers 37 pages. Subjects covered are temperature, paint viscosity and thinning, paint application, multiple coats of paint, test pieces, records, mixing paint, measuring, mixing and filtering, cleaning up yourself, the work, the spray booth and dust, painting movements, using spray cans, using a spray gun, building up the coat of paint, drying/curing, washing up, other methods and tips and problems, recognizing what went wrong and how to fix it.

Chapter 6 deals with hand painting. Brush sizes are discussed, the paint and thinning, then technique, charging the brush, keeping a 'wet' edge and cleaning and storing the brushes are all covered.

Chapter 7 covers fixing blemishes. This chapter covers fixing minor blemishes without stripping the whole surface and starting again.

Chapter 8 covers possibly the most difficult part of finishing a locomotive, the lining. The correct sequence of lining is covered to eliminate problem corners and joins. Use of a lining pen is shown and several useful ideas are given to enable you to line out various different shapes. A lining wheel tool is shown in use and it appears to complement the lining out pen. Lining of the wheels is covered in detail with suggested simple fixtures shown as photos. Finally, removing errors is covered. This gives you the reassuring feeling that if

something does go wrong, it can be corrected.

Chapter 9, transfers. Setting out guidelines with masking tape is essential to the accurate location of transfers. Waterslide transfers are covered together with varnishing the finished transfers. Dry transfers and Letraset are mentioned as is making your own transfers using various methods.

Finally, chapter 10 covers looking after the finished paintwork, transporting the finished locomotive and cleaning and polishing.

All in all this is an excellent book. As someone said to me at the Model Engineer Exhibition, "I am a professional model maker and this is the best book I have ever read on modelling". I agree it is, so no matter what sort of model you are painting if you have not got a copy of this excellent book, place your order today. You will not regret it.

How (not) to paint a locomotive
ISBN: 978-0-9553359-0-7

By Christopher Vine

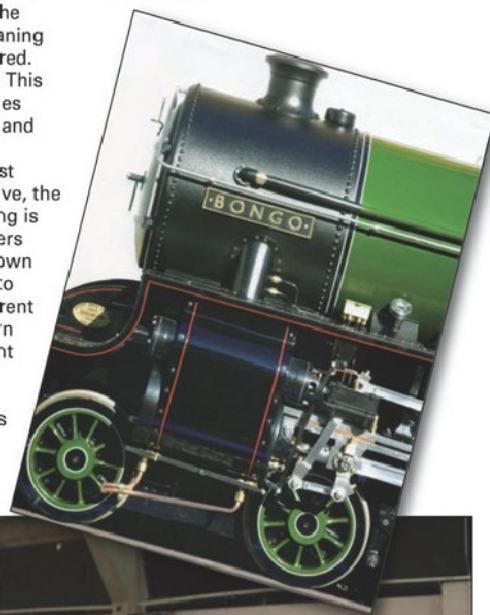
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Scribe a Line

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. GK Bartlett receives a Workshop Practise book for his 'Silly mistakes' and Dave Robinson receives one for his excellent tip on soluble oil.

Star Letter

Silly mistakes

A lot of opinions have been expressed recently about safety and HSE issues. We all have opinions on this and personally I feel in favour of those who think it has been overdone to the detriment of commonsense. I know I would never criticise anyone on the basis of posed pictures, as we don't know the circumstances under which the pictures were taken.

We all do silly things from time to time, some (few I hope) are Safety orientated, others may just cause a waste of precious time. The two most stupid things I have done recently may cause some amusement to readers. The first taught me a safety lesson.

When using aerosol paint cans we have to shake our guts out to mix the paint properly, particularly if it is the second tin of the same colour to avoid shading. The idea of mechanising this process is very attractive and I have used a method several times over the years with no problem. This has been always with the thought that one day it will go badly wrong.

The can is gripped very lightly in the three jaw Lathe chuck by the rolled over section at the valve end and with left hand on the clutch lever and low speed, tools wound to the tailstock end and a finger in the concave end of the can for support it can be spun for a few seconds. Well, the last ever time it did get out of control as anyone would guess.

The can shot along the axis of the lathe until it hit the point of a tool, which went straight through and in a split second I had a hell of a mess and a sheet of flame. Fortunately by the time I got the pin out of the fire extinguisher the fire was out apart from a small smoky flame from the hole.

