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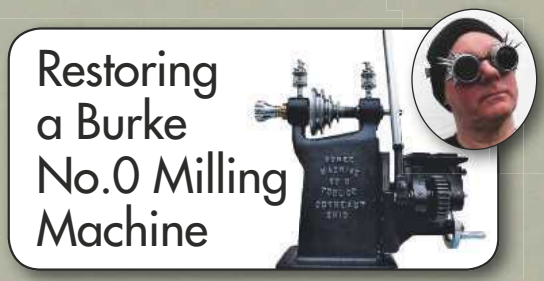

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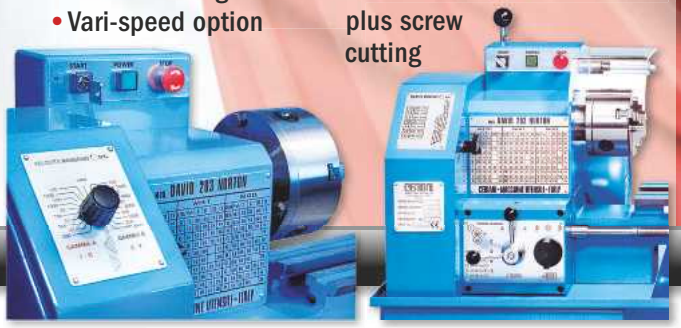

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Published by **MyTimeMedia Ltd**.
Enterprise House, Enterprise Way,
Edenbridge, Kent TN8 6HF
Tel: 0844 412 2262
From outside UK: +44 (0)1689 869840
www.model-engineer.co.uk

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print & digital media publishers

Model Engineers' Workshop, ISSN 0959-6909, is published monthly with an additional issue in August by MYTIMEMEDIA Ltd, Enterprise House, Enterprise Way, Edenbridge, Kent TN8 6HF, UK. The US annual subscription price is 52.95GBP (equivalent to approximately 88USD). Airfreight and mailing in the USA by agent named Air Business Ltd, c/o Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA. Periodicals postage paid at Jamaica NY 11431. US Postmaster: Send address changes to Model Engineers' Workshop, Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA. Subscription records are maintained at CDS GLOBAL Ltd, Tower House, Sovereign Park, Market Harborough, Leicester, LE16 9EF. Air Business Ltd is acting as our mailing agent.

On the Editor's Bench

Spreadsheets Abound!

I made something of a rod for my own back in the last issue with two different spreadsheets by authors being made available to readers. Confusingly one of these was a download link from the author's website and the other was available on request by email. The tide of requests inevitably meant a few folks got the wrong spreadsheet, so I started again and sent BOTH spreadsheets to everyone who sent me a request. So, if you have been scratching your head over the 'other spreadsheet' I sent you, I hope that explains it. There was a minor inconsistency between the instructions in the article and printout in the photo – the instructions as in the article do work, but the output won't look exactly the same as the picture.

Thanks also to John Firth who sent me the following link to an online calculator: http://www.swarfer.co.za/lathe/pcd/pcd.php This is a bit more complex, but it does allow you to set the origin to bottom left, instead of the centre of the circle, which avoids you having to use negative offsets. John also points out that Ted Knight's spreadsheet can be modified to produce 'bottom left' co-ordinates by the offset of the centre to each of the X and Y co-ordinates.

12-volt Motor Controller

There is a chip, called the 555 timer IC, that divides those with an interest in electronics smack down the middle. Many, especially old-schoolers, will praise an ingenious little package that costs pennies and crams comparators and switches together and can be used as the heart of an incredible number of different projects and gadgets. Others will point out that an even tinier and cheaper microcontrollers that can be programmed to do anything a 555 can do, better – and much more besides.

The catch, of course is the 'programmed' bit. The great thing about the 555 is that you just need a handful of discrete components to make it the heart of a useful project. I still remember the kudos of taking a 'Star Trek siren' to school, built around a 556 chip (two 555s in one package) some 40 years ago. Even the most complex projects I've built since then haven't had half the praise!

Over my time as editor, I have had several requests and seen many more on the forum, for a simple, flexible DC motor controller capable of handling medium powered motors. In this issue we have a design from *Inchanga*, based around a 555 chip. It's unashamedly straightforward, and hopefully will provide a straightforward solution for many readers.

Photo Competition

I've been a little disappointed by the level of entries so far for the *MEW* 25th Anniversary Photo Competition. You still have a couple of weeks to get your entries in, so get your camera into your workshop and take a few snaps of what goes on! There are some nice prizes and you could make the cover of *MEW*!

THE MODEL ENGINEER EXHIBITION
An update from Diane Carney, Editor of Model Engineer

The MEX at Sandown has always received great support from the many model engineering clubs and societies who put on a fantastic display for the public. Year after year the best Model Engineers in the country enter their work in the Loan and Competition sections, which provide a display of excellence second to none. These two factors are at the core of our exhibition and they are what make MEX special. Falling attendance of the model engineering trade suppliers, however, has been evident at all model engineering exhibitions in recent years, not just at the MEX. With this in mind the sponsors of the Model Engineer Exhibition, MyTimeMedia Ltd. have decided that now is the time to seize the opportunity to restructure the traditional Exhibition format, taking into account the diminishing trade presence.

We are presently mapping out a new formula for a better and, most importantly, enjoyable show for clubs, exhibitors and visitors and the date of the next MEX will be announced in due course. We wish to make sure that the next Exhibition focuses, as all previous Exhibitions have, on the quality of the Model Engineering displays and offers greater opportunities for clubs to engage in live steam demonstrations as well as the traditional static displays. The type of venue we have in mind will provide a great atmosphere and be an attraction in itself.

At the moment we are very much in the planning stage. Exhibition organisers, Mike Law, Steve Eaton and myself are quite excited about the changes and the future of the MEX, which will ensure the show is viable for continuing success.

MEX is organised by Model Engineers for Model Engineers; we do listen carefully to the clubs who have supported us, as it is very much your show. We will inform club Secretaries directly of our plans as soon as possible and then ask you for ideas and your opinions. I hope to have some news in the next few weeks so that exhibitors can place the dates in the 2016 Club Diary and help us work towards a new style exhibition in which we will all enjoy taking part.

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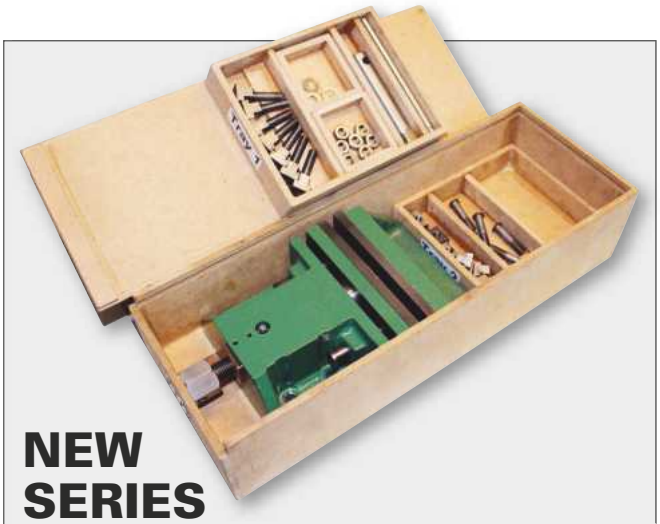


NEW SERIES

David Piddington has designed a useful table-length milling vice, you can make one too as the castings are available from Hemingway Kits.

PLUS Dave Fenner gives his perspective on 25 years of change in the Model Engineers' Workshop, Ian Strickland recounts a contemporary version of the Miller's Tale and Harry Cosh writes on a Quorn and a Crane in his workshop.

Regulars

ON THE COVER

This professional-looking spot welder has a microwave oven transformer at its heart. See Dyson Watkin's detailed article on page 42.

Visit our Website

for extra content and our online forum

www.model-engineer.co.uk

So what does STEN really stand for?

In 1943 Harold J. Turpin, inventor of the STEN sub-machine gun gave an interview to Model Engineer. Find out how it played a part in a Norwegian amateur historian's search for the truth about its name.


THE STEN CARBINE

The Model Engineers' Workshop 25th Anniversary Photo Competition

Come on get snapping! Great prizes and great fun – take a shot that captures 'the spirit of home engineering' – however you define it! Head to the 'Workshop' section of the www.model-engineer.co.uk website for full details of the rules and how to enter.

Some of the other live topics on the forum include:

- TIG Welding – the skills involved in moving from gas welding to TIG.
- Backlash - Steppers, Toothed Belts & Ballscrews – how to work out specifications for a CNC conversion!
- ML7 Repairs and Renovation – What does and doesn't need tweaking on an older machine?
- Positioning a lathe – so just where *IS* the best place for it to be?

A Camlock Top-Slide Swivel Clamp for the Mini-Lathe

Martin Widdowson describes an interesting modification that may also find application to other types of lathe.

I find this is a most useful modification for the Mini-Lathe as the standard arrangement isn't convenient or easy use, so this was high on my list for change. The cost of materials is negligible, requiring only a 200mm length of 8mm diameter silver steel, a piece of 60 x 12mm diameter mild steel and two M4 machine screws. Entirely optional would be to buy another top-slide base for modification and retain the original as a spare.

The modified topslide.

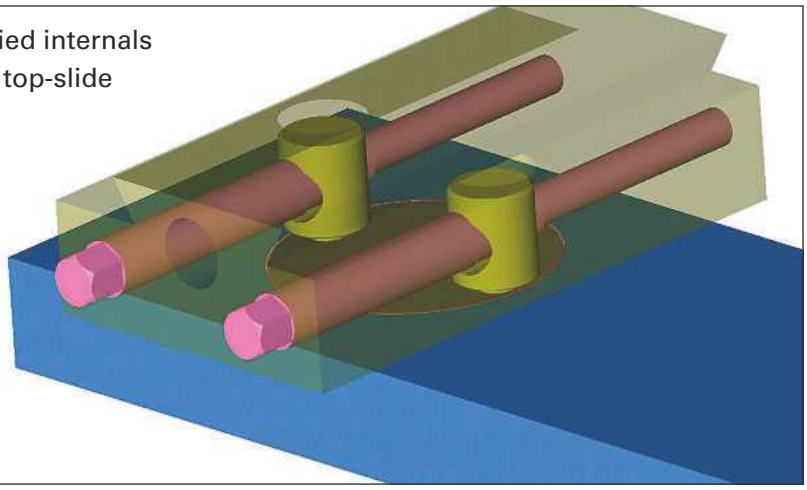
Construction

I started with the silver steel cams by loading the stock into an 8mm collet to retain as much concentricity as possible without resorting to the 4 jaw chuck. Leave about 40mm protruding and drill and tap to M4 x 10mm deep. You may need tailstock support for the next part, which is to turn the diameter down to 5.5mm x 36.5mm long. Ensure you keep it parallel and aim for a good a finish so it feels nice and smooth once assembled into the reamed hole you're about to make in the top-slide base. The next thing to machine on this part is the eccentric, which I did by holding my Mini-Lathe's 95mm diameter ER25 collet chuck in the 3 jaw chuck of my larger lathe and was offset by the insertion of a 0.75mm metal shim between them. The same effect could be had by offsetting the collet chuck in the 4 jaw chuck of the Mini-Lathe or less conveniently, by clamping directly in the 4 jaw, but this would mean having to reset for the other cam. Again, try for a good finish on the eccentric to give a smooth action in use. Machine the larger ends as per the drawing to a dimension of 7mm across flats so a ring spanner or socket fits snugly.

Finally, harden and temper all over to leave them in a tough rather than brittle condition. I managed to obtain the desired tempering result after hardening by placing the cams on the top tray of my better half's electric oven (whilst out shopping) and selecting a temperature of 250°C. By being physically close to the heating elements during the warm up phase, they were subjected to a higher temperature than indicated, enough to leave them nicely blued, but adequately hard to resist wear and tear in use. I baked mine for about one hour.

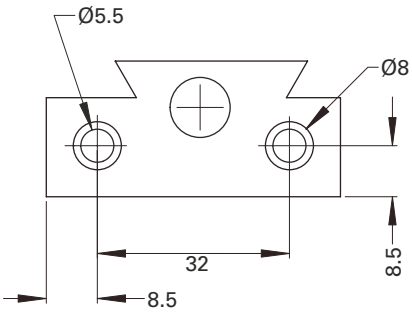
The followers come next and are a simple turning job with a cross-drilled hole, so just follow the drawing and all should be well.

Modified internals of the top-slide

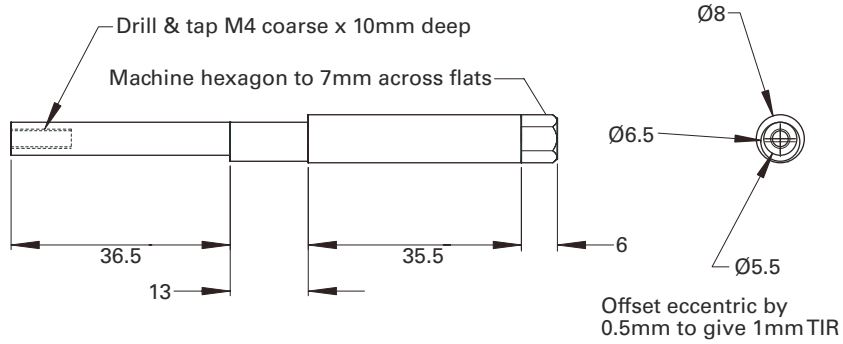


A Little Caution

Potentially the modification to the top-slide base is the most critical part of the job because it's a key component of the lathe itself. However, bases are available quite cheaply (around £17), so some may consider it prudent to buy one with the intention of using it as the basis of the update.



Base



Cam

When you strip the base from the cross-slide, you'll see the circular clamping plate has two M6 tapped holes. On my lathe their PCD is 32mm, but I suppose there's a small chance this could vary between the numerous variants that are in use, so when machining the top-slide base check this dimension matches the drawing and if it doesn't differ by too much, substitute your actual dimension in place of the one shown, alternatively, making another clamping plate with a 32mm PCD would be quite easy to do.

Machining the Base

Once together, the cams run parallel to the dovetails and pass straight across the diameter of the current clamp bolt holes. Whilst there is no problem in drilling the 8mm and 5.5mm holes through which the cams fit, a little thought is required to ensure the holes align well enough such that the cams don't bind excessively once assembled.

I decided to drill and ream the 8mm holes in the milling machine. For squareness & accuracy, the base was secured to an angle plate bolted directly to the milling table and I utilised the feedscrew dials to get the proper positions from each edge of the base. I didn't feel too confident in being able to reliably machine through to the bottom end of the base with the 5.5mm drill & reamer and have it stay straight, so I elected to turn an 8mm diameter stub mandrel that would let me 'wring' the base onto it to allow the hole to be completed by carefully drilling & reaming from the tailstock. However, it might be possible to do the whole job from one end in the milling machine, by super-gluing a 5.4mm drill into an 8mm diameter piece of stock to serve as a guide to promote concentricity.

I can report the method I used worked well and meant the base could continue to its final machining operations, which were to open out the clamp bolt holes to a diameter of around 12.2mm (at the same PCD as the clamp plate) and to pop an 8mm counterbore or flat-bottomed drill down both of the larger holes to create flat surfaces against which the end faces of the eccentrics could bear, without inducing axial movement or binding of the cams when rotated.

The various components. INSET: The followers.

Refitting & Adjustment

Reassembly of the top slide to the lathe is easy. Simply screw each of the followers fully home into the circular clamp plate of the cross slide whilst ensuring their cross drilled holes are in alignment with those in the base as it is lowered back into place. Upon trying to pass the cams into place you should find that they will not fully enter and this is to be expected, so lift the base and unscrew each follower half a turn until each cam just goes home without binding. Once achieved, adjustment is complete and final assembly & lubrication can follow.

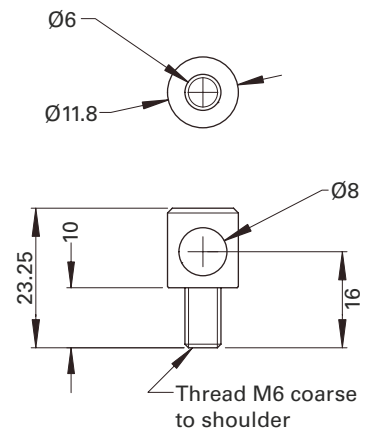
Fit two short machine screws at the small ends to prevent the cams working their way back out and the job is done.

In Use

Camlocks are a very effective way of securing components as you will see with this modification. The only word of caution I offer is not to over tighten the cams, I mostly use the ring end of a short combination spanner and find just a nip is all that's needed to confidently lock the base from moving. ■

The drilled topslide.

The underside of the modified topslide.



Follower

Readers' Tips

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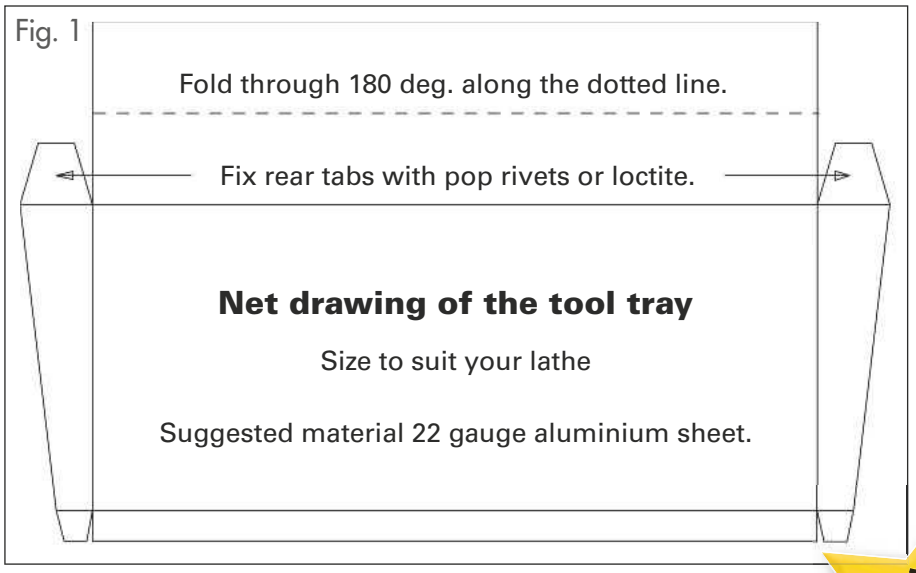
Email your workshop tips to **neil.wyatt@mytimemedia.com** marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 400 words and a picture or drawing. **Don't forget to include your address!** Every month we will chose a selection for publication and the one chosen as **Tip of the Month** will **win £30** in gift vouchers from Chester Machine Tools. Visit **www.chesterhobbystore.com** to plan how to spend yours!

Fig. 1



This month's winning tip is from Geoff Walker, who wins £30 of Chester gift vouchers for his swarf tray.

TIP OF THE MONTH WINNER!

Swarf Solution

Nothing really new about this reader's tip, lathe users have been making swarf trays for years. Mine is shown in **photos 1** and **2**. My tips are about the development, positioning and fixing of a tray to the cross slide. The tray you see is made from 22 gauge anodised aluminium and is fitted to a Myford 3½ inch M type. This is an old lathe with 60 years of bed wear, mainly at the headstock end. In the absence of felt wipers, a tray was essential to help prevent the ingression of tiny swarf particles under the saddle. It can also be seen in photo 1 that the lead screw also receives some protection from the tray. It has been in use for 4 years and is rarely off the lathe.

First tip is to give it a low profile with a taper towards the front. Secondly position the tray so the underside is just above the surface of the bed. My tray will just pass under a 6 inch four jaw chuck and even with the low profile will still collect a substantial amount of swarf. The development of the tray or net as they are now called is fairly simple and shown in **fig 1**. No sizes are given as they will be determined by your machine. As a size guide mine is 3 x 6 inches.

Photograph 2 shows two alloy blocks which are fixed to the tray with small 3mm. screws. The blocks should be just a neat sliding fit in the width of the two outer cross slide tee slots. The central screws in the blocks when lightly pinched will raise the blocks in the slot and secure the tray in place. Steel screws are shown in the photo although brass screws would be ideal. The screws are below the top surface of the cross slide and so do not interfere at all with the top slide even when it is rotated for screw cutting or taper turning. The tray can also be in place when a vertical slide is in use, the slide being fixed to the cross slide in the centre tee slot.

If you decide to make a tray I would suggest making a thin card template to test the formed shape on the lathe. A rectangular block of hardwood with square edges and sized to the inside width and length of the tray will make the forming of the tray much easier. You can add some strength by folding over the longer vertical edge to double the thickness and securing the rear tabs with pop rivets or adhesive.

This month's runner up is Brian Wood, with some snappy advice on dressing brazed joints. He wins a copy of Chris Vine's *How Not to Paint a Locomotive*.

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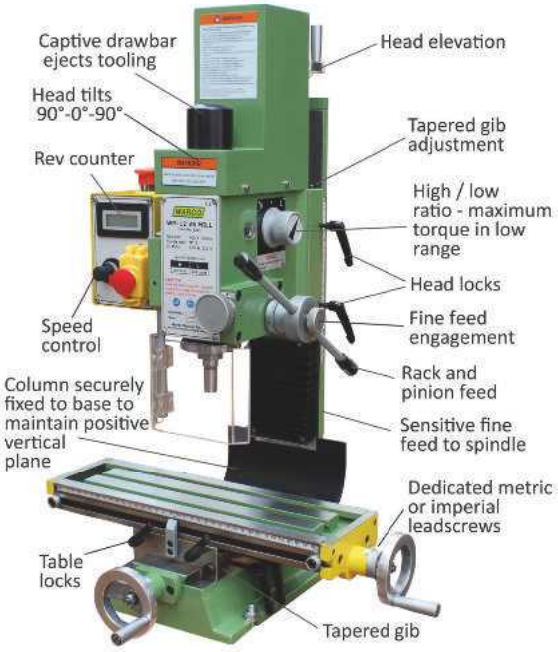

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Making a Rotating Chuck Adaptor

Ted Fletcher makes an accessory you never know you need, until you do!

Recently I was asked to skim the commutator of an armature, but unfortunately the armature shaft wasn't centred at either end. To eliminate excessive carbon brush wear and arcing at the brushes it is essential that the commutator is turned concentric to the motor shaft. The armature shaft was hardened so I was unable to centre it in the usual manner, however, using a larger lathe, a dial test indicator, a four jaw chuck, and a lot of adjustment I managed to skim the commutator to a satisfactory standard. Where I worked in the 1950's we had an American made lathe, I cannot remember the make, but it had a purpose made revolving chuck for just such tasks as mentioned above. There was a standard chuck on the lathe mandrel and a rotating chuck in the tailstock, something akin to a revolving centre. I have rarely seen revolving chucks for sale, and when I have they have been expensive, especially for someone like me who may never have the need for one ever again. So, after some thought I decided to make an adaptor which would convert a standard chuck to a rotating one for possible future use, when it is fitted in the tail stock of a lathe. Please note neither chucks have guards fitted, so when and if you are using this gadget proceed with caution, start with a low chuck speed!

I decided that the adaptor (**photo 1**) had to be easily and quickly fitted and to be just as quickly detached from the chuck after use. Like many other model/hobby engineers I have a selection of bearings and bushes, chiefly ex-washing machine motors bearings and a few taper roller bearings from cars. The adaptor is not likely to be used very often and will not be subject to axial thrust, so I decided that a pair of sealed ball bearings would be adequate.

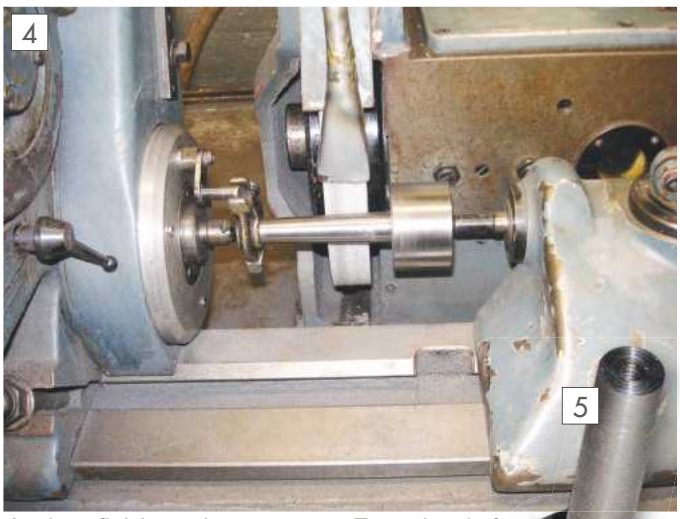
It can be seen from the two drawings (which are deliberately not to scale), and the photographs of the general arrangement, that the idea can easily be adapted to other makes of lathes.

I procured a short damaged length of 50mm bar from my favourite supplier, the skip. The piece of bar was slightly bent about mid point, it was obviously a piece which had been cut off a much longer length, how on earth you kink a 50mm bar I don't know. Using my horizontal/ vertical band saw (what a great piece of workshop equipment they are) I cut the bar at the point where it had been slightly bent.

I am a member of the Yorkshire Coast College model engineering group, so took the pieces of bar to the model engineering evening class, tidied up the damaged end and centred both ends of both pieces using one of the College's large lathes. Whilst at the College I took the opportunity to roughly turn one piece in preparation for taper turning at home. I have a Myford taper turning attachment and soon fixed up the roughed out piece between centres and turned the taper (**photo 2**). Years ago I made myself several turning tool holders similar to what David Fenner did in his recent article on lathe tools. I am amazed how tough these tip tools are, I get an excellent finish and they don't need accurate grinding and seem to last forever. It was one of my home made tools which I used for this job. Look out for these tips at Traction Engine Rallies, Auto Jumble sales and make your own holders, they might not be as good as the manufacturer's, but are still very good for would be engineers like myself

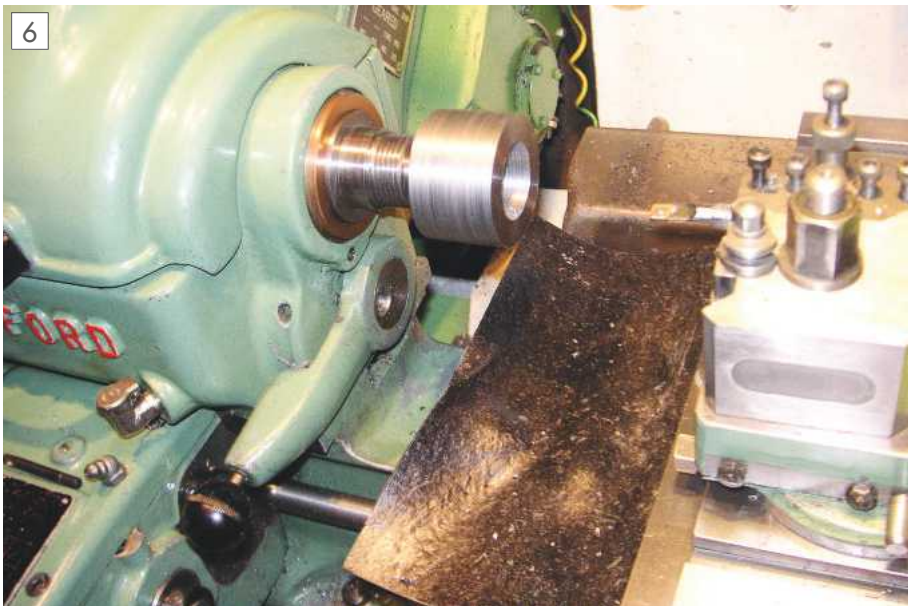
The College machine shop has cylindrical and surface grinders, so on my next visit, I took along the piece which now had a turned 2MT taper along its length and using the cylindrical grinder ground the taper to a mirror finish. Setting up the cylindrical grinder is a time consuming job for the first timers, there is no point in believing the scale marked on the machine for the accuracy required. This job needs to be set up and ground between centres. To set the machine up I got a 2MT machine reamer and a DTI from the stores, you will find that these reamers are centred at both ends. With the reamer mounted between centres and the DTI mounted on the face of the grinder, I traversed the grinder table back and forth with the stylus of the DTI bearing down every so slightly on the reamer 2MT taper, until the DTI showed no deflection. The four security nuts were then tightened up, a final traverse was made to ensure that no slight movement had taken place during tightening up process. For jobs like this the correct driving dog must be used and a small amount of grease

Set up for grinding.



