No.248

THE MAGAZINE FOR ALL HOBBY & MODEL ENGINEERS

MODEL ENGINEERS' WORKSHOP

Join the conversation about this issue: www.model-engineer.co.uk

NOVEMBER 2016

Raising the roof

Laurie Leonard has a workshop upgrade

A Lathe Mounted Belt Sander

A step-by-step guide to making this useful tool

COVER FEATURE

Richard Smith describes his radical quick change tooling system

£4.50
mytimemedia ENGINEERING GROUP
9 770959 690126 48

THE ESSENTIAL MAGAZINE FOR EVERY ENGINEERING WORKSHOP

PRO MACHINE TOOLS LIMITED

Tel: +44(0)1780 740956
Fax: +44(0)1780 740957

emco · WABECO 1935 1935 · CERIANI · TE CO · GOLmatic Maschinenbau · EMCO Hobbymaschinen · PROXXON · swiss tec Since 1865

Precision European made machine tools for the discerning engineer!

Wabeco CNC Mill CC-F1410

2 year warranty

- Table –500 x 200mm
- Z axis – 280mm • Speed – 140-3000 rpm • Power – 1.4 KW

Wabeco Lathe D6000

- Centres – 600mm
- Centre Height – 135mm
- Speed – 30-2300 rpm
- Power – 1.4 KW

5 year warranty

TECO Mill VF400

- Table – 450 x 160mm
- Z axis – 320mm
- Speed – 365-1800 rpm
- Power – 250 W

Ceriani Lathe David 203

- Centres – 500mm • Centre Height – 200mm
- Speed – 100-1800 rpm • Power – 0.75 HP

Wabeco Mill F1210

5 year warranty

- Table – 500 x 150mm
- Z axis – 280mm
- Speed – 140-3000 rpm
- Power – 1.4 KW

Ceriani Mill David 403

- Table – 420 x 160mm
- Z axis – 300mm
- Speed – 100-3000 rpm
- Power – 1.5 KW

ACCESSORIES

Lathe Chucks, Drill Chucks, Tipped Tools, Boring Bars, QCTP, HSS Tools, End Mills, Slot Drills, Machine Vices, Clamping Sets, Slitting Saws, Arbors, Boring Heads, Radius Mills, DROs, Rotary Table, CNC fits, Collet Chucks, Collet Sets, Flanges, Face Mills, Shell Mills and Much More...

Wabeco CNC Lathe CC-D6000

- Centre Distance – 600mm
- Centre Height – 135mm
- Speed – 30–2300 rpm
- NCCAD • Power – 1.4 KW

2 year warranty

TECO Lathe MD 200

- Centres – 300mm
- Centre Height – 52mm
- Speed – 250-2000 rpm
- Power – 250 W

MORE MACHINES AND ACCESSORIES ON LINE

Our machines suit the discerning hobbyist as well as blue chip industry

We regularly ship worldwide

Please contact us for stock levels and more technical detail

All of our prices can be found on our web site:

www.emcomachinetools.co.uk

PRO Machine Tools Ltd.
17 Station Road Business Park, Barnack, Stamford, Lincolnshire PE9 3DW
tel: 01780 740956 • fax: 01780 740957
email: sales@emcomachinetools.co.uk

MODEL ENGINEERS' WORKSHOP

Published by MyTimeMedia Ltd.
Suite 25, Eden House, Enterprise Way,
Edenbridge, Kent TN8 6HF
+44 (0)1689 869840
www.model-engineer.co.uk

SUBSCRIPTIONS
UK - New, Renewals & Enquiries
Tel: 0344 243 9023
Email: help@me.secureorder.co.uk
USA & CANADA - New, Renewals & Enquiries
Tel: (001)-866-647-9191
REST OF WORLD - New, Renewals & Enquiries
Tel: +44 1604 828 748
Email: help@me.secureorder.co.uk

CURRENT AND BACK ISSUES
Tel: 01733 688964
Website: www.mags-uk.com

MODEL ENGINEERING PLANS
Contact: www.myhobbystore.co.uk/contact
Website: www.myhobbystore.co.uk/me-plans

EDITORIAL
Editor: Neil Wyatt
Tel: +44 (0)1689 869 912
Email: neil.wyatt@mytimemedia.com

PRODUCTION
Designer: Andrew Tompkins
Illustrator: Grahame Chambers
Retouching: Andrew Tompkins
Ad Production: Robin Gray

ADVERTISING
Senior Account Manager: Duncan Armstrong
Email: duncan.armstrong@mytimemedia.com
Tel: 01689 869855

MARKETING & SUBSCRIPTIONS
Subscription Manager: Louisa Coleman

MANAGEMENT
Group Advertising Manager: Rhona Bolger
Email: rhona.bolger@mytimemedia.com
Chief Executive: Owen Davies
Chairman: Peter Harkness

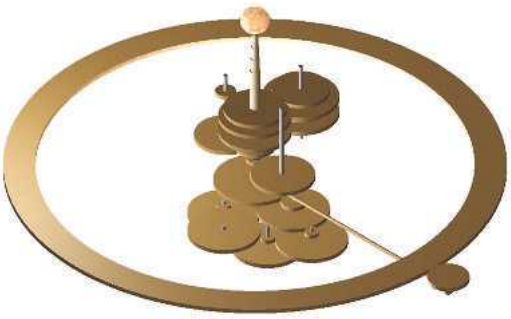
mytimemedia
print & digital media publishers

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 dsb.net 3 Queensbridge, The Lakes, Northampton, NN4 7BF.
Air Business Ltd is acting as our mailing agent.

recycle
When you have finished with this magazine please recycle it.

Paper supplied from wood grown in forests managed in a sustainable way.

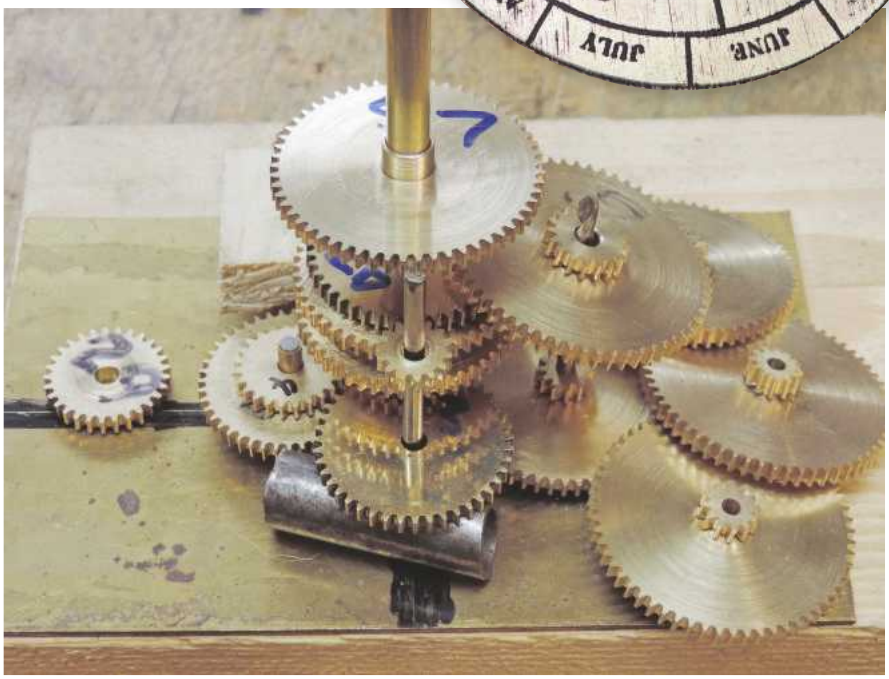
On the Editor's Bench



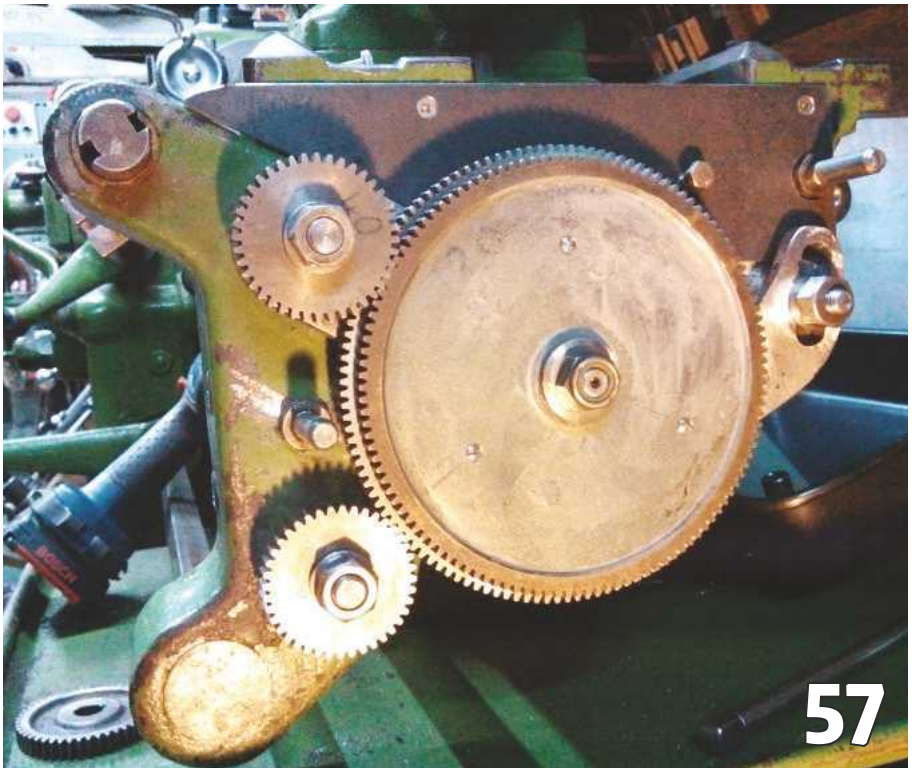
As always I have a good crop of projects vying for my attention, but the last month has seen me making real progress on a Jovilabe. What on Earth is that? you ask. Just as an orrery models the movement of the planets around the sun, a Jovilabe is a working model of Jupiter and its moons, usually just the four bright Galilean moons. It may also be an indicator of where in the heavens top find Jupiter. The original use for these devices was to help calculate longitude, as the movement of the moons can be used to work out the time to a high degree of accuracy.

My Jovilabe will use over thirty gears to whirl the various moons around at a sedate pace, while also spinning Jupiter to show when the Great Red Spot will be visible. It will also show where in the heavens Jupiter can be found, including allowing for the 'retrograde' or backwards movement of Jupiter around the time it lines up with the Earth each year.

Progress with the gears has been surprisingly rapid, as I use the same generating process as for the Adept change gears– in fact it was the success of those gears that made me realise the Jovilabe was a realistic proposition. Some experiments rapidly proved that although using over and under-size gear blanks produces slightly oddly-shaped teeth, these gears run together well; in turn this allows slightly mismatched pairs of gears to be used on the same centres. This in turn opens up the possibility of using a wide range of gear ratios to achieve a high level of accuracy with no more than four gears required for each ratio.



Contents

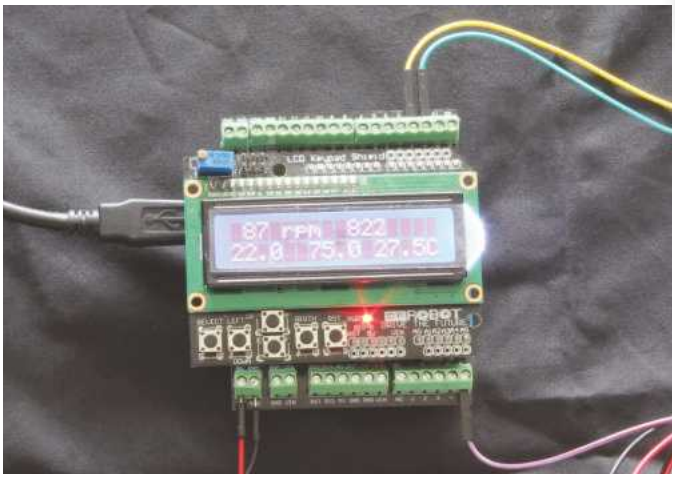


See page 60 for details.

Coming up...

in the December issue

Once you have enjoyed this issue, look out for the next, packed full of more tools and techniques!



Regulars

ON THE COVER

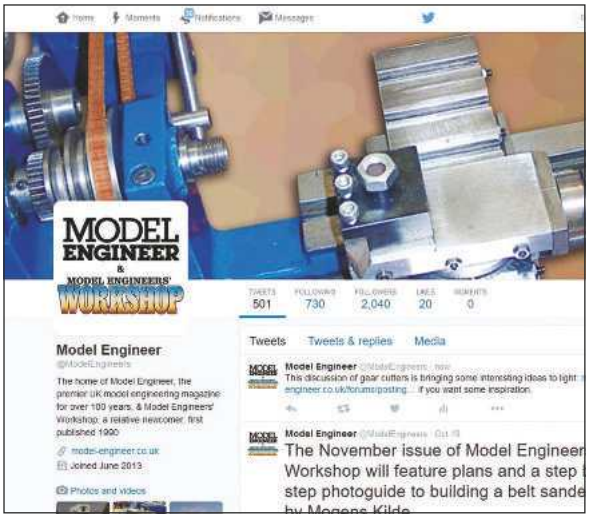
Our contributor Richard Smith pictured in his workshop. We feature his ingenious prototype tooling system on page 35.

HOME FEATURES WORKSHOP EVENTS FORUMS ALBUMS

Visit our Website

www.model-engineer.co.uk

Why not follow us on Twitter: twitter.com/ModelEngineers



You can also visit our website for extra content and join in our online forum

Hot topics on the forum include:

- **What Did You Do Today?**
  Join in and tell us what you're up to - a recent highlight was making helical gears on a universal milling machine.

- **The 'Aircraft general Discussion'**
  Tall tales from Kiwi Mosquitos to Humber Hawker Hunters!

- **Restoring a Beaver VBRP Milling Machine**
  Follow Paul Major's tool refurb blog!

- **M8 Tapping Drill**
  217 posts on threading a hole! It's a record!

CLASSIFIEDS EXTRA SUBSCRIBE ARCHIVE SUPPLIERS

WARCO

2 NEW MILLING MACHINES from Warco!

WM16B belt drive mill

£1,250
including VAT and UK mainland delivery, excluding Highlands and Islands

- Poly vee belt drive - very positive and smooth running system
- Brushless motor
- Infinitely variable speed
- Rack and pinion drilling action
- Rigid square column
- Head tilt calibrated 45°- 0 - 45°
- Rev. counter
- Spindle taper 3MT
- Powerful 1 kw motor
- Table size 700 x 180mm
- Standard equipment: drill chuck and arbor

GH18 gear head mill

- Oil immersed steel tempered gears
- Rigid construction with large section square column
- Rack and pinion drill feed
- Head tilt calibrated 45°- 0 - 45°
- Positive quill depth stop
- Powerful 1kw motor
- Speeds 6 – 95/1,420rpm
- Table size 700 x 190mm
- Spindle taper 3MT
- Supplied with 13mm drill chuck

£1,365
including VAT and UK mainland delivery, excluding Highlands and Islands

✓ *Both mills operate on a single phase supply.*
✓ *A wide range of accessories, including cabinet stands, are available.*
✓ *Digital readout can be fitted.*

Warco Winter Open Day

Warco House,
Fisher Lane, Chiddingfold, Surrey GU8 4TD
Saturday 5th November 2016 • 9:00am - 1:00pm

T: 01428 682929 Warco House, Fisher Lane, Chiddingfold, Surrey GU8 4TD
E: sales@warco.co.uk W: www.warco.co.uk

WARCO

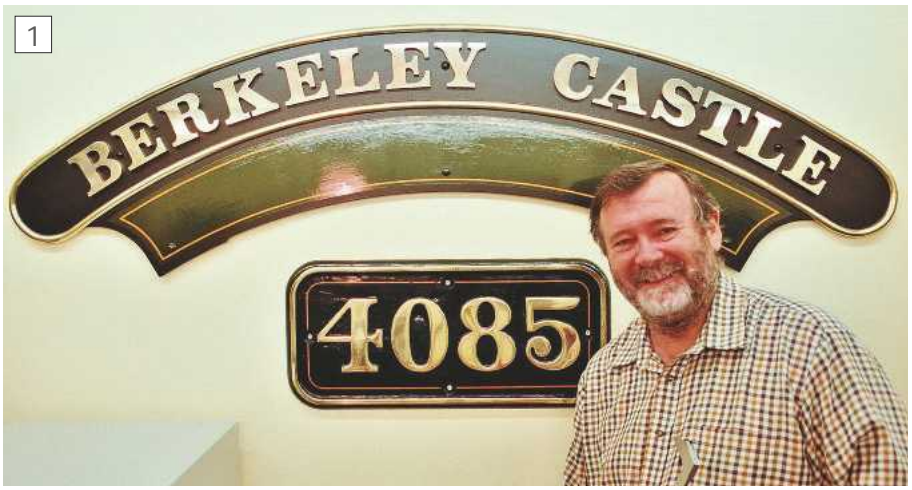
Making a Replica GWR Nameplate

With obvious applicability to making other large nameplates, John Smith describes his technique.

When still a schoolboy, I purchased a Great Western cabside plate from British Rail for the princely sum of £12-10s-0d. I tried to persuade my Dad to buy some nameplates, which were £25 each, but he said that it would be a waste of money. Thanks Dad! The plate arrived at Maidenhead station, wrapped in a piece of sacking. I carried it home, which was a struggle for a kid. The cabside I was allocated was from Castle Class number 4085, Berkeley Castle. I later found out that this was the locomotive which killed arguably the greatest ever railway chief engineer - George Jackson Churchward.

Three years ago I decided that the genuine cabside would display better with a replica nameplate, and that I would make one. There is a market for replica plates. There must be thousands of committed GWR enthusiasts who simply cannot justify the expense of a genuine plate. And heritage railways and loco-owning groups often produce replica plates to allow their engines to masquerade as a different member of their class, giving anoraks like me the thrill of the unexpected. A replica plate will typically make between £500 and £750 at auction.

Two years ago I created a digital drawing **(Figure 1)** from an original dyeline print of the 1937 Swindon drawing of locomotive nameplate letters. It was easy to see the radius to which the draughtsman's ink spring-bow compasses was set for each radius on each letter, so the end result is extremely accurate. I have used the drawing to have individual letters water-jet cut from 1/16" brass sheet for 7¼" gauge locomotive nameplates. The drawing was also used to produce a True Type font which has been gratefully accepted by several GWR heritage railways and model railway suppliers.



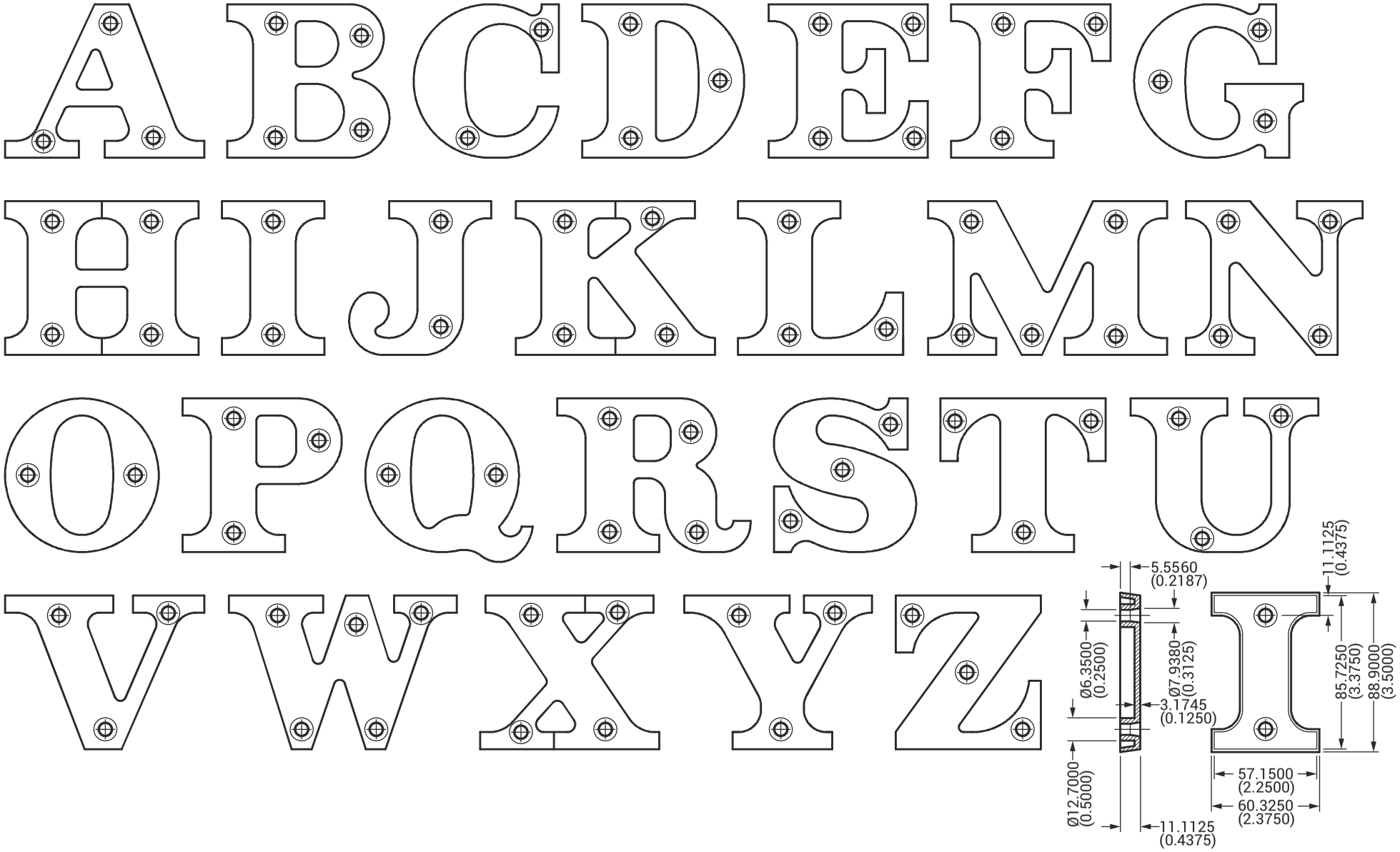
Replica Berkley Castle nameplate – George Churchward's nemesis

My first nameplate, **photo 1**, used cast brass letters which required machining all over. Tapered end mills were a big help, but it still took the best part of a day to machine a single letter. The worst part of it was that my drawing highlighted just how inaccurate some of the casting patterns were. The end result was OK to the untrained eye, but not to the trained one! I decided that I would have to make another nameplate, King John, and that this time I would use as much automation and accuracy as possible.

Frank Burridge's book, Nameplates of the Big Four gives most of the dimensions needed to produce an accurate digital drawing of a GWR backplate (I use DraftSight.). The key dimension missing is the radius of the lower edge, but Swindon General Arrangement drawings show the radius of the splashers on each named class and the National Railway Museum can provide this vital dimension if you email them. Of course, there are also many plates in museums to measure up and photograph.

A letter back from the wire eroder

Manor nameplate



1. The profiles shown are those at the face of the letters where the height is 3.375”
2. The vertical lines at the top & bottom of letters H, K & X (towards the middle of the letters) mark the position of a 90° ‘V’ depression 1/16” deep & 1/8” wide which is painted black
3. Original GWR cast letters were hollowed out at the rear to conserve brass & featured Ø1/2” bosses in the rivet positions

GWR Standard Letters For Engine Nameplates

Digitised by John M. Smith July 2012 from GWR Drawing No.110738, Swindon, December 1937

The traditional nameplate fixing kit

The 'improved' nameplate fixing kit

The backplate was laser-cut from 3mm cold-reduced steel sheet (the authentic 1/8" being unobtainable outside of the US) complete with the six mounting holes (a snip at £45 including the steel). The letters were wire-eroded from solid brass. Cast brass letters cost about £30 each plus a day's labour. Wire-eroded letters cost £70 each including the cost of the brass plus virtually no labour cost. OK, it is expensive, but **photo 2** shows what you get for your money. The letters are 3-dimensionally accurate to about a thousandth of an inch. You just need to polish (800 grit wet & dry followed by Solvol Autosol) and mount them. Having said that, the letters do look better if the edges are 'softened' a little by filing or the use of a Dremel with a grinding stone. The more you take off, the better the letters look.

The other beauty of CAD/CAM is that you can correct a visual problem. **Photograph 3** shows a typical Manor nameplate. You will see that an optical illusion makes the letter "O" appear to be too small. This is easily corrected by making the "O" about 1/8" taller than the other letters, which is what I did.

The traditional fixing kit for a GWR nameplate is shown in **photo 4**, which is rather sad given that the cheapest genuine GWR nameplate will set you back £5000. I felt that I could improve on this and produced the fixing kit shown in **photo 5**. It holds the plate precisely parallel to the wall and looks just right. You can see how it works. The three bottom round-headed bolts act as spacers. The top three bolts attach brackets with downward-facing projections which fit into slots in three wall brackets.

The plan comes together

Digital files were emailed to the laser-cutter and the wire erosion firm. **Photo 6** shows the project coming together nicely, and so far I had only left my armchair to mill the letter blanks down to 7/16" and make the fixing kit.

Original GWR cast letters were riveted to the backplate using rivets which taper from 5/16" diameter at the face of the letter to ¼" diameter halfway through the letter. These rivets are hard to replicate today as I have found riveting brass (with approximately 80% copper content) impossible to source. My first nameplate used tapered brass inserts, threaded M4. They had to be tapered as the cast bosses were not sized generously (they were also in the wrong places, which was another source of frustration). The inserts were satisfactory but the "rivets" did not have the authentic copper colour. With King John, I used 5/16" diameter parallel inserts, also threaded M4, pressed into the letters and made from SAE 660 continuously-cast phosphor bronze, which is beautiful to machine and has just the right 'coppery' look.

The letters are first drilled right through 4mm and the holes spotted through to the backplate. If you do this before the brass frame of the nameplate has been attached, the backplate weighs a lot less and is much easier to position on the drilling machine

The bending jig in use

›

table. The holes in the letters are then opened out and machine-reamed 5/16" diameter. Make the inserts half a thou over size with the bottom 1/8" of length two thou under to provide a lead in and to hold some Loctite 603. The beauty of letters screwed on from the back is that they can be attached after the backplate has been painted.

Now comes the part where I chickened out when making my first nameplate. The frame of a GWR nameplate is made from 5/8" OD x 10 SWG brass tubing slit and bent around the backplate, plus a piece of the same tubing (halved), soldered and riveted to the backplate below the letters. This is a major challenge. Trevor Tremblen of Swindon Copper Boilers did the job for me for the Berkeley Castle plate. For the King John plate, a friend with a Bridgeport ran down a length of the tubing with a 3mm slitting saw. I then had the tubing fully annealed by a heat treatment firm – about an hour between 580°C and 600°C, in an inert atmosphere, allowing the tubing to cool slowly in the furnace. Don't believe the huge number of web-sites which advise quenching brass from red heat to anneal it; this works for copper, but not for brass! You will need to rub the tube with 400 grit wet & dry to remove the discoloration caused by the annealing process.

When faced with an immoveable object, the resourceful model engineer looks for a way to apply an irresistible force – or bending moment in this case. The set-up is shown in **photo 7**. A bending jig was laser cut and attached to a four-inch length of 30mm square BMS by means of two 5/16" diameter dowels and two M8 bolts. The large radius is some 5" less than the radius on the top of the nameplate and is used to bend the tubing to fit the backplate; this can be done, by hand, quite easily. The radius of the 'circle' on the end is ½" less than the radius on the ends of the backplate, to allow for spring-back. The bending moment is applied using a length of thick-walled steel tubing with an internal diameter of 5/8". A two-inch-long slot is cut into the business end with a slot drill. The brass tubing can then be bent quite easily around the jig, which is held in the vice. Do it as a series of bends, pulling the steel tubing out 3/8" at a time until a complete 180° bend is achieved. You have to watch for, and correct, any tendency for the tube to twist. But it worked very well! I wanted to bend the tube cold, as I had read that bending brass hot can cause it to fracture and the tubing is too expensive to allow that to happen.

Of course, the jig can only be used for the first end; the second has to be bent around the actual backplate – unless, like me, you cheat. I cut the annealed split tubing in half and used the jig for both ends. An inch long tightly-fitting brass pin is positioned inside the join. After riveting, the join was filled with a brass shim, held in with Loctite; after draw-filing the join is virtually invisible. Put a 1/8" diameter countersunk brass rivet either side of the join; one ½" from each end, and four more spaced equally around the top.

I had a piece of halved tubing left over from the Berkeley Castle plate, courtesy of my friend with the Bridgeport and the slitting saw. I made a bending former from chipboard with a radius of 42" to allow for spring back. As soon as I started bending the halved tubing around the former, I realised that it was not annealed. With enormous difficulty I succeeded in bending it around the former, but it then sprang back again almost to its original shape. Un-annealed halved tubing is horrible stuff which will do its best to maim you. I had a choice to make. Should I have the material annealed, or should I acquire a sturdy ring roller to tame the material? I decided to buy the ring roller, **photo 8**, and a very satisfactory result was easily achieved. I remain convinced that annealed halved tubing could have been simply pushed around the chipboard former, using a few clamps here and there. As I did not use soft solder to attach the halved tubing to the backplate, I used ten 1/8" diameter snap head brass rivets rather than the regulation 5.

Put a 1/16" radius Milliput bead all round where the tubing meets the backplate. Then the plate is ready for painting. Opinion is divided as to whether the sides of the letters were originally painted black. Did original black paint wear off the sides of letters due to over-enthusiastic cleaning with a wire brush, or were the originally-polished sides painted at a later date, after they had become discoloured and dirty? I decided to paint the sides of the letters for King John – starting with a 2-pack etch primer from Phoenix Precision Paints.

Precision Paints can also supply the shade of green appropriate to the age of the original locomotive. A Beugler pin-striping tool makes short work of achieving a sharp transition from black to green below the brass frame, plus a crisp 1/8" wide orange lining. The end result, **photos 9 and 10**, is very pleasing and I found the exercise instructive. I stand in awe of the Swindon workers who made these iconic objects with their bare hands and without recourse to sophisticated heat treatment plant.