When I recovered, I had many hours of work to clean up myself, the lathe, the workshop, a small mill some feet away and the sky light over the top.

I had to strip the Lathe completely to clean up the bed ways etc and this is where I found that Meths would remove acrylic paint before it has completely hardened without affecting the

original paintwork. I had to use this on the machines, the skylight and other fittings etc. The wall behind had to be repainted although no fire damage was done fortunately.

Of course, if I had taken the trouble to make a wooden plug with a centre in it for the outer end of the can it probably would not have happened but this is definitely not a tip it just isn't worth it.

The second stupidity was that I went to a trader a year or so ago with a very good friend who shall be nameless but very well known and we purchased a job lot of large Phosphor Bronze bushes. We both said they could be useful for Stirling engine cylinders or liners. Also we knew perfectly well that they were sintered and what that meant but the Grey cells failed to connect. Later I used one of these in an experimental engine, which was built originally as a test rig to try a couple of other ideas.

At first test the engine had good compression and ran really well but on later tests it would run for a time and then slow down and stop with little compression left. The multitude of oily bubbles below the piston told the story. Although the bush was only used as a liner the minute passages go in all directions.

Once the bush was replaced with a steel liner all was well and the experiments could continue. It must be a first though, I mean, what kind of idiot makes an engine of any sort with a perforated cylinder. As per the other ideas if anyone is interested one had some merit the other not.

One possibility did come out of all this though is that maybe the sintered bushes if thinned down and thoroughly cleaned could be used as regenerators however, I personally believe regenerators as a separate component in hot air engines of less than about 60 cc displacement are a waste of space. More is lost in dead space than is gained in the Thermodynamics.

GK Bartlett, Birmingham, by email



Foot switch safety 1

I am writing in response to David Atkins letter regarding foot switch safety in MEW issue 129.

Although he is correct in that it would be dangerous if a circular saw could be started by stepping on the footswitch, most (if not all) modern circular saws come equipped with a No Volt Release (NVR) switch. Perhaps someone can confirm if this now a legal requirement?

Using a footswitch with such a saw means that it could only be started by stepping on the switch AND pressing the start button. Releasing the footswitch would turn it off, and thus cause the NVR to drop out. Stepping on the footswitch again would have no affect, as you would need to press the start button again. Under these circumstances, a footswitch

would probably enhance safety rather than reduce it.

Kerin O'Brien, by email

Foot switch safety 2

Diamond lapping and Len Mason's baby lathe

For people that would like a foot operated 'panic button', and wish to use it with a machine that has a no-volt switch they could use a footswitch using a pair of press-to-break contacts (instead of the press to make as in Ted's) and install it in the live lead of the supply to the machine.

Should things start to get a bit hairy, all you need do is give the switch a quick dab with the foot and the interrupted supply will cause the no-volt to disconnect. Further presses will have no effect until the machine is manually restarted.

The item on the diamond lapping

of engine components reminded me of something I read in Model Engine Constructor. The chap involved, warned against using diamond lapping paste because, as he put it, 'a diamond is forever', I.E., fail to remove every grain and the engine will very quickly wear out, something that lappers may like to think about.

By the way, do you know of anyone that has built and is operating Len Mason's Baby Lathe? I keep doing a bit on the one I am making and one day, even hope to finish it.

David V Atkins, by email

The editor replies

I don't know of anyone who is making Len's baby lathe although I saw the original on display at the Model Engineer

Exhibition. Are any other readers making this lathe?

Removing broken taps and steel bolts from non-ferrous metals

There is a useful, and little mentioned, method to remove broken taps and bolts, particularly small ones, from dissimilar material. I understand that it is an electrolytic method. This is to soak the hole with the broken piece at the bottom in an Alum solution. I did it several years ago when I broke a 1/8in. tap in a piece of brass. I seem to remember that it took several days to remove.

The method came up again by a machinist friend of mine when he had a similar problem. He solved it mechanically by drilling out the hole, making an insert and retapping. He was not prepared to let the Alum process the work because of the time (reported) that it took.

Can one of our erudite chemical readers help by putting some practical facts and limitations to this process? What little I know of it is shown by the following questions.

