No.228

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MODEL ENGINEERS' WORKSHOP

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Wabeco Lathe D6000E

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- Centre Height – 135mm
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- Power – 1.4 KW
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Wabeco Lathe D4000E

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- Speed – 30 to 2300rpm
- Power – 1.4 KW
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Wabeco CNC Mill CC-F1410E

- Table – 700 x 180mm
- Z axis – 280mm
- Speed – 140 to 3000rpm
- Power – 1.4 KW
- Size – 950 x 600 x 950mm
- Weight – 122Kg
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MODEL ENGINEERS' WORKSHOP

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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mytimemedia
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

More Stuff

This is the second of your new, longer issues of *MEW*. I'm pleased to be able to include a really great range of practical articles. The only issue is that, as the magazine gets bigger, I am finding more short spaces to fill. If you have ever thought of writing for *MEW* and have been put off by the thought of writing a long missive, why not write up a 'quicky'? I particularly need articles that are a bit more substantial than a readers tip up to about two pages long. As a guide, a two-page article might be about 1500 words and six pictures. If you are interested drop me an email at **neil.wyatt@mytimemedia.com** and I will send you the author guidelines.

Get Snapping

I make no apologies for plugging our 25th anniversary photo competition again. As well as giving you the opportunity to win some great prizes, I'm hoping it will give me the opportunity to publish some great photos. I have had a few queries about what the 'spirit of home engineering' actually means – well that's really up to you! I'm hoping for pictures that show what people actually do in their workshops rather than just a 'this is my workshop' shot. So, people using machines, machines actually at work or particularly interesting or eyecatching setups or devices.

Even non-winning pictures will still get a chance to be used as the magazine cover, for which we will pay a standard fee.

Readers Tips

One part of the magazine that has no shortage of ideas is the Reader's Tips page, sponsored by Chester Machine Tools. I've decided to increase the usual number of tips published to three and have been able to widen the range of runner up prizes. I want to make one plea, though – please remember to send me your address with your tip, it does make sending winners a prize easier!

A good proportion of the tips I receive come from established *MEW* authors, but I'm sure that many other readers have equally great ideas, so put on your thinking cap and send me your tips!

Metrinch

I must give a special name-check to Peter Lawrence; Peter called to give me chapter and verse on all the havoc that the proposals for the Metrinch will cause. Once I had pointed out that number 228 was our April Issue, he was delighted to discover, not the hoax, but that he was the first 'victim'! Subsequently, I received a steady trickle of emails and the occasional call on the subject which I gently directed to the discussion of the topic at www.mode-engineer.co.uk, where, hopefully, the true status of the matter was clear. Oddly enough, in the discussion it came up that in July 1959 the UK yard grew slightly, and the USA yard shrank by slightly more to make them both exactly 0.9144 metres. The irony is that this means no matter how much we love our imperial units – they are already defined in terms of a metric standard!

My apologies to anyone who has disposed of their workshop measuring equipment in anticipation of the change.

25 YEARS OF MODEL ENGINEERS' WORKSHOP

Putting together this month's issue has been more frantic than usual, as I've also been working on a celebratory 'special' to mark *MEW's* first quarter century. I have probably broken the record for speed reading magazines, with the result that *25 years of Model Engineers' Workshop* will contain an excellent and varied selection of articles. Some time ago I asked what people would like to see, and it was clear that Harold Hall's grinding rest would have to be there! Other self-contained tool builds include a 4-jaw chuck, a precision level and a tangential tool – amongst many more. There's also a primer on arc welding and an introduction to four-facet drill grinding including designs for a suitable jig. On top of this there are reflections on the past, present and future of *MEW*. All in all, I am sure that the special will be a real treat for every *MEW* reader, with plenty of ideas and food for thought.

arcPremium»

Micro-Grain Carbide End Mills

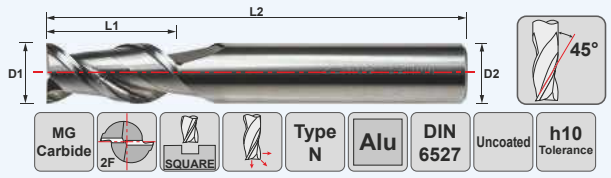
Uncoated Carbide End Mills

Arc Premium Uncoated end mills are specially ground for milling aluminium. Sharper cutting edges are possible with uncoated end mills. Also, where indicated, the higher helix angle of 45° helps to evacuate the chips quickly thus reducing the amount of heat generated and producing a good surface finish. Arc Premium Uncoated end mills are ideal for machining aluminium, brass, plastics and other non-ferrous materials.

TiAlN Coated Carbide End Mills

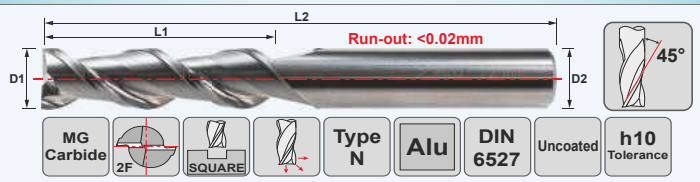
Arc Premium TiAlN coated end mills are coated with the highly regarded Balzers Balinit® Futura Nano TiAlN (titanium aluminium nitride) coating offering high-performance machining and long tool life. Depending upon machine limitations, TiAlN coated end mills can operate at speeds up to 100% higher than uncoated end mills. Arc Premium TiAlN coated end mills are recommended for machining steel, cast iron and stainless steel.

2 Flute Carbide End Mill For Aluminium Std. Length Uncoated



Code	Cutter Diameter D1	Shank Diameter D2	Flute Length L1	Overall Length L2	Price
060-284-05002	2.0mm	6.0mm	8mm	57mm	£7.50
060-284-05003	3.0mm	6.0mm	8mm	57mm	£7.50
060-284-05004	4.0mm	6.0mm	11mm	57mm	£7.50
060-284-05005	5.0mm	6.0mm	13mm	57mm	£7.50
060-284-05006	6.0mm	6.0mm	13mm	57mm	£7.50
060-284-05008	8.0mm	8.0mm	19mm	63mm	£12.00
060-284-05010	10.0mm	10.0mm	22mm	72mm	£18.50
060-284-05012	12.0mm	12.0mm	26mm	83mm	£23.00

2 Flute Carbide End Mill For Aluminium Long Series Uncoated



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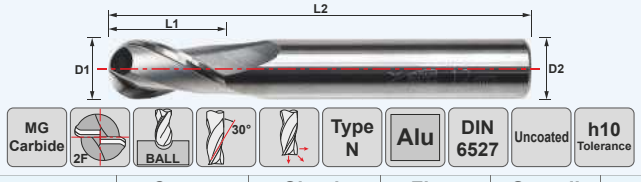
060-284-06002	2.0mm	4.0mm	8mm	60mm	£9.85
060-284-06003	3.0mm	4.0mm	12mm	60mm	£9.85
060-284-06004	4.0mm	4.0mm	15mm	60mm	£9.85
060-284-06005	5.0mm	6.0mm	25mm	75mm	£13.50
060-284-06006	6.0mm	6.0mm	25mm	75mm	£13.50
060-284-06008	8.0mm	8.0mm	30mm	75mm	£19.25
060-284-06010	10.0mm	10.0mm	40mm	100mm	£29.95
060-284-06012	12.0mm	12.0mm	45mm	100mm	£39.95

2 Flute Carbide Ball Nose End Mill For Aluminium Standard Length Uncoated



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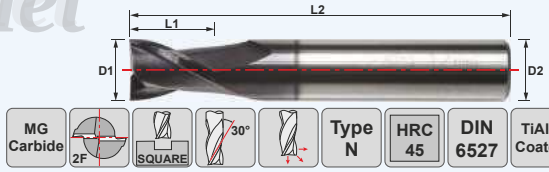
060-284-07004	4.0mm	6.0mm	11mm	57mm	£12.25
060-284-07005	5.0mm	6.0mm	13mm	57mm	£12.25
060-284-07006	6.0mm	6.0mm	13mm	57mm	£12.25
060-284-07008	8.0mm	8.0mm	16mm	63mm	£17.50
060-284-07010	10.0mm	10.0mm	19mm	72mm	£24.50
060-284-07012	12.0mm	12.0mm	22mm	83mm	£31.25

2 Flute Carbide End Mill Stub Length TiAlN Coated



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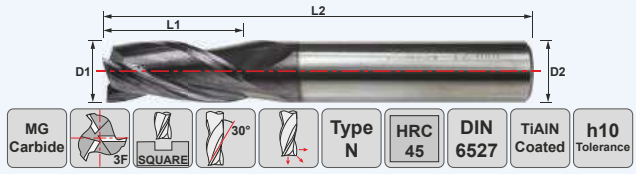
060-284-01001	1.0mm	3.0mm	3mm	38mm	£7.97
060-284-01002	2.0mm	3.0mm	3mm	38mm	£7.20
060-284-01003	3.0mm	3.0mm	4mm	38mm	£7.20
060-284-01004	4.0mm	4.0mm	6mm	50mm	£7.80
060-284-01005	5.0mm	5.0mm	8mm	50mm	£7.80
060-284-01006	6.0mm	6.0mm	10mm	54mm	£8.90
060-284-01008	8.0mm	8.0mm	12mm	58mm	£14.00
060-284-01010	10.0mm	10.0mm	14mm	66mm	£20.00
060-284-01012	12.0mm	12.0mm	16mm	73mm	£27.00

3 Flute Carbide End Mill Standard Length TiAlN Coated



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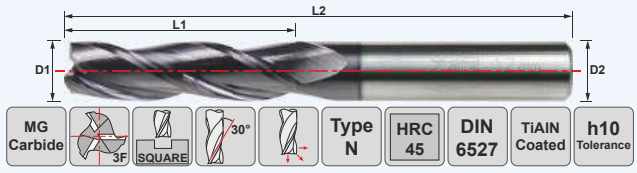
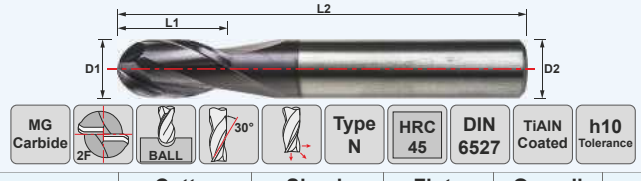
060-284-02001	1.0mm	3.0mm	3mm	38mm	£8.17
060-284-02002	2.0mm	3.0mm	6mm	38mm	£7.40
060-284-02003	3.0mm	3.0mm	7mm	38mm	£7.40
060-284-02004	4.0mm	4.0mm	10mm	50mm	£8.00
060-284-02005	5.0mm	5.0mm	11mm	50mm	£8.00
060-284-02006	6.0mm	6.0mm	13mm	57mm	£9.10
060-284-02008	8.0mm	8.0mm	19mm	63mm	£14.20
060-284-02010	10.0mm	10.0mm	22mm	72mm	£20.50
060-284-02012	12.0mm	12.0mm	26mm	83mm	£28.30

3 Flute Carbide End Mill Long Series TiAlN Coated



Code	Cutter Diameter D1	Shank Diameter D2	Flute Length L1	Overall Length L2	Price
060-284-03003	3.0mm	3.0mm	15mm	57mm	£9.50
060-284-03004	4.0mm	4.0mm	19mm	57mm	£10.20
060-284-03005	5.0mm	5.0mm	25mm	63mm	£12.25
060-284-03006	6.0mm	6.0mm	25mm	75mm	£14.50
060-284-03008	8.0mm	8.0mm	30mm	75mm	£18.95
060-284-03010	10.0mm	10.0mm	35mm	75mm	£24.50
060-284-03012	12.0mm	12.0mm	45mm	100mm	£39.50

2 Flute Carbide Ball Nose End Mill Std. Length TiAlN Coated



Code	Cutter Diameter D1	Shank Diameter D2	Flute Length L1	Overall Length L2	Price
060-284-04001	1.0mm	3.0mm	3mm	38mm	£9.95
060-284-04002	2.0mm	3.0mm	6mm	38mm	£8.95
060-284-04003	3.0mm	3.0mm	7mm	38mm	£8.95
060-284-04004	4.0mm	4.0mm	10mm	50mm	£9.50
060-284-04005	5.0mm	5.0mm	11mm	50mm	£10.90
060-284-04006	6.0mm	6.0mm	13mm	57mm	£11.30
060-284-04008	8.0mm	8.0mm	16mm	63mm	£18.40
060-284-04010	10.0mm	10.0mm	19mm	72mm	£25.50
060-284-04012	12.0mm	12.0mm	22mm	83mm	£35.00

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See review in MEW 228

EMG-12
End Mill Re-Sharpening Module

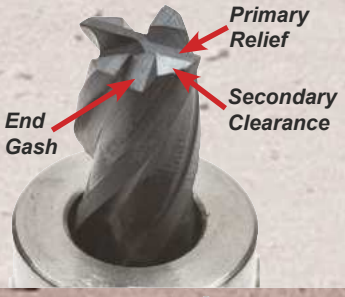
Fast: Re-Sharpening in under 3 minutes
Portable: Weight under 7kg
Small: Size under 29cm (1ft.) cube

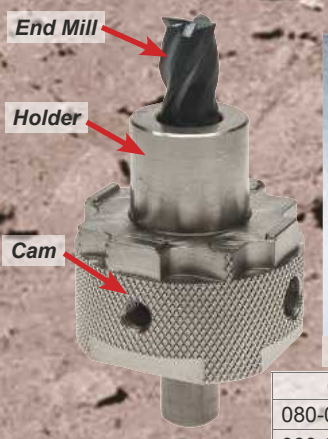
The EMG-12 Re-Sharpening Module is an end mill grinder and is used for re-sharpening the axial cutting edges on the end of carbide and HSS end mills.

The EMG-12 will re-sharpen both normal and centre cutting 2, 3, and 4 flute end mills between 2mm & 12mm diameter.

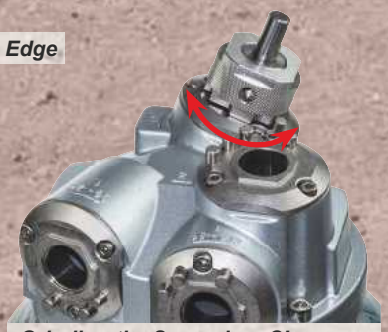
The built-in tool setting jig (on the right of the module) is used to set the tool length and flute orientation prior to grinding.

Once the end mill is correctly set in the holder/cam assembly, the various angles are ground by simply rotating the cam assembly back and forth in the ports on the top and front of the module. A specially profiled SDC or CBN grinding wheel takes care of the rest. The SDC diamond grinding wheel (for carbide) is pre-installed inside the module. A CBN grinding wheel (for HSS) is available as an optional accessory.





Setting the Flute Orientation



Grinding the Secondary Clearance

Grinding the Gash

Code	Description	Normal Price Inc. VAT	Introductory Price Inc. VAT*	Carriage
080-060-10100	ERM-12 End Mill Re-Sharpening Module	£850.00	£798.00	£10.00
080-060-10101	ERM-12 SDC Grinding Wheel (for carbide)	£63.00	£60.00	FREE
080-060-10102	ERM-12 CBN Grinding Wheel (for HSS)	£63.00	£60.00	FREE

* Introductory price valid until 31st May 2015 subject to availability. Carriage rate to UK mainland only. E.& O.E.

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UNBEATABLE VALUE ENGINEERING PRODUCTS

Contents

Coming up...

in the June issue

HEAVY METAL

Cameron MacKeown describes a robust headstock extender made to increase the capacity of his lathe. This ambitious project has greatly increased the capacity of his far-eastern machine.

PLUS In response to many requests for a simple 12 volt motor controller *Inchanga* offers a robust and up to date design, Mark Frampton introduces his spring parallels for use with a milling vice and Martin Widdowson describes a camlock topslide for mini-lathes.

Regulars

ON THE COVER

The EMG-12 from Arc Euro Trade has a familiar look to it, but it offers a very new way of sharpening your end mills.

Visit our Website

for extra content and our online forum

www.model-engineer.co.uk

The Model Engineers' Workshop 25th Anniversary Photo Competition

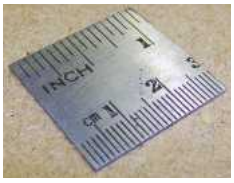
Come on get snapping! Great prizes and great fun – take a shot that captures 'the spirit of home engineering' – however you define it! Head to the 'Workshop' section of the www.model-engineer.co.uk website for full details of the rules and how to enter.

Latest Events

Do you fancy an engineering day out with like minded people? The website has an online calendar of Steam rallies and model engineering club open days, which you can also automatically link to an outlook or online calendar using the Ical button. If you want full details of minor events such as club running dates, just click the link for a more detailed PDF list.

Some of the other live topics on the forum include:

- Forgotten engineering techniques - passing on old toolroom secrets and more.
- Learning to love the metrinch? Our April spoof set off some interesting discussion – see it here!



- What did you do today? – Come on, we are waiting to find out!
- Positioning a lathe – so just where *IS* the best place for it to be?

One Small Step for Man

One giant leap for the home workshop! *Sorry – I got carried away.*

John Stevenson introduces the new EMG-12 End Mill Re-Sharpening Module from Arc Euro Trade.

For years model engineers have been fascinated with tool and cutter grinders, from the simple to the complex. It's probably true to say that a tool and cutter grinder is high on the list of machines to own, when budgets permit, or you can get around to it.

The EMG-12 Module.

There are many simple kits out there like the Kennet, Worden, Stent and others, leading up to the ultimate, The Quorn, which has often been described as the holy grail of Model Engineers.

When considering a kit, there are several challenges to overcome. Do I want to build it? Can I build it and how long will it take for me to build it? Time and cost probably don't come into it too much, I suppose, as you are building it for your own pleasure.

Once you have built it, how easy or difficult is it to use? Some of the kits are straight forward, leading up to the more complex processes involved with kits like the Quorn. Setting up time can either be described as interesting if you like the thinking process, or time consuming, if all that you really wanted to do was to re-sharpen an end mill quickly.

Now let's take the staple diet of a milling machine which is end mills or slot drills. Unless you are squaring up big blocks of material you only use the last 1mm up to ~4mm of a cutter, depending on the size and rigidity of the machine, so in theory if you were able to keep this last bit sharp then the cutter would have a very long life.

Cutters fail because they degrade on the cutting edge and being human we always try to get the utmost out of one, so as it degrades you need more force to push the cutter through the work. This starts a vicious circle because it degrades more, you need more force which again degrades even more, then BANG! 'Damn - who'd have thought that?'

R.I.P that cutter which, with care should have lasted years, but care costs money, be it sending out for regrind or getting the kit made Quorn out for the mental challenge ahead.

Now as some readers and members of the M.E. forum know, I run a bodging shop, sorry jobbing shop, for a living. I also own a commercial tool and cutter grinder, similar to a Clarkson, bought new 20-odd years ago and its probably only got less than 10 hours on it in all that time. The truth is that at commercial rates I cannot afford to use it.

Last year I was over in China for the best part of a month with Ketan from Arc Euro Trade doing various factory tours and shows. This has to be done as it's the only way to ensure some quality control, as working by email or phone will not achieve the same thing. At one factory we visited they were producing all sorts of projects from large machining centers for wind turbines to small tooling. Unlike hobby machines none of this was built to a price, only to a quality. There's not much point trying to save 10 Yuan on a slide way grinder with a travel of 68 metres!

This factory was that large they even built their own CNC machining centres for their own use, as well as various other machines.

One of the machines that caught my eye was a range of end mill grinders. Each machining centre had one of these and the operator after swapping tools, sharpened the end up and replaced it in the carousel. The part that interested me was the speed at which he did this. Basically he picked a cutter up, put it in a holder, poked it into 3 holes on the machine and that was it. So in typical Stevo fashion, learnt off Yosser in the TV program *Boys from the Black Stuff*, I asked 'Gizzago!'

The operator showed me how to use it'. Remember he's got no English and I don't think I'd have got far with the three Chinese words I know, so basically hand

2

It's possible to get carried away sharpening cutters.

3

The collets and cams supplied as standard.

signals. Now my turn, got it first go, but slow having to feel my way through. So I signalled for another cutter. Phone out, stop watch on and for a 12mm, 3 flute cutter it took 58 seconds. Did I mention I was in love with this machine?

Later on that day discussing machines and orders and I asked about these grinders, just a basic question like 'How much?' I should have asked 'How MUCH!!!???' Just let's say if that you have to ask you can't afford.

After more talks and bearing in mind their grinders were far bigger than the average home shop needs, let alone can, afford they offered a smaller version and that is what you see in the picture. I have no idea whose idea it was to make it look like a lunar lander, it certainly wasn't ours and their commercial versions are large cast boxes but after all the tittering in the back seats, it works, and works well.

We specified cutters from 3mm to 12mm in 2, 3 or 4 flutes and they must be either conventional 4-flute with the clearance hole in and/or centre cutting. They came up with 2mm to 12mm in normal or centre cutting. It will grind carbide and HSS. The unit weighs just under 7kg or 15 pounds. The size is just under 29cm cube or a foot cube.

It ships with an electroplated diamond wheel but CBN wheels are also available. I have no idea on the life of the wheel. I have had the prototype machine for about 6 months [up till mid-March] and for the first 3 months I only used the diamond wheel grinding everything whilst I was waiting for the CBN wheel to arrive. During that time it has done in excess of 400 cutters and when I came to swap it for the CBN to do a load of HSS cutters I could see no wear (**photo 2**).

Over Christmas I swapped it back to a Diamond wheel and went to visit some friends down in Welsh Wales as I'd offered to show it them and also grind some cutters up. It turned out that most were HSS but these electroplated wheels don't seem to suffer like the resin coated wheels, also they are coarser than you would think. Anyway over a period of 2½ days we sharpened every cutter he owned, 175 in total. Everyone who has seen and tried this machine has been amazed at how quick and how good a job it does.

It takes between 5 and 10 minutes to train someone up to use it. There are two very simple setting operations, cutter height and tooth location. Both of these are done with a simple inbuilt setting jig and that's all there is to set the cutter. Two Allen keys are supplied with the machine and that's all you need as regards tooling, one is for setting the cutters the other is for changing a wheel which is a five minute job. The wheels are special to the machine as all the angles are built into the wheel and the cams.

The machine comes with a set of 7 holders 3, 4, 5, 6, 8, 10, and 12mm as well as 24 cams, all in a very nice aluminum padded and profiled box with all the sizes printed on the foam insert (**photo 2**).

There are 8 cams for 2 flute cutters in 2, 3, 4, 5, 6, 8, 10, and 12mm sizes and the same for 3 flute and for 4 flute. There is no 2mm holder as they assume the 2mm will be on a 3mm or 6mm shank. You can play mix and match using, say, a 6mm holder but 3mm cam. There are no holders for imperial cutters as it's a metric machine but they are very easy to make as the holder is just a piece of 20mm steel with a grub screw hole in and bored to suit whatever cutter you need.

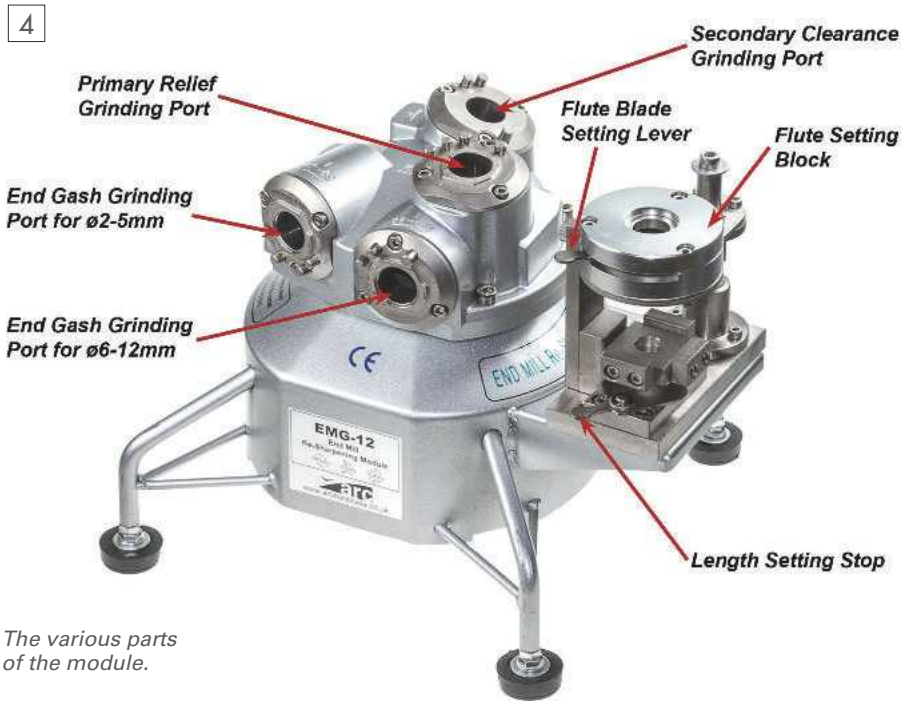
A ¼ inch holder would be used with a 6mm cam as it's the closest size, ⅜ inch with a 10mm cam and ½ inch with a 12mm cam. The differences between a 10mm cam and a 12mm cam are not visible with the eye, they are that subtle. Where the skill would be with the operator on a T&C grinder, the skill here is built into the machine. The machine has a die cast alloy body with hardened steel inserts where the cams and holders fit and these are also hardened for long life.

The surround and legs are pressed/tubular steel and the motor is a 3 phase brushless unit that works off its own single phase power unit that plugs into the back via a 4 pin plug.

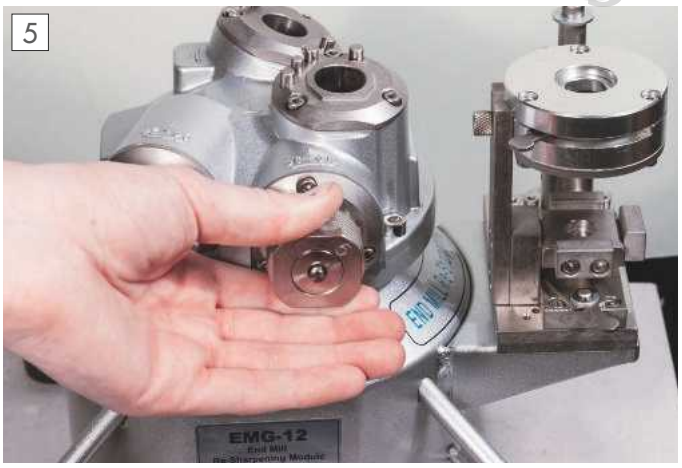
The manual has been put together here in the UK by people actually using it and saying what they are doing and has then been translated from my Ilson dialect into proper English and clear concise pictures taken of each operation.

Looking at the machine in **photo 3** you can see that it has four ports in it to take the cutter but you only use three. The two horizontal ones at the front are nearly duplicates. These ports do the gashing of the flutes for centre cutting (**photo 4**). The left hand one does 2mm to 5mm and the right hand side one does 6mm to 12mm.

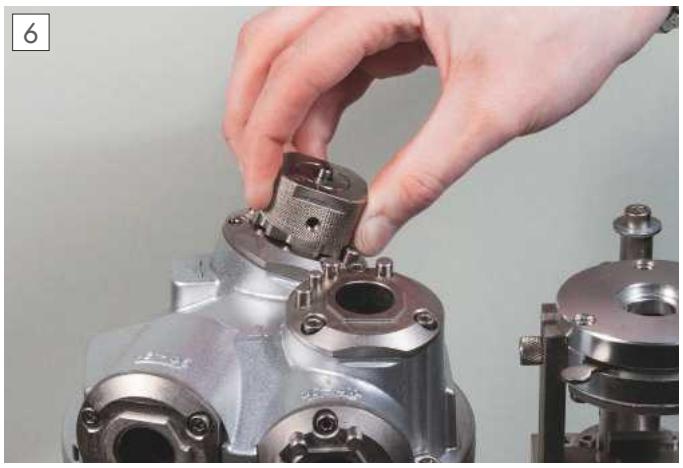
4



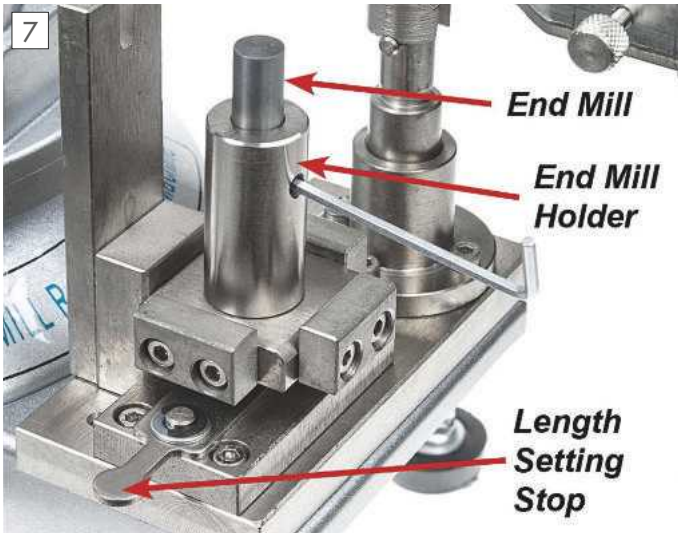
The various parts of the module.



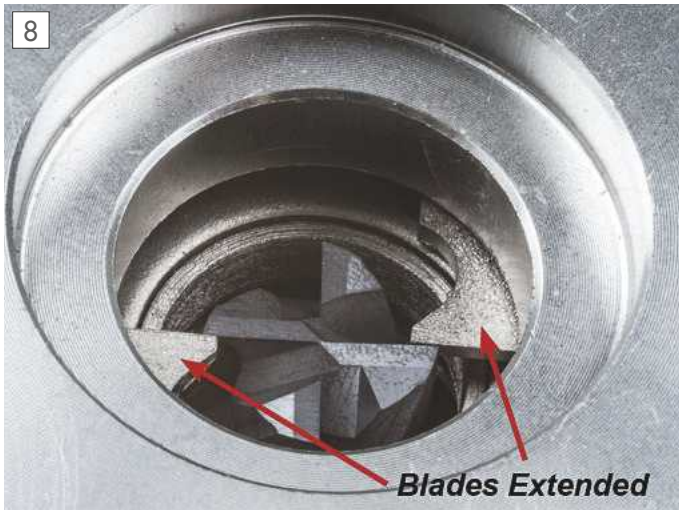
Gashing a cutter.



Putting on the secondary clearance.



Using the depth setting jig.



Aligning the flutes.

Both are clearly marked with raised die cast numbers. The port above does the primary grind and the far one does the secondary or clearance grind (**photo 5**).

To set the machine you place the cutter into the holder, cutting edge down so it sits onto a length setting stop and the grub screw is tightened up (**photo 6**). The cam is then fitted to the holder once it has been reversed and the flute setting block swung over and the longest cutting edge is rotated so it sits in the 3 o'clock position and then the cam grub screw is tightened and that is all the setting required (**photo 7**).

Each cam has index lugs on it equal to the number of flutes and these are then positioned between the relevant pins on each port and with the wheel running the holder and cam is pushed in and rocked between the pins until it stops cutting. This is done for each flute in turn and then you move on to the next port.

As you can see there are hardened pins on each of the ports. Two of the pins are for locating the cam so it is in the correct position; the other pins are just stop pins so none of the three different cams can be inserted incorrectly.

It really is a very easy machine to use but more importantly because of the lack of skill needed to operate this and the speed it can do a whole selection of popular cutters it can save a lot of money. The first 17 solid carbide cutters I reground came out of the carbide/HSS scrap box where badly damaged or broken cutters live before being converted into slotting tools or fly cutters. All these required cutting back with a carbide slitting saw to get rid of broken flutes but the machine can handle a cutter with a blank end, i.e. no original cutting edges left.

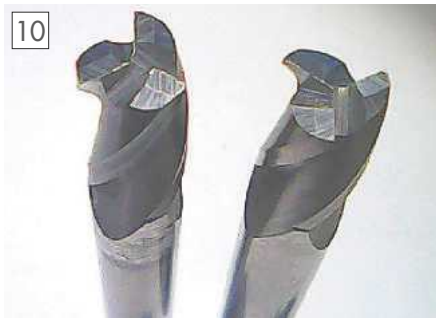
Photograph 8 shows a close up of two 8mm cutters, one is worn with the typical wear damage and the other has been backed off to get rid of damage. **Photograph 9** shows a close up of the same two cutters after grinding. I must apologise for these last two pictures as they were taken at x5 magnification under a USB microscope and the quality of the lighting could be better. What looks like flaking of the edges are actually minute burrs thrown up by the wheel. To the naked eye they look perfect.

With the OK from Ketan at Arc Euro Trade, I will be taking this machine to the Harrogate show for the whole of the three days. The Harrogate show, this year runs from Friday, 8th of May until Sunday the 10th of May.