In closing, let me say that it is has not been my intention to produce nameplates which are indistinguishable from the real thing. That would be forgery and it would be well-nigh impossible. The rear of a genuine plate is usually quite corroded, especially where it attached to its three mounting brackets, and the top edges of the letters are worn from decades of polishing. ■

8

Bending half-tubing with a ring roller

9

The finished King John plate

The belly of the plate

10

Modifications to a Myford 7 Series Lathe

In a short series, Inchanga, in South Africa, describes work carried out on the tailstock and carriage of his lathe.

Modifying the Myford Super 7 tailstock – Part 2

This modification provides a positive lubricating system that reduces the wear to the base plate and bed. This involves machining a narrow oil groove in each bearing face, **photo 6**, and a corresponding oil nipple hole on the front and back face. Mount the base plate upside down on the table of the vertical milling machine using raising parallels to clear the lump for the clamping bolt and run a 2mm slot drill along each face to a depth of 0.5mm or so. The two gib adjustment screws provide a convenient datum for the ends of each slot, which can be judged by eye. The oil nipple holes have to be far enough towards the back to clear the carriage when the tailstock is fully towards the headstock, so that the nipples do not foul.

I used a FC3 throwaway cutter and also used this to make two oil holes to half the depth of the casting near the back of the slot. The position of the oil holes were transferred to the two side faces by making a tiny witness mark with the cutter and a 3mm hole drilled to communicate with the two slot holes. The outer end was opened up to suit the tap for the oil nipple. The base plate casting is nominally 5/8 inch thick in this area so a hole 5/16 inch from the bottom is the centre of the face. I was only able to purchase some M6 threaded grease nipples, so the holes were tapped to suit these. (The original Myford oil nipples used 2BA threads, approx. 5mm diameter). Where the oil passage enters the oil groove use a small countersink to form a little pocket. Once all the drilling has been completed blow through the passages to clear out any trapped swarf and clean up the bearing surfaces with a fine slip stone to remove burrs. Finally wash all the abrasive material away with paraffin and then wash and dry in soapy water before reassembling. **Photograph 7** shows the finished base plate and **photo 8** shows the clearance of the oil nipples from the carriage assembly when the tailstock is fully forwards on the bed.

Incidentally if you have a long series drill you could (with care in setting up) drill across the base plate to use one oil nipple to feed oil into each oil groove. The writers' choice would be to have the oil nipple on the front of the base plate where it is clearly visible as a reminder to the operator to apply the oil gun. Having oil nipples hidden away on the back is counter-productive.

Machining oil grooves on tailstock base plate casting

All that remains to be done is to reassemble the top portion of the tailstock and adjustments to set the tailstock alignment. Spread some thin oil over the two mating surfaces before fitting the top portion in place, ensuring it sits down fully in the keyway tenon slot by tapping it down with a rubber hammer. Attach the clamping plate below the bed and adjust the Nyloc nut to give adequate clamping pressure. The simplest way to adjust the Nyloc nut is with a tube spanner up from under the bed through the bed gap.

Tailstock alignment

For alignment a test bar is the best method. This is a length of round bar of about 25mm diameter that is truly parallel and about 15-inches long with a centre in at least one end. (Some prefer to make this adjustment using the test bar between centres). Using the graduated scale plate on the end of the tailstock can make the initial setting, but this is only a rough guide.

If you have a parallel test bar and a DTI, then it is only a few minutes' work to get things spot on. If you haven't got a DTI there is no need to panic, a set of feeler gauges work just as well. Assuming you will be using feeler gauges then mount the test bar in the 3-jaw chuck and bring up the tailstock centre and lock the barrel firmly and the bed clamp. Fix a round nose tool in the tool post and run the saddle towards the chuck end of the bed. Move the tool until the tip just touches the side of the test bar and zero the cross slide dial. Wind out the tool by 20-thou (0.5mm) and run the saddle towards the tailstock noting the gap between the tool tip and the test bar. If it touches somewhere along the length, then start again at the tailstock end and re-zero the cross slide dial. Ideally if the tailstock is aligned correctly there will be the same gap all the way along the travel of the tool as we wind the saddle backwards and forwards. The exact difference we can measure either with a DTI or a set of feeler gauges, **photo 9**.

Set the saddle at the tailstock end and place a feeler gauge of say 20-thou (0.5mm) between the tip of the tool and the test bar. Adjust the cross slide until it is just nipped but can be slid about. Remember how it

›

Modified tailstock base plate

Modified base plate showing adequate clearance of oil nipples from carriage

feels. Set the cross slide dial to zero and do not move the cross slide again. Now remove the feeler gauge and run the saddle all the way to the other end of the bed and try the feeler gauge again. If the gauge feels the same as at the other end then you are spot on. But it is very unlikely you will be that lucky! If the gap between the tool at the tailstock end is greater than at the headstock end then the tailstock is too far towards the back of the lathe and needs to be brought forward. The difference in gap can be measured using the cross slide dial, moving the tool tip until the feeler gauge is nipped the same as at the other end. If, say, the gap is 5-thou more at the tailstock end then the tailstock needs to be moved that distance towards the front. If the gap is closer then the tailstock needs moving back by the amount measured. One of the two pusher screws need slackening and the one that moves the tailstock in the correct direction needs to be tightened up. As the bed clamp lever is exerting considerable pressure this is hard but doable as you are fighting the friction between the top portion and the base plate. You can see the movement by using the feeler gauge and choosing one with the correct thickness. If the top doesn't want to move because of the clamping bolt pressure this can be eased off a bit to allow easier movement. When you have the correct setting snug up both the screws to prevent any incorrect

Checking clearance with a feeler gauge

movement and check the setting again. It takes much longer to write this procedure than to do it.

If you do not have a prepared test bar then you can do the alignment on the fly. Select a piece of round mild steel about 25mm in diameter and at least 12' long, preferably a free cutting variety, and put a centre hole in one end. Mount this in the 3-jaw chuck and bring up the tailstock centre to support it. Using a round nose tool put on a cut of ≈5-thou and using the slow self act make a run from the tailstock to the headstock. When the cut is complete measure the diameter at each end of the bar. If the diameters are exactly the same then it is correctly aligned. However, if the tailstock end is a smaller diameter than the headstock end then the tailstock is too far towards the front of the lathe. Suppose the tailstock end is 8-thou smaller than the headstock end. To correct this, we need to move the tailstock half the distance, in this example 4-thou, as we are measuring the diameter but we need to correct the radial distance.

Checking vertical alignment

Purists would use a parallel test bar between centres and a DTI for this but I hate messing around! The vertical alignment can also be checked with a simple gauge that can be made in very little time. This consists of a short piece of ground flat stock and a threaded pillar. The base of the gauge spans the two bed top surfaces and has a vertical rod that can be adjusted in height. I used an off-cut of gauge plate about 8mm thick x 25mm wide and drilled a hole in the centre and tapped it ¼' x 40 tpi. The vertical pillar was made from ¼' brass rod with about ¾' of thread on one end and a nut to lock the setting. I also parted off two short pieces of the same rod as dowels. These are placed in the 3-jaw chuck and the tailstock chuck. In use the gauge is placed at one end of the bed (making sure no dirt or swarf is trapped between it and the bed) and the vertical rod is adjusted so that a thin feeler gauge is just nipped between the two rods. **Photograph 10** shows the gauge at the tailstock end and **photo 11** at the headstock end.

If the two positions give the same amount of nip on the feeler gauge, then the two heights are the same. If one end is looser than the other, then by selecting a different feeler gauge the error can be established. This measurement confirmed the ≈2-thou error due to wear of the base plate. I slipped some pieces of aluminium baking foil between the tailstock upper and lower portions and repeated the measurement. This reduced the error to about 0.5-thou, which is satisfactory. Incidentally this gauge is modified from a tool height-checking gauge I use that quickly allows me to check the tip height of my cutting tools. A different vertical rod is used with a tiny centre point at the top.

Correcting serious wear

For more serious wear it would be best to machine a pocket into each side of the tailstock base plate with an end mill or slot drill and to insert two strips of gauge plate or bronze strips secured with screws from the topside. The pocket would be about 6mm less in size than the base plate wearing surface in length and the new bearing surface sunk into this pocket. (On the gib plate side the unworn surface is left as a guide to the original casting thickness).

The surface of these inserted plates should protrude slightly above the cast iron surface. These are then ground to bring the thickness back to the original measurement of the unworn portion. In the same operation the two cast iron gib bearing portions could be given a very small cut to true them up and clean up the rubbing faces.

A method used by the writer for a similar correction is, however, a bit easier. In this method the surface to be corrected is drilled to take a round bronze pillar, which fits into the counter-bored (flat-bottomed) hole with a small countersunk screw to attach it. For the Myford tailstock three pillars about 5/8-inch diameter and ¼-inch in length would suffice for each side of the base plate. These could be plunge-milled with a 5/8-inch slot drill to about 3/16-inch in depth. Two are placed near the ends and the third in the middle on each side. You would need to avoid the area where the two gib adjustment screws are located. The round stubs of bronze should have the screw head well below the surface and the

pillar length should be that it protrudes above the surface by about 0.5mm or so. It is best to make the pillars a close push fit in the holes or to secure them with locking adhesive as well as the screw threads so they do not come adrift in use. When the pillars have been sunk into the casting the base plate is then set up on the milling machine and the protruding ends of the pillars trimmed to the correct height. You can use either a fly-cutter or an end mill larger in diameter than the stubs, a ¾-inch cutter would be fine. Bronze sliding on cast iron is a beautiful bearing combination.

Bed grinding

If the wear to the bed upper surfaces is considered too bad to rectify by simple means, then very often it is necessary to surface grind the bed and slideways to bring it back to 'as-new' condition. This however is an expensive operation and heavily reliant on the skill of the person doing the work. You normally only get one chance; if a mistake is made the bed is likely to be scrap! The bed and associated items are shown in fig. 2 from the Super 7 manual. Note that the inner and outer slideways extend all the way along the bed and include the headstock mounting platform for alignment purposes. The headstock has a large key on the bottom that fits into the gap and the two alignment screws set the axial alignment along the bed. The headstock bolts are partially tightened and the two alignment screws (item 44 in fig 2) adjusted using a test bar and a DTI to ensure the headstock is parallel to the vertical slideways on the bed.

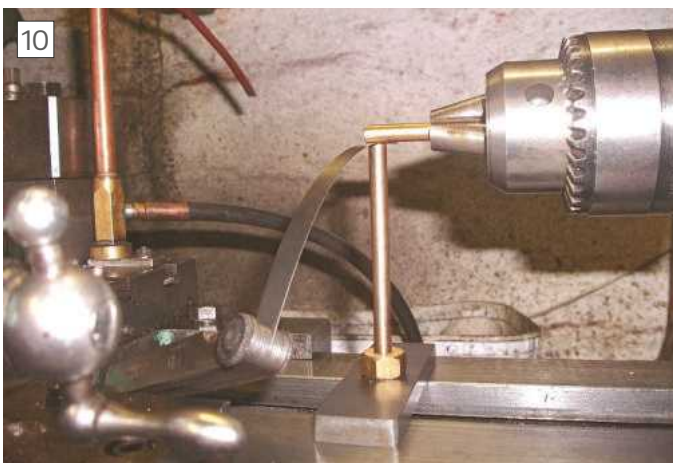
The recent series by Alan Hearsum in ME on refurbishing a ML7 lathe has a lot of useful information on renovating beds and slideways using hand tools. Although not as quick as surface grinding the final finish is as good if not better when the surfaces are hand scraped and lapped by a skilled operator. On the subject of scraping of bearing surfaces. Some years ago I saw the crosshead slide bearing pad on a Lancashire cotton mill engine that was about to be broken up for scrap. This engine was about 100 years old and the crosshead sliding surfaces had been hand scraped. Over the nearly 100 years the engine was in use the crosshead must had made millions of traverses on this part of the cast iron bed. You could still see the tiny little scraper marks and the little depressions that held the lubricating oil. The scraped area was about 4-foot long and 2-foot wide and would have occupied at least two fitters working together to scrape the bearing surface. From old textbooks on the subject it is known that an area would be firstly chipped out with a hammer and chisel, then hand filed reasonably flat. Finally, a large surface plate would be anointed with lampblack (soot)) and oil and slid over the work area. This would show the high spots that the fitters then went to work on with the hand scrapers. Working in small areas, like floor tiles, the whole slide would eventually be brought to a uniform flatness. Can you imagine a modern fitter tackling such a task today? It must have taken at least 7 days working to finish the job. Thank goodness we now have milling machines and surface grinders to reduce the manual labour required.

The other factor that needs to borne in mind is that on lathes such as the Myford 7 series if the top surface of the bed has to ground then we also have to grind the top surface of the headstock mounting platform. The headstock mounting platform of course does not wear, but it defines the headstock spindle height above the bed. If the bed is ground down to remove severe gouges and scratches, then the headstock spindle height effectively increases. Not only this but the tailstock spindle height also drops by the same amount, so the error is carried forward. (One way to correct this is to shim up the tailstock to the new spindle height). It is therefore essential to take as much material off the headstock mounting platform as is taken off the bed upper surface. Fortunately, in the Myford 7 series the two are set at the same height during manufacture so it is only necessary to run the grinding wheel over both at the same setting. If the tailstock base plate is also surface ground during the bed renovation, then we introduce a similar error. Suppose we need to grind off 20-thou to correct the wear, an unlikely event but possible. If we did not add an additional spacer of 20-thou to the bottom of the tailstock we would end up with the tailstock spindle being 20-thou lower than the headstock, which causes a long parallel shaft supported by the tailstock centre to be turned taper. However, it is messy to add thin spacer blocks so we can bring the tailstock back into alignment in the vertical plane by removing an additional 20-thou off the headstock mounting platform. Alternatively, a much greater amount would be cut off the bottom of the base plate, say 3mm, and pieces of 4mm thick ground flat stock attached with countersunk screws and then ground to get the correct thickness, but that is a lot of extra work and expense. Hence, before a bed is ground for any reason we need to accurately measure all these parameters to ensure we do not introduce an error by accident.

Grinding material off the top of the bed also reduces the height of the inner and outer vertical slideways. If the outer vertical edges of the bed slideways need to be ground to eliminate wear and provide a truly parallel surface then the carriage gib screws can easily compensate for the small loss of bed width, but the carriage vertical adjustment is not so easily corrected.

Fortunately, the Myford 7 series bed is fairly tolerant of slight errors in grinding because it uses laminated or 'peelable shims' to make minute adjustment to the saddle slideways in the vertical plane. These are small stacks of brass shims; each one is 2-thou in thickness. These shims are fitted at the front and rear of the carriage to adjust the gib plates and set the vertical movement.

They are similar to a deck of playing cards with a central hole through which the clamping bolt passes. If the stack is ten deep then the total thickness is 20-thou. If the shim thickness is too great then the individual shims can be peeled off one at a time using a knife blade to separate them. If one shim is removed the stack is now 18-thou thick, if two are removed it is now 16-thou thick etc. This small variation in thickness is normally adequate to correct the running clearance. Using this method means that the grinding is not so critical, unlike other machines, if the bed is ground the corresponding rubbing gib plates also need to be ground by the same amount to compensate, which is an additional operation and adds to the cost involved. ■



Vertical height gauge at tailstock end

Vertical height gauge at headstock end

Raising the Roof

Laurie Leonard undertook a major refurb of his workshop and offers some cautionary advice on dealing with asbestos.

My workshop is basically a concrete sectional garage but with a personal door instead of garage doors. It was assembled from precast concrete uprights, precast concrete panels, metal windows and corrugated asbestos sheet roofing sheets. It is about thirty-five years old but some twenty-five years ago it was dismantled at my previous house, transported 130 miles and rebuilt where I live today. A general view is shown in **photo 1.**

General view of workshop before work commenced

The corrugated cement asbestos roof was secured to the 1" angle iron purlins with hook bolts which carry a rubber seal where they fit over the asbestos roof sheets. For several winters I thought that these seals had failed as there was water dripping off the purlins, so they were replaced and ultimately replaced and silicone sealed. I still had days of drips and I finally realised that the cause was not leaks but condensation as the problem only really manifested itself after a frost. I tried putting up some insulation in the form of polystyrene sheets held up with string but this did not really work as can be seen in **photo 2**. I also concluded that the roof sheets were slightly porous. A better level of insulation was required. My original intention was to remove the roof, put on a layer of chipboard or similar, cover with felt and two inches of polystyrene and then to replace the original roof.

Trial insulation with polystyrene

However, this would still leave the problem of asbestos. Whilst in the sheet form, undisturbed, as on the roof we are advised that it presents little hazard but it would still be present. A far better solution would be to replace it with a modern material. After working on the costing I concluded that the approximate 30% additional cost of using a coated metal foam sandwich instead of the above would be worth while. This sandwich is about 40mm thick and so I effectively raised the roof by this amount.

Planning

Before undertaking such a project it was necessary to plan it. This I did whilst recovering from an operation. Having planned it and ordered the materials it was the middle of December; not the best time to be replacing a roof. Also, the poor light in December did not help photographing the stages of the work.

Asbestos Disposal

Due to the carcinogenic properties of asbestos there are strict regulations on its disposal and so before ordering any materials or planning the work it is necessary to research this topic. The old asbestos roof was removed in line with my local authority's advice. I have not described the process of removal as it is important that individual advice is taken. My understanding is that many councils

›

Samples of the roofing bolts/screws

Roof sheet cut back for gutter drip and arrangement to support end caps/barge boards

employ someone who will come out and inspect any asbestos products on domestic premises and offer advice on safe disposal.

Material Procurement.

Reference to Yellow Pages was made to find suitable local suppliers, look under "Roofing Materials". Prices seem to vary but when choosing a supplier form a judgement on how helpful they are likely to be if you have problems or need to ask questions. I found the supplier that I chose, reference 1, very helpful and he answered all my email queries very quickly and I was not afraid to ask what might seem to be damn fool questions.

A budget price (June 2009) for the 40mm sandwich I used was £29 per square metre (inc VAT) but on top of this you need the screws to secure it, mastic for joints and an 8mm hex socket driver to fit into your battery drill to set the screws. The sheets are available in various colours but I did not want to make an impact in the garden and there is an argument that a light colour will reflect the heat in the summer and so light grey was chosen. Samples of some of the special screws complete with sealing washers are shown in **photo 3**. The long self drilling bolts are not shown as they had been used up before the photograph was taken. Also shown are the driver and a bolt cap which is colour matched to the roof sheets. My supplier made up a comprehensive fittings pack which included all the above and I would recommend this approach.

The size of each side of the roof was measured and the angle of the ridge calculated/measured. The latter was not easy as the ends of the workshop were concrete triangular sections which had casting relief and tolerance. Measurements were taken of the triangle at its extremities to reduce the error. From these measurements the angle was calculated so that the ridge sheets could be supplied pre bent. Two lengths of each were supplied for the inner and outer runs which was in excess of the amount required but the sheets were just overlapped as it was not thought worth cutting them. At about 3m long these sheets would easily bend under their own weight despite the pre bent angle so careful handling was required to prevent a permanent casual bend/crease. In transit these were carried with one edge up.

It is normal for the insulation and inner metal surface to be trimmed back at the gutter end of the sheet to provide a drip for the gutter. My supplier wanted to know this distance. It is dependent on where the gutter is fitted in relation and the eaves overhang. This aspect can be seen in **photo 4**. After the photo was taken the gutters were raised and moved out as part of the final finishing of the job but at this stage the overhang is clearly shown. The change in gutter mounting was allowed for when ordering.

I was advised that a neater job is made if the internal ridge sheet just sits on the top

Internal ridge sheet sitting on the wooden battens which in turn are sitting on the 1" angle

purlins so that the edges of the sheets are not visible. This distance was measured and given to the supplier and the sheets made to fit (an example of a reason to go to a supplier who cares and is prepared to hold your hand). This inner sheet can be seen in **photo 5**, resting on the wooden battens which in turn are on the 1" angle purlins.

Material delivery.

I had intended to collect the material to save the delivery cost but was convinced by my wife to pay up. This cost will obviously vary with the journey distance. The main roofing sheets, when delivered, were shrink wrapped onto a pallet with protective membranes between sheets. We had to break this down to unload them into my garage but I would recommend delivery to limit any damage to the materials in transit.

Timing

December is not the best time to take the roof off your workshop particularly if like me you can not empty it but having got the materials delivered and removed a lot items to temporary store in the garage I wanted to get on with the job so I could get back to jobs in hand. I estimated that my son and I could get the old roof off and a minimum of the new roof on to keep out the rain in a day bearing in mind the limited daylight in December. We just managed this including the fitting of an additional angle the length of the roof to act as a new shelf support. This is described later in article. A second day was needed to put in more bolts and sort out the ridge and end caps. The job was not finished until a couple of months later because of a "technical" snag and the weather. See 'problems' below.

Preparation for new roof.

Once the old roof had been safely disposed of, I was left with the purlins that supported the old roof that were 1" angles with a sharp edge up. To provide a suitable landing for the new sheets it was recommended that wooden battens were placed in the angle to provide a flat surface for the sheet to bed onto. These were placed in situ and subsequently held by the roof bolts. These can just be seen **photo 5** together with the inner ridge sheets prior to squaring up ready to accept the roof sheets.

Roofing sheet clamped prior to bolting.

Gap in ridge filled with polystyrene. Applying the gunned mastic.

Ridge filler work completed

Trial fit

Having measured the workshop to order the material, the number of sheets per side was known. Allowing for a slight overhang at the ends and the use of angle caps/barge boards at each end, the job was done with whole sheets but a problem was noticed. The workshop was

The protruding roof bolts

Use of builders' foam to seal between roof sheets and walls

Completed roof

Roof bolts in the correct, troughs, and incorrect, peak, positions.

not square. Badly erected? Moved over twenty years? Whatever the reason it was decided to have a trial fit of all the sheets so that adjustments could be made to accommodate the problem if necessary. Having done this and satisfied myself that the skew could be accommodated, one sheet on each side was removed to provide

The two cartridge gun lengths

working space, the remaining sheets being moved along in turn for fitting.

Fitting

The sheets were placed in situ, squared to the ridge and clamped, **photo 6**. The centre line of the 1" angle was marked and boltholes predrilled with a pilot hole of about the tapping size for the bolt using a drill guide. Yes, I know that this tends to defeat the use of the hardened drill point on the bolts but drilling through 40mm and aiming for a 1" angle could lead to errors (in fact I was drilling though about 100mm see below). The bolts are inserted in the troughs not on the peaks as on the old roof and as would seem logical.

Strip mastic was supplied to seal the joints between sheets and the lap joints are secured with short self-tapping screws. The bolt spacing was as prescribed by the supplier and it was found that ample bolts had been supplied.

The ends of the sheets are square to the sheet face and so there is a small "v" shaped

Finished area of new shelves showing additional angle supports

Spalled concrete and rusty re-bar

Spalled concrete and rusty re-bar

gap along the ridge. I was advised that this could lead to a cold spot and should fill the gap. Due to the shallow angle of the roof there was little gap but this was filled with some polystyrene sheet.

The ridge closure sheets were placed in position and a pencil line drawn along the roof sheets to indicate the position of the ridge fillers. These were bedded in a gunned mastic about 15mm in from the pencil line with mastic applied above and below the fillers, **photo 7**. The fillers with the ridge sheets in position are shown in **photo 8**.

The roof sheet retention bolts protruded through the purlins, **photo 9**, and were easily cut off with a disc cutter. The internal surface of the roof was protected during this operation to prevent potential future rust staining from the metal dust. A disc cutter was used as the bolt ends are hardened to make them self-drilling.

The right angle end caps/barge boards were specified at 150mm deep to cover the foam sandwich and to provide a reasonable overhang for weather protection. At this depth they could be prone to wind damage so an arrangement was needed to tack these down. Use was made of the bolts that secured the purlin brackets to the concrete workshop ends to secure battens. A counter drilled hole, large enough to cater for a socket on the securing nut ensured that there was no fouling and the bolts were replaced by lengths of studbar to cater for the extra length required, photo 4. The angle end caps/barge boards were cut to length with a fine hacksaw blade and the raw ends sealed with the special sealant provided. These were then screwed to the roof sheets with self-tapping bolts and to the battens with the hex head screws provided.

With the roof complete it was evident that there were gaps in places between the concrete wall sections and the roof. These were sealed with a bead of builders' foam, **photo 10**. Silicone sealant was tried but in the main the gaps were too big and experience has shown that, should it ever be necessary to remove part of the roof, it is relatively easy to slice through the foam to release the seal.

The finished job is shown in **photo 11**, which also shows the new wooden double glazed windows.

Problems

However good the planning, I always seem to hit some problem or other with a job like this. I mentioned that the pilot holes I made in the roof sheets were going through 100mm. Although I had been advised to put the bolts in the troughs I went into "engineering" mode and put them where they were least likely to leak. Although they held they were only holding in the battens and not in the metal angle. I discovered the problem part way through the job when I realised the bolts were not long enough. Although they were tight and had penetrated the angle it was only the drill point protruding. On checking the number of supplied bolts I could not leave them all in so I had reclaim some and plug the holes left with self tapping screws. Bolts in the right and wrong positions can be seen in **photo 12**.

The only other real problem was my mastic gun. The gunned mastic supplied for bedding the ridge sealing strips was in a 400ml cartridge and my gun would only accept 300ml cartridges. The difference in gun length can be seen in photo 13. This was only discovered when trying to insert the cartridge. Due to the time of day I had to make the roof roughly weather tight so the ridge sheets were fitted with the sealing strips but these were fitted dry and the job completed later. This turned out to be a couple of months later because several periods of snow intervened.

Conclusion

At the time of writing the new roof has been on now for about six months. The previous winter was the coldest with more frosts than there has been for a long time. No drips. The workshop is also noticeably cooler in full sun. However the biggest impact is on entry. It is now welcoming. Compare the inner views in photo 2 and **photo 14**.

The reflective properties of the white metal inner skin increase the lighting level in the workshop. An earlier mod had attempted to achieve this with white painted hardboard but this went mouldy and black.

Pencil wire brush used to clean rusty re-bar

Re-bar primed

Level made good with external filler. Cracks and porous areas highlighted by silicone waterproofing solution

Now back to my Hemmingway tool grinder kit.

A Couple of Asides

Maintenance

As stated above my workshop is about 30 years old. Although it is made of concrete I have carried out maintenance work on it every couple of years. This is nothing very technical; I have no building qualification. When the workshop sections were transported to my new home they were laid flat on the bed of the lorry instead of vertical and this led to cracked components. Also, some of the steel reinforcing bars were probably too near the surface of the panels when they were cast and this has led to spalling of the concrete.

To keep the effects of the above to a minimum, every couple of years I scrub the complete outside with a weak bleach solution to remove any algae and dirt and then give it a good rinse with clean water. Where there are signs of loose or flaking concrete I remove this. This usually exposes signs of rusty re-bar, **photos 15 and 16**. The rust is attacked with a pencil wire brush on an electric drill, **photo 17**, and the cleaned metal is treated with red oxide primer, **photo 18**. The removed concrete is replaced with exterior grade filler and sanded back to profile, **photo 19**.

The whole exterior is then given two coats of waterproofing silicone solution. This process can be quite alarming as it shows up all the cracks and porous areas. This can be seen in photo 20 which was taken before the solution had dried. As stated above the workshop is some thirty years old and the above treatment seems to keep things in check.

Shelving

There is never enough storage space so shelving is a must but how to support it when the walls are concrete panels? For the last thirty or so years I have managed with ordinary shelf brackets supported on wooden planks carried on the bolts that hold the wall panels to the uprights. I certainly did not want to drill into the concrete for many reasons. This worked but the span of the panels is 4ft and the shelves inevitably sag and thing fall off (this set the burglar alarm off once). Support was needed mid span.

The solution was to provide the support from the roof structure downwards hence the addition of an angle onto the roof trusses whilst the roofing sheets were off. Part of one of these can be seen in red primer in photo 5. A proprietary shelving system was also purchased for the large areas and an area of the finished job in **photo 20**. Angle supports were made to fit the chosen shelf spacing, the whole being bolted into position in case removal is necessary. The under shelf supports were bolted to the vertical supports and tack welded for added strength and to prevent sagging from slop in the bolted joint.

Use of structural bolts to attach wooden shelf supports

Further Upgrade

The metal-framed windows have been replaced with wooden double glazed ones. One of the reasons for doing this was security as the original windows were very insecure and could easily be forced. A draught seal was also incorporated into the opening window. The door is now the most vulnerable point and draughty but some air is needed.

Together the upgrades have completely changed the look of the workshop and brought it up to date. ■

[Editor's note: Although concrete based asbestos products are classed as low-risk, if in good condition and left undisturbed, removing asbestos is dangerous and undertaken at your own personal risk, we advise that you ask a professional to do it for you.]

References

●Roofing sheet supplier

NEW-CLAD LTD
Unit 5 New Quay Road
Stephenson Street Ind.Est.
NEWPORT
NP19 4PL
Tel 01633 275455
Email info@new-clad.co.uk

THE PERFECT CHRISTMAS GIFT

JUST £19.99

Avoid the long queues and treat your loved one with a gift subscription to their favourite magazine. You get to save money, and they get their magazine delivered direct to their door! You could even treat yourself… Don't miss out - subscribe today!

GREAT SAVINGS! UK Print offer

CHOOSE FROM A RANGE OF MAGAZINES GREAT SAVINGS
DOWNLOADABLE GREETINGS CARD WITH GIFT SUBSCRIPTIONS

SAVE 37%

7 ISSUES FOR £19.99
~~FULL PRICE £31.50~~

SAVE 27%

7 ISSUES FOR £19.99
~~FULL PRICE £27.30~~

SAVE 32%

6 ISSUES FOR £19.99
~~FULL PRICE £29.40~~

SAVE 31%

7 ISSUES FOR £19.99
~~FULL PRICE £29.05~~

SAVE 34%

8 ISSUES FOR £19.99
~~FULL PRICE £30.40~~

SAVE 26%

6 ISSUES FOR £19.99
~~FULL PRICE £27.00~~

SAVE 30%

6 ISSUES FOR £19.99
~~FULL PRICE £28.50~~

SAVE 33%

6 ISSUES FOR £19.99
~~FULL PRICE £29.94~~

SAVE 33%

6 ISSUES FOR £19.99
~~FULL PRICE £29.94~~

SAVE 31%

7 ISSUES FOR £19.99
~~FULL PRICE £29.05~~

SAVE 26%

6 ISSUES FOR £19.99
~~FULL PRICE £27.00~~

HURRY! LIMITED TIME ONLY

SUBSCRIBE SECURELY ONLINE: www.mymagazineoffers.co.uk/X361

CALL: 0344 243 9023* AND QUOTE X361

BY POST: PLEASE COMPLETE THE FORM AND POST IT TO THE ADDRESS PROVIDED.