- What is the recommended optimum solution strength?
- Obviously this method won't work when the steel tap or bolt is broken in a steel piece as they are not dissimilar materials and there would be no electrolytic action. But between which materials will it work?
- Will it work on stainless steel bolts? What about a brass screw in a steel piece?
- If the bolt/tap size is increased to say 1/4th or 1/2inch does the time become impossibly long or is the process independent of size (within reason)?
- Any other useful facts not covered by these uninformed questions.

Ted Wale, by email

Model Engineer Exhibition

First off, congratulations on your appointment to the editorship of MEW, and good luck in your efforts to satisfy the unruly readership!

After visiting the show at Ascot and noting the average age of the attendees, I would surmise that most readers will have got to the age where they have learnt from long experience how to survive what would not be considered to be 'safe' working practices. As a consequence they do not take kindly to being told what they have done for years is wrong.

On the other hand, as someone who had dealings with the liability insurance world, I do realise what a difficult job you will have to ensure that what appears in the magazine is not going to cause problems now or in the future.

I would suggest that you don't take to heart the comments on some of the web sites, as they are more akin to 'saloon bar' ravings rather than considered arguments.

Regarding the show at Ascot, congratulations on a wonderful display of models and the tooling, which was of most interest to me. The venue worked quite well and was an interesting building to look at but I do think a larger exhibition hall type of venue would be better. I was slightly disappointed in the number of trade stands, but if the magazine circulation and show attendance grows, I would expect the trade to return.

As to the content of the magazine, it should be as varied as possible, much in the vein that David Fenner and you have been producing. Although I am sure there are many model makers as readers there are also many readers who are what I would term as 'rough' engineers who restore cars and motorbikes, repair all sorts of mechanical objects for friends and family and generally enjoy things 'mechanical'.

On that note, one thing I would like to see is a 'what's on' column with dates for events such as open days at industrial museums and exhibitions with a mechanical theme. This would not only be of interest to the readers but it would help the trusts and charities that need people to come on open days to keep alive our industrial heritage.

John Harris, Maidenhead, by email

Editor's reply

The Exhibition appeared to be a great success, with many people commenting how much they enjoyed it. If readers want a diary type page of interesting events, they only have to let me know what is going on at least 4 months in advance and a diary page can be done. What would you like to see included?

Electrolytic derusting

That was a fascinating article in MEW about electrolytic derusting. I did a bit of homework and came to the conclusion that it works by the red rust (tri-feric tetroxide) being reduced to black rust (ferrous oxide) by electrolytic hydrogen.

As the ferrous molecules are much smaller than the ferric molecules, most of them just fall away from the work piece. I can't see why this should be better than ordinary phosphoric-acid based rust removers, though in recent years these seem to have been weakened to the point of near uselessness.

I would like to offer a warning, however, concerning the de-rusting of cutting tools. Rust pits may be small but deep dislocations, which penetrate into the metal and weaken it, often accompany them. Also the rusting and the derusting are liable to introduce hydrogen into the metal, which makes it brittle. I would suggest that a derusted cutting tool cannot be considered 'safe' and should only be used for the lightest duties.

Walter Gray, by email

Darex Drill Doctor, still stumped

I was pleased to see in the latest issue of MEW the letter from Mr Vanherle about the Darex drill sharpener, with the good news that he had solved the problem of unsatisfactory performance.

I proceed to my workshop to try his method only to find that the drill bit (3/64") I tried to touch up finished far worse than when I started! It will take a lot of grinding - by hand or other means - to get it looking more or less normal! I am quite mystified that after following the instructions, and the modification Mr V recommends, most carefully I am no nearer success.

Do I have to put the device away again on a high shelf to gather dust, or wait patiently 'til I solve the problem myself or some kind individual points out the error of my ways? If you can find space in the next or future issue to print this note it

might have an interesting result.

Anthony Keogh, by email

Anodising in the home workshop

In "Scribe a Line" of issue 127 of **Model Engineers' Workshop**, in an answer to what Dr. John Ponsonby wrote, you pose the question what may be the difference between "hard" and "regular" anodising. Basically the process in both cases is the same. Essentially, anodising involves immersing aluminium in a bath of diluted sulphuric acid called the electrolyte, and running a low-voltage DC current through the acid solution. The result of normal anodising is a thin coating of aluminium oxide on the surface of the original aluminium. If the acid solution is cooled to the freezing point of water and the amount of electric current increased substantially, the process is called hard anodising.