Whilst there if anyone attending the show wants to bring some cutters up I will sharpen them whilst they wait or if its busy they can collect them from the stand later. I must put a cap on of 4 – 5 cutters per person to give everyone a chance, they need to be from 3mm to 12mm or ⅛ to ½ inch in 2, 3 or 4 flute and they can be carbide or HSS.

The show organizers will be providing a charity box on the stand for donations, we will not be charging. This will be an ARC stand for the purpose of demonstrating this machine only. ARC will not be selling any products at the show. ■

Worn cutters before...



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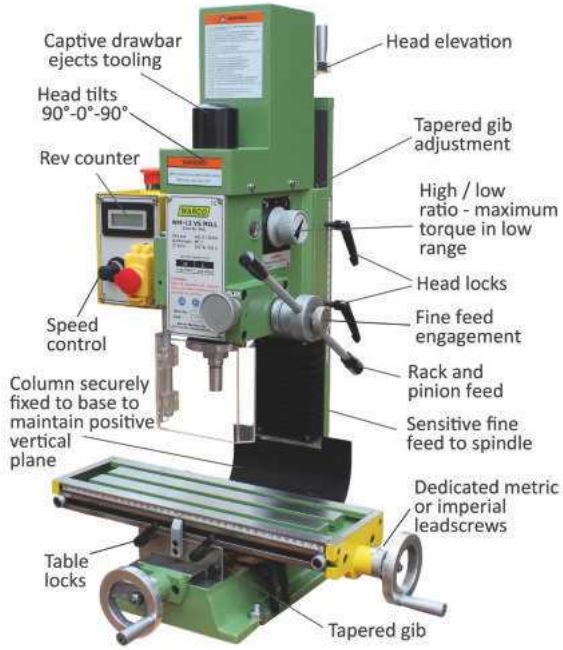

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Cleaning Coolant

John Pace was troubled by dirty coolant, so he devised a neat oil-skimmer for keeping it clean.

I have a coolant system on all of my machines, and for machining I use a neat cutting oil. As some machines are not used all of the time, I find that the neat cutting oil keeps the machines oiled and rust free. I used Rocol V-cut SS (a semi-synthetic soluble cutting oil) in the system on my Myford lathe for a while, when it was used for some work where the neat cutting oil was unsuitable. Despite the claim by the makers for this product there was some damage to the bedways due to rusting. When the job was finished I changed back to the neat cutting oil. Even after some time (years) there is still visible pitting on the bedway. I believe the damage was caused because of some interaction between the coolant and the oil used to lubricate the machine slides.

Nearly boiled coolant with tramp oil floating on the surface.

My latest project is a universal grinding machine, for which I originally bought the V-cut SS coolant for this as it is recommended for grinding applications. The machine at this time is only partially operational and has only done a limited amount of grinding as it is used to make and finish some of its own parts. The water soluble coolant system has proved to be a problem as the coolant has become contaminated with lube oil and grinding debris. Some modifications to the machine slideways to collect the excess oil have helped but an oil skimming system is needed to clean the remainder. These systems are available from suppliers such as J&L but are for more industrial operations than the small system that I have and are also quite expensive.

Cleaning the old coolant

First of all I set about cleaning up the existing coolant, it should be a clear translucent green liquid but has turned into a grimy looking green gunge. There has been some discussion on the M.E. forum about coolant systems regarding bacterial content and cleaning and this can be a cause for concern with any coolant system. I have about 10 litres in the system and emptied and stored it in some cleaned empty milk containers. The coolant was boiled using an old kettle and as the coolant is heated the oil contamination rises to the top and forms a thick layer. The kettle is turned off before it boils (**photo 1**). Using an old coffee jar with a pair of tubes poked through the lid and a vacuum source, I used a pump but a vacuum cleaner would do, the lubricating oil layer is sucked off the top and is

Tramp oil vacuumed off the top of coolant.

Filtering the partly cleaned coolant.

Comparison of old cleaned coolant and freshly mixed.

The main parts of the home-made coolant skimmer.

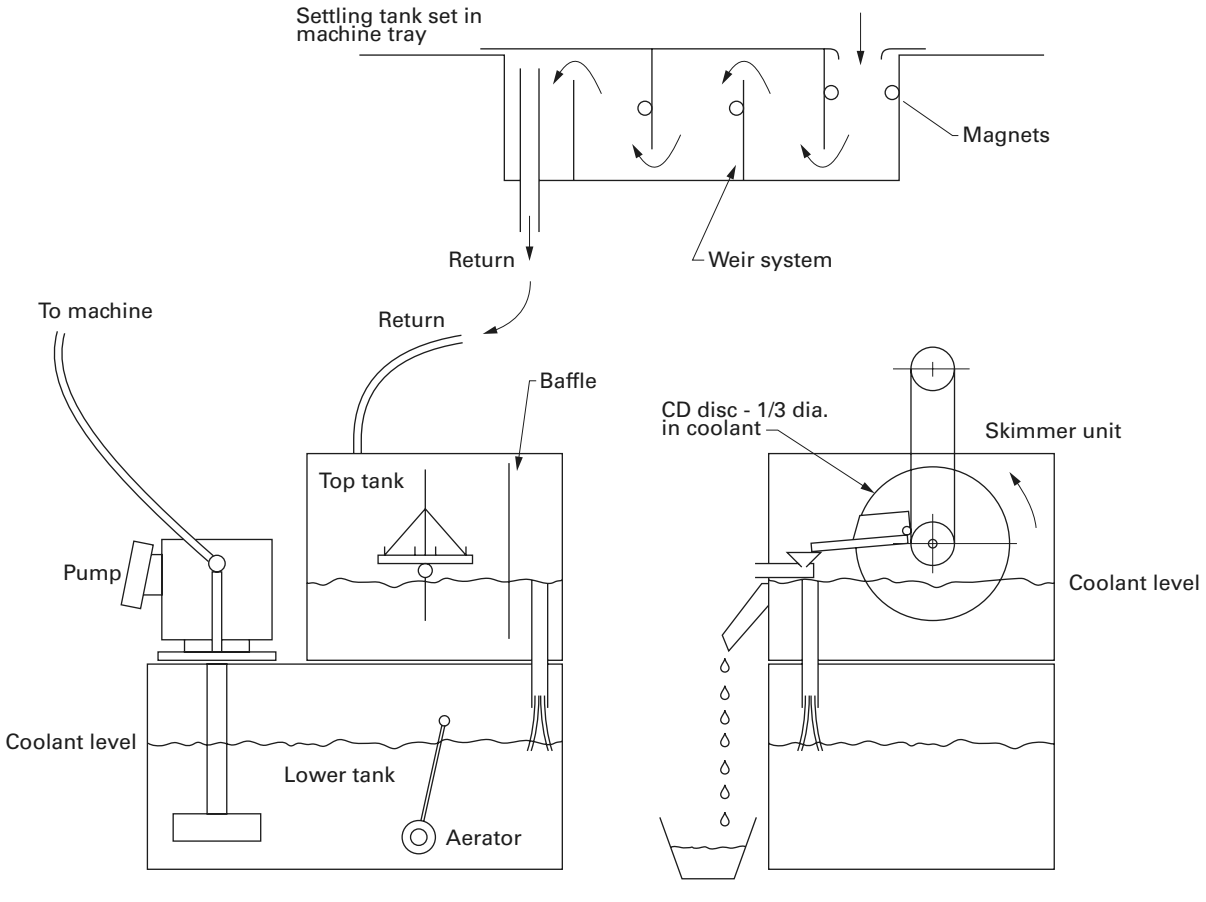
collected in the jar and disposed of. As can be seen in **photo 2** there is still some debris floating on top.

Turning on the kettle again the coolant is allowed to boil for a while, hopefully this will kill off any unwanted bugs in the coolant. Boiling the coolant does not seem to affect the coolant in any way. To remove the small amount of remaining debris seen in **photo 3** a plastic container is suspended over a clean bucket, holes are punched in the base of the container and a piece of paper towel placed over the holes. Some sand is placed over the top of the paper and the container filled with coolant. Gravity will do the rest as it filters through leaving the remaining muck behind. As can be seen from **photo 4** the one on the right is some freshly mixed coolant and the one on the left cleaned coolant, they look the same. Doing this on industrial quantities of coolant would not be a practical proposition but for the small home shop avoids having to dispose of dirty coolant and replacing it with freshly mixed.

Oil Skimmer

In the long term, something needs to be done to help with cleaning the system to prevent the need for cleaning on a regular basis. Having made a start by collecting the lube oil from the slideways, some additions to the coolant system have been made. My skimmer unit is made up from scrap – I used an old CD disc as the main working part. I had to buy a geared motor to drive the unit but these are fairly cheap, the motor I used is a Como drills unit available from RS or Maplins and other outlets (RS part number 420-647). It runs on 12 volts at about 7 rpm. I used an O ring for the drive belt and some simple aluminium pulleys. The frame is just some scraps of steel sheet. The spindle is made from stainless steel, although the coolant is a rust preventative suspending a plain steel shaft above the evaporating liquid would soon rust it. **Photograph 5** shows the finished unit and **fig. 1** shows the general layout of the coolant system. As can be seen from the photos the construction is very simple and a dimensioned drawing is not needed

Fig. 1



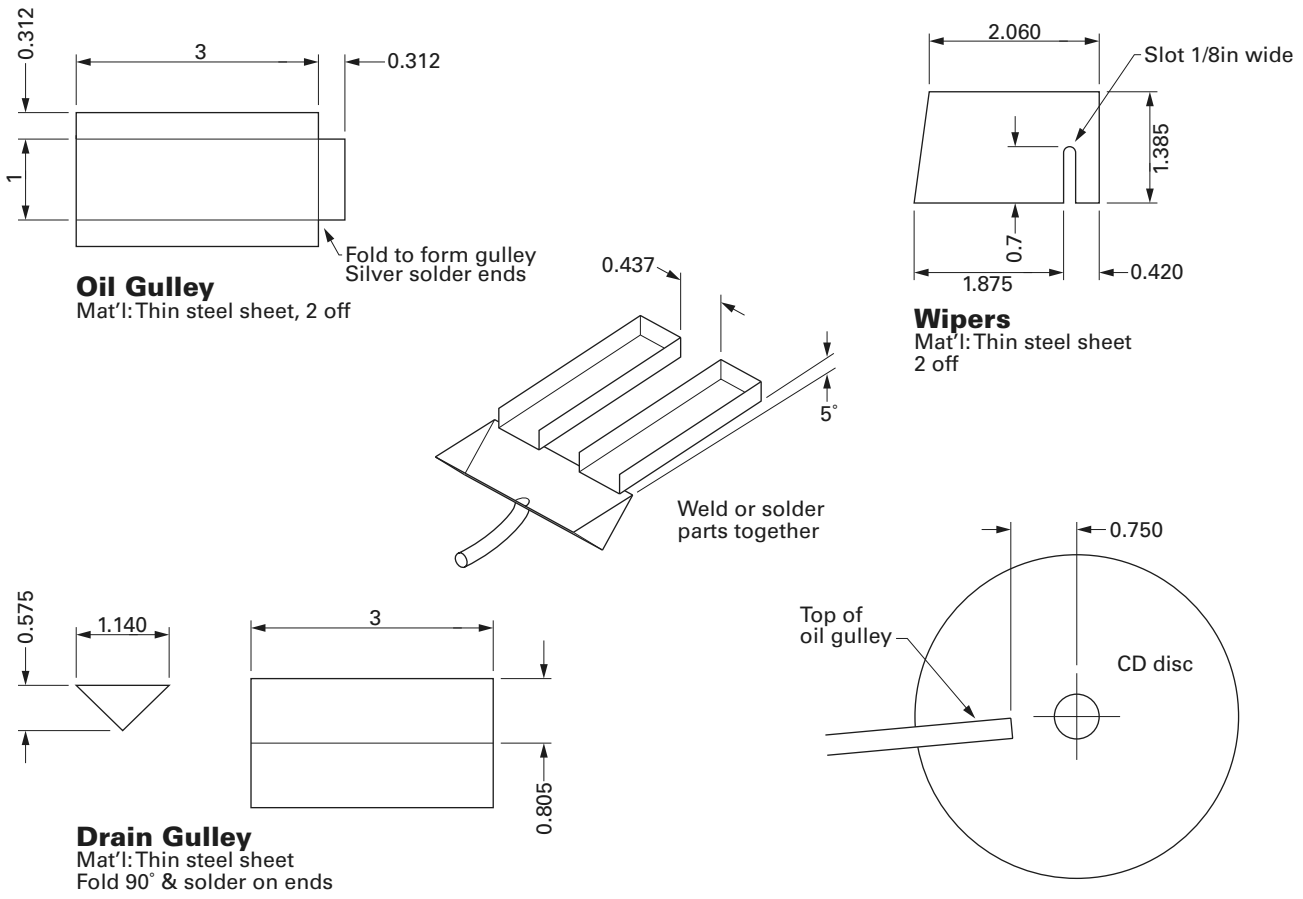
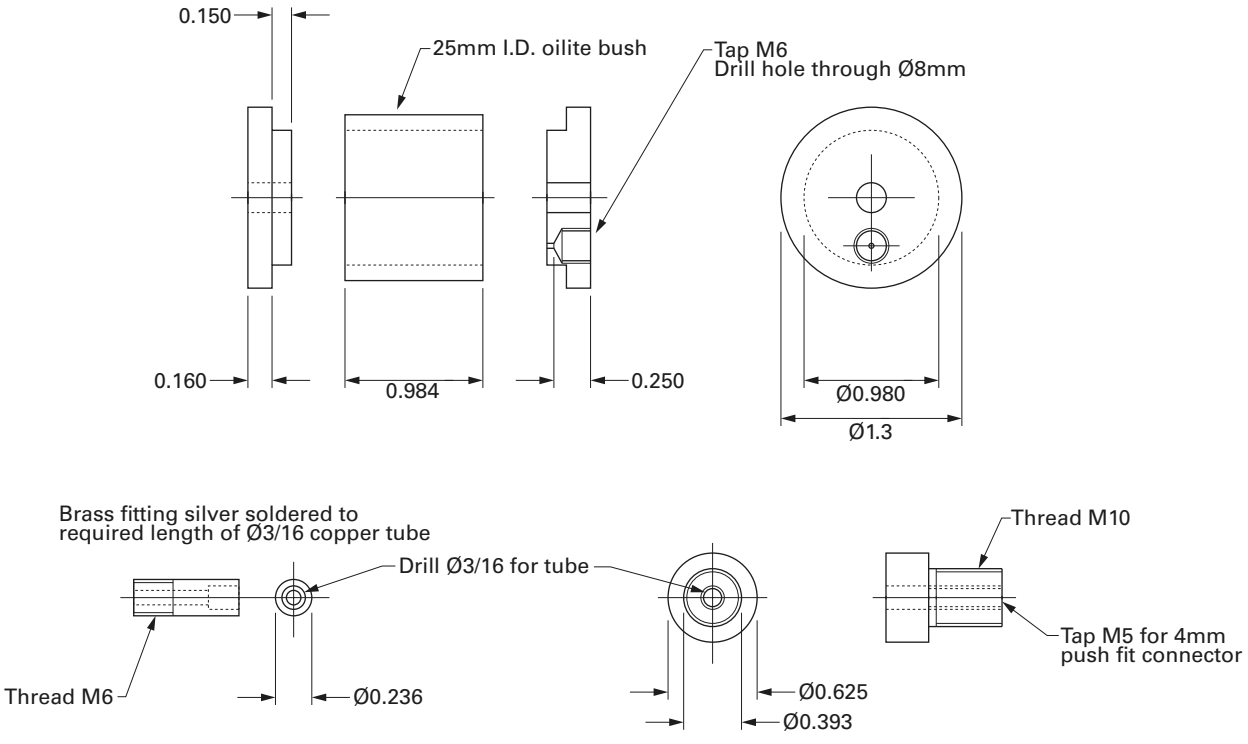


Fig. 2

Fig. 3



Aerator

Skimmer unit fitted in coolant tank.

The complete coolant system with aerator fitted in bottom tank.

Even if the machine is not in use I blow some air through and circulate the coolant twice a week to keep the system aerated and prevent stagnation.

and any similar unit made will have to be designed to suit the coolant system. **Photograph 6** shows the skimmer fitted to the top tank, the two wiper plates have been changed to thin mild steel as these work better than the plastic wipers. **Figure 2** shows basic dimensions of some of the parts, the positioning of these very much depends on the size of the system that it would be fitted to. The wipers just sit in the gullies and rest against the rotating disc, the slot fits over the upturned rear edge. The pipe exits the side of the coolant tank using a suitable fitting that is well sealed against leakage and the waste is collected in a suitable container for disposal.

On the grinding machine there is a settling tank inset to the coolant tray on the machine, this has a weir system and magnets to catch the fine grindings. From here the coolant falls into a top tank and then into the main tank to be pumped back to the machine. The skimmer unit is fitted to the top tank as this has a constant level irrespective of the total volume of the system. The skimmer is only used after the machine has finished working, as when the coolant becomes still any oil will settle on the top and can be removed. The skimmer is only run for about 15 minutes at a time, and this is enough to remove any floating tramp oil and keep the system clean.

System aerator

In addition to the oil skimmer, an aerator has been fitted to the lower coolant tank, this simple device bubbles air into the coolant and prevents anaerobic bacteria from building up and spreading through the system. J&L sell these for about £50 but I made mine from and old oilite bush. **Figure 3** shows the construction, I use a connector and hose to the workshop air supply which is regulated to 30 psi to supply the aerator. **Photograph 7** shows the complete system, the aerator is in the bottom tank. Even if the machine is not in use I blow some air through and circulate the coolant twice a week to keep the system aerated and prevent stagnation. This coolant system is very small and there would no doubt be some advantage in having the system larger to enable the coolant to slow down in the intermediate stages, this would allow better and more consistent skimming while the machine is in operation.

Good housekeeping is the final answer to having a clean coolant system, and cleaning the system out at regular intervals still needs to be done. The use of a system cleaner such as Castrol MTC (**photo 8**) can help with this. Under the new regime the machine is much more pleasant to use with a stream of clean coolant (**photo 9**). Searching on the internet for 'anaerobic bacteria in machine coolant systems' brings up a lot of information on the hazards and countermeasures to combat this, all well worth reading. ■

Castrol MTC coolant system cleaner.

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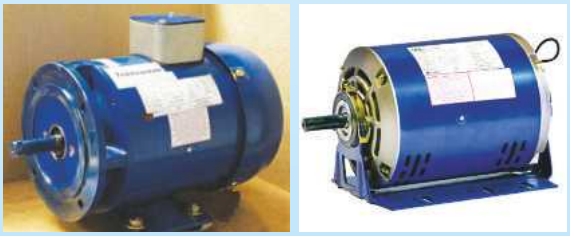

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Tools from the bin

Howard Jennings takes the mantra 'repair, reuse, recycle' seriously.

Of course, when I mention 'the bin' (or the 'trashcan' for many non-UK readers) I mean recycling as well. Here we have the opportunity to do our bit for the recycling of materials as well as saving a bit of cash. I use the term 'tool' in its widest form – that is an implement, especially one held in the hand, for performing or facilitating mechanical operations. Some of the tools that I mention in this article will be familiar to old hands. However, even for old hands I think there might just be some new twists! Let's do some old favourites first. They lose nothing from being repeated and will definitely help new starters. Please read on…

Sharp edged hacksaw tools.

Squared edged tools from hacksaw blades.

Toothed tools from hacksaw blades.

Further interesting tools from hacksaw blades.

Hacksaw Blades

No good engineer should ever throw a hacksaw blade away! There are so many uses for worn-out, broken hacksaw blades that it would be almost impossible to describe them all here. I have put together a few photos of tools I have made over many years using hacksaw blades. I've divided the photos up into four sections.

Photograph 1 is the first 'group'. These are all 'knife'-type tools, i.e. they all have some type of sharp edge. Clearly, being made from old hacksaw blades which are usually made of high-speed steel in one guise or another, such blades will hold their edge in a tight situation. I have used these for trimming, clearing grooves out, shaving wood and numerous applications.

Photograph 2 is the second 'group' and shows square-edged tools which I have made for use as scrapers. In this photo the third tool in from the left was designed for getting into holes, which explains why you see the semi-hooked end. The long blade with the 'hockey stick'-type end was made for getting at the edge of holes that intersect inside a job. You can see that I've also clamped two blades together with a pop-rivet which doubles up the thickness of the blade for getting down a groove. Finally, on this section, my particular favourite, which is rarely out of my hand, is the tool on the far right of the photo. It has square edges all the way round (except where the sharp corner of the angle is). This tool is a 'jack of all trades'. I use it for deburring around hole edges, sides of machined work, clearing out grooves, scraping away swarf. It's particularly good for removing sealant etc. The original tool took me ten minutes to grind up but I've never been without it for ten years (as you can see by the condition of it!)

Photograph 3 shows another application for old hacksaw blades. Note that the teeth at the end of the blade (furthest from the handle, about 25mm along the blade near the mounting hole) are in perfect condition. They just don't get used in the normal life of the hacksaw blade. As you can see from the photo, I have ground away most of the teeth on these tools, leaving a small section of them that can then be used as a small pad-saw. Clearly it's wise to remove most of the remaining teeth from the handle end and wear gloves and/or wrap it with tape to protect your hands. Tools like this have pulled me out of many a tricky situation where I have needed to cut through metal that is difficult to get at with any sort of conventional saw.

Finally, **photo 4** shows some interesting little tools with hooked sharp ends. The two tools on the left have been used for removing things like o-ring seals and / or circlip-type rings which are 'embedded' for one reason or another in an assembly. The

›

tool on the far right will be of some interest to you if you've ever broken a key in a barrel lock. I made this tool to slip down by the side of the broken key section inside the key barrel and I was able to pull out the broken key! I don't need to tell anybody who's had that problem just what a cost-saving device this can be. Note that to make this tool work I 'thinned' down the thickness of the blade (with careful use of the side of the grinding wheel) to less than half its thickness. I found that, even having done this, providing it's used with care, the material still retained its property of toughness and hardness.

These hacksaw blade tools mostly took me minutes to make on the grinder and have been absolutely invaluable on many jobs. Many of them were initially made as a 'one-off' but eventually found their way into becoming long-term regular tools.

Old files

These really are the classics! I have probably a dozen old files lounging in a drawer and they come out to tackle some really tricky jobs. Here are a couple in **photo 5**. The tool on the top of the photo is the absolute classic, a scraper. I made this one some years ago and, as you can see, it makes a regular appearance on the bench! The tool at the bottom of the photo is a shaper tool, the cutting blade being made of an old file (you can see the machining marks where the teeth were removed). I made this tool for putting a rather long key-way into a vee-belt pulley. I remember during my apprenticeship we were expected to file away the teeth on an annealed file. One of my apprentice colleagues got 'a rocket' for sneaking off and using a surface grinder to remove the teeth instead! His approach would make a much better job though!

Just for completeness, a couple of notes on how to work with old file material. This is a high-carbon steel and it needs careful annealing before attempting to machine it. Heat it up to red heat and 'heat soak it' for fifteen to twenty minutes. It is important to do this as it gives time for the carbon in the steel to rearrange itself. Then allow the file to cool back to room temperature naturally before you attempt the removal of the old teeth. It won't machine like EN1A free-machining mild steel but, particularly with using tungsten carbide tipped-tools, a reasonable finish can be obtained. Then harden it by heating back to red heat again, soaking at this temperature and plunging it into water. All sorts of tunes can be played here on the heat treatment. For example, as in the case of the scraper pictured in photo 5, the end of the scraper was heated red hot and plunged into cold water. Of course, some tempering will probably be needed depending on what your tool has to do. For instance, a very well known use for old file material is making form-tools such as a 'fly-cutter type' compound curve tool (cut by hand) for shaping steels or brass.

Tools from worn out files.

Swarf collector for a milling machine.

Swarf collector for lathe.

Margarine pots.

The swarf collector on the lathe.

Margarine tubs

Perhaps some of you are sat reading at your breakfast table and maybe the margarine tub is close to hand and near to running out. It almost goes without saying that these tubs, washed out, are great in the workshop for storage of small tools.

Still at the breakfast table, I spy the cereal packet! This is an old favourite but using this type of cardboard as a precursor to sheet fabrication work has become the norm for me.

I store all my small HSS milling cutters in two or three of these tubs, cut-down inside a drawer to stop them moving around and getting lost and damaged. **Photograph 6** shows a use for storage and you can see how my steel wool is safely tucked up in one of these, keeping it from rusting. Next to it you can see the sort of plastic containers that turn up in takeaways these days. I became sick of finding bits of used emery paper floating around my workshop so they were all given a home in one of these containers. Now I can always find a nice worn bit when I'm looking for the last polish on a piece of steel, and save a bit on the cost of emery paper!

In the foreground you can see some cut-down tubs. You can see by their condition that they are used frequently. They are used for collecting swarf during some machining operations, particularly on the milling machine. I hate finding swarf all over the place, it's no good for the machines and it always seems to turn up on a surface where you least want it – e.g. when clamping things into the vice or onto the machine bed. So I try to collect it as much as I can and it saves wear and tear to the vacuum cleaner as well.

Photograph 7 takes this one stage further. You can see I have mounted two margarine tubs (glued together) on the end of a magnetic stand arm to collect flying swarf on the milling machine and my shaper. Aha I hear you say! You can't glue this type of polymer/plastic together… can you? Yes you can! I came across an adhesive kit at a show a few years ago that allows you to use cyanoacrylate adhesives (superglue) on these types of polymers/plastics. The secret is in an activator that comes with the kit. This is from Five Star Adhesives (**ref. 1**) of which I am a good customer and nothing more. I originally bought this adhesive kit and took a 'flyer' on it. I was very sceptical but I had to use this adhesive in anger on a fabrication machined from solid polythene and I was absolutely astonished how effective it was. Eventually this led me to the fabrication you can see in photo 7.

So, continuing with our breakfast table theme, I also prepared a swarf collector for my lathe as you can see in **photo 8**. My lathe is a six inch swing Harrison, a biggish lathe for home workshops, but this was the kind of lathe I was trained on as an apprentice and, when I saw it twenty odd years ago, I fell in love with it and haven't looked back since! It just so happens that a margarine tub fits rather neatly between the shears as you can see on **photo 9**. Initially it was all very well just having a margarine tub there but I wanted to keep the swarf away from the bed shears themselves. So, after a number of attempts at using bits of tape to attach 'wings', I tried out the adhesive approach, cannibalising a number of margarine tub tops and the result is as shown. I have a swarf collector that directs quite a lot of the swarf into the tub and I can pick it out periodically and throw it in my swarf bin. Obviously, for those of you with smaller lathes, a 'standard' margarine tub could be adjusted to do a very similar job.

Tips on gluing

I've found it very useful to use a cotton bud to apply the activator, which comes in a small bottle and is very easy to spill. You can barely see where you have applied the activator so you must be very careful and methodical about how you apply it. Also, don't forget to apply the activator to both surfaces that are being glued together. When using the cyanoacrylate / superglue adhesives if you're not wearing gloves then expect to find your fingers glued together, stuck to the job and/or your work surface! Surgical gloves are a real benefit here. The types of adhesive that Five Star sell are a bit more sophisticated than the stuff in the local hardware shop. They tend to be more viscous, some of them have 'gap-filling' capability, have toughening additives and they have delayed setting times. We're only talking a few seconds longer but it can really help and/or be annoying that things don't instantly appear to stick together. I admit that I have done all these silly things, so you have been warned!

A quick note on how to store cyanoacrylates. Many of you will have found these adhesives 'go off' to form a hard lump in the bottle. The secret of keeping them in good condition for years is to keep them in a sealed container in the freezer. This goes one stage further than keeping them in the fridge as 'Five Star' recommended. I find the adhesive is liquid or near a liquid at these temperatures and you get a bit more working time.

Cardboard

Still at the breakfast table, I spy the cereal packet! This is an old favourite but using this type of cardboard as a precursor to sheet fabrication work has become the norm for me. It may sound really tedious, particularly to new readers, to prepare accurately a cardboard version of your proposed fabrication but for even quite simple jobs I would highly recommend this. The times in the past I have uttered streams of unmentionable expletives when something has been found to be wrong at the last stage and I have thrown the result of a lot of work into the scrap bin. The use of cardboard can save all this. Remember, these cardboard boxes that your cereal turns up in have to be very accurately made and predictable as they are processed through packaging machinery that is working at blurring speeds. So, let's take advantage of this in our home workshops. Another nice feature of this type of cardboard is that it is roughly similar in thickness to much metal sheet. The cardboard tends to be about 0.5mm thick and I'm usually working with metal sheet from this thickness upwards. So it's possible, with care, and maybe a bit of glue / sticky tape, to fabricate something that will actually fit exactly where your fabrication will be used. You can iron out any fitting problems well before you start to cut metal. Chucking away a bit of cardboard that's taken you ten minutes to cut up is considerably less upsetting and costly than chucking away a metal fabrication that may have taken you several hours to make.

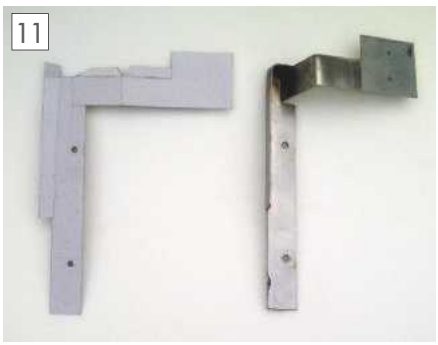

10

Milling machine DRO bracket.

By way of an example, take a look at **photo 10**. This shows the Digital Readout (DRO) mounting I made for my Chester UK (I'm only a customer, nothing else) Bridgeport clone milling machine quill. I have taken off the detachable handle wheel so you can see things more clearly.

I needed a DRO mounting on the quill for machining axles where the milling machine head was being used at an angle for machining the kingpins. The knee handle wheel dial is useless in this situation. I looked around for an 'off the shelf' solution but I didn't like the price of what I found. The off the shelf offering would have been fitted using the screws and mounting for the scale (shown in photo 10) next to the automatic quill feed stop mechanism. Two arms of the aluminium cast frame of this product would then have been used to hold the DRO top and bottom. However, in my view, this approach would leave the access to this area of the machine too cluttered. It is bad enough as it is.

I decided to use the 'scale screw' mounting approach but with a stainless steel bracket to lift the DRO up and out of the way. However, the bracket needed was a complicated shape in three dimensions. It took me four cardboard 'mock up' attempts to get to a bracket design I was happy to cut in stainless steel (**photo 11**).


11

The bracket and cardboard template.

Clearly, if I had had to draw out on a stainless steel plate a 'design' measured as accurately as I could, I would have been very unlikely to achieve such a complicated bracket design in one go. The cardboard 'mock up' provided a flat development which was then used to mark out the metal development accurately that was eventually cut out and formed into the final shape. Note that at each stage it was easy to draw around the earlier cardboard attempt and add on / take away the bits needed.

Just before we leave cardboard from cereal packets. I have also found it useful where some form of repetition is important. For instance transferring hole centres. My approach to this is to mark out your best measurement of the hole centres and punch the holes out. It then easy to check the centres on the job. If things are not right it is no trouble to draw around your template make the adjustments and try again. Alternatively have separate hole punched cardboard pieces that you stick in their final position with paper glue. Either way, you end up with an accurate marking out template for transfer to the metal. I have found this approach invaluable when co-ordinate drilling multiple castings.

Shims from cans

Later in the day, having left your breakfast table, you may be sitting down enjoying a relaxing drink from a can. Again, as I mentioned with the cardboard from your cereal packet, ring pull cans, in fact any can that food or drinks are contained in, is manufactured very accurately and the ring pull can is no exception.

Photograph 12 shows material cut from such a can. You have a very convenient, cheap and predictable aluminium shim material to hand. I use this in my workshop for the obvious purpose of shimming tools to centre height on one of my lathes. Another handy


12

Shims from a can.

use is for protecting jobs from the vice jaws to avoid bruising or grip marks when filing, preparing or finishing a job. The same goes for protection of finished surfaces when mounting work in chucks, particularly 4-jaw chucks, which can get quite high forces from the jaws as you adjust onto centre.

It doesn't stop with your drinks can! Other types of cans have interesting and useful materials which can be reused. I have to draw the line here, for safety reasons, with aerosols. Remember, the propellants in these cans are highly inflammable, and often the contents as well. More generally, use gloves when cutting cans.

Tools from a suspension strut.

Car parts

I'm sure many of you do your own car repairs and will have carried out replacement of your suspension components, particularly shock absorbers and / or the front struts. Sometimes the old parts are taken back by the retailer for refurbishment. Increasingly these days, the old part heads for the scrap bin, however, just before it gets there, there are some bits of material waiting for us that can make useful tools. **Photograph 13** shows a couple of tools I have made which have overcome some problems I have had when machining castings. The black piece of tube with the bolt and flange that you can see at the top of photo 13 was made quickly as a casting jack. I had found that the tube was quite a neat fit over a boss on a casting and I was able to set up the casting using a machine vice on the milling machine. Then, using the jack to support the casting, I drilled and bored it through to take bearing races. The black section of tube had more than sufficient volume to contain the swarf during these operations. If you look closely at the tube in the photo you will see its provenance from an old Nissan I used to own.