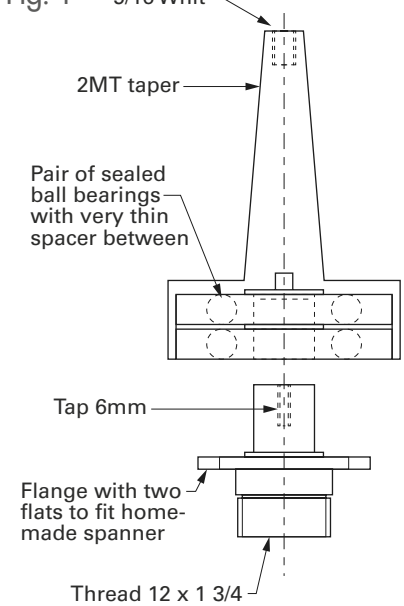
A mirror finish result.

Tapped end of the drawbar.



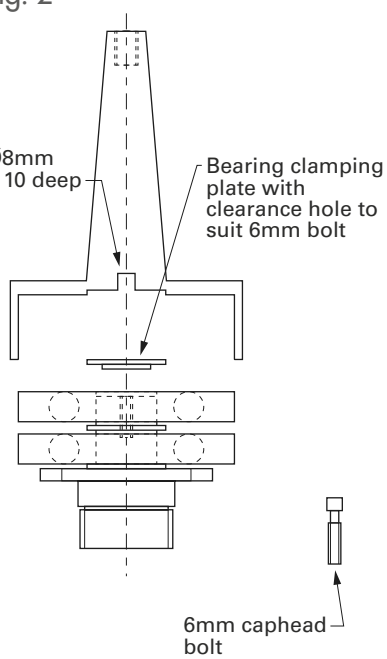
Boring the adaptor.

Fig. 1



Rotating Chuck Attachment
(General arrangement only)

Fig. 2



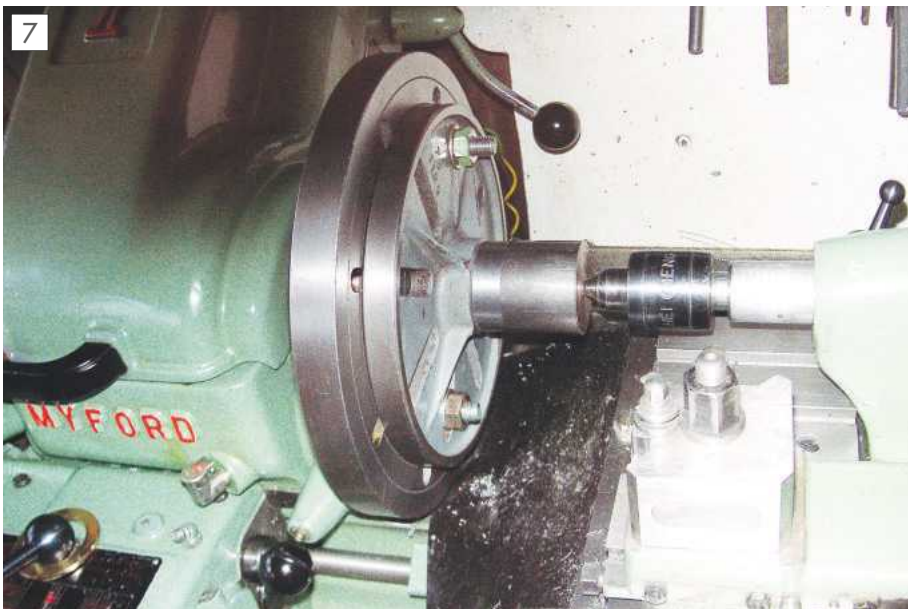
applied to the centre at the non-drive end. These machines are not like angle grinders, they are precision machines designed to remove very small amounts of metal, so therefore very light cuts are the order of the day. It is advisable to dress the wheels before using the grinder, the College's machine, a Jones and Shipman has a built in diamond dresser for that very purpose. **Photograph 3** shows the bearing housing in the grinder with the guard in position and **photo 4** the grinding completed. It goes without saying that coolant MUST be used at all times to keep down the dangerous dust and to obtain the desired fine finish. The College stores has a precision 2MT master, with which to check the ground articles against, using engineers' blue.

With the 2MT taper now completed, the larger end was fitted to a four jaw chuck and checked for any run out using a test dial indicator, then the taper end was drilled ¼ inch and tapped 5/16 inch BSW for a draw bar (**photo 5**). Now back home the new 2 MT taper was inserted in the Myford mandrel, as shown in **photo 6**, and with the draw bar fitted for security, the larger end was bored out as shown to accommodate the two ex-washing machine motor sealed bearings. A 50 thou or so recess was further bored to ensure the bearing inner could not come in contact with the bottom of the bearing housing and a second recess was bored clearance for a 6mm cap head bolt 10mm deep.

As I had already centred all four bar ends at the College I was also able to carry out the next stage at home on the Myford. Once again turning between centres to ensure accuracy, one end of the second piece was turned as copy of a Myford mandrel, and then a thread 12 x 1⅛ inch, 55 degrees was also cut. For those not familiar with turning between centres the piece of metal usually has to be longer than the finished article to provide space upon which to fit the dog. The dog should be screwed up very tight, as there is nothing worse than a slipped dog and then trying to pick up the thread once again.

Next I reversed the bar and, still working between centres, turned a shoulder so that the inner part of the bearing was a tight

If you don't fancy putting your newly made adaptor in the four jaw chuck because of the possible jaw marks, or perhaps you haven't got a four jaw chuck, there is another way of carrying out the final operation, and this is what I actually did.



Using two faceplates back to back.

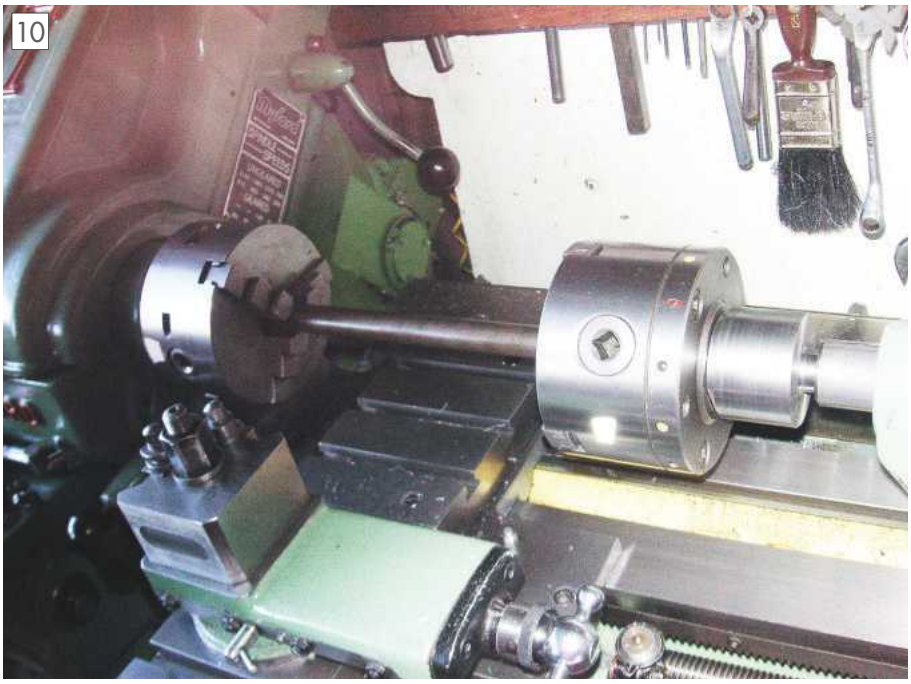
push fit on the shaft against the shoulder. To ensure free running of the bearings I also made a very thin spacer to fit on the newly made shaft, such that both bearing inners were locked together. A small piece was turned up as a bearing security cap which is shown in the centre of fig 2, a hole was drilled for clearance 6mm, to allow a 6mm cap head bolt to pass through. When the bolt is in place and tightened, it will lock the two bearings together with the spacer trapped between them in the newly made adaptor bearing housing. If you don't fancy putting your newly made adaptor in the four jaw chuck because of the possible jaw marks, or perhaps you haven't got a four jaw chuck, there is another way of carrying out the final operation, and this is what I actually did. For this you will need two face plates, if you just have the one, maybe you can borrow another from a friend. Fit one of the face plates to the lathe mandrel in place of the chuck, then bolt the two face plates together face to face, initially not too tight, as you will need to clock up the second face plate using a DTI on its outer rim. Once accurately aligned tighten up the bolts (**photo 7**). If this is the first time you have used two face plates in this mode it might be advisable to check both, one at a time on the lathe mandrel on their outer rim for any run out, and lightly skim if necessary. When I checked mine they were spot on and I think most will be. Now the newly made adaptor can be screwed into the second face plate thread, ready for parting off the extended piece of bar which was necessary to fit the driving dog. This arrangement permits removal and re insertion of the adaptor without loss of alignment should that be necessary. Whilst I had the adaptor piece screwed into the faceplate, I drilled a 5mm hole and tapped it for a 6mm cap head bolt, 10mm deep into the non screwed end.

The component parts, including the spanner.

The completed adaptor.

The next operation was to mill away two flat areas on the flange to fit a home made spanner, so that when I wanted to remove the chuck from the adaptor I had something that I could work against. The final metal working operation was to make an open-ended spanner to fit the two flats which I had already machined on the adaptor flange. I have several pieces of 3mm sheet steel off cuts, I selected a piece, 'blued' it, marked out the jaw area and general shape of the spanner, then with the hacksaw and chain drilling removed the metal to form the spanner. **Photograph 8** shows the component parts ready for assembly.

Last of all I assembled the two parts using Loctite bearing fit adhesive, such that the adaptor revolved with ease when in use. **Photograph 9** is the completed adaptor and **photo 10** shows it assembled and fitted in the lathe tailstock ready for use. ■



The adaptor fitted to the lathe.

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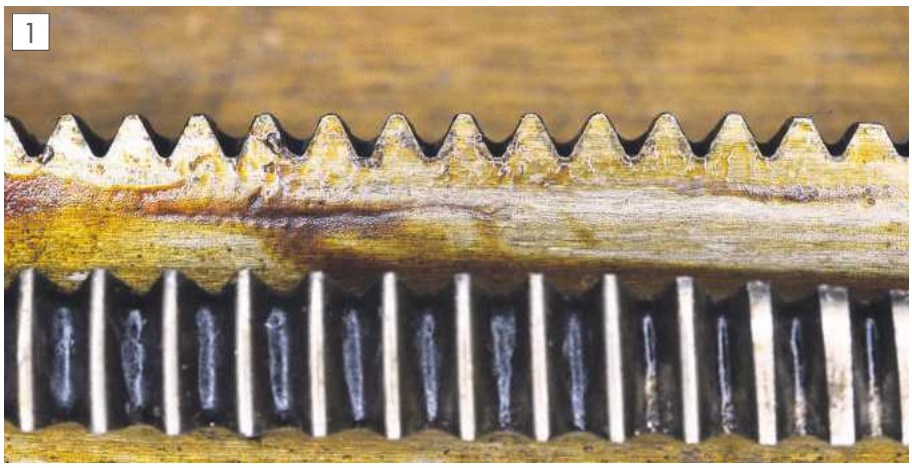
Fitting a Chuck Backplate

Roderick Jenkins take us through the process of fitting a lathe chuck.

My lathe came with a 6-inch 4 jaw independent chuck. This is very useful for gripping irregular items but the large size does have a couple of limitations. Perhaps the most important is that the chuck is too big to fit comfortably on the dividing head on my milling machine. Also, I sometimes like to mount a job with the jaws reversed so that that it beds against the face of the steps but the length of the jaws mean that they meet in the middle before the job is gripped. So I looked around for a smaller 4 jaw. Eventually I found a 4-inch 4 jaw independent chuck on eBay. A nice purchase but it needed a backplate. Fortunately I already had a backplate casting: This is how I went about fitting it.

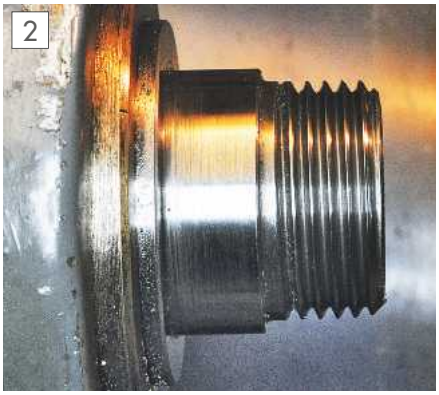


Typical Whitworth thread form.

The lathe is a Myford Super 7. The mandrel nose thread is 1⅛ inch x 12tpi and the register diameter is 1.250 inch diameter. The thread angle is 55° so, Myford being English, one might expect that the thread form is Whitworth which has rounded crests and roots, like this 1 inch BSW tap (**photo 1**). Inspection of my mandrel nose thread showed it to be exactly 1.125 inch diameter but examination of the thread shows that the form is pretty much triangular with a slight flat at the crest and root (**photo 2**). Over the years, there has been quite a bit of discussion as to whether a register is necessary for accurate positioning of screw-on chucks. Whether a register is necessary or not, the Myford uses one so this is the most important part to get right; the screw can be fairly loose on the mandrel nose, provided that the backplate is a snug fit on the register. Some years ago I made a nose fitting to allow chucks to be fitted to my rotary table (**photo 3**). This replicates the Myford nose and so can be used as a thread/plug gauge for testing progress when fitting a backplate.

The chuck itself fits on a register on the backplate. It is usual for the backplate to butt up against the face that has the mounting holes drilled through it (**photo 4**). In the case of the independent 4 jaw chuck this is in the central area and the whole backplate fits inside the diametrical register. On self- centring chucks, because of the scroll mechanism, the bolt holes are at the periphery of the chuck and the diametrical register is inside the face register. Consequently we can use a smaller backplate for a 4 jaw independent chuck than we would have to use for a self-centring chuck of similar diameter, which is fortunate as that is what I had!

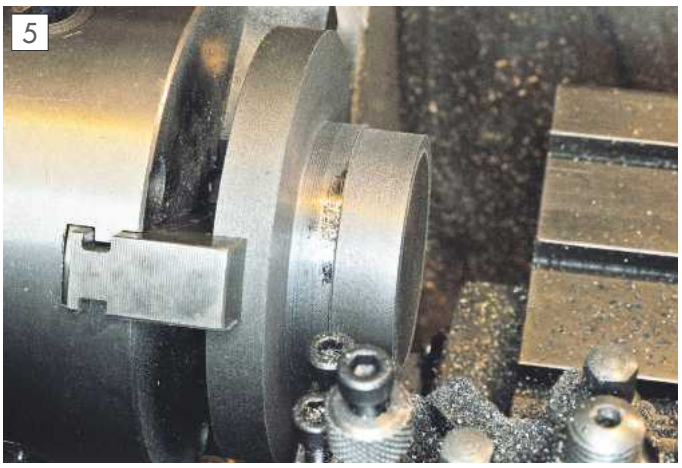
The first job was to clean up the backplate casting. I held it by the boss in the 3 jaw SC chuck and turned the 'skin' off the casting face and edge. The as-cast surface of cast iron can contain some impurities from the sand and, since it is the first part to cool, can become chilled which gives it a hard surface. It is therefore recommended to use a relatively deep initial cut to get under the skin. I used a general purpose replaceable tungsten carbide tip at a speed of around 200rpm which seemed comfortable. It is possible to see a shiny area where the tool has



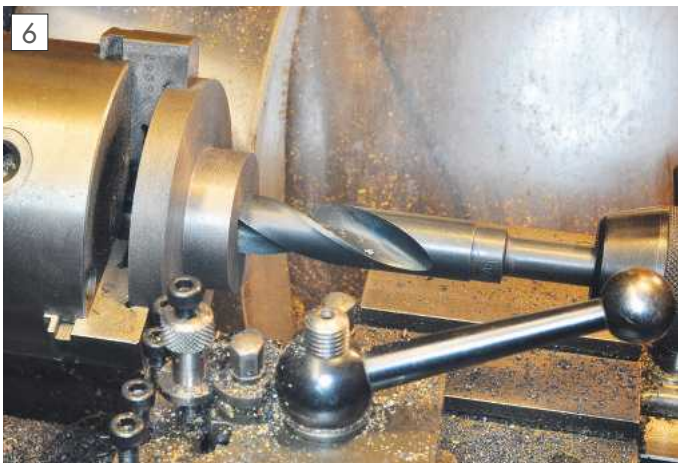
Myford spindle nose register and thread.

False nose with Myford thread and register.

Back of 4 Jaw chuck showing register and bolt holes.



Turning backplate boss with shiny hard spot.



Drilling backplate with 1 inch blacksmith drill.

Setting boring tool square to lathe axis.

Cutting the thread.

rubbed a hard spot rather than cut (**photo 5**). Increasing the depth of cut cured this – the rest of casting machined very nicely. I then turned the casting around in the chuck to turn the boss. The actual diameter of the boss doesn't matter so it just needed cleaning up before preparing to make the thread and register.

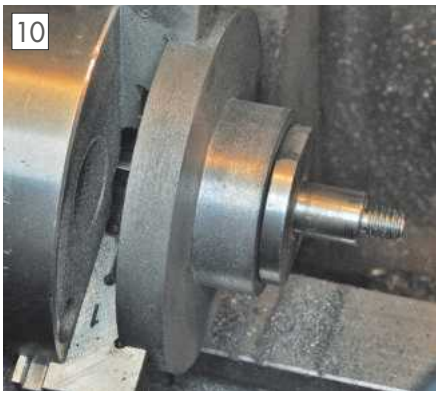
A starting point for cutting the thread is the core diameter of a 1⅛ inch 12tpi Whitworth thread which is 1.018 inch. I used a succession of drills to get the hole to 1 inch in diameter (**photo 6**) before using a boring bar to bring the hole to size. These days I use replaceable tungsten carbide tip tools for screwcutting but, sadly, my tips don't have a sufficient depth to cut such a large thread so I had to resort to a HSS internal threading tool, which is actually a Myford boat tool, already ground to the 55° Whitworth angle. This tool has no top rake but fortunately this is not an issue with cast iron. The threading tool needs to be set up at centre height and at the correct 90° angle to the axis, most easily accomplished using a threading gauge set against the turned surfaces (**photo 7**).

When it comes to cutting threads, I'm generally of the 'topslide parallel' school rather than the 'topslide at half thread angle'. Both methods have their merits and one is sometimes better than the other, depending on the circumstances. When cutting internal the threads the parallel method seems more straightforward to me. The theoretical depth for a 55° 12tpi V thread is 0.080 inch. I touched the tip of the tool against the internal bore, zeroed the friction dial on the cross slide and then cut the thread using the lowest direct speed and the VFD turned down to minimum, which results in the chuck rotating at about 120rpm. I increased the depth of cut by 0.005 inch on each pass and proceeded to cut the thread completely through the backplate. Because 12tpi is an even number, the thread dial indicator can be engaged at any whole number.

On every couple of passes I moved the topslide towards the chuck by 0.001 inch so that the bulk of the thread cutting was on the leading edge of the tool. As the depth of cut approached 80 thou I tried screwing the false nose into the backplate. It was nowhere near going in. This was, I'm afraid, only to be expected. The forces involved in screwcutting a large thread like this conspire together to push the tool towards the centre. The remedy was to make several passes with the cutting tool at the same setting. Each pass took a cut as the spring on the tool gradually overcame the forces pushing it out of the way (**photo 8**). When a trial fitting showed that the false nose was starting to engage the threads I disengaged the lead screw and turned a couple of thou off the crests of the thread. The crests were pretty ragged anyway due to the nature of cast iron. I continued cutting the thread by increasing the cut by only one thou each time and cutting twice at the same setting until the false nose was able to be easily screwed in right up to the register.

The next task was to change the threading tool for a boring bar and cut the register. This needs to be deep enough so that the face of the boss will butt up against the register face on the lathe nose. I made it 1/10 inch longer than measured on the lathe nose. Once I got close to the correct size I proceeded very cautiously, taking ½ thou cuts and cutting twice at the same setting until the false nose could be screwed all the way home with firm finger pressure (**photos 9** and **10**). The rest of the turning

Backplate showing register.



Testing with false nose.

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on the backplate was completed with the embryo backplate screwed on to the lathe mandrel nose but before doing this I took a light cut across the register face with the boring bar and then rounded off the corners with a hand tool.

So, with the backplate now mounted on the lathe nose I carefully turned the diameter to be a very snug fit in the chuck recess and then faced across the front. The thickness wasn't too important but I wanted to minimise the chuck overhang, yet ensure that the backplate thickness was at least 4 threads deep for the holding screws.

I was hoping that I could use metric screws to hold the chuck to the backplate, they being ready available locally but it turned out that 5/16 inch screws fitted the clearance holed through the chuck very nicely and the heads of these screws also fitted snugly into the counterbores of the chuck face. Since I was screwing into cast iron I chose BSW, rather than BSF, because the coarser thread has less chance of stripping in the relatively brittle metal. The backplate needed to be drilled and tapped for the screws holding it to the chuck. Prior to this I went over the chuck recess with a scraper to remove any burrs. I mounted the backplate onto the chuck and then drilled a dimple with a 5/16 inch drill through the chuck bolt hole (**photo 11**). I then removed the chuck and used the dimple as a guide to drill a 6.7mm tapping hole for 5/16 inch BSW. The backplate was moved to the George Thomas Universal Pillar Tool for tapping (**photo 12**). This size of tap is probably a bit big for the UPT but fortunately cast iron is fairly easy to tap and it does ensure that the tap is perpendicular. I then assembled the chuck and backplate with this one screw and dimpled the three remaining holes before drilling and tapping.

Originally, I'm sure, this old chuck would have been fitted with slotted cheese head screws but I wanted to use hexagon socket heads. Although the heads of the socket screws fitted the counterbores, they were too tall (**photo 13**). Obviously, the screws must be recessed below the face of the chuck. Careful examination of a screw head with my callipers showed that there was sufficient material to remove a bit from both the top and bottom of the head so that it was small enough yet still had sufficient meat left to hold together. I put the threaded part of the screw in the tailstock chuck and then used this to introduce the head into the 3 jaw chuck jaws to ensure that it was reasonably axial before removing the drill chuck (**photo 14**). This sort of behaviour can be construed as cruelty to chucks! In my defence I used only very light clamping pressure and took very fine cuts. I then turned the screw around and took some height off the top surface, leaving me with a short head screw (**photo 15**). Repeating this operation for the 3 remaining screws left me with a nice small 4 jaw chuck ready for my lathe (**photo 16** and **17**).

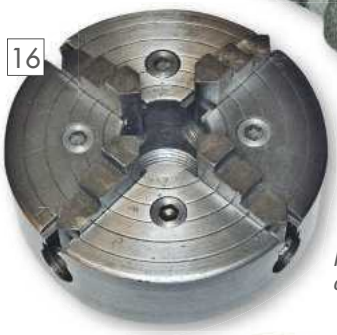
I could have avoided much of the above work. Backplates are available from various sources for Myford and other lathes with the thread and register already machined. However, these backplates are all only available in steel. Cast iron backplates, with their free carbon content, are kinder to the lathe spindle and less likely to seize on the mandrel. More importantly, this was an interesting exercise (and I already had the casting). ■

Spotting 1st screw location.

Tapping 1st screw hole on UPT.

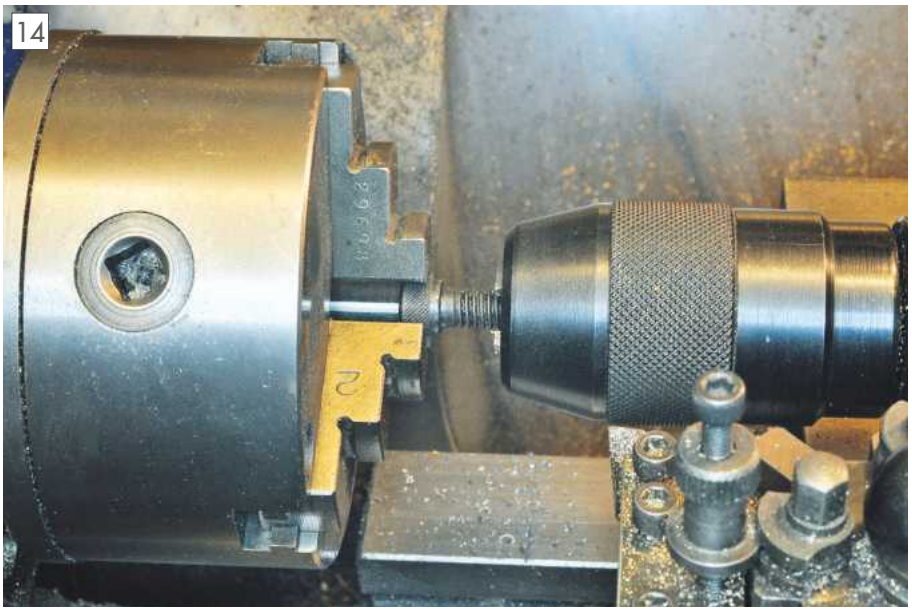
Determining amount of screw head to remove.

Modified screw.



My 'new' chuck.

Fitted backplate ready for use.



Setting up screw for head shortening.

A Spring Parallel for the Machine Vice

These useful little devices from Mark Frampton are an ingenious aid to accuracy with the milling machine.

The machinist is often called upon to set one edge of a job vertically in the vice so that an edge can be machined at 90 degrees to it. This can be a fiddly business even with a conventional machine-vice, but if the vice is the sort fitted with so-called 'pull-down' jaws, it is just about impossible. 'Pull-down' jaws move both towards each other and downwards as the clamping pressure is applied, thereby eliminating the well-known and troublesome phenomenon of jaw-lift. If an edge needs to be set vertical, it follows that the lower edge cannot be seated properly on its supporting parallels. The downward movement of the jaws will cause the job to heel over in the direction of least support and the setting will be lost. Trying to hold the job upright by hand, or tap it with a mallet, while tightening the vice is futile – the vice will win every time – while the results of inserting wedges or pieces of packing beneath the work are likely to be hit-and-miss. What is needed is some reliable means of accommodating the out-of-squareness of the work, so that the desired setting may be attained easily and may then remain undisturbed when the vice is tightened. This the spring parallel is designed to do.

Spring parallel.

The device sprung open.

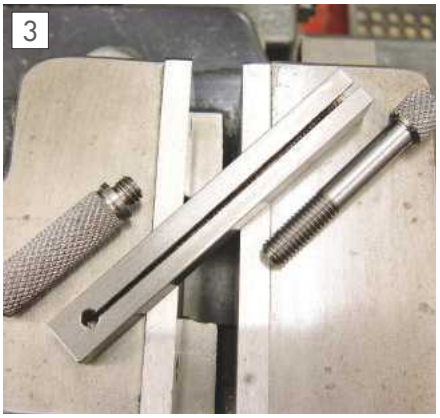
Placed under the work, and nominally parallel, the spring parallel is a piece of rectangular-section steel, split along its length into two conjoined fingers which may be sprung apart by a screw so as to create a tapered support block having an included angle of up to two degrees, (**photos 1** and **2**).

Design

Two important and related features of the design are the placement and operation of the expansion screw. It will be appreciated that, in use, the device is rather hidden away beneath the work and between the vice jaws, and yet the screw must be accessible at all times for the purpose of adjustment. To meet this consideration, a hole is drilled right through the bar along its axis and then tapped close to one end for the screw. The screw thus protrudes horizontally from the end of the bar, its shank extending well clear of the vice jaws so that its head is accessible to the operator's fingertips at all times, even when it is overhung by a long workpiece. The slot which separates the fingers of the device passes horizontally through the centreline of the thread, which is formed with a taper tap only. Herein lies the secret of the design, for when the screw is tightened, the entry of its nose into the tapered part of the thread creates the wedging action by which the fingers are sprung open. Finger-pressure alone is quite sufficient to open the device to its fullest extent. Provided the job has been seated properly on the device, the machinist can adjust the angle of the taper until the side of the job is truly vertical, confident that it will remain so when the vice is finally pulled up tight.

When carrying out adjustments, the device must be held firmly with one hand while the expansion screw is turned with the other, and in order that this can be accomplished without having to take both the job and the device out of the vice, a knurled handle, long enough to reach comfortably beyond the vice jaws, is screwed into the tail end of the device, the through-hole being tapped for this purpose (**photo 3**).

It is recognised that the taper of the device, when it is sprung open, will not be uniform along its length, and that the precision with which a vertical can be set must therefore be compromised if, during the setting procedure, there should be any longitudinal movement of the workpiece in relation to the device. A simple, adjustable-rod end-stop has therefore been designed which can be attached to the device, in place of the handle, to provide a means of consistently locating the work (**photos 4**, **5** and **6**). Although it is still a little early to be definite, experience gained with the prototypes suggests that the end-stop is a refinement which is unnecessary for any but the most exacting work, and might, therefore, be dispensed with.