Hard anodising is more commonly found in industrial or commercial applications than in consumer products. It produces a much thicker coating of aluminium oxide that penetrates holes and fissures in the surface to create a more uniform appearance than regular anodised aluminium. Aluminium processed by hard anodising may have a grey surface, but other colours can be created.

Regular anodising is simpler to do and the anodised objects can quite easily be dyed in virtually all colours of the rainbow. Because of its thinner layers of oxide, all imperfections found on the surface of the aluminium object (i.e. scratches) are not covered and they seem to show much clearer than on the untreated object. But because of the more modest requirements of the set-up, regular anodising can quite easily be done at home. The materials involved are cheap and usually readily available. Anodising in the home workshop in a very simple, small-scale set-up is easy. Even though the process is simple, the results are very good and cannot be distinguished from what industry produces. Everyone can do it.

Michel Christiaens, by email

Editor's comment

Please see Michel's article about anodising elsewhere in this issue.

Baird Mechanical Television

I am looking for contacts who have built a simple Baird Mechanical Television. There is much info on the Internet (perhaps too much!), but to hear from people who have actually built such devices would be of great help.

Michel Jacot, by email

The use of CNC in the home workshop

Over the last few years there have been many articles regarding equipping the workshop with CNC machine tools, either purchased fitted, or as a conversion, but little about using the system. There must be far more beginners when it comes to using CNC systems than those just using basic machines so should there not be some articles giving guidance on its use.

A simple project based article, or two, would certainly make its use a lot clearer to the majority of the magazines readers. What about it CNC owners?

Harold Hall, by email

Reader's tips

Best Tip

Soluble oil problems

From time to time suds or coolant becomes a subject of discussion mainly because the best coolants are soluble oils, which, when unused for a period of time 'go off' and become smelly and acid. In another life I had some autos and other machines using suds. I found that the worst culprits were the machines with enclosed tanks, which were always the most difficult to clean out. The best machine in this respect was a Ward plug board auto that kept the majority of its coolant in the wide tray with only a small sump.

However, this is only true when in constant use. When not used all the time, tramp oil forms on top of the coolant sealing it to the air. The reason is well known of course, it is that anaerobic bacteria cause the trouble. In my present life (retired), as a hobby engineer this is a problem because we generally use machines intermittently with often long standing periods. One has moments of annoyance but then go on to do something more important. About 18 months ago I thought about it again resulting in a visit to the local aquarium suppliers and bought a tank aerator. I rigged this up, putting it on a bracket and connected it to a 5/16in. dia. piece of tube with half a dozen holes drilled in it with one end sealed and the other to the aerator tube and switched on. This has been on now for about eighteen months and the coolant seems to keep quite sweet. The aeration breaks through the usual 'seal' of tramp oil. I don't think the electricity expenditure is noticeable and the little bubbling sound doesn't bother me. If you have this suds trouble you may find this solution works for you too.

Dave Robinson, by email

Useful vice modification

I often need to cut down small screws or saw and file small pieces of metal or plastic. I use a simple cheap clamp-on vice and before it was modified the workpiece could move because the jaws would not close parallel due to the tolerances on the guides. So I milled a flat in the end of the front jaw, drilled and tapped it to take a grub screw to act as a jack. All it takes now is to load the workpiece, take up the slack on the grub screw, adjust as necessary and the workpiece stays put. This particular vice did not have a vee groove so one was added at the same time as the grub screw feature was incorporated.

Ralph Sparrow, by Email



Cross Drilling

I was taught this method of cross drilling round bar stock by a retired toolmaker that described it to be as accurate as most jobs require. I have found it to be as accurate as I need. The great advantage is the speed of setting up.

It is easiest to use this method if you have a vertical milling machine or a cross vice for a drilling machine.

The bar stock is held in a vice which is clamped to the bed of the machine with the position for the cross drilling more or less centred under the chuck. A centre drill is held in the chuck. A steel rule is held at right angles across the bar stock and the chuck is wound down until the centre drill just nips the rule against the bar stock. It is instantly apparent if the drill is not centred on the bar, as the rule will be sloping in one direction.