The second tool in the photo is the shaft from a front suspension strut. I suspect these are made of some form of toughened and surfaced hardened alloy steel. Judging by the finish obtained by the grinding, chromium looks to have had its part in this steel too. However, from our point of view in the workshop, this is steel that can resist the forces we are likely to see during machining. To this end I was presented with a problem of machining a casting where I needed to produce a bypass for oil around a bearing. It was a bit of a belt and braces job but if that's what the customer wants… I could easily drill down past the bearing in the aluminium casting with a long series 6mm diameter drill. But I needed to break through to this hole at a depth of some 100mm with a similar sized slot drill set at angle to the casting wall. After some deliberation I spied this shaft that I had cut out of the old strut (don't attempt to disassemble a strut that still has compressed gas in it) and upon measuring its diameter I found it would suit one of my Bridgeport collets quite nicely. So I set to work, cut the shaft to length (which I found I could do with a hacksaw), faced up both ends and drilled to take a 6mm 'throwaway' slot drill. This was then glued in with epoxy resin (UHU Endfest) which I cured at over 100°C for the maximum strength I could get. The tool worked brilliantly and now resides in my tool drawer.

Note the short piece of black tube to the left of the picture. This usually covers the end of the slot-mill, protecting the cutting edges. Some of you who have pet dogs may recognise the tube (cut down) as that from the centre of rolls of dog waste bags! I've been looking for a use for these for a long time and some of them are making their way to my other slot drills in the tool drawer.

Just a short safety note on cutting up shock absorbers/ struts. These days some cars have pressurised gas filled systems as part of the damper system. If in doubt leave well alone.

Copper from plumbing

Call me old-fashioned but I do my own plumbing and I still like to use copper, although the plastic systems are taking over fast. Any of you who have done a bit of plumbing at home using copper will find that you're left with a few short lengths of copper pipes (I'm referring to those up to about a maximum of 100mm). Don't even think about throwing this away! Usually I cut these tubes along their length and anneal them by heating them red hot and letting them cool naturally to room temperature. It's then easy to open them out into really useful pieces of copper sheet. These find their way into protecting shafts and tubes during operations in the vice, particularly using taps and dies. **Photograph 14** shows some of the pieces of tube and their flattened out counterparts.

In **photo 15** I have taken one of the uses for the pieces of flattened out tube one stage further. I have made some soft jaws for a vice. All that is required is a couple of short slits in the sides of a piece of flattened out tube that is about 10mm wider than the vice jaws. **Photograph 16** shows how it is very easy to clamp the piece of flattened out tube in the vice and tap it around the vice jaws with a hammer, a bit like wrapping a parcel. **Photograph 17** shows the final result, that is some really robust soft jaws costing next to nothing.

Of course, copper is a first class conductor of electricity and, although the copper used in plumbing is not an oxygen-free grade used for electrical installations, I've certainly found it more than good enough for making contact clips over the years. It's really easy to bend the copper into a tight tube around the stripped wire, soft-solder it in place and drill a small hole for your screw contact. 'Job's a good 'un!'

By way of an example, **photo 18** shows the contact I 'improved' on my welding set earth clamp made of a piece of 10mm central heating tube and a 10 - 15mm adaptor that was lying around in my plumbing box.

If you have some tube punches about, and it's always easy to make one yourself on the lathe (I've made them with old steel

Copper bits from plumbing.

Vice soft jaws from copper tube.

Making soft jaws.

Finished soft jaws in position.

Welding set earth clamp repair.

tube) and, provided the copper is in its fully annealed state, you can punch it and make yourself copper sealing washers. Such washers have a habit of needing replacing at the most inconvenient moments so having a quick method of making them is a godsend.

In general, copper is really useful material to have around in small quantities like this. This is because it's soft, it's malleable, it's reasonably strong and it's great for quick repairs. Even if you can't see an immediate use, having a few pieces of copper about is a really valuable 'tool' to have to hand.

Round up from the bin

Just before we leave this 'run around the block' on a few useful tools that can be way-laid from discarded product containers on their journey to the bin, I have come across one or two other useful bits and pieces that some of you might be interested in. I am sure some of you have spotted the next one already: in **photo 19** there are these plastic caps that have been popular for holding dry ingredients on the top of sauce jars in recent years. I find these really invaluable for mixing silver solder flux to a paste with water. These shallow dish / pots are really convenient whilst you're in the actual process of applying the flux to a joint.

Some useful bits and pieces I've spotted come from your humble soap dispenser which seem to have made their way to our bathrooms and kitchens displacing hard blocks of soap. Inside these dispensers, as you can see in **photo 20**, there is what looks to be a stainless steel spring, which I cut out and chuck in my 'spring box'. These springs are particularly attractive as, unlike, say, springs from ballpoint pens, they require reasonable force to compress them. Springs of a similar ilk turn up in many spring-loaded tools such as some types of pliers, particularly circlip pliers, which have a habit of breaking on you at the most inconvenient moment. Notice also on photo 20 that short length of plastic tube and the rather nifty seal, which are handy things to have around in the workshop.

By way of a 'stop press' I had occasion to make up a 'funnel' for use in filling a particularly tricky oil reservoir in my car of all places – a long and horrible story I won't go into here! A conventional funnel was almost useless unless you had a specific tube-size that would fit on the end of it. Of course, I didn't have anything! So I cast around in the bin and came across the bleach bottle which you can see in **photo 21**, cut down and combined with the kind of short length of tube that you find in household cleaner sprays. I had the perfect tool for topping up this reservoir. I am sure you will note that the rate that oil will flow through the small tube is quite low. However, this was a real advantage as the reservoir in the car had to be very accurately filled. It was then I remembered that my lathe, pictured in the background of photo 21, has a similar problem: that is, filling the quick-change lead-screw gearbox is quite a fiddle with a conventional funnel. Armed with my new funnel this just ceases to be a problem. I have absolute control of the filling and hence no mess.

Plastic posts useful for mixing flux.

Bits from a soap dispenser.

In general, copper is really useful material to have around in small quantities like this. This is because it's soft, it's malleable, it's reasonably strong and it's great for quick repairs.

Bleach bottle funnel.

To sum up...

I am sure that many of you already use some of the bits and pieces of materials that are on their way to the bin, much as I do. But here and there I hope you've found new ideas that you might adopt in your workshops. Happy hunting! ■

REFERENCE

1. Starloc Five Star Adhesives, 12-14 Arcwright Court, Astmoor Industrial Estate, Runcorn, Cheshire, WA7 1NX, 01928 560044 http://www.glue-shop.com

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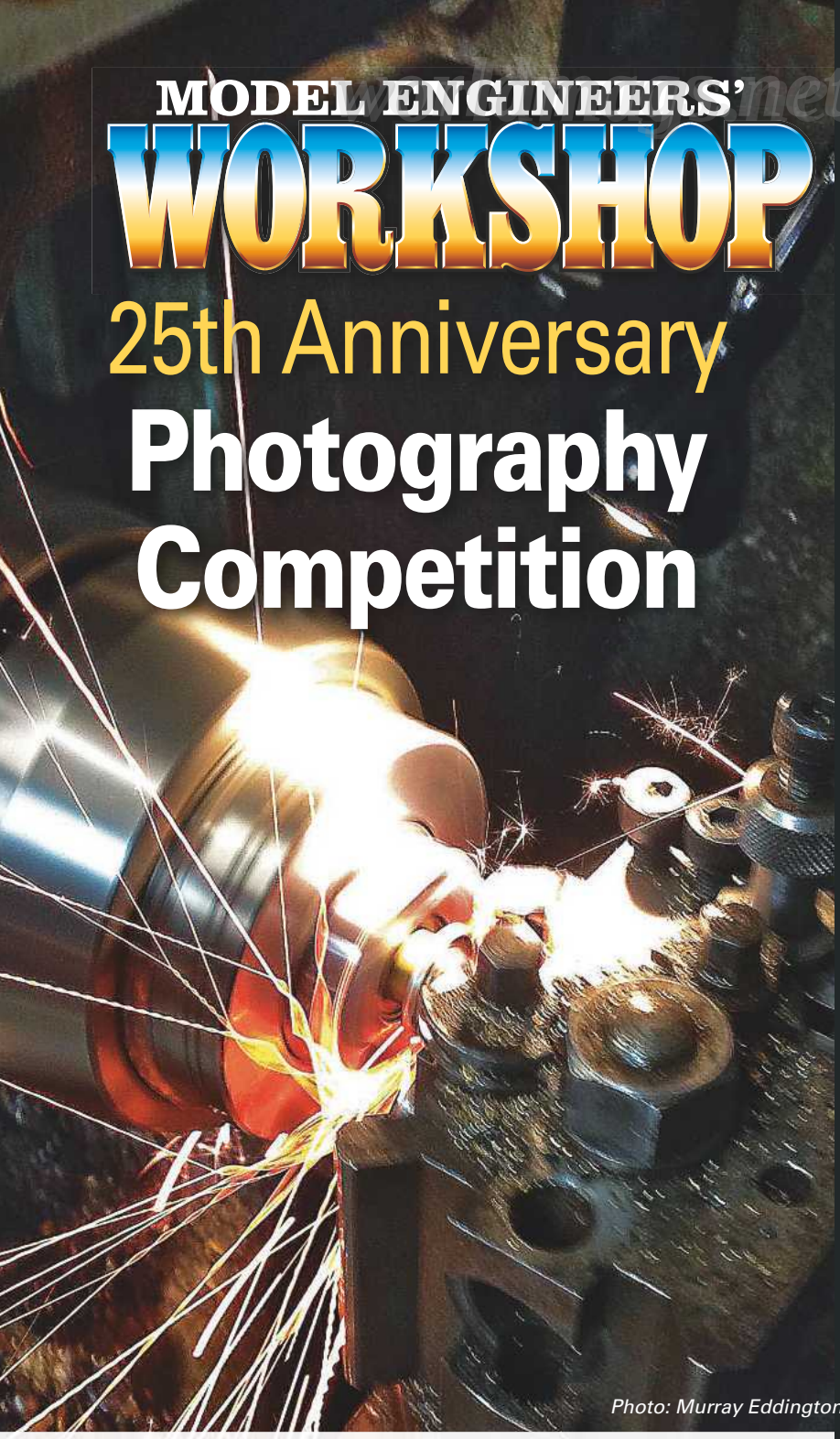

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Take a photograph that sums up the spirit of home-workshop engineering.

The subject can be anything that reflects what you achieve in your home workshop – from a home-made machine tool to the intense concentration on the face of someone carrying out a delicate machining operation. The challenge is to take a picture that captures the spirit of home workshop engineering, rather than just documenting a tool or a process.

The winning photographs will be featured in MEW later in the year together with other entries that achieve an 'honourable mention'. I'm hoping that some of the images will provide us with striking covers for the magazine, and any images used for this will bring the entrant our usual cover fee regardless of whether or not they are a main prize-winner.

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The deadline for entries is 30th May 2015. All submitted photographs must be saved as TIFF or JPEG files of at least six megapixels uncompressed size. JPEG files should be saved at a high quality setting. Images may be portrait or landscape in format. If you choose to adjust or crop the entered image, please supply an unedited, uncropped version as this will ensure we can achieve the highest quality of reproduction in the magazine. For images showing machining processes in action, please ensure that appropriate safety precautions are observed.

Up to three entries per person are permitted, email your entries to neil.wyatt@mytimemedia.com (send large files in separate emails) together with your name, address, a title for the image and up to 500 words to accompany the image. Please also include a head and shoulders picture of yourself.

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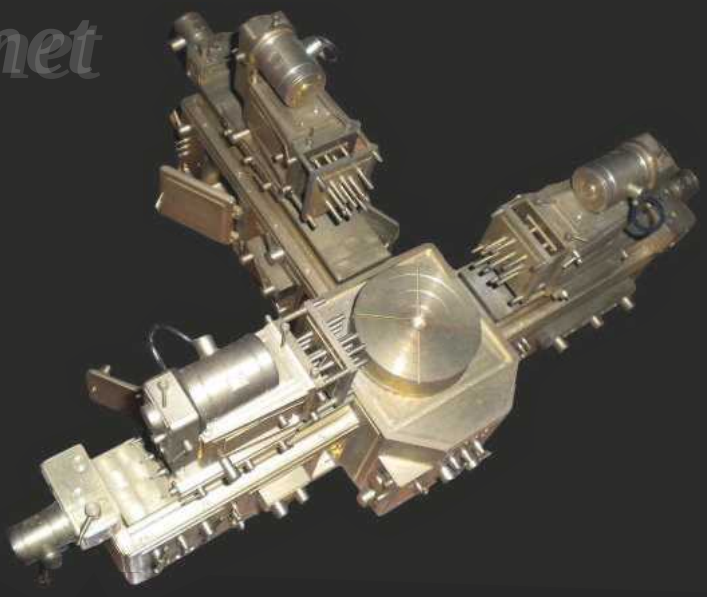
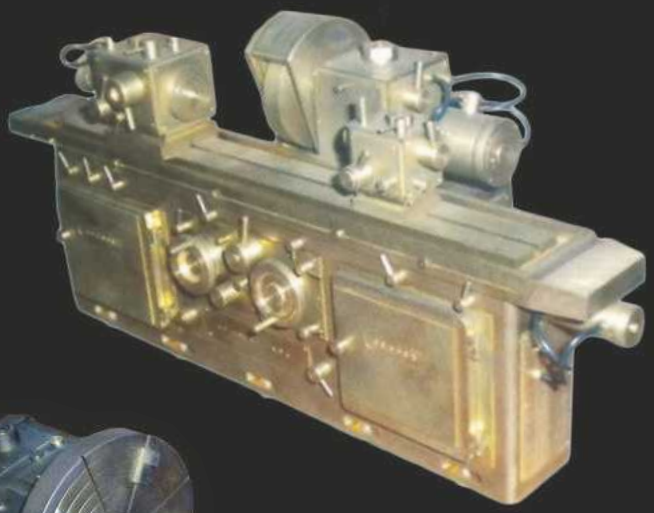


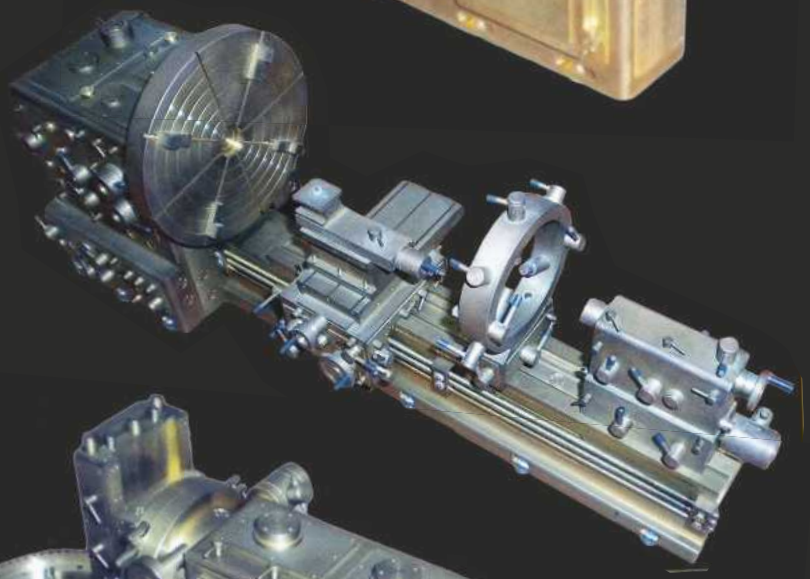
Scultura Meccanica Riproduttiva

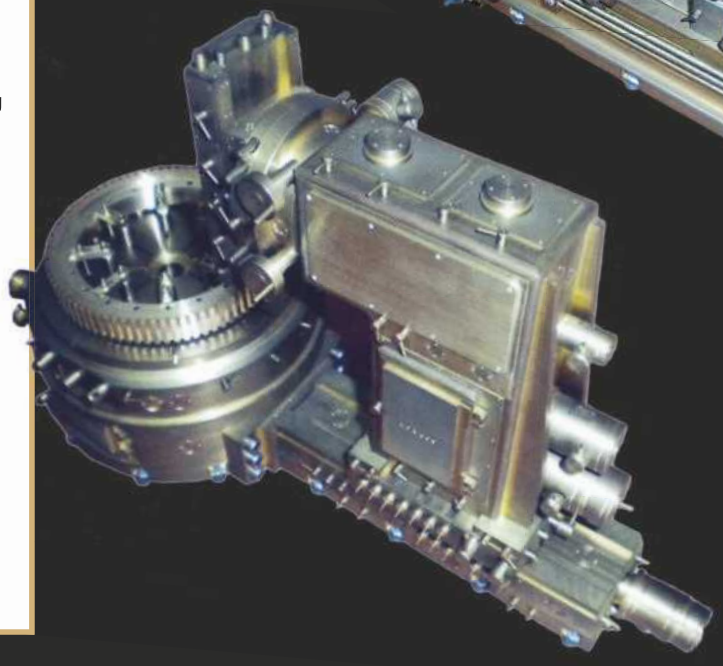
Machine Tool Sculpture - The intriguing work of Fulvio Levati.

It's not often that art and machinery collide, although I remember the work of the Mutiod Waste Company in the 80s. In the 90s the Mutoids moved to Italy, and now from Italy here is a very different talent linking machinery and art. Fulvio Levati is an Italian artist who describes himself as the 'promoter of a new form of expressione art linked to industrial equipment'. His works are an intriguing and engaging mixture of machining skill and artistic imagination, being based on recognisable full-size machine tools of various types: a lathe, a cylindrical grinder, a radial jig borer, a gear shaper, all amended with fanciful additions, not least a profusion of extra controls and handles. Some of the more complex works resemble muti-axis CNC machines. Nonetheless, it is clear that Fulvio has an intimate understanding of the machines which inspire his art - they are modelled in proportion at the relatively small scale of just 1:10. He uses steel as his main material, enhanced with touches of brass detailing, and achieves a smooth satin finish which many modellers would envy.

One of Fulvio's works has been selected by the museum of the Unione Costruttori Italiani Macchine Utensili (UCIMU), the Italian industrial machine manufacturers' trade association. Anyone seeking further details can contact Fulvio Levati at **levafurio@yahoo.it** ■







Using Slitting Saws on the Lathe

Keith Johnson makes a robust slitting arbor and fixture and gives advice on its use.

Many of the components we make often require slitting, usually through one side to produce a clamping action, as in **photos 2** and **3**. Slitting saws are designed for this type of operation, cutting only on their periphery and having hollow ground side faces, to provide clearance. They are frequently used on Horizontal Milling Machines, however, with a simple fixture and vertical slide - I use a Myford non swivelling type - we can cover all our slitting needs on the lathe.

All the slitting saws I use in this way are imperial size - 3 x 1 x 1/16 inch, so all dimensions and speeds referred to suit this saw size. It should be easy to adapt the dimensions for other sizes of saw. Again, the drawing sizes are to suit my Simonet DZ450 Lathe, but you may amend them as required to fit your machine of choice.

The full set of accessories.

Typical split clamps.

Typical split collar.

The Method

In use the cutter arbor runs on centres driven by the lathe catch plate, operating against a carrier secured to the headstock end of the slitting saw arbor, a flat is provided for carrier clamping. Select a suitable size carrier before making the arbor and machine the end to suit its size.

The vertical slide is secured onto the lathe compound slide using an adaptor plate, in the position normally occupied by the toolholder. The slitting fixture is secured to the face of the vertical slide, with four t-nuts, studs, washers and hexagon nuts. Work pieces are clamped in various ways to the fixture for slitting, see the general arrangement (**fig 1**).

Cutter Arbor (fig 2)

Make the arbor from 36mm A/F hexagonal EN1A mild steel. The hex section will give easy, rigid clamping whilst tightening and slackening the cutter securing nut. Always grip the arbor in the bench vice, across its flats, when fitting a cutter. It's best to remove the driving carrier prior to clamping in the vice.

Chuck the material to run true, face end flat, centre drill to 6mm diameter, fit running centre and adjust pressure, turn all sizes to +2mm on all diameters and -1mm on all lengths. Reverse in chuck, face end flat, centre drill to 6mm diameter and turn single diameter, again leaving finishing allowances.

Set lathe for turning on centres, Finish turn to suit chosen carrier on this single diameter end.

Remove from lathe and mill or file the clamping flat, secure the selected carrier and return to lathe on centres. Complete machining with arbor running on centres, ensuring a sharp corner is made at position of cutter location. Turn an undercut for tool runout before screwcutting a 20TPI thread. Finally, chamfer all corners to complete.

It should be easy to adapt the dimensions for other sizes of saw. The drawing sizes are to suit my Simonet DZ450 Lathe, but you may amend them as required to fit your machine of choice.

Spacer (fig 2)

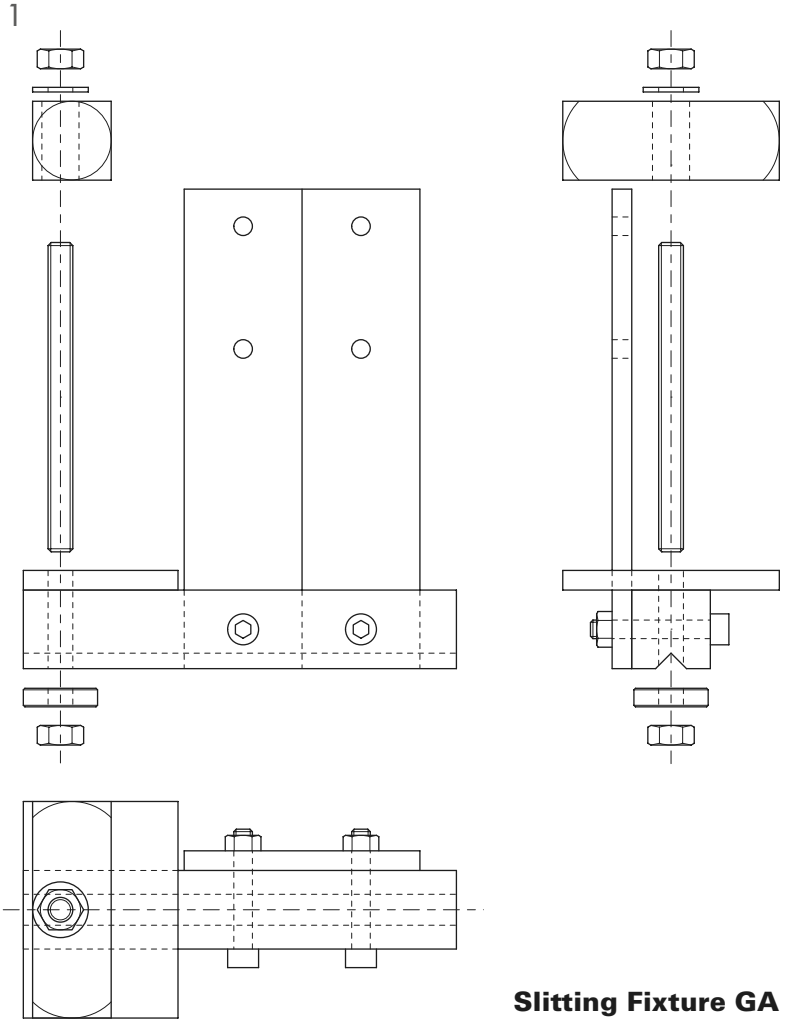
Start with a 36mm diameter x 70mm EN1A blank. The spacer must be made with both faces parallel and square to the bore to ensure true running of the cutter in use. Chuck to run true, centre drill, drill through, bore to 25.4mm diameter, check size using arbor, aiming for a sliding fit. Turn the outside diameter to 34mm, and face front flat. File a small nick on the outside, close to this faced end. This will identify the truly square end of the spacer. Chamfer all corners and part off at 41mm long.

Face to length, either by holding in bored soft jaws, or on an expanding mandrel, do not remove any material from the marked reference end. Check in several positions with a micrometer to prove faces are parallel.

Clamping Nut (fig 2)

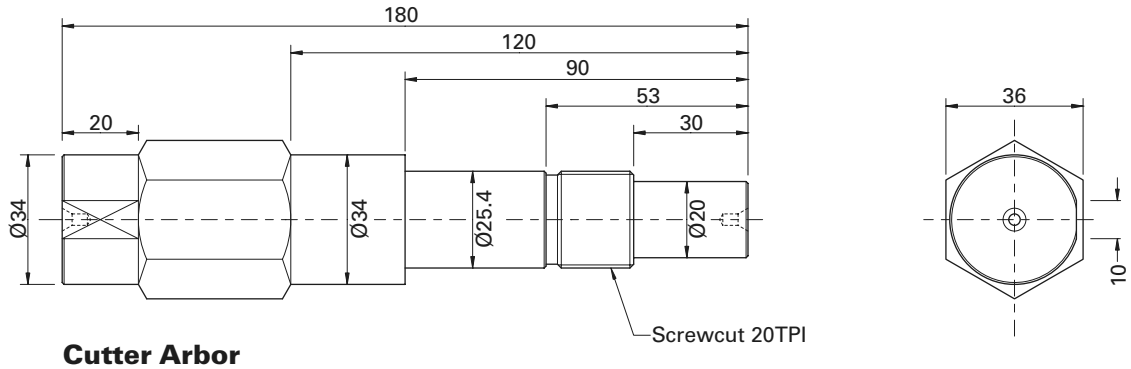
The locking face of this nut must also be flat and square to internal threads, again to ensure the true running of cutters in use. Use a 17mm length of the same material as for the arbor.

Fig. 1

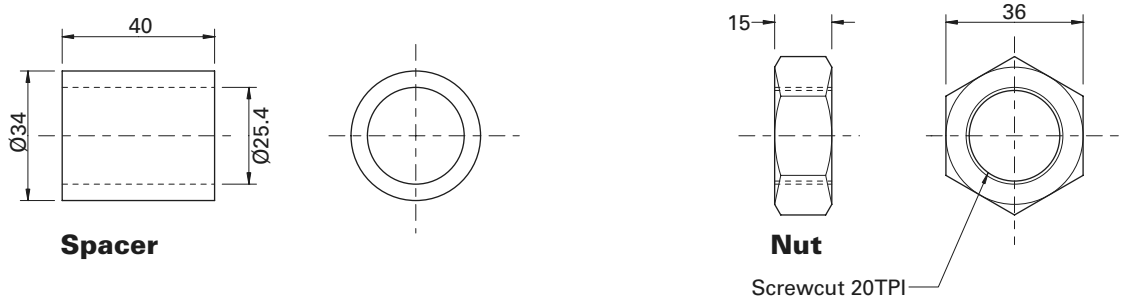


Slitting Fixture GA

Fig. 2

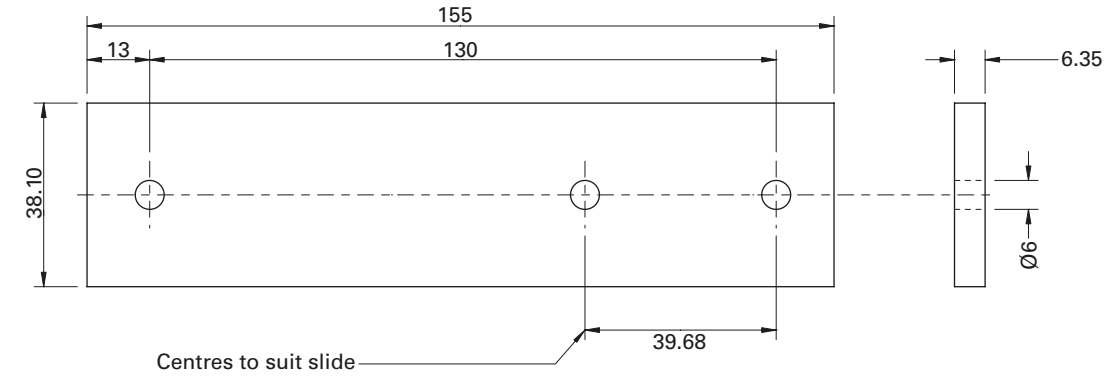


Cutter Arbor

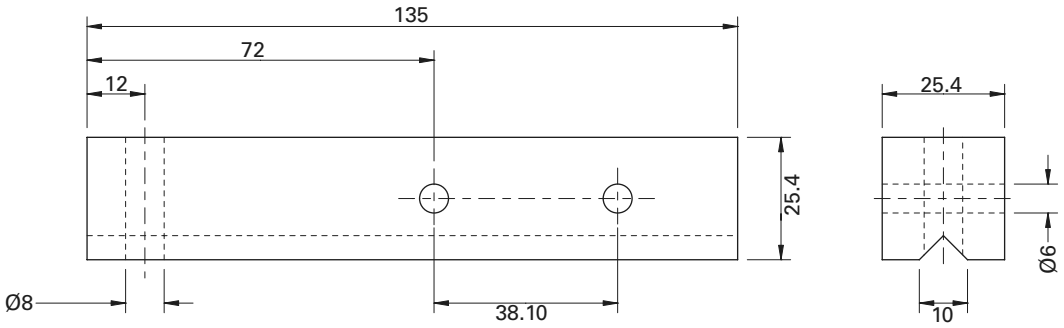


Spacer **Nut**

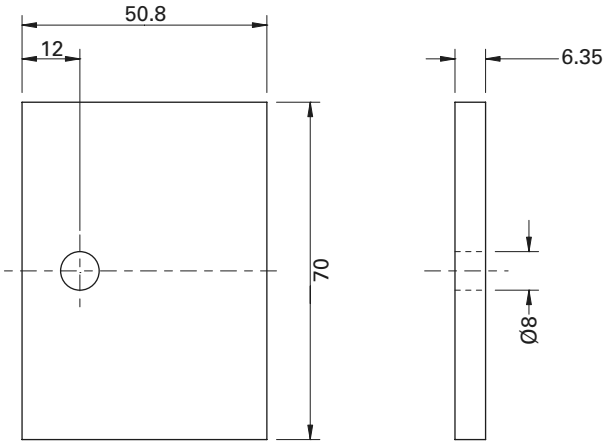
Fig. 3



Mounting Straps



Base Block



Platform

Chuck to run true, centre drill, drill through, bore to core diameter, screwcut 20TPI to fit arbor face front flat and chamfer corners and again file a small nick to identify the accurate face. Face to length and chamfer corners on second side, again go for parallel faces, or always use the nut in the marked direction, so that the known square face is in contact with the spacer prior to fully tightening.

Mounting Straps (fig 3) 2 Required

These are made from 38.1 x 6.35 x 157mm (1½ x ¼ inch flat stock) bright mild steel (BMS). Mill ends square and size to 155mm long, Drill to details, deburr and make safe all corners and edges.

Base Block (fig 3)

Use a 25.4 x 25.4 x 137mm (1 inch square stock) EN1A blank. Mill ends square and size to 135mm long, Drill to details, and mill v-groove centrally along one face only. Deburr and make safe all corners and edges.

Platform (fig 3)

Make from 50.8 x 6.35 x 72mm (2 x ¼ inch flat stock) BMS. Mill ends square and size to 70mm long, drill to details, deburr and make safe all corners and edges.

Clamping Strap (fig 4)

Use 72mm of the same material as for the base block. Chuck to run true, face flat, chamfer corners at 45 degrees to a full circle, reverse in chuck and repeat on second end, sizing to 70mm long.

Mark out, centre drill, drill 12mm diameter offset hole, deburr and make safe all corners and edges.

Stud (fig 4)

This is made from 102mm of steel M8 Allthread. Chuck to run true, face end flat, chamfer at 45 degrees, reverse in chuck and repeat, sizing to 100mm long.

Washer (fig 4)

Use 25.4mm (1 inch) diameter EN1A. Chuck to run true, centre drill, drill 8mm diameter, face front flat, turn to 24mm diameter, chamfer corners, part off at 6mm thick.

Adaptor Plate for Myford/Simonet (fig 5)

Start with a 132 x 90 x 16mm piece of bright mild steel plate. Mill ends of the blank square and size to 130mm long, mark out and drill 10mm holes, then drill and tap M8 holes. I turned a pair of headed bushes to fit the mounting holes in the vertical slide base. Two M8 cap screws pass through the bushes, locating and clamping the slide to this adaptor plate. Two 10mm t-bolts take care of clamping to the Simonet compound slide.

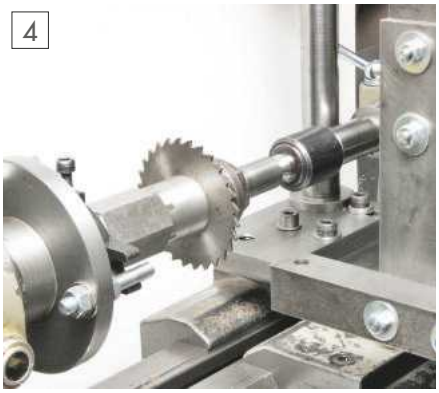
Setting up Lathe for Slitting

Set the lathe as if for turning between centres, with a catchplate and headstock centre, together with a revolving centre in the tailstock position. Place the vertical slide into position on top of the compound slide, clock the face of the vertical slide square to the lathe axis and fully tighten down. Secure the slitting fixture to the face of the slide.