Spring parallel, component parts. Handle, shank and expansion screw.

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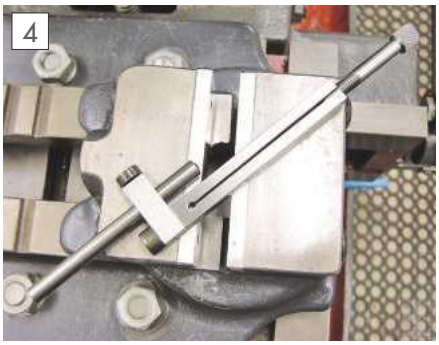
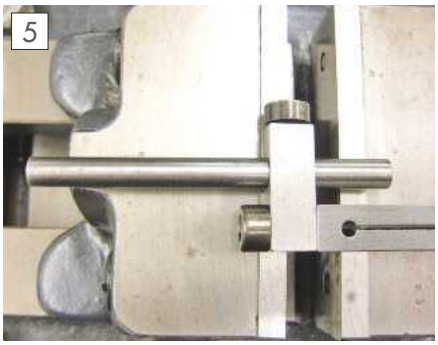


Spring parallel fitted with end-stop.



Close-up of end-stop.

End-stop, component parts.

Construction

The drawing shows the device as I made it, and the sizes quoted are suitable for a three-inch (80-millimetre) vice.

In working out the details of the design, I made two prototypes. For the first, I used an offcut of black mild plate which I planed to size on the shaper and then centre-popped for the cross-hole which I put in at the drill-press. The remaining facing, drilling and tapping operations were carried out in the lathe. Not possessing a long-series drill, I had to drill the 5mm diameter through-hole from each end, which involved setting the job up twice in the four-jaw chuck. On reflection, it seemed that time might have been saved by beginning with a length of round stock. I tried this approach on the second prototype, and while the lathe-work was certainly completed more quickly, the planing operations necessarily took longer, and overall, there was very little in it. Being free-cutting material, however, the round stock did machine to a much better finish than the black bar, as the photographs show.

The machining operations are entirely straightforward, and the only point to watch is that the female thread for the expansion screw must be formed solely with a taper tap which should be put in for three or, at the most, four turns only.

I cut the slot by eye using a hacksaw, and took off the burrs with a tri-square Swiss file.

The knurled handle and knurled-head expansion screw, together, add the finishing touches to the device, but if constructors wish to save themselves some time, the separate handle could be eliminated by simply increasing the length of the main rectangular bar and the home-made screw could be replaced with an ordinary Allen cap-head, as used on the original prototype (**photos 7** and **8**).

Prototype spring parallel.

Prototype spring parallel, component parts. Simple shank without handle and cap-head expansion screw.

The end-stop, if provided, should be made as compact as possible, particularly if the device is to be used on the shaper. Mishaps can occur on the shaper if bolts or studs are allowed to project above the general level of the work, for the simple reason that the machine will be at rest during the setting-up process and the operator may fail to appreciate that one or other of the fasteners will lie in the path of the tool, until, that is, he starts up, and a collision occurs, possibly after moving the table over.

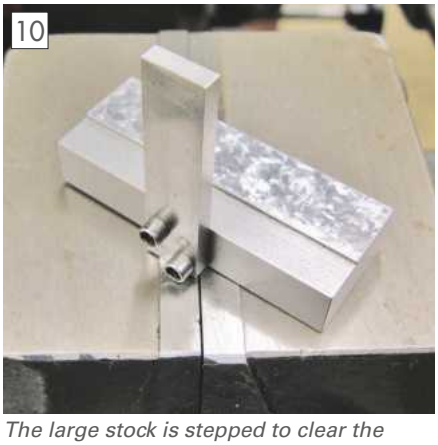
Use

While a spring parallel is just the ticket when it comes to setting a previously-machined edge vertical, what it cannot do is indicate when a true vertical has been achieved. A separate test must be made, and some ways of doing this will now be considered.

Perhaps the single best tool for this is a tee-shaped square of the special pattern developed by George Thomas for just this sort of eventuality, and described in his book *The Model Engineer's Workshop Manual* (**ref. 1**), although I doubt he had spring parallels in mind when he was writing. So far as is known, such squares cannot be bought, and anyone who wants one must make his own. A few suggestions as to how to go about this are given in the text. Unlike a conventional try-square, the stock of the original George Thomas tee-square rests neither on the floor of the vice, nor on parallels, but on the top of the fixed jaw, and the blade passes down between the jaws so as to make contact with the side of the job.

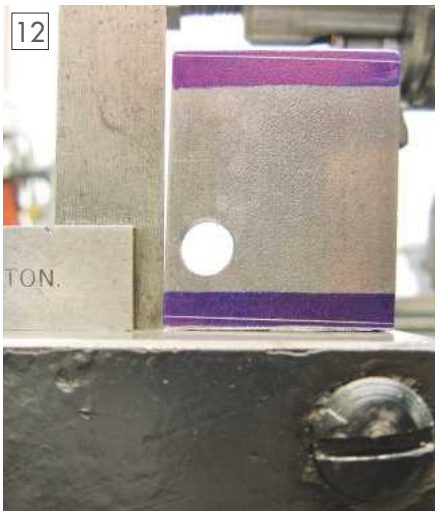
My own version of the tee-square differs from the original because my vice has floating jaws which pull down when the vice is tightened. Since it cannot be assumed that the upper surfaces of the jaw-plates will be parallel to the bottom of the vice, the stock of the square has been made much larger and rests not on the top of the fixed jaw-plate, but instead on the ground surface of the main casting behind the fixed jaw-plate (**photos 9** to **16**).

Tee-square.



The large stock is stepped to clear the floating jaw plate of a pull-down vice.

A view from the other side.

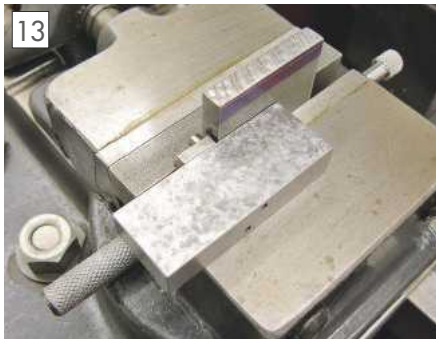


A typical job that cannot be held upright in a pull-down vice.

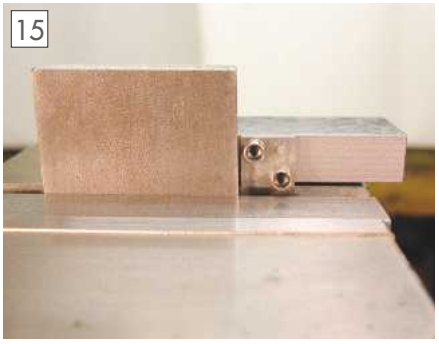
If the only tool available is a conventional square, it will be necessary to take a trial cut over the work and then apply the square, inverted, to test for a right-angle between the upper and vertical surfaces of the work (**photos 17**, **18** and **19**).

Whatever kind of square is used, it must be remembered that if the most accurate results are wanted, it is not possible to judge by eye alone whether or not the blade of the square is making a proper contact with the work all along its length. The surest way to proceed is to press the stock firmly down, and then trap two slips of paper between the blade and the job. If, when tugged gently with the fingers, the two slips are tight, and present the same resistance to being pulled out, the corner of the job may be assumed to be square within fairly close limits.

If the available square is too large to be used as described above, an alternative approach would be to use it to scribe a line across the job at right-angles to the intended vertical and then set this line horizontal with the aid of a miniature surface gauge. This straightforward process



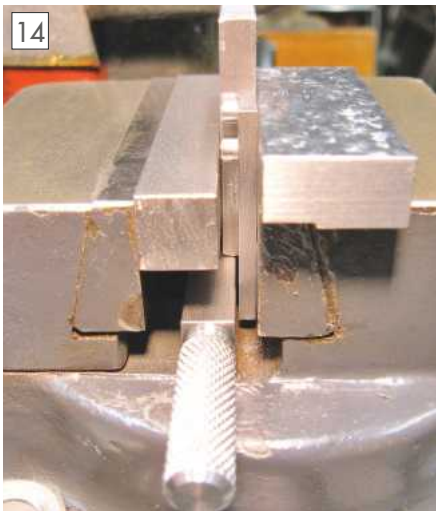
The position of the tee-square in use.



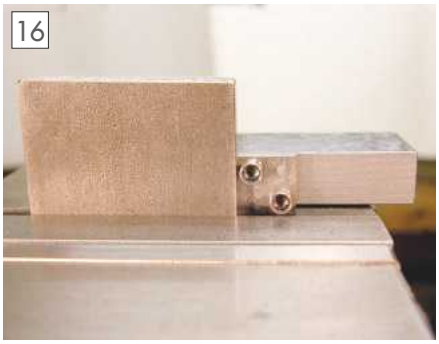
Before adjusting the spring parallel. The side of the job is not vertical.

is begun by setting the scriber of the gauge to indicate one end of the line. If, having moved the gauge, the other end of the line does not coincide with the scriber point, the spring parallel is adjusted slightly, the gauge reset, and another test made (**photos 20**, **21** and **22**).

The comparisons are fairly quickly made and, on that score alone, the method may be recommended, but its use does depend on having enough space to use the gauge. On a really large machine, it would be possible to work with a full-size gauge which would stand on the table alongside the vice. The gauge in the photographs, however, is just three inches (80mm) high. Intended solely for indicating – the needle is too slender to be used reliably for



Offsetting the spring parallel to make space for the blade of the square.



After adjusting the spring parallel. The side of the job is now vertical.

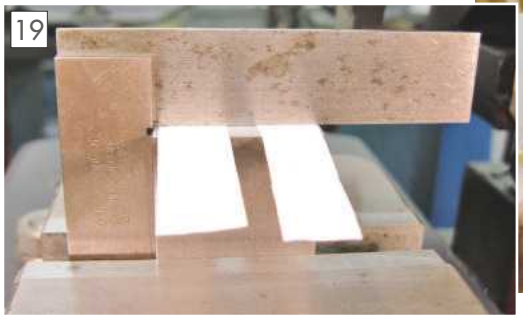
marking-out – it was made expressly to fit on top of the pictured vice which occupies almost the whole table area of what is, by industrial standards, a small machine. Fortunately, there exists on this vice, behind the fixed jaw, a ground-flat area suited to the use of a gauge.

Not all vices are so provided but, even then, all is not lost, for recourse may always be had to that most venerable of

The job is not square.

After adjusting the spring parallel, a light cut is taken before retesting with the try-square.

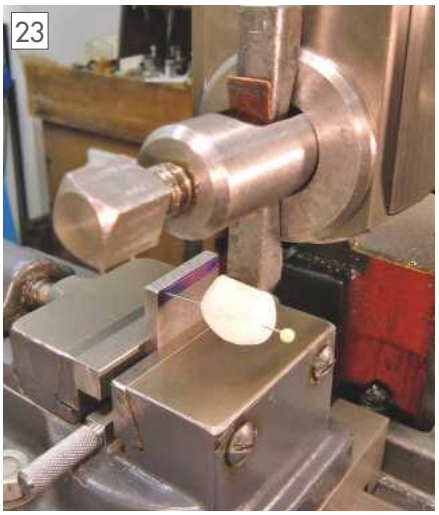
Miniature surface gauge.



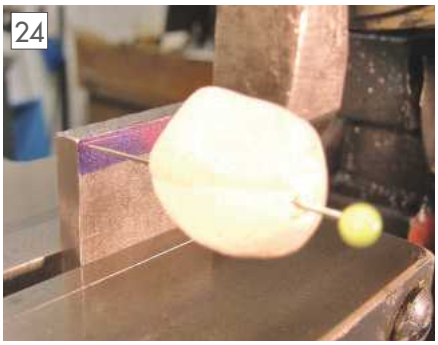
If the job is square, the two slips of paper will present the same resistance to being pulled out.

The needle is set to the scribed line.

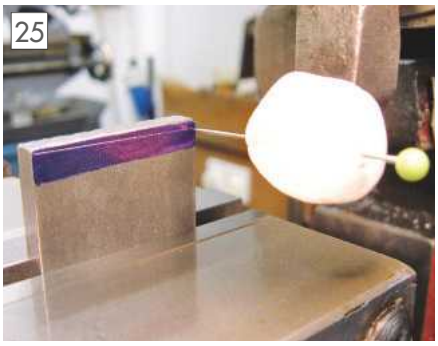
Checking the other end of the scribed line.



The sticky pin.



Indicating first one end of the scribed line...



...and then the other.

Machining under way. A visual check confirms the accuracy of the setting.

If the workpiece should be so out-of-square that the device reaches the limit of its adjustment before a vertical can be set, do not strain it by over-tightening. Instead, proceed in stages, gradually truing the job up by taking a light cut across its top edge and then turning it upside down and taking another cut.

improvised devices, the sticky-pin! This is nothing more than an ordinary sewing pin embedded in a lump of Plasticene or Blu-tac and affixed to the end of the tool. The pin is applied to the work in the same way as the scriber of the surface gauge, the only difference being that it must be traversed by pulling the machine round, in the case of the shaper, or winding the slide back and forth, in the case of the mill (**photos 23**, **24** and **25**).

Although these methods are open to the objection that they rely upon visual inspection rather than definite mechanical indication, surprisingly accurate results can be obtained by their careful use (**photo 26**). As with all marking-out, the best results are obtained when the marking consists of neat fine lines, and the use of a magnifying glass will materially assist with the checking process.

If the workpiece should be so out-of-square that the device reaches the limit of its adjustment before a vertical can be set, do not strain it by over-tightening. Instead, proceed in stages, gradually truing the job up by taking a light cut across its top edge and then turning it upside down and taking another cut, repeating this process as many times as is necessary, until the remaining out-of-squareness is within the normal range of adjustment of the device.

Unless there is some residual error in the set-up – a sagging table on a shaper, for example – the spring parallel is no longer needed once one edge of the job has been brought square with the vertical. The remaining squaring-up operations can be completed by inverting the work onto a conventional parallel in the usual way.

Future developments

Several developments of the device have been envisaged but not yet tried.

One possibility, with the object of applying the principle to the support and adjustment of larger workpieces, is the ganging together of spring parallels by interposing a hollow spacer between them and then tying the whole ensemble together with a stud passed through the cross-holes and secured with a couple of nuts.

Another idea is to produce spring angle parallels, so that tapered workpieces might be machined at any angle within the range of the device. ■

REFERENCES

1. *The Model Engineer's Workshop Manual*, George H. Thomas. ISBN: 9781857610000

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One Man and his Lathe

Chris Gunn and his Colchester Bantam

I started model making in metal over 50 years ago, not long after I started my apprenticeship at Timsons, a local company making printing machines. We were able to buy a house in 1965 as we were both working, and with the help of a brickie neighbour I soon built a brick garage with a workshop on the end, and an inspection pit at the garage end. I was lucky to get an old lathe from Timsons, in fact it was said to be an example of a lathe that Timsons built during WW2. This was very basic, with a flat belt drive from a countershaft, and not much in the way of accessories. It had power feed in one direction, screw cutting and not much else. This lathe was pretty worn, the crosslide nut was almost completely worn away, but once stripped and the dimensions obtained, I was able to get a set of LH Acme taps from Timsons toolroom which I still have today. Making a new nut made it useable and this seemed to confirm that the provenance of the lathe was right. I duly completed a Stuart 10H on this equipment, and then a Stuart 10V, and a hot air engine from the pages of the Model Engineer, which ran just once. Then I upgraded my lathe to a not quite so old lathe but still belt driven with a back gear, but this did have power feed in both directions which was a big step up (**photo 1**).

I started on a Tich next, and also built a few Tich boilers which I sold via the small ads in *M.E.* I moved jobs a couple of times, and started on a Rob Roy, building the boiler for that in my lunch hours when I worked in the research centre at British Steel in Corby. Next I upgraded to an old Harrison L5 which stood me in good stead for about 10 years. This is shown if you look carefully in **photo 2**, taken in the early to mid 70's. It had a geared head avoiding belt changing and back gear engaging, which made a big difference. I was gradually working my way to a lathe that replicated those that I had worked on during my apprenticeship in terms of power and ease of operation.

My second lathe.

Over the years I built a pair of 5 inch Gauge, steam outline, but battery powered Boxhills, with a wheelchair electric motor hidden under the dummy boiler and side tanks, then I made a pair of Simplexes. I sold one of these in 1984, and the other one of them is nearly finished 30 years later. I also built a 7¼ inch gauge Tich as well, and that is finally nearly finished too.

I had the chance to buy a Colchester Bantam Mk 1 about 30 years ago in around 1985 which had the basics, but not too many accessories (apart from 2 chucks, a faceplate and change gears), but the one thing it did have, was a capstan attachment and some capstan tooling, something I had used at work which made for fast operation. My lathe is shown in **photo 3**.

A Harrison L5 Lathe is in here, somewhere...

My Bantam.

›

Transwave converter.

Start stop lever.

Parting off under power.

The collection of chucks.

I bought the used machine from a local machine tool dealers, M&M Webb, but I cannot remember the price now. I have searched for the serial number, but cannot find it in the position specified. I have a handbook with a number on it, but as the manual is a copy, I do not think the number is right for my machine. I would guess that my example was at least 12 years old when I bought it, so is now 40 years old. The machine has been out of production for a while, although the Colchester company still exists within the 600 Group producing larger lathes, and another company within the group, Harrisons, produces smaller lathes of about the capacity of the Bantam. However there are still plenty of good examples to be found on the second-hand market; many were supplied to schools and Universities, and these often come onto the market. Some of the later Mk 2 versions are painted grey rather than the apple green of my example, and longer bed versions are described as Bantam 1600 models. After starting this article I have been keeping my eye open for used examples, and I have seen a few. The price for these machines is usually half that of a good ML7, ranging upwards from £750 depending on condition and specification. At the risk of upsetting the Myford devotees, I would suggest that one can get twice the lathe for half the money. The Myford on a stand weighs in at 365lbs, half the weight of the Bantam.

It is also easy to pick up used D1-3 chucks, as well as items like change wheels and steadies, should the originals be missing. There are also new items available from some suppliers. A taper turning attachment is also available, and I have seen these on offer used, as well as the capstan attachment. Some new spare parts are available, and operators manuals and spares list are readily available. There are also Bantam forums on the internet for support.

Some of the used lathes available have been 3 phase examples which would require a phase converter to operate the original main and coolant motors like I do, and some had been converted to operate by plugging into the single phase mains by the addition of an inverter to drive a new 220v 3 phase motor in order to cover the full speed range of the machine. I would suggest that for best results when turning steel the coolant system fitted should be retained, and a separate single phase coolant pump and tank can be bought from some of 'our' suppliers that can be used in conjunction with the existing feed hose and chip tray if the machine has been converted by fitting an inverter.

Some of our suppliers also offer single phase input inverter and motor kits to bolt if one wanted to convert a 3 phase machine. Obviously the cost of conversion must be factored in.

In 28 years I have had my 3 phase motor fail twice, on the first occasion I bought a second hand motor which lasted 10 years, and on the second, more recent occurrence, I chose to have the original motor rewound so I could simply swap motors to keep going. I did consider and cost a full motor/inverter conversion, but the rewind option was considerably cheaper and quicker to execute. I now have had my spare motor rewound as well, standing by for duty. I suspect that continuously switching the motor on and off or reversing when making screws or fittings does tend to overheat the motor when running from a phase converter, but overall I suppose the breakdowns I have had not interrupted things too much. I suppose that this highlights the only omission in the specification of the Bantam, and that is a main spindle clutch. All its bigger brothers are fitted with clutches which leave the motors running continuously. Perhaps the other omission is a tee slotted cross slide, although the mounting for the rear toolpost, if fitted, does carry 2 tee slots. It would be possible to mount a cylinder for example, on a plate on the cross slide for boring. Apart from my very first lathe, I have never made a practice of milling in the lathe, as this is so restricted in every respect.

I started my apprenticeship in the machine shop on the milling section, with not many restrictions on what could be

held and machined, so this rather spoilt me when it came to milling in the lathe. Quite early on I was lucky to get an old vertical milling machine, which was old but heavy, and I rebuilt this and used it with a homemade vice for all my milling, but that is another story.

The lathe came on a twin pedestal base, with the suds tank slung between the pedestals, and like all lathes tends to be top heavy when on a base unit. I elected to leave it assembled when I moved it, and it was delivered on a truck with a tail lift, so two of us moved it into the workshop using rollers and a pinch bar. It was fairly easy to get it into position and then put a jack under the suds tray at each end in turn, using a spreader plate, to get the rollers out when in position. My workshop floor was not as flat as I had thought, so I used some pieces of lead flashing to level it up. The lathe is compact and its footprint is 53 x 25.5 inches or 1350 by 650mm, and it weighs in at 765lbs or 343KG. The machine should be lifted using the lifting pin through the bed on the centre of gravity, and not by slinging around the headstock and tail stock. Luckily the machine handbook indicates that the machine will perform well when free standing, provided it is levelled. The weight and heavy construction must play a part here, and it is only required to be bolted down if high speed out of balance work is done continuously.

The lathe was bought as a 3 phase machine, and I elected to keep it that way, and buy a suitable phase converter to run it. I chose a Transwave converter, which has proved to be a very good choice, as that has run for 28 years as well running the lathe and also my Bridgeport miller (**photo 4**). It has only blown a capacitor twice in that time. Each time I have taken it back to the manufacturers for repair as they are about an hour away from me. Both times it was repaired while I waited and at minimal cost. I chose this solution as once the main motor is running the suds pump can also be turned on. One has to remember to switch off in the reverse order. The Bantam has a 2 speed motor, and that works with the converter too.

At the time I bought the lathe, inverters were just becoming available, and I used these professionally, but they were very expensive, huge and not that reliable, so not really an option for the home workshop at that time. We had to keep several spare units for our customers, and frequently swapped one drive for another, and that was repaired ready for the next breakdown.

Having started with a really basic lathe, and worked my way up to the Bantam, the features that I like about the Bantam help me to work as fast as is sensible in a hobby environment, where my time is precious. The lathe has power feed in both directions, and the feed will trip out against the appropriate stop. This is handy when producing a lot of swarf, as one can get on with something else while the swarf is being generated. It has a geared head, so no belts to change over; no back gear and no drive pin to engage, just selector levers.

The head and spindle are built to the best industrial standards, with hardened and ground gears and splined shafts, and super precision bearings. I have never had one hint of a problem with the head in the time I have used it. The lathe is built heavy for its size, and is built to the best standards with no short cuts to save money. The lathe has six speeds with the lathe running at low speed, and another 6 at high speed. It is not difficult to find a speed that is right for the job in hand. The top speed is 1600 rpm much higher than plain bearing machines, which is very handy on small diameter work. If the gear selectors are partly disengaged one can spin the chuck freely, which is very handy when setting something up in the independent 4 jaw. Feed speeds are easily changed by a selector lever as well. The chuck mounting is a D1-3 mount so it is possible to change chucks very fast indeed, no more trying to unscrew a chuck that is reluctant to come off, and good accurate location too. It is safe to run the lathe in reverse with this mounting for any operation without the possibility of the chuck coming unscrewed.

The start/stop/reverse lever is attached to the apron, and moves with it, so that wherever one is working, one's hand falls naturally on the lever (**photo 5**) very handy indeed, (if you are right handed) and very fast to get at in an emergency without stretching across the work. The lathe is fitted with a foot brake too which would suggest it may have come from a school or college. It should be noted that this all remains operational as all the original electrical equipment still exists as I am using a phase convertor to run the lathe. Changing the motor and using an inverter could mean that these items may not operate unless modifications are made.

The lathe bed is a twin vee-flat bed, which means it is not only rigid, but the carriage sits snugly on the front vee way, and once locked is rigid enough to allow parting off under power. A rear toolpost is fitted which usually carries a throw away tip parting tool which is always ready for use. Parting off is almost always done with the rear toolpost, running in reverse while flooding the cut with coolant, as coolant is just a press of a button away. When the parting process sounds like bacon frying, all is in order. **Photograph 6** shows parting off under power running backwards. The tailstock is located on the rear vee, and this means that this is located accurately, and any wear on the front vee will not affect the tailstock. Wear is likely to be minimised anyway as the bed is hardened and ground.

I started my apprenticeship in the machine shop on the milling section, with not many restrictions on what could be held and machined, so this rather spoilt me when it came to milling in the lathe.

Over the years I added to the basic chucks that came with it, namely a 5inch 3 jaw, an 8 inch independent 4 jaw and a faceplate. I bought a Polish 6 inch 3 jaw with 3 sets of jaws, one being soft, a self centering 4 jaw, really handy for square stock and a Burnerd multisize collet chuck and a full set of collets. **Photograph 7** shows the collection of chucks. I bought fixed and travelling steadies as well. I have a rear toolpost, and a quick change toolpost with plenty of holders. I use replaceable tip tools for most basic operations, and these stand up well and last if one is careful. I use HSS tools when something special is needed. I still have some cemented carbide tipped tools for a few special jobs, like radiuses.

The main toolpost is fitted with quick change toolholders, and I get by with about 7 or 8 for the work I do. The frequently used tools stay in a toolholder, and there are always one or two spares for

Toolholder tray.

something used infrequently. I keep the toolholders on a tray fitted to the splashguard so they are within very easy reach as shown in **photo 8**. The lathe is still very accurate, and in combination with the multisize collets, can produce accurate work using bar stock.

The capstan attachment (**photo 9**) is really handy for producing items in quantity, with space for 6 tools in the turret. It is also possible to use a Coventry diehead for external threads on screws and fittings. I spent most of my time as an apprentice in the turning section operating a Ward 3A capstan fitted with either chucks or collets and bar feed, and when one got going, not a moment was wasted changing tools. Some say, as we use our equipment in our hobby, there is no need to rush as we are not on a production line, but I would counter that by saying that our hobby time is precious and limited, and we need to make as good use of it as we can.

Capstan attachment.

4 inch Garrett.

With the combination I have described above, making parts is as fast as it can be in a hobby situation, and my ongoing project which is nearly finished, a 6 inch scale Garrett 4CD meant the manufacture of some very chunky parts, and the Bantam did not flinch at the challenge. I also made a 4 inch scale Garrett, as shown in **photo 10**.

Having almost finished my Garrett 4CD traction engine, I have had a look at an upgrade, and have considered a Harrison M300 with a gap bed so I could tackle the larger items on my next project which could well be another traction engine. This, however would mean I would need to replace all my tooling as well, so I am very reluctant to change. Then I was tempted with a well presented longer bed Mk 2 Bantam 1600, but again did nothing, so maybe this indicates I am happy with my old Mk 1. ■

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- Alternative version available for use on small lathes with screw on chucks.

Simple Speed Control of DC Motors

Many applications where a low power direct current motor is required often calls for a method of adjusting the speed. A typical application in the home workshop might be to drive a leadscrew on a milling machine table whilst surfacing a long work piece. The motor replaces the tedious turning of the handle and if the speed can be set slow enough the end product is not only better but with a lot less effort. By making the motor to run at high speed the table can be brought to the required position in little time. The larger industrial milling machines have table drive motors as normal fittings but the budget type of milling machine for the home workshop mostly do not have this luxury. Although one can buy add on drive mechanisms they tend to be expensive and not always applicable to all of the small milling machines.

Whereas many model engineers can come up with a suitable mechanical adaptation to fit a small motor and gearbox to drive the leadscrew the subject of speed control is often one they are unfamiliar with. So this article offers some alternative methods, some very basic and easy to implement and ending with a useful accessory that can be made for little outlay in effort or money.

One of the most common requests on the ME forums is for a simple, reliable controller for 12V DC motors. *Inchanga* spent a large part of his career working on motor drives for a military contractor and, in retirement, spends much time on motor drives for radio telescopes including the Square Kilometre Array being built in the Karoo Desert. He offers us a tested design planned for construction by relatively inexperienced hobbysists.

DC Motors

Today there are many small dc motors available for a reasonable cost that can be adapted for many different jobs in the workshop. In the automotive industry the type most used is known as a *permanent magnet brush* motor and these are used all over in modern cars for windscreen wipers, power steering drives, electric windows, seat adjustment, wing mirrors, radiator cooling fans and many other applications. They come in all shapes and sizes from weeny ones to quite powerful ones with loads of torque and often with a built-in worm gearbox attached.

However, not all of these are rated for continuous operation. Windscreen wiper motors and power steering motors generally are continuously rated but some others, such as window winder, mirror adjusters and seat adjustment motors are only designed for very intermittent operation. Although they are very powerful in short bursts they may overheat and fail if used continuously under full load. So select your motor carefully to avoid disappointment.