YOUR DETAILS: (This section must be completed)

YOUR DETAILS: (This section must be completed)

Mr/Mrs/Miss/Ms..... Name..... .....

Surname.....

Address .....

.....

Postcode.....Country.....

Tel/Mob.....

Email.....

D.O.B.....

Magazine..... Price .....

GIFT RECIPIENT (Complete 'Your details' first)

(Complete if you are buying a gift subscription)

Mr/Mrs/Miss/Ms..... Name..... .....

Surname.....

Address .....

.....

Postcode.....Country.....

Tel/Mob.....

Email.....

D.O.B.....

Magazine..... Price .....

* Lines open Mon - Fri - 8.00am - 8.00pm GMT & Sat - 9.30am - 3.30pm GMT. Calls are charged at the same rate as standard UK landlines and are included as part of any inclusive or free minutes allowances. There are no additional charges with this number. Overseas calls will cost more.

PAYMENT DETAILS

Please make cheques payable to MyTimeMedia Ltd and write code **X361** and magazine title on the back.

☐ Postal Order/Cheque ☐ Visa/MasterCard ☐ Maestro

Card no: (Maestro)

Cardholder's name: .....

Valid from ..... Expiry date..... Maestro issue no.....

Signature ..... Date .....

SEND TO: MY TIME MEDIA LTD, SUBSCRIPTIONS, 3 Queensbridge, The Lakes, Northampton NN4 7BF

TERMS & CONDITIONS: UK Print offer only. Offer ends 15th December 2016. All subscriptions will begin with the first available issue of 2017. For full terms & conditions visit www.mytimemedia.co.uk/terms. From time to time, your chosen magazine & MyTimeMedia Ltd may contact you regarding your subscription, or with details of its products and services. Your details will be processed in full accordance with all relevant UK and EU data protection legislation.

If you DO NOT wish to be contacted by MyTimeMedia Ltd & your magazine please tick here: ☐ Email ☐ Post ☐ Phone. If you DO NOT wish to be contacted by carefully chosen 3rd parties, please tick here: ☐ Post ☐ Phone. If you DO wish to be contacted by carefully chosen 3rd parties, please tick here: ☐ Email

Digital Calipers – A Comparative Review

It's fair to say that, although a proportion of readers will still use mechanical vernier calipers on a regular basis, and an even larger proportion will have one sitting at the back of a drawer, the vast majority will rely on one or more pairs of digital calipers for most of their accurate measuring tasks. Digital callipers are so handy and easy to use that they even get used for the majority of jobs where a micrometer would be ideal. Even a relatively worn or cheap digital vernier will allow you to work to better tolerances than some past model engineers who had to make do with no more than a pair of simple, non-measuring, calipers and a skilled sense of touch.

1

The Mitutoyo caliper is very well packaged and comes with a sheaf of paperwork.

2

The storage case is inside a bright orange slip case.

That said, the merits of various calipers from cheap and cheerful to the top of the range have been debated on the Model Engineer forum and elsewhere many times. From fundamental accuracy to battery life it's clear that not all calipers are equal, but just how big are the differences and what issues should you bear in mind when choosing a pair? For this test three brand new calipers, supplied by Machine DRO, www.machine-dro.co.uk, were put through their paces for this test, at each of three price points as well as some older budget calipers. These were:

Machine-DRO - ME-CAL-TOL-150 price is £12.76 inc vat, their own-brand entry-level caliper.
Moore & Wright - MEB-MW110-15DBL price is £23.70inc vat (list price is £47.40inc) from their Value Line series.
Mitutoyo – 500-196-30 price is £80.00inc vat (list £118.80inc) popularly known as one of the 'Absolute Digimatic' calipers.

I also tested the two of my varied collection of 'budget' calipers:
Proops branded, a rather old pair.
Aldi 'Workzone' nowhere near as old, but looking rather tatty as the silver paint has scratched off.

One quick aside, because of their general resemblance to mechanical vernier calipers, these devices are often referred to as 'digital verniers'. It's possible to come up with a complex justification for such a name, but if you want to stay out of meaningless arguments, I suggest you call them 'digital calipers'.

Mitutoyo Absolute Digimatic

This is a professional measuring instrument and is the only one of the calipers that came with a test certificate – that matches the serial number on the back of the caliper body, figure 1. It comes in a nice quality blown plastic box with a spare SR44 (silver oxide) battery clipped to an impressive sheaf of paperwork, the caliper itself is sealed in a plastic bag with a sheet of VCI (rust inhibiting) paper and a slip of the same between its jaws, **photos 1 & 2**. The main instruction leaflet folds out to almost A2 size with many language sections. It is not particularly user friendly, but does include a proper explanation of the digital communications protocol of the calipers – this is different from that used by most inexpensive calipers and digital scales.

The digimatic works in a slightly different way from the other calipers; when you first switch on you are prompted to zero it and use a special button (that needs to be depressed well home and held there) to set the origin, it also will never miscount because of moving the slider too fast. This is the 'Absolute' aspect of the calipers as no matter what you do they will always remember where they were and show an accurate reading – this is what really sets them apart from cheaper calipers. Unlike my old calipers which I always zero before use, over a couple of weeks with the digimatic it hasn't needed the origin resetting and reliably shows zero every time it is closed, aside from when I took the battery out.

As mentioned it used a silver oxide battery and the expected service life is 18,000 hours or 3.5 years per battery. The caliper has a true absolute/incremental mode

3

The reading head design is subtly different from the usual appearance.

The Moore and Wright caliper has distinctive styling.

so you can directly measure the difference between two sizes without having to change the zero point.

Although from a distance they look much like most digital calipers the detail design is subtly different, **photo 3**. Instead of the otherwise obligatory 'threading chart' on the back of other calipers, it has an assortment of code, serial and model numbers and reminders of how to set the origin and move between absolute and incremental mode.

As you would expect from a high-end instrument, the finish of the Digimatic is excellent; it has a virtually mirror finish to the surfaces of the rail and the corners of the rail are finished so as to be comfortable to hold. The jaws are well finished but have a sharper corners, presumably to ensure measuring accuracy.

The neat adjustment button and general silky-smooth action of the Mitutoyo make it a pleasure to use.

Moore and Wright Digitronic Value Line Series

Sitting between the budget end of the market and the full professional instruments, Moore and Wright's value line is aimed at the serious hobbyist or production environments rather than the toolroom. These Moore and Wright calipers are the most distinctive of all the pairs I have seen. The body is blue, rather than black, with an oval window and distinctive heavily ribbed thumb-rest, **photo 4**. It comes in a blown plastic case that strongly resembles, but is not identical to, the Mitutoyo one together with a less daunting set of paperwork, a spare battery and the caliper itself inside a ziplock bag with a slip of VCI paper, **photos 5 & 6**.

Like the Mitutoyo it keeps its zero very well, but it doesn't have the same 'protected' zero-button. It also shares the absolute mode, something I haven't seen on cheap calipers yet a very useful feature. It is well finished and pleasant to handle, but not quite to the 'silkyness' of the Mitutoyo standard. I should mention that, as the name suggests, more expensive calipers are available from M&W which are directly comparable to the Mitutoyo. The M&W caliper doesn't have a socket for remote reading.

Less paperwork, but still a slip of VCI and an internal bag from M&W.

It uses a CR2032 lithium battery, a spare is supplied, which is covered by an internal seal. I am not sure of the purpose of this seal as the external cover seems perfectly adequate and in common with the other calipers this isn't a sealed unit. I have a suspicion that if you left the seal out you could use a thicker CR2045 battery. The expected battery life is a year.

They don't come with a test certificate but the instruction leaflet does state that they certify it has been inspected and meets the standards set out in their catalogue. The leaflet itself is clear and gives guidance on use.

Still nicely presented and with excellent instructions, the Machine DRO own-brand caliper

Machine DRO Calipers

These are marketed as a budget caliper, but I understand they are at the better quality end of the 'generic Chinese caliper' and sold at a low mark up to achieve a competitive price. Like many of these entry level calipers the box is a robust plastic one with a high density foam insert, **photo 7**. A nice touch is a bit of extra soft foam in the lid to stop the calipers rattling.

A subtler slipcase from M&W

In the box is a spare LR44 battery and a silica gel sachet, together with Machine DRO's own instruction leaflet which is, to be honest, the most attractive and readable of the three. There are different versions available with tolerance, preset or ABS modes and the use of these is clearly explained on the leaflet.

This version was the tolerance type, and you can easily set high and low limits, handy when doing a repetition job. It has a standard 'sino' interface, as also used on digital scales, hidden behind a removable cover, **photo 8**.

As you might expect, this budget caliper doesn't feel as smooth or well finished as the M&W and Mitutoyo instruments, however, it is better than some other budget calipers that need the sharp corners of the beam breaking in order to make them pleasant to handle. It has a smaller display size than the other two new calipers.

Comparative Tests

I carried out a series of comparative tests across the three new calipers, as well a 'Proops' branded unit that is about sixteen years old and a 'Workzone' (Aldi) caliper.

The Proops unit has lost its fine adjustment wheel, but is not unpleasant to use, perhaps

The read head of the M-DRO caliper

From the top, M-DRO, M&W then Mitutoyo at the bottom, if this prints well, you will be able to see how the finish improves as you go down the pile.

The three calipers all have reasonably sized gib screws, making adjustment easier.

because it is well worn in, I would say it is comparable to the Machine-DRO unit to use – it was probably made before large numbers of very cheap calipers appeared on the market. The Workzone caliper is the roughest feeling of the five and has a large, angular silver-coloured body. These both use LR44 cells and, interestingly, both have larger digits than the Mitutoyo and M&W calipers. The Proops caliper has a 'sino' interface but the Aldi one does not. I also did incomplete tests on my very first set of calipers, a glass-filled nylon pair reading only to 0.1mm or 0.01 inch; with a small display, awful feel and high battery consumption, they stopped working during the tests. But don't condemn all plastic calipers - polycarbonate ones under Moore and Wright's Baty brand name are used for measuring delicate objects such as collectables and antiques, although they probably aren't the best choice for a metalworking workshop.

Beam Parallelism and Fit

The 'beam' is the part of the caliper along which the read head moves, **photo 9**. The fit of the caliper head to the rail can usually be adjusted with two gib screws on most calipers although many owners don't realise this and use the locking screw instead. If you use the proper gib screws then you will get the most accurate results. The three calipers (Mitutoyo, M&W and Machine DRO) have large enough screws for them to be relatively easily adjustable, **photo 10**, some cheap units use very small screws that need the use of a tiny jewellers screwdriver.

All three of the new calipers also showed no difference in width between each end of the rail, this meant that once adjusted the head moved freely along is entire length. The Proops and Aldi calipers had 0.01mm difference, which explains why they tend to become a bit tight when fully opened; this may be due to wear, however. I have another cheap pair where the difference was so great I had to work on the rail with a diamond slip as when it was set not to be wobbly at the jaw end, it would not open past half way. I haven't included that pair in the test as I have no idea where it came from, but take it as read that it is a poor performer. The plastic caliper was all over the shop, with errors of varying size up to 0.06mm along the beam.

Thumb Rollers

The thumb rollers help you get consistent and delicate feel with the calipers. Funnily enough this simple component reflects the comparative qualities of the instruments, that on the Mitutoyo being particularly well finished with a nice crisp knurl. The Proops caliper has had its roller broken off, **photo 11**, and this seems to be a problem with other cheaper units which seem to have less 'meat' on the hook which holds the roller than the branded items.

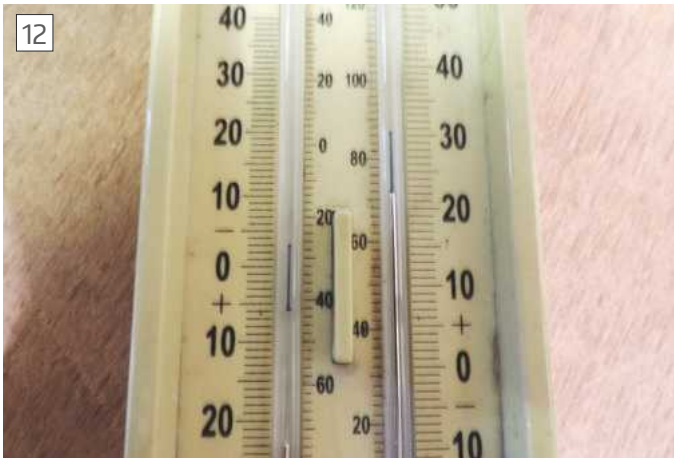
Basic Accuracy

I have an accurate 25.00mm carbide test rod, used for setting my 1-2" micrometer. I used this to test each of the calipers. All three of the new calipers (Mitutoyo, M&W and Machine DRO) read a rock steady 25.00, my elderly Proops read 24.99 which is creditable for an elderly unit. The Aldi one gave readings of 25.03 and 25.02, despite the tatty appearance this one has not had a huge amount of use and I shall not rely on it in future. It is also noticeable that the Mitutoyo and M&W calipers read zero when closed, every single time.

Temperature Sensitivity

Naturally any caliper will be calibrated at a fixed temperature, typically 20 centigrade (this is quoted on the Mitutoyo test certificate), but in our workshops we regularly see changes in temperature of several degrees over a day. Naturally the beam of the vernier will expand, but as most workshop metals will expand by a similar amount this probably doesn't make a critical difference. What is of more concern is the 'drift' in readings with temperature that I have previously noted. To run this test, I placed the five calipers in the fridge for three hours until they had stabilised at 6°C. I then made sure each one was zeroed and adjusted it to read 100.01 millimetres. It was a fairly warm day and within minutes I could see the displays of the cheaper units flickering. After three hours and stabilising at 22.5°C, **photo 12**, the results were telling. The Mitutoyo and M&W calipers still read 100.01, rock solid despite a 17-degree temperature change, **photo 13**. The Machine DRO caliper's reading had dropped by 0.07mm and the Proops rose by 0.07mm. The Workzone calipers reading had dropped by a full 0.12mm. When closed the M&W and Mitutoyo calipers both read zero, the Machine DRO retained its -0.07mm error and the Workzone went to -0.13, **photo 14**, very little further change. Interestingly, the Proops read 0.12, suggesting that the temperature change had really upset it.

Oops! The venerable Proops caliper lost its thumb roller many years ago, but is still accurate enough to use, if not perfect.



A max-min thermometer was used for the temperature stability test.

Now a 17 degree temperature change is extreme, even if we warm up a cold workshop on a frosty day, but these results show that even just a change of a few degrees is enough to make cheap calipers drift out of calibration by enough to cause problems if we are working to fine tolerances. The answer is simple, try not to let them heat or cool down rapidly and always zero them regularly.

Current Consumption

I have a sensitive ammeter capable of measuring down to 0.1uA, so partly insulating the batteries with a slip of paper I was able to take current readings for each caliper. I was initially surprised to see the M&W was by far the greediest taking 3.5uA, with the Mitutoyo not far behind with 3.0uA (actually, its reading consistently swapped between 2.8 and 3.3). The Machine -DRO caliper used a tiny 0.3uA, Proops 1.7uA and the Aldi 0.6uA. I should add that the plastic calipers use a whopping 5.7uA!

With this sort of device the active current consumption is very much related to the 'clock rate' or how fast the processor inside is working. I suspect that the two high-end calipers both work rather faster than the cheaper units.

But, the popular wisdom is that inexpensive calipers eat batteries compared to the better units, and what of Mitutoyo's claim of a 3 ½ year battery life? There had to be more going on so I decided to take a second set of readings with the displays switched off. The difference was immediately apparent. Both the Mitutopyo and M&W calipers gave readings of 0.0uA – in other words their consumption when switched off was less than I could measure. The Machine DRO flickered between 0.0 and 0.1, so I estimate a consumption of a creditable 0.1uA. In contrast, the cheap Proops unit still used 0.4uA when switched off and the Workzone one 0.3uA.

These currents are very low, indeed it suggests the Aldi unit should have a battery life of about five years. In practice, however, most people's experience is that cheap calipers will last up to a year on a new battery, usually failing rapidly in the cold winter.

The measured figures bear out the observation made elsewhere that high quality calipers do use much less current when switched off.

Another observation is that the Moore and Wright and Workzone calipers both switch off automatically – in fact my only real criticism of the M&W calipers is that they switch off a bit quickly, although they remember their setting. The others don't, or at least don't do so in less than about 20 minutes. Whether you have cheap calipers or high end ones, it IS worth switching off the display to extend battery life.

Real Budget Calipers

I did a few quick checks on a brand new budget pair for a comparison. It is more poorly finished than any of the ones tested above, with sharp edges to the beam. It took several resettings before it would reliably read zero and on the 25mm standard it reads between 25.01 and 25.02 depending which end of the jaws you use. My verdict on this one is that it might find a use as a drilling machine depth indicator, but you wouldn't want to use it regularly or rely on its accuracy, yet other relatively inexpensive budget calipers clearly perform better than this.

Conclusions

Its clear from these tests that, as you pay more, you really do get better quality. At the real budget end of the market things can be hit and miss because two apparently similar calipers can be rather different in terms of accuracy, temperature drift or current consumption, for example.

The Mitutoyo Digimatic Absolute calipers are understated but clearly a top-end product. They are a delight to use, and you know you can just pick them up and use them without having to worry they have drifted or lost their origin. If you can afford them and are someone who gets pleasure out of owning and using the best, then these are for you.

The Moore and Wright value range are rather more colourful, and in practice, not far behind the Mitutoyo to use. To be honest, they will probably meet all the practical needs of most model engineers. And at under £24 you don't have to invest

A seventeen-degree temperature change did not affect the Mitutoyo's reading – the M&W caliper was also rock solid.

a lot to get the quality feel, better battery life and great accuracy, even with changing temperatures, of the M&W calipers.

On the other hand, if you are on very tight budget or you want some 'hack' calipers to live in the swarf tray, then still choose with care. Budget calipers are not all equal, and you could do far worse that the Machine DRO budget pair; at less than £13, it really seems foolish to bother going for anything cheaper as they are both accurate and well finished enough to be comfortable to use. Whatever budget calipers you use, though, zero them frequently and remember to switch off the display when not in use.

Finally, why not visit a reputable supplier like Machine DRO and do a comparison yourself. Of course the danger is you go out planning to buy budget and come home with a Mitutoyo... ■

The Workzone caliper was most affected by changing temperatures, drifting about 0.007mm per degree, enough to cause material errors in the average workshop.

Readers' Tips

What a Knit-Wit

TIP OF THE MONTH WINNER!

Our winning tip is from Geoff Theasby, a name which will be familiar to readers of Model Engineer's Club News pages.
Needing a short length of aluminium rod, and not having any in stock, I visited the two nearby domestic hardware shops, to no avail. Returning home, I spotted some used knitting needles in a charity shop. Bingo! Choice of materials, wood, aluminium, st/steel, plastic even carbon fibre, a foot long or so, in diameters from 2 mm to 50 mm.

If there are no hardware shops open, a wool shop, Hobbycraft, or market stall would be a good bet. The model shops in Sheffield are a 30 minute bus ride away, which is no use if you are in extremis. There are conversion tables on the interweb for US/UK sizes, and readers may even have a resident expert handy for advice, or emergency materials. Why? I have a magnetic VHF radio aerial base, for use with the car, for amateur radio purposes, and I lost the vertical element. Measuring the base internal thread as 4 mm, I had a suitable M4 die, so cut off an appropriate length for the frequency from the knitting needle, threaded one end M4, added a locking nut, and Robert's your aged relative! This is a No 8 (UK) 4mm diameter needle, and the 'button' at the top fortuitously protects against eye injuries.

MINI TIP – Taking Up the Slack

Thanks to Steve Middleyard for this bit of advice

Referring to Issue 242 and Laurie Leonard's' problems with his slack quill...I have used a motorcycle chain lube for many years...not only does it provide lube for machine slideways but if applied to a rather slack quill on a drill press will absorb radial pressure too....it works well.

This not a joke... honestly chain lube is akin to a shim in the correct application.

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 I'll 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!

Please note that the first prize of Chester Vouchers is only available to UK readers. Other prizes are at the discretion of the Editor.

MAIL ORDER / SALES COUNTER
The Allendale Group Ltd,
Machine DRO Dept,
Pindar Road, Hoddesdon,
Hertfordshire. EN11 0BZ.

MACHINE-DRO.CO.UK

measuring tool supplies

PRECISELY WHAT YOU NEED

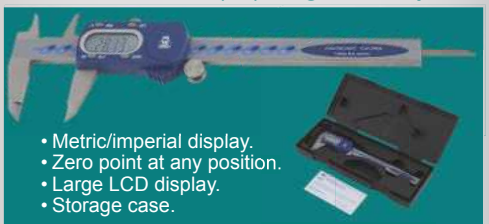
Tel: 01992 455921 Online: www.machine-dro.co.uk

150mm (6") Digital Caliper

- Metric/imperial conversion.
- Tolerance set - user defined "under tol", "ok" and "over tol".
- Storage case.

Part no	Range	Price
ME-CAL-TOL-150	0-150mm(6")	£12.76

M&W 150mm (6") Digital Caliper



- Metric/imperial display.
- Zero point at any position.
- Large LCD display.
- Storage case.

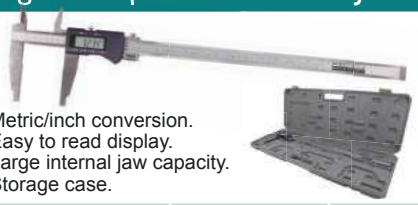
Part no	Range	Sale
MEB-MW110-15DBL	0-150mm(6")	£23.70

Mitutoyo 150mm (6") Caliper

- Large and clear LCD readout.
- Fine adjustment with thumb roller.
- ABSOLUTE Digimatic Measurement.
- Storage case.

Part no	Range	Sale
MIT-500-196-30	0-150mm(6")	£80.00

Digital Caliper with Internal Jaws



- Metric/inch conversion.
- Easy to read display.
- Large internal jaw capacity.
- Storage case.

Part no	Range	Price
ME-CAL-LO-500	0-500mm(20")	£95.32
ME-CAL-LO-600	0-600mm(24")	£105.14

150mm (6") Centre Pitch Caliper

- Adjustable precision ground points.
- Metric/imperial conversion.
- High quality hardened stainless steel.
- Storage case.

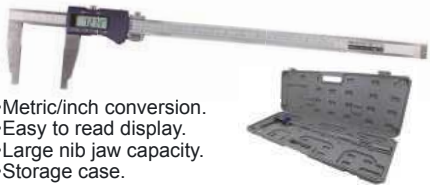
Part no	Range	Price
ME-CAL-CL-150	0-150mm(6")	£43.26

150mm (3/4"-6") Internal Caliper

- Specialist Internal bore caliper.
- Raised contact points making it easier to measure stepped bores, groove etc.
- Storage case.

Part no	Range	Price
ME-CAL-INT-150	19-150mm(3/4"-6")	£44.90

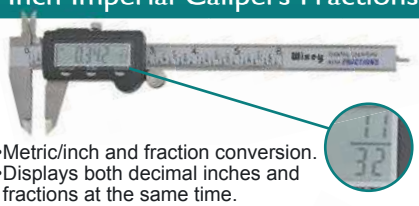
Digital Caliper with Nib Jaws



- Metric/inch conversion.
- Easy to read display.
- Large nib jaw capacity.
- Storage case.

Part no	Range	Price
ME-CAL-LO-500-NB	0-500mm(20")	£84.22
ME-CAL-LO-600-NB	0-600mm(24")	£97.97

6 Inch Imperial Calipers Fractions



- Metric/inch and fraction conversion.
- Displays both decimal inches and fractions at the same time.
- Precision ground measuring faces.

Part no	Range	Price
WR100	0-150mm(6")	£27.50

150mm (6") Offset Calipers

- Adjustable front jaw.
- Jaw slides up and down and can be locked at any point.
- Constructed out of high quality hardened stainless steel.
- Storage case.

Part no	Range	Price
ME-CAL-OF-150	0-150mm(6")	£43.26

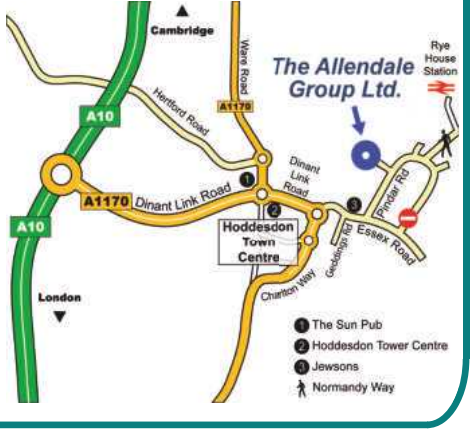
Tel: 01992 455921 Web: www.machine-dro.co.uk

VISIT US TODAY

The Allendale Group Ltd,
Machine DRO Dept,
Pindar Road, Hoddesdon,
Hertfordshire, EN11 0BZ.

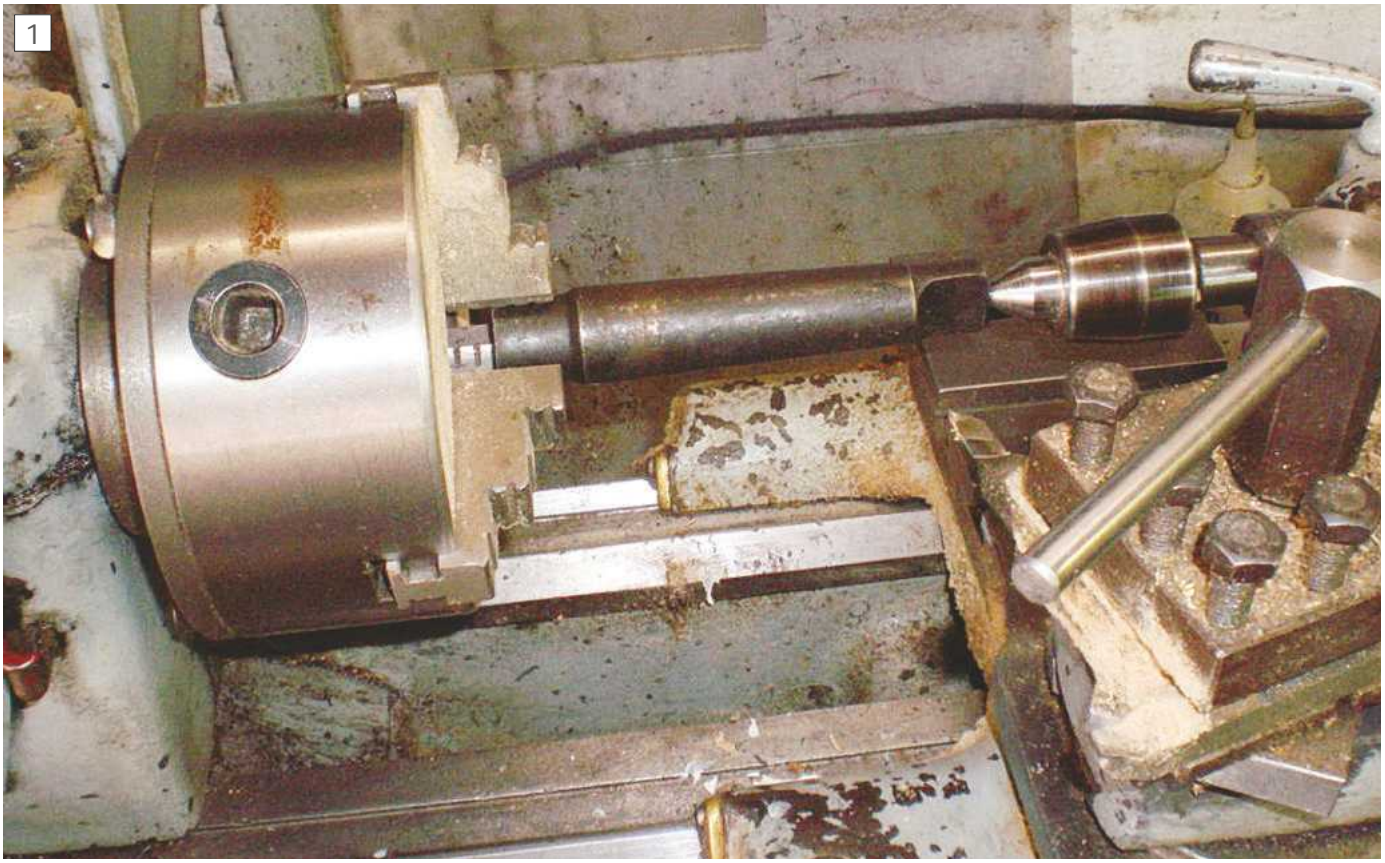
Monday to Friday: 9:30am - 5:30pm

Email: sales@machine-dro.co.uk
Web: www.machine-dro.co.uk
**All prices include VAT • P&P charges apply*



Uses for Old Drill chucks

Brian Howett finds uses for ex-power drill chucks and old Morse taper drill shanks.



Cleaning up the old shank.

Tapping for a drawbar thread

Threading the end of the shank

Having had to dispose of some unserviceable drills, the keyless chucks can be recovered for re-use in a number of ways.

Stage one - The chuck is secured with a left hand thread Phillips screw inside the back of the chuck.

Stage two – once the screw is removed the chuck is then attached by means of a

Recovered chucks fitted to recycled shanks

Recovered chuck fitted to a bench drill

An Allen key helps removal

3/8" or ½" UNF thread. Fit a long series type Allen key (larger the better) in the chuck, and tighten. This should give sufficient leverage to unscrew the chuck.

Now seek out a worn-out No.2 Morse shanked drill with shank in good condition. No2 Morse drills have a soft Morse taper and sufficient material before the end of the drill flutes to saw off the shank, you can discard the remains of the drill. It should be a simple enough task to graft on a suitable section of thread.