To centre the drill over the bar, slowly move the table/vice towards the low end of the rule. When the rule is parallel with the top of the vice the drill is centred. Using a white background behind the vice makes it easier to check that the rule is parallel. Checking by eye will usually be as accurate as you need. Once set up, drill carefully with the centre drill. I normally use a small sharp centre drill to start the cross drilling. If the bar is of a very small diameter I use a small milling cutter to produce a flat for the centre drill to start from.

John Harris, Maidenhead, by email



Cutting Oil Dispenser



There are probably many owners of small machines who, like myself apply the cutting oil from a small container to the tool area, using a small brush. If the brush is normally returned to and left in the container, it tends to be over-charged with oil, especially when the container is full, which then leads to waste of oil and

unnecessary mess. A dispenser similar to that shown in the photograph will keep the oil at a constant level and so prevent some of the excess oil going to waste.

No dimensions are shown, as these will depend on the size of the items used, the main two being, a small plastic bottle for a reservoir and a dish from whatever source is available. That shown is a measure, which was supplied with a bottle of garden insecticide, but a larger plastic bottle or one that has contained a well-known petroleum jelly may also be suitable. Two small screws are used to hold, the clip for the neck of the bottle (made from a strip of metal or tubing) and then the dish to the backplate.

A hole in the bottle cap is required to let the oil out and the clip is set at a height required for whatever level of oil is to be allowed into the dish. Some form of fixing to wherever the dispenser is to be placed is needed to complete the project.

Maurice Rhodes, by email

Two Morse taper collets

In David Haythornthwaite's article on MT2 collets, *MEW* issue 128 p39), he mentions using a dial gauge set EXACTLY on centre height, against a MT2 centre to obtain the correct taper angle.

To have a bit of latitude of about 1/16in. either side of centre, swap the ball probe, (left) on the end of the gauge plunger with an 'Elephant's Foot', (right) made from 1/16in. dia silver steel, polished to a good finish, hardened and polished again.

Jim Whetren, Glastonbury, by email



19/9/07 10:45:57

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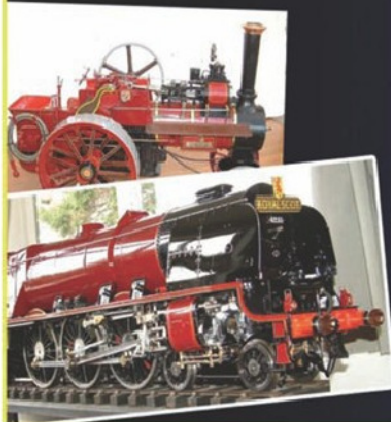
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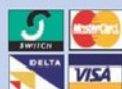
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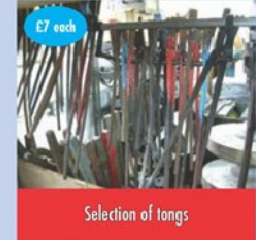
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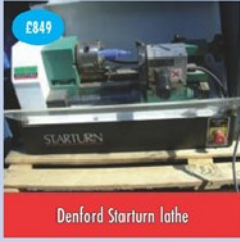


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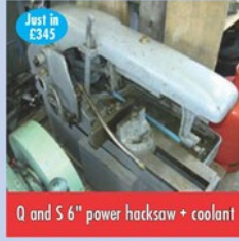


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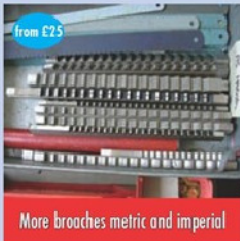
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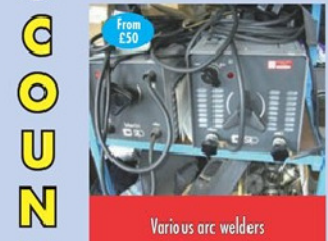
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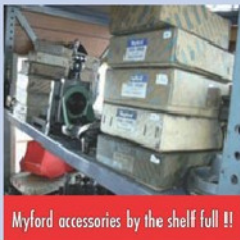
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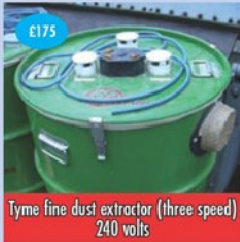


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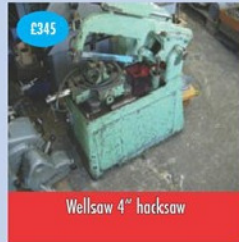


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