Holding the cutter arbor by its hexagonal portion in the left hand, slide on a slitting saw, with its teeth pointing downwards, slide on the spacer with its marked end touching the cutter and screw on the securing nut, again with its known good face to contact the spacer. Grip the arbor in a bench vice and fully tighten the nut, a sharp tap on the spanner with a copper hammer will shock the nut fully tight. Secure the carrier to the arbor and carefully place everything onto the lathe centres. Take a quick glance to check the cutter teeth are pointing downwards at the front, with the carrier tail on the correct side of the catchplate driving pin. A short piece of copper wire or thick fuse wire, twisted around the driving pin and carrier tail will ensure contact is maintained between them at all times.

Alternatively use a grinding carrier which has a slot to span the driving pin, again keeping constant drive between items (**photo 4**).

4



Setting the lathe.

Using the Fixture

1. Slitting Collars and Components using a single stud to clamp

This is probably the most regularly used configuration, and is suitable for any component that can be clamped through a convenient hole (**photos 5** and **6**).

2. Slitting at the end of a Square Bar

This arrangement provides a method of end slitting long items (**photo 7**), also small components can be machined on the end of a bar, set up and slit on the lathe, then parted off later.

3. Slitting at the end of a Round Bar

By turning the base block over to put the v-groove uppermost, as shown in **photo 8**, round bar components can be clamped and slit. **Photographs 9** and **10** again demonstrate how small part machined items can be slotted whilst still on the bar, this is often the simplest way of holding such components.

Fig. 4

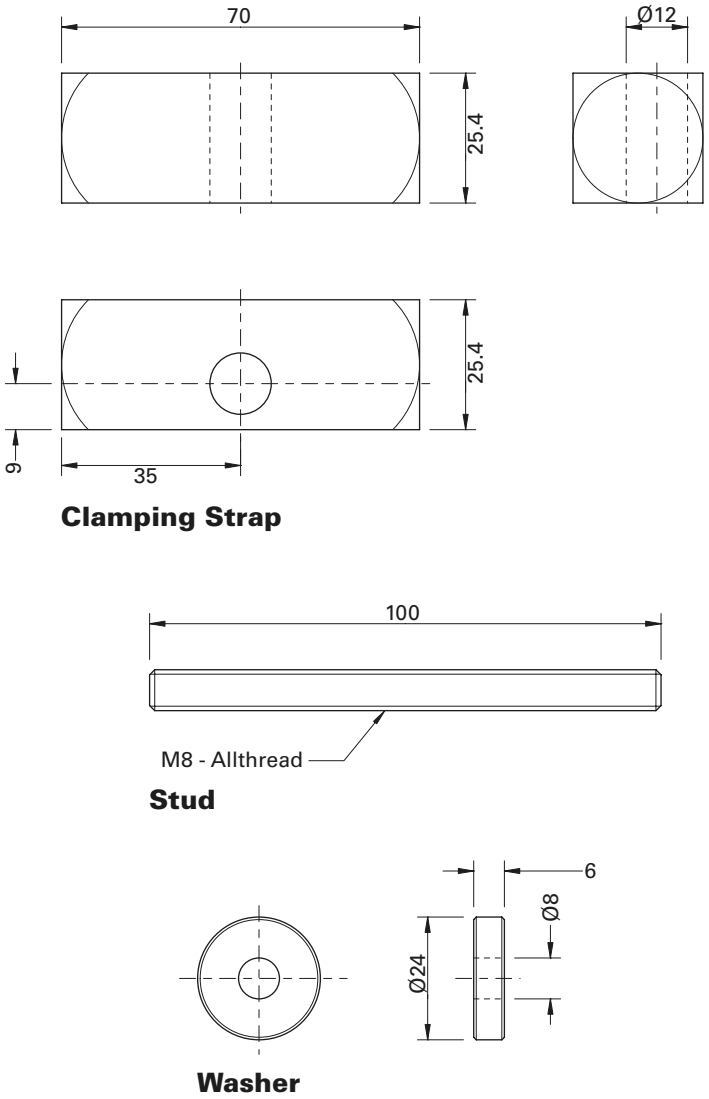
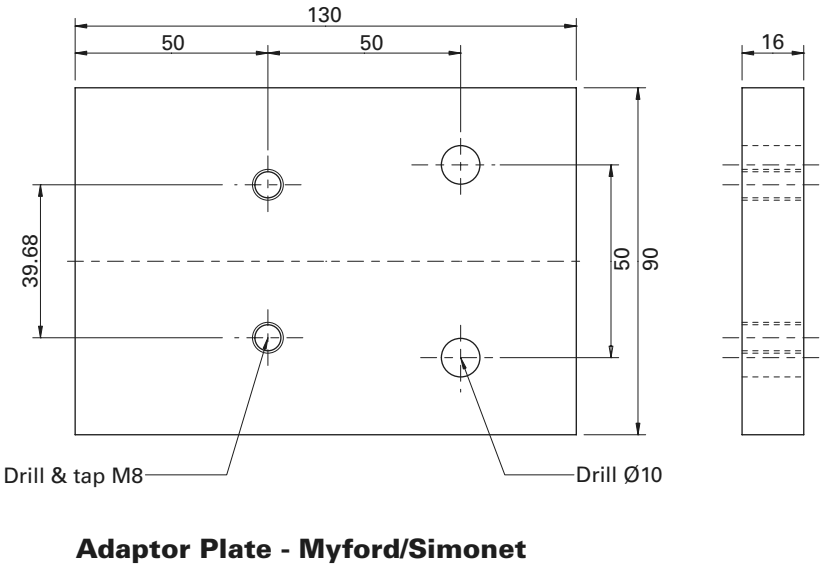


Fig. 5



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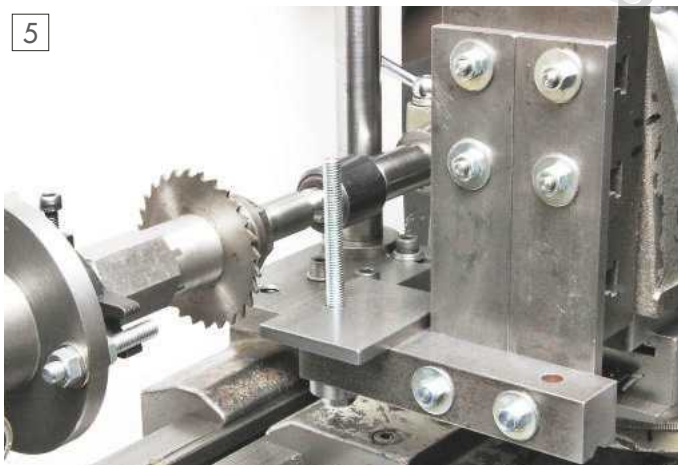
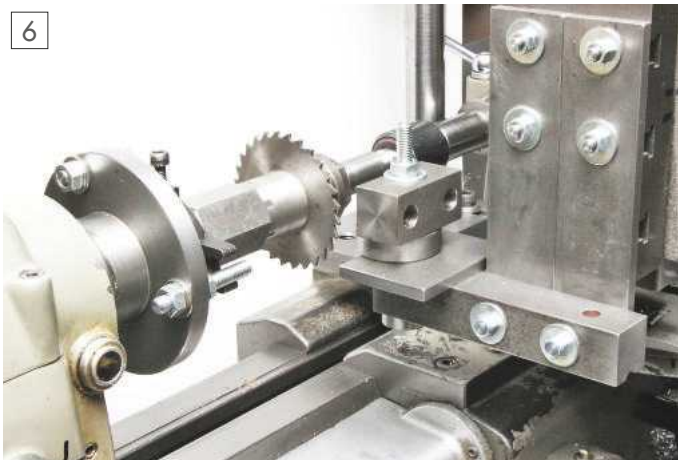


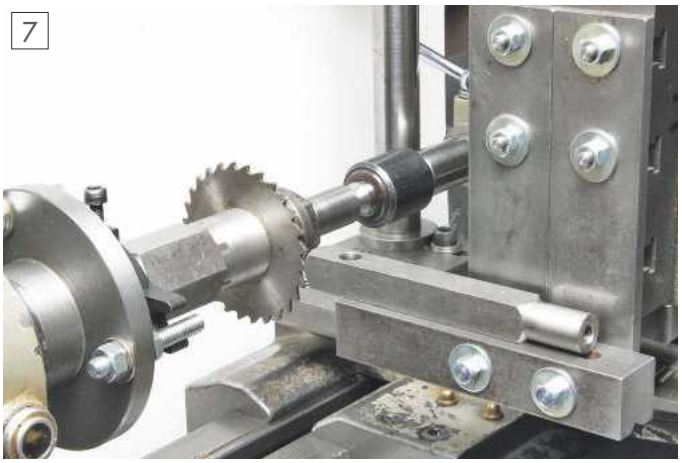
Ready for component.

6



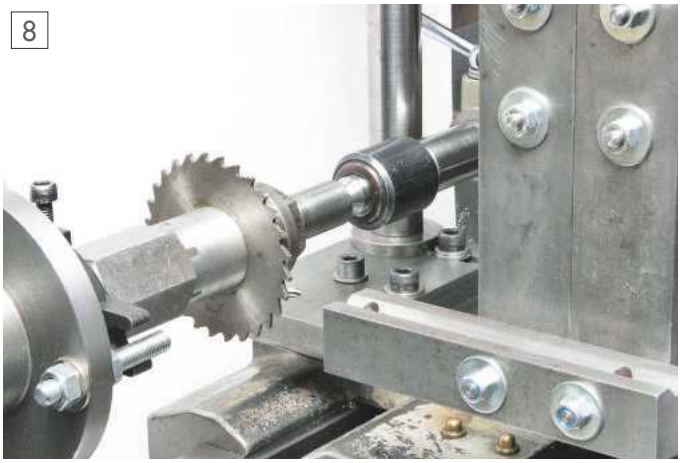
Securely clamped.

7



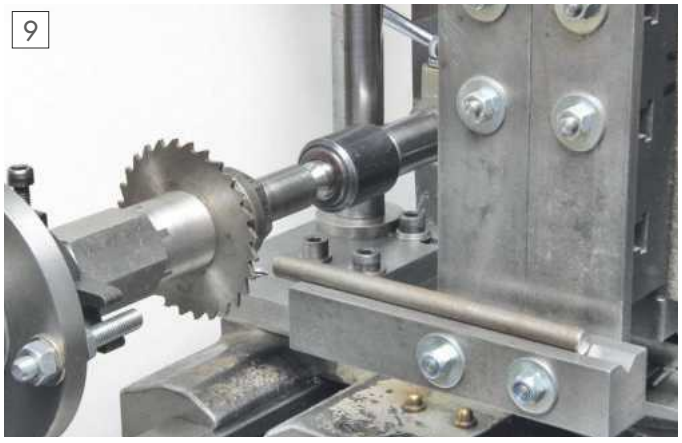
Square bar component.

8



Turn over base block.

9



Round bar component.

10

Method of clamping bar components.

Notes on Slitting Technique and Spindle Speed

Always mark out the position of a cut on a component before slitting. With a steel rule, edge on, across one face of the slitting saw, position the component to match. Fully tighten clamps, re-check the position and lock both the saddle and compound slide. Adjust the vertical slide to set the component on centre in relation to cutter and lock it.

All my machining is carried out dry without floods of coolant. I do, however, have a tin with a paint brush that sits in a drop of lubricating oil. This tin is always to hand whichever machine I am using, so from time to time saws, drills and taps etc. get a wipe from the brush to lubricate them.

I respect cutting tools, keeping surface speeds to middle of the road numbers, to match dry working conditions. When using a 3 inch diameter slitting saw as described - 40/50 Feet per Minute is ideal.

To find the RPM to get any particular speed in feet per minute for any cutter use the following formula:

RPM = FEET PER MINUTE x CUTTER DIAMETER [In Inches] x 0.42

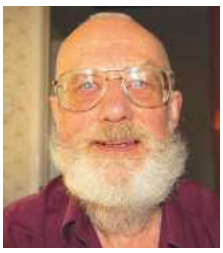
For a 3 inch cutter this gives:
50 RPM = ~40 FPM
63 RPM = ~50 FPM

Set the machine spindle speed to the above speed range. Apply a brush of oil to the stationary cutter and onto the component at the position marked for the cut. Take a glance around the set up and make that all is okay and the component is clear of the cutter. Switch on and start the machine, carefully advance the cross slide until the component touches the cutter. With both hands on the cross slide handwheel at all times, advance gently, feeling the cutting action.

Look over the fixture at the cutter to observe the distance travelled. Cutting forces are very light and you will soon be to depth and through the component. Wind the cross slide out and clear of cutter. Stop the spindle and switch off the machine. Undo the clamps and remove the completed component. Never reach over or apply oil from the brush with the cutter running -- it will only end in tears! ■

Any Number you Like...

Making a New Division Plate



Ted Knight offers a step-by-step guide to making 'missing' division plates.

A friend asked me to make a new gear wheel for his old and much loved audio machine. It has 79 teeth at module 0.3. My dividing head could not do 79 so I needed a new division plate. This is how I made the new division plate using a spreadsheet and the mill and also how to write a spreadsheet.

	A	B	C	D	E	F	G	H	I
1	Number	X	Y						
2	1	0.199	1.864			Number of divisions		59	
3	2	0.396	1.833			Radius		1.875	
4	3	0.589	1.780						
5	4	0.775	1.707			6.28318			
6	5	0.952	1.615						
7	6	1.118	1.505						
8	7	1.272	1.378						
9	8	1.411	1.235						
10	9	1.534	1.078						
11	10	1.640	0.909						
12	11	1.727	0.729						
13	12	1.795	0.541						
14	13	1.843	0.347						
15	14	1.869	0.150						
16	15	1.874	-0.050						
17	16	1.858	-0.249						
18	17	1.821	-0.445						
19	18	1.764	-0.636						
20	19	1.686	-0.820						
21	20	1.590	-0.995						
22	21	1.475	-1.158						
23	22	1.343	-1.308						
24	23	1.197	-1.443						
25	24	1.037	-1.562						
26	25	0.865	-1.664						
27	26	0.683	-1.746						
28	27	0.493	-1.809						
29	28	0.298	-1.851						

The new division plate and a print out of the spreadsheet.

Making the new division plate

I was able to get a slice off the end of a four inch diameter free cutting steel bar. This was clamped to the mill table with clearance behind for drill break-through. If you can get flat steel plate for yours it will be easier to clamp it clear of the drilling circle by using the corners. Mark the centre point and centre drill it. Scribe a circle at the radius of your intended drillings, not essential but a useful visual check when drilling. With the drill at the centre point, set X and Y dials at zero, noting the direction of backlash. Now it only remains to centre drill at each point as shown in the spreadsheet with the last one usually at twelve o'clock. With care, this can be done to an accuracy of one thou. If the centre drill does not break through then a clearance drill for the parallel part of the index pin can be used. A close fit on this is not needed because the locating action is with the angled surface of the pin.

The spreadsheet can also be used to position the clearance holes for the fixing screws. Change the number of divisions in cell H2 to 3. The columns of numbers will stay the same length but will be repeated every three lines. Measure the dimension between the three fixing holes on an existing plate. The radius of the fixing holes will be this dimension divided by 1.732 (the square root of 3). The centre of the plate can then be taken out, either with your boring head or in the lathe.

This spreadsheet is also useful for locating drillings on the mill table without the need for a dividing head.

Mounting the new plate

Attach the new plate to your dividing head and rotate the chuck to bring the degrees scale to zero. The position of the index pin is the location to stamp the number of divisions for that ring.

Writing the spreadsheet

In cell A1 put Number, in B1 put X and in C1 put Y. Next, in cells A2, A3 and A4 put 1, 2 and 3. Then put your cursor on cell A2 and drag it down to A4. This will show as all three cells shaded in a box. Put your cursor on the small square at the bottom right hand corner of the box and drag it down to the number of divisions you need.

In cell F2 put Number of divisions and in cell F3 put radius. I have chosen 59 divisions in cell F2 because it is useful in clock making if you have a moon dial (29 ½ days). In cell F3 I have put 1.875 because I work in inches but this spreadsheet will equally use millimetres if preferred. In cell F5 put 6.28318. This number is two times Pi and it is used because computers work in radians, not degrees.

Next, we need to do the calculations. For the X column put your cursor on cell B2 and drag it down the full length of the column. Then press the equals (=) key. The cursor will return to cell B2, ready to accept the formula. Key in $F$3*SIN ($F$5*A2/$F$2). Now hold down the control key and press Enter. What this formula means is – multiply the radius (F3) by the sin of 6.28318 times the number (A2) divided by the number of divisions (F2). The formula for the Y column is the same except we use COS instead of SIN. Put you cursor on cell C2 and drag it down as before. Press the equals key and key in $F$3*COS ($F$5*A2/$F$2). Hold down control.

This spreadsheet is also useful for locating drillings on the mill table without the need for a dividing head. If you would like a copy of the spreadsheet, send an email to **neil.wyatt@mytimemedia.com** with 'Spreadsheet' in the subject line. ■

22nd ANNUAL

NATIONAL MODEL ENGINEERING AND MODELLING EXHIBITION 2015

HARROGATE SHOWGROUND
MAY 8th 9th 10th

Ticket Office open 10am

Exhibition 10am - 5pm (4.30pm Sunday)

The National Model Engineering and Modelling Exhibition is one of the largest exhibitions of its kind in the UK and you are invited to look at this impressive list of clubs attending the show. Each stand will be displaying models built by members of the club with up to 60 exhibits on each stand. Members will be on hand to answer any questions you may have and are able to offer advice and give details of how to join your local group.

The National Model Engineering Exhibition is renowned for its huge specialist trade stand section.

THE FOLLOWING TRADERS WILL BE IN ATTENDANCE (additional traders likely)

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ALLENDALE ELECTRONICS
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LOCATION

The Great Yorkshire Showground is conveniently situated on the A661 Harrogate to Wetherby Road.

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Easy Access A1(M)
Leeds A61 York A59

BY RAIL:
Harrogate Railway Station. Connections to Leeds and York mainline stations.

BY AIR:
Leeds/Bradford Airport six miles.

BUSES:
A courtesy bus departs from Harrogate Bus and Railway Station on the hour from 9am till 2pm for the Model Engineering Exhibition.

Last bus from the Exhibition into Harrogate departs 5pm. (4.30pm on Sunday).

The National Model Engineering and Modelling Exhibition is one of the biggest exhibitions of its kind in the UK.

THE FOLLOWING CLUBS WILL BE IN ATTENDANCE

MODEL ENGINEERING

- York City and District Society of Model Engineers
- Leeds Society of Model and Experimental Engineers
- Hull and District Society of Model and Experimental Engineers
- Grimsby and Cleethorpes Model Engineering Society
- Bradford Model Engineering Society
- City of Sunderland Model Engineering Society Ltd
- West Riding Small Locomotive Society
- The Tyneside Society of Model and Experimental Engineers
- Pickering Experimental Engineering and Model Society
- Scunthorpe Society of Model Engineers
- Cleveland Association of Model Engineers
- South Durham Society of Model Engineers
- The Society of Model and Experimental Engineers
- Huddersfield Society of Model Engineers
- Brighouse and Halifax Model Engineers
- Keighley and District Model Engineering Society
- The Stirling Engine Society

RAILWAY

- Ground Level 5" Gauge Mainline Association
- Teesside Small Gauge Railway
- Association of 16mm Narrow Gauge Modellers
- The Gauge 1 Model Railway Association
- 7¼" Gauge Society

MODELMAKING

- The Guild of Model Wheelwrights

CLUBS AND ASSOCIATIONS

- Southern Federation of Model Engineers
- The Northern Association of Model Engineers
- London and North Western Railway Society

MODEL BOATS

- Kirklees Model Boat Club
- Claro Marine Modellers
- Rawdon Model Boat Club
- Teesside Model Boat Club
- York Model Boat Club
- Redcar Model Boat Club
- Tynemouth Model Boat Club
- Stewart Park Model Boat Club
- Leeds and Bradford Model Boat Club
- Wearside Model Boat Club
- Boat Building by Martin Ranson and John Abbott

MODEL AIRCRAFT

- West Yorkshire Model Aircraft Club
- Harrogate Model Flying Club

RADIO CONTROLLED TRUCKS

- Durham RC Scale Models

Club enquiries contact: Lou Rex on 01977 661998

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Under 16s	£3
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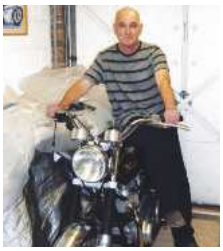


Adrian Filmer shares some useful tips and gadgets that have helped him in his hobby.

My main interest has always been classic British motorcycles, restoring, maintaining and riding them. Very early on it became obvious to me that a lathe was an absolute must. So some thirty odd years ago I bought a new Myford ML7R which I still have, and more recently a mill-drill. These two machines form the mainstay of my workshop. What follows are a few of the problems I have encountered and resolved.

Having equipment at your disposal means that you have control over the job being undertaken, you are not entrusting your precious part to someone else, hoping that they have understood what is required and will carry it out to your satisfaction.

I had for many years a 1939 ex-WD BSA M20 which provided me with all year round reliable transport. These old bikes have rear stands, and mine was so worn that when I was riding it the stand was constantly hitting the rear mudguard. Simple job I thought. I asked a local welder to build up the worn area of the stand with weld, I could then file it back to re-establish the required clearance. Upon collecting the stand I saw that he had welded the opposite side to that which I had requested, the outcome of which was that I then had a bike that I could not put on the stand unless it was pointing uphill. On level ground the stand was too upright and the bike would promptly roll off it.

Our small home workshop machines are sometimes asked to perform tasks bigger than their maker's intended. Often it's a flat refusal but sometimes they can be persuaded to cooperate.

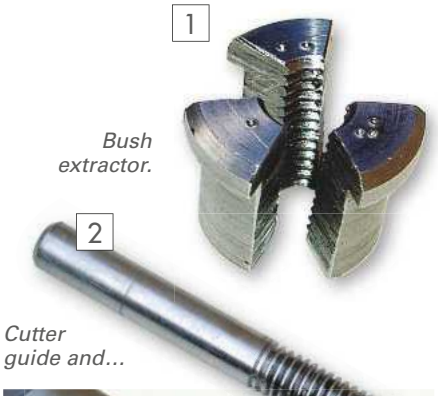
My current project is to rebuild my 1972 750 Norton Commando. I bought this bike about ten years ago, mechanically sound and in nice condition. After a little use it started to exhibit a propensity to leak oil from – well just about everywhere really, hence the need for a rebuild, and to weld a small crack in the crank case. Different welder this time.

With the engine rebuilt and left sitting on the bench I turned my attention to the gearbox. No real problems here but I wanted to reduce the amount of end float on the layshaft. I decided to accomplish this by turning a thin distance piece and fitting it behind the flange of the layshaft bush. The bush in question was in good condition so I wanted to re-use it if possible. It was however fitted into a blind hole, so how to extract it without damage? If it were to have been renewed it could have been tapped and extracted with a bolt and tube, bored out or split with a hacksaw blade until it collapsed. Although in a blind hole the bush itself was not blind and did not reach to the bottom of the hole, there being a few mm clearance here. The scheme I devised seemed on the face of it to be unlikely to succeed, but worth a try. In fact it worked beautifully, just a little fiddly to position.

Firstly I marked the bush and housing with a reference point so that it could be refitted in its original orientation. I then turned a steel top hat, drilled and tapped 8 mm. This was cut into six segments, alternate segments being discarded, the remaining three were marked to retain the correct thread sequence (**photo 1**). In use each segment was slipped into the bush in the correct order and held in place with a blob of grease. A piece of 8 mm studding was carefully started in the thread. Once fully engaged, with the aid of a small screwdriver the segments were evenly arranged and with a tube washer and nuts the bush was extracted.

Back to the engine sitting on the bench. It had leaked oil! This did not bode well; there was only a little assembly oil in it. I checked the drain plug, it was tight. Closer inspection revealed that the drain plug was not making full contact with the crankcase, it was tipped, touching on one side with a gap of maybe 20 thou opposite. It was difficult to be precise as the drain plug was partially shrouded in a counter bore. The crankcase thread had at some time been repaired with a ⅜ UNC helicoil but it had been poorly executed, the insert was not square to the mating face. Stripping the engine again was not an option; an in-situ solution had to be found. I decided to make a pilot guided re-facing tool. The pilot was turned to ⅜ diameter between centres and screw cut. Screw cutting between centres allowed me to achieve a stiff fit in the helicoil, as the work can be removed from the lathe to check on progress. With no movement in the pilot I now had a reliable guide (**photo 2**). The cutter (**photo 3**) was made using pieces of power planer blade Loctited into slots cut across the end. This proved most successful. In use I had intended inserting a short piece of steel into the hole which would bear on the end of the pilot; by shortening this a few thou at a time I could control the depth of cut. In practice this was not necessary as the 'uncontrolled' tool left a very acceptable surface finish.

Our small home workshop machines are sometimes asked to perform tasks bigger than their maker's intended. Often it's a flat



Bush extractor.

Cutter guide and...

...the cutter.

refusal but sometimes they can be persuaded to cooperate. So it was with this next job. Some years ago I wanted to turn some brake linings to fit the drums. I had extra thick linings (non-asbestos of course) bonded to my brake shoes, the drill being to mount the brake plate complete with shoes on the lathe, lock the shoes in the 'brake on' position and turn to fit the drum. By so doing a good brake is achieved from the outset without the need to 'bed them in'. Problem! The brake plate had to be swung in the gap of the lathe; that ruled out the chuck. The face plate couldn't be utilized either, because projecting features on the brake plate created too much overhang and the job fouled the bed. The problem was resolved by turning a 2MT-brake plate adaptor with a draw bar (**photo 4**) and by temporarily removing the back gear lever assembly sufficient clearance was obtained to do the job.

For one off or even occasional use the cost of a special tool can be difficult to justify. **Photograph 5** shows the mainshaft pinion puller I made, all materials supplied by the scrap box. The two retaining rings were made from old ball race outer tracks. These tools for one off use do not need to be elaborate, just functional, and there is a pleasure to be had from making and then using them and a potentially difficult job made easy. Making special tools produces better end results, it avoids injured fingers and butchered components.

Photograph 6 shows an oil seal guide tool which leads an oil seal over the end of a camshaft. **Photograph 7** is another guide tool. This one to lead a strong eyeless circlip over the end of a heavily splined gearbox shaft. The little time taken to make such a tool is handsomely repaid.

A tool for loosening/tightening a slotted bearing retaining ring, made from a short piece of scaffold tube is shown in **photo 8**. Easy to make, it gives the user a controlled feel to tightening which a hammer and drift does not always do, and the bonus of course is that it does not inflict wounds on the ring.

My leather swarf apron, attached to the lathe saddle, is shown in **photo 9**. A piece of old briefcase was cut and sandwiched between two steel strips and fixed with a single screw in the travelling steady mounting hole. The problem here is that swarf becomes trapped between the steel strips and cross slide. An experimental wiper was fitted, made from a plastic milk bottle. Fitted some years ago it proved so successful it has remained a permanent feature. The milk bottle plastic has shown no signs of degrading or breaking down in the presence of cutting oil etc., and maintains close contact with the cross slide, excluding swarf from the slide ways.

Finally a cautionary tale concerning an enthusiastic eighteen year old paint spraying in the garage. We'll call him – yes alright, it was me. Writing this now I marvel at the sheer stupidity of it and you will too. I had one of those model makers' spray guns which comprised of a spray head with a trigger into which screwed a glass paint jar and a canister of propellant. Ideal for spraying models, but not for bits of motor bike. After a short time of spraying, the canister would become very cold and condensate and the pressure would drop dramatically. I would then have to wait until the pressure returned to normal before spraying could resume. These frustrating delays were not acceptable, I'm young and impatient and want to get on with it. Idea!

Why not stand the canister in warm water? So I did, I filled one of those old fashioned enamelled jugs with warm water, you know the type, white with a blue handle and a blue rim, and spraying continued apace. As my confidence in this new system increased, so too did the temperature of the water (surprising that!) until the inevitable happened.

The explosion within the close confines of the garage was absolutely deafening and the silence which followed was total. My parents came out of the house because they thought Concorde was going over (sonic boom). The atmosphere was like an early morning mist which hangs over the fields. The canister had exploded whilst still in the water. Had I been holding it I would have lost my hand for sure; had I been looking at it I would have been blinded. Fortunately I was doing neither. The canister was flattened, the bottom blown out. The enamelled jug was in its three component parts, base, handle and body which was opened out into a gull wing shape, burst open at the seam. The garage walls were, and still are, coated in a mixture of black cellulose and shards of vitreous enamel and glass, 'nuff said. ■

4

Brake plate adaptor.

5

Pinion puller.

6

Oil seal fitting guide.

7

Circlip guide tool.

8

Slotted ring tool from a scaff bar.

9

Leather swarf apron.

Readers' Tips

This month's winning tip is from Greville Ferry. He wins £30 of Chester gift vouchers.

Welding Round Belt

Whilst browsing the trade stands at an Exhibition I noticed on the Peatol stand some round plastic belting, sold by the metre. I was interested as my Warco 918 lathe, though elderly has given me all I've needed in my late entry into model engineering, but the very narrow vee belts are not easy to come by in the lengths required. So I bought a couple of metres.

Mr Morrison explained the process of welding the join, as elaborated in the leaflet provided. This was to clamp an old kitchen knife vertically in the vice, heat it with a blow torch and holding the two ends of the required length of belting in each hand press them lightly onto the hot knife and slide them forward keeping them accurately aligned with each other for the hot plastic to weld together.

When I eventually tried this out I found it practically impossible to achieve an accurate alignment by sight, and even more difficult to hold the two ends steady while the plastic cooled and set.

Ho hum! What was needed I thought was some kind of jig to align the two cut ends reliably and hold them steady for a minute or so. This is what I came up with.

I made two little clamps out of scrap brass and epoxy glued them to the faces of a small 'quick-clamp' as seen in the accompanying photo. After a couple try outs I got the hang of it and satisfactory belts were produced quite easily.

Greville Ferry

This month's second runner up is Peter Matthews, with not so much a tip, as a tip-off. He gets a Digital Depth Gauge as a prize.

Ripe for Modification

On sale at Aldi at the moment are these 'Mini Grinders' they come with a grindstone at one end a buffing wheel at the other, and they even have a flexible drive and variable speed control. With a little bit of adjustment they could make a handy tool post grinder.

Peter Matthews

No more than one prize with a value of £30 will be given each month. By entering you agree your entry can be freely published and republished MyTimeMedia on paper or electronically and may be edited before appearing. Unpublished tips may be carried forward to future months. You will be acknowledged as the author of the tip. There is no guarantee that any entry will be published and if no publishable tips are received a prize will not be awarded. The decision of the editor is final.

We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'.

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!

This month's first runner up is Jacques Maurel, with some advice on joining round belting. He wins a copy of Chris Vine's *How Not to Paint a Locomotive*.

Through the Looking Glass

This is very useful when off-hand drilling in an awkward position (see photo). Fix the mirror on the workpiece (double sided tape for example), the drill is well aligned (perpendicular to the mirror plane) when the mirror image is in line with the drill bit. I use a piece of polished stainless steel sheet, but you can use a standard mirror and drill just to one side of it.

Warning: Be careful not to break the mirror as this will invariably result in 7 years of misfortune for you!

If ever you want to pass through the mirror, first read this reference book: *Alice's Adventures in Wonderland* by Lewis Carroll (1865).

Jacques Maurel

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Improvements to a Popular Bandsaw Part 2

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

Bandsaw clamp

These changes to the vice turn it into a very versatile system for holding all manner of work. However for very small work pieces it is often more convenient to use the clamp shown in **photo 15**. This clamp simply clamps into the bandsaw vice. The advantages of this clamp are that small work can be set up on the workbench and then transferred to the bandsaw for cutting. The clamp has a vee block at one end that facilitates setting up round work for cutting whilst the other end of the clamp is better suited for flat work pieces.

The bandsaw clamp.

A general view of the bandsaw.