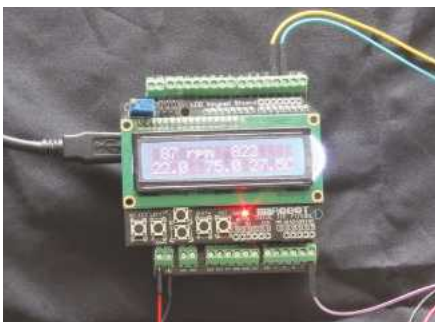
My first venture in this field was when I had insufficient "daylight" for a job on my Chester Champion Mill/drill. The photo sequence, **photos 1-5**, shows cleaning up of old drill shank, tapping drawbar thread, then turning thread shank, seated in the lathe morse taper spindle.

When another deceased drill came my way, **photo 6**, I thought the friction clutch unit, **photo 7**, could well have a further use as a "Tapping head". This was quite easy to do, but the friction control range was only suitable for small taps.

Yet another MT2 shank was re-used to make a pipe centre, using two ball races, **photo 8**.

In our Next Issue

Coming up in issue 249
On Sale 2nd December 2016



David Prout uses an Arduino to produce an indicator diagram for his Jan Ridder Coffee cup Stirling Engine.

Murray Eddington has a few novel ideas for the workshop, including the simplest boring head ever!

Mike Cox upgrades his gasless MIG welder to use gas.

Woe is me! For I have been careless!

Peter Shaw digs his way out of a hole.

A momentary loss of concentration, and my saddle crashed into the headstock. There then ensued a cacophony of unpleasant sounds: the noise of tortured metal, the scream of slipping belts, and the deep growl of a 500W motor which successfully kept on turning despite the mechanism being locked up solid. And in the following quiet, there was heard the immortal words, "Oh Dear!". And so started "the great recovery plan".

First job was to release the jammed up mechanism. Fortunately, I have dismantled these parts before so was able to easily dis-assemble everything. I say easily, but in fact it involved a fair amount of brute force, but once dis-assembled, I discovered that the only obvious damage appeared to be the leadscrew nut having been forced out of its clamp. One of the leadscrew cover screws was mangled during removal – caused by the cover being placed under great tension by the lock-up. The leadscrew nut was reassembled, a replacement screw sourced from the stores, and reassembly proceeded without any further problems.

Next came the moment of truth – what would happen when power was applied? To my relief, the motor turned and turned the mandrel, and I could manually move the saddle easily in both directions. Thus the lathe was at least usable in manual mode.

Then I tried longitudinal turning under power. In this mode, my lathe has three built in ratios for this purpose – 0.1mm/rev, 0.15mm/rev, and 0.2mm/rev. In lowest mandrel speed, all three ratios were satisfactory, if a little rough. However, in highest mandrel speed, whilst the two upper ratios were satisfactory, the lowest ratio was unusable due to rough running and vibration. This turned out to be a bent flange on the smallest groove of the three-speed changing device, and this eventually broke away completely – see the photograph.

So, a replacement was required, and the only reasonable method was to make one. I therefore set about drawing the item as this would give me some ideas on what needed to be accurately made, and what could conceivably be less accurate. This turned out to be limited to the bore as the item rotated on a bronze bush. I therefore decided to lap the bore, and this in turn required me to make a suitable lap similar to the long expanding one shown in Len Mason's book "Using the small lathe". There were other problems, such as what tool could I use to create the flatbottomed grooves remembering that the three grooves are close together hence any tool needs to be able to get down the side of the adjacent flanges; and how could I create the three driving lugs shown in the mirror view? The grooves were cut using a tool with a very narrow blade similar to a parting off tool, taking three separate plunging cuts and then skimming sideways to create a smooth bottomed groove. The three driving lugs were created by using a 6mm milling cutter to cut the gaps, but because the gaps have varying width, it meant taking two cuts per gap, each cut following one of the sides of the gap.

The eventual result is shown in the photograph, and although it isn't perfect, it does the job satisfactorily. Time will tell how long lasting it is because I used EN1A steel whereas I suspect the original may have been cast iron. ■

Showing damaged and replacement item. Front view shows grooves and broken flange whilst the view in the mirror shows the driving lugs at the rear.

gandmtools

Just a small selection from our current stock

Buy online now at: www.gandmtools.co.uk

Harrison TR330 Variable Speed Centre Lathe, 3ph, Tooled, VGC, **£3750.00** plus vat.

Emco FB2 Vertical Milling Machine, 1ph, Vice, Chuck, VGC, **£1650.00** plus vat.

Brookes 38 KG Anvil & Stand, VGC, **£300.00** plus vat.

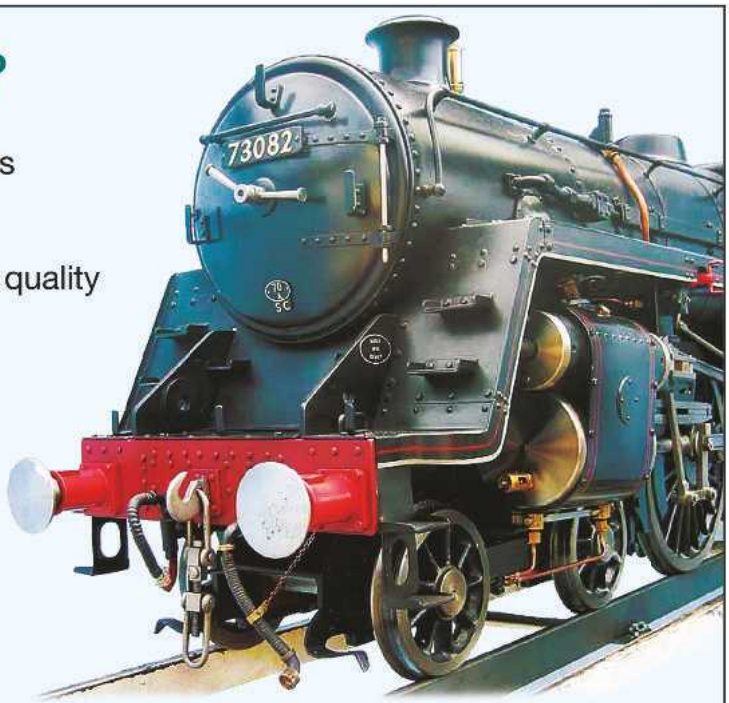
• **Telephone enquiries welcome on any item of stock.** • **We hold thousands of items not listed above.** • **All items are subject to availability.** • **All prices are subject to carriage and VAT @ 20%.** • **We can deliver to all parts of the UK and deliver worldwide.** • **Over 7,000 square feet of tools, machines and workshop equipment.**

Opening times: 9am -1pm & 2pm – 5pm Monday to Friday. Closed Saturdays, except by appointment.

telephone: 01903 892 510 • **www.gandmtools.co.uk** • e-mail: sales@gandmtools.co.uk

G and M Tools, The Mill, Mill Lane Ashington, West Sussex RH20 3BX

Don't know what it's worth?



- Good prices paid for all live steam models
  Locomotives from gauge 1 to 10¼ inch
  Traction engines to 6 inch scale
  Part-built or broken through to exhibition quality
- A no-obligation offer and firm decision over the telephone
- Fully-insured collection nationwide
- Payment in full on collection

Speak to the experts

STATIONROADSTEAM.COM

Build, buy & sell all types and sizes of locomotives, traction & stationary engines

Call Mike or Jayne Palmer on 01526 328772

Station Road Steam Ltd, Unit 16 Moorlands Industrial Estate, Metheringham, Lincs LN4 3HX

Open daily Monday to Friday from 8am to 6pm, visitors welcome by appointment

PRO MACHINE TOOLS LIMITED

Tel: +44(0)1780 740956
Fax: +44(0)1780 740957

Up to 5 year warranty on selected WABECO Machines!

Precision machines made in Germany for the discerning engineer!

2 year warranty

Wabeco CNC Lathe CC-D6000

- Centre Distance – 600mm
- Centre Height – 135mm
- Speed – 30 to 2300rpm
- Power – 1.4 KW
- Size – 1215 x 500 x 605mm
- Weight – 150Kg
- NCCAD/ NCCAD Pro

Wabeco produce quality rather than eastern quantity

CNC machines are offered with a variety of CNC control and software systems, and still be used as manual machines.

Wabeco produce precision made machines by rigorous quality control and accuracy testing.

All lathes and mills are backed by an extensive range of tools and accessories

5 year warranty

Wabeco Mill F1210

- Table – 700 x 180mm
- Z axis – 280 mm
- Speed – 140 to 3000rpm
- Power – 1.4 KW
- Size – 900 x 610 x 960mm
- Weight – 101Kg

Wabeco Lathe D6000

- Centre Distance – 600 mm
- Centre Height – 135mm
- Speed – 30 to 2300rpm
- Power – 1.4 KW
- Size – 1230 x 500 x 470mm
- Weight – 150kg

5 year warranty

Wabeco Lathe D4000

- Centre Distance – 350mm
- Centre Height – 100mm
- Speed – 30 to 2300rpm
- Power – 1.4 KW
- Size – 860 x 400 x 380mm
- Weight – 71kg

5 year warranty

Wabeco CNC Mill CC-F1410

- Table – 700 x 180mm
- Z axis – 280 mm
- Speed – 140 to 3000rpm
- Power – 1.4 KW
- Size – 950 x 600 x 950mm
- Weight – 122Kg
- NCCAD/NCCAD Pro

2 year warranty

EMCO · WABECO · CERIANI · swiss tec · TECO · GOLmatic Maschinenbau · PROXXON · EMCO Hobbymaschinen

MORE MACHINES AND ACCESSORIES ON LINE

Our machines suit the discerning hobbyist as well as blue chip industry

We regularly ship worldwide

Please contact us for stock levels and more technical detail

All of our prices can be found on our web site:

www.emcomachinetools.co.uk

PRO Machine Tools Ltd.
17 Station Road Business Park, Barnack, Stamford, Lincolnshire PE9 3DW
tel: 01780 740956 • fax: 01780 740957
email: sales@emcomachinetools.co.uk

A Carbide Insert based Quick Change Tooling System for a lathe

Richard Smith describes an interesting approach to using carbide inserts.

My lathe came with a standard 4 way toolpost, **photo 1**. There are a number of problems with them. First, you can't mount more than two tools without them fouling each other and probably stabbing you so forget about four-way. Second, each tool needs individual packing to put the tip on centre height. My turning tools need shim steel and my others need a couple of millimetres. I never had the exactly the right packing. Third, the toolpost completely blocks your view of the actual turning so that you have to lean over the lathe which is both undesirable and uncomfortable. I looked at buying a quick change toolpost (QCTP) system where each tool has an individual toolholder with its own height setting screw and one toolholder at a time mounts on to a large permanent toolpost. These solve the packing problem at the expense of a buying a toolholder for each tool and possibly improve visibility, but are not cheap.

Along with the lathe I bought a set of indexable tools, **photo 2**. These all use the same triangular inserts held at different


1


2


3

angles to the tool shank.

I wondered if I could use just one insert in a single mounting to duplicate the five positions the inserts are actually used in on the lathe. I sketched an insert mounted symmetrically on a holder rotating about a central hole, fig 1. This arrangement gives all the five tool insert positions, and more. Tools are normally mounted so that the tips are close to the top left topslide corner, minimising the overhang and maximising the access to the work. Locating the pivot point close to this corner with only a small radius to the tip will do the same thing.

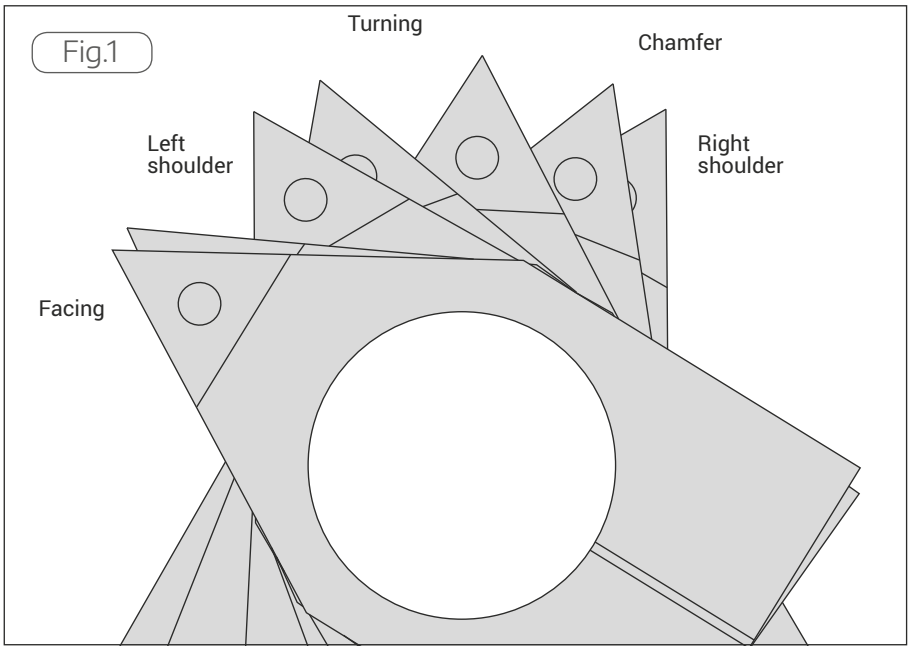
The basic operations are all just a rotation away from each other, no tool changing. What follows describes my prototype system which I have been using for some months. It was made using what I had lying around so that I could try ideas out.

This is the system baseplate which replaces the standard 4 way toolpost, **photo 3**. Sticking up is an M10 caphead screw which has 2 flats filed on it to take a spanner so that it can be rotated. It interchanges with the 4 way and clamps to the topslide with the central counterbored caphead screw.

At the front is an M8 caphead which pushes a rod to clamp the head of theM10. This arrangement allows the final clamping position to be easily adjusted, **photo 4**.

Each insert holder or tool clamps to its own pillar allowing the individual height to be adjusted. The cylindrical pillars are clamped to the baseplate using a cylindrical nut together with a washer and a removable handle, **photo 5**. These parts are easily made and the only really critical dimension is the height of the pillars which all need to be the same so that the handle clamps in the same place each time. The handle has a flat milled on it to spread the load on the washer. The washer, nut and handle are all easily replaced if they wear.

Photo 6 shows how the clamp caphead and cylindrical nut are located near the top left corner of the baseplate and hence the top left corner of the topslide.




8


9


10


11


12


13

The pillar with the insert holder drops over the cylindrical nut, **photo 7**. The triangular carbide insert is screwed to the insert holder which is adjusted once to bring the tip to centre height and clamped to the pillar. The inserts are made to very close tolerances so it should not be necessary to adjust the setting when they are changed. Traditional quick change systems are designed to accommodate tools that need resetting each time they are reground.

Next the washer drops on, **photo 8**. The same washer is used every time so with matching pillar heights the handle clamps in the same place each time, which you will recall is adjustable on the baseplate.

Now the handle is pushed through the hole in the cylindrical nut, **photo 9**.

A quarter turn locks everything firmly, photo 10. The handle is positioned out of the way. The handle can also go in the other side of the nut moving it back 180 degrees which proved very useful when facing near the capacity of the faceplate and inside the chuck guard, **photo 11**.

The following sequence shows how

simply unclamping, rotating and reclamping the tool allows different turning operations. There are no tool changes and repositioning is fast and easy. This shows the end being faced, **photo 12**.

Turning to a shoulder, **photo 13**.

Chamfering the end, **photo 14**.

Relieving the centre, **photo 15**.

Turning a shoulder in the opposite direction, **photo 16**.

Other common operations include boring and parting-off so to I added tooling for both. After drilling a hole in the end the tool has been changed to the boring bar block, **photo 17**.

There are several things to be said about this, **photo 18**. First, it is a solid block with no height adjustment and is clamped directly to the baseplate with the bar shank directly above the topslide maximising rigidity. This is possible because of the location of the clamping arrangement in the top corner of the baseplate. Second, the mounting hole for the boring bar was drilled and reamed with the block in position on the lathe. The bar was rotated slightly to bring the tip exactly on centre height. This block uses three grubscrews for clamping, it is a prototype after all. The next version will use a split clamping arrangement and the block will be thicker around the bar which will also allow versions for larger bars. The clamping end will be the standard pillar height plus a quarter of the 1.5 mm thread pitch of the clamp which will move the handle action 90 degrees back so that the clamped position of the handle will be near to the lathe axis. Third, I keep the baseplate aligned with the lathe and a small plate on the side of the block acts as a guide to set the bar exactly in line with the lathe. Drop the block on, drop on the washer and insert the handle, bring the guide up against the edge of the baseplate and lock with a quarter turn. The bar performs much better than it did in the 4 way.

Parting off, **photo 19**. This uses a pillar to be able to set the tip height.

The insert carrying blade sits on a square step, I don't have a dovetail cutter, and is held tightly at the bottom with

overlapping button head screws. At the top I have used the dovetailed clamp which was part of the original parting off tool, **photo 20**.

Like the parting-off tool this lines up with the edge of the baseplate (using the step), **photo 21**.

I have also made an external threading tool based on the insert kit that I already had. This replicates the tool geometry but as the shim supplied measured out parallel I have not included it and simply cut deep enough for the inserts, **photo 22**.

This is the whole tool, **photo 23**. This one is not self aligning but I expect the next one I make will be. It also has a pillar for height adjustment. I have not made an internal threading tool yet but it is essentially a boring bar holder.

There is another major advantage to the system which was one of the original aims, visibility. This photo shows the operators view turning with a tool in the 4 way toolpost and standing normally, **photo 24**. To see what is happening you have to lean over the lathe to look down over the toolpost which I found uncomfortable and tiring.

This is the same workpiece using the system and taken from the same position standing normally, **photo 25**.

This is a prototype system so what have I learned so far?

The parts are easy to make using basic turning and milling (no dovetails). The only really critical dimension is the height of the pillars which need to be the same so that the handle always tightens in the same position.

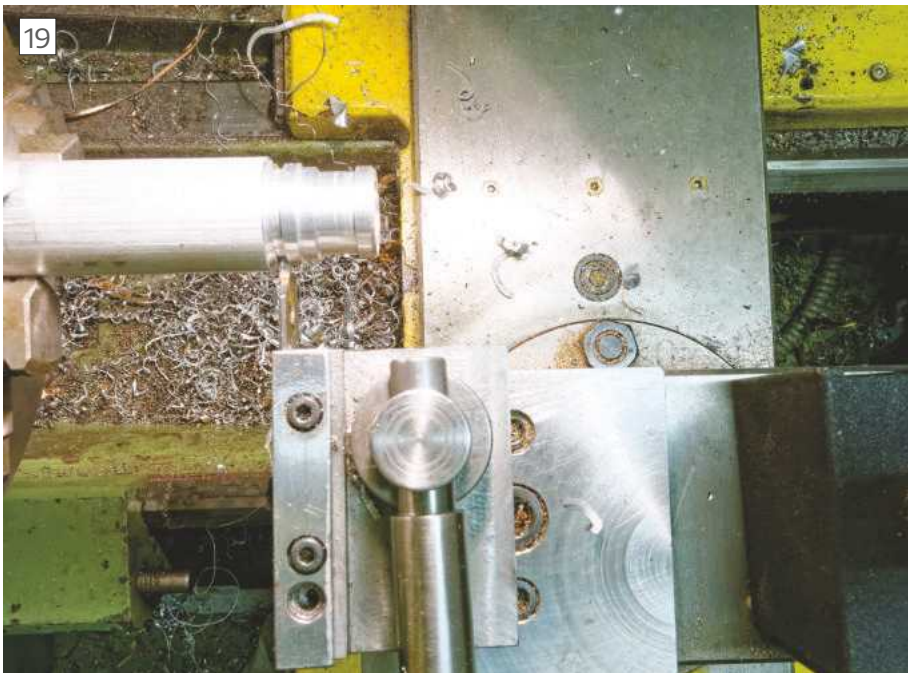
The one insert holder and pillar replaces the whole 5 tool insert set and there are no actual tool changes needed for the different operations, just unlock, rotate, and lock.

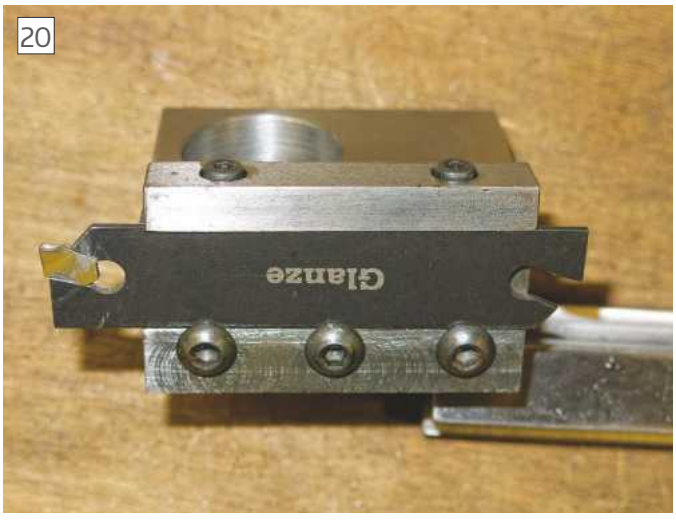
The height setting works fine and I have the tip exactly on centre height rather than just close. As inserts are made to tight tolerances I doubt if I shall need to adjust this again.

Changing from turning to boring to parting off takes moments so definitely quick change.

Tools such as internal threading and boring bars can be mounted over the

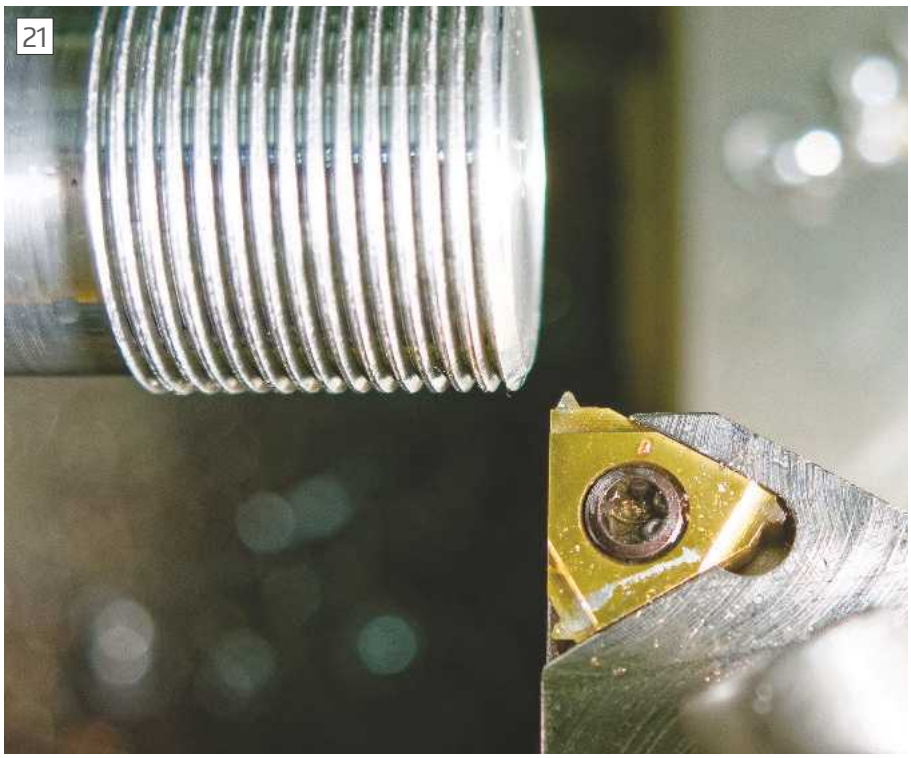

18


19



20


21



centre of the topslide because of the offset clamping arrangement. By drilling and reaming the mounting block while clamped in position, round tools can be guaranteed to be on the centreline and supported over the centre of the topslide for maximum rigidity. My 10 mm boring bar was prone to vibrate noisily in the 4 way but not in the block. The alignment guide is handy.

The parting off blade and insert work as well as in the 4 way and it is easy to set the tip height and the guide plate makes setting up square to the work very quick. However, I think there is room for improvement.

The external threading tool works and was not as difficult to make as I had feared.

What next?

- Design and make a Mark 2 system using new steel bought for the purpose instead of from the odd bits I had lying around!
- Explore using different inserts for different materials and with different tip radii. There are a huge number of types of insert produced for industry and plenty of suppliers for quantities of ten or more. Only a few suppliers will supply singly and then with a limited range. Some of these don't list the maker or even the international code but just some reference of their own. However, one supplier lists 16 mm side triangular inserts in two grades, a General Purpose for stainless steel, mild steel, bronze, aluminium and cast iron, available with two tip radii, and a Ground and Polished for aluminium, stainless steel and plastics with three tip radii available, making five possibilities. If I make five insert holders and buy one insert of each type I will have covered the same range of possibilities as twenty-five tools plus twenty-five toolholders plus twenty-five inserts. A huge difference in cost and in storage space.
- Make several sizes of boring bar blocks (probably three) and a similar one for my internal threading tool.
- Probably remake the parting off tool using a blade and insert from the Q-cut system.
- Look at possibly using different insert shapes.
- Extend the system! ■

Richard has now carried out some of this further work on his system and is preparing an article which will include details of the making and measurements for the final system. If you have any ideas or comments on the system, please send them in to Scribe a Line.

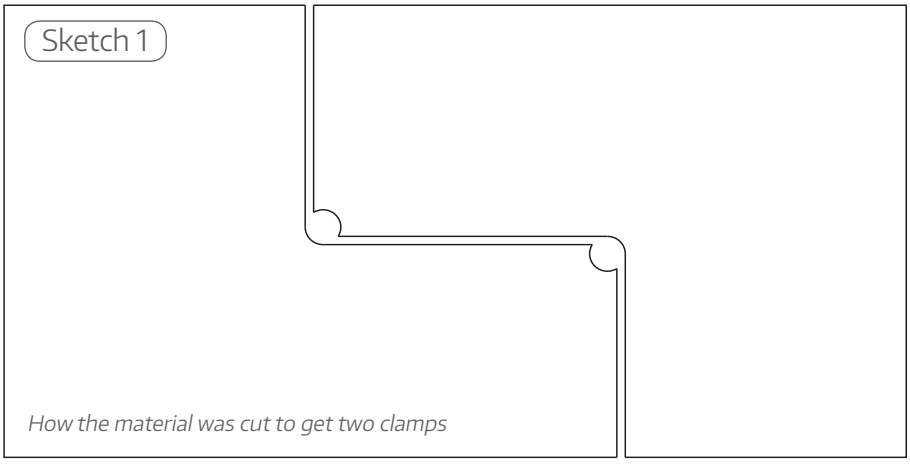
Milling Clamps for Large Work

Thor Hansen makes some sturdy aids to workholding.

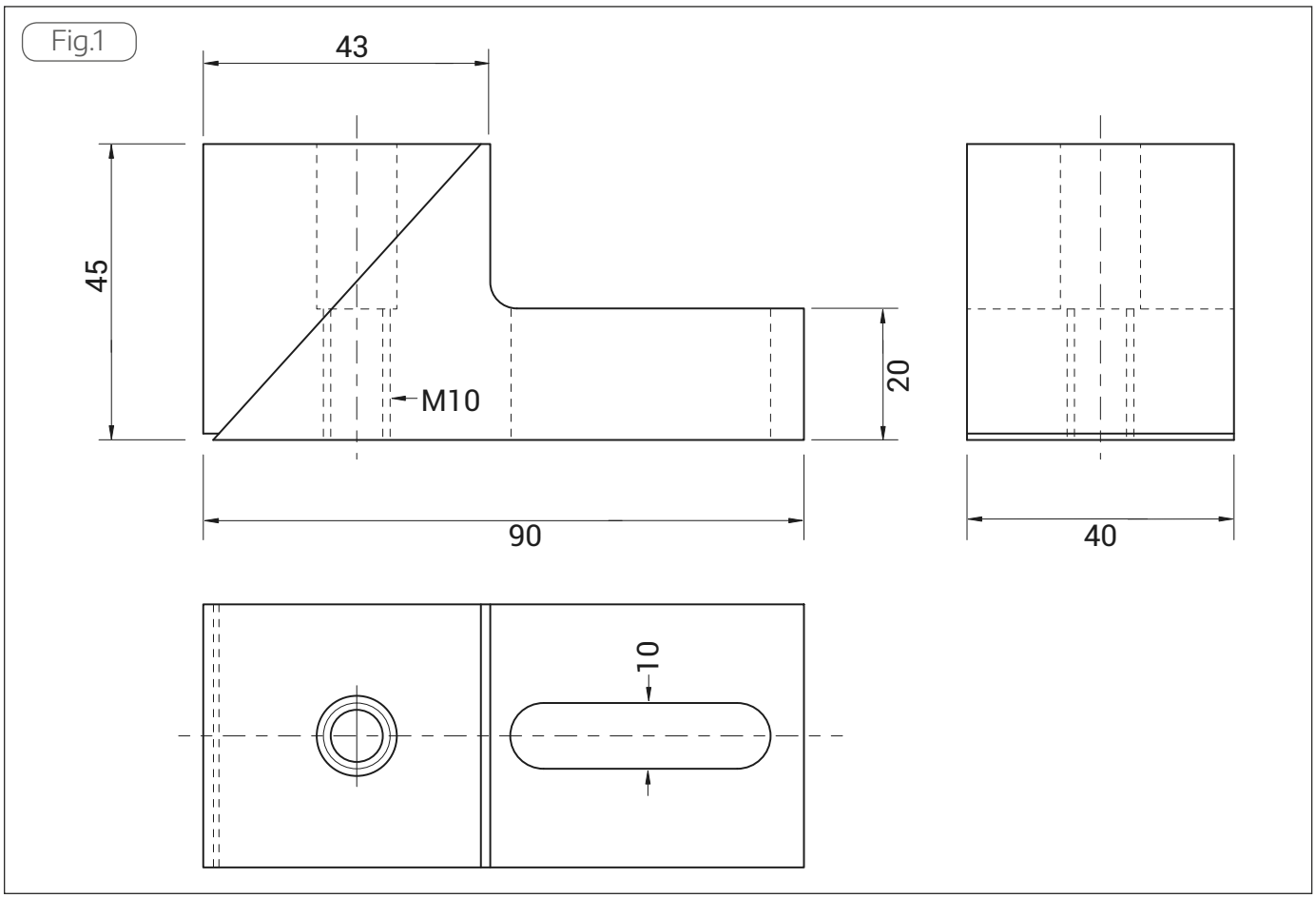
Clamps in use together with angle plates

Many years ago I made a couple of clamps (maybe they are called "free vice jaws"?) to be able to clamp large square or rectangular work pieces to the milling table, **photo 1**. I usually use the clamps together with one or two angle plates. I got the idea from a brochure showing some substantial clamps with the moving part guided by dovetails. Mine are smaller than the one in the brochure, to suit my small milling machine. To make them easier to make I just got a friend to make an approximately 45 deg. cut on his bandsaw when I had finished my machining.