The beauty of the permanent magnet motor is that it is easily reversible by simply swapping the wires to the supply voltage, although some wiper motors are designed so they only run well in one direction. However, getting a speed control to work adequately is not as simple as one might expect.

Series Wound - Universal Motor

The permanent magnet motor is a derivative of the series wound motor, also known as the *Universal Motor* as it can operate on ac or dc supplies. The big failing of the universal motor is it is not easily reversible. **Figure 1** shows the basis of the series wound motor.

The motor has one or more normally two field windings on the stator. These generate the field magnetic flux by the current passing though them. The polarity of the flux generated in the field windings and the direction in which current flows in the armature determine in which direction the armature rotates. The field windings are connected internally to the brushes that connect to the armature segments. No matter which way round the supply is connected the motor always runs in the same direction, depending on how the internal wiring is connected. So operation on ac or dc is the same. A common use of the series wound motor in automotive applications is as the engine starter motor, which only has to rotate in one direction. (A variant used on aircraft is the two winding series motor that has two separate field coils, one being connected in opposite polarity to the other to allow reversing. This motor has a 3-wire system and only two of the wires are ever used at any time. These are used as cowl-gill motors to adjust the airflow onto the engine cylinders and prop-pitch motors and are normally 26V dc with a high running current).

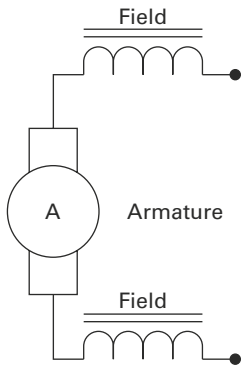
To reverse the series wound motor you have to physically change the field winding connections to reverse the flux polarity. For a single field coil type this entails 4 wires need to be brought out of the motor casing to a terminal strip for setting with links in the correct polarity. A dual field motor needs 6 wires. Many small series wound motors do not have external connections to the field and armature, just two wires for the supply, and this makes modifying more difficult, you have to open the motor and change the connections internally. The permanent magnet motor does not use field windings, as the name suggests, the field flux is provided by magnets such that it has a fixed polarity. The one minor downside is that it can only operate with a dc supply. Operation using an ac supply voltage will cause rapid burning of the commutator segments as the net rotational force is reversed every half cycle and the armature remains stationary.

The armature current also flows through the field winding and this winding needs to be a very low resistance to reduce voltage drop, which limits the power output. In the permanent magnet motor this voltage drop does not exist and all the current is available to generate torque, assuming the magnetic flux is adequate.

Simple Speed Control

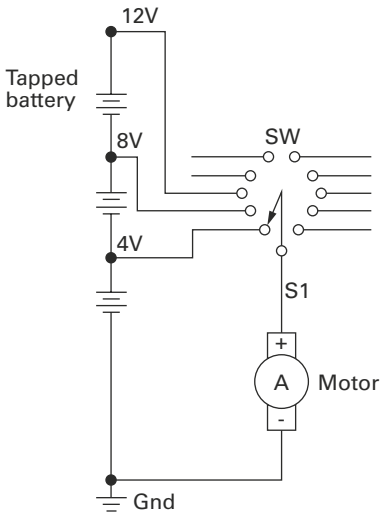
One simple method to reduce a motor speed is to reduce the supply voltage to the motor. Automotive dc motors are designed to operate on a relatively limited voltage range, typically about 14V being common. Although they are often called *12V dc motors* the range of battery voltage for a 12V vehicular system varies between 10.8V to 15.6V, these being the accepted minimum and maximum battery voltage for a modern 12V system. In practice they work well over a much wider range of voltages provided the load is not too high. A 12V motor can normally safely work intermittently on up to twice its normal voltage for short periods, and this allows an increase in torque when most needed to get something moving.

Fig. 1



Starter motors although specified for 12V vehicles are in fact motors designed to operate on about 6V, so the torque is much greater when 12V is used. This ensures they have adequate cold cranking torque when the battery voltage falls in sub-zero temperatures. Formula 1 engines typically use an external 6V starter motor run on 24V to get sufficient torque to turn over the high compression engines.

Fig. 2



Running a dc motor on less than its nominal voltage is not in any way damaging to the motor, but operating a 12V motor at a supply voltage very much above about16V with a heavy load may cause problems unless some extra electronics is used. **Figure 2** shows a cheap and cheerful method of speed control.

In this method taps are made on a standard 12V battery using every second cell. A 12V lead-acid battery consists of six cells connected in series, each being nominally 2V. Unfortunately the days when car batteries had the cell linking straps accessible are long gone, today they are hidden within the battery casing and all we have are the positive and negative terminals available to make connections to.

The battery is tapped and the wires taken to a suitable multi-pole rotary switch. By rotating the switch we can select 4V, 8V or 12V. This gives a three-speed control system. On 12V the motor runs at maximum speed. When the 8V tapping is selected it runs at about 60% of the speed and when 4V is selected it runs the slowest. Three speeds are not very useful but if we tapped every cell we could get a 6-speed system. The switch needs to be able to carry the motor current. The problem with this simple method is that some motors may not start under load when fed from a very low supply voltage. A dc permanent magnet motor, like the series wound motor, has a high starting current, typically 5 to 10 times greater than its running current, but the current drawn rapidly falls off as the motor accelerates towards its maximum speed. This is due to the Back EMF generated within the armature windings opposing the supply voltage due to the commutating action of the brushes on the armature segments. (The dc motor and the dc generator are physically identical, a dc permanent magnet motor can be used as a dc generator without any modification). When the motor has no load on the output shaft the current drawn is quite small, but as the mechanical load increases the current drawn rises as the speed begins to fall. At some point the current drawn is sufficient to overcome the extra mechanical load and the speed and current both reach a steady value. We will come back to the Back *EMF* problem a little later.

The beauty of the permanent magnet motor is that it is easily reversible by simply swapping the wires to the supply voltage, although some wiper motors are designed so they only run well in one direction.

Pulse Width Modulation

Fortunately today we can call on the electronics industry to cater for our needs and one of the most commonly used types of motor speed control is known

as *Pulse Width Modulation*. Although this sounds very complex it isn't really once you understand the basic principle. The armature of the motor has some mass and hence inertia so it tends to behave like a flywheel absorbing sudden changes in speed so a constant speed is obtained.

The basis of PWM is to use a constant supply voltage and to vary the length of time it is applied to the motor. If it were applied for 100% of the time the motor would run at maximum speed. If however the motor was turned on (and hence also turned off) for, say, half the time the average voltage and current would be 50% of the full supply voltage and current. Under this condition the motor would run at half speed. Although the *average current* is only half the normal operation, when the motor is turned on the *peak current* is the same as when running continuously. It still develops close to maximum torque, so very slow running is possible with this method. By being able to continuously vary the on and off ratio of the supply we can obtain an infinitely variable speed control with adequate torque. This is illustrated in **figure 3** where a 50% and a 20% duty cycle are shown.

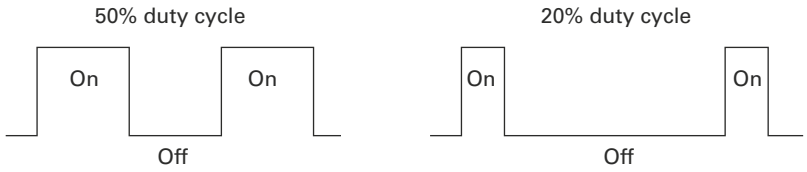
If the switching rate is rapid enough the armature mass smoothes out the pulses and a steady speed is obtained. (As long as the switching frequency is high enough to make the inertial mass effective there is no benefit to be gained by raising the switching frequency any further). If the duty cycle were 1% the motor would be only switched on for this time period and it would be off for 99% of the time, it probably would not start and run with such a low duty cycle. So duty cycles lower than about 5% may be a problem unless the load is fairly light.

A common way around this problem is to use a much higher supply voltage than the motor was intended for and to limit the duty cycle. I recently came across a small antenna positioner for a satellite dish that uses a nominal 36V supply to operate a 12V windscreen wiper motor with PWM to control the speed of movement. This allowed very fine speed control to almost zero speed and a huge amount of torque even at a creeping movement. Although this sounds rather drastic it isn't. If the PWM duty cycle were set to 33% it is the same as running the motor from a 12V supply. As mentioned earlier, when extra torque is needed to start a heavy load moving going to 50% or more can provide the extra urge to start the load moving, then the duty cycle can be reduced to normal running conditions. This is fairly common in large dc motors with up to 300% overload current used for short periods. Permanent magnet dc motors are surprisingly robust beasts! Heating in the armature windings is the result of the average *current flowing*, if this is low the heating is also low.

Although PWM is fairly simple to do for those well-versed in electronics, it is not a simple task for those who know little about electronics, but have a need for some form of speed control. This probably covers the majority of model engineers; those not involved in electrical or electronic fields, so I have designed a simple and cost-effective solution, which will suit most model engineers requirements. I could have gone further but cognisance of the constructor's possible lack of knowledge and constructional skills, as well as keeping the cost to minimum, drove the project. The details of a continuously variable speed control for small motors are shown in **figure 4**.

Because the intention was to use low cost electronic components, which are readily available, I had to make some concessions in the design, but even so the design will probably fulfil 90% of the users needs.

Fig. 3

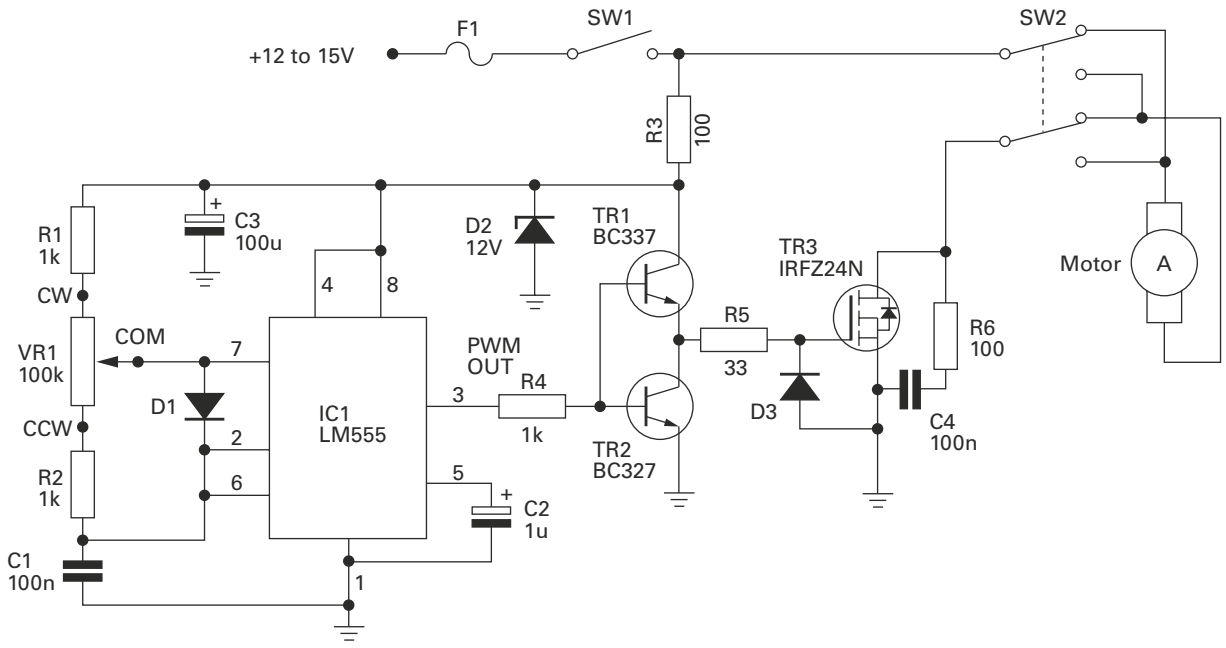


Principle of Operation

The heart of the circuitry is an oscillator that runs at 150 Hz and hence generates 150 pulses per second. This is a fairly low frequency; it is three times the mains frequency of the UK. I could have chosen a higher frequency but my experience of PWM applications with small dc motors is that some motors either will not work satisfactorily on very high switching rates or may emit a loud screeching noise when switched at many kilohertz. If you want to experiment it only needs a change of one component value to alter the frequency (C1). Reducing the value of C1 from 100nF to 10nF (0.1uF to 0.01uF) will give a switching frequency of about 1.5 kHz and 1nF (0.001uF) will give about 15 kHz.

However, very high switching rates do introduce other problems, the main one being RFI (*radio frequency interference*)

Fig. 4

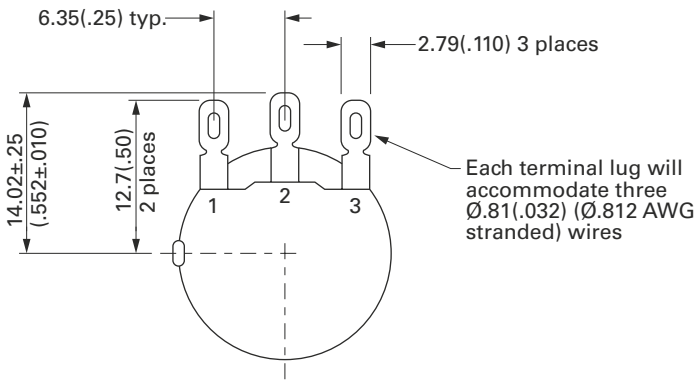


which may cause funny noises on a broadcast AM receiver, hence it is usually preferable to keep the switching frequency fairly low and 150 Hz is a nice area to start with.

Figure 4 shows the major circuitry. This is contained on a small printed circuit board about the size of a business card. Hence, it occupies very little real estate. I could have used all surface mount technology devices, but that defeats the object for a home constructor, and it could have been shoehorned onto a board a little bigger than a postage stamp! It uses one low cost integrated circuit the Signetics / Philips NE-555 timer and a handful of easily obtainable components at a very modest cost. (Many semiconductor manufacturers make this device. I used a Texas Instruments LM-555, originally made by National Semiconductors before Texas Instruments bought the company, hence the LM prefix).

The oscillator is configured using IC1, the ubiquitous 555 timer. This generates a fixed frequency – variable pulse length output. With the variable resistor VR1 at one end of its travel the duty cycle is 99% and at the other end it is 1%. The ratio of R1, R2 and VR1 set the duty cycle range. If R1 is raised in value the maximum duty cycle is limited to less than 100%. If R2 is raised in value the minimum duty cycle is raised. With R1 and R2 being 10kΩ the maximum and minimum duty cycle is about 80% and 20%. The points marked CW, CCW and COM on the pot and the board denote the full clockwise, full counter clockwise and the common slider terminals. The pot will have three terminals or tags for the wiring. To determine the various terminals hold the pot and rotate the shaft fully clockwise. With an ohm-meter measure the resistance between the centre terminal and the other two terminals. The CW terminal will show a very low resistance to the COM terminal and the CCW terminal will the same as the pot nominal value. **Figure 5** shows a typical pot terminal configuration. In this diagram terminal 1 is the CCW terminal, 2 is the COM and 3 is the CW terminal. Pots come in various shapes and sizes, some have tags as shown and some are intended for mounting directly on a printed circuit board with wire pins. Other types have an additional single pole switch attached, but these are normally log law types for volume controls in audio equipment and are not suitable for our application.

Fig. 5



Solder Lug Terminal

Motor Power Stage

Integrated circuits (ICs) are not normally capable of driving the motor directly; a typical IC can only supply a few milliamps of current. The 555 timer is somewhat better as it can deliver up to ≈200mA peak current but this still too low to drive anything but a micro-motor. So the final portion of the circuitry consists of the power stage. This consists of a high current Mosfet (*Metal Oxide Silicon Field Effect Transistor*) which switches the motor on and off. The signal from the 555 timer drives a pair of transistors as a driver stage. Although Mosfets are voltage driven devices large peak currents flow in the gate-source region during part of the switching periods.

Transistors TR1 and TR2 are a special type of driver stage called a ***totem-pole*** which converts the low current from the 555 IC into several amps peak gate current needed to drive the main switching transistor, TR3. At switch on of the pulse the peak current drawn by the Mosfet gate can be several amperes for a few microseconds.

The gate of a Mosfet behaves like a large value capacitor in parallel with a very high resistance, which can be several millions of ohms (meg-ohms, symbol = MΩ), and it has to be charged up to a certain dc voltage before the device begins conducting. Conversely the gate capacitance if not discharged will hold the device in conduction until it drops below a certain voltage. The internal gate discharge current is very low, a few microamps normally, so if a Mosfet gate were momentarily connected to a 12V battery it would conduct fully. However, with the gate terminal now open circuited the gate voltage decreases very slowly as there is no proper discharge path, except the inherent internal resistance of a few meg-ohms. Consequently the device can remain in conduction modes for a long time before the gate voltage falls below the conduction voltage. Hence, it is imperative to have a means of discharging the gate when desired. This is the function of the totem-pole driver stage. The start of the Mosfet conduction is denoted by the parameter *Vgs-threshold*, which is normally around 2 to 4V. But this parameter is for the drain-source region to conduct a very small current, typically 250 microamps is a common test figure. To attain conduction values of several Amperes requires a much higher gate voltage, typically 10V being a common figure. Between the gate threshold voltage and the fully conducting region the device behaves like a resistor with a high value and this generates heat internally due to the current flowing. A fully conducting Mosfet acts more like a switch with practically no resistance, hence the heat generated is low even with a high current flowing. It is important to make the transition from *off to on* and *on to off* in as short a time as possible to reduce the resistive heating effect. A typical Mosfet with a proper driver stage can transit correctly between the two states in less than 1-microsecond.

The two transistors are driven from a common signal and wired in such a way that only one of them can be conducting at any time. If both transistors were to be turned on the driver signal would be shorted to ground. Transistor TR1 is turned on fully (TR2 is hence switched off) and it applies full supply voltage to the Mosfet gate. The resistor R5 limits the peak gate current to a safe level to protect TR1 and TR2 from excessive current and to reduce radio frequency interference. The 555 timer IC also uses a similar totem-pole output stage but it is limited in current capability and if the intermediate driver where not used the heat generated within the IC may cause erratic operation. For low current Mosfets the extra driver stage could be omitted and the drive taken directly from the 555 output. During switch off the top transistor TR1 is turned off and the bottom transistor TR2 is turned on so discharging the gate terminal by effectively shorting it to ground. Diode D3 clamps any spikes to less than 1V negative to protect the Mosfet gate junction.

The high peak gate drive current is supplied by the capacitor reservoir C3 and is needed to rapidly charge the gate capacitance of the Mosfet and to discharge it to turn it on and off quickly. If the turn on and turn off is slow the device experiences excessive dissipation during the transition between fully off and fully on and this leads to a higher device temperature. In order to get full saturation (lowest on-resistance) the gate voltage needs to be above about 10V for the lowest dissipation in the device. This is a hefty device and is rated at many amps of current, if adequately heatsinked. The International Rectifier IRFZ 24N is rated at 17A continuous current, but under pulsed operation, as it is being used here, it can safely handle 68A of peak current. I selected it because it is reasonably priced and very rugged, there are many other manufacturer's devices that could be used as an alternative.

When TR3 is turned on it shorts the motor return lead to ground and this type of switch is known as a *'low-side switch'* as it operates in the ground return unlike SW1 which is known as a *'high-side switch'* as it operates at the supply potential. Low side switches have very low voltage across them when conducting and suit the driving method chosen. In automotive electric's

almost all the older vehicles use high-side switching for the various items but this is rapidly being superseded by semiconductor low-side switching controlled by computers. In modern automotive designs the battery voltage is supplied to all devices in a ring-main fashion and the individual devices are switched with low-side switches. This reduces the amount of heavy current wiring required in the vehicle harness.

One thing to note is the very low *on-resistance* of a power switching Mosfet, the IRFZ 24N has a value of only 70 milliohms at 17A current (0.07Ω). This is comparable with a good quality toggle switch, although no toggle switch can switch as fast as a Mosfet can. The IRFZ 24N can easily switch large currents at up to 500 kHz. Although you can obtain lower on resistance values today these devices still tend to be more expensive than the IRFZ 24N. Also included are a resistor and capacitor (R6 and C4) connected in series across the Mosfet to clamp high frequency transients, known as a *snubbing network*. This reduces any RFI (radio frequency interference) caused by the rapid switching. All Mosfets contain an inherent reverse polarised diode between the drain and source terminals, generated in the manufacturing process, which clamps any negative voltage spikes generated by motors etc. so protecting the device. This parasitic diode has a current and voltage rating the same as the device Drain to Source junction so it is a hefty diode.

Also shown are the main on/off motor switch and the reversing switch. The switches are mounted on the front panel of the enclosure with the speed control pot for operation by the user. Both of these switches carry the full motor current and hence need to be adequately rated, for a small windscreen wiper motor a switch rated at 10A is prudent. The fuse in series with the 12V supply should also be suitably selected; a 6A fuse will probably suffice for most applications, should something go wrong it should rupture protecting the motor.

Refinements to Basic Circuit

In some cases the motor must run at a precise speed which does not vary with applied mechanical load. This is often the case for precision servo systems. In this case an extra part is added to the motor which is a speed-measuring item known as a tachometer (tacho for short). This is a small ac generator attached to the armature shaft and the ac voltage developed is either applied to a frequency measuring circuit or the ac voltage is converted to a dc voltage with rectifier diodes. As the speed of the armature varies the circuitry monitors this output and adjusts the PWM generator to obtain a constant speed. This is a closed loop speed control system, which would be nice to have but entails a special motor fitted with a tacho generator. These motors are normally used in a PID control system (Proportional Integral Drive) where when the position required is far from actual position the motor can be run at full speed to reduce the time needed. As the position error reduces the motor speed is reduced towards zero as the position is acquired, these are mostly used on CNC milling machines to speed up production.

Power Supply

I haven't shown any sort of power supply as that will largely depend on the motor chosen. For a typical 12V windscreen wiper motor for a normal vehicle a supply capable of supplying at least 6A with minimal voltage sag under load would be appropriate. The supply regulation doesn't need to be very good, even a battery fed from a charger will suffice. The motor isn't too fussy about ripple and small changes in supply voltage, in fact the commutating action of the armature brushes will shake any supply a little as the current is rapidly pulsed on and off. A fairly crude unregulated supply using a transformer with a bridge rectifier and a large electrolytic capacitor giving about 15V would be adequate. Another possible alternative for intermittent use is a small sealed lead-acid (SLA) 12V battery, such as a 7Ah type. This can be kept charged with a simple external charging circuit. My favourite charging IC is the PB 137ACV made by ST Micro Electronics. This is a three-terminal device almost identical to a LM-7812 12V/1A regulator but it is especially made for lead-acid battery supplies. It was developed for solar panel chargers feeding a lead-acid battery. The PB in the prefix is for *plumbum*, the Latin name for lead. The 137 is for 13.7V and it can supply 1.5A current. The PB 137 has an internal switch that isolates the battery when the input supply is removed, so it does not discharge the battery. Using the PB 137 with a typical SLA it may be left continuously connected with no danger of over-charging as the 13.7V cut-off is below the maximum battery safe working voltage of 14V. Full details for the PB137 can be found on the ST Microelectronics site at www.st.com

One thing to bear in mind is the maximum safe working voltage of the IC. This is limited to 16V maximum. The 12V zener diode D1 limits the supply voltage to IC1 to this value. The power transistor TR3 gate drive also must not exceed 20V, so a nominal 12V battery suits both these needs nicely. If the supply you intend to use is below 15V then the zener diode D2 can be deleted.

The IRFZ-24N is rated at 55V so the 12V supply plus any spikes generated by the motor are well catered for. The big brother of the IRFZ 24N is the IRFZ 44N, this is rated at 49A continuous current at 55V and a safe peak current of 160A and is a direct drop-in replacement, although somewhat more expensive as the on-resistance is only 22mΩ (0.022Ω).

For operation with 24V or higher voltage motors the IRFZ-24N is safe for 24V motor supplies as it can withstand up to 65V spikes, the peak of any spike generated is unlikely to exceed twice the supply voltage. This means 48V spikes are the highest to be expected, so the 65V rating is adequate. For higher voltages a mosfet with a higher rating is recommended. The control board should be run from a lower voltage not exceeding 15V and the motor supply being whatever the needs are. A 24V motor could use a supply of two 12V batteries in series and the control board supply tapped off the bottom 12V battery.

Construction

The various components except F1, SW1, SW2 and VR1 are mounted on a printed circuit board. This can be glassfibre FR-4 or G-10 of 1.5mm thickness. The board is single sided with the components mounted on the side opposite to the tracks.

Most components require a 0.7mm clearance hole, except the power Mosfet, which requires 1.2mm holes for its leads and a 3.2mm screw hole to fasten it to the heat sink bracket with either a M3 or 6BA screw and nut. The tab of the transistor must be insulated from the heatsink and a TO-220 insulator kit consisting of either a mica washer or preferably an elastomer thermally conductive washer plus an insulated bush are required. These are standard parts from an electronic wholesaler. The heat sink can be bent up from 1.6mm or 2mm aluminium plate to fit the transistor, ensure no burrs can puncture the insulating washer and cause a short circuit. For additional heat sinking the bracket can also be bolted to the box, assuming it is heat conductive. Bend the transistor leads carefully to fit the heat sink and the holes in the board with no stress to the leads. Assemble the Mosfet onto the heatsink with the insulating washer and bush with a M3 or 6BA screw, washer and nut before soldering the Mosfet leads. Check with an ohmmeter between the Mosfet mounting tab and the heatsink that no shorts occur. The mounting tab is internally connected to the Drain of the device (the middle pin) and a short here would make the motor run at full speed.

All resistors are 1/4W types with a 10% or better tolerance. The small capacitors are 50V rating and are all 0.1 inch spacing (2.54mm). The smoothing capacitor is a 16V or 25V electrolytic with a 0.1inch (2.54mm) radial lead spacing and must be polarised correctly, check the marking on the body. The same applies to C2 which is a solid tantalum capacitor with either a 16V or 35V rating, low value tantalums are often only available in 35V rating. The diodes are all 1N4148 or 1N914 except D2, which is a 12V 1/2W Zener regulator diode and all require a 0.3 inch (7.62mm) lead spacing. (The positive end of the diodes have a ring denoting the correct polarity). Exercise care when forming the leads so the fragile glass body is not damaged. The resistors are not polarity conscious and may be fitted either way around with a 0.4 inch (10mm) lead spacing. Preform the leads to the correct pad spacing so the components fit flat on the top of the board.

Take especial care with the orientation of the semiconductors. The IC has a notch on one end showing the correct orientation. Inserting an IC the wrong way around will destroy it when powered up. If you wish you could fit an IC socket that the device can plug into, but a socket costs more than the IC today. The ICs will come with partially pre formed leads that are slightly splayed, bend these carefully so that all the leads fit into the holes correctly. Similarly take extra care with TR1 and TR2 they are physically identical apart from the type number and incorrectly fitting them will cause failure. Double check as each component is inserted in the board, once they are soldered in it is more difficult to correct a mistake. The board may be mounted with spacer pillars using the corner holes and M3 or 6BA hardware to the inside of the main box.

To be continued...

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Lathe Headstock Extension

Do you need a 500mm chuck? Cameron McKeown pushed his equipment to the limit, giving him the capacity to build a 6-inch traction engine.

It's something that all of us have been guilty of at one time or another – machine abuse! Many of us push our home workshop equipment to do the things they were never designed for, or ever thought capable of doing. How many times have we wished we had just that little bit more swing, saddle travel or extra length to a milling table? Over the years I have seen some amazing out of the box thinking in both the home and professional workshops to gain just that little bit more capacity to get the job done in house. This article describes the design concept and manufacture of a headstock extension to increase the swing of my lathe (**photo 1**).

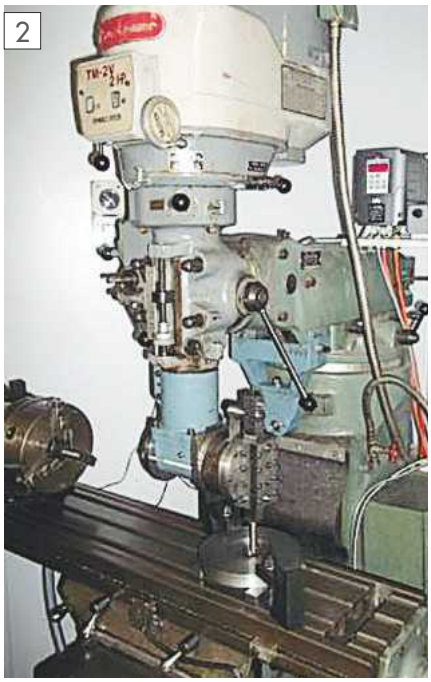
Headstock extender and faceplate.