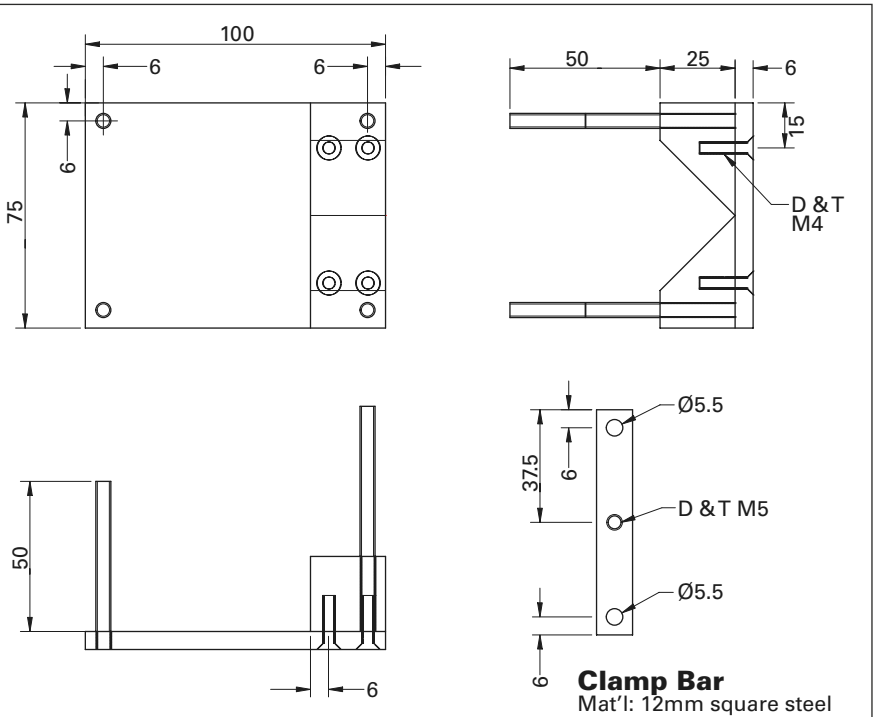


Fig. 6

The clamp was very easily made, see **fig. 6**. The base was just a scrap of 6mm plate 75 x 100mm. The vee block was fabricated in two halves by cutting a piece of 25 x 25mm bar at a 45 degree angle using the bandsaw and mounting the two pieces on the plate. In my case this made a fairly accurate vee block but this depends greatly on the accuracy of the saw. If necessary then the two angled ends of the bar can be milled so that the angles are identical. The clamp bar was made from a length of 12mm square bar. The central screw can be used to secure thin rods into the vee block. The threaded rods in the four corners of the clamp are just lengths of M5 studding that are fixed in place with epoxy resin.

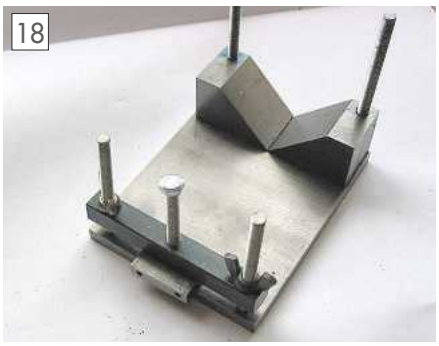
Photograph 16 shows a substantial piece of 50mm steel bar and **photo 17** shows a short piece of 10mm bar mounted in the clamp. **Photograph 18** shows how small pieces of flat material can be mounted for cutting and **photo 19** shows the clamp mounted in the vice and cutting in progress.

The bandsaw hydraulic cylinder

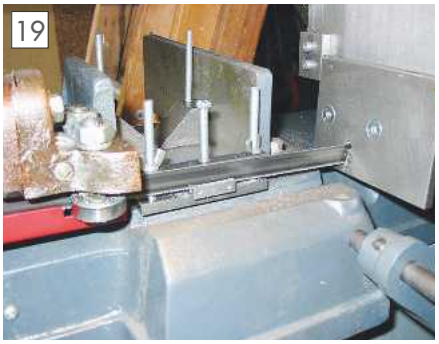
This was very much inspired by an article by David Fenner in *MEW* 126, describing a hydraulic cylinder for a bandsaw. I was enthusiastic to build such a cylinder because it is quite difficult to cut thin

Clamping a 50mm bar.

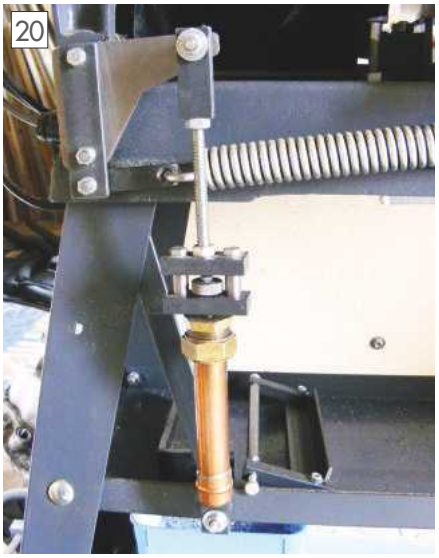
Clamping a thin bar.



Clamping a flat bar.



The clamp in use.



Bandsaw arm down.

Bandsaw arm up.

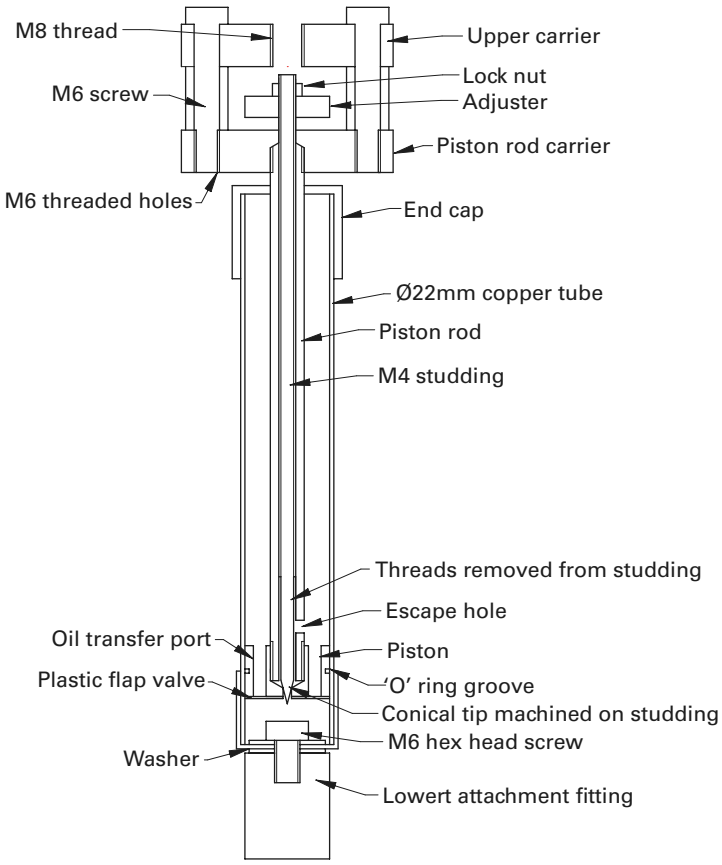
walled tubing and other thin components with the standard saw's spring counterbalance system. However, when I costed the components for the Dave Fenner design it ran into tens of pounds. After a little thought I realised there was a much cheaper way to make a hydraulic cylinder based around readily obtainable plumbing components.

The finished cylinder, mounted on the bandsaw is shown in **photo 20**. This photo was taken with the bandsaw arm down for horizontal cutting. **Photograph 21** shows the cylinder with the bandsaw arm raised. The bottom end of the cylinder is attached to the bandsaw stand shelf. All the weight of the saw arm acts on this attachment point so the shelf needs to be strengthened.

The cylinder itself is made from a length of 22mm copper pipe, as used for domestic plumbing. Copper pipe is extruded and it has a smooth, round internal bore so it is ideal for this application. The end of the cylinder is closed by a standard 22mm stop end soldered onto the pipe. The top end of the cylinder is closed with a standard 22mm compression stop end fitting. The main purpose of this component is not to seal the top but to act as a guide for the piston rod that connects to the piston in the cylinder. The piston rod connects to the piston rod carrier. The piston rod carrier connects via two spacers to a second carrier that links to the bandsaw arm. Between the two carriers is a knurled thumbscrew that operates a needle valve at the base of the piston rod that controls the flow of oil from one side of the piston to the other and thereby controlling the rate of descent of the bandsaw arm. It should be noted that the normal spring counterbalance system can still be used to control the downwards force of the blade on the work being cut but the rate of descent is controlled by the hydraulic cylinder.

Figure 7 shows the general assembly of the cylinder. The piston and piston rod slide up and down in the cylinder. As the piston rod is lifted oil can pass rapidly

Fig. 7



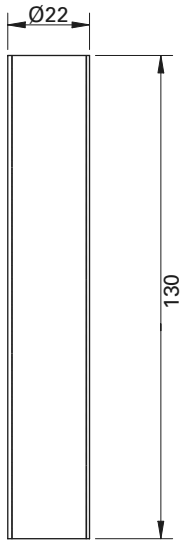
Cross Section Of Hydraulic Cylinder

through the transfer ports in the piston via the flap valve. However, when the piston rod is pressed down, the flap valve closes and the oil must flow slowly through the needle valve in the bottom of the piston. The opening of the needle valve can be controlled by screwing the needle up and down with the adjuster knob.

Making the hydraulic cylinder

The cylinder (**fig. 8**) is made from a 133mm length of 22mm copper pipe. Both ends were faced off in the lathe and the length reduced to 130mm. The ends of the tube were carefully deburred and polished with steel wool. A standard 22mm stop end was taken and soft soldered to one end. To do this the stop end was cleaned internally with steel wool. The end of the tube and the stop end were lightly coated with an active flux and then pushed together. The joint was heated slowly in a blowtorch and the junction of the two parts prodded periodically with some solder wire. Once the solder

Fig. 8



The Cylinder
Mat'l: 22mm copper pipe

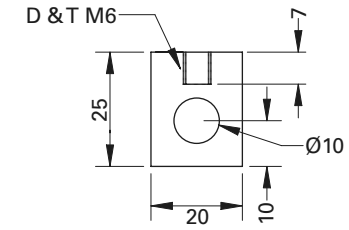
It should be noted that the normal spring counterbalance system can still be used to control the downwards force of the blade on the work being cut but the rate of descent is controlled by the hydraulic cylinder.

was seen to melt then it was fed into the junction until it was seen to flow right round the joint. Whilst hot excess solder from the joint was wiped off with a pad of steel wool. Once cool the tube was washed thoroughly with plenty of water to remove any excess flux. The tube was then chucked in the lathe and the closed end was centre drilled and then drilled out to 6mm. Using a large drill I deburred the hole on the inside of the tube.

The lower attachment fixture (**fig. 9**) was made from a 25mm length of 10 x 20mm steel bar. This was drilled out and tapped as shown in the drawing.

The cylinder was attached to the lower attachment fixture using a M6 x 10mm screw and two heavy washers, one inside and one outside the cylinder. The fixture was held securely in the bench vice and the screw tightened hard down using a socket on the end of an extension.

The piston rod (**fig. 10**) was made next. A 125mm length of 8mm round steel was chucked in the lathe. The end was faced, centre drilled and then drilled with a 4mm drill for as deep as it would go. It was then turned around in the chuck and the



The Lower Attachment
Mat'l: 10 x 20 M.S.

Fig. 9

operations repeated. The drill was changed to a 4mm long series drill and the drilling continued until the hole connected with the hole from the other end. This drilling of the piston rod takes a long time because it is necessary to withdraw the drill often to keep the deep hole clear of swarf. Both ends of the piston rod were threaded M8 using a tailstock dieholder as indicated in the drawing. The piston rod is cross drilled with a 3mm drill, 12.5mm from the end, to provide an escape hole for oil passing through the piston.

The piston (**fig. 11**) was made from a length of 25mm steel round. This was chucked in the lathe and the end faced off. It was centre drilled and drilled out 2mm diameter for a depth of 15mm. This hole was opened out to 6.8mm for a depth 10mm and tapped M8. The tapping was finished off with a plug tap to ensure that the hole was threaded to the bottom. The piece was then parted off at 12.5mm.

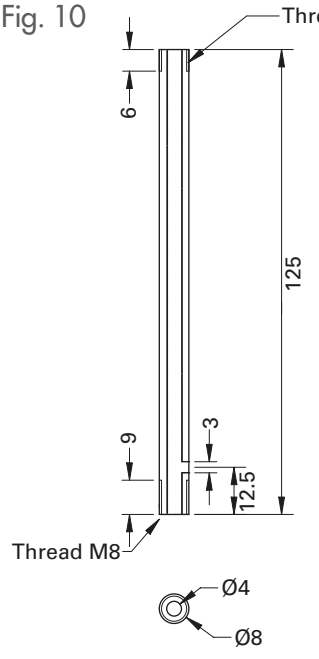
The piston rod and piston were both degreased and the threads on the piston rod were lightly smeared in epoxy resin. The piston was screwed on to the piston rod and it was tightened up. This assembly was left for the adhesive to set. The assembly was re-chucked in the lathe by the 8mm piston rod and the end of the piston was faced off and the piston length adjusted to 12mm.

The outside diameter of the piston was reduced until it was an easy sliding fit in the cylinder. The O-ring groove was cut using a parting tool with a width of 1.6mm. The depth was determined by trial an error. The groove was originally cut about 0.5mm deep and a 1/16 x 1/2 inch O-ring stretched into the slot. It was then tested with the cylinder to see it would enter. It would not and the groove was deepened a little more and the fit re-tested. After a few cut and test operations a good fit of the piston in the cylinder was obtained. The measured final depth of the groove was 0.9mm. Before removing the piece from the lathe the end face was scribed with two lines at right angle to each other.

The end face was then marked up for drilling the holes in the piston. The hole centres are 3.5mm from the edge of the piston. This distance was marked using jenny callipers at each end of the scribed lines. The four intersections were then marked using firstly a prick punch and then a centre punch. Two opposing marked positions were then drilled out all the way through the piston using a 3mm drill. The other positions were drilled out 2.5mm. These two holes were then tapped M3. All the holes were carefully deburred.

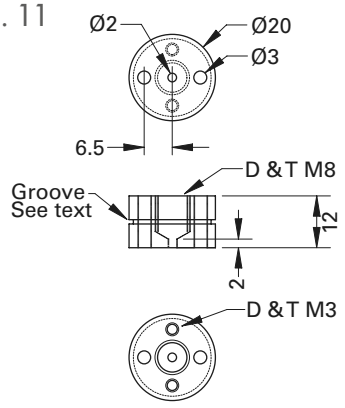
To be continued...

Fig. 10



The Piston Rod

Fig. 11



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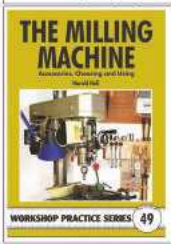

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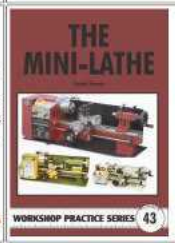

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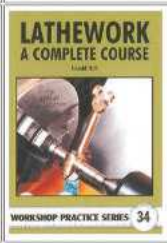

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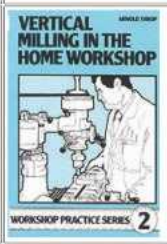

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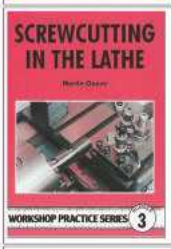

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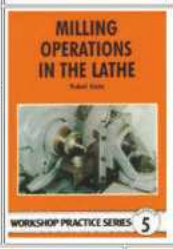

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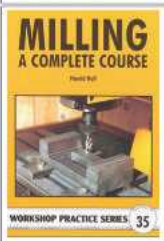

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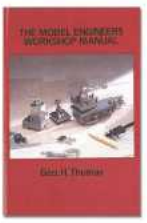

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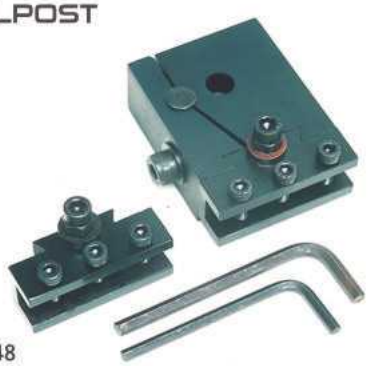

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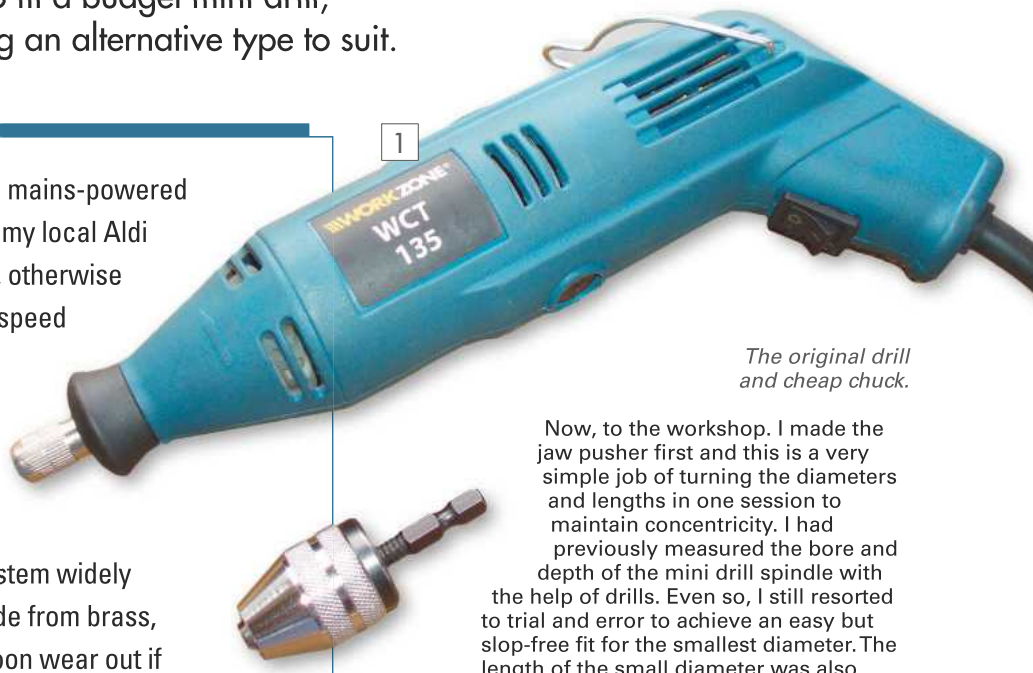
A Drill Chuck for a Budget Mini Drill

Unable to buy a proper chuck to fit a budget mini drill, Alan Wain resorted to modifying an alternative type to suit.

A few years ago, on a whim, I bought a mains-powered budget mini drill on 'special offer' from my local Aldi supermarket; it must have been cheap, otherwise I wouldn't have bought it. The drill has speed control and has been very useful for intricate grinding and cut-off jobs, as well as proving its worth under my ageing car on more than a couple of occasions. In my opinion, the tool is let down by the poor collet chuck system widely used with these mini drills. Usually made from brass, the collets don't grip very tightly and soon wear out if the tool spins. Also, to use a reasonable range of drills, special types are required on a common size shank.



1

The original drill and cheap chuck.

Although not difficult to make, replacement collets purchased commercially seem outrageously priced for what they are and I have resorted to making some when I ran out. I browsed the internet for a proper chuck to fit mini drills but could not find one suitable for the 8 x 0.75mm thread on the spindle of my example. What I did spot during my search, were small chucks with a ¼-inch hexagonal drive, sometimes referred to as 'screwdriver chucks' because they fit battery-powered screwdrivers. This jogged my memory that I actually owned such a chuck that had languished, unused, in a drawer for so long that I can't remember how or why I had acquired it. The unmodified drill and hexagonal drive chuck are shown in **photo 1**.

Duly resurrected from idleness, the chuck was taken apart to see how it could be modified for use on the mini drill. The first thought was to simply drill out the backplate and re-thread to fit the 8mm spindle. However, after careful measurement I realised that this wouldn't work because the mini drill spindle is too short, and 4mm of the available 14mm of thread are shrouded by the nose of the drill body. The disc that pushes the jaws to close them would have to be extended to meet the tip of the mini drill spindle. The measurements also revealed that axial travel of the jaws is 8.25mm from open to closed, leaving only 5.75mm of thread engagement with the spindle when fully open. Drills larger than 4mm are unlikely to be used with my mini drill, so I settled on this as an approximate maximum capacity, thereby reducing the required axial travel to 6mm. This would give a minimum thread engagement of 8mm. An essential requirement would be to use the thread shrouded by the mini drill body. This could be achieved in three ways: reducing the unthreaded portion of the backplate; adding a threaded spigot to enter the mini drill body and removing the overhang from the nose ring. This combination addressed the thread/travel requirements but the shaft is still too short to push the chuck jaws closed, hence the extended 'jaw pusher'. **Figure 1** shows the general arrangement and components designed according to the measurements made. The 4.95mm spigot on the jaw pusher keeps it co-axial with the end of the spindle and shares the closing force to prevent possible distortion of the spindle tip.

Not having the 8 x 0.75mm metric fine tap needed, the job had to wait a couple of days until my order arrived from Chronos.

Now, to the workshop. I made the jaw pusher first and this is a very simple job of turning the diameters and lengths in one session to maintain concentricity. I had previously measured the bore and depth of the mini drill spindle with the help of drills. Even so, I still resorted to trial and error to achieve an easy but slop-free fit for the smallest diameter. The length of the small diameter was also finalised by trial and error, turning small amounts off the end, trial fitting and checking with a loupe for zero gap between the 7.5mm diameter and the tip of the spindle. With no gap, both diameters should be bearing on their respective parts of the spindle. After parting off (I hack-sawed mine off in the vice) I reversed in the chuck to face off.

My first attempt at the backplate ended in disaster whilst turning the spigot after reversing in the chuck. Being cautious of damaging the threads, although protected, I clearly didn't tighten the chuck sufficiently and the work twisted and was ruined. For the second try, I machined the part the opposite way around so as to turn the spigot first. The only problem with this is that the chuck body could not be 'tried' for a good fit; therefore the threading operation had to be done carefully to ensure the correct depth of thread. From thread data charts for standard metric threads of 1mm pitch, I established the difference between maximum and core diameters to calculate the required in-feed of 0.615mm. By keeping cuts very small and making three or four passes at the final in-feed, I achieved as near perfect a fit as I have ever managed. Cutting threads on a Hobbymat lathe is tedious because there is no clasp nut on the lead-screw. This means the cutter must be wound out and the spindle reversed to return the tool to the start of the thread each time before putting on the next in-feed. For that reason, I was exceptionally pleased with myself for successfully cutting my first

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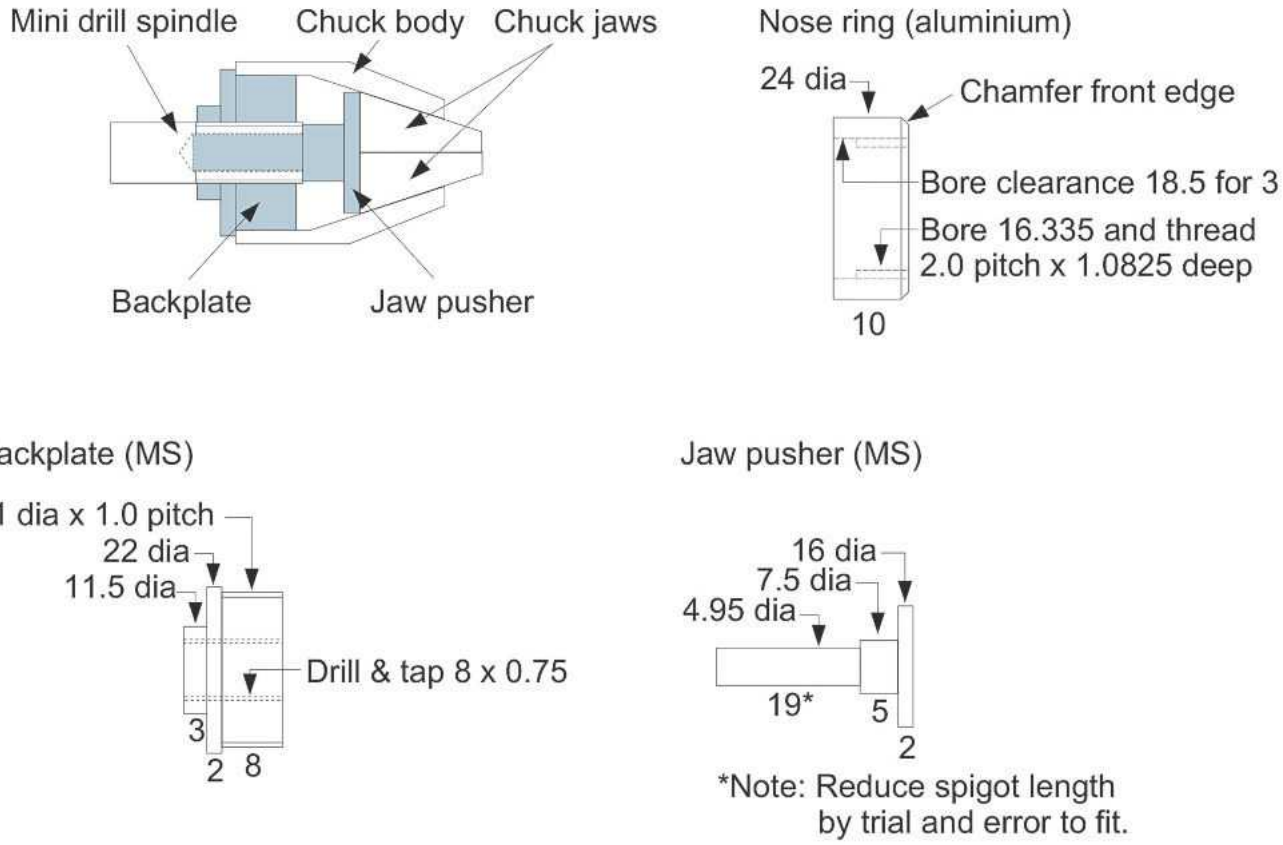
Fig. 1

General Arrangement
(not to scale)



thread by dial only. Although parted off in the lathe, instead of re-chucking to finish the face, I filed the inside end whilst holding in soft vice jaws. I didn't want to risk a repeat of the previous attempt.

After assembly the chuck worked well, closing fully whilst using the full length of spindle thread (**photo 2**). The last part of the modification was to reduce the length of the plastic nose ring. The thread moulded into the original is limited to two opposing sections. This and the curvy outside shape influenced the decision to make a new ring instead of shortening the original. The nose ring thread measures 18.5 x 2.0mm and, being a through thread rather than blind, I thought it would be a good exercise for my first foray into internal threading in the lathe. I also thought that nylon would be a forgiving material and a good substitute for the moulded plastic original.

I had two unsuccessful tries at this. Despite putting in plenty of time grinding a threading tool and mounting it to allow for the helix angle, the resulting parts just wouldn't screw onto the nose of the mini drill. In fact I bruised the first turn of the male thread whilst trying to screw on a ring that I was convinced should fit. I have since read on forums that nylon is not the easiest of materials to work with.

I settled for making the part from aluminium, leaving the outside diameter parallel in case there is a future need to mount the mini drill. **Photograph 3** shows the manufactured chuck components and replacement nose ring, along with the redundant original chuck parts in the background.

What does it work like? Quite well as it happens. I have no idea how concentric the chuck itself is but Swiss watch accuracy can hardly be expected of an item available new on eBay for as little as £4. Consequently, I see little value in trying to measure run-out, especially for a tool that will almost always be hand-held. It does seem to run smoothly with no noticeable wobble at drill points.

All in all this has been a successful and satisfying project. At least now I don't have to make new collets for my mini drill before I can use it. ■

The new chuck fitted to the drill.

The new and old components.

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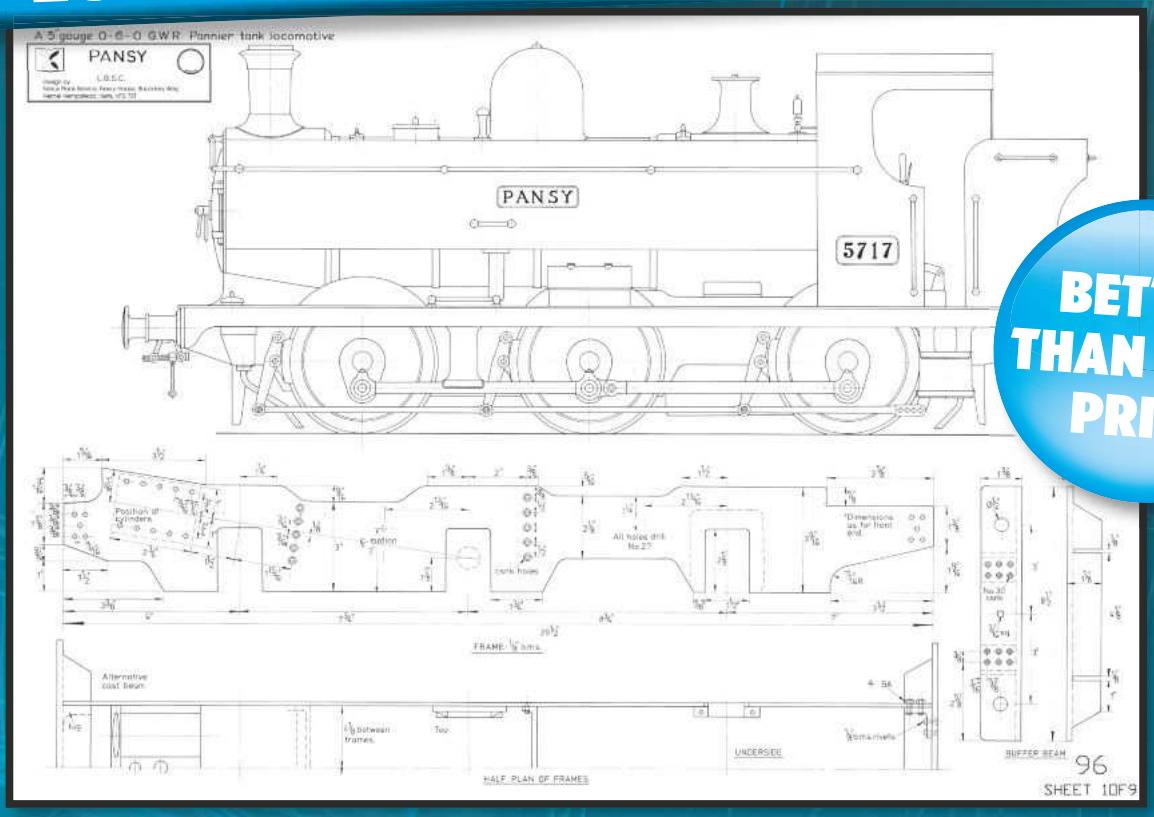

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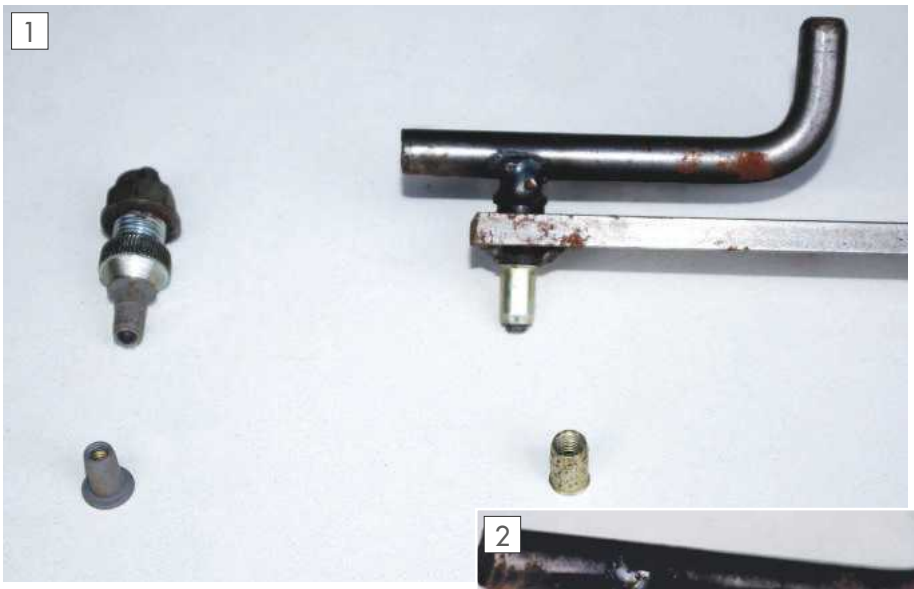
An introduction to Part 3 Sheet Metal Work

Dave Fenner concludes this occasional series.

In this final section of this overview of basic sheet metal work, we will consider ways and means of holding pieces together. Items which are intended to be dismantled again may be attached by screws or bolts, while those intended to be in place more permanently may be riveted, soldered, brazed, welded or glued. Industrial processes, such as lock forming and non-penetrating riveting, are well outside the reach of most home workshops so they will not be discussed. There are also many situations where something else has to be attached to a sheet metal part, so we will touch on means of adding screw threads to thin sheet material.