The clamps were made from an off cut, about 40 x 45mm and just over 90mm long. To get two clamps from the piece I



How the material was cut to get two clamps



Milling Clamp drawing

drilled two holes and used a hacksaw to make two cuts from each side into each drilled hole, see **sketch 1**. The holes are just large enough to put a mini hacksaw blade through, so I could elongate the drilled hole enough to get an ordinary hacksaw blade in and cut to the next hole.

The work was clamped in my 4-jaw and the bottom of the two pieces was then faced in the lathe. The top faces were milled in the milling machine. The slots for clamping the clamps to the milling table were milled with a 10mm slot drill.

At the big end an 8.5mm hole was drilled from the top and all the way through. It was opened up to 10mm for a depth of around 25mm. The rest of the hole was tapped M10, **fig. 1**.

After the visit to the bandsaw, the hole in the upper part was elongated using a 10mm slot drill, this will give the jaw a few millimetres of travel, forward and downwards. The sawn surfaces were then cleaned up in the milling machine. ■

5 INCH GAUGE LMS JUBILEE CLASS

THREE CYLINDER LIVE STEAM

AN EXHIBITION STANDARD MODEL AT A GREAT VALUE-FOR-MONEY PRICE

NAMES AVAILABLE
- GALATEA
- LEANDER
- TRAFALGAR
- WARSPITE

"Wow! Simply stunning. My order reservation is on its way!"
Mr P.B. Hampshire

FULL 12 MONTHS WARRANTY

A FIRST CLASS COLLECTOR'S MODEL AT HALF THE PRICE OF A ONE-OFF PROFESSIONAL BUILD!

MODEL IS SUPER DETAILED

Summary Specification

- 3 Piston valve cylinders
- Walschaerts valve gear
- Cast iron cylinder blocks (Bronze liners)
- Cylinder drain cocks
- Lubricator
- Silver soldered copper boiler (CE marked and hydraulically tested)
- Superheater
- Screw reverser
- Boiler feed by injector, axle pump and tender mounted hand-pump
- Stainless steel motion
- Sprung axle boxes with needle roller bearings
- Working leaf springs to all axles
- Etched brass body with rivet detail
- 2 working safety valves
- Working steam brakes

Ready-to-run...

Following the fantastic success of our 5" gauge 14xx model we are delighted to introduce our latest offering - the LMS Jubilee Class.

All our models are new designs, delivered ready-to-run, painted and fully finished. We do not offer kits. Your locomotive comes complete with a fully compliant, CE marked, silver soldered copper boiler. Each is hydraulically tested to twice working pressure and supplied with a test certificate.

Technical specification...

Constructed of the finest materials this 3 cylinder locomotive is an excellent performer as well as a first class showcase model.

This coal-fired model is capable of pulling a dozen adults with ease.

Hand-built to order...

We can achieve high quality and value for money by building our models in batches using the latest CNC facilities. Each model is assembled by hand the same way now as would have been the case 100 years ago. Each model can take up to 1000 hours to machine and assemble.

The model is available in a choice of four names and two liveries - LMS Crimson Lake, or BR lined green. If you wish, your model can be delivered without name plates and numbers - so you can fit you own.

Place your order reservation now...

The Jubilee is limited to a single batch production this year. Once this batch is completed there will be no further deliveries of this model until 2020 at the very earliest.

We only build models against a firm customer order. The order book is now open and reservations will be accepted on a first come, first served basis. Production capacity is limited.

To secure the name and livery of your choice an early order reservation is recommended.

Each of these fine locomotives takes a number of months to build and for orders received now delivery is scheduled for April/May 2017.

Great value...

Priced at just £10,995.00 the Jubilee Class represents outstanding value and is probably less than half the price of a one off commission from a professional model maker (who would undoubtedly want several years to complete the model for you). In fact you would be hard pressed to find a second-hand model of similar quality for the price of this brand new locomotive.

You can reserve your model now for a deposit of just £1,995.00. You will be asked for an interim payment of £4,500.00 in October 2016 as the build of your model progresses and a final payment of £4,500.00 in April 2017 in advance of delivery.

Delivery and packaging charges extra according to country.


CAB CONTROLS

"As an award winning professional model maker I was delighted to be involved in the development and testing of this fine 3 cylinder model. Like the 5" 14xx model that preceded it the Jubilee Class is detailed to an exhibition standard and is a great track performer.

After 12 months of development I am proud to have delivered a model that reflects the power and grace of the prototype"

Mike Pavie

Request your free brochure today...

Find more information at www.silvercrestmodels.co.uk
or e-mail info@silvercrestmodels.co.uk
Alternatively clip the coupon below, or call 01327 871437. Send no money now.

FREE BROCHURE REQUEST FORM

Please send, without obligation, my free 5" gauge LMS Jubilee full colour brochure

To: Silver Crest Models Limited, Bragborough Farm, Welton Road, Braunston, Northamptonshire NN11 7JG.

Name .....

Address .....

..... Post Code .....

MEJ01

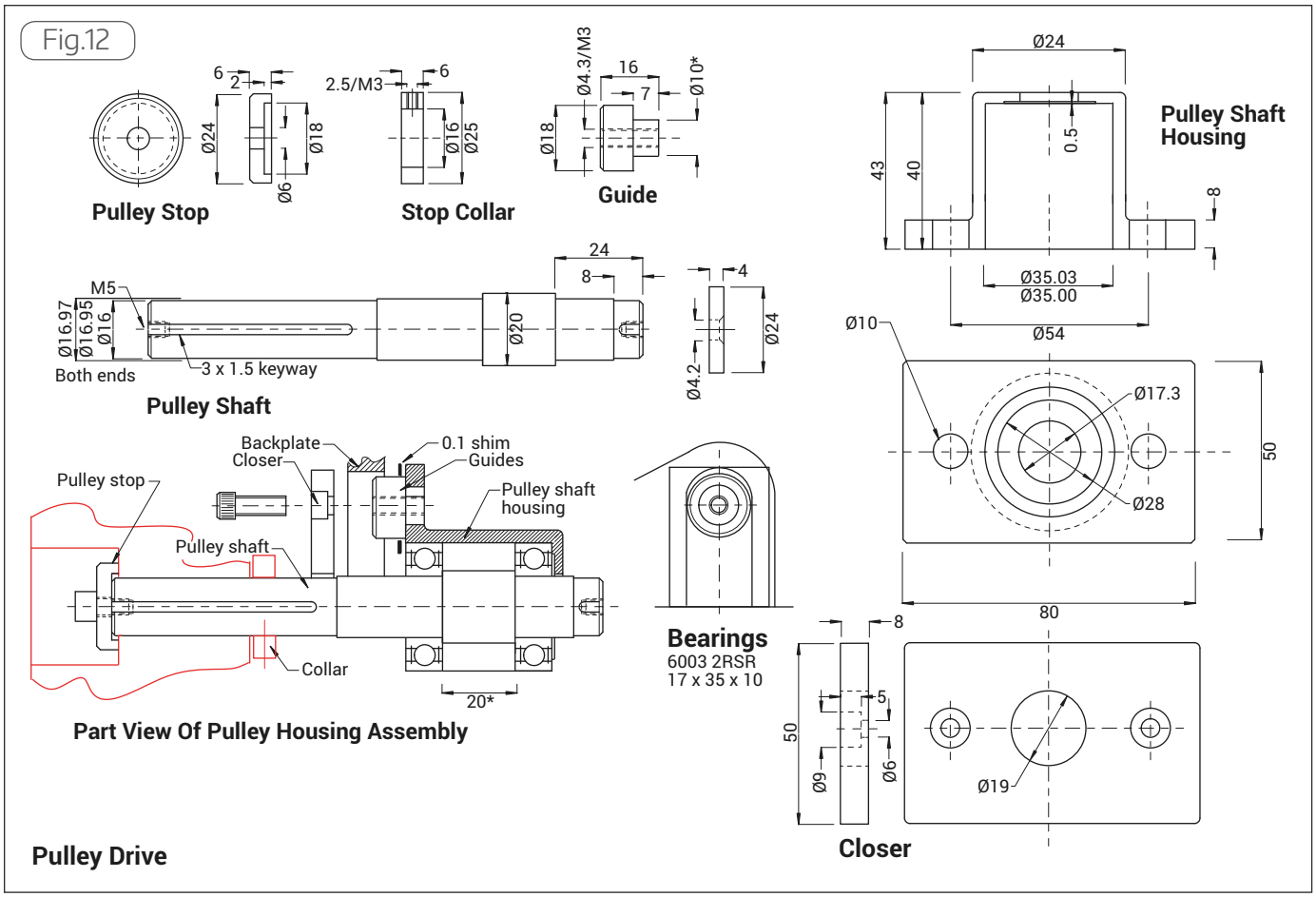
Registered No. 7425348

ON SALE NOW!

AVAILABLE AT WHSMITHS,
GOOD INDEPENDANT NEWSAGENTS AND AT WWW.MAGS-UK.COM

Gear Cutter

Alan James Aldridge describes a flexible machine for the production of gears in the home workshop – part three



Pulleys

Three pulleys in each set are shown. The material selected is aluminium and as I have some reservations about screw threads and that metal the design has evolved to get rid of screws in the construction as far as possible. Only the large driven group have the through bolting, the driving set is solid. Apart from having the correct groove size and therefore the right cutting tool the start of each batch of grooves has to be set in by the same amount and that also says the individual widths of pulleys have to be exact on both groups to ensure true running is the result and not running off. One has a little latitude as the driven group are built up so it is possible to rectify errors. The driven group comprise a master pulley, the middle one, in to which the other two fit with registers. The largest one has a large hollow end of 40 mm diameter. In both driven and drive the pulley group is held to the shafting with the inevitable keyway and a draw bolt from the outer end picking up a thread in the shaft. I see no alternative to a key in this work as the drive has to be positive and capable of overcoming the cutting forces, which can be relatively high.

In making the pulleys the drive side is made first and acts a template, of sorts, to the driven set to get the alignment right. It will be useful to have a belt available. The actual belts come in a good series of lengths and the one shown is in the catalogue. The first groove in a batch does not present any problems but moving down the pulley has to be exact and here one has to be accurate in getting the 2.38 mm pitch. The how is important. I made a gauge from silver steel in the form of a thread and then cut it down to provide a flat facing. The gauge was hardened and used to scribe the centre lines of the grooves. A second part of the gauge was a stop collar which, held to the pulley facing, gave the first groove position on each pulley. It works well. From there on there is not much to say about machining as it is quite basic turning and boring work. The pitch for the screw thread is 3/32 inch (2.38 mm) which should not be a problem in selecting change wheels. The other half of the problem is getting the length, or width, each pulley correct to comparatively close tolerancing, say, 0.05 to 0.1 mm.

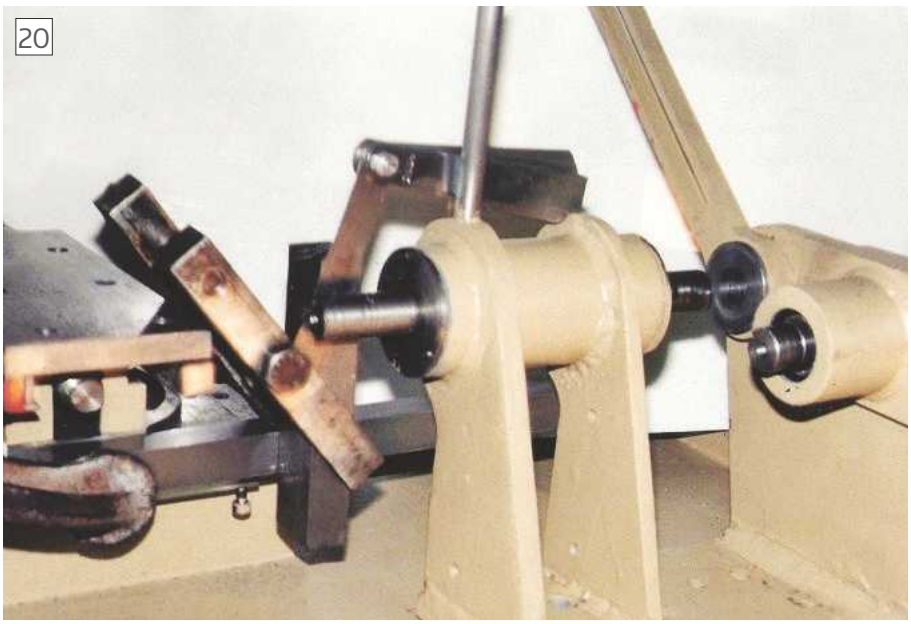
Shaft

The shaft for my machine was made long but could be shorter by 30 mm (**fig. 12**). The siting of motor, its shaft length, access to the cap screws in the slot cove plate and clearing other equipment will all have to be taken into account when deciding the best length. Therefore wait until the cutter head appears before making decisions. The shaft is straight forward machining by centring a round bar and reducing the diameters and producing the required lengths with the ones marked as being important. Ball bearings should be fitted such that the bearing will come off the shaft with a good shake.

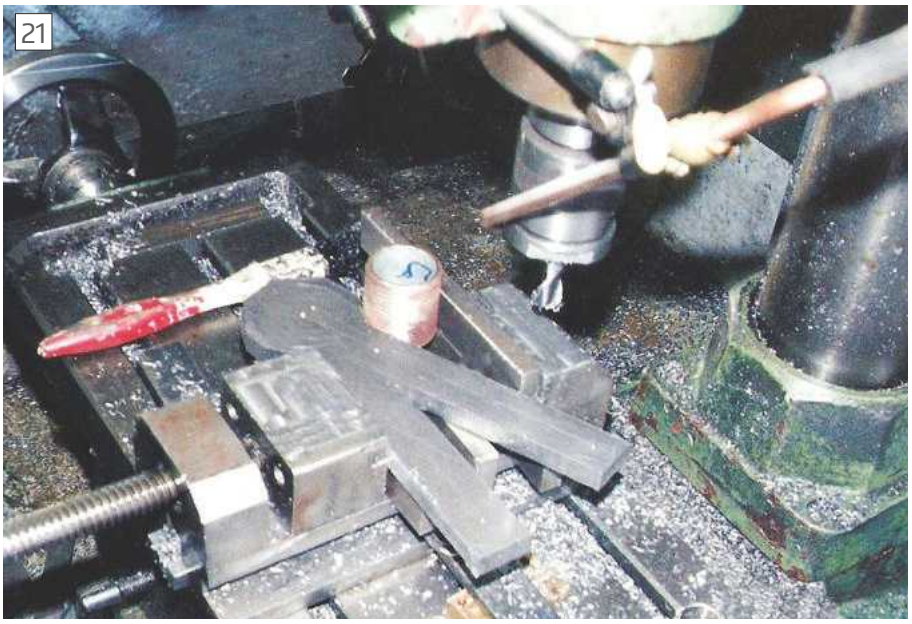
Shaft Housing

Reference should be made to **figure 12** which links the cutter head to the pulley drive as this contains the crucial

dimensioning to get these two inline and placed one to the other. The base and the large trapezoidal plate at one end provide the data marks for the pulley and cutter shafting. One can see that the slot allows the pulley drive to move back and forth to accommodate smaller or larger driving gears between pulley and cutter groups. There is also an arm which will carry other gears to the back of the machine be for hobbing operations. There is not a great deal of room for error in putting these pieces of equipment together. This is seen in the odd 43 mm length of the pulley drive shaft housing. It is important as is important as is the recess at the base so the bearing moving parts run clear of the stationary ones. There is a shim which will be positioned against the open end which will do much the same as the blind end but will also ensure the bearings are locked up and the shaft does not wander left to right.



Improvised arrangement for aligning tables



Milling the auxiliary drive arms

Baseplate

The big vertical plate (**fig. 13**) is the key to these placements and I would suggest forking out some cash to have it laser cut to get a first class finished slot and accompanying round hole, although it could be milled (photo 19). For laser cutting the supplier will require a drawing, not necessarily to scale, but it has to have all the datum points fully referenced. With the plate available the closer, guides and housing can be made. The guides are stepped buttons with a fairly good fit to the slot which come just shy of poking through the plate.

The production of the right angle between the end and base plate follows broadly the methods used for the vertical slide. The two triangular plates which hold the cutter head housing can be aligned with purpose made arbor which will pass into the round hole in the trapezoid plate but that is not strictly necessary. The hole is there to be able to reach into the cap screw on the cutter head shaft. I, in fact, used the full build of the housing bearings and shaft with a collar to pick up the plate hole and get good alignment. With fabrication by welding it is possible to accommodate gaps quite easily and in many cases it is a good idea to have a 1 or 2 mm gap to get adequate penetration of the weld, though proper Vee joints are still preferred. In the baseplate there are four through bolt holes to take M8 or M10 screws and two dowel holes. Each bolt should have a washer and a layer of goo, both sides of the plate, to close of the bolt and plate to stop coolant leaks. For the dowels there is only an underside bolt and washer. The dowel should be as large as one can manage and in my own base it is 16 mm diameter, drilled for a M10 screw from the underside.

The gear arm is made from plain steel with a long milled slot, another candidate for laser cutting, perhaps, or from a welded construction. It has to be straight in all planes. The bottom ends in a round and fairly tight fitting connection to the gear arm carrier. The two piece construction of this a carrier means that the arm once set can be held tight by the two small screws being tightened up. The hole through the carrier permits access to the cutter head shaft end and cap screw, therefore there has to be a gap of, say, 1 mm between the two parts of the carrier assembly.

Motor Plate

Towards the back of the cutter head baseplate is a hinge and the motor carrying arm or plate. No drawing has been provided as different motors will require different setting out of the fixings. In use the arm is continually moving a small amount so the bearings or bushes, in bronze, need to be good fits to the hinge pin. The plate length and motor layout will also depend to some extent on the belting available. I think it advisable not to have too short a distance between pulleys.

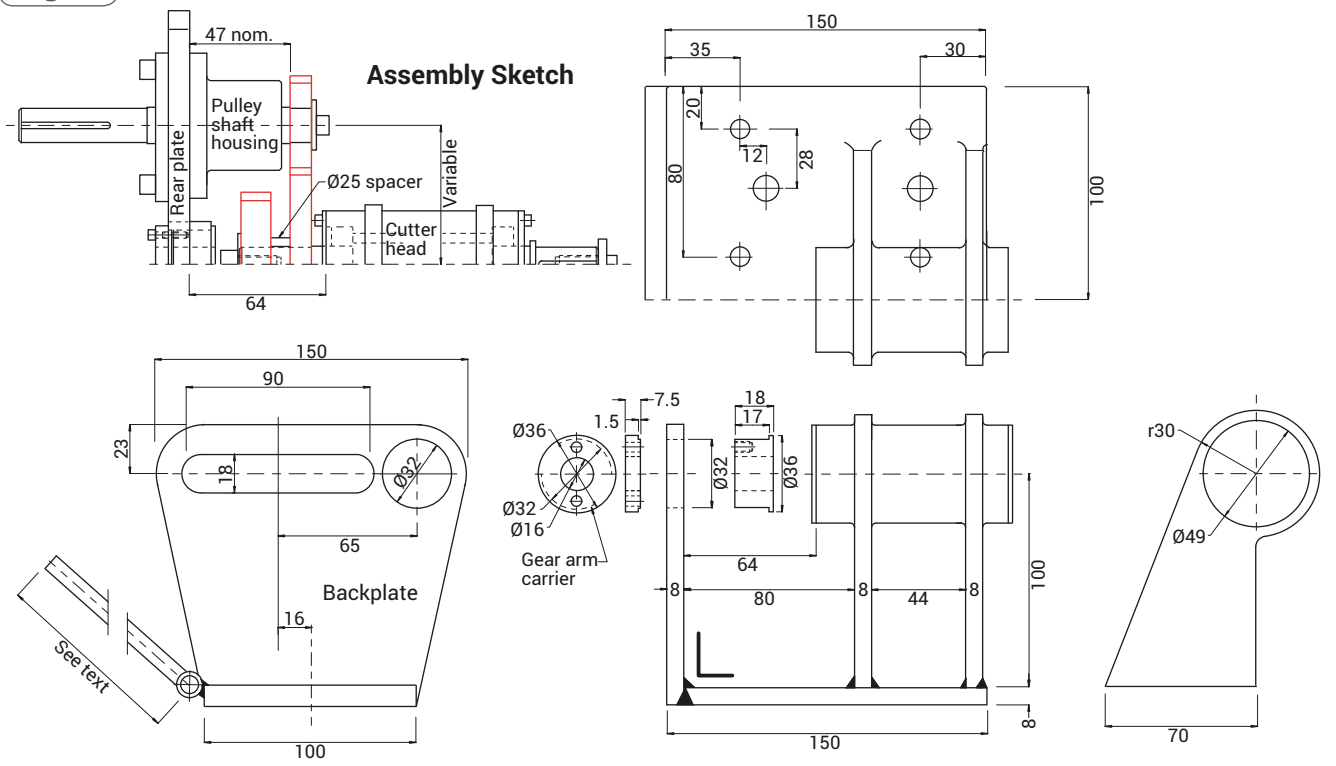
Assembly

Once all the main parts are available they can be put together on the baseplate and stand. The long table, the cutter head and the pulley drive have to lie parallel to each other. All these parts should also align with the stand sides.

The long slide carries the rotating table and its slide and one can assemble these parts getting the two tables square to each other. This assumes that all the tables are properly made with square ends and set square to each other. In a workshop with limited facilities this might not be an easy proposition and one will have to improvise as best one can, which is illustrated in **photograph 20**.

Alignment on the table side is set by

Fig.13



Rounding the head of the arms

the long table which is bolted to the stand baseplate. The base is not a precision datum but it can be used. I took some time levelling the stand to floor dimensions so the four of them are within 1 mm of each other. This was done by placing a hefty steel block on the table overlapping the sides of the stand and using an ordinary tape. Where necessary, slips or shims were pushed between the plates. The slides will need to be tightened at the gibs for their respective tables so they barely move and then they can be considered on line.

A ground square bar or bright bar will lie across the rotating base facing or the slide end above it, clamped by whatever is available, which in my case is a large G clamp. Without that one could try two smaller vertical bars drilled top and bottom to take long screws with a second bar behind the table lying substantially parallel to the one in the front.

Off the ground bar there are two more, identical pieces of bar, one not seen in photograph, from which measurement can be made to the shaft running through the cutter head to good accuracy either using verniers or feeler gauges. There also has to be parallel alignment in the vertical plane which is equally important. This requires the table bases and driving machinery base to be on common line. I used a cheapish laser to get the alignment but one can get good enough results with steel bars. Two long ground bars can be clamped to the rotating table top with toolmaker's clamps so they spread out and come under the cutter shaft with the cutter head base only lightly held down. It is all a little cramped for space and awkward to do, which is why the laser was bought, but it is workable. One will find that tightening down the screws or bolts may pull the base off line and therefore shimming will need to be applied under bases to compensate. Give yourself one whole clear day to do the work.

Auxiliary Drive Arms

Strictly not required just yet, are the universal joints and the arm which carries the drive to the back of the gear cutter to drive the worm when hobbing and the second arm off the feedscrew of the workpiece towards the cutter. These arms could be laser cut as well as they will require no further work. **Photographs 21 and 22** show the amount of work required on a miller which is likely to be far more difficult to do on a vertical slide. **Photograph 23** is a general view of cutter head and pulley

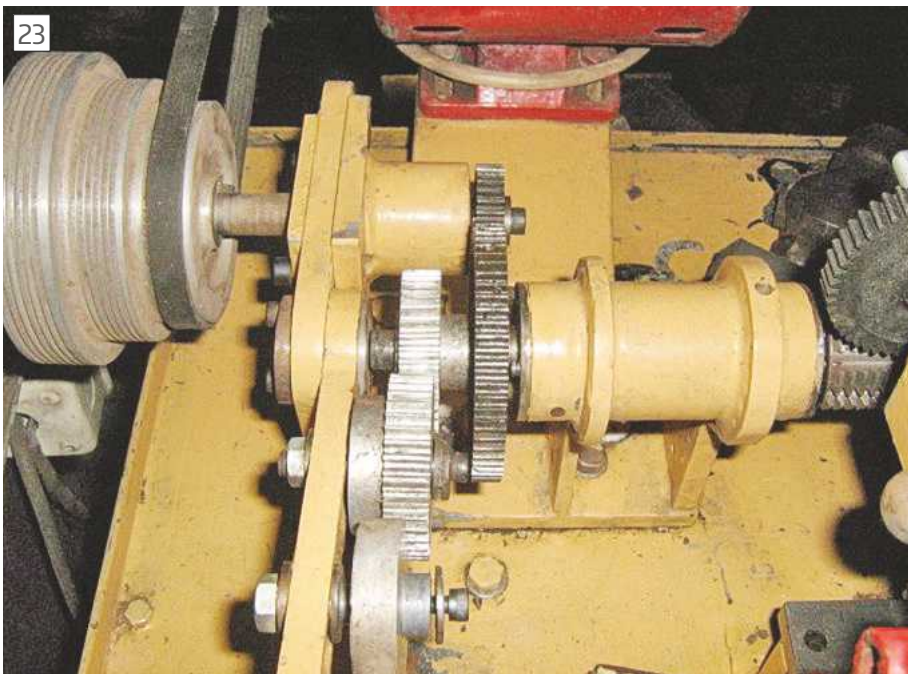
drive connection showing the auxiliary drive arm.

The arms could be fabricated to provide the slotting and the add-on machined bosses but that is also none too easy and will require some form of fixture to make it a reality. The other part of the auxiliary arm construction is the making of a universal joints as described earlier.

Tooling

It surprises me that I am still adding workshop equipment to the gear cutter after fifteen years of use. It is the same for the lathe whose appetite for new attachments also seems never ending. This section includes the actual cutters required to generate gear teeth both for single tooth cutting and hobbing and a method and tooling to back off cutting teeth and making adapters to suit particular gearwheels.

Tooling is possibly the heart and soul of gear cutting and there is also a great deal of related information about how gears work and their associated mathematics. Most of the latter is to be found in text books, though a few articles in the Model Engineer have a basic approach to what can be a very difficult subject to grasp, if one does not have any previous experience. Fortunately, contributors have made all of this much easier to understand, so that one can almost ignore the finer points and rely on others experience, notes and the tables they have produced and be able to make quality gears.