The initial idea was nearly four years ago and is born out of the need to machine two different lengths of risers for my milling machine to allow for a larger throat distance between the table and head. I needed this extra throat clearance to better utilise a vertical slotting attachment I built which mounts to and is driven from the quill of the milling spindle, (**photo 2**). As funds and my workshop space are limited I could not afford nor could I fit the traditional rear ram mounted slotting attachment designed for this type of machine.

The first order of business was to work out how to swing a 380mm diameter x 160mm long fabricated cylinder in a lathe capable of swinging only 330mm. With the gap out I could manage the swing but the length and how to hold it becomes an issue. I made some inquires to have risers machined in a commercial workshop but this turned out to be just as expensive as purchasing a new riser. The cost was way outside what I could justify for the very odd time I would require the extra capacity and there the idea came to an end, or so I thought.

Skip forward about 6 months and I was visiting a good friend of mine, John, who had just finished building a small hit and miss single cylinder diesel engine. The first thing that took me was how big the fly wheels were and looking at his small Myford lathe I asked who he had got to machine them. To my surprise, the reply came that I did them on the myford; doing a quick size up in my mind I couldn't see how it was possible. Everything became clear when a headstock extension was produced and fitted off onto the bed of the lathe with a drive gear fitted off into the morse taper of the lathe spindle (**photos 3 & 4**). The problem of how to machine my risers was solved, design and build my own headstock extension. The diesel engine shown in **photos 5 & 6** is a single cylinder that runs very nicely on biodiesel distilled from used fish and chip oil. As a further point of interest this engine was made entirely 'mind to hand' with no drawings other than running sketches.

With the headstock extension concept in mind I wanted to take its capacity to the absolute maximum so with measuring tape in hand I concluded that 680mm was possible but was it practical. After a weekend of measuring and sketching, a design took shape (**figs 1, 2 & 3**) and from this a number of questions were raised. A riser for the saddle would have to be made to meet the new centre height. The travel of the saddle was only 165mm not the 340mm required for a swing of 680mm. The total weight of the extension without a chuck mounted was around 65kgs, so if I did go ahead with this project a method of lifting the assembly onto the lathe bed would have to be devised.

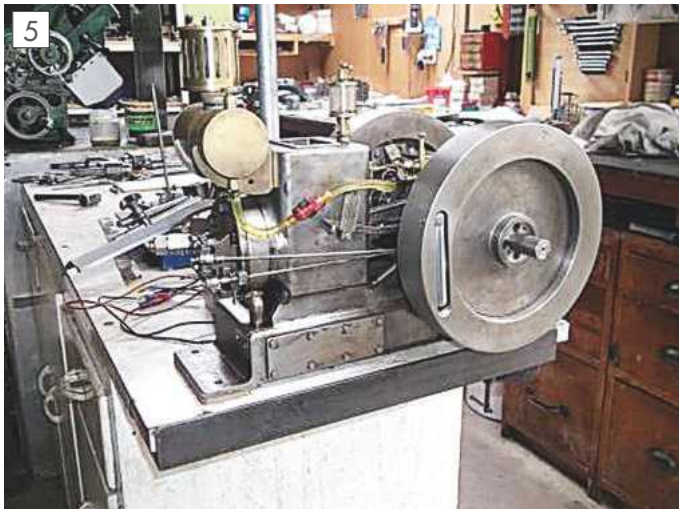


Vertical slotting attachment.

The solution to the first problem was to use the lathes existing top slide to mount onto the saddle riser allowing for two fixing positions to cover the 340mm in

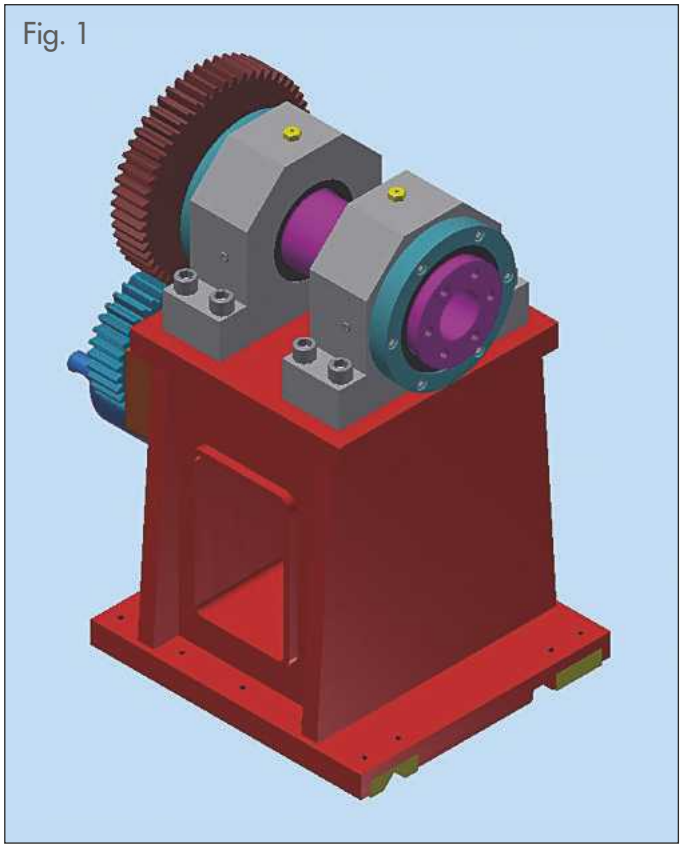
A front view of the Myford headstock extender.

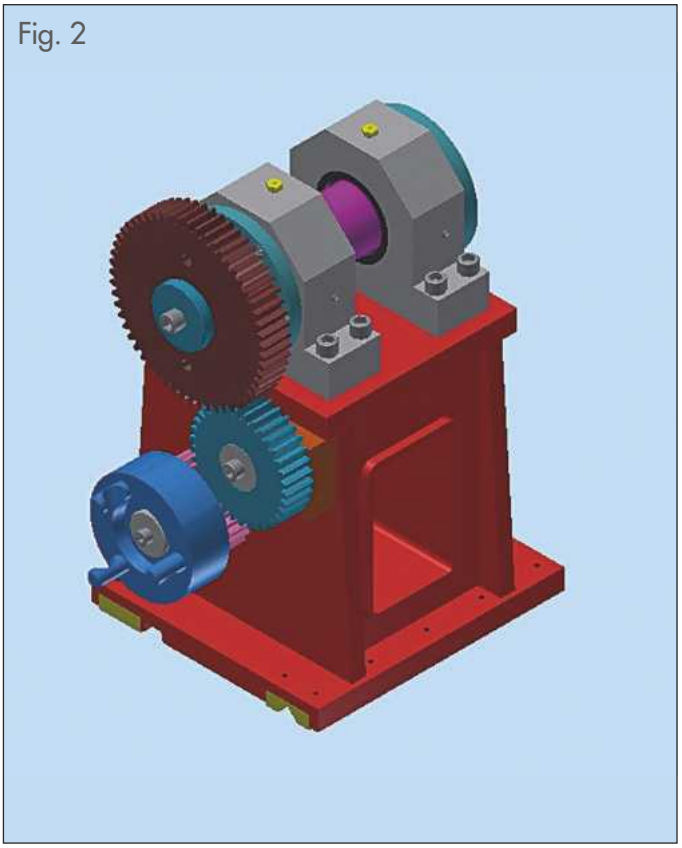
And a rear view.



The hit and miss diesel engine.

The engine from another angle.

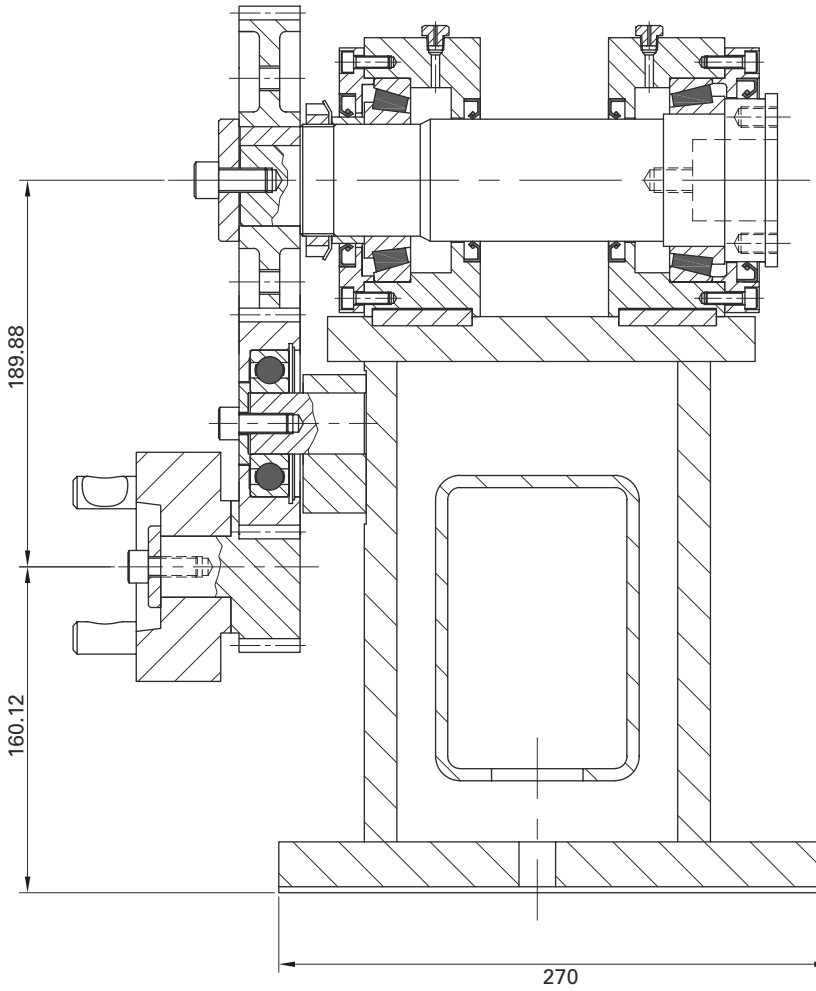




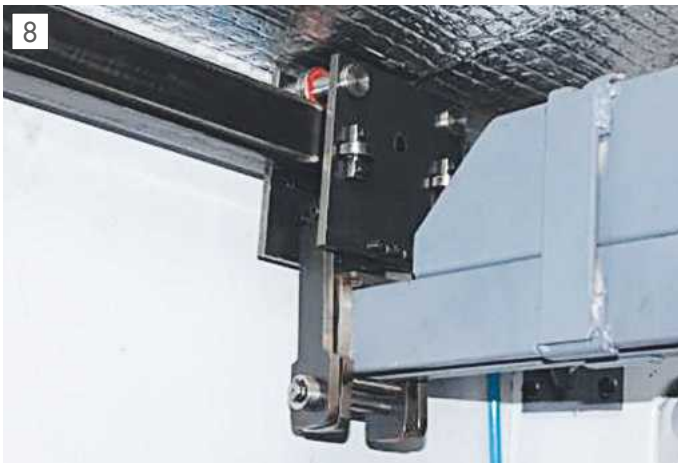
Saddle riser.

two bites (**photo 7**). The second problem of lifting was a little bit more difficult to overcome and ended up becoming a project in itself. There was no point beginning with a headstock extension until the problem of lifting the thing into position was dealt with. After looking at all the lifting options that I could fit into my workshop space a solution was developed that would also meet many other lifting needs at the same time. A simple overhead crane capable of travelling the full length of the workshop bay and also allowing full coverage of the workshops width allowing me to also lift heavy gear onto the milling machine table. To maximise the lift envelope within the bay the traditional crane wheel trucks that prevent the bridge from crabbing and jamming up could not be used. A very compact carriage was developed that was completely universal in its action. One end of the carriage can move up to 500mm before the other end decides to follow along. This means the bridge can be up to 15 degrees out of square from the SHS rails. Swing arms with a universal pivot on the end trucks allow the bridge to crab but also allow the bridge to lengthen preventing lock up during travel (**photos 8** & **9**). This arrangement will lift 150kgs comfortably allowing easy travel around the workshop space (**photo 10**).

Fig. 3



With the problem of lifting now dealt with the manufacture of the headstock extension could begin. Firstly dxf files of the plate profiles were generated from the cad drawings and passed onto a local laser cutter. Material for the bearing housings came via scrap offcut 60mm plate from a local heavy engineering firm. This determined the final sizing for the housings. It was also oxy-cut into two blocks at no extra cost to minimise machining. Material for the shaft came via a local scrap yard that had an old overhead crane that had been sitting out back for years. The wheels stub axil were the perfect size for the job, however pressing the wheel off to get to the axil was a different story, needless to say next time around I would rather spend the extra money for off the shelf cut stock rather than try and take the cheaper scrap option.



Overhead crane showing universal joint.

A front view of the UJ.

Lifting the headstock extension.

With the bulk of the materials now at hand machining and fabrication could begin. First off were the headstock extensions structural frame and the saddle riser. With all the parts laser cut it was a perfect fit up. Even the rhs tube was a neat tap in fit. As my welding skills aren't the greatest my plan was to tack weld with my mig welder to ensure everything was square and straight, then have a professional shop do all the final welding. I ended up asking at my local tech college's structural fabrication department to see if they would be interested in welding up the fabrication, they were more than happy to do so as long as it could be done as a student exercise. I had no problems with this and I couldn't have been happier with the result. I often find when things are outside the capability of my workshop how much interest is generated by just showing people what I am trying to achieve. This often results in wanting to help through goodwill.

Machining the base of the extension.

The headstock extension structural frame was then machined to size (**photo 11**). The slide way blank inserts were pre machined, fitted and final machined in situ to set final height, squareness and centre position to the lathe bed (**photos 12** & **13**). My thinking behind having inserts fitted rather than machining the v way shape directly into the base was in case I made a muck up of it. Easier to machine new inserts than trying to fix an out of position cut in the base.

The saddle riser was then machined (**photos 14**, **15** & **16**) together with a new purpose fitted tee-slot rotary base for the

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Setting the head angle ready for machining.

Machining the vee-way.

Machining the top of the saddle riser.

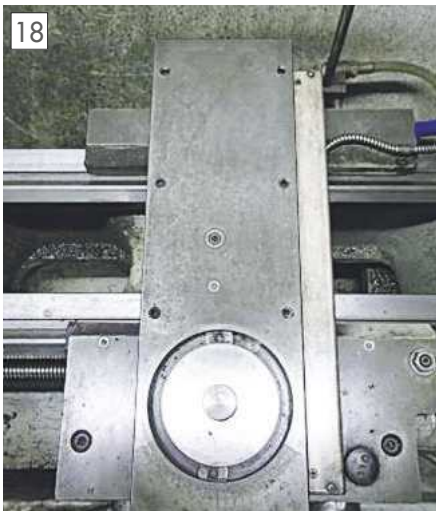
...the face of the riser.

...and the rotary base register.

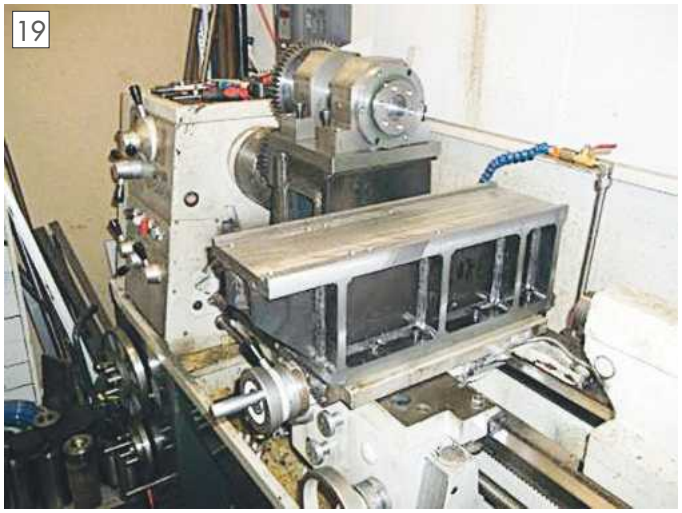
Putting tee-slots in the rotary base.

top slide (**photo 17**) which would allow for positioning in two locations to cover a full radius cut of 340mm. The lathe saddle was then marked for drilling and taping the six mounting holes for the saddle riser, when not in use they are plugged off with grub screws (**photo 18**). Once drilled and taped the saddle extension could be trial fitted (**photo 19**). The bearing housings and shaft were tackled next. The outside shape of the housings was pre-machined in the mill and the bearing and seal bores were then machined setup in the four jaw chuck in the lathe. This then allowed the machined diameters to be used as a clock up reference to machine the final outside shape on the milling machine, the location keys on the underside of the housings were machined in last. The shaft was a straight forward turning operation using the scrap axil shaft obtained earlier. To position and lock the headstock extension to the lathe bed I have utilized the fixed steady's bed clamp.

To be continued...



Mounting holes for the saddle riser.



A trial fit of the saddle riser.

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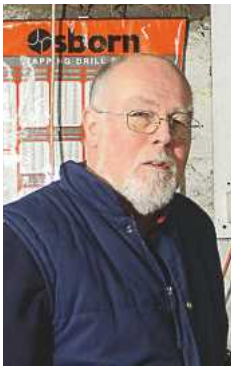

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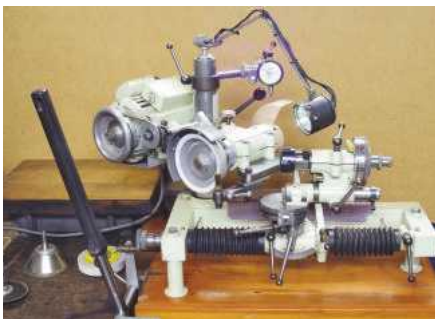

» Harry Cosh on a Quorn and a Crane in his workshop

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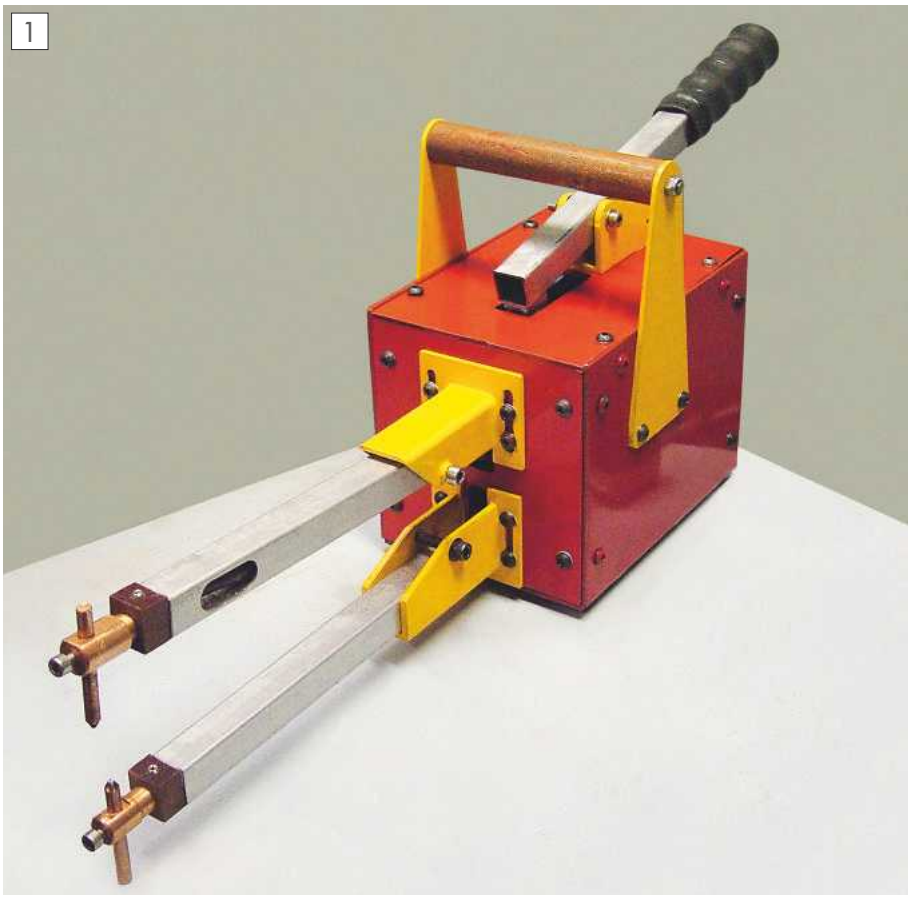
A Spot Welder

Dyson Watkins details a simple spot-welding machine based around a scrap microwave transformer.

My decision to construct the welder arose from viewing some experiments shown on 'YouTube'. The machine is based upon the use of a mains transformer salvaged from a microwave cooker. The cooker needs to be at least an 800W version, in order to be of sufficient size to provide a high enough current after rewinding. This is the only component required from the microwave. A heavy duty push on / release off switch will also be required, together with a mains plug and socket and a supply of insulated stranded connecting wire. If any doubts or uncertainties are felt regarding the electrical elements of the work, do seek advice from a qualified electrician and get the welder checked prior to use.

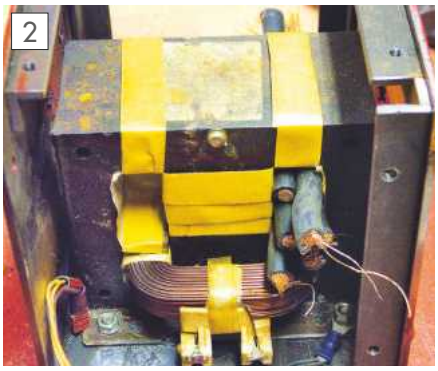


The spot welder.

Transformer modification

This task is not difficult, but care must be taken to avoid damaging the primary winding because this is needed in the final assembly. If a large vice is available, then the task is quite easy, taking just a few minutes. Set up the transformer so that the upper surface of the primary winding is just below the tops of the vice jaws, so that, in the event of over enthusiastic hacksawing, the blade will be prevented from slipping downwards and damaging the primary winding. The secondary winding to be removed, is the one with many turns of very thin wire . The primary has a heavier gauge wire seen in **photo 2**.

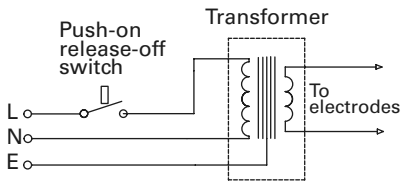
This photograph shows the slots left after removing the primary winding. One slot has been filled with scrap cable pieces simply to check the highest number of turns possible using the new winding. Using 25sq.mm cable, five turns are possible, but before winding the cable into the slots, insulate the contact area with insulation tape. The tape to be used should be either 'Mylar' or 'Kapton polyamide' Using ordinary adhesive plastic tape should be avoided to ensure that softening of the tape does not take place, thus compromising the effectiveness of the insulation should the transformer warm up appreciably during periods of heavy use. Wind the cable into the slot ensuring that no excessive sloppiness is present,



The transformer.

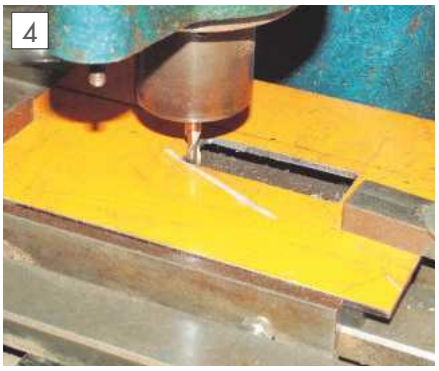
and secure the turns using a couple of strong cable ties (**photo 3**). Leave the cable ends about 18 inches long, but they will need to be trimmed back later on, during final assembly. The electrical parameters are given in **Table 1**. Should you wish to experiment by changing the number of turns on the secondary winding, this is the time to do it, Removing one turn on the secondary winding will increase the output current appreciably, with a reduction in the output voltage. I used five turns.

The new secondary winding.

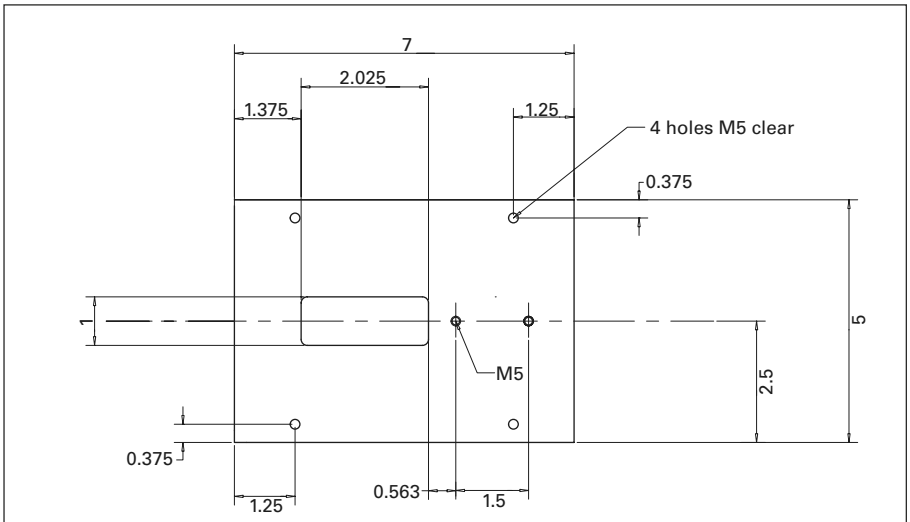


Wiring Diagram

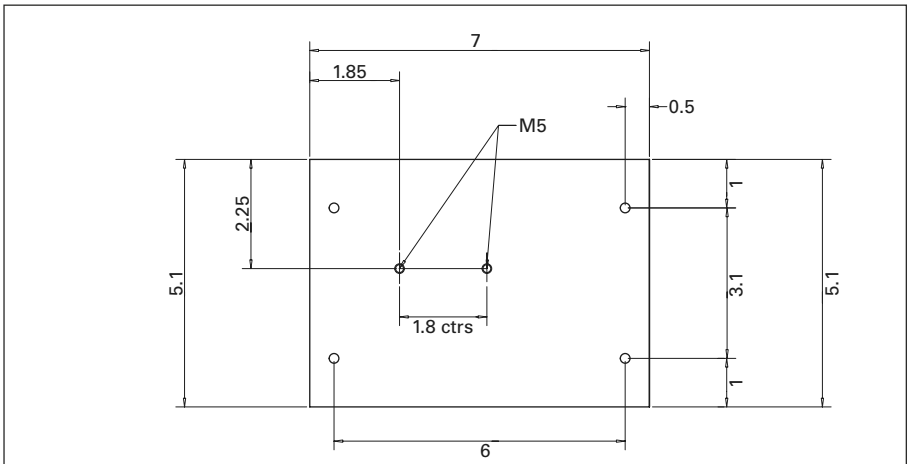
Table 1
Transformer properties with secondary at five turns.
PRIMARY VOLTS 240V
PRIMARY CURRENT (OFF LOAD) 1.8A
OPEN CIRCUIT SECONDARY VOLTS 4.23V
MEASURED SECONDARY CURRENT 811A (Short circuit measurement using a clamp meter)



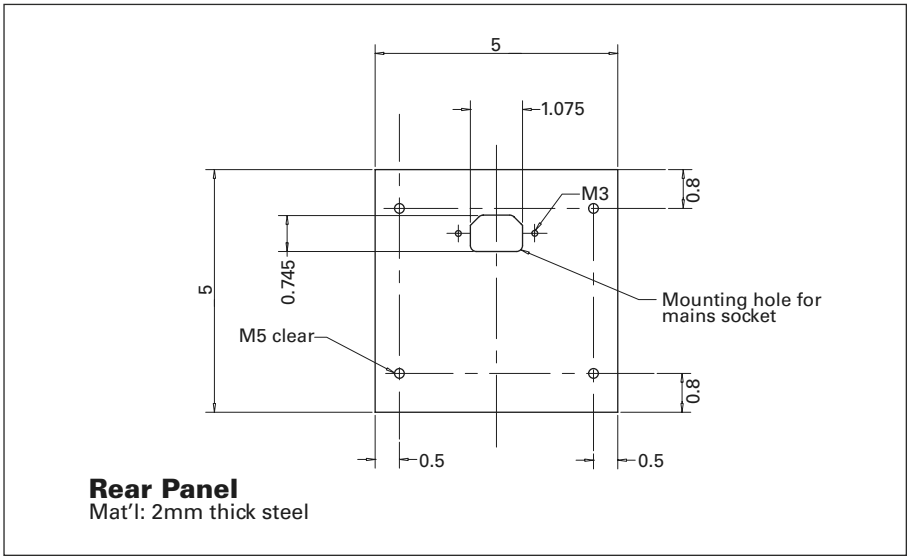
Milling the slot for the upper arm.