Nuts bolts and screws

Regular nuts and bolts, will be familiar to readers, and therefore need no particular comment. Normal self-tapping screws are simply driven through a predrilled hole, forming a thread in the process. Thin sheet may produce only a turn or so of thread thus the joint has limited strength. Two basic approaches exist to give greater load carrying ability. The first relies on the hole being created by deformation rather than cutting, using a process known as friction drilling. This can be undertaken using a special bit fitted to a sufficiently powerful drill press. One of the firms specialising in this is Flowdrill, and their kit will form holes in sheet or thin tube which then allows for several turns of thread to be formed either with a self-tap screw or conventional tap.



M4 and M5 nutserts shown with the tooling to pull in.

The second approach relies on adding a threaded part, which may have either male or female thread. Stud welding is a widely accepted industrial process and one technique uses a stud featuring a centre pip, to create the initial contact. The welding kit can use capacitive discharge circuitry, and when fired, melts the pip and some of the head and sheet metal to give a secure attachment. One claim for the process is that the reverse side of the sheet is not marked.

Rivnuts and nutserts come in two basic forms. The first is simply pressed into a predrilled or punched hole, and press force is sufficient to deform the sheet around the rivnut, (which is shaped with serrations) locking it into place. The second type is fed through the hole, then either pulled using a threaded tool, or pressed from the reverse side. **Photograph 1** shows two of the pull in type (M4 and M5) with home brewed insertion tools. **Photograph 2** shows how the nutsert has deformed when pulled in.

For the amateur who has welding kit, it can be straightforward to simply weld a nut in place. For applications such as car seat belt mountings, the nut would typically be welded to a thick plate which is in turn attached to the body. In model making, small nuts might be attached using either soft or silver solder, although in the smaller sizes, the thickness of the sheet may provide sufficient engagement for a normal tapped thread.

Deformation of M5 nutsert.

In modern car production, there are many styles of captive nut, those shown in **photo 3** may be used to attach front wings. Although there is relatively limited thread engagement, (less than a turn) the material is a high strength steel, and therefore considerably more effective than a regular self-tapper driven into the mild steel wing or body material. The metal used also seems to corrode more slowly.

For low strength automotive attachment, typically for trim, there are various plastic inserts and rivets, some of which are locked in place by pushing in a central pin. Others are locked by screwing in a self-tapping screw. There is also a range of spring clips which may be used for various purposes such as on door cards. These may bear directly on a hole in the metal, or can be fitted with a plastic blind tube. Others are intended to secure brake pipes or cables to a metal edge. A selection of these is shown in **photo 4**. Bresco Vehicle Services is a highly reputed supplier of a wide range of these types of components; their website is www.bresco.com

3

Captive nuts, two shown with screws, the third has double engagement design.

4

Various metal and plastic clips. Clockwise from top left : 1 & 2 clips for door cards, 3 may be used as hole liner for 2, 4 secures brake pipe to edge of sheet, 5 expanded by screw e.g. for headlamp retention.

5

Several 3/32in. rivets with home made snap.

Rivets

Prior to the development of cost effective and reliable welding techniques, most structural iron and steel fabrication relied heavily on rivets to hold parts together. Many styles of head were developed together with well-established design criteria for loading, spacing etc. For the purpose of this article, it is proposed to limit the scope to the small solid rivets typically used in model making e.g. locomotives, and those used for specialist automotive work – usually 'pop' rivets.

The process of fitting a rivet involves several stages – putting the rivet of appropriate length in the hole and pulling the sheets together – compressing the rivet to fill the hole creating an interference fit – and finally forming the head. **Photograph 5** shows a few 3/32 inch rivets and the associated snap, (made from a bolt) left over from constructing running boards for a 7¼ inch gauge Royal Scot some 30 odd years ago, (hence the slightly rusty appearance). My recollection is that our tooling was very rudimentary, just rivet snap to support the head, and hammer to compress and shape the rivet. The underside was hidden from view and we sought a strong joint rather than an exhibition finish. A neater result can be obtained with a succession of shaped punches, as described by Peter Wright in his excellent book *Model Engineering – a Foundation Course*.

Whilst often frowned upon for car repairs, blind rivets, usually known as pop rivets, are easily applied from one side only, and can thus be used to join sheets of metal or attach a sheet to a tubular frame. This may also involve joining dissimilar metals such as aluminium and steel, and applications may be found on Land Rovers and various older designs of racing cars. These rivets are fitted using a dedicated gun, which pulls a headed mandrel through the tubular rivet, compressing it and expanding it on the reverse side. When the tensile limit of the mandrel is reached, it breaks off leaving the head and a short stub within the rivet. One criticism of the standard pop rivet is that it allows fluid leakage. Versions have therefore been developed which provide a sealed joint. **Photograph 6** shows a selection of 3/16 inch aluminium rivets also a gun with a compressed rivet.

3/16in. Pop rivets with rivet gun. Gun has interchangeable noses for different rivet sizes.

6

Carrs fluxes, also solder paste.

7

Soldering and brazing

These are both processes where a metal whose melting point is lower than that of the work, is melted and effectively used as a glue to hold the parts together. Here I will regard soldering as the lower temperature soft soldering, and brazing as the higher temperature operations encompassing silver soldering and brazing. For all types of soldering, a basic requirement is cleanliness. Just as with glue, the presence of dirt, oil, or oxide can prevent the formation of a secure bond.

For thin gauge brass and tinplate, soft soldering can be the preferred option. In recent years, solder has become lead free, and some say, a bit more difficult to work with. Having secured a good supply of the old fashioned stuff, I cannot confirm this. One factor which can have a bearing on the ease and effectiveness of the process is the choice of flux. Carrs is a firm producing a range of fluxes for different metals. Some of these are shown in **photo 7** together with a

›

Temperature controlled soldering iron with selection of tips.

For heavier work, a 125 watt electric and 100 watt gas soldering iron.

Propane cylinder, torch, interchangeable heads with older paraffin blowlamp.

Gas welding torch.

Twin carbon arc torch is powered by a basic arc welder.

pack of solder paste which can be a useful alternative to wire solder. Different weights of metal will also call for different powers of soldering iron. In the past it might have been necessary to have a small 15 watt iron for delicate work including electronics, something larger for model aircraft parts (say 30 watts), and still larger for car radiators. Modern developments have produced affordable temperature controlled irons such as that shown in **photo 8**. The desired temperature is dialled up, and within the power limitation of the device (60 watts), held within close limits. A range of interchangeable tips covers very fine to coarse work. If more power is needed then something like the 125 watt electric iron or the 100 watt gas powered version both shown in **photo 9**, might be the answer. Higher power still may be obtained from a plumber's blowlamp, or the propane torch noted below.

Historically, much model boiler making work was undertaken using petrol or paraffin blowlamps to work with silver solder. Nowadays, these have given way to propane torches, which are more controllable and can be fitted with alternative flame heads to suit the size of the work. **Photograph 10** illustrates a propane torch, the alternative heads, and gas cylinder, with an old paraffin blowlamp in the background. It is certainly possible to use other heat sources for these processes such as oxy- acetylene, carbon arc, or TIG, however they will be considered later under welding.

Soldered and brazed joints will frequently be constructed as lap joints thus giving a good area of 'glue metal' which can be loaded in shear. This may be contrasted with a butt joint where the stressed area could be just the thickness of the material multiplied by the joint length. Others with more relevant experience have written on the 'how to' of soldering and silver soldering. Here I will restrict my advice to stressing the need for cleanliness.

Alloy wire is available for aluminium soldering. I have seen this process demonstrated at several model engineering shows, and the clearly experienced protagonists make it look easy. Again, this is something I have not tried.

Welding

The welding process differs from brazing and soldering in that both the filler material and the parent metal are melted and fused together. Going back a few years, welding outside major factories, would have been either oxy-acetylene or electric arc (otherwise known as stick welding). The falling cost of equipment has now brought MIG and even TIG welding into the realms of the amateur workshop. Car factories make extensive use of electric spot welding machinery, often robot controlled. For the amateur, two approaches are available to spot welding, which will be noted below.

Back in the late 60's, I was able to acquire an oxy-acetylene kit, and in those days, the cost of cylinder rental did not seem too steep. Perhaps it is an age factor, but my recollections are that the neatness of the welds achieved was far better than anything I can produce nowadays certainly with the MIG, (which naturally deposits more metal) and probably with the TIG. Gas welding gives a degree of flexibility which the others do not, and if fitting a repair panel, then the ability to apply local heat makes it easier to persuade things to fit. For rusted nuts and bolts, it is also an excellent means of helping them apart, and the small size of the nozzle makes for easy access. The range of thicknesses for welding spans the very thin to 6mm or more. However when working on thicker metal, the factors of gas consumption, speed and cost are likely to favour one of the electric processes. More recently, I have once again acquired a gas welding torch (**photo 11**), but as yet have not sourced the cylinders, regulators or hoses.

After several years with no welding kit, during the late 70's, I bought one of the

cheap 140 amp air cooled electric arc welding sets, i.e. a stick welder. After a short learning curve, this proved satisfactory for working with metal having a thickness of 3mm to about 6mm. If overworked, the safety cut out would trip, and play would be adjourned pending cooling down. In the early 80's, this was replaced by a fan cooled 200 amp unit which served well until about 2003, when the main switch failed.

Stick welding has the cost advantage that no gas is needed, and it is possible to add simple extension cables to allow welding quite a distance from the power source. (The 200 amp unit was successfully employed in the construction of a three storey fire escape.) As there is no gas, you can weld outdoors and be unaffected by wind. The downsides are first that it does not work well on thin material (for me, about 2.5mm is the limit, though more highly skilled operators may manage thinner), second that you need to stop regularly to change the welding rod, and third the flux coating on the rod, which is intended to melt and shield the weld, preventing oxidation, remains in place afterwards. Its removal with a chipping hammer can be tedious and time consuming. Special rods are available for other metals such as cast iron, however my experience is limited to mild steel.

One device which fell from grace when the MOT rules were tightened regarding brazing, is the twin carbon arc torch (**photo 12**). This can be powered by a small arc welder and needs only about 30 to 40 amps capacity. Like the gas torch, it can also be used as a source of concentrated heat to free rusted bolts, though the shape makes inferior access.

The relative cost of MIG (metal inert gas) welding sets has come down dramatically over recent years. The 165 amp unit shown in **photo 13** was bought in the early 90's for about £450. You can probably get something similar for about the same money today. For purely car type work on material from 1mm to 1.6mm, there is a range of very much cheaper devices which work well and could actually be easier to use at lower power levels. With MIG, oxidation is prevented by the shielding gas, which is fed through the torch, (**photo 14**) together with the welding wire. The basic adjustments are the gas flow, the power level and the wire speed. The welder shown gives the option of using either 0.8mm or 0.6mm diameter wire, has 6 selectable power levels, and controls to give timed on-off weld duration. As the weld is shielded by the gas, any wind will blow the gas away and lead to porous or oxidised welds. Work is therefore normally undertaken indoors, but care should be exercised to avoid a build-up of fumes.

The gas can be plain carbon dioxide, and in fact many privateers make unofficial use of pub cylinders, sometimes refilled through fire extinguisher channels. Compared to a 'proper' MIG gas mix of argon and carbon dioxide, the latter on its own gives more spatter. Recently the company Hobbyweld has come on the scene and provides welding gas cylinders on a deposit basis with no rental contract. For MIG work, two mixes are offered, the choice being determined by the thickness of material to be worked on.

Mention was made earlier of punched holes for spot welding. The hole of about 6mm diameter is made in the top skin. The two skins are then clamped together, and the MIG wire aimed at the lower sheet in the centre of the hole, which is then progressively filled from the centre outwards, melting into the upper sheet, to create a welded joint.

MIG offers a significant speed advantage over both the oxy-acetylene and stick processes, but is affected by wind. You can now obtain flux cored gasless MIG wire for which there is no need for the gas cylinder with its associated expense. As yet I have not tried this so am unable to comment on the effectiveness or ease of use.

It is possible MIG weld aluminium using aluminium wire and a ptfe liner. The latter helps the soft wire to feed without kinking. I tried this briefly but not for long enough to gain proficiency.

During the late 1990's I had become involved in low level motorsport, and felt that a TIG welder would be a good idea. The unit shown in **photo 15** has a number of bells and whistles (gas post flow, power ramp up/down, AC/DC, etc.) and also functions as a basic stick welder.

The AC facility allows aluminium to be welded, but I have to admit that I have found this metal extremely difficult. It is easy enough to produce decent joints in 3mm thick material, but 16 gauge sheet is entirely another matter.

TIG welding has a degree of similarity with gas welding in that the torch is held in one hand and the filler wire in the other. TIG equipment is yet another area where equipment development has raced ahead over the past decade. Size, weight and costs have reduced significantly, however the gas required is pure argon, so there are no cheapskate alternative sources as with CO2. Argon is available from Hobbyweld.

13

165 amp MIG welder.

14

Torch for MIG welder.

15

TIG welder.

TIG welding torch.

Electric spot welder with power and pulse count controls.

Like the MIG process, TIG welding relies on gas shielding and should be undertaken free from draughty conditions.

Whereas a MIG torch has the wire fed through the centre, surrounded by gas, the TIG torch (**photo 16**) has at its centre, a tungsten electrode gripped in a collet. The electrode material will be chosen for either aluminium or steel, its diameter according to the thickness of work and the business end ground to a point for steel or left ball ended for aluminium.

Overall, my own experience is that while the TIG set is occasionally useful, it has been by far the most expensive but also the least used of the items of welding kit.

It was noted that car assembly plants use electric spot welders. Smaller units are available to the amateur but they are costly if purchased new. The welder shown in **photo 17** was bought second hand at a closure sale for about £50. Its action clamps the work between the two electrodes, then passes a series of high current pulses through the work melting the interface, creating a weld. Two control knobs vary the current level and the number of pulses. It is also possible to vary the clamping pressure.

As the weld is effectively hidden, it is good practice to test weld together two sample pieces of the same parent material and then tear apart in the bench vice. A good weld will tear out leaving a hole in one sheet. For those with an interest in cars, seeking further reading, I would suggest the Automotive Welding Manual, published by Haynes which covers the various types of welding, and also plasma cutting.

Adhesives

I have a vivid memory dating back to about 1970, of a friend who needed to replace a front wing on a Mini. Not having welding equipment, he carefully removed the old metal, ground flat the residual spot welds, and proceeded to fix the new panel with Araldite. At the time several of us expressed our misgivings, but the car remained in use for a number of years and no problems arose, although I can't recommend this approach!

Later on, I understand that some British Leyland cars had their roof panels held on by a suitable adhesive, and at our factory in the mid 80's, we certainly undertook a few experiments using a Permabond product which was considered as a potential substitute for spot welding.

Adhesive technology is advancing all the time, - for the construction industry the phrases 'no nails' and 'sticks like xxxx' come to mind, and in a similar way there are various suppliers such as 3M who have developed clever glues for metalwork. There is even a form of epoxy which can be released by applying an electric current across the joint. Information on the increased use of adhesives in vehicle construction can be found at www.adhesives.org

Conclusion

This short series of articles has attempted to give a brief overview of working with sheet metal. A number of processes and items of related tooling have been discussed. I have endeavoured to highlight the limitations of my own experience, and hope that others with more specialised insight into particular areas, may care to write in offering their own contributions, adding to the general store of knowledge. ■

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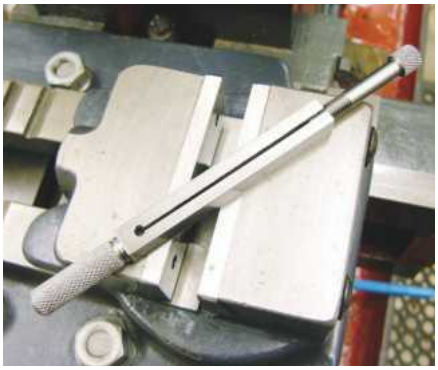

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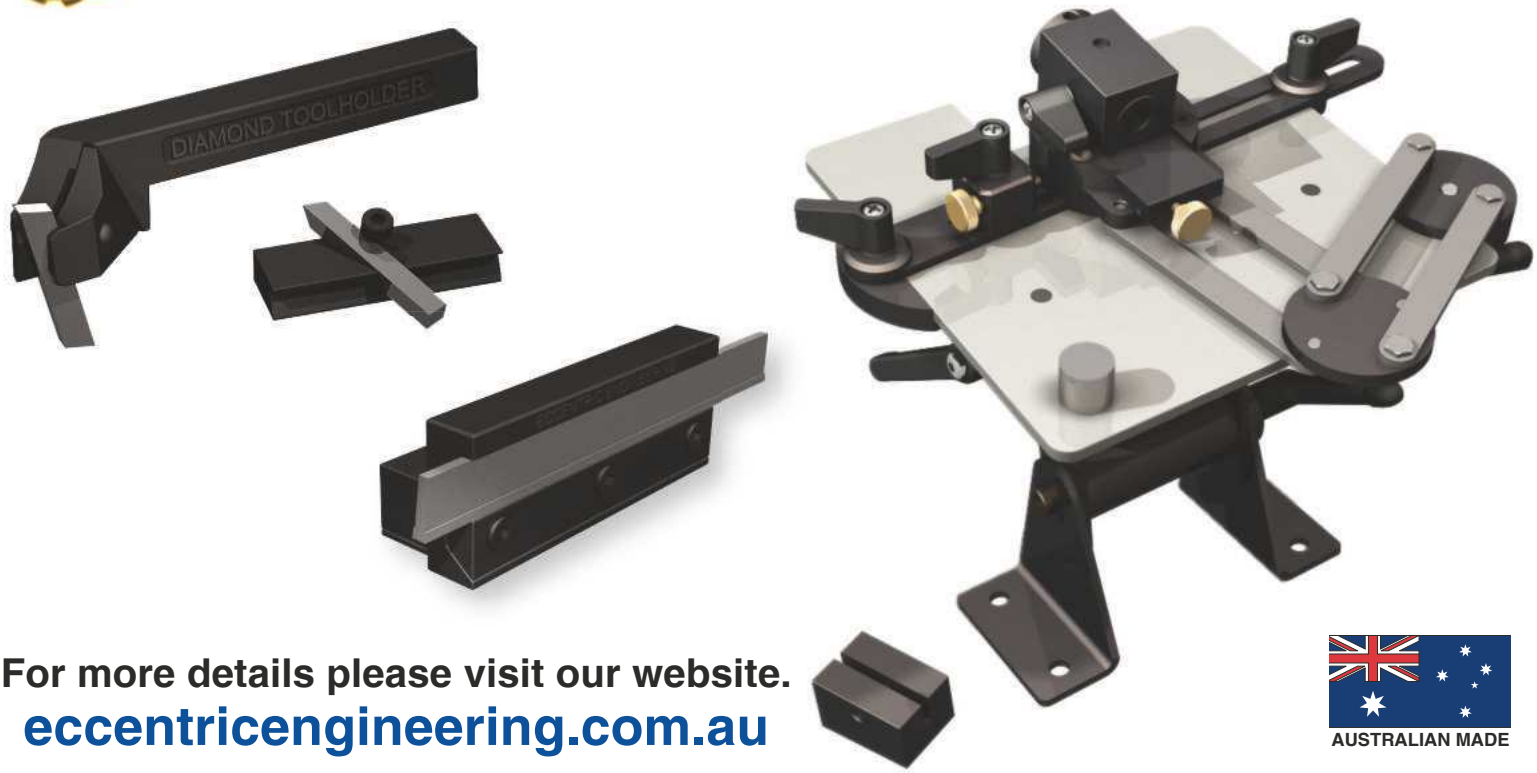

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Making a Clock Depthing Tool Part 2

Glenn Bunt describes a specialist tool for the clockmaker.

Whoopee! I have just finished a major project! I've designed and manufactured a three train Musical Longcase Clock. It has taken me two years to complete, many evenings and weekends in my workshop and yes, now it's finished.

This article describes one of the tools I have made to assist in the manufacture of the clock. It is a depthing tool.

The clock gear depthing tool.

Screw Stop Bush

The screw stop bush (**fig. 8**) is pressed into position in a previously drilled and counter bored hole. It is located on the inside lower face on one plate. It is made of mild steel and is used to reduce wear when the depthing tool adjustment screw pushes and rotates against it. 8mm diameter mild steel bar is faced off and lightly spot drilled in the lathe. The spot centre is then drilled with a 3⁄16 inch drill bit but only as deep as the lip angle (118 degrees). Outside diameters are turned to suit the previous holes drilled into the left hand side plate.

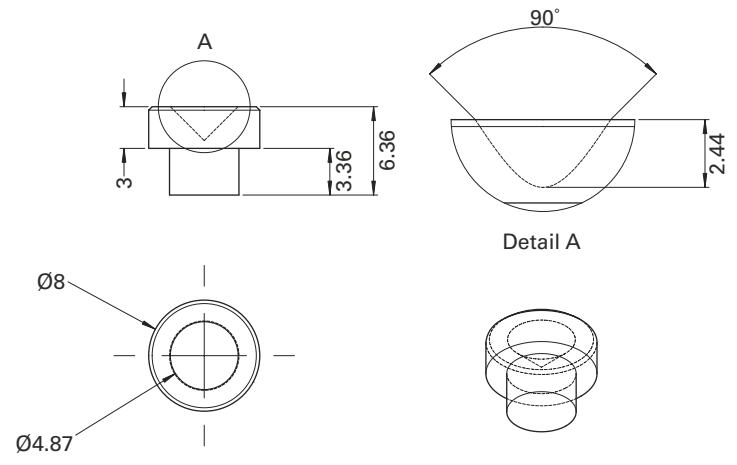
Hinge Bar

The hinge bar (**fig. 9**) hopefully needs no explanation!

Adjustment Screw

I wanted an aluminium knurled head on the adjustment screw (**fig. 10**) but I thought it would be better both for wear and strength to use a steel thread. In the end I chose a 35mm long M5 metric cap screw and made a knurled (aluminium) screw head to fit it. The steel cap screw will require the end of the thread to be formed in a point, this locates in the screw stop bush.

Fig. 8

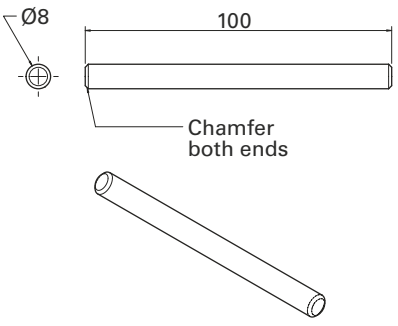


Screw Stop

Clamp Plate Screws

The clamp plate screws (**fig. 11**) are made of aluminium bar and four off are required. These are used to tighten the

Fig. 9



Hinge Bar

clamp plates against side plates locating the silver steel spindles into the depthing tool plate V slots.

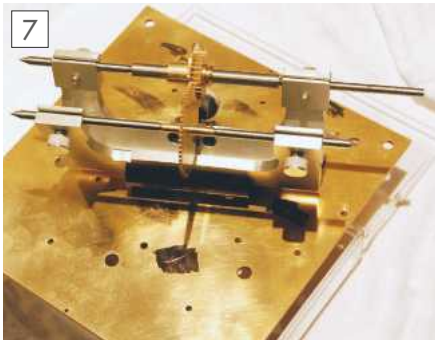
The Clock Spindles

The completed and assembled depthing tool and some of the spindles/adaptors I have made for it are shown in **photos 7**, **8** and **9** and **fig. 12**. I have included drawings for some spindles that I used for my clock and the reader may find them useful for their clock making activities. I often find with a new clock that new spindles are required to suit the clock wheels. The spindles are made from silver steel bar - 3/16 inch or 5mm diameter is an ideal size. The pointed end should ideally be hardened by heating the tip to cherry red and then dunking in water or oil, re-polish the tip and then apply heat until a straw colour.

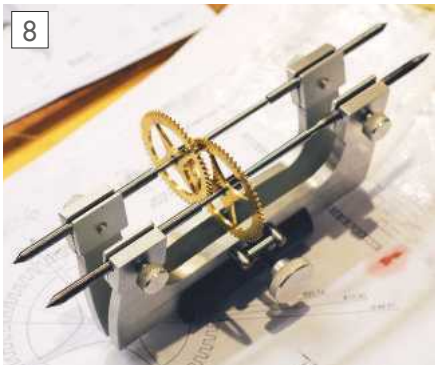
Old bushing tool sets (spindles) can often be found at car boot sales and make a good source of spare spindles for a depthing tool.

Depthing Tool Assembly

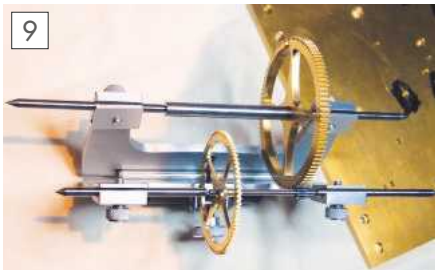
The screw support bars are bolted to the outside of one of the depthing tool plates using the previously drilled and counter bored holes. Before final tightening the swivel bar is located into each of the



The depthing tool with spindle adaptors.

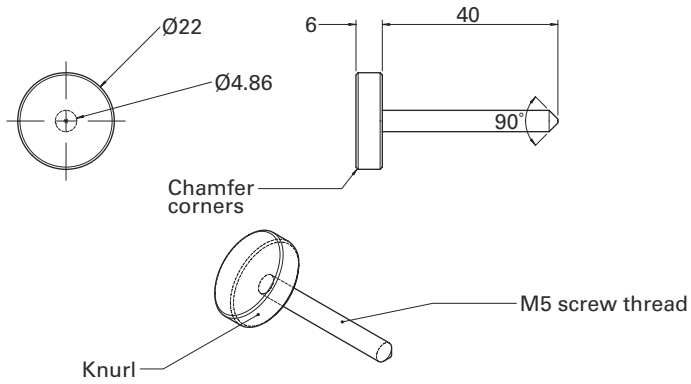


Another view of the finished tool.



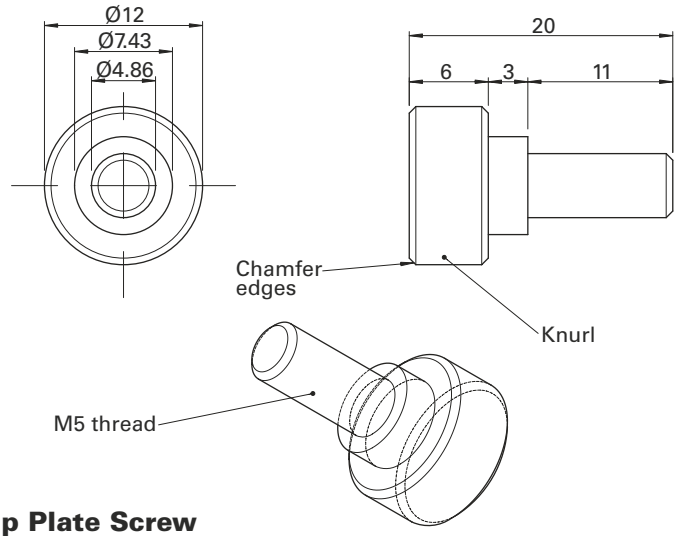
Using a spindle adaptor for depthing the clock's great wheel.

Fig. 10



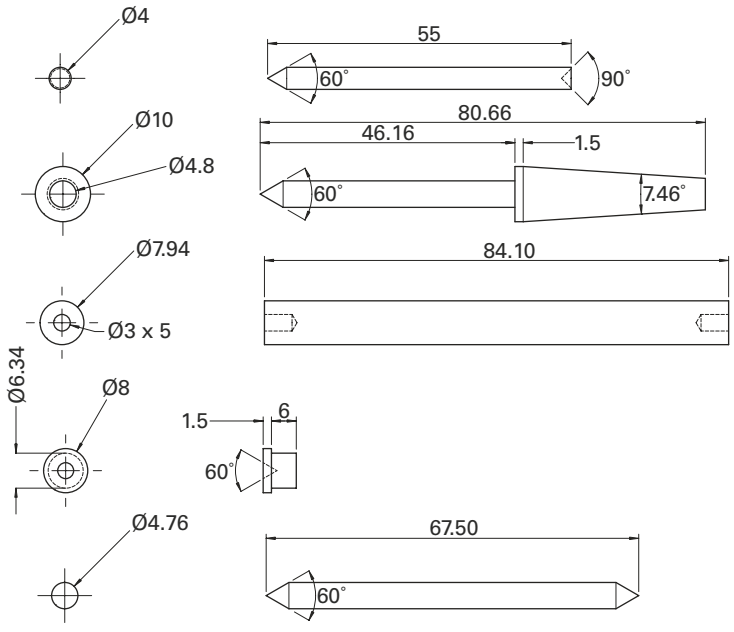
Adjustment Screw

Fig. 11



Clamp Plate Screw

Fig. 12



Clock Spindles

support bar's 3 mm diagonal holes, so that it is held in place between them. The screw stop bush should be pressed into the opposite plate facing inwards.

Take the bulldog spring clip and gently prise it apart, fit one depthing tool plate into the opening. Locate the spring clip into the slot on the outside of the plate. Again gently prise the bulldog clip spring apart and insert the second plate in the same way.

Now prise both plates apart and gently lower the 8mm piece of silver bar stock into each of the V slots which are located the bottom inside of the plates. The plates should now swivel and hinge on the bar. This may a good time to add a bit of light oil to the bar!

Insert the main adjustment screw into the threaded hole in the swivel bar and through the clearance hole in the depthing tool plate, locate the pointed tip at the end of the thread into the stop bush on the other plate.

If all goes well the tool should now swivel on the inserted bar as the adjustment screw is rotated. The depthing tool can now be opened up wide and the clamp plates and screws inserted on the top of each plate.

Using the Depthing Tool

Photograph 10 shows the depthing tool in use. An 8 mm special arbor locates a snail and an hour wheel between spindle centres. A motion wheel (it will engage with a moonphase wheel) is also held between spindle centres that are located on each plate of the depthing tool.

The location of spindles is adjusted endways so that the clock gears are correctly positioned and the pointed end of the spindles are level with each other. It is very important that if the tool is not perpendicular to the clock plate then it will impart an error in the position of the pivot hole.

The tool has been adjusted so that the clock gears are meshed together and run smoothly. The photo shows the tool marking the position of a pivot hole in relation to the centre arbor. The clockmaker will know where the new pivot hole should be in order for the arbor and wheel not to interfere with other components, the tool will scribe an arc where the pivot hole needs be located in order to achieve correct backlash and smooth running. ■

Using the depthing tool to mark out gear centres.

Scribe a line

YOUR CHANCE TO TALK TO US!

Drop us a line and share your advice, questions and opinions with other readers.

Metric Translation Gear

Dear Neil, I wanted to share some (perhaps) useful information for you and the readers.

What I have done is 3-D printed your 63-tooth gear (*MEW* 204, Universal Thread Cutting on a Mini Lathe) using our local public library's 3-D printer. I also printed an 80-tooth replacement change gear for my Sieg SC3 min-lathe after trashing the original one by running the carriage into a brick wall under power feed <blush>. So I can share some observations about doing this and some of my 'test' results. By the way, a (badly) 3-D printed 80-tooth replacement gear from an American supplier cost me about $40CDN/20 GBP. The 3-D print cost me almost exactly 1/10 of that at the library!

The gears were printed on a Makerbot Replicator 2 printer using PLA feedstock. The 80-tooth design file came from Thingiverse where a fellow had designed a complete set of mini-lathe change gears: http://www.thingiverse.com/thing:180038/#files

Since my initial success Dan has added a file for the 63-tooth metric/Imperial conversion gear.

From my reading on the subject, it seemed that PLA was not the polymer of choice for this due to its brittleness. However, it is all the Toronto Public Libraries offer due to its low odour when printing in a public space. To try and compensate a bit, I printed it with a 'skin' (I think the outer layer is called in the printer driver) of 10 which gives a hub and tooth periphery thickness of about 5 mm which has proven satisfactory. I use the minimum infill of 10% with this.

I didn't really think this would work so I have given the 80-tooth specimen some pretty rough treatment. Latterly this involved turning a 2 inch+ piece of high carbon or alloy steel under power feed at some 350 rpm and 0.020" DOC with an industrial carbide tool bit. There was smoke, occasional sparks and the (500W brushless motor) lathe stalled with some regularity during this abuse. The chip tray had lots of blue as well as tan chips in it. 'Nuff said. The 80-tooth PLA gear looks as good as new for all this.

Yesterday I installed the 63-tooth gear to cut a 12M-1.5 test thread on a steel shaft (my lathe has a 16TPI leadscrew). I can report that commercial test nuts went on the thread just fine and that the gear is still in good shape.

I also wondered how the PLA might stand up to various solvents that might be encountered, so I soaked some small scraps for a month in 99% isopropyl alcohol (rubbing alcohol, 2-propanol), kerosene/paraffin, and pure biodiesel (B100). The only effect I could see after this time was perhaps a slight swelling in the kerosene soak but the physical properties seemed unchanged in any of these solvent baths. FYI, B100 is one of the most plastic-unfriendly solvents I have ever seen (it liquefies polystyrene on contact!) so I was surprised to see no effect on PLA. I use it as an excellent all-purpose cutting lubricant/drilling fluid since it is chemically related to lard oil, but has a much lower viscosity making it lighter consistency than even 3-in-1 or WD40.