The cutter head with drive arms fitted

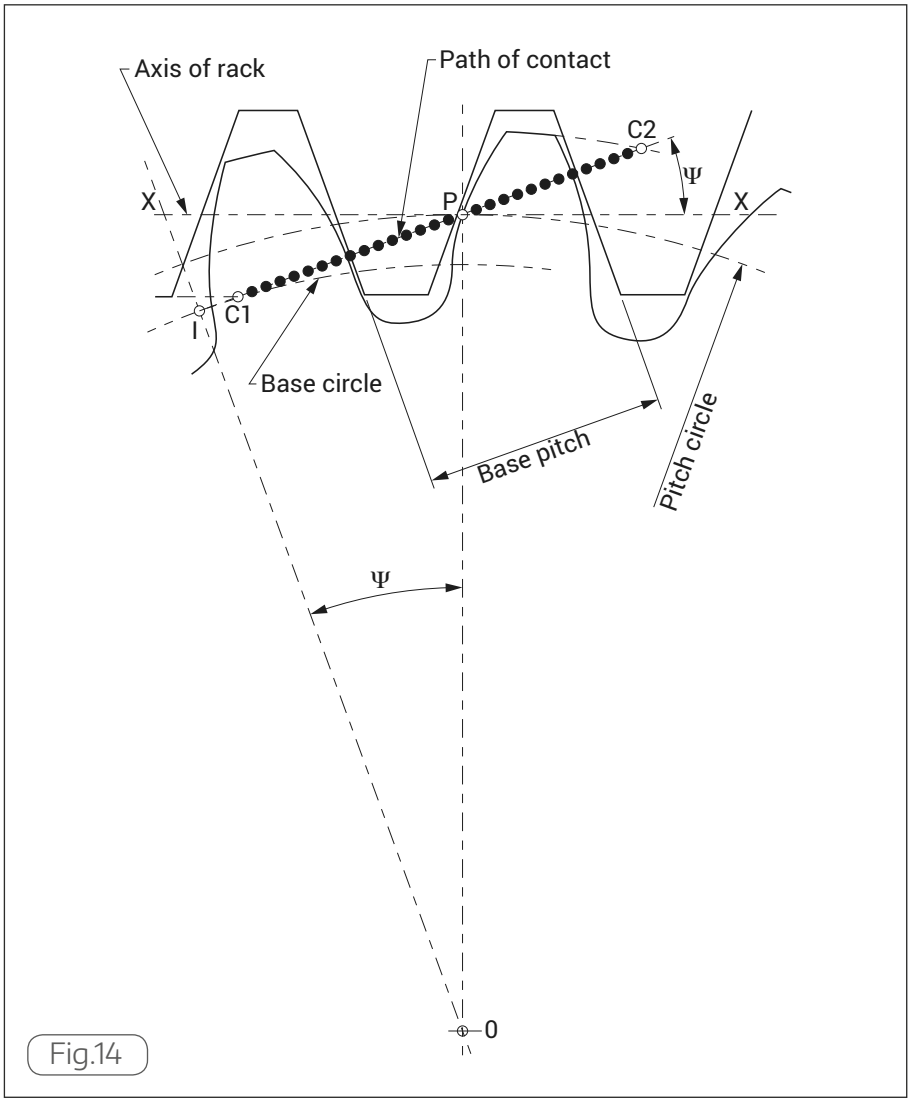


Fig.14

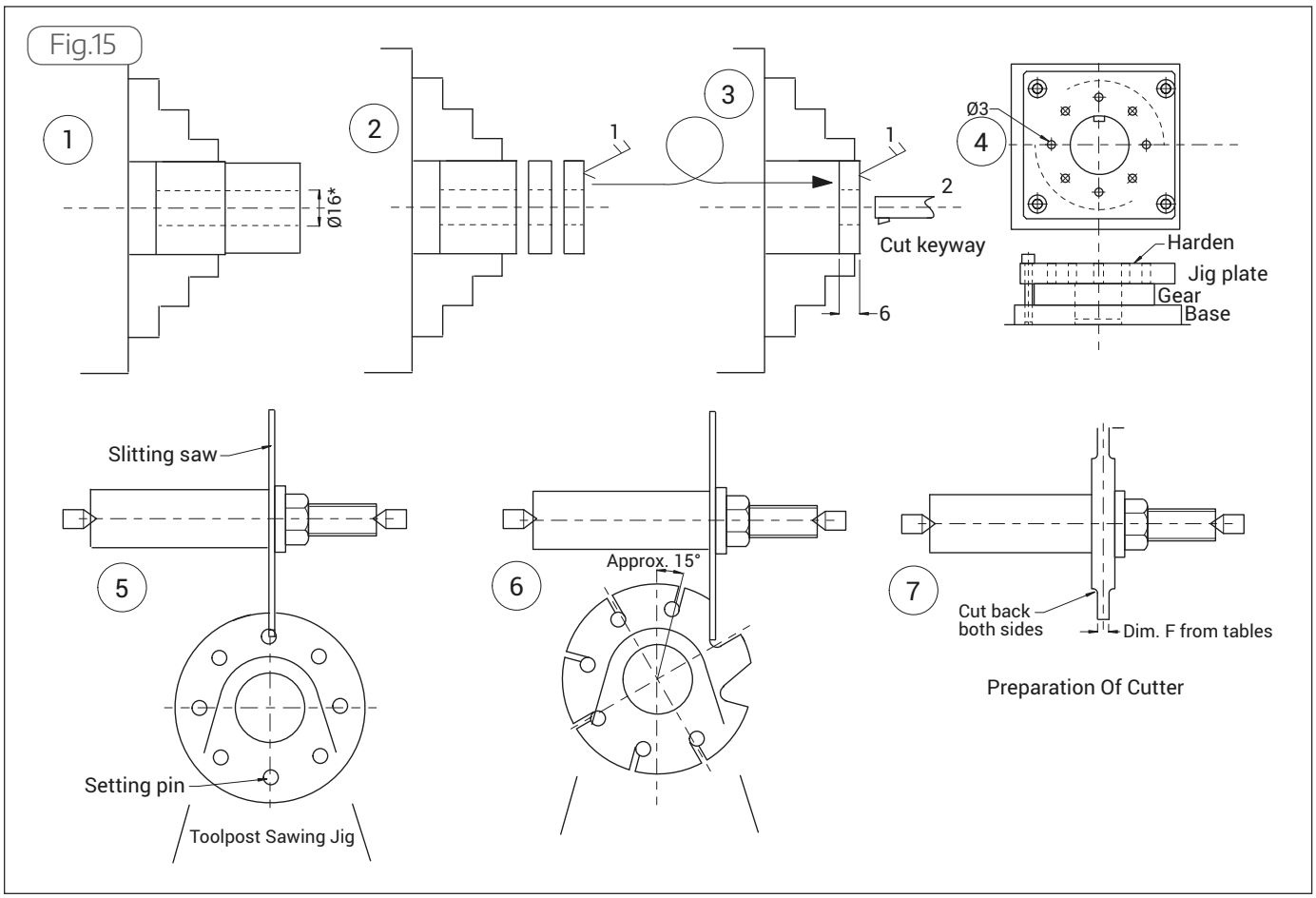
I am only going to give a brief summary of how to go about the fundamentals of the technical parts for designing and making cutters, cutters for cutters and then address the way the gear cutter machine is set up to achieve the best results. At first this will be confined to spur gear with straight teeth, which are by far the most commonly required gears. Later other forms of gearing will be explored.

Terminology

In making gears one will come across plenty of new terminology much of which does not make too much sense unless one is in the business or have some good knowledge of geometry. The first of these terms met is probably pressure angle.

'The pressure angle is the angle between the common normal and the interior common tangent to the kinematic pitch circles.'

And I am sure most of us are none the wiser. I would have a small problem with the way we model engineers usually express this angle as one might be able to see in **figure 14** the two angles shown do not quite match our notion that it is the ends of the contact touching a two tooth faces that give the angle. However, pressure angles are there as a guidance mostly about interference tooth to tooth and tooth strength. The angle of 20 degrees pressure angle appears to be the most popular choice amongst model engineers though there is 30 degrees, which applies mainly to marine turbine propulsion and 14 ½ degrees, which is possibly the most common industrial gear pressure angle. 14 ½ degrees may seem to be an odd selection, why not 15? The sine of 14 ½



happens to be very close to 0.25 (1/4) which made laying out the tooth geometry much easier in older drawing offices which did not have the benefit of computers. That really is all we need to know about pressure angles, unless you make clocks.

The second and third terms are pitch circle and diametric pitch which are merely convenient ways of expressing the circular line around which the pitching of the teeth has a specific value and this is dependent on the diametric pitch of the teeth, which is the number of teeth per inch of pitch circle. There is a kinematic significance as well but that is bye the bye. For plain spur gears these three terms will be nearly all one needs to know about gearing until one comes to their application in sizing and making gears. The rest of the terms will be found in table 1 and the little bits of arithmetic should be readily understood.

Gear Cutter Data

As the size of a gear diameter grows, so the shape of the tooth changes, for the common involute gear tooth the smaller gears have a much more of a curved flank than the bigger ones and though the big and small can run together they cannot be cut by the same cutter, unless we have hobs which 'generate' rather than cut a tooth. For single tooth cutting that means we have to have a selection of cutters to cover the full range from a rack to the smallest gear. That could mean we have to make some 8 cutters. In practice I would think it means making a cutter for the particular pair of gears being made and then adding others as time goes on.

Table 1, is employed to pick off the various dimensions of a form cutter, is based on David Lammas' article on gear cutting which appeared in July 1991 with imperial measurements. I have up dated this table and put into metric measurements. Now that may create a problem, as many of us use the favoured Myford lathe with its imperial dimensioned accessories and many of the rest of us do not want to change. However, the changeover is painless. In the table dividing the metric numbers by 2.54 on a calculator will give the imperial alternative.

The figures in the table refer to 1DP or 1 module. Diametric Pitch and Module are merely a convenient way of expressing the number of teeth on a particular wheel of given diameter and from it, other dimensions are derived. Therefore, one can have a gearwheel with a 2.5 inch diameter pitch circle with several differing numbers of teeth, that is one wheel could have 20 teeth, another 25 and yet another 30, which give 8, 10 and 12DP respectively. For Modules the numbers will be the inverted, 1/8, 1/10, and 1 /12.

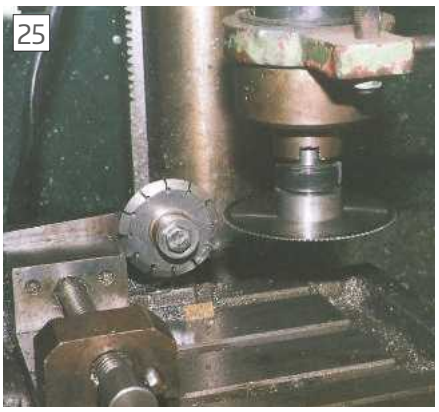
As one goes down the scale to the very small gears, the cutter blank becomes very thin with a tendency to bend during machining, therefore the blank should be at least 4mm wide but locally thinned at the cutting edge, or with a triangular shape, say 40-45 degrees, before thinning the extreme end to the width indicated in tables. For bigger wheels, the pin size of a cutter becomes uneconomic as we only require about 8 mm length by 5 mm wide of cutting edge instead of a disc some 50 mm diameter. I have only made one cutter of this sort of size and used plain mild steel as the cutting pin with an 8 mm piece of round silver steel, reduced with a step down to 6 mm and threaded, passing through the plain steel just ahead of the centre line. The threaded hole also had a short, shallow countersink. The pin was then made in the ordinary way to size and silver soldered locally at the silver steel countersink end, which at the same time hardened and tempered the cutting edge. Unusual, but it did all that was required.

Cutter Blanks

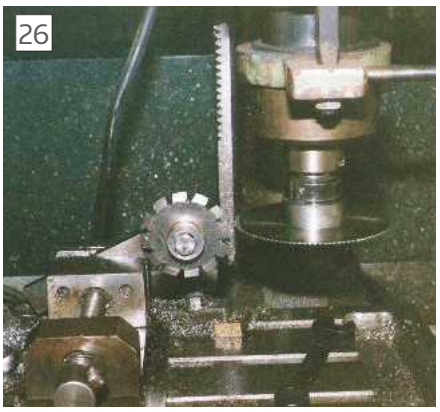
In gear cutting the size of the actual form cutters can, by and large, be a single diameter to cover the full range of gears to be made. Taking a cue from industrial cutters, 60 mm seems to be a popular size. Cutter blanks are made from a tool steel, with grade 476 (1.55% c, 12% Cr, 0.85% Mo, 0.28 V) , silver steel or gauge plate (pitho) being the ones I have used. The latter two will be familiar, but the tool steel machines well using sharp tooling.

Figure 15 illustrates the blank cutting procedure. In the photographs the three stages beyond the basic turning and parting off from the round bar are illustrated. The cutter, while in the lathe,

Using a hardened jig to guide drilling of holes in a cutter blank



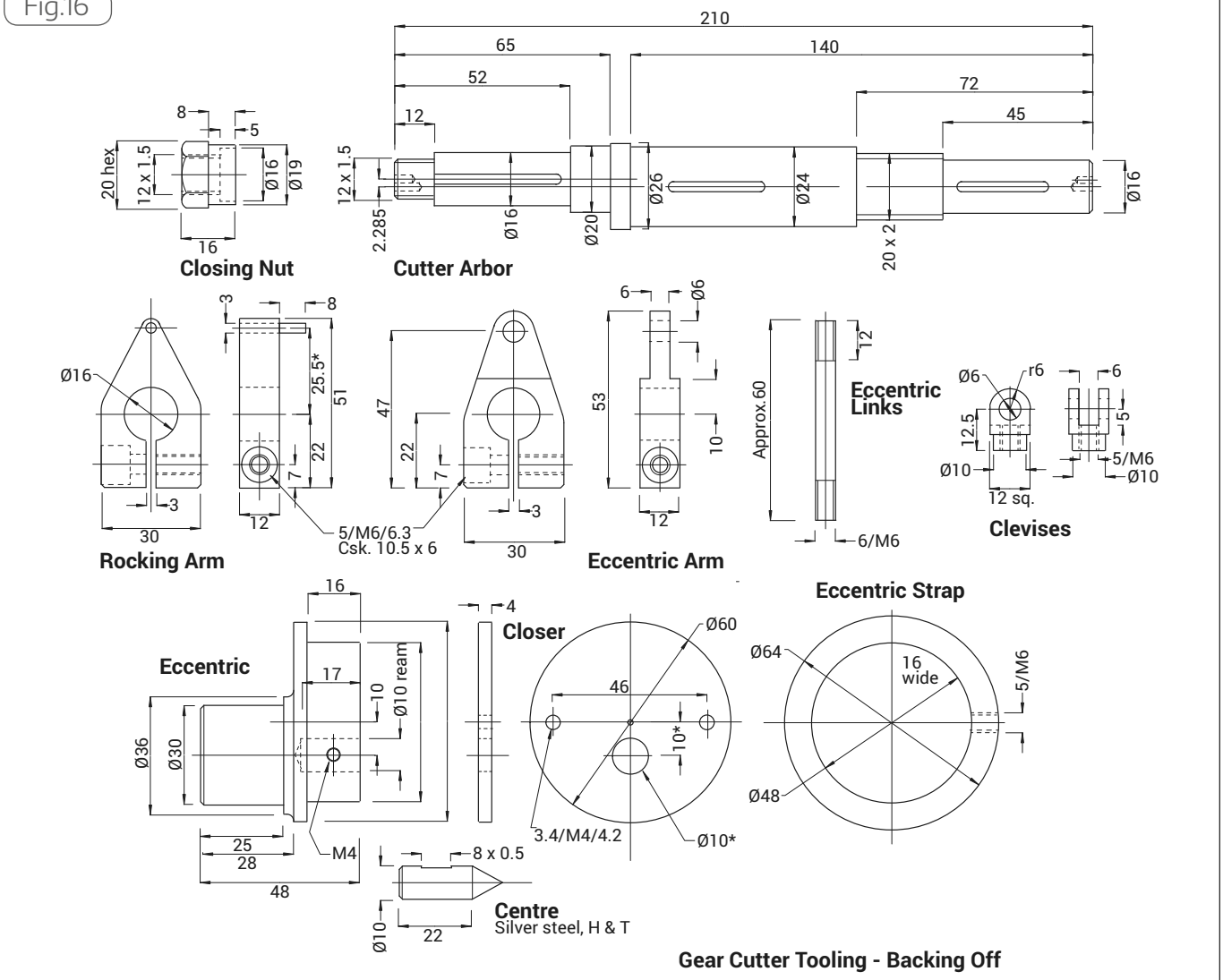
Making the first cut in a cutter blank



... and making the second cut

would be cut for a keyway with a special attachment, KeyCutter. The cutter then goes to a lock up shaft held on lathe centre in the divider of or a homemade holder which sits in the toolpost on the lathe centre line. In the **photo 24** the disc is mounted under a machined dividing plate, made on the same attachment as the ratchets, on the drill press with a ring of small holes drilled in at the base of every tooth. The actual disc lies under the dark coloured top disc which is hardened to resist cutting from the drill bit. In **photo 25** the cutter sits vertically on an arm jutting out from the vice, with the slitting saw cutting on the drilled hole centres. In following **photo 26** a second cut is made with the arm lifted upwards to present a new line and a good size gap. One can employ a dividing attachment which would help in getting the slots on the centre line of each of the holes in the ring. The second cut is off centre and leaves a slightly angled facing. The number of teeth is quite optional and while, at one time, I filled the blank with teeth, today I have usually half the number, usually about six or on bigger cutters eight, which requires an extra operation to open out the slot between teeth. ■

Fig.16

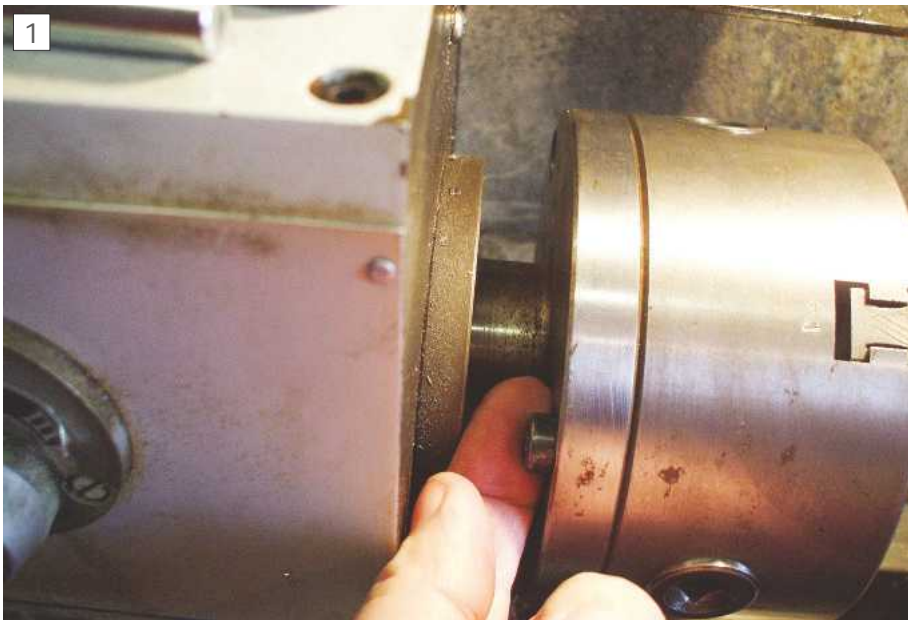


Chuck Fixings on Small Lathes

A flanged lathe spindle has several advantages over one with a screwed nose, but one drawback – access to the chuck securing nuts or screws. John Hinckley has a quick and easy solution to this common problem.

As part of the various machining processes involved in my latest project, I have had to change my lathe's three jaw chuck to a collet holder and back again several times. My lathe, a far eastern-built one of the 9 x 20 variety is fitted with a flanged spindle to which the chuck is mounted with three socket head screws. These are recessed into the spindle flange and are removed (and re-inserted, of course) with a short, slightly angled Allen key. Lose that and you're stymied, at least until you buy or make a replacement. Add to that the fact that there is precious little space behind the flange for old and increasingly non-nimble fingers, and changing chucks becomes a real chore, **photo 1**.

So I determined to do something about it. The solution was simple, if a little inelegant. It occurred to me that all I needed to do was extend the bolts such that the head was protruding beyond the rear face of the flange and change the head to hexagonal. Hey presto! Problem solved. I purchased some 8mm x 40mm hex head screws and set about shortening them to just under 30mm from under the head to the tip of the thread. (My local store didn't have any 30mm ones in stock.) Next turn up three sleeves to 12.5mm diameter, 10mm long and internally threaded 8mm and screw these onto the hex head screws, **photo 2**.



Extracting one of the original screws

Checked for fit and when I established that the bolt could be inserted OK, I Loctited the sleeve onto the bolt.

I replaced all three bolts and was now able to tighten the chuck with an ordinary 13mm ring spanner and apply significantly more torque in doing so as well as having something more substantial to grab hold of, **photo 3**. Purists will no doubt point to the fact that there are now three whirring bits of metal, just waiting to catch the unwary - to which I say "look at the other side of the chuck!" I would have preferred to have made the bolts as one piece and made them prettier, but that's a job for another day when the present project, or the one after, is finished. As a 'proof of concept' venture, it was successful. ■

Comparison between the original Allen screw and the replacement one.

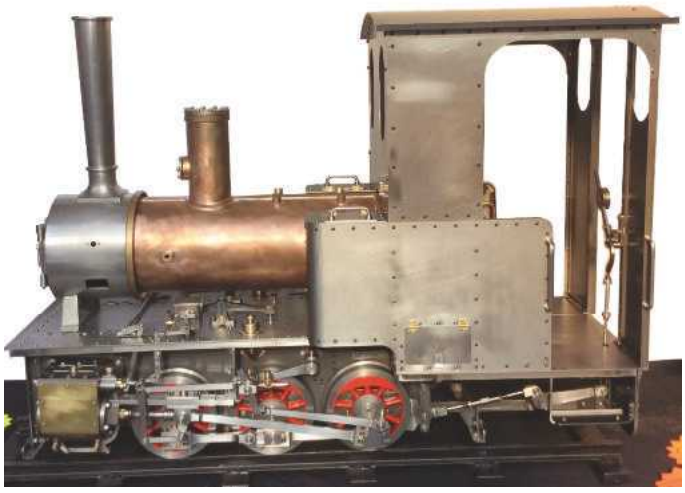
The new screws in position

POLLY Model Engineering Limited

Manufacturers of the famous POLLY kit-build 5" locomotives
Suppliers of drawings, castings, materials, parts, accessories, tools and books to the model engineering hobby.

Choose from the wide variety available and build a POLLY LOCO using the most basic workshop tools. Move on to more advanced projects as your workshop develops. Whether your interests are stationary engines, fine scale standard gauge locos, or narrow gauge, whatever your requirement, there is so much available from POLLY, from nuts and bolts to complete loco kits.

7 ¼" gauge GWR Collett Goods Doncaster 2016



7 ¼" Narrow Gauge Koppel 0-6-0 under development based on Ken Swan Design.






Polly Model Engineering Limited
Atlas Mills, Birchwood Avenue, Long Eaton
NOTTINGHAM, ENGLAND, NG10 3ND
Tel: +44 115 9736700 Fax: +44 115 9727251 email: sales@pollymodelengineering.co.uk
www.pollymodelengineering.co.uk

Scribe a line

YOUR CHANCE TO TALK TO US!

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

(Not so) Smart Machine

Dear Neil, my trusty Smart & Brown has gone wrong (again) due to the rather inadequate method of selecting back gear.

The idea was obviously recognised as not ideal by Smart & Brown as it was dropped from the Model A MkII version.

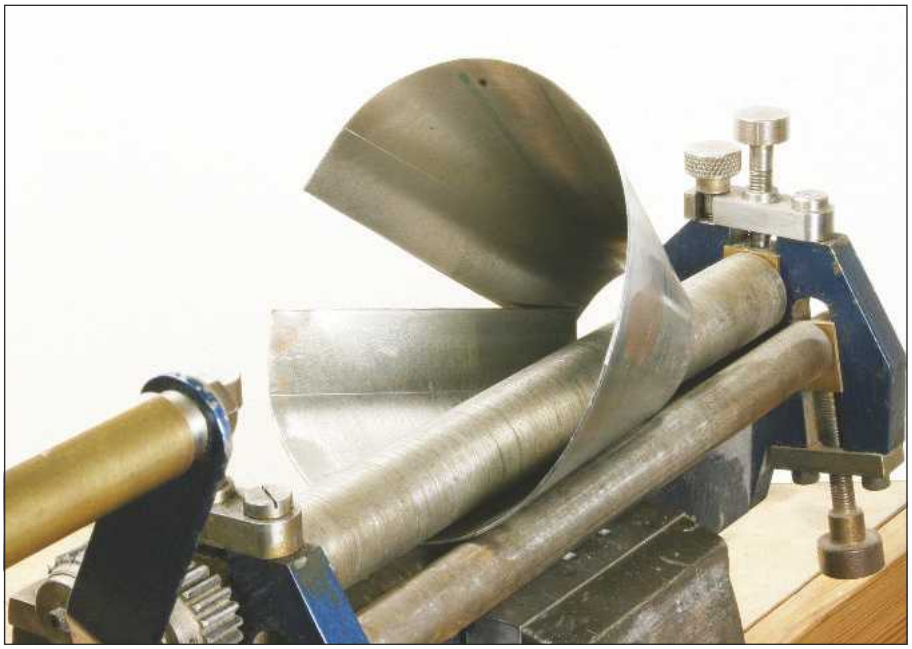
In order to effect a repair, I need to remove the spindle from the headstock in order to access the drive belt pulley where a spring loaded pin is located.

I would be grateful if any of your readers with knowledge of this machine can give guidance on how it comes out as, though all the gearwheels are free of the spindle, I still cannot remove it.

Alternatively, is there a specialist who could come to me as I obviously cannot take the three-quarters of a ton lathe to them.

Many thanks,
Pete Trow, Lyminge, Kent.

I only have a postal address for Pete, so if any readers have any advice to please write to or email me and I will pop them all in an envelope and forward it on, Ed.



Cone-fusion

Dear Neil, Marcus Bowman (MEW Issue 241) wrongly uses the height of the untruncated cone in his explanation of the development of the cone whilst he should have used the length of the sloping side.(this length is 107+49.3=156.3).When calculating the angle S he should have used the dimensions 156.3 and 49.3 which should have resulted in 127.8degrees. Compare these results with fig.5 and you will notice this figure is totally wrong.

If you do not believe my statements, try Marcus's recipe on what I call a Chinese Hat (i.e. an untruncated cone of low height and large diameter with a half cone angle in the region of 75 degrees).

Henk Slinggerland, The Netherlands

Stepper Motors

Dear Neil, I would like to find out a bit (a lot) about stepper motors, suitable drivers and power supplies.

I am a long time reader of ME & MEW but cannot recall a series in either.

My interest is in powering the lead screw of a very small lathe, the practical engineering is OK but I can't seem to find anything for a raw beginner about the motor. Maybe a starter kit is available.

It would need fast and slow movement for cylindrical turning, and quick movement for large movements, since there is no lead screw nut.

Can readers recommend any books or on line information.

Derek Sawyer, by email

Perspex Bonder Again

Dear Neil, Ken Willson has queried bonding techniques for Perspex. As noted solvent bonding is only useful for very accurate joints, however I have also needed more a forgiving adhesive. There is a "glue" for Perspex which contains some solvent but also some acrylic monomer which polymerises to solid transparent acrylic when exposed to light, especially UV (sunlight works very well). I have used it quite successfully for some years, look up "Acrifix IR 0192". It is available in Australia but I am not sure of the distributers in England, made in Germany I think.

Arthur Davies

And Again!

G'Day Neil,
Re: the scribe a line item on bonding Perspex, MEW no 246. D.J. Wilkinson mentioned the use of Tensol by the RAF.

I can confirm that the RAF were still using "Tensol" Cement in 2006. It was used for bonding the various items attached to acrylic parts on the Canberra, Nimrod and Jaguar aircraft (Cockpit Canopy, Navigation light covers, Compass corrector card holders etc). It is still available online sold as Tensol 12 by a number of Aerospace industry suppliers including Silmid Ltd.

Ian Kitson, Australia

Pillar or Packer?

Dear Neil, Peter Shaw`s pillar drill extension (issue 243) seems to be a useful conversion and , no doubt , a pleasurable project. Now, I accept that I`ve probably missed the point, but I think, in similar circumstances, I would just put a packing piece on the drill base.

Barry Bodiam. Sheppey, Kent

Socket to me

Dear Neil, Marcus Bowman's article on making a socket spanner for a car wheel security bolt was interesting and informative albeit far beyond the abilities of a low level non CNC pseudo engineer such as myself. I can only doff my hat in envy to anyone who can do things of that nature.

However, in case you've not been inundated with other potential solutions to the problem I might as well throw in my tuppence worth.

I'd be inclined to take one of the other wheel bolts to an accessory shop and buy a complete set of suitable security bolts with the included socket spanner, then drill the existing bolts, tap them with a left handed thread, make a matching bolt and remove the offenders by that method.

It might be more trouble than paying an exorbitant fee by a service station, but it's much more satisfying to cock a snook at them, and finish up with your own spanner for future.

Colin Porter, Blackpool

Ultrasonic Cleaner Tips

Dear Neil, just a point regarding ultrasonic cleaners. Often in my experience one needs to clean a small part and one is faced with filling the cleaner up with an expensive solvent or cleaner. I discovered if you put the part in an appropriate small container with the solvent, (I used an old 35mm film container) and then put that in the cleaner filled with tap water. The cleaning action still works. I would guess it would work with small metal containers, but probably not jam-jars!

It dawned on me today, as Basil Fawlty said "special subject the bleeding obvious" but some of us are slower than others, perhaps I am not alone.

Regards

Mike Matthews, by email

Electrical Safety

Dear Neil, regarding Ted Fletchers article on Power motor connections issue August 2016 Although I am must state Ted is regarded as a qualified and competent electrical engineer many are not.

I find this article a little cavalier in its approach.

We all have dabbled in electrics with both home and workshop but as I always say competence must be judged by experience knowledge and training.

I know my limits and from this have installed 3 phase inverted systems into my own workshop. To still dabble with single phase motors that take so much power and with all the complication of soft start and centrifugal switching is in my mind redundant.

However, we look back to your article and not only fault finding but repair. In the hands of an expert such as Ted this is all part of life but in the hands of your readership this may be this end of life.

Electrics and electrical engineering should be for experts the changing of delta wiring in motors and the subsequent earthing of components.

The workshop should be an example of all that is safe.

Also the workshop should be treated the same of any workplace with certificated examination on a 3-year cycle (IEE regulations) Now I should disclose my relationship with my comments I am a HSE consultant and also a model engineer.

I have grown up with respect for electrical engineering and all that goes before it.

Your article by Ted Fletcher I see no disclaimers and so I would expect that you take full responsibility for any future outcome in this respect of this article.

You imply that all your readers are competent.

Tony Hicks

I am very aware of issues around electrical safety, and I wouldn't want to encourage readers to take risks. I have printed this letter as I feel it never does harm to remind people to take care and work within their competence, but I would point out that the various machine tools in our workshops are equally capable of causing death or injury if misused. I invite readers to express their views on this issue, here or on the model-engineer.co.uk forum - Ed.

Another man and his lathe.

On reading the current MEW, I too have a South Bend Model A, a youngster, only made in 1956.

It once belonged to a well known optical company, so had lead a "quiet life" compared with many lathes in industry.

It came to me dismantled, and I had nothing to guide me in its reassembly.

It was soon obvious to me I had not got the space to install the motor as shown in the current MEW article. My first task was to make a robust table, with built-in aluminium drip tray. I purchased some Wonder-weld aluminium welding strip at an exhibition, and welded/soldered up the corners. This proved easier than I thought.

The motor supplied was a bit old and feeble, so a 1HP DC variable/reversing motor was obtained.

I built a column up the back to move the motor to a new position, the cam-lock belt tensioning device worked fine in the vertical plane instead of the horizontal plane as per original design.

The countershaft was also "past its best" and some chrome bar (scrap from local tractor workshop – ex-hydraulic ram rod) plus some phosphor-bronze bushes have since given trouble-free operation.

I have made many attachments for it, almost a subject in itself for an article, just one I felt worth mentioning. I made a 63 tooth gear, indexing from an old gear attached to the rear of the main spindle, and "shaving" each tooth. This was an old sleeve valve timing gear from a Bristol Hercules engine dug up at a local airfield. 63 is about half of 127 – the Imperial/Metric screwcutting conversion gear. The pitch error is so small as to be ignored. I have since obtained a 127 – but not used it (yet).

My SB has done many years work since these photos were taken – long overdue a new paint job.

A good friend of mine has a Smart & Brown Southbend look-alike. A very nice machine.

Brian

Camera Mod

Dear Neil, I've been getting MEW since it first started as a spin off from Model Engineer, which I've been getting since 1970.

I think that it's great that Ian Johnson was able to adapt the camera (MEW Issue 241) or his partner.

He states that it can't now be used on a tripod. I suggest that a threaded bush in the bottom of the grip would work, use a through hole in the bush to release the air. That would also permit use on a mono-pod. The other location would be to drill and tap one or both ends of the base 1/4" BSW parallel to the long axis. I would also suggest drilling and tapping a hole directly above the camera shutter release so that a cable or pneumatic release could be used when it's on a tripod.

Incidentally many plastics machine nicely with woodworking router bits.