Case Top Plate
Mat'l: 2mm thick steel



Side Plate
Mat'l: 2mm thick steel, 2 off



Rear Panel
Mat'l: 2mm thick steel

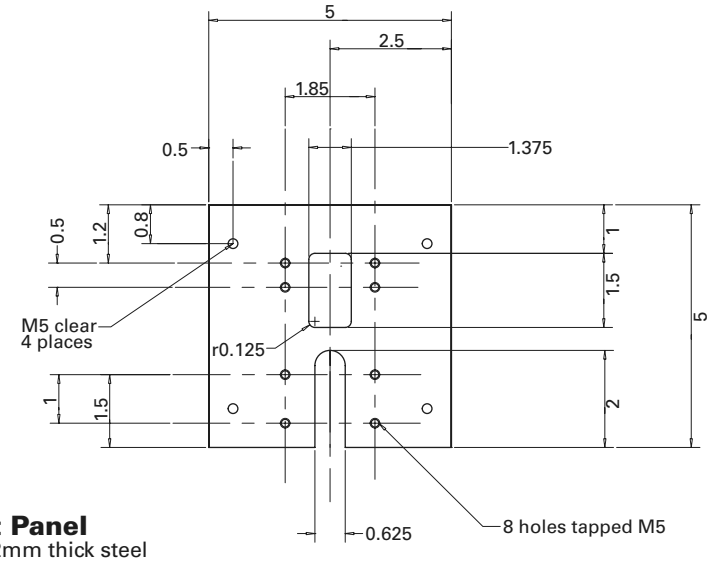
Construction

The casing was made from 11 swg steel plate, and in my case I happened to have a quantity of sheet available from a previous job. It does not need to be this thick, but although heavy, produces a solid construction. Thinner material will however suffice as the box structure is extremely rigid. I found that the easiest method of cutting out the panels was to rough them out using an angle grinder furnished with a cutting disk, and leaving a little extra for finishing on the milling machine. During assembly the panels are fixed to each other by bolting to lengths of 1 x 1 inch steel angle, and this enables easy access to the internal components if required.

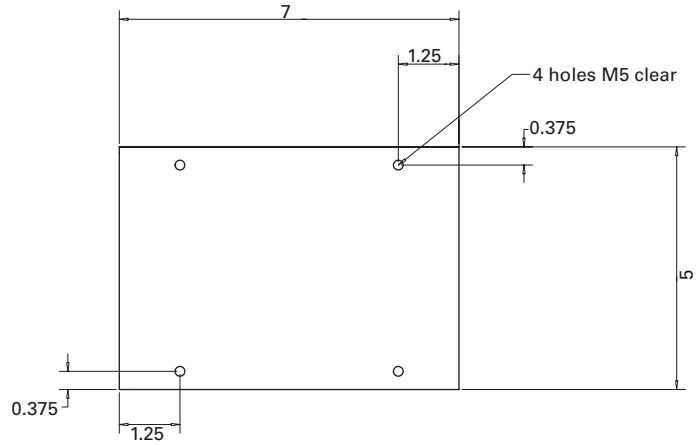
A typical set up is shown in **photo 4** where a slot is being milled out in the top panel to allow access for the upper arm, and handle linkage. Milling the panels to their overall dimensions can be conveniently carried out in pairs, which will save time, and will ensure that they end up the same size.

The electrode arms and the handle were made from 1 inch square section steel tube. The slots in the arms were added in order to make the cable connection a good deal easier, otherwise extra cable will have to be added into what is already a tight space. Remember that the shorter the cable, the less resistance and consequently less current loss. The slots also provide a means of cooling during periods of heavy use.

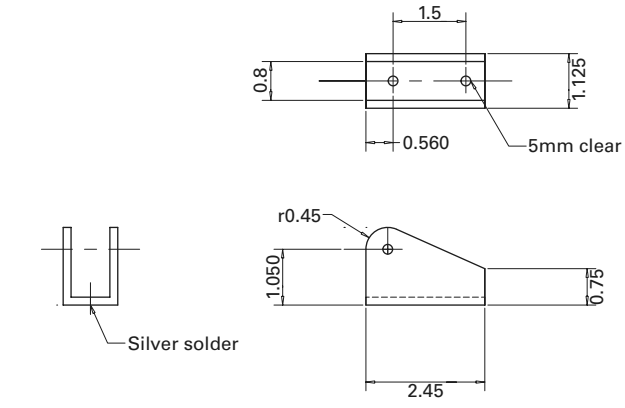
The cable used for the secondary winding is rather stiff, and to obtain good electrical conductivity, the holes in the ends of each of the electrode carriers need to offer a snug push fit when the cable is fitted inside. To further improve the conductivity two grub screws are used to clamp the cable inside the joint (**photo 5**). It is worth sourcing the other items before



Front Panel
Mat'l: 2mm thick steel

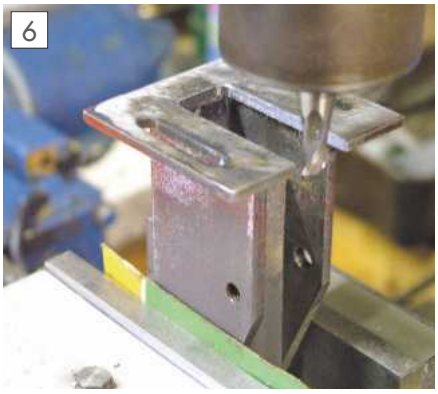


Bottom Case Plate
Mounting hole positions will depend on transformer used



Handle Pivot Bracket
Fabricate from steel angle

An electrode and electrode carrier.

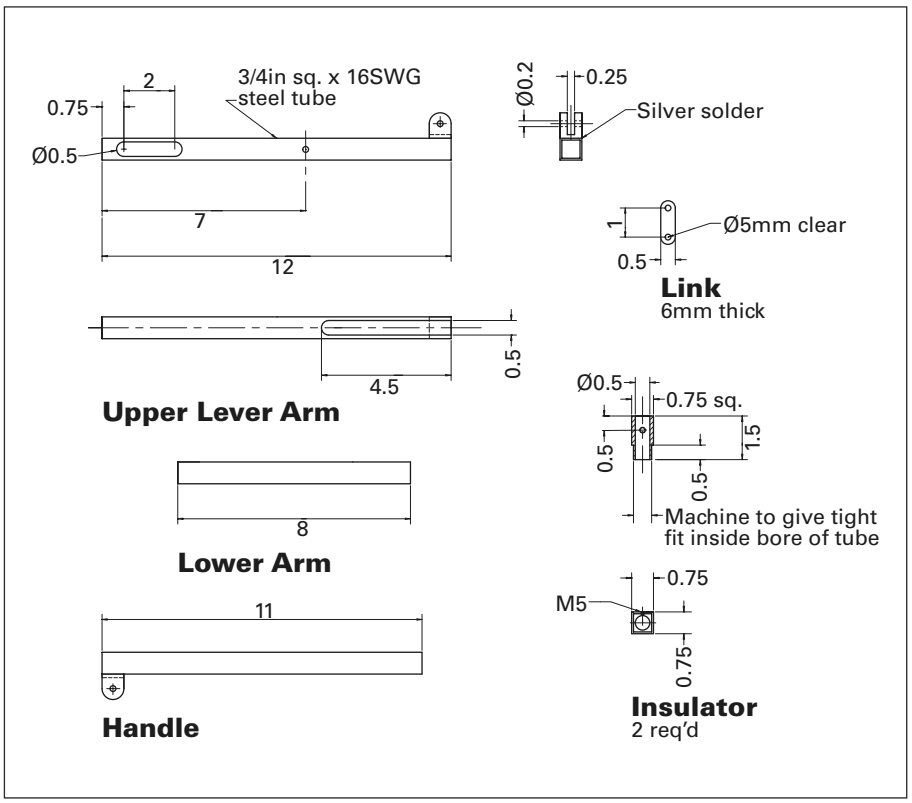


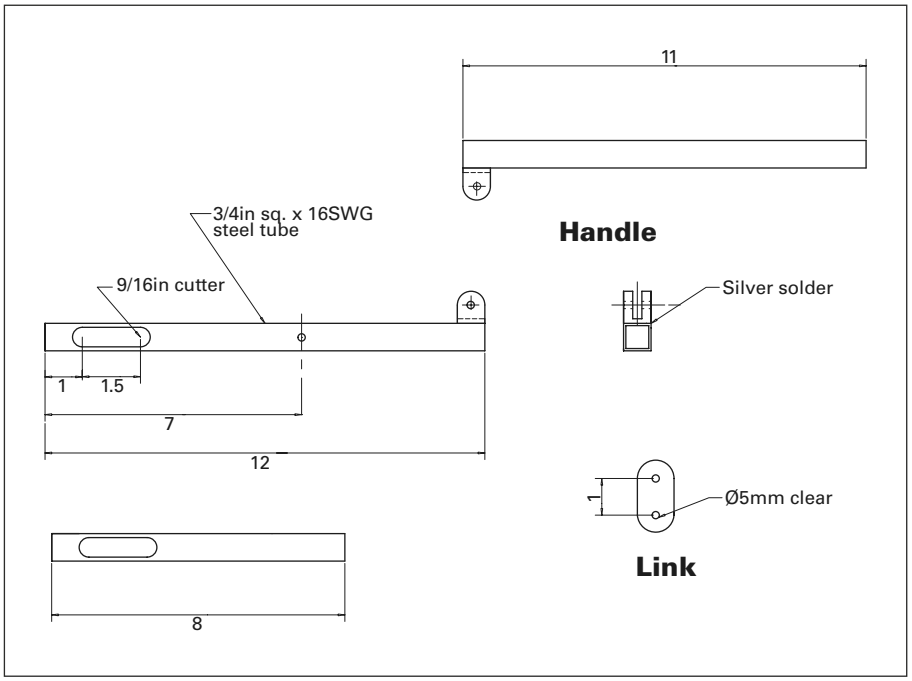
Truing up a fabricated bracket.

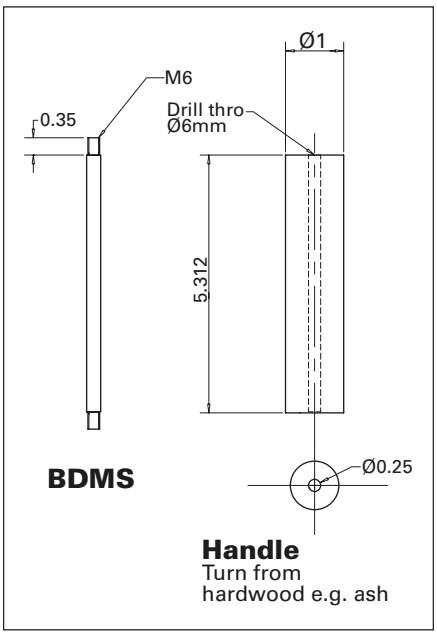
Set up for radiusing.

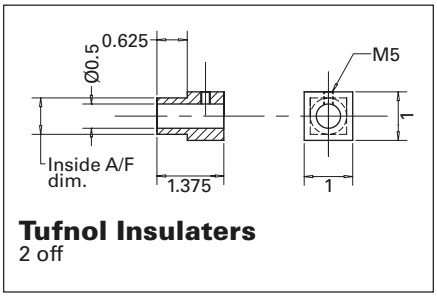
making them up. I managed to get most of the copper from eBay suppliers. With this in mind, small differences in the raw material sizes can be accommodated by adjusting the final dimensions.

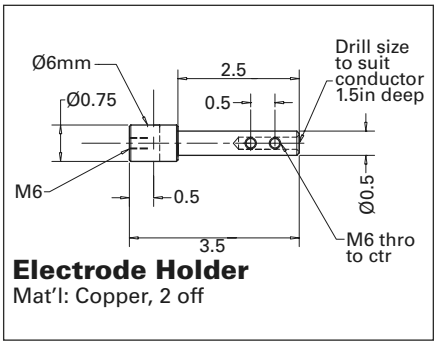
The insulators in which the electrode holders are held, are made of tufnol. I chose this material because it has a higher working temperature than nylon, as well as being harder than many of the common plastics, and not least, because I already had a chunk in my scrap box. These were made before machining the electrode holders, because I wanted to ream the bores. (It is easier to machine the cylindrical shanks of the holders to give a snug fit in the bores. I think so anyway). It is also worth making the tufnol components at least 1.5 inch long to provide enough bearing length when side load is applied during use. Remember to

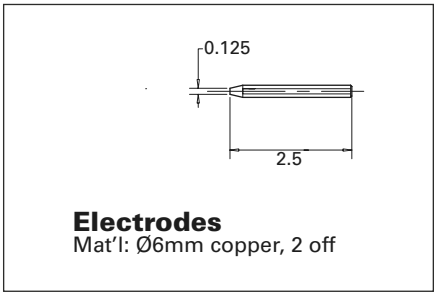








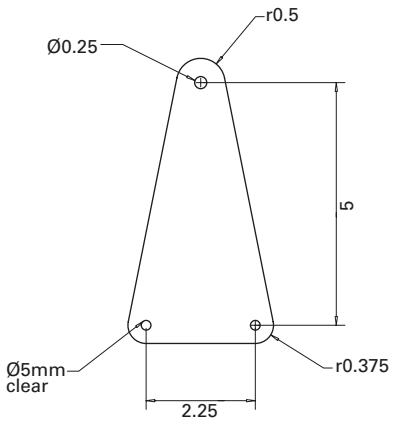




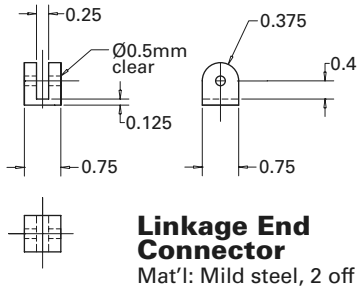
leave a little extra thickness on the top of each insulator to accommodate the length of the grub screw, because pressure from the grub screw could crack the tufnol or strip the thread.

The brackets in my welder were fabricated from steel angle, and left over sheet, then silver soldered together. If you're a bit masochistic, they can be machined from solid! Welding could be used if preferred. The spacing of the bottom bracket can be achieved by using a scrap of steel tube left over from the arms plus a piece of packing of thickness 'T', equal in thickness to the diameter of the cutter used to mill out the waste. A snug fit is needed, so that tightening of the clamping screw pulls the sides of the bracket firmly against the lower arm. I had considered making a cam lock but found it was unnecessary. **Photograph 6** shows a set up which enables machining of the bottom bracket after attaching the back plate. This view shows machining of the exit slot for the cable. The handle bracket serves the purpose of housing the return spring as well as providing the fulcrum point for the handle. A method of machining the radius on the top edges is shown in **photo 7**. The handle return spring is shown in **photo 8**. No details have been given because the spring chosen will dictate the final sizes of the two location bosses. Make these so that they are a tight fit inside the spring. I also turned a groove on the outside of each to

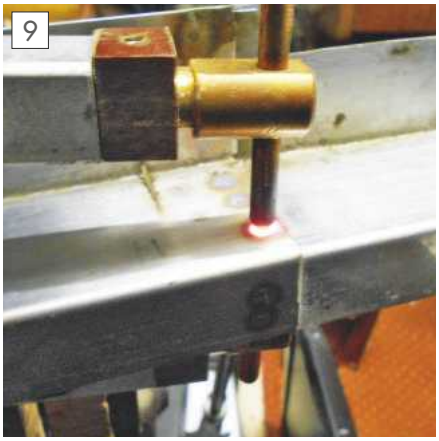
The handle return spring arrangement.



Handle Bracket
Mat'l: 3mm thick mild steel, 2 off



Linkage End Connector
Mat'l: Mild steel, 2 off

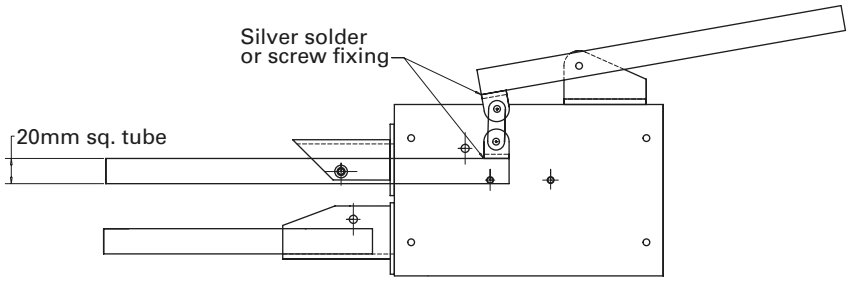


Making a weld.

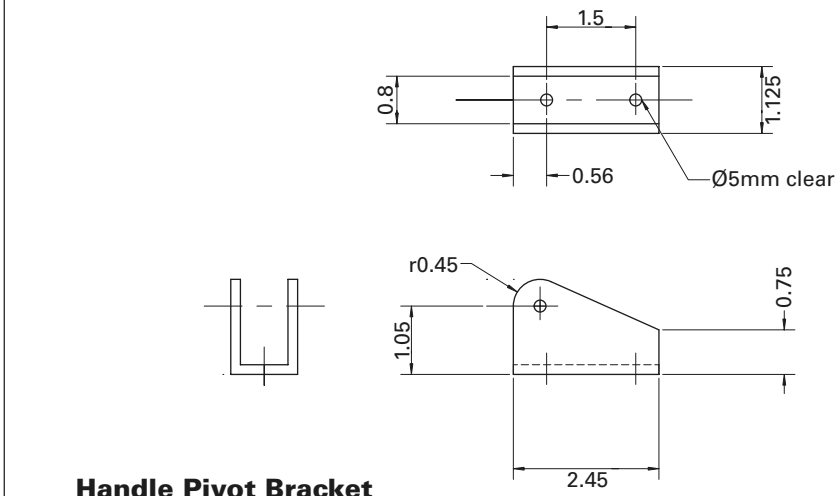
allow the spring to grip firmly which will prevent the spring popping off when the handle is pushed downwards. The first spring I fitted went into orbit never to be found again.

The actual process of welding is shown in **photo 9**.

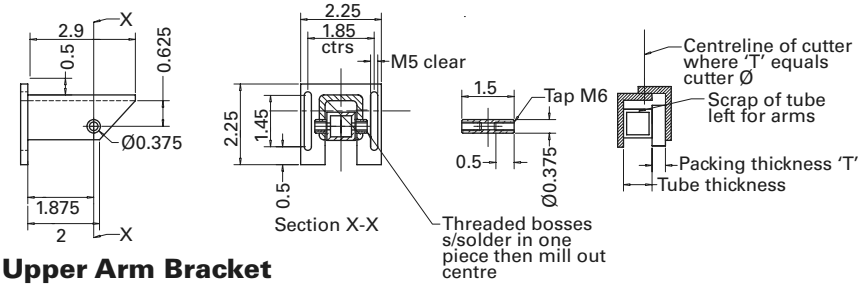
I had initially intended to fit a timer into the circuit with the idea of achieving consistency in the welding process, but found that due to variations in the material flatness when the electrodes are closed on to the material being welded, the actual time taken tended to vary. I put this down to the variation in cleanliness and sometimes lack of flatness of the parts being welded. It is therefore important to give the surfaces a clean up beforehand. It is however quite easy to judge the point at which the power needs to be switched off.



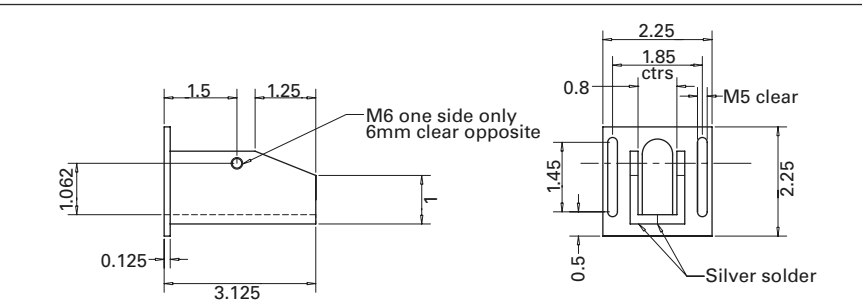
Linkage Layout



Handle Pivot Bracket



Upper Arm Bracket



Lower Arm Support Bracket Fabrication

Electrical components required:

- 800 W mains transformer salvaged from a microwave oven.
- Heavy duty single pole change over microswitch (spco) 10Amp rating minimum.
- Mains socket 10Amp rating.
- 25 sq mm cable for the secondary winding. 4 metres needed.
- Insulated connecting wire.

■

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Improvements to a Popular Bandsaw Part 3

Michael Cox makes some modifications to an imported 4 x 6 Bandsaw.

The flap valve (**fig. 12**) was made from some transparent plastic that it commonly found on bubble/ blister packs. The plastic was 0.2mm thick. The disc was cut by scribing the plastic with sharp dividers. This rapidly scores the film and the outside can be snapped away cleanly leaving a disc. The small holes were cut using a wad punch. The flap valve is shown in **photo 22**. The plastic disc was attached to the piston using two small M3 pan head screws. The completed piston/ piston rod assembly is shown in **photo 23**.

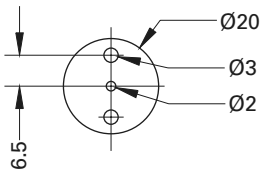
The upper closure of the cylinder is a standard 22mm compression stop end fitting. The end cap was chucked in the lathe, centre drilled and then drilled out to 8mm.

The needle (**fig. 13** and **photo 24**) was made from a 120mm length of M4 studding. This was chucked in the lathe and a 30 degree included angle point was machined with the top slide set over by 15 degrees. The threads were removed from a 30mm section from the point.

The two carriers (**figs 14** and **15**) were made from 50mm lengths of 10 x 20mm steel bar and were drilled and tapped according to the drawing. The two spacers (**fig. 16**) were made from 10mm bar drilled out to 6mm and then parted off in 12mm lengths.

A general view of the bandsaw.

Fig. 12



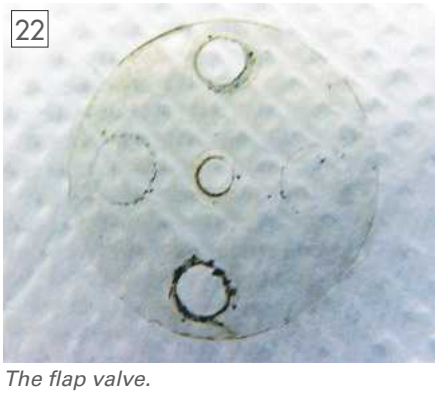
Flap Valve
Mat'l: see text

The adjuster (**fig. 17**) was made from 20mm round bar. This was faced off, drilled out 3.3mm for a depth of 9mm and then knurled. It was tapped M4 and then parted off to 6mm.

The cylinder was now ready for assembly. The drilled out end cap of the compression fitting was slid over the piston rod. The threaded end of the needle was screwed into the piston rod carrier so that about 20mm protrudes. The needle was then slid into the piston rod and the piston rod carrier was screwed to the end of the piston rod. The function of the needle valve was checked by screwing the needle in and checking that the tip of the needle seats properly in the hole in the bottom of the piston. The compression ring and olive was slipped over the cylinder and the inside lubricated with a little oil. The piston was pushed into the cylinder. The end cap and the compression nut were tightened together. This should be done carefully. If the nut is over-tightened then the bore of the cylinder will be reduced and it will be impossible to remove the piston from the cylinder. The nut should be tightened just sufficiently to retain the end cap on the cylinder. The adjuster was screwed onto the needle followed by the lock nut and the two locked together. The upper carrier and spacers were assembled and bolted to the piston rod carrier. The hydraulic cylinder was now complete (**photo 25**) apart from filling it with oil.

Attention was next turned to fixing the cylinder onto the bandsaw. A bracket (**fig. 18**) was made that attaches to the bandsaw arm pivot and to the ring originally used as the spring attachment point. To fix this the bandsaw pivot pin must be drilled and tapped M6. Ideally the pivot pin should be removed and the

22

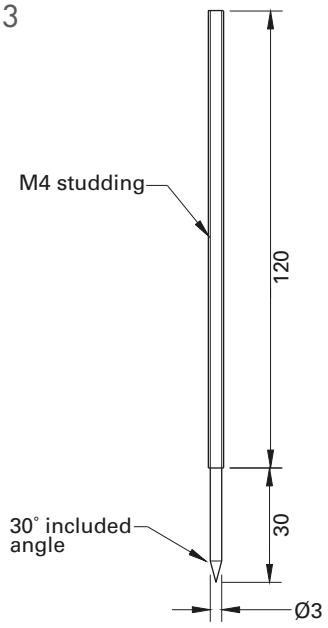


The flap valve.

23

The piston showing screw holes and transfer holes.

Fig. 13



Needle

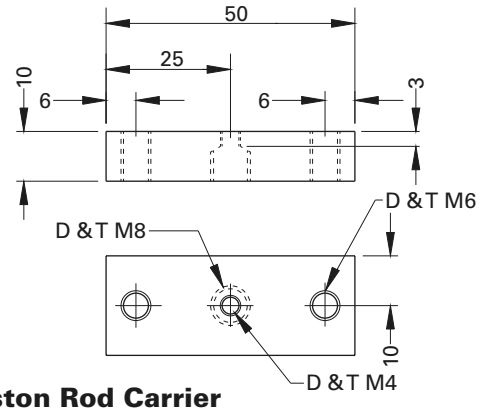
24

The needle.

25

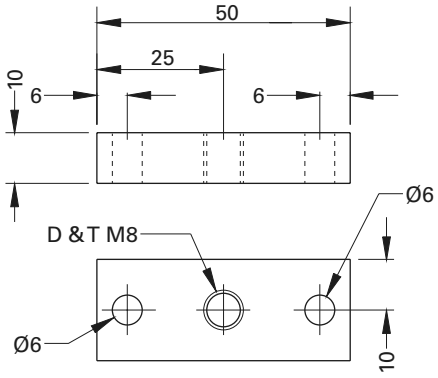
The cylinder and push rod assembly – open.

Fig. 14



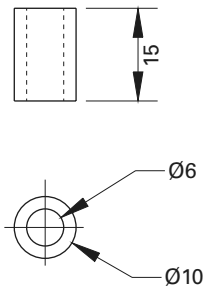
Piston Rod Carrier

Fig. 15



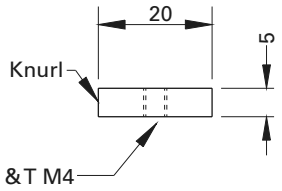
Upper Carrier

Fig. 16



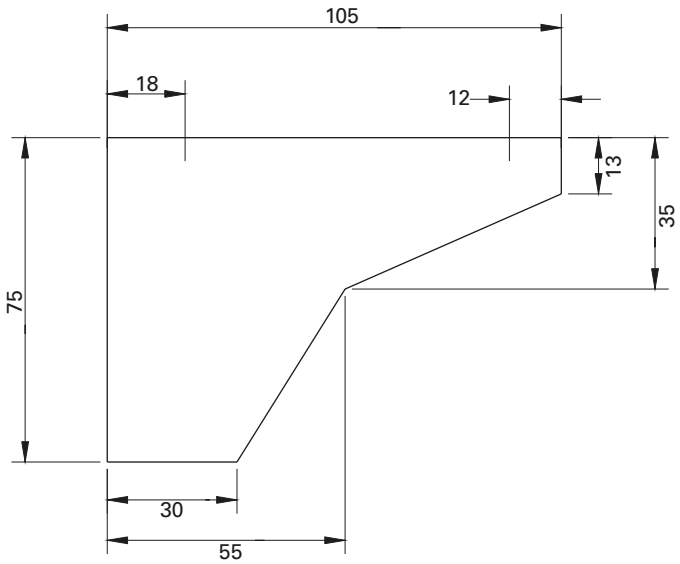
Spacers
2 req'd

Fig. 17



Adjuster

Fig. 18



Band Saw Arm Bracket
Mat'l: 6mm plate, all corners radiused 4mm

drilling and tapping done on the lathe. However, I drilled the hole freehand, with the pin in situ, using a portable electric drill after first carefully marking the pin centre and centre punching.

The upper carrier connects to the upper attachment fixture (**fig. 19**) with a 100mm length of M8 studding. The studding is locked to the upper carrier with a locknut. The upper attachment fixture has a long threaded portion and this enables the distance between the upper carrier and the attachment point to be varied. Once adjusted to the correct distance it too is locked with a lock nut. The upper attachment fixture was fixed to the bracket by a stepped bush (**fig. 20**) and an M6 screw, as shown in **photo 26**.

The lower fixing point for the cylinder is a point 150mm along the edge of the shelf measured from the outside of the bandsaw stand. This point was marked on the edge of the shelf. This point has to take all the weight of the bandsaw arm and the shelf needs to be strengthened to resist these forces. The first step was to fix a length of 25 x 25 x 3 steel angle the whole length of the shelf secured to the stand at both ends. A 6mm hole for the fixing point was then drilled through both the shelf and the angle. The second step was to fix a piece of 4 x 20mm strap iron from this fixing point to the screw that fixes the cast iron base of the bandsaw to the stand. The lower attachment fixture was fixed to the fixing point by a stepped bush (**fig. 21** and **photo 27**) washer and an M6 screw. Note that the stepped bush and washer is cut at an angle to compensate for the sloping sides of the stand.