I have found only one issue with the gear printing process and that is that the 3-D files as they stand have a central bore that is slightly too small and needs filing or boring out. Plus the keyway slot needs some filing after this too. This seems like small stuff for a $4 change gear! I may try and fix the design files myself at some point and test them out.

Rong Fu Feedback

Dear Neil, Inchanga's report on his RF 25 made interesting reading, as some of his experiences mirror mine.

The primary belt on my Warco Minor failed, within six months. This was not surprising, given that the motor was misaligned. The replacement, with the motor repositioned has lasted for the last fourteen years. Oddly, the secondary belt is the original!

He has inspired me to check the gib strips on my machine, as they never seem to stay in adjustment for very long. Another 'tomorrow' job!

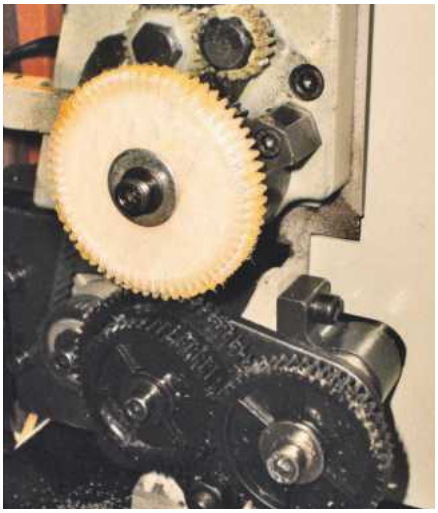
The supplied angle vice, looking too flimsy, did not appeal; so with a cash adjustment, a 4 inch Vertex vice was supplied.

The column clamping nuts, rather than the bolts, soon showed signs of imminent failure, so the machine functions with shop made ones, on the original bolts. Similarly, the leaf nuts for the Y travel have been replaced with T bar headed ones, but like Inchanga, oily hands are always the result of using them!

To prevent swarf falling onto the bedways of the base, an acrylic cover was fitted, using a small piece of aluminium angle , and the setscrews for the Y axis stops. This is fine, but needs to be kept clean so that the dial is visible beneath. A LED torch is aids visibility of the dial. As the article says, it is a mistake to separate the column from the base, I did, and fear that the consequences are still being felt.

To minimise belabouring the head bearings, the spindle pulley retaining nut (L.H. threaded) was thinned and a piece of plate, bored to suit, with two tapped holes (¼ BSF in my case) used with a removable plate carrying two clamping screws, and central forcing screw to bear on the slackened drawbar. If tightening the forcing screw does not break the taper, a light tap with a mallet suffices.

Howard Lewis, by email



The only other issue with the gears was an initial wobble when the gears were mounted. I have decided this is due to irregularities in the outer edges of the hub where the extra layers of PLA are laid down and the shaft bolt and washer resting on that part of the gear. I have taken to using an oversized washer (¾ inch or so) underneath the hex bolt head and that has resolved the problem by distributing the side location forces to the side walls of the gear rather that the hub edge alone.

Anyway I wanted to share all this with you and your readers if they have not seen this before. Attached is a photo of the translucent PLA 63-tooth gear installed on my lathe for cutting the 12M-1.5 thread.

Peter Brickell, Toronto, Canada

Smiling Phases

Dear Neil, Flushed with the success of my home-made rear parting tool for my Warco BH 600 I set to making some jenny wheels for a swager I was re-furbishing, using 2 ½ inch bar. Parting off was conducted at pretty high speed, using neat cutting oil coolant. All went brilliantly until I parted the third wheel. That dropped awkwardly, was captured by the protruding chuck jaws and jammed into the toolpost mounting. Long story short - 2 headstock mounting bolts sheared, headstock shifted ⅛ inch. Oh dear.

An American web forum produced sound advice on a similar lathe sold in America and re-location and alignment of the headstock took time but was ultimately successful. Phew.

The disassembly process meant that the motor had to come out, which caused me to return to a thought that had periodically afflicted me ever since I bought the lathe - why not go three-phase and gain the benefits of variable speed control? Serendipity intervened with the arrival of my copy of *MEW* - with an advert by Newton-Tesla illustrated by a photo of a BH600 with one of their conversion packages fitted. I rang and spoke to George Newton, who was helpfulness personified and promptly e-mailed me a copy of the paperwork (including the dreaded wiring diagram) for the package. Re-assured, I placed an order immediately.

The package consisted of a motor, inverter and control box, which were very well packed and delivered exactly on time. I was delighted with the quality and also very impressed to find that I needed nothing other than the contents of the box to complete the job.

Installation of the motor was very straightforward and required no modification to the lathe or the pulley system. I was grateful for that because my lathe is firmly bolted down in a corner of my workshop, so all the work had to be done from the front and the motor lifted over the lathe to be installed. Everything lined up perfectly however.

I was a little bit anxious about the wiring, even more so when I opened the wiring junction box on the side of my lathe and saw the mass of cables, relays, etc. Again, complicated by the location of the lathe, which meant having to use a mirror to see

the connectors, however, once I had decided to retain only the panic button on the front of the lathe, as an isolator for the whole electrical system and re-position the connectors in the junction box to accommodate the wiring for the lathe motor, work light and coolant pump, I was able to follow the wiring diagram easily. I chose to do away with the forward/reverse lever on the lathe and utilise the start/stop function on the new control box, which meant that after I had removed the saddle lever and the associated switches (which had been horribly temperamental anyway), I gained another inch of saddle travel and was left with the basis for mounting a much improved saddle stop arrangement. After some thought, I decided to mount the control box on the front of the headstock, where it falls most easily to hand when I adopt my normal pose in front of the lathe. All that required was a bit of fiddling with the switch-box on the front of the lathe and re-locating the spindle speed algorithm to the splash-guard.

I was so confident that I completed re-assembly before testing the installation. It worked perfectly. Smooth and quiet. I love the soft start/stop (no more dimming the house lights when I start it up) and the ability to vary speed while turning, especially parting off, is an absolute revelation.

Bob Oliver, Upper Killay, Swansea

Aligning a Myford (1)

Dear Neil, in reply to Peter Bryan's letter in issue 226. You have a problem, Peter, common to very many home workshop lathe owners. First, it must be understood that levelling in this context does not refer to level as most would understand it, but to setting the lathe with zero twist along the beds length. It has probably, in my estimation, acquired this term for the process due to the only easy way of achieving this is to use a precision level comparing both ends. Being level though is quite unimportant, thankfully, as few can afford the cost of a precision level. Let's though get back to your situation.

By using the term engineers' level do you mean a precision level or is it one of the levels that can typically be found in an Engineers combination set, if this, then it is nowhere near accurate enough. However, from your wording, I am assuming that it has been set using a precision level, though even these are made in varying degrees of precision, so absolute precision cannot be guaranteed.

Having levelled the lathes bed, within the limits of your measuring device, you indicate that you can improve the situation by making adjustment to the lathes mounting, thereby adding a little twist to the bed. To which you add, 'not a satisfactory solution'. To this I do not agree, though with a proviso later.

All machine tools are made to be within permitted tolerances, even precision ones. If this were not so then they would be astronomically expensive. Therefore, it has to be accepted that a new lathe invariably will not turn parallel, but with your distrust of adding a very little twist you are committing yourself to working with a machine not turning parallel.

Very many lathe owners cannot justify the expense of a precision level and set their lathe by a means of trial and error until a satisfactory situation is achieved, a method that I adopt. In this case the owner has no idea of the amount of twist in the bed or even how level it is, perhaps having used a DIY level for starters.

Let's now consider your situation in more detail, but unfortunately there lacks some important detail. First you state that your test piece has an 0.005 to 0.007 inch taper over five inches protruding from the chuck. You then say levelling the lathe improves the situation but you do not say by how much. Another piece of information that would help is what diameter of bar you are using and how deep a cut is being taken and how sharp the cutter is.

I would suggest at least a 1 inch diameter bar with a depth of cut of 0.002 inch followed by two or three spring cuts without adding anymore depth. You do of course need a razor sharp tool to take depths of cut which will likely be in the order of 0.0001 inch deep on the final pass. Free cutting steel 230M07 would be preferable, even leaded if available.

I do assume you have checked for movement in the lathe's bearings and you have locked the cross and top slides whilst the cut is being taken and the bed is in good condition.

Assuming these conditions are met I would suggest the following. Level the lathe, turn your test piece and check dimensions. Now adjust the lathes mounting until the test piece is parallel, say within 0.001 inch. Follow this by placing the level on the bed and at one end place a shim under the level at the edge of the bed, changing the thickness until the reading is the same as the other end. From this you will be able to see the amount of twist in the bed and hopefully reassured by how little it is.

It is often overlooked, but if you raise the jacking screw by say 0.01 inch, then you have probably raised the lathe by 0.001 inch and lowered the mounting by 0.009 inch as the mounting is often far weaker than the lathe itself.

I have to make the proviso that I feel 0.007 inch is a lot to correct by adding a twist to the bed but unfortunately you never gave us the value when the bed was levelled.

Could I suggest that you may find my pages on my website on the subject of 'Setting a lathe to turn parallel' of some use. These are at www.homews.co.uk/page309.html

Harold Hall, by email

Aligning a Myford 2

Dear Neil, I had a similar problem to Peter Bryan with my Super 7. It was possible to correct it by adjusting the tailstock end of the bed as shown in the Myford handbook but this put a definite twist in the bed. This seemed to be introducing a second problem to solve the first, so I re-levelled the bed.

After much head scratching I concluded that the only reason the lathe was turning a taper was because the headstock was not parallel to the bed. As the headstock is pulled against the front shear by two screws I reasoned that by placing some shim at one side I could correct the alignment. After three complete stripdowns and re-builds I ended up with a 0.003 inch shim at one end and a lathe that turns to within 0.0002 inch over a 5 inch length. It all took a couple of days but well worth the final result.

Jon Swindlehurst, Wirral

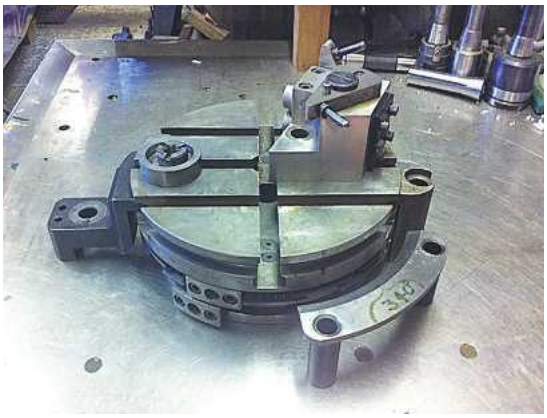
Mystery Machine

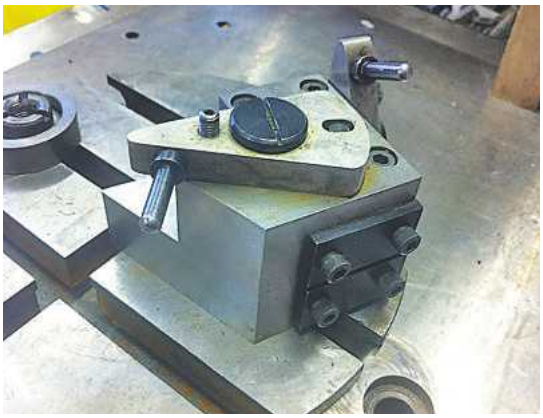
Dear Neil, sometime ago I emailed you with information on a mystery item. Now it's my turn to ask for some help in identification!

Some long time ago I acquired some equipment from a toolroom that was closing. This is the item in the photos and it's been in the cupboard ever since. It's obviously some sort of rotary/dividing table, but has no gearing or external way of turning it once setup. It appears to have a system of dividing/locking plates below the actual table, but as to the large piece seen here in the top I have absolutely no idea. Looking at the quality I guess it was a very expensive piece of equipment when new. It also comes in a fitted wooden box.

If you would be good enough to ask the readership if anyone has any idea I would be most grateful. Otherwise it will probably just sit under the bench for evermore.

Mike Hibbins, by email





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One Man and his Lathe

Jon Freeman and his Chester Challenger

Experience of using larger industrial machines led Jon Freeman to change to a much bigger lathe. Was this the right choice for him?

The story of my meandering into model engineering may be familiar to many. From an early age I was fascinated by clocks, steam locomotives, anything mechanical. While still at school I decided to start building a miniature loco, and with some help from kindly members of a local model engineering club and the metalwork teacher at school, a start was made on a simple 0-4-0, 'Juliet'. I acquired my first lathe, a small lathe, popular at the time. The following forty years saw very little progress, the time being occupied with a career in industry, paying mortgages, and all the predictable distractions of an ordinary life.

With the prospect of retirement and some free time at last, I signed up for some spare-time voluntary work in the locomotive restoration department of a nearby heritage railway. I was soon let loose machining items for full-size locos in steel, brass and bronze using a variety of ancient industrial machines, lathes much bigger and heavier than the small lathe I was accustomed to.

I dusted off the home lathe and made a few more parts for Juliet. I quickly learned that although the small lathe was adequate for making very tiny items, for even quite small parts it was often quicker and easier to use a larger lathe. Whereas at home I could just about tickle 0.020 inch (or 0.5mm) off the diameter of a short piece of one inch steel before the chatter set in or the spindle stalled, I could remove ten times as much per cut on a heavy lathe, using tipped tools and running at much higher RPM. Some tasks could be completed in minutes on a big lathe that would have taken hours on the small lathe! Clearly I needed a bigger lathe for my home workshop, keeping the small lathe for the small stuff…

Chester Challenger lathe.

I can be impetuous, as I was on the day I set off to visit Chester Machine Tools. Although I had not done any research beforehand, using my new experience with bigger lathes I had in mind some essential minimum requirements:

- Big, heavy, solid and stiff
- Digital readout (DRO)
- Power feed to saddle and cross slide
- Quick change tool post
- Good range of metric and imperial screw cutting options

I also had some thoughts on what I did not want. Having acquired a small mill-drill, I no longer wasted time messing about with swivelling vertical slides or any other bolt-ons to press the little lathe into use for milling or any other tasks for which it was not designed. I was looking for a straightforward, no nonsense lathe. I departed Chester having placed an order for the 'Challenger', a 16 speed, geared head, 750kg heavyweight, similar to that available from a number of suppliers as type 'GH1440' (**photo 1**).

The lathe was delivered, hoisted onto the drive outside. Moving it into the workshop and into position was quite a pantomime involving all available local muscle, a fork lift, engine hoist and anything handy and round for use as rollers. I should have thought this through beforehand, but the lathe needed levelling as the concrete floor was anything but. My solution was to make a set of six screw adjusters, one for each of the holes provided for bolting down the lathe, four at the headstock end and two below the tailstock. Using a spirit level, the machine was quickly levelled by

An interesting turning job.

Interesting job closeup.

adjusting the six screws. As the final part of setting up, a long, stout, brass bar was chucked in the three jaw and a very light cut taken along the length using a freshly sharpened HSS tool. The diameter measured at each end was then compared and any difference noted. If more than a thousandth of an inch or so, the leveller at the tailstock end was adjusted as the difference evidenced a minute degree of twist in the bed. This process was repeated until no error was measurable.

After twelve years I've used the Challenger to produce parts both great and small. I've worked on locos ranging from 5 inch up to 'standard' gauge, machined parts for agricultural machines, and once machined a steam truck flywheel, so heavy I could barely lift it. Beyond straightforward turning, I've had the occasional interesting job such as the steam valve fitting shown in **photos 2** and **3**. This was for a standard gauge GWR loco, and involved mounting a large casting on the faceplate in various positions and orientations prior to facing, parallel and taper turning, and screw cutting.

In all this time I've never needed or even wanted a bigger lathe. The large 3-jaw chuck will not hold anything smaller in diameter than about 4mm, but for the smallest stuff I grip a smaller 3-jaw chuck in the large one, that does the trick. For large work, with a tipped tool I can easily rip 5mm or 3/16 inch from the diameter of a 3 inch steel round turning at 585 RPM with an aggressive feed-rate, so long as I keep an eye out for any fires started by hot flying swarf! With a lathe weighing three quarters of a ton, I'm glad to say I've never managed to make the machine shake, rock or complain in any way. Oh yes, I did once destroy a fairly expensive parting tool, but this taught me not to try any ambitious parting operations on steel without flooding it with cooling, lubricating suds.

The DRO (seen in photo 1) makes work quicker and easier, also helping avoid mistakes. It is also useful being able to flip between metric and imperial readout at the touch of a button – no more cursing the lead screws and graduated dials for being in the 'wrong' units. The Newall DRO fitted to my lathe stores positional information for a number of tools. This, along with the quick change tool post, enables rapid tool change without having to re-establish datum at each change – a great aid to speedy and efficient working, particularly with batch or any repetitive work.

Challenger lathe thread chart plate and controls.

Greasy lathe change wheels.

When it comes to screw cutting, I do remember dismissing one of the smaller lathes at Chester, because the screw cutting chart attached did not include 26 TPI threads, a known favourite. I did not notice at the time that the Challenger, a metric lathe by design, although showing how to set for many useful imperial threads, did not include 19 TPI in its chart, a need I would subsequently discover.

To set up for screw cutting on many lathes including the Challenger, requires selecting and fitting a pair or set of change-wheels, and setting some knobs, handles and levers to the positions indicated on the screw cutting chart affixed to the lathe (**photo 4**). Changing the wheels is a bore, not difficult, just tedious, messy and time consuming (**photo 5**). I noticed from the chart however, there are many possible combinations which are not listed in the chart (and this applies to many other lathes). This led me to create an Excel spreadsheet to show all the screw cutting possibilities for all of the 2048 possible ways of setting up the Challenger, in both metric and imperial. From this I found three different ways of setting the machine to cut 19.05 TPI threads. Although not exactly 19 TPI, this was close enough – strictly a metric pitch of one and a third millimetres.

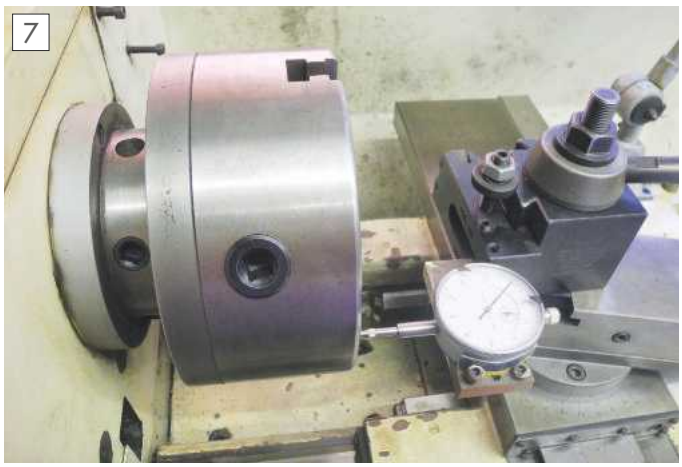
The spreadsheet also revealed several ways of setting for many frequently used threads, sometimes meaning no mucky wheel changing was needed, just setting the knobs and levers to positions revealed by the spreadsheet, rather than the chart!

One thing not on my list of requirements, that would have been if I'd known what I know now is camlock spindle nose fitting. The Challenger has Camlock D1-4, and it is excellent.

My small lathe had a threaded spindle nose. After carefully cleaning muck and swarf from the threads, a faceplate or chuck would be screwed onto the spindle nose. This is all well and good, but precludes any serious use running the lathe in reverse for fear of the chuck unscrewing. If the chuck runs true enough then good, but what to do if it runs out? Camlock addresses these problems. First, you can run the lathe in either direction with confidence. Those of a nervous disposition might prefer to cut threads such that the tool rushes away from the chuck instead of towards it. The other benefit of Camlock is that it provides for minute adjustment to get the chuck running as true as you can be bothered to set it. **Photograph 6** shows the chuck removed from the spindle. The Camlock chuck is pulled hard onto a precision

›

Camlock chuck removed.



Setting chuck to run true.

Setting 4 jaw.

Boring eccentrics.

ground cone by cams interlocking with curved recesses in the three pins. When fitting a chuck, the trick is to offer it up into position and then turn the three cams to just pinch gently. **Photograph 7** illustrates my preferred method for adjusting and testing for true running. The DTI is brought up to the face of the chuck with jaws removed, the spindle is turned by hand and each cam in turn is gradually tightened, while noting the effect on the DTI reading. With the DTI bearing close to the outer edge, a couple of minutes spent going around selectively and progressively tightening the cams should be enough to pull the chuck into 'true'. This becomes easier with practice. With my 3-jaw self-centring chuck, this also means a piece of round can be chucked and expected to run 'true' within about five thousandths of an inch – quite good enough for most purposes. Where the ultimate in true-running accuracy is required I use the 4-jaw, adjusted as described above and then the work centred with aid of the DTI as shown in **photo 8**.

Some jobs require setting the work-piece off centre. The job shown in **photo 9** started being chucked concentrically and turned to required finished diameter. The 4-jaw was then re-set with aid of DTI to the required eccentricity, the job was then drilled and bored. Finally, slices were cut off and faced to produce two sets of four eccentrics for a pair of miniature steam locos.

Would I buy the same lathe again? Let's review my original list of essential minimum requirements. All that's changed is the addition of 'Camlock', which it has. I've only a couple of trivial complaints against the Challenger. It came fitted with a chuck guard. No doubt this was to comply with Health and Safety requirments, but it was pretty useless as in most cases it caught none of the swarf, and the chuck jaws clouted it when holding larger work. I thought I might re-fit it a little higher, but... This is not to make light of safety. All machine tools are potentially dangerous and accidents using lathes of this size can and do result in life-changing injury or death.

The only other wish would be for variable speed control, because the lowest speed of 45RPM is still a little scary for some screw cutting operations, many of which I do by disengaging the drive and turning the chuck by hand. The range of speeds is otherwise all I've ever needed.

One day I realised I hadn't touched the small lathe, a Myford ML7, for more than a year. I placed an ad and sold it. I think this proves how satisfied I am with the Challenger for all tasks great and small, but to be honest I don't need a lathe quite this big and heavy, and the three-phase supply is an additional cost. This is a very large lathe by model engineering standards, rated for industrial use. It doesn't get anything like industrial use in my workshop and stands a good chance of remaining in near-new condition when the time comes for me to down tools. **Photograph 10** shows how quickly and effortlessly holes up to 30mm diameter can be drilled through steel, but how often do I do this? If going out to buy a lathe today, I'd be looking for something about two thirds of the weight, half the price, and single phase. Not needing a lathe rated for continuous industrial use, from Chester I might look again at their Crusader or Coventry models, or from Warco the GH1236, GH1330, or similar. I would certainly choose another geared head lathe with 'Camlock' spindle. I would not choose a lathe with a 'T slotted' cross slide, for milling operations I use a milling machine – the right tools for the job! ■

Drilling hole with 30mm drill.

Jon's change gear spreadsheet can be downloaded from jons-workshop.com/ and select links and downloads. We'll also put a link on the forum at model-engineer.co.uk

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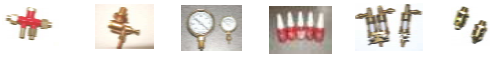

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A Clutch for Mini Lathes

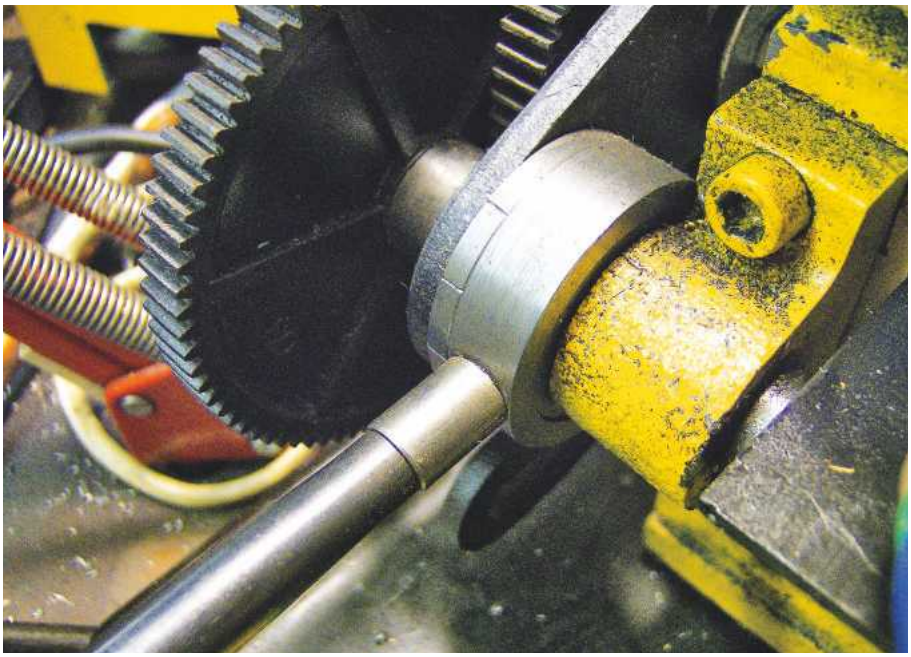
Tyro presents a simple solution to leadscrew declutching for these popular lathes.

One of the shortcomings of mini-lathes is the lack of a clutch mechanism for the leadscrew. It is not wise to rely on disengaging the split nut to isolate the leadscrew as the handle can fall under its own weight, potentially leading to a disaster. One must make a rule of reaching to the back of the headstock to disengage the tumbler reverse as a precaution whenever self-act is not required.

If a handle is fitted to the far right hand end of the leadscrew, to allow manual feed, then another problem arises. Even with the tumbler reverse disengaged, a significant amount of effort is required to turn the full train of change gears. This is particularly true when the standard 16:1 train for finishing cuts is left in place. One solution to this problem is to divide the leadscrew in two and add a dog clutch. This is rather drastic and the area where the clutch would go is inside the control box.

Ian Sinclair (*MEW* 91, July 2002) addressed this problem by adding an extra tumbler gear, operated by a lever through the rear gear guard. Observing that, on setting up any series of change wheels, the last action was to slew the gear quadrant around to engage the gears, it occurred to me that this might offer a different clutch mechanism. If a lever could be attached to the quadrant to allow it to be moved up and down, then the action would be simple and the worst case would be driving a single extra gear at a ratio of 1:4.

The standard quadrant rotates about the outer diameter of the leadscrew bearing. There was ample room here for a top-hat shaped sleeve to provide a more accurate bearing for the quadrant. This was attached to the quadrant by three countersunk 6 BA screws through its 'brim'. In the 'head' of the top hat I drilled four holes at 30 degree intervals. I fitted a circular sleeve around the 'head', with a short stub, threaded 2 BA. To complete the engagement mechanism I turned up a lever to match the others on the machine. This screws into the stub and has a peg on the end to engage any one of the holes in the top hat. This allows the angle of the lever to be varied to suit any possible angles of the quadrant.



Attachment of the lever to the quadrant.

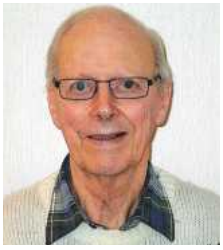
Moving the lever up and down now simply engages or disengages the change gears, however it was not possible to adjust the locknut to get the quadrant to both be moveable and reliably stay in position. This was not made any easier by the inaccessibility of the locknut. I solved these two problems by turning up an extended nut from ½ inch bar tapped M8 with an 8mm A/F hex on the end and fitted this over a belleville spring washer. After a little trial and error a reliable adjustment was found which allowed easy engagement and disengagement of the gear train without any tendency for the gears to disengage under load. The belleville washer is essential, as it maintains a reasonably constant clamping pressure, despite any small variations in the thickness of the quadrant (which is a steel stamping). Finally, a rectangular section of the gear cover was cut away in order to allow the lever to protrude.

In use the appropriate gear train is set up in the normal way, and the lever engaged in the most convenient of the four holes in the 'top hat'. With the gear cover in place and forward or reverse gear selected the leadscrew drive may be engaged simply by moving the lever down, or up to disengage. I still recommend disengaging the tumbler reverse when self-act is not required as a precaution. ■

The extended nut and spring washer.

The lever extends through the front of the gear cover.

Advice on Milling Vices



Alec Payne describes some of the different milling vices, with particular attention to one of a self-centring design.

When I retired some 20 years ago, the first job I did was to build myself a workshop. Having built it, I started to equip it, initially with a second-hand Myford ML 7 lathe. After a couple of years I sold this and bought a new Super 7 closely followed with a Myford VM-E milling machine. I had never done any milling so I had a steep learning curve. I found that one of the most difficult tasks when milling a workpiece is how to hold it firmly on to the machine table.

K Series vice - Prisma jaw.

When I bought the machine I also bought a Vertex K series 4-inch milling vice. This is an excellent vice, not too expensive and accurately made. After a year or two I added its big brother, a K series 6-inch vice. Again I was very impressed by the engineering. The only drawback is the weight – about 25 kg. I also bought a 'Prisma' jaw for this vice (**photo 1**). This a jaw with horizontal and vertical V grooves milled in it, enabling it to hold round materials horizontally or vertically. It simply replaces the fixed jaw liner and is well worth having, as it also works as a normal jaw. Each of the 'K' vices has a detachable rotating base.

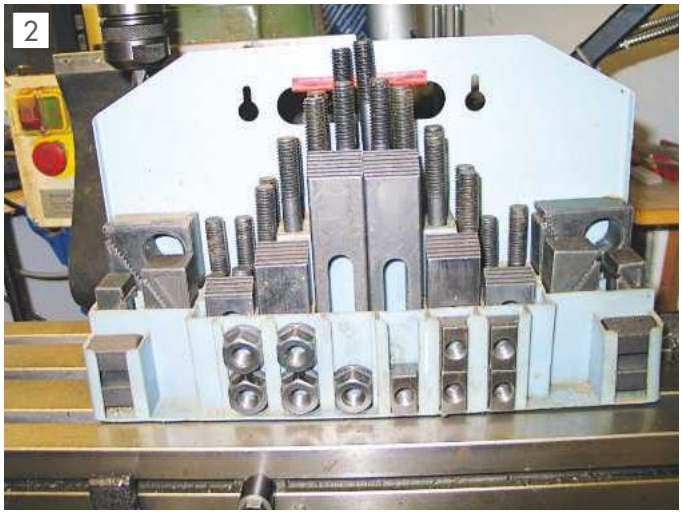
I next bought a clamping set (**photo 2**). This is a standard set available from several retailers and is very useful when a vice won't do the job. One little hint – if you buy one of these sets make sure you get one in which the Tee nuts are of the correct width for the slots on your machine, because these vary. The slots on my machine are nominally 9/16 inch (14mm) wide. When I bought my clamping set (on offer at a M.E. exhibition), I thought they were 5/8 inch, so I had to modify the Tee nuts to reduce them from 5/8 to 9/16 inch.

About six years ago I built the Hemingway Screw Cutting Gearbox kit for the lathe. The castings for this were too big for either of these vices and an awkward shape for the clamping set, so I bought a two part vice, the jaws of which can be positioned anywhere along the machine bed enabling very long items to be gripped. These vices are not very expensive and can be very useful (**photo 3**).

For some time I have looked at advertisements for self-centring vices. These are vices where the jaws each move by the same amount in opposite directions, thus maintaining the centre. A few years ago I looked at one at the Model Engineer exhibition and was not too impressed. There seemed to be quite a bit of slack in the movement. It may have been possible to adjust this out, but I decided to leave it for the time being.

Recently I looked on the website of a well-known company who advertise in *Model Engineer* and found some new Soba self-centring machine vices which looked a much better job, so I purchased one with 4 inch jaws. **Photographs 4** & **5** show it closed and open. I thought it would be a good idea to do some evaluation tests to see how accurate it was.

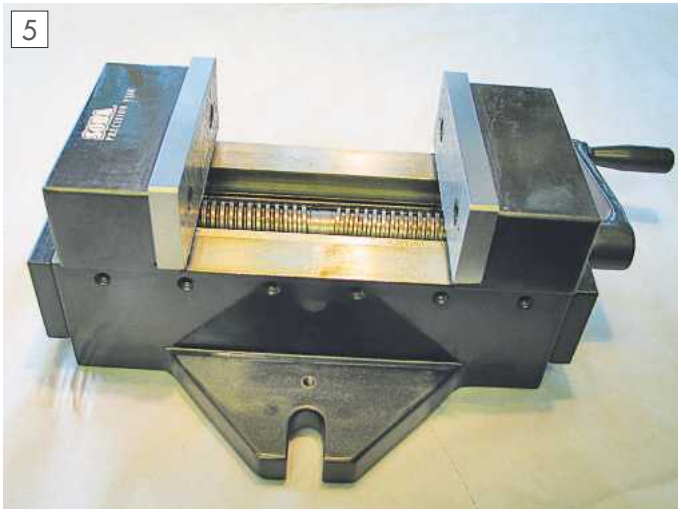
The purpose of the evaluation was to check the basic accuracy of the vice. In order to do this, it was bolted to the milling machine table and clocked so that



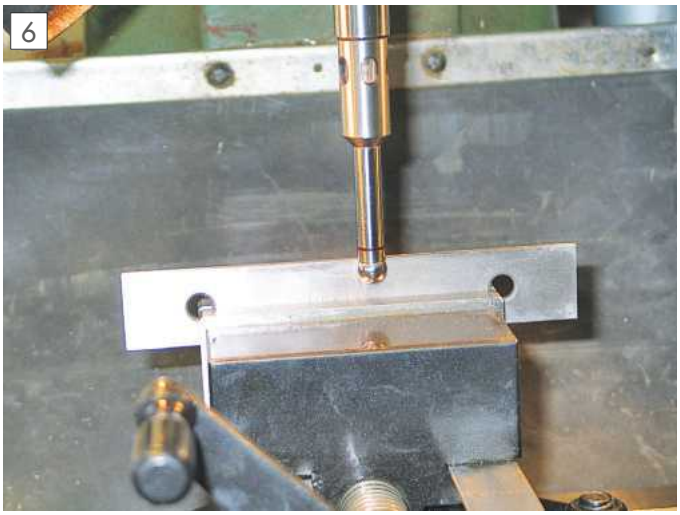
Standard clamping set.