Victor J Croasdale, Spring Valley, Illinois, USA

Westbury & Shute

Dear Neil, I read with interest the bits about Edgar Westbury in No 245.

I don't know how well known it is that the late author Nevil Shute wrote a book based on Edgar Westbury – Trustee from the Toolroom. This was published after the author's death. It is certainly an interesting book, and I think reflects very well on Edgar Westbury.

Best wishes, and many thanks for a treasured magazine.

Roger Hemp, by email

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

Write to The Editor, Neil Wyatt, Model Engineers' Workshop, MyTimeMedia Ltd., Suite 25, Eden House, Enterprise Way, Edenbridge, Kent TN8 6HF. Alternatively, email: neil.wyatt@mytimemedia.com

Adapting an imperial lathe to cut metric threads (or metric to imperial)

Peter Nicholson gives us his approach to translating between the metric and imperial systems.

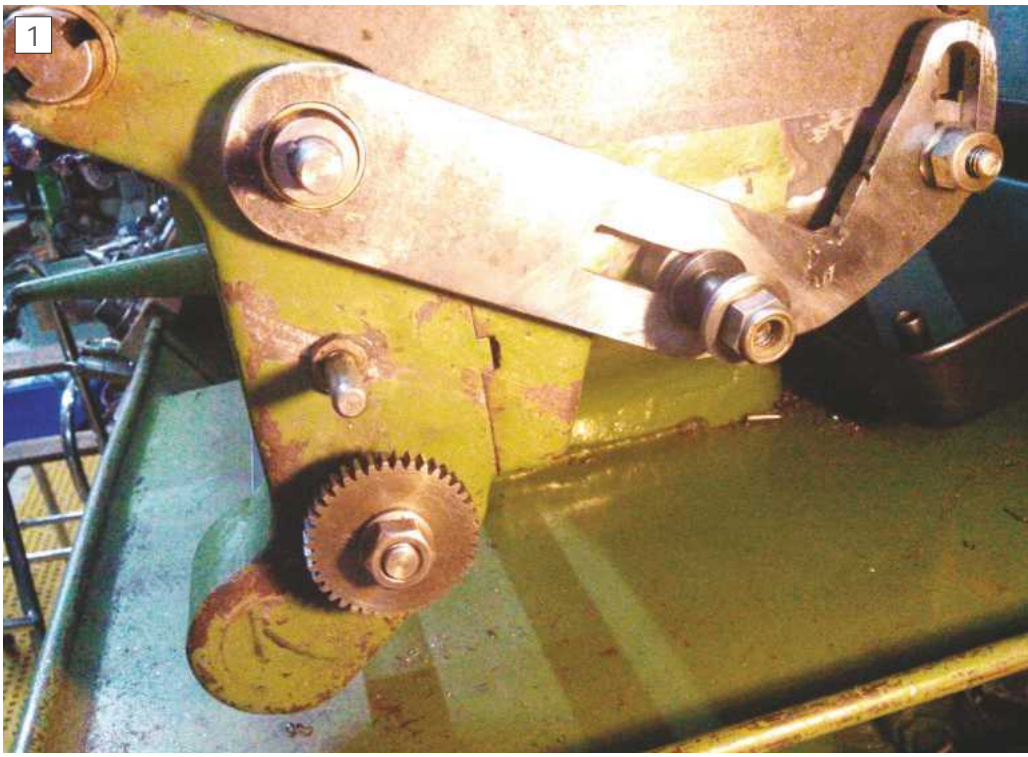
For some time, I have been interested in adapting my American MONARCH CK tool room lathe to cut Metric threads. Unfortunately, there is not much room in the gear train section on the left hand side of the headstock to use the 127/120 tooth compound gear required to give accurate metric pitches. What is usually done is to use a compromise compound gear of approximately half the size with 64/63 teeth. Besides not giving exact pitches, just dismantling the existing imperial gear train and replacing it with the 64/ 63 compound gear (which may need to be reversed 63/64 to give greater accuracy in some of the pitches) and setting the gears to mesh properly is a time consuming, awkward and oily business which needs to be done again when the job is finished.

The Monarch has both a FEED screw for power feed to the carriage and a LEAD screw for thread cutting. These are selected with a single throw over lever (just next to where the feed and lead screws emerge from right hand side of the Norton quick change gearbox), which engages either one or the other, (through identical cogs) so they cannot operate both at the same time.

For Imperial thread cutting, you read off the required Threads Per Inch (TPI) on the Norton quick change gear box, throw over the lever to engage the lead screw, and start thread cutting in the normal way by engaging the half nuts on the lead screw.

For cutting Metric threads, I decided to add a 127/120 gear train to the tailstock end of the lathe to connect both the lead screw and feed screw together, by attaching 40 tooth gears to their ends. This could be permanently set up to cut Metric threads. Thus for cutting Metric Pitches (P), the throw over lever is moved to select the feed screw to turn this gear train. This in turn would drive the lead screw from the tailstock end of the lathe, the speed of which has been changed by the new gear train to cut Metric Pitches.

All of the above required



- Extending the Feed Screw and Lead Screw shafts, so that the input driver and out driven gears could be added.
- Working out the theory
- Making a Banjo to mount the 127/120 tooth compound gear
- Making a cover for the new gear train.

Extending the feed and lead screw shafts required accurate holes bored in the end of each shaft, the making up two short spindles to hold the input and output gears and pinning the spindles to the shaft with roll pins.

In boring the shafts, I could have removed them and used the lathe to accurately centre and drill and ream the spindle holes. Since removing them would have been a large job in itself, I decided to drill them in situ using a well-known but a not very well appreciated technique.

After centre punching the shafts I started the lathe, set the lead screw turning and hand drilled the shaft with an electric drill, held as straight as possible parallel to the shaft. It was a slow job since the hole was about two inches deep and I used only one a drill for the job, the size of which was only a few thou smaller than the final hole (It was a 5/8 inch drill). The hole had a very slight initial taper, but within an inch was parallel sided, which suited me fine, as it made an easy start for the 16mm reamer and helped to keep it parallel. After the whole was reamed I inserted the 16mm spindle. I then checked for runout, but there was none. I repeated the procedure for the feed screw.

The technique relies on the fact that it is because the WORK that is turned not the

›

drill bit (although the drill can be turned as well). It would appear that turning the work or turning the drill would give the same result, but this is not the case. This is why holes can be drilled or bored accurately in a lathe

If when a drill turns, if starts to deviate off centre, the length of drill which fits into the newly drilled part of the hole, backing up and guiding the drill will easily overcome the flexural tendency of the drill to right itself and since the drill only cuts at its point, the rest of the drill will follow down the newly drilled section of the hole, getting further and further off the axis of rotation.

If however, the work is turning, any tendency for the drill to deviate off axis in a set direction can't happen. This is because as the drill is rotated in a circle, the radius of the hole being drilled at the tip of the drill will equal the amount of the deviation so after half a turn, there is no tendency for the drill to deviate any further and so it continues to stay on axis.

An interesting project using this technique could be a power driven, rotating drill press table, say with either belt or friction drive, for drilling deep holes.

For the screwcutting theory, there are two things involved, threads per inch (TPI) which is set using the existing gearbox, and the desired metric pitch (P) in mm.

From *Screwcutting in the Lathe* by Martin Cleeve, two formula are given:

(1) TPI = 25.4/ P (P is metric Pitch)
(2) TPI = 1/IP (IP is Inch Pitch

Now I wish to use 24TPI (or 1/24 Inch Pitch) to give a Metric Pitch (P) of 1mm.

To do this, I need to slow down the feed screw by means of gears, from the 24TPI selected, to give an effective 25.4TPI

Thus the effective TPI = 24 x 127/120 = 25.4

Equation (1) becomes 25.4 = 25.4/P thus giving the P = 1mm, as desired.

Or when expanded 24 x 127/ 120 = 25.4/P rearranging to leave 24 on the LHS by itself

24 = 25.5 x 120/127 x P = 24 /P

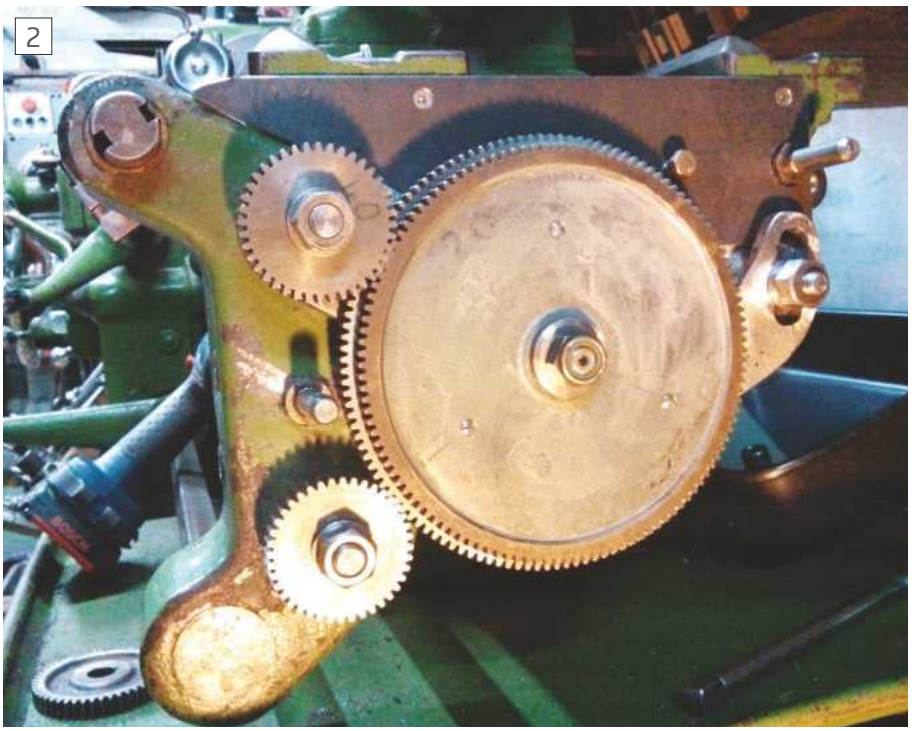
I have renamed the LHS of equation as "Lathe Threads per Inch" (LTPI) since when the lathe is set to cut 24TPI, it is actually cutting 25.4TPI

LTPI = 24/P

I have put this in table form. To use the table, if the required P is 2mm then select a LTPI of 12 to cut this pitch.

Or you can divide 24 by the required metric pitch in this case 2mm ie. 24/ 2 = 12. Thus selecting 12LTPI on your lathe gives this pitch.

In constructing the gear train, the formula used is used is Driver/Driven. If more than one set of gears is used then this repeats, i.e. Driver/Driven x Driver/Driven.


2


3

Only first and last gears and compound gears (gears on the same shaft) are used in gear calculations. All other single gears are idlers and do not count, as they are only used as fillers to help join first to last.

For the gear train, I used a 40 tooth gear on feed screw driving a 127/120 compound gear (Driven/Driver) in turn driving a 40 tooth gear attached to the lead screw.

Hence Driver/Driven = 40/127 x 120/40 = 127/120, slowing the rotation of the lead screw as required.

However, as can be seen from table 1, in order to get all the Metric pitches, I needed to replace the lead screw gear with a 48 tooth gear for some pitches. If I choose a 20LTPI, the Effective TPI now equals 20x48x127x 120/40 = 25.4 as before. In the table use the LTPI = 20/P column while using the 48 tooth gear.

Note that the pitch of the leadscrew on your lathe does not matter, since the adaptor does not involve any changes due to differing leadscrew pitches.

I chose 40 teeth for the feed screw gear only because I had it, and the available TPI from the Norton gearbox fitted the equation. Other gears can be chosen to fit your lathe. The only critical gear is the 127 since it is a prime number and the smallest gear which gives accurate conversion, (it being half of 254) and these are readily available.

I made up a table showing this. For the 40 tooth lead screw gear use LTPI=24/P and for the 48 tooth leadscrew use LTPI= 20/P

The Banjo, **photo 1**, to hold the 127/120 compound gear was made from a piece of scrap plate and all holes cut out by hand. I made a template out of thick card to ensure that I was able to engage, disengage and adjust the gears. One end of it pivoted around a small circular bush which fitted concentrically over the lead screw spindle

Table 1

LEAD screw gear 40 tooth	40 tooth on FEED Use LTPI = 24/P	48 tooth on FEED Use LTPI = 20/P
PITCH	**LTPI**	**LTPI**
.5	48	40
.75	32	X
1.0	24	20
1.25	X	16
2.0	12	10
2.5	X	8
3.0	8	X
4.0	6	5
5.0	X	4
6.0	4	X

and was attached to the end of the lathe with 3 screws. Doing this enabled the 127/120 compound gear to be meshed with one gear at a time, **photo 2**.

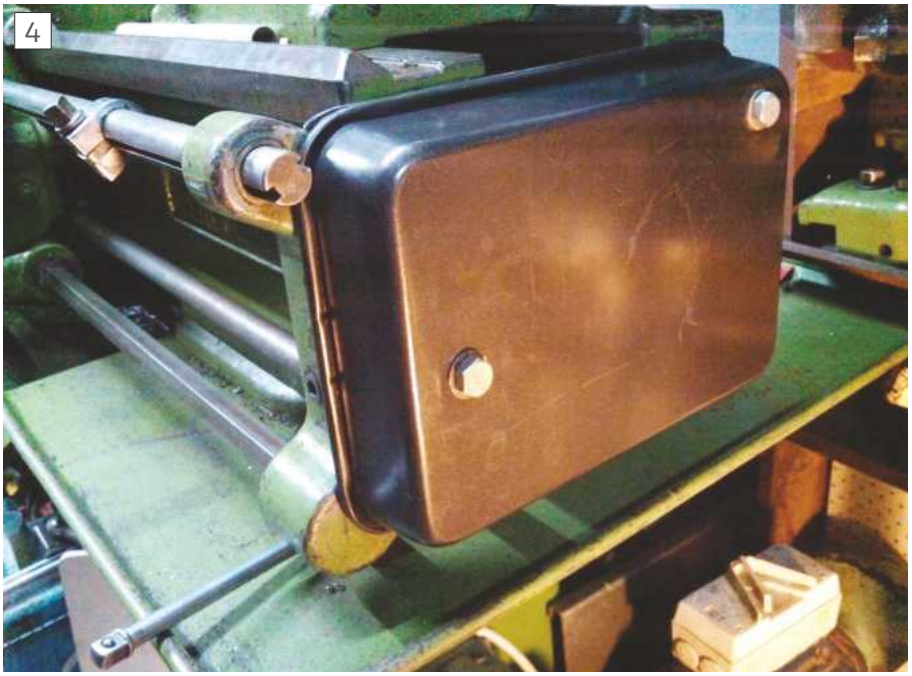
The gear guard was made out of a baking tin, **photos 3 & 4**, as I was unable to find anything more substantial of the size needed. I drilled and tapped the end of the lathe in two places and inserted pins which mate with tubes, mounted on the inside of the baking tin and held in place with short bolts through the cover which go into the tubes, which were internally threaded for a short distance. This enabled me to remove the guard easily, as I do not have much room to have a hinged guard. I screwed a bolt into the small back plate that was needed to cover the inside of the127/120 gear to hang the alternative gear, to prevent it getting lost.

When not using the converter I swing up the banjo, disengaging it from the feed screw.

This lathe has a number of unique features. In the photo there is a third shaft parallel to the lead and feed screws. This shaft has 2 clamps (or saddle stops) one on each side of the saddle which can be set in any desired position. When using power feed or when thread cutting and the saddle bumps into one of these stops, the shaft moves a single dog clutch in the headstock and disengages the drive. This means that threads can be cut up to a shoulder and nor is it necessary to disengage the power feed or the half nuts, since a lever on the shaft also provides forward and reverse of the feeds and leads. It is also useful for not hitting the chuck. A fourth shaft operates the lathe clutch.

Further there is a small lever on the side of the graduated cross slide which when turned, stops the movement of the cross slide at a fixed point either towards or away from the work as the cross slide handle is turned. The purpose of this is to facilitate thread cutting. The American way to cut threads is to advance the compound rest for each pass. The compound rest being set to half the angle of the thread to be cut. (i.e. Set at 30 degrees). So after each pass the cross slide is moved back to clear the thread, and the longitudinal feed moved to bring the tool back past the start of the work. All that is needed for the next pass is to add a little more feed via the Compound rest, and wind the cross feed in till it hits its stops.

Each 16mm spindle was turned down in my lathe. The easiest way to get the shafting running true in the chuck is to turn down a set of soft jaws to approximately the diameter of the shaft. If you have not got soft jaws and there is a slight amount of wear in the chuck and you can't get the shaft central, then loosen the jaws rotate the shaft a little then retighten. This often works, but if you still can't get the shaft to run true, half tighten the jaws, then tap the end of the offending jaw with the wooden shaft end of a hammer, then complete the tightening the chuck.


4

The lengths of the spindles were made longer than required - to be cut to length later. The 40 and 48 tooth gears that I used had 9/16-inch central hole and had a keyway slot. I turned spindle down to this diameter over about half its length, then after allowing for the width of the gear turned down the rest to 1/2 inch, diameter then threaded this section with a 1/2 Whitworth die which had placed in a holder which fitted into the tailstock.

Two washers were made. One to act as a collar, with a 9/16-inch hole, the other having a 1/2inch hole. Their diameter's were about a half the diameter of the smaller gear and they were about 1/8 thick. I then cut a keyway. With a small Woodroofe key cutter mounted in my milling machine. The speeds in RPM used for both the lathe and milling machine are the same. They both depend on the diameter of the work (or cutter) turned.

For those who use Imperial. Use the diameter of work in inches – say 1/2 inch. Multiply by 3. This gives the circumference approximately of 3/2inches. To change to feet divide this by 12. This gives which 3/24 or 1/8 of a foot. Now the maximum speed for HHS is 100 Feet/ minute, (for Carbide tips, 400 FPM), so invert and multiply out, i.e. 100x 8/1. Thus use a maximum chuck or cutter speed of 800 RPM. Then reduce a bit, and use approximately 600 RPM.

For those people who use Metric – say a 12mm spindle or cutter. Multiply by 3 to give the circumference of 36mm. Divide by 1000 to give Metres - 36/1000. Now the speeds for HHS is 30M/minute (120M/minute for Carbide). Invert 36/1000 and multiply by 30, ie. 30x1000/36. This gives 900 RPM, maximum. Therefor use approximately 600RPM.

The spindles were fitted to ensure correct mesh over their width, then cut to length. Both shafts were cross drilled and pinned with two roll pins.

Just as an aside, using the above calculation and using an absolute maximum speed of 40 FPM (1/10 of the maximum for carbide) and a carbide tool the hardest material can be cut, e.g. Allen cap screws, drill bits, even bearings for circlip grooves.

For those who do not have separate lead and feed screws, a possible solution exists. Use the existing single lead/feed screw to drive the previously described gear train (on the right hand end of the lathe) then, by attaching an identical threaded leadscrew (passing from right to left underneath the apron) driven by those gears The saddle could be engaged by means of a simple half nut on the bottom of the apron. As this half nut would only take threading loads it could be a single nut which could be moved to engage the second lead screw.

For those who need to adapt a Metric lathe to cut Imperial threads all that needs to be done is to turn the 127/120 gear the other way around. ■

MODEL ENGINEERS' WORKSHOP

SUBSCRIPTION ORDER FORM

DIRECT DEBIT SUBSCRIPTIONS (UK ONLY)

Yes, I would like to subscribe to *Model Engineers' Workshop*

☐ Print + Digital: £13.50 every 3 months

☐ Print Subscription: £11.25 every 3 months

YOUR DETAILS MUST BE COMPLETED

Mr/Mrs/Miss/Ms.....Initial .....Surname .....

Address .....

.....

Postcode ..... Country .....

Tel ..... Mobile.....

Email ..... D.O.B .....

I WOULD LIKE TO SEND A GIFT TO:

Mr/Mrs/Miss/Ms.....Initial .....Surname .....

Address .....

.....

Postcode ..... Country .....

INSTRUCTIONS TO YOUR BANK/BUILDING SOCIETY

Originator's reference 422562

Name of bank.....

Address of bank .....

.....

.....Postcode .....

Account holder .....

Signature..... Date .....

Sort code ☐☐☐☐☐☐ Account number ☐☐☐☐☐☐☐☐

Instructions to your bank or building society: Please pay MyTimeMedia Ltd. Direct Debits from the account detailed in this instruction subject to the safeguards assured by the Direct Debit Guarantee. I understand that this instruction may remain with MyTimeMedia Ltd and if so, details will be passed electronically to my bank/building society.

Reference Number (official use only) ☐☐☐☐☐☐☐☐☐☐

Please note that banks and building societies may not accept Direct Debit instructions from some types of account.

CARD PAYMENTS & OVERSEAS

Yes, I would like to subscribe to *Model Engineers' Workshop, for 1 year* (13 issues) with a one-off payment

UK ONLY:

☐ Print + Digital: £56.99

☐ Print: £47.99

EUROPE & ROW:

☐ EU Print + Digital: £64.95

☐ EU Print: £55.95

☐ ROW Print + Digital: £64.95

☐ ROW Print: £55.95

PAYMENT DETAILS

☐ Postal Order/Cheque ☐ Visa/MasterCard ☐ Maestro

Please make cheques payable to MyTimeMedia Ltd and write code V1001 on the back

Cardholder's name.....

Card no: (Maestro)

☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐

Valid from..... Expiry date..... Maestro issue no.....

Signature..... Date.....

TERMS & CONDITIONS: Offer ends 2nd December 2016. MyTimeMedia Ltd & Model Engineers' Workshop may contact you with information about our other products and services. If you DO NOT wish to be contacted by MyTimeMedia Ltd & Model Engineers' Workshop please tick here: ❑ Email ❑ Post ❑ Phone. If you DO NOT wish to be contacted by carefully chosen 3rd parties, please tick here: ❑ Post ❑ Phone. If you wish to be contacted by email by carefully chosen 3rd parties, please tick here: ❑ Email

POST THIS FORM TO: MODEL ENGINEERS' WORKSHOP SUBSCRIPTIONS, MYTIMEMEDIA LTD, 3 QUEENSBRIDGE, THE LAKES, NORTHAMPTON NN4 7BF

Please visit **www.mytimemedia.co.uk/terms** for full terms & conditions

CODE V1001

HURRY OFFER CLOSES 2nd DECEMBER 2016

PRINT + DIGITAL SUBSCRIPTION

- 13 Issues ***delivered to your door***
- ***Great Savings*** on the shop price
- ***Download*** each new issue to your device
- A ***75% discount*** on your Digital Subscription
- Access your subscription on ***multiple devices***
- Access to the ***Online Archive*** dating back to Summer 1990

PRINT SUBSCRIPTION

- ***13*** Issues ***delivered to your door***
- ***Great Savings*** on the shop price
- Save up ***to 23% off the shop price***

SUBSCRIBE TODAY

On the Wire NEWS from the World of Hobby Engineering

Garden of England Modelfest Saturday 10 December 2016

Richard Rundle has given me details of this event which should interest readers in the south-east, it is in support of a good cause, Demelza Hospice Care for Children who cover SE London Kent and East Sussex.

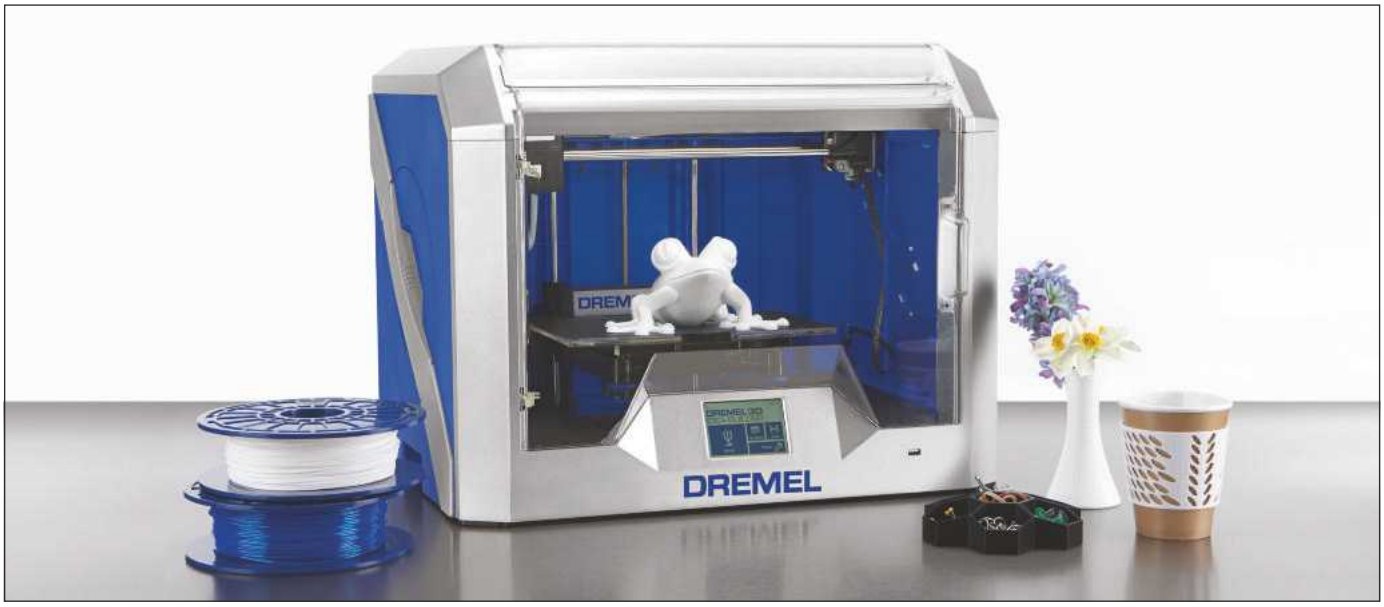
The show embraces the skills of those who construct Boats & Ships; Architectural models; Radio Control Trucks, earth movers and other vehicles; Dolls Houses & Miniature scenes ; Model Railways; Model; Meccano; Sci-fi figures; Military models; Model Engineering; Model aircraft; and much more.

The 'Modelfest' is at the Angel Centre, Angel Lane, TONBRIDGE, Kent. TN9 1SF from 10:30 to 16:30. Admission is £5 with accompanied under 14s free.

LazerBond

In the last issue we gave a price of £11.99 for LazerBond, apparently the correct price is £9.99. One reader contacted us asking about safety issues around the use of the UV LEDS; the LazerBond packaging does offer advice on the safe use of this item.

News from Dremel



There's lots of news from Dremel in the run up to Christmas. They are releasing three, four and 'five star' kits based around the Dremel 3000 multi-tool. The top of the range five-star kit features five versatile attachments alongside the Dremel 3000. As well as a line and circle cutter, multipurpose cutting kit and flexible shaft attachment, the kit also includes a detailer grip to offer increased control, as well as a shaping platform which enables users to sand and grind at both 45 and 90 degree angles. Presented in an aluminium toolbox, it also includes 75 different accessories. The tree-star beginner's kit starts at £39.99, while the four star is priced from £79.99 and the 5-star from £99.99.

The really big new, however, is in 3D printing. The popular Dremel 3D Idea Builder, launched last year, has been followed up with the 3D40 Idea Builder which has integrated software, WiFi connectivity and a full colour touchscreen. With one of the largest build platforms available, the Dremel 3D40 gives the flexibility to create even bigger objects with a combined print resolution of 100 Microns enabling printing at a high definition. Printing has got even faster too and, printing at a range of just +/- 1mm, means it is ideal for projects that require both intricacy and speed.

The 3D Idea Builder has increased connectivity and can print objects either by direct link to a computer or via a USB stick. The new model also comes with Wi-Fi compatibility, allowing users to monitor their build and interact with the 3D40 remotely too; so it is simple to check the temperature, time remaining and slice layer, as well as being able to cancel and pause printing and all without having to hover over your printer to know what stage it is at.

The Dremel 3D40 Idea Builder costs £1,099, and is available from October 2016 from retailers and the Dremel online shop.

We hare hoping to feature the 3D40 Idea Builder soon in a series looking at using 3D printers in depth.

For more details of all the Dremel multi-tool kits and 3D printers, visit **www.dremel.co.uk**.

Mtroniks
electronics innovation

25 years of know how

DCi-75 (inc. Handset)
Brushed Loco speed controller
FROM £119.99
Available as 12V, 24V or 48V
Forwards & Reverse
100% Waterproof!
True traction control!

DCi-120 (inc. Handset)
Brushed Loco speed controller
FROM £199.99
Available as 12V, 24V or 48V
Forwards & Reverse
100% Waterproof!
True traction control!

DCi-250 (inc. Handset)
Brushed Loco speed controller
FROM £314.99
Available as 12V, 24V or 48V
Forwards & Reverse
100% Waterproof!
True traction control!

digiSound602
Real sound, 2 x 50W module
£199.99
Available sounds:
Class 08, Class 20
Class 31, Class 37
Class 40, Class 42
Class 50, Class 55
Class 66, Class 67
Generic Perkins

Special offer!!
Order any digiSound602 sound module at the same time as the DCi-120 Loco controller and get the sound module for half price!!

Loco Handset
Full control of direction, speed and sound
£44.99
For use with any DCi controller

Please feel free to call us for advice or to discuss your requirements!
01943 461482

24 Month Warranty on all Mtroniks electronic products

Mtroniks Loco products are available direct from Mtroniks, either over the phone or through our website

High quality speed controls designed and manufactured since 1987 in the UK

Mtroniks
electronics innovation
41A Ilkley Road, Otley, LS21 3LP, UK
Tel: +44(0)1943 461482 Fax: +44(0)1943 468335
www.mtroniks.net
enquiries@mtroniks.net
www.facebook.com/MtroniksLtd
Twitter : @mtroniksteam

Machining and Building the Acute Tool Sharpening System

Over the last two issues, John Ashton described how he built this versatile sharpening system from Eccentric Engineering's kit.

Unfortunately, several photos, numbers 22 to 28 were omitted between the two instalments, so we have included them here:

Top plate

Machining outer diameter of workhead

Parts requiring matching holes

Assembled and reamed

Note position of alignment hole

Parallel links

Link joiner

A Miniature Belt Sander for your Lathe

This step-by-step guide from Mogens Kilde explains this a useful addition for any workshop.