The upper bracket and attachment point.

The lower attachment point.

Once the cylinder was installed on the bandsaw it was filled with oil. The grade of oil is not critical and anything in the range of SAE 30 –140 seems to work. To fill the cylinder, the top compression cap was undone and the saw lifted to a position where it is half way between vertical and horizontal. Oil was poured into the cylinder until it was full to the brim and the arm lowered and then raised to the half way position. Repeating this filling process two or three times ensures that the cylinder is full. The top compression cap was then retightened. With the bandsaw arm down and the needle valve closed the arm could be lifted easily to the half way position but once there the arm would remain stationary. Opening the needle valve allows the saw arm to descend at a controlled rate.

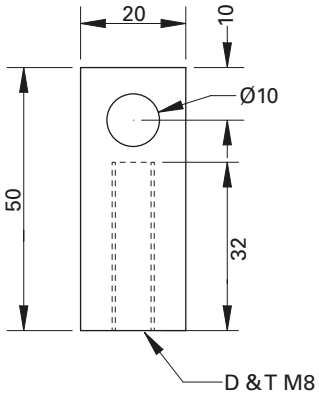
The original spring counterbalance system for the saw was connected via the linkage that can be clearly seen in photo 26. The two links are shown in **fig. 22**.

The hydraulic controlled feed is very useful in a number of situations. Cutting with very slow federates gives an excellent surface finish. The major benefit however is when cutting thin materials and tubes. Without a controlled feedrate then there is a great tendency for the saw teeth to snatch at the thin material and this can result in the teeth being ripped from the blade. With a slow controlled down feed the blade takes small nibbles from the material being cut rather than big bites and snatching is eliminated.

Conclusion

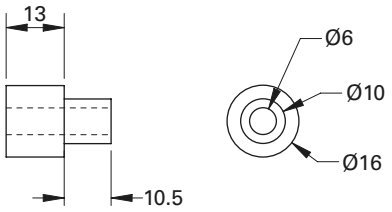
Many modifications to the band saw are covered in this article. These have been carried out over a five year period as and when improvements were needed or identified. The saw is much more versatile now in that it can reliably saw small and large lengths of material, thin and thick material with greater convenience and with greater comfort. ■

Fig. 19



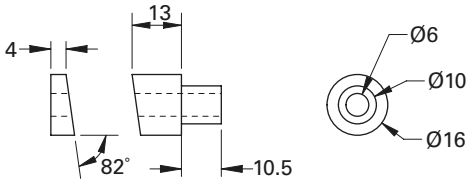
Upper Attachment Fixture
Mat'l: 10 x 20 MS

Fig. 20



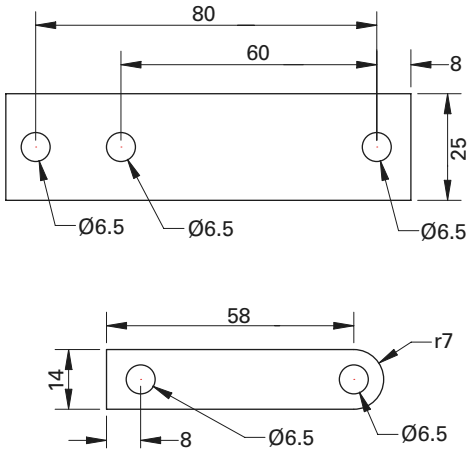
Stepped Bush

Fig. 21



Stepped Bush And Washer

Fig. 22



Spring Linkages
Mat'l: 4mm MS

Some Ideas on Using Rare Earth Magnets in the Workshop

I bought a pack of 50 rare earth (neodymium) magnets some time ago when I was buying some other items from a Far-Eastern eBay store. At the time they were simply an amusement but I have slowly found uses for them and find them useful to have around. Their magnetic force is astounding to anyone only used to old fashioned magnets. These are 10mm diameter and 2mm thick and the highest strength N52 material. According to the web site they have a force of 1.5Kg for this size, easily capable of pinching skin if you let them go at the wrong moment. They can also be found in disk drives and other modern equipment although they may not be such convenient shapes as the commercially bought versions.

Simon Davies has some attractive tips, particularly for those who mainly work in non-magnetic metals.

A troublesome alignment task.

Firstly, a means to help to setup thin objects in a lathe chuck:

Although I have not seen this idea published elsewhere, I cannot believe that it is original. However it may be useful to somebody looking to hold thin items squarely in a 3 or 4 jaw chuck when it is either not possible or inconvenient to use other means. The essence of the solution is to use the rare earth magnets to both provide spacers from the chuck body to two parallels and to hold everything in place at the same time.

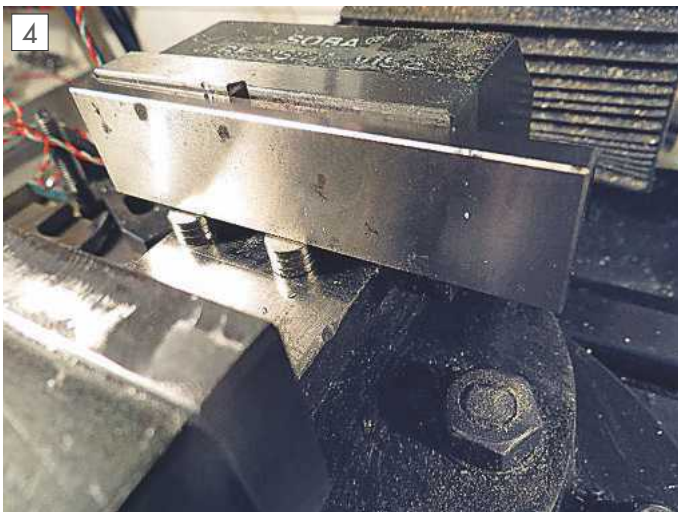
The series of photos will I hope illustrate the problem they help to solve. All too often there is a need to grip something towards the outer ends of the chuck jaws (never good practice of course) and at the same time ensure that the object is true to the axial line of the lathe (**photo 1**). One solution is a Morse taper plug with an adjustable threaded rod setting the object a certain distance from the chuck body. However sometimes there is no room for such a tool or the hole in the mandrel is needed.

In this case, I used several magnets stacked into 3 equal piles and applied to the chuck body as shown with a pair of small parallels providing a bridge across the centre hole in the chuck (**photo 2**). The depth can be adjusted by varying the number of magnets or by using different parallels. Add the object, tighten the chuck loosely and apply gentle force from the tailstock as shown in **photo 3**. In this particular case which was being machined slowly, I did not remove either the magnets or the parallels however it would be wise to do so if the object was rotating more rapidly.

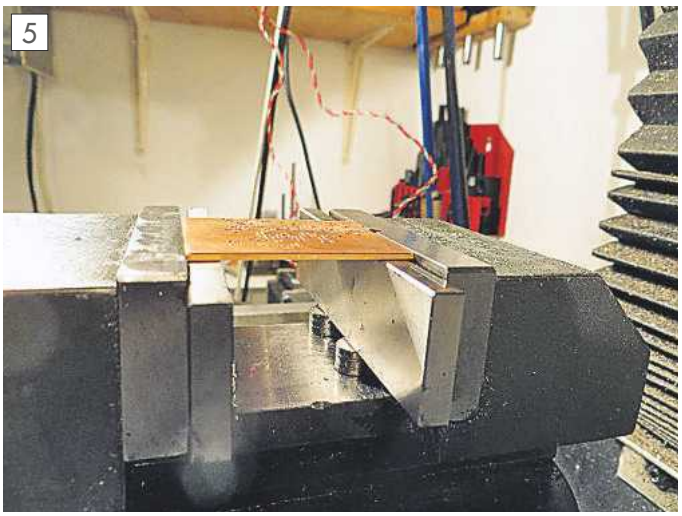
A second solution is illustrated with **photos 4** and **5** where the magnets have been used to hold parallels in place in my mill vice. They serve a twofold purpose here,

Parallels supported on stacks of magnets.

Adding support from the tailstock.

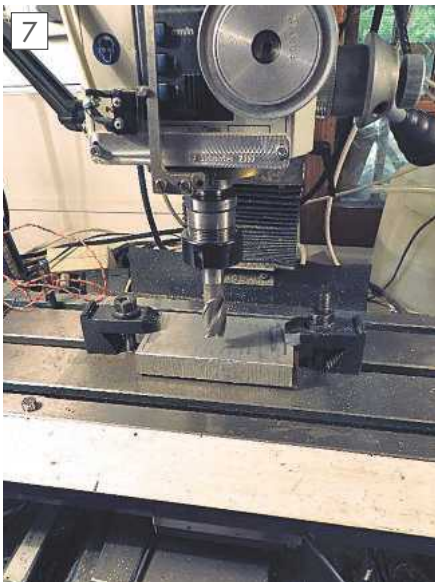


Magnets supporting a parallel in the machine vice.



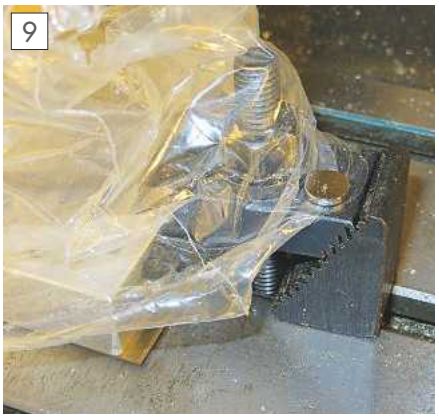
A thin workpiece supported on the parallels.

The magnetic bag solution to reducing coolant spray.



The aluminium workpiece.

Magnets fix the bag to the head.



...and to the work table.

A hole is made for the coolant nozzle.

firstly adding 2mm increments to the width (height) of the parallel and secondly ensuring that the parallel has less inclination to topple over when the object is placed on top. Note that I have found no formal specification for the thickness of the magnets so this may not be a perfect method when real precision is required. In this case, I would use the magnets to stick the parallels to the vice jaws and use a more accurate object to add height to them.

Finally, a solution aimed more at the CNC'ers amongst us. I generally use my CNC mill with carbide cutters running dry or with manually applied fluids to improve the surface finish. I rarely use the optional pumped coolant and fluid since it makes such an abominable mess. This is especially the case once the cutter diameter reaches much above say 3mm where cutting fluid is flung in all directions including mine. My solution is to press a cheap plastic bag such as freezer bags into use and attach in place with magnets (**photo 6**). Enough slack needs to be included to ensure that the bag is not pulled away from the top or bottom and equally, it needs to be taught enough that the polythene does not fall into the cutter area. Of course, each setup requires a new set of polythene but freezer bags are cheap and easily disposed of after use.

The solution is not entirely perfect but it restricts the vast majority of the sprayed fluids to the confines of the table. Nipping the polythene to the outer side of the t-slots means that the fluids will dribble down the plastic and into the t-slots for eventual collection rather than just forming a puddle. I have shown some posed photos showing the 'before' state about to machine a lump of aluminium clamped to the table **photo 7**. Magnets clamp the bag to the head (**photo 8**) and to the table (**photo 9**) and a hole is cut into the side for the coolant nozzle (**photo 10**). Photograph 6 shows the effectiveness with the 18mm end mill running at 2200rpm and a thin stream of water just visible as it heads to the cutter tips. I was using pure water in this case but the bag can be seen collecting the spray as the t-slots fill up.

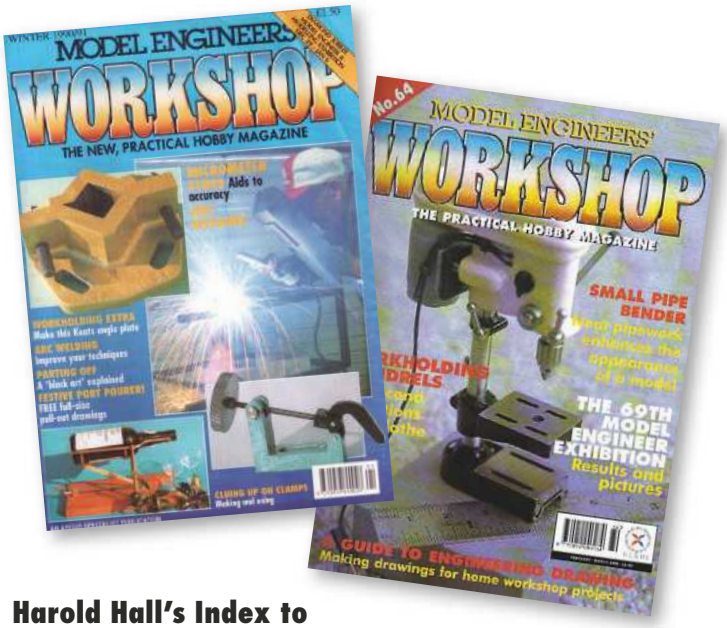
One final word of advice is to have a demagnetiser available for returning parallels and any other components to a non-magnetised state! ■

Do you want to Build a Snowman?

Indexes for Model Engineers' Workshop

MEW's Editor, Neil Wyatt gives an overview of the various indexes available for your favourite magazine. And no, you won't find instructions for machining snow…

Every twelve issues, we publish a detailed index for Model Engineers' Workshop, but in this information age there's obviously the potential for computer based indexes which can be faster and easier to use. An internet search for 'Model Engineers Workshop Index' will bring up several options. I personally use at least three of the indexes, as they all work in slightly different ways and each has its own strengths. I suggest you try them out and see which you get on best with.



CAHW (Computer and Home Workshop)

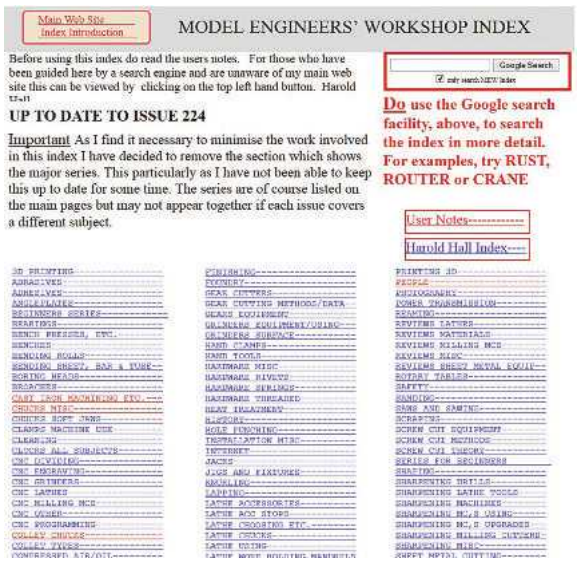
This database maintained by Barry Chamberlain is used to compile the indexes published in *MEW* every twelve issues, and unlike all the others below, it is a paid for product supplied on CD. It includes a thumbnail display facility with the covers of all issues. This index is fast to use if you know what you are looking for – either issue, title or author name. It is also possible to browse articles by category. Naturally, you don't need an internet connection to use the database.

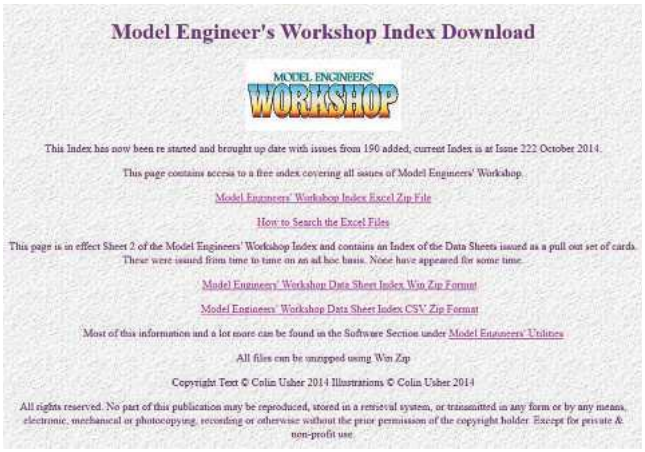
cahw.co.uk/index.html

Harold Hall's Index to Model Engineer's Workshop

Harold Hall's index is an online one, and useful if you want to browse articles on a particular subject. It lists issue, page, title, expanded title (really a few keywords) and author name. As well as listing these for each subject area, there is a google search facility that examines the pages.

www.homews-mew-index.co.uk/

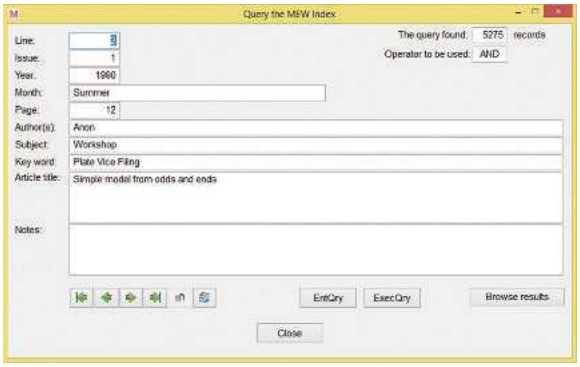




Colin Usher's Index

Colin Usher long maintained indexes for *MEW*, *Model Engineer*, *Engineering in Miniature* as Excel files. Colin did stop maintaining the *MEW* index in June 2012 (but not the other publications), so in late 2014, I decided to bring it up to date. Colin now mirrors the index updates posted at my website, but is presently lagging a few months behind.

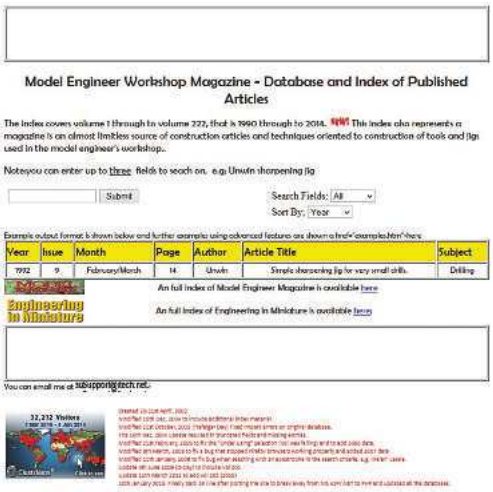
www.colinusher.info/Model%20Engineering%20Indexes/



Dias Costa's Search Engine

For those who are comfortable with using database programs, Dias Costa's utilities provide advanced search and query facilities using Colin Usher's various indexes or my own *MEW* spreadsheet index. This is probably the best search method if you aren't sure what you are looking for, especially as each search generates a dedicated table with just the relevant articles in it. A little computer skill is needed, so if you get stuck, post a question on the Model Engineering forum www.model-engineer.co.uk

www.diascosta.org/ME_MEW_EiM/



The Model Engineers' Workshop Index

This is my own website, and has monthly updates of an Excel-spreadsheet index which builds on Colin Usher's huge spreadsheet. Like the original version it lists issue, year, month, page, subject, author, keyword (actually a short description) and article title. The two changes from the original approach are firstly to give the first names of authors, as well as surnames, and secondly the data is presented slightly differently so it can be imported into Dias Costa's database with no need to 'clean' irregular lines. There is also a pdf version of the index on the site for those who don't have Excel or a compatible spreadsheet program.

www.neilwyattenvironmental.co.uk/services-pages/model-engineers-workshop-index

I hope you have found this index useful. If you have, please share a link to this page with your fellow model and hobby engineers!

The Australian Model Engineer's Workshop Index

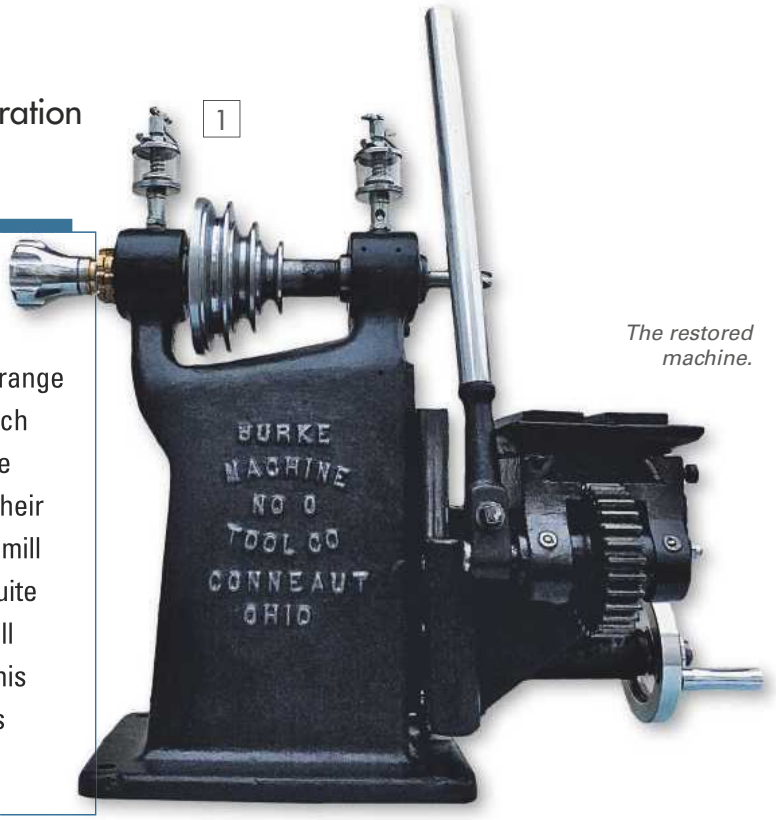
This website offers an online search facility of the *Model Engineers' Workshop* Index, but presently only up to October 2014. It appears to use the Model Engineers' Workshop Index as its source data, but this isn't clear. Handy if you want to do a quick search when you are online:

www.itech.net.au/modelengineer/mew_magazine.php

Polishing a Gem

Restoration and Rebuild of a Burke No.0 Horizontal Mill

Gary Arthur Ayres – based in Guernsey, Channel Islands – tells the story of his restoration of a tiny Burke No.0 Milling Machine.



The restored machine.

The Burke Machine Tool Co moved to Conneaut, Ohio from Cleveland in 1910 and remained there until 1948 (**ref. 1**). During that period they manufactured a range of horizontal milling machines including the No.0 which you see here. I have been unable to date the machine accurately, but it appears that the 'zero' was one of their early products so it's reasonable to assume that this mill is about 100 years old (**photo 1**). It is, I believe, also quite rare: google 'Burke No.0 milling machine' and you will find only three or four examples, one of them being this very machine. This is in contrast to the No.4, which is ubiquitous, at least in North America.

When I saw the mill for sale online at a very reasonable price I rang the seller straight away, albeit at that point with little hope that he would be willing to pack it and ship it from mainland England to Guernsey. He was, however, extremely helpful and for a very fair additional sum he built a sturdy wooden crate and bolted the mill to the bottom of it for me. Financially speaking, so far so good. However, a few phone calls to shipping companies later I saw my expenditure beginning to rack up steeply. One of the drawbacks of island life!

When and why this vintage American machine crossed the Atlantic I do not know. All the seller was able to tell me was that it had sat under his Dad's workbench untouched for some thirty years. In other words, for one third of its life it had not been subject to any wear and tear whatsoever, and although the pulleys and most of the spindle locking nuts were absent the machine was in good condition, cosmetic considerations aside. The bearings were in great shape, and the table travel smooth on all three axes. **Photograph 2** shows the mill straight out of the crate.

My first job was to disassemble the mill and clean the parts in kerosene (**photo 3**). The existing light green paint was then removed using a chemical paint remover. My understanding is that machine tools from the very early 20th century were usually painted black (those lovely pale greys and muted greens being a later development), so I decided to try using matt black stove paint – a bit of an experiment, but no problems so far. To add a subtle contrast, the raised lettering on the main casting was picked out in some gloss British Standard Dark Sea Grey which was left over from the previous overhaul of my Dore Westbury Mk1 (**photo 4**).

The Burke No.0 has a small handwheel and leadscrew on the Y axis. The X and Z axes, however, are actuated via lever operated rack and pinion feeds. This – as many readers will be aware – was a relatively common system on older

The machine in the condition I received it.

A kerosene bath.

horizontal milling machines and tends to be associated with repeat production milling. The 'zero' may only stand some fifteen inches high, but it is not a toy! The two operating levers appear not to be entirely original, in that the shafts are made from straight aluminium bar, possibly in place of steel with wooden hand grips. However, the aluminium polished up very nicely to a gleaming finish and looks fine. The brackets which lock the levers to the pinion shafts are original.

While this little machine would look handsome enough as an ornament in the corner of someone's living room, my intention is to use it for its proper purpose. For this reason I was not particularly concerned with creating a historically accurate reproduction machine, but aimed to make something that would actually work. I did, however, pursue an aesthetic which respected the look of the original machine without adhering to it too literally. I therefore allowed myself a degree of poetic license – within limits. A spare aluminium handwheel I had in a drawer was adapted for the Z axis feed by widening its bore and milling two curved slots in it (for appearance's sake) on the trusty Dore Westbury (**photo 5**). This is readily interchangeable with the feed lever. The remaining one-and-a-half oiler cups were replaced with two rather dashing drip-feed oilers (**photo 6**).

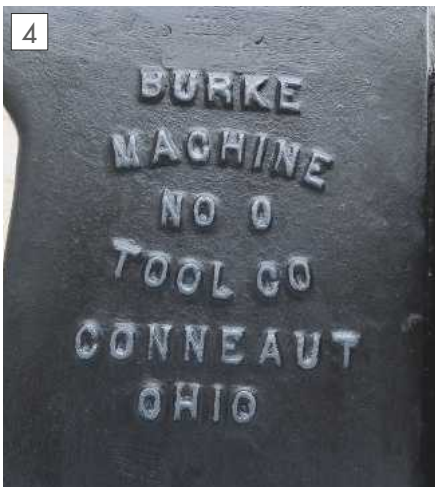
In its original form, this machine would have been equipped with three flat-belt pulleys, probably driven by an overhead lineshaft. Sadly, these had been plundered by persons unknown before the machine came into my hands. In the interests of practicality I replaced them with an A-section V-belt step pulley of the kind that is widely available. The largest of the pulleys had to be turned off in the lathe as it was too big for the machine. A bit of polish lent the step pulley a lustre which contrasts nicely with the matt black paintwork.

The spindle of the Burke No.0 is of course equipped with plain bearings. The front bearing is tapered, so the spindle is secured by locking nuts on the rear bearing only. The arrangement requires two nuts fore and two aft of the bearing to prevent back-and-forth movement while the front end of the spindle 'floats' in its tapered housing. Of the four nuts, only one was present on the machine as received. I machined a bronze collar in lieu of the missing front nut – this can be seen in **photo 7**, partially hidden by the pulleys. Two new rear nuts were made in brass, the threads to match the spindle being cut with a 15/16 inch x 20 tpi UNS tap and notches milled on the outer diameters for easy adjustment by hand. A drawbar was made simply from round steel bar threaded at each end, by which time I had reached the conclusion that this little beauty of a mill deserved one final funky touch: the large shiny drawbar locking knob which is shown to good effect in **photo 8**.

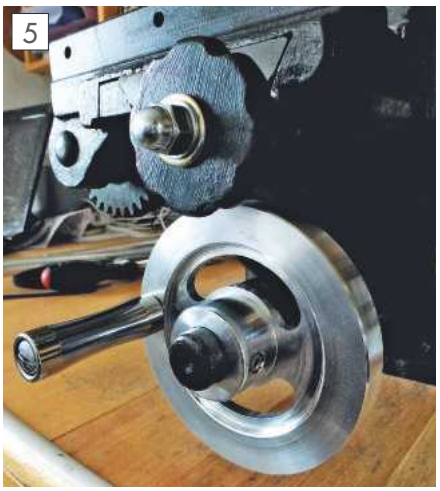
Collets? Brown and Sharpe No. 7 – quite elusive, and all the way from America by mail order (I told you the costs had racked up!). Also – courtesy of an online friend in California – a very nice old endmill holder made by the Putnam Tool Co. of Detroit, Michigan (**photo 9**).

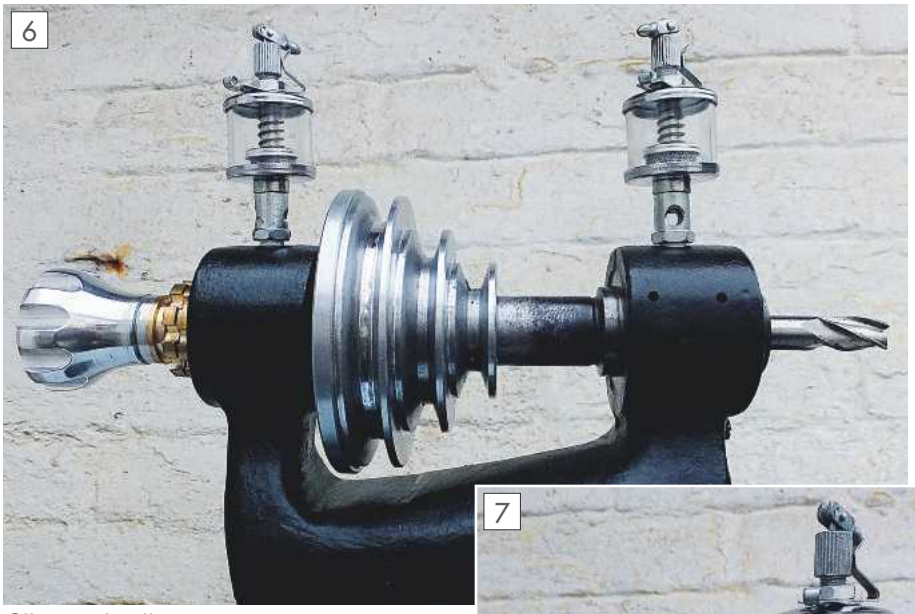
Oh – I almost forgot. The observant reader will have noticed a minor omission – the small matter of a motor and drive system. Well... I'm still weighing up a couple of options, one of which could – I guess – form a brief 'PS' to this article in due course.

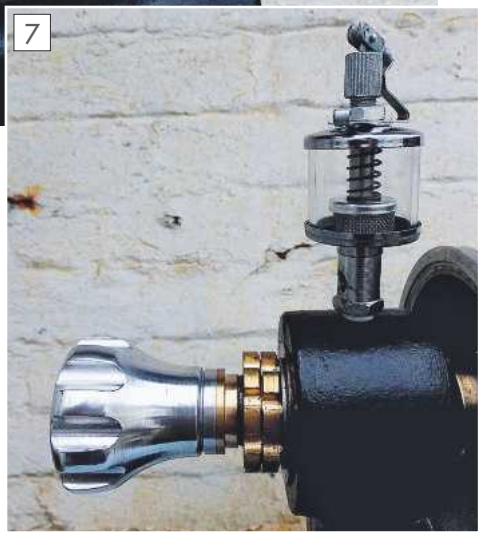
If anyone has any questions about the machine, I'm happy to be contacted by email at **gary.arthur.ayres@gmail.com** ■



4 *The paint job.*


5 *Z-axis handwheel.*


6 *Oilers and pulleys.*


7 *Spindle locking nuts and collar.*

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1. http://vintagemachinery.org/mfgindex/detail.aspx?id=132&tab=0


8 *Drawbar locking knob.*


9 *Endmill holder.*

On the Wire NEWS from the World of Hobby Engineering

New Proxxon MF 70 MICRO Miller CNC

The Proxxon MF 70 MICRO Miller CNC is a new milling machine from the respected German manufacturer Proxxon. This accurate all round metalworking and drilling machine is suitable for model makers and model engineers.

The base of this machine is constructed of grey cast iron and the compound table is made of high strength aluminium. All axes are fitted with adjustable dovetail slides. The die-cast aluminium headstock has a special, balanced DC motor with continuously variable speed control and full-wave electronics. Tool holding is through triple slit MICROMOT steel collets; the machine comes with one of each of 1.0, 2.0, 2.4, 3.0 and 3.2mm collets. The table has three T-slots of the MICROMOT standard size (12 x 6 x 5mm). The mill is fitted with stepper motor drive for the milling table and milling head but without a CNC control unit or CNC software.

The MF 70 MICRO Miller is priced at £594.96 including vat, valid until 31st December 2015. For more information, please call w0333 240 6967 or visit www.brimarc.com.

The 25 years of Model Engineers' workshop special is now available from MyHobbyStore for just £4.99. Go to www.myhobbystore.co.uk and search for '25 Years'

Arc Euro Trade offer free shipping until September

No that doesn't mean you have to wait several months for your parcel to arrive! It means that orders to all UK mainland destinations will be shipped free of charge until 30th September 2015. Visit their website www.arceurotrade.co.uk to take advantage of the offer, The offer excludes shipment to Highlands, Islands or Northern Ireland for orders over 2kg and excludes all shipments to Channel Islands.

By the by, I recently tried a couple of the new micro-grain carbide milling cutters from Arc Euro Trade. A TiAlN coated one for steel and an uncoated one for use with aluminium. They are very sharp and work well, leaving an excellent finish.

Machine DRO's Moore and Wright Summer Promotion

This summer Machine DRO are offering up to 50% off selected Moore and Wright products. Examples of some of the great savings to be had are 20% off set squares, 10% off height gauges and a massive 50% saving on a digital vernier. Even my humble workshop benefits from a number of M&W measuring equipment, all of which is beautifully made and finished, so perhaps it's time to treat yourself?

Machine DRO are also running offers on a range of other products including waterproof digital callipers, height gauges and remote readout angle gauges.

Full details are on their website www.machine-dro.co.uk where you can also sign up to receive news of future promotions by email.

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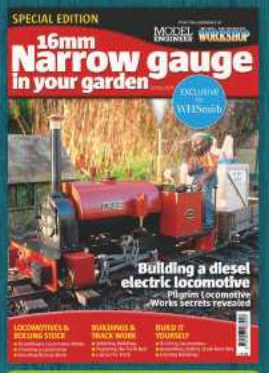

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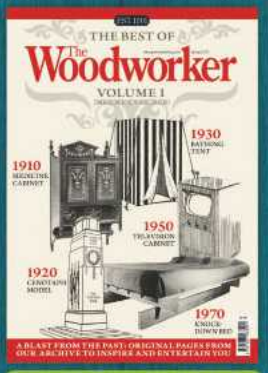

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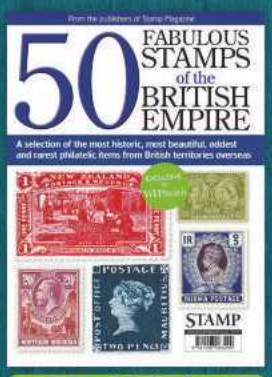

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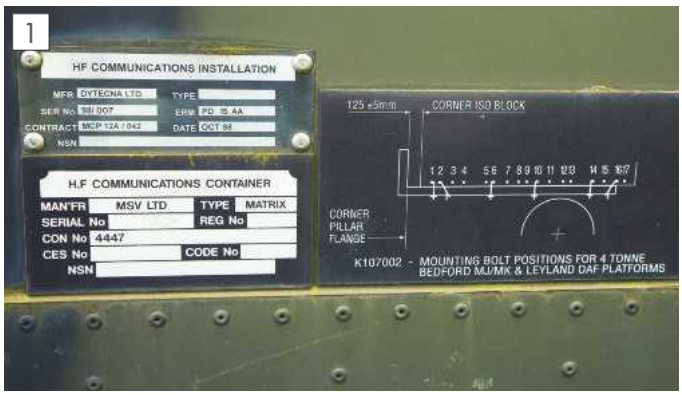
Workshop in a Can

Surely putting a portable workshop into place is a simple exercise – isn't it? Think again - Bob Reeve tells the tale.

A year or so ago, David Clark gave a reasonably comprehensive view of how readers might acquire or construct a structure which could be the basis for a Model Engineers Workshop. Recently, Pete, a long time friend and co conspirator, decided that he needed such a structure to augment his existing workshop: a substantial brick built structure housing his massive Colchester Triumph lathe and lots of other things that will all come in useful one day. His solution came as something of a surprise to me.



Information plates.

The requirement was that it should be reasonably small so as to be easy to heat in winter, yet large enough to house his Myford, a bench mill and a bench drill. More critically it needed to be installed quickly on a steeply sloping rural site so as not to impede other building works going on at the same time.

The proposed and actual solution was a workshop in a can. Admittedly a rather large can, declared surplus to requirements by the UK Ministry of Defence and made available to the general public via an agent dealing in such things at a price that wouldn't break the bank. The approximate dimensions are a footprint of 8 x 15 feet and 8 feet high. All that was required was some simple strip foundations and the usual services.

However, as this cunning plot was being hatched, the UK was facing its wettest February on record. It rained and rained and rained and although the strip foundations were laid, the large ash tree nearby was giving up its grip on the rain sodden ground and had to be felled. It was then cut up and needed to be moved out of the way. But the ground remained sodden for some time, the remains of the ash tree didn't move far and progress came to a halt until things improved.

Eventually the rain stopped, the sun shone and the proposed solution was delivered to the site. It was in fact a steel shipping container fitted out to be a HF communications equipment repair facility (**photo 1**). As might be expected it is very robust and has the standard mountings for transport on a Bedford or Leyland chassis plus a lot of other features that are not found in the usual run of hobbyist workshops (**photo 2**). But more of that later.

It now needed to be moved from where it was delivered on a sloping field about 50 m onto the prepared foundations (**photo 3**) down a steep grassy slope. Note the steepness of the slope provides a convenient site to store the remains of the ash tree.

The one very obvious downside was its weight. All up, it would have originally weighed in at about 4 tonnes, but less than that when stripped out for sale to the public. After that, very little of the weight is removable, the size was considerable and, with a steep grassy slope to negotiate, something more than a few rollers was required. Fortunately a 15 tonne track laying JCB was to hand (**photo 4**) which should have been capable of dealing with the weight and the steep slope, but not until a problem with the throttle cable had been fixed (**photo 5**)!

The container was hitched to the jib near the first joint using the eye provided. Even

As supplied.

Strip foundations.

with the bucket removed the load would have been too great with the jib fully extended (**photo 6**). It also helped control the load having it closer to the cab. Even so it was a little scary having such a large mass moving down the hill backwards (**photo 7**). Note that the container was roughly level, it is the ground that was not!

As the container approached its final resting place, there remained the tricky business of locating it on its foundations (**photo 8**) and levelling it (**photo 9**). Having settled the container on its new perch, there was just the trunk of the ash tree to deal with before access was clear and the facility was ready to commission. With the JCB still to hand that did not pose a problem (**photo 10**).

Once the obstructions were cleared the container could be made ready for its intended purpose. One of the more unusual features was that the workshop came complete with its own balcony which could be deployed when the sun


4

Track-laying JCB.


5

Fixing the throttle.

6

Ready for rigging the load.


7

On the move.

8

Positioning on foundations.

Having settled the container on its new perch, there was just the trunk of the ash tree to deal with before access was clear and the facility was ready to commission.


9

Levelling.


10

Removing the Ash Tree.

shone and the tea was about to be served by the in-house catering staff (**photo 11**).

Another feature is a small crane adjacent to the door and folding in such a way that loads can be swung through the doorway. The crane, of course, needs to be load tested before being declared safe to use. In this case the British Standard Small Person Test. Presumably it passed (**photo 12**)!

The only other external feature of note was the air conditioning system. In my experience, UK home workshops are not normally equipped with air conditioning and keeping the rain out has a much higher priority. The equipment is largely external and can be seen on the left in **photo 13** and with the access ladder provided in **photo 14**.

As befits its military origins this is an air conditioning unit with a few extras. The louvered panel can be removed to reveal a large air filter drum which includes a particulate filter to remove any dust or radio-active fallout and an activated charcoal section in case of a poison gas attack. All in all, probably the safest structure to be inside for miles around.

The downside of this defensive construction is that the door is air tight and there are no opening windows. The upside is that if it was necessary to concentrate on a particularly tricky piece

Open for business.

Load test.

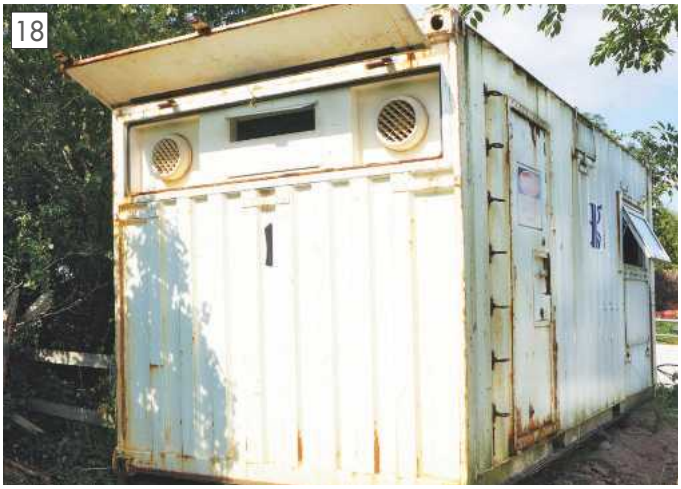
Air conditioning equipment.

Access provided.

Internal fittings.

Railway on the ceiling.

A safe place.



Also in white.

Even better equipped.

To complete the picture.

of machining it would take a lot to create a distraction outside.

The internal fittings are equally comprehensive. Starting with the insulation, this was within the double skin throughout. It will be interesting to see how it copes with a really cold winter. For hot summers the air conditioning should be more than adequate. There is a workbench and storage cupboards, plus a chair that can be clamped to the floor (**photo 15**). When the lathe is installed, that might come in useful if the job being turned is really out of balance and with an interrupted cut!

Fluorescent lighting is included (**photo16**) as well as red lighting (for covert night time machining?) and there are 240v and 24v circuits ready wired. The real surprise internally are the other fittings on the ceiling. These are features I would love in my own workshop. They comprise three overhead load carrying rails interconnected by a turntable arrangement that would look familiar (but upside down) to any railway enthusiast. Just the thing for moving a heavy universal dividing head out of its storage cupboard and on to the table of the milling machine.

I am also impressed by the facility shown in **photo 17**. This is the solution to the perennial problem of "I need a safe place to put this". However, I suspect the combination might cost extra.

Should you wish to acquire one of these units see **references 1** and **2** (I have no connection with either). Be aware that there are a variety of specifications which cover different sizes and a wide range of fittings not at all similar to the ones shown. For example those living in more northerly locations might find one in Arctic White fits in better with the surroundings (**photo 18**).

This one is an ex-Navy underwater sensors facility. It is noticeably larger, but in poorer condition than the previous one; but it was also half the price!. Note the built in access to the roof. A workshop with a roof garden would be possible.

On the other hand a batch came up recently each fitted with a Harrison M300 with all the accessories and ready to go (**photo 19**) and a better-than-average bench drill down the other end (**photo 20**). Needless to say the asking price reflected the extras fitted.

The downside of this defensive construction is that the door is air tight and there are no opening windows. The upside is that if it was necessary to concentrate on a particularly tricky piece of machining it would take a lot to create a distraction outside.

Which leads to the all important question of how much might it cost? The quick answer is about the cost of a decent used Myford. The first one pictured was £2000 plus delivery. It seems to me a very cost effective solution if this is what you want. ■

Acknowledgements

I am grateful to Bob Worsley of BW Electronics (http://bwelectronics.co.uk/) for permission to use photos 19 & 20.

REFERENCES

1. http://www.ramco.co.uk/sales/index.php
2. http://www.mod-sales.com/

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Happy Birthday to MEW

This summer marks the twenty-fifth anniversary on *Model Engineers' Workshop*. Founding editor, Stan Bray, remains a regular reader and wrote to me with his thoughts on this milestone:

Dear Neil, I really had no idea until I read it in *MEW* that the magazine is twenty five years old. Where have all those years gone?

It was interesting how it started, I had been on to the management for a couple of years to do it but nobody believed it would be a success. However I was asked to do a special on setting up a home workshop and it sold out in a matter of days. They were still not entirely convinced but finally agreed to allow me to start *MEW* as a quarterly publication. (Hence the fact that the early ones were not numbered) I had no copy at all to work with and it was a case of getting in the workshop and making things to use for articles. I also twisted the arms of a couple of friends to supply something. There could not of course be any series it not being practical with three months between issues. Anyway the first copy came out and sold out in two days so a reprint was done and that also sold out in a couple of days.

Management were still not convinced but when the same thing happened to the second issue they began to sit up and take notice. There was a larger print run for the third one and again they all went off the shelves, at which point the decision was made that it should be a monthly publication. This left me in an awkward position. There were still very few articles arriving and so I was doing most of those that appeared and I was also committed to *Model Engineer* with 'Bray's Bench' and 'Club Chat', as well as writing specials and these were not only on model engineering. I was living near Cambridge and having to travel to Hemel Hempstead on a fairly regular basis.

In those days computers were not the machines they are today and those that were available were using DOS so it was a case of typing all the copy. There was no digital photography, all pictures had to be carefully lit, exposure worked out and the camera carefully focused. Although the company had facilities for developing and printing I usually did that as well at home. These days the digital camera takes care of everything, exposure, focussing, framing, etc. In addition it is possible to make as many exposures as one wishes and select the best, there is no waste of film. You can also instantly see the result, no waiting to develop and print the film. There was no CAD and so drawings were done on the drawing board, using pen and ink which was all very time consuming.

With *MEW* becoming a monthly publication something had to give. Fortunately at this time Harold Hall had sent in a couple of very good articles and he lived in Hemel Hempstead. A first class engineer and draughtsman as well as an expert photographer, he was just the man that was needed. Realising that I couldn't do everything I asked him if he was interested in taking over *MEW*, he was and the rest is history.

Well the story has gone on a bit but that is how it all started, you know the rest. I am quite sure that the magazine is in excellent hands.

As far as doing some articles is concerned I will make no promises, but just say perhaps. I am part of the old brigade that worked with files and hammers and although I have tried to keep up with modern methods I am not certain that I have a place in today's model engineering.

Stan Bray

If you want to learn more about the history (and a bit about the future) of MEW, *look out for the* 25 Years of Model Engineers' Workshop *special which is on sale now 'from all good newsagents'. It's packed with some of the best articles from the past, with ten classic designs to make, including Harold Hall's popular grinding rest.*

Topiary Tribulation

Dear Neil, can you help me? I'm looking for an engineering company or individual to complete a small project I started involving a battery powered hedgetrimmer. The blade and gearbox are made but it needs a lightweight spine to keep the blade rigid. A bridge section holding the blade, motor and handles is required. The handles are articulated and house the trigger so some design is needed. Also they need to source a suitable pancake motor and a compatible battery (backpack) and make the link piece between the motor and spur gear and put it all together. All of the local firms I've asked can't do it or don't get back to me. So if you know anyone who can do this sort of thing I would be grateful. I live in St Leonard's on Sea in East Sussex so nearer to there would be better for the travelling.

R.W. Harris

Sweet Solution

I have read with interest the suggestions for rust removal that appeared throughout last year. Here is another one!

An approximately 50/50 mix of water and molasses (obtained from a local rural supply business) in a suitable plastic container does an excellent job. I am currently using a 20 litre bucket with a lid which is about ⅔ full of the mixture. For no other reason than the lack of an excess of shed space, this sits outside and seems to performer equally well in summer and winter (occasionally down to -8 Celsius overnight) although immersion times in winter may need to be extended a little.

I wire the part requiring treatment, lower it into the mixture and hook the end of the wire over the rim of the bucket where the lid will hold it in place and keep the rain out. A week later the part will have a black coating which I hose off before cleaning the part with a bench grinder mounted wire wheel. Sometimes a second treatment is required. My current concoction has maintained its effectiveness over last two years.

While not certain, it seems to me that only the rust is affected. As an indication of the effectiveness of this method, I have attached a photo of a half treated part together with one of a spanner which was subject to some very aggressive/active rust and required two treatments.

Although the solution does not appear to be caustic, the usual safety precautions should be observed, including the use of good quality rubber gloves (probably not at the wire wheel) to prevent your hands being stained black. The mixture itself produces mould which I scoop off the surface now and then, bag and add to the household garbage bin.

The first time I saw this process in action it was being used to strip the rust from a 1950's Chevrolet mudguard using a wooden crate lined with black plastic sheet ... so the size of the part is not an issue.

This molasses mixture will kill grass and no doubt other plants so methinks it might not be a good idea to throw it on your garden!

Russell Nicholson, Armidale NSW, Australia

Quick Change Artist

Dear Neil, when I took delivery of my Warco WM280V-F lathe in April 2013 I also ordered and fitted a piston type Quick Change Tool Post holder. My method was much like that described in the March 2015 article by John Ashton, however I did not think that a nut was the appropriate method for setting the tool post orientation.

I could not envisage ever re-fitting the original tool post so elected to modify the top screw assembly by boring it out and tapping it M14 x 1.5mm by 20mm deep using a plug tap. I turned the tool post down such that it is 100mm above the base, and opened up the original tool post spacer/washer to 14.5mm diameter.

The original tool post handle was fitted to the QCTP securing nut and the piston tool handle fitted to the modified top securing nut.

The result can be clearly seen in the accompanying photographs which I consider to be a much more practical and elegant solution enabling rapid and easy changes to be made.

Barry Chamberlain

Chain Gang

Dear Neil, I note with interest the article by Peter Wilton on page 28 of *MEW* for February 2015. It is an ingenious solution for a problem most of us amateurs have when using chain drilling for cutting out an interior piece of metal. My method has always been a bit rough and ready. Could I suggest making the jig simpler by having the two holes in the jig at the required centre distance apart and making two silver steel punches, one longer than the other and both with hardened points? If one is fixed with a grub screw and the other free to slide, then having scribed the concentric circles or lines, it will be a simple matter to mark where all the holes are to be drilled. This suggestion would also mean that only two punches would be required for different size holes and just a new block to hold them.

Could I suggest making the jig simpler by having the two holes in the jig at the required centre distance apart and making two silver steel punches, one longer than the other and both with hardened points?

Some years ago I made up a simple jig for marking the centreline on a piece of plate and centre punching holes if required. This consists of body which is a piece of round mild steel ⅝ inch diameter by ½ inch long. It has three holes drilled in it and these MUST be accurately spaced and must be exactly on the diameter. Each is ⅛ inch diameter, the outer two about ⅛ inch deep and into these are pressed or loctited ⅛ inch pieces of silver steel or mild steel round. The centre one is reamed ⅛ inch diameter for about ¼ inch and then ¼ inch diameter for the rest to accommodate the shank of the punch. The punch is made from a piece of silver steel 1.5 inch long by ¼ inch diameter, sixty degree point must be accurately machined so that it is concentric with the shank. It is hardened and tempered to a light straw at the point. The design can be used on the edge of bar stock up to 7/16 inch wide. (On flat stock also to that width.) The dimensions can be adjusted to suit larger material. In use it is simply placed on the bar and twisted so that both pins are firmly held against the bar and used a centre punch or scriber.

I must stress that I do not know if this is an original design but cannot recall seeing anything like it in my experience.

Peter Brown, Orange, NSW Australia

English as She is Spoke

Dear Neil, the recent discussion on the word, 'harridge' invoked certain memories of when I was an apprentice to a large railway wagon works about twelve miles away from Huddersfield in Horbury and generally referred to a built up edge caused by machining.

It was probably a general engineering term in the early sixties and even today, I still refer to a built up edge as an 'arridge', (drop the H).

On a similar note, most of us will own a deburring tool and which is known simply as that but at another engineering company I worked for, (I was still a lad then and prone to lark about), a fellow workmate asked if I'd hidden his 'hurdy gurdy', which I hadn't, but not having heard of this tool before asked him what it was. It transpired it was now known to be the popular 'Noga' deburring tool and he gave a brief account of why he called it so.

"You use it by turning it in a clockwise direction, like the organ grinder did when he was making music in the street umpteen years ago". He explained.

The word stuck and at another company I worked for, when I asked for a hurdy gurdy to remove a sharp edge on a workpiece, the foreman looked baffled. The name though, soon caught on throughout the firm which gave rise to an amusing incident when the youngest of the team was asked to nip up to the local tool distributors, (Dixon Hall), for a couple of drills plus a couple of hurdy gurdy's, which was how it was written on the works order.

The poor lad must have been put in a very embarrassing position when stood in a queue and asked to explain what the **** is one of those?

It would be interesting to find out if this term has also been used in other areas.

John Calvert

We would love to hear your comments, questions and feedback about MEW

Write to The Editor, Neil Wyatt, Model Engineers' Workshop, MyTimeMedia Ltd., Enterprise House, Enterprise Way, Edenbridge, Kent TN8 6HF. Alternatively, email: neil.wyatt@mytimemedia.com

It's not often that we print articles that have appeared elsewhere, but in this issue we are going to make a modest exception to this rule. My attention was drawn to some information that had been 'doing the rounds' on the internet about tests of different penetrating oils and their ability to loosen badly rusted nuts and bolts. Having battled this particular challenge more times than I care to remember, I felt that this was a certainly something worth sharing with readers.

After a little searching it turned out that the original article, by Lloyd Bender, was published in the April 2007 issue of our American contemporary, *Machinists' Workshop*. The author is keen for the information to be shared as widely as possible, so I'd like to thank Lloyd and George Bulliss, editor of *Machinist's Workshop* for their kind permission to reproduce it here.

Naturally the selection of 'off the shelf' penetrating oils is a little different from what readers in the UK or elsewhere might find at their local motor factors, but no doubt a similar diversity of results could be expected. The 'homebrew' recipe is now well tested, but many users have reported that automatic transmission fluid (or power steering fluid) don't mix very well so shake the mixture well before use!

Neil Wyatt

Penetrating Oils on Test

Lloyd Bender in the USA tested some penetrating oils and came to some interesting conclusions.

A question that is often raised by mechanics is the effectiveness of penetrating oils in loosening rusted fasteners. Do the commercial products really loosen bolts and, if so, which one works the best? To find out, four of these (Kano Kroil, Liquid Wrench, PB Blaster, and WD-40) were tested for performance along with a home brew mix of one part power steering fluid with one part acetone.

Natural exposure would be representative of real world applications, but requires a very long time and a number of replicate samples to handle the wide sample-to-sample scatter encountered in natural exposure. Using artificially accelerated corrosion reduces the time required and provides nearly identical test samples. The testing done was not on bolts, since I don't have access to equipment for measuring the torque on threaded fasteners, but can measure the load on a sliding fit.

So you can decide if this was a fair test, this is what I did. A ⅝ diameter rod of cold finished low carbon steel was lathe drilled, parted off in 0.50" lengths, and numbered sequentially. Each length was individually reamed to 0.250 inches. All pieces along with commercial ground ¼ x 1 inch dowel pins were ultrasonically cleaned together for twenty minutes in methanol to remove all machining fluid and oil. A dowel was inserted into each length using light finger pressure leaving ¼ inch of dowel exposed at each end. Years of exposure were simulated by twelve hours of alternate immersion using ten minutes in a 3% solution of NaCl (table salt) followed by 50 minutes of drying in 105°F air.

The corroded samples were randomly divided into five groups as shown in photo 1 plus one control group left as-corroded. One fluid ounce of penetrating oil was used to immerse each group of three samples for a period of twelve hours. Samples were then drained on paper towels to remove the excess oil for ease in handling. A Baldwin compressometer on 1200-pound scale was used to determine the load required to move the dowel pin. This was done in numerical sequence in a single blind test -- samples only identified by number and not with the penetrating oil used.

Penetrating oil	Average load	Price per fluid ounce
PSF / Acetone Mix	53 pounds	$0.10
Kano Kroil	106 pounds	$0.75
Liquid Wrench	127 pounds	$0.21
PB Blaster	214 pounds	$0.35
WD-40	238 pounds	$0.25
None	516 pounds	--------

The first and foremost conclusion I reached from the results -- any oil is better than trying to strong-arm things apart dry. These products actually do free up rusted parts. The price and performance of mixing your own penetrating oil is interesting, but keep in mind that most of the cost in the commercial products comes from the easy applicator can. If you have the time and opportunity for soaking overnight, the home brew method appears to be a winner.

By the way, on the subject of cost, the price quoted is what I paid locally to obtain the minimum quantity possible. Buying in bulk and shopping around can reduce the price of the commercial penetrating oils substantially.

A discussion of this article is archived at: http://www.homeshopmachinist.net/bbs/showthread.php?t=20589 ■

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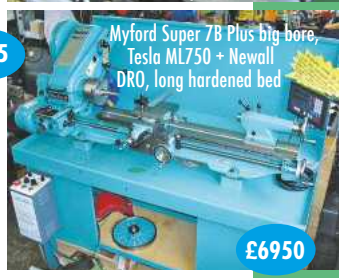

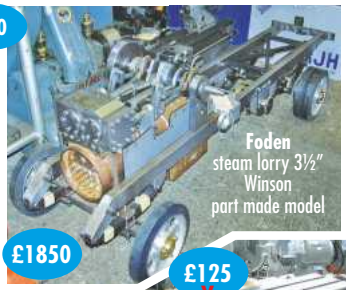

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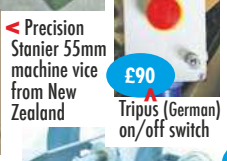

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