Two-part machine vice.

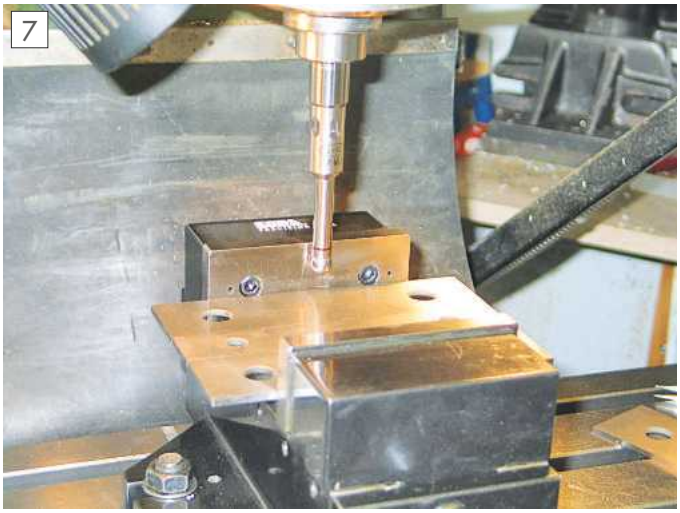
Self-centring Vice – closed.



Self-centring vice – open.



Finding the centre of the jaw opening.



Measuring the jaw movements.

The vice appears to be well made, nicely finished and very accurate. The working parts are ground and the exterior nicely painted. There was no perceptible play in the jaws or the feed screws. I am sure it will prove to be very useful in the future.

the jaws were accurately aligned with the slots. A flat piece of steel plate ⅛ inch thick was held in the jaws and a reading taken on each side of it with an electronic edge finder (**photo 6**). The readings of the Y axis DRO were taken at each side, and the centre position calculated. The Y axis was moved to the centre position, the DRO zeroed and the Y axis locked ensuring that we had a zero reference point for the jaws.

The jaws were then opened progressively in 0.5 inch steps up to the maximum opening of 4 inches (**photo 7**) and the distance the front and rear jaws moved was clocked. At each point the jaws were lightly closed on to a steel parallel to represent a workpiece. At all positions the two jaw movements agreed to within about 2 thou which I considered to be within measurement error, so this was very satisfactory.

The next test was to check whether the tops of the jaws were level with the machine bed. This was done using a DTI held in the quill and running the vice along the X axis. Again there was no detectable error (**photo 8**). I repeated this test measuring at the bed of the vice with a similar result.

The final check was to set the DTI on the top of each jaw in turn and measure any lift occurring when the vice was tightened on to a piece of steel. There was only about 1 -2 thou. Lift which I felt was acceptable.

Conclusions

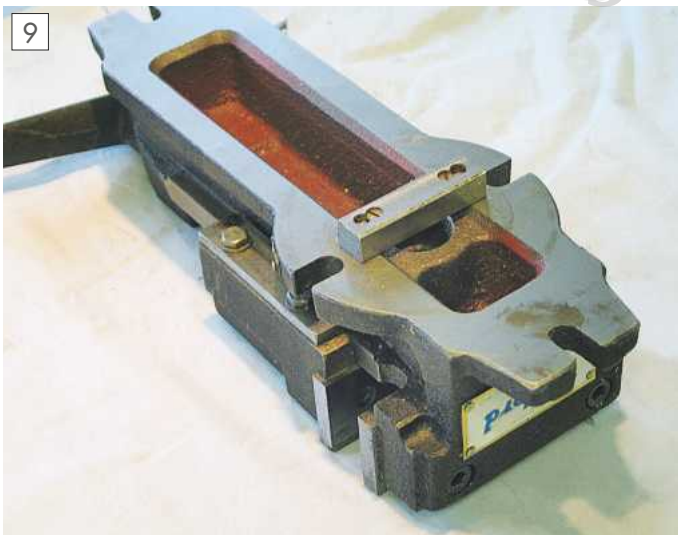
The vice appears to be well made, nicely finished and very accurate. The working parts are ground and the exterior nicely painted. There was no perceptible play in the jaws or the feed screws. I am sure it will prove to be very useful in the future.

I must point out that the measurements carried out were specific to my self-centring vice. It is possible that others may not have the same accuracy.

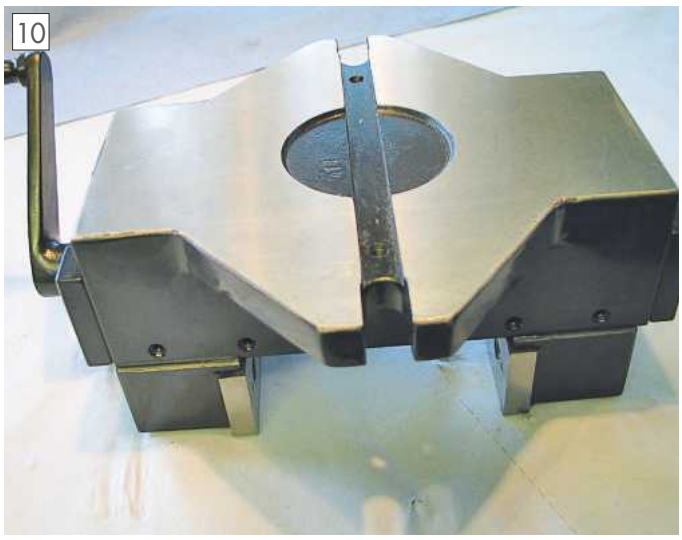
Checking the accuracy of the top of the jaws.

Vice modifications

I found it to be quite a chore to have to clock my original K series milling vice parallel to the bed each time I wanted to

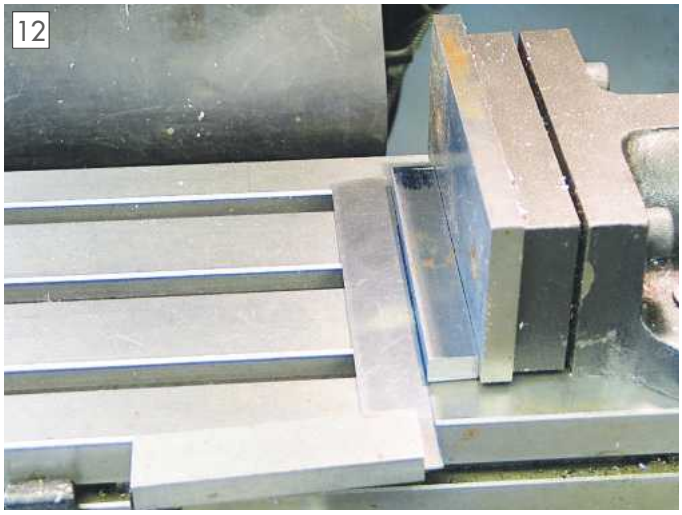


Tenon fitted to the K series vice.



Cast groove in base of self-centring vice.

Tenon fitted to the self-centring vice.



Setting the jaws on the two-part vice.

use it, so I decided to fit a tenon under the base of the vice which would drop into one of the slots in the machine bed. In my case I decided to fit the tenon to the vice itself, rather than to the rotating base. I thought that this removes one source of error, and also reduces the overall height of the vice considerably (**photo 9**), not to mention the weight!

The Myford VM-E which has bed slots which are nominally 9/16 inch (14mm), however, to make it easy for the Tee nuts, the slots are slightly oversize. For the tenon to work accurately it is necessary for it to be a close but sliding fit in the slots, so careful measurement is required. I made my tenons out of 5/8 inch square material thinned down in one dimension to fit the slots. I made the material about twice as long as was needed, then sawed it to length for the tenon. Having cleaned up the pieces, the left-over piece was clamped in the vice jaws with about 5/16 inch protruding above, and the vice turned upside down on the bed, with the protruding piece in one of the slots, ensuring therefore that the vice jaws were parallel with the table slots. The vice was clamped in position using pieces from the standard clamping set. Before doing this I had checked with a DTI that the slots in the machine bed were true to the quill when the bed was moved in the X axis.

For the tenon to work accurately it is necessary for it to be a close but sliding fit in the slots, so careful measurement is required. I made my tenons out of square material thinned down in one dimension to fit the slots.

The slot for the tenon was now milled into the base and the tenon fitted as recently described in *Model Engineer* by Roger Vane (issue 4491). This modification was carried out on both the K series vices and it saves a lot of time when the vice is fitted to the machine bed.

When I looked at the self-centring vice I saw there was already a groove cast in the base between the mounting holes (**photo 10**). This groove was approximately ½ inch wide by ⅛ inch deep so I decided that if I carefully widened it to fit the tenon the job would be virtually done. All that would remain to be done was to fit the retaining screws. The vice was again mounted upside down on the machine bed with the tenon in one of the grooves and clamped. The table was set up so that the centre of the mounting holes was under the centre of the quill. The slot was then carefully milled on each side until the tenon was a snug fit, then two holes were bored to take the locking screws (**photo 11**).

Should any of the above vices need to be set up on the slant rather than parallel to the bed, I simply remove the tenon.

The two part vice does not need this modification because the jaws run at right angles to the X axis of the machine bed, and they can easily be set up using an engineer's square (**photo 12**).

Happy milling! ■

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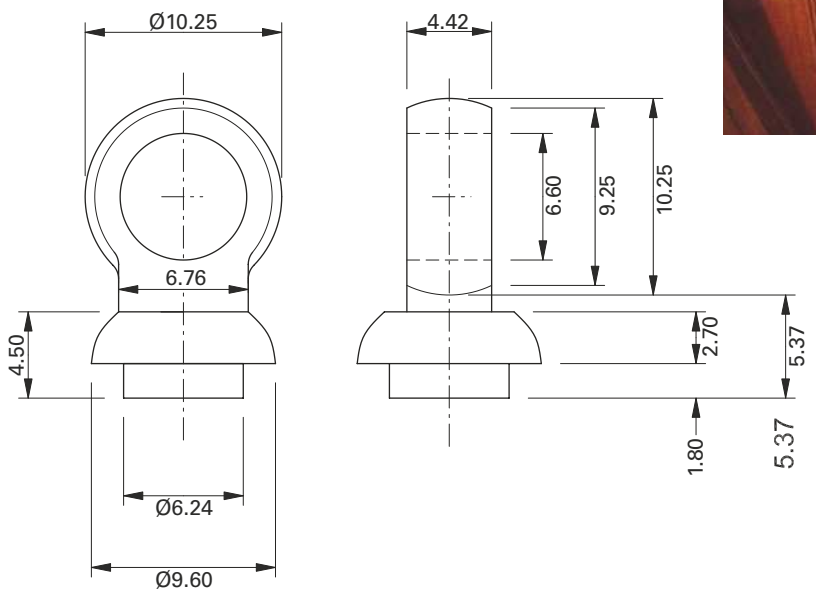
Repairing Rob's old dressing table

It's not what you do, it's the way that you do it... Peter Shaw passes on some useful hints and tips.

During 2011 and 2012, there were a small number of comments from people new to Model Engineering asking that established modellers should explain more and refrain from using phraseology such as 'in the usual manner' as, by definition, someone new to this hobby will not know what this is. As it happened, during the early part of 2012, my elder son, Rob, asked me to look at the possibility of repairing a damaged drawer pull on an (at least 65 years to my personal knowledge) old dressing table. In fact, the repair eventually consisted of making new parts using a wide variety of techniques, some of which were new to me. I then thought that an article detailing the procedures I used, along with the problems I encountered and the mistakes I made, may be of interest and use in demonstrating just what can be done.

Dressing table with new plate and pillars. (Photo by Rob.)

Fig. 1



Original Pillar

All dimensions in mm

The practicalities - pillars

The first step was to draw, as far as possible, the existing pillar using CAD (**fig 1**). I then made a few subtle changes to make things slightly easier (**fig 2**), and then added in all the cutting lines for the ball and the base (**fig 3**). In my CAD program, the cutting lines can easily be drawn by using a 'linear array'. This is a command which takes one line and repeats it as many times as necessary with a set distance between each pair of lines. I then used the CAD 'dimension' command to measure each chord across the circle or arcs (for the base) and entered these figures into a spreadsheet. I then had to convert that into actual cross-slide movement, i.e. maximum diameter of ball – required diameter. The spreadsheet was used for this.

The next problem is that whilst the leadscrew step chosen was 0.25mm, the blade width of the parting off tool that I was going to use to make the cuts is

1.84mm. Therefore it is necessary to consider which way the cuts are being made and use the appropriate corner of the tool. I used the left hand corner of the tool for the right hand side of the ball. Therefore, the right hand corner should be used for the left hand side of the ball. Wale, in ref. 2 commented that his parting off tool was too flexible and kept bending, but he was cutting silver steel, a much harder steel, whereas I was cutting brass. Suffice to say that I had no problem whatsoever.

Another problem is that the base of the pillar requires the use of the left hand corner of the tool. The end result was that the valley between the base and the ball had to be very carefully cut to ensure that the tool did not inadvertently cut into the wrong part.

All of this meant that as one changed from cutting on the right hand side to the left hand side, or vice versa, it was necessary to move the leadscrew sufficiently to allow for the width of the tool blade. All this was worked out before hand and entered onto the spreadsheet.

I have to admit that what I am about to describe is the idealised situation and is the result of fumbling my way through to a satisfactory solution. In other words, I did not create my pillars exactly as described, but near enough. Remember as well that a total of four pillars are required, hence there is scope for assembly line procedures. Certainly it is much easier having set up for a particular operation to then be able to complete a number of items at the same time. Unfortunately, I managed to make a mess of two components which meant starting again for those two items. In addition, there is a definite order in which the work should be done (found out the hard way) which means that the most obvious work sequence is not necessarily the optimum sequence.

Initial thoughts were to make the four steel bars first from ¼inch diameter steel. The problem here is that whilst ¼inch is relatively stiff, 4mm is considerably less so. Furthermore, there is a small, but nevertheless there, amount of flexibility in the mandrel bearings. The inevitable result is that trying to reduce ¼inch to 4mm will result in a slightly tapered length unless steps are taken to reduce this effect. One idea would be to use a travelling steady, but I do not have one. Another idea would be to use tailstock support. On the other hand, one can accept and work with it and that is what I did. Not perhaps the best engineering practice but still acceptable I think. Now one end of the steel rod has to fit inside a 4mm drilled hole in the end of the brass cylinder, but there is no certainty that the drill will cut exact to size, if anything, it may cut slightly large. Therefore the diameter of the steel rods should be reduced until they just fit the previously drilled nominally 4mm hole. Another consideration is that the opposite end has to have a 4mm thread cut on it and due to extrusion effects, a starting diameter slightly less than 4mm may be appropriate. Therefore by accepting these two considerations, a slight amount of tapering can be accommodated.

The overall length of the steel rod is to be 5mm inside the brass pillar head plus 22mm distance through the wood drawer

Fig. 2

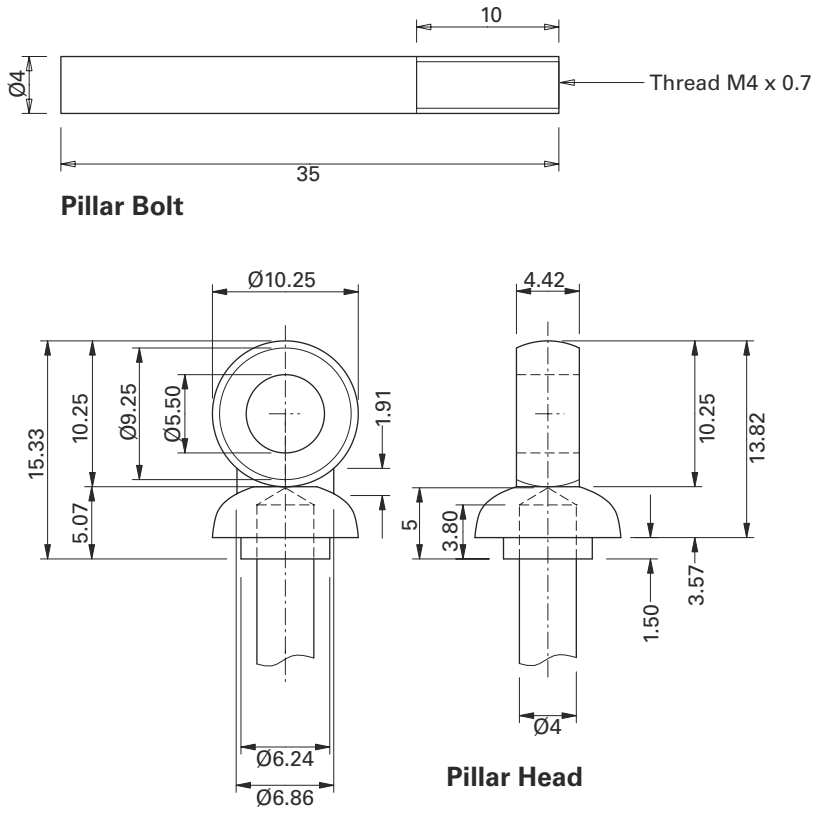
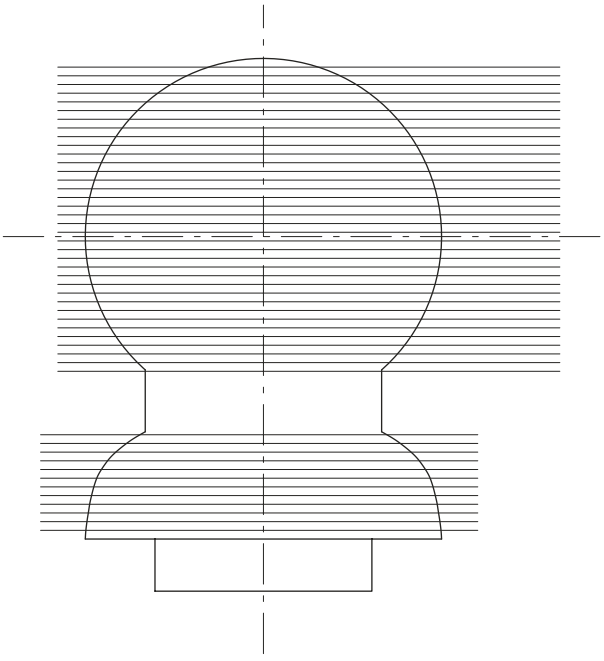


Fig. 3



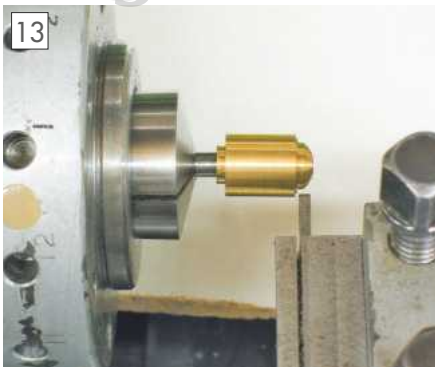
Brass blank and completed steel rod.

front plus an allowance for the nut and washer inside the drawer. In all, I decided on an overall length of 35mm. (Later reduced to 33mm when I received the dome headed nuts I used). I also decided on a screwed length of 10mm (later reduced to 8mm) as this would allow 3mm inside the wood itself and allow for some compression or incorrect measurement of the wood.

The actual first job then, is to cut four lengths of brass bar, face one end and then drill the 4mm holes to a maximum depth of 5mm. Therefore, the brass bar was mounted in the 4-jaw independent chuck and set to run true. Why? Although the bar is 11.11mm in diameter, and the required diameter of the finished pillar is 10.25mm, when I came to solder the steel rods into the brass bar , the rods were very much slacker than I expected hence could not be relied upon to be true. I think this was due to the different expansion rates of steel and brass, brass being almost twice that of steel. Therefore by setting true in the 4-jaw independent chuck, I was allowing for an amount of mis-alignment which would be turned off later. After facing and drilling to depth, a length of 17-18mm was cut off. This was repeated three times.

Now the nominal 4mm steel rods could be made. The ¼ inch steel bar was mounted in the three-jaw chuck with 35 - 40mm sticking out and then turned down until the outer end just fitted into the matching hole in one of the brass cylinders. The rod was cut off, and the operation repeated for the other three rods. Each rod was now reversed, inserted into a 4mm collet in the headstock, and a 10mm long M4 x 0.7mm thread started by screwcutting in the lathe. Using the lathe in this way ensures a good start to the thread. Each thread was finished off by a standard circular die after cutting a short taper on the end of the rod to make it easier for the die to start cutting.

The four rods were now soldered into the four brass blanks. Despite taking care to obtain a good fit between the drilled hole and the turned length, there was a fair amount of slack between the two parts once heated, leading to them not being particularly well aligned. The way the soldering was done was to stand the brass on a piece of thick steel with the 4mm hole uppermost, heat the brass with a medium flame on the blowlamp until solder would melt and run into the hole. I used cored solder, that is solder with cores of flux inside, but it would be equally acceptable to use separate flux and non-cored solder. The end of the steel rod was cleaned with wire wool, smeared with flux and inserted into the hole whilst the brass was still hot. Heat transfer from the solder onto the rod heated the rod and flux until the rod was able to be pushed to the bottom of the hole. Surplus solder is pushed out by this process and the whole then allowed to cool.

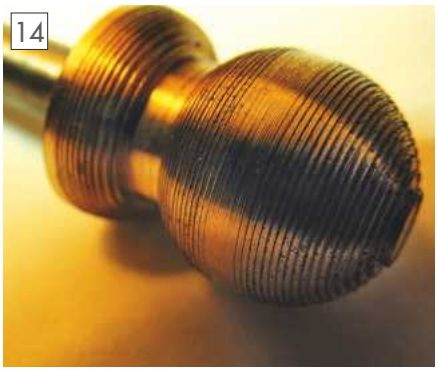


Part turned ball.

Milling the sides of the ball.

The next job was to create the spigot which located the brass blank in the plate and clean the excess solder from the steel rod. **Photograph 12** shows these procedures completed. Next the blank was turned to the correct length and diameter, followed by carefully turning the steps to make the embryo ball. **Photograph 13** shows the start of a ball and shows that I used my homemade parting-off tool. Unfortunately, a momentary loss of attention meant that the last cut I did on this blank was far too deep and thus this particular blank had to be scrapped. Note the use of the collet to hold the blank by holding the bar, and the minimum amount of room left between the end of the collet and the brass cylinder to allow the cutting tool to turn the spigot and clean up the excess solder on the bar.

The actual turning of the steps did initially seem somewhat awkward. In fact, once I started, it became very easy although a certain amount of care was needed to get all the cuts exactly correct. In the end, for each part of the operation, once everything was set up, it came down to:



Ball ready for smoothing.

Drilling the pillar.

- Making the cut.
- Retracting the tool.
- Advancing the leadscrew.
- Ticking off the cut just made on the chart.
- Reading the next cut from the chart,
- Making the cut.
- etc.

Once started, it was really easy – except for momentary lapses in concentration!

Once the cuts were completed (**photo 14**), the serrations were smoothed with a file, followed by emery cloth, then fine wet-and-dry until a suitable finish was obtained. Next, each pillar was mounted on the vertical slide on the lathe, a milling cutter inserted into a collet in the headstock and each side milled to leave a central thickness of 4.42mm or thereabouts as it is not that important how thick it is (**photo 15**). Finally, the thinned pillar was relocated in the vertical slide and the through hole drilled (**photo 16**). **Photograph 17**, unfortunately slightly blurred, shows the final result.

All that remained now was for the four pillars, two plates, four 4mm washers and four 4mm domed nuts (ordered via eBay) to be sent to Rob who duly installed as was shown in photo 1.

And that was that, an interesting job in which I discovered various skills I did not know I had, made a few mistakes (and learned from them) and showed that with relatively simple equipment new parts could indeed be made. ■

Completed pillar.

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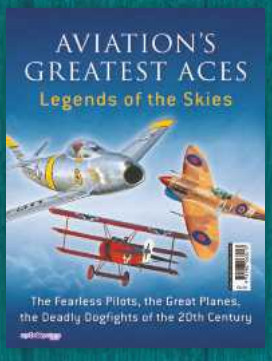

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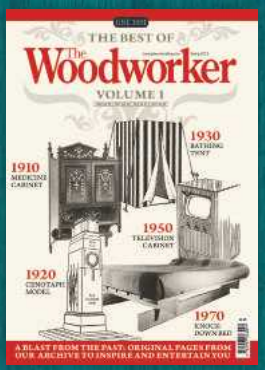

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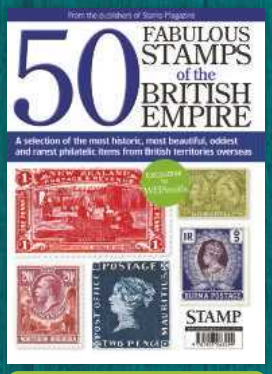

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Tip Top Tap Tips

Stub Mandrel advises on starting a collection of taps and dies.

We wouldn't be able to make much in our workshops without joining things together, and using screwed fasteners has the advantage that what we join can be taken apart again. This means that something we all need to do from time to time is make our own screw threads. Although the lathe is the ideal way to cut accurate threads, most of the time we find ourselves tapping and threading (making internal and external threads) with taps and dies for both practicality (it's hard to cut very small threads) and convenience.

1

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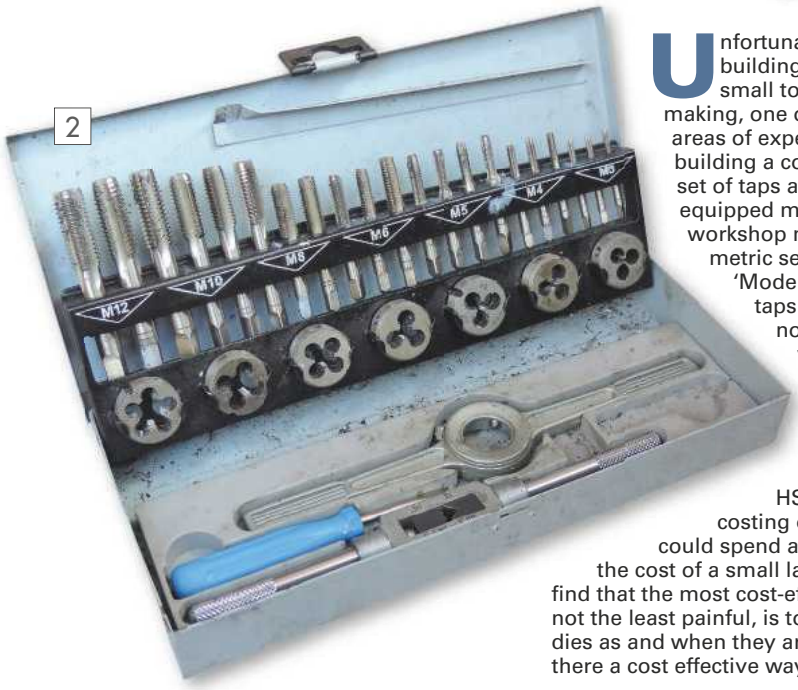

Unfortunately, when building a collection of small tools for model making, one of the significant areas of expenditure can be building a comprehensive set of taps and dies. A well equipped model engineering workshop might have BA, metric sets, as well as 'Model Engineer' ME taps in 40 and 32 tpi, not to mention various Whitworth threads above ¼ inch and perhaps several other types. With a full set of HSS BA taps often costing over £100, you could spend as much on taps as the cost of a small lathe. Many people find that the most cost-effective route, or if not the least painful, is to acquire taps and dies as and when they are needed, but is there a cost effective way to get started?

In the past people often had 'half sets' of BA taps – sizes 0, 2, 4, 6, 8 and often 10, such as my grandfather's LAL set (**photo 1**). These six sizes will be enough for most small model making projects, and can still be obtained. If funds are tight you could start with a decent carbon steel set, and replace any breakages with HSS as you go along. If funds allow, a full set of eleven BA sizes is worth getting, particularly if most of your work is on small models, the alternative being a set in the smaller metric sizes.

Those making larger models, workshop tooling or other bigger items are probably best starting with a good metric set, these will typically look much as that in **photo 2**.

Beware economy carbon steel metric sets – these often are very poorly made, only have one or two taps per thread size and the, often hexagonal, die nuts. The latter are really only any good for restoring damaged threads, and my experience of the taps is that they work, but aren't very good. Recognise them by their dull grey surface finish.

Many of our advertisers carry sets of 2mm to 12mm taps and dies in HSS (which will be a bright silvery colour), for very reasonable prices – so reasonable you may wonder if they are worth getting. The truth is that industry gets through these metric taps and dies by the container load, and quantity = economy, and we benefit from the savings. Although the dies are not split, you can expect them to produce good quality threads that will be a good fit in commercial nuts. The taps, in my experience, are accurate, sharp and tough.

A metric set like this will cover most of your day-to-day needs, allowing you to get on with the job in hand, and fill in more esoteric sizes later. It's worth noting that, aside from the thread form (60 instead of 55 degrees) M6 is the same pitch and diameter as 0BA and M5 is a good substitute for 2BA and 3mm is close to 5BA. I don't mean you can use a 5BA nut on an M3 screw, but you can substitute the threads for each other in most applications. M2 lies between 8 and 9BA and may come in handy from time to time, but is typically not included in these sets.

Taps typically come in three types – taper, second and plug, also known as bottoming or, sometimes, finishing (**photo 3**). Each tap has a progressively smaller taper on the end, and they should be used in turn to create the thread.

Most of the new metric sets also have a significant difference in the outer diameter of the taps, so the second tap creates a 'tight' thread whilst the plug tap gives a looser fit (think how you can 'spin' a standard nut down a matching screw). Modern taps also often have grooves around the shank – one for taper, two for second and none for the plug tap. This is a great help when trying to distinguish them in the smaller sizes.

Unlike taps, dies usually only come as one for thread size, but look at them carefully and you will see that on one side there is a shorter 'lead' into the thread. Normally you cut threads with the side having the longest lead – usually, but not always, the side with writing on it (**photo 4**). If you need to cut up to a shoulder you can invert the die allowing you to squeeze in an extra turn or two of full thread.

Good technique, using either a tap or die, is essential. I was taught two half-turns and one half-turn back, but in practice you will find some materials more willing than others. If the tap gets stiff, or starts to squeak, turn it back to break the chips. With smaller taps, especially, remove the tap completely every so often to clear the chips. Remember that it's only the first few threads that take nearly all of the load on a screw thread – if you are tapping a hole there is little value in making it deeper than the thickness of a nut you would expect to carry the same load.

To avoid breakages or drunken threads, one also needs to ensure squareness. Various tools, guides and accessories, have been described. If find that a close fitting sleeve with a flat end used with a taper tap having plenty of lead is an effective way to start a good accurate thread. Never force a tap, or use an oversize tap holder. I generally prefer T-handle tap holders, as in **photo 5**, to the straight type as supplied with the sets pictured earlier. I use the smallest holder I can get away with. For the smallest sizes (say 10BA) a pin vice is better than a tap holder. Dies are more difficult to keep straight – when tapping in the lathe the ideal is some form of dieholder that fits the lathe tailstock, often turning the lathe by hand or with a handle, rather than under power.

Finally, all threadcutting can be improved by using a good lubricant. Good tapping oils and compounds (such as Trefolex and RTD) cope well under pressure and some are designed to cool the tool by evaporating as well as lubricating. Different people will swear by tallow, milk or even spit for different compounds. Others will argue for and against using a lubricant on cast iron. One thing most agree about is that very light oils, even paraffin, are good for aluminium and that if using small taps in copper, use a proper tapping compound and great care! ■


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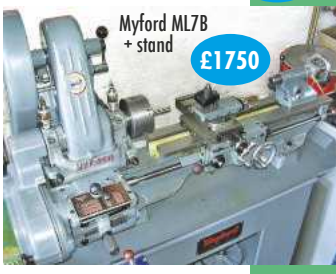

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