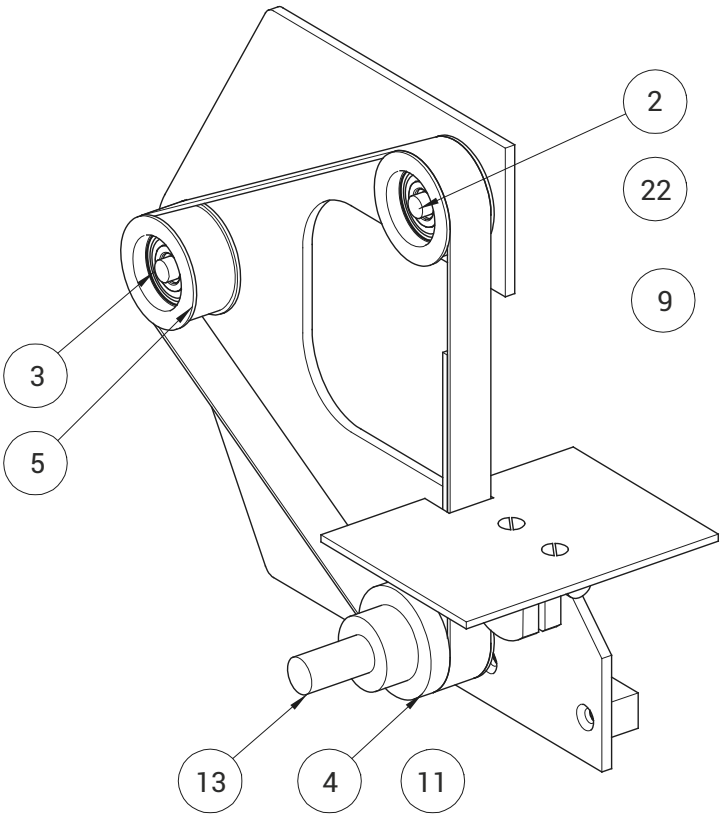
In this article I'll describe how I made a small belt sander attachment for my bench lathe. For the entire article please make reference to the general arrangement, **fig. 1**.

The first part that I made was the main frame for the tool, **fig. 2**.

The frame was made from a 3.0mm mild steel plate. The layout of the outer contour as shown in the drawing was marked out, and also the positions of all holes where marked out and centre punched, **photo 1**.

Please note that the position of the 2 counter sunk 4,0mm holes, should be placed according to the distance from the underside of your cutting tool, and the centre point of the lathe. In my case the measure from the cutting-tool base and the lathe centre was 11.5mm.

Fig.1



Component List		
I.D.	Qty.	Name
1	1	Sanding belt 13 x 451mm
2	3	Shaft
3	3	Bearing 608Z
4	1	Driving wheel
5	2	Belt wheel
6	1	Tool main frame
7	1	Tool holder
8	1	Belt back plate
9	1	Work plate
11	1	Work plate adjusting bracket
12	1	Work plate adjusting bar
13	1	Tool drive shaft
14	1	M3 x 10
16	2	M4 x 10
17	4	M6 x 20 hex. ch.
19	3	Washer
22	2	M4 x 10 c/s
23	2	M3 x 10 c/s

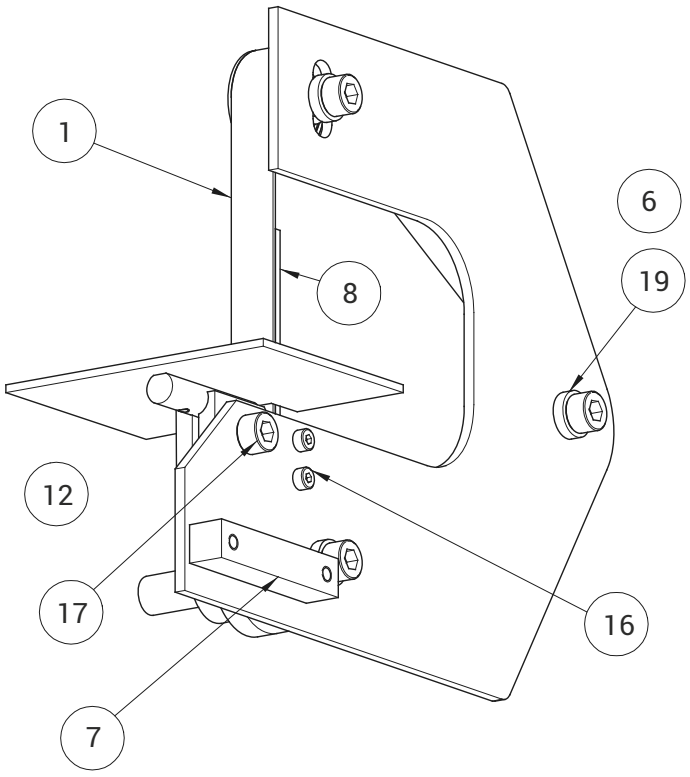
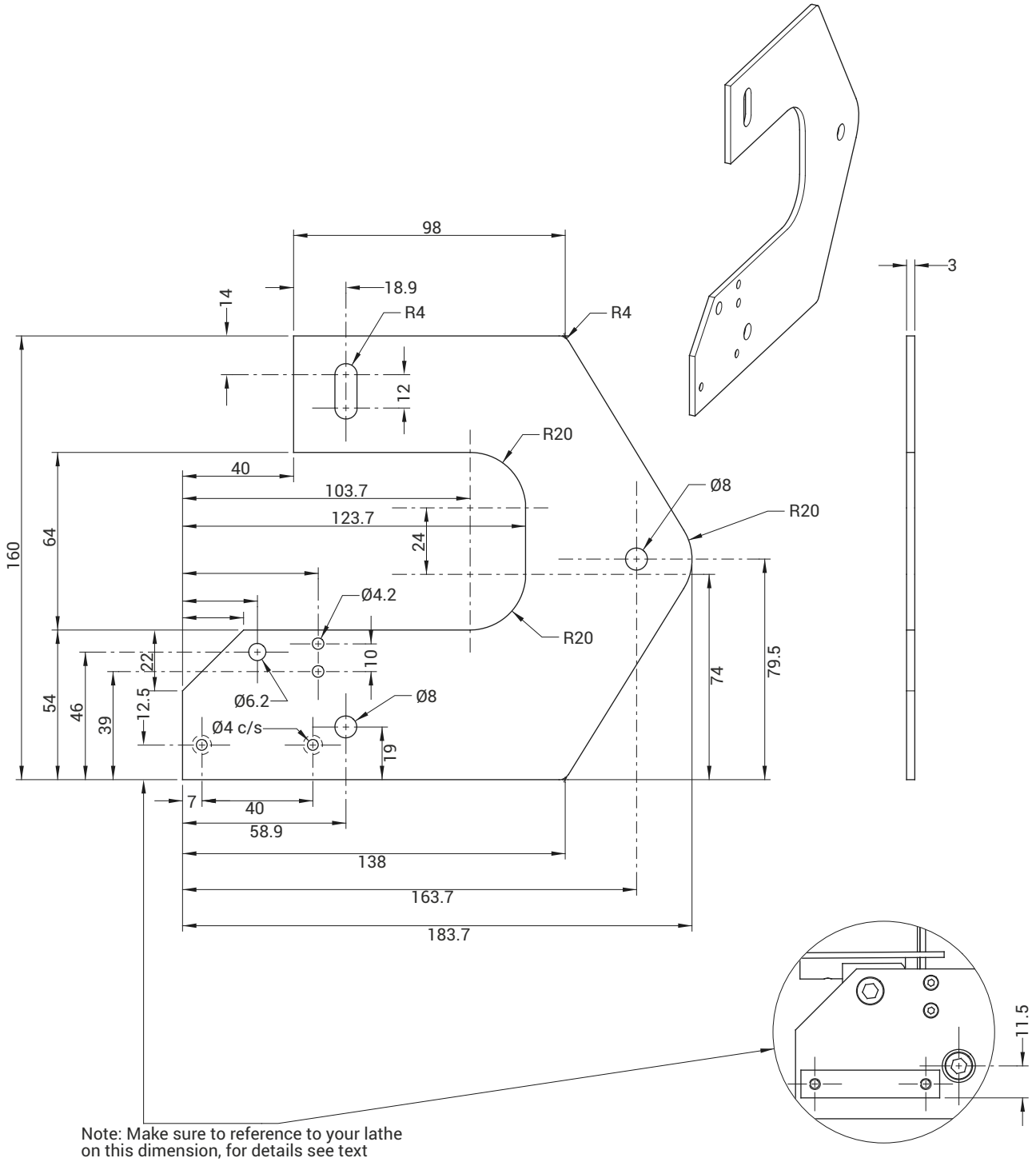
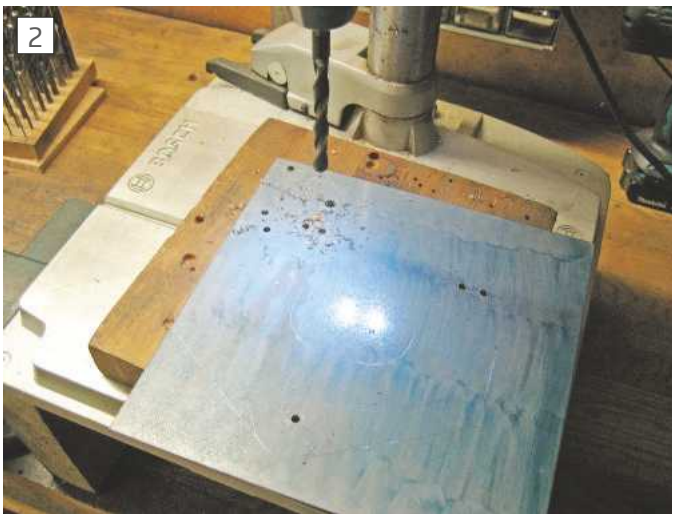


Fig.2



Tool Main Frame

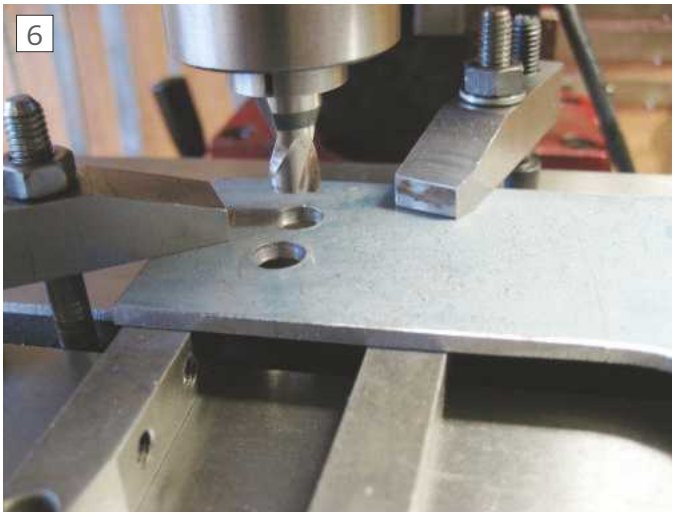


Next job, I drilled all holes, remember always to use a centre drill first before drilling to final dimensions, **photo 2**.

After deburring all holes, the next job was to cut out the contour of the frame plate this was done using my band saw, **photo 3**.

After the rough cut out, the outline was finished using appropriate files, **photo 4**.

Next the frame was taken to the drill press and the two 4mm holes were counter sunk, **photo 5**.

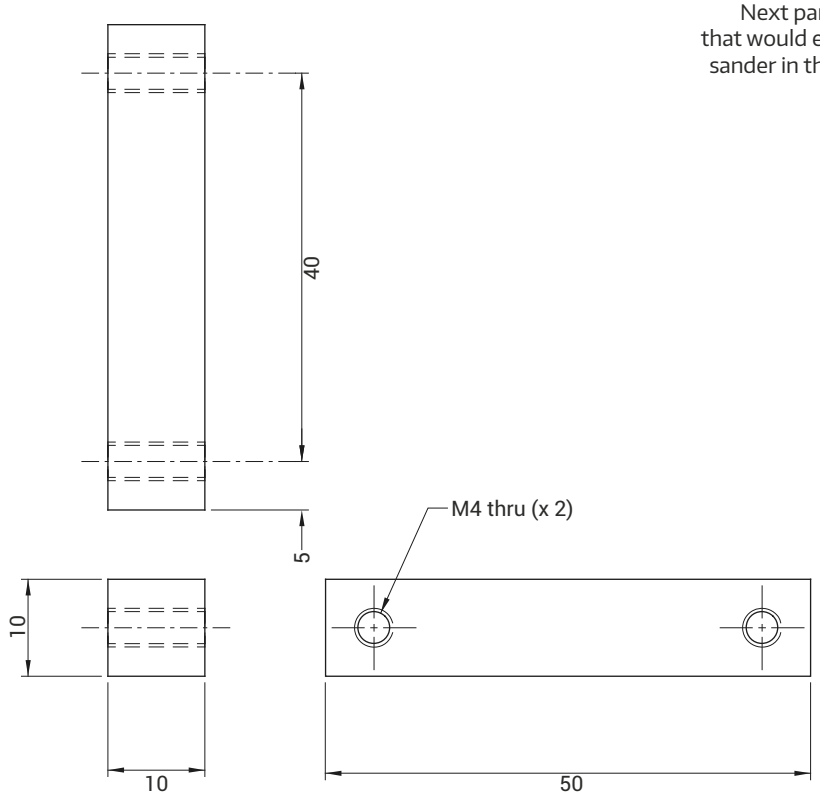


To finish the frame plate the work piece was placed onto the bench mill and I could mill out the material between the upper two Ø8mm holes, and this way form the 8x12 slot, **photo 6**.

After going over the whole part with emery cloths and a sanding pad, the frame was finished, **photo 7**.

Fig.3

Next part that I made was the bar that would enable me to hold the belt sander in the tool holder of my lathe.



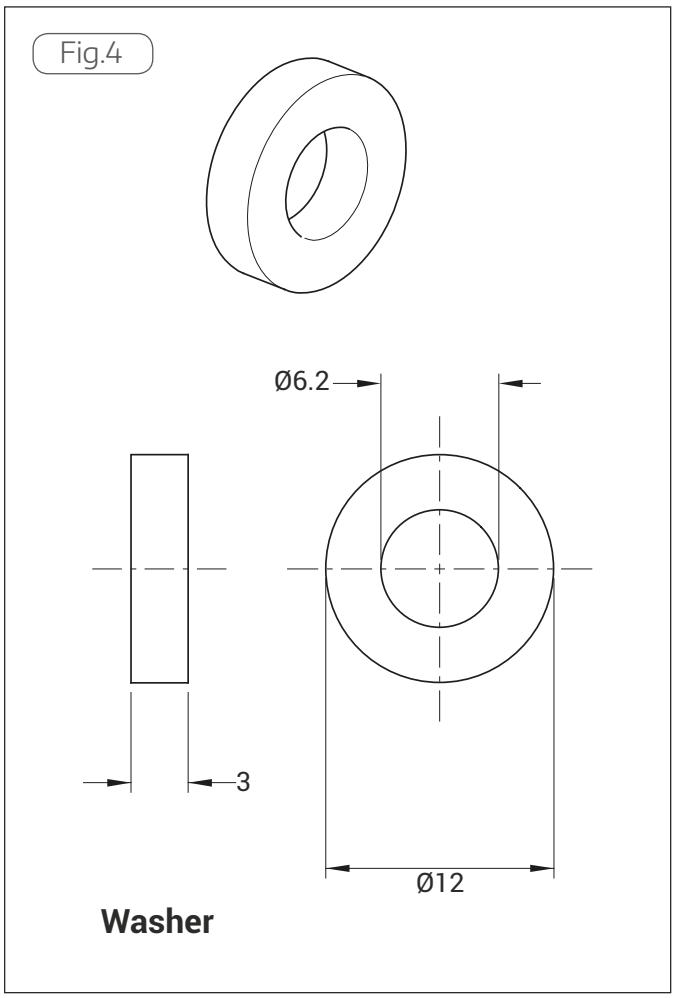
Tool Holder

This part was made from a 10x10mm cold rolled steel. I cut the piece a little over size, **photo 8**.

The part was placed in the bench mill, and after locating the zero point, the tapped holes were drilled and tapped, **photo 9**.

The tool holding bracket was mounted to the main frame, **photo 10**, and I was ready to go on to next set of parts.

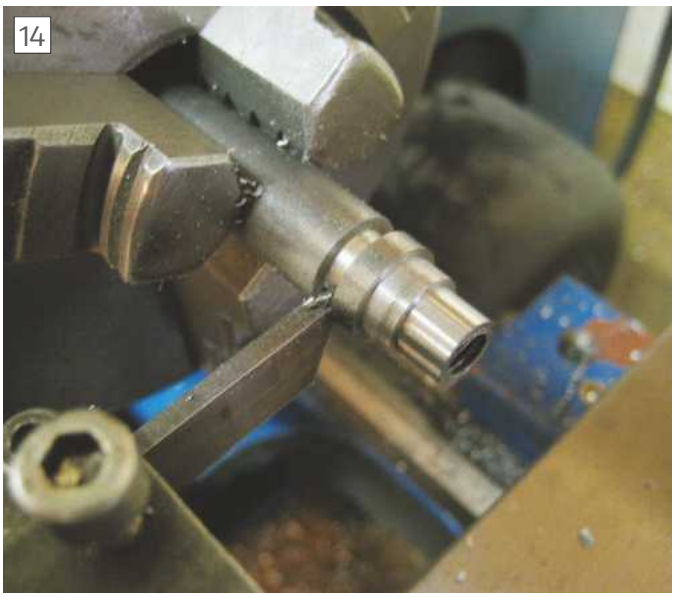
The washers were made from 12mm free machining steel and their job is supporting the shaft for the driving wheel and the two belt wheels, **photo 11**.



These parts were three washers, fig 4.

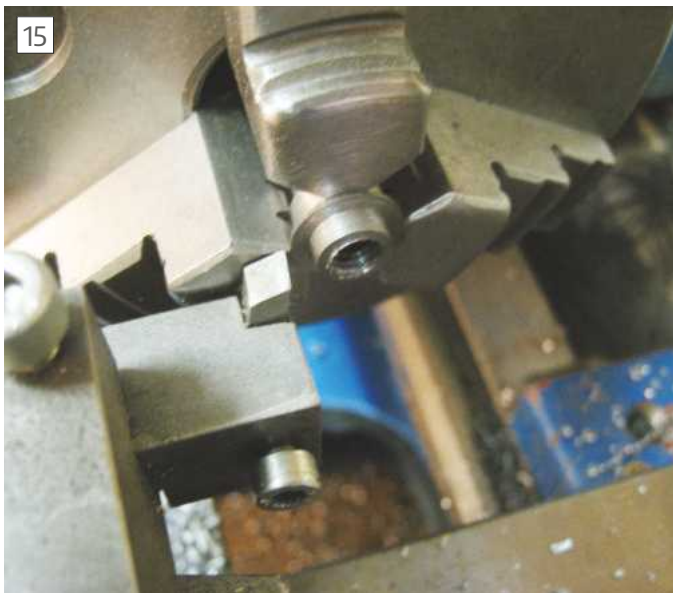
Making these washers was a simple drill and cutoff operation on the lathe, **photo 12**.

The shafts were made from 12 free machining steel. First job was to drill and tap the M6 tapped hole, **photo 13**.



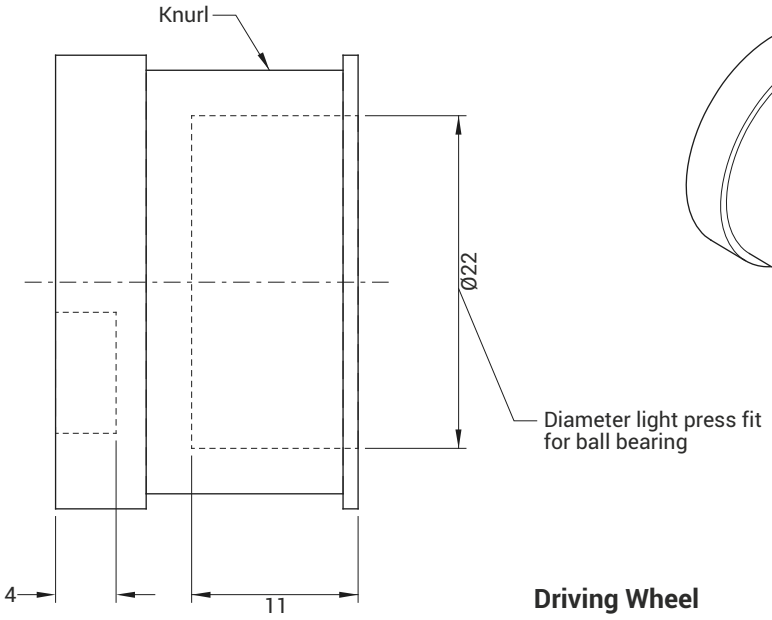
After turning down the shaft according to the drawing, I paid special attention to the nominal 8mm diameter, **photo 14**.

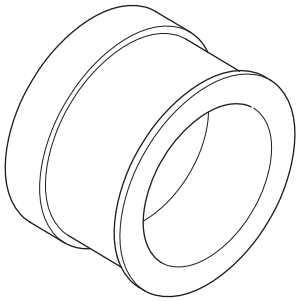
This measurement should be made as close as possible to 8.02mm as I would like to make a light press fit for the ball bearings.



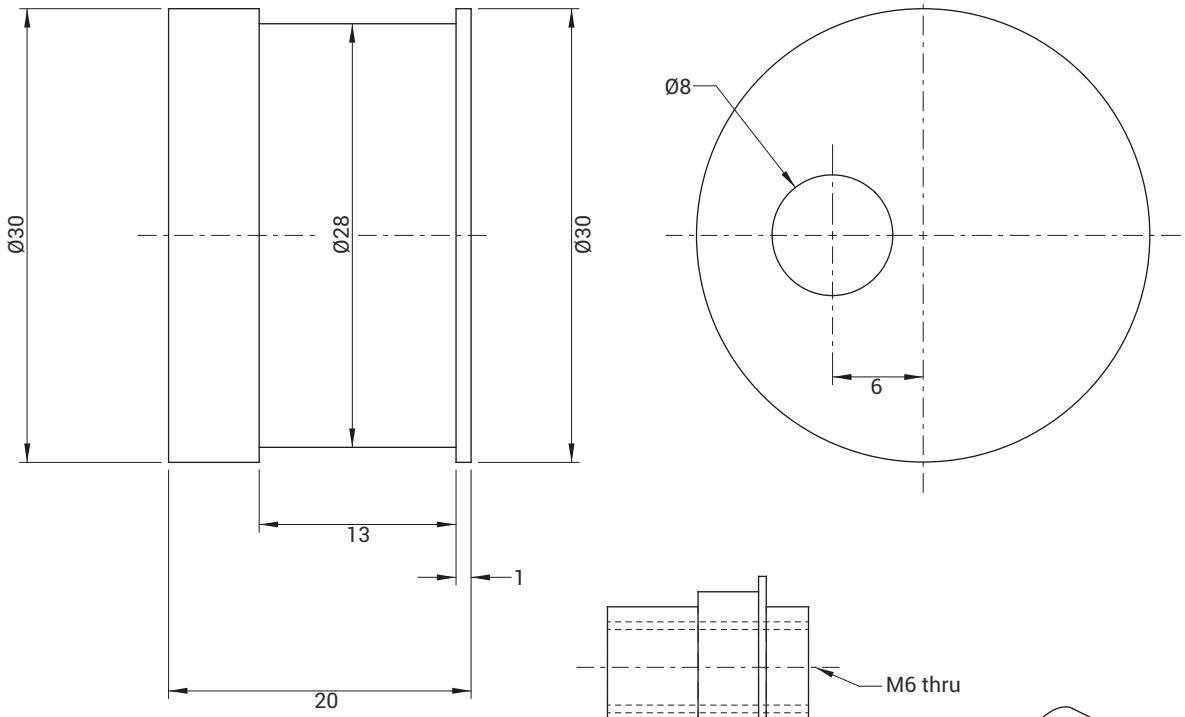
Next the parts are cut off, turned over in the chuck and the short 8mm section was turned, **photo 15**.

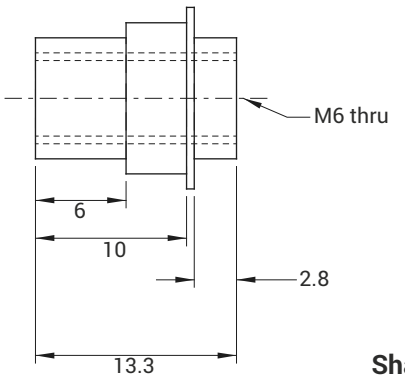
Fig.5

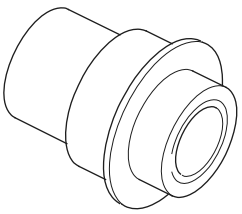




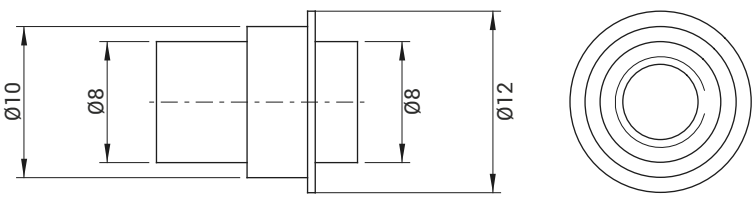
Driving Wheel







Shaft



MODEL ENGINEERS' WORKSHOP CLASSIFIED

Remap

making things possible

Remap is a charity that helps children and adults with disabilities to achieve greater independence and enjoyment of life's opportunities.

Our volunteers make special one-off pieces of equipment and everything we do is given free to our clients.

Join us and use your skills to help children and adults

Find out more at www.remap.org.uk

email: volunteer@remap.org.uk

or telephone 01732 760209

Registered Charity Number 113766

HOME AND WORKSHOP MACHINERY

Genuine Used Machines & Tooling

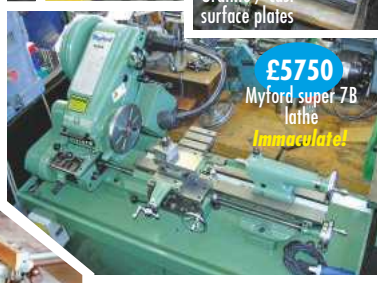
144 Maidstone Road, Foots Cray, Sidcup, Kent DA14 5HS

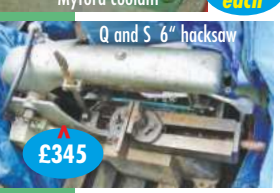
Telephone: 0208 300 9070 - Evenings: 01959 532199 - Facsimile: 0208 309 6311

www.homeandworkshop.co.uk • sales@homeandworkshop.co.uk

Opening Times: Monday-Friday 9am-5.30pm - Saturday Morning 9am-1pm

10 minutes from M25 - Junction 3 and South Circular - A205





MYFORD GENUINE PARTS
Running out fast!
Purchased from Nottingham
*Check the **web site** for full list!*

NOW ARRIVED!

- Bridgeport mill
- Harrison M300 lathes
- Sajo (Sweden) VRF 52M vertical mills
- Ajax AJT1 mill
- Colchester Triumph lathe
- J & S 540 grinders
- Startrite 18-S-10 metal bandsaw
- SIP pedestal spot welder
- Manual forklifts
- Surface tables
- Warco surface grinder
- Box and pan folder + more!

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

DISTANCE NO PROBLEM! • DEFINITELY WORTH A VISIT • ALL PRICES EXCLUSIVE OF VAT

Just a small selection of our current stock photographed!

We are currently seeking late 'Myford Super 7B' & 'Super 7 large bore' model lathes!

SHIPPING WORLDWIDE

New even easier to use Web site!

CHESTER
Machine tools

Come and visit us at our Winter 2016 Open Week

5th - 9th December at our Hawarden showroom, CH5 3PZ.

Orderline: 01244 531631

DB7VS Lathe
300mm Between Centres
180mm Swing Over Bed
£699

Stand Included

Craftsman Lathe
570mm Between Centres
300mm Swing Over Bed
£2,145

D13 Drilling Machine
13mm Drilling Capacity
0.25kW Motor
600-2500rpm Spindle Speed
£90

Century Mill
22mm Millling Capacity
600x180mm Table Size
MT3 Spindle Taper
£999

Stand Not Included

626 Turret Mill
20mm Millling Capacity
660x152mm Table Size
R8 or MT3
Spindle Taper
£1,533

H80 Band Saw
Horizontal Band Saw
85x85mm Rectangle Capacity @ 90°
90mm Round Capacity @ 90°
0.4kW Motor
£158

Milling Collet Set

Model	Stock Code
MT2 Metric	003-101
MT3 Metric	003-102
MT2 Imperial	003-104
MT3 Imperial	003-105

£90

4 Jaw Independant Chucks

Size	Stock Code	Price
80mm	011-101	£60
100mm	011-102	£75
125mm	011-103	£84
160mm	011-104	£127

5pc Indexable Lathe Tool Sets

Shank	Stock Code	Price
8mm	031-521	£43
10mm	031-522	£45
12mm	031-523	£58
1/2"	031-503	£58

Boring Tool Sets

Taper	Stock Code	Conn.	Tapping	Diameter	Tool Size
MT2	001-400	1 1/2"x18TPI	M10	50mm	1/2"
MT3	001-401	1 1/2"x18TPI	M12	50mm	1/2"
R8	001-402	1 1/2"x18TPI	7/16"	50mm	1/2"

£70

10pc Angle Set

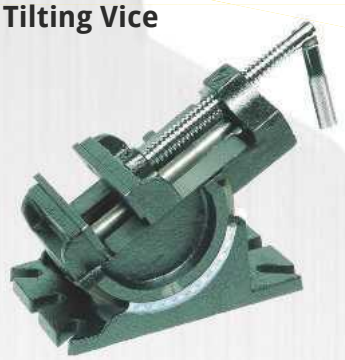
Stock Code
081-742

£39

4" Hobby Tilting Vice

Stock Code
062-127

£45



"... most competitive prices in the UK!"

www.chesterhobbystore.com
sales@chesterhobbystore.com

Chester Machine Tools, Clwyd Close
Hawarden Industrial Park, Hawarden
Chester, CH5 3